

**A PARADIGM ANALYSIS OF ECOLOGICAL SUSTAINABILITY:
THE EMERGING POLYCENTRIC CLIMATE CHANGE PUBLICS**

by

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A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Energy and Environmental Policy

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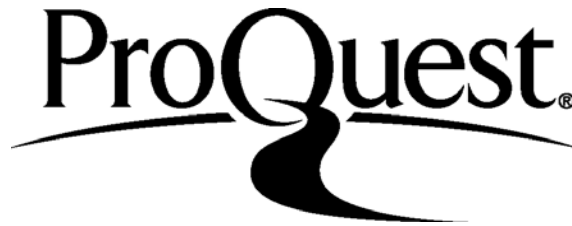
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THE EMERGING POLYCENTRIC CLIMATE CHANGE PUBLICS**

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ABSTRACT

Climate change poses significant complications to the development model employed by modern societies. Using paradigm analysis, the dissertation explains why, after 21 years, policy failure haunts the field: a key impediment is the unquestioned assumption that policy must adhere to an economic optimality principle. This results in policy models which fail to uphold sustainability, justice, and equality due to an emphasis on economic growth, technology, and technical and bureaucratic expertise. Unable to build consensus among low- and high-carbon economies, and searching for what one economist has called an oxymoron – “sustainable growth” (Daly, 1997) – the policy process has foundered with its only international convention (the Kyoto Protocol) having lost relevance.

In the midst of this policy failure, the dissertation offers and defends the premise that alternative strategies have emerged which signal the prospect of a paradigm shift to ecological sustainability – a paradigm in which social change takes place through commons-based management and community authorship in the form of network governance and where sustainability serves as governor of growth – something unavailable in an optimality-guided world. Especially, a strategy of polycentricity is discussed in detail in order to elucidate the potential for a paradigm shift. This discussion is followed by an evaluation of two innovative concepts – the Sustainable Energy Utility and the Solar City – that might fit the polycentricity strategy and bring forth transformative change. The dissertation finds considerable potential rests in these two concepts and argues the critical importance of further development of innovative approaches to implement the ecological sustainability paradigm.

Chapter 1

INTRODUCTION

In his seminal work on energy development and energy policy responses, Amory Lovins urged for the explicit consideration of a model that outlined two potential pathways for future development (Lovins, 1976). One, termed the ‘hard’ path of energy development, was considered the pathway of 20th century energy development, characterized by inflexibility, large-scale deployment of energy generation sources, the necessity and desirability of expert and bureaucratic acumen, and abundance of cheap electricity (Lovins, 1976). Shocks to the energy system, however, contributed to the realization that the hard is brittle, fragile, oppressive, and weak (Lovins & Lovins, 1982). The other part of the model is a ‘soft’ pathway of energy development, characterized by elements such as adaptability, diversity, flexibility, sophistication, parsimony, community, restraint, and artisanship (Lovins, 1976). The notion that the two paths could be pursued at the same time, Lovins dismissed as ‘spherical nonsense’ (Lovins, 1977).

Lovins’ inquiry began with the question ‘what is the path not taken?’ Understanding energy development in terms of a ‘paradigm’ – a constellation of shared values and solutions (Kuhn, 1970/1996) – this question directs attention to the possible need to ‘shift’ into a new direction. Indeed, the push for soft path energy development in response to the energy shocks of the 1970s contributed to an enhanced understanding of concepts such as energy security of price and supply, effects of environmental regulation on market dynamics, and the level of government

involvement in energy development. To an extent, these efforts in response to the 1970s oil shocks can be regarded as policies to induce a paradigm-shift.

However, while exploring response strategies to reconsider energy development dynamics, modern society appears to have been overtaken by a more fundamental and potentially much more deleterious consequence: the effects of energy consumption and other anthropogenic sources of greenhouse gas (GHG) emissions on the balance of atmospheric chemistry and, as a result, our collective climate (Intergovernmental Panel on Climate Change [IPCC], 2013).

Political response to the risk of climatic change has been slow. Indeed, the scientific community has warned of the potential consequences of an atmosphere saturated with the effluents of, among others, energy consumption, for over a century (Bolin, 2007). The political community came together in 1992 and initiated a debate on proper response strategies. Now, more than two decades into this debate, which produced a range of decisions and agreements, the pertinence of Lovins' question not only remains but, considering recent admonishments by the IPCC (2014) on business-as-usual consequences, is perhaps more poignant than ever: 'what is the road not taken?'. Indeed, the fundamental threat exposed by observed and projected climatic changes has the potential to endanger much more than the consequences of suddenly rising oil prices.

For this reason, the question 'what is the road not taken?' is positioned as the opening question in the line of inquiry of this dissertation. To answer the question, one first needs to consider not only the current road (Ch. 1) but also needs to expose its limitations to a point where it is clear that the current road is untenable (Ch. 2). To that

end, this first chapter explores the global climate change debate that society has embarked upon and lays out several of its characteristics.

1.1 The Challenge of Climate Change

The seasonal rise and fall of the now famous ‘Keeling Curve’ (Keeling, et al., 2005) has depicted atmospheric concentrations of carbon dioxide (CO₂) (and other greenhouse gases (GHGs)) beyond the natural range in which human society evolved and prospered. Consequences of this pattern are suggested to be significant (IPCC, 2014). The international community has embarked on a path of international negotiations to address the issue (Section 1.2.1.). Resolutions and agreements of this path can be characterized along several key elements (Section 1.2.2.).

1.1.1 Negotiating Climate Change Policy: a Multi-decadal Endeavour

The international community has embarked on an ambitious pathway of negotiations with the aim of establishing a collective action agreement. As a result, a global climate change policy response has been going on over the past two decades to decide our collective future climate. Exhaustive analysis of this endeavor has been provided by a wide range of commentators, analysts, and negotiation delegates – including a highly detailed assessment of the climate change negotiations (Wytze van der Gaast, 2015). ¹ The brief overview given here seeks to cover several of the key

¹ For additional insights into the rich history of the climate change negotiations, a good starting point is Gupta’s (2010) analysis, Daniel Bodansky’s prolific library of articles and book chapters, and Bäckstrand’s and Elgström’s (2013) overview of the European Union’s role in the negotiations. Additionally, the International Institute for Sustainable Development (IISD) maintains an ‘Earth Negotiations Bulletin’ that covers the process of the negotiations themselves and documents their primary outcomes and prospects.

decision moments of the efforts of the international community and is not meant to be exhaustive.

1.1.1.1 Pre-1992: The Early Days of Negotiations

Prior to the introduction of the 1992 United Nations Framework Convention on Climate Change (UNFCCC), climate change had begun to gain political traction. Table 1.1 provides an overview of several important moments. In 1988, for instance, governments began to play a larger role in the negotiation phase, whereas previously primarily nongovernmental actors had shaped the climate change debate (Bodansky, 2001). An important consequence of such governmental involvement is the ‘territorialization’ of climate change: while climate change is a global process of change in nature, the issue was increasingly framed according to its dynamics in relation to existing discrete political units (Paterson & Strippel, 2007). This process of territorialization has largely persisted throughout the climate change negotiations. For instance, nation-states sought to identify whether climate change posed a threat or an opportunity to the national economy, whether sinks within national borders could be deployed towards emission reduction targets, and what emission reduction targets could be justified through domestic politics and economics.

The territorialization of climate change, furthermore, produced a striking difference in terms of how countries formulated climate change policy or how they negotiate their position (Bodansky, 2001; Leas-Arcas, 2011). For instance, European countries favored response strategies similar to the one deployed for ozone protection, with a comprehensive agreement among many nation-states, while other countries (notably the United States, the former Soviet Union and Japan) favored a strategy around flexible national strategies and programs (Bodansky, 2001). In part, these

divisions were caused by differences in economic structure and energy economy but considerations of leadership and reputation also played a role (Bodansky, 2001; Gupta, 2010).

Table 1.1; Key moments in the pre-1992 period

Year	Activity	Key Message
1979	First World Climate Conference	Nations must act to prevent anthropogenic climate change disturbances
1985	Villach Conference	Rising atmospheric concentrations of greenhouse gases will lead to rising global average temperatures
1985	Advisory Group on Greenhouse Gases Established	First cooperative framework for undertaking climate change science
1987	Brundtland Report	The climate affects and is affected by other global issues; waiting for certainty may take too long
1988	Toronto Conference	Developed countries should reduce emissions by 20% by 2005 against a 1988 baseline
1988	IPCC established	Cooperative science institutionalized
1989	The Hague Declaration	High-level political attention: Mobilized heads of state of 22 countries on the climate change issue
1990	Second World Climate Conference	Developed countries should reduce their emissions by at least 20% by 2005 to pursue stabilization of global atmospheric concentrations. Developing countries should use modern technologies
1990	IPCC Report	Business-as-usual will increase global average temperature by 1° by 2030

Sources: Gupta, 2010; Bodansky, 2001

1.1.1.2 1992: The United Nations Framework Convention on Climate Change (UNFCCC)

The 1992 United Nations Conference on the Environment and Development (UNCED) is seen by many as a watershed moment in the discourse on the

environment and sustainable development (Najam, et al., 2002). Prior to this conference, climate change was in the process of being re-conceptualized as an issue deserving political attention, not just scientific discovery (Bodansky, 2001; Gupta, 2010). It became clear early on that the global scope of climate change required consideration of this problem as a ‘collective action’ issue, thus demanding high levels of participation and a broad negotiation platform.

In the run-up to UNCED, developing countries began to voice their position in the negotiations, fueled by successes the developing countries had been able to realize in the Montreal Protocol on Substances that Deplete the Ozone Layer (Bodansky, 2001). A second split emerged between the overall positions of the developed countries versus those of the developing countries, commonly coined the “North-South divide”. One particular element of the position of the developing countries was the emphasis on seeing the climate change issue not just as an environmental issue but also as an issue of relevance to the development discourse (Najam et al., 2002). As a consequence, developing countries pushed for the positioning of climate change authority in the United Nations General Assembly, rather than more narrow agencies such as UNEP, the World Meteorological Organization (WMO), or the IPCC.²

When seen as a problem of collective action – an issue that affects all and can only be sufficiently addressed when cooperatively approached under an enforceable

² However, other than agreeing on the need for financial assistance and technology transfer, the developing countries were far from a unitary voice (Bodansky, 2001). The negotiation positions brought forth by the developing countries ranged from the small-island nation-states (SIDS), who see climate change as an existential threat and therefore favored strong and swift action, to the Organization for Petroleum Export Countries (OPEC), whose economic model lead to the favoring of limited to no action.

and common set of rules and regulations – the perceived lack of authority over the conduct of nation-states other than provided for in existing international law is argued to require the introduction of a global treaty with the power to outline and demand action (Zaelke & Cameron, 1990). The UNFCCC is the first global attempt at such a document in the climate change context. Modeled after previous experiences with nuclear armament, ozone depletion, and acid rain, the platform created by the introduction of the UNFCCC is the so-called ‘convention-protocol’. Through such a platform, the Convention text – in the case of climate change, the UNFCCC – establishes general procedural guidelines while subsequent Protocols are to elaborate on practical and specific means to realize stated objectives (Bodansky, 2001). A key strength of such a platform is that it offers a stable legal and institutional context that allows for gradual but persistent development capable of incorporating new knowledge (Gupta, 2010).

The UNFCCC text, as such, is a document of limited influence and power; future protocols were to create additional stringency and effectiveness. In fact, the text can be argued to do little more than create the legal and institutional context in which future texts and decisions can take place. Bodansky (2001), for instance, highlights how the text a) preserves the negotiation position of all sides, effectively representing a ‘lowest common denominator’, b) is ambiguous in its wording, and c) defers further action to later negotiations. However, this was not necessarily reason for concern as, as Bodansky (2001, p. 34) puts it, the Convention was meant to be more of a “punctuation mark” rather than an end-point in the negotiations.

Several components of the UNFCCC text stand out deserving of further attention. First, the ‘ultimate objective’ of the UNFCCC document as outlined in

Article 2 of the text, is one of atmospheric GHG concentration stabilization at a ‘safe level’ (UNFCCC, 1992, art. 2, p. 9). This objective can be considered an expression of the principle of sustainability. Industrialized countries agreed to voluntarily reduce or limit their GHG emissions to 1990 levels by the year 2000.

Second, the UNFCCC maintains a set of guiding principles with which to reach this goal (Article 3). In particular, the Convention outlines the need to maintain a fair distribution in its principle of “common but differentiated responsibilities” and respective capabilities. This principle highlights that, while all countries share a common responsibility for the resolution of the issue of climate change, the level of responsibility is differentiated based both on contribution to the problem (i.e. historic emissions) and on capability to address the problem at hand. Other principles are the precautionary principle highlighting that uncertainty is not sufficient justification for inaction (subject to cost-effectiveness); principles of justice such as countries’ rights and needs to pursue sustainable development and the ethic to assist particularly vulnerably countries. Finally, political economy concerns motivated the creation of article 4.2 that aims to promote least-cost compliance opportunities. In fact, discussions about cost minimization and optimization are a central component of what can be called the ‘Kyoto era’ (Aldy, Baron, & Tubiana, 2003). This is further reflected in the UNFCCC by article 3, par. 5 that expresses that a “supportive and open international system” towards sustainable economic growth should be promoted but not unjustifiably restrict international trade. This clause highlights the tension between strong climate change action and economic growth and development.

The Convention text established a negotiation process, termed the Conference of the Parties (COP), which was tasked with the further elaboration and

implementation of action measures with which to realize the ultimate objective of the UNFCCC. This COP negotiation track has been ongoing ever since the Convention's ratification in 1994 and, at the time of this writing, the international community is gearing up for its twenty-first installment (COP-21). This COP process is seen as the main platform of UN-based action and, as such, a brief overview of several key COP decisions provides insight into the negotiations (Table 1.2).

Table 1.2; Major COP decisions

Negotiation Round	Key Message ^a
UNFCCC adoption (1992)	Convention text adopted at UNCED. Outlines intent to seek stabilization of atmospheric greenhouse gases.
UNFCCC enters into force (1994)	Convention text enters into force.
COP-1 (Berlin, 1995)	Berlin Mandate: Two-year process to develop more stringent emission reduction and limitation targets.
COP-2 (1996)	Adopted Ministerial Declaration rejecting 'harmonized policies' (thus favoring flexibility), accepted IPCC findings, and called for short-term legally binding targets.
COP-3 (Kyoto, 1997)	The Kyoto Protocol: GHG emission targets for Annex I countries.
COP-4 (Buenos Aires, 1998)	Adopts 'Buenos Aires Plan of Action': establishes deadlines for Kyoto Protocol work for the year 2000.
COP-5 (1999)	No major conclusions.
COP-6 (The Hague, 2000)	Negotiations collapsed after EU rejection of compromise positions.
COP-6 <i>bis</i> (Bonn, 2001)	Agreement reached on flexible mechanisms (no limit on credits a country could claim), sinks (broad application), and financing.
COP-7 (Marrakech, 2001)	Marrakech Accords: Concluded Buenos Aires Plan of Action. Sets the stage for Protocol ratification. Provides clarification on many operational rules for the Protocol.

Table 1.2; continued

COP-8 (New Delhi, 2002)	Delhi Ministerial Declaration: accelerate technology transfer and assist developing countries. Russia postpones ratification of Protocol.
COP-9 (Milan, 2003)	Adopted decisions to strengthen institutions and procedures of the Kyoto Protocol.
COP-10 (Buenos Aires, 2004)	Set out to complete the unfinished work of the Marrakech Accords
COP-11 (Montreal, 2005)	Kyoto Protocol ratified, enters into effect. The COP also agreed on a process for considering future action beyond 2012.
COP-12 (Nairobi, 2006)	Reach agreement on the Nairobi work programme on Impacts, Vulnerability, and Adaptation: a knowledge dissemination platform. Also established the Nairobi Framework, to support developing countries in their efforts to develop Clean Development Mechanism (CDM) projects.
COP-13 (Bali, 2007)	Established the Bali Road Map, a two-year plan of action towards a more stringent and effective international climate change agreement to follow up the Kyoto Protocol. As part of that plan, the COP created the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP). The Adaptation Fund was also launched at this time.
COP-14 (Poznan, 2008)	Progress was made on a range of issues, especially those of interest to developing countries, such as adaptation, finance, and technology. The negotiating Parties also agreed to a intensified negotiating schedule for 2009.
COP-15 (Copenhagen, 2009)	COP was attended at the highest political levels. Major outcome was the Copenhagen Accord which includes agreement on limiting global average temperature increase to no more than 2 degrees Celsius in relation to pre-industrial levels. Another major component was agreement on long-term finance. Despite such progress, talks were overwhelmingly seen as a failure.
COP-16 (Cancun, 2010)	Fleshed out the Copenhagen Accord: official agreement to commit to 2 degree Celsius target, operationalization of technology mechanism, creation of Green Climate Fund, and a new Cancun Adaptation Framework.

Table 1.2; continued

COP-17 (Durban, 2011)	The Durban Agreement lays out a new two year plan to reach universal agreement by 2015 – to be managed by the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP). Also agreed to commit to a second commitment period of the Kyoto Protocol.
COP-18 (Doha, 2012)	Laid out a time plan to realize the objective formulated in the Durban Agreement. Closed the Bali Action Plan to realize single negotiating stream. Launch of the second commitment period of the Kyoto Protocol through the Doha Amendment to the Kyoto Protocol.
COP-19 (Warsaw, 2013)	Produced the Warsaw Framework for REDD+ * which addresses a series of methodological questions, institutional arrangements and results-based finance.
COP-20 (Lima, 2014)	Key function of the negotiation: produce a viable draft negotiation text for COP-21. Main outcome document (“Lima Call for Climate Action”) remains heavily bracketed signaling substantial obstacles for the 21st COP in Paris in 2015.

* REDD+ = Reducing Emissions from Deforestation and Forest Degradation, including conservation, sustainable management, and carbon stock enhancement.

a: Sources: Earth Negotiation Bulletin (ENB) from the International Institute for Sustainable Development (IISD); Leas-Arcas, 2011a; UNFCCC, 2014

1.1.1.3 The Kyoto Protocol

Motivated by the Berlin Mandate (COP-1, Berlin, 1995), which argued the weak nature of the current Convention and the need to move towards more effective action, negotiators pursued agreement on more stringent quantified emission reduction and limitation targets (also called ‘QELROs’). The product of this pursuit introduces the next key phase of the negotiation process. At COP-3 (Kyoto, Japan, 1997), the international community agreed on a Protocol designed to effectuate the Berlin Mandate’s recommendations. This Kyoto Protocol has been widely seen as a cornerstone of the international climate change policy framework, building off of the Convention foundation.

This agreement introduces a variety of new elements. Several stand out:

- Developed countries are to reduce total emissions of greenhouse gases (GHGs) by an aggregate of 5.2% for the 2008-2012 commitment period. The aggregate allows for differentiation among nation-states (see Table 1.3) and the European Union negotiated an aggregate ‘bubble’ for its member states, thus allowing for even further differentiation.
- The Protocol offers a set of policy options and measures that countries can utilize to create a climate change policy portfolio with which to pursue the reduction target. Examples are energy efficiency policies, afforestation and reforestation measures, and market-focused measures to reflect true prices or otherwise prevent adverse pricing dynamics.
- The Protocol introduces operational mechanisms that are to facilitate emission reductions. These mechanisms are ‘joint fulfillment’ (also referred to as ‘burden sharing’), ‘joint implementation (JI)’, the ‘Clean Development Mechanism (CDM)’, ‘Emission Trading (ET)’, and the Financial Mechanism.
- In contrast to the developed countries and in line with the principle of common but differentiated responsibilities, developing countries were encouraged to make voluntary carbon emission cuts but were not assigned mandatory reduction or limitation targets.

Table 1.3; Overview of the targets-and-timetables approach

Nation	Change from 1990 emissions (%)
European Union, ¹ Bulgaria, Czech Republic, Estonia, Latvia, Liechtenstein, Monaco, Romania, Slovakia, Slovenia, and Switzerland	-8
United States	-7
Canada, Japan, Poland, and Hungary	-6
Croatia	-5
New Zealand, Ukraine, and Russia	0
Norway	+1

Table 1.3; continued

Australia	+8
Iceland	+10
All Annex B Parties	-5.2

Source: Glover, 2004; Gupta, 2010

¹The European Union was assigned a collective target that was further broken down into member state specific targets (known as the 'EU bubble')

* Emission trajectories along 'business-as-usual' scenarios make the impact of the Kyoto Protocol more significant: while a 5.2% below 1990 level is aspired, 'virtual' (Byrne & Glover, 2001) emission reductions are higher as emission trajectories deviate from scenarios of no emission control. The Kyoto Protocol, therefore, can also be said to represent a 29% cut in emissions (Leal-Arcas, 2011).

It is this 'targets and timetables' feature that is oftentimes identified as one of the key strengths of the Kyoto Protocol, together with its legally binding character (Leal-Arcas, 2011a). The introduction of its flexibility mechanisms is another component that often attracts praise, allowing for cost-effective compliance (Gupta, 2010). However, the Kyoto Protocol is not without criticism as agreed-upon targets were:

- relatively lenient with high levels of flexibility,
- the 2008-2012 time period essentially signaled a 8-12 year delay of a next, potentially stronger agreement,
- the Kyoto Protocol was heavily market-focused,
- and developing countries were not assigned with mandatory targets (Gupta, 2010; Leal-Arcas, 2011a).

Even when seen as a substantial step forward, complications with how to elicit compliance to the targets remained a significant issue (Stokke & Ulfstein, 2005). In addition, the 1997 COP left many of the operational specifics open for further negotiation at subsequent COPs. Moreover, ratification of the text required at least 55% of the negotiating Parties representing at least 55% of Annex-I emissions signing on to the document and its provisions. Ratification of the Kyoto Protocol didn't take

place until 2005 and, considering the significant differences in negotiation positions, several negotiating Parties were able to secure substantial gains in return for their support (e.g., Leal-Arcas, 2011a).

1.1.1.4 Securing a Post-Kyoto Agreement

Considering the limited lifespan of the Kyoto Protocol (its first commitment period ended in 2012), another critical moment in the negotiations is represented by COP-13 (Bali, Indonesia, 2007) as it sought to outline a negotiation track towards a follow-up agreement to Kyoto. The Kyoto Protocol demonstrates a number of deficiencies such as its lack of enforcement, its weak environmental integrity and its low participation rates (in terms of participants with mandatory targets and in terms of the section of global greenhouse gas emissions included under the Kyoto Protocol) that limit its potential effectiveness (Leal-Arcas, 2011). Building on the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP; established in 2005), the Bali Action Plan introduced a second negotiation track, the Ad-Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) to advance long-term action and to include all signatories to the Convention. This negotiation track is to focus on several key elements (e.g., finance, technology, mitigation, international consultation and evaluation, adaptation, etc.) and, as Leal-Arcas (2011) notes, this division into a two-track negotiation process is especially poignant as this second track includes major negotiating Parties that were, until now, either only observers (e.g., the United States) or that did not face any legally binding emission reduction obligations (e.g., China). Similar to the 1995 Berlin Mandate, the Bali Action Plan scheduled a deadline for

agreement at COP-15, two years after the Bali Conference, at which a new post-Kyoto framework was to be decided.

1.1.1.5 A Failure to “Seal the Deal”

In part due to the designation of the event as *the* place where a follow-up agreement had to materialize, the anticipation for the 2009 COP-15 in Copenhagen, Denmark was enormous. This anticipation is captured by the unofficial slogan of COP-15 to “seal the deal”. However, despite frequent preparation rounds to hammer out a workable draft text for the convention, COP-15 started with a lengthy and cumbersome draft text, reflective of entrenched negotiation positions (Bodansky, 2010). For instance, at preparatory meetings, “states simply restated their positions at meeting after meeting” (Bodansky, 2010), creating a quite unproductive process and, eventually, instilling a sense of realism that Copenhagen would not – in fact, could not – be as successful as initially hoped for.

The conference ended up being one of the most well attended intergovernmental negotiations on the environment, attracting over 40,000 representatives and attendees. The high volume of participants, observers, activists, and other attendees caused major upheaval in the conference planning process leading to the exclusion of many non-essential participants and observers from the main components of the conference. The tumultuous conference, where the Danish organization had to overcome several crippling obstacles such as an early leak of a draft text as well as developing country pressure to maintain large and open discussion among all negotiating Parties (rather than, as the Danes wished, smaller break-out groups) resulted in a delay of negotiations in earnest until the final days of the conference (Bodansky, 2010). In the midst of criticism and broad cynicism about the

conference's proceedings, a smaller negotiation group forced a conference breakthrough in order to ensure COP-15 would produce a meaningful outcome. The breakthrough outcome in the form of the Copenhagen Accord detailed, among others, an approach of domestic pledges of action, an acknowledgement that global average temperatures should not rise beyond 2° C, and a commitment of financial support to developing countries. Ultimately, this closed door meeting – held between President Barack Obama (U.S.), Premier Wen Jiabao (China), President Luiz Ina'zio Lula da Silva (Brazil), Prime Minister Manmohan Singh (India), and President Jacob Zuma (South Africa) ³ – attracted much criticism from the other COP participants, arguing the illegitimate and undemocratic nature of this meeting. Opposition by several Parties – most notably, Bolivia but also Venezuela and Sudan (Bodansky, 2010) – prevented the Conference of officially adopting the main outcome document (the Copenhagen Accord brokered between the small group of negotiation Parties and then presented to the rest of the Conference) and, instead, simply “took note” of the outcome document. Subsequently, Parties could “associate” themselves with the outcome document, lending it more credibility and future promise.

This outcome was decried by many as a failure leading to an overall questioning of the validity, desirability, and capability of the UN-based process (Hoffmann, 2011; Bodansky, 2010). An example of strong criticism is offered by Lavanya Rajamani: the Accord “can plausibly be characterized as ‘rotten’ not just because it is weak and will not contain climate change in its current form, but also because even in this weak form it faces considerable legal and procedural challenges

³ This is one of the first active displays of power by what is now known as the BASIC countries (Brazil, South Africa, India, and China).

to its operationalization” (Rajamani, 2010, p. 26). Similarly, the Accord has been characterized as a “paper-thin cover-up of what was a near complete failure” representing “the worst possible outcome – the overlay of a thin veneer of success over what is a deeply flawed outcome, perpetuating a process that is unable to overcome entrenched differences” (Dubash N. , 2009, pp. 8-10).

The disappointing Copenhagen outcome produced much debate throughout 2010 as to its importance and the future direction of the climate negotiations (Dubash, 2009; Bodansky, 2010; Egenhofer & Georgiev, 2009; Doninger, 2009). Nonetheless, many of the negotiating Parties decided to “associate” themselves with the Copenhagen Accord, submitting plans to reduce their emissions.

The Copenhagen Accord introduced a new style of how commitments are made and upheld within the international community. Unlike earlier attempts at “targets and timetables”, the Copenhagen Accord establishes a “pledge and review” process that can be characterized as a “bottom-up” approach where Parties identify domestic emission reduction measures and adaptation options and pledge their actions to the international community (Netherlands Environmental Assessment Agency (PBL), 2010). A domestic review process then takes place to determine the effectiveness of these measures and actions. This is in stark contrast to the more “top-down” process of targets and timetables characterization which has been the favored model since the start of the negotiations (Hare, Stockwell, Flachslan, & Oberthür, 2010).

1.1.1.6 Recovery from Copenhagen’s Failure

The contribution of COP-15 paved the way for COP-16 (Cancun, Mexico, 2010), which resulted in the official adoption of many of the Copenhagen Accord

elements into the UNFCCC process. Importantly, it also imbued the “pledge-and-review” approach into the negotiation process. The main elements of the Cancun Agreement are provided in Box 1. The Cancun Agreements have been widely recognized as a success that re-positions the UNFCCC as the main body to address climate change internationally (Taminiau, 2010a, 2010b).

Box 1. The Main Elements of the Cancun Agreements (Taminiau, 2010a)

1. Acknowledgement for the first time in a UN document of the need to keep global average temperature rise below 2 oC.
2. Industrialized and developing country pledges are officially recognized under the multilateral process.
3. USD 30 billion in fast start finance up to 2012 and USD 100 billion annually by 2020 from industrialized countries to support climate adaptation in the developing world.
4. Establishment of a Technology Mechanism composed of a Technology Executive Committee (TEC) and a Climate Technology Center and Network (CTCN).
5. Establishment of a Cancun Adaptation Framework to allow better planning and implementation of adaptation projects.
6. Future consideration of new carbon market mechanisms going beyond a project-based approach. In addition, the text strengthens the Clean Development Mechanism (CDM).
7. Launch of a REDD+ phase.
8. Extension of the work of the AWG-LCA and KP-AWG for another year while leaving open the legal form of the eventual outcome of the negotiations.

Despite COP-15 and COP-16 affirmation to the pledge-and-review approach, the overall objective of the negotiations remains to deliver a comprehensive, legally binding and effective agreement in line with the ultimate objective of the FCCC. However, Copenhagen’s (2009) failure and Cancun’s (2010) modest success lowered expectations for Durban (COP-17, 2011) to realize a comprehensive, legally binding agreement. Essentially, COP-17 was tasked with two key objectives:

1. To maintain momentum in the process towards an agreement that includes all main emitting Parties (especially, the United States and the BASIC countries Brazil, South Africa, India, and China).; and

2. To revitalize the Kyoto Protocol through the establishment of a second commitment period, and as such, prevent the creation of a “commitment gap”.

Considering that the Conference ended up being successful at these two key objectives, the Durban Outcomes were widely regarded as a “breakthrough”⁴ or “turning point”⁵ although this can be drawn into question (Byrne & Taminiau, 2012; Taminiau & Byrne, 2012). The Durban Outcomes were seen as a significant return of the negotiation focus towards the aim of a universal and legal agreement through the introduction of the Durban Platform for Enhanced Action. This new negotiation track is to establish momentum towards a “protocol, legal instrument, or an agreed outcome with legal force” applicable to all Parties by the end of COP-21 (Paris, France, 2015). This new agreement is to enter into effect in 2020. Other key outcomes of the Durban conference are presented in Box 2.

⁴ See, for example, a memo by the European Commission titled “Durban Conference Delivers Breakthrough for Climate”. This memo can be found as European Commission Memo/11/895 (11/12/2011) at: <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/11/895&format=HTML&aged=0&language>

⁵ As described by the UN on the UNFCCC website: http://unfccc.int/key_steps/durban_outcomes/items/6825.php

Box 2. Overview of the key outcomes of the Durban Agreement. Source: (Taminiau J. B., 2011)

1. Establishment of the Durban Platform for Enhanced Action which mandates the negotiations to realize a “protocol, legal instrument, or an agreed outcome with legal force” applicable to all Parties by the time of COP-21 (Paris, France, 2015) and to be implemented by 2020.
2. Agreement to continue with a second commitment period of the Kyoto Protocol. The second commitment period will cover seven years from 2013-2020 (check whether end date has been fixed).
3. The operationalization of the Green Climate Fund which is to realize financial flows of USD 100 billion per year by 2020.
4. Operationalization of the Adaptation Committee and formulation of the information that needs to be incorporated in National Adaptation Plans.
5. Agreement on the modalities and procedures of the TEC to assist technology development and transfer.
6. Decision on the procedures for the measuring, reporting, and verification (MRV) of emissions in both developing and developed countries.
7. Inclusion of carbon capture and storage in the CDM through agreement on its modalities

The pathway to such an agreement was discussed at the next COP in Doha (COP-18, 2012). Dubbed the “Doha Climate Gateway”, the negotiations agreed on a timetable to adopt a universal climate agreement by 2015. In addition, the conference concluded the Bali Action Plan (three years after its original deadline), so that work can be concentrated on the single negotiation track of the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP). It also followed up on the Durban Outcomes and launched a new commitment period under the Kyoto Protocol,⁶ and

⁶ The negotiations settled on a 8 year second commitment period which entered into effect on Jan. 1st, 2013. A key consequence of this adoption of a second period is the continuation of the Kyoto Protocol’s “flexibility mechanisms” (JI, CDM, and Emissions Trading). Importantly, any surplus assigned amount units (AAUs) – a key Kyoto Protocol carbon accounting unit – can be carried over without limit into the second commitment period. While restrictions apply, such a carry-over is expected to reduce the stringency of the second commitment period. Access to the mechanisms

made progress towards the creation of further financial and technological support to drive sustainable growth in developing countries.

The most recent two COPs (Warsaw, COP-19, 2013 and Lima, COP-20, 2014) further elaborated the roadmap outlined by the ADP. COP-20 delivered a first draft text to allow submission of the formal draft text in time for COP-21 in 2015. However, this draft text remains heavily bracketed, essentially including many different negotiation positions where compromises will still need to be made. Other key contributions were developments on the Warsaw Framework for REDD+ to cut emissions from deforestation, the introduction of transparency measures towards the long-term finance objective of USD 100 billion annually by 2020 (primarily shaped through an agreement by developed countries to publicly state on a biennial basis their efforts towards this objective and through the introduction of Ministerial meetings on long-term finance), and the operationalization of the Climate Technology Centre and Network (CTCN). As such, the CTCN is now ready to support developing countries' climate change actions on issues of technology transfer and development.

1.1.2 A Characterology of Climate Change Action

From the brief, non-exhaustive historical overview of the climate change negotiations presented above, several critical characteristics become clear. In particular, one can uncover: a set of action principles that inform decision-making, a top-down focus, a commitment to several policy desiderata, a commitment to

remains uninterrupted for all developed countries that have accepted targets for the second commitment period.

commodity-based decision-making, a ‘big bang’ style of approach, a short-term focus, and a particular ‘formula of success’.

1.1.2.1 Climate Change Action Principles

Leadership: By outlining specific commitments for developed countries (called Annex I countries in the Convention parlance)⁷, the climate change response framework seeks to elicit stronger compliance and action from developed nations. What Gupta (2010) calls the ‘leadership paradigm’ is first introduced in Article 3 of the UNFCCC text. Article 3.1 states that climate protection measures need to consider intra and inter-generational equity considerations in accordance with the common but differentiated responsibilities and respective capabilities principle. Further, article 3.1 expressly stipulates that ‘developed country Parties should take the lead in combating climate change and the adverse effects thereof’. Art. 3.2 recognizes the special vulnerability of developing countries vis-à-vis other countries and Art. 3.3 introduces the precautionary principle. Finally, the stipulation that the Convention takes into account that “economic development is essential for adopting measures to address climate change” further highlights the debate for the “right to grow”.

7 The division between Annex I and non-Annex I is based on the realization that certain countries have been majority contributors to the issue of climate change in the past and that many of these will continue to do so for some time. As such, these nations are expected to reduce emissions first and lead by example. The nations that fall into this group are called the Annex I countries. This group of countries largely consists of the nations that belong to the Organization for Economic Cooperation and Development (OECD). In addition, the nations designated as ‘economies in transition’ from Central and Eastern Europe are included as well. The Convention text urged these nations to reduce emissions by the year 2000 to 1990 levels.

Sustainability: The Convention text introduces the ultimate aim of the climate change policy effort as the stabilization of atmospheric greenhouse gas concentrations at a safe level and prevent “dangerous anthropogenic interference with the climate system” (Art. 2). While little guidance is offered by the Convention text as to what level constitutes such a safe level or when such a level should be realized, the text does offer that stabilization “should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner” (UNFCCC, Art 2.). As such, natural, social, and economic constraints apply when one considers the speed and aggressiveness of international climate change action.

Cost-effectiveness: Art. 3 of the UNFCCC also considers the necessity of a perspective of cost-effectiveness to ‘ensure global benefits at the lowest possible cost’. The principle, in emphasizing cost-effectiveness, argues the need for a comprehensive and full-focus perspective, stipulating that climate protection measures need to consider socio-economic contexts, cover all relevant sources, sinks, and reservoirs, and consider adaptation and comprise all economic sectors.

Commitments: Article 4 outlines a range of commitments for the ratifying Parties, keeping in mind the separation introduced in line with the principle of common but differentiated responsibilities. In particular, Art. 4.1 of the UNFCCC calls on all Parties to develop and publish “national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol” (Art. 4.1.a). Another commitment of note is the call to ‘promote and cooperate in the contexts of technology transfer in all relevant sectors

(Art. 4.1.c.). A voluntary target of emission reduction on the order of 1990 levels by 2000 is included in the Convention text for Annex I Parties to be achieved “individually or jointly” (introducing the possibility of joint implementation). What can be considered the heart of the Kyoto Protocol (Yamin, 1998) is listed in Article 3 which stipulates that Annex I Parties are to, either individually or jointly, establish their emission level at the assigned amount with an overall view of reducing the aggregate emission of the greenhouse gases by at least 5 % below 1990 levels. As such, the Kyoto Protocol offers information on two kinds of targets, those that are applied individually and a collective commitment to an aggregate target (Yamin, 1998). The aggregate target essentially reflects an overall cap on Annex B emissions.⁸ Especially their legally binding character was hailed as a major breakthrough element of the Kyoto round of negotiations (Yamin, 1998). However, it was clear early on that many countries were allowed much flexibility and were faced with lenient reduction targets. This was especially true for the Russian Federation and Ukraine (Yamin, 1998) leading to concerns about ‘hot air’ (Byrne & Glover, 2001; Woerdman, 2005). These emission reductions are to be realized in the Kyoto Protocol’s ‘first commitment period’, which ran from 2008 to 2012. The notion of such a ‘budget period’ was heavily contested, especially by the bloc of developing countries (the G-77), and its specifics were largely decided upon in the end by, at the time, the ‘big three’ of the EU, US, and Japan (Yamin, 1998). In this, the EU had to concede its position of earlier, shorter, budgets to the US and Japan who both sought the additional flexibility a longer and later period would provide (Yamin, 1998). The

⁸ The Annex B nations are those who agreed in Kyoto in 1997 to an emission reduction target and consists of 39 nations.

Kyoto Protocol's first commitment period ended in 2012. In Doha (COP-18, 2012), the *Doha Amendment to the Kyoto Protocol* sets up an additional piece of the Kyoto era puzzle as it includes new commitments for those Annex I Parties who entered into the second commitment period. This new commitment period runs from 1 January 2013 to 31 December 2020. In addition, the amendment includes a revised list of GHGs that will be subject to reporting throughout the second commitment period. The second commitment period establishes an aggregate reduction target of at least 18% below 1990 levels in the 8-year period from 2013 to 2020. As mentioned in Chapter 1, however, the composition of participating Annex I Parties is different from those that agreed to participate during the first commitment period. Most notably, Japan, Russia, and Canada refused to enter into the second commitment period.

Mitigation flexibility: the Kyoto Protocol adopts a 'basket-approach' in terms of the greenhouse gases that fall under the jurisdiction of the agreement. The agreement covers six GHGs.⁹ Yamin (1998) describes the negotiation difficulty the COP process encountered in delineating this basket of gases where the EU and Japan were initially opposed to the inclusion of long-lived industrial gases (SF₆, HFCs, and PFCs). It will become clear below that the 'basket' approach has some significant consequences for how climate change policy takes place and how instruments are designed to approach such policy objectives. In particular, the basket approach required a pathway for translating mitigation efforts that address one particular gas in terms of the contribution to the overall target of emission reductions. This pathway,

⁹ Carbon dioxide, methane, nitrous oxide, two hydrofluorocarbons, and sulphur hexafluoride.

formulated under the rubric of the ‘carbon dioxide- equivalent emission unit’, can be positioned to have fundamental consequences.

Financial support and technology transfer: Article 11 of the UNFCCC introduces the Financial Mechanism, accountable to the COP and composed of modalities and procedures capable of facilitating the transfer of financial resources from Annex I to non-Annex I Parties, including resources related to technology transfer. In terms of developing countries (non-Annex I Parties), Article 4 of the UNFCCC describes the need of “new and additional” financial resource transfer to assist developing countries in their efforts. The Article outlines how developing country implementation is contingent on developed country action and support, noting the overriding priority of economic and social development and poverty eradication for developing countries. Similar to the call for financial support, and supported by notions of ecological modernization, ‘leaders’ are urged to support the process of transferring environmentally sustainable technologies to the ‘laggards’. The implementation of such technology, under the technological and economic paradigm that shapes the Kyoto era, is seen as a prime pathway of ecological restoration while allowing social progress.

Review: The Convention text introduces a review process that is to determine the adequacy of such commitments. This institutionalized review process leads Gupta (2010) to recognize a key benefit of the contemporary climate change approach in that it offers a process of continuous development and refinement.

1.1.2.2 Top-Down Negotiation Framework

Ever since the first Earth Summit in 1992, the international community has pursued the formation of a climate policy regime motivated by the notion that

cumulative challenges will not be faced voluntarily (Ford, 2003; Newell, 2008). Independent, ‘rational’ behavior is not expected to seek resolution to collective action problems as short-term material gains, exclusively available to the decision-maker, are awarded with priority compared to actions beneficial to the broader social landscape. Collective action, as the theory goes, can only be set into motion when pressured by an external arbiter mandating change or through privatization (Brennan G. , 2009). As such, the challenge becomes to negotiate agreement in the form of a global climate policy regime with a unitary source of ultimate authority and a hierarchical chain of command from the top-down in order to overcome the complications of the collective action problem (Hare, Stockwell, Flachslund, & Oberthür, 2010; Brennan G. , 2009; Leal-Arcas, 2011b; Wiener, 2007).

This challenge has been answered in the climate change negotiations by establishing a primary focus on the activities of nation-states. The Convention text, the Kyoto Protocol, the Marrakesh Accords, the Bali Action Plan, etc.; all are agreements between nation-states and it is nation-states that are subject to their provisions and guidelines. Management responsibility to change the course of atmospheric chemistry, therefore, is positioned at the nation-state level. While other policy virtues can be derived from this approach (see below), a particular argumentative basis can be found in the global scope of the problem of climate change requiring a global response. The “inescapably global” nature of the policy problem, it is argued, requires a comprehensive and inclusive negotiation process among all involved (Depledge & Yamin, 2009).

1.1.2.3 Targets-and-Timetables Approach

A primary discussion point throughout the negotiations has been the search for emission reduction targets capable of mitigating the problem of climate change. The 1988 Toronto Conference already called for emission reduction targets, calibrated against a base year and to be realized at a certain target date. This ‘targets-and-timetables’ approach, in line with the top-down nature of the negotiations and its agreements, consists of the allocation of quantitative emission reduction targets to nation-states. Up until the most recent rounds of the negotiations, these emission reduction targets have been allocated to the developed Parties. The non-inclusion of non-Annex I Parties has long been a highly contentious characteristic of the negotiation outcomes, causing much difficulty. For instance, the Byrd-Hagel Resolution that was unanimously adopted by the US government can be put forth as a direct consequence of this lack of ‘parallelism’ (Byrne & Taminiau, 2011). However, the Durban round of negotiations clearly envisions the evolution of similar commitments by developing Parties in the still-to-be-worked-out follow-up agreement that is slated to enter into effect in 2020. An overview of the characteristics of the targets-and-timetables structure is provided in Table 1.4.

Table 1.4; Characteristics of the Targets-and-Timetables Approach

Focus	Top-Down (Multi-lateral Agreement)
Participation	Stringency divided in two Annexes
Legal Basis	Internationally Binding
Commitment Basis	Single component commitment (i.e. quantitative emission and reduction obligations [QELROs])
Development	Static

Source: Adapted from Taminiau & Byrne, 2012.

1.1.2.4 Short-Term Focus

Recent discussions appear to have settled on a long-term target of keeping global average temperatures below a two degree Celsius increase. However, for most of the negotiations, it was wholly unclear what the long-term basis for mitigative action was and agreement on this issue was far from settled. Examples of such a short-term focus are plentiful. For instance, the Convention text called for a voluntary reduction by the year 2000 and the Kyoto Protocol focused on a commitment period starting only ten years into the future. Similarly, nation-states developed action plans for emission reduction that were relatively short-term in focus. More recent action plans have started to take the long-term nature of the climate change problem into account and have articulated emission reduction targets that span out (much) further into the future. For instance, the European Union has established a roadmap of action that spans to 2050, significantly lengthening the scope of mitigative action. However, in terms of the international negotiations, it is, as of yet, unclear how the Durban Roadmap will play out for a follow-up agreement. For instance, even now that the international community has largely adopted the 2 degree Celsius target, much contention remains as to what it will take to reach this target and whether this target is desirable and appropriate.

1.1.2.5 Commodity-Based Policy Measures

The international community has settled on a commodity-based approach with which to address climate change (Bernstein, Betsill, Hoffman, & Paterson, 2010). In fact, a deepening of the commitment to this paradigm can be observed despite the near-collapse of the interstate negotiations indicating the consensus around the premise that the construction of markets is the policy measure of choice (Bernstein,

Betsill, Hoffman, & Paterson, 2010). A key driving force of this ongoing marketization is the business-politics dynamic (Paterson, Dryzek, Norgaard, & Schlosberg, 2011) and the search for flexible and efficient solutions to climate change. Driven by a neoliberal impulse but also formed through contest-reform cycles (Paterson, Dryzek, Norgaard, & Schlosberg, 2011), the marketization of the atmosphere favors dominant, powerful, actors that excel at navigating the capitalist landscape in their pursuit for accumulation (Bumpus & Liverman, 2008) at the expense of non-elites and the global south (Lohmann, Hällström, Österbergh, & Nordberg, 2008; Byrne, Glover, & Martinez, 2002). This is a clear signal of the Modern Model's signature 'governance by capital' approach.

The emission reduction targets are integrally linked to the Kyoto Protocol's 'flexibility mechanisms'. These mechanisms establish a geographic flexibility in terms of the location of emission reduction activities, allowing nations to claim activities performed elsewhere towards their own targets through trade. To further illustrate the focus on flexibility, it is interesting to note that a component of the negotiations that failed to materialize was a proposal for 'temporal flexibility' put forth by both the US and Japan which would have allowed Parties to effectively 'borrow' GHG emission capacity from future generations (Yamin, 1998). Especially Japan, US, Canada, and New Zealand (the so-called JUSCANNZ group) were in strong favor of the introduction of the flexibility mechanisms. The flexibility mechanisms are a crucial component of the practical strategy outlined by the Kyoto Protocol:

- *Joint Implementation:* The Protocol's sixth Article details how Annex I Parties can use so-called "emission reduction units" (ERUs) to assist in the realization of their mitigation target. ERUs are generated through mitigation or sequestration projects that take place in another Annex I Party as long as the projects meet certain

standards. For one, the projects need to meet an ‘additionality’ standard, meaning mitigation effects need to be additional to effects that would occur through business-as-usual activities. In addition, another provision of the Kyoto Protocol, the ‘supplementarity’ provision, describes how ERUs can only be used to meet a portion of the mitigation commitment, but no agreement on the actual supplementarity cap was reached at Kyoto.

- *Clean Development Mechanism (CDM)*: Often dubbed the ‘Kyoto surprise’, the CDM was a late addition to the draft text. The mechanism allows Annex I Parties to support projects that take place in non-Annex I Parties and claim “Certified Emission Reductions” (CERs). Such projects need to contribute to the dual objective of sustainable development and the ultimate goal of the Convention. The CDM, like JI, is subject to both the additionality standard and the supplementarity principle. Since its implementation, the CDM has been a particularly successful Kyoto Protocol mechanism.
- *Emissions Trading*: Article 17 of the Kyoto Protocol provides further insight into the difficulty encountered by the negotiating Parties to agree on detailed elements of the Protocol. Article 17 briefly describes Emission Trading as an available mechanism but quickly states that the COP process will need to further define the “relevant principles, modalities, rules, and guidelines, in particular for verification, reporting, and accountability for emission trading”. Supplementarity, again, is introduced as a key component of the degree of emissions trading but no further guidance is provided by the Kyoto Protocol.

1.1.2.6 Big Bang Approach

The Kyoto era, furthermore, can be characterized by a continuing search for an all-inclusive agreement, called a ‘Big Bang’ approach by some (Falkner, Stephan, & Vogler, 2010). In a way, this line of thinking results in a mentality where only full agreement can be termed the final success and every negotiation needs to be aligned with this ultimate objective. Such agreements, when finally made, can take up a defining character – the Kyoto Protocol, for instance, dominated discussions and

sometimes appeared as the ‘only game in town’. As such, participation and alignment with the Kyoto Protocol became determinative of perceptions of willingness to act on climate change.

1.1.2.7 The Kyoto Era ‘Formula of Success’

The above characteristics can be translated to a particular ‘formula of success’ (Byrne & Taminiau, 2011; Taminiau & Byrne, 2012). This formulaic approach to the complex problem of climate change rests in a shared belief that markets are a primary platform for climate change resolution, transforming the policy problem to an energy transition issue that is largely economic and technological in scope. The formula of success, therefore, is to prioritize least-cost resolutions to environmental conflicts and, where possible, conducive to economic growth. The reduction of the atmosphere in all its complexity to a resource produces the view that ‘good’ climate change policy is policy that obtains an optimal value from the atmospheric services (Byrne & Taminiau, 2011; Taminiau & Byrne, 2012; Byrne & Glover, 2001).

1.1.3 Examples of Climate Action

The formula of success of the climate change approach has established initial results. Despite the fact that the narrative of this manuscript will continue in subsequent chapters with an argument for transformative change, this section here briefly covers some essential results of the climate change approach.

1.1.3.1 The Clean Development Mechanism (CDM) and carbon market trading

In many ways, the CDM has been tremendously successful. With 7,572 projects registered as of November 2014 and many more in the pipeline, the CDM is expected to generate 2,220,706 kCERs (Fenhann, 2014) and is often hailed as *the*

example cost-containment mechanism with which to combat climate change. Seventy-one percent of the projects are in the renewables category, followed by methane and coal bed reduction efforts (Fenhann, 2014). Additionally, the CDM offers a sizable potential for technology transfer flows, the value of which was estimated at \$470 million in 2007 (de Coninck, Haake, & van der Linden, 2007). More current estimates and studies, however, reveal significant difficulties in the CDM market (Ch. 2). Additionally, offset mechanisms like the CDM allow for increased emission levels by the Certified Emission Reduction (CER) buyer creating in effect a zero-sum game with no net effect on global emission patterns when ‘additionality’ clauses and baseline estimates are accurate (Erickson, Lazarus, & Spalding-Fecher, 2014).

Another clear example of climate change action is the widespread implementation of carbon pricing mechanisms (World Bank, 2014). These efforts to set a price on carbon reflect a drive to internalize carbon effects into the market structure in the hope to sensitize market participants for the otherwise external consequences of carbon pollution. Importantly, however, at a time when the international drive for emission markets have largely come to a standstill – the second commitment period of the Kyoto Protocol (2013-2020) only covers 12% of global greenhouse gas emissions and has so far only been ratified by nine countries (World Bank, 2014) – many of these efforts take place at sub-national, national, and regional levels (Figure 1.1). Indeed, the world’s emission trading systems are now worth up to \$30 billion (World Bank, 2014).

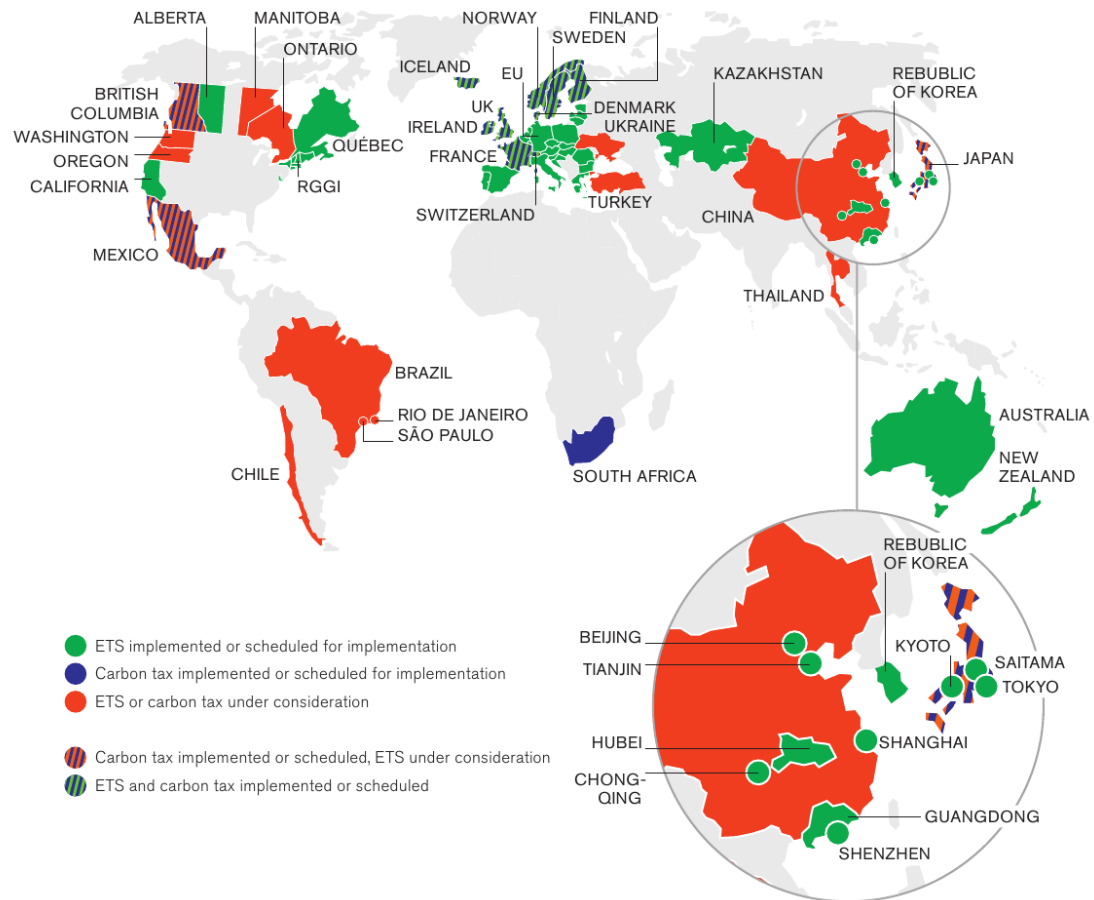


Figure 1.1; Overview of the proliferation of carbon markets around the world.
Source: (World Bank, 2014).

1.1.3.2 Decoupling of Economic Activity and Carbon Emissions

Another primary point of solace within the climate change narrative is the observed pattern of decoupling between economic activity and carbon emissions. Corresponding to the drive for efficiency, countries around the world are now able to squeeze additional value out of each unit of emissions (Figure 1.2). Naturally, these progress indicators should be, in particular, read in conjunction with total greenhouse gas emission patterns and economic activity levels which reveals some difficulties with the relative level of decoupling between economic activity and carbon emissions

(Ch. 2). Additionally, concerns of ‘leakage’ are revealed when demand-based productivity changes are observed: embodied emissions in energy-intensive goods are imported to OECD countries, displacing the location of emissions and reducing the contribution of productivity increases in national profiles (OECD, 2014).

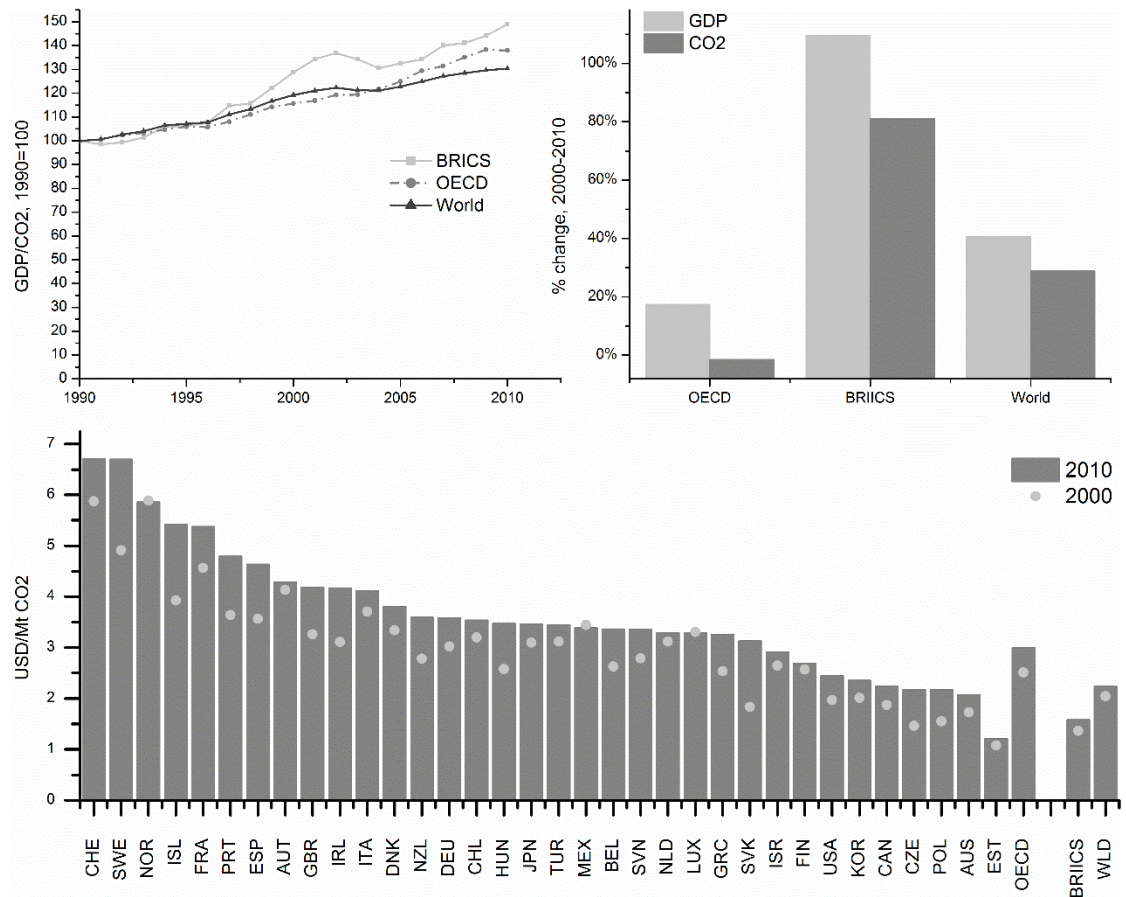


Figure 1.2; Carbon productivity profile of the OECD, the BRICS, and the World.

1.1.3.3 Bringing down competitive costs

Similar to efforts to internalize greenhouse gas emissions, solace can be found in rapidly falling prices for renewable energy options (Figure 1.3). As per Figure 1.3,

the levelized cost of electricity (LCOE) demonstrates a rapid downward pattern over the past five years for both solar and wind energy (Lazard, 2014). These rapidly falling prices contribute to the rising implementation of renewable energy (Section 1.1.3.4). Projections see these costs, in the face of assumptions that increase fossil fuel costs, to overtake the costs of conventional generation of energy (Breyer & Gerlach, 2013). Proponents of the current approach, arguing the self-directed forces of the market, perceive these changes as indicators that an energy transition will be self-fulfilling: once costs of energy technology options falls sufficiently in relation to incumbent technologies, the assumption goes, the energy transition will accelerate without required outside intervention. However, again, important limitations to this perception exist that hamper the materialization of this picture of energy development (Ch. 2).

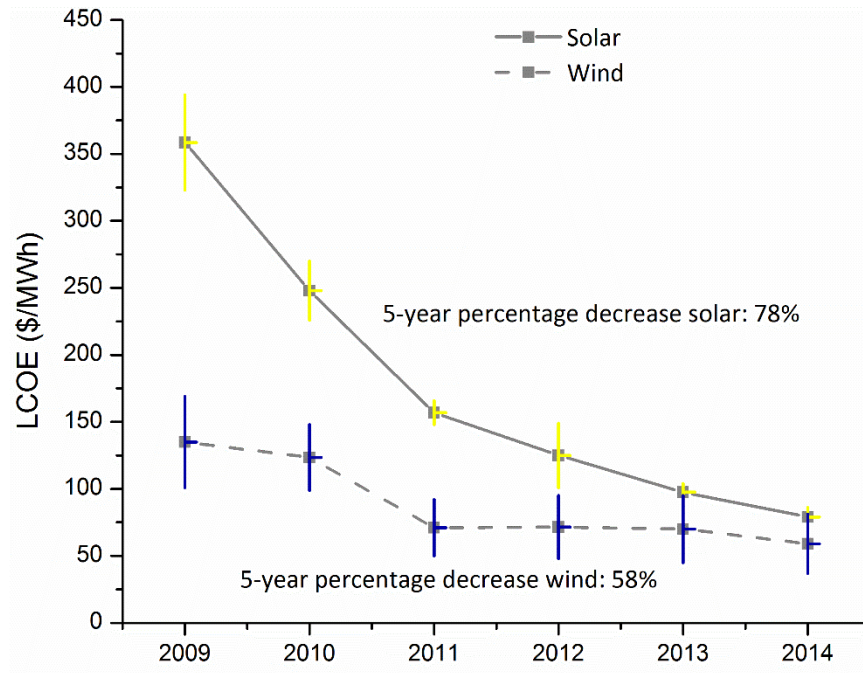


Figure 1.3; Wind and solar LCOE. Source: (Lazard, 2014).

1.1.3.4 Pursuit of the ‘Greenshift’

As mentioned, the production and consumption of energy is a particular contributor to the issue of climate change. Indicators hailed by proponents of the current pathway as evidence of an energy transition towards a greener energy economy revolve around the penetration rate of renewable energy in modern societies. As such, the focus is on the level of implementation of renewable energy technology options. A recent publication by the Renewable Energy Policy Network for the 21st Century (REN21) on the global status of renewable documents this ‘greenshift’ (REN21, 2014). Indeed, results have so far been impressive (Table 1.5), particularly in wind energy and solar photovoltaics (PV).

Table 1.5; Renewable energy status around the world. Source: REN21, 2014.

		Start 2004	End 2012	End 2013
Investment				
New investment (annual) in renewable power and fuels	Billion USD	39.5	249.5	249.4
Power				
Renewable Power capacity (total, excl. hydro)	GW	85	480	560
Renewable Power capacity (total, incl. hydro)	GW	800	1,440	1,560
Hydropower	GW	715	960	1,000
Bio-power	GW	<36	83	88
Geothermal	GW	8.9	11.5	12
Solar PV	GW	2.6	100	139
CSP*	GW	0.4	2.5	3.4
Wind power	GW	48	283	318

* CSP = Concentrating Solar Power

1.2 A Different Path?

In their defense of the global climate change regime, Depledge & Yamin (2009) offer that the regime has been able to a) provide momentum towards continuous advancement, b) collect reciprocal deals due to, among others, the long-term nature of the process, c) establish a learning process, and d) establish perhaps the most rigorous and respected monitoring and review process. In part due to these contributions, and despite the recognition of many weaknesses with the current regime, Depledge & Yamin maintain that “whatever substantive options are proffered, *they should be pursued within the framework of the existing global regime*, rather than seeking out new institutional structures (Depledge & Yamin, 2009, p. 452; emphasis in original). The authors defend this position by evaluating the limited potential that, according to the authors, exists with so-called ‘limited group negotiations’ – smaller negotiation platforms other than the UN. Another argument positioned by Depledge &

Yamin to maintain this position is the recognition of the “inescapably global” nature of the issue of climate change, provoking international relations theory and the denomination of climate change as an ‘collective action’ problem. The above sections have documented the long history of negotiations, the policy paradigm around which the international community has settled, and several remarkable results that occurred during the climate change response strategy period.

However, despite that most of the critique that this dissertation offers is contained within Chapter 2, signs of significant difficulty have already emerged from the above descriptions: the negotiations have been ongoing for over two decades without realizing an agreement that is in line with its own formula of success. Furthermore, the historical overview highlights in several occasions that negotiating Parties have substantially different positions leading, for instance, to reductions in the stringency of the agreements, extra flexibility, and non-compliance.

Indeed, it will become clear in Chapter 2, that there is significant reason to doubt the current road will be able to deliver on its own principles of sustainability, justice, and equity. Lovins’ question of the road not travelled remains pertinent as a host of indications have been observed that propose more stringent and successful efforts are required to maintain long-term ecological viability. For instance, potentially irreversible decline in biodiversity (Solomon, Plattner, Knutti, & Friedlingstein, 2008), sudden permafrost melt (Schuur, et al., 2008) and unexpected speed of ocean warming and acidification (Rhein, et al., 2013) point perhaps to limitations in the Kyoto era approach. The brief description of the two decades of negotiations already shows how the international response to climate change has been, overall, remarkably unsuccessful despite deployment of significant resources and political attention at the

highest levels (Prins & Rayner, 2007; Helm, 2009; Leal-Arcas, 2011a; Tollefson, 2011; Victor, 2009). In fact, many researchers have described the current process of international negotiations to arrive at a response strategy as a dead end. For instance, Joanna Depledge notes how the “ossifying” Kyoto era negotiations “not only got ‘stuck’ but is digging itself into ever deeper holes of rancorous relationships, stagnating issues, and stifling debates” (Depledge, 2006, pp. 1, 3). Hoffmann makes a similar observation: “it would seem that the megamultilateral response is slowing if not grinding to a halt” (Hoffmann, 2011, p. 16). In effect, it has become apparent that, due to entrenched negotiation positions, climate policy dynamics have fixed themselves along a “climate impasse” (Levy & Spicer, 2013; Purvis & Stevenson, 2010).

To maintain ecological viability on the long-term, a different path may be more suitable. Interestingly, the Durban Platform for Enhanced Action opens up a window of opportunity to reflect on different pathways as it maps out a pathway to collective action that will not be implemented until 2020. Indeed, considering the history of the negotiations, 2020 might even be optimistic. This window of opportunity allows for investigation into different strategies of change. This dissertation recognizes two strategies of change that have been put forth. On the one hand, there is the United Nations sanctioned effort to maintain meaningful climate change action in the absence of a global agreement in the form of ‘pledge-and-review’ (Taminiau & Byrne, 2012). However, a growing body of literature suggests that critical gaps exist in the current approach and need to be addressed by wholly different strategic approaches than those envisaged in the COP process if the risks of climate change are to be moderated to a level anticipated in the UNFCCC. The second strategy of change recognized in this

dissertation, therefore, relates to policy options that have emerged outside recent COP agreements. Particularly, the notion of ‘poly-centric’ action, in contrast to current ‘mono-centric’ action within the COP process and structured around a much wider range of actors without a central form of authority, offers a strategy of change which some have highlighted as a promising way forward (Hoffman, 2011; Bulkeley & Castán Broto, 2012; Ostrom, 2012).

More fundamentally, Byrne & Taminiau (2015), Byrne, Wang, Taminiau, & Mach (2014), Taminiau, Wang, & Byrne (2014), and Taminiau & Byrne (2015) argue for the need for the implementation of a new paradigm specifically focused on long-term ecological viability and social progress rather than current focal points of commodity-based management. They propose a ‘Social Change 2.0’ framework that emphasizes community efforts, common resources, and quality-of-life considerations. This dissertation reflects on the capability of the polycentric strategy to be an operational arm of this new paradigm with new and innovative processes of social change.

1.3 Study Aim and Chapter Overview

Using the illustrative case of the intertwined global approach to climate change and energy development, this dissertation seeks to distill a ‘road not taken’ by focusing on a new strategy of change (poly-centricity; chapter 4). To do so, the dissertation reflects on the fundamental character (paradigm; chapter 3) of the current approach and discusses an alternative (paradigm shift). This alternative is further elaborated on by reviewing two operational arms (sustainable energy utility and the solar city; chapters 5 and 6) that could be situated in the polycentric strategy of change.

The study aim, as such, is ambitious but can be dissected in five elements.

These elements align with the following chapters:

1. To uncover the fundamental limitations that exist in the currently dominant approach (Chapter 2).
2. To introduce how the current strategy has opened up a window of opportunity for new strategies of change to take center stage and evaluate two such strategies: ‘pledge and review’(primarily in Appendix A) and ‘polycentricity’ (Chapter 3).
3. To show how polycentricity, as a strategy, can potentially overcome these limitations and position new virtues that perhaps make it a more attractive option for future climate change action and effort (Chapter 4).
4. To evaluate options to reorient energy development away from its current climate change-inducing nature but along new lines of development other than those currently dominant. The dissertation discusses first an alternative to the conventional energy utility by looking into the Sustainable Energy Utility (Chapter 5) and provides a follow-up analysis of an innovative strategy of repurposing the urban fabric into a solar city (Chapter 6)
5. To bring the findings of this manuscript together into a narrative that represents a viable alternative to the current path (Chapter 7).

Two essential hypotheses of the study can be distilled from the above:

1. The potential for transformative change is restrained under the current strategy with which international society approaches climate change. In particular,
 - This approach fails to garner global support;
 - This approach fails to materialize discernible progress towards its ultimate objective;
 - The approach neglects key sustainability implications of change due to its translation of sustainability into a ‘governance by capital’ approach revolving around efficiency; and, finally,
 - The approach neglects key justice implications of change due to its statist and corporate focus that positions decision-making within the

context of the 'carbon economy' and neoliberal context, restricting input and agency from civil society.

2. Polycentric action could find new conditions required for transformative change to thrive. Moving away from the currently confined operational space and, instead, capturing new operational and social dynamics and actors allows for an advancement of the ultimate objective of climate change action in a sustainable and just way.

Chapter 2

THE LIMITATIONS OF THE KYOTO ERA APPROACH

The observations described in Chapter 1 suggest difficulties with the current policy approach. The long duration of negotiations without any clear sign of agreement at a sufficient level of stringency of CO₂-equivalent cuts signals deep conflicts between negotiating parties. Moreover, the ‘Copenhagen’ collapse can be seen as an intensification of these conflicts (Bodansky, 2010). Recitation of problems like these has led oftentimes to the characterization of the current response strategy as insufficient and incapable of meaningful or transformative change (Prins & Rayner, 2007a; Prins & Rayner, 2007b; Leal-Arcas, 2011a; Tollefson, 2011; Victor D. G., 2011).

From early on some have worried about the effectiveness of the strategy but worried more that it is the ‘only game in town’ – seemingly leaving its reinforcement as the only option (Aldy, Barrett, & Stavins, 2003). However, the breadth and diversity of alternative response strategies – such as, for instance, introduced by Kennedy & Basu (2014) – that are possible suggests this line of reasoning is flawed. Consideration of alternative strategies, therefore, is not a sign of giving up on our ‘first, best’ but, rather, recognition that climate change action viability, durability, and stringency perhaps need to be sought elsewhere.

The task of Chapter 2 is to demonstrate the limitations associated with the currently dominant response strategy. To do so, a selection of characteristics and outcomes are identified and discussed in some detail. More specifically, the chapter sets out to highlight the failure of adherence to the sustainability principle (Section 2.1.), the high likelihood that future negotiations will continue to struggle to garner the

necessary support (Section 2.2.), and the difficulty of realizing climate justice through the current approach (Section 2.3.). In brief, Chapter 2 summarizes the sustainability, governance, and equity problems of the current policy approach and describes why many have concluded that these three hurdles are unlikely to be overcome.

2.1 The Sustainability Failure

The sustainability principle, outlined initially under the UNFCCC as ‘stabilization at a safe level’ and subsequently translated to ‘staying under 2 degrees Celsius global average temperature increase’, represents a critical component of any strategy seeking to address climate change: the prevention or mitigation of the problem must include efforts to reduce anthropogenic pressure. For instance, under the Kyoto Protocol, the sustainability principle was to be effectuated through quantitative emission limitation and reduction objectives. The extent to which the approach described in Ch. 1 has been able to live up to the sustainability principle is outlined in this section. To that end, this section discusses the pattern of GHG emissions (2.1.1.), the ‘ambition gap’ (2.1.3.), and the trade-off between economic sustainability versus ecological sustainability (2.1.4.) focusing particularly on the empirical record of (absolute and relative) decoupling (2.1.4.1) and the experience of the carbon markets (2.1.4.2).

2.1.1 Rising GHG emissions

May 2013 might very well find a prominent place in the history books as, for the first time in human history, atmospheric concentrations of carbon dioxide (CO₂) surpassed the 400 parts per million (ppm) milestone (UNEP News Centre, 2013). Despite the aim of over two decades of international rhetoric and negotiation to bring

down the emissions that contribute to climate change, the continuing upward climb of global average atmospheric CO₂ has become a telling symbol of global society's apparent inability to effectively respond to the issue of climate change.

The contemporary chemistry of our atmosphere, let alone the expected chemical balance if left unaddressed, is in stark contrast to the findings of the scientific community of what can be considered an appropriate level. In fact, work by Dr. Ron Prinn and his colleagues at the Massachusetts Institute of Technology's shows that global concentrations *already* surpassed climate sensitivity threshold levels (AGAGE, 2014; Weiss & Prinn, 2011).

While the exact level and severity of these consequences remains uncertain, increased scientific insight has advanced the notion that business-as-usual, represented by a continually rising atmospheric concentration of GHGs is untenable (Intergovernmental Panel on Climate Change [IPCC], 2014). Our continued inability to effectively engage the issue of climate change is expected to produce profound environmental, economic, and social consequences. Thought experiments of what a world under such a scenario could look like convey dramatic potential consequences (New, Liverman, Schroder, & Anderson, 2011).

The IPCC, established in 1988 to synthesize the available science and distill useful messages for policy-makers, reports in its Fifth Assessment Report how global mean surface temperatures for 2081-2100, relative to 1986-2005 will likely be 1.4°C to 3.1°C higher (IPCC, 2013).¹⁰ A global rise in temperature is but one of many

¹⁰ The estimate for global mean surface temperature in 2081-2100 depends in large measure upon the trajectory of greenhouse gas emissions, especially carbon dioxide (CO₂). Here, the estimated temperature increase is given for the so-called Representative Concentration Pathway (RCP) 6.0, a scenario that is prescribed with a

expected changes to the biogeochemical system, including ice cover reductions and sea level rise (Figure 2.1A-2.1D).

670 ppm CO₂ concentration and a 6.0 W/m² radiative forcing in year 2100 relative to 1750 (IPCC, 2013). Three other RCPs, identified by their radiative forcing level in 2100 (RCP2.6, RCP 4.5, and RCP 8.5) return different estimates ranging from 0.3°C to 1.7°C, 1.1°C to 2.6°C, and 2.6°C to 4.8°C, respectively. These RCPs reflect a aggressive mitigation scenario (RCP 2.6), two stabilization scenarios (RCP 4.5 and RCP 6.0) and a scenario in which emissions continue a rapid growth rate (RCP 8.5). RCP 6.0 is used here because it's prescribed CO₂ concentration level corresponds with scenario analyses of business-as-usual (Byrne, Kurdgelashvili, & Taminiau, 2012).

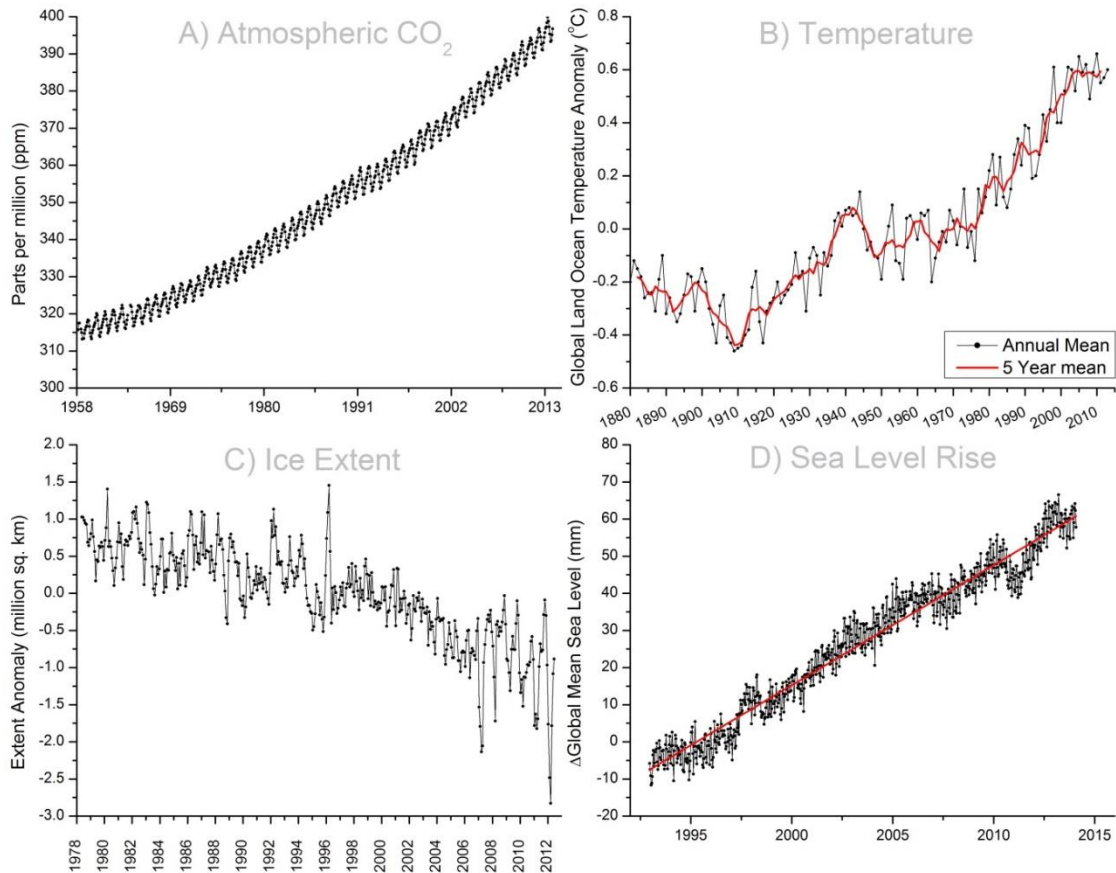


Figure 2.1; 2A-2D - Overview of global environmental change processes (B, D, and D) attributed to climate change and linked to rise in global atmospheric CO₂ (A).

Sources by graph:

- Atmospheric CO₂ concentrations (ppm) derived from in situ air measurements at Mauna Loa, Observatory, Hawaii at 3397m (Keeling, et al., 2005). The resulting curve is the famous 'Keeling Curve' after Charles D. Keeling – the scientist initiating and maintaining the long-term data observations.
- Global Land-Ocean Temperature Index (C) (Anomaly with Base: 1951-1980). Updated from Hansen et al. (2006) with data provided by the National Aeronautics and Space Administration (NASA) (2014).
- Data computed by NASA Goddard Space Flight Center (GSFC) and provided via the NASA National Snow and Ice Data Center (NSIDC) (2014).
- Data taken from Nerem, Chambers, Choe, & Mitchum (2010).

It has become increasingly clear that the body of evidence points to an anthropogenic cause of climate change. In fact, according to their probability

structure, the IPCC concludes in its most recent assessment of the available scientific evidence that it is “extremely likely” – associated with a >95% probability – that climate change has an anthropogenic cause. However, despite efforts to reconfigure our collective climatic future, Working Group I of the IPCC notes an acceleration in decadal increases in emissions and a continuous increase in 1970-2010 emissions (IPCC, 2013). 2000-2010 growth patterns now display about a 2.2% growth rate, equal to an annual average emission growth of one gigaton CO₂-equivalent, up from an annual average of 1.3 % during 1970-2000 (IPCC, 2013). Indeed, it appears emission patterns closely follow the high end of projections complicating the picture even further (Friedlingstein, et al., 2014).

The corollary of such a business-as-usual development trajectory is social and natural system structure and function degradation (Boko, et al., 2007; Fischlin, et al., 2007; IPCC, 2013). The overall concern is that the degradation of both social and natural system functioning could undo 20th century’s social and economic progress and achievements and set society on a course of persistent struggle (IPCC, 2014). For instance, in their analysis on impacts, adaptation, and vulnerability, Working Group II (WGII) of the IPCC confirms that continued development along a 20th century business-as-usual trajectory could result in food, economic, and social insecurity on a scale not seen before (IPCC, 2014). One way WGII conveys this overall message is through the identification of five integrative reasons for concern (RFCs) that summarize some of the key risks across the sectors and global regions. These RFCs provide insight into some of the consequences associated with rising global average

temperatures, corresponding other global environmental change processes and adaptation ¹¹ limits. The WGII identifies five such RFCs:

1. Unique and threatened systems: ecosystems and cultures that display limited adaptation capability are at “very high” risk under warming conditions on the higher end of the spectrum.
2. Extreme weather events: climate change induces changes in weather patterns that can take extreme forms such as displayed through heat waves, coastal flooding, or extreme precipitation. These risks, similar to above, tend to increase at higher temperatures.
3. Distribution of impacts: the IPCC has documented again and again that many of the risks are unevenly distributed and that marginalized communities and peoples generally face greater consequences.
4. Global aggregate impacts: climate change at the global level produces aggregate consequences for ecology, economy, and society.
5. Large-scale singular events: the notion of “tipping points” or “planetary boundaries” suggests the risk of abrupt and irreversible change (Röckstrom, et al., 2009; Schuur, et al., 2008; Solomon, Plattner, Knutti, & Friedlingstein, 2008). The IPCC notes that a disproportionate relationship exists between the likelihood of the crossing of such fundamental ecological limitations and the rate of warming.

Now that the IPCC has published its fifth assessment report, it has become a familiar narrative but it is nonetheless important to reiterate here: the ‘socio-metabolism’ (Haberl, Fischer-Kowalski, Krausmann, Martinez-Allier, & Winiwarter, 2009) of modern society is critically dependent on the combustion of fossil fuels to power all aspects of modern life. Without it, the modern ‘carbon economy’ cannot

¹¹ Definition of adaptation as provided by the IPCC: “The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects” (IPCC, 2014, p. 5).

continue current operations and growth patterns unless a suitable substitute is implemented at a large scale. As such, energy has taken up a key geopolitical position in a state's national interests (Klare, 2008; O'Hanlon, 2010; Yergin, 2008; Yergin, 2011). In particular, the supply and use of energy represents the largest share of greenhouse gas (GHG) emissions (IPCC, 2014). Moreover, a continuous increase in global energy use is observed and is accompanied by rising GHG emissions. Primary contributors to this acceleration in energy use and emissions were rapid economic growth and an increase of the share of coal in the global fuel mix (IPCC, 2014). WG I of the IPCC estimates that, when no climate change mitigation efforts are applied in this sector, CO₂ emissions will continue to increase to about 55-70 GtCO₂ by 2050; this corresponds to an 80-130% increase compared to the 2010 level of emissions (IPCC, 2014). End-of-the-century emissions would be even higher. Fundamental reorientation and transformation of society's energy supply system is required to meet the Convention's ultimate objective of stabilization of atmospheric GHG concentrations. A primary component of such transformation is the substitution of unabated fossil fuel conversion technologies by low-GHG alternatives (IPCC, 2014).

However, while modern societies have rapidly expanded their energy supply since the start of the Industrial Revolution, 'energy poverty' – the concept of not being able to access or afford reliable energy – continues to plague almost one third of humanity (International Energy Agency (IEA), 2010). Lack of access to suitable energy options effectively imposes an "energy poverty trap" that keeps communities in an impoverished state (Groh, 2014). In contrast, those who reside in the modern enclave can enjoy the services and benefits brought about by energy supply but do so against ever increasing levels of "energy obesity" (Tertzakian, 2009) – the energy-

driven development process requires more and more energy, and hence emits more GHG emissions, to sustain its expansion.

2.1.2 Ambition Gap.

Study after study demonstrates the complicated common future human society faces if climate change is left unabated. For instance, the World Bank's "Turn Down the Heat: Why a 4°C Warmer World Must be Avoided" outlines not only that the world is currently on track for a significantly warmer world, but also conceptualizes the problematic consequences such a world would bring (The World Bank, 2012). Among others, the IPCC Fifth Assessment Report (Intergovernmental Panel on Climate Change [IPCC], 2014) and the World Economic Forum's "Global Risks 2013" (World Economic Forum, 2013) report have since reiterated this warning. The business-as-usual projections highlight the urgency to move towards stronger emission reductions.

In order to comprehend the challenge posed by climate change, Pacala and Socolow (2004) famously broke down the challenge into manageable groups of action, which they called 'stabilization wedges'. This concept has since been widely deployed in assessments of response strategies and their sufficiency (Dietz, Gardner, Gilligan, Stern, & Vandenberg, 2009; Drury, Denholm, & Margolis, 2009; Williams, et al., 2013). At the time, the challenge for the next five decades – the boundary of the problem statement Pacala and Socolow sought to address – was to come up with an action portfolio that would allow for the halting of additional emissions (i.e. reach a stabilization in emissions). Since then, the politically acceptable definition of 'sustainability' within the climate change discussion has become the limiting of global average temperature increases to 2°C. However, unlike argued for by Pacala and

Socolow, global emission patterns have increased rather than decreased, exacerbating the challenge. Now, in an effort to rethink the ‘stabilization wedge’, Davis et al. (2013) maintain that emissions will need to show a ‘peak-and-decline’ pattern in the next five decades. The intensification of the scale and urgency of the problem, in fact, now demand a sharp reduction in emissions rather than a ‘simple’ stabilization. Others come to a similar conclusion (Byrne, Kurdgelashvili, & Taminiau, 2012; Nordhaus, 2010).

However, as the United Nations Environment Program (UNEP) characterizes in their annual “Emissions Gap Report”, a considerable gap continues to exist between what the world has so far pledged to do and what is needed (UNEP, 2013). This gap forms the ‘Ambition Gap’, offering clear insight into the need to raise ambition levels (Rogelj J. , et al., 2010). More specifically, the UNEP Emission Gap Report 2013 establishes several key findings in their research on the ambition gap (UNEP, 2013). First, to correspond to limiting average global temperature rise to 2 °C – the target agreed upon in Copenhagen and Cancun – emission levels need to be approximately 44 gigatonnes of carbon dioxide equivalent (GtCO_{2e}) in 2020 (range: 38-44 GtCO_{2e}). Business-as-usual estimates by UNEP, however, project a global emission level at 56 GtCO_{2e} (range 54-60 GtCO_{2e}), effectively creating a 12 GtCO_{2e} gap.¹² Finally, while

¹² This 12 GtCO_{2e} gap corresponds to earlier findings by UNEP in their efforts to determine the gap. For instance, the 2012 iteration of the report outlined a 8-13 GtCO_{2e} gap but noted that in all likelihood the gap would be at the higher end of the estimate (United Nations Environment Program [UNEP], 2012). The 2011 estimate, at 6-11 GtCO_{2e} was somewhat lower – due to lower economic growth prognoses (United Nations Environment Program [UNEP], 2011). Overall, since 2010, estimates of the emission gap have continued to increase and UNEP has repeatedly documented that current efforts – even when all pledges are stringently applied- are insufficient to close the gap. More ambitious action levels are required.

UNEP shows that it is possible to close the remaining ambition gap through the implementation of (much) more aggressive domestic action (supported by international assistance), emission reductions will need to be very steep indeed to maintain a feasible chance to limit global average temperature warming to 2° C or even 1.5° C (a target called for by, primarily, the Small Island Developing States [SIDS]). Importantly, in their calculations, emissions will need to peak before 2020 and will need to continue a sharp decline for the rest of the century.

2.1.3 Economic growth vs. sustainability

The pursuit of climate stability is often phrased in terms of economic costs. Due to the significant dependence of modern society on abundant flows of energy, energy growth patterns are seen as a key driver of economic growth. As a result, economic growth and growth and energy use follow a pattern of “‘synergistic development’ – a process of reinforcing growth between [energy] and [...] economy” (Byrne, Glover, Lee, Wang, & Yu, 2004, p. 495). This leads Newell & Paterson (1998, p. 693) to conclude that: “strong networks of mutual dependency thus exist between the state and the energy sector.” The protection and support of the energy sector is therefore a key issue on the agenda of the nation-state leading to a potential weakening of a state’s commitment to aggressive climate change action (e.g., Newell & Paterson, 1998; Benjamin & Paterson, 2012; MacNeil & Paterson, 2012).

Similarly, Byrne, Wang, Taminiau, & Mach (2014) offer an account of how combined state and corporate interests affect considerations of transition towards low-emission, climate resilient, green energy economies. In particular, they recognize that the dominant political economy architecture – the overall constellation of relationships between energy producers and consumers, the alignment of political and economic

power, and the institutional, legal, and policy framework – is capable of either accelerating or inhibiting social change. In this, they propose that a key component is represented by the ‘structure of social valuation’ which is defined as “the social dynamic that directs actions and establishes goals based upon its evaluation of their merit” (Byrne, Wang, Taminiau, & Mach, 2014, p. 4). This structure is produced by the existing dominant and powerful political and economic architecture which shapes the context in which decisions are made. As outlined by Byrne, Wang, Taminiau, & Mach (2014), this architecture creates and, simultaneously, favors certain decision-making criteria that fit with a technological paradigm of ‘more is better’ and the economic ‘cornucopian’ (Byrne & Yun, 1999) governance paradigm. An oft-used quote by the Center for Energy and Environmental Policy (CEEP) community presents a sophisticated articulation of the result of this dynamic:

Quantitative production has become, for our mass-minded contemporaries, the only imperative goal: they value quantification without qualification. In physical energy, in industrial productivity, in invention, in knowledge, in population the same vacuous expansions and explosions prevail (Mumford, 1961, p. 570).

The positioning of climate change as an argument for reduction, in a world where cornucopianism and “more is better” mentalities prevail, therefore naturally encounters resistance (Byrne & Taminiau, 2015). Development is often still considered in Rostowian (Rostow, 1990) terms of linear development towards an end-all configuration of high-throughput and carbon intensive societies. The “carbon economy,” as such, resonates throughout the development discourse and developing countries frame their pursuit for development along modern energy economy conceptualizations, including those of abundant energy (e.g., Mathai, 2009).

The current position of energy, especially in its abundance (Sovacool, 2011; Huber & Mills, 2005), limits the menu of social change options available within the discussion on climate change. The negotiation position of many developed and developing countries alike reflects this limitation as, throughout the negotiation process, prominent developed and developing countries have argued for flexibility and leniency in terms of their emission reduction targets based on the grounds of prohibitive cost (as evaluated from the dominant architecture) or on the need to continue energy expansion. The United States is a case in point as it has persistently argued, throughout the Kyoto era of 1992-2009 the importance of flexibility, parallelism, and uncertainty.

The limits imposed by the meta-narrative and ideology that currently support the pursuit of the high-carbon lifestyle as the ultimate expression of what it means to life well (Byrne et al., 2009) complicate any argument for fundamental reconstruction of the energy economy and society's influence on our environment (Byrne, Wang, Taminiau, Mach, 2014). Transformative social change is then likely to only be successfully pursued when such fundamental notions inherent in society are taken into account and are actively targeted for reconfiguration. Efforts that fail to do so, as are existing in several examples within the energy-climate debate today (Byrne & Taminiau, 2015; Taminiau & Byrne, 2015), are unlikely to deliver the (energy) transition in the timeframe demanded by the scientific community or to stay within politically accepted boundaries of atmospheric chemistry distributions.

The result of the above is a negotiation dynamic where, due to concerns about limits to economic growth, developed nations propose only limited emission reduction

targets and have supported the use of mechanisms to restrain economic damage. The implicit acceptance in this is that:

- Some degree of global warming is acceptable even though the consequences of such warming is most likely to affect the poor nations of the world the most; and
- Developing nations are called upon to deliver emission reductions, in the name of market efficiency and cost-effectiveness, and counted towards the account of the developed countries.

2.1.3.1 Economic Crisis, Absolute Decoupling, and the Environmental Kuznets Curve

As briefly indicated in Chapter 1, there is clear and ample evidence of relative decoupling (see also OECD, 2014). This is unsurprising as profit-maximization strategies continually seek to gain additional value from each unit of input. A more fundamental notion, however, lies within the concept of *absolute* decoupling: resource demand/impact decreases even when economic growth continues. In this context, the empirical record is less robust. Indeed, several studies on environmental dependency find that there is no empirical evidence for decarbonization or dematerialization at higher economic growth rates or incomes (Jackson, 2011; Hepburn & Bowen, 2012; Steinberger, Krausmann, Getzner, Schandl, & West, 2013; Andreoni & Galmarini, 2012).¹³

¹³ Interestingly, however, a form of absolute decoupling does take place elsewhere: between the fulfillment of human needs and energy consumption or carbon emissions (Steinberger & Roberts, 2010). This line of reasoning supports strategies that seek to halt energy growth and carbon emission growth and counteracts frequently made arguments of a ‘return to the stone age’ when such strategies are put in place.

Some argue a relationship between economic growth and resource use/environmental degradation captured by the term Environmental Kuznets Curve. This position maintains that, after a period of degradation, environmental circumstances improve when economies grow (He & Richard, 2010; Sephton & Mann, 2013). However, a growing body of literature continues to critique this position that economies can grow their way out of environmental harm (Stern, 2004; Mills Busa, 2013) to the point where the position has become largely untenable:

The idea to grow first and to deal with environmental issues later has been proven false empirically. Its appeal was and is based more in wishful thinking rather than sound evidence (Steinberger, Krausmann, Getzner, Schandl, & West, 2013, p. e70385).

The close ties between the energy sector and the overall health of the economic system raises the question whether economic crisis, such as experienced since 2008, has a meaningful influence on the global emission pattern. While there is no clear sign that the mitigation efforts deployed by the world are successful, economic recession appears to have been able to materially affect the rising emission pattern of global GHG emissions (Figure 2.2). Even then, the effect is short-lived and relatively marginal:

The 2010 growth overcomes the 1.4% drop in emissions recorded in 2009, which was due to the GFC [i.e. global financial crisis], putting global CO₂ emissions back on the high-growth trajectory that persisted before the GFC [...]. Thus, after only one year, the GFC has had little impact on the strong growth trend of global CO₂ that characterized most of the 2000s (Peters, et al., 2012, p. 2).¹⁴

¹⁴ An effect that should not go unnoticed, however, is its consequence in terms of public opinion about climate change: the decline in public concern about climate change in the U.S., for instance, can reliably be attributed to increased economic insecurity due to the economic crisis (Scruggs & Benegal, 2012).

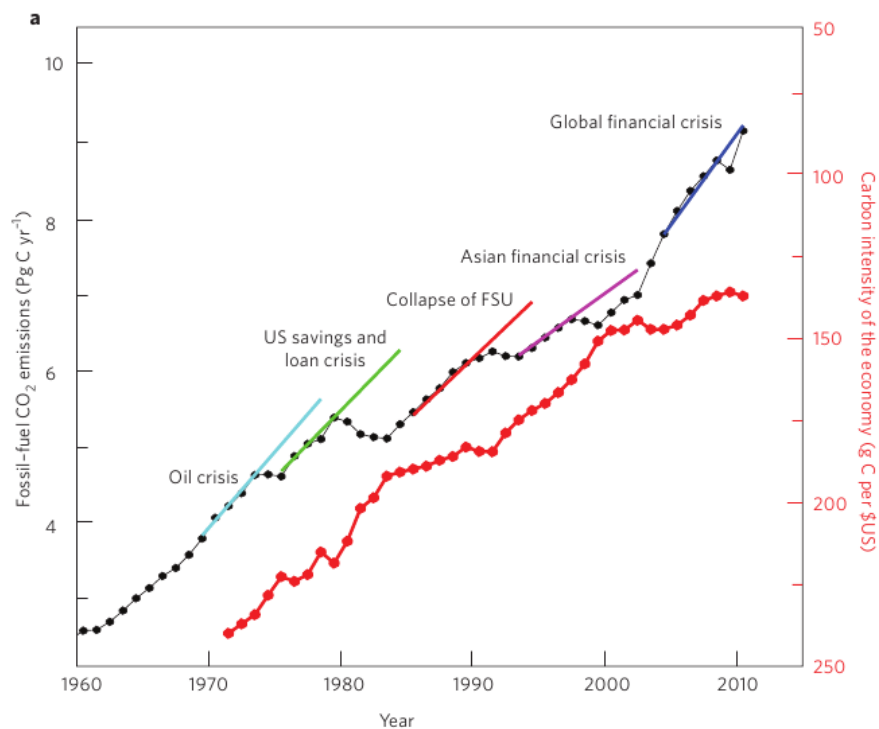


Figure 2.2; Economic crises and global emissions of GHGs. Source: (Peters, et al., 2012).

2.1.3.2 Carbon Markets and the CDM

Trading at approximately €0.10 per certified emission reduction (CER) and €6.8 per European Union allowance (EUA), two of the primary carbon pricing mechanisms in the European Union Emission Trading Scheme are at prices considered far too low to motivate (transformative) change (Löfgren, Wråke, Hagberg, & Roth, 2014) (Figure 2.3). The observed price pattern for the two trading mechanisms has several root causes. In the case of the EU ETS, the following is frequently pointed to as causes for the observed price decline (Carbon Market Watch, 2014):

- Yearly emission limits were set higher than business-as-usual emission patterns;

- International offsets (such as the CERs) exacerbated this surplus. In fact, offsets cover over half of the excess carbon market allowances.; and
- The economic crisis further contributed as it slowed down emission patterns, creating a larger gap between the cap and actual emission patterns.

Meanwhile, the CDM market faces its own difficulties:

- The low price spurred a considerable decrease in the whole CDM pipeline. For instance, an 88% decrease in submission for validation has been observed in 2013 over 2012, ten times fewer projects and programme of activities (POAs) registered in 2013 over 2012, and March 2014 displayed the lowest monthly CER issuance for the past three years (World Bank, 2014).
- The lackluster market has resulted in significant losses; one analyst puts the asset value write-down at \$66 billion (Philp, 2013).
- Major market players have left the CDM space (World Bank, 2014). Knowledge, expertise and skills thus flee the market undermining future trust and confidence in a recovery. Similarly, a Point Carbon (2013) survey documents how 45 percent of compliance entities communicate their end of CDM project investment and 26 % say they will stop procurement and trading of primary CERs (Point Carbon, 2013).

Several modifications have been proposed to address these difficulties. The efforts grouped under Phase III of the ETS system are: a redesign of the aggressiveness of the cap, a single cap (as opposed to national caps), full auctioning of allowances and issuance of allowance based on ‘top 10%’ benchmarking, and restricting the inflow of international offset credits primarily by banning credits from industrial gas destruction projects (especially HFC-23 and adipic acid).¹⁵ In light of

¹⁵ Other main changes to the EU ETS are the entry by Croatia, bringing the total number of countries under the ETS to 31 and plans to link the EU ETS to Australia’s domestic trading system (European Commission, 2012).

continued surplus estimates, agreement on an additional measure was reached: the ‘back-loading’ of allowances in the EU ETS to create a ‘false scarcity’ to address the rising surplus – calculated by the European Commission to rise to 2.6 billion credits by 2020 (European Commission, 2014) but outside critics arrive at significantly higher surplus numbers (Sandbag, 2014). This ‘back-loading’ positions 900 million credits at the end of phase III, reducing the auctioning amounts in 2014, 2015, and 2016 by respectively 400, 300, and 200 million credits (Carbon Market Watch, 2014). This is a temporary fix, awaiting new regulations to be issued for Phase IV. What is clear, however, is that the significant surplus of emission credits will likely reduce the overall emission reduction effectiveness of the two carbon pricing mechanisms for quite some time to come. Indeed, commentators have described the ETS as in a “terminal decline” (Oliver, 2014) with “essentially worthless” credits for trading (Clark, Chaffin, & Blas, 2013).

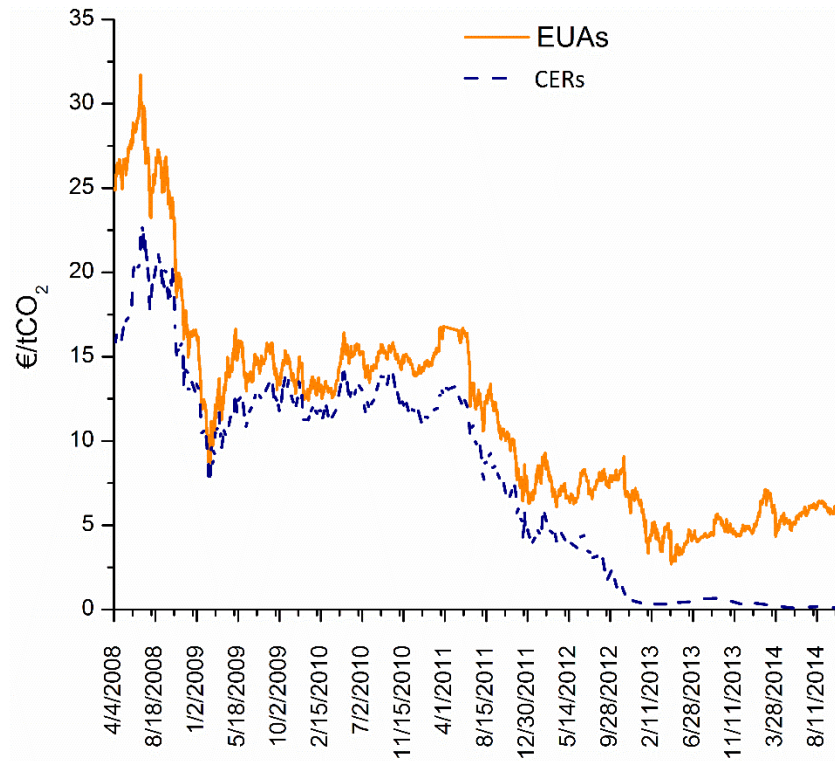


Figure 2.3; CERs and EUAs future prices. Source: Intercontinental Exchange (ICE) (Quandl, 2014).

These criticisms are just the latest in a long line of accusations directed both at the EU ETS and the CDM. For instance, the CDM has been accused of: allowing projects with massive credit generating potential but marginal sustainable development benefits to gain windfall profits and opening up the CDM to ‘gaming’ (Wara M. , 2007; Wara & Victor, 2008), having a limited impact on sustainable development in general due to a prioritization of emission reductions (Olsen, 2007), facing perverse incentives in relation to setting baselines (Lohmann, Hällström, Österbergh, & Nordberg, 2008), and the difficulties surrounding the additionality

clause (Schneider, 2009).¹⁶ Another point often raised is the reliance on outside consultants that do not possess requisite knowledge, are overworked, failed to follow instructions, or spent only limited time on each project evaluation (Schneider, 2009; Michaelowa & Purohit, 2006). This last point will likely be exacerbated by the recent ‘exodus’ (World Bank, 2014) of experts out of the CDM market space.

Recent publications continue these discussions. For example, the research literature suggests a pessimistic outlook on the net contribution on emission reductions (primarily due to additionality failures and baseline estimation failures) by the CDM: the mechanism could have a net positive contribution of as much as 3.6 billion tons of CO₂-eq by 2020 (Erickson, Lazarus, & Spalding-Fecher, 2014). Other continued criticism is the unequal distribution of CDM projects and the high influence by methane and industrial gas destruction projects (Watts, Albornoz, & Watson, 2015).

¹⁶ For instance, evidence exists to suggest the flawed character of the rationale that positioning emission reduction activity in developing countries actively supports their economic and sustainable development. For example, experience with the CDM – tasked with the dual objective to realize sustainable development and cost-effective emission reductions – suggest that the monetary outputs are prioritized and privileged over the contribution to sustainable development (Sutter and Parreno, 2007; Gupta et al., 2007). An important aspect related to this trade-off is that while sustainable development benefits are mandated through the Kyoto Protocol provisions on the CDM, they are not expressed in a monetary value and therefore perhaps play only a limited role (Olsen, 2007; Olsen & Fenhann, 2008). Moreover, due to their commodity market status, CDM project flows closely follow foreign direct investments and are as such highly skewed towards a handful of countries.

2.1.3.3 Theoretical account on the pervasiveness of market efficiency versus sustainability

The abstraction of climate action into an aggregated economic unit in the form of a fungible credit entangles environmental protection – and, as such, the prevention of social harm – with other interests and values (Byrne, Glover, & Martinez, 2002).

Leigh Glover captures this as follows:

“Illustrative of the difficulties of creating an emissions market among nations is how the original objective of lowering emissions becomes tangled with other interests, such as allowing nations to profit from emission credit sales, the acceptance of short-term failure as the basis for success in the longer term, and allowing incidental emission reductions to have equivalent values to those resulting from investment” (Glover, 2004; p. 397).

Not only does this devalue the atmospheric commons and singularizes the language with which we approach the atmosphere (Martinez-Allier J. , 2008), it also legitimizes the capture of the commons through commodification. Glover (2004), furthermore, succinctly summarizes other criticisms directed at the process of commodification:

“critics of the Kyoto mechanisms have argued, using insights from political economy, that emissions trading and other measures have perpetuated the ability of developed states to maintain a global economic advantage, to evade the costs of emissions reductions, and to continue to displace the costs of the fossil fuel energy system onto poorer nations, future generations, and the environment.” (Glover, 2004, p. 369).

In relation to the commons, Oran Young depicts three basic governance approaches:

1. A property-rights system that encloses the system in question;
2. Supranational or world government; and

3. The establishment of a commons-based management structure along codes of conduct as found in communal management systems of small-scale societies.

A famous iteration of how to decide among these governance options is captured by Garret Hardin's "tragedy of the commons" (Hardin, 2005). The argument goes as follows: commons-management schemes cannot be trusted as wealth maximization efforts will inevitably lead to the destruction of the good that was to be held in common. Instead, property-based governance structures could, according to Hardin, be hopefully re-dimensioned to include the valuation of ecological risk and damage to incentivize the property-owner to sustainably manage the good. The thesis developed by Hardin can be seen as a precursor to current efforts to position sustainability as a principle of economics, not ecology, and thus refine market-based decision-making to harness optimization as a tool for environmental improvement (Byrne & Taminiau, 2015) and, in effect, modernizing nature (Paterson, Dryzek, Norgaard, & Schlosberg, 2011; MacNeil & Paterson, 2012; Bumpus & Liverman, 2008; Byrne, Martinez, & Ruggero, 2009; Glover, 2004; Byrne & Yun, 1999).

Hardin's premise has been challenged by many (Ostrom E. , 1990; Poteete, Janssen, & Ostrom, 2010; Agrawal & Ostrom, 2001; Casari & Plott, 2003; Ostrom & Ostrom, 2009). Well-functioning commons governance institutions and strategies have been documented some of which are several centuries in length (Casari & Plott, 2003; Coop & Brunckhorst, 1999). Unlike the translation of sustainability into economic prescriptions available for exchange, such a commons-based management style would position sustainability as a component of the commons where social institutions observe and adapt to limits defined in natural or social terms (Byrne & Taminiau, 2015). This train of thought suggests that, rather than Hardin's conclusion that, unless proper management schemes are put in place, the commons are frail and destined to be

exhausted by modern activity, it is the commodification approach that fails to adequately capture the dynamism of the commons (Byrne & Taminiau, 2015). In other words, empirical observations of success by commons-based operations suggest that it is not the commons that are frail but, rather that the “moderns cannot be trusted in the commons” (Byrne & Taminiau, 2015).

2.2 The Governance Failure: Negotiation Gridlock

The previous sections document the failure to adhere to the sustainability principle. One obvious question is to consider whether follow-up negotiations will be able to put in place agreements that could revitalize the sustainability effort and reach sustainability objectives. This question is addressed in this section, where the consequences of rising multi-polarity is evaluated (2.2.1.), where the problem of climate change itself as a ‘super wicked’ problem is discussed (2.2.2.), and where several additional developments shed light on the issue (2.2.3.).

2.2.1 Multi-polarity

The nation-state centered approach of the Kyoto era has encountered significant geo-political shifts over the past two decades. These shifts amount to a new pattern of interaction among nation-states (Subacchi, 2008), what one observer called the ‘New World (dis)Order’ (Roberts, 2011). Characterized as a rising multi-polarity, power capabilities among debate participants shift where are at least three nation-states have far greater power compared to the rest (Lesage, Van der Graaf, & Westphal, 2010). ¹⁷ The shifts that together represent this new pattern of interaction

¹⁷ Conversely, others have argued for a case of ‘nonpolarity’ where, with the observation of rising power from some nation-states, absence of power asymmetry

are expected to complicate negotiations even further. An early example of how this plays out is the emergence and sudden importance of the BASIC bloc of negotiating Parties (Hochstetler & Milkoreit, 2014). According to Roberts (2011), the new pattern of interaction is primarily shaped by the following three trends:

1. The U.S. faces a dilemma of hegemonic decline in relation to rising power China. This point is further supported by several other analysts (Schum, 2014; Christoff, 2010; Dimitrov, 2010). The U.S.-China relationship is indicative of a wider 'North-South' strain on the ability of the negotiation process to produce progress (Paterson, Dryzek, Norgaard, & Schlosberg, 2011; Joshi, 2013). This is not to say that combinations of cooperation are impossible however as demonstrated by, for instance, U.S. – China collaboration in the Asia-Pacific Economic Cooperation (APEC) summit which recently announced a 'historic' climate change deal between the two superpowers (Rauhala, 2014).¹⁸

emerges, creating a “flat world” (Friedman, 2005). However, here, in line with Legase, Van de Graaf, & Westphal (2010), the multi-polar concept is applied but nuanced with the observation that ‘polarization’ (defined as “the tendency of actors to cluster around the most powerful states in the system” (Rapkin et al., 1979: 263, as quoted by Legase, Van de Graaf, & Westphal (2010, p. 77)) is marginal. In fact, due to the observation of marginal polarization but increased ‘multi-polarity’, a case can be made that today’s multipolar world is more fragmented and has more players as power equalization brings in additional parties into the privileged role of powerful negotiator (Legase, Van de Graaf, & Westphal, 2010).

¹⁸ Critically, the ‘historic’ deal can be forcefully criticized for lacking in both ambition and its breakthrough character. For instance, Sunita Narain (Centre for Science and Environment, India) commented that the deal was “neither historic nor ambitious, but just a self-serving agreement between the world’s two biggest polluters. The deal will actually take the world towards a catastrophic beyond 3 °C temperature increase pathway” (India Climate Dialogue.net, 2014). Navroz Dubash (Centre for Policy Research, India) is more optimistic but comments that “this is smart politics by the G2. The US target and the Chinese peaking year will certainly require some effort, but are probably not stretch targets. And it allows both countries to claim leadership in breathing life into the climate talks” (India Climate Dialogue.net, 2014).

2. Negotiating blocs, especially the Group of 77 (G-77), have to deal with increasing levels of fragmentation. This point is further supported by in-depth investigation into the G-77 (Williams M. , 2005; Vihma, Mulugetta, & Karlsson-Vinkhuyzen, 2011). Explicit divergence occurs when looking at the long un-contested common but differentiated responsibilities principle: especially ‘weaker’ nation-states in the G-77 (such as SIDS/AOSIS and LDCs) have begun to argue for stronger action and transparent action from the stronger G-77 nations (Vihma, Mulugetta, & Karlsson-Vinkhuyzen, 2011). Another realm of explicit divergence relates to adaptation financing and which countries within the G-77 should be entitled to such support, fracturing the G-77 group along similar lines but focusing especially on whether oil-exporting countries should be entitled to receive adaptation financing (Vihma, Mulugetta, & Karlsson-Vinkhuyzen, 2011).
3. European Union leadership, prominent throughout most of the climate change negotiations (Gupta, 2010; Leas-Arcas, 2011), is weakening. (Ahnliid & Elgstrom, 2014; Bäckstrand & Elgström, 2013).

When these three lines of action play out, the climate diplomacy’s center of gravity, as described by Purvis & Stevenson (2010) and illustrated in Figure 2.4, can be expected to shift even further away from its already precarious position in terms of realizing a top-down, strong regime. Finding sufficient support for a strong global top-down agreement has already proven very problematic as many major negotiating parties (e.g., U.S., China, India, Russia) largely see such a proposition as a non-starter, favoring instead a weaker regime along bottom-up formulations (Purvis & Stevenson, 2010; Leal-Arcas, 2011a; Leal-Arcas, 2011b; Victor D. G., 2011). ¹⁹

¹⁹ Indeed, recognizing the negotiation power of several hegemonic parties, particularly the United States, reveals an overall characteristic of fragility. Evidenced by U.S. intransigence throughout the Kyoto Protocol negotiations and its resulting limitations for a Kyoto Protocol roll-out, this fragility can substantially hamper the effectiveness and integrity of a global climate change agreement. This argument of fragility is particularly critical when reflected upon in the light of later findings (Chapter 4, 5, and 6).

In sum, existing major fundamentals of the climate change policy paradigm are likely unsuitable to reach desired ends: the major negotiating Parties simply do not align on these fundamentals, have largely never aligned on these fundamentals, and will most likely continue to be misaligned with expected top-down climate change architectures along the lines sought (see Figure 2.4). Negotiation position placement of key parties in Figure 2.4 was based on their motivation to create (for itself and for others) a system of legal obligations with non-compliance consequences (i.e. their alignment with a “strong” regime) and their willingness to establish domestic mitigation measures on the basis of science and determined through negotiations (Purvis & Stevenson, 2010). As such, a “bottom-up” alignment means the Party has iterated its preference for domestically formulated commitments while a “weak regime” alignment refers to the Party’s position on enforced compliance by a global agreement. For example, the United States has iterated it will be willing to enter into a global agreement but only when others (particularly China) are likewise bound by the agreement, the U.S. has put forth relatively weak commitments throughout most of the negotiations, and has placed emphasis on domestic control of the commitments (Chapter 1).

With Europe losing negotiation power, developing countries establishing fragmented negotiation positions, and U.S. – China hegemonic conflict, this is not likely to change anytime soon. For instance, the fracture of country alignments have occurred, according to Roberts (2011), along the lines of solidarity, responsibility, capability, and vulnerability, producing a complex range of negotiation positions and interests. Finally, to overcome entrenched negotiation positions, trust is a critical commodity (Bodansky & Diringer, 2010). However, trust is rapidly becoming a scarce

resource within the negotiations (Dubash, 2009), enforcing the notion that ‘Kyoto era’-type solutions are unviable. The new, multi-polar and fragmented world order likely requires a rethink of existing assumptions and presumed linkages between theory and praxis. Building on earlier accounts describing experiences with hegemonic decline, Roberts (2011) establishes that this new (dis)order is likely to be characterized by higher levels of competition, conflict, and chaos.

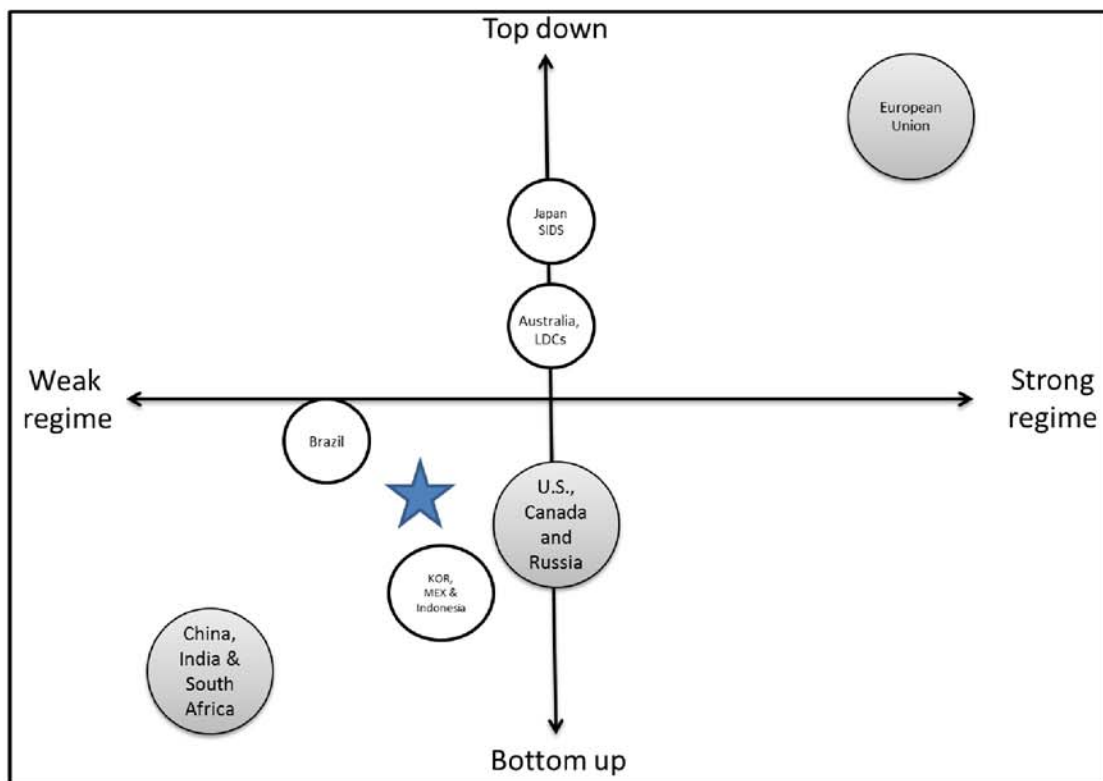


Figure 2.4; Climate Diplomacy Reality according to Purvis & Stevenson (2010).

Note: Alignment with a “Strong” regime, in this case, results in a Party’s high motivation to create (for itself and for others) a system of legal obligations with non-compliance consequences. “Top down”, in this case, is used to refer to a willingness to establish domestic mitigation measures (by 2020 and 2050) on the basis of science and determined through negotiations. The star in the graph depicts the center of gravity in terms of the emission weighted midpoint of negotiating positions (Purvis & Stevenson, 2010).

2.2.2 “Super Wicked Problem of Climate Change”

A useful characterization of climate change can be constructed from Rittel & Webber’s (1973) conceptualization of “wicked” problems common to public policy and planning (Rittel & Webber, 1973; Rittel & Webber, 1984). Separating problems into “tame or benign” topics for discussion – which are relatively easily solved through the application of science and engineering principles – and “wicked” problems, Rittel & Webber sought to contribute to the resolution of particularly difficult policy issues. “Wicked” problems pertain the discussion of open societal systems and any problems that reside within them and Rittel & Webber (1973, 1984) identified ten characteristics for a problem to be considered “wicked”. Some of the features of “wicked” problems were later found to be overlapping or phrased in ambiguous wording so, to simplify, Steve Rayner (2006) deconstructed the ten characteristics into a more accessible set of six characteristics. That is, “wicked” problems:

- Are symptomatic of deeper problems;
- Present unique opportunities for action that can’t be easily reversed;
- Are unable to offer a clear set of alternative solutions;
- Are characterized by contradictory certitudes;
- Contain redistributive implications for entrenched interests; and
- Are persistent and insoluble.²⁰

²⁰ For completeness, the ten distinguishing features as identified by Rittel and Webber (1973, 1984) are:

Climate change, however, introduces several additional characteristics that are not captured by this set of identification principles. As such, Levin et al. (2009; 2007)

There is no definitive formulation of a wicked problem. Instead, “[t]he information needed to *understand* the problem depends upon one’s idea for *solving* it” (Rittel & Webber, 1984, p. 136).

Wicked problems have no stopping rule. “[T]he would-be planner can always try to do better.” (Rittel & Webber, 1984, p. 138).

Solutions to wicked problems are not true-or-false, but good-or-bad.

There is no immediate and no ultimate test of a solution to a wicked problem. Rather, the authors contend that public policy pursues *re-solution*: “any solution, after being implemented, will generate waves of consequences over an extended – virtually an unbounded – period of time.” (Rittel & Webber, 1984, p. 139).

Every solution to a wicked problem is a “one-shot operation”. There is no opportunity for rigorous experimentation as any implemented solution is consequential.

Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions. Instead, “a host of potential solutions arises and another host is never thought up.” (Rittel & Webber, 1984, p. 140).

Every wicked problem is essentially unique.

Every wicked problem can be considered to be a symptom of another problem. As such, “marginal improvement does not guarantee overall improvement.” (Rittel & Webber, 1984, p. 142).

The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem’s resolution.

The planner has no right to be wrong: “In the world of planning and wicked problems no such immunity is tolerated. Here the aim is not to find the truth, but to improve some characteristics of the world where people live. Planners are liable for the consequences of the actions they generate; the effects can matter a great deal to those people that are touched by those actions.” (Rittel & Webber, 1984, p. 144).

augment the concept of the “wicked” problem through the introduction of their “Super Wicked” problem. “Super Wicked” problems encapsulate four additional features not included under “wicked” problems:

- *Urgency*: "Those wishing to address super wicked problems such as climate change [...] do not have the luxury of "coming back" to the political system for a retry" (Levin, Cashore, Bernstein, & Auld, 2007, p. 6).
- *Chaos*: there is a notion of "cooperation under anarchy" as public authorities do not control all the choices that need to be made.
- *Globalism*: "Unlike other environmental problems with discrete antagonists and protagonists, human-induced climate change results from individual and collective activities at multiple scales, as well as marketplace activities" (Levin, Cashore, Bernstein, & Auld, 2007, p. 7). In other words, everyone contributes to the problem of climate change and everyone is affected.
- *Hyperbolic discounting*: discounting of the future even beyond what the economic tool of the discount rate suggests is considered rational. This pushes resolution of the problem out into the future.

Several other analysts (e.g., Prins & Rayner, 2007; Lazarus, 2009; Hoffmann, 2011) support the characterization of climate change as a “Super Wicked” problem. The response strategy adopted throughout the Kyoto era mimics those of earlier response strategies to environmental or collective action problems such as ozone depletion, nuclear weapon proliferation, and acid rain (Prins & Rayner, 2007a). However, in line with the notion of the “super wicked” problem, one can question the “formulaic”, one-shot approach that has been applied throughout the Kyoto era:

"To be clear, our argument is not against large-scale policy interventions, rather our approach recognizes that the very nature of super wicked problems militates against the political achievability of one shot, large-scale responses." (Levin, Cashore, Bernstein, & Auld, 2007, p. 4).

Moreover, vulnerable to powerful political and economic forces, especially when incorporating the element of time (Lazarus, 2009), strong and effective commitments are not only difficult to achieve but, even when agreed upon, difficult to preserve over time. As such, it is important to seek pathways to insulate the response strategy from such forces.

Nonetheless, the questioning of the approach is of relatively recent origin:

“the two-decade story of climate change negotiations [...] is remarkable for how consistent it is. For the vast majority of the last 20 years, there was no significant questioning of the basic assumption that brought us the UNFCCC and the Kyoto Protocol – the appropriateness and efficacy of megamultilateralism” (Hoffmann, 2011, p. 16).

2.2.3 Further complications: mainstreaming, development vs. climate, adaptation.

Over time, it has become increasingly clear that the interrelationship between other development factors and issues and climate change needs to be incorporated in the operational toolbox of the international climate change governance structure. This need is informed by observations that directly link development prospects around the world to climate change (Anderson, 2011; Padgham, 2009). This is both due to the fact that development pathways determine the magnitude of GHG emissions *and* the finding that climate change adversely affects development opportunities (Sathaye, et al., 2007). Three considerations are presented here that are contributing to a further understanding of the interaction – and to an expected greater emphasis – on the need for integration between climate change and overall development issues.

2.2.3.1 Development versus environmental protection

The international negotiations on climate change are differently perceived among nations of the Global South compared to those of the Global North. Generally, whereas the North values environmental protection, the countries of the South prioritize development. Many authors emphasize this dichotomy in perspective (Agarwal & Narain, 1991; Najam, Huq, & Sokona, 2003; Najam A. , 2005; Ockwell, Haum, Mallet, & Watson, 2010). The opposition of developing countries to mandatory emission reduction targets is fueled by retributive and egalitarian proposals of justice and equity based on the historical responsibility of developed countries and the demand for space to develop (Paterson, Dryzek, Norgaard, & Schlosberg, 2011; Byrne, Kurdgelashvili, & Hughes, 2008; Najam A. , 2005; Najam, Huq, & Sokona, 2003; Shrivastava & Goel, 2010).

However, Najam (2005) recognizes that, over time, the countries of the South have become increasingly engaged in international environmental discussions. Considering that they tend to view the legitimacy and effectiveness of global environmental governance through this lens of poverty alleviation, energy justice, and energy poverty (Najam, 2005), the increased participation and involvement in the international community by developing countries projects a trend of increasing importance of the development narrative within environmental discussions.

2.2.3.2 Synergy potential between development and climate change

Scientific efforts to understand climate change are increasingly focusing on the interaction and potential synergy between development considerations and the field of climate change. Climate change science – as synthesized by the IPCC – shows an evolution towards increasing recognition of the importance of development within the

climate change narrative (Ahmad, 2009). Strong inter-linkages exist between development considerations and climate change. For example, Munasinghe (2000) notes that development, equity, and sustainability considerations should be integrated with climate change efforts as they share fundamental scientific and epistemological links. The linking of these issues would also likely result in a more balanced set of arguments and is expected to lower the barrier for participating Parties to accept strategies that address climate change problems (Munasinghe, 2000). These arguments, among others, are also brought forward by multiple other authors (see, e.g., Sathaye et al., 2007; Adger et al., 2007; Yohe et al., 2007; Najam et al., 2003; Beg et al., 2002).

Table 2.1; Evolution of Climate Change and Sustainable Development Considerations in IPCC Repors. Source: Ahmad, 2009; Najam et al., 2003.

IPCC First Assessment Report (AR1; 1990)	IPCC Second Assessment Report (AR2; 1995)	IPCC Third Assessment Report (AR3; 2001)	IPCC Fourth Assessment Report (AR4; 2007)
Climate + Impacts	Climate + Impacts	Climate + Impacts	Climate + Impacts
Cost-effectiveness	Cost-effectiveness	Cost-effectiveness	Cost-effectiveness
	Equity	Equity	Equity
		Alternate development pathways	Alternate development pathways
			Sustainable development

2.2.3.3 The Rise of Adaptation as a Primary Component of Agreement

Adaptation as a policy recourse has not been a dominant component of the international negotiations on climate change as these have, for the most part, been focused on the mitigation of the climate change issue. However, with new realizations that some level of climate change will happen – and, with it, the (negative) consequences of such changes in patterns – the topic of adaptation has become more relevant and prominent in the discussions (Bauer, Feichtinger, & Steurer, 2012). However, the adaptation challenge remains opaque, with limited understanding of its magnitude and, moreover, actual implementation of adaptation efforts appears to be lacking (Ford, Berrang-Ford, & Paterson, 2011; Berrang-Ford, Ford, & Paterson, 2011). The increasingly forceful positioning of the issue of adaptation as a primary component of agreement so close to the current road’s deadline of 2015, but without full understanding nor real-time applications, complicates the likelihood of agreement even further.

2.2.3.4 Climate Change Policy Integration

The final trend – closely related to the ones mentioned above – is that climate change policy is increasingly seen to follow a pathway of climate policy integration (Mickwitz et al., 2009; Ahmad, 2009; Nunan, Campbell, & Foster, 2012; Chuku, 2010; Yedla & Park, 2009). Similarly, efforts are underway to make development “climate change compatible” (CDKN, 2010a; CDKN, 2010b).²¹ In short, these kinds of efforts can be described as:

²¹ However, Redclift (2005) recognizes that a sustainable development concept that panders to the needs of global neo-liberalism results in constructs such as “green capitalism,” “ecological modernization,” and “win-win” scenarios. He argues that such constructs often fail to recognize the specific local context as social circumstance

"the incorporation of the aims of climate change adaptation and mitigation into all stages of policy-making in other policy sectors (non-environmental as well as environmental); complemented by an attempt to aggregate expected consequences for climate change adaptation and mitigation into an overall evaluation of policy, and a commitment to minimize contradictions between climate policies and other policies" (Mickwitz et al., 2009, p. 19).

2.3 The Equity Failure

The Kyoto era framework places questions of justice and equity at the core of its operational principles, at least in theory (Okereke, 2010). For instance, as documented, inter- as well as intra-generational equity is a key component of the UNFCCC text and the common but differentiated responsibilities is an expression of pursuing a just framework. In fact, some maintain that there are no Convention provisions that do not one way or another relate to questions of justice (Paavola & Adger, 2002).

Considerations of justice have been given many different names and presented in different sets (Okereke, 2010; Parks & Roberts, 2006). Shue (1993), for instance, famously documented the difference between 'subsistence' and 'lifestyle emissions' showing that the two are, in fact, not equal and that this difference should be accounted for in any climate change strategy. Several lines of justice considerations can be identified:

- *Corrective, Compensatory or Retributive justice*: historical patterns of, among others, energy use and land use have led to a differentiated emission profile of the nations of the world (Meyer & Roser, 2010). Especially, a small sub-set of countries has

is often difficult to accustom to such general constructs. The limitations of such constructs are further debated by Taminiau & Byrne (2015) in their discussion on 'green growth'.

particularly contributed to the problem of climate change while many other countries have a much more marginal contribution. Incorporating this element into questions of justice and emission reduction activities is seen as a compensatory strategy for the observed injustice. Compensation, in the Kyoto era mind-set, is often translated to financial and technological assistance from 'North' to 'South'.²²

- *Distributive/Distributional justice*: the question of distribution of burden among nation-states is related to the question of compensatory justice. However, distributional justice adds additional components to the problem. Particularly, a significant differentiation exists in terms of vulnerability to the consequences of climate change. Incorporating these differences in a response strategy reflects attempts to address distributional justice questions (Meyer & Roser, 2010).
- *Generational justice or neutrality*: The long-term nature of climate change, furthermore, raises the specter of generational distribution of climate change effects and availability of energy resources. Burning up the fossil fuels in this generation removes energy options for future generations while, at the same time, saddling future generations with the consequences of climate change (Archer, et al., 2009).
- *Systemic justice*: especially among developing countries, the perception exists that there is a systemic bias in the international climate change regime towards the North, reflecting of historical patterns of inequity (Najam, Huq, & Sokona, 2003; Okereke, 2010; Dorsey, 2007).
- *Procedural justice*: related to the previous concern of systemic justice, procedural justice considerations highlight the fairness of the process itself in terms of, for instance, participation of all actors involved. Meaningful involvement should be open to all parties.

²² Simplified dichotomy based on 1) historical emission patterns, 2) differences in benefits gained from historical emission patterns, 3) vulnerability differences, and 4) wealth differences (Meyer & Roser, 2010).

- *Substantive justice*: It is unjust to disproportionately affect segments of the population and all have a right to a clean and healthful living environment.

In an effort to judge whether the international climate change negotiations have pursued a just framework, Roberts (2011) offers eight criteria:

1. Procedural justice, giving equal voice and participation to all, needs to be in place.
2. Equitable sharing of the global burden and wealthy countries should take the lead and assist poorer nations.
3. Actions should be grounded in science.
4. The tipping point of 2 degrees Celsius needs to be avoided
5. Emission reductions will have to be 80-95% below 1990 levels by 2050 and at least 25-40% below that baseline by 2020.
6. A global ‘peak’ in emissions needs to take place by 2015 to protect coastal populations.
7. A just solution refrains from overly taxing the poor, nor raise their energy costs disproportionately as compared to their income.
8. The costs of adaptation should be borne by those who caused the problem.

Other discussions about climate justice introduce similar criteria. Roberts (2011, p. 779) subsequently discusses the criteria in light of observations of the climate change negotiations history and concludes that “justice remains at the core of the [negotiation] stalemate” as, for instance, power plays by a few dominant countries repeatedly violates notions of procedural justice (specifically, power plays during the Kyoto Protocol and the Copenhagen Accord), ‘grandfathering’ of emissions fails burden-sharing propositions, and emission targets are not aligned with mandates from the scientific community thus failing the third test. Similar failures can be observed throughout the negotiations on other justice tests such as ‘peaking’ and equitable

burden sharing. Roberts (2011) does note how the pledges for adaptation finance and ‘fast-start finance’ flows bring justice principles associated with assisting poorer nations to the forefront. However, initial major debate about the language of the provisions (Stadelmann, Roberts, & Huq, 2010) and recent research findings suggesting that “the distribution of adaptation funds do not support the larger goal of climate justice” (Barrett, 2014) and that “in practice, adaptation finance has reflected developed country interests far more than the principles of justice adopted by the Parties” (Ciplet, Roberts, & Khan, 2013, p. 50) signals a continued failure to uphold these principles of justice.

Additionally, criticism is leveled by many against the practical expression of the Convention’s pursuit for justice and equity, arguing that too often it is operationalized through a neoliberal focus that makes a pursuit for justice practically impossible (McCarthy & Prudham, 2004; Roberts, 2011; Taminiau & Byrne, 2012).²³ Such political economy insights are especially well suited to expose the connection of corporate influence and political action (Paterson, Dryzek, Norgaard, & Schlosberg, 2011; Levy & Egan, 2003; Lohmann, Hällström, Österbergh, & Nordberg, 2008) but can be further assisted by political ecology accounts that include the more nebulous and complex landscape of the international arena: comprised of nation-states, NGOs, corporations, grassroots groups, overall civil society and the ecological dimensions. Political Ecology joins the perspective of political economy with that of an

²³ Interestingly, some maintain that there is no place for justice in international regimes, terming the notion of ‘justice in international politics’ an “oxymoronic expression” in light of state’s egotistical and self-maximizing perspective (Franceshet, 2002; Okereke, 2010). This provides further insight into the failure to uphold the principle of justice.

understanding of ecology, elevating the implications generated by environmental degradation and the motivation of actors to address global environmental change (Robbins, 2004). In contrast to political economy, which limits its scope to productive value and capitalist reasoning, political ecology sees the additional value in environmental protection which can be used as an account to describe non-state actors (such as civil society) and their fight for justice and environmental protection.

As noted by, for instance, Glover (2004), Byrne & Glover (2002), and Byrne, Glover, & Alroe (2006), the political ecology account especially brings the notions of ‘ecological justice’ and the ‘commons’ to the forefront. Recognizing human-environment interaction through a political ecology lens that emphasizes scale, power relations, the organizing principle of sovereignty, the prevailing discourse, and the conception of space opens up additional realizations. Political ecology expands the account to include socio-ecological considerations and implications of inequality and injustice at different scales, between class, race, and gender, and focuses on explicating dominant narratives and ecological orthodoxies (Ford’s [2003, p. 127] “enclosures that shape and are shaped by social relations of power”). For instance, through a discourse analysis, Adger et al (2001) identify two primary discourses within the climate change debate: the dominant managerial commodity-based paradigm (largely described above) and populist proglifacy (as found in the critique of political economy). However, Adger et al (2001) argue that both discourses fail to fully maintain the social discourse as they fail to address the social processes associated with climate change adaptation. In essence, Adger et al. conclude that current policy-making institutions are out of touch as:

“local scale environmental management moves with a distinct dynamic and experiences alternative manifestations of environmental change and livelihood imperatives.” (Adger et al., 2001, p. 681)

Byrne & Taminiau (2015) highlight how the governance by capital strategy confines social agency to a form of ‘consumer democracy’ (Schwarzkopf, 2011) and an, potentially misplaced, optimistic belief in technological solutions. Community landscape inhabitants – i.e. everyone in the affected community – are reduced to anonymous end-use consumers through this approach (Byrne & Yun, 1999; Dubash & Williams, 2006). Byrne & Taminiau (2015) continue with a discussion of how moving away from this approach and reconstituting social relations to energy could enable the wider public landscape to help decide and act on sustainable futures (Yu, 2009; Byrne & Toly, 2006; Byrne, Martinez, & Ruggero, 2009) and thus establish a form of ‘energy democracy’ (Simmons, Dawson, & Harris, 2013). Repurposing policy, economics, and engineering to the active search for sustainable public benefits, with an active role of civil society, comprises a significant promise currently largely neglected by the managerial response strategy dominant in the Kyoto era (Byrne & Toly, 2006; Lutsey & Sperling, 2007; Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Byrne, Martinez, & Ruggero, 2009; Byrne, Wang, Taminiau, & Mach, 2013).

Substantial authority is awarded to scientific knowledge to outline climate change action (as evidenced by the quantification of emissions). Van Kerkhoff & Lebel (2006) offer several critiques on this notion in their discussion on sustainable development. These critiques show that research-based knowledge is *not* independent of the processes that have gone into creating it. For instance, Agarwal, Narain, & Sharma (2002) argue that it is the Western scientific expertise that enables developed countries to ensure that their interests are reflected in the research agenda and the

formulation of climate change's operational provisions. This realization results in an undervaluation of the developing country's and civil society's concerns and priorities.

Finally, in contrast to other non-state actors, corporations have arguably gained considerably more power in the governance structure due to their characteristics and fit with the capitalist economy in a globalized world (Schreuder, 2009). As Schreuder (2009) describes, this is especially true for transnational corporations (TNCs) that can navigate the globalization process in their pursuit for profit maximization. To an extent, large (multi-national) non-governmental organizations (NGOs) appear to also have gained a foothold in international environmental governance (Ford, 2003) and environmental standard setting (e.g., Bostrom & Hallstrom, 2010) but smaller, grassroots organizations still have a lot of difficulty in getting their voices heard (inter)nationally. Due to their position, corporations have been able to lobby governments (Leggett, 2000; Gelbspan, 1997; van den Hove et al., 2002) and, as a result, have been shown to tremendously benefit from the current climate change governance configuration (e.g., Sandbag, 2011).

2.4 Lessons Learned from the Kyoto era

Through the text provided in Chapter 1 and in the sections above, several critical lessons can be extracted with which to explore new strategies of change in the emergent, new, post-Kyoto landscape. Not the least of these lessons is that a key limitation of the convention-protocol process employed by the Kyoto era is the slow and cumbersome process: "by design, the convention-protocol model encourages deference of difficult issues" (Glover, 2004, p. 355). What is frequently cited as a strength of the regime approach – its evolutionary development (Depledge & Yamin, 2009, p. 434) – can, when one reflects on twenty-plus years of negotiations,

simultaneously be seen as a key weakness as progress is slow and difficult negotiation topics can be endlessly pushed further down the road. Some other findings are:

- A ‘one-shot’, ‘formulaic’ response strategy is not likely to be of sufficient capability to address the problem at hand.
- The ‘carbon economy’ and current development equals growth equation complicates ambition levels of nation-states.
- Climate diplomacy reality and expected changes in the constellation of negotiation positions provide a strong case against continuing on the current pathway.
- A mitigation-focused targets-and-timetables solution is hampered by the observed need to add many aspects from social reality. Changes need to go beyond current conceptualizations of ‘green capitalism’, ‘win-win’ scenarios, or ‘green growth’.
- The politicization of climate change at the national level (Paterson & Stripple, 2007), furthermore, opens climate change policy up to bargaining rather than absolute environmental protection setting. Powered by notions of ‘climate hegemons’, ‘veto states’, unbalanced biographies and histories of ‘historical materialism’, and ‘governance by capital’ dynamics, the climate change regime-building process is vulnerable to ‘lowest common denominator’ outcomes.

In short, the following conclusions can be drawn from this chapter:

1. A policy model focused on nation-states (especially Annex 1 or developed nation-states) and corporations as the key deciders has failed to generate support from non-Annex I nations and, generally, has led to little discernible progress in responding to the climate change challenge.
2. Support for this model fails due to the excessive focus on the commodity and the hegemonic position of certain nations in the negotiation dynamics. It has become apparent that there is a dichotomy in the perspectives on climate change mitigation and adaptation between the developing and developed countries.

3. A policy model that relies on market efficiency to generate change has failed to produce a strategy on the level needed to tackle the challenge. Indeed, the neglect of sustainability implications can be seen as a key factor in the stalled Kyoto process. The conservative tendency, largely informed on efficiency grounds, undermines global commitment to tackle climate change. Especially civil society leaders in non-Annex I states argued that the legitimate needs of development were sacrificed or marginalized with the singular call for efficiency.
4. The policy model neglects justice implications of change and, as such, negates the interest of overall civil society, which often finds more credibility in climate action built from within than imposed from without.
5. Furthermore, the practice of strong sustainability on an infrastructure level creates conflict with dominant political economy architectures, termed the 'dynamic conservatism' of political economy (Byrne & Rich, 1983), but can perhaps be circumvented at the community level (Byrne, Wang, Taminiau, & Mach, 2014; Byrne & Taminiau, 2015; Taminiau & Byrne, 2015).

Chapter 3

CANDIDATES FOR A PARADIGM SHIFT

Climate change can be justifiably positioned as the greatest collective action problem the international community has ever faced (Cole, 2011; Cole, 2008; Ostrom E. , 2012). However, as the discussion in Chapter 2 revealed, ongoing international efforts to devise a ‘big bang’ or ‘one-size fits all’ approach to deal with climate change has, in effect, delivered a “one-size fits nobody” (Adler, 2005) outcome (Sovacool & Brown, 2009; Helm, 2009; Andersson & Ostrom, 2008).

The case has been made that the current climate change strategy is limited in its capability to realize some of its own stated objectives. Operational strategies that differ from the current approach have also been briefly introduced. On the one hand, the United Nations sanctioned strategy of ‘pledge-and-review’ can be considered a departure from ‘Kyoto era’ confines as it opens up new pathways for investigation, particularly a ‘building block’ strategy in contrast to current ‘big bang’ pursuits (Taminiau & Byrne, 2011). On the other hand, a strategy has emerged which seeks to open up the playing field to additional actors, mechanisms, and levels of action. This strategy of ‘polycentrism’ seeks action by a much wider variety of actors, merging them across levels of action and deploying new mechanisms to realize change.

To understand and evaluate these operational strategies, it is first critical to elaborate on the notion of the ‘paradigm’ itself and, especially, on the concept of the ‘paradigm shift’ through ‘revolutionary science’. To do so, this chapter focuses on the theoretical framework offered by Thomas Kuhn (Section 3.1.). This discussion is followed by a review of the larger paradigm in which the climate change approach finds itself, that of economic optimality, and is contrasted against a paradigm of

ecological sustainability (Section 3.2.). This discussion is followed by a brief exposé on the operational strategies of polycentricity and pledge and review that could fit the precepts of paradigmatic change (Section 3.3.). As will become clear, one candidate (polycentrism) stands out compared to the other ('pledge-and-review') and the discussion then shifts to a more in-depth investigation of polycentrism (Section 3.4.) followed by research questions and methods (Section 3.5.).

3.1 Paradigms and the Paradigm Shift

Thomas Kuhn's notions of the paradigm and the paradigm shift form a crucial component of this manuscript (Kuhn, 1970/1996). Kuhn's theory, based on a detailed historiography of moments of great scientific upheaval, questions the orthodox image of knowledge development-by-accumulation and instead posits the possibility of radical and rapid change.

Darwinian revolution in biology, Lavoisier's oxygen theory of combustion, the Einsteinian and Newtonian revolutions in physics, the Copernican revolution in astronomy; all share, according to Kuhn, characteristics that brought him to the introduction of the 'paradigm'. Paradigmatic unity, Kuhn argues, is what enables description of scientific communities as, for instance, Darwinians, Newtonian physicists, etc. and, as such, represents the shared constellation of assumptions, beliefs, and values that the particular scientific community holds in common which, subsequently, allows the testing of scientific experiments, the prediction of results, and the search for new knowledge. However, citing the revolutionary character of the history of science, Kuhn proposes the critical importance of the paradigm shift: the radical transition from one shared constellation to another.

A selection of elements can be made that together constitute Kuhn's theory of paradigmatic change. Notably, these are the scientific community, the paradigm, "normal science", "extraordinary/revolutionary science", and the paradigm shift. The following sections detail each of these elements to provide a conceptual understanding of the theory.²⁴

3.1.1 Scientific Communities

The scientific community forms an integral component of Kuhn's paradigm theory: "no analysis which neglects the *communal* nature of a paradigm can capture the essence of the concept" (Eckberg & Hill, see book). The scientific communities are those men and women of the science field who hold in common a set of facts, theories, and methods; in fact, the community can itself be identified through revealing this commonality:

"If science is the constellation of facts, theories, and methods collected in current texts,"

Kuhn ponders,

"then scientists are the men who successfully or not, have striven to contribute one or another element to that *particular* constellation" (Kuhn, 3rd edition, p. 1; emphasis added).

²⁴ Positioning Kuhn's Paradigm Theory at the heart of the conceptual framework has become somewhat of a tradition here at the Center for Energy and Environmental Policy (CEEP). As such, the sections below draw not only from Kuhn's own work or from the works of several of his critics/defenders but are also informed by writings of my peers. A notable acknowledgement is in place to Lily Odarno's (2014) description of Kuhn's theory in her dissertation.

Scientific communities that busy themselves with the same subject matter, therefore, can deploy a different constellation of scientific notions, essentially a different viewpoint, leading to them seeing the same subject matter in wholly different ways. When applying paradigm theory, an important notion that arises from this realization is to identify the communities or groupings that articulate, produce, and defend a particular constellation in relation to the subject matter. Another important element offered by Kuhn is the notion of incompatibility between scientific communities that uphold different constellations of scientific notions. Due to an “incompleteness of logical contact”, scientific communities maintain viewpoints based upon their professional development and training that are incompatible with the viewpoints of other communities.

3.1.2 Paradigms

Kuhn defines the notion of the paradigm as “universally recognized scientific principles that for a time provide model problems and solutions to a community of practitioners” (Kuhn, 1996, p. x). The community of practitioners, i.e. the scientific community, uphold a “super theory” that offers “a distinctive way of seeing all the phenomena within its domain” (Gutting, 1980, p. 12). The fundamental theoretical assumptions embedded within such a paradigm are derived from earlier examples that have been demonstrably solved through deployment of scientific means in line with those assumptions. Effectively, Kuhn positions this “disciplinary matrix” (Kuhn, 1970/1996, p. 182) as the source of scientific propositions, the identification of areas for future research, the solution to pertinent research problems, and the deployment of

methods deemed appropriate for problem-solving.²⁵ This matrix allows for the rational discussion of research protocols, research efforts, and research outcomes. Importantly, the paradigm therefore identifies the instruments available for problem-solving, the problems that need solving, and the solutions that are deemed acceptable as solutions (Wolin, 1968). In other words, paradigms offer the scientist with a map of what the world does and does not contain thus offering a constitutive basis for research activity.

3.1.3 Normal Science and Paradigms

Kuhn defines normal science as “research firmly based upon one or more past scientific achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice” (Kuhn, 1996, p. 10). Normal science is the research conducted by scientists in the absence of crisis and is deployed along three foci for factual scientific investigation. The first of these foci is the effort to reveal “the nature of things” or the “determination of significant fact” (Kuhn, 1996). Armed with the assumptions, tools, and facts of their paradigm, normal scientists set out to solve problems with increased precision and to apply this explanatory power in a higher number of situations. A second effort by the normal scientist is to match facts with theory by directly comparing findings with predictions from the paradigm theory. A final and third foci for factual scientific investigation is the “mopping up” or the further articulation of the paradigm to resolve residual ambiguity. As such, Kuhn re-

²⁵ In his effort to outline the paradigm, Kuhn draws, among others, upon work done by Ludwig Wittgenstein and the notion of the family resemblance or natural family constituted “by a network of overlapping and crisscross resemblances” (Kuhn, 1996, p. 45).

imagines the purpose of science away from previously accepted conceptualizations (as, for instance, espoused by Karl Popper):

“Normal science does and must continually strive to bring theory and fact into closer agreement, and that activity can easily be seen as testing or as a search for confirmation or falsification. Instead, its object is to solve a puzzle for whose very existence the validity of the paradigm must be assumed.” (Kuhn, 1996, p. 80).

Normal science, therefore, occurs at a time when the existing paradigm is firmly embedded and goes unquestioned. In fact, the research often reaffirms the paradigm as it solves scientific propositions appointed by the paradigm as in need of solving. Characterizing normal science as a puzzle solving effort, Kuhn argues the “highly cumulative enterprise” that is normal science which seeks to “force nature into the preformed and relatively inflexible box that the paradigm supplies” (Kuhn, 1996, p. 24). In fact, “no part of the aim of normal science is to call forth new sorts of phenomena; indeed those that will not fit the box are often not seen at all” (Kuhn, 1996, p. 24). In other words, when successful, normal science allows for the further articulation of the prevailing paradigm and finds no new novelties of fact or theory. It is the desire to ‘solve the puzzle’ in ingenious ways and with application of great intellect that drives the normal scientist.

The characterization of paradigms as puzzles, Kuhn notes, offers a useful and insightful conceptualization. Paradigms, like puzzles, provide for a sense of expectation and certainty that resolution of the problem at hand is possible if not assured as long as the rules of the game are followed and the player is capable. Here, it becomes evident how the paradigm identifies problems as it can largely only do so if capable of offering criteria for choosing problems that can be assumed to have solutions. The rules of the game analogy offers a second insight as scientists are

provided with a “disciplinary matrix” that consists of, at least, four elements.²⁶ These elements were originally only briefly described in Kuhn’s first edition of his essay but have since been elaborated further as Kuhn describes in the postscript of subsequent editions. The four elements of the disciplinary matrix are a) symbolic generalizations, b) beliefs, c) values, and d) exemplars.

Symbolic generalizations are “those expressions, deployed without question or dissent by group members, which can be readily cast in a logical form” (Kuhn, 1996, p. 182). Considered the formal or “readily formalizable” components of the matrix, these generalizations form the foundation for the application of logical and mathematical manipulation. Such formulaic applications allow for the production of knowledge through their re-articulation in the various sub-fields in which they are applied.

Beliefs, or “metaphysical parts of the paradigm” (Kuhn, 1996, p. 184), allow for the conceptualization of problems through analogies and metaphors that assist the scientist in his endeavors. These shared models of a community can be positioned along a spectrum of ontological-heuristic conceptualizations.

Third, the disciplinary matrix consists of values which establish a sense of community among paradigm participants, extending deeper and further across the community than either symbolic generalizations or beliefs. Values play, according to Kuhn, a particularly valuable role when the community landscape is faced with existential crisis and the choice between the two – or more – incompatible ways of

²⁶ Kuhn hints at the existence of other elements of the disciplinary matrix but only describes the four elements discussed in this manuscript in some detail.

practicing their discipline. Values also assist in the identification of crisis in the first place.

A final component of the disciplinary matrix is shaped by exemplars. As Kuhn considers it the “most novel and least understood” component of his narrative, he devotes a full heading of his postscript to it (Kuhn, 1996, pp. 187-191). In her dissertation, Lily Odarno (2014, pp. 26-28) offers a summary account of Kuhn’s narrative on exemplars and their importance. Kuhn’s introduction of the exemplar created much initial confusion. Masterman (1970, p. 70; as quoted by Eckberg & Hill, 1979) sought to clarify some of this confusion by outlining the following:

[if] we ask what a Kuhnian paradigm is, Kuhn’s habit of multiple definition poses a problem. If we ask, however, what a paradigm does, it becomes clear at once [...] that the construct sense of “paradigm,” and not the metaphysical sense [...] is the fundamental one. For only with an artifact can you solve puzzles.” (emphasis in original).

The key, therefore, is not what an exemplar *is*, but what it *does* (Eckberg & Hill, 1979). As such, exemplars offer scientists the lens with which to view new problems as it allows for the identification of similarities with previous problems and as “subjects for the application of the same scientific law or law sketch” (Kuhn, 1996, p. 189). The scientist will approach new problems from the vantage point of the old problem and, perhaps more importantly, from the vantage point of the old solution: “the function, then, of an exemplar is to permit a way of seeing one’s subject matter *on a concrete level*, thereby allowing *puzzle solving to take place*” (Eckberg & Hill, 1979, p. 120; emphasis in original). The exemplar can thus be seen to stand out from the other elements of the disciplinary matrix as it offers direct practical guidance in terms of actions rather than beliefs, values or symbolic generalizations.

3.1.4 Anomalies, Crisis, Extraordinary Science

While the process of normal science does not seek to discover novelty, it is nonetheless very adept at delivering such discovery. As it continually seeks to further articulate the existing paradigm, normal science is bound to encounter anomalous research outcomes. Anomalies, that is an unexpected finding that violates the “paradigm-induced expectations that govern normal science” (Kuhn, 1996, p. 57), are characterized by a “stubborn refusal” (p.97) to be incorporated into existing paradigms. There is no “theory-determined place” in the scientists’ phenomenological “field of vision” to successfully nest such anomalies, leading the normal scientist to seek how it fits in the overall puzzle.

However, when science seems unable to effectively account for the anomaly, when the piece doesn’t appear to fit the puzzle, the transition to crisis and extraordinary science has begun. The anomaly gains recognition by a wider set of the community’s participants as just that and increased activity is directed at its resolution. Anomaly resolution can essentially occur in one of three ways. One, the scientific community finds a way to fit the anomalous result of the scientific effort into the overall paradigm. Two, the scientific community can consider the anomaly too complex for current capabilities and decide to shelve the issue for later reconsideration once technical and instrumental capabilities improve. Finally, the anomaly can drive alternative formulations; opening up for discussion previously fixed assumptions and presuppositions. The rules of the game of normal science become unhinged and blurred, allowing for new configurations of research efforts:

“The proliferation of competing articulations, *the willingness to try anything*, the expression of explicit discontent, the recourse to philosophy and to debate over fundamentals, all these are symptoms of a transition from normal to extraordinary research. It is upon their

existence more than upon that of revolutions that the notion of normal science depend.” (Kuhn, 1996, p. 91; emphasis added).

Fueled by resistance, attempts to reconsider the dominant theory at hand produce alternative conceptualizations of the theory creating a blurred and complex paradigmatic matrix. For instance, drawing on experiences documented within the field of astronomy, efforts to reconfigure existing dominant theory to observed anomalies produced a situation where “astronomy’s complexity was increasing far more rapidly than its accuracy and that a discrepancy corrected in one place was likely to show up in another” (Kuhn, 1996, p. 68), symptomatic of a crisis state: established consensus weakens and standards and rules are called into question. Anomalies, crisis, and extraordinary science can thus produce new paradigms, opening up the process of the Paradigm Shift.

3.1.5 Paradigm Shift

The Paradigm Shift describes a destructive-constructive process of paradigm change in which the ‘old’ paradigm is discarded and the new paradigm is accepted. To describe this process, Kuhn draws on a parallel with the process of political revolution (indeed, Kuhn appropriates the term ‘revolution’ from political science to outline the Paradigm Shift). Revolution, according to Kuhn, is driven by a sense that the old paradigm suffers from a fundamental malfunction that renders it insufficient and incapable of explaining the new world. In addition, like political revolution, scientific revolution motivates scientists to suggest new paradigmatic contexts in which science from now on should be conducted, resting on wholly new elements of models, theories, and facts. Illustrated by Kuhn’s persistent usage of the term “paradigm *choice*” (emphasis added), this process reflects argumentation based on normative considerations in line with Kuhn’s notions of paradigmatic incompatibility and

incommensurability.²⁷ The “gestalt switch” – which according to Kuhn leads scientists to *suddenly see* or understand the new paradigm and, as such, motivates them to become a proponent of the new paradigm – is subjectively determined. Kuhn sees two paradigms as incommensurable to each other; i.e. there is no fundamental overlap between the two worldviews. This removes the possibility for logical discourse (Kuhn’s “incompleteness of logical contact”) between scientists in one paradigm and the other and, therefore, removes any logical criteria on which a scientist can determine whether he/she shifts to the new paradigm:

“Like the choice between competing political institutions, that between competing paradigms proves to be a choice between incompatible modes of community life. Because it has that character, the choice is not and cannot be determined merely by the evaluative procedures characteristic of normal science, for these depend in part upon a particular paradigm, and that paradigm is at issue. When paradigms enter, as they must, into a debate about paradigm choice, their role is necessarily circular. Each group uses its own paradigm to argue in that paradigm's defense.” [...] “...that exhibit can be immensely persuasive, often compellingly so. *Yet, whatever its force, the status of the circular argument is that of persuasion.* It cannot be made logically or even probabilistically compelling for those who refuse to step into the circle.” (Kuhn, 1996, p.94; emphasis added).

In effect, non-logical criteria (or what Kuhn describes as “faith”) become the scientists’ argument for shifting paradigms. In other words, it is not predicated on objective and scientific determinants – i.e. it is not necessarily rationally compelled – but, instead, more closely reflects a notion of *choice*, affected by persuasion (or, in

²⁷ In a sense, this argument reflects Schumpeter’s (1949) notion of ideological context: when in one mind-set, the scientist can’t recognize or identify the different ideological context; it is only through a ‘gestalt switch’ that the scientist can start to think outside of the original ideological context (i.e. paradigm) and ‘see’ the other paradigm.

some cases, force). Unguided due to the lack of a “neutral arbiter”, the decision between paradigms is more like a battle between adversaries, competitive in nature rather than guided by rational deliberation (Wolin, 1980, p. 173). Nonetheless, the existence of a notion of choice should not be made out to be that paradigmatic allegiance is totally arbitrary; the emerging paradigm needs to be capable of explaining the world, including the earlier anomalies, in a way that allows for new modes of puzzle solving.

The incommensurability argument is derived from the fundamental nature of the paradigm itself. By extension, a paradigm shift is a reconsideration and reconstruction of fundamental components of the scientific activity that “changes some of the field’s most elementary theoretical generalizations as well as many of its paradigm methods and applications” (Kuhn, 1996, p. 85). While the old and the new paradigm, during the transition stage from one to the next, can be effectively called into action to resolve the same or very similar problems, Kuhn highlights that there will be a significant and decisive differentiation in the modes adopted by the two paradigms in their approach of the problem at hand (Kuhn, 1996, p. 85). As Lily Odarno (2014, p. 34) reflects: “The consequence of this [incommensurability] is that scientists and schools of thought guided by different paradigms will always tend to be at cross-purposes with each other.”

3.1.6 Brief Summary Account of Kuhn’s Paradigm Theory

In short, Kuhn argued that the perspective of linearity in scientific development should be reconsidered. Instead, a non-linear development theory might be more appropriate as it can account for momentous change and upheaval experienced in the scientific community. Importantly, Kuhn identified three phases of

his non-linear development theory: normal science, extraordinary science, and what is here introduced as revolutionary science to more precisely pin-point the moment of paradigmatic insecurity.

Like with extraordinary science, revolutionary science is science that is informed by a growing sense that the existing paradigm has ceased to function adequately as it fails to account for new observations. Revolutionary science is taken here to account for the moment right before a choice about paradigms needs to take place (Figure 3.1). New propositions for wholly new ways of thinking are put forth. The matrix itself, rather than individual components of the matrix, opens up for discussion. This discussion and debate between opponents and proponents of the new paradigm, according to Kuhn, can result in three potential outcomes: 1) the newly proposed paradigm is defeated, 2) the newly proposed paradigm is co-opted and results in an interdisciplinary new matrix that is the combination of the old and the new, or 3) a paradigm shift takes place, the old paradigm is rejected and the new paradigm accepted. Normal science now becomes scientific efforts that align with the matrix offered by the new paradigm.

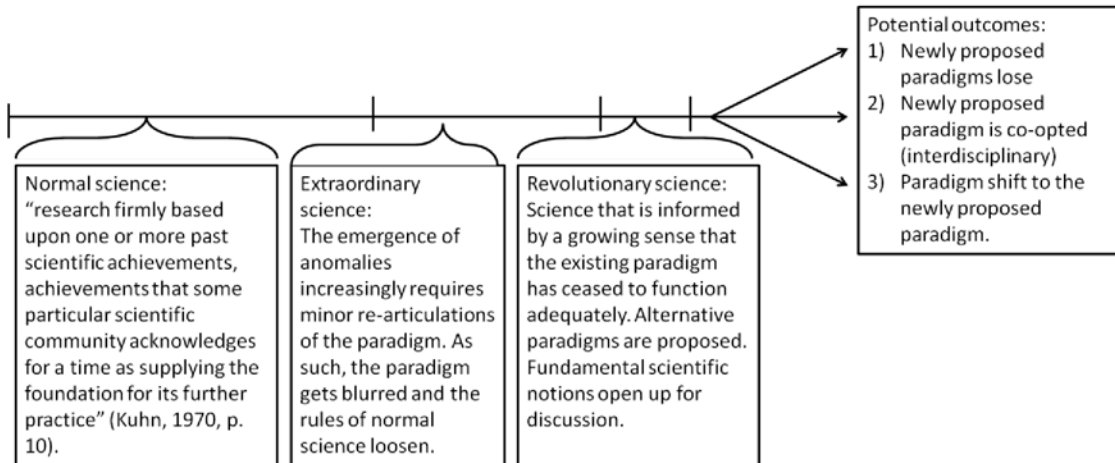


Figure 3.1; The Stages of Scientific Development According to Kuhn (1970).

Note: While the timeline is not to scale, it provides an indication of the possible duration of each phase relative to the other stages. Moreover, the Figure shows the three potential outcomes of scientific development according to Kuhn.

3.1.7 Considering Paradigm Theory in the Context of Social Problems

With the statement that "it remains an open question what parts of social science have yet acquired [...] paradigms at all. History suggests that the road to a firm research consensus is extraordinarily arduous" (Kuhn, 1996, p. 15), Kuhn opens up the question how his theory applies to other fields of study. While positioning social science as pre-paradigmatic, Kuhn immediately recognizes that there is no need for an apparent conflict between his theory and social sciences as social activities are often characterized by periodization and distinctive styles. Others have since weighed in on the discussion but have encountered much difficulty in their attempts of accounting paradigms in their respective fields. Two essential components of the paradigm theory, community and consensus, can be positioned at the foundation of much of this difficulty. For instance, Eckberg & Hill (1979, p. 117) observe that, for the field of sociology, "there are almost as many views of the paradigmatic status of

sociology as there are sociologists attempting such analyses.” Similarly, Gutting (1979, p. 13) accounts that “[t]he very existence of so many attempts by social scientists to use Kuhn’s work to arrive at a basic understanding of what is going on in their disciplines shows that they have no consensus in Kuhn’s sense [...]” Hubert Dreyfus, for instance, argued the central importance of power and intellectual ‘fashion’ in changes from one way of thinking to another. In this line of thought, it is not as much a change in paradigm that occurs but, rather, a style or, as Flyvbjerg (2001) puts it: “it is not a case of evolution but more of fashion” (p.30). Similarly, Foucault sought different terminology: “let us say, to be more neutral still [...] body of discourse” (Foucault, *The Order of Things*, p. 344).

However, these difficulties should not lead to the conclusion that Kuhn’s treatise is unavailable to the social sciences. The observation that many different communities exist in the non-scientific communities, which maintain a form of consensus similar to Kuhn’s notion of the paradigm, leads Gutting (1980, p. 15) to suggest that the search for paradigms should not occur “amongst themselves, but amongst the communities that they study.” Redirecting Kuhn’s framework of the paradigm away from the scientific community and their political theories onto the political community itself might present a more rewarding strategy. This point is supported by Wolin’s (1980) work on *Paradigms and Political Theories* where he argues the misconception that underlies attempts to reconstruct “traditional” theory with a new “scientific” theory and the problematic nature of describing traditional theory’s development pathway as one that fails to produce knowledge cumulatively. In line with Kuhn’s admission that social sciences has a functionally different *raison*

d'être, namely the targeting of a social need, Wolin accounts that the political scientist pursues a different finality:

"In contrast to the scientist, who seeks to elicit acceptance of his theory from his fellow-scientist, the political theorist has viewed this form of acceptance as a secondary matter. The reason is not simply that a genuine "community" of theorists has been a rarity, but rather that the kind of power the theorist seeks is to be found in the political community itself. [...] The aim of many political theorists has been to change society itself: not simply to alter the way men look at the world, but to alter the world." (Wolin, 1980, p. 179).

The discontent with a current status of society is the motivation of the political scientist and its resolution his aim. Hobbes' address in his key work *Leviathan* to "he that is to govern a nation" illustrates the significantly different target audience and the inherent objective of the work: to guide social change. Similarly, Karl Marx's work on Political Economy envisioned a new state of organizing and doing. In other words, unlike the scientist, the political scientist does not seek to uncover facts of the world in an attempt to test their "fit" with existing theoretical accounts but, rather, to make the case that current social dynamics and arrangements produce negative outcomes. Developing a major theoretical account of such existing dynamics does not lead to the resolution or mitigation of the negative outcomes and, instead, the theorist seeks to deliver a representation of the possibilities for future social change and its outcomes. As such, in line with Gutting's (1979) statement earlier, Wolin argues the focus of paradigm theory to not be on the political theorists themselves but rather be directed at political society:

"[...] Kuhn's conception of paradigms seems out of place when it is applied to a context for which it had not been devised. [...] My proposal is that we conceive of political society itself as a paradigm of an operative kind. From this viewpoint society would be envisaged as a coherent whole in the sense of its customary political practices,

institutions, laws, structure of authority, and citizenship, and operative beliefs being organised and interrelated. A politically organised society contains definite institutional arrangements, certain widely shared understandings regarding the location and use of political power, certain expectations about how authority ought to treat the members of society and about the claims that organised society can rightfully make upon its members." (Wolin, 1980, p. 183)

and

[...] "This ensemble of practices and beliefs may be said to form a paradigm in the sense that the society tries to carry on its political life in accordance with them." (Wolin, 1980, p. 184).

This is not to say that the functioning of political society is uninformed about theory but rather that the expression of theory in an operating society represents the dominant paradigm that is supported by societal consensus about its applicability and desirability. As a consequence, the theoretical basis is taken for granted. It is only through moments of crisis, according to Wolin and in line with Kuhn's notions of extraordinary science, that many great theories were produced and found a foothold in society.

3.2 Optimality versus Sustainability: The need for a Paradigm Shift

Globalization of the Modern Model ²⁸ has delivered significant contributions to human society, ranging the gamut of human-environment and human-human interactions in the form of, for instance, healthcare, transportation, sanitation, telecommunications, and lighting. The successes of modernization are so highly regarded that national governments have repeatedly promised the spread of the

²⁸ This phrase is taken from lectures by Professor John Byrne (Center for Energy and Environmental Policy – University of Delaware) in the doctoral seminar entitled Technology, Environment, and Society. I owe him thanks for helping me to understand the characteristics of the paradigm of the modern model.

Modern Model as a political objective. Indeed, the Millennium Development Goals (MDGs) and its successor Sustainable Development Goals (SDGs) are expressions of this globalization effort. Importantly, the development of energy provision is at the foundation of the delivery of this promise (Johansson, 2005; Nussbaumer, Bazilian, & Patt, 2013).

To guide these developments, modern society has placed several distinctive characteristics at the heart of the Modern Model. Especially, strategies that guided development throughout the 20th century relied heavily on economic optimality as a chief guiding principle in the design of energy, technology, markets, and policy (Byrne & Taminiau, 2015). The optimality objective of ‘the greatest benefit for the greatest number’²⁹ is thought to be achievable through explicit reliance on the so-called ‘bottomless well’ of human ingenuity expressed particularly in scientific and technological innovation (Huber & Mills, 2005; Simon, 1980). The success of the modern endeavor, indeed, has produced the conceptualization that human welfare can continually be improved and that, eventually, an end to poverty can be realized when technological and economic criteria guide development (Taminiau & Byrne, 2015). These considerations place efficiency and increasing marginal utility at the forefront of decision-making in the Modern Model: ‘Pareto Frontiers’ (Weimer & Vining, 2011) are continually pursued, supported by the rationale of efficiency.

Challenges to the Modern Model, for instance in the form of climate change or energy poverty, are answered with terms of ‘market failures’ and the need to adjust self-directing market forces to encapsulate such ‘externalities’. In other words, a

²⁹ Also often captured by ‘reallocations that make at least one person better off without making at least one person worse off’ (Weimer & Vining, 2011, pp. 55-56).

‘governance by capital’ (Byrne & Taminiau, 2015) approach is deployed that seeks to attenuate ecological repercussions of human activity but simultaneously allow for continued maximization of economic growth (Byrne & Yun, 1999). This ‘governance by capital’ strategy is to be supported by public policy measures that allow for economies of scale, the creation of new markets, and improved management of existing markets (Paterson, Dryzek, Norgaard, & Schlosberg, 2011). This modified form of optimality has been termed a ‘weak’ notion of sustainability (Pezzey & Toman, 2003; Pezzy & Toman, 2005) where market participants are sensitized and incentivized towards low- or no-carbon options. A ‘carbon credit’ commodity has been introduced with the aim to intensify competition between various energy options with which the ‘playing field’ is to be shifted towards low- or no-carbon energy sources (Paterson & Stripple, 2012; Paterson, Dryzek, Norgaard, & Schlosberg, 2011). The ‘governance by capital’ approach, as such, seeks to reduce the ecological repercussions of economic activity without eliminating the potential for continued maximization of economic growth (Munasinghe, 2010; Byrne & Yun, 1999).

Under the optimality paradigm, future energy development and its ecological footprint are to be decided by this ‘governance by capital’ approach, with citizens exercising control through their decisions as end-use consumers of energy (Byrne & Taminiau, 2015; Taminiau & Byrne, 2015). Within this frame of mind, social agency is confined to a form of “consumer democracy” (Schwarzkopf, 2011) and an optimistic belief is placed in technological cures (Byrne & Mun, 2003; Dubash & Williams, 2006; Byrne & Toly, 2006). This positioning of the individual brings to the forefront conceptualizations of the ‘individual as beneficiary’ – enjoying all that is provided – over notions of the ‘individual as author’ – individuals and communities

democratically capable of governing their own energy future (Taminiau & Byrne, 2015).

Chapter 1 and Chapter 2 have made clear the limitations and downsides of the currently dominant approach of ‘top-down’ management of the climate change challenge following along economic optimality lines. Following published work by Byrne & Taminiau (2015), Taminiau & Byrne (2015), and Byrne, Wang, Taminiau, & Mach (2014), both chapters point to the need for a paradigm shift. As alluded to in previous sections, the ‘weak’ sustainability approach seeks to work around environmental limitations without significantly altering economic activity processes, captured by Byrne & Taminiau (2015) by the metaphor of the ‘speed bump’ versus the ‘stop sign’: once the environmental complication is dealt with in one way or another – for instance through the implementation of a new technology source – business as usual proceeds. However, the introduction of the ‘planetary boundary’ (Rockström, et al., 2009), establishing a fundamental character to natural systems, reveals a complication to the marginal ‘governance by capital’ decision-making process as such ‘stop signs’ are difficult, if not impossible, to translate into marginal ‘speed bump’ options for decision-making. Critical life-support functions might be unavailable for substitution (Common & Perrings, 1992; Ekins, 1996; Dryzek, 2013) while green technology may actually deflect attention in the false belief that boundaries are being addressed by technological innovations (Byrne & Toly, 2006).

Also, the failure to incorporate the local social discourse due to the out-of-touch and remote character of decision-making through displayed linearity of thinking – local problems require local governance, regional issues require regional governance, and global issues require global governance – is called by one observer a

form of ‘rationalist arteriosclerosis’ resulting in a a mono-logical and low self-reflexive strategy of change (Plumwood, 2002). This depiction of the governance system corresponds to the description provided in Chapter 1 and the first several sections of Chapter 2. As a result, credibility and support for transformative change can be more readily found *within* civil society rather than seeking a pathway that imposes change *on* civil society (Byrne, Wang, Taminiau, & Mach, 2014).

Figure 3.2 below summarizes the characteristics of the social change strategy under the optimality paradigm where technological solutions, technical and administrative expertise, optimal growth, commodities, and private wealth are central elements and ecological problems are considered ‘speedbumps’ rather than ‘stop signs’.

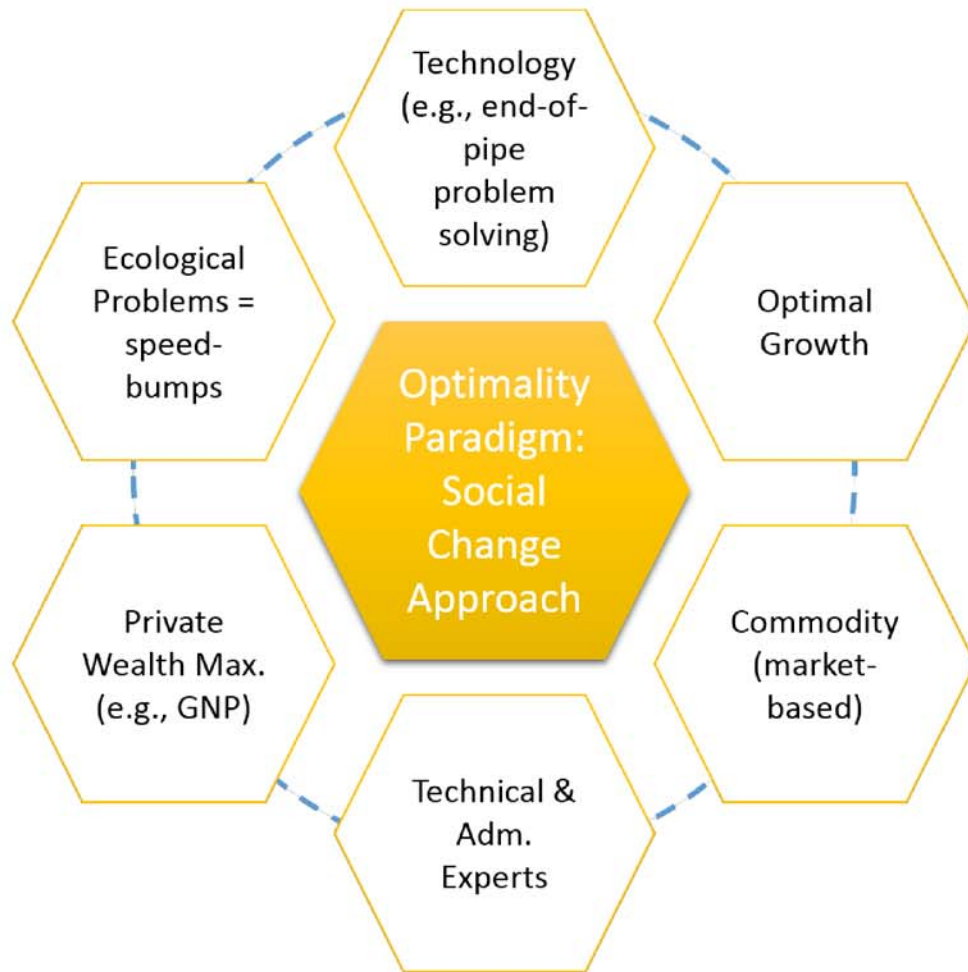


Figure 3.2; Social change under the Optimality paradigm.

In an operational sense, the Kyoto era paradigm, as described, relies to a great extent on the variable of efficiency in its efforts to effectuate climate change mitigation. Least-cost pathways of action are preferred and whether action itself should be undertaken is determined by carbon pricing. This process can be argued to produce notions of success in decision-making that fail to account for ethical measures of progress such as freedom and justice instead “reserving ideal status for the purportedly objective and efficient decision” (Byrne, 1987, p. 82). In fact, such

decision-making neglects the wider context of human life and creates a situation where the “means-end rationale” sublimates “value-rational action (Ellul, 1964; Dahl, 1974; Kalberg, 2005; Weber, 2005). The translation of value propositions into scientific principles and rational action, based on the axiom of efficiency, thus distorts the means-ends divide and places emphasis on the *how* rather than the *why*. Tellingly, Weber (2005) argues that the increasing intellectualization and rationalization do not necessarily allow for an increased capability of man to position himself in reality. Instead, by limiting meaning to the purely practical and technical, meaning in action *itself* becomes disenchanted (Weber, 2005). This reductionist focus on instrumental rationality (‘Zweckrationalitat’) is seen by many to gain prominence over value-rationality (*Wertrationalitat*) (thinkers such as Jurgen Habermas, Michel Foucault, and Max Weber offer such accounts). Richard Livingston offers a nice quote to illustrate this situation:

“[I]f you want a description of our age, here is one: the civilization of means without ends” (Livingston, date; as quoted by Flyvbjerg, 2001, p. 53).

Lewis Mumford, in his description of the ‘democratic-authoritarian bargain’, early on recognized the consequences and implications of society’s devotion and allegiance to Modern Model politics, technology, and economics and envisioned a new pathway with which to approach technology, capital, and societal development:

“[W]e had better map out a more positive course: namely, the reconstruction of both our science and our technics in such a fashion as to insert the rejected parts of the human personality at every stage of the process. This means gladly sacrificing mere quantity in order to restore qualitative choice, shifting the seat of authority from the mechanical collective to the human personality and the autonomous group, favoring variety and ecological complexity, instead of stressing undue uniformity and standardization, above all, reducing the insensate drive to extend the system itself, instead of containing it within definite

human limits and thus releasing man himself for other purposes. We must ask [...] what is good for man: not machine-conditioned, system-regulated, mass-man, but man in person, moving freely over every area of life” (Mumford, 1964, p. 8).

More generally, not limited to the scope of urban governance, Taminiau, Wang, & Byrne (2014) emphasize five key drivers of change:

- Ecology: strategies of change will need to recognize and sustain operations within the fundamental character of ecological and planetary limits;
- (Energy) Economy: viable strategies of change within ecological sustainability paradigms will need to contain components directed at the transformation of economic activity towards a low-carbon development pathway;
- Urban Living: Cities form a key component of strategies of change for the future as many cities already are and others will increasingly be major players in the climate change challenge (both as contributors to the problem as well as contributors to the solution);
- Technology: in particular energy technologies will need to be reoriented towards low-carbon energy sources. Taminiau et al. (2014), following Saul & Perkins (2014), Prasad (2014) and Barnett et al. (2014) in the same book, suggest a particular focus on the benefits and future promise of energy efficiency and high-efficiency PV;
- Long-term change: strategies of change will need to incorporate a long-term focus.

In short, the discussion of optimality, and its operational failure as discussed in the previous two chapters, signals the need for a new paradigm. A paradigm of ecological sustainability is explored in the rest of this dissertation. In doing so, the dissertation looks, in particular, to the role of communities and civil society, seeks to determine whether reflexivity and learning play a central role in the alternative strategy analyzed here, whether the alternative strategy can be brought to scale, and whether the fundamental character of the social and natural commons is observed and

respected (Byrne & Taminiau, 2015). To do so, the dissertation recognizes that two alternative strategies are available for analysis: pledge-and-review and polycentricity.

3.2.1 Pledge-and-Review: A UN Sanctioned Strategy

The Copenhagen Accord facilitates the creation of a ‘pledge-and-review’ infrastructure as it invites both Annex I and non-Annex I Parties to submit their planned mitigation actions (i.e. ‘pledges’). In contrast to the top-down architecture described in Chapter 1, this permutation involves the collation of national, domestically-binding, pledges that, together, are to add up to sufficient international effort (Netherlands Environmental Assessment Agency (PBL), 2010).

The pledge and review infrastructure has since been reinforced by the Cancun Agreements and currently represents a new ‘only game in town’ of any significance ³⁰ – until, at least, the Durban Platform for Enhanced Action finds implementation in 2020 – that covers a wide range of Parties, including critical negotiating Parties such as the U.S., China, India, and Brazil. In fact, over 100 countries have submitted their planned measures to reduce or limit their emissions. Together, these countries account for 78% of global emissions from energy use (Van Der Gaast & Begg, 2012).

Driven by the recognition that the ‘big bang’ approach promulgated throughout the Kyoto era is unlikely to succeed, pledge-and-review represents more of a ‘building blocks’ approach (Falkner, Stephan, & Vogler, 2010) that tries to incrementally realize progress by focusing on individual, smaller ‘pillars’ (Heller, 2008) of a larger

³⁰ The second commitment period of the Kyoto Protocol is another platform currently in effect but has suffered greatly as key Parties have withdrawn from the system.

agreement. Several such pillars were introduced in the Cancun Agreements such as the Green Climate Fund, the Technology Mechanism, and the Adaptation Framework.

Considering that the ‘center of gravity’ of the negotiation positions of many of the key negotiating Parties continues to be in line with a weak, bottom-up regime (Purvis & Stevenson, 2010), higher participation levels is a key outcome of the pledge and review approach. Parties that remained reluctant to sign up for an agreement along the lines of the ‘global deal’, such as Brazil, South Africa, India, the U.S., and China, indicated their support to the Copenhagen Accords and formulated mitigation pledges accordingly (Joint Implementation Quarterly [JIQ], 2009). For instance, Brazil announced a 36 % emission reduction below business-as-usual by 2020 and China presented a 45% reduction in carbon intensity by 2020 compared to 2005 levels (JIQ, 2009). One of the main contributions of the Copenhagen Accords and Cancún Agreements, therefore, has been to extract pledges from previously reluctant negotiating Parties.

In contrast to the ‘targets-and-timetables’ approach of the Kyoto era, pledges are derived from a different decision-making platform (Table 3.1). For one, as opposed to the static division of Annex I and non-Annex I, the pledge-and-review approach introduces the possibility of a continuum of stringency among countries. This continuum of stringency finds its basis as nations formulate country-specific pledges in line with national considerations and projected development pathways. Additionally, whereas the Kyoto era sought single-component commitments in terms of a single quantitative emission reduction target, submitted pledges demonstrate much broader flexibility as multi-component commitments ranging from reforestation to carbon intensity targets have been formulated.

Table 3.1; Key differences between pledge and review architecture and the Kyoto era objective. Source: adapted from Taminiau & Byrne, 2012

Component	Kyoto era	Pledge and review
Compromise	Consensus	National considerations only
Rules	According to standards (MRV, etc.)	Flexibility in design
Commitment	Single-component	Multi-component
Conditionality	Conditionality not accepted	Conditionality accepted
Bindingness	Predominantly viewed as binding	Ambiguous
Stringency	Strict division according to capability	Continuum of stringency possible
Spatial focus	Global cap	National cap

One structural barrier prevalent in the pursuit of a top-down agreement was the UNFCCC consensus rule (Dubash N. , 2009). The shift away from consensus on a global scale towards the consideration of national interests, values, and priorities offers the prospect of firmly embedding climate protection measures in the wider context of sustainable development (van der Gaast & Begg, 2012; van der Gaast, 2015; van der Gaast & Taminiau, forthcoming). Considering the perception of the climate policy issue as an inhibitor of overall development (Najam, Huq, & Sokona, 2003; Ockwell, Haum, Mallet, & Watson, 2010), such a reorientation of climate change action in line with wider objectives and priorities may prove significant. China, for instance, moves forward with climate change mitigation and adaptation actions not because of carbon control aspirations but rather due to domestic policy priorities such as energy security and clean technology market potential (Stigson, Buhr, & Roth, 2013).

Many pledges include a conditionality clause that stipulates the need for support, financial or otherwise. Support mechanisms have been introduced, such as the

Technology Mechanism and the Technology Needs Assessment (TNA), that are to identify support needs and link these needs to available resources (Van Der Gaast & Begg, 2012). These individual pillars can support nation-states, especially developing countries, in their efforts to outline climate protection measures. Linking smaller, established mechanisms and newly introduced mechanisms together to create a coherent framework of climate protection in line with domestic considerations of sustainable development thus holds promise (Van Der Gaast & Begg, 2012; Falkner, Stephan, & Vogler, 2010; van der Gaast & Taminiau, forthcoming).

Similarly, the decentralized articulation of needs and development prospects opens the door to bilateral and multi-lateral cooperation. The portfolio of pledges and bilateral and multi-lateral agreements, directed towards problem-specific components, could potentially accelerate action as it circumvents difficult political economy considerations that are prevalent in UN-based negotiations (Leal-Arcas, 2011b). Negotiations at the UN encompass around 200 nation-states that each have different positions, vulnerabilities, and desires on how climate change action is formulated. Going outside such negotiations through the alignment of common interests, values, and needs, thus offers an alternative pathway that could prove more fruitful (Leal-Arcas, 2011b). A recent example of this is the announcement of a climate ‘deal’ between the United States and China in November, 2014 (Rauhala, 2014).

As a strategy, pledge and review emerged out of necessity: last-minute negotiations between a handful of Parties at ‘Copenhagen’ hammered out the deal to ensure some progress could be documented from this much anticipated summit. As documented in Ch. 1., the original objective of ‘Copenhagen’ was to come to a much more significant agreement among all Parties but negotiation positions did not align

and the conference tried to do too much, too fast. The fact that pledge-and-review emerged from a standpoint of necessity, filling a gap that would occur without agreement, limits its candidacy in terms of the fundamental nature of the ‘paradigm shift’. Furthermore, pledge and review was designed to be aligned with a potential future agreement that would still be stipulated along many of the same dimensions as the Kyoto era objective: a preeminence of nation-states, a high likelihood of continued reliance on commodity-based structures, and a probable commitment to ‘slowest, lowest common denominator actions’ despite perhaps more aggressive action by some. In effect, the strategy likely will return to the set paradigm – rather than breaking free from it – once the ‘blocks have been built’ and agreement among many of the Parties has been secured.

Indeed, the return to ‘realpolitik’ at the 2009 Copenhagen Conference, where dominant domestic politics and material realities superseded commitments to international treaty-making (Carter, Clegg, & Wåhlin, 2011) and gave birth to the ‘pledge-and-review’ strategy at the international stage,³¹ is seen by many as a ‘lowest common denominator’ outcome that remains inferior to the ultimate objective of a strong and legally binding ‘global deal’ (Falkner, Stephan, & Vogler, 2010; Egenhofer & Georgiev, 2009). Additionally, the notion that Copenhagen was supposed to finally ‘seal the deal’ and create a firm global agreement further undercuts the idea that future development of ‘pledge-and-review’ dynamics will significantly alter the way of thinking and doing as described in the first two chapters of this dissertation. In fact,

³¹ The ‘pledge-and-review’ strategy is by no means a strategy that is newly devised. Early on in the international negotiations, Japan introduced this strategy as a potential way forward and received much support from, among others, the United States.

the development path of the Durban Platform for Enhanced Action not only establishes a new target for global agreement along likely similar dynamics as Kyoto era style but also demonstrates mounting pressure from civil society and governments to get it right this time: i.e. to establish a binding global agreement at Paris in 2015 that will enter into effect in 2020. These considerations potentially reduce the newly UN-sanctioned strategy of pledge-and-review to a temporary distraction; something to do while diligently working under the ‘shadow of the future’ cast by the Kyoto era and to, someday (according to outlined plans in 2015 and then in 2020, but experience shows delay is expected), finalize the ultimate objective that eluded the international community throughout the Kyoto era: the creation of a ‘mono-centric’, comprehensive, stringent, legally binding, ‘targets-and-timetables’ agreement.

These arguments are here used to reject pledge and review as a candidate for further study in this manuscript in terms of the starting point of the analysis: what is the road not taken? This starting point requires a more fundamental departure: not a temporary ‘off-ramp’ in search of a new ‘on-ramp’ but rather, a ‘crossroads’ presenting a wholly new direction. Nonetheless, analysts, including myself (Taminiau & Byrne, 2012; van der Gaast & Taminiau, 2015), have suggested potential roads where pledge and review could offer significant benefits. As such, to provide this strategy with due attention, I refer to Appendix A for a more detailed discussion and analysis of this option.

3.2.2 Polycentricity

While the importance of scale has been at the center of many investigations in other fields, including environmental topics such as watershed management, the presumption that, due to the global nature of the problem of climate change and the

guidelines offered by collective action theory, a global response strategy was the only obvious way forward (Wiener, 2007; Hare, Stockwell, Flachslund, & Oberthür, 2010) has only been drawn into question more recently (Ostrom E. , 2010; Cole, 2011). The “monocentric” view of climate change action, as detailed in the previous chapter, is being answered by a perspective that seeks to suggest a different way forward. This notion of “polycentricity” (Ostrom E. , 2010; Cole, 2011; Wagner, 2005; Black J. , 2008), as briefly introduced in Chapter 1 and 2, essentially mixes scales, mechanisms, and actors (Sovacool B. , 2011) and uncovers difficulties with the collective action assumption that, without an external arbiter, action will not take place (Ostrom E. , 2010; Brennan G. , 2009).

The widening perspective of including additional actors and scales has, in fact, not only made clear that significant action potential exists within these multiple levels of governance but, more importantly, that considerable effort is being successfully expended to capture this potential. For example, the exhaustive work done by Barry Rabe details U.S. state efforts and concludes it to be a force to be reckoned with (Rabe B. G., 2002; Rabe B. G., 2006; Rabe B. G., 2004; Rabe B. G., 2006a; Rabe B. G., 2008). In addition, it has been a tradition here at the Center for Energy and Environmental Policy (CEEP) to investigate bottom-up strategies and uncover their potential and transformational promise (Taminiau & Byrne, 2012; Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Byrne, Kurdgelashvili, & Taminiau, 2012; Byrne, Wang, Taminiau, & Mach, 2014).

It is important to note at this time that polycentrism, in contrast to its frequently used conceptualization, does not simply refer to localized, sub-global action. Instead, as mentioned briefly in the introduction, the concept revolves around a

mixing of scales and actors. In a sense, the concept relies on a “nestedness” of activity levels (Andersson & Ostrom, 2008; Ostrom E. , 2012), where jurisdictions overlap. Each activity level, in this sense, is functionally defined rather than geographically restricted and is sought to be established at its most appropriate scale (Sovacool B. , 2011). These elements lead to the following description of polycentrism, as originally introduced in the 1960s in the context of metropolitan governance:

“[Polycentrism] connotes many centers of decision-making which are formally independent of each other. Whether they actually function independently, or instead constitute an interdependent system of relations, is an empirical question in particular cases. To the extent that they take each other into account in competitive relationships, enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts, the various political jurisdictions in a metropolitan area may function in a coherent manner with consistent and predictable patterns of interacting behavior. To the extent that this is so, they may be said to function as a ‘system.’ (Ostrom, Tiebout, & Warren, 1961, p. 831)

Ostrom et al. (1961) position such polycentrism in opposition to what they label ‘Gargantua’ (i.e. large-scale governance):

“Many of the interests of smaller publics might be properly negotiated within the confines of smaller political community without requiring the attention of centralized decision-makers concerned with the big system. This task of recognizing the smaller publics is a problem of ‘field’ or ‘area’ organization. The persistence of bureaucratic unresponsiveness in the big system, however, indicates it is not easily resolved.” (Ostrom, Tiebout, & Warren, 1961, pp. 837-838)

Scaling up the concept of polycentricity to issues of global governance, Ostrom introduces the climate literature to the concept through the following definition:

“A polycentric system exists when multiple public and private organizations at multiple scales jointly affect collective benefits and costs.” (Ostrom E. , 2012, p. 355)

In short, and in contrast to ‘straightforward’ localized action, polycentrism finds justification in the realization that there are inescapable flaws in the isolated use of any form of governance, whether it be top-down, bottom-up, or free market privatization (Sovacool B. , 2011). Polycentricity, as an advancement of collective action theory, offers additional utility as it outlines that collective action is more likely to emerge through multiple and diverse small-scale networks rather than one homogenous system (Ostrom E. , 2010). Indeed, separating the concept from monocentric hierarchy even further, a polycentric ‘system’ contains governmental units that engage in collaboration, competition, interaction, and mutual learning (Cole, 2011). This creates a broad conceptualization of polycentric climate and energy governance which “involve[s] multiple scales (local, regional, national, and global), mechanisms (centralized command and control regulations, decentralized and local policies, and the free market), and actors (government institutions, corporate and business firms, civil society, and individuals and households)” (Sovacool B. , 2011, p. 3833). This conceptualization of polycentricity aligns with Hooghe & Mark’s (2003) “Type II” concept ³² that demonstrates the following characteristics³³:

³² A shared similarity can further be found in relation to the concepts of ‘adaptive governance’ (Folke, Hahn, Olsson, & Norberg, 2005), ‘polyphonic federalism’ (Schapiro, 2005), ‘interactive federalism’ (Sovacool B. , 2008a; Sovacool B. , 2008b), ‘multi-level governance’ (Bulkeley & Betsill, 2005; Bulkeley & Betsill, 2013), ‘condominio’ (Schmitter, 1996; Schmitter, 2000), and ‘consociational power sharing’ (Lijphart, 2004).

³³ These characteristics are in contrast to those of Hooghe & Marks’ “Type I” concept of general-purpose jurisdictions, non-intersecting memberships, limited number of jurisdictions over a limited number of levels, and a system-wide architecture (Hooghe & Marks, 2003).

- *Task-specific jurisdictions*: multiple, goal-oriented, independent jurisdictions that fulfill distinct functions.
- *Intersecting memberships*: smaller jurisdictions do not necessarily fit neatly within the borders of larger jurisdictions.
- *No limit to the number of jurisdictional levels*: non-hierarchical jurisdictions at diverse scales and organized at a scale and dynamic that aligns with its function.
- *Flexible design*: the burden of change and mobility in order to conform to citizen expectation is placed on the design of the jurisdiction – in contrast to placing the burden on the citizen to conform to the general, system-wide architecture (Ostrom, Tiebout, & Warren, The organization of government in metropolitan areas: a theoretical inquiry, 1961). Flexibility in design and number includes flexibility in creating, discontinuing, growing, or shrinking a particular jurisdiction (Frey & Eichenberger, 1999).

3.3 Exploring the Polycentric Framework

The exploration of the polycentric framework is conducted in two phases. First, the research directs its attention to evidence of the existence and viability of the polycentric strategy. Next, through exploring the continuing debate on the value of the polycentric proposition, the research extracts two critical elements that the polycentric strategy needs to be able to prove in order to position itself as a viable alternative strategy. This section describes the research questions that are at the heart of this investigation, followed by a description of Phase I and Phase 2 research.

3.3.1 Research Questions

To test the hypothesis that polycentric action can find new conditions for transformative change to thrive, can capture new operational and social dynamics and actors, and can advance the ultimate objective of climate change action in a sustainable and just way, the research maintains a set of questions that guide its

evaluation. Essentially, these research questions revolve around the principles introduced in Chapter 2: sustainability, equity, and justice. The following research questions guide the research:

- Can a polycentric strategy of sizable dimensions be uncovered? A particular dimension explored in this regard is the element of diffusion: do polycentric strategies experience a curve of diffusion capable of extending the strategy beyond niche adoption? This will be largely addressed in Phase I research.
- Can the strategy be argued to extract values and virtues in line with a move away from optimality-based decision-making and towards ecological sustainability? In particular, can the strategy be shown to avoid the pitfall of carbon reductionism and instead include sustainability and justice considerations more forcefully? This will be largely addressed in Phase I research but will reverberate throughout Phase II research as well.
- Can the strategy address challenges made to its address and demonstrate the values and virtues it claims to be effective at? For instance, as will become clear, virtues related to participation and citizen involvement are often stated as critical components of a polycentric strategy. Whether these kinds of claims can be operationalized will largely be tested in Phase II research by looking at two operational components of polycentrism that seek to instill institutional, lasting change and to achieve transformative, infrastructure-level change.

3.3.2 Phase I: Can a Polycentric Strategy of Sizable Dimensions be Uncovered and can Initial Virtues be Extracted?

Phase I research addresses the first research question and seeks to provide initial insight into the other two research questions. A particular element embedded within this question is the component of diffusion: an important consideration of a practicable polycentric approach is whether polycentric policy experiments find a pathway of diffusion through the wider system. Diffusion, according to the literature, can be facilitated through internal and external determinants (Walker, 1976; Berry & Berry, 2007). The internal determinant approach establishes the basic assumption that political, economic, and social factors that are internal to the jurisdiction propel innovation (Jordan & Huitema, 2014, Berry & Berry, 2007). In contrast, the external determinant approach positions the activities of other jurisdictions as motivating factors for adoption of policy innovations. A prominent component of the external diffusion assumptions has been one of geographic proximity (Berry & Berry, 2007) but caveats to this prominence have recently been raised (Matisoff & Edwards, 2014). Indeed, the mechanisms of learning, competition, and coercion also are frequently awarded a dominant position in external policy diffusion (Jordan & Huitema, 2014a; Jordan & Huitema, 2014b; Shipan & Volden, 2008; Shipan & Volden, 2012). For instance, the seven lessons regarding diffusion as documented by Shipan & Volden (2012) are:

- Policy diffusion is not just a process of spatial clustering;
- Governments compete with each other;
- Governments learn from each other;
- Diffusion of policies is not always beneficial (i.e. race to the bottom types);

- Capabilities (political, governmental) are important to the diffusion of policies;
- Diffusion depends on the characteristics of the policies themselves; and
- Decentralization is crucial for policy diffusion.

To investigate diffusion patterns and explore the size of the polycentric strategy, Chapter 4 will take a look at urban climate change governance while Appendix B investigates U.S. state level diffusion and activity. The investigation of U.S. state level experimentation is relegated to Appendix B as Chapter 5 and Chapter 6 largely maintain a focus on local level experimentation.

3.3.2.1 Why U.S. State Level Experimentation?

The U.S. is conventionally perceived as largely uninterested in addressing climate change due to federal inaction on the subject (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Selin & VanDeVeer, 2011). However, the U.S. system of divided powers, structured along federalism, offers ways to bypass or re-route the normal pathway of Congressional policy setting, Presidential agency implementation, and judicial oversight and enforcement (Farber, 2014). Especially state governments (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Rabe B. G., 2008) and, more recently, the executive branch (Baker & Davenport, 2014; Farber, 2014), have sought to fill the governance gap created by Congressional reluctance to permit comprehensive federal climate policy (Bang, 2011).

Famously, Justice Louis Brandeis once posited that the U.S. states could “serve as a laboratory; and try novel social and economic experiments.”³⁴ The notion of the

³⁴ Taken from *New State Ice Co. v. Liebmann* (1932, p. 23).

state as a ‘laboratory of democracy’ has resulted in the particular analytical focus of fragmentary mitigation efforts directed at the U.S. state government (Carley & Browne, 2012). One common way to document state level action in the U.S. is to reflect on several prominent policy tools that have been implemented in a wide range of U.S. states. The policy tools discussed in Appendix B are Renewable Portfolio Standards (RPS), Energy Efficiency Resource Standards (EERS), and regional application of cap-and-trade market-based policy tools. Many other initiatives and strategies are being implemented by U.S. states but these are left outside of the scope of this dissertation. For instance, many states have produced Climate Action Plans, implemented transportation policy portfolios, or created aggressive appliance standards that have delivered sometimes significant results (Drummond, 2010; Wheeler, 2008).

3.3.2.2 Why Urban Climate Change Experimentation?

Several examples of polycentric activity offer productive insights into the promise of polycentricity as a strategy. Some of these examples, particularly at the state level in the United States, are documented in Appendix B. Chapter 4, however, focuses on one particular example of polycentric application: city-level experimentation. Over recent years, a substantial database on urban experimentation and climate change action has emerged (Bulkeley & Schroeder, 2012; Bulkeley & Betsill, 2013; Castán Broto & Bulkeley, 2013; Hoffmann, 2011; C40 Cities, 2014; Rosenzweig, Solecki, Hammer, & Mehrotra, 2011; Kousky & Schneider, 2003). This database documents a governance shift in climate change and energy policy towards urban-level decision-makers who are taking matters in their own hands and are aggressively pursuing climate change action. The database documented in Chapter 4

shows how urban climate change experimentation appears to be a recent phenomenon but is rapidly diffusing across urban communities.

From a theoretical perspective, the critical importance of the urbanization process in development narratives surfaces as a key motivating factor to look at city-level action. The process of urbanization has been a defining feature of development for the past 100 years (Seto, Sánchez-rodríguez, & Fragkias, 2010). In particular, cities play an interesting role surrounding the issue of climate change. Figure 3.3 represents an attempt to illustrate the importance of the urbanization pattern: the figure shows five decades of development for the BASIC countries, the United States, and the European Union. Thus, several answers to the question ‘why cities?’ can be posited:

- *Population:* The world’s cities now represents 54% of the world’s population (United Nations, 2014). This share will continue to increase to 66% by 2050. Especially Africa and Asia are expected to document rapid growth in urban population; India, China, and Nigeria, stand out in particular as they are projected to account for 37% of the projected growth of the world’s urban population (United Nations, 2014).
- *Capital:* 80% of global Gross Domestic Product (GDP) is generated in cities and climate change is expected to negatively impact the urban economic environment (Carbon Disclosure Project, 2014).
- *Energy use and greenhouse gas emissions:* While methodological differences in attribution establish wide-ranging estimates of urban contributions to global energy use and greenhouse gas emissions (Satterthwaite, 2008; Kennedy, Ramaswami, Carney, & Dhakal, 2011), it is clear that cities contribute a significant share in terms of energy consumption and greenhouse gas emissions (van Staden, 2014). This image appears relatively uniform across the world, as cities in developed nations (Hammer, 2008) and in developing countries (Dhakal, 2009) demonstrate similar profiles.
- *Vanguard of knowledge development:* cities, especially the world’s mega-cities, are often positioned as hubs of not only economic

activity but also innovation and development (Beaverstock, Smith, & Taylor, 1999; Kourtit & Nijkamp, 2013).

- *Experimentation*: Of course, a key decision factor to focus on the urban environment in Ch. 4 is the observation of rampant climate change mitigation and adaptation experimentation in the urban context (Bulkeley & Schroeder, 2012; Bulkeley & Betsill, 2013; Castán Broto & Bulkeley, 2013; Hoffmann, 2011; C40 Cities, 2014).
- *Networks*: the introduction of networks is a key component of the polycentric strategy. Interestingly, social networks in cities appear to scale super-linearly (Schlapfer et al. 2014). Investigating social connectivity in Portuguese cities, Schlapfer et al. (2014) found that a) the degree (i.e. size of the network) and total volume of human-human interactions (i.e. number of interactions within the network) scale super-linearly at the same pace and b) that networks in large-scale cities might be as tightly knit as they are in smaller towns and cities. They arrive at the finding that these characteristics suggest that larger cities are especially well-suited to facilitate the diffusion of information and new ideas or “other interaction based processes” (Schlapfer et al., 2014, p. 7). This points to a potential answer to the sustainability problem: cities display strong networks that, when strategically applied, may provide impetus towards solutions.

The image that emerges is one of opportunity but also substantial risk: cities bring together people into extensive social networks, encompass substantial wealth, demonstrate high productivity and know-how but are at the same time vulnerable to the consequences of climate change (van Staden, 2014). The combination of these factors suggests significant mitigation and adaptation potential, diffusion of policy options, and actual GHG emission profile changes due to these developments.

For these reasons, Chapter 4 explores urban city level activity and seeks to determine the size and capability of the polycentric strategy.

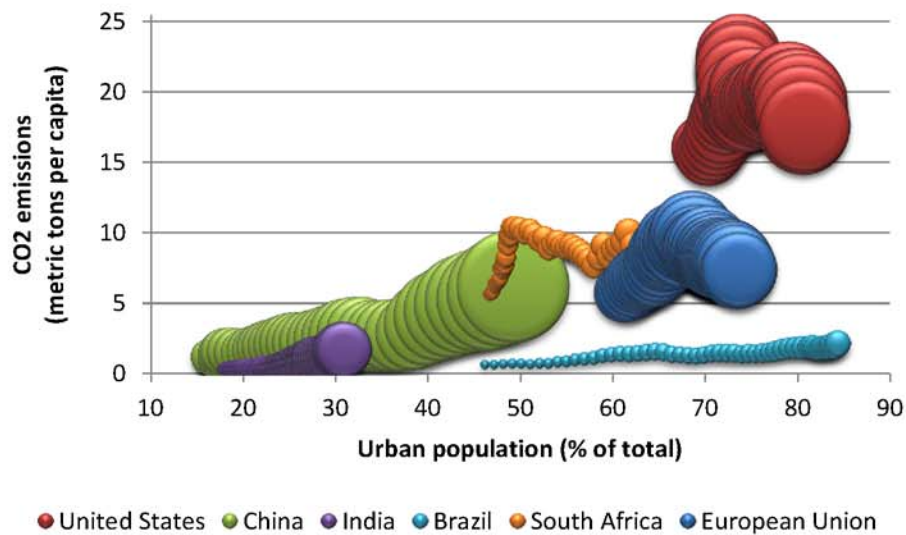


Figure 3.3; Overview of five decades of development (1960-2010). The size of the bubbles represents overall national carbon dioxide emissions (kilotons). Source: the World Bank's World Development Indicators database.

3.3.3 Phase II: Can a Polycentric Strategy Provide an Operational Response to Criticism and Effectuate its Virtue Claims?

The second phase of the research presented here evaluates two operational activities that can suitably be placed within an polycentric strategy in order to determine the strategy's capacity to answer criticism from proponents of the monocentric strategy and to determine whether it can provide operational and practical evidence of some of its own virtue claims. Therefore, before providing the research framework of Phase II, it is useful to reflect on the ongoing debate on the power and promise of polycentricity from both the angle of monocentrism and from the perspective of defending polycentrism.

When seen in the terms provided in Section 3.2.2., it becomes clear that 'regular' climate policy has always been at least 'weakly polycentric' (Cole, 2011). For instance, two of the countries that have taken up a recalcitrant position in the

international negotiations, the U.S. and China, have already embarked on (sub-) national policy experiments that amount to significant efforts to address climate change (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Wong, 2013; Li & Wang, 2012). The debate between polycentrism and monocentrism has, in different forms, been underway for some time now. As such, the arguments of both sides of the debate have been fleshed out in some detail. While this chapter has demonstrated substantial evolution, diffusion, and performance of the polycentric strategy in the context of urban climate change action, the debate on the merits of monocentrism on the one hand and polycentrism on the other hand continue. As such, drawing from the lessons learned throughout this dissertation so far, it pays to reflect on this ongoing debate and structure it to extract critical components that could further advance the case for a polycentric strategy in the context of an ecological sustainability paradigm.

3.3.3.1 Challenges Raised by Collective Action Theory

Collective action theory applies to “settings where decisions about costly actions are made independently but outcomes jointly affect everyone involved” (Ostrom E. , 2010, p. 551). The theory positions individuals and decision-makers as short-term, independent, actors who have material maximization in mind (Brennan G. , 2009). As a result, this expected behavioral pattern is thought not to produce significant action on collective action problems without externally imposed regulations or through the means of privatization (Brennan G. , 2009; Hardin, 2005). This line of thinking can be traced throughout history without much critical thought as to its appropriateness or accuracy (Lichbach, 1996; Schelling, 1978; Vatn, 2005; Brennan G. , 2009). As a result, many see a globally enforceable treaty as the only way out (Cole, 2008; Sandler, 2004; Ostrom E. , 2012). The assumptions embedded

within collective action produce several arguments as to why action without an external arbiter or a thorough process of privatization are not likely to succeed.

Criticism leveled against polycentricity from the collective action perspective tends to argue from a position of *chaos*: polycentrism contains too many actors, too many actions, too many scales, without oversight. This aligns with the earlier identified need to establish an external arbiter to prevent anarchical battling between sovereign states. Sovacool & Brown (2009) summarize the position of proponents of global action as follows:

“Those in favor of relying on the national/global scale of climate action believe that it best promotes uniformity and consistency along with economies of scale, and avoids spillover effects.” (Sovacool & Brown, 2009, p. 322).

3.3.3.1.1 The “Leakage” Argument

One of the principal concerns raised by collective action theory is the notion of ‘leakage’. In fact, the problem of leakage is frequently used as a firm ‘stop sign’ in any effort to change the comprehensive nature of climate change agreements. Per illustration, resistance to, for instance, ‘carbon dioxide only’ cap and trade systems – in contrast to the CO₂eq. currency used today – revolves around the fear of ‘leaking’ where activity patterns will shift to the use of other gases that are not covered by the system (Stewart & Wiener, 2007). Leakage, as such, can perhaps be seen as the most significant downside of localized, bottom-up, approaches (Wiener, 2007; Sovacool & Brown, 2009) as such efforts produce differentiated geographic regulatory environments and distort price signals (Sovacool & Barkenbus, 2007; Barrett & Stavins, 2003).

According to Wiener (2007), these ‘leaks’ or ‘shifts’ are driven by three primary ‘levers’: a price effect, a ‘slack off effect’, and a capital relocation effect. Setting a carbon price, for instance, whether through taxation or subsidy programs, changes comparative advantage balances. This price effect can make products from non-regulated areas more attractive thus reducing the overall impact of the program. Similarly, corporations can seek to relocate to such non-regulated areas. The ‘slack off effect’, finally, is introduced by Wiener (2007) to signal climate change’s ‘prisoner dilemma’ style dynamics where aggressive action by one party can actually reduce the incentive for aggressive action by another party. These ‘levers’ have three primary outcomes:

- These processes undermine the ecological effectiveness of the action;
- Leakage, and the threat of its economic consequences, can form a significant political obstacle and reduce the possibility for action;
- Unregulated areas may, paradoxically, become more emissions-intensive due to the processes of leakage. This can even result in a net negative effect.

The concern of leakage is a reality in the design of environmental protection schemes. Around the time of the construction of a particular environmental protection scheme, the Regional Greenhouse Gas Initiative (RGGI; colloquially referred to as ‘Reggie’), for instance, a study by the American Council for an Energy Efficient Economy (ACEEE) concluded that leakage is a “big concern” that could potentially offset 60-90% of the program’s estimated emission reductions (Prindle, Shipley, & Neal Elliot, 2006). The study, however, also notes how a more intense focus on energy efficiency could considerably reduce the problem of leakage. Unilateral action can

also spur technological change and innovation, perhaps further reducing the effects of leakage (Golombek & Hoel, 2004; Di Maria & van der Werf, 2006).

3.3.3.1.2 The “Uniform Mixing” Argument

Another argument raised by the proponents of global agreement using collective action theory is the notion of ‘uniform mixing’. This argument revolves around the reality of climate change where greenhouse gases rapidly mix in the atmosphere, eliminating any direct relationship with local emission points and, instead, becoming part of the global depository of atmospheric or oceanic carbon. This argument drives the need for global agreement and globalized action as benefits from localized action are dispersed among the international community just as the carbon gases are. Mitigative actions, therefore, are seen as more beneficial when they occur at higher levels of governance (Wilbanks, 2007). In addition, the uniformity of emissions drives arguments revolving around the currently favored homogenous, standardized, emission-flexible approach. Adaptation, in contrast, is a concept that is inherently contextual and that offers variability and flexibility. Any benefits produced through adaptive actions are seen as to stay within the community that performs these actions. This line of thinking produces the visualization of the argument provided below (Figure 3.4).

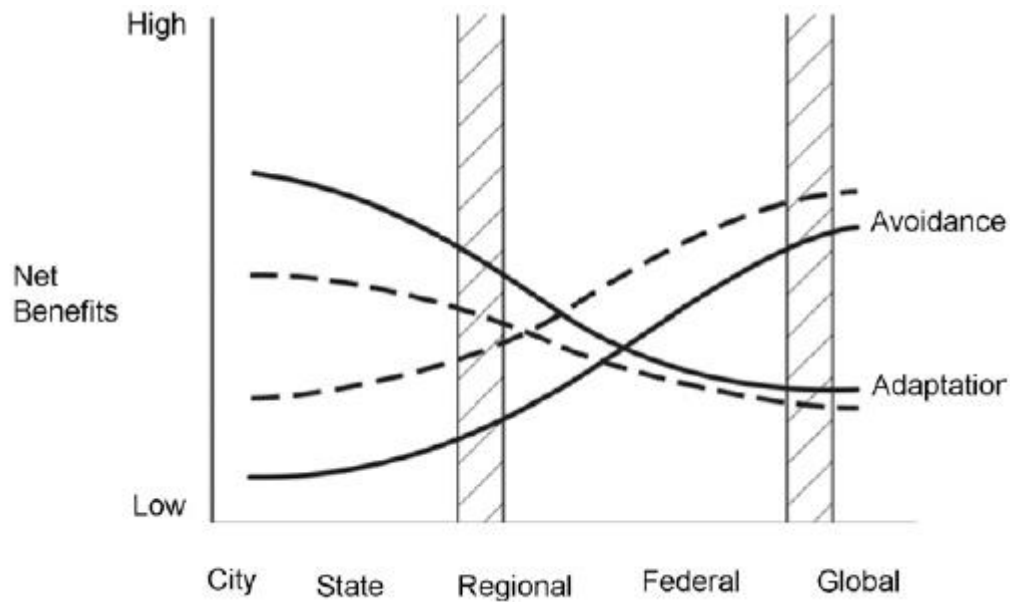


Figure 3.4; Illustration of expected governance level in relation to mitigative or adaptive actions (Wilbanks, 2007).

Solid lines depict moderate climate change; dotted lines depict more substantial climate change.

3.3.3.1.3 The “Regulatory Patchwork” and the “Economies of Scale” Arguments

An additional political obstacle to localized action is the argument of the ‘regulatory patchwork’ (Wiener, 2007): inconsistency due to variable local approaches could result in a ‘patchwork’ of regulations and actions that become difficult to navigate or understand. Especially, multi-state or multi-national corporations and organizations could face a plethora of different regulations with which they need to comply. Examples of such fragmentation, such as found, for instance, in the U.S. Renewable Portfolio Standard (RPS) policy landscape (Carley & Browne, 2012; Carley S. , 2011; Barbose G. , 2012), are often brought forward as an argument supporting centralized action (Wiener, 2007; Sovacool & Barkenbus, 2007). Indeed, a

full decentralization of efforts can be argued to introduce a range of additional complications due to the introduced complexity of such a patchwork (Andersson & Ostrom, 2008). The complexity, for instance, can lead to struggle and conflict between local groups without recourse to external arbitrage mechanisms (Alston, Libecap, & Mueller, 1999) or stagnation and inefficiency due to isolation and information costs (Andersson & Ostrom, 2008).

A related argument is the “economies of scale” argument where larger scales through coordinated efforts can deliver a better outcome. Such efforts are argued to be qualitatively better due to the possibility of avoiding duplication of efforts, addressing blind spots, eliminating redundancies, and an overall improvement of efficiency (Sovacool & Brown, 2009). Any sub-global efforts, this argument goes, will fail to control important sources of pollutants (Wiener, 2007).

3.3.3.1.4 The “Free Riding” Argument

A final key argument often leveled against proponents of localized action is that of ‘free riding’. Considering that, in line with the uniform mixing argument, local abatement efforts are accompanied by local costs but are seen to deliver “essentially no local climate benefits” (Wiener, 2007, p. 1965). This results in the situation that non-cooperation or non-participation delivers benefits without costs, thus incentivizing parties to either not participate or agree to participation but limited compliance. As highlighted in Chapter 1 and 2, the international negotiations already offer a platform where free riding takes place: not only are many of the parties exempt from taking costly actions, some of those that are subject to emission reduction rules have largely evaded compliance (e.g., Canada).

Pessimistic views of this ‘opportunistic’ behavior warn of a potential ‘race to the bottom’ where local decisions to relax regulations further reduce costs but consequences are distributed among the international community (Wiener, 2007). The notion that, due to the distributional consequences of climate change, there are, indeed, certain parties that can be considered “winners” further elevates the danger of free riding in the absence of a comprehensive and effective global agreement.

3.3.3.1.5 The “Legitimacy and Accountability” Argument

Polycentric governance systems are characterized by fragmentation, complexity, and interdependence. Importantly, this positions both state and non-state actors in the roles of regulators and regulated (Black J. , 2008). The chaotic nature of polycentric governance, according to Black (2008) encounters challenges in the literature along functional, democratic, normative, and systemic lines:

- *Functional challenges:* these challenges revolve around the notion that there is a lack of overall coordination. There is no central authority coordinating activity. As such, “there may not be a body [...] to [...] steer or coordinate the activities of the multiple participants in such a way that the regime moves toward the resolution of the problem which it both defines and is defined by” (Black J. , 2008, p. 140).
- *Systemic challenges:* social system fragmentation can present differing implications within law by regulatory norms.
- *Democratic challenges:* these challenges arise from complications with the notion of representation. These challenges thus revolve around questions such as: Who participates? To whom are the participants accountable? How is accountability determined?
- *Normative challenges:* competing conceptions of the goals and objectives that need to be pursued can arise.

These challenges result in the contestation to polycentric regimes that they might be dysfunctional and discordant:

“[Polycentric] sharing of responsibilities naturally generates contestation, so the system must include mechanisms through which disputes over the consequences of collective decisions can be resolved. It is an extremely complex system. No single planner would ever design such a mess, nor can any external force impose such complexity on an unsuspecting community.”(McGinnis, 2005, p. 168; as quoted by Sovacool, 2011, p. 3833);

3.3.3.2 In Defense of Polycentricity

Critical thought as to the appropriateness of collective action theory or the desirability of a global agreement have veered off in the investigation of sub-global efforts (Morgan M. , 2000; Victor, House, & Joy, 2005; Rayner S. , 2010; Schreurs, 2008). Motivated by studies that highlight the potential or actual contribution of sub-global efforts (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Lutsey & Sperling, 2007; Carley & Browne, 2012), these investigations have produced a range of characteristics and virtues that can be associated with such strategies. Combined, these characteristics and virtues offer an initial answer to the challenges raised by collective action theory.

3.3.3.2.1 The “Individual as Author” Argument

One of the arguments positioned in favor of a polycentric approach recognizes that significant emission reductions do not necessarily require participation and compliance by the major, single-point emitters. Instead, an argument of the “power of the individual” realizes that significant cumulative emission reductions can be achieved by a focused effort of many, small-scale emitters such as individuals, households, and businesses. In fact, the problem of climate change can be to a large

extent attributed to the actions and choices of these actors (Kates & Wilbanks, 2003). As a corollary, part of the solution also lies with these actors. For instance, Dietz et al. (2009) calculate how modifying 17 household action types at a national level in the U.S. could save an estimated annual 123 million metric tons of carbon by the tenth year of interventions. This correlates to approximately 20% of household direct emissions or 7.2% of US national emissions (Dietz, Gardner, Gilligan, Stern, & Vandenberg, 2009). Other studies in relation to the power of the small-scale but cumulative application of climate change reduction efforts demonstrate similar findings (Fuller, Portis, & Kammen, 2009; Gardner & Stern, 2008; Vandenberg & Steinemann, 2007). In effect, the argument serves to re-appreciate the potential contribution of small-scale emitters of carbon and to position small-scale networks of participants as a formidable opponent to large-scale system-wide solutions.

3.3.3.2.2 The “Benefits Not Only Global” Argument

To counter the argument that mitigative actions only produce global benefits, proponents of polycentric governance point out the myriad of co-benefits that take place at all levels and among all actors (Ostrom E. , 2010; Ostrom E. , 2012; Sovacool & Brown, 2009). For instance, climate change concerns such as carbon control are often tied in with a range of other concerns such as resource scarcity, resilience, security, capitalizing on market potential (Matisoff, *The Adoption of State Climate Change Policies and Renewable Portfolio Standards: Regional Diffusion or Internal Determinants?*, 2008), policy entrepreneurship, networking, and other co-benefits (Engel, 2009).³⁵

³⁵ A similar case can be made for adaptation measures. Urban resilience, for instance, is degraded on a variety of levels and dimensions by climatic change leading urban

This argument shares a similarity with the previous argument as it emphasizes that local actions can have considerable impact, but differs in that it stresses the additional benefits that occur from mitigative action at all scales:

“Given that many of the actions generating GHG emissions are taken at multiple scales, activities that are organized at multiple scales generate benefits to those who act, ranging from households, farms, and cities at a local scale to regions within a state, states, regional units that cross state boundaries, and the globe” (Ostrom E. , 2010, p. 552).

Mitigation, like adaptation, can thus also be contextualized based on the specific circumstances of the locality in which mitigative action is applied: co-benefits of mitigative action differ per area of application. The proponents of polycentric governance, therefore, argue that it is simply not true that mitigative actions, along Wiener’s (2007) assertion made earlier, can only be seen to produce global benefits. In addition, this argument can also be positioned as an initial response to the concern of ‘leakage’: additional benefits within the regulated area could improve the benefit-cost ratio and de-incentivize capital relocation.

3.3.3.2.3 The “Race to the Top”, “Tipping Point”, or “Domino Effect” Argument

In contrast to Wiener’s (2007) assertion of the prospect of a ‘race to the bottom’, proponents of polycentrism argue that, considering the realization that significant mitigation potential exists with each level of action and that significant co-benefits can be reaped at each level of action, the potential exists for an entirely different outcome. As actors seek to reap these benefits, competition, innovation,

resilience improvement strategies to emphasize diversity, flexibility, adaptive governance, and learning and innovation in relation to climate change in their broader development policy framework (Leichenko, 2011).

mutual learning, etc. could drive, in fact, a ‘race to the top’ (Rabe B. G., 2006). Functioning as ‘laboratories of democracy’ and ‘agenda setters’, sub-national or sub-global efforts can motivate action by other actors or at other levels (World Resource Institute [WRI], 2007) perhaps triggering a kind of ‘domino effect’ (Engel & Saleska, 2005, p. 189).

This process could perhaps be even further extended into the international arena where, once, for instance, certain countries have adopted policies that have been experimented with at lower levels of governance, other countries are motivated to follow suit. This is exactly the thesis that Geoffrey Heal and Howard Kunreuther stipulate in their game-theoretic analysis of a potential ‘tipping point’ in the international negotiations: increased levels of action by countries could ‘tip’ the scales in favor of global action (Heal & Kunreuther, 2011).

3.3.3.2.4 The “Mutual Learning” and “Experimentation” Arguments

Experimentation and social learning are positioned as critical components of polycentric processes of change (Nevens, Frantzeskaki, Gorissen, & Loorbach, 2012; Bos & Brown, 2012; Bos, Brown, & Farrelly, 2013; Hoffman M. , 2011). This realization suggests that modern society’s currently vast expertise with technical innovation and learning can be expanded towards wider, societal, learning through such processes (Bos & Brown, 2012, p. 1341).

3.3.3.2.5 Network Governance

An additional useful framework with which to offer insights into polycentrism is Network Theory. As will become particularly clear in the next chapter, polycentric activity frequently structures itself along membership in transnational networks. These

networks are hypothesized to deliver critical virtues. For instance, Benioff et al. (2013) discuss the role of networks in low emission development strategies and, specifically, review the role of the Low Emission Development (LEDS) network. In this effort, they discuss Network Theory at length in the context of climate change mitigation and low emission development. Specifically, following, for instance, Börzel's account of Rod Rhodes' seminal contribution to public administration describing an emergent polity in British governance outlined by self-steering, interdependent, policy networks (Börzel, 2011), networks can be positioned as a separate governance strategy next to hierarchies and markets. In particular, in contrast to command-and-control hierarchies or market self-coordination through commodification, networks function through non-hierarchical coordination founded on resource sharing and trust (Börzel, 2011). Indeed, governance by network delivers, among others, advantages of speed, flexibility, increased reach, innovation, and specialization (Goldsmith & Eggers, 2004). Experimentation and social learning, furthermore, are facilitated through network governance as lessons learned are shared and debated (Neuens, Frantzeskaki, Gorissen, & Loorbach, 2012; Bos & Brown, 2012; Bos, Brown, & Farrelly, 2013; Hoffman M. , 2011; Sabel & Zeitling, 2012).

3.3.3.2.6 The “Flexibility” or “Accommodating Diversity” Argument

Public problems, when seen through a process of constant revisability, are approached pragmatically (Karkainen, 2004) and this experimentalism goes beyond simple trial and error as ends are reflexively re-determined. Solutions, seen as a ‘step along the way’, enables a flexible and adaptive approach to public problems.

Additionally, there is a sense within polycentrism of the need to ‘accommodate diversity’: realizing, for instance, the unjust distribution of climate change

consequences (Douglas, et al., 2008), the differing nature-society relationships (Guha & Martinez-Allier, 1997), and different climate change drivers are seen as motivating factors for a pluralistic response to climate change in order to reflect the observed heterogeneity.

3.3.3.2.7 The “Gaming” Argument

The polycentric narrative also levels a criticism against the currently isolated approach of top-down global governance. One argument within the narrative surfaced after findings that the Clean Development Mechanism (CDM), especially in its early years of operation, was subject to considerable ‘gaming’ of the system. More specifically, the mechanism was being (ab)used to generate exorbitant amounts of emission reduction units through easily deployed measures and activities that would likely be implemented with or without CDM support, especially HFC-23 gas destruction activity (Wara & Victor, 2008; Wara M. , 2007). Large-scale, homogenous systems, the narrative goes, are not capable of capturing the existing heterogeneous complexity and are thus ill-prepared when faced with local manipulation. Interestingly, this argument is also raised in the narrative that seeks to highlight the limitations of polycentrism (Ostrom E. , 2010).³⁶

³⁶ This is also the case for several of the other arguments. ‘Leakage’, for instance, as indicated in the text, is also considered a problem of activities that have emerged from the dominant discourse of top-down, global actions. Similarly, ‘free riding’, can be said to occur within the Kyoto Protocol as some have been able to negotiate favorable targets or have not sought to comply with their targets while others have been burdened with more stringent targets or have aggressively pursued their targets.

3.3.3.2.8 The “Global Consultant” Argument

Closely related to the previous argument, proponents of matching scale to the problem at hand can raise criticism to the CDM for another reason. Validation of CDM projects, for instance, often is done by external “global consultants” (Ostrom E., 2010). Not only are such ‘global consultants’ expensive, limiting availability of funds for local recipients (Michaelowa, CDM host country institution building, 2003), they often are unaware of the local context, are overworked, and have limited time availability for each CDM project possibly leading to inadequate verification (Schneider, Is the CDM fulfilling its environmental and sustainable development objectives?, 2007; Michaelowa & Purohit, 2006).

3.3.3.2.9 The “Participation, Legitimacy, Responsiveness” Argument

More directly, the “global consultant” and the “gaming” argument both reflect a preference for localization or, at least, recognition of local context in the narrative of polycentrism. This argument comes to the forefront even more strongly in the ‘participation, legitimacy, responsiveness’ argument. Situated closer to communities and arranged along functionality rather than geography, polycentric action networks are argued to be more responsive to the needs and wants of their constituents. Similarly, their participation in decision-making, not only improves responsiveness but also is argued to ensure or enhance legitimacy in the eyes of the affected community (McGinnis, 2006).

This argument can additionally be positioned as a response to the free riding concern. Ostrom (2010) notes how empirical support for the theoretical prediction of non-cooperation at small- and medium-scale levels is rather weak. Cooperation has been frequently documented (Poteete, Janssen, & Ostrom, 2010; Agrawal, 2002) and,

in several cases, has withstood the test of time (Casari & Plott, 2003; Coop & Brunckhorst, 1999). This leads Elinor Ostrom to note:

“What we have learned from extensive research is that when individuals are well informed about the problem they face and about who else is involved, and can build settings where trust and reciprocity can emerge, grow, and be sustained over time, costly and positive actions are frequently taken without waiting for an external authority to impose rules, monitor compliance, and assess penalties.” (Ostrom, 2010, p. 555).

3.3.3.2.10 The “Values over Interests” Argument

Political economy critiques of top-down architectures show that interstate interaction oftentimes leads to the prioritization of interests over values (Eckersley, 2004; Brüttsch, 2012; Newell & Paterson, 1998). In contrast, foreign engagements by metropolitan agents are oftentimes constructed based on a recognition of common values, supported by potential common interests (Brüttsch, 2012; Engel, 2009) breaking the congruence that now exists between sovereignty, nationality, citizenship and territoriality (Eckersley, 2004, p. 46). National political economy interests and architectures, as such, could potentially be circumvented through neural network applications of action (Byrne, Wang, Taminiau, & Mach, The Promise of the Green Energy Economy, 2014; Engel, 2009).

3.3.3.2.11 The “Safety Net” Argument

Recognizing that it is not in the best interest of some actors to proceed with certain measures or actions, polycentrism additionally argues the value of a sort of “safety net” (Sovacool B. , 2011) where other actors can pick up these problems and allocate their resources towards their resolution (Andersson & Ostrom, 2008).

3.3.3.2.12 The “Timing” Argument

A final argument offered by the polycentric narrative is one of time. Elinor Ostrom (2012) asks whether we ‘must wait’ for global solutions or perhaps can find new strategies that allow for near-term action. The Durban Platform brings this question even more forcefully to the forefront: the plan of action of the international community at this point foresees no global agreement until at least the year 2020. In contrast, the ‘bottom-up’ strategies of polycentrism can start today. In fact, they already have.

Polycentrism can therefore be positioned as an answer to the ‘lowest, slowest common denominator’ approach identified in the previous chapter. Polycentrism, focusing on processes of learning, experimentation, collaboration, etc. does not seek a ‘common denominator’; instead, it seeks to identify the strong elements within any area, actor group, or level of governance, and facilitate the deployment of actions and measures that can inspire and motivate others.

3.3.3.3 An unsettled debate

Environmental governance has been undergoing substantial change. Whereas conventional approaches emphasize a leading role for states through a ‘pure mode of governance’ (Lemos & Agrawal, 2006), hybrid collaborations between different social agents have emerged over time. Such alternative institutional forms of governance reflect a ‘bifurcation in authority’ that leads to a co-existence of multiple and diverse actors in the decision-making process (Karkainen, 2004). The emergence of such ‘polycentric’ governance structures allow for ‘task-specific’ rather than ‘general purpose’ governance (Karkainen, 2004; Ostrom, 2010, 2011). In other words, a diverse set of actors can participate in the decision-making process regarding an

(environmental) issue that concerns them. Within such decision-making structures, authority becomes non-exclusive (i.e. no exclusive authority for the sovereign state), decision-making is non-hierarchical and post-territorial (Karkainen, 2004).

While ongoing efforts are directed towards interstate negotiations, the international community is, simultaneously, confronted with a plethora of actions that are taking place despite the absence of an established external set of rules or a global arbiter. Formulated under the rubric of ‘polycentrism’ or ‘new governance’, these efforts essentially challenge the legitimacy of collective action theory and the singular focus on (inter)state action (Scott & Trubek, 2002). In fact, as discussed in Chapter 4, the commitment to non-state actions has deepened and strengthened over time (Bulkeley & Betsill, 2013) in part due to the realization of interstate negotiation ineffectiveness (Hoffman M. , 2011). The emergence of hybrid governance structures (Karkainen, 2004) that actively reconfigure and redistribute authority to articulate processes of change (Bulkeley & Betsill, 2013) cause exclusively statist explanations of change to lose ground and highlight that the theory of collective action apparently insufficiently deciphers such processes of change (Ostrom E. , 2010; Ostrom E. , 2012).

Driven by factors such as increased complexity and associated uncertainty, irreducible diversity (i.e. the unavailability to uniformity), the realization of the limits of traditional top-down regulation, legitimacy, and subsidiarity (Scott & Trubek, 2002), new governance articulations of change find expression within the field of climate change. New governance takes on a variety of forms as authority is dispersed and fragmented, heterarchical chains of command are formed, accountability is sought in the public realm, adaptability and flexibility to meet new challenges are essential,

and new knowledge is continuously created (Scott & Trubek, 2002, p. 8). As such, a new paradigm of how to formulate and implement climate change mitigation and adaptation might emerge (van der Heijden, 2013).

However, polycentricity will need to prove its value other than raising the specter of continued non-action within the international negotiations. Simply stating that disillusionment with the international negotiations is driving a wide variety of actors to action (Hoffmann, 2011) is insufficient. This chapter has made a start to this case. Nonetheless, the chapter has also observed that there is an ongoing debate on the merits and possibilities of polycentrism to fulfill its promise. To address the arguments provided in the debate, it is useful to structure their meaning in the aggregate (Figure 3.4). Specifically, the arguments against polycentricity stating that a ‘patchwork’ of efforts will not be able to effect sufficient change and that ‘leakage’ will be destructive to the strategy’s probabilities of success can be structured as an argument that polycentrism will drive insufficient scale of change. Similarly, the legitimacy/accountability argument and the ‘patchwork’ argument can be structured as a challenge that polycentrism will result in a chaotic strategy. Arguments opposing these structures are also illustrated in Figure 3.4. For instance, safety net and timing arguments can be structured as a response to scale, arguing that some level of action is better than no action. Moreover, the ‘race to the top’ argument can be structured as a position that polycentric activity, while local and decentralized, can produce change on a level that is sufficient to limit the negative consequences of free riding and leakage. The challenges that, therefore, can be extracted from the debate are:

- *Sustainability challenge*: Can local effort produce infrastructure-level change?

- *Governance challenge:* Can institutions find meaningful expression in polycentrism, capturing values and community participation?

Critically, recognizing that national governments and markets experience difficulties in addressing a ‘Super Wicked’ problem such as climate change that displays high levels of complexity and diversity, opens up the question: ‘who governs now?’. In terms of energy, conventional utilities similarly face problems in addressing climate change, responding to social concerns *and* maintaining a profit-based business model. Is there a need for a new governor of energy?

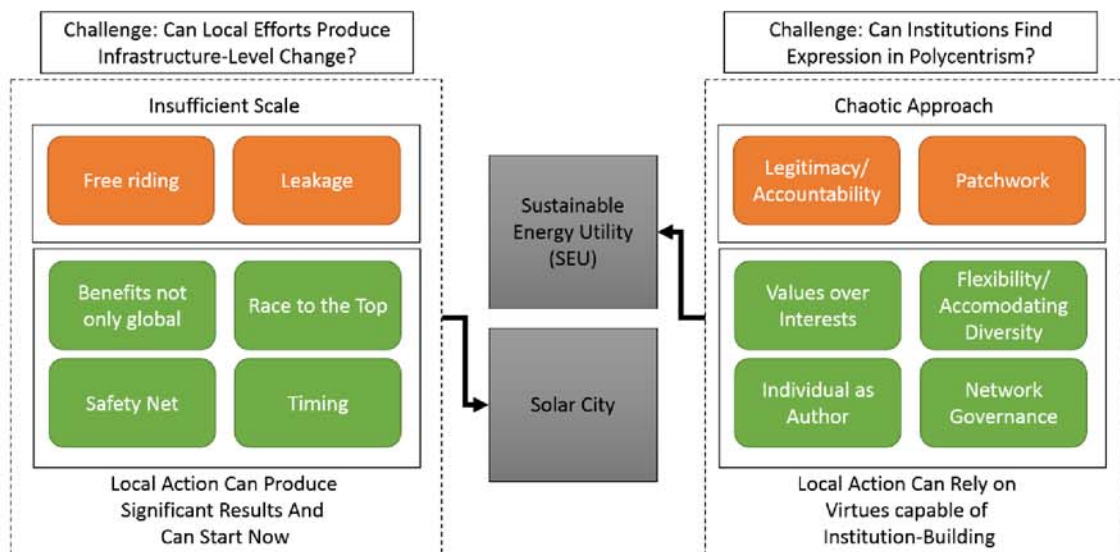


Figure 3.5; Overview of the polycentricity debate.

3.3.3.3.1 Why Infrastructure-scale Change?

Cities, especially, mega-cities are described by some as prime examples of unsustainability due to, among others, their dependence on large amounts of energy,

their high contribution to ecological problems, and their detachment of ecology. For instance, China's 35 largest cities, at 18% of the population, represent 40% of the country's energy use and CO₂ emissions (Dhakal, 2009). Indeed, considering that the Asian continent will continue to experience rapid urbanization – the continent will see its urban population increase by about 1.4 billion people by 2050 (UN, 2012) – new strategies for urban livability and energy economy restructuring are necessary to restrain energy use and associated environmental degradation. The realization that China annually adds about 1.7 billion m² of new floor space (Bin & Jun, 2012) elevates the urgency to deliver such new strategies. As such, urban energy economy restructuring is cited as a key prong in any strategy to address climate change. For example, global organizations such as the World Bank, the United Nations Environment Program, and the Organization for Economic Co-operation and Development each have embraced city energy economy restructuring as a key tool to meet low-carbon development objectives (OECD, 2013a, 2013b; UNEP, 2012, Suzuki et al., 2010).

Urban deployment of strategies are often amalgamated under concepts such as the 'eco-city', 'sustainable city', or 'solar city' (Byrne, Taminiau, Kurdgelashvili, & Kim, 2015) and have found widespread local, regional, and national acceptance (Joss, Cowley, & Tomezeiu, 2013). These initiatives challenge standard energy development models based on centralized supply, generated external to the city, and suggest greater attention to decentralized energy and city autonomy. This dissertation places a particular emphasis on the concept of the 'solar city' – where PV energy technology is deployed at the infrastructure scale within city boundaries – but other energy

technology options, such as energy efficiency, are also available to municipal action (Chapter 6).

3.3.3.3.2 Why a Focus on Institutional Energy Governance?

Lower level actors often face difficulties that can be circumvented or addressed by top-down strategies. In particular, transformative change requires a substantial amount of resources that are sometimes difficult to come by for, say, a municipality. Examples of difficulties facing municipalities are limitations in the budget or authority of municipalities, the need for civil society engagement to sustain sustainability efforts, and capacity building requirements in terms of management and leadership (Wang, Hawkins, Lebrede, & Berman, 2012). The critical importance of such components is underscored by several other analysts. For instance, Seto et al. (2014) identify the following key factors for the successful pursuit of urban climate change governance:

- Institutional arrangements capable of smoothing the integration of mitigation with other urban agenda priorities;
- A multi-level governance context that enables and empowers cities to pursue low carbon development;
- Political will and spatial planning capabilities to integrate land-use and transportation planning; and
- Sufficient levels of capital inflows and incentives to support ambitious climate change strategies.

In particular, the modern energy regime is a major component of the climate change challenge: the contemporary configuration of the modern energy economy, fueled by optimality precepts, maintains a *modus operandi* that ineffectively addresses negative consequences of its operation or inadequately incorporates other perspectives

that allow for alternative energy development. Critically, housed within the optimality paradigm, modern energy development is characterized by unbridled expansion in energy use and consumption and operationalized through centralization and large-scale deployment. Indeed, the very institutions that govern energy in modern societies, those of the conventional energy utility, thrive in optimality contexts but, as we will see, demonstrate a less impressive performance record when placed in ecological sustainability contexts. It is therefore critical to uncover energy governance pathways that excel within an ecological sustainability paradigm context. To do so, this dissertation explores the performance record of three institutional approaches to energy governance: a) those of the conventional energy utility, b) those of the Energy Service Utility (ESU), and c) those of the Sustainable Energy Utility (SEU). The SEU is briefly introduced below but described in more detail in later chapters.

Positioned as a new governor of energy-economy-environment relations, an SEU was first conceived in a series of policy papers published in 2006-2007 (Byrne, et al., 2007; Byrne & Toly, 2006). This led to the enactment of the idea by statute in the U.S. state of Delaware in 2007. Versions of the strategy have subsequently been created in several U.S. jurisdictions and the model is under active consideration in Asia and Europe.

In short, an SEU aims to redefine social and market forces to realize a fundamental transition to sustainability. Departing from the supply-side approach of conventional energy utilities, the SEU offers a comprehensive approach to deliver on-site energy services. It pursues a carbon-free energy economy, providing energy services rather than energy commodities, accelerating a transition to a decentralized energy service and governance geography, and directly involving the wider

community in the decision-making process. An SEU functions as a central clearing house for comprehensive programs (efficiency, conservation, renewable energy; materials, water, energy) and is authorized to leverage private capital markets and deploy self-financing strategies in its efforts to deliver energy services to the community it serves.

3.3.3.4 Phase II Evaluation Context

3.3.3.4.1 Just Sustainability

While evaluation of effectiveness is a critically important characteristic, both in terms of potentially disruptive innovations but also in terms of their wider adoption (i.e. which policies make most sense to adopt?), it remains an underdeveloped perspective (Hilden, Jordan, & Rayner, 2014; Jordan & Huitema, 2014). As a result, a knowledge gap exists for policy-makers as to what policy instruments are effective and this appears especially true for climate policy (Kerr, 2007). As Kerr (2007) for instance shows, climate policy often is subject to inflated claims of success that are undeserved and can perhaps more reliably be explained by serendipity.

The earlier identified ‘ambition gap’ demonstrates the Kyoto era failure to gather a sustainability effort that is up to the task at hand. As Byrne & Taminiau (2015) account, what is required is a translation of sustainability as a firm ‘stop sign’ rather than its current conceptualization as a ‘speed bump’ available for marginal decision-making and navigation based on the price of carbon. In addition, as provided for by Byrne, Kurdgelashvili, & Taminiau (2012), this challenge should not just be seen as a challenge to certain actors but rather, extends to all actors; developing

countries and developed countries alike need to present aggressive movement towards climate change emission reductions. The failure to meet the sustainability principle enshrined in the climate regime foundational texts, raises the obvious challenge to any strategy that seeks to be positioned as an alternative response: does the alternative response strategy present a stronger sustainability case?

Moreover, the two big public ideas of ‘ecological sustainability’ on the one hand, and ‘climate justice’ (Goodman, *From Global Justice to Climate Justice? Justice ecologism in an era of global warming*, 2009) or ‘environmental justice’ on the other hand can produce a dichotomous conceptualization. Schellenberger & Nordhaus (2004, p. 12) highlight this conceptualization when they ask:

Why, for instance, is a human-made phenomenon like global warming – which may kill hundreds of millions of human beings over the next century – considered “environmental”? Why are poverty and war not considered environmental problems while global warming is? What are the implications of framing global warming as an environmental problem and handing off the responsibility for dealing with it to “environmentalists”?

To advance the capture of both public ideas at the same time, Julian Agyeman has championed the notion of ‘just sustainability’, the marriage of sustainability and environmental justice. Highlighting the conceptual overlap between the concept of sustainability and environmental justice, Agyeman and colleagues emphasize the focus of ‘just sustainability’ as being directed towards:

1. realizing a sustainable level of human activity and
2. opening up political opportunity for mobilization and action for local and community actors and policy-makers.

The environmental justice case, therefore, no longer is limited to the ‘simple’ case of reducing ‘bads’ in the community at hand but, rather, recognize that a ‘not

here, not anywhere' kind of approach is more appropriate (Agyeman & Evans, 2004). In addition, environmental justice policy prescriptions should not only be targeted at the reduction of 'bads' but are equally meaningful in the proactive distribution and achievement of environmental 'goods'. Similarly, the sustainability case, under a 'just sustainability' conceptualization, increasingly refocuses to include equity, justice, and governance not as an afterthought but, rather, as critical and equal components of what it means to be sustainable. Widespread energy poverty, energy (in)justice, and climate justice concerns become intrinsic dimensions of a transition to new energy trajectories (Newell & Mulvaney, 2013).

'Ecological justice' or 'just sustainability' recognizes the inherent limitations of the individualistic neoliberal paradigm that promotes personhood and social fragmentation. Instead, both concepts prioritize common social and ecological interests and seeks for response strategies that can effectuate the practical pursuit of commonly held benefits (Byrne, Glover, & Alroe, 2006; Byrne & Taminiau, 2011). In strong contrast to the currently dominant managerial response, heavily reliant on science and technology, these concepts rearrange the challenge towards the full inclusion of fundamental environmental boundaries, institutional limitations, and social and environmental justice. The call for an 'embodied' experience of climate change, in contrast to the disembodied process of commodification, is further supported by the lessons learned in Chapter 2.

As such, not only is poly-centricity tasked with the demonstration of a 'sustainability case' and a 'justice case' separately, there is also the firm call for a transition pathway that captures the conceptual nexus between the two. In other words, the poly-centric strategy will somehow need to refrain from the capture by

conventional thinking and adhere to principles of ‘ecological justice’ and ‘just sustainability’. In effect, it will need to demonstrate its capability to act as a disciplinarian, where participants of the polycentric response discipline the system and mandate it to adhere to these guiding principles.

3.3.3.4.2 Engagement and Permanence

The managerial, market-based approach dominant throughout the Kyoto era essentially relies on a certain level of de-contextualization and abstraction; sustainability rules are translated into marginal decision-making components, local context is translated to a uniform number of CO₂ units fungible for exchange with other de-contextualized units derived from other locations, and civil society concerns are amalgamated into negotiation positions at the highest levels. One author terms such processes as the ‘politics of translation’ and shows, through political ecology narratives of case studies relating to the CDM that the local context is a factor of significance:

“In particular we have been able to show that projects governed by similar processes within the UN climate regime, and involving similar ensembles of project developers, financiers, and verifiers, manifest very different outcomes because of the distinct social processes and diverse ecologies they encounter and with which they have to negotiate in order to be able to extract value” (Newell & Bumpus, 2012, p. 63)

Similarly, advanced by Norgaard (1995), co-evolutionary development describes a mutual compatibility between eco-system and social system that can allow for sustained interaction with positive mutual responses and/or feedbacks that improve the living conditions of people. This co-evolutionary perspective results in the notion that the imposition of a modern social system on an ecological system with which it lacks such a co-evolutionary basis is unlikely to succeed: “A valuable aspect of the

co-evolutionary view is that it emphasizes that development is a continuous process, largely building on the past, rather than a discontinuous process with wholesale implantations of technologies and social systems” (Norgaard, 1995, p. 116). In other words, the co-evolutionary perspective essentially results in the argument for endogenous decision making for local populations (Norgaard, 1995, p. 120). Key concepts that have been developed within the Kyoto era confines, such as technology transfer, oftentimes fail to capture this realization as they supplant endogenous knowledge systems with modern ones in the pursuit of more efficient action (e.g. Sam Ninan, 2009).

Context is also important as, in contrast to the Kyoto era de-contextualization, poly-centricity offers a perspective of heterogeneity and heterarchical power structures aligned with specific local circumstances and community position. The exclusion of context in any analytical approach dealing with poly-centricity, therefore, is likely to eliminate important phenomena.

As such, factors that sustain sustainability need to be incorporated. More specifically, Wang et al. (2012) identify three factors that are critical to sustain sustainability efforts in a polycentric setting: a) managerial strength or governance capability, b) citizen support, c) financial support. These three factors are further supported by other pieces of literature. For instance, based on a global survey of polycentric action, the foremost challenges are financial (78% of respondents cite financial shortages as a significant challenge), managerial (leadership identified as a key factor to sustain sustainability efforts), and external (support from networks for knowledge and otherwise) (Aylett, 2014).

3.3.4 Structuring the Research

The above can be captured in a set-up that outlines concisely the elements under consideration. Starting with the five key drivers of change introduced by Taminiau et al. (2014) in the context of an ecological sustainability paradigm, Phase I evaluates urban and U.S. state level experimentation while Phase II investigates two operational expressions of the strategy.

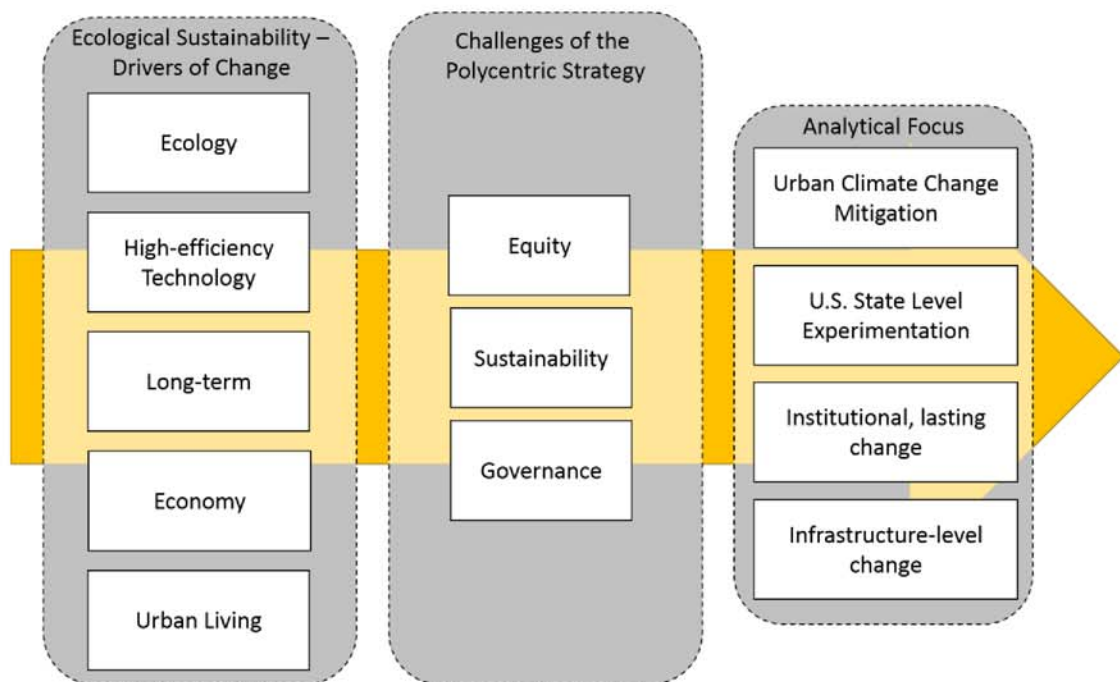


Figure 3.6; Dissertation Approach.

Chapter 4

URBAN CLIMATE CHANGE EXPERIMENTATION AND ACTION AROUND THE WORLD

As will become clear in this chapter, action at the local level has been intensifying over the past decade or so (Bulkeley & Betsill, 2013). This has, for many, eliminated the notion that polycentricity is ‘just’ some ‘side show’ (Bulkeley & Castán Broto, 2012; Castán Broto & Bulkeley, 2012; Hoffman, 2011) and has, in fact, positioned polycentricity as a new means to organize political space, steer societal response and action, and to govern climate change in the presence of ‘governance gaps’ (Abbott, 2014) that arise due to absence of a larger, international, framework of action. This chapter focuses on urban climate change experimentation and action. A detailed account of another contemporary polycentric strategy of action, performed by US state level governments in the form of Renewable Portfolio Standards (RPS) and Energy Efficiency Resource Standards (EERSs), is detailed in Appendix B. The conclusions drawn from Appendix B, those of substantial climate change commitment and over-compliance, are, however, used in this chapter to substantiate the polycentric approach.

4.1 The Evolution of City-Level Action

Municipal intentions to act on climate change are increasingly common. Bulkely & Betsill (2013) characterize the evolution of city-level action by a differentiation into two distinct phases. First, *municipal voluntarism* characterized an early phase in which small and medium-sized cities initiated some form of response to climate change (Bulkeley, cities and climate change book). This phase of action continues to this day as especially small cities adopt climate change action plans from

a voluntary standpoint (Bulkeley & Betsill, 2013). Borrowing the term for a description of developing cities' unwillingness to act on climate change unless it provides substantial local benefits, these efforts of municipal voluntarism in part came to be under conditions of a 'Coincidence of Agenda's' (Dulal & Akbar, 2013): cities were not necessarily attempting a strategic reorientation of the climate change debate but, rather, recognized the co-benefits that could occur and the opportunity to participate in the stifled global climate change discussion (Hoffman M. , 2011).

Starting in the early 2000s, the next phase is one of *strategic urbanism* where more overt action and political commitment is directed at an integrated urban agenda that positions climate change as an integral component (Bulkeley & Betsill, 2013). Municipalities now contextualize the consequences of climate change to their own specific situation (Carbon Disclosure Project, 2014). As such, the assessment of climate change action – unlike municipal volunteerism's relatively limited agenda of (energy) sustainability – now typically includes many additional considerations such as vulnerability and risk. In addition, municipalities now structure their role in climate governance in such a way as to apply pressure on national governments to spur on more aggressive action. While forms of municipal voluntarism persist for smaller municipalities, strategic urbanism has engendered multi-city platforms, sometimes consisting of thousands of cities, which together seek to outline urban climate governance along political economy considerations of carbon control, resource scarcity, resilience, and security. An example of this strategy is the rapid growth of the United States Conference of Mayors Climate Protection Agreement: By 2005, the agreement encompassed a little under 150 mayors, by 2007 over 500 mayors have associated themselves with the agreement and, currently, the list stands at 1060

mayors together representing a total population of about 89 million people.³⁷ The agreement compels the mayors to a) meet or beat the Kyoto Protocol targets, b) urge state and federal government to enact more aggressive climate change policies, and c) urge U.S. Congress to enact national GHG emission reduction legislation. This strategy has found global replication. For instance, the 6,147 signatories to the European Covenant of Mayors aim to meet and exceed the EU objective of 20% emission reductions by 2020.³⁸ Indeed, a study on the contribution of municipalities in the province of Foggia (Italy) finds that, for all 36 municipalities studies (representing over 260,000 people), targets exceed the 20% mark by several percentage points and one municipality's sustainable energy action plan even sets the target at 72% (Lombardi, Rana, Pazienza, & Tricase, 2014). Another example of strategic urbanism is the C40 Cities Climate Leadership, a platform for the world's megacities to collaborate and plan for climate change action, which now encompasses 70 cities, 18% of global GDP, and roughly 1 in every 12 people.³⁹

As documented by scholars such as Bulkely & Betsill (2013), Hoffmann (2011), and Bulkeley & Schroeder (2012), a key characteristic of strategic urbanism is the blending of public and private authority and a renewed interest in new ways to structure low-carbon transition pathways through such innovative 'partnerships'. Such

³⁷ Detailed information on the United States Conference of Mayors and the Climate Protection Agreement can be found at:
<http://www.usmayors.org/climateprotection/list.asp>.

³⁸ Detailed information on the European Covenant of Mayors is available at:
http://www.covenantofmayors.eu/about/covenant-of-mayors_en.html.

³⁹ Detailed information on the C40 Cities Climate Leadership Program is available at:
<http://www.c40.org/>

innovative positioning of new ways of doing and thinking, together with the rapid rise of transnational urban networks like but certainly not limited to the platforms mentioned above, have further broadened the movement to, unlike the phase of municipal voluntarism, increasingly include municipalities in the ‘Global South’ (Heinrichs, Krellenberg, & Fragkias, 2013; Aylett, 2011; Kithiia, 2011). While not limited to cities in the Global South, these cities increasingly incorporate other elements of climate change into the urban governance decision-making, especially adaptation, risk, resource scarcity, and vulnerability considerations (Heinrichs, Krellenberg, & Fragkias, 2013; Aylett, 2011; Kithiia, 2011). For instance, the multi-stress environment of the case study cities investigated by Heinrichs et al. (2013), Delhi, Bogotá, and Santiago de Chile, appears to motivate especially policies capable of advancing local adaptive capacity and realizing co-benefits.

Additionally, a first mover advantage consisting of local champion reputation, local administration innovation, the development of new networks and the creation of new knowledge can be observed (Hansjürgens & Heinrichs, 2014) which could spur further diffusion to communities currently not active in polycentric action.

4.2 Diffusion

Urban climate change experimentation and action demonstrate a tendency of exponential growth over time (Hakelberg, 2014). For example, adoption rates of climate change action were 70% of all jurisdictions in California in 2010, up from about 50% only two years earlier (Bedsworth & Hanak, 2013). This trend is supported by Wang et al. (2012), who surveyed U.S. cities and found that sustainability momentum is especially related to financial support, managerial capacity, and stakeholder and citizen involvement. At the global level, the Urban Climate Change

Governance Survey (UCGS), based on results from 350 cities worldwide underscores the widespread diffusion of climate change action: seventy-five percent report activity in both mitigation and adaptation (Aylett, 2014). The foremost challenges reported by the cities in the survey, similar to Wang et al.'s (2012) findings, are financial: funding deficiencies for implementation represents a significant challenge for 78% of cities and 67% of cities report financial shortages for staff additions (Aylett, 2014).

Regarding enabling action, the survey further identifies the following top three factors that enable the design and implementation of climate change action: 1) leadership from the mayor or elected official, 2) leadership from senior management, and 3) support from networks such as ICLEI (Aylett, 2014).⁴⁰

However, as hinted at in the previous section, urban climate change experimentation at the strategic level is relatively new. For instance, sampling one hundred cities around the world, Bulkeley & Castán Broto (Bulkeley & Castán Broto, 2012; Castán Broto & Bulkeley, 2013) find that 79% of the experiments they surveyed were initiated after 2005. Similarly, Hoffman's (2011) database of climate change experimentation, which includes urban level experimentation, also shows the recent but rapid emergence of climate change experimentation. Table 4.1 documents several of the city networks that are currently operating, together representing many thousands of cities – most of these networks did not initiate operation until after about 2005.

⁴⁰ The significance of funding is further supported by the survey's prodding of factors that enable implementation planning and implementation: the next three key factors all relate to a lack of funding (Aylett, 2014).

Table 4.1; Overview of city networks engaged in climate change mitigation efforts.

Name	Year	# of members	Region	Commitment
C40 Cities – Climate Leadership Group	2005	70	Global	GHG emission reduction targets have been implemented by many members (ARUP, 2014).
Carbomm Cities Climate Registry	2010	422	Global	The platform documents a reported total of 830 climate and energy commitments, 771 GHG inventories, and 3870 mitigation and adaptation actions (Carbomm Cities Climate Registry, 2014)
Climate Alliance	1990	>1,700	Europe	Voluntary commitment to reduce CO ₂ emissions by 10% every five years (Climate Alliance, 2014).
European Covenant of Mayors	2008	6,175	Europe	The European Covenant of Mayors have committed themselves to an average 29% emission reduction by 2020, thus voluntarily exceeding EU emission reduction targets (Climate Alliance, 2014; Cerutti, et al., 2013).
ICLEI – Local Governments for Sustainability ^a	1990	>1,000	Global	Participating local governments adopt voluntary emission reduction targets.
Mexico City Pact	2010	147	Global	Cities commit to a selection of action points, including GHG emission reduction targets and reporting requirements.
US Conference of Mayors Climate Protection Agreement	2007	1,060	United States	Cities commit to meeting or exceeding Kyoto Protocol targets.
World Mayors Council on Climate Change	2005	>80	Global	Advocacy platform to for enhanced engagement of local governments as stakeholders in multilateral efforts.

a. Note: the current status of ICLEI membership is difficult to determine as the organization has been, and continues to be, in a high state of flux with many new additions to the organization but also many towns/cities renouncing membership. For instance, while the platform had 565 members in 2010 in the United States, it has since dropped by about 20% to 450 members in 2012 (Krause, 2014).

4.2.1 Assessment of Urban Climate Change Action and Experimentation

To provide an overview of the current state of urban climate change action and experimentation, and to document its widespread diffusion, an assessment of the current databases on the topic was performed. The results are provided per geographic region in the subsections below. The results are structured along ‘carbon trees’ that document time horizon and emission reduction target in one overview illustration. Overall, it becomes clear that many cities around the world have been willing to articulate stronger targets and have committed themselves to longer time horizons than nation-states have been willing to do so far.⁴¹

The ‘carbon trees’ document the articulated targets and timetables of 395 municipalities around the world. However, only several data points are included for the continents generally associated with the ‘Global South’. This does not necessarily translate into a finding that action is not as common among southern municipalities as

⁴¹ It is important to note that, for cities that have multiple targets in place (e.g., a target for 2015, 2020, 2030, and 2050), the long-term target was selected for representation in Figure 4.6. Additionally, the carbon trees for the Global North cover vastly more cities. This could be an indication of higher levels of activity in the North but could also easily be a consequence of sampling: a select few resources document the efforts by cities around the world and they have membership dues that might limit inclusion of non-North cities. Finally, direct comparison between data points is not productive considering targets can be phrased in wholly different permutations. For instance, whether they are carbon dioxide only or include other GHGs, whether all sectors of the economy are included or just a few, or whether chosen baselines create a more stringent/less stringent target are considerations that would come into play.

many of the transnational networks require membership status to be included in the database. Additionally, one of the most comprehensive databases, the Carbonn Climate Registry, is a relatively new organization that is still processing many of the submissions by municipalities.

4.2.1.1 North America

The registries accessed for this research contain information on 153 cities in North America (Appendix F).⁴² From the carbon tree that documents the emission reduction targets of all these 153 cities, it becomes clear that many cities pick 2020 and 2050 as target years. However, emission reduction targets of >30% for 2020 or >80% for 2050 targets is common indicating the willingness by these cities to go beyond targets commonly put forth in international negotiations on climate change. However, a key component to consider is that many different permutations of how targets are issued exist compounded further by differing baselines, GHG packages, etc. Note, for instance, that many cities in the United States have adopted the 2005 baseline in accordance with US national positions. Many other cities still have 1990 as an emission baseline – depending on specific municipal contexts and emission profiles, these baseline years can make a substantial difference in the actual stringency

⁴² Interestingly, information on ICLEI membership in the United States is difficult to obtain as the organization has recently been in a high state of flux with many new additions to the organization but also many towns/cities renouncing membership. For instance, while the platform had 565 members in 2010 in the United States, it has since dropped by about 20% to 450 members in 2012 (Krause, 2014). There appear to be no up-to-date accounts of ICLEI USA membership which limited the survey of US cities: ICLEI has removed membership lists from their websites after pressure in the U.S. from activists arguing its illegitimate position of an international and external organization telling communities in the U.S. what to do.

of the target. Interestingly, 2050 appears to be about as far as cities can see as none of the timetables look beyond that year – despite the scientific narrative that emission reductions will need to continue to take place beyond this time period.

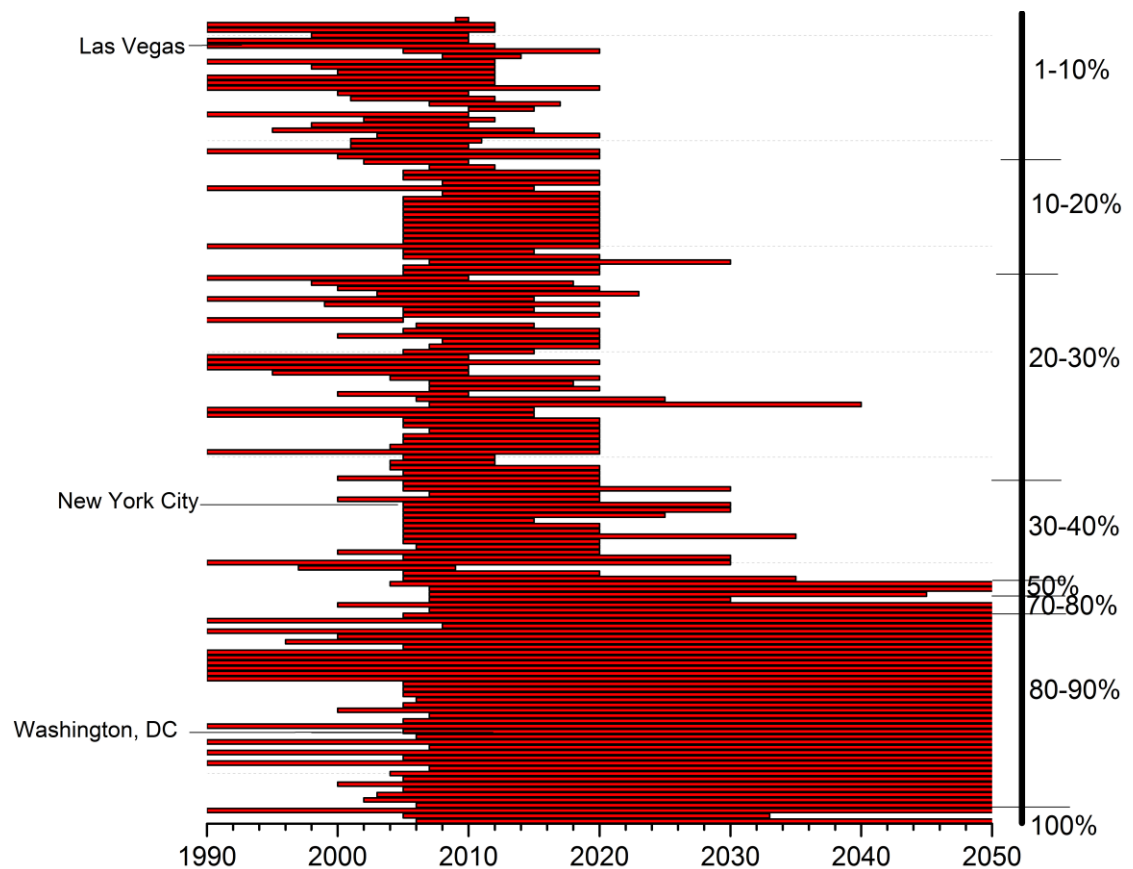


Figure 4.1; Carbon Tree of North America. The majority of data points are obtained from the International Council for Local Initiatives (ICLEI) USA Annual Report 2010 (ICLEI, 2010). Several others are obtained from (CDP, 2012; ARUP, 2014). The vast majority of these data points pertain to cities in the United States.

4.2.1.2 Europe

For the European Union, 112 cities are reported in the databases accessed for this assessment. The cities in the European Union appear to be more ambitious in their target setting as the carbon tree has a quite narrow base – high targets with a relatively short timespan. For instance, several Dutch, Danish, and Belgian cities pursue a carbon neutral city by 2025-2035. How these cities want to pursue such a target differs, in some cases substantially, from case to case. Groningen, for example, pursues a carbon neutral city by 2025 through strategies such as the planting of extra trees and the deployment of renewable energy (Reckien, et al., 2014; Heidrich, Dawson, Reckien, & Walsh, 2013). In line with European Union directives, most cities in the EU maintain a 2020 target year. However, while only a small number of North American cities with target year 2020 have emission reduction targets beyond 20%, it appears a relatively large number of cities in Europe have a 2020 target year but have outlined targets >20%. Like with the North American carbon tree, two other popular target years are 2030 and 2050.

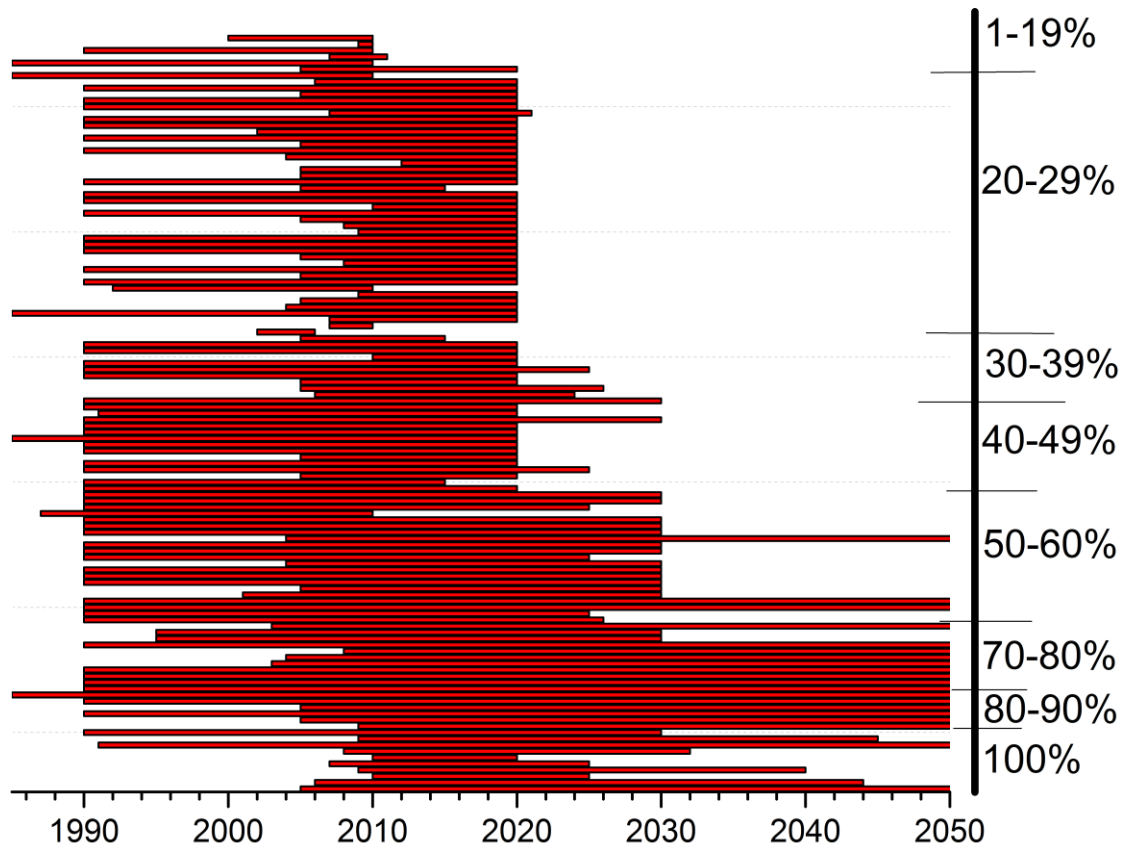


Figure 4.2; Overview of 112 cities in the European Union of their climate change baselines, targets and target years. Majority of the data points derived from (Reckien, et al., 2014; Heidrich, Dawson, Reckien, & Walsh, 2013). Several others are obtained from (CDP, 2012; ARUP, 2014).

4.2.1.3 Asia

For the purposes of this dissertation, 76 cities in Asia were documented to have climate change mitigation targets. In terms of additional data, however, not much is known of these cities as the Carbonn Climate Registry (<http://carbonn.org>) still only reports limited information on each city. The registry is a work in progress and it is expected that much more detail will become available. The carbon tree, meanwhile shows that the targets set in Asia – a large portion of the data points are Japanese

municipalities – do not appear to be as ambitious as those of the North American or European cities. For instance, none of the cities have announced carbon neutral targets (100% emission reduction targets) and a large share of the cities have outlined targets below 20% emission reductions.

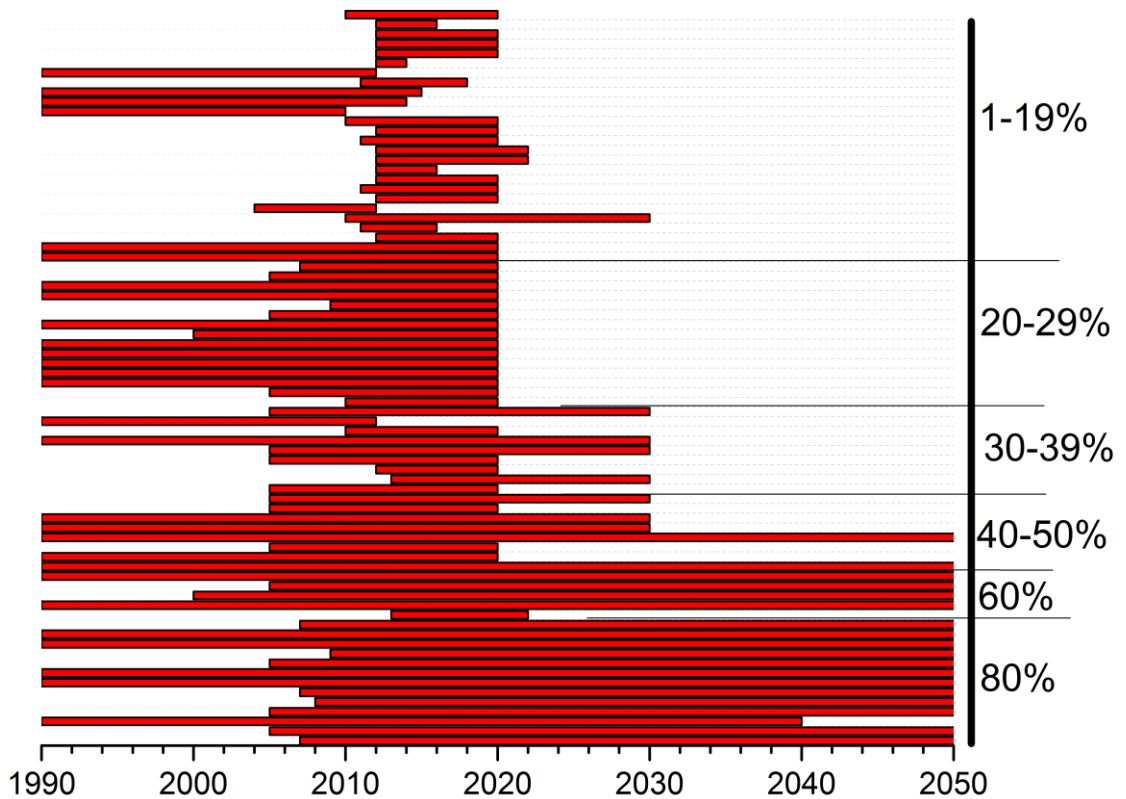


Figure 4.3; Carbon tree of cities in Asia. Majority of data points retrieved from the Carbonn Climate Registry (<http://carbonn.org>). Several others are obtained from (CDP, 2012; ARUP, 2014).

4.2.1.4 South America, Africa, and Oceania

A much smaller number of cities in South America, Africa, and Oceania have reported their targets and timetables to the databases used for this survey of activity. However, this does not necessarily mean that cities in these areas are not engaging in climate change action. It is possible that these cities face informational and administrative barriers in reporting their targets and timetables to the registries used here. In addition, as mentioned, some of the databases are relatively young and will likely report more cities in the near future – for instance the Carbons Climate Registry was launched in 2010 but started with only 51 reporting cities that reported their first data points in 2011. Now, the Carbons Climate Registry contains information on 422 cities (12% of the world’s population (de Moncuit, 2014)) around the world but, for many cities, the information provided is still scarce and needs to be fleshed out further. Still, aggressive targets are also being outlined in these regions of the world. For instance, Durban has an ambitious program to measure its GHG emissions and to lower its emissions by 24.5% by 2020 while several South American cities like Sao Paulo and Buenos Aires foresee 30% emission reductions in 2021 and 2030 respectively.

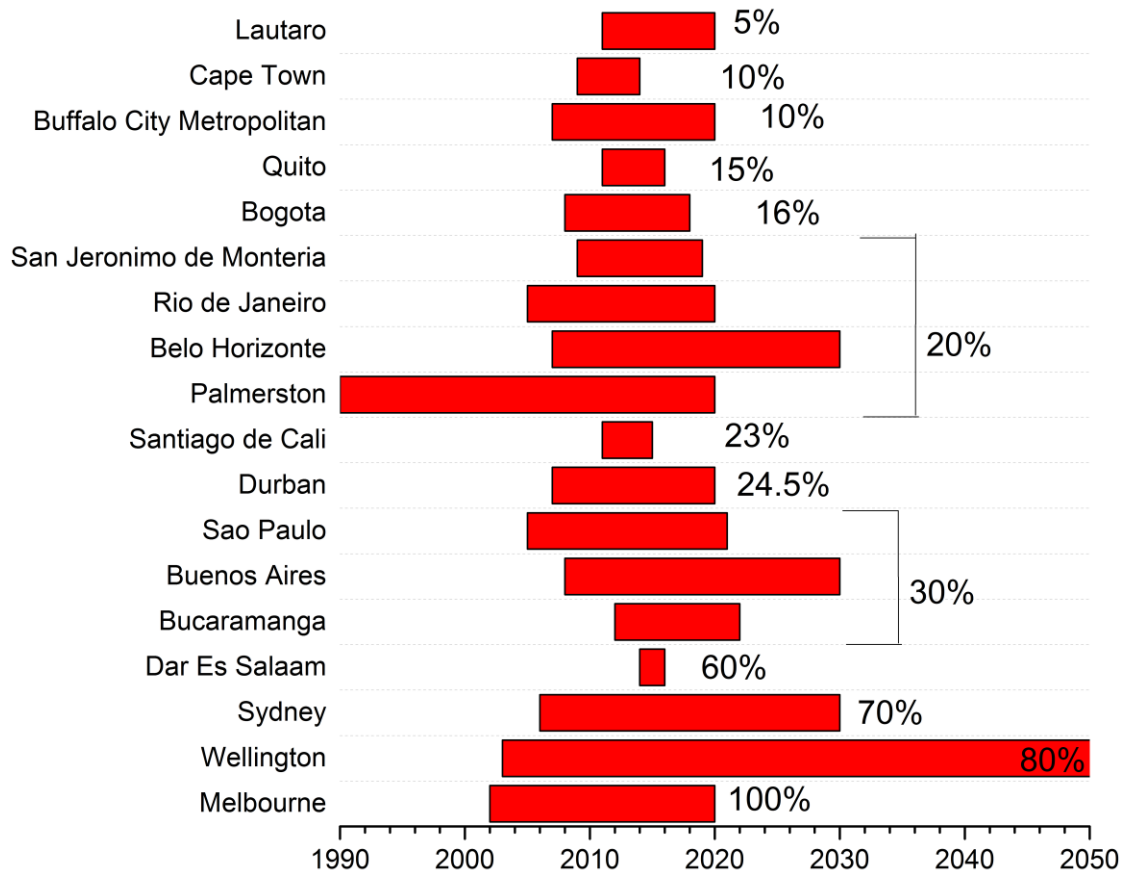


Figure 4.4; Carbon tree of cities in Africa, South America, and Oceania. Majority of data points retrieved from the Carbonn Climate Registry (<http://carbonn.org/>). Several others are obtained from (CDP, 2012; ARUP, 2014).

Nevertheless, a particular question of importance is whether diffusion patterns are limited in geographic scope. Working Group III of the IPCC, for instance, documents how climate action planning has been most prevalent in Annex I cities, creating a mismatch between expected future urban growth, with the greatest mitigation potential, and the actual places where planning takes place (Seto, et al., 2014). In part, Annex I cities are compelled to act on climate change due to legislation

from above. For example, French law stipulates that municipalities with more than 50,000 inhabitants must implement climate change action planning efforts (Yalçın & Lefèvre, 2012). Similarly, Sugiyama & Takeuchi (2008) note how, in Japan, climate change action planning is mandatory for 1,800 municipalities and 47 prefectures. Indeed, many of the cities reported in the Asian region are Japanese cities.

Another part of the equation is shaped by the cities of the developing countries who are limited by institutional, infrastructural, social, economic, and other factors in their approach to climate change (Gisselquist, 2014). A form of ‘governance paradox’ emerges:

Whereas the largest policy leverages are from systemic approaches and policy integration, these policies are also the most difficult to implement and require that policy fragmentation and uncoordinated, dispersed decision-making be overcome. The urban governance paradox is compounded by weak institutional capacities, especially in small- to medium-sized cities that are the focus of projected urban growth [...] (Grubler, et al., 2012, p. 1313).

Nonetheless, by highlighting activity in cities of the Global South, it becomes clear that these cities are, indeed, also quite active. The next few paragraphs focus on a policy effort that stands out due to not only its rapid diffusion pattern but also its Latin American origin: the Bus Rapid Transit (BRT) policy and technology option.

Bus Rapid Transit (BRT) ⁴³ has experienced significant diffusion around the world (Wirasinghe, et al., 2013; Deng & Nelson, Recent developments in bus rapid transit: a review of the literature, 2011). Indeed, 146 cities - serving 24 million customers per day - have adopted the policy, including many non-Annex I cities (Fig.

⁴³ For a detailed description of this technology options, please see the UNEP ClimateTechWiki site: <http://www.climatechwiki.org/technology/brt>

4.5) and often receives widespread support by commuters (Center for Science and the Environment, 2008; Deng & Nelson, 2012). BRT can be delineated by various definitions (e.g. (Levinson, et al., 2003), but it effectively captures the speed and reliability of rail service but – critically – the operating flexibility and *lower cost* of a conventional bus system (Deng & Nelson, Recent developments in bus rapid transit: a review of the literature, 2011). While the concept can be traced back by several decades (Fig. 4.7), the modern concept was developed by planners and designers from Latin America (Deng & Nelson, Recent developments in bus rapid transit: a review of the literature, 2011) and experiences in Latin American cities are often cited as success stories of the concept (Müller, 2014; Goodman, Laube, & Schwenk, 2006). Diffusion afterwards has spread to the rest of the world and back to the United States (Fig. 4.7).

Many argue the positive contributions of the BRT system, including decongestion of city streets, flexibility and adaptability of the system, higher ridership, higher speed, travel time saving, enhanced reliability and safety, improved passenger comfort and convenience (Goodman, Laube, & Schwenk, 2006; Hoffman A. , 2008; Kim, Darido, & Schneck, 2005). Additionally, the technology option is estimated to contribute to GHG emission reductions (Vincent, Delmnont, & Hughes, 2012) – it also qualifies for the CDM – but precise estimates of this contribution present substantial methodological complications (Sayeg & Bray, 2012). All in all, the policy/technology option successfully realizes a transportation modal shift in a notoriously difficult policy field (Cain, Darido, Baltes, Rodriguez, & Barrios, 2006; Deng & Nelson, 2011; Wirasinghe, et al., 2013) in cities around the world. More broadly, beyond BRT, Bulkeley & Castán Broto (2012; 2013) also show how urban

climate change action is not limited in its geographic scope as they assess 100 cities around the world.

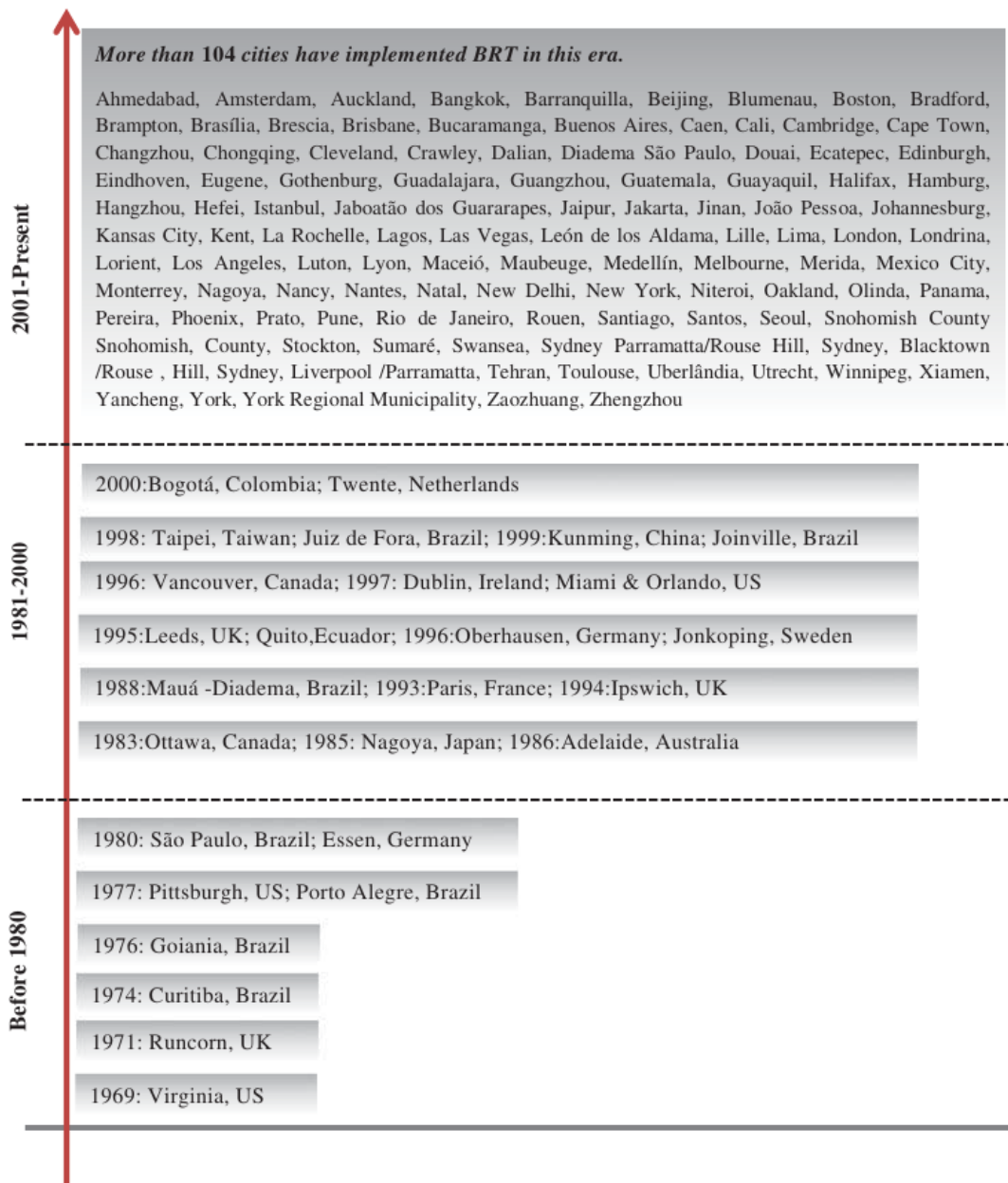


Figure 4.5; Diffusion of Bus Rapid Transit throughout the world. Source: (Wirasinghe, et al., 2013; Deng & Nelson, Recent developments in bus rapid transit: a review of the literature, 2011).

4.3 Values and Virtues of Community Network Action

Importantly, to broaden away from the commodity-based reductionism of the Kyoto era, it is critical to show polycentrism can include additional actors, can widen the values and virtues included in decision-making, and can learn and adapt. As such, this section tackles these three elements.

4.3.1 Broadening access to decision-making

Climate change governance at the city level can be considered largely a public affair (Bulkeley & Castán Broto, 2012; Castán Broto & Bulkeley, 2013). For instance, Bulkeley & Castán Broto (2012) find that the majority of experiments in their sample are led by local governments, strengthening the notion that climate change interventions are a means for governance at the local level. Aylett (2014), in his study of 350 cities around the world finds a similar result. While leadership is positioned at public levels, a range of additional actors participates and oftentimes leads climate change experiments. For instance, Bulkeley & Castán Broto (2012) find that 34 out of 627 experiments are led by community-based organizations such as grassroots movements and that such leadership forms especially appears in experiments targeting the built environment. Figure 4.6 illustrates several research findings that further support this line of reasoning.

A dominant form of local climate change experimentation is through the formation of partnerships (Hoffmann, 2011). For instance, Bulkeley & Castán Broto (2012) find that 296 of 627 experiments are executed by a partnership of a multitude of different actors with a high level of diversity. Similarly, Hoffmann (2011) documents a wide multitude of different partnerships among the various actors in his sample of climate change experiments. In particular, and unlike Kyoto era processes,

non-governmental organizations (NGOs) and community-based organizations (CBOs) are often found to be key initiating and implementing actors in climate change governance at the local level. For instance, Aylett (2014) notes how CBOs and NGOs are considered by city governments as key supporting actors for local climate change action and oftentimes provide active engagement in the policy-making process. Similarly, Hoffmann (2011) in his sample finds a critical role for NGOs and sub-national governments. Others expressly include broader citizen action. For example, Aylett (2014) notes how the general population is often in support of the local climate change action plans (at least from the perspective of the cities responding to the survey). An example of explicit inclusion of the importance of the overall population can be found in the Delhi Climate Change Action plan where the local government calls for citizen involvement:

It is action at the ground which makes all the difference in achieving our goals. In this, every citizen has a role to contribute. I hope this monograph will encourage all civil society groups and government departments to forge a set of programs which can make Delhi a mega city (Government of National Capital Territory of Delhi, 2009; as quoted by Aggarwal, 2013, p. 1909).

Leadership	Source	Partnership	
<ul style="list-style-type: none"> Local government (413/627). Private (97/627). CBO (34/627). Other (83/627). 	Bulkeley & Castán Broto (2013) Castán Broto & Bulkeley (2013)	<ul style="list-style-type: none"> Private sector common partner. Includes small actors. Limited international participation (e.g. World Bank). Multitude of partnerships and actors involved. 	SAMPLE-BASED
<ul style="list-style-type: none"> NGOs (13/58) and sub-national governments (12/58) key initiating actor of experimentation. Multiple (15/58), corporations (14/48) and cities (11/58) key implementer. 	Hoffmann, 2011	<ul style="list-style-type: none"> Multitude of different partnerships with wide ranging engagement from different actors. 	
<ul style="list-style-type: none"> Strong local CBO/NGO support (70% of cities surveyed) stable across regions. General population also highly supportive. 	Aylett, 2014	<ul style="list-style-type: none"> Private sector “trails far behind” – 26% report engagement. Active engagement from CBO/NGO – primarily as input into policy-making, less so implementation. 	
<ul style="list-style-type: none"> Local government executes national plan by translating it to city strategy. 	Aggarwal, 2013 – Delhi (India)	<ul style="list-style-type: none"> Each citizen a ‘Bhagidar’ – strong citizen involvement. However, plan developed ‘top-down’. 	CASE STUDY

Figure 4.6; Overview of research results on leadership and partnerships in local climate change governance.

It is findings of community participation and community authorship like these that support the notion that polycentrism can advance equity and justice considerations. Sovacool, in his evaluation of four polycentric transnational networks finds that such action can produce benefits for equity, inclusivity, information, accountability, organizational multiplicity, and adaptability (Sovacool, 2011). A point of contention sometimes raised is the apparent exclusion of adaptation strategies in urban climate change strategies (Stone, Vargo, & Habeeb, 2012; Castán Broto & Bulkeley, 2013). However, Aylett (2014, p. 13), among others (see, especially, Carbon Disclosure Project, 2014), finds considerable evidence of adaptation efforts: 73% of cities surveyed include both adaptation and mitigation in their strategies while an additional 3% of respondents only focus on adaptation.

4.3.2 Co benefits argument (values over interests).

To address concerns of free-riding, and other issues raised in Ch. 3, in voluntary endeavors like the Climate Protection Program (CPP), it is helpful to try and understand the motivational factors behind urban participation in such platforms. Using a set of variables related to the categories of risk, stress, and opportunity, Brody et al. (2008) identify that local profiles of high risk, low stress, and high opportunity explain much of the variation in CPP adoption: localities that are vulnerable to climate change (measured by the authors in terms of temperature change, coastal proximity, and extreme weather event casualties) but put comparatively low levels of stress on the climate (measured through emissions per capita, carbon intensive industry profiles, and transportation patterns) and display high levels of opportunity to capitalize on change (measured through solar energy use, level of college education, and prevalence of environmental non-profits) are most likely to adopt CPP membership. These results are corroborated by other studies. For instance, Zahran et al. (2008) find that localities that place a high stress on the climate are least likely to participate in the CPP while localities with high civic and environmental capacity to act are most likely to participate in the program (see also Krause, 2012). These findings signal a potential disconnect in diffusion patterns for local action in two ways. First, in terms of the United States, spatially, high stressor communities tend to be located in the interior while communities at risk are positioned on the coastal areas of the US. Next, perceptually, vulnerable communities insignificantly respond to climate change unless consequences are obvious according to Zahran et al. (2008a; 2008b). The emerging concern is that diffusion patterns for local climate change action, here described as participation in the CPP, might display a disconnect between communities – i.e. between active and inactive communities – thus limiting the overall contribution the

CPP might be able to engender (Zahran, Grover, Brody, & Vedlitz, 2008a; Brody, Zahran, Grover, & Vedlitz, 2008; Zahran, Brody, Vedlitz, Grover, & Miller, 2008b). In a similar vein, Kern & Bulkeley (2009) find that European transnational municipal networks can be characterized as networks ‘of pioneers for pioneers’ – a ‘hard core’ of pioneers primarily gains from network formation while a periphery of more or less passive cities remain uninfluenced by the network’s actions.

However, evidence of horizontal diffusion, where communities next to communities that have joined climate protection efforts are more likely to do so themselves, suggests a possibility of urban climate governance outgrowth (Krause, 2011). Additionally, evidence that “orchestration” of cooperation in climate change is facilitated by the “traditional” actors of states and intergovernmental organizations further allows for the possibility of governance outgrowth – meaning that these “traditional” actors often guide, broaden, and strengthen transnational and sub-national climate governance (Hale & Roger, 2014). Further, transnational municipal networks themselves promote diffusion and implementation (Hakelberg, 2014). Moving forward, recognizing that real and perceived costs of GHG reduction efforts might dissuade certain municipalities – particularly those with profiles associated with such costs such as carbon intensive industries – horizontal diffusion could find further fertile ground once other municipalities demonstrate the benefits of such action above and beyond their contribution to climate change mitigation, capitalizing on the substantial co-benefits of climate change mitigation (Lee & van de Meene, 2013; Ürge-Vorsatz, Herrero, Dubash, & Lecocq, 2014).

Indeed, as noted by Aylett (2014) in his global survey of 350 cities, the respondents noted co-benefits as a critical component of climate change action. The

top 5 non-environmental priorities served by urban climate change mitigation and adaptation plans were: 1) increase access to basic services, 2) reduce violence, 3) promote equity, 4) improve community facilities, and 5) reduce poverty (Aylett, 2014). As such, the diffusion potential extends beyond the factors considered by Zahran et al. in terms of CPP membership as co-benefits extend beyond climate change. In terms of motivating factors to engage in climate change action in the first place, Aylett (2014) arrived at the following top-five factors:

1. Demonstrate leadership;
2. Promote sustainable urban development;
3. Improve the quality of life;
4. Understanding the local climate related risks and vulnerabilities; and
5. Creating green jobs.

4.3.3 Revisability and Learning

As introduced in Chapter 3, an expected virtue of polycentrism is the strategy's capability to learn and adapt to changing circumstances. Indeed, these are positioned as critical components of polycentric governance strategies, captured by the term of climate change experimentation (Nevens, Frantzeskaki, Gorissen, & Loorbach, 2012; Bos & Brown, 2012; Bos, Brown, & Farrelly, 2013; Hoffman M. , 2011). Empirical analysis of experimentation shows key factors that enable learning and outgrowth of experimentation (Bos & Brown, 2012): The existence of champions, networks, space (financial and temporal), science/research, reputation, and bridging organizations are identified. Availability of time and budgets allowed, for instance, for high quality processes of learning while champions and networks provide leadership and span boundaries (Bos & Brown, 2012).

Bos & Brown (2012) extend their argument by providing a framework for social change through experimentation. The design of experimentation in order to contribute to transformative change, according to Bos & Brown (2012)⁴⁴ needs to account for the following:

- It needs to explicitly focus on social processes that allow for the creation of innovation networks. This focus, therefore, includes but extends beyond technical experimentation and allows for the exploration of alternatives that are context-specific.
- Explicitly create contexts for experiments that move beyond cognitive engineering frameworks. This can be seen as an argument for the inclusion of community members and the inclusion of additional values (the two sections above).
- Experiments should be ready to translate learning results into their consequences on the existing, dominant architecture.

The collaborative nature of polycentrism allows for public and private stakeholders to engage in consensus-oriented decision-making (Ansell & Gash, 2008). By bringing multiple stakeholders together in common forums with public agencies, collaborative governance emerged in response to the failure of downstream and high-cost regulation and provides an alternative to the adversarialism of interest groups and

⁴⁴ To facilitate such designs, Nevens et al. (2012) propose ‘Urban Transition Labs’ that rely on co-creation and collaboration and help experiments advance through the stages of process design, problem structuring, back casting, experimenting and, finally, monitoring and evaluation.

to expert managerialism (Ansell & Gash, 2008) commonly found in the strategies of change outlined in Chapter 2. The promise of experimentation at lower levels remains one of disruptive and transformative change (Hoffman, 2011). The application of multiple policy portfolios at different scales can offer insight into which policy options work well and which do not.

Experimentalist governance, by nature, opens up additional space for learning as it engages the problem at hand from a broad variety of perspectives and includes a broad multitude of different partnerships and actors. Furthermore, recognizing that solution searching is time and space contingent and, as such, ‘one way street’ thinking is inappropriate, the new way of thinking “demands constant revisability of ends as these are rethought and adjusted or altered in the course of experimentation and mutual learning” (Wilkinson, 2010, p. 679). The networked approach, moreover, allows for interaction and engagement across divides. For instance, Elinor Ostrom (2010) notes how the C40 networks arranges periodic meetings that “enable extensive exchange” of information and allow for learning. A practical example is also offered by Ostrom: in 2005, 18 large cities sent delegations to the City of London to review, among topics of local strategies and funding opportunities, its recently implemented congestion charge. Since then, Milan and Stockholm have implemented their own version of a congestion charge (Börjesson, Eliasson, Hugosson, & Brundell-Freij, 2012; Rotaris, Danielis, Marcucci, & Massiani, 2010) and New York has tried to implement it but failed despite widespread public support (Schaller, 2010). This fits in the diffusion patterns outlined in previous sections but expands on it by directly correlating it to a particular event in 2005 where learning could have taken place and could have been the source for later urban road pricing schemes in the other locations.

Others, similarly, position information sharing and learning as critical components of the polycentric strategy. For instance, Galaz et al. (2012) find that network participants highly value the learning component that their membership in the network provides. Moreover, learning takes on multiple dimensions as it, for instance also allows for a trust-building process as participants learn to trust each other through successive rounds of successful experimentation and problem resolution (Cole, 2015; Poteete, Janssen, & Ostrom, 2010; Ostrom, 2010b).

4.4 Performance

In any case, the overall impression is one of substantial action. For instance, in a recent report, ARUP aggregates the commitments (reduction commitments and otherwise) of 228 cities representing 436 million people. The aggregated effort by these cities corresponds to cumulative emission reductions of 2.8 gton CO₂-eq. by 2020, 6.1 gton CO₂-eq. by 2030, and 13.0 gton CO₂-eq. by 2050 (ARUP, 2014). These 2050 cumulative savings are equal to the combined current annual emissions of China and India (ARUP, 2014). Interestingly, the largest 40% of cities account for the vast majority of committed (80%) over all three timescales (ARUP, 2014). For adaptation, a similar message is obtained by the Carbon Disclosure Project (CDP) in its Global Cities report: their survey of 207 cities indicates substantial levels of action and planning to protect the combined population of over 394 million people (Carbon Disclosure Project, 2014). A key consideration is to reflect on the ultimate meaning behind all this activity: are cities capable of redirecting the greenhouse gas emission curve through the planning and implementation of climate change action strategies as detailed above?

One of the most visible urban frameworks of climate change mitigation action is the climate change action plan (Seto, et al., 2014). However, the relationship between climate change action plans and their impact is not straightforward. For instance, Millard-Ball (2012) finds “little robust evidence that climate plans play any causal role in implementing greenhouse gas reduction strategies” (p. 290) and, instead, citizen environmental preference is considered the more likely causal candidate. This finding positions climate action plans simply as a tool that “[codifies] outcomes that would have been achieved in any case” (Millard-Ball, 2012, p. 301). In other words, climate action plans are just one of several possible frameworks in which mitigation actions and objectives are placed (Seto, et al., 2014). This is fully in line with earlier comments about the “coincidence of agenda’s” and the pursuit of co-benefits. Similarly, others argue that climate change action plans need to be more comprehensive in order to address city-specific experiences of climate change: the excessive focus on “atmospheric” drivers of climate change, i.e. greenhouse gas emissions, too often neglects “land-based” drivers such as albedo limiting the plans’ impact on city-specific climate change induced challenges (Stone, Vargo, & Habeeb, 2012). Nonetheless, Millard-Ball (2012), through a quantitative assessment of municipal action of 478 cities in California, concludes that cities with climate change action plans are substantially more active in terms of emission reduction efforts than municipalities without such plans. Similarly, investigating participation in transnational networks, Lee & Koski (2014) find that the action of joining a transnational network produces a stronger commitment to climate action and motivates city-level policy.

The assessment of performance can be illustrated in two ways. First, it is helpful to consider the extent of the contribution of city level activity in terms of projected impact. Such an assessment of city targets and policies provides insight into the future expected contribution by municipal actors to the alleviation of the problem of climate change. Second, it is helpful to review the available literature that discusses actual emission reductions already achieved by cities around the world. While this data is preliminary – most cities have only recently embarked on comprehensive climate change mitigation action (see sections above) – it provides an insight into the performance track record so far.

4.4.1.1 Projected reductions

Commitments to emission reductions are often reported along emission reduction targets in a certain target year against a baseline. One way to consider the impact of urban level action is to document the targets outlined by the various cities. For instance, the cities associated with the European Covenant of Mayors have committed themselves to an average 29% emission reduction by 2020, thus voluntarily exceeding EU emission reduction targets (Climate Alliance, 2014). As of March 2013, 37 % of signatories adopted exactly the 20% by 2020 target, but 43% established a target between 20% and 25%, 9% targeted a 25-30% reduction, and 12% seek emission reduction cuts beyond 30% (Cerutti, et al., 2013). Indeed, it is common that targets exceed national or international commitments (Seto, et al., 2014). For instance, in a study of German cities, Sippel (2011) finds that the average annual city reduction target of 1.44% exceeds the national pace. Similarly, Reckien et al. (2014) find a 1.7% reduction per year for their sample of 111 cities in the European Union. Generally, higher targets are positioned with more affluent cities and have target years further in

the distance (Figure 4.8) (Seto, et al., 2014). Figure 4.8 includes, through bubble size, the expected emission reductions where Greater London represents the largest reduction at 27 million tCO₂e (0.027 GtCO₂e).

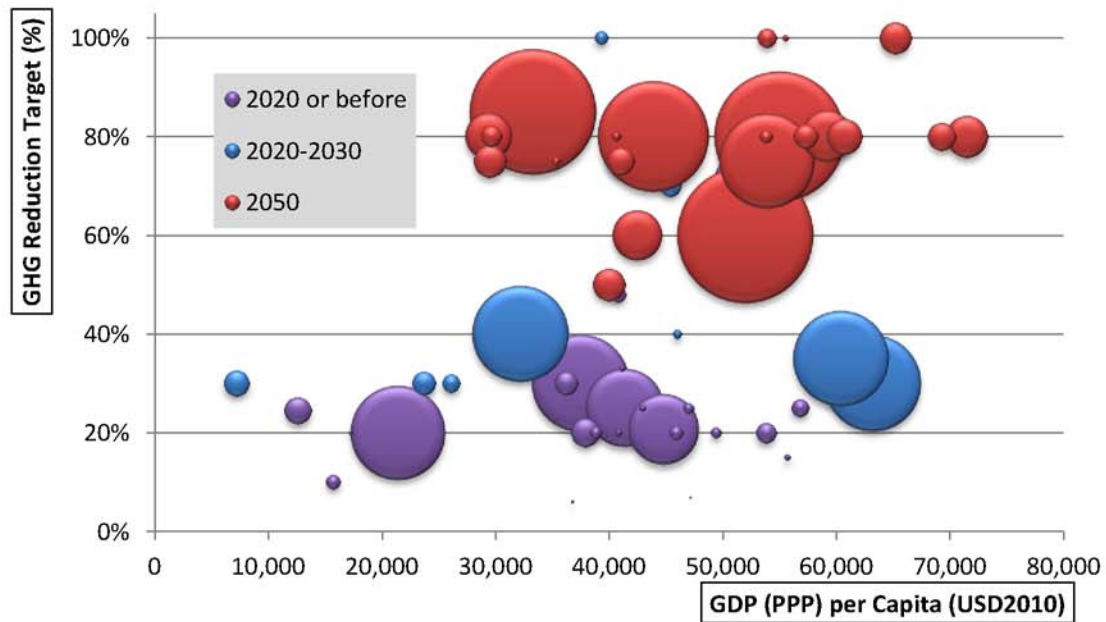


Figure 4.7; A mitigation target illustration for 56 cities. Bubble size represents target emission reductions in tCO₂e against baseline emissions. Due to variation in baseline setting, target gases, accounting methods, etc., this chart serves only illustrative purposes. Sources: baseline emissions and reduction targets obtained from the Carbon Disclosure Project and Carbonn.org. GDP data obtained from (Istrate & Nadeau, 2012). Graph presents an expanded overview from the one presented by (Seto, et al., 2014).

Other ways to demonstrate future impact is to estimate emission reductions that will be realized in a certain year. For example, for the entire Covenant of Mayors project, Cerutti et al. (2013) estimate an annual 0.39 - 0.42 GtCO₂e emission reduction

in 2020. Documenting the experience of 228 cities representing 436 million people, ARUP (2014) estimates that the aggregated efforts by these cities corresponds to 2.8 GtCO₂e *cumulative* emission reductions by 2020, 6.1 gton CO₂-eq. by 2030, and 13.0 gton CO₂-eq. by 2050. Annual emission reductions estimated by ARUP (2014) for this sample of cities puts the projected contribution at 0.45 GtCO₂e in 2020, 0.40 GtCO₂e in 2030, and 0.43 GtCO₂e in 2050.⁴⁵ In their analysis on 'bridging the wedge', Blok et al. (2012) introduce 21 wedges that, together, could be capable of closing the emission gap documented earlier. One of those wedges, 'major cities' is relevant to this section and Blok et al. (2012) estimate that the efforts of cities around the world will be able to reduce emissions by 0.7 GtCO₂e in 2020. A University of Utrecht Master Thesis also offers a projected result: 0.86 GtCO₂e (range: 0.67–1.10 GtCO₂e) in 2020 (Wouters, 2013). Reckien et al. (2014) assess 200 large and medium-sized cities across 11 European countries and show that currently planned climate change action within these cities could translate to a 37% reduction in GHG emissions by 2050 for these 11 countries (assuming the cities are nationally representative). Reckien et al. (2014) calculate that this finding corresponds to a 27% GHG emission reduction for the EU as a whole. Assuming that all active cities at the time would reach their 7% emission reduction objective measured against a business-as-usual scenario by 2020, Lutsey & Sperling (2008) estimate the US cities contribution to 0.597 GtCO₂.

⁴⁵ ARUP notes how a large share of cities in their sample have not yet articulated 2030 or 2050 targets. As such, once these cities get closer to 2020 – and can assess whether they have met, exceeded, or failed their target – it is expected that follow-up and more stringent targets will be formulated. In other words, the current 2050 estimate is an underestimate of what the entire sample of cities could be capable of reducing.

Significantly, when combined with state level efforts at the time, Lutsey & Sperling (2008) calculate a stabilization at 2010 levels in US emissions until the year 2020.

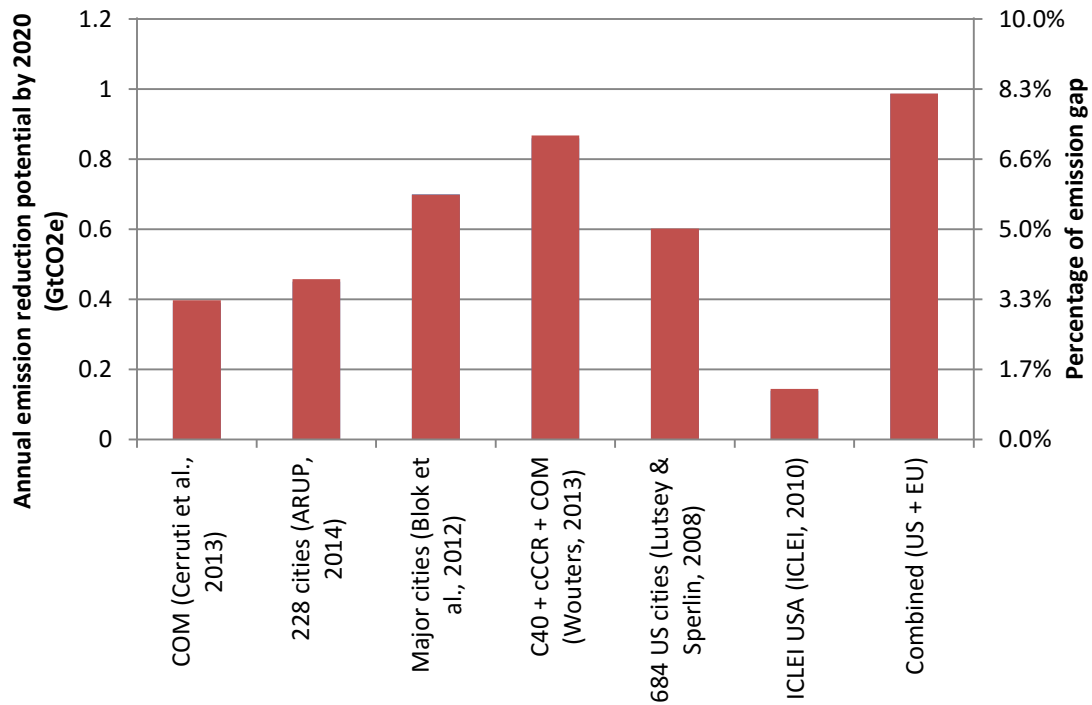


Figure 4.8; Overview of several sources and their estimated annual emission reductions from city efforts in 2020. Note: these assessments provide estimates of city groups that often have multiple memberships across groupings limiting the utility of a comparative analysis of the results presented here. Right y axis is as percentage contribution to closing the 12 gt ambition gap.

Another study further emphasizes the important role that cities have to play in the global challenge of climate change mitigation: according to an estimate by Ericson & Tempest (2014a) urban actions could reduce global GHG emissions by 3.7 GtCO₂e by 2030 and 8.0 GtCO₂e by 2050 against their business-as-usual scenario. This

estimate by Ericson & Tempest (2014a) offers clear insight into the potential contribution of municipalities in the various “core” sectors over which they have control (Figure 4.10).

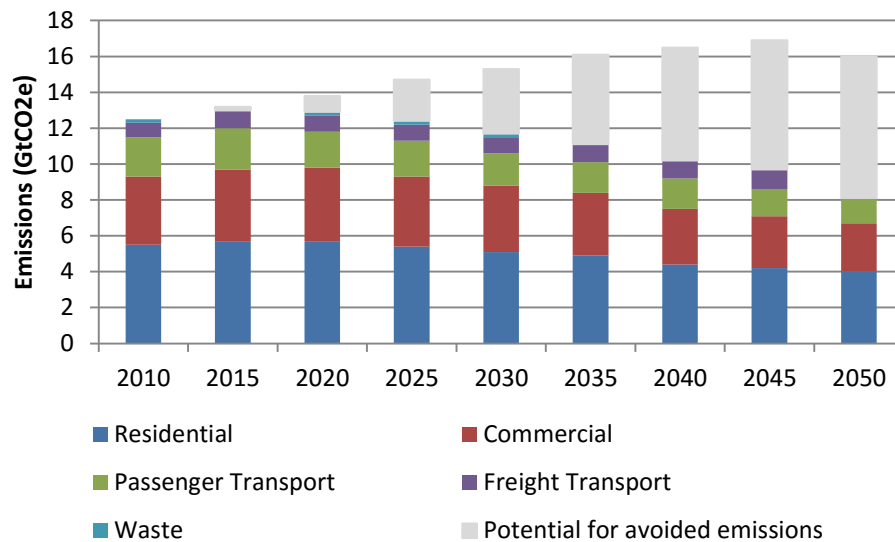


Figure 4.9; Potential for avoided emissions by aggressive urban action as calculated by (Ericson & Tempest, *Advancing climate ambition: How city-scale actions can contribute to global climate goals*, 2014a). Their scenario analysis only includes sectors under direct urban governance as listed in the Figure.

4.4.1.2 Achieved reductions so far.

The available research on actual achievements by cities is limited (Krause, 2011; Seto, et al., 2014). Self-reported data is available, however. For instance, the Carbon Disclosure Project (CDP) documents how the cities of Denver (US), London (UK), Madrid (Spain), Durban (South Africa), and Taipei (Taiwan) were able to reduce their emissions by a total of 13.1 million tons CO₂ equivalent since 2009,

equal to a 12% reduction in emissions (Carbon Disclosure Project, 2014). Similarly, in their 2010 annual report (later editions are apparently unavailable), *Empowering Sustainable Communities*, ICLEI USA (2010, p. 46) reports, among others, the following:

- Aspen, CO: community-wide greenhouse gas emissions decreased by 8.3% from 2004 to 2007.
- Austin, TX: the community avoided the emission of 188,453 metric tons of CO₂e over 2007-2008.
- Berkeley, CA: GHG emissions were reduced by more than 7% over the 2000-2005 period.
- Boulder, CO: community GHG emissions declined by more than 1% over 2008-2009, the third year of decline in a row.
- Chicago, IL: GHG emissions were brought down by 1.2 million metric tons of CO₂e during the first two years of the City's climate action plan implementation (2008-2010).
- Minneapolis, MN: community-wide emissions decreased by 7% between 2000-2006.
- NYC, NY: city-wide emissions decreased 12.9% between 2005-2009, including a 4.2% drop between 2008-2009.
- San Francisco, CA: emissions were reduced to 5% below 1990 levels by 2005.
- Seattle, WA: GHG emissions were brought down to 7% below 1990 levels by 2008. As such, the City of Seattle met its Kyoto Protocol target. Moreover, population growth during the same time on the order of 16% establishes a 20% per capita emission reduction.

More recently, Kennedy et al. (2012) studied a small sub-set of six cities (Berlin, Boston, Greater Toronto, London, NYC, and Seattle) and found that all are reducing their per capita emissions and are doing so faster on average than their

respective nation-states. Kennedy et al. (2012) researched the six city sample over the 2004-2009 time period. An updated and expanded overview of city's progress on emission reductions is calculated in Figure 4.9. Building on the data collected by Kennedy et al. (2012), the graph shows the emission profile of a selection of cities. Figure 4.11 confirms many of the findings established by Kennedy et al. (2012) as it shows how the observed trend of per-capita emission declines continues. This finding hints at the option that municipal action can deliver substantial results but Kennedy et al.'s (2012) conclusion is limited due to inventorying complications at the city level compared to the nation-state level, the fact that some reduction efforts are outside of the authority of municipalities, and the small sample size (Kennedy, Demoullin, & Mohareb, Cities reducing their greenhouse gas emissions, 2012; Ibrahim, Sugar, Hoornweg, & Kennedy, 2012). Such problems are targeted by the recent (December 8, 2014) launch of the *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)*, which was introduced by the World Resources Institute (WRI), the C40 Cities Climate Leadership Group (C40), and ICLEI during the COP20 event in Lima, Peru.

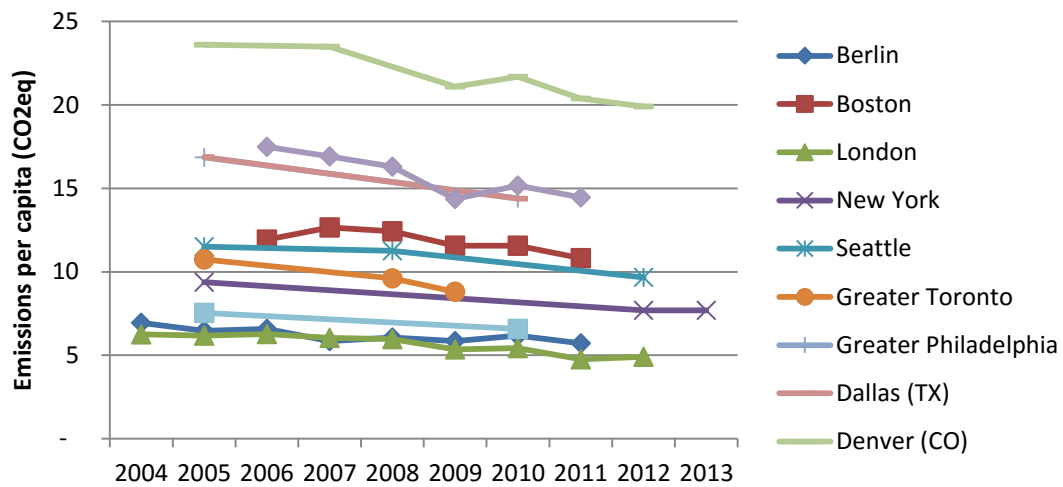


Figure 4.10; Updated and expanded overview from the research results of Kennedy et al. (2012). Detailed emission profiles of the cities discussed in Figure 4.9 are provided in Appendix C. Cities that have at least two inventory years have been included in this illustration.

A more detailed breakdown of the changes in several of these cities is presented in Table 4.2. The Table shows that, despite population growth in all cities, each city has been able to reduce its total emissions over the timeframe studied. Next, Table 4.3 demonstrates how the cities compare to the performance record of their respective nation-states. On average, the cities continue to outperform the track record of their respective nation-state. However, due to authority distributions across governance levels in their multi-level context (Corfee-Morlot, et al., 2009), these cities cannot necessarily claim these emission reductions as direct consequences of their actions. Nonetheless, tracking progress in this manner does provide useful insight into the efforts and results of the cities and their trajectory towards low-carbon development.

Table 4.2; Overview of changes in each case study city (%). The table builds off of the work done by Kennedy et al. (2012) but updates and expands the selection.

City	Berlin	Boston	GT	London	NYC	Seattle
Timeframe	2004-2007	2006-2011	2005-2009	2004-2012	2005-2013	2005-2012
ENERGY	-5.70%	-3.04%	-2.45%	-12.55%	5.65%	1.49%
(a) Stationary combustion	-6.60%	-3.74%	-4.21%	-12.92%	-23.14%	1.32%
(b) Mobile combustion	-3.07%	-1.26%	-0.59%	-11.14%	5.33%	1.58%
(c) Fugitive sources			-		2.92%	
INDUSTRIAL PROCESSES	2.80%		-3.69%			-46.94%
AFOLU			1.80%			
WASTE		-19.63%	1.80%		-20.12%	-23.02%
TOTAL	-5.07%	-3.52%	-2.42%	-12.47%	-12.70%	-7.02%
Population	0.15%	6.34%	2.51%	11.78%	5.65%	10.67%

Table 4.3; Comparative overview of performance record of city sample with their nation-state (bold).

	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	t CO2e /cap/yr	%/yr		
											N*	C*	N*	C*
Canada	23.2	22.6	22.0	22.7	22.0						-0.28		-1.21	
GTA		10.7			9.6	8.8						-0.48		-4.50
DE		12.2	12.3	12.0	11.9	11.1	11.5	11.5			-0.11		-1.06	
Berlin	6.94	6.5	6.6	5.9	6.1	5.9	6.2	5.7				-0.17		-2.56
UK	11.4	11.2	11.1	10.9	10.5	9.5	9.7	9.0	9.2		-0.28		-2.61	
London	6.3	6.2	6.3	6.0	6.0	5.4	5.4	4.8	4.9			-0.17		-2.86
USA	24.6	24.5	24.1	24.3	23.4	21.7	22.2	21.7	20.8		-0.48		-2.05	
Boston			11.9	12.7	12.4	11.6	11.6	10.8				-0.22		-1.81
NYC		9.4							7.7	7.7		-0.21		-2.25
Seattle		11.5			11.3				9.7			-0.26		-2.33
					Average						-0.29	-0.25	-1.73	-2.72

Note: C=cities and N=national numbers

4.5 Overview of Polycentrism

The above details a substantial diffusion and scale record of performance for a variety of polycentric activities. To be sure, the above by no means reflects the full account of polycentric activity on climate change. Indeed, substantial potential remains within many other spheres of action. Importantly, such reductions could be achieved with currently available technology at likely lower cost than many other alternatives. In particular, Blok et al. (2012) demonstrate that a selection of 21 coherent major initiatives can close the existing emission gap, moving beyond the national pledges made by participating nation-states. Such efforts can be put in place under a polycentric approach.

Indeed, efforts to capitalize on the savings potential within each of these ‘major initiatives’ is underway in one way or another. To provide insight in the scale and sophistication of current polycentric activity, Abbott (2012) documents a census of polycentric activity as operated by the state, by corporations, by civil society organizations or through a combination of the three (Figure 4.12). The ‘complex’ that emerges in Figure 4.12, once again, demonstrates that polycentricity is not ‘some side-show’ of activity nor that it is too recent to be determined as a viable strategy moving forward. In line with earlier accounts of urban strategies, in fact, it appears that polycentricity along other lines of evidence is shaping up to become a strategic, coordinated, and consistent policy portfolio (Lutsey & Sperling, 2008). Indeed, the rapid diffusion and emergence patterns, as detailed partly above in the previous sections, have inspired some to term recent polycentric activity as a ‘Cambrian explosion’ of activity (Abbott, 2012).

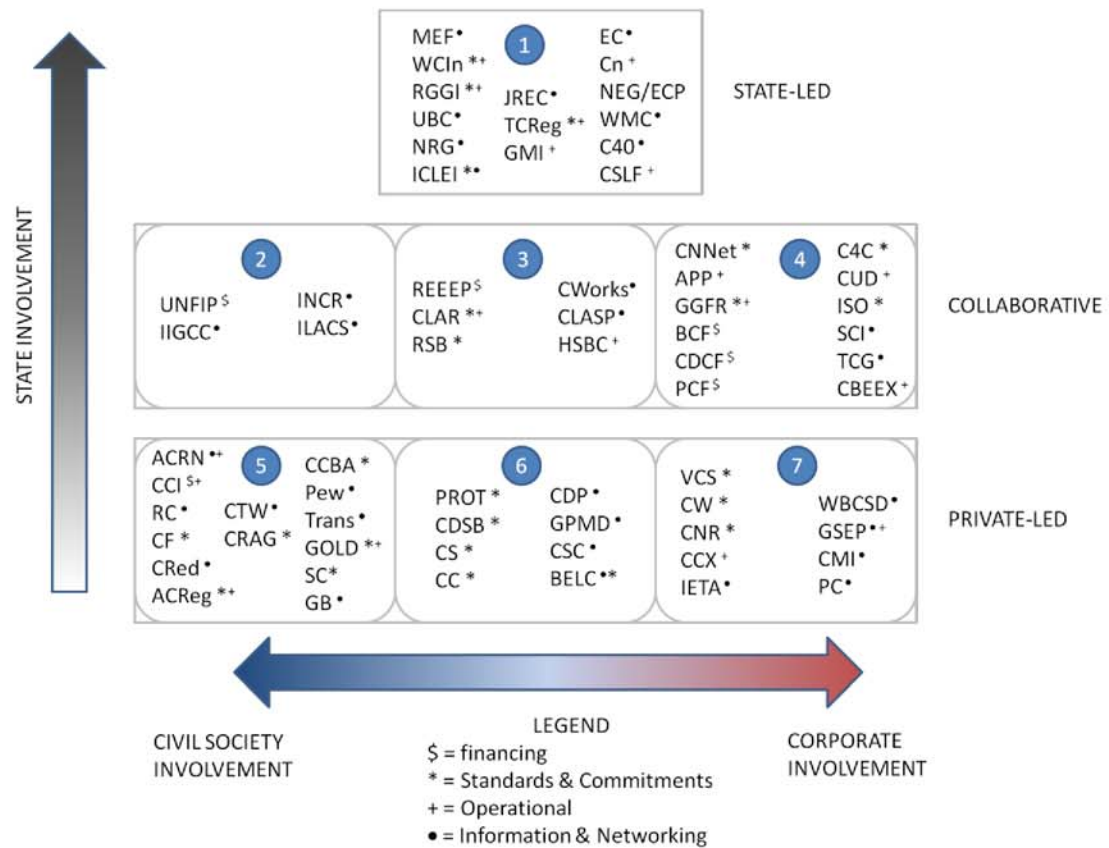


Figure 4.11; Census of the polycentricity complex. Adapted from Abbott (2012).
Overview of abbreviations in appendix D.

Chapter 5

INSTITUTIONAL INNOVATION TO GOVERN ENERGY AND ARRIVE AT ECOLOGICAL SUSTAINABILITY ⁴⁶

The modern energy regime is a major component of the climate change challenge: the contemporary configuration of the modern energy economy maintains a *modus operandi* that ineffectively addresses negative consequences of its operation or inadequately incorporates other perspectives that allow for alternative-energy development. In particular, housed within the optimality paradigm, modern energy development is characterized by unbridled expansion in energy use. It is therefore critical to uncover strategies of change that excel within an ecological sustainability paradigm context. Here, such a strategy of change is described in the framework of polycentricity and local action.

Following the methodological outline described in Chapter 3, this Chapter uses Taminiau, Wang & Byrne's (2014) and Byrne, Wang, Taminiau, & Mach's (2014) suggestion to focus on energy governance institutions in order to preserve society's operating space in the context of ecological threats such as climate change. More specifically, the chapter takes a closer look at the energy utility institution and evaluates its position within an ecological sustainability paradigm. This analysis is followed by a discussion on alternative institutional setups that perhaps better allow for ecological sustainability dynamics to materialize. The two alternative institutional setups discussed in this chapter are the Energy Service Utility (ESU) and the Sustainable Energy Utility (SEU).

⁴⁶ Note: the chapter draws upon co-authored, published work (Byrne & Taminiau, 2015, Taminiau & Byrne, 2015). It offers new thinking beyond the published work.

The chapter covers a variety of issues related to the modern energy economy. First, the chapter outlines a significant but usually unnoticed potential by focusing on the energy resource that is too often considered antithetical to the optimality paradigm and its excessive focus on growth: energy use reductions (Section 5.1). Next, the chapter discusses the modern energy utility business model and highlights some inherent complications between the model's main focus and the potential of absolute energy use reductions (Section 5.2). The chapter then evaluates the performance record of conventional energy utilities in terms of their ability to realize energy savings (Section 5.3). Realizing shortcomings, the chapter then introduces the ESU model and continues with an evaluation of performance by these non-utility administrators of energy saving programs (Section 5.4). In the next section, the chapter introduces the SEU model, contrasts its dynamics with those of the ESU, and evaluates early performance by the Delaware SEU application with particular attention directed at the Delaware SEU's 2011 sustainable energy bond financing (Section 5.5). Then, the chapter considers the climate change challenge and evaluates, in light of an ecological sustainability paradigm, where attention should be directed (Section 5.6). Summary conclusions are provided in Section 5.7.

5.1 Economic Potential of Energy Savings

The energy space offers substantial promise in terms of a polycentric, energy use reduction strategy. For example, looking at the next ten years, Dietz et al. (2009) assess the 'reasonably achievable emission reduction' for *all* U.S. households. In particular, Dietz et al. (2009) assess the 'behavioral wedge', investigating the potential of policies and interventions that target household behavior. This focus is chosen by Dietz et al. (2009) due to both its much faster implementation potential and its much

more responsive character, potentially leading to near-term emission reductions. The result is impressive: over a ten year period, U.S. household emissions can be reduced by approximately 20% (Dietz, Gardner, Gilligan, Stern, & Vandenberg, 2009). This finding roughly corresponds to 7.4% of U.S. national emissions or slightly more than the national emissions of France at the time (Dietz, Gardner, Gilligan, Stern, & Vandenberg, 2009).

Indeed, a strategy focused on reducing energy use could capture existing value and capital that has been largely ignored by the modern energy regime: the potential and promise of halting and reducing demand growth or, more specifically, by focusing on energy service needs rather than energy demand (Byrne, Martinez, & Ruggero, 2009). Figure 5.1, for instance, documents how energy technology options and their cost profiles show substantial variation but, more importantly, how the energy technology option of not using energy consistently comes out as the most cost-effective option available. In line with a paradigmatic 'gestalt switch', optimality, as a pathway of change, ignores and, indeed, fears the de-growth risks of energy reduction (Martinez-Alier, Pascual, Vivien, & Zaccai, 2010) while sustainability models harness economic savings of reducing energy commodity flows as the main mechanism to capture the inherent public benefit (Byrne & Taminiau, 2015). Reconsidering and redirecting economic capital flows from the explicit objective of growth in private wealth to the public objective and needs of establishing a sustainable energy infrastructure (i.e. conservation and renewable energy), opens society's existing ability to prosper *and* observe planetary boundaries. Additionally, such a pathway allows for the achievement of public purposes along fair and just sustainability and prosperity principles (Taminiau & Byrne, 2015; Byrne & Taminiau, 2015; Jackson, 2011). In

sum, a framework of New Economics – an economics of public benefit, governance in the interest of that benefit, and a commons culture of socially appreciated natural limits and public purposes (Byrne & Taminiau, 2015) – could enable the practical pursuit of ecological sustainability.

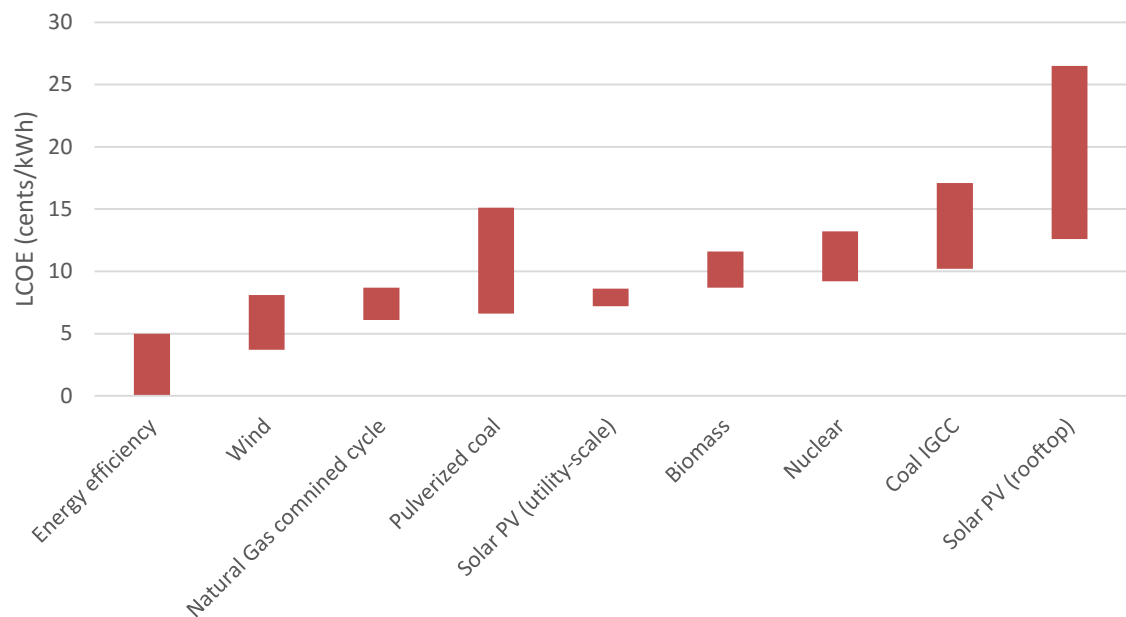


Figure 5.1.; Levelized cost of electricity (LCOE) for different energy technology options. Source: Lazard (2014).

Significant re-directable capital is available. A groundbreaking analysis performed by McKinsey Global Energy and Materials arrives at the conclusion that an infrastructure-scale and comprehensive strategy can roughly cut down 23% of projected demand and eliminate the emission of 1.1 gigatonnes of greenhouse gases on an annual level – most critically, the required investment capital of \$520 billion is well below the gross energy savings of \$1.2 trillion such a strategy would yield (Granade et

al., 2009). Such results repeatedly surface in investigations looking into the economic potential of energy savings. For instance, in the U.S., enhanced building energy performance options are estimated to require \$279 billion in investments but would yield over \$1 trillion in savings across a 10-year period (Rockefeller Foundation, 2014). International and global studies find similar energy savings potentials (Tuominen et al., 2012; European Commission, 2014; Nemry et al., 2010; Laitner et al., 2013; Laitner, 2014; Young & Mackres, 2013; IEA, 2014). Globally, the World Business Council on Sustainable Development, for example, reports a 60% energy savings potential in the built environment by 2050 (WBCSD, 2014). Other benefits also apply; for instance, a recent report by the Brattle Group reports significant potential for reducing short and long-term customer costs primarily through reductions in capacity procurement costs (Faraqui, Sergici, & Spees, 2014). A final global estimate pencils out the ultimate character of conservation: worldwide self-funding conservation potential – where the benefits are sufficient to cover for investment costs – is estimated at a significant US \$30 trillion (Dobbs et al., 2011). With careful consideration, sensible financing strategies, and a comprehensive approach, similar self-funding investment potential exists in onsite renewable energy generation (Byrne, Taminiau, Kim, Seo, Lee, 2015; next chapter of this dissertation) and microgrids (Burr, et al., 2014), raising the prospect of turning society's landscape inhabitants not just into 'prosumers' – where consumers take up the additional role of production in conjunction with consumption (Griajalva & Tariq, 2011) – but sustainable and empowered citizens (see the Architectural League of NY, five thousand pound life, for an interesting movement in the United States on the topic of the 'sustainable citizen'). Melissa Lane, in an attempt to define the 'sustainable citizen', draws from Epictetus'

polites ei tou kosmou (“you are a citizen of the cosmos”; in this case to mean a citizen of the world) to broaden the ‘prosumer’ notion from renewable energy production towards the co-production of social and ecological relations: “the ideal of sustainability must involve an ideal of sustainable citizenship, in which the relations that one helps to produce are themselves sustainable”.⁴⁷

A critical question that arises is why this potential is not being realized. For instance, as the Consortium for Energy Efficiency (CEE) documents, investments in demand-side management schemes to capture this potential remain substantially below the investment levels required to unlock such energy efficiency options (CEE, 2013). Moreover, estimates of investment levels required to meet infrastructure-scale and transformative change range well into the trillions of dollars (Fulton & Capolino, 2014; American Society of Civil Engineers, 2013; Dobbs et al., 2013). For instance, the European Union (EU) faces an emerging funding gap on the order of €500 billion to renew the continent’s energy grid and meet stated targets (Jacobsson & Jacobsson, 2012). While attention by utilities to supply chain requirements and end-user sited efficiency measures can deliver incremental change, it will become clear in the sections below, much more is needed to move from incremental change to transformative change. For one, incremental change strategies are poorly positioned to aggregate and pool projects into infrastructure-scale investments.

One component in all this are the barriers that exist in the energy space relating to energy efficiency and, ultimately, energy conservation. Examples of this are (Granade et al. 2009; Eto et al., 1996):

⁴⁷ A detailed description of Melissa Lane’s thoughts can be found at <http://archleague.org/2013/11/sustainable-citizenship-3/>

- Energy efficiency measures require a substantial up-front investment, only to be recouped over the (long) lifetime of the measure;
- Hassle or transaction costs – the costs associated with acquiring the energy efficiency measures in terms of, e.g., time, materials and labor;
- Lack of access to (low-cost) financing;
- Efficiency potential is highly fragmented across many millions of locations and users. As Granade et al. (2009, p. 9) put it: “This dispersion ensures that efficiency is the highest priority for virtually no one.”
- Finally, measurement and verification of energy savings is essentially counterfactual and difficult and are often measured by powerful actors with a substantial stake involved. Such performance uncertainties create key difficulties for consumers when they need to evaluate claims about future benefits.

As such, as reports such as the one by Granade et al. (2009) offer, a comprehensive strategy is required that, at least, positions energy efficiency as a critical and ‘first, best’ resource for energy development, integrates methods that open up the significant up-front investments required, addresses the alignment between conventional energy utilities, consumers, regulators, manufacturers, and government agencies, and fosters innovation to continue ongoing development. Such a strategy, as will be shown in following sections, finds difficulty and resistance in existing energy regimes. As such, one explanation of why this potential has not been realized thus far increasingly appears to be paradigmatic: optimality (including its ‘green growth’ version (Taminiau & Byrne, 2015) versus sustainability as the guiding principle for investment. Indeed, drawing from the work of Amory Lovins and the ‘road not taken’, Lovins already noted that it can be considered ‘spherical nonsense’ to pursue hard and soft paths as complementary pathways (Lovins, 1977).

5.2 The Modern Energy Utility Business Model in Relation to Energy Savings

Projections of necessary expansion of energy supply are common: growth rates in demand and use are often at the bedrock of energy use projections such as performed annually by the IEA or the U.S. EIA. The conventional energy utility fits within such a conceptualization of our energy future; in fact, the current energy utility configuration is a direct cause and product of this pattern of expansion (Byrne & Taminiau, 2014). Brennan & Palmer (2013) further provide support for this line of thinking:

- *Business model:* the conventional energy utility business model has been - in many cases for more than a century - centered on the supply of energy, not the reduction of energy use.
- *Corporate culture:* The guaranteed rate of return, Brennan & Palmer (2013) posit, may be incompatible with the dynamism of scaling back energy consumption. An important consideration within this is the fiduciary responsibility investor-owned utilities have towards their shareholders.
- *Competition:* regulated utilities can only play a limited role in competitive sectors while energy efficiency is a sector that can entail numerous technological and service design solutions with the aim of a reduction in energy use.
- *Politics:* conventional utilities require assurance that energy saving measures will not harm their business case.

As a result, the dynamics of the conventional energy utility business model result in a number of disincentives (York & Kuschler, 2011; York, et al., 2013):

- Utility revenues are negatively affected by a downturn in energy sales; i.e. when energy sales reductions outperform process savings from energy efficiency programs. Rate increases are required to overcome this disincentive.
- The costs to operate, monitor, and market the energy efficiency programs may hurt the utility's revenue requirement.

- Unlike conventional asset expansion (such as the construction of additional capacity), energy efficiency programs do not establish a rate of return under conventional ratemaking.

These concerns lead to the need to establish a viable business model capable of capturing societal benefits while ensuring profitability. A conventional energy utility business model would need to be guaranteed three “carrots” through regulation in order to be motivated to include energy efficiency (Satchwell, Cappers, & Goldman, 2011; Hayes, Nadal, Kushler, & York, 2011): assurance of cost recovery of program costs, disincentive reduction through recovery mechanisms, and the provision of shareholder incentives. This need has been recognized for quite some time now (see, for example, (Hirst & Blank, 1994; Golove & Eto, 1996; Satchwell, Cappers, & Goldman, 2011)) and has been especially translated in the need for ‘decoupling’⁴⁸ – the elimination of the link between utility revenues and electricity sales (Brennan T. , 2010). In fact, the political economy dynamics of the conventional energy utility suggests that decoupling can contribute to the reduction of utility opposition (Brennan T. , 2010).⁴⁹ This line of reasoning of ‘regulatory capture’ or ‘regulatory commodity’ (Byrne & Taminiau, 2014) creates the situation that utilities could be persuaded to include energy savings implementation measures as long as accompanied by decoupling as it reduces the need for complicated rate cases for cost recovery and instead automates the process:

⁴⁸ A database of U.S. states that have decoupling policies in place is being maintained by Pamela Morgan (Morgan P. , 2012).

⁴⁹ Currently, 18 out of the 23 states documented by NREL have performance incentives (also called “shareholder” incentives) in place, and nine states (of which five have performance incentives) have rules for monetary penalties in place in the case of non-compliance (Steinberg & Zinaman, 2014).

This automatic (by rule/formula) adjustment in prices to varying volume changes is the reason that electricity providers may seek regulation in the form of energy efficiency standards. This is because once energy efficiency standards are in place, this quantity regulation leads to and provides significant and overall compelling arguments that decoupling is a necessary mechanism to ensure that energy efficiency standards are successful by potentially re-aligning utility incentives with that of the regulatory authority (Croucher, 2011, p. 3604).

Without regulation, the utility business case would argue in favor of traditional supply-side operations (York, et al., 2013). Important consequences, however, arise when this ‘regulatory commodity’ is established:

- *Rate Increases:* Administrative costs and incentive payment costs are passed on to the customer base leading to the paradoxical case that energy reductions require higher rates despite empirical evidence showing energy efficiency’s superior cost profile (Lazard, 2013). Figure 5.2 reports how prices, revenues, and sales have developed in the United States since 1990: despite recent slowdowns in energy sales, prices have been on the rise since about 2000. This is particularly true when a regional breakdown of prices in the U.S. is assessed.
- *Regulatory Encroachment:* To compel energy utilities to perform to stringent energy efficiency mandates, relatively advanced and elaborate regulation and government involvement is required:

“Decoupling, in isolation, is not sufficient to induce investment in efficiency by utilities. Rather, decoupling, if successful, will eliminate a utility’s disincentive to invest in efficiency programs. Additional policy measures, such as an EERS [(energy efficiency resource standard)] that requires utility compliance coupled with performance incentives, may be necessary to drive utilities to invest or administer efficiency programs.” (Steinberg & Zinaman, 2014, p. 21)

- *Risk shift:* risk associated with market changes is shifted from the utility to the consumer, which can be beneficial for the consumer (if sales increase, leading to lower rates) or harmful (if sales decrease, leading to higher rates) (Steinberg & Zinaman, 2014).

This leads some to question the appropriateness of selecting the conventional energy utility as the main driver of energy efficiency (Brennan & Palmer, 2013;

Palmer, Grausz, Beasley, & Brennan, 2013; Byrne & Taminiau, 2014). Indeed, some, compelled by the observations that the expected rapid rise in decentralized renewable energy and the large investment gap required to maintain and update existing infrastructures, argue a ‘death spiral’ for the conventional energy utility: rising rates for fewer sales coupled with larger numbers of ‘prosumers’ producing their own energy can dramatically affect the utility business model (Martin, Chediak, & Wells, 2013). Indicatively, industry analysts allay such fears arguing an expectation that utility regulators will step in when such changes will start to have a significant financial impact (Moody's Investor Service, 2013). Indeed, their very *expectation* that the regulatory regime will continue to provide for the investor-owned utility (IOU) business model throughout changing circumstances signals their strong dependency on the regulatory regime to cope with change. However, this does not take away the point that conventional energy utilities will require modification in their structure and form to account for upcoming challenges. For instance, drawing parallels with the telecommunications and aviation sectors when they argue that new developments threaten the regulatory paradigm of cost recovery, the Edison Electric Institute (Kind, 2013), the U.S. utilities’ own trade group, positions the following “game changers” as fundamental challenges to the utility landscape:

- (Rapidly) falling costs of distributed and renewable energy resources;
- An enhanced and increasing focus on the development of new technologies in the distributed energy space;
- Increasing customer, regulatory, and political interest in energy saving measures and demand side management;
- The rising prominence of government programs to incentivize certain new technologies;

- The declining price of natural gas;
- The slowdown in economic growth trends; and
- Rising electricity prices in certain areas of the county.

On top of all this, it is a different question altogether to consider the implementation of sustainable energy (conservation and end-user sited renewable energy) at an infrastructure-scale level. Energy sustainability at this level will intensify current challenges and produce additional conflicts. For one, what can be called the ‘dynamic conservatism’ of political economy (Byrne & Rich, 1986), efforts at infrastructure-scale levels, motivating energy transitions, are threats to the status quo and will produce resistance. The importance of these threats is emphasized by current investor-owned energy companies:

1. A rapid and sustained transition to a sustainable energy future, as called for by the scientific community in relation to ecological boundaries, will present a financial loss and the cost of ‘stranded assets’ will need to be recovered (Rozenberg et al., 2014; Robins, 2014). Such stranded assets, i.e. investments that (rapidly or even fully) depreciate in the case of an energy transition – such as, for instance, coal fired power plants that are unavailable to survival pathways such as ‘clean coal’ – frequently make up a significant share of the energy mix of conventional energy utilities reducing their appetite for promoting fundamental energy transitions;
2. Transitions to sustainable energy increase the long-term cost of capital to owners of the existing energy infrastructure as successful energy efficiency programs decrease conventional utility financial returns;
3. Unless integration takes place on the terms and conditions of profitability as set by the current energy companies, the development of renewable energy threatens the viability of the current energy architecture and the energy sector as a whole; and
4. Small-scale, onsite integration of renewable energy generation options and the development of microgrids is not only expensive but contradicts the architectural logic of modern utility systems.

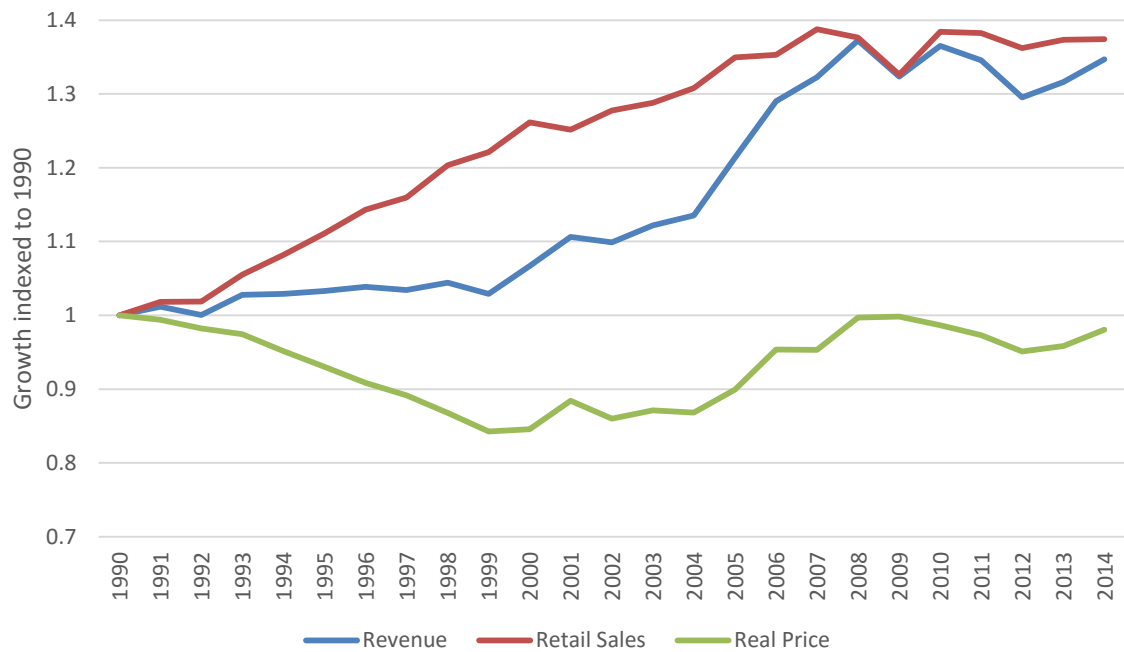


Figure 5.2: Trends in utilities' revenues, retail sales, and electricity prices. Sales, revenues, and price data obtained from the U.S. Energy Information Administration (EIA), Form EIA-826 (March 5, 2015). Revenues and prices reported in chained 2009 dollars, calculated using U.S. Bureau of Economic Analysis (bea.gov) data.

However, some level of optimism is also available as energy saving measures can be observed to spin off benefits and actually affect electricity sales. For instance, an interesting trend in retail sales can be observed in Figure 5.2: since about 2005, retail electricity sales have stopped growing. A range of factors are credited with this pattern such as the erosion of manufacturing, the economic slowdown and a resulting slowdown in industrial activity, new (building) codes and standards, fuel switching, the rise of distributed generation, demand side management efforts by utilities, and more efficient appliances (Smith, 2013; Faruqui & Schultz, 2012; Plumer, 2013).

Similarly, Nadel & Young (2014) analyze the contributions of energy efficiency programs, policies, and weather conditions. They arrive at the conclusion that savings from energy efficiency programs and warmer winter weather have substantially contributed to the slowdown in electricity consumption, especially when looking at the residential and commercial sectors (Nadel & Young, 2014). This pattern of slower electricity demand growth is deemed the “new normal” by Faruqui and Schultz (2012) who see this pattern stay at around 0.7 to 0.9% annual growth. Others, such as the United States EIA, forecast that demand growth will remain relatively flat only for a small period of time: after 2015, growth is expected to return to its pre-recession nearly 1% growth rate (EIA, 2015). In any case, the key takeaway from this paragraph is that energy conservation measures, especially when applied at infrastructure-scale levels, are likely to be able to affect the growth pattern of electricity sales when applied intelligently.

5.3 The Performance Track Record of the Modern Energy Utility

The energy savings performance track record of the modern energy utility in the United States shows a fairly flat development pattern for most of the 1992-2012 period but an observable increase in energy savings in recent years (Figure 5.3). This pattern corresponds to the profile of energy saving investments made by energy utilities (Figure 5.4). Total energy savings in 2012 were a robust 140 million MWh across all utilities in the United States, as documented in the Energy Information Administration database Form 861. A marked drop in energy conservation spending in the 1996-2003 period (Figure 5.4) is attributable to deregulation and restructuring according to the EIA (EIA, 2000). While energy efficiency spending – for both natural gas and electricity – currently experiences rapid growth, the 2013 expenditures

correspond to about 2% of operating revenues and approximately 8.5% of capital expenditures (Edison Electric Institute, 2014).

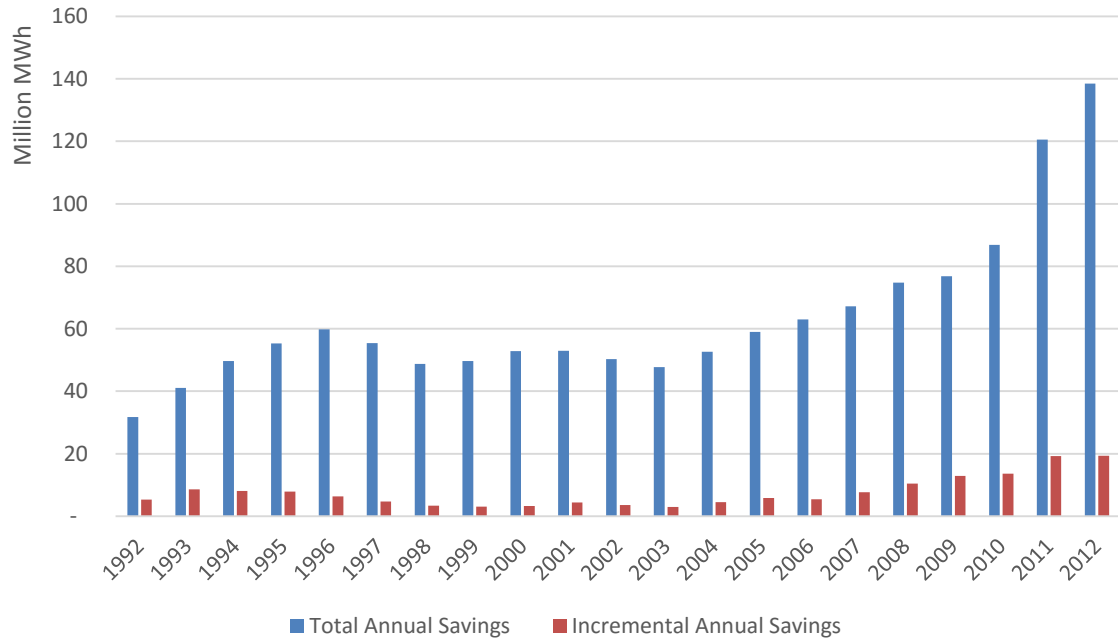


Figure 5.3; Annual energy savings from U.S. utility sector energy efficiency programs. Incremental annual savings refer to energy-saving measures installed in the reported year. Total annual savings include savings from all measures already in place in a reporting year to account for lifetime savings from multi-year energy saving measures. Data obtained from the U.S. Energy Information Administration (EIA), Form 861 (February 19, 2015). Importantly, programs operated by non-utility Demand Side Management (DSM) administrators, such as the New York State Energy Research and Development Authority (NYSERDA), Efficiency Vermont, or the Delaware Sustainable Energy Utility (SEU) are excluded.

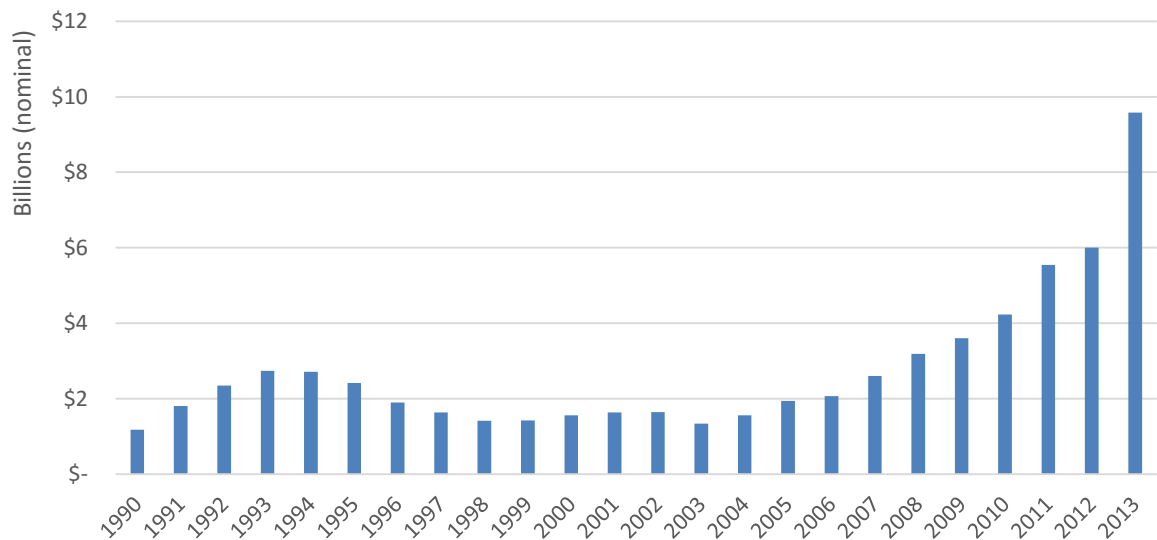


Figure 5.4; Annual total costs of utility administered DSM programs. Costs presented here include both direct and indirect costs associated with energy efficiency and load management efforts. Data obtained from U.S. Energy Information Administration (EIA) Form 861 (February, 2015).

Another way to consider the above realizations in action is to reflect upon the efforts of energy savings by conventional energy utilities. A useful metric is to evaluate the savings as a percent of retail sales. Two metrics are used in this section: annual electricity savings as a percent of retail electricity sales and incremental electricity savings as a percent of retail electricity sales. Annual savings as a percent of sales serves as a proxy for the percentage of a utility's load that is met using energy efficiency measures (CERES, 2011). Another way to look at this is to see the percentage as the contribution of energy efficiency to a utility's overall resource mix. However, annual savings, as reported by conventional energy utilities across the United States offer a somewhat uncertain profile as there is not only considerable uncertainty over things such as baseline year against which savings are measured,

capacity factor of energy savings used, accounting, monitoring, and verification practices and the assumed lifetime of energy saving instruments but there is likely also considerably variety across utilities making it difficult to draft a utility-sector average. Incremental savings as a percentage of sales, on the other hand, offers an improved overview of a utility's current energy efficiency programs – it can be considered a proxy for reductions in load growth.

In point of fact, when looking at the annual energy savings performance record of several utilities, it is clear that there are vast differences between the utilities (Figure 5.5). For instance, while SEMPRA utility (which includes all its subsidiaries), is listed by CERES as one of the top-performing utilities in the country in this metric, it has only recently, but rapidly, increased its efforts. Other utilities, like Duke Energy (the largest utility in the country with about 7% of all retail sales in the United States) and American Electric Power (AEP) (another very large utility with about 4% of all retail sales in the U.S.) show a dramatically lower performance – although it should be noted that some subsidiaries of Duke Energy show impressive performance. An example of a strong performer is the California-based Pacific Gas and Electric (PG&E) which shows an impressive track record, arriving at about 17% of retail sales in 2012 during the 1992-2012 time period.

However, in line with Section 5.2., these savings can be argued to be policy-driven, rather than utility motivated. For instance, both SEMPRA and PG&E are located in California. California is described by Nadel (2014) as one of the leading states in energy efficiency where aggressive energy efficiency policies have been in effect since the 1980s – indeed, particular effort was directed at decoupling revenue from sales (Rosenfeld & Poskanzer, 2009). Other regions that Nadel (2014) identifies

as promising – Pacific Northwest, New England – are also aggressively pursuing energy efficiency policy by ramping up energy efficiency investments. Another way to make this point is illustrated in Figure 5.6, where DSM savings per state are calculated against the retail sales of that state and subsequently compared against the American Council for an Energy Efficient Economy (ACEEE) energy efficiency ranking. As Figure 5.6 shows, the ranking and performance in 2013 roughly correspond, indicating that policy is likely a driving force for utility action. For instance, CERES (2014) finds that three energy utilities (PG&E, SEMPRA, Edison International) perform much better than the rest of the utilities and all are located in California – ranked second place in the ACEEE scoring and, more broadly, California is well-known for its aggressive environmental and energy policy (see also Appendix B on US State Level Action).

Two states with currently strong non-utility DSM administrators in place (see sections below) argued the downsides of policy dependency and regulatory enforcement of DSM efforts: Oregon and Vermont, both with impressive energy efficiency records before and during restructuring and with strong regulatory contexts and incentives, argued that, despite such contexts, utility corporate culture and lack of competition would lead to slower energy efficiency implementation and lower results (Sedano, 2011). Fears about such a potential lack of performance motivated both states to create their own non-utility DSM administrators, Energy Trust of Oregon and Efficiency Vermont – independent energy efficiency entities charged with administering the ratepayer funded programs and a sole mission of sustainable energy (Sedano, 2011). Additionally, a policy dependency establishes the situation that, when policy contexts degrade (e.g., budget cuts necessitate a less stringent EERS), energy

efficiency efforts likewise degrade as IOUs set their efforts at the new targets (Sedano, 2011).

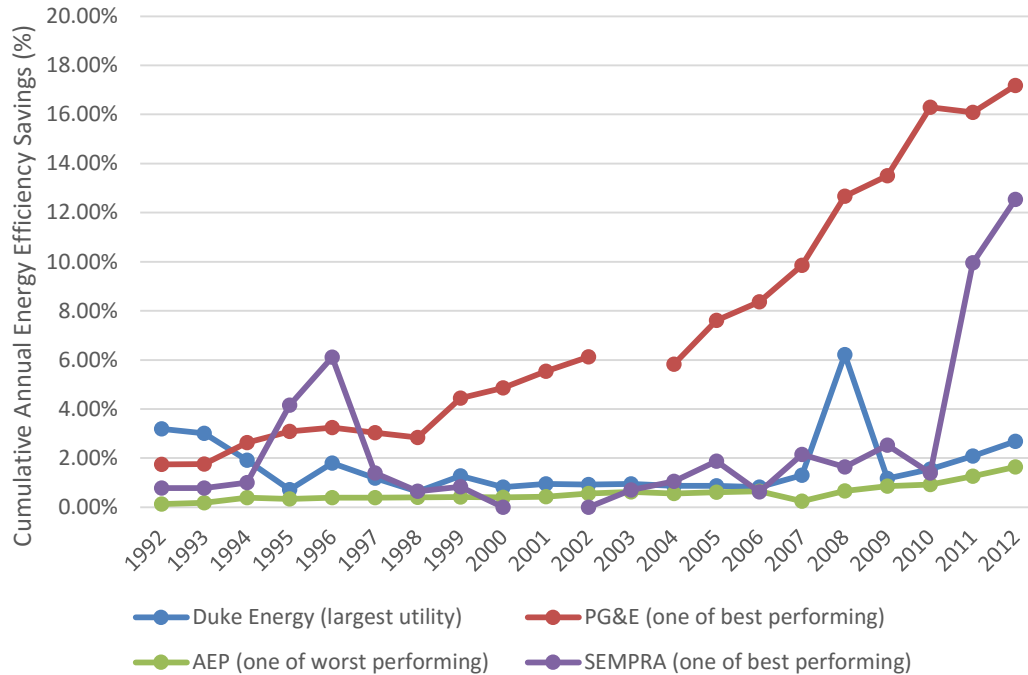


Figure 5.5; Energy savings performance record of four utilities (Duke Energy, PG&E, AEP, & SEMPRA), benchmarked by CERUS (2014) as some of the best and worst performing utilities in terms of 2012 savings over sales. Data obtained from the U.S. Energy Information Administration (EIA), Form 861 (February 19, 2015). Rapid rises and declines might indicate poor data quality, but perhaps can also serve as an indication that low-hanging fruit (easily accessible for quick savings when required for instance by regulators) is captured for brief periods of time. No data available for the gaps in SEMPRA and PG&E.

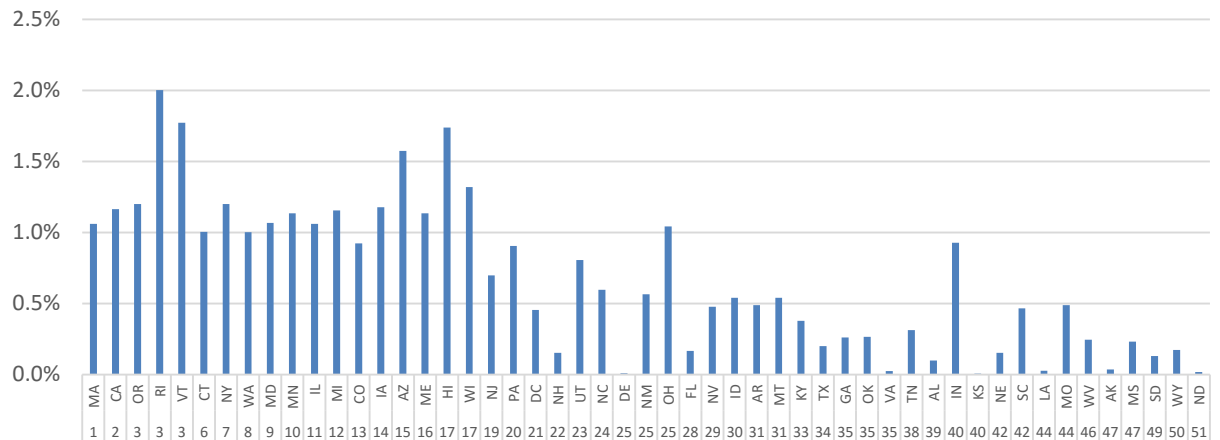


Figure 5.6; Incremental Energy Efficiency Savings in 2013 as a ratio of electricity retail sales per state compared against the ACEEE ranking (from left to right: strong policy to weaker policy context). This chart includes the performance of all reporting utilities in all U.S. states (municipal, IOU, non-utility DSM administrators, etc.) but excludes power marketers.

A track record of the average utility in the United States can also be extracted from the EIA database Form 861. As Figure 5.6 reports, the average utility reports incremental energy savings of a little below 1% in 2012. The annual savings record (red line) shows the annual savings as reported by all utilities throughout the 1992-2012 period (this is a cumulative measure of programs these utilities operate). However, as noted above, there are some uncertainties with this metric. The blue line documents the cumulative *incremental* savings against retail sales, effectively documenting the average savings path an average utility would travel over the 1992-2012 period if it would start saving electricity in 1992, arriving at about 4.2 % of retail sales in 2012. Critically, however, about 28% of all retail sales in the United States are not covered by DSM programs (or, at least, not reported to the EIA) – contrasting all

savings against total sales in the country would therefore yield a different and likely lower curve.

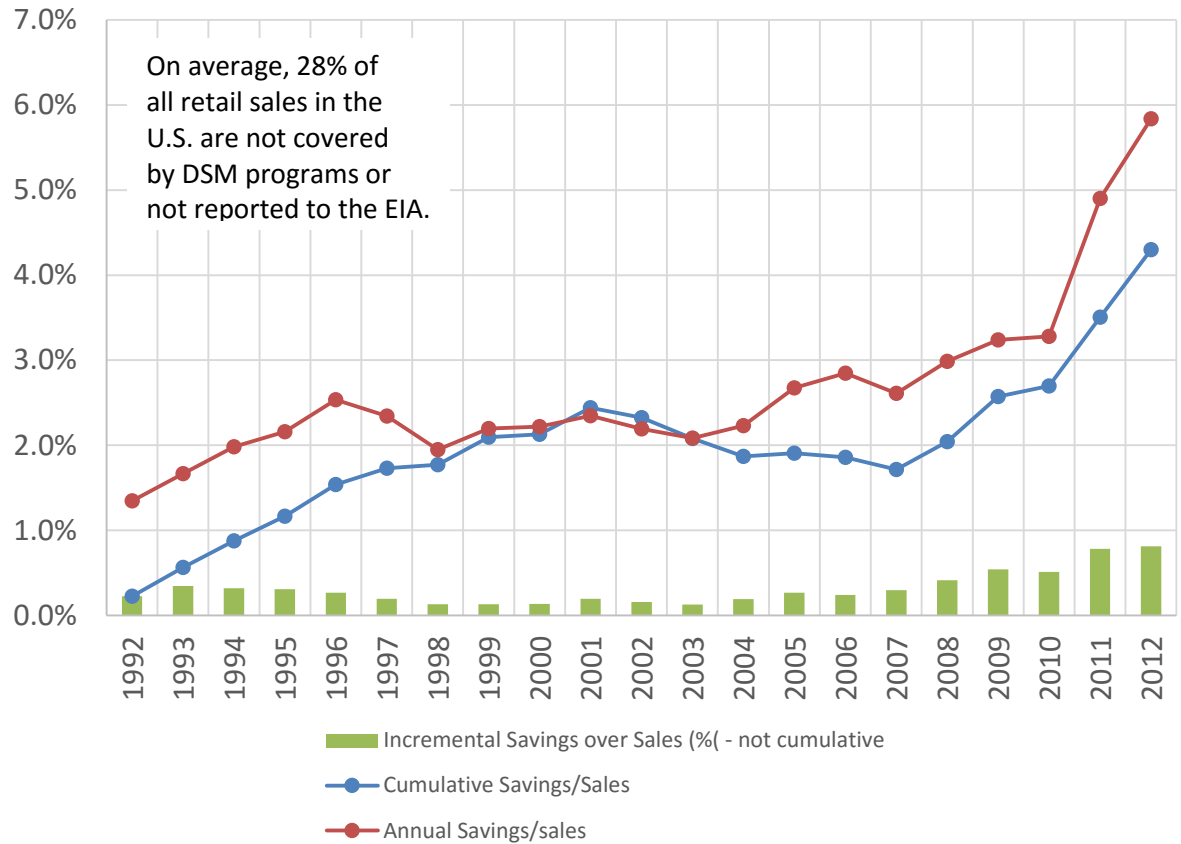


Figure 5.7; Savings performance record of utilities that report DSM savings to the U.S. Energy Information Administration (EIA) per EIA Form 861 (February, 2015) (non-utility DSM administrators are excluded). Savings are documented against retail sales of the utilities with DSM programs in operation (64.2% of all retail sales in 2012). The blue dotted line represents the average savings performance record of a utility that initiates savings programs in 1992 – DSM program savings are assumed to last 10 years. The red solid line indicates the average cumulative annual savings reported by the DSM utilities which includes savings realized prior to 1992.

These performances are reason for optimism (Nadel, 2014). However, there are some problems associated with the data reported by the EIA Form 861 other than the earlier reported uncertainties:

1. Energy efficiency measures and programs are ratepayer funded creating the situation where private gains (the guaranteed rate of return of investor-owned utilities) are supported by the community rather than (as we will see below) the situation where the critical benefits are located within the community using private funds.
2. Energy savings are estimated by the utilities using engineering analyses or perhaps observational data. However, it is difficult to establish a credible counterfactual baseline to determine how much energy is actually saved.
3. Energy savings are measured in energy units, creating uncertainty as to the actual savings for participants in terms of their utility bill. For instance, rebound effects could occur as energy efficiency measures make the use of additional energy easier and more attractive. While a growing body of research suggests that the rebound effect is overblown and counterproductive as it inhibits the implementation of change strategies – for instance, Gillingham et al. (2013) deem the position a ‘distraction’ and an illegitimate excuse for inaction – incremental change is likely more vulnerable to rebound consequences in relation to transformative, permanent, changes to the energy system.
4. While these private-sector efforts are growing (in some cases quite rapidly), the energy efficiency potential as a whole remains underdeveloped (see section above); and
5. Cost profiles only include the costs incurred by the utilities. However, most energy saving programs – such as rebates that only cover a portion of the costs of purchase of energy efficient appliances – require participants to incur a (substantial) part of the costs. This cost can be estimated at about 70% (Nadel, 2014). Similarly, Molina et al. (2014) find that, for a selection of U.S. states, participants costs range from 25% to 262% of program costs. According to Arimura et al. (2011), demand-side management programs operated by utilities perform at about 5 – 6.1 cents/kWh. Taking into account participants costs of 70%, an estimate of costs of 8.5 – 10.4 cents/kWh is more likely (depending on the discount rate; 5% and 7% respectively).

5.4 The Energy Service Utility (ESU) Model: Non-Utility Administrators to Close the Energy Efficiency Gap?

While utilities were the unquestioned administrator of energy efficiency programs for a long time, other administrative and governance options have emerged in addition to the traditional energy utility in the wake of the 1990s restructuring of the energy market (Eto et al., 1998). More specifically, Eto et al. (1998) outline two major alternatives to utility administration and governance of energy efficiency program administration, design, implementation, and evaluation: positioning such authority in existing or newly created governmental agencies or by creating nonprofit corporations or authorities. In a 2011 update of a much-cited 2003 report (Harrington, 2003), the Regulatory Assistance Project (RAP) includes another option: a hybrid administration where new ways of cooperation are explored for instance between municipalities and cooperatives (Sedano, 2011). ⁵⁰ Noting that no one option is preferable in all cases (a table by Eto et al. (1998) listing the benefits and downsides of all three structures is reproduced in Appendix E), Eto et al. (1998) list the following benefits for third-party administration and governance (i.e. non-utility administration of DSM programs):

- Organizational form, structure, and mission statements of such entities can match public-policy goals (such as market transformation);
- Minimization or elimination of conflicts of interest;
- Flexibility in planning and procurement; and
- Staffing options for such an organization might be especially strong, attracting highly motivated and skilled technical and administrative staff.

⁵⁰ Indeed, a recent report by the American Council for an Energy Efficient Economy (Nadel & Herndon, 2014) outlines 18 possible iterations of the ‘utility of the future’.

Downsides to non-profit, third party administration and governance are a) that the creation of new institutional designs is time intensive but can be worthwhile if the state or region has a long-term commitment to energy efficiency and b) the creation of such an institution requires broad consensus and political will in order to complete the process – a commodity that is often lacking and, therefore, success is not guaranteed. Eto et al. (1998) arrive at a decision tree outlining the decision thought process that would need to be undertaken in each situation to decide whether utility, state, or non-profit corporation options are preferable. Several specific questions of this decision tree are whether the utility has shown adequate past performance, whether the utility is currently willing or able to step up performance, whether the utility's geographic territory aligns with the required scope, whether any utility conflicts of interest can be observed and whether the required duration of funding is short-term or long-term. The case being that non-utility administrators are, according to the decision-tree, preferable when utilities have shown inadequate performance or have shown unwillingness to improve, when territories are misaligned with objectives, when conflicts of interests can be observed or when long-term funding requirements are needed (Eto et al., 1998).

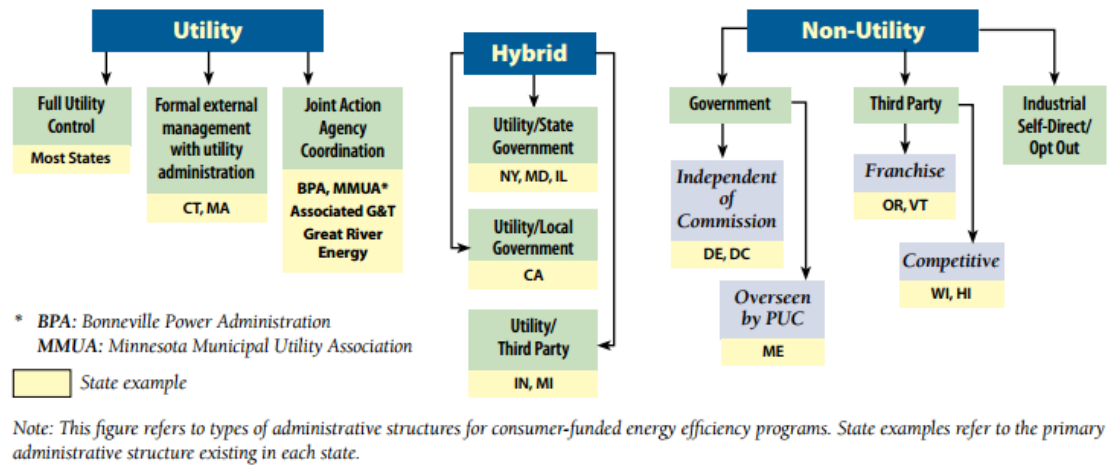


Figure 5.8; Overview of types of administrative options for energy efficiency programs with examples for each type (Sedano, 2011).

The non-utility – including the separate category as listed by Sedano (2011) of the hybrid option (Figure 5.8) – as an administrative and governance option of energy efficiency programs is intriguing as it aligns with the notion that, even though several mechanisms have been proposed to overcome conflicts between optimality-based energy utility business models and sustainable energy development and – as documented in the previous section – several utilities show impressive track records, energy efficiency or renewable energy frameworks might well be replaced by new models specifically designed to excel in the direct delivery of sustainable energy. As discussed by Byrne & Taminiu (2015), such new frameworks recognize the conflicts but do not argue the need for regulatory mediation and, rather, engage in competition at both a political and economic level. A new way to govern energy is offered by these frameworks and the likelihood grows that the new governor will emerge from political and economic competition.

Byrne & Taminiau (2015) aggregate several non-utility structures under the heading of the Energy Services Utility (ESU) model in their analysis of the performance of such ‘utilities’. Some definitions of such a model are far-reaching, essentially positioning it as a long-term evolution to a new all-encompassing utility structure (e.g., Nadel & Young, 2014, p. 55). In contrast, the delineation applied by Byrne & Taminiau (2015), also applied here, is less complex: ESUs are models that provide services such as hot water, clean electricity, or sustainable materials instead of commodities like kilowatt-hours, therms, and so on. The ESU model has found widespread application in the U.S. and internationally (Vine, 2005). A selection of distinctions between the ESU model and the utility model is characterized in Table 5.1 (for a more exhaustive comparison, see Hannon et al., 2013). The distinctions between conventional investor-owned energy utilities and energy service utilities lead some to reserve significant space for the new model in a transition to a low-carbon economy (Foxon, 2013; Fox-Penner, 2010). Critically,

- Energy service contracts establish long-term, close, and comprehensive relationships between the energy service utility and the *customer* unlike the standard, billing-based, and distant relationship between the conventional energy utility and the *consumer*. In part, the distant and standardized relationship between the utility and the consumer is a result of the fiduciary responsibility the utility has to its shareholders.
- While the optimality-based utility business case couples revenue to energy consumption, the energy service utility couples revenue to energy conservation. In other words, unlike conventional energy utilities, energy service utilities are actively incentivized to reduce energy consumption (and associated greenhouse gas emissions).

Table 5.1; Selection of distinctions between the ESU and the utility-based model.
Source: adapted from Hannon et al., 2013, p. 1036.

Building Block	ESU	Energy Utility Model
Customer relationship	Long-term service contracts	Impersonal and standardized
	Close cooperative, candid and trusting relationship	Short-term supply contracts Customer responsible for managing most conversion processes
Key activities	Energy supply and energy performance contracts typically finance, design, build, operate, and maintain small to medium scale demand management measures and low carbon supply energy projects	Typically engage in energy generation and supply and, less likely, distribution and transmission:
		<i>Generation</i> – finance, design, build, operate, and maintain large-scale, centralized energy generation and distribution infrastructure.
		<i>Supply</i> – electricity trading and metering & billing of energy supply. Rarely go ‘beyond the meter’.
Key resources	<i>Both energy supply contracts (ESCs) and energy performance contracts (EPCs):</i> Financial resources and technical, financial, and legal expertise to develop small to medium scale demand management and low-carbon supply energy projects.	<i>Distribution and transmission</i> – some may engage in T&D via arms-length T&D network operators
		Financial resources and technical, financial, and legal expertise to develop large-scale centralized generation and distribution infrastructure. Customer facing services i.e. nationwide metering, billing and customer service network.

Customer facing services i.e. operation and maintenance, billing, etc.	Fossil fuels (e.g., gas, coal).
<i>ESCs only:</i>	Centralized generation and distribution technologies.
Technology: decentralized, primary conversion and distribution technologies	
Fuel	
<i>EPCs:</i>	
Technology, secondary conversion equipment.	

The most widely cited U.S. energy service utilities are Efficiency Vermont and Energy Trust of Oregon (Hamilton, 2008; Parker and Hamilton, 2008; Nadel & Young, 2014). However, as Figure 5.8 indicates, a variety of ESU (non-utility DSM administrators) models have been introduced in the United States. To consider whether such new models can outperform the utility model, the following non-utility DSM administrators were evaluated:

- **Efficiency Vermont (est. 1999)** – operated by the Vermont Energy Investment Corporation (VEIC), EV is funded by an energy efficiency charge on utility bills and partly through the Regional Greenhouse Gas Initiative (RGGI). Efficiency Vermont is responsible for the administration of energy efficiency programs in the state (except for Burlington which continues to be served by Burlington Electric Department). The energy efficiency utility provides technical assistance, rebates, and other financial incentives to Vermont households and businesses.
- **Efficiency Maine Trust (est. 2002; assumed DSM administration in 2010)** – the organization overseen by the state’s Public Utility Commission. Like Efficiency Vermont, it is funded by a charge on utility bills. In addition, the organization has relied

substantially on funding from the American Recovery and Reinvestment Act (ARRA) for the last several years. Efficiency Maine's mission is to lower the cost and environmental impacts of energy use primarily realized through rebates on high-efficiency lights and equipment.

- **Hawaii Energy (est. 2009)** – Hawaii Energy is the ratepayer funded DSM administrator for Hawaii, Honolulu, and Maui counties. Oversight is maintained by the Public Utility Commission.
- **Energy Trust of Oregon (est. 2002)** – the energy efficiency utility serves the customers of Portland General Electric, Pacific Power, NW Natural and Cascade Natural Gas. The utility is funded by a surcharge on utility bills and overseen by the PUC.
- **NYSERDA (est. 1975; assumed *partial* DSM administration in 1998)** – the New York State Energy Research & Development Agency (NYSERDA), a state agency, administers a program called New York Energy \$mart funded through a surcharge on utility bills. Utilities in the state, however, continue to also administer their own programs.
- **New Jersey Clean Energy Program (est. 2003)** – the organization pays third-party contractors with monies raised through a surcharge on electricity bills.
- **Focus on Energy (Wisconsin; est. 2001)** – offers financial incentives, like rebates, to households and businesses in the state. Funded by a surcharge on utility bills raised by the state's IOUs, the organization allows municipal and cooperative utilities to opt out and administer their own programs. Some IOUs administer voluntary programs in the state.

Figure 5.9 reports the performance track record of the non-utility DSM administrators listed above. Clearly, impressive results have been realized by Efficiency Vermont, Efficiency Maine, the Energy Trust of Oregon, and Hawaii Energy: these non-utility administrators of energy efficiency vastly outperform the average utility efforts. However, when contrasted against the performance of the average utility throughout 2000-2013, several of the non-utilities appear to mimic a

similar performance record. However, the Figure is also a little misleading considering the average utility is reported here for their cumulative results realized over 13 years (assuming a 10 year lifetime of measures) while some of the other non-utility DSM administrators have a much shorter track record. As such, Figure 5.10 provides, perhaps, a more reasonable comparison between all the non-utilities evaluated here and the average utility. For comparison, the performance track record of the best performing utility (PG&E) is included in the graph as well.

It now becomes clear that non-utility DSM performance is well above average. Especially when one considers that Efficiency Maine, the New Jersey Clean Energy Program, and Focus on Energy (Wisconsin) – two of which represent the lowest track record in Figure 5.10 for non-utility DSM administrators – have encountered funding problems as portions of their dedicated funds have been raided to fill general obligation gaps in the state budget (Nadel & Young, 2014) likely lowering their overall performance. In addition, NYSERDA, the other low-performing non-utility administrator, does not have full jurisdiction of energy efficiency in the state as IOUs continue operating their own programs. This could lower their potential to substantially outperform the IOU average as savings here are related to statewide electricity retail sales. Finally, many of the non-utility administrators continue to provide similar programs as those provided by IOUs (in particular: rebates for energy efficient lighting options).

Hawaii Energy appears to outperform even Efficiency Vermont and the best performing energy utility (PG&E). However, the performance track record of Hawaii Energy only spans a couple of years. In addition, Hawaii has the highest electricity prices in the country as it is enormously dependent on energy imports (Downs & Cui,

2014). In addition, electricity sales in the country, in part due to its efficiency efforts, have been falling leading to a higher percentage reported in Figure 5.9 and Figure 5.10. Nonetheless, the performance by Hawaii has been very impressive indeed and are supported by an aggressive EERS policy (see Appendix B). ⁵¹

⁵¹ The Hawaii Public Utilities Commission reports how fossil fuel dependence has declined from 92% in 2003 to 72% in 2013 due to, in part a rising share of efficiency as a resource which was practically non-existent in 2003 and accounted for 12% of the energy mix in 2013 (<http://puc.hawaii.gov/wp-content/uploads/2013/04/PUC-FY-2014-Annual-Report.pdf>). Nonetheless, a recent report, State of Hawaii Energy Efficiency Potential Study, highlights how cost-effective cumulative energy efficiency potential in the state is 6,210 GWh – 144% of the current 4,300 GWh EERS target (http://puc.hawaii.gov/wp-content/uploads/2013/04/State_of_HI_Potential_Study_Final.pdf).

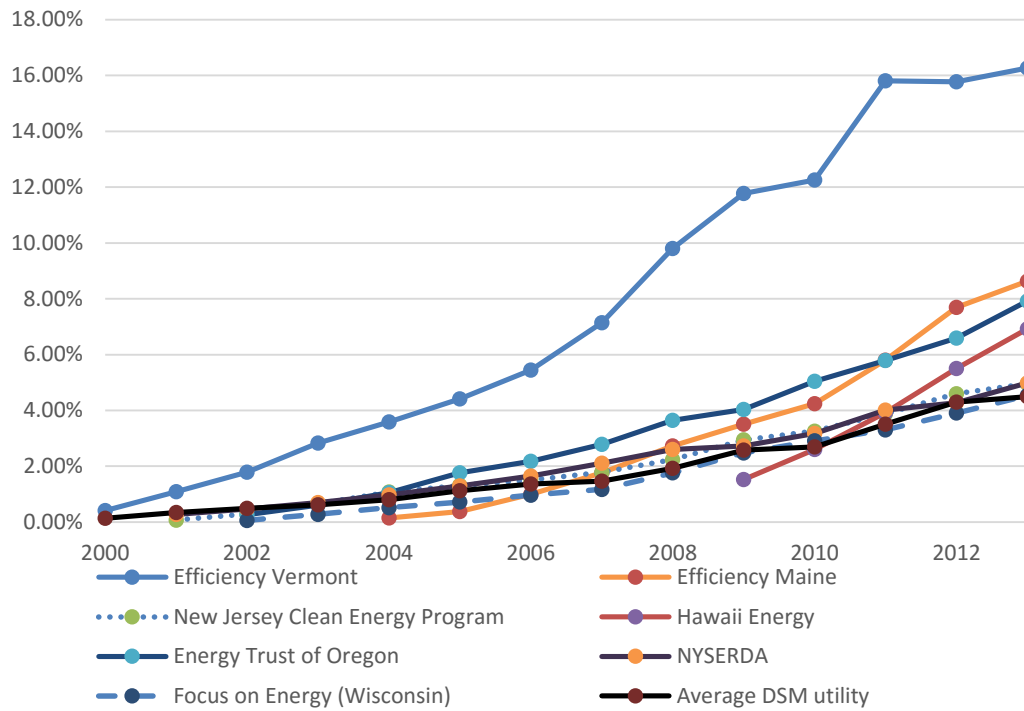


Figure 5.9; Assessment of performance record of non-utility DSM Administrators and compared against the average performance track record of conventional utilities. Source: EIA Form 861. Savings were primarily reported in calendar year format. In several instances, program/fiscal year savings were used as a proxy.

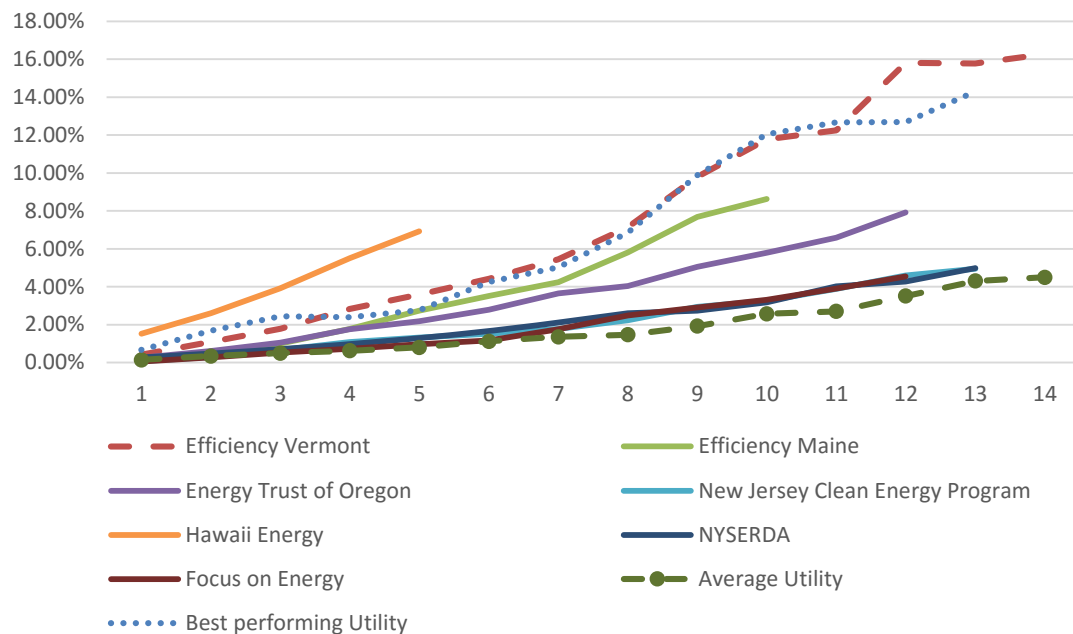


Figure 5.10; Assessment of non-utility performance where start of performance track record has been equalized among all non-utilities. The performance track record is contrasted against the average DSM performance of all other utilities (lowest performance in this graph) and against those of the best-performing utility (PG&E) across the same number of periods (years) – taken here to represent 2000-2013 for these two utilities. Note: savings were primarily reported in calendar year format. In several instances, program/fiscal year savings were used as a proxy. Lifetime of measures assumed to be 10 years.

5.5 The Sustainable Energy Utility (SEU) Model, Application, and Diffusion

The success of various ESUs within the regulatory paradigm of the investor-owned utility has motivated some to position the problem as evolving the energy sector to a ‘utility 2.0’ platform. Under such a conceptualization, IOUs could be framed as “traffic cops, coordinating the flow of electricity instead of functioning as a monopoly” (Martin, 2014; Fox-Penner, 2010). Such a platform would open up competition between ESUs, compensated by conventional utilities for their delivery of

decongestion and other ancillary and system benefits and their lower-cost energy services to the customers of the conventional utilities.

However, ESUs, due to their relatively recent introduction and unfamiliarity – when contrasted against the known business model of the investor owned utility that can count on guaranteed rates of return – continue to be perceived by financial organizations as higher risk models compared with IOUs (Hannon et al., 2013). This likely compounds already persistent barriers of limited capital availability, high upfront installation costs, and negative perceptions of risk and securitization.

However, a deeper, more fundamental constraint can be observed: the ESU model and its applications anticipate parallel operations with the IOU model and, as such, do not necessarily pursue a pathway of replacing optimality economics (Byrne & Taminiau, 2015). For instance, the ESU model is highly dependent on funds raised by conventional utilities from their customers to underwrite the energy efficiency measures in the first place (Table 5.2). Not only does this create the situation where the ultimate consumers are paying for the energy use reduction efforts – which benefit the consumer but also the IOUs through grid decongestion, peak shaving, etc. – but, more importantly, leads to the situation that, if the conventional utilities are not present (for instance, in the case that warnings of a ‘death spiral’ materializes), ESUs would cease operations as well. This dependency clearly limits the potential for positioning the ESU as paradigm-shift inducing. Another consideration is that a key pathway of energy efficiency savings, for both IOUs and ESUs appears to be, for a large part, energy efficient lighting options by offering rebates to customers although many are trying to increase the share of ‘deep retrofits’ (i.e. long-term and substantive measures) in their portfolio. For instance, the Energy Trust of Oregon provided rebates

for just over 2 million high-efficient light-bulbs in 2013. Such a pathway is limited in its scope and application as it relies on one technology option (e.g, CFL or LED bulbs), still requires a substantial payment to be made by the customer to acquire the technology, and has a limited lifespan of typically around 8 years which does not induce a long-term savings profile.

Table 5.2; Overview of main funding sources for Efficiency Maine and Efficiency Vermont to illustrate the dependence on rate surcharges that flow through IOUs.

Revenue sources	Efficiency Maine (2014)		Efficiency Vermont (2013)	
	\$ (millions)	%	\$(millions)	%
Rate surcharge	\$15.1	34.3%	\$44.9	87%
Federal Funds ^c	\$5.4	12.3%	-	
FCM ^a	-	-	\$4.2	8.1%
RGGI ^a	\$10.4	23.6%	\$2.7	5.2%
Other	\$13.1 ^b	30%	\$0.1	0.2%

Notes:

a. FCM= forward capacity markets. RGGI= Regional Greenhouse Gas Initiative.

b. Efficiency Maine will benefit from a substantial Maine Yankee Settlement to be paid out during three years (until FY16).

c. Federal funds still include funds from the American Recovery and Reinvestment Act (ARRA) but there will be no new funding from this source moving forward. As a result, the other components will make up a larger share of the total.

Infrastructure-level change in the energy sector might require a more fundamental rethink of the utility model in order to align with the ecological sustainability paradigm and a fit with a polycentric strategy of change. As such, ‘Social Change 2.0’ strategies of change – where the institution no longer depends for its implementation on its compatibility with the 20th century utility model (like ESUs do) – are needed for a more complete model of transformation. Byrne & Taminiau (2015) and Taminiau & Byrne (2015) – and others before them at the Center for

Energy and Environmental Policy (CEEP) (Houck & Rickerson, 2009; Byrne, Martinez, & Ruggero, 2009; Mathai, 2009) – argue that the Sustainable Energy Utility (SEU) model is an example of such a model that could simultaneously overcome prevailing barriers, realize a dial-back in energy use, enlarge the role of renewable energy, and empower a shift in social, economic, and ecological paradigms.

5.5.1 The SEU in Brief

The SEU model was first conceived in a series of policy papers published in 2006-2007 in an effort to deal with changing circumstances in the U.S. state of Delaware (Byrne et al., 2007; Byrne & Toly, 2006). In 2007, the Delaware SEU was enacted by statute and the model has since experienced a diffusion pattern across several jurisdictions in the United States – counties in Pennsylvania and California and the District of Columbia are actively pursuing the implementation of their own SEUs – and internationally – research for Korea, India, and Africa, among others were performed and found favorable results (Mathai, 2009; Agbemabiese, 2009; Yu, 2009).

In brief, the SEU positions itself as a new governor of energy-economy-environment relations and several contributions and innovations are central to the transformative promise of the model. For one, and critically, the SEU model introduces a New Energy Economics that draws its power from the commonly held wealth of the community (Byrne, Martinez, & Ruggero, 2009). In addition, the SEU model presents a comprehensive strategy to deliver on-site energy services and thus forcefully departs from the centralized, supply-side dominated, approach of conventional energy utilities. Also, the SEU model, functioning as a ‘community utility’, empowers citizens to actively engage and fundamentally revise their relationship with energy use. Finally, the key purpose of the SEU model is to adhere to

sustainability-defined constraints – in contrast to optimality-defined actions – as it seeks to cut energy use in an absolute sense. A summary of key differences between IOUs, ESUs, and SEUs is provided in Table 5.3.

In sum, the SEU promotes energy economy restructuring along the principles of sufficiency, justice, and sustainability. The next sections provide more detail as they evaluate a) how the SEU engages the community in which it functions (Section 5.5.2), b) how it positions the value inherent in all communities (Section 5.5.3), and c) how it attracts financial support to deliver transformative, infrastructure-level change (Section 5.5.4). Following sections discuss practical implementation of the SEU model in Delaware (Section 5.5.5) and offer an evaluation of the impact (Section 5.5.6) and transformative potential (Section 5.5.7) of the SEU model.

Table 5.3; Overview of key differences between the IOU, ESU, and SEU models.
Source: Byrne & Taminiau, 2015.

	IOU	ESU	SEU
Key purpose	Expansion of supply and distribution infrastructure	Reducing utility costs by investing in the efficiency of end-use technology of energy services	Commons-based sustainability: cuts energy requirements based on sustainability-defined constraints
Business model	Increasing electricity sales and earning a guaranteed rate of return from investments	Supplements IOUs by taking over energy efficiency activities that conflict with the core business model of IOUs	Apply commonwealth economics (community savings potential) to fund Social Change 2.0 investments
Governance	Stockholders and utility regulators	Utility regulators	Community utility

Utility-client relationship	Producer-consumer	Service provider - customer	Seeks to empower sustainable citizens and communities
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5.5.2 The SEU and Community Trust

The utility-client relationship operated by the SEU positions people and communities as self-organizing, proactive, self-reflecting, and self-regulating – in contrast to producer-consumer and service provider-customer relationships dominant in IOUs and ESUs. An effort to emphasize this characteristic has lead us to the denomination of the SEU model as a ‘community utility’ (Byrne & Taminiau, 2014). In this position, the SEU empowers residents and businesses to embark on a future of sustainable energy, moving beyond limited conceptualizations of ‘prosumers’ and towards sustainable citizens (Byrne & Taminiau, 2015). The performance of the model, therefore, is judged on its capacity to provide public benefits, foster social acceptance, and maintain social engagement – the community that is served by the SEU is also the community that evaluates its performance (Byrne, Martinez, & Ruggero, 2009). A state of ‘community trust’ is, as such, essential to the survival of the SEU model as, without community engagement, the model ceases to exist or, at least, ceases to operate as a paradigm-shift inducing agent of social change.

Critically, a community utility like the SEU model, allows for community-designed environmental, social, and governance objectives. The contemporary technocratic energy development model, which highly emphasizes the voices of experts and technocrats (think, for instance, about the design and construction of a nuclear power plant) and is paid for by community members through their energy bills, is thus reconstituted towards a model where energy experts, technocrats, and financial analysts are subservient to community goals (Byrne & Taminiau, 2015).

Optimality and maximum short-term profitability, as such, are decision-making criteria that become available for discussion and space is opened to introduce additional decision-making criteria such as quality of life and long-term sustainability. Indeed, the model is designed with the notion in mind that these latter criteria will dominate decision-making by the community.

Programs operated by the SEU model are constructed in such a way that participants (i.e. community members) can assess and indicate their energy service needs and a model for energy development is matched to these needs. Advanced investment-grade energy audits subsequently determine where improvements in energy use in the community can take place and what energy reduction measures and technologies are suitable for the energy service needs profile of the participant. Design of energy service delivery, as such, is tailored to the participant. The results of these investment-grade energy assessments are then reported in a long-term guaranteed savings agreement between the energy service corporations (ESCOs), the participant, and the SEU outlining the energy savings available and *contractually guaranteeing* their materialization. A guarantee of this nature offers certainty to community members and allows for adequate financial planning as savings free up their budget. Pooling together these savings potentials of the community – i.e. the commonwealth, see next section – the community is then able to engage debt issuers to overcome high initial up-front capital costs and program costs. As such, payment agreements between the SEU, debt issuer and the participant are drafted outlining a debt service payment schedule. Critically, this agreement is constructed in such a way that debt service payments and remaining utility bill payments after savings together do not exceed the utility bill payments prior to installation of the energy saving measures. Community

members, as such, are guaranteed to not have to pay any additional costs other than the utility bill payment they were making before the implementation of the energy saving measures. Indeed, once all debt service payments are fulfilled, the community members will pay only their remaining utility bill while also gaining ownership of the conservation measures. Thus, no capital costs are borne by the community members other than paying back the debt service over time. Finally, a program agreement between debt issuer, participant, SEU, and ESCOs is drafted that outlines the functioning of the overall program. Importantly, all agreements, while tailored to the specific conditions of the participant, are drafted from standardized documentation allowing for the pooling together of participants and for smooth completion of the paperwork.

This set-up, or modalities of it, strengthens the community trust in several ways. For one, the program is customizable to local conditions (e.g., the repayment terms, the portfolio of energy saving measures, and the portfolio of on-site renewable energy options can be tailored to participant profiles). In addition, in contrast to dominant rebate strategies deployed by IOUs and ESUs, the participant incurs no upfront capital costs. Moreover, the participant owns all improvements and associated benefits after debt service expires. Next, monitoring and verification protocols support participant goals (if monitoring and verification efforts report energy saving shortfalls in relation to the guaranteed energy savings, the ESCO is held responsible under the guaranteed savings agreement and will need to remedy the performance shortfall or provide compensation). Critically, energy savings are denominated in dollar amounts, and, in contrast to more difficult to establish counterfactual baselines for energy use over time, offers participants certainty, clarity, and security: savings are in dollars,

shortfalls are in dollars, and compensation to remedy shortfalls are in dollars. Finally, the application of the commonwealth – the pooling together of savings potential among all community members – provides a pathway for low-cost capitalization as the strategy takes advantage of community pooling and transaction standardization.

The SEU thus becomes a trusted advisor of the community as it delivers, among others, independent, objective monitoring and verification of investment performance, provides long-term program durations (20-25 years per contractual engagement), and supplies low-cost capital to finance the whole arrangement.

5.5.3 The SEU and the Commonwealth

Another concept introduced by Amory Lovins is central to the operation of the SEU model: the ‘negawatt’ (Lovins, 1977). Like the concept of the negawatt, the core value proposition of the SEU model is that it is more cost effective to reduce energy consumption than it is to expand energy supply to meet rising consumption. In the aggregate, as documented in section 5.1, deploying an effective and comprehensive strategy could yield a substantial wealth of energy use reduction potential. The ‘commonwealth’ – the ongoing mutual promise to share the costs and benefits of building an energy scheme that uses less – is applied to underwrite the energy use reduction measures and investment costs and attract financial capital from the capital markets. Investments in this manner are supported by the collective gains available in the community – in this case lower energy bills – and simultaneously produce collective gains such as improved public health and biodiversity recovery. Sustainability is further promoted by the SEU’s additional focus on on-site renewable energy, thus creating an enduring commonwealth.

By investing in less use, funded by the difference between waste and conservation and, for large investments where significant up-front capital costs could be a substantial barrier, drawing from the significant wealth of the commons, the SEU model delivers a practical strategy for a sustainability-defined energy development pathway. In addition, future expansion costs for additional energy capacity – or remediation and restoration costs associated with the clean-up – are avoided.

Figure 5.11 demonstrates how commonwealth resources can be used to pay back the bond debt service throughout the maturity of the bond. The combined value of the commonwealth resource opens up this option as the energy service contractors are eager to tap into this market and will thus back up their installation measures with promises of guaranteed savings. Finally the use of standardized and transparent contractual arrangements for all participants further strengthens the credit worthiness, as these documents have established a solid track record in other types of arrangements elevating private market trust.

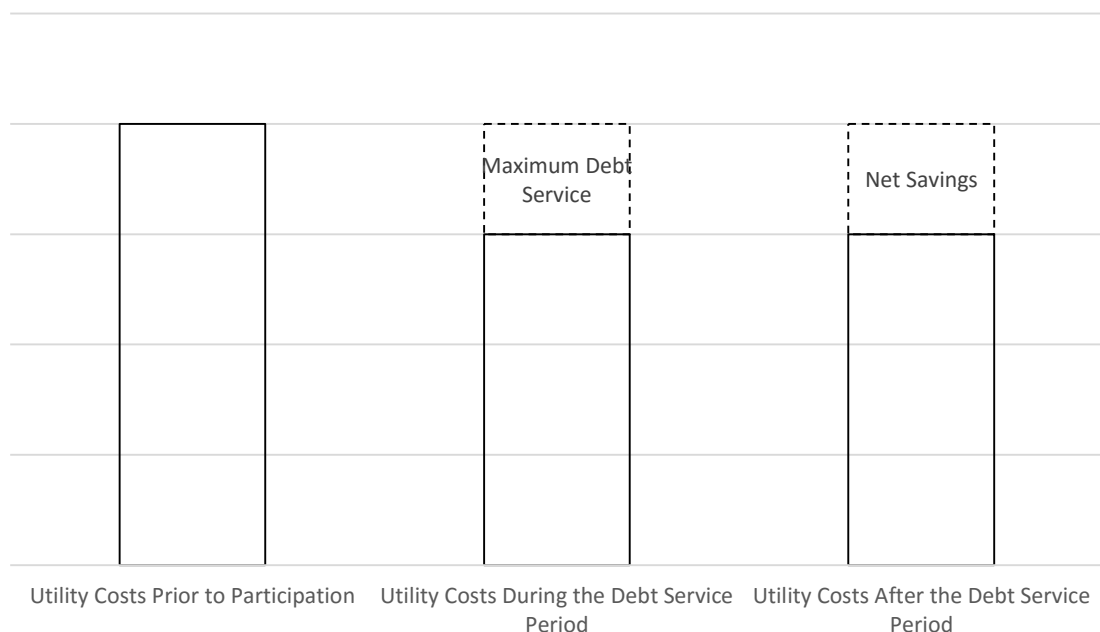


Figure 5.11; Example illustration of the application of the commonwealth principle for a program participant. Source: Citi, 2011

5.5.4 The Financial Identity of the SEU Strategy

Using the commonwealth, i.e. the energy savings available within the community, the SEU offers an innovative and practical strategy to overcome the oft-cited barriers to successful energy efficiency and conservation efforts such as the high up-front costs and limited capital availability. In addition, and in contrast to the other business models of energy development, the strategy deployed by the SEU offers ratepayer protection even as the strategy pursues infrastructure-scale investment. The New Energy Economics can leverage capital from a variety of sources (philanthropic, energy and carbon auction markets, ratepayer benefit charges, crowdfunding,⁵² etc.)

⁵² Crowdfunding is an intriguing example of the effort to democratize finance by expanding conventional financial resource pool inputs of big banks and private

but the signature innovation of the SEU is the deployment of tax-exempt revenue bonds that unlock the vast capital available in the private capital market.

In 2011, the issue of the statewide tax-exempt bond issue in Delaware realized a \$72.5 million financing for sustainable energy measures from the capital market, sufficient to invest in energy saving measures that deliver a guaranteed \$148 million in energy savings (Citi, 2011). This transaction was the first of its kind and others are planned for counties in California and Pennsylvania. Considering debt service costs, thus including interest for the capital flows, equals \$110 million, the transaction will result in a \$37 million premium over the course of the lifetime of the program. This premium will benefit the agencies and institutions of the state of Delaware that participated in the program, thus lowering the cost-of-government (Figure 5.12).

investors to a much wider audience. ‘Crowdfunding’ or ‘democratic finance’ allows for individuals to become reinvested in the energy decision-making landscape and actively participate in the selection of energy futures by pooling many small investments from a large number of community members. A proposal by the authors to apply the SEU model in conjunction with democratic finance options was awarded by the Massachusetts Institute of Technology (MIT) Climate CoLab competition with a first prize in its category and shared second prize for the contest overall (Taminiau et al., 2014). See also Chapter 7 of this manuscript.

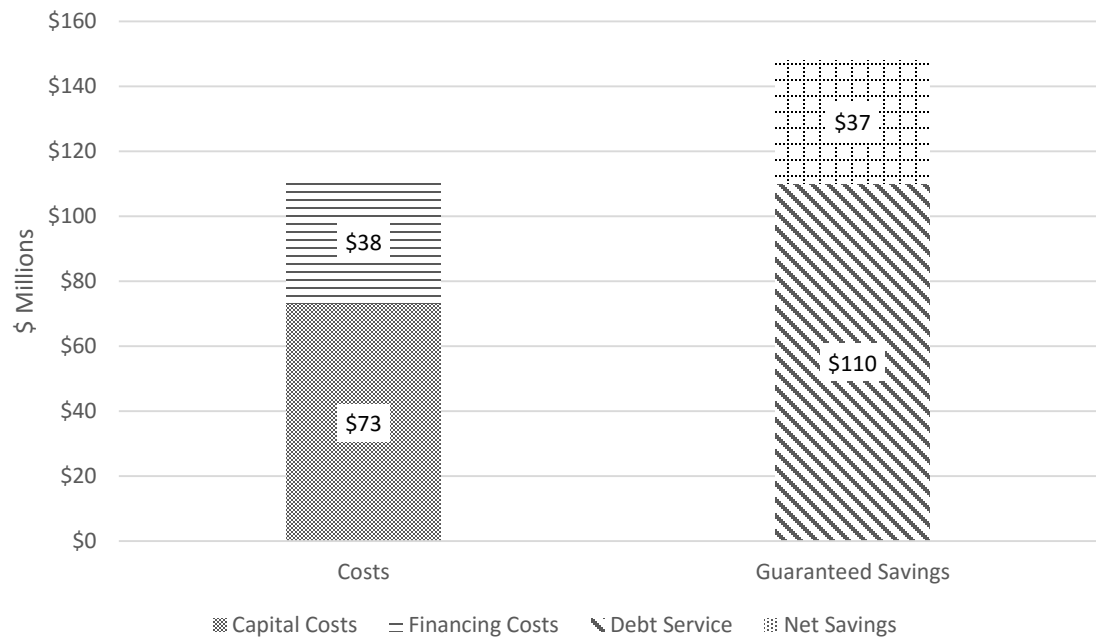


Figure 5.12; Overview of the Delaware SEU Sustainable Energy Bond issue’s costs and guaranteed savings. Source: Citi, 2011.

The example provided by the Delaware SEU offers insight into how the SEU model could unlock the significant energy savings potential when it is applied in a comprehensive strategy: Byrne & Taminiau (2015) extrapolated the Delaware SEU numbers to a national SEU application and arrived at a \$25 billion energy investment market in the public sector alone (i.e. applying the model for municipal, universities, schools, and hospital building) capable of generating about 300,000 green jobs and reduce greenhouse gas emissions by 225 million metric tons. Indeed, a Master Thesis by a colleague here at CEEP calculated the potential of the SEU model in relation to existing energy performance efforts at the U.S. federal level and found that the SEU model would outperform such programs with similar objectives by a factor of six (Schafer, 2012).

5.5.5 Impact of the Community Utility Approach

The SEU capitalization strategy introduces a savings potential for participating organizations which promises private investors a return on investment, backed by contractor performance guarantees. Benefits of the program include:

- Program participants receive cost savings on their utility bills, which are contractually guaranteed to cover the full cost of all energy saving measures (including the application of renewable energy options to reduce grid demand). Additional benefits can accrue from contractual monetary savings as future price volatility and perhaps unstable consumption patterns do not undermine the business case – unlike when energy service contracts are formulated in physical units (therms, kWhs, etc.) within a regulated utility environment (thereby invoking contradictions in the business model of the utility). For this reason, public investment planning may actually be less risky when an SEU approach is employed.
- Contractors have an incentive to forecast conservative energy savings amounts to ensure compliance with contractual obligations. Any additional savings increase the public benefit.
- Aggregating all participants under a single financing lowers transaction costs and borrowing costs thereby reducing the total cost of the investment – a benefit especially to medium- and small-size MUSH actors whose sustainable energy investments (considered on their individual merits) are too small to attract bond buyers.
- Credit risk is low in the case of public agencies with strong credit histories which is rewarded with the lowest cost of capital in the marketplace.
- Perhaps most important, the New Energy Economics applied here uses the public sector's normally superior credit rating to underwrite public infrastructure transformation as the leader in societal infrastructure change thereby positioning the public sector – and its far more transparent decision-making processes – to define sustainability. This commons leadership approach replaces commodity thinking as the governor of sustainability.

Initial evaluations of the impact of the Delaware SEU's bond and other programs was performed by Byrne & Taminiau (2015). The Delaware SEU has operated its programs for about three years. One evaluation option is to consider the performance of the Delaware SEU bond application in relation to more conventional energy efficiency programs such as rebates and loans. The Delaware SEU has operated a number of rebate programs and the evaluation of performance of these programs and bond performance is provided in Table 5.4. The Table 5.4 shows how the bond program outperforms rebate options as it delivers substantial energy use reductions on the order of nearly 10% of the state's households' energy use. Critically, the bond application affected less than 5% of the building footprint of the public sector in Delaware and, as such, an ongoing investment process could be implemented to reproduce the results of the bond program indefinitely – other bond issuances could target other sections of the building footprint and, by the time that the investment cycle has covered most/all of the Delaware building footprint after numerous bond issuances, the buildings participating in the initial bond offering will be ready for a new round.

Considering the suite of loan and rebate programs operated by the Delaware SEU are very similar to those implemented by IOUs in the same region, the comparison allows for some initial conclusions regarding the potential of the New Energy Economics approach vis-à-vis its conventional counterpart. According to the findings in Table 5.4, the New Energy Economics of the bond program yield energy savings at 40% lower cost per unit of saved energy and avoid 25% more carbon per invested dollar. Again, the bill savings from the bond program are guaranteed savings whereas the loan and rebate program savings – like with programs of conventional

utilities – rely on estimates using average appliance lifetime, use patterns, baselines, etc. and are not guaranteed.

Table 5.4; Delaware SEU Savings Profile – Energy Efficiency

Lifetime savings	Sustainable Energy Bond ¹	Rebate Programs ²
Avoided grid energy use (MMBTUs) ³	7,253,592	1,139,157
Emissions avoided (metric tons of CO ₂) ⁴	661,687	122,646
Total capital costs ⁵	\$67,435,000	\$17,295,143 ⁶
Costs/MMBTU avoided ⁷	\$2.05	\$3.34
Costs/metric ton of CO ₂ avoided ⁷	\$22.42	\$31.02
Gross program bill savings ⁸	\$147,889,405 (guaranteed)	\$5,179,935 (estimated)

¹ Savings data are sourced from Investment Grade Energy Audits.

² The Delaware SEU maintains several rebate programs. The programs, with the average rebate per participant in parentheses: Appliance Rebate (\$68), Residential Lighting (\$1.13 per bulb), Home Performance with Energy Star (\$497), Green for Green (\$3,647), and Efficiency Plus Business (\$1,909).

³ Electricity savings have been converted to primary energy savings to reflect avoided grid energy use.

⁴ The emission factor for the PJM Interconnection for 2012 (0.510 ton CO₂/MWh) has been used. To reflect changes in the fuel mix of the grid due to policy factors (such as renewable energy portfolio standards) and market factors (such as the improving competitiveness of renewables), this emission factor is assumed to decrease by 1.9% per year (based on analysis of recent PJM data). A 7-year lifetime is used for the rebate programs and a 20-year lifetime is used for the sustainable energy bond.

⁵ The SEU bond covered all capital, operating and maintenance, and transaction costs. An all-in cost for the August 1, 2011 Bond was \$110 million, producing a net revenue stream of \$38 million. Because rebate program costs cover only a portion of total capital and operating costs (e.g., recipients must pay the difference between the rebate and the device cost, and they must assume installation and maintenance cost themselves), it is not possible to report a net revenue stream with the accuracy of the Bond program. It is important to note that the SEU bond covers all capital costs – not simply the incremental cost of the efficiency improvement. By contrast, rebates cover only incremental costs of efficiency improvements.

⁶ The program cost is \$9,403,826, of which \$3,381,993 was used to offer rebates. The rebates, however, only cover 30% of the total capital cost of the equipment. Participants must cover the remaining 70% of the capital cost. These costs are included in the total capital cost reported here.

⁷ In contrast to the total capital costs—which reflect all costs associated with the equipment—the costs illustrated here are limited to the additional cost associated with the energy efficiency equipment compared to a benchmark conventional energy unit. In this regard, the reported costs reflect the needed additional cost to go beyond ‘business-as-usual’ and to opt for the more efficient unit. Based on a review of the research literature and results from DOE-2 (a simulation software developed for the U.S. Department of Energy), it is

assumed that, on average, the capital cost premium paid for a more efficient device is 22%. There is evidence that the premium in the residential sector is higher than in non-residential applications. However, statistical variation around sector estimates can be large. Therefore, a composite value is used.

Another evaluation option is to consider the Delaware SEU's contribution to local renewable energy development. As documented in Appendix B, Delaware is among the 36 states employing Renewable Portfolio Standards that mandates that 25% of electricity sales from qualifying renewable sources by 2026 and a solar 'carve out' of at least 3.5% of sales needs to be realized in 2026. In addition, an obligation to comply with these state standards exists for utilities which is facilitated by buying Renewable Energy Credits in a competitive market organized by the SEU. As such, in 2012, the Delaware SEU established an auction platform for spot and future solar REC (SREC) trading, and the SEU's involvement has positioned the solar market in Delaware as 7th in the country on a per capita sales basis (Sherwood, 2014; Scheider & Sargent, 2013). The effects on local renewable energy generation are reported in Table 5.6.

Table 5.6; Delaware SEU Savings Profile – Solar Energy Programs

	Dover Sun Park¹	2012 SREC Auction²
Avoided grid energy use (MMBTUs) ³	111,332	669,332
Emissions avoided (metric tons of CO ₂) ⁴	16,334	84,125
Program costs ⁵	7,309,132	27,343,093

¹At 10 MWp, the Dover SUN Park is one of the largest public sector installations on the U.S. east coast. As per the contract between the SEU and Delmarva Power, the SEU purchases 10,600 SRECs in year 1 and 2 and sells them back to Delmarva Power in year 4 and 5 of the five year program.

² The 2012 SREC program established a multi-tiered solicitation for long-term SRECs. Contracting with SRECTrade, the SEU awarded 20-year contracts to 166 PV systems with an estimated 7.7 MW of capacity.

³Electricity savings have been converted to primary energy savings to reflect avoided grid energy use. The total SRECs generated by the Dover SUN Park and the SREC Auction contain a 20% multiplier for in-state products. Here, this multiplier is subtracted. The Dover SUN Park displaces distribution (+3%) and the 2012 SREC Auction avoids both transmission and distribution losses (+7%). Additionally, it is expected that the PV panels will lose 0.5% per year of their rated power on average over 20 years and balance of system losses will average also 5% over the 20-year period.

⁴The PJM emission factor for 2012 (0.510 ton CO₂/MWh) has been used. To reflect changes in the grid, this emission factor decreases by 1.9% per year.

⁵ In the case of the Dover SUN Park transaction, program costs reflect the cost to purchase the SRECs throughout the program lifetime and payment of SEU fees. For the SREC Auction, program costs include the purchase of SRECs for 20 years as well as the costs to contract with SRECTrade and payment of SEU fees.

5.5.6 The transformative potential of the SEU concept

A combined overview of the benefits presented in the previous sections is provided in Figure 5.12. Unlike findings reported in earlier figures on savings, the savings profile reported in Figure 5.12 includes both natural gas and electricity savings for the Delaware SEU, Efficiency Vermont, and the Energy Trust of Oregon. This was done as the Delaware SEU bond, being a long-term investment strategy, primarily taps into savings associated with natural gas consumption. In other words, the conservation measures implemented through the DE SEU bond program include many long-term technology options that target comprehensive consumption patterns of the participants – in contrast to the efficient lighting character of the savings profiles of utility-based and ESU-based efforts that is dominated by electricity savings. Importantly, the savings of the bond are contractually guaranteed and this profile exists for the implementation of only one bond issue.

Note, however, that the Figure is not intended to allow for direct comparison between the performance of Efficiency Vermont, Energy Trust of Oregon and the Delaware SEU – instead, it serves an illustrative function to provide insight into the

potential and promise of this new model. Direct comparison is complicated as the savings performance profile for Efficiency Vermont and Energy Trust of Oregon reports past performance while the DE SEU is expected (but, for the bond, guaranteed) performance against projected electricity sales. Moreover, there are uncertainties embedded in the graph and future actual savings profiles will be, among others, determined by:

- The evolution of natural gas and electricity sales in Delaware, Vermont, and Oregon. For instance, Figure 5.12 was calculated based on an expectation that Delaware natural gas and electricity sales will continue its 2001-2012 growth pattern but this does not have to be (likely will not be considering the current state of flux of the energy market with new technologies continually being introduced such as electric vehicles, smart grids, micro grids, distributed generation etc.) the case;
- Efficiency Vermont and Energy Trust of Oregon might demonstrate more aggressive performance now compared against their past performance when they were just starting out as they have completed a learning curve;
- Efficiency Vermont and Energy Trust of Oregon both have outlined intentions to diversify their portfolio of energy saving measures, including expanding their portfolio to address ‘deep retrofits’ with tools other than rebates; and
- Efficiency Vermont and Energy Trust of Oregon will be able to continue to rely on their ratepayer funded annual cash flow that will be available for additional investments, pushing up their performance record.

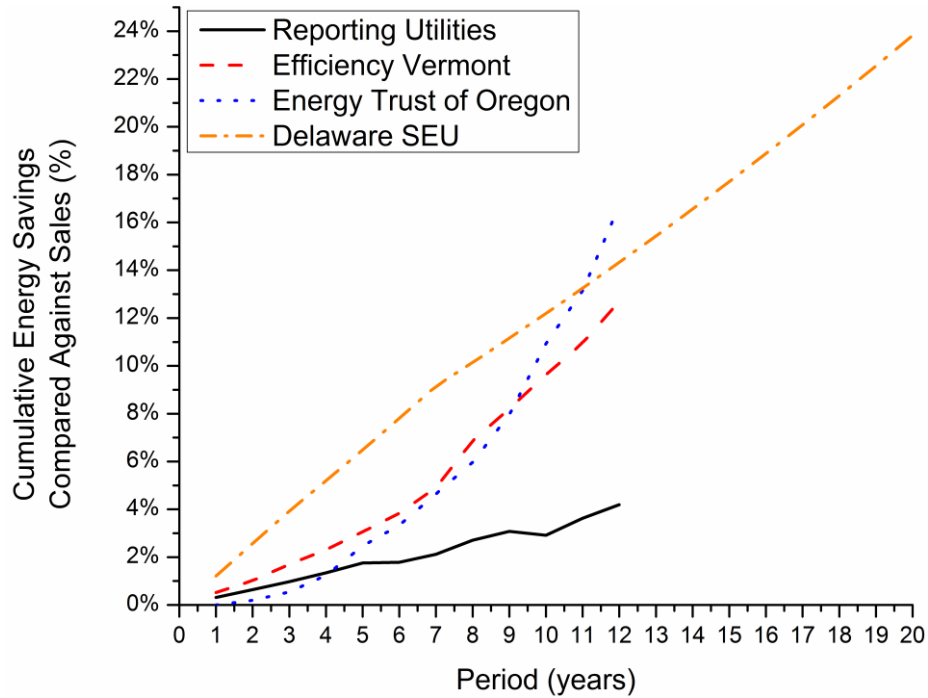


Figure 5.13; Savings profile of the DE SEU, Efficiency Vermont and Energy Trust of Oregon in terms of their natural gas and electricity saving programs. For comparison, the performance of the average conventional utility is included in the graph even though it only includes its electricity savings performance (i.e. natural gas sales and savings are not included for this utility group). The Delaware SEU data include a single application of the bond issue calculated over the lifetime of the bond (20 years), the application of the loan and rebate programs (7 years), the Solar REC auction, and Dover SUN Park program. Like Figure 1, the data for Efficiency Vermont, Energy Trust of Oregon, and the Reporting Utilities, are drafted from reported savings and sales. The Delaware SEU data, however, draw from a combination of reported savings and expected future savings. To calculate expected future savings against future sales in the state of Delaware, sales growth rates are based on 2001–2012 growth patterns. Notably, bond issue savings are drawn from contractually guaranteed savings.

Nonetheless, considering the DE SEU bond issue only involves about 4% of the floor space of MUSH buildings in Delaware, such bond issuances could occur

(much) more frequently resulting in dramatically increased savings. In addition, even though they are extrapolated to account for lifetime savings, SREC and rebate savings only occur from three years of DE SEU operations – moving forward, the DE SEU could naturally enhance its savings profile by implementing additional programs. Overall, it becomes clear that the DE SEU’s rate of conversion of energy sales to energy savings is unprecedented (Byrne & Taminiau, 2015).

Interestingly, early insights into the actual performance of the Delaware SEU bond issue suggests a record of over-performance: total savings in year one, for the participants where data is already available, exceeds the guaranteed savings by \$68,806 (Table 5.7). Chu et al. (2015) further document a considerable contribution to climate change mitigation (44 million pounds of avoided carbon dioxide emissions in year one) and to employment (786 jobs in year one) from the participants that have recorded their savings. While additional savings data for other participants still needs to be processed, these initial savings are encouraging and these excess benefits are to the advantage of the participants.

Table 5.7; Overview of the Guaranteed and Verified Savings of the Delaware SEU Bond issue. Source: Chu, Bruner, & DePrima, 2015.

Project	ESCOs	Guaranteed Savings for Year One	Verified Savings or Post-Installation Projected Savings for Year One	Excess Benefits
DSU	Johnson Control	\$804,249	\$832,245	\$27,996
DTCC-Terry	Pepco	\$131,303	\$143,865	\$12,562
DTCC-WS	Pepco	\$318,564	\$323,152	\$4,588
Legislative Mall	Honeywell	\$427,928	\$437,917	\$9,989
Carvel & RR	Amaresco	\$495,757	\$495,757	0

Sussex County	Trane	\$113,806	\$122,943	\$9,137
DSCYF	NORESCO	\$149,580	\$154,114	\$4,534
Total		\$2,441,187	\$2,509,993	\$68,806

5.6 Diffusion of the SEU model

The transformational power of this strategy has been has received endorsements from the U.S. White House and the Asian Development Bank and the SEU model experiences active diffusion within the U.S. and around the world.⁵³ To facilitate diffusion, the Foundation of Renewable Energy and Environment (FREE) provides knowhow and advice to organizations across the U.S. and internationally to take advantage of the SEU model. For instance, the Sonoma County Water Agency (SCWA) in California is set to issue a \$30-\$50 million bond issue for Sonoma County. Interestingly, this bond issue innovates beyond earlier iterations of SEU bonds as it includes material and water savings potential available in the community. A partnership with the California Statewide Communities Development Authority (CSCDA) seeks to provide outgrowth of the application to the entire state of California which would significantly advance the SEU model. Similarly, a recent launch by the Pennsylvania Treasury in collaboration with FREE of the Sustainable Energy Finance Program is a further example of the diffusion of the SEU model. Finally, through the partnership between FREE and Applied Solutions (an agency dedicated to serving community needs in all U.S. jurisdictions), many more

⁵³ International investigation is, among others, documented in a special issue of the Bulletin of Science, Technology, and Society (BSTS, 2009). This special issue contains articles on SEU investigations in, inter alia, South Korean, Indian, and African development contexts.

communities throughout the U.S. are being engaged and informed about the SEU concept and promise.

5.7 The SEU and equality, justice, polycentricity

Sustainability as an expression of the commons represents a fundamental departure from sustainability embedded within the optimality narrative (Byrne & Taminiau, 2015). For instance, fundamentally, *matching* energy supply to be directly in line with energy service needs is wholly different compared to providing ever growing energy supply options to satiate unending demand. Similarly, where marginal decision-making processes – which decide whether action should be undertaken based on the marginal cost of one extra unit of action – can suffer from rebound effects as energy efficiency measures make the use of additional energy easier and more attractive, infrastructure-scale system transformation along guaranteed savings for 20-25 years provides long-lived, system change. On top of that, the positioning of the SEU as a community utility, drawing from the commonwealth and reliant on community trust, changes the end-user relationship to energy from one of consumer to one of empowered sustainable citizen – indeed, the application of the SEU model changes the public or commons character of energy-society relations as a whole. It's difficult to imagine how this change enables privatization to return in the form of spending to have more.

Renewable energy applications under SEU models serve to provide remaining energy use after energy savings measures have been implemented. Positioning energy supply options in this manner counteracts consequences of a 'greenshift' under growth processes (see Section 6.1) as the context-specific nature of participants' energy profiles dictates diversity through customer-sited energy applications rather than

uniformity and centralization. The provision of just enough energy supply options to meet remaining energy demand furthermore directly counteracts mentalities of ‘more is better’, ‘bigger is greener’, and ‘small is stupid’ and, instead celebrates restraint. Finally, the fact that energy systems put in place by SEU programs are owned by the community (i.e. the program participants) shifts away from the corporate character of large-scale and centralized energy development and, instead, celebrates a commons-based character of energy supply.

Equality as a construct of the commons establishes benefits out of reach for growth-based equality pursuits in at least three ways. First, unequal consequences of planetary boundary overshoot – such as climatic change – are addressed by creating a system that thrives by explicitly staying within such boundaries. This change equalizes the position of the powerful with those of the ‘other’ (other places, other peoples, other generations). Moreover, rather than seceding control to bureaucratic and technical experts, SEU models empower people to control their own energy futures as community participants articulate the energy service needs they require. Finally, equality as a construct of the commons allows for resource decoupling in an absolute sense to occur where welfare benefits are realized with lower energy use in an absolute sense – a process that can continue as energy saving technologies progress and, in the case of the bond program, additional bond issuances are made.

Chapter 6

REPURPOSING THE URBAN FABRIC: THE POTENTIAL AND PROMISE OF THE COLLABORATIVE SOLAR CITY CONCEPT ⁵⁴

An additional component of the methodological framework is to evaluate energy technology pathways available to urban decision-makers that can deliver infrastructure-level change in the context of a shift to an ecological sustainability paradigm. Here, this chapter evaluates a strategic option that could become available to cities around the world and that mimics the SEU option discussed in the previous chapter: to employ currently unused ‘rooftop real estate’ of the urban fabric and position this commonwealth to attract financing through bond markets.

The energy technology option discussed in this chapter is photovoltaic (PV) energy. The global PV market is characterized by rapid developments over the past years. For instance, over 150 GW of PV capacity has been installed in the last four years (2010-2014) – more than the cumulative installation volume in the previous four *decades* (International Energy Agency, 2014a, p. 7). Additionally, the market as a whole has experienced significant decreases in (system) prices and can attract lower cost of capital for financing due to market maturation (IEA, 2014a, p. 18). Installation rates of the technology option globally frequently exceed those of other renewable energy technology options (REN21, 2014).

Modern energy regimes, however, are expected to rely on fossil fuels for decades to come and non-modern energy economies continue to experience crippling

⁵⁴ Note: the chapter draws upon co-authored, published work (Byrne, Taminiau, Kurdgelashvili, & Kim, 2015; Byrne, Taminiau, Kim, Seo, & Lee, 2015; Taminiau et al. 2014). The chapter offers new thinking beyond the published work.

circumstances of energy poverty (Rozita et al., 2014; IEA, 2011). Moreover, as discussed partially in the previous chapter, projections continue to foresee growth in consumption (IEA, 2014c).

It is considerations like these that motivate the International Energy Agency to argue that a dramatically different configuration of policy, finance, and markets will be required to transform the energy system at a fundamental level (International Energy Agency, 2014b). In their most recent Energy Technology Perspectives Report (IEA, 2014b), the IEA outlines that when an effective strategy can integrate the powers of policy, finance, and markets, it can unlock a global \$115 trillion in fuel savings (with a \$44 trillion investment; net savings of \$71 trillion, \$5 trillion when applying a 10% discount rate). In this same report, the IEA offers initial guidance on how to unlock this potential. Two elements stand out: a) it will likely be necessary to reassess the current policy mechanisms in effect which are currently primarily support schemes such as feed-in tariffs, output based subsidies and quota systems; and b) they note that governments have a unique role to play to stimulate financial investment (IEA, 2014b). While some of the specifics of the strategy provided by the IEA veer off course compared to the strategy introduced in the previous chapter – in particular, the IEA focuses on elevating carbon prices in carbon markets and promotes risk shifts to consumers and taxpayers and away from investors – these two notions of policy change and government responsibility and leadership are discussed in more detail in this chapter.

As documented in Chapter 4, city climate change mitigation and adaptation strategies are becoming ubiquitous (Hoffmann, 2011; Ostrom, 2011). In part due to this activity, Taminiau, Wang, & Byrne (2014) suggest that a key ‘driver of change’

towards the ecological sustainability paradigm will be the reshaping of urban life and energy economy restructuring. In line with that reasoning, this chapter hones in on a new concept of the ‘solar city’, developed by the author in collaboration with colleagues, which actively positions (mega-)cities as a new strategic actor in energy development and climate change mitigation. In contrast with earlier notions of cities as icons of unsustainability, dependent for their resources on external actors, the solar city concept argues the potential of empowerment, autonomy, and leadership in the new ecological sustainability paradigm. At heart, the concept revolves around the strategic retooling of the urban fabric to one of a solar city – the city-wide application of sustainable energy technology realized through strategies aligned with the ecological sustainability paradigm (Byrne, Taminiau, Kurgelashvili, Kim, 2015; Byrne, Taminiau, Kim, Seo, & Lee, forthcoming). This chapter provides an in-depth exploration of this concept and its potential. In addition, the chapter outlines a practical strategy with which to realize solar cities.

Prior to investigating the solar city concept, it is worthwhile to explore the Modern Model’s answer to climate change challenges in the energy space via an exposé on the topic of “Green Titans” (Byrne & Toly, 2006). This exposé is provided in Section 6.1. Following sections actively explore the potential of the unused ‘rooftop real estate’ that all cities possess. Section 6.2 first covers a literature review of assessments of urban PV potential. Next, the chapter outlines a methodological approach developed by Byrne, Taminiau, Kurgelashvili, & Kim (2015) with which to assess city-wide PV potential (Section 6.3). This methodology is then applied to six municipalities around the world to show the widespread potential of the concept (Amsterdam, London, Munich, New York, Seoul, & Tokyo) (Section 6.4). Next,

practical strategies for the development of actual solar cities are discussed, using finance strategies akin to the one discussed in the previous chapter: Section 6.5 and Section 6.6 evaluate the potential for municipalities to engage the capital market. Section 6.5 first discusses the emergence and promise of the ‘green bond’ and ‘climate bond’, briefly evaluating their market developments. Then, Section 6.6 introduces the option for Solar Cities in the six municipalities to engage the capital markets and find financial support for the solar city strategy. Finally, Section 6.7 evaluates the findings in light of polycentricity, equality and sustainability principles.

6.1 The Modern Model’s Pattern of “Bigger is Greener”

To address climate change but remain on a pathway of optimal growth, the modern energy project faces quite a massive challenge indeed. For instance, the US EIA shows how world energy use is expected to total 820 quadrillion British Thermal Units (BTUs) in 2040 – a 56% increase in energy consumption (EIA, 2013). Proposals to address this challenge range from ‘dash for gas’ transitional strategies, nuclear revivalism, ‘clean coal’ pursuits, and renewable energy futures (Byrne & Toly, 2006). Proponents find solace in the fact that other technologies, such as the information and telecommunications sector have successfully scaled similar transformation challenges in previously unpracticed short timeframes.

However, the energy regime of the Modern Model reveals a potential social complication: energy development principles were structured in favor of increasingly large-scale and centralized technologies that could provide massive amounts of energy – what Amory Lovins depicted as the “hard path” of development (Lovins, 1977). Indeed, a celebrated trend within the green energy sector’s rapid growth is the shift to large scale applications of renewable energy, substantiating calls for green ‘Manhattan

Projects’. Propelled by principles of economies of scale and efficiency improvements – and supported by sometimes generous financial policy support – dreams of 10, 15, 20 megawatt (MW) wind turbines lead to a championing of the industry along the lines of ‘bigger is greener’ or, perhaps, a ‘small is stupid’ mentality. Energy infrastructure data maintained by the U.S. Federal Energy Regulatory Commission (FERC) offers an example of this trend (Figure 6.1).

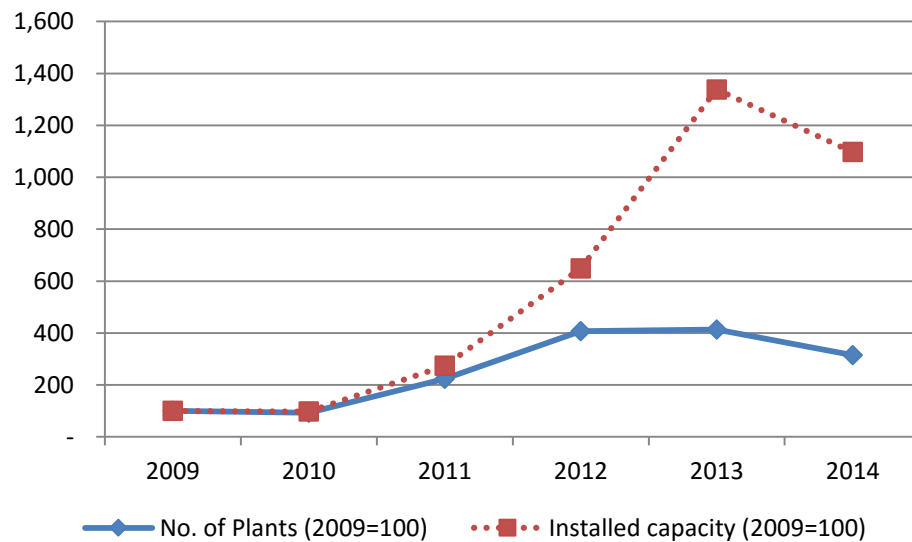


Figure 6.1; Index of energy infrastructure data from Federal Energy Regulatory Commission (FERC) reporting annual solar PV installations and capacity additions (Taminiau & Byrne, 2015).

Proponents of this energy future ignore that current constructs provide for such ‘bigger is greener’ and ‘more is better’ claims along existing consumption-production and nature-society relations: such a course of action could negate the social promise that was thought to be inherent to sustainable energy and, in fact, could become simple

‘life extension projects’ (Byrne & Toly, 2006) for the modern energy project. As ‘Big Wind’, ‘Big Solar’ and others are integrated into the existing structure of ‘Giant Power’, promises of a democratized energy world and notions of ‘energy for all’ evaporate and are replaced by an economic rationalism of expansion and growth.

Decentralized and horizontal outgrowth of energy, allowing for innovative energy access and new end-user relationships to energy based on individual contexts, are challenged by these ‘Giant Power’ (Byrne & Toly, 2006) constructs that function around centralized, oligopolistic, and hierarchical energy geographies and economics. The result is an inherently modernist endeavor: environmental narratives are seamlessly incorporated into the modernization project. Self-criticism is only applied to the ‘end-of-pipe’ consequences of current social relations to the environment - i.e. modernity’s pollution consequences – rather than challenging the corporate character of energy development, the class differences that substantiate capitalist expansion and community fragmentation, or existing patterns of inequality (Byrne & Toly, 2006).

This is not to say that there are no efforts to advance a decentralized outgrowth of the energy system. Indeed, as introduced in the previous chapters, there is substantial evidence of rapid growth of decentralized energy sources to the point where it may become a challenge to existing energy institutions. However, in line with the above, a limitation can also be uncovered in the dynamic of optimality-based decision-making and decentralized green energy: when decentralized energy support and penetration reach a significant level, it interferes with the energy infrastructure and, more importantly in the context of this chapter, it uncovers limitations with the policy mechanisms that aim to support its growth. This requires a little more elaboration as is done in the following paragraphs.

Current efforts to support the rollout of renewable and decentralized energy have been extensively investigated in the literature. A particular dichotomy is maintained by many analysts – focusing primarily on feed-in tariffs (FIT) on the one hand and Renewable Portfolio Standards (RPS) on the other hand – and have found these two mechanisms to be effective (Mario & Simone, 2014; Sarasa-Maestro, Dufo-Lopez, & Bernal-Agustin, 2013; Avril, Mansilla, Busson, & Lemaire, 2012). A popular endeavor has been to try and determine the more successful policy platform out of the two and it is typically found that FIT outperforms RPS (Dong, 2012; Kwon, 2015). However, as was argued in a working paper by the author and colleagues, both platforms possess the same policy virtues that support renewable energy development (Taminiau et al., forthcoming), rendering the competitive exercise of RPS vs. FIT perhaps irrelevant vis-à-vis investigations that synthesize these virtues into policy platforms that are context-specific (see also Davies, 2012).

In light of the investigation presented in this chapter, a particularly poignant component of both policy mechanisms is their focus on enabling project development by addressing financial and transactional challenges that inhibit the procurement of clean distributed generation in conventional markets (Byrne, Taminiau, Kim, Seo, & Lee, 2015). Examples of such challenges are high transaction costs, insufficient market liquidity, and a lack of access to low-interest capital. In other words, both RPS and FIT seek to modify the existing enabling conditions for project development to occur – they just differ in their primary deployment method as one uses direct remuneration to ‘fill the gap’ (FIT) while the other obliges utilities to acquire renewables (RPS) and is often supplemented by market-based exchange platforms to ‘fill the gap’ (Byrne, Taminiau, Kim, Seo, & Lee, 2015). Critically, both mechanisms

thus rely on a project-to-project based development pattern and on project economics; the result is an inherently incremental development pathway (Byrne, Taminiau, Kim, Seo, & Lee, 2015). While both mechanisms have been able to facilitate the deployment of substantial amounts of renewable energy capacity, they are therefore unable to assure sizable market development and generally lack the capacity to pool projects into large investments. This can be evidenced by Germany's recent policy pull-back – significantly changing the policy circumstances in which projects are deployed, primarily in the form of a significantly reduced FIT payment structure, and motivated, among others, by the rising cost of maintaining a FIT program at ever increasing size – or by the 'boom and bust' cycle of energy support in the United States. For example, Figure 6.2 displays annual PV market growth in the German market. It can be seen that the 2010-2012 period experienced significant growth on the order of 7.5 GW/year. However, with the series of policy reforms starting in 2012, the market has responded with a dramatic pull-back of installations: 2014 growth is about 70% lower than annual growth during 2010-2012. Similarly, absent Congressional Action, the United States support pattern for clean energy technology is "falling off a cliff", experiencing a 75% total decline in spending from the 2009 high-point – which was primarily due to the American Recovery and Reinvestment Act of 2009 – to its 2014 level effectively establishing a similar 'boom and bust' curve (Jenkins, et al., 2012).

Infrastructure-scale deployment of energy will demand a large amount of resources, especially financial resources used to meet the up-front capital requirements. An impression of the challenge is offered by Wüstenhagen and Menichetti who offer this perspective on the issue: "while mobilizing private

investment is obviously not trivial, the true challenge policy makers are facing is not primarily about ‘paying a green premium’, but one of influencing strategic choices of those investors who will deploy capital anyway, and are selecting between opportunities in conventional and renewable energy projects” (Wüstenhagen & Menichetti, 2012, p. 3).

A focus on the governance of energy finance is required (Newell, 2011) – such a focus could integrate the perspectives of market, policy, and finance actors to materialize infrastructure-scale development of sustainable energy strategies (Byrne, Taminiau, Kim, Seo, Lee, 2015). Such a perspective can accelerate and strengthen the promise of polycentricity as it scales sustainable energy strategies such as energy efficiency and renewable energy to the infrastructure-level. In line with Newell’s conclusion relating to energy governance in the context of energy poverty and climate change (Newell P. , 2011), it appears that current policy structures are geared toward governance *for* energy finance rather than a focus on governance *of* energy finance. Focusing on setting the enabling conditions for project finance to occur, both policy platforms are unable to govern energy finance itself directly.

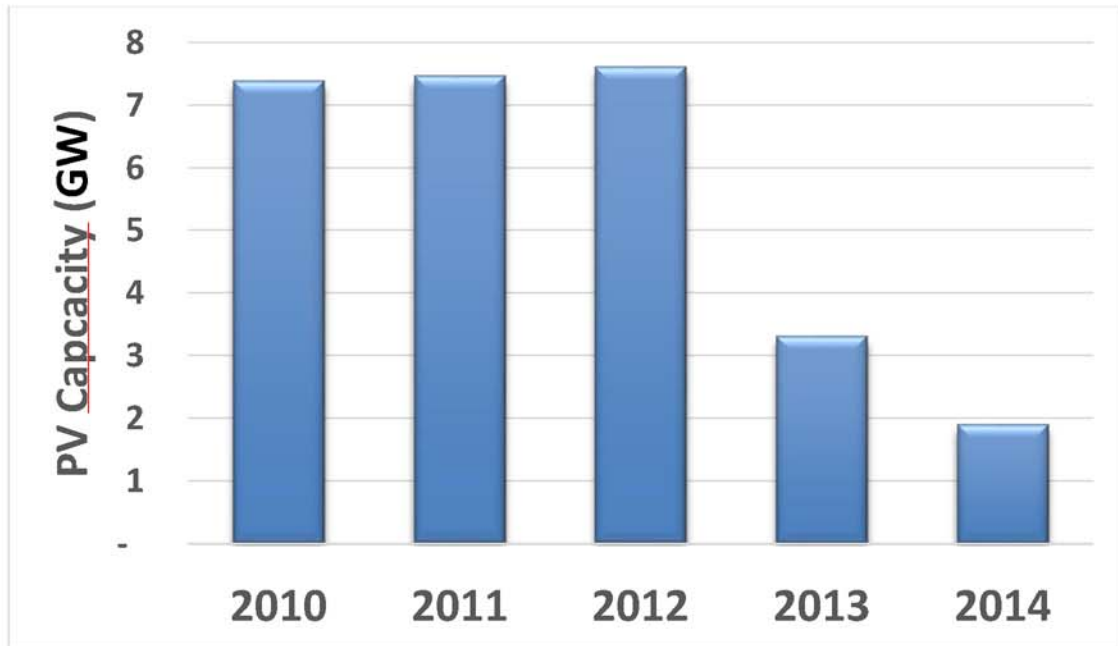


Figure 6.2; German annual PV growth.

A strategy where, like with the strategy introduced in the previous chapter, the commonwealth of the community is deployed in order to facilitate infrastructure level change in renewable energy along commons-based management might be more appropriate as it alters consumption-production relations to at least those of prosumers and, when coupled with energy saving strategies, those of sustainable citizens. Such a strategy could reposition public ownership of renewable energy generation technologies, rely on community participation rather than individualistic fragmentation, and provide energy for all (within, in the case of the strategy outlined below, municipal boundaries). The next sections introduce this strategy of the solar city and position it as a practical strategy potentially capable of moving society towards a sustainable energy future.

6.2 Literature review of urban PV potential assessments

Efforts to determine the generation potential of rooftop PV have been performed across various scales and regions. For instance, national assessments of potential have been calculated for various countries of the European Union, United States, Israel, Greece, Canada, Spain, Brazil, and Bangladesh (Defaix, van Stark, Worrell, & de Visser, 2012; Suri, Huld, Dunlop, & Ossenbrink, 2007; Denholm & Margolis, 2008; Paidipati, Frantzis, Sawyer, & Kurrasch, 2008; Vardimon, 2011; Izquierdo, Montañes, Dopazo, & Fueyo, 2011). Assessments of regional potential have also been conducted (Wiginton, Nguyen, & Pearce, 2010). In addition, small-scale assessments of neighborhoods or city blocks are also common and several assessments for city-wide potential have been conducted (Peng & Lu, 2013; Plunkett, Shipley, Hill, & Donovan, 2003; Bergamasco & Asinari, 2011; Bergamasco & Asinari, 2011; Ghosh & Vale, 2006; Karteris, Slini, & Papadopoulos, 2013; Kabir, Endlicher, & Jägermeyr, 2010; Zawilska & Brooks, 2011). For example, CEEP performed such a calculation for the City of Newark (Delaware; roughly 30,000 population) and arrived at the finding that 96 MWp could be installed (sufficient for over 75% of annual daylight electricity needs (CEEP, 2009).

Typically, these studies find considerable technical potential for rooftop PV: studies performed in the U.S., EU, Israel, Canada, Spain, Brazil, and Bangladesh find that widespread rooftop PV deployment could cover 15-45% of national electricity consumption (Defaix, van Stark, Worrell, & de Visser, 2012; Suri, Huld, Dunlop, & Ossenbrink, 2007; Denholm & Margolis, 2008; Paidipati, Frantzis, Sawyer, & Kurrasch, 2008; Vardimon, 2011; Izquierdo, Montañes, Dopazo, & Fueyo, 2011). For example, the technical deployment potential in the U.S. was estimated at 664 GWp,

the European Union at 951 GWp, and Canada at 73 GWp (Defaix, van Stark, Worrell, & de Visser, 2012; Denholm & Margolis, 2008; Pelland & Poissant, 2006).

Others calculate potential for, for instance, Hong Kong and the Greater London Authority (GLA) and find similarly impressive results. For instance, for the City of Hong Kong (over 7 million inhabitants), Peng & Lu (2013) assessed the technical rooftop potential at almost 6GWp (roughly 6 TWh/yr.), sufficient for 14.2% of the city's 2011 electricity consumption. In addition, they calculate that such an installation level corresponds to the reduction of about 3.7 million tons of GHGs and an energy payback time of 1.9-3.0 years (Peng & Lu, 2013). Similarly, for London, over 9.2 GWp could be deployed, sufficient to provide 19.2% of the city's total electricity needs (Doust et al., 2011).

The concept of the solar city draws its power from these assessments. In addition, the energy technology option has significantly advanced over the last decades, prices have fallen precipitously, and solar energy levels, even in locations with modest solar resources, provide substantial energy potential. Sophisticated tools to track the progress of PV installation in cities have been developed. These 'solar maps' document existing and/or planned PV installations within the area, promote the fact that PV is a tangible and valuable option by providing insight into its yield in each location, and assist businesses and residents to design and implement ambitious installations.

6.2.1 Assessment methodologies

Calculating PV potential of an urban landscape is challenging due to the elevations, densities, and various urban morphologies (e.g., high-rise buildings, sloped roofs, etc.) and often compounded by a lack of advanced data. A host of

methodological approaches have been put forth but these can be grouped into three primary sets (Schallenberg-Rodriguez, 2013). Depending on data availability, scale of the study area, and other resources, these categories can be described as follows (Byrne, Taminiau, Kurdgelashvili, & Kim, 2015):

- **Sample Methodology:** estimating the available rooftop area by sampling a sub-set of the urban fabric and then extrapolating to the total area. The method has been used by, e.g., Izquierdo et al. (2011) and is especially suitable for large regional assessments (Schallenberg-Rodriguez, 2013). Some level of accuracy is sacrificed usually due to a lack of access to advanced data that covers the city/region.
- **Multivariate Sampling-Based Methodology:** this approach draws correlations between population density and available rooftop area and includes (many) additional variables to advance specificity compared to the regular Sample Methodology. The method, relying still on samples and other relatively easily accessible data, is generally seen as requiring relatively low resource loads. However, due to the inclusion of additional variables, can be more time consuming.
- **Complete Census Methodology:** This methodology seeks to compute the entire rooftop area in the study region. Existing statistical datasets that contain building-based information (e.g., floor area, number of floors, number of buildings, etc.) but is increasingly applied using advanced cartographic data sets (usually through advanced software such as Geographic Information Systems (GIS)). Typically, such cartographic data sets allow for the computation of each single rooftop in the study region. This method pathway theoretically provides the most accurate results as it includes the entire building stock – assuming that all assumptions and preconditions going into the study are accurate.

6.3 Application of the Solar City concept to the City of Seoul

In any case, at the heart of any methodological approach to determine city-wide urban rooftop PV potential are two key steps that will need to be navigated: a) an

estimate of the entire roof area needs to be calculated, and b) the suitability of this area will need to be determined in light of PV requirements. Byrne, Taminiau, Kurdgelashvili, & Kim (2015) offer an outline of how to arrive at estimates of Solar City applications and applied it to the City of Seoul (Korea), briefly summarized in the next section.

6.3.1 Determining Available Rooftop Area in Seoul

For the City of Seoul, up-to-date cartographic information was unavailable. Instead, total floor space data from the Korea Statistical Information Service (KOSIS) was used. Table 6.1 reports the floor space estimates per building type. A total floor space of roughly 605 km² is calculated. However, the vertical nature of a city like Seoul, naturally, needs to be accounted for (Table 6.2). Looking at the city's building stock by floor, an estimate of the total number of floors can be calculated (Table 6.2) and an average area per floor allows for an estimated 187 km² of total rooftop area in the City of Seoul (Table 6.3). Byrne, Taminiau, Kurdgelashvili, & Kim (2015) show how a triangulation of the estimated 187 km² was performed using outdated (2002) cartographic information: by calculating both methods using 2002 data, they show that the method outlined in this paragraph only overestimates at about 4% compared to using advanced software and calculations.

Table 6.1; Seoul number of buildings and floor space. 2012 data from KOSIS

	Total	Dwellings	Comm.	Ind.	Educational/ social	Other
Nr. of Buildings	646,891 (100%)	494,704 (76.5%)	129,391 (20%)	3,117 (0.5%)	15,562 (2.4%)	4,117 (0.6%)

Floor space (000m ²) ^a	605,444 (100%)	277,018 (45.8%)	157,171 (26.0%)	9,457 (1.6%)	51,181 (8.5%)	110,618 (18.3%)
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a. Numbers do not sum due to rounding. For full numbers, please see Byrne, Taminiau, Kurdgelashvili, & Kim (2015).

Table 6.2; Number of floors in the city of Seoul. 2012 Data from KOSIS

	Total	1 floor	2-4 floors	5 floors	6-10 floors	11-20 floors	21-30 floors	≥31 floors
Nr. of Buildings (000s) ^a	647 (100%)	144 (22%)	414 (64%)	50 (8%)	21 (3%)	13 (2%)	3 (1%)	0.2 (0%)
Calculation to get floor space	sum	x 1	x3	x5	x8	x15	x25	x50
Nr. of floors (000s) ^a	2,094 (100%)	144 (7%)	1,243 (59%)	250 (12%)	169 (8%)	201 (10%)	74 (4%)	12 (1%)

a. percentages and numbers do not sum due to rounding. For full numbers please see Byrne, Taminiau, Kurdgelashvili & Kim (2015).

Table 6.3; Estimated rooftop area for the city of Seoul.

Total area of all buildings (m ²)	Total floors of all buildings (est.)	Average area per unit floor (m ² /floor)	Total rooftop area (m ²)
605,444,189	2,093,850	289	187,050,838

6.3.2 From total rooftop area to suitable area

A common approach to calculate suitable area from total rooftop area is to use utilization factors. From the literature it becomes clear that a wide range of utilization factors are in use (Byrne, Taminiau, Kurdgelashvili, & Kim, 2015). These factors determine the portion of the total rooftop that is typically open and available to PV installation. Using NREL data from Denholm & Margolis (2008) and Lopez et al. (2008), the calculation for a Seoul Solar City relied on a 60% availability factor for

commercial, industrial, education/social, and public/agro-fisherey building types while a 39% factor was used for residential to account for their typically slightly less attractive rooftop real estate. This latter number is in line with Peng & Lu (2013) who used 39% for the City of Hong Kong, supported by on-the-ground analysis of several case study buildings. Like Seoul, Hong Kong is a mega-city with a similar high-rise architecture. The results of these assumptions are provided in Table 6.4. Byrne, Taminiau, Kurdgelashvili, & Kim (2015) further use several Seoul-specific restrictions (particularly, the widespread use of heliports in the city) and Table 6.4 records their results, finding that the suitable area for PV system configurations is 89.5 million m².

Table 6.4; Suitable rooftop area by building type. ^a

	Res.	Comm.	Industrial	Ed./Soc.	Pub./Other	Total
Total area of buildings (m ²)	277,017,527 (45.8%)	157,170,562 (26%)	9,457,290 (1.6%)	51,180,728 (8.5%)	110,618,082 (18.3%)	605,444,189 (100%)
Total rooftop area (m ²)	85,584,041 (45.8%)	48,557,548 (26%)	2,921,812 (1.6%)	15,812,189 (8.5%)	34,175,247 (18.3%)	187,050,083 (100%)
Suitability factor (%)	39%	60%	60%	60%	60%	50%
Suitability area (m ²)	33,377,776 (35.4%)	29,134,529 (30.9%)	1,753,087 (1.9%)	9,487,314 (10.1%)	20,505,148 (21.8%)	94,267,854 (100%)
Suitable area after Heliport/other set aside (5%)	NA	NA	NA	NA	NA	89,544,961 (100%)

a: Building types are those developed by the Korean government and reported by KOSIS. Education/Social category includes schools, universities, hospitals, etc. Public/Other includes indoor markets for fishery products, vegetables and fruits, and forest products.

6.3.3 From suitable area to PV system installment

Finally, the method designed by Byrne, Taminiau, Kurdgelashvili, & Kim (2015) provides for the final step by determining PV system installation potential. To do so, the method includes additional considerations such as panel-to-panel shading

and service and maintenance requirements. In addition, a final assumption needs to be made about the efficiency of the solar PV system. Current module efficiencies sold in the market vary between 14% and 23% (Wang, Byrne, Kurdgelashvili, & Barnett, 2012; Barbose, Darghouth, Weaver, & Wiser, 2013; European Photovoltaic Industry Association, 2013). The obvious purpose of preparing a technical potential estimate for rooftop PV for the city is to enable analytical consideration of large-scale deployments.⁵⁵ If the city embarked on a strategic plan to make best use of its PV-available roof area, PV module manufacturers and vendors would likely lower bid prices in order to participate in large-volume market opportunities.⁵⁶ Therefore, a module efficiency at the upper end of the current market – 20% is used for the calculation.

The results are provided in Table 6.5.

⁵⁵ Different technologies exist to convert sunlight to electricity. Two options have relevance for this study: flat plate photovoltaic (PV) and concentrating PV (CPV). To increase the electricity generated from a given roof area, one could consider the use of CPV. However, as Wang et al. (2012) note, important limitations exist with CPV technology. Especially, additional cost due to, among others, high-accuracy tracking requirements, material specifications, and direct beam dependency lead to our focus on PV flat panel for the present analysis. Wang et al. (2012) demonstrate that module costs for CPV need to be considerably lower compared to flat plate PV for the same target Levelized Cost of Electricity (LCOE).

⁵⁶ The case study assumes deployments would occur annually for a part of the available roof area. It is likely the plan would need to be 10 years in length – the same length of time currently used by the Korea national government to plan thermal and nuclear power plant additions.

Table 6.5; Rooftop area available by use after accounting for GCR and SA.

Tilt	GCR (%)	SA (%)	Available roof space (m ²)					Total
			Res.	Comm.	Ind.	Ed./ Soc.	Pub./ Other	
0	100%	20%	25,367,110	22,142,242	1,332,346	7,210,358	15,583,913	71,635,969
5	80%	17%	19,927,754	17,394,380	1,046,657	5,664,273	12,242,324	56,275,388
10	66%	13%	16,830,650	14,691,005	883,989	4,783,951	10,339,664	47,529,259
15	57%	10%	15,027,686	13,117,248	789,293	4,271,476	9,232,039	42,437,743
20	51%	7%	14,016,731	12,234,813	736,195	3,984,122	8,610,973	39,582,834
25	46%	3%	13,527,451	11,807,734	710,497	3,845,049	8,310,392	38,201,123
30	42%	0%	13,401,753	11,698,016	703,895	3,809,320	8,233,171	37,846,154

Table 6.6; Technical potential for PV deployment in the city of Seoul at 20% module efficiency.

Tilt	Gen. (MWh/ MWp) ^a	Res. MWp (GWh)	Comm. MWp (GWh)	Ind. MWp (GWh)	Ed./Soc. MWp (GWh)	Pub./Other MWp (GWh)	Total MWp (GWh)
0	1228.61	5,073 (6,233)	4,428 (5,441)	266 (327)	1,442 (1,772)	3,117 (3,829)	14,327 (17,603)
5	1267.31	3,986 (5,051)	3,479 (4,409)	209 (265)	1,133 (1,436)	2,448 (3,103)	11,255 (14,264)
10	1299.13	3,366 (4,373)	2,938 (3,817)	177 (230)	957 (1,243)	2,068 (2,687)	9,506 (12,349)
15	1326.07	3,006 (3,986)	2,623 (3,479)	158 (209)	854 (1,133)	1,846 (2,448)	8,488 (11,255)
20	1346.65	2,803 (3,775)	2,447 (3,295)	147 (198)	797 (1,073)	1,722 (2,319)	7,917 (10,661)
25	1360.77	2,705 (3,682)	2,362 (3,214)	142 (193)	769 (1,046)	1,662 (2,262)	7,640 (10,397)
30	1368.34	2,680 (3,668)	2,340 (3,201)	141 (193)	762 (1,042)	1,647 (2,253)	7,569 (10,357)

a: conversion parameter derived from Seoul meteorological data and calculated with PV Planner software.

6.3.4 Pursuing a Seoul Solar City

Table 6.7 summarizes the assessment of technical potential for rooftop PV for Seoul. At a five degree tilt, the city could install 11,255 MW_p of PV (14,26 TWh). The assessment finds that about 30% of the total rooftop area can ultimately be technically

useful for solar PV installations with the majority share on residential and commercial rooftops.

Table 6.7; Summary of Study Findings.

2012 Population (Millions)	10.5
2012 City Electricity Use (TWh)	47.23
2012 City Peak Demand (GW)	10.1
Solar Potential Electricity Supply (TWh)	14.26
Potential of Rooftop Solar Supply as a % of City Total Electricity Use (all hours)	30%
Potential of Rooftop Solar Supply as a % of City Total Electricity Use (daylight hours)	65.7%
Solar Potential Total Capacity (GW _p)	11.255
(Seoul Rooftop Solar Potential in GW _p) ÷ (Seoul Peak Demand)	1.11
Solar Potential Peak Shaving during noon – 2 pm for typical August weather	> 50%
Seoul Solar Supply during noon – 2 pm for typical May weather	>95%

The technical potential assessment demonstrates the significant promise of the Solar City concept for the city of Seoul. At a 2012 electricity use of 47.23 TWh, the 14.26 TWh solar electricity generated under a five degree regime for Seoul Solar City is estimated to be 14.26 which is equivalent to 30% of the city's electricity consumption and allow the city to power 66% of its daylight needs from 9 am to 6 pm (Table 6.7). The 11.255 GW_p distributed solar power plant would correspond to over 110% of the peak load demand of Seoul (KEPCO furnished an estimate of 10.1 GW peak demand to CEEP for 2012). Naturally, socio-economic factors and policy context will constrain the realization of all of this potential.

Peak shaving during daylight hours would be an important contribution of Seoul Solar City. To illustrate this point, data from the Korea Electric Power Corporation (KEPCO) was used to calculate peak shaving potential for the city of

Korea. However, the available electricity demand data from KEPCO was grouped in three blocks – 9 am to 6 pm, 6 pm to 11 pm, and 11 pm to 9 am – complicating the assessment of peak shaving benefits due to averaging of electricity demand. Also, the load profile of the city during these hours would need to be defined, raising another complication in determining the peak shaving effect. An attempt was made to approximate Seoul city's daylight load curve from 10 am to 5 pm to demonstrate the potential contribution of PV for peak shaving purposes. The analysis is based on the assumption that the city's load profile resembles that of a large hotel, a conservative approach to a complex question which requires detailed spatio-temporal data to properly determine impact. Still, the elementary analysis is instructive: for a typical May in Seoul, three-quarters of all hourly electricity needs of this busy city between 9 am and 4 pm, and over 90% of consumer needs between noon and 2 pm could be serviced by a Seoul Solar City. More than one-half of its hourly needs between noon and 2 pm during typical weather for the months of February, August and November could be furnished by the distributed solar plant located on a portion of the city's rooftops.

Because August is often the peak month for electricity use, this finding of rooftop PV's potential has special significance. Most of the power plants serving Seoul are located nearly 1,000 km south of the city. Seoul Solar City could materially decongest the transmission and distribution (T&D) system during peak hours of the peak month, thereby improving performance of the electric grid, extending the life of key T&D equipment, and improving reliability during one of the most vulnerable periods of grid service. When monetized, these system benefits could greatly enhance the cost-effectiveness of Seoul Solar City. Early work on the topic suggested that

system benefits alone could offset initial capital costs by more than 30% (Perez, Zweibel, & Hoff, 2011).

6.3.5 Solar City Potential Around the World

Using the methodology described above, the same kind of calculation can be performed for a range of additional locations to highlight the significant potential of the concept. Byrne, Taminiau, Kim, Seo, & Lee (2015) calculated the potential for 5 additional municipalities, the results of which are provided in Figure 6.1 (they used slightly different numbers leading to slightly different results for Seoul). Clearly, the Solar City concept shows much promise (Table 6.8 and Table 6.9).

Table 6.8; Suitable rooftop area for PV implementation. Source: Byrne, Taminiau, Kim, Seo, & Lee (2015).

City	Pop. (millions)	Pop. Density (thousand/ km ²)	Total rooftop space available (million m ²)	Suitable space (million m ²)	Suitable rooftop area m ² /capita
Amsterdam	1.08	6.7	22.0	11.0	10.2
London	3.1	10.0	74.9	34.9	10.9
Munich	1.4	4.5	40.2	18.7	13.4
NYC	8.4	10.7	181.9	83.5	9.9
Seoul	9.8	16.2	187.1	89.5	9.2
Tokyo	9.0	14.5	204.3	96.4	10.7
Total	32.8		710.4	334	

Table 6.9; Rooftop area (million m²) after accounting for GCR and SA at different tilt angles. Source: Byrne, Taminiau, Kim, Seo, Lee (2015).

City	Tilt (degrees)						
	0	5	10	15	20	25	30
Amsterdam	8.8	6.9	5.8	5.2	4.9	4.7	4.6
London	27.9	21.9	18.5	16.5	15.4	14.9	14.7
Munich	15.0	11.8	9.9	8.9	8.3	8.0	7.9
NYC	66.8	52.5	44.3	39.6	36.9	35.6	35.3
Seoul	71.6	56.3	47.5	42.4	39.6	38.2	37.8
Tokyo	77.1	60.6	51.2	45.7	42.3	41.1	40.8
Total	267.2	210.0	177.2	158.3	147.4	142.5	141.1

Infrastructure-scale strategies capable of delivering on the solar city vision can expect significant impacts. Figure 6.1 indicates the technical potential for PV deployment in the six case study cities. Such a deployment would accrue benefits associated with decentralized and distributed energy architectures such as grid decongestion during peak demand periods, location flexibility to address ‘hot spots’, energy supply tailoring to customer load demand, and avoided costs for additional power and/or transmission. In brief, city-wide deployment of PV offers the potential of substantial energy independence, city leadership, and energy democratization.

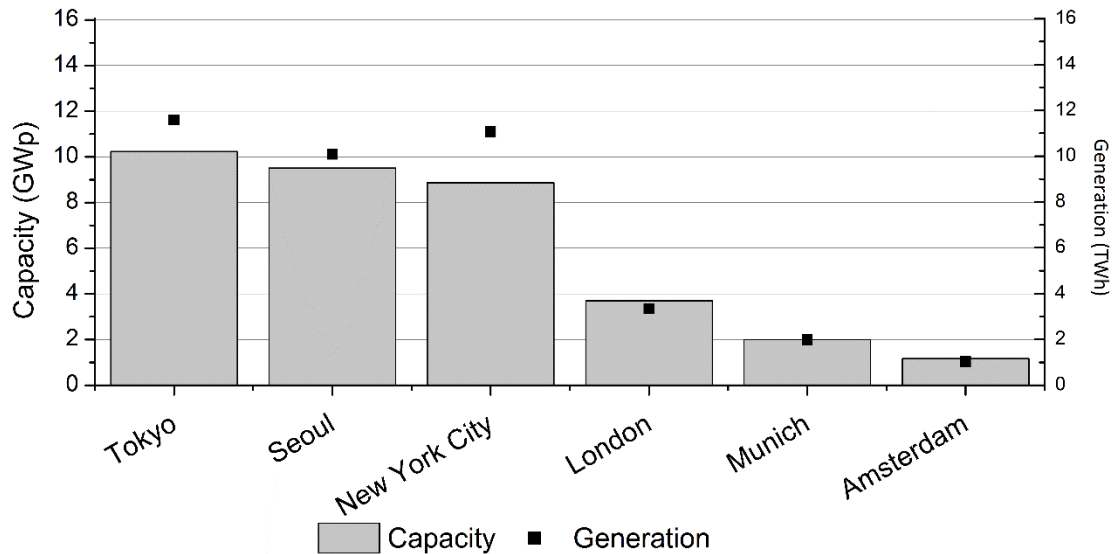


Figure 6.3; Overview of the solar city potential in six municipalities around the world using the methodology developed by Byrne, Taminiau, Kurdgelashvili, & Kim (2015). Source: Byrne, Taminiau, Kim, Seo, & Lee (2015).

One way to put the findings into perspective is to contrast these outcomes with national expectations for solar energy development. Based on the assumption that 30% of the solar city can be completed by 2020 with the right financing and policy strategy in place, Table 6.8 shows that a Solar City strategy in many cases exceeds the national installation of PV on a per capita basis. However, from Table 6.8 it also becomes clear that both Germany and Japan – two nations that have aggressively pursued solar energy – are expected to realize higher per capita numbers at the national level in part due to their already high installed PV capacity levels. Table 6.8 also reports a more limited application of the solar city strategy, focusing on commercial rooftops including those of public agencies, schools, and hospitals.

Table 6.10; Comparison of solar city applications and national projections for PV market development. Source: Byrne, Taminiau, Kim, Seo, & Lee (2015).

City	Pop by 2020 (millions)		Solar City by 2020				Year 2020 National comparison	
	City	National	30% of C&P buildings		30% all buildings		GWp	Wp/cap
			GWp	Wp/cap	GWp	Wp/cap		
Amsterdam	1.14	17.0	0.11	92	0.35	307	4.0	238
London	3.3	66.0	0.33	101	1.11	337	10.0	152
Munich	1.50	80.1	0.18	119	0.60	397	52.2	652
New York	8.33	333.8	0.8	96	2.66	319	45.0	135
Seoul	9.82	51.4	0.86	87	2.85	290	4.4	86
Tokyo	9.16	123.5	0.92	101	3.07	335	48.8	395
Total	33.25	671.8	3.2	99	10.64	331	164	276
				(avg)		(avg)		(avg)

6.4 Realizing the solar city application

The above sections describe initial findings of substantial promise for several cities around the world. However, keeping in mind the globally relevant multi-trillion dollar infrastructure investment gap described in the previous chapter, practical challenges for cities to mount a city-wide strategy of these kinds of proportions exist that will need to be overcome. In particular, practical strategies for solar city implementation will require a funding flow capable of materializing PV deployment at the GWp scale. To that end, this section briefly evaluates a) the capital availability for cities, b) the revenue sources commonly deployed by cities to raise additional capital, and c) a new, innovative, pathway for low-cost capital access using the commonwealth resource of the city (its rooftop generation capacity as an asset) in a green bond strategy. First, however, this section takes a brief look at climate and energy policy in relation to solar finance.

6.4.1 Lack of capital by cities

As briefly introduced earlier in the manuscript, the global Urban Climate Change Governance Survey (UCGS) highlighted the critical importance of financial support for urban climate change action, mitigation as well as adaptation (Aylett, 2014). A dissertation performed here at the Center for Energy and Environmental Policy (Argyriou, 2014) similarly outlines how the City of Philadelphia (U.S.) struggles to find access to low-cost capital. Indeed, Argyriou (2014) lists this as one of the key challenges that cities will need to overcome to support their efforts to transition to a solar city.

In addition, up-scaling the action by cities will further pressure already strained public budgets: local governments in OECD countries currently take responsibility for 70% of public investment and 50% of public spending in environment (OECD, 2010). Pressure on the public budgets of local governments, moreover, will worsen as costs related to adaptation will increase in the face of global inaction, costs of mitigation will increase as cities vie for positions for urban climate change leader, and cost related to price rises in carbon-intensive products will increase as mandatory and voluntary markets seek to internalize the carbon externality. This consideration is further compounded by the chronic infrastructure ‘funding gap’ that demonstrates the lack of financing currently readily available to governments to correct infrastructural deficiencies (American Society of Civil Engineers, 2013; Ehlers, Understanding the challenges for infrastructure finance, 2014).

Other potential constraints to city climate change planning can be: a) the significant decline in sub-national investment, b) the lower credit rating of local governments vis-à-vis the national government, c) and sovereign borrowing constraints further limit the ability of cities to increase public investment (OECD,

2014b). As a result, effective climate change action at the urban level on the long-term, i.e. moving beyond current assessments of climate change action, will require a restructuring of the enabling environment. For instance, national policies could create the conditions for carbon pricing, property rights protection through sound investment policies, leverage additional finance by supplementing local capital markets with low-interest loans, loan guarantees, green bonds, or through green investment banks, or by providing training to enhance capacity of local governments to access private capital markets (OECD, 2014b).

6.4.2 Revenue Sources available to cities

Cities have various pathways available to them to raise revenue. Critically, urban taxation can be seen as the “most important revenue source for cities” in the OECD (OECD, 2010) (Figure 6.2). Indeed, many cities use taxation strategies to address climate change (OECD, 2010). A prominent example is the use of property taxes to influence land use patterns and development. Nonetheless, the OECD reports that there is substantial potential for sub-national ‘greening’ of the taxation system as most taxation restructuring to account for environmental degradation has occurred at the national level in part to minimize geographic distortion across regions (OECD, 2010). Similarly, grants, fees, and other options are available to cities to address climate change. A prominent example of local charges being applied to address environmental conditions is London’s congestion charge (Beevers & Carslaw, 2005).

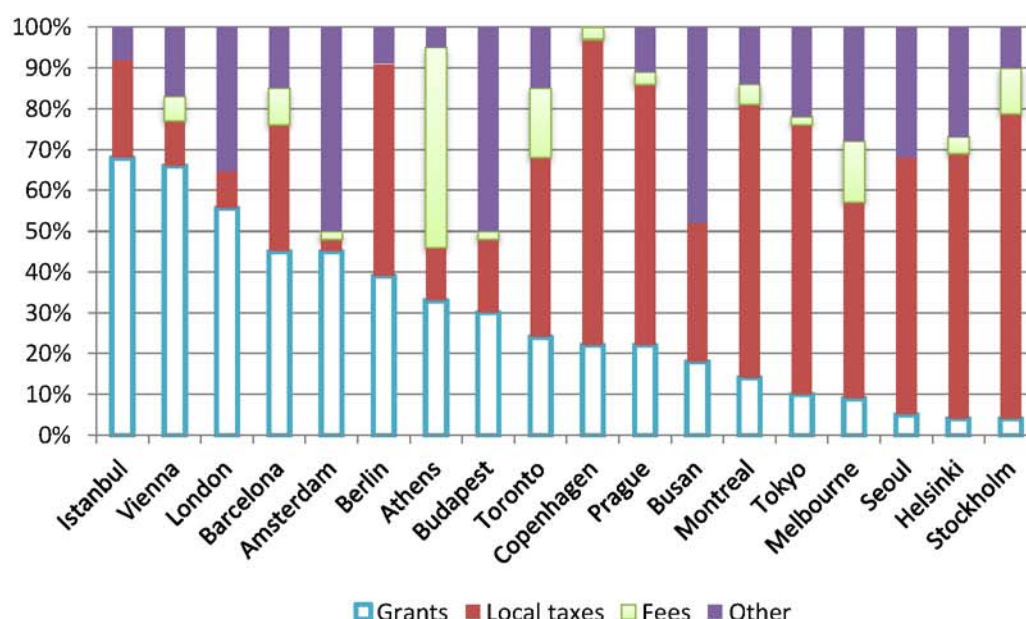


Figure 6.4; Overview of city revenue sources across the OECD. Taxes and grants together account for the majority of revenue sources in this sample. Source: OECD, 2010.

6.4.2.1 A Particular Note on Cities in Developing Countries

A particular obstacle for cities in developing countries relates to the early stages of access to capital: low or non-existing creditworthiness ratings substantially limits the capacity of these cities to attract additional financing. For instance, under the auspices of its *City Creditworthiness Program*, the World Bank estimates that only about 4% of the 500 largest cities in developing countries are able to access international financial markets (World Bank, 2013). Similarly, only about 20% of these cities have access to local capital markets (World Bank, 2013). This will be, according to the World Bank, a “first key step” to get the finance flowing and close the funding gap. Such efforts can potentially come with substantial rewards: for every dollar invested in efforts to enhance creditworthiness, the World Bank expects to be

able to leverage over \$100 in private sector financing. It is expected that programs like those by the World Bank will produce a more favorable investment climate in cities in developing countries. Such improvements might make these cities suitable for the solar city financing strategy outlined in subsequent sections.

An additional option available to cities in developing countries is to access the carbon market for financing. Several analysts have investigated this option (Marr & Wehner, 2012; Clapp, Leseur, Sartor, Briner, & Corfee-Morlot, 2010; The World Bank, 2010). For instance, Marr & Wehner (2012) investigate the application of the CDM (single, bundle, and PoA versions) in an urban context. A key struggle that Marr & Wehner identify in this context is that the CDM project boundary definition is typically very narrowly defined and, in general, the CDM option is too project focused – they recommend exploration of city-wide CDM projects structured in Programme of Activities (PoA) to be placed within the newly emerging NAMA context. They note, however, that such a strategic application of urban CDM projects will be dependent on the willingness of industrialized countries to provide long-term, multi-million dollar budgets. A similar line of reasoning is presented by the World Bank (2010) on the topic, arguing for a modification of the PoA option to more fully be able to account for city-wide applications. A role could be played in this matter by new sectoral market mechanisms. On the same topic, Clapp et al. (2012) note how urban application of the CDM project is “extremely limited”. They link this underrepresentation to the difficulty for cities to enter the carbon market and the difficulty of setting up urban mitigation projects (Clapp et al. 2012). Noting that CDM can more appropriately be positioned as a supplementary source of income for urban projects, Clapp et al. (2012)

stress the importance of the following challenges when CDM/JI is applied in urban contexts:

- Financial and budgeting challenges due to, in part, high start-up costs and project failure risks. Critically, carbon finance pathways only deliver financial support after the project is completed. Start-up costs, such as technology procurement, will need to rely on other financing sources.
- Overlapping jurisdictions of GHG emitting sources;
- Lack of knowledge about carbon market possibilities among urban governments or local stakeholders;
- Specific capacity limitations to develop, monitor, and implement projects along CDM requirements;
- High transaction costs associated with the long timeframes of urban projects;
- High complexity in administration;
- The typically smaller size of urban projects compared to other projects in the CDM pipeline;
- Potential underperformance in terms of carbon reductions verified and Certified Emission Reductions (CERs) ultimately delivered. Some projects received less than half of the expected credits;
- Political contexts that dissuade carbon market projects.

6.4.3 Green bonds and climate bonds

As noted by Byrne, Taminiau, Kim, Seo, & Lee (2015), the repositioning of renewable energy options like PV away from their current conceptualization as ‘decentralized’ and ‘add-on’ and towards one of infrastructural development can be a useful way to consider the integration of policy, finance, and markets. Similar to the

roll-out of the modern energy economy, this would entail a public commitment to development of PV as integral components of infrastructure development.

However, this positioning introduces additional considerations above and beyond the project-to-project based character of current PV development. Similar to the energy efficiency barriers introduced in Chapter 5, significant up-front capital costs, long-term investment horizons, opaque project risks, irreversible and possibly illiquid investment and the ‘public good’ character of these investments need to be taken into account. Answers to the infrastructure ‘funding gap’ point to private finance (High level expert group on SME and infrastructure financing, 2013; OECD, 2014a; Croce, Kaminker, & Stewart, 2011), motivated by the realization that institutional investor represent over \$92 trillion in assets and have an investment portfolio congruent with long-term investments and are climate sensitive (OECD, 2014b; Mercer, 2011). However, so far, portfolios of investors such as pension funds and insurance companies are only limitedly directed at infrastructure as an asset class despite the large funding potentials and observed high levels of interest (OECD, 2013; UNEP, 2014).

An intriguing development in the capital markets has been the emergence of ‘green’ and ‘climate’ bonds. Pioneered by supranational organizations and agencies like the World Bank, this fledgling market has rapidly expanded since its 2007 inception and 2014 performance was particularly boosted due to the increased issuance of municipal and corporate green bonds. Indeed, in 2014, so-called ‘climate bonds’ and ‘green bonds’ markets issued \$36.6 billion and the total market is now estimated at \$502 billion (Climate Bonds Initiative, 2014; HSBC, 2014; Bloomberg New Energy Finance, 2014). Figure 6.3 presents an estimate of the infrastructure gap

for electric power at a \$12.2 trillion deficiency and the rapid growth of the green bond market. The potential of the bond market for climate change and development strategies is further underscored by the estimate that the *total* bond market (at \$100 trillion in outstanding debt) is significantly larger than the estimated \$63 trillion equity market (Climate Bonds Initiative, 2014; HSBC, 2014; Bloomberg New Energy Finance, 2014). In addition, the ‘green’ and ‘climate’ bond market is expected to grow considerably (Climate Bonds Initiative, 2014; HSBC, 2014; Bloomberg New Energy Finance, 2014). Highlighting municipal bond issuances made in the past years emphasizes the importance and potential even more:

- Massachusetts issued the first labeled green bond by a municipality (\$100 million);
- Gothenburg issued a \$79 million (SEK500 million) bond;
- The City of Johannesburg (South Africa) issued a \$136 million bond (ZAR1.45 billion); and
- The State of Delaware in the urban belt of the east coast of the U.S. issued a \$73 million bond (see Chapter 5).

While the green bond market is new and faces some challenges – in particular, the industry is seeking a widely accepted definition of what can be called ‘green’ as many different definitions are now in effect (Veys, 2010) – substantial benefits can be expected from the move towards the bond markets as a financing strategy (OECD, 2014a):

- Bonds represent standardized capital market instruments, enhancing the liquidity of the instrument particularly for sufficiently large issue sizes. Additionally, large issue sizes can be included in bond indices further enhancing investor attractiveness.
- A wide target audience is available in the bond market.

- Bonds can be issued with long maturities, further enhancing their profile for the long-term investor.
- A well-structured bond can attract low-cost financing and maintain less stringent covenants.

A PV strategy like that of the solar city concept, moreover, represents an long-term ‘asset- backed’ offering where, once installed, a low-post completion risk profile and a steady cash flow of returns (perhaps complemented by carbon markets) can be expected further showcasing the advantage of a bond approach (OECD, 2014a; Ehlers, Packer, & Remolona, 2014b; Moody's Investor Service, 2014):

- Cumulative default rates tend to be lower for bond financing than other debt financing at longer timescales;
- Default recovery rates are higher for bonds;
- Bonds display significantly more stable credit ratings;
- *Standardization of payment structures:* the coupon structure of bonds and end-of-life bullet repayment of bonds is more familiar to (institutional) investors;

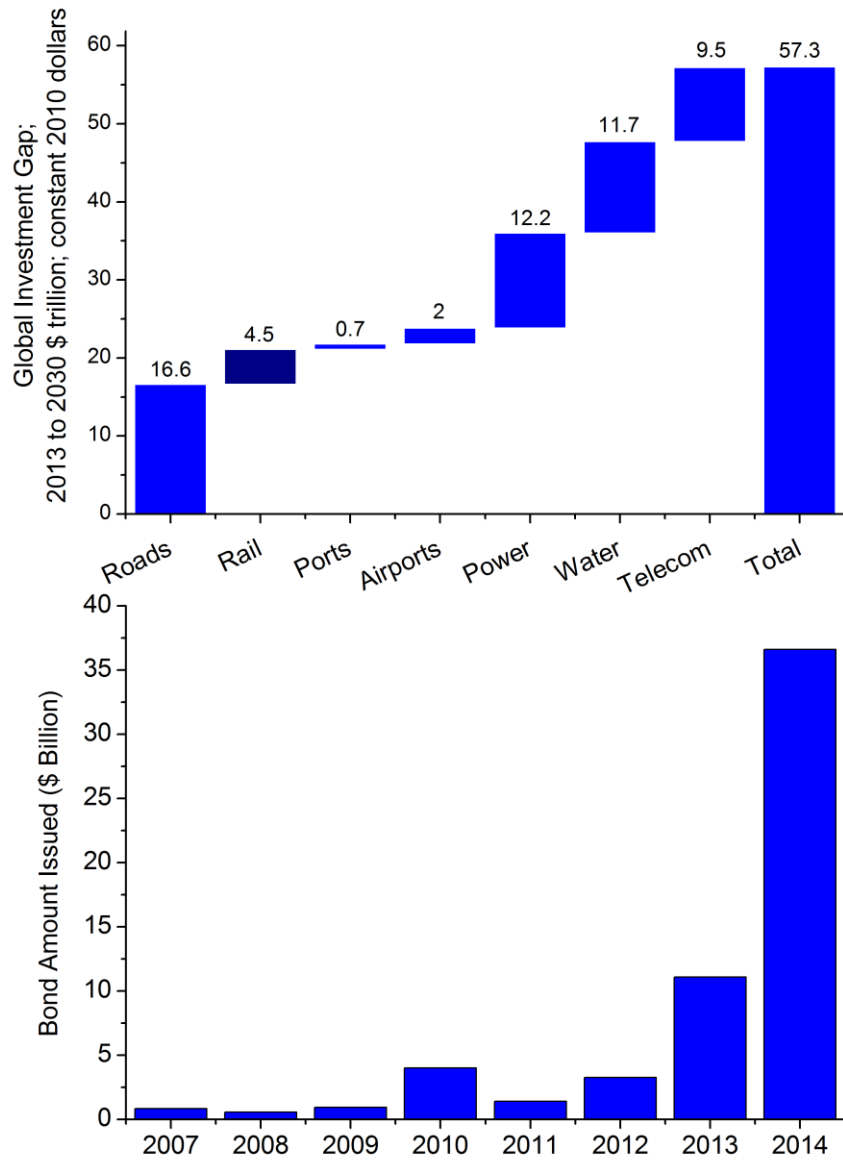


Figure 6.5; Investment gap for power at \$12.2 trillion globally (top) (Dobbs, et al., 2013) and the rapid increase in the use of green bonds (bottom) (Climate Bonds Initiative, 2014; HSBC, 2014; Bloomberg New Energy Finance, 2014).

6.5 Exploring Investment in the Solar City Concept

The positioning of PV development in the urban context at the infrastructure scale represents a strategy of social progress that includes the architecture of not only policy development but institutional change and designs new governance models to implement a transition to a renewable energy future. A ‘solar city’, in this context, is a public sector-led, infrastructure-scale design and investment strategy.

Governments and public authorities can significantly influence the underlying infrastructure investments that make energy investments possible (World Bank, 2010, p. 261; IEA, 2014b, p. 278-279). The fact of their influence opens up the possibility to leverage these institutional actors and the assets they govern to expand opportunities for large renewable energy investment. Combining control of infrastructure with the role of sovereign pledges on creditworthiness, solar cities can attract private capital for investments in renewables which considerably enhances acceptance of the major innovations needed to realize a genuinely low-carbon social development pathway. The next sections explore such a pathway, trying to address conceptual challenges while exploring practical steps available to local governments to realize solar city status.

6.5.1 Finance Conditions in the Case Study Cities

The challenge for an infrastructure-level strategy for municipal PV begins with the analysis of a viable economics for the option, including possible policy framework needs. As Veys (2010) points out, only relying on the “green” character of the bonds substantially limits the audience for the capital offering to, for instance, socially responsible investment (SRI) and ethical funds. Access to the broader capital markets will be necessary to substantially accelerate the mass-deployment of renewable energy

options. To do so, cities are actively exploring options. In September 2014, New York City, for instance, launched its Green Bond Program in order to expand the investor base available to the city, to create a model for other municipalities across the U.S. to reproduce, and to encourage a greener capital character for the city (Stringer, 2014). Tokyo, similarly, is to benefit from a green bond program launched by the Development Bank of Japan as this \$315 million bond issuance at 0.25% and three year maturity will help finance green projects in the city – indeed, as an indication of significant investor interest, the bond was over three times oversubscribed.⁵⁷

The cost of capital is a critical consideration in the option for solar city financing. To assess the cost-of-capital, bond yield curves were established for each city (Figure 6.4) (Byrne, Taminiau, Kim, Seo, & Lee, forthcoming). The bond yield curve is created by evaluating relevant (sub-)national bond issuances during 2013 and 2014 to offer representative cost of capital estimates. A detailed description of the process can be found in Byrne, Taminiau, Kim, Seo, & Lee (forthcoming) but a few points are important to realize.

First, the bond yield curve for the City of London depends on a central government agency called the Public Works Loan Board (PWLB). Subnational governments, like the City of London, can borrow money from this agency which, in turn, garners its capital from the bond market. As a result, interest rates are inflated and centrally determined by the Treasury (Cox & Schmuecker, 2013). In particular, a recent interest hike has spurred investigation and interest in forming a subnational municipal finance bond agency with bond authority (Cox & Schmuecker, 2013).

⁵⁷<http://www.climatebonds.net/2014/10/development-bank-japan-issues-green-property-bond-eur-250m-315m-coupon-025-3yr-aa3a-3x> (Accessed March 7, 2015)

However, PWLB loan data for the City of London was used to construct the yield curve.

Second, due to relatively low frequency and relatively low issuance volume, the bond yield curve for Germany was constructed using national 2013-2014 data supplemented with several past issuances in Bavaria, Berlin, Hamburg, and Bremen (Byrne, Taminiau, Kim, Seo, & Lee, forthcoming).

Third, sub-national tax exempt bond issuances issued by the Bank of Dutch Municipalities and sub-national tax-exempt bond issuances issued by the City of New York were used to construct the yield curve for Amsterdam and New York, respectively. Finally, Tokyo Metropolitan Government issued 19 bonds for the 2013-2014 period at 630 billion Yen. The yield curve for Tokyo was derived from these local issuances by the Tokyo Metropolitan Government. For Seoul, a national level yield curve was used due to the limited availability of data for Seoul Metropolitan Government.

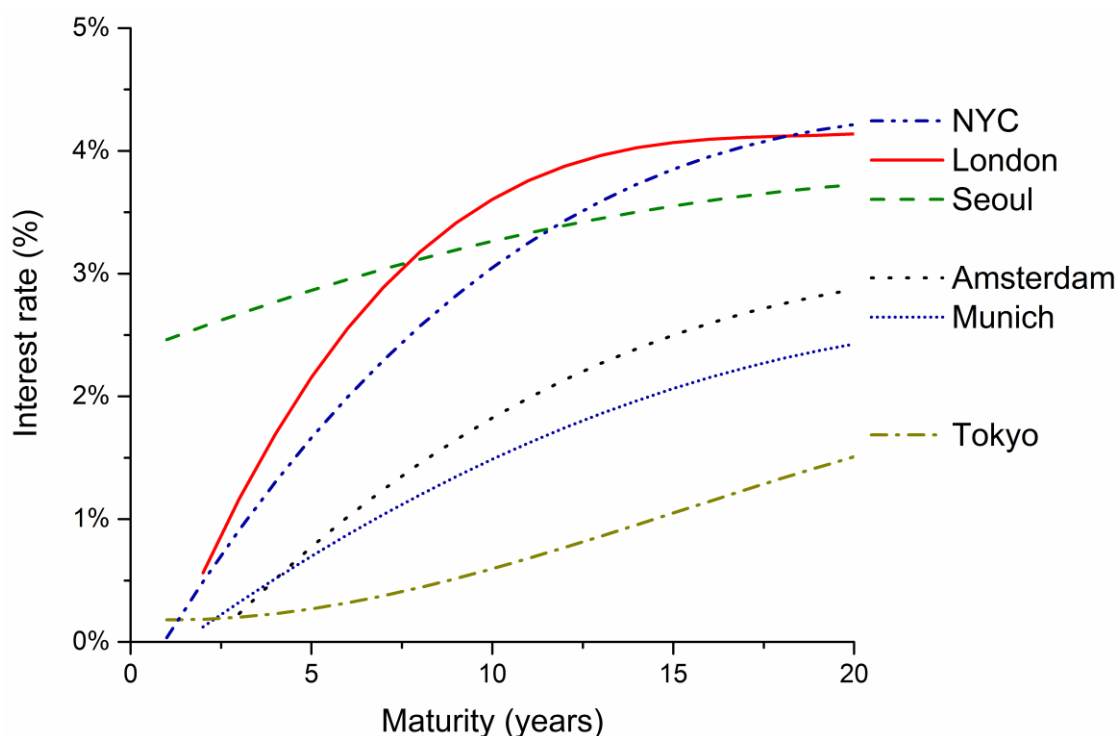


Figure 6.6; Overview of the bond yield curves calculated for all six municipalities.

6.5.2 Policy Conditions in the Case Study Cities

Each city and host country present quite a different profile in terms of PV implementation and performance (Table 6.11). A policy analysis was conducted for each of the six municipalities and is reported in detail by Byrne, Taminiau, Kim, Seo, & Lee (forthcoming). The sections below briefly summarize the key policy inputs used for the analysis in Table 6.12 and 6.13.

Table 6.11; Status of the PV market in each of the locations in 2013. Source: IEA PVPS, 2014.

Country	Pop. (million)	PV in 2013 (MWp)	Cumulative PV (MWp)	Cumulative Wp/capita	PV Penetration (%)
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Netherlands	17	360	723	43	0.6%
Germany	81	3,305	35,766	442	6.4%
UK	64	1,546	3,377	53	1.0%
Korea	50	445	1,475	30	0.4%
Japan	127	6,968	13,599	107	1.4%
USA	316	4,751	12,079	38	0.4%

Table 6.12; City-specific inputs for PV prices and retail electricity rates. Source: Byrne, Taminiau, Kim, Seo, & Lee, forthcoming.

City	2013 Turnkey installed system price (\$/W) ^a	System cost input (\$/W) ^b	Commercial electricity retail rate (cents/kWh) ^c
Amsterdam	\$1.99	\$2.14	14.8
London	\$2.40	\$2.55	16.8
Munich	\$1.90	\$2.05	23.3
NYC	\$3.57	\$3.72	22.4
Seoul	\$2.30	\$2.45	11.6
Tokyo	\$3.44	\$3.59	19.4

Table 6.13; Summary of the Policy Scenario inputs. Source: Byrne, Taminiau, Kim, Seo, & Lee, forthcoming

City	Policy measures	Input	Other
Amsterdam	FIT	\$0.114/kWh	Market sensitivity: -3%/yr in FIT payment level
London	FIT	\$0.16/kWh.	
Munich	FIT	0.14 \$/kWh. ^a	Self-consumption levy of 40% of EEG surcharge
NYC	ITC NY Sun Initiative	ITC: 30% NY SUN: 6%	ITC applied after deduction of other rebates Percentages of installed cost
Seoul	SREC market Local FIT	\$0.126/kWh \$0.10/kWh	Market sensitivity: -3%/yr in SREC price
Tokyo	FIT	\$0.27/kWh. ^b	

- a. The FIT rate for Germany is lower than the commercial electricity retail rate. As such, the analysis assumes that all electricity generated will apply against electricity bill savings.
- b. Tokyo's FIT applies only for excess electricity. However, generators are offered the choice for either self-consumption or grid feed-in. Considering the FIT payment is higher than commercial electricity retail rates, the policy benefits calculation performed here uses the FIT payment rate.

6.5.3 Exploring a Solar City Application in the Case Studies

A solar city vision of energy development, aggregating and bundling the potential of many rooftops into infrastructure-scale applications, requires access to substantial amounts of capital and needs to be supported by a clear and consistent policy strategy. Importantly, many cities report a lack of funding or limited access to affordable capital as a key challenge in moving sustainable energy and climate change strategies forward, complicated further by competing priorities for other areas of public administration (Aylett, 2014). For example, London has calculated that the ambitious target set by its mayor to reduce CO₂ emissions by 60% by 2025 will cost approximately GBP 40 billion whereas the existing climate change mitigation framework of London is projected to cost GBP 14 billion by 2025 (Carbon Disclosure Project, 2011)

The 100 million GBP London Green Fund (LGF) is a first step at providing financial resources to mobilize green energy investment in the city and the fund seeks to attract additional funding.⁵⁸ Investment need is further illustrated by looking at realized costs of several urban green projects (Kennedy, et al., 2010). For instance, the

⁵⁸ <https://www.london.gov.uk/priorities/business-economy/championing-london/london-and-european-structural-funds/european-regional-development-fund/jessica-london-green-fund> (Accessed March 7, 2015)

capital costs of a solar center receiver station in Seville, Spain, is estimated at \$41 million (Kennedy, et al., 2010), which can dwarf the public budget for renewable energy of a city of this size.

To investigate the actual application of the solar city concept in the six case study cities, a scenario analysis was conducted using PV Planner software. This scenario analysis combines the data presented in the previous section and computes the essential financial metrics to gauge the consequences of a solar city application. To determine solar city feasibility two main pathways were investigated:

1. *Finance*: a scenario that offers insight into the financing benefits of the bond market; and
2. *Policy*: a scenario where policy benefits are included to reflect on improvement of the business case of PV in each city when current policy conditions are applied.

6.5.3.1 Finance

Using the earlier yield curves reported in Figure 6.4, we calculate for each city the payback period (PBP), the benefits-to-cost ratio (BCR), and the net present value (NPV) without applying any policy benefits. Other than commonly calculated levelized cost of electricity (LCOE) estimates, NVP, PBP, and BCR are metrics that are especially relevant to the investor community (IEA, 2014b, p. 279-280).

A critical assumption that underlies the calculation – based on the commonwealth and community trust principles of the strategy – is that all electricity generated by PV in the city boundaries is treated as ‘self-consumption’. In other words, the city operates as a unit where electricity consumption at any point of the day is higher than electricity generated. PV generation thereby fully offsets city electricity bills, creating a revenue stream equal to system output multiplied by the city’s average

commercial electricity retail price. Such price setting could occur in the form of an administered price set by the local government; administrative pricing of this nature would resemble actual commercial retail price setting through regulatory dockets.

The results of the analysis are provided in Table 6.13. The table reports the shortest possible financing period where the PBP is shorter than the financing period. In other words, the results shown here indicate a full debt service payback within the debt service time period and without negative cash flow at any point during the project. It becomes clear that the bond market offers substantial benefit: a solar city strategy, under the conditions used here, is available for Amsterdam, Munich, NYC, and Tokyo without a need for policy support. However, without policy support as Table 6.13 reports, financing periods would have to be of long duration. London, due to a combination of high interest rates and low electricity generation per kWp) and Seoul (due to low electricity retail prices) would not be able to secure a PV solar city project and expect a positive cash flow in each year of the project. Naturally, the cash flow could be supported with policy (shown in next section) or by supplementing findings by carbon market proceeds (not calculated in this dissertation). Particularly for the case of the City of London, financing could be possible if additional mechanisms are in place: the analysis shows a PBP of just over 24 years (within a possible 25 year financing period) but cash flow would dip negative during debt service periods. To overcome this effect, support mechanisms other than policy (calculated below) could be put in place – an example of an additional strategy is to include citizen funding through crowd investment/donations that could be structured along different interest rates or different repayment structures.

Table 6.14; Overview of financial metrics under certain financing conditions in each case study city. NPVs reported for a 100 MW installation.

City	Financing period (yrs)	Interest rate	PBP	BCR	NPV (millions)
Amsterdam	25	3.02%	21.48	1.13	\$33.9
London	Not financeable in 25 years				
Munich ^a	12	1.74%	10.84	1.89	\$209.1
NYC	23	4.29%	19.45	1.23	\$107.5
Seoul	Not financeable in 25 years				
Tokyo	20	1.51%	17.21	1.35	\$126.2

Notes:

- PV tilt optimized for each location with PV Planner: Amsterdam (37 degrees), Greater London Authority (36 degrees), Munich (33 degrees), New York City (26 degrees), Tokyo (21 degrees), and Seoul (22 degrees). All are south-facing.
- Estimates for O&M costs vary considerably in the literature. Several sources, however, seem to converge at around 20 \$/kW/yr which is used here (Byrne, Taminiu, Kim, Seo, & Lee, forthcoming).
- A large-scale application of a solar city vision should be able to negotiate state-of-the art equipment. As such, we assume a 20% module efficiency. State-of-the-art inverters are documented at 98.5% efficiency. Further, we applied a 90% power derate factor and a 0.5% degradation factor.
- Rising electricity prices are observed in most regions of the world. Here, we assume an across-the-board electricity price escalator of 2%.
- a. The recent update to the renewable energy sources act in Germany (EEG 2014) established a 40% tax on the EEG surcharge for the self-consumption of generated electricity which is applied here. This lowers the commercial electricity retail rate from 23.3 cents/kWh to 20.08 cents/kWh.

6.5.3.2 Policy

A second scenario analyzes solar city applications when a level of public financial support for the project is provided consistent with the policy inputs in Table 6.12. In light of the above-mentioned assumption that PV electricity can be applied to the electricity bill savings against average commercial electricity retail prices for the city as one operating unit, cities that offer policy benefits that only apply for excess electricity but are lower than commercial retail prices – like is the case for Munich – produce the same results as in the above scenario. In light of the rapid decline in PV system prices, rising grid parity conditions, and observed retrenchment of policy support (especially the case in Germany), policy support conditions are assumed to

only be held in place for a ten-year period despite current use of 15 to 20 year FIT contracts.

Table 6.15 reports the findings of the policy benefits analysis. The application of policy benefits improves the business case for solar energy in each city. In the case of NYC, the improvement is large. The 30% federal investment tax credit and the 6% rebate provided by New York together reduce the initial capital costs considerably, allowing for a much shorter financing period without negative net cash flow in any year. Ten year policy benefits, like FIT and SREC contracts, in contrast, only allow for faster payback of the debt service and do not reduce the debt service itself. This is, for instance, the case for Seoul: when local and national benefits are applied in full for ten years, these offer sufficient policy support to cover the debt service in less than ten years. However, the Seoul FIT is designed for small-scale installations and the results reported in Table 6.14 assume only partial application of this policy benefit. Once benefits expire after ten years, the remainder of the debt service still needs to be repaid. However, commercial retail electricity prices for Seoul (lowest among the six case study cities) are insufficient to cover outstanding costs. Similarly, London's benefits, under these scenario assumptions, are almost sufficient to pay back the debt service in ten years. However, since that is not the case, the financing needs to have a much longer maturity in order to pay it back with energy bill savings once policy benefits expire.

Table 6.15; Overview of financial metrics under bond financing and current policy conditions. NPVs are reported for a 100 MW installation.

City	Financing period (yrs)	Interest rate	PBP	BCR	NPV (millions)
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Amsterdam	21	2.92%	13.68	1.46	\$117.3
London	25	4.14%	14.17	1.40	\$134.7
Munich ^a	12	1.74%	10.84	1.89	\$209.1
NYC	11	3.25%	9.67	2.14	\$335.1
Seoul ^b	Not financeable within 25 years				
Tokyo ^c	16	1.15%	12.88	1.58	\$205.2

Notes:

- Same assumptions and inputs apply as documented in the notes of Table 6.

- Policy benefits assumed to only run for ten year period.

a. The results for Munich are the same as in Table 6. Due to recent cut-backs in the FIT payment levels, commercial retail electricity rates are higher than the FIT. As such, self-consumption of the generated electricity becomes favorable vis-à-vis opting for the FIT. Considering the city-wide application level, self-consumption is assumed to always be available and, as such, the reported results are the same as all generated electricity continues to be compensated against commercial retail electricity rates.

b. The scenario uses both the national SREC market (12.6 cents/kWh) and the local FIT payment (10 cents/kWh). This is allowable under existing policy conditions. However, the Seoul FIT is specifically designed for small-scale installations. Here, we assume that the FIT is available under this solar city application for the first 10 MWp of the installation as presented in Table 3 (commercial only: 0.86 GWp). National SREC market prices are assumed to de-escalate at 3%/yr. When a full FIT is applied for all the electricity generated throughout the first ten years, the system becomes financeable in a ten year timeframe.

c. Assumes that all generated electricity is available for the 27 cents-kWh FIT payment for a ten year period. After that, electricity generated is compensated against commercial electricity retail rates.

Primary options to improve the business case for PV in each city are to: a) lower the installed system cost (through, for instance, a rebate, market development, or by following the German policy model for soft costs (Seel, Barbose, & Wiser, 2014)), b) increase the average electricity price avoided by PV through a FIT-style incentive, or c) increase the policy benefit payment through an RPS-style SREC incentive. The changes necessary to bring the PV business case to a ten year financing period were calculated for each variable individually and for each city (Table 6.15). A combination of modifications is also possible but is not presented here. The findings show that it is possible for each city to finance a solar city application in a ten-year period by modifying existing parameters. However, some of these parameters are more open to modification than others: for instance, increasing electricity prices may

be politically infeasible in some jurisdictions. Especially, system cost reductions required to allow a 10 year financing are in line with year-on-year declines in observed costs over the past years – for instance, the system cost of residential and commercial PV systems in the U.S. declined by about 6%-7% per year throughout 1998-2013 but decreases have accelerated in recent years (Barbose, Darghouth, Weaver, & Wiser, 2013; Feldman, et al., 2014). Moreover, a large-scale application of solar energy in cities, organized as an infrastructure program, should be able to drive manufacturers and construction corporations to lower system prices. It is also possible to achieve reductions by learning lessons from Germany and other countries on how to reduce soft costs (Seel, Barbose, & Wiser, 2014).

Table 6.16; Required policy and other modifications to ensure a ten year financing of the solar city option through the bond market.

City	Retail Electricity Price (¢/Kwh)		FIT payment (¢/Kwh)		SREC Price (\$/MWh) ^a		Req. system cost reduction
	Current	Req.	Current	Req.	Current	Req.	
Amsterdam	14.8	16.4 (↑10.8%)	11.397	13.8 (↑21.1%) _a			↓7.2%
London	16.77	17.6 (↑4.9%)	16	16.81 (↑5.1%)			↓2.6%
Munich	23.3 (before tax) 20.08 (after tax)	22.5 (↑12.1%) ^b	Recent national FIT policy reform has dramatically reduced the PV tariff to a point below retail rates, incentivizing self-consumption.				↓11.7%
NYC	22.4	22.6 (↑0.9%)	-	1.0			↓0.9%
Seoul	11.6	16.9 (↑45.7%)			126	209 (↑65.9%)	↓23%
Tokyo	19.35	24.5 (↑26.6%)	27	32.15 (↑19.1%)			↓16.9%

- a. These variables maintain a 3% de-escalator in compensation in order to remain market sensitive. The possibility of fixed contracts, however, due to the scale of the project involved could lower the required compensation level.
- b. This finding corresponds with lowering the recently enacted self-consumption levy from a current 40% of the EEG surcharge to a new 10% of the EEG surcharge.

Applying a solar city vision to 30% of all commercial and public buildings by 2020 as reported in Table 6.16 provides insight into the cost profile of a solar city vision. Calculated against a future 2020 population, it becomes clear that a solar city vision on commercial and public buildings only requires \$200-\$360 per person living in the city to reach about 100 Wp/capita (Table 6.16). While multi-billion dollar investment opportunities are available in the case study cities, particularly when the analysis is extended to non-commercial and public buildings, bond offerings can be scheduled in series in order to manage investment flows of this magnitude. Solar city applications could also utilize recent innovations such as yield-co spin-offs or other innovative refinancing schemes in order to sustain capital flows such as New Jersey's Warehouse for Energy Efficiency Loans (WHEEL).

Substantial benefits can be accrued from a solar city strategy, also reported in Table 6.17. Job creation numbers were calculated using the following numbers (Cameron & van der Zwaan, 2015):

- Manufacturing (person-years/MW): 6.0-34.5 with a median of 18.8;
- Installation (person-years/MW): 6.4-33.0 with a median of 11.2;
and
- O&M (jobs/MW): 0.1-1.65 with a median of 0.3.

A range of additional economic benefits apply. For instance, a range of ancillary benefits of distributed PV for the New York City/Long Island area utilities and ratepayers have recently been estimated at \$0.41 per kWh and includes fuel price mitigation, distribution loss savings and transmission loss savings (about 25

cents/kWh) (Perez, Zweibel, & Hoff, 2011). Additional benefits that accrue to society at large include environmental, health, and grid security benefits are estimated to be about \$0.16/kWh.

Table 6.17; Overview of the cost profile of a solar city vision when applied on 30% of the commercial and public buildings in the case study cities by 2020.

	PV (GW p)	Wp/ capita	Capital Investme nt (\$ billions)	\$/ capita	Direct employment benefits a			System Benefits b	
					M (perso n- years)	I (perso n- years)	O& M (job s)	Value of electrici ty generat ed (\$ billions)	Net benefits to the sector and its custom ers (\$ billions)
Amsterd am	0.11	92	0.24	207	2,068	1,233	33	0.98	0.74
London	0.33	101	0.95	288	6,205	3,695	99	2.99	2.04
Munich	0.18	119	0.37	246	3,385	2,015	54	1.80	1.43
NYC	0.8	96	2.98	357	15,040	8,960	240	10.03	7.05
Seoul	0.86	87	2.11	215	16,168	9,633	258	8.92	6.81
Tokyo	0.92	101	3.30	361	17,295	10,305	276	10.45	7.15
Total	3.2	99 (averag e)	9.94	279 (averag e)	60,160	35,840	960	35.18	25.23

Notes:

-M= Manufacturing; I= Installation; O&M= operation and maintenance.

- person-year: the full-time employment of one person for the duration of 1 year

a. Median values for solar PV employment factors as found by Reference 140 were used. The findings are illustrative as employment conditions differ substantially by location.

b. System benefits are calculated over the lifetime of the installation (25 yrs of electricity production with a 0.5% degradation rate and 90% power derate factor) using the numbers provided by Reference 141 on the upper bound for NYC/Long Island (41 cents/kWh) for each city. Net benefits include environmental and health benefits, decongestion and resilience benefits, etc. as defined by (Perez, Zweibel, & Hoff, 2011) – minus the investment and installation costs for the solar city vision.

6.6 The Collaborative Solar City – Democratic Finance

As noted earlier in this dissertation (Chapter 3), super-linear scaling of social networks takes place as humans come together in larger and larger cities (Schlapfer et al., 2014). As this process continues (Chapter 4), social connectivity and polycentric networks strengthen. As part of a collaborative contest at the Massachusetts Institute of Technology (MIT), the author and colleagues introduced the notion of democratic finance to capture the power of such networks and apply it to the build-out of renewable energy at an infrastructure-scale level (Taminiau et al. 2014). Building off of the idea of an SEU and the model of solar cities, where the economic and governance dimensions of energy-society relations are transformed to reflect sustainability, governance, and equity principles, democratic finance envisions the collaborative repurposing of ‘energy obese’ citizens to ‘energy wise’ investors and positions them as active participants in the energy transition of the community. In brief, the strategy envisions local community representations – often local governments – to collaborate with retail investors – i.e. community landscape inhabitants – by drawing their support for the solar city strategy.⁵⁹

In brief, the strategy envisions citizens as retail investors that can crowdfund sustainable energy measures on community buildings in order to accelerate the energy transition to a sustainable energy future. In contrast to individualized accounts of the

⁵⁹ The MIT contest category in which we participated focused on the United States Federal Government and, as such, our proposal was focused on drawing retail investment from US citizens to advance renewable energy on federal building rooftops. However, in the context of this chapter, the strategy is applied to advance the solar city model: local governments engage with their constituents to advance renewable energy within the jurisdiction of the city.

prosumer, the community focus aggregates ‘individual as author’ contributions to society and establishes ‘community as author’ frameworks.

The contest proposal, submitting in the category of ‘U.S. government’, relied on the build-out of renewable energy on US federal buildings. Realizing that the estimated 135 million sq. meters (1.4 billion sq. feet) of available rooftop real estate on federal buildings – calculated using the methodology proposed by Byrne, Taminiau, Kurdgelashvili, & Kim (2015) – and the vast potential of the multi-billion dollar market of retail (i.e. small-scale) investors represented two sources of overabundance that, when combined, offer a powerful strategy for community involvement and participation, the proposal suggested the creation of a digital platform outlining investment projects akin to earlier established models such as the U.S. based Mosaic and the U.K. based Trillion Dollar Fund. The strategy places the funding source of *programmatic* renewable energy transition – the aggregation of many projects in one platform under one strategic operation – into the polycentric network.

Figure 7.1 is an illustration of how crowdfunded investments could theoretically support large investment levels from large polycentric networks. It shows how democratic finance can, by tapping into the polycentric network of various actors and (small-scale) investors can enlist the support of the community in the development of projects like SEU sustainable energy finance issues of bonds or, as proposed originally in the contest submission, straight through a dedicated platform accessible to all members of the global community.

A particular benefit of the strategy could be its direct connection of community authorship with the renewable energy transition. Moreover, as noted by

the World Bank (2013), crowdfunding strategies offer much promise for including developing country activities: they estimate a crowdfunding market in the developing world at about \$90 billion. The construction of such a market, and its deployment towards a sustainable energy future, could assist developing countries as they ‘leapfrog’ beyond development pathways employed by developed countries in the 20th century. Here, again, (large) cities stand out as initial targets for the strategy: one of the key enabling factors of successful crowdinvestment strategies, as noted by the World Bank (2013) study, is an active engagement by the community through social networks. Early efforts, like as those displayed by Kickstarter, Indiegogo, Mosaic, and the Trillion Dollar Fund, offer a promising illustration of the strategy’s vision. For instance, Kickstarter recently surpassed the \$1 billion mark in crowdfunding. Sunfunder, a platform specifically designed to target solar energy development in developing countries has already financed over \$2 million in solar projects, collaborating with 16 solar companies in 6 countries and has contributed to delivering affordable energy to over 250,000 people. On their website, they express the ambition to raise and deploy \$1 billion over the next five years and invest these into solar projects in the developing world. These platforms provide a clue about the potential of a collaborative solar city strategy. Importantly, democratic finance principles go beyond those of donation-based or perks-based crowdfunding – which constitutes the majority of the current global crowdfunding landscape – and, instead, positions community members as active investors in their own – and, in the case where investments are made across community boundaries, in others’ – energy futures. This positioning brings the ecological sustainability paradigm and the polycentric

operational response full-circle: energy ‘obese’ consumers are recalibrated to energy ‘wise’ investors and active authors.

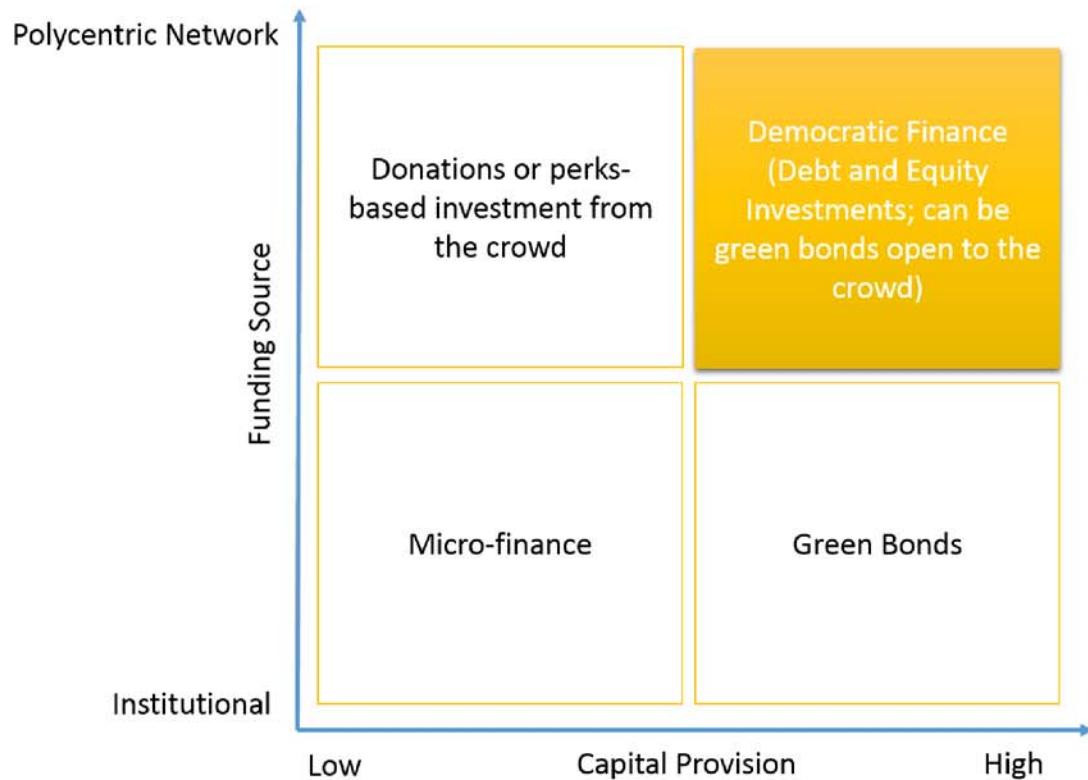


Figure 6.7; Overview of investment pathways in the context of the dissertation.
Source: Adapted from the World Bank (2013).

In addition, this model can be seen to complement the SEU model: whereas the SEU positions itself as a community utility (by and for the community), democratic finance opens up an additional pathway for active positioning as an engaged stakeholder. Indeed, a central tenet in the democratic finance proposal is that part of the returns of the investment cycles could be returned to the community investors so

that they don't only see the indirect benefits of participation through cleaner environments, lower cost-of-government, and lower energy use but also direct benefits in terms of a financial rate of return on their investment.

Another modality is to deploy democratic finance funds at a temporally different phase of the green bond issuance. For instance, setting up a solar city bond issue costs considerable amounts of money and resources. Community support to bring forth such resources could be a component of democratic finance – the funds pay for administrative and other costs associated with tapping into the private capital market to pay for the overall energy conservation measures. These early costs could be included in the debt service to return these investments to the community members that funded the effort. Other potential options are for the SEU to pilot one of its energy efficiency measures – for instance, for one of the participants in the SEU bond issue – and make it available to crowd investing.

6.7 Moving forward on the Solar City Concept

The strategy outlined in the previous sections illustrates the positioning of the commonwealth available to cities in order to attract private investment to fulfill public benefits. Naturally, the strategy does not have to be limited to solar energy. Indeed, considering Lazard's LCOE analysis of renewable energy technologies, perhaps a more prudent first approach would be to construct a bond strategy at this level for energy conservation. Nonetheless, the strategy demonstrates the significant potential that exists in the sample set of cities.

Another element to consider is the complexity of the strategy: there are many moving parts (installers, financial industry, policy, citizens, utilities, etc.) that need to be considered before a strategy of this nature can be implemented. The level of

complexity involved would likely limit the availability of this strategy, at least initially, to advanced cities that would need to pioneer the option. However, interesting opportunities for follow-up research are to evaluate portfolio management approaches of this strategy: constructing a portfolio of city efforts – spanning multiple cities and multiple technologies (e.g., solar and conservation combined) – could lead to the inclusion of cities in developing countries as potential creditworthiness complications with these cities (as mentioned in Section 6.4.2.) might be overcome when coupled with strong credit elements of advanced cities. For instance, Durban, in South Africa is already engaged in renewable energy efforts and greenhouse gas mitigation strategies – they have publicly announced their intentions of becoming a solar city – and could thus make a good first candidate for such a portfolio strategy: a selection of optimal buildings in Durban could be made – buildings especially well-suited for the technologies involved in the portfolio and managed by organizations with especially strong reputations and credit worthiness – and then included in a portfolio approach together with, for instance, New York City and Seoul. First illustrations of such a portfolio approach are provided by Lee & Zhong (2015). Establishing such a polycentric network of city activity is in line with the findings of Chapter 4 and could be orchestrated by entities such as the SEU outlined in Chapter 5.

Finally, further research would need to be conducted to consider the make-up of the bond offerings. Perhaps it is possible to separate out the bond offering in multiple tranches available for investing to establish a stronger cost, benefit, risk and tax profile of the offering. For instance, Lee & Zhong (2015) outlines how ‘interest-only’ tranches could attract investment – profits of the strategy would be primarily directed towards this tranche of the bond – while simultaneously reducing the risk

profile of the other tranches. Byrne, Taminiau, Kim, Seo & Lee (2015) hint at the use of such a 'hybrid' bond for the solar city strategy. This could perhaps be a viable way to strengthen the solar city option as outlined in this chapter.

Chapter 7

SOCIAL CHANGE 2.0: JUSTICE AND DEMOCRACY IN THE ENERGY AND CLIMATE CHANGE SPACE

The previous chapters outline an emerging paradigm of ecological sustainability, phrased in terms of polycentric and bottom-up action. The chapters note how cities claim an increasingly prominent role in the climate change challenge and outlines how many of these efforts exceed the commitments made by participants in the mono-centric approach. The concepts of the SEU (Ch. 5) and the Solar City (Ch. 6) are examples of repurposing policy, economics, and engineering to the active search for sustainable public benefits. Both concepts, and the strategies outlined within them, envision a more direct pathway for civil society inclusion. The SEU, positioned as a community utility, relies on community trust and offers a pathway for the application of the commonwealth to engender public benefits and unlock a significant potential. The Solar City concept empowers urban populations to move away from their common conceptualizations of being distant from the energy question due to their remoteness from sources of generation and towards authorship of sustainable energy futures. In particular, the collaborative solar city concept, where community members themselves have a direct stake in the strategy beyond benefits of clean air and reliable energy, demonstrates the ability to regain energy futures authorship.

SEUs engage in competition with IOUs and, based on the findings in Chapter 5, can do so meaningfully and successfully. Solar Cities reclaim public space and can meaningfully engage the political and class relations that revolve around energy production and consumption as the strategy provides purpose and meaning for previously ‘dead’ rooftops – moreover, solar energy is only one expression of the

Solar City concept as green roofs, energy efficiency strategies, sustainable forms of transportation, etc. are also available for the strategy outlined in Chapter 6.

Polycentric strategies include previously excluded actors and mix authority within emerging participatory networks of action. The mono-centric approach, aligned within the larger paradigm of optimality, placed considerable emphasis on (supra)national governments and (transnational) corporations for the governance and steering of the climate change debate. As reported in Chapter 3, part of this focus stems from an argument of order: creating platforms accessible to many more actors could be considered chaotic and messy. The challenge for polycentric strategies, other than offering innovative examples of bottom-up pathways for local action as done in Ch. 5 and Ch. 6, therefore, is to deliver an answer to the presumption that chaos or anarchy are inferior to order and regime-building. The previous chapters have tackled this challenge by showing impressive potential and outlining ecological sustainability alignment.

While, as the quote that opens this dissertation formulates, this dissertation does not pretend to provide *the* answer to climate change, it offers a credible strategy with which climate change could be tackled through polycentric networks and actions. This final chapter reflects on the findings presented in the dissertation by by outlining the principles of Social Change 2.0 strategies (Section 7.1), by evaluating the position of individuals in social change 2.0 strategies (Section 7.2), by suggesting a way forward in the COP and UNFCCC processes (Section 7.3.). Section 7.4 concludes the dissertation.

7.1 Social Change 2.0 Principles

As Mumford asks, we need to consider whether we advance strategies that are good for "machine-conditioned, system-regulated, mass-man" or whether we pursue and develop strategies that align with "man in person" (Mumford, 1964, p. 8). The dissertation offers that the SEU model is representative of this strategic pursuit. The proposals under the green growth narrative – the end-of-pipe greening of existing unequal and hierarchical energy geographies, the reliance on resource efficiency when faced with absolute growth, and the conceptualization of community members as energy consumers along the democratic-authoritarian bargain– are challenged by this new commons-based paradigm arguing the reallocation of capital to serve the public benefits of equality, sustainability, and justice (Taminiau & Byrne, 2015). As such, the SEU model is paradigm shift inducing as it competes – both politically and economically – with the existing utility framework.

The ‘Social Change 2.0’ strategy of which the SEU model is a part is proposed as the way forward. In the energy and climate space, the SEU shows a practical articulation of this strategy by matching supply to energy service needs and empowering the community landscape. By doing so, it prioritizes the position of energy efficiency and conservation – now too often considered a ‘fifth fuel’ afterthought in supply-dominated energy geographies. To prioritize energy saving within the supply-dominated business model, like that of the conventional energy utility, requires extensive regulatory frameworks and rate recovery mechanisms yielding the paradoxical outcome that, despite frequent affirmations of the cost effectiveness of energy saving compared to energy production, end-users are subjugated to rent-seeking behavior – they pay more for less. The value proposition that the SEU model maintains moves away from this conceptualization and instead

creates a practical strategy to unlock existing community value of future energy savings and leverages this resource to realize infrastructure-level investments in measures that cost-effectively result in energy use dial-back.

To effectuate this overall ‘Social Change 2.0’ framework, the following principles can be extracted from this dissertation:

- *Just Sustainability:* The strategies discussed in this chapter seek to bring down energy consumption and fulfill remaining consumption with local supply. Justice principles are maintained as the community as a whole is involved with the transition through democratic finance, commonwealth, and community trust applications.
- *Community Involvement:* Community as author principles position authority to formulate and pursue energy futures firmly within the community (cities, virtual networks, etc.).
- *Public Wealth:* Unlike optimality precepts that position growth in private capital (i.e. GNP) as the objective of change, Social Change 2.0 strategies seek public benefits, propped up with private investments.
- *Equality:* Community landscape inhabitants are equally considered and global problems are dealt with. Relocation of harmful processes in the name of cost-effectiveness is no longer considered a viable and acceptable strategy – instead, social change 2.0 strategies create new institutions and industries that revolve around local action and local benefits.
- *Governance by network:* relying on the trends of third party government (private firms and nonprofits) and hybrid government, the digital revolution, and rising citizen demand for control, the social change 2.0 framework relies on a governance by network approach.



Figure 7.1; Social Change 2.0 Characteristics

7.2 Consumers, Prosumers, or Sustainable Citizens?

The response strategies available to civil society in the face of global challenges, as we have seen in this manuscript, are evolving. Previous response strategies of protest, ballots, and directed purchase do not allow for the full expression and authorship of civil society's landscape inhabitants. In part, this realization arises when one considers the substantial time, knowledge, and financial resources that need to be invested by civil society members to effectively apply these pathways. This generally restricts access to such options to those with exceptional interest and

motivation, who Simmons et al. (2013), term “Zealots and Professionals”: only those with significant interests and resources can engage in direct democracy pathways.

However, technological advancements and digital connections through the internet have now established a trajectory where it is no longer the case that you have to be zealous or professional in all matters of the topic. Contemporary culture is starting to recognize the transition of millions of people from the traditional ‘consumer’ to that of the ‘prosumer’ – a conceptualization that includes both the production of resources and the consumption of these resources by the same individual. The conceptualization of the ‘prosumer’ is often connoted by elements such as liberating, empowering, and, sometimes even revolutionary (Comor, 2010). Pointing to Alvin Toffler’s 1980 *the Third Wave*, Comor (2010) outlines this supposed revolutionary character where, unlike the First Wave (agrarian society) or the Second Wave (the Industrial Revolution), the Third Wave (the prosumer society) will celebrate diversity, decentralization, and diffusion. Toffler’s concepts have since been picked up by contemporary visionaries such as Jeremy Rifkin’s and his *Third Industrial Revolution* arguing, among others, the advent and benefit of the ICT sector and to some extent in Thomas Friedman’s notion of the *Flat World* arguing the trajectory of eliminating hierarchies.

In the context of this manuscript, the notion of the prosumer is especially relevant in relation to decentralized renewable energy production systems, particularly photovoltaic (PV) energy systems (Schleicher-Tappeser, 2012): their fully scalable and structurally adaptable character enables consumers to participate in the production process, degrading the need for vertical integration currently so pervasive – and necessary – in modern energy regimes. Yet, as Comor (2010) asks, does prosumption

drive creativity and autonomy or, in light of existing commodity-framed relations and the idolization of the role of the individual rather than the community, is it an expression of cooptation and pacification? For instance, Solar City – the company, not the concept introduced in Chapter 5 – has advanced the capability of many in the U.S. to become prosumers but their socio-economic relations with their utility remain one of contractual hierarchy: they are positioned as individuals entering into contracts with a PV leasing company (Solar City) and as sellers to their energy governor (the utility); community as a social relation is not a meaningful part of the equation. As such, prosumers remain subject to the hierarchical capitalist constructs of the modern energy regime while the conventional energy utility seeks regulatory support to extract guaranteed rates of return from the emerging energy system. Similarly, prosumers remain in an alienated position due to deeply *individual* contract relations between the prosumer and the utility and technology provider: rather than restoring the deleterious effects of community fragmentation, the prosumer movement – in these iterations – might end up strengthening it.

Promising innovations such as solar gardens and community solar exist that address these social relations more directly by aggregating ‘individual as author’ relations to establish movements and powerful narratives. Such narratives are part of the ecological sustainability paradigm outlined in this manuscript. This paradigm envisions the advent of the sustainable citizen: working together, relying on social capital available within the community, reducing anthropogenic pressures on the environment. Society will need to instill institutional change and social change processes that get us there. Chapters 4, 5, and 6 offer insights into how sustainable citizens might be created: repositioning authorship to communities such as cities,

establishing community utilities such as SEUs,⁶⁰ strengthening the community through a combined, community-wide strategy of the solar city – all enhance sustainable citizenship. Indeed, communities, through polycentric networks can engage issues more freely and more easily.

7.3 Looking Forward to COP-21 and Beyond

It is tempting to consider the expended resources that have been put into the Kyoto era process throughout the past two decades and conclude that this strategy of change is a ‘first best’ (Hare, Stockwell, Flachsland, & Oberthür, 2010; Wiener, 2007) pathway. Certainly, building off of a range of decisions that have already gained significant political traction and reputation has its advantages. However, as Chapter 2 particularly showed, deficiencies in the Kyoto era process have positioned it at such a standpoint where further action along the same pathway has largely become untenable: climate diplomacy realities are not in line with this approach, sustainability and justice principles continue to go unmet, and civil society participation and control is limited.

⁶⁰ The community utility notion does not have to end at the energy space. For instance, as chapter 5 notes, SEUs are experiencing an innovation trajectory to materials and water use. Similarly, I am currently involved in a team effort to conjure ‘SEUs’ – organizations that function according to the same principles of sufficiency, dial-back, savings over expansion, and community benefit but within different spheres of society. For example, one can consider the functioning of an organization designed to scale down prison populations by reducing recidivism rates through community programs paid for by private capital. In return, investors can yield a rate of return on their investment – fewer prisoners means fewer costs for the state/government, these savings can be passed back to the investor until debt service costs are paid back; remaining operational costs of the programs after start-up are likely to be (much) lower than operational costs of housing inmates – while the public yields benefits of community strengthening, lower cost-of-government, and restoration of social relations.

Indeed, new lines of thought recently uttered from within the United Nations process, i.e. the COP process and its resulting decision, appear to have largely abandoned the Kyoto era's enforcement style approach and, instead, appear to favor more of a facilitative positioning along current climate diplomacy realities (appendix A). For instance, recent, post-Cancun, discussions appear to have settled around facilitative approaches as evidenced by the introduction of the International Assessment and Review (IAR) and International Consultation and Analysis (ICA) processes) (Oberthür, 2014). Rather than relying on enforcement principles such as negative incentives, these processes rely on facilitative elements such as building transparency producing a "record of the facilitative sharing of views" (Oberthür, 2014). Similarities in strategies between pledge-and-review and polycentrism can be uncovered as both move away from a hierarchical chain of command and focus on heterarchical proposals for future climate change action. However, as discussed, pledge-and-review narratives retain a focus on the nation-state and future research will need to identify whether new proposals, supported by civil society, can find expression in this architecture. Nonetheless, from the perspective of COP-21, it appears defensible that the Kyoto era process is highly unlikely to continue and a new architecture will be structured in its place.

The key argument moving forward is that room needs to be created to allow experimentation to flourish. Serious consideration needs to be applied to the viability and appropriateness of a polycentric strategy as the new architecture, finding ways to support and accelerate transformative change within this overall structure. The dissertation has made the preliminary case that expressions within polycentrism are, due to their decentralized and contextualized nature, more likely to be in line with civil

society demands and open up decision-making to non-elites and non-state actors. In addition, values and other considerations than economic efficiency can come to the forefront as evidenced by the co-benefit argument. As such, as the dissertation has shown, and is broadly supported in the literature, factors that drive local action are:

- *Ability*: The ‘resources’ available to a locality in terms of its authority to govern, for instance, energy matters but also administrative, political, and financial capability to act. A part of additional relevance, however, is the support structures in place that are offered by national and/or regional governments to stimulate local action (OECD, 2011).
- *(Local) knowledge*: relevant (scientific) knowledge can drive local action. For instance, vulnerability assessments that maintain a granularity that is useful to local decision-makers can spur adaptation and/or mitigation actions as it helps identify key sectors or activities that contribute to risk mitigation.
- *Networks*: participation in networks maintains interest, allows for the exchange of expertise, helps in the identification of funding opportunities and subsequent securing of said opportunities, and helps provide access to good practice (Kern & Bulkeley, 2009).
- *Co-benefits*: local climate action is spurred on by the capacity to formulate action in terms of achieving co-benefits, “bundling” actions into a portfolio of activities able to generate many additional benefits (Koehn, 2008; Aggarwal, 2013). These activities are then closely connected to other local development strategies, realizing benefits and

avoiding duplication (van der Gaast & Taminiau, forthcoming; Carmin, Roberts, & Anguelovski, 2009).

An architecture that can leverage these conditions and capacities could bring a substantially more productive climate change strategy into action. From the UNFCCC perspective, consideration of polycentricity moving forward, could thus mean adopting a facilitative approach where local experimentation is supported and local demands and needs are taken into account. This facilitative architecture would then be constructed around guiding flows of energy, human expertise, technical material, knowledge, institutional innovation, and a sharing of lessons learned. Appendix A offers one such pathway, but the main thrust of the dissertation is that looking beyond the UN scope could yield more productive outcomes.

A key point that would be different, therefore, is reducing the pledge and review strategy's focal point on the nation-state and, instead, embracing the full diversity and spectrum of modalities that are a part of a polycentric strategy. The facilitative architecture will need to be constructed in such a way that communities from around the world can share lessons learned and share innovation such as the Solar City or the SEU models. Relying on 'Social Change 2.0' characteristics, the resulting 'publics' of communities around the world, connected primarily through the digital world of the internet but supported by physical and tangible relationships of community interaction and intangible virtues such as a sharing of values and objectives, this strategy shows considerable promise moving forward and should be awarded serious consideration.

The dissection of authority away from the singular and statist perspective and into the fray of the larger constellation of social actors not only leads to politics

between different levels of scale but, more fundamentally, a redefinition of actor roles (McCarthy J. , 2005). Decision-making legitimacy in global environmental issues can now be taken, offering critical agents of change new recourse through the establishment of wider configurations of participation and inclusion. Such a discursive framing of participation, inclusion, and action leads to the possibility of a ‘publics’ – a “collective space of deliberation” (Mason, 2008, p. 12) – which allows for new institutional phrasings and polycentric cooperation.

7.4 Moving Forward in the 21st Century

Optimistic accounts of optimality paradigms see a ‘logical end conclusion’ of optimality processes in the form of a collaborative commons as costs are reduced, more advanced technologies are deployed, and more is produced. A recent example of this is Jeremy Rifkin’s *Zero Marginal Cost Society* (Rifkin, 2014). While Rifkin’s work can be applauded for forecasting the end of capitalism and the rise of a new paradigm (what he calls the collaborative commons) where abundance of everything becomes available as marginal costs fall due to the fundamental processes of capitalism – he argues capitalism’s drive towards lower costs will produce its own demise – the emphasis on more and free goods sound remarkably similar to optimality’s proponents. Doubling down on the optimality promise, in the hope that the Zero Marginal Cost Society materializes at the end, could, as indicated in this dissertation, result in some complications.

However, Rifkin is right to recognize the advent of new interaction patterns such as ‘peer-to-peer (P2P)’, collaborative consumption, and the sharing economy, and new manufacturing patterns such as 3d printing. Yet, the continued reliance on the very same principles that led to the overshoot of planetary boundaries is troublesome:

technological advances to reduce costs, pursuit of abundance, etc. A more viable alternative is presented in this dissertation: that of the pursuit of the ecological sustainability paradigm. It shares many traits with Rifkin's new paradigm (sharing, common access, digital participation and exchange) but provides an additional emphasis on reducing anthropogenic pressures rather than enhancing them.

The dilemma of the 'road not taken' as introduced in Chapter 1 can thus be answered with evidence that the polycentric road along an economic paradigm of ecological sustainability can be considered the better option. A New Economics of sufficiency and a New Policy of public benefits achieved through the commonwealth brings a social discourse to energy and climate change within reach. The Social Change 2.0 strategy injects human personality into (energy) development agendas as it supports social innovations like the SEU. Fundamentally, such a strategy repositions the community away from the conceptualization of the 'individual as beneficiary' – enjoying all that is provided but without influence – and towards the notion of the 'community as author' where individuals and communities democratically govern their own energy future. Diffusion of the SEU model, city climate change action, and the widespread promise of solar cities, among many others, delivers a promise of advanced prosperity and restructured ecology-energy-society relations. A 21st century sustainability paradigm that seriously considers both the need to advance equality while maintaining the long-term ecological viability is within our reach.

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Appendix A

PLEDGE AND REVIEW: POTENTIAL STRATEGY MOVING FORWARD

The dissertation focuses on the polycentric strategy of change where additional actors are invited in the discussion, levels of action are blended together, and the climate change challenge is addressed by many, in many locations, and throughout time. This strategy is oftentimes characterized as ‘chaotic’ or ‘messy’ as there is limited oversight and limited direction other than provided by the networks themselves. Within the UNFCCC framework approach, an additional strategy has surfaced in the wake of the Copenhagen failure to seal the deal and this strategy now fills up the official space available in the negotiations until the Durban Platform for Enhanced Action is agreed upon (slated to happen in December, 2015) and implemented (slated to occur in 2020). This strategy has been dubbed in this dissertation ‘pledge-and-review’ and has been briefly introduced in the dissertation Chapter 3. The ‘pledge-and-review’ strategy, often also framed under terms of ‘building blocks’, as discussed in Chapter 3 appears to align with many of the optimality paradigm traits.

This appendix discusses the strategy in more detail. In particular, it describes a pathway that could strengthen the pledge-and-review option by focusing on the harmonization potential of the mechanisms of this strategy. Overall, the UNFCCC has a propensity to continually introduce new mechanisms and, after two decades of negotiations, the list of possible mechanisms has become quite long. For instance, recent introductions include the Climate Technology Centre and Network (CTCN), Nationally Appropriate Mitigation Actions (NAMAs), New Market Mechanism

(NMM), Low Carbon Development Strategies (LCDSs or also called LEDS), the Technology Executive Committee (TEC), and several others.

A harmonization overview was developed by the Joint Implementation Network (JIN), primarily through the efforts of Wytze van der Gaast, and this harmonization potential offers insight into the potential functioning of ‘pledge-and-review’ when polycentric strategies of change are not supported. A recent publication of the work further describes this strategy (van der Gaast & Taminiau, 2015) and the rest of this appendix primarily draws from that work. The primary emphasis of that work was directed at the implementation of Technology Needs Assessments (TNAs) in conjunction with the other climate policy processes. Wytze van der Gaast has since elaborated on the issue further in his dissertation (van der Gaast, 2015).

A.1 The rise of the ‘bottom-up’ pledge-and-review architecture

Looking forward to COP-21 and beyond, it is unlikely that a ‘top-down’ strategy can be maintained that focuses on establishing global targets and assigning national targets irrespective of what individual countries put forth (Morgan, Tirpak, Levin, & Dagnet, 2013). The climate diplomacy balance, what one observer calls the ‘New World (dis)Order’ (Roberts, 2011), is simply not there for this objective to materialize later this year at COP-21. If, indeed, COP-21 and subsequent COPs are unsuccessful at establishing such a global target, the top-down strategy is effectively relayed to the remnants of the Kyoto Protocol. With the withdrawal of Canada, Japan, and Russia and the reluctance of other nations to take on emission reduction targets in the Kyoto Protocol framework, the Kyoto Protocol – while already weak during its first commitment period (Leal-Arcas, 2011a; Victor D. , 2001; Raustiala, 2005) – now represents only a marginal effort to address climate change: combined, the countries

that adhere to the Kyoto Protocol over the 2013-2020 period only represent about 15% of global emissions and this share is expected to decline over time. If this happens, and the most recent negotiating text suggests there is no reason to assume a global target will be hammered out at COP-21, it is likely that a system of national submissions along the lines of ‘pledge-and-review’ takes its place at the international negotiations. For instance, on the level of ambition – which could be seen as a key element of what a ‘top-down’ strategy could mandate in terms of quantitative emission reduction targets as was done in the Kyoto Protocol – the draft negotiating text maintains four options (which will need to be negotiated throughout the year and at COP-21) of which only one essentially maintains a ‘top-down’ perspective (option 4)⁶¹:

- *Option 1*: Each Party to take action at the highest level of ambition/mitigation ambition, reflecting its national circumstances, and to progressively increase that level of ambition;
- *Option 2*: All Parties to take action at the highest level of ambition and to progressively increase that level of ambition, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, with developed countries taking the lead;
- *Option 3*: Parties to enhance their actions and contributions in accordance with Article 4 of the Convention; and
- *Option 4*: A global emission budget to be divided among all Parties in accordance with the principles and provisions of the Convention, in order to limit global warming this century to below 1.5 °C consistent with

⁶¹ The particular reference to a target below 1.5 °C this century – certainly not agreed upon by most major emitting Parties – could point to the submission by developing country groups such as G+77 or the Small Island Developing States (SIDS) who have consistently pushed for stringent targets. If so, it would bolster the assessment that the chances of adoption of this clause are unlikely as these developing country groups have faced marginalization and neglect before.

the Intergovernmental Panel on Climate Change (IPCC) assessment. The distribution of the global emission budget should be undertaken in accordance with historical responsibilities, ecological footprint, capabilities and state of development.

Similarly, much room remains for identifying the tools and ideas that will be deployed to bolster effective mitigation. As the Earth Negotiations Bulletin (ENB) notes in its summary analysis of the February 2015 Geneva Climate Change Conference (one of the final major negotiations prior to the COP-21), the draft negotiating text continues to include a wide portfolio of old and new mechanisms and ideas on how to deploy mitigation including Reducing Emissions from Deforestation and forest Degradation (REDD+), sector and market mechanisms, or an enhanced Clean Development Mechanism (ENB, 2015, p. 14). Strikingly, and in line with the assessment that a global agreement along the lines of a top-down architecture is unlikely, the key output from recent negotiations has been the introduction and agreement on intended nationally determined contributions (INDCs) – the mechanism with which national governments indicate their post-2020 commitments. Finally, on facilitation and compliance, critical in relation to the ‘legal status’ of any future agreement, the draft negotiating text maintains a broad record of possible options, including a “compliance committee” with “two branches, namely an enforcement branch and a facilitative branch” (FCCC/ADP/2015/1, p. 82) akin to the Kyoto Protocol and an option arguing that “no specific provisions [are] required” (FCCC/ADP/2015/1, p. 83). Compliance has been a critical component of multilateral environmental agreements (MEAs), most notably evidenced by Canada’s public statement that it would pursue non-compliance, subsequent ineffective compliance enforcement by the Kyoto Protocol compliance committee, and eventual withdrawal from the Kyoto Protocol by Canada (Murtha, 2009; Oberthür, 2014). Recent, post-

Cancun, discussions on the issue appear to have favored facilitative approaches as evidenced by the introduction of the international assessment and review (IAR) and international consultation and analysis (ICA) processes (Oberthür, 2014). Rather than relying on enforcement principles such as negative incentives, these processes rely on facilitative elements such as building transparency and producing a “record of the facilitative sharing of views” (Oberthür, 2014). This hardly sounds like a structurally strong and enforcing top-down approach.

A turning point in the negotiations has been the 2009 Copenhagen COP. The 2009 failure of the Copenhagen conference is often positioned as a return to ‘realpolitik’ where dominant domestic politics and material realities superseded commitments to international treaty-making resulting in an overall collapse of the talks (Carter, Clegg, & Wåhlin, 2011). The ‘Copenhagen Accord’, the main outcome document that emerged from the talks and constructed by several of the key negotiating Parties, has since been denounced as a ‘lowest common denominator’ outcome that is seen as inferior to the ultimate objective of a strong and legally binding ‘global deal’ (Falkner, Stephan, & Vogler, 2010; Egenhofer & Georgiev, 2009). Nonetheless, subsequent COP agreements has continually affirmed the importance of many of the elements of the Copenhagen Accord and new processes and mechanisms, like, for instance, IAR and ICA align with the Copenhagen perspective on national contexts and national authorship.

As such, despite its initial characterization as a lowest common denominator, the Copenhagen Accord, and subsequent agreements, have effectively outlined a potential alternative strategy for long-term shared action. The latest several COP negotiation rounds have further fleshed out this strategy in a surprising tempo: the

Kyoto Protocol approach has been largely abandoned and, as discussed above, it appears increasingly likely that any new global agreement will be shaped along the lines of nationally determined commitments. How this will play out, however, remains to be seen. For instance, as the ENB documents, the Geneva negotiating text puts forth a plethora of proposals including various proposals on how to determine the sufficiency of parties' nationally determined commitments/contributions or the time frames for submission of such commitments (ENB, 2015). It appears, however, that one possible and perhaps likely articulation of a future agreement is in line with the pledge and review style approach and structured around a "dynamic agreement" where domestic mitigations are submitted to the international community and periodically reviewed and, where needed, strengthened (ENB, 2015).

The Copenhagen Accord facilitated the creation of such a 'pledge-and-review' infrastructure as it invited both Annex I and non-Annex I Parties to submit their planned mitigation actions (i.e. 'pledges') and offer them up for review. In contrast to the top-down architecture, this permutation involves the bottom-up collation of national pledges that, together, are to add up to international effort (Netherlands Environmental Assessment Agency (PBL), 2010). This structure has subsequently been reinforced by follow-up COP outcomes such as the Cancun Agreements and the Durban Platform for Enhanced Action. For example, the Low Emission Development Strategy (LEDS; also often called LCDS for Low Carbon Development Strategy), a key planning tool with which to identify options for low-emission development, was described in the Copenhagen Accord as "indispensable to sustainable development" and, since then, follow-up COPs have confirmed this critical positioning of the mechanism:

- the Cancun Agreements (2010) agreed that developed countries are to develop low carbon strategies while encouraging developing countries to do so as well “in the context of sustainable development”,
- the Durban Platform (2011) invited the submission of plans and related information on their progress towards LEDS and encouraged developing country Parties to do the same, and
- The Doha Outcome (2012) reaffirmed prior commitments to the importance of LEDS and called for capacity building to move forward on both NAMAs and LEDS.

In light of climate diplomacy realities, the pledge and review strategy currently represents the ‘only game in town’ that covers a broad range of Parties, including critical negotiating Parties such as the United States, China, India, and Brazil. Over 100 countries have responded to the Copenhagen and Cancun calls for pledges and have submitted planned measures to reduce or limit their emissions (Van Der Gaast & Begg, 2012). Together, these countries account for 78% of global emissions from energy use (Van Der Gaast & Begg, 2012).

The most recent iteration of ‘pledges’ is the INDC process. As Grubb emphasizes, the INDC tool will play a central role in the Paris negotiations: “Do not underestimate their [i.e. INDCs] significance: all countries are expected to submit INDCs that represent a ‘progression’ from their current commitment [...]. This amounts to a significant shift from the original Convention, which placed the emphasis on industrialized country leadership, to a fully global process” (Grubb, 2015, p. 299). At the time of this writing, eight INDCs have been submitted in preparation for the COP-21 (counting the European Union as one). As Decisions 1/CP.19 and 1/CP.20 call for “all Parties to communicate to the secretariat their INDCs well in advance of COP-21 (by the first quarter of 2015 for those Parties ready to do so)”, others will likely follow soon. The INDCs are to offer clarity, transparency and understanding of

the contribution the national government is willing to make in terms of both mitigation and/or adaptation. INDCs communicate information on, among others, quantifiable targets and timetables, implementation periods or timeframes, scope and coverage, assumptions and methods, and a normative claim of how the submitting Party considers its INDC to be “fair and ambitious” in light of its national circumstances (Decision 1/CP.20). Table 1 offers a brief overview of the INDCs of the eight nations that have already chosen to submit their contribution.

Table A1; Overview of submitted INDCs. Source:
<http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>

Nation	Key components	Description
Switzerland	<i>Target:</i> reduce GHG emissions by 50% by 2030. <i>Base year:</i> 1990 <i>Time period:</i> 2021-2030 <i>Sectors:</i> energy, industrial processes and product use, agriculture, LULUCF, waste.	approximately corresponds to an avg. reduction of GHG emissions by 35% over the 2021-2030 period and, by 2025, a reduction of GHG by 35% compared to 1990 levels is expected. Planning in 10-year cycles allowing for a modification of targets. Carbon credits from international mechanisms will be used for compliance. <i>Fair and ambition:</i> target is in line with science and will largely be realized domestically.
Latvia and the EC on behalf of the EU and its Member States	<i>Target:</i> 40% domestic reduction in GHG emissions by 2030 <i>Base year:</i> 1990 <i>Sectors:</i> economy-wide (100% of emissions covered)	Contribution will be “fulfilled jointly” among all member states of the EU. No contribution from international credits; Domestic legally binding legislation already in place;

	<i>Time period: 2021-2030</i>	<i>Fair and ambition:</i> target is beyond current 20% emission reduction by 2020 commitment (which included the use of carbon credits). The target is in line with IPCC and consistent with halving global emissions by 2050 (against 1990).
Norway	<i>Target:</i> at least 40% reduction of GHG emissions by 2030; <i>Base year:</i> 1990 <i>Time period:</i> 2021-2030 <i>Sectors:</i> economy-wide (100% of emissions covered)	Norway intends to fulfil their commitment through a collective delivery with the EU and its Member States. No international carbon credits would be used under such an agreement. If no such agreement takes place, Norway intends to fulfil contribution individually but will make use of international carbon credits;
Mexico	<i>Unconditional target:</i> reduce 25% of GHG emissions and short lived climate pollutants emissions by 2030; <i>Conditional target:</i> when supported, target could increase to 40% reduction. Subject to global agreement <i>Base year:</i> Below business-as-usual (BAU) <i>Gases covered:</i> all gases not controlled by Montreal Protocol plus black carbon	Includes both adaptation and mitigation components. Mitigation includes a unconditional and a conditional target, subject to global agreement. <i>Fair and ambition:</i> the INDC emphasizes the “unprecedented” nature of unconditional commitment. Further, Mexico is a developing country with a modest contribution to global emissions (1.4%; 5.9 tCO ₂ e per capita). INDC seeks synergies between mitigation and adaptation. INDC includes black carbon, a short-lived climate pollutant. The unconditional target will reduce black carbon by 51% and other GHGs by 22% while the conditional target foresees a 70% black carbon and a 36% GHG emission reduction.

		<p>INDC includes an adaptation component. Adaptation priorities: protect against extreme weather events, improve resiliency of strategic infrastructure, and to improve ecosystem resiliency. INDC seeks to strengthen adaptive capacity of the “most vulnerable”.</p>
United States	<p><i>Target:</i> 26-28% by 2025 <i>Base year:</i> 2005 Sectors: economy-wide (100% of emissions)</p>	<p>INDC emphasizes U.S. will do “best efforts” to reach 28%. No intend to use international carbon market mechanisms. <i>Fair and ambition:</i> INDC emphasizes the already “substantial policy action” in place to reduce emissions by 2020. The 2025 target represents a “substantial acceleration” of the current emission reduction pace. Target aligns with a straight line emission reduction pathway to economy-wide reductions of 80% or more by 2050.</p>
Gabon	<p><i>Target:</i> at least 50% below BAU by 2025 <i>Base year:</i> 2000 <i>Time period:</i> 2010-2025</p>	<p>No use of international carbon market mechanisms. BAU scenario forecasts 105% growth in emissions over 2010-2025, mostly due to LULUCF.</p>
Russian Federation	<p><i>Target:</i> 25-30% reduction by 2030 <i>Base Year:</i> 1990 <i>Time Period:</i> 2020-2030</p>	<p>INDC emphasizes target needs to be read in the context of being “subject to the maximum possible account of absorbing capacity of forests” <i>Fair and ambition:</i> INDC emphasizes that carbon intensity of the economy has decreased since 2000. If target is achieved, INDC notes that further GHG emissions/GDP reduction will take place. Notes the “global significance” of its boreal forests and places forest management as “one of the most important” policy elements of Russian climate policy.</p>

Liechtenstein	<p><i>Target: 40% reduction by 2030</i></p> <p><i>Base year: 1990</i></p> <p><i>Time period: 2021-2030</i></p>	<p><i>Fair and ambition:</i> INDC emphasizes that Liechtenstein is an insignificant contributor to the climate change challenge (0.0073% of global emissions). Reduction path considered ambitious in light of “already highly technical environmental standards” applied in the country and in line with IPCC recommendations.</p>
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Note: the INDCS, unless noted otherwise, cover all GHGs not controlled by the Montreal Protocol (CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, NF₃). Notably, only Mexico includes an additional metric in the form of Black Carbon.

A.1.1.1 Pledge and review policy virtues

Previous work contrasted the ‘Kyoto era’ framework of action with that of the pledge-and-review approach (see Byrne & Taminiau, 2012; Taminiau & Byrne, 2012). These results are replicated in Table 2, supported by data from Stigson, Buhr, & Roth (2013). Differences of particular significance are the focus on unilateral considerations for arriving at nationally determined targets, the multi-component formulation of mitigation and adaptation actions, and the introduction of flexibility in design:

- Including only unilateral considerations in the process of arriving at nationally determined targets and plans likely allows for easier completion. Moving away from the need of consensus in the negotiations – which is a critical element in Kyoto era COP negotiations, most strongly illustrated by the Copenhagen’s COP outcome of “taking note” of the Accord rather than adopting it due to dissensus (Dubash N. , 2009) – can breach lowest common denominator approaches. International politics, such as the call for more stringent targets by other countries, can be taken into consideration but the process of, for instance, introducing an INDC would, in a pledge-and-review process, only be controlled by domestic politics. However, it remains unclear how multi-lateral assessment and review processes can influence these plans and commitments and, when needed, raise ambition levels.

- The multi-component formulation of commitments, as illustrated by Mexico's INDC in Table 1, allows for official communication of the possibility of enhanced ambition subject to global agreement. In addition, the broader formulation options for communicating commitment and the flexibility in design (e.g., a broader range of modalities) could bring additional information on the table (Stigson, Buhr, & Roth, 2013). For instance, as a respondent in an interview conducted by Stigson, Buhr, & Roth (2013) noted, there is a possibility that multi-component formulation could enhance transparency and “infuse trust and confidence both externally and internally as it opens up for self-assessment and addresses uncertainty which was prevalent with respect to binding agreements and top-down targets” (p. 25). .

Table A2; Key differences between pledge and review architecture and the Kyoto era objective. Source: (Taminiau & Byrne, 2012; Stigson, Buhr, & Roth, 2013).

Component	Kyoto era	Pledge and review
Compromise	Consensus	National considerations only
Rules	According to standards (MRV, etc.)	Flexibility in design
Commitment	Single-component	Multi-component
Conditionality	Conditionality not accepted	Conditionality accepted
Bindingness	Predominantly viewed as binding	Ambiguous
Stringency	Strict division according to capability	Continuum of stringency possible
Spatial focus	Global cap	National cap
Legal character	Predominantly seen as binding	Ambiguous, to be decided

Other virtues that are potentially generated with a shift to pledge-and-review style decision-making can also be identified. For one, higher participation levels is a critical outcome of the approach. Already, over 100 nations pledged their national targets in response to the call by the Copenhagen Accord (Joint Implementation

Quarterly [JIQ], 2009). In particular, the strategy has been able to extract commitments from key negotiating Parties that were previously reluctant to issue commitments or to generally participate in the process during the Kyoto era. The prime example of this is the November 12th, 2014, U.S.-China joint announcement on climate change articulating their intention to cooperate bilaterally to advance the mandate of the Durban Platform for Enhanced Action and describing their respective post-2020 actions on climate change (The White House, 2014). For instance, the United States introduced in this announcement its post-2020 action in line with the subsequently submitted INDC while China announced its intention to achieve the peaking of CO₂ emissions ⁶² around 2030 and to improve non-fossil fuel penetration in primary energy consumption to around 20% by that time (The White House, 2014). The announcement has subsequently been hailed as a ‘historic breakthrough’ (Hoye & Yan, 2014). This development can be seen in light of the virtue of developing targets in the context of national circumstances as, for instance, China arguably moves forward with climate change mitigation and adaptation not because of carbon control aspirations but rather due to domestic policy priorities of energy security and clean technology market potential (Stigson, Buhr, & Roth, 2013). The consideration of national interests, values, and priorities offers the prospect of embedding climate protection measures in the wider context of sustainable development (Van Der Gaast

⁶² An interesting side note is that the announcement stipulates carbon dioxide emission reductions rather than the greenhouse gases not covered by the Montreal Protocol as is common in the INDCs (see Table 1). Once China completes and submits its official INDC, it will be interesting to see whether commitments will be formulated in the form of a basket of GHGs or limited to carbon dioxide emissions and what the consequences of this choice will be.

& Begg, 2012). Considering the developing country perception of the climate policy issue as an inhibitor of overall development (Najam, Huq, & Sokona, 2003; Ockwell, Haum, Mallet, & Watson, 2010), such a reorientation of climate change action in line with wider objectives and priorities may prove significant.

A.1.1.2 Potential Complications with the pledge and review strategy

Key complications can be identified under the strategy. First and foremost, similar to findings that the Copenhagen Accord pledges were insufficient to address climate change in line with IPCC recommendations and UNFCCC objectives (Rogelj J. , et al., 2010), the Climate Action Tracker labels the recent INDCs in terms of ambition and decarbonisation requirements as “medium” (Switzerland, EU, Norway, Mexico, U.S.) or “inadequate” (Russian Federation) (Climate Action Tracker, 2015).

⁶³ While the rating is preliminary, it signals that ambition levels will likely need to be raised substantially to address the existing ‘emission gap’ (United Nations Environment Program [UNEP], 2011). This ‘emission gap’ is a critical complication associated with pledge and review, convincing analysts of the continued need for a stronger, top-down architecture (Hare, Stockwell, Flachsland, & Oberthür, 2010; Wiener, 2007). The ‘deep’ vs ‘broad’ tension – effectively pitting ambition versus participation, respectively – has since Copenhagen consistently been geared towards the ‘broad’ perspective (Grubb, 2015). While ‘coalitions of the willing’ can now

⁶³ Note that the Climate Action Tracker also provides a “medium” rating for China and an “inadequate” rating for Japan. However, considering that these countries have not yet provided an official INDC submission to the UNFCCC, their ratings have been excluded in the text. These countries are expected to submit their INDC prior to COP-21.

breach least common denominator approaches prevalent in top-down discussions thus raising both urgency and ambition, unwilling nation-states could remain behind. A key driver limiting action in such nation-states remains concerns about economic competitiveness (Stigson, Buhr, & Roth, 2013). This “structurally weak” approach could elevate ambition levels as new participants are attracted or are convinced by the submission of others but, as signalled by the INDCs and earlier pledges, is challenged by commitments that fall short. These early indications lead Grubb to warn of a “Lima hangover” (the COP where INDCs were introduced) as he sees it will become “plain that the ‘bottom-up’ intentions do not remotely match the ‘top-down’ ambitions” (Grubb, 2015, p. 301).

The unilateral introduction of commitments faces other complications. For one, unilateral pledges lack a harmonized character as assumptions related to baselines, land-use change, domestic and international offsets differ significantly (Wada, Sano, Akimoto, & Homma, 2012) likely complicating comparison. In addition, legitimacy concerns persist as the move away from a common emission reduction target effectively limits interstate influence to the yet-to-be-fleshed-out functioning of multilateral assessment such as IAC, where it is unsure whether developing countries, in particular, will be able to raise ambition levels from the developed countries.

In line with the above, another critical complication is how the international community will elicit compliance from the unilateral participants. The unilateral commitments will be domestically binding as they are to be grounded in domestic law but, as such, the international community will have limited influence. Facilitative processes to assist in the formulation of targets and pathways is one thing, enforcing

the implementation of these plans is another. Especially when considered in the light of Canada's public announcement that it would follow non-compliance with the Kyoto Protocol and the limited options for recourse of a top-down agreement, with relatively advanced facilitation and enforcement capability (Murtha, 2009; Oberthür, 2014), the capacity to elicit compliance in a pledge-and-review style approach can be called into question.

A final complication, similar to ambition and compliance, is one of urgency. A continuing problem of 'cherry picking' can be observed – as evidenced, for instance, by the INDC of the Russian Federation limiting its attention to forest management – where attention would be directed towards potentially easier building blocks (the proverbial 'low-hanging fruit') while more complicated components of climate policy would be postponed. How pledge-and-review is to accelerate action remains a critical open question.

To limit global average temperature increase to 2 °C will require strong action. Under the COP process, periodic reviews of the adequacy of submissions will need to be complemented by a process capable of facilitating and, if needed, enforcing higher levels of ambition. Ideally, a 'race to the top' mentality can be instilled in the negotiating Parties by focusing on, for instance, the following objectives (Morgan, Dagnet, Hohne, Oberthur, & Li, 2014):

1. The specification of a global long-term goal for emissions other than the 2 °C target. For example, the target could specify a phase-out of emissions to net zero.;
2. Create a predictable commitment cycle and decide upfront that every cycle needs to extract greater commitments and contributions from negotiating Parties.;

3. Create an assessment and revision process for each cycle that allows for the identification of additional emission reduction measures.

However, considering the above, any agreement at COP-21 is far from certain let alone an ambitious one that stipulates progressively stronger action. As it is unclear how the COP-21 negotiations will play out, and whether a multilateral agreement will be put in place, one additional element for consideration is on how individual nation-states can move forward. In particular, in order to submit a credible and suitable INDC and, subsequently, meet INDC targets, countries will need to advance strategic low-emission and low-carbon approaches. The ‘broad’ perspective of the negotiations over the last years since the 2009 COP have introduced a wide range of mechanisms and processes with which countries can identify their options. However, one consequence of this prolific creation of new mechanisms has been a fragmentation of the climate change policy ‘toolbox’ (van der Gaast & Begg, 2012, Chapter 4). Fragmentation has been recognized as a potential problem within the climate change discussions. For example, the Doha Climate Gateway decision package emphasized the importance of mechanism harmonization (van der Gaast & Taminiau, 2015). One aspect of the current reality of the international negotiations, therefore, is political attention to policy harmonization and, perhaps, integration. In particular, resource-constrained developing countries face potentially significant hurdles as a result of this fragmentation: redundancies, overlap, resource fragmentation, and potentially undesirable policy interactions are some example barriers introduced by this complex landscape (Fukuda & Tamura, 2012; Torres, Winkler, Tyler, Coetzee & Boyd, 2012; Tyler, Boyd, Coetzee, Torres, & Winkler, 2013). A strategy of harmonization could establish policy coherence, minimize duplication, recognize trade-offs, and produce synergistic results (van der Gaast & Taminiau, 2015). Indeed, for several mechanisms,

a substantial potential for harmonization is apparent that could mutually strengthen the functioning of these mechanisms and allow for a more efficient identification of low emission development pathways (van der Gaast & Taminiau, 2015). Such a strategy could unlock potential benefits that accrue under a bottom-up pledge-and-review framework (Byrne & Taminiau, 2012). The next section elaborates on this harmonization potential.

A.2 Why Harmonization?

The task to come up with a ‘protocol, another legal instrument or an agreed outcome with legal force’ applicable to all Parties in 2020, as mandated by the Durban Platform for Enhanced Action, will require careful navigation and effective support to help with the identification of low-emission and climate-resilient development opportunities. Many operational mechanisms and processes have been introduced to construct such a support profile and their effective and smart use, absent a strengthening of the polycentric framework according to lines introduced in the rest of this dissertation, will be critical in the closing of the so-called ambition gap of 8-12 gtCO₂-eq. Current fragmentation of this climate change policy ‘toolbox’ hinders the coherent formulation of appropriate transition pathways (van der Gaast & Begg, 2012, Chapter 4). This is recognized within the climate change discussion. For instance, the Doha Climate Gateway decision package emphasizes the importance of harmonization (van der Gaast & Taminiau, 2015). As such, political attention to policy harmonization is the current reality of the international negotiations and active consideration is directed at the mapping of policy interactions (van der Gaast & Taminiau, 2015).

Nonetheless, many of the discussion so far has been rhetoric and actual interactions and interrelations between mechanisms, building blocks, and processes

remains largely unclear (e.g., Torres, Winkler, Tyler, Coetzee, and Boyd, 2012; Tyler, Boyd, Coetzee, Torres, and Winkler, 2013). The continued introduction of new mechanisms complicates this even further and especially resource-constrained developing countries face significant hurdles overcoming such barriers (van der Gaast & Taminiau, 2015). Potential problems are redundancies, unnecessary duplication, fragmentation of scarce resources, and potentially undesirable policy interactions (Fukuda & Tamura, 2012). It has become apparent that developing countries struggle to navigate this landscape (Tyler et al., 2013). A strategy that resolves this complex landscape and establishes policy coherence, minimizes duplication, recognizes trade-offs, and produces synergistic results could construct a viable strategy of change moving forward.

At the moment, policy harmonization remains underutilized (van der Gaast & Begg, 2012; van der Gaast & Taminiau, 2015). Transformational change could be realized with the smart and effective integration of policy mechanisms within wider policy contexts (van der Gaast, 2015; van der Gaast & Begg, 2012). Similar to the strategies of change listed in Chapter 5 and 6, such mainstreaming could establish climate policy mechanisms capable of shifting away from project-to-project characters and towards structural and long-term mitigation (Jung et al., 2010; Fukuda & Tamura, 2012).

A.3 Climate Policy Mechanisms Available for Harmonization

Van der Gaast & Taminiau (2015) evaluated a set of climate policy options that could be harmonized to result in potentially more effective deployment of resources and implementation of adaptation and mitigation measures. This set includes: NAMAs, TNAs, National Adaptation Plans (NAPs), and Low Emission

Development Strategies (LEDS). Van der Gaast & Taminiau (2015) discuss these in more detail but, in short:

- *NAMAs*: national-level objectives, sectoral programmatic plans, or individual projects often dependent on technology, financing, and/or capacity-building support;
- *NAPs*: comprehensive strategies and programs to advance country-specific climate resilient development and to identify weaknesses and gaps in the enabling environment that hinder adaptation processes in line with national sustainable development objectives;
- *LEDS*: key forward-looking tool to integrate climate change into long-term national socio-economic policymaking and initiate strategic transition to a low emission and climate resilient economy. In this, the need for a highly collaborative process with high levels of engagement by different stakeholders throughout the process is frequently emphasized to ensure local ownership of the process.
- *TNAs*: identifies and prioritizes soft and hard technologies and measures that offer maximum short- and long-term climate and development benefits and provides a strategic action plan to contribute to the country's social, environmental, and economic development through technology development and transfer.

A.4 Commonalities Available for Harmonization

Van der Gaast & Taminiau (2015) identify a range of commonalities between the selected processes:

- The processes emphasize the *importance of participatory processes* as stakeholders can add important 'hands-on' information to the analysis, while their successful engagement can lead to early exposure to proposed actions and some level of 'buy-in' (see, e.g., Tilburg et al., 2011; Karakosta and Askounis, 2010).
- *All processes employ a common focus on the overall development context* of the developing country, 'mainstreaming' climate change into the context of sustainable development.

- The processes all have a *common need for assistance with implementation in developing countries*, in terms of financial support for the process steps, networking, training, data needs, etc.
- The processes aim at identifying *country needs to create or designate institutional and governance bodies* that can spearhead the process, identify relevant (research) resources, and streamline the findings.
- The processes aim at identifying *country needs to employ a stocktaking exercise to identify current and ongoing activities and policy contexts*.
- The processes have a common focus on working on a *strategic pathway* including action plans with Monitoring, Reporting, and Verification (MRV) requirements at the technology level, and sector and national level.

A.5 Building a Harmonization Strategy

A detailed discussion of the harmonization potential, based on process steps, is given in van der Gaast & Taminiiau, 2015). Examples of harmonization are:

- using similar background material for revisiting a country's long-term development vision within which the further analysis will have to be embedded, including strategic sectors for achieving climate and development goals;
- prioritizing technologies in a TNA by exploring their climate and development benefits at a desired scale in the country. These portfolios of priority technologies can subsequently be fed into an LEDS, NAMA or NAP process; and
- TNA, or jointly with a NAMA or NAP analysis, applies a market or system analysis to identify technology implementation barriers and technology innovation blockages and explore solutions for these. These solutions would form the basis for technology innovation strategies and this could form part of an overall LEDS.

A.6 Concluding Remarks

This appendix was included in the dissertation to highlight how there is potential within the UNFCCC negotiation framework to advance climate change mitigation and adaptation action and provide due recognition of the importance of this strategy. The strategy is discussed in much more detail in the dissertation by van der Gaast (2015).

In contrast to the ‘messy’ approach outlined in this dissertation, the harmonized approach discussed in this appendix offers a pathway of continued relevance to nation-state negotiations and ‘Kyoto era’ style characteristics. As the world gears up for the next COP negotiation round in Paris – destined by some as *the* negotiation round in terms of future climate change action – it is, at this point, unclear which strategy will be followed moving forward. Significant potential exists in both strategies but, as discussed in Chapter 3, the polycentric strategy of change appears to allow for a more forceful departure of ineffective Kyoto era characteristics while the pledge-and-review strategy is vulnerable to capture by optimality thinking.

Harmonization, nonetheless, remains an important aspect to consider as many modalities of harmonization are possible. This potentially opens the scope for a polycentric strategy of change that is supplemented by a harmonized strategy at the national level in order to preserve resources and establish learning-based platforms accessible to all actors. For example, knowledge gained through networks such as the LEDS Global Partnership and the CTCN could be mobilized to advance and support climate change action by polycentric networks of city actions. The LEDS Global Partnership and CTCN could, for instance, help identify capacity needs, offer information on available technologies, and help secure financing.

Appendix B

OTHER EXAMPLES OF POLYCENTRIC ACTION

B.1 Renewable Portfolio Standards (RPS)

A detailed overview of the RPS policy tool is provided by a large number of analysts (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Carley & Browne, 2012; Rabe B. G., 2006; Wiser, Barbose, & Holt, 2011). The RPS, in fact, has become the most prominent and popular energy and climate policy tool to be adopted at the state level (Carley & Browne, 2012). At the moment, twenty-nine states, two territories, and the District of Columbia have a mandatory RPS in place while an additional eight states and two territories have established voluntary renewable energy goals (Table 4.1).

Table B.1; Overview of U.S. states' RPS and Renewable Portfolio Goal (voluntary) targets. Twenty-nine states, Washington, D.C. and two U.S. territories have an RPS in place. An additional eight states and two U.S. territories have Renewable Portfolio goals. Source: DSIRE, 2014

State	Target
RPS	
Arizona	15% by 2025
California	33% by 2020
Colorado	30% by 2020 (IOUs) 10% by 2020 (Co-ops and large munis)*
Connecticut	27% by 2020
Delaware	25% by 2026
Hawaii	40% by 2030
Illinois	25% by 2025
Iowa	105 MW
Kansas	20% by 2020
Maryland	20% by 2022
Maine	10% by 2017 (new RE)
Massachusetts	22.1% by 2020

Michigan	10% & 1,100 MW by 2015
Minnesota	25% by 2025
Missouri	15% by 2021
Montana	15% by 2015
Nevada	25% by 2025
New Hampshire	24.8% by 2025
New Jersey	20.38% RE by 2021 4.1% solar by 2028
New Mexico	20% by 2020 (IOUs) 10% by 2020 (co-ops)
New York	29% by 2015
North Carolina	12.5% by 2021
Ohio	12.5% by 2024
Oregon	25% by 2025
Pennsylvania	18% by 2021
Rhode Island	16% by 2020
Texas	5,880 MW by 2015
Vermont	1) RE meets any increase in retail sales by 2012; 2) 20% RE and CHP by 2017
Washington, D.C.	20% by 2020
Washington, state	15% by 2020
Wisconsin	10% by 2015
Northern Mariana Islands	80% by 2015
Puerto Rico	20% by 2035
Renewable Portfolio Goal	
Oklahoma	15% by 2015
North Dakota	10% by 2015
South Dakota	10% by 2015
Utah	20% by 2025
Indiana	10% by 2025
West Virginia	25% by 2025
Virginia	15% by 2025
Guam	25% by 2035
US Virgin Islands	30% by 2025

The RPS policy tool was first introduced in 1983, when Iowa enacted the Alternative Energy Production law – which was subsequently revised in 1991 (Lyon & Yin, 2010). A similar initiative soon was underway in Minnesota (1994; DSIRE,

2014). However, discussions about how to design an RPS began in earnest in California in 1995 as an effort to maintain public support for renewables and to retain public benefits in the context of energy restructuring processes (Morris, Wiser, & Pickle, 1996; Wiser, Pickle, & Goldman, 1998; Rader & Norgaard, 1996).

Recognizing the demands of the restructured energy market, the debate at the time primarily centered around three new mechanisms with which to support renewable energy:

1. Programs funded by an electricity distribution surcharge;
2. Voluntary renewable energy purchases through green power marketing; and
3. The renewable portfolio standard (Wiser, Pickle, & Goldman, 1998).

In the debate on these three mechanisms, characteristics of the later debate about the pros and cons of the RPS surfaced. The market-based nature of the mechanism, its relatively simple administrative structure, its decentralized focus, its estimated cost-effectiveness and positive contribution to diversification, and mandatory character were offered as pros of the mechanism (Rader & Norgaard, 1996; Wiser, Pickle, & Goldman, 1998). Opposition centered around, among others, the ambitious nature of the policy mechanism, its uncertain cost profile, its potential limitation to only prioritize ‘low-hanging fruit’, and its potentially much more complicated administrative burden than estimated by the mechanism’s proponents due to issues such as monitoring, compliance, verification, and reporting (Wiser, Pickle, & Goldman, 1998).

California's discussion on the RPS in the late 1990s did not result in the state implementing a RPS at that time.⁶⁴ However, it did spark the interest of the wider clean energy advocacy community which rapidly picked up the concept (Wiser, Namovicz, Gielecki, & Smith, 2008). What followed was a rapid diffusion of the policy mechanism throughout the United States (Figure 4.1). In addition, Figure 4.1 demonstrates that most of the states have subsequently amended or reconfigured their RPS policy. Many of these amendments and reconfigurations were made to strengthen the RPS (Wiser, Namovicz, Gielecki, & Smith, 2008). However, this is not always the case. For instance, in May of 2014, Ohio was the first state to freeze its multi-year renewable energy ramp-up schedule (DSIRE, 2014). In addition, Ohio relaxed the acquisition rules for its utilities, allowing a larger share to be acquired from out-of-state (DSIRE, 2014). Nonetheless, the overall impetus appears to be one of continuous strengthening of the RPS policy mechanism (Wiser, Barbose, & Holt, 2011; Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007).⁶⁵

⁶⁴ California ultimately chose to enact a distribution surcharge-funded renewables program (Wiser, Pickle, & Goldman, 1998). However, later, in 2002, California did proceed with the enactment of a RPS. In fact, this RPS is frequently cited as among the strongest – if not, the strongest – RPS in the nation (Rabe B. G., 2006; Rabe B. G., 2008).

⁶⁵ This becomes extra clear when one compares, for instance, the analysis presented by Byrne et al. (2007) with the overview presented in this chapter in Figure 4.1 and Table 4.1. Many of the targets set by the RPS policies are now more stringent than they were in 2007.

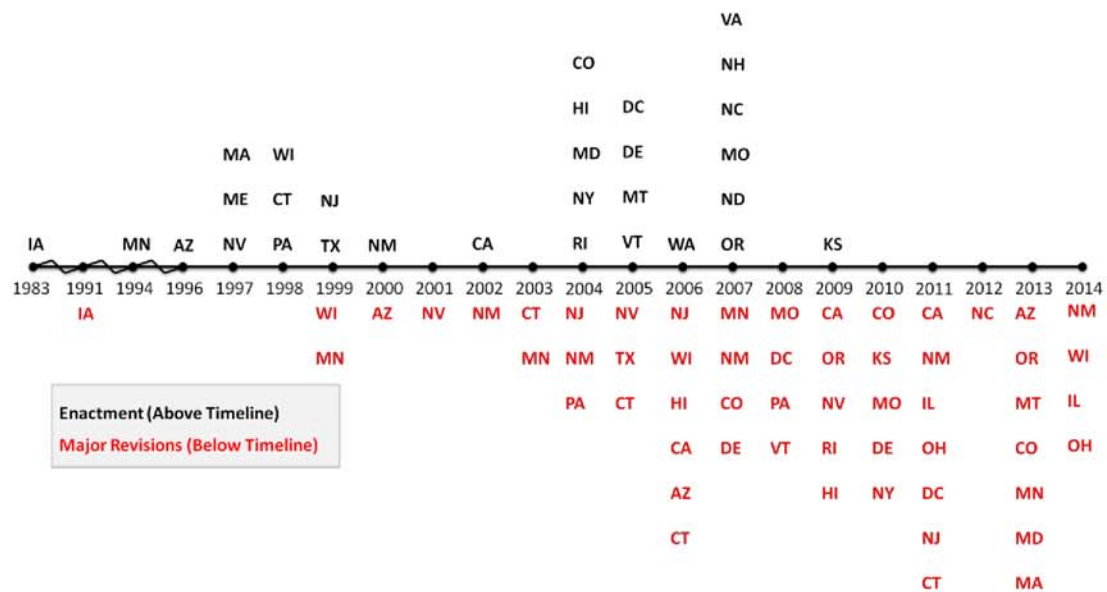


Figure B.1; Timeline of RPS diffusion and reconfiguration among U.S. states.
Source: updated from (Lyon & Yin, 2010; Wiser, Namovicz, Gielecki, & Smith, 2008) using the Database of State Incentives for Renewables and Efficiency (DSIRE, 2014).

An interesting question is to ask why this policy mechanism has seen such a rapid diffusion pattern. Answers to this question potentially elucidate the further potential of sub-national and sub-global policies to ramp up to meet the sustainability challenge. In his seminal work, *Greenhouse and Statehouse – The Emerging Politics of American Climate Change Policy*, Barry G. Rabe (2004) offers several explanations for why states deem RPSs so attractive. Among others, Rabe (2004) identifies policy entrepreneurial activity within his case studies and extracts arguments that highlight economic benefits. This assessment has been followed by several analysts trying to identify diffusion rationales (Lyon & Yin, 2010; Chandler, 2009; Huang, Alavalapati, Carter, & Langholtz, 2007; Carley & Miller, 2012; Fowler & Breen, 2013; Yi & Feiock, 2012; Stoutenborough & Beverlin, 2008; Matisoff, The Adoption of State

Climate Change Policies and Renewable Portfolio Standards: Regional Diffusion or Internal Determinants?, 2008; Wiser & Barbose, 2008b). Together, these studies provide insight into why states might adopt RPS policies:

- *Geography*: Distance from other states with RPS policies in effect is cited as an important factor (Stoutenborough & Beverlin, 2008; Chandler, 2009).
- *Renewable energy potential*: for instance, states with a large resource for wind energy are more likely to adopt the RPS policy (Lyon & Yin, 2010; Matisoff, 2008; Stoutenborough & Beverlin, 2008; Yi & Feiock, 2012).
- *States with a restructured electricity market*: like with the original debate surrounding the RPS, a restructured electricity market likely opens up the narrative of state government action (Lyon & Yin, 2010).
- *Citizen Wealth*: a positive relation can be extracted between citizen wealth and policy adoption (Carley & Miller, 2012; Yi & Feiock, 2012; Chandler, 2009)
- *Electricity fuel mix*: while research shows that local environmental benefits (for instance, in states with a heavy reliance on coal) does not significantly explain the diffusion pattern, states are more likely to adopt an RPS when they are not very dependent on natural gas (a resource often positioned as a transition fuel) (Lyon & Yin, 2010; Stoutenborough & Beverlin, 2008).
- *Political/Legislative Ideology*: states with a strong Democratic presence in the state legislature appear more willing to accept the RPS while Republican States appear less willing (Lyon & Yin, 2010; Stoutenborough & Beverlin, 2008; Huang, Alavalapati, Carter, & Langholtz, 2007; Fowler & Breen, 2013).
- *Private interests/Citizen Ideology*: states with an organized renewable energy interest movement or strong citizen ideology appear more willing to accept the RPS (Lyon & Yin, 2010; Carley & Miller, 2012; Yi & Feiock, 2012; Matisoff, The Adoption of State Climate Change Policies and Renewable Portfolio Standards: Regional Diffusion or Internal Determinants?, 2008). However, the

hypothesis that economic benefits of job creation is a driving force for RPS adoption appears unsupported (Lyon & Yin, 2010).

These characteristics perhaps signal why certain states, particularly the states in the south-east of the U.S. (see Figure B.2), have not adopted the RPS mechanism as of yet. As such, this could indicate how sub-national efforts could be limited in attracting participation just like (inter)national efforts. However, it also demonstrates that there are a range of factors that allow for sub-national action, opening up governance pathways for climate change that are perhaps left unexploited when focusing on mono-centric applications only.

Several analysts have sought the answer to the sustainability question in a comparative analysis between the RPS tool and other policy instruments, particularly the hypothetical implementation of a national cap-and-trade system. Palmer & Burtraw (2005), for instance, conclude that a national cap-and-trade mechanism would be more cost-effective and appropriate compared to a national RPS. This line of reasoning is supported by other authors as well (see, for example, (Fischer & Newell, 2008; Bird, Chapman, Logan, Sumner, & Short, 2011)).

However, analyses that demonstrate the higher effectiveness of policy instruments that have been consistently shown to be politically unpalatable (at least in the U.S.) are perhaps of limited value. A national cap-and-trade program could well be more effective in reducing greenhouse gas emissions but, in the case that it is unlikely to ever see implementation, only distracts from the question of RPS effectiveness. In a way, such a focus only serves to continue ‘carbon tax or trade’ discussions that have been ongoing for decades (Poterba, 1991; Wittneben, 2009). Moreover, the RPS tool is not directly targeting greenhouse gas emission reductions. Rather, the tool seeks to elevate the implementation of renewable energy technology.

The sustainability contribution of the RPS tool needs to be reflected in light of these points. Evidence exists that the RPS tool is able to contribute to both the elevation of the share of renewable energy as well as contribute to decarbonization of society's energy mix (see, for instance, (Luke & Eastin, 2014; Rabe B. G., 2008; Carley S. , 2011; Carley & Browne, 2012; Yin & Powers, 2010; Wiser, Porter, & Grace, 2004). Case study evidence shows RPS effectiveness in facilitating the implementation of renewable energy (Rabe, 2008) and establishing competition between renewable energy producers (Langniss & Wiser, 2003). Indeed, a “convincing” (Carley & Browne, 2012, p. 493) case can be made that the RPS policy on average effectively increases the overall amount of renewable energy (Bird, et al., 2005; Doris, McLaren, Healey, & Hockett, 2009; Yin & Powers, 2010; Sherwood, 2013; Carley S. , 2009).

However, as Carley & Browne (2012) document, RPS policies do not address energy demand leading to the observation that these policies do not necessarily raise the percentage share of renewable electricity in the overall electricity mix (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Wiser, Namovicz, Gielecki, & Smith, 2008; Cory & Swezey, 2007). Other complications that hinder overall RPS effectiveness are non-compliance (Rabe B. G., 2008; Wiser, Namovicz, Gielecki, & Smith, 2008; Wiser, Barbose, & Holt, 2011). As Carley & Browne (2012) document, noncompliance can, at least partly, be ascribed to problems associated with project siting (Wiser & Barbose, 2008b; Rabe B. G., 2006), intermittency of renewable energy (Lafrancois, 2010), and firm response differentiation. Additionally, experience shows that RPS support has particularly advanced wind energy (Buckman, 2011; Wiser, Barbose, & Holt, 2011), a strategy pursuing least-cost, large-scale deployment of

renewable energy (Taminiau et al., forthcoming). Technology-specific carve outs and multipliers have emerged as a regulatory response to this perceived lack of diversity (Browne & Carley, 2012) and positive results have been achieved (Wiser, Barbose, & Holt, 2011; Buckman, 2011). Finally, ‘carbon leakage’ concerns arising from the patchwork status of RPS implementation is further positioned as an consideration that might limit current RPS effectiveness (Carley S. , 2011; Carley & Miller, 2012).

The above amounts to a contradictory image of RPS effectiveness, with some citing the effective nature of the instrument while others cautioning against such optimism. A recent comprehensive analysis combined these research results, including both findings of negative and positive relationships between RPS implementation and renewable energy deployment, and produces an outcome that, overall, concludes that RPS implementation results in a positive net effect on renewable energy development: a 1% increase in RPS stringency creates aprox. 0.3% renewable energy share in the energy mix (Shrimali, Jenner, Groba, Chan, & Indvik, 2012).

The RPS policy response can be argued to be a significant departure from a limited U.S. response status quo in the climate and energy policy landscape. In fact, as demonstrated by Figure 4.2, the current level of implementation of the RPS policy tool displays a high level of coverage in terms of retail sales, population, CO₂ emissions, Gross Domestic Product, and geography. In other words, the absence of a federal approach for renewable energy and climate change policy has spurred a widespread response in the U.S. states. While difficulties such as mentioned above exist with the new policy tool (see Carley & Browne, 2012 for a more exhaustive overview), RPS experimentation and recombination with other policy instruments that have gained

traction in the U.S. policy landscape can deliver a response that accelerates the energy transition.

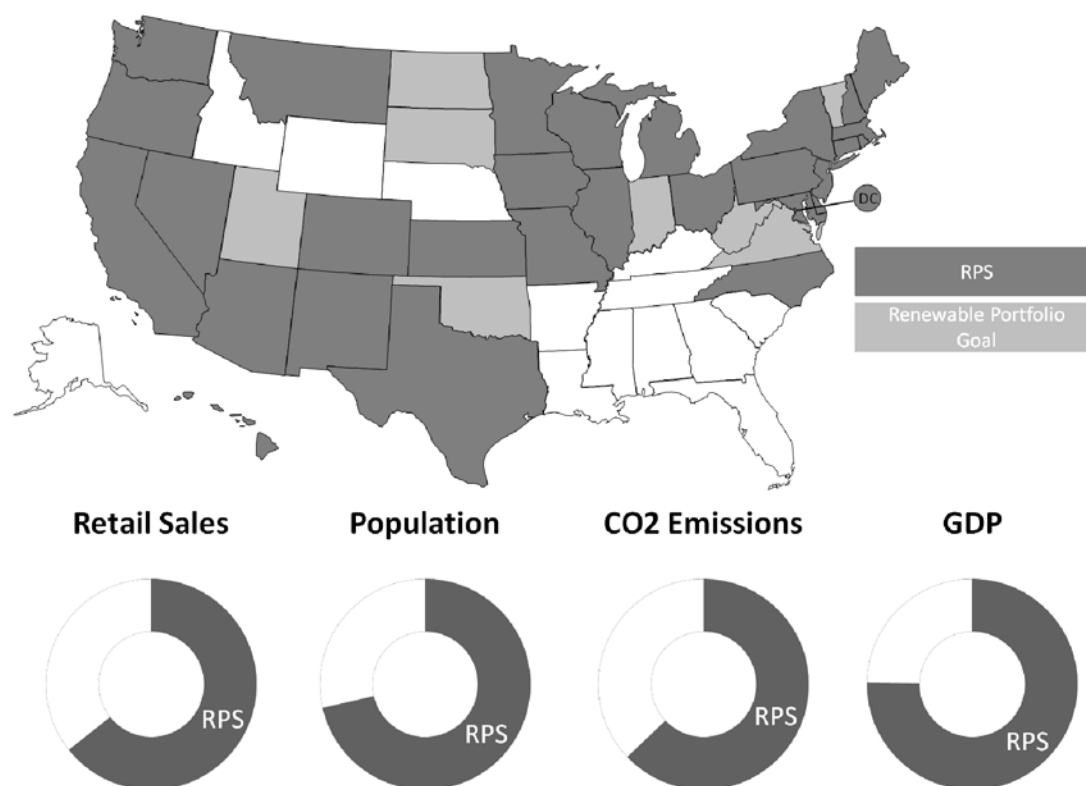


Figure B.2; Overview of RPS and Renewable Portfolio Goal (voluntary) policies in place in the United States. Source: Adapted from DSIRE, 2014 by adding doughnut charts on retail sales (Energy Information Administration, 2013), population (United States Census Bureau, sd), CO₂ emissions (Energy Information Administration, sd), and Gross Domestic Product (GDP) (US Bureau of Economic Analysis, sd).

Despite the potential problems with compliance cited above, the record of performance of the RPS policy instrument appears to be largely one of compliance (Figure 4.3). Only a select number of states fail to demonstrate full compliance. Even

so, while RPS compliance in a particular year might not be fully met, Figure B.3 shows how full compliance is often achieved in other years. Additionally, while expected to climb when targets rise, compliance costs have generally been low (less than 3% of average retail rates in most states), solar set-asides appear particularly effective in spurring PV implementation, and renewable energy capacity additions can be at least partially ascribed to RPS policy as 61% (46 GW) of capacity additions serve entities with RPS obligations (Barbose G. , 2014).

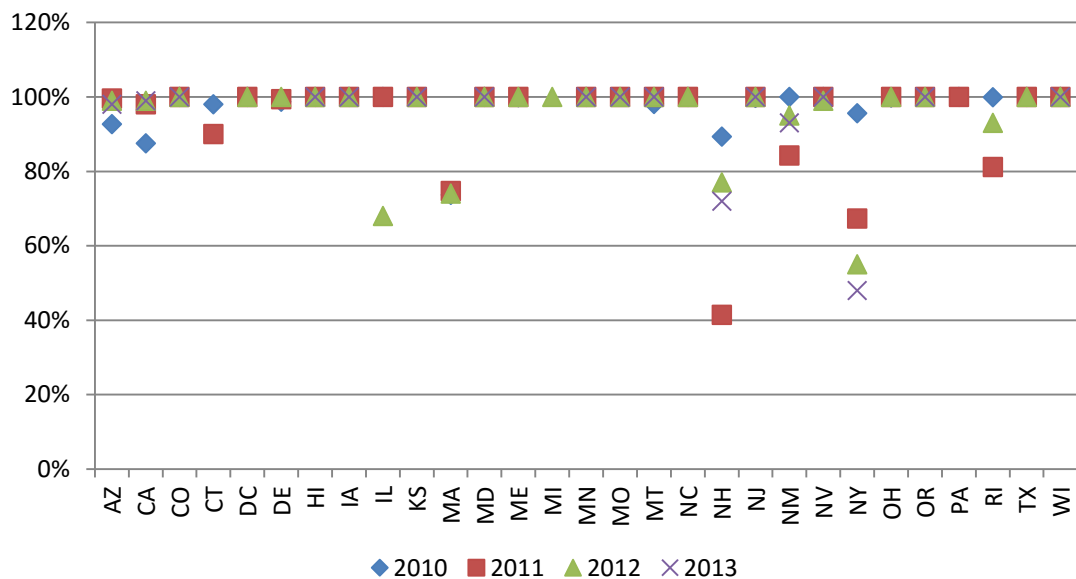


Figure B.3; Record of performance for RPS compliance over 2010-2013. Data points show compliance with the states' 'total RPS'. In other words, compliance differences exist within the various tiers (e.g., solar/non-solar) of states' RPSs but these are not included here. Data from Lawrence Berkeley National Laboratory (LBNL) (rps.lbl.gov).

B.2 Energy Efficiency Resource Standards (EERS)

In terms of energy efficiency, an “unprecedented expansion” of rate-payer funded energy efficiency programs is underway in the United States (Barbose, Goldman, & Schlegel, *The Shifting Landscape of Ratepayer Funded Energy Efficiency in the U.S.*, 2009). In part, this development can be attributed to the implementation of the Energy Efficiency Resource Standard (EERS). Sharing many similarities with RPS programs, the EERS policy essentially establishes a mandate to reduce the use of electricity (and, in some cases, natural gas) by a described percentage or amount against a target year or time-period (Nadel, *Energy Efficiency Resource Standards: Experience and Recommendations*, 2006; Brennan & Palmer, 2013). In addition, again similar to the RPS policy instrument, EERSs can be accompanied by market-based exchange systems to offer flexibility in meeting compliance requirements (Nadel, *Energy Efficiency Resource Standards: Experience and Recommendations*, 2006). The shared similarities with the RPS policy instruments leads some to argue EERS policies are analogues to RPSs (Sciortino, Nowak, White, York, & Kuschler, 2011).⁶⁶ However, energy efficiency outperforms renewable energy’s relatively high levelized cost of electricity (Lazard, 2013) and is more homogenous in its availability as it doesn’t share renewable energy’s

⁶⁶ A comparative policy instrument is in place in the European Union. Directive 2012/27/EU establishes a 20% reduction in energy use by 2020 mandate (European Parliament and Council, 2012). Subsequently, this Directive finds national implementation. To date, energy use reductions are not permitted to be subject to cross-border trading (i.e. white certificates) but individual nation-states have enacted provisions for white certificate activity.

characteristic of significant geographic variance (Nadel, Energy Efficiency Resource Standards: Experience and Recommendations, 2006).

Depending on the definition used, different accounts emerge on the adoption level of EERS. For example, For instance, the DSIRE database accounts for twenty states with an EERS but excludes seven other states that are typically included in other databases (see, for example, (Sciortino, Nowak, White, York, & Kuschler, 2011)).⁶⁷ An example of a definition is provided by Palmer et al. (2013, p. 44): “a legally binding numeric target for energy use reduction stated in either percentage or quantity terms”. Table 4.2 provides an overview of the current status of EERS policy implementation in the United States.

Table B.2; Overview of U.S. states’ EERS and their targets. Source: (American Council for an Energy Efficient Economy [ACEEE], 2014).⁶⁸

State	Target
Arizona	Annual savings targets began at 1.25% of sales in 2011, ramping up to 2.5% in 2016 through 2020.
Arkansas	Annual reduction of 0.75% of total electric kWh sales in 2014 and 0.9% in 2016.
California	About 0.9% annual savings through 2020. Demand reduction of 4,541 MW through 2020.
Colorado	0.8% of sales in 2011, increasing to 1.35% of sales in 2015 and 1.66% of sales in 2019.
Connecticut	Targets equivalent to annual savings of approx. 1.4% through 2015
Hawaii	Reduce electricity consumption by 4,300 GWh by 2030
Illinois	0.2% annual savings in 2008, 1% in 2012, 2% in 2015 and thereafter.

⁶⁷ DSIRE structures these as states with energy efficiency resource goals.

⁶⁸ Several EERS policies also have targets for natural gas in place, the targets in the table are limited to electricity.

Iowa	Varies by utility from 1-1.5% annually through 2014
Maine	Annual saving targets of 1.6%, total savings of 20% by 2020.
Maryland	15% per-capita electricity use reduction goal by 2015.
Massachusetts	1.4% in 2010, 2.0% in 2011, 2.4% in 2012, 2.5% in 2013, increasing to 2.6% by 2015.
Michigan	0.3% annual savings in 2009, ramping up to 1% in 2012 and continuing through 2015.
Minnesota	1.5% annual savings and thereafter.
Nevada	20% of retail electricity sales to be met by renewables and energy efficiency by 2015 and 25% by 2025.
New Mexico	5% reduction from 2005 total retail electricity sales by 2014, and an 8% reduction by 2020.
New York	15% cumulative savings by 2015.
North Carolina	Renewable generation and/or energy savings of 6% by 2015, 10% by 2018, and 12.5% by 2021 and thereafter.
Ohio	22% by 2025
Oregon	0.8% of 2009 electric sales in 2010, 1.4% in 2013 and 2014.
Pennsylvania	3% cumulative savings from 2009 to 2013; 2.3% cumulative savings 2014-2016.
Rhode Island	Annual savings of 1.7% in 2012, 2.1% in 2013, 2.5% in 2014.
Texas	20% incremental load growth in 2011; 25% in 2012; 30% in 2013 onward.
Vermont	Expected cumulative savings of approx. 6% from 2012-2014
Washington	Biennial and Ten-Year Goals vary by utility.
Wisconsin	Annual savings of 0.66% of sales in 2011-2014.

Steinberg & Zinaman (2014) and ACEEE (2014) position the beginning of the EERS policy instrument with Texas in 1999, but energy efficiency efforts have been in place in some way or another since the energy crises in the 1970s leading some to argue that the beginnings of the EERS can be found with Florida in 1980 (Palmer, Grausz, Beasley, & Brennan, 2013). The Texas EERS required electric utilities to offset 10% of load growth through end use energy efficiency but these targets have subsequently been increased to 15% of load growth by 2008 and 20% by 2009 and additional energy savings objectives have been put in place (American Council for an Energy Efficient Economy [ACEEE], 2014).

Like with the RPS, many different design options and features are available with the EERS (Steinberg & Zinaman, 2014). A key differentiating factor is the target level but also target type, units used, incentives, and compliance flexibility (Steinberg & Zinaman, 2014). For instance, the level of savings specified by the EERS in Texas is approximately 1% of reference consumption while New York's EERS is up to 15% in 2015 (Steinberg & Zinaman, 2014).

Similar to the RPS, many of the EERS policies, after initial adoption, have subsequently been revised and oftentimes made more stringent (Downs & Cui, 2014; Steinberg & Zinaman, 2014; Figure 4.4). The EERS policy also enjoys a rising popularity: since Texas, twenty-five other states have followed suit (DSIRE, 2014) and the majority of adoptions of EERS policies have only taken place recently (Figure 4.4). General supporting rationales offered for this expansion of the EERS policy are rising concerns about energy price volatility and increases, energy security considerations, and climate change (Brennan & Palmer, 2013). The attractive low levelized cost of energy saving measures (Lazard, 2013), furthermore, can be seen as a supporting rationale for the increasing focus on energy saving policies: for instance, the Bipartisan Policy Center's Strategic Energy Policy Initiative terms energy efficiency the "cheapest and cleanest energy source" in the U.S. (Bipartisan Policy Center, 2013, p. 67). Other common benefits cited by policy-makers to justify EERS adoption are: overcoming market failures, reaping environmental benefits (including climate change mitigation but also improving local air quality), reducing peak electricity demand, driving economic development, create green jobs, and improve energy security (Brennan & Palmer, 2013; Palmer, Grausz, Beasley, & Brennan, 2013).

Energy policy diffusion literature, while plentiful for RPS adoption events, appears more limited for EERS (King, 2014). For instance, a Georgetown University Master Thesis finds a strong relationship between a state's political and citizen liberalness but finds no significant relationship between electricity decoupling nor retail electricity prices and the likelihood of EERS adoption (King, 2014). Meanwhile, a recent ACEEE study concludes that economic competition and air quality considerations matter in EERS adoption patterns: poor air quality relative to other states and higher electricity costs have a positive relationship with EERS adoption (Dillingham, 2014). Finally, a comparative analysis of policy adoption between net metering, RPS, and EERS, finds that citizen wealth and ideology is significant in a direct comparison between the three policies, but also finds that, accounting for stringency in design, a significant negative association exists between EERS adoption and electricity deregulation for 'weak' EERS policies while 'strong' EERS policies have a significant relationship with electricity price and climate degree day variability (Carley & Miller, 2013). The authors concluded:

EERS policy adoption, therefore, is most likely when political considerations are not preeminent over economic ones, suggesting that policymakers may be primarily concerned with practical problem-solving (Carley & Miller, 2013).

Several states have indicated a substantial pull-back away from energy efficiency savings. For instance, legislators in Indiana eliminated the state's long-term energy savings goals (Frazee, 2014) and Ohio froze its EERS requirements for two years allowing large customers an option of opting out and, in addition, Ohio's Senate Bill 310 substantially weakened the EERS (Database of State Incentives for Renewables and Efficiency (DSIRE), 2014). Utilities in both Indiana and Ohio have signaled they will continue energy efficiency programs but at levels below what would

have been required by the EERS (Kiker, 2014). Nevertheless, like with the RPS, on average, states are ramping up their commitments to energy efficiency (Downs, et al., 2013; Kiker, 2014).

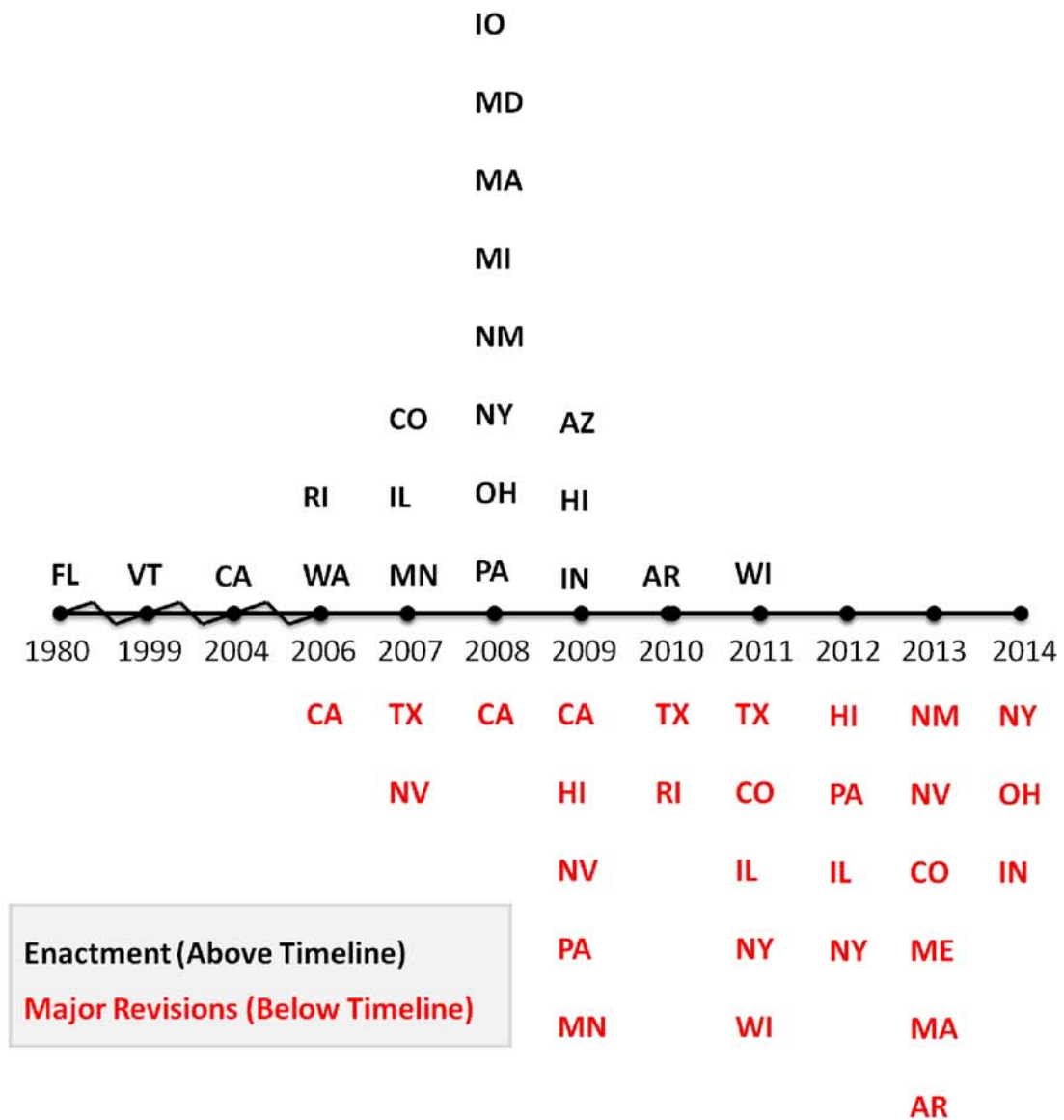


Figure B.4; Overview of EERS diffusion pattern. Adapted from (Palmer, Grausz, Beasley, & Brennan, 2013).

EERS policies establish mandates for energy use reductions but do not establish an absolute cap on energy use; in other words, effectiveness tests significantly depend on counterfactual baseline estimates (Brennan & Palmer, 2013). Such a reference scenario determines the energy use level if no EERS policy framework would have been implemented. Palmer et al (2013) provide an overview of the level of stringency of U.S. EERS policies for twenty states using such a reference scenario. They conclude that the combined contribution of the twenty states they investigated amounts to a 12.7% reduction in covered electrical load and a 11.5% percent in overall state load (Palmer, Grausz, Beasley, & Brennan, 2013). A recent calculation by the National Renewable Energy Laboratory (NREL) estimates a 5% electricity consumption reduction below projections by 2015 and about 8-15% by 2020; corresponding to a reduction in national electricity consumption of about 3% in 2015 and 4%-6% in 2020 (Steinberg & Zinaman, 2014). The stated policy goals exceed the historical performance record of U.S. ratepayer-funded energy efficiency savings (as documented by, for instance, by (Arimura, Li, Newell, & Palmer, 2011)) by a significant margin. This is accompanied by a rising expenditure by utilities: in the U.S., utilities spent about \$5.9 billion on efficiency in 2012 (Downs, et al., 2013).

Table B.3; Overview of the stringency of U.S. States' EERS policies as estimated by two articles.

State	Palmer et al. (2013)			Steinberg & Zinaman (2014)	
	Year ^a	Share of sales covered ^{b, d}	Percent of reference (state) ^{c, d}	Year	Annual Savings Required in 2020 (% of state load) ^g

			Percent of reference (covered) c, d					Method 1 ^f	Method 2 ^f
Arizona	2020	99%	18.2%	18.1%	2020	11.4%	11.4%		
Arkansas	2013	61%	1.5%	0.9%	2014	2.5%	6.2%		
California	2020	74%	16.2%	12.0%	2014	3.8%	6.5%		
Colorado	2020	57%	14.9%	8.5%	2020	7.7%	7.7%		
Florida	2019	84%	3.8%	3.2%	-	-	-		
Hawaii	2030	100%	35.2% ^e	35.2% ^e	2030	19.0%	19.0%		
Iowa	2020	74%	13.4%	9.9%	2013	3.8%	10.0%		
Illinois	2020	89%	16.1%	14.3%	2020	14.4%	14.4%		
Indiana	2020	100%	12.6%	12.6%	2019	9.2%	10.7%		
Maryland	2015	100%	16.1%	16.1%	2015	14.7%	27.2%		
Massachusetts	2012	86%	5.5%	4.7%	2015	10.6%	21.1%		
Maine	-	-	-	-	2016	8.2%	12.9%		
Michigan	2020	100%	9.6%	9.6%	2020	9.7%	9.7%		
Minnesota	2020	100%	14.7%	14.7%	2020	15.3%	15.3%		
New Mexico	2020	67%	8.7%	5.8%	2020	5.2%	5.2%		
New York	2015	100%	16.9%	16.9%	2015	15.0%	27.5%		
Ohio	2025	88%	19.1%	16.8%	2025	10.3%	10.3%		
Oregon	-	-	-	-	2014	4.5%	10.5%		
Pennsylvania	2013	96%	2.9%	2.8%	2016	5.0%	7.8%		
Rhode Island	2014	100%	10.0%	10.0%	2014	8.3%	22.7%		
Texas	-	-	-	-	2020	2.6%	2.6%		
Vermont	2011	94%	6.9%	6.4%	2014	9.8%	21.0%		
Washington	-	-	-	-	2021	8.1%	8.1%		
Wisconsin	-	-	-	-	2014	2.6%	6.6%		

^a Policies defined with last year requirements prior to 2020 continuing each year after their final specified year are shown with a final year of 2020.

^b Covered Sales Share is the percent of 2009 electricity sales covered under the EERS divided by the total state electricity sales.

^c Stringency determined by Palmer et al. (2013) based on an overall 0.9 % annual growth rate in demand in the absence of the EERS. Importantly, therefore, the projections of energy demand in the absence of the EERS policy are not state-specific. Other important assumptions are full EERS compliance and consistent energy reduction results year after year. In addition, the reference scenario is calculated by Palmer et al. (2013) to reflect their estimate of the amount of electricity use in a given year but for the EERS.

^d EERS policies across the U.S. differentiate between investor-owned utilities, co-ops, and municipal utilities. The policies can seek to elicit compliance from any combination of these three groups, causing differences in coverage. ‘state’ in the final column reflects the results when one considers state-wide sales and demand patterns according to Palmer et al.’s (2013) reference scenario.

^e Some of the calculations by Palmer et al. (2013) can perhaps be seen as somewhat strenuous. For instance, the calculation for Hawaii, going out all the way to 2035 is executed based on assumptions that early savings results persist throughout the entire time period without performance erosion. However, the overall case that EERS can be seen as a significant attempt at restructuring energy landscapes remains standing.

^f To account for the differences in final year, Steinberg & Zinaman (2014) deploy two methodologies. Method 1 assumes that annual savings requirements in the years without specified targets – so, the years following the final years of the policy up to 2020 – are equal to annual savings requirements in the final target year. Method 2 assumes that incremental savings requirements in the years without specified targets is equal to the incremental savings required in the final target year. Working under the assumption that implemented energy saving measures continue to contribute savings without erosion of performance up to 2020, Method 1 makes states with near-term targets seem less stringent, while Method 2 may exaggerate savings for these states.

A caveat to the results presented in Table 4.3 can be made in the observation that ‘conventional’ energy savings expectations as documented by surveyed energy efficiency experts largely align with EERS contributions, suggesting that the policy instrument could perhaps be made more aggressive (Faruqui & Mitarotonda, Energy Efficiency and Demand Response in 2020 - a Survey of Expert Opinion, 2011).⁶⁹ Additionally, considerable uncertainty questions and regional differences remain in terms of evaluation, monitoring, and verification of estimated energy savings (Loper, Capanna, Sobin, & Simchak, 2010; Messenger, Bhavirkar, Golemboski, Goldman, & Schiller, 2010; Palmer, Grausz, Beasley, & Brennan, 2013, pp. 50, Table 7; Vine, Hall, Keating, Kushler, & Prah, 2012); especially considering most estimates assume full compliance and full results throughout the lifetime of the measures. Similarly, ex-

⁶⁹ The experts predict that reductions in electric energy use will be on the order of 5 to 15 % relative to a BAU-scenario that does not contain energy efficiency policies while natural gas reductions will be 5 to 10 % by 2020.

post evaluation in some nation-states of the European Union was limited and early laxness in efforts might have simplified compliance (Bertoldi & Rezessy, 2007; Pavan, 2008; Giraudet, Bodineau, & Finon, 2011).

Nonetheless, the twenty-five states that have put EERS policies in place represent a significant portion of U.S. population, GDP, emissions, and retail electricity sales (Figure 4.4). The scale of the EERS policies, moreover, becomes extra apparent through ACEEE estimates suggesting, when in full compliance, a savings levels equivalent to the combined electricity consumption from Maryland, Washington, Minnesota, Vermont, and Rhode Island (American Council for an Energy Efficient Economy [ACEEE], 2014). This is also approximately equivalent to powering a million homes for twenty years (Downs & Cui, 2014).

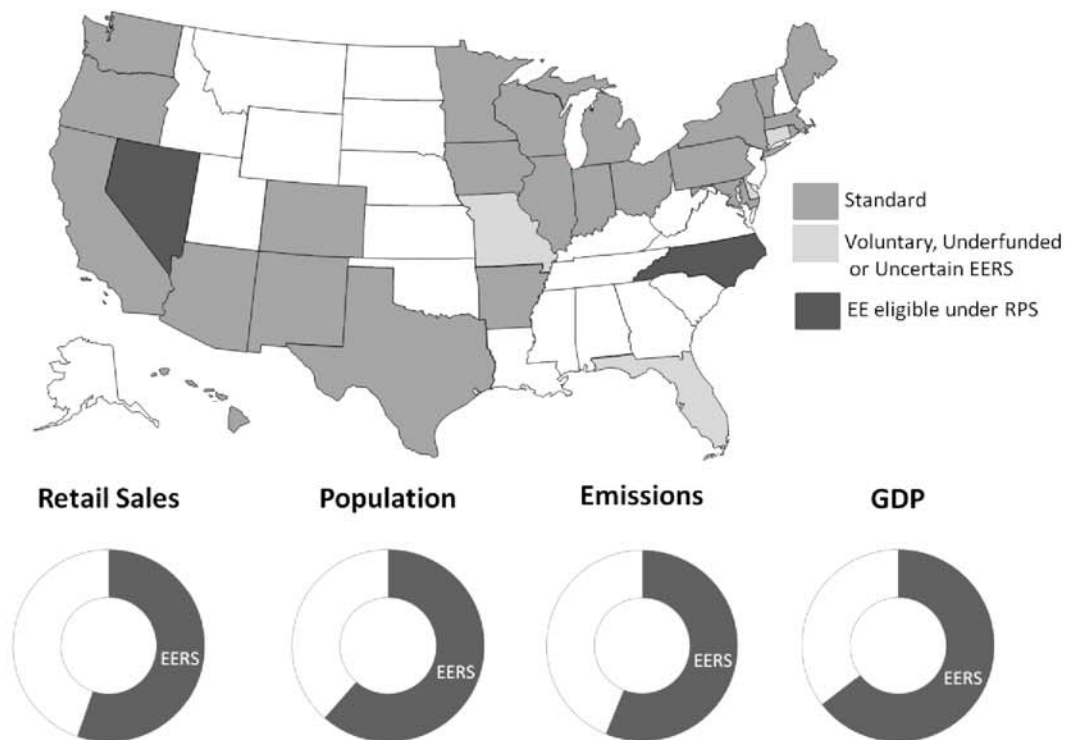


Figure B.5; State Energy Efficiency Resource Standards (EERS). Source: Adapted from (American Council for an Energy Efficient Economy [ACEEE], 2014; Steinberg & Zinaman, 2014) by adding information on retail sales (Energy Information Administration, 2013), population (United States Census Bureau, sd), emissions (Energy Information Administration, sd), and GDP (US Bureau of Economic Analysis, sd).

Finally, an important consideration with EERS policy implementation is whether the stated goals are being observed. To date, states with EERS policies have demonstrated full or near full compliance with EERS mandates: thirteen states exceeded their savings targets in 2011 and fifteen states reached full compliance in 2012 (Downs & Cui, 2014). The compliance record for EERS policy implementation for 2011 and 2012 is documented in Figure 4.5. This performance record suggests that the EERS policies are contributing to substantial electricity consumption reductions: a

planned total of over 18 million MWh in energy savings 2012 was overshoot with 2 million MWh (Downs & Cui, 2014). Substantial over-compliance in some states shows, additionally, that EERS targets are, perhaps, not stringent enough.

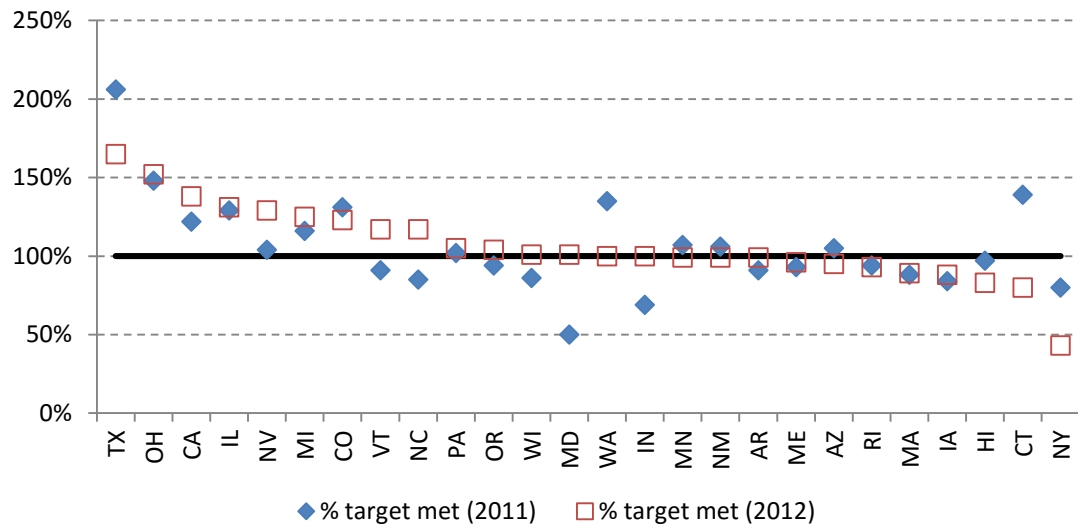


Figure B.6; Compliance record for EERS policies across the United States. Source: (Downs & Cui, 2014).

B.3 Executive Action

A recent U.S. National Climate Assessment warns that climate change “has moved firmly into the present” (Melillo, Richmond, & Yohe, 2014) and U.S. civil society is largely in favor of stronger U.S. climate change action (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013; Leiserowitz, et al., 2013). The U.S. Congressional environment, however, has been effective in opposing U.S.-wide climate change action throughout most of the climate change negotiations (Ch. 1). The current Administration, presided by Barack Obama, has pursued a different track to

seek climate change action. A recent piece of work by CEEP, to which I contributed, documents U.S. clean energy policy (CEEP, 2013). The following paragraphs are based on those findings.

On June 25, 2013, President Obama issued a memorandum that directs the EPA to produce standards and guidelines for conventional power plants. In September 2013, the EPA announced carbon pollution standards for power plants pursuant to Section 111(d) of the Clean Air Act. On June 2, 2014, the EPA proposed its ‘Clean Power Plan’: state-specific rate-based goals for CO₂ emissions from the power sector combined with guidelines for states to follow in developing plans to achieve these goals. The overall objective of this piece of regulation is to achieve approx 30% CO₂ emission reductions by 2030 compared against a 2005 baseline. To reach this target, the EPA proposal suggests the following four ‘building blocks’ for states to implement:

1. Improve the efficiency of all coal-fired electricity generating units in the state by 6%;
2. Increased operation of all existing natural gas combined cycle units to a 70% capacity factor. Increased operation of these facilities is assumed to offset existing generation at coal-fired facilities in the state.;
3. Improve the penetration rate of renewables by 2 to 25 % depending on the state, assume that any nuclear power plants under construction will be built, and that 5.8% of all existing nuclear capacity does not retire.; and
4. Increased use of energy efficiency programs in order to bring down electricity consumption by 9 to 12% by 2030, depending on the state.

However, how these ‘building blocks’ are to be implemented is largely left up to the state (Potts & Zoppo, 2014; Wilson, Rankin, & Miller, 2014). Final guidelines will be issued by the EPA in June 2015 and states must submit implementation plans

by June 2016. Determining how states are affected by the new ruling has proved difficult as the EPA's assumptions need to be aligned with individual state profiles (Potts & Zoppo, 2014). While states have begun the exploration of how the Clean Power Plan plays out for their states – for instance, energy efficiency policy design has received renewed interest as a result of EPA's efforts (Steinberg & Zinaman, 2014) – the overall question that remains is whether the Clean Power Plan will be able to hold up under scrutiny of the Supreme Court (Potts & Zoppo, 2014).

At 28% of national greenhouse gas emissions, the transportation sector represents a significant source of the U.S. contribution to climate change (Environmental Protection Agency [EPA], 2013). Regulatory measures to improve the Corporate Average Fuel Economy (CAFE) standards as introduced in 2010 represent a substantial change in U.S. transportation policy. In 2010, CAFE standards were raised by the federal government for model year 2016 (MY2016) for new passenger vehicles to 34.1 miles per gallon (mpg); a 15% increase from MY2011 standards. Additional standards were introduced for MY2025 in 2012: CAFE standards to up to 54.4 mpg represent a >90% increase over MY2011 levels (The White House, 2012; Center for Climate & Energy Solutions [C2ES], sd). These efforts were simultaneously accompanied by the introduction of new greenhouse gas emission standards for transportation: newly proposed greenhouse gas emission standard levels at 225 grams/mile in 2016 and 143 grams/mile in 2025 represents a 36% drop in emissions per mile. Figure B.6 provides an overview of these changes.

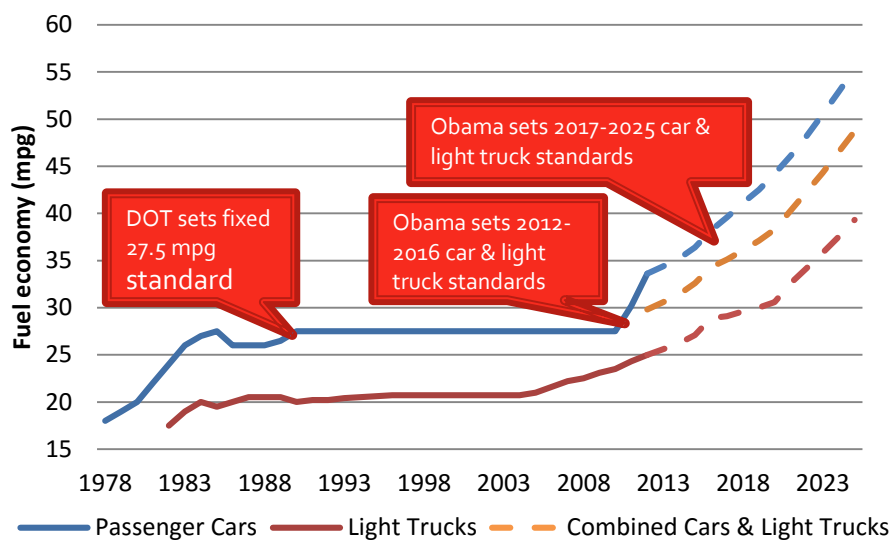


Figure B.7; U.S. fuel economy standards over time with key turning points inserted.
Source: CEEP, 2013. DOT= Department of Transportation.

Appendix C

CITY SAMPLE ACCORDING TO UNEP FORMAT

The emissions profile of the cities described in Figure 4.9 are provided here. All the inventories of the various cities have been reformatted according to UNEP and IPCC guidelines using the International Standard for Determining Greenhouse Gas Emissions for Cities.⁷⁰

Table C1; Seattle Emission Profile in Standard Format. Source: (Ericson & Tempest, 2014b).

	SCOPE	TOTAL			
Year		1990	2005	2008	2012
Population (Thousands)		516	573	594	635
ENERGY (MtCO₂e)		5,560	5,374	5,582	5,454
a) Stationary Combustion		2,148	1,887	2,058	1,912
Electricity (incl. T&D losses)	1,2,3	364	196	143	91
District heating or cooling, CHP, and energy from waste	1,2,3	540	722	833	822
Commercial & Institutional	1	710	741	838	814
Residential	1	608	519	581	529
Manufacturing Industries & Construction	1	466	431	496	478
Other	1				
b) Mobile Combustion (MtCO₂e)		3,412	3,487	3,524	3,542
Road transportation: LDVs	1	1,512	1,572	1,510	1,603
Road transportation: trucks	1	635	681	677	720

⁷⁰ For additional information on the format, please see:
http://www.unep.org/urban_environment/PDFs/InternationalStd-GHG.pdf

Road transportation: buses	1	49	56	68	66
Railways	1	86	90	89	65
Domestic & International Aviation	3	940	904	976	905
Domestic marine	3	41	42	35	42
International marine	3	150	143	169	141
c) Fugitive Sources					
INDUSTRIAL PROCESSES	1	448	1,095	990	581
AFOLU	1				
WASTE		123	126	117	97
Solid waste disposal on land	1,3	122	124	115	95
Wastewater handling	1,3	2	2	2	2
Waste incineration	1,3				
TOTAL		6,131	6,595	6,689	6,132
Offset Purchases		-	(196)	(143)	(91)
TOTAL with GHG Offsets^[9]		6,131	6,399	6,546	6,041

Table C2; Energy profile of the City of London over time. Note: CO₂e given in MtCO₂e and population in millions. Source: (Greater London Authority, 2014).

	SCOPE	TOTAL					
Year		'90	'00	'05	'10	'11	'12
Population		6.8	7.2	7.5	8.1	8.2	8.3
ENERGY		45	50	46	44	39	41
a) Stationary Combustion		35.6	41.6	36.5	35.2	30.4	32.1
Electricity (incl. T&D losses)		-	22.7	20.6	20.7	18.4	19.2
District heating or cooling, CHP, and energy from waste	1, 2, 3						
Commercial & Institutional	1	-	8.7	5.8	5.3	4.4	4.8
Residential	1	-	10.2	10.1	9.2	7.5	8.2
Manufacturing Industries & Construction	1						
Other	1						
b) Mobile Combustion		9.5	8.7	9.9	8.6	8.6	8.6
Road transportation: LDVs	1						
Road transportation: trucks	1						
Road transportation: other	1	7.2	6.6	7.3	6.4	6.4	6.4
Railways	1	1.4	1.2	1.2	1.3	1.3	1.3

Domestic aviation	3	0.9	0.9	1.4	0.9	0.9	0.9
Domestic marine	3	0.0	0.0	0.0	0.0	0.0	0.0
Other	1						
c) Fugitive Sources							
INDUSTRIAL PROCESSES	1						
AFOLU							
WASTE					0.0	0.0	0.0
Solid waste disposal on land							
Wastewater handling	1,3						
Waste incineration	1,3						
TOTAL		45.1	50.3	46.4	43.8	39.0	40.8

Table C3; Energy profile of the City of New York. Source: (Pasion, Amar, & Delaney, 2014).

	SCOPE	TOTAL		
Year		2005	2012	2013
Population		7,956,113	8,344,397	8,405,837
ENERGY		71,128,557	61,747,719	62,311,958
a) Stationary Combustion		44,200,644	34,275,178	33,972,017
Electricity (incl. T&D losses)]	1,2,3	23,190,977	15,176,405	15,064,439
District heating or cooling, CHP, and energy from waste	1,2,3			
Total Buildings ^[14]	1	21,009,667	19,098,773	18,907,578
Residential	1	13,806,147	11,471,992	11,163,556
Commercial & Institutional	1	5,638,004	6,164,809	6,286,455
Manufacturing Industries & Construction	1	1,565,516	1,461,972	1,457,567
b) Mobile Combustion		26,006,558	26,538,319	27,391,698
Road transportation: LDVs	1	8,670,487	8,727,250	9,000,857
Road transportation: trucks	1	1,088,701	932,139	967,397
Road transportation: buses	1	693,049	581,398	583,190
Railways	1	22,429	25,849	30,170

Aviation	3	14,345,894	15,426,641	15,948,743
Marine	3			
Other-electricity subways and commuter rail	1	1,185,998	845,042	861,341
c) Fugitive Sources - biogenic + natural gas distribution		921,355	934,222	948,243
INDUSTRIAL PROCESSES	1			
AFOLU	1			
WASTE		2,933,865	2,362,288	2,343,522
Solid waste disposal on land [15]	1,3	2,707,874	2,125,890	2,130,464
Wastewater handling	1,3	225,991	236,398	213,058
TOTAL		74,062,422	64,110,007	64,655,480

Table C4; Energy Profile of the City of Boston. Source: (City of Boston, 2013).

	SCO PE	TOT AL	TOT AL	TOT AL	TOT AL	TOT AL	TOT AL
Year		2006	2007	2008	2009	2010	2011
Population		587,816	593,136	600,685	612,669	617,594	625,087
ENERGY		6,811,987	7,304,887	7,275,565	6,914,467	6,981,676	6,604,746
a) Stationary Combustion		4,888,863	5,384,857	5,356,209	5,006,843	5,076,166	4,705,856
Electricity (incl. T&D losses)	1,2,3	2,608,608	2,977,297	2,924,876	2,669,954	2,731,173	2,565,091
District heating or cooling, CHP, and energy from waste	1,2,3						
Commercial & Institutional & Industrial ^[1]	1	1,595,012	1,652,549	1,648,825	1,572,403	1,553,043	1,447,153
Residential	1	685,243	755,011	782,508	764,486	791,950	693,612
Manufacturing Industries & Construction	1						
Other	1						
b) Mobile Combustion		1,923,124	1,920,030	1,919,356	1,907,624	1,905,510	1,898,890

Road transportation: LDVs	1						
Road transportation: trucks	1						
Road transportation: other	1						
Railways	1						
Aviation	3						
Marine	3						
Other	1						
c) Fugitive Sources							
INDUSTRIAL PROCESSES	1						
AFOLU	1						
WASTE		201,5	207,5	193,3	173,9	166,4	161,9
		22	69	29	99	80	68
Solid waste disposal on land	1,3	171,4	177,0	166,3	148,5	139,1	138,8
		84	08	22	50	76	28
Water and Sewer Treatment[2]	1,3	30,03	30,56	27,00	25,44	27,30	23,14
		8	1	7	9	4	0
Waste incineration	1,3						
TOTAL		7,013,	7,512,	7,468,	7,088,	7,148,	6,766,
		509	456	894	466	156	714

Table C5; Emission profile of the City of Chicago. Sources: (ICF International, 2012; McGraw, Haas, Young, & Evens, 2010)

	SCOPE	TOTAL		
Year		2000	2005	2010
Population				
ENERGY		40.4	40.6	41.5
a) Stationary Combustion		24.4	25.9	26.3
Electricity (incl. T&D losses)]	1,2,3	12.9	16.0	17.0
District heating or cooling, CHP, and energy from waste	1,2,3			
Total Buildings ^[14]	1	11.5	9.9	9.3
Residential	1			
Commercial & Institutional	1			
Manufacturing Industries & Construction	1			
b) Mobile Combustion		16.0	14.7	15.2
Transportation: on-road	1	6.6	6.5	6.8
Transportation: off-road	1	0.7	0.7	1.0

Aviation [2]	3	8.7	7.5	7.5
Marine	3			
Other-electricity subways and commuter rail	1			
c) Fugitive Sources - biogenic				
INDUSTRIAL PROCESSES	1	1.6	1.5	0.2
AFOLU	1	(0.1)	(0.1)	-
WASTE		1.5	1.5	1.6
Solid waste disposal on land [15]	1,3	1.1	1.2	1.3
Wastewater handling	1,3	0.4	0.3	0.3
TOTAL [1]		43.5	43.6	43.4

[1] Doesn't add up due to rounding.

[2] Aviation was not included in the 2010 inventory. Calculations in the dissertation made based on the assumption that no significant changes in aviation emissions have taken place.

Table C6; Emission Profile of the Greater Toronto Region. Source: (Greening Greater Toronto, 2011)

	SCOPE	TOTAL 2005	TOTAL 2008	TOTAL 2009
Year				
Population		5,555,912	5,974,328*	6,113,800
ENERGY		54,719,234	52,898,944	49,351,350
a) Stationary Combustion		28,086,692	26,184,480	23,352,423
Electricity (incl. T&D losses)	1,2,3	11,944,800	9,503,340	6,487,560
Energy from waste	1			
District energy and CHP, Energy from Waste, Commercial & Institutional, Residential,				
Manufacturing Industries & Construction ^[10]	1,2	16,141,892	16,681,140	16,864,863
Other				
b) Mobile Combustion		26,632,542	26,714,464	25,998,927
Road transportation: LDVs	1	16,545,712	16,197,043	15,843,428
Road transportation: Trucks	1	5,730,900	5,463,021	5,101,099
Railways	1			
Domestic & International aviation	3	4,355,931	5,054,400	5,054,400

Marine	3			
c) Fugitive Sources				
INDUSTRIAL PROCESSES		3,439,463	2,932,116	2,932,116
AFOLU	1			
WASTE		1,470,077	1,588,991	1,576,127
Solid waste disposal on land	1,3	1,440,314	1,557,518	1,537,852
Wastewater handling	1,3			
Waste incineration	1,3	29,762	31,473	38,275
TOTAL		59,628,774	57,420,051	53,859,594

Table C7; Emission Profile of Berlin. Source: (Amt für Statistik Berlin Brandenburg, 2014)

	SCOPE	TOTAL					
Year		1990	2000	2005	2009	2010	2011
Population		3,409,737	3,386,667	3,387,828	3,431,675	3,442,675	3,460,725
ENERGY		24,240,000	22,545,000	20,299,000	18,526,816	19,575,699	17,985,716
a) Stationary Combustion		19,203,000	16,777,000	15,326,000	13,809,132	14,725,378	13,105,468
Electricity (incl. T&D losses)	1,2,3						
District heating or cooling, CHP, and energy from waste	1,2,3						
Commercial & Institutional & Residential	1						
Residential	1						
Manufacturing Industries & Construction	1						
Other	1						
b) Mobile Combustion		5,037,000	5,768,000	4,973,000	4,717,684	4,850,321	4,880,248
Road transportation: LDVs	1	3,660,000	4,108,000	3,593,000	3,347,265	3,387,254	3,460,887
Road transportation: trucks	1						
Road transportation: other	1						
Railways	1	975,000	832,000	463,000	514,316	496,383	525,706
Aviation	3	368,000	799,000	885,000	828,445	941,252	864,112
Marine	3	35,000	29,000	32,000	27,658	25,432	29,543
Other	1						
c) Fugitive Sources							
INDUSTRIAL PROCESSES	1	5,090,000	2,843,000	1,618,000	1,578,860	1,723,506	1,792,825
AFOLU	1						
WASTE							

Solid waste disposal on land	1,3					
Wastewater handling	1,3					
Waste incineration	1,3					
TOTAL		29,330,000	25,388,000	21,917,000	20,105,676	21,299,205
						19,778,541

Table C8; Emission Profile of the City of Chicago.

	SCOPE	TOTAL		
Year		2000	2005	2010
Population				
ENERGY		40.4	40.6	41.5
a) Stationary Combustion		24.4	25.9	26.3
Electricity (incl. T&D losses)]	1,2,3	12.9	16.0	17.0
District heating or cooling, CHP, and energy from waste	1,2,3			
Total Buildings ^[14]	1	11.5	9.9	9.3
Residential	1			
Commercial & Institutional	1			
Manufacturing Industries & Construction	1			
b) Mobile Combustion		16.0	14.7	15.2
Transportation: on-road	1	6.6	6.5	6.8
Transportation: off-road	1	0.7	0.7	1.0
Aviation	3	8.7	7.5	7.5
Marine	3			
Other-electricity subways and commuter rail	1			
c) Fugitive Sources - biogenic				
INDUSTRIAL PROCESSES	1	1.6	1.5	0.2
AFOLU	1	(0.1)	(0.1)	-
WASTE		1.5	1.5	1.6
Solid waste disposal on land [15]	1,3	1.1	1.2	1.3
Wastewater handling	1,3	0.4	0.3	0.3
TOTAL		43.5	43.6	43.4

Table C9; Emission Profile of Greater Philadelphia. Source: Delaware Valley Regional Planning Commission (DVRPC, 2014)

	SCOPE	TOTAL	
Year		2005	2010
Population		5,529,489	5,633,428
ENERGY		88.6	78.8
a) Stationary Combustion		54.8	48.4
Electricity (incl. T&D losses)]	1,2,3		
District heating or cooling, CHP, and energy from waste	1,2,3		
Total Buildings ^[14]	1		
Residential	1	21.2	18.5
Commercial & Industrial [1]	1	33.6	29.9
Manufacturing Industries & Construction	1		
b) Mobile Combustion		27.3	26.1
Transportation: on-road	1		
Transportation: off-road	1		
Aviation	3		
Marine	3		
Other-electricity subways and commuter rail	1		
c) Fugitive Sources - biogenic		6.5	4.3
INDUSTRIAL PROCESSES	1	3.2	2.2
AFOLU	1	(0.8)	(1.5)
WASTE		2.2	1.6
Solid waste disposal on land [15]	1,3		
Wastewater handling	1,3		
TOTAL		93.2	81.1

Table C10; Emission Profile of Toronto City. (Toronto City, 2014).

	SCOPE	TOTAL		
Year		1990	2008	2012
Population				
ENERGY		21,604,365	21,986,324	18,170,489
a) Stationary Combustion		14,310,925	13,602,928	9,787,093
Electricity (incl. T&D losses)]	1,2,3	5,569,300	5,217,000	2,699,629
District heating or cooling, CHP, and energy from waste	1,2,3			

Total Buildings ^[14]	1	8,741,625	8,385,928	7,087,464
Residential	1			
Commercial & Industrial [1]	1			
Manufacturing Industries & Construction	1			
b) Mobile Combustion		7,293,440	8,383,396	8,383,396
Transportation (no rail, planes, or boats)	1	7,293,440	8,383,396	8,383,396
c) Fugitive Sources - biogenic				
INDUSTRIAL PROCESSES	1			
AFOLU	1			
WASTE		5,447,253	2,681,451	2,142,572
Solid waste disposal on land [15]	1,3			
Wastewater handling	1,3			
TOTAL		27,051,618	24,667,775	20,313,061

Table C11; Emission Profile of Dallas, Texas. Source: (City of Dallas, 2012)

	SCOPE	TOTAL	
Year		2005	2010
Population		1,213,825.0	1,197,816.0
ENERGY		20,187,735	16,896,430
a) Stationary Combustion		16,046,867	12,857,603
Electricity (incl. T&D losses)]	1,2,3	12,043,444	10,714,678
District heating or cooling, CHP, and energy from waste	1,2,3		
Total Buildings ^[14]	1	4,003,423.0	2,142,925.0
Residential	1		
Commercial & Industrial [1]	1		
Manufacturing Industries & Construction	1		
b) Mobile Combustion		4,140,868.0	4,038,827.0
Transportation: on-road	1		
Transportation: off-road	1		
Aviation	3		
Marine	3		
Other-electricity subways and commuter rail	1		
c) Fugitive Sources			
INDUSTRIAL PROCESSES	1		
AFOLU	1		

WASTE		305,857.0	332,957.0
Solid waste disposal on land [15]	1,3	305,857.0	332,957.0
Wastewater handling	1,3		
TOTAL		20,493,592	17,229,387

Table C12; Emission profile of the City of Denver. Source: (Department of Environmental Health, 2012).

SCOPE		TOTAL					
Year		2005	2007	2009	2010	2011	2012
Population		561,695	577,834	591,882	600,396	620,059	634,437
ENERGY		11,583	11,813	10,726	11,192	10,887	10,751
a) Stationary Combustion		7,045	7,129	6,629	6,913	6,694	6,406
Electricity (incl. T&D losses)]	1,2,3	5,036	5,034	4,594	4,913	4,726	4,604
District heating or cooling, CHP, and energy from waste	1,2,3						
Total Buildings ^[14]	1	2,009	2,095	2,035	2,000	1,968	1,802
Residential	1	752	766	775	765	765	685
Commercial & Industrial	1	1,257	1,329	1,260	1,235	1,203	1,117
b) Mobile Combustion		3,358	3,534	3,173	3,298	3,231	3,300
Surface transportation	1	2,540	2,608	2,355	2,400	2,342	2,398
Aviation	3	818	926	819	898	889	902
Marine	3						
Other-electricity subways and commuter rail	1						
c) Fugitive Sources	3	1,180	1,150	924	981	962	1,045
INDUSTRIAL PROCESSES	1						
AFOLU	3	1504	1581	1625.79	1701	1630	1745
WASTE	1,3	169	185	137	136	126	129
Solid waste disposal on land [15]	1,3	169	185	137	136	126	129
Wastewater handling	1,3						
TOTAL		13,256	13,579	12,489	13,029	12,643	12,625

Appendix D

ALTERNATIVE ADMINISTRATION OPTIONS FOR ENERGY EFFICIENCY PROGRAMS

Table E1; Benefits and downsides of three administrative and governance options for energy efficiency programs (Eto et al., 1998, p. 55).

Criterion	Utility administration	Existing state agency	New non-profit institution
Compatibility with public policy goals	Utility expertise and infrastructure is an advantage Utility clout with 'upstream' entities is an advantage but service territory limitations lead to market and administrative inefficiencies in certain programs	Statewide scope may minimize administrative and transaction costs Agency's ability to meet energy efficiency policy goals must be assessed	Organizational form, structure and mission (e.g., statewide, regional) is strongly aligned with market transformation goals
Accountability and oversight	Significant potential exists for conflicts of interests or perceptions of conflicts of interest with other market participants Regulatory oversight mechanisms are well developed although process can be bureaucratic	Low potential exists for conflicts of interest with private market participants Public input process may be well developed but agency may have limited experience with accountability and evaluation standards used for energy efficiency programs	Minimal conflicts of interest exist with market participants Governance and accountability issues are significant

Administrator effectiveness	Existing, well-developed mechanisms for input and feedback from stakeholders	Expanded mission for existing agency; assessment of historic track record	Most flexibility on competitive procurement but institution building takes time and resources
	Some utilities have highly qualified, experienced staff	State procurement rules may make it difficult to select 'best value' programs and proposals	Can create efficient, lean organization quickly with clearly defined mission
	Desired public outcomes may not be compatible with utility financial interests	State agency may not have required technical expertise	High probability of attracting qualified administrative and technical staff
Transition issues	Transition costs are low	Transition issues may be significant	Political will and support needed to create new institution

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