BUILDING ENERGY GOVERNANCE IN SHANGHAI

by

YiHsiu Michelle Kung

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 Urban Affairs and Public Policy

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ABSTRACT

With Asia's surging economies and urbanization, the region is adding to its built environment at an unprecedented rate, especially those population centers in China and India. With numerous existing buildings, plus a new building boom, construction in these major Asian cities has caused momentous sustainability challenges. This dissertation focuses on China's leading city, Shanghai, to explore and assess its existing commercial building energy policies and practices. Research estimates that Shanghai's commercial buildings might become a key challenge with regard to energy use and CO_2 emissions as compared to other major Asian cities. Relevant building energy policy instruments at national and local levels for commercial buildings are reviewed. In addition, two benchmarks are established to further assess building energy policies in Shanghai. The first benchmark is based on the synthesis of relevant criteria and policy instruments as recommended by professional organizations, while the second practical benchmark is drawn from an analysis of three global cities: New York, London and Tokyo. Moreover, two large-scale commercial building sites – Shanghai IKEA and Plaza 66 – are selected for investigation and assessment of their efforts on building energy saving measures. Detailed building energy savings, CO_2 reductions, and management cost reductions based on data availability and calculations are presented with the co-benefits approach. The research additionally analyzes different interventions and factors that facilitate or constrain the implementation process of building energy saving measures in each case. Furthermore, a multi-scale analytical framework is employed to investigate relevant stakeholders that shape Shanghai's commercial building energy governance. Research findings and policy recommendations are offered at the close of this dissertation. Findings and policy recommendations are intended to facilitate commercial building energy governance in Shanghai and other rapidly growing second-tier or third-tier cities in China, and to further contribute to the general body of knowledge on Asia's urban building sustainability.

Chapter 1

INTRODUCTION

The current surge of urbanization is unprecedented in the history of humanity. The phenomenon has significantly changed urban-built environments and has created urban sustainability issues, especially in Asia. With numerous existing buildings, plus a new building boom, construction in these major Asian cities has caused momentous sustainability challenges. Existing buildings consume a significant amount of energy and are responsible for 40 percent of the world's total primary energy consumption and account for 24 percent of the world's carbon dioxide emissions (CO_2 emissions) (IEA, 2006). Therefore, the dissertation focuses on how to retrofit existing buildings to reduce their energy use and environmental pollution in cities. An urban building energy governance framework will be conceptualized from the general literature. In addition, the policy benchmark is based on the synthesis of relevant criteria to identify desirable building energy policy instruments. The research also examines the building energy policy practices in three major world cities – New York, London, and Tokyo – to identify which building energy policies have actually been adopted in these recognized cities in the developed world. Specifically, Shanghai's urban building energy governance structure and policy framework will be identified and assessed. The case study emphasizes the role of the private sector initiatives in the retrofitting of two major commercial building complexes in Shanghai: IKEA and Plaza 66. The research provides an assessment of Shanghai's building energy governance structure and policies in relation to what is recommended in the general literature and what has been adopted in New York, London, and Tokyo. Moreover, the IKEA and Plaza 66 buildings are selected for investigation and assessment of their efforts on building energy saving measures, which can contribute to an understanding of how to retrofit existing commercial buildings for better building energy performance.

1.1 The Significance of Building Energy Governance

In modern society, most people spend 70 percent to 90 percent of their time in buildings, which provide shelter, work space, and places for commerce and leisure (Goldstein & Watson, 2002). The ways buildings are designed, constructed and maintained not only have an impact on their operating costs, but affect the world's energy consumption patterns and environmental conditions over their lifetimes (ABC, 2007). While one-tenth of the global economy is dedicated to the building sector, buildings are also responsible for a larger share of energy use, waste generation, and greenhouse gas emissions (Roodman & Lenssen, 1994). According to the United Nations Environment Programme, the built environment is responsible for 40 percent of total energy use and 40 percent of CO_2 emissions (UNEP, 2006; See Figure 1-1).

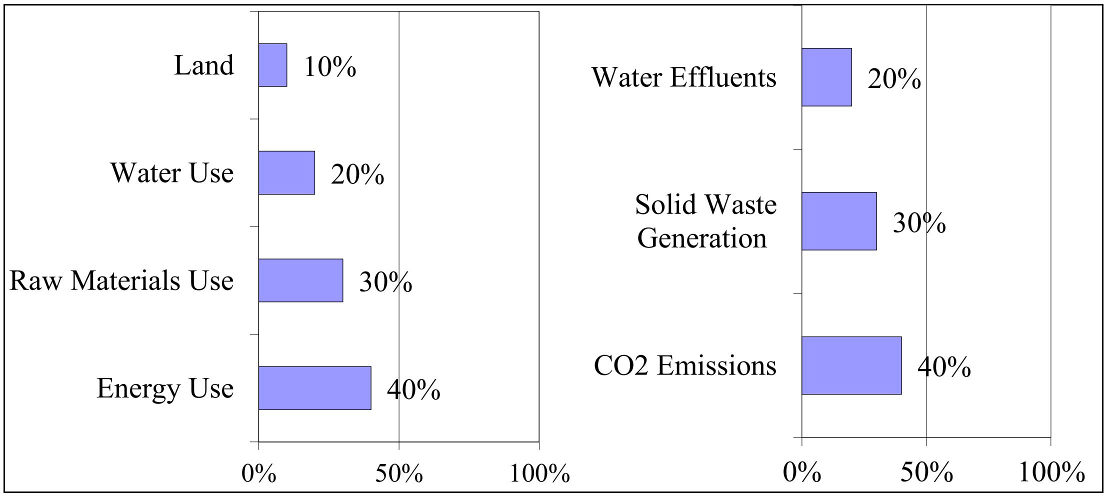

Figure 1-1: Share of the Built Environment in Resource Use and Emissions

Source: UNEP, 2006

According to the Intergovernmental Panel on Climate Change (IPCC) *Fourth Assessment Report*, building-related CO_2 emissions (including the use of electricity) could increase from 8.6 billion tons in 2004 to 11.4 billion tons in 2030 under a low-growth scenario (Levine & Ürge-Vorsatz, 2007). Under a high-growth scenario, that number increases to 15.6 billion tons with North America and Western Europe currently account for major shares of CO_2 emissions from buildings, but the projection trends of developing countries are growing fast in the near future (See Figure 1-2). Overall, building-related CO_2 emissions projections will continue to increase and they will represent around 30 percent of total CO_2 emissions globally by the year 2030.

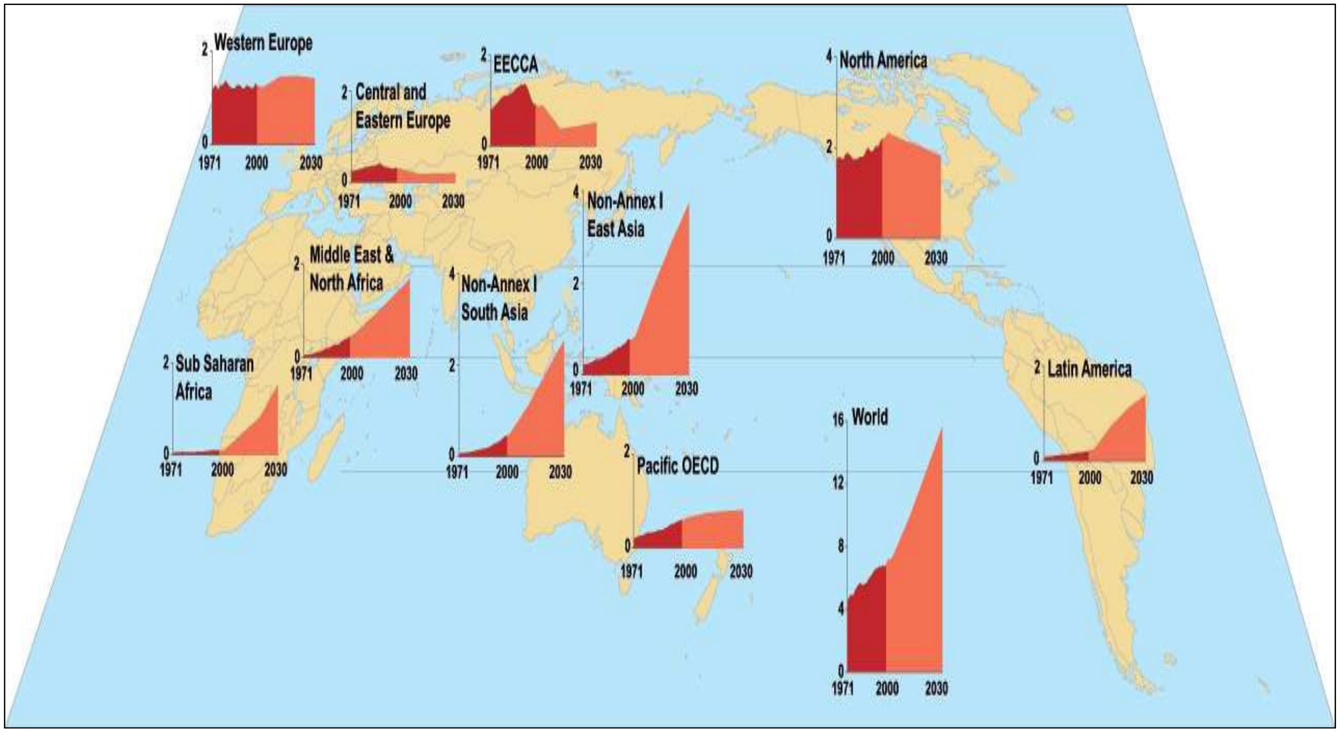

Figure 1-2: CO_2 Emissions from Buildings

Note: Eastern Europe, Caucasus and Central Asia (EECCA)
Source: Levine & Ürge-Vorsatz, 2007

On the national scale, the experiences of developed countries reveal that the degree of industrialization has a positive correlation with energy use from the building sector. Namely, energy consumption and CO_2 emissions from buildings tend to progressively increase along with economic growth and changes in industrial structure (CCICED, 2009). Likewise, the building sector accounts for the major share in all selected global cities in the North (See Figure 1-3). In some cities, building energy use even constituted over 70 percent of city-wide CO_2 emissions (In New York City, buildings account for 75 percent of CO_2 emissions, 94 percent of electricity use, and 85 percent of water consumption). Therefore, to the problem of improving building energy efficiency has become a crucial urban governance issue and has caught extensive global attention.

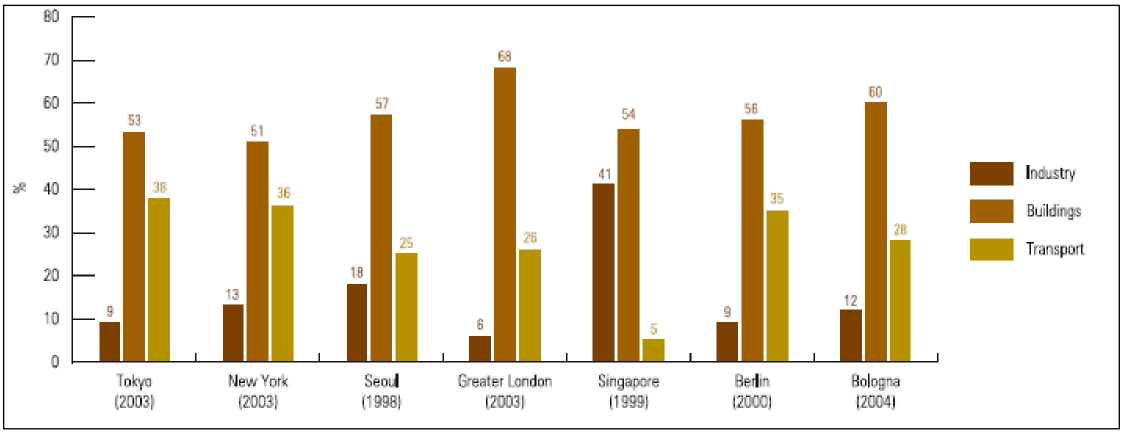

Figure 1-3: Energy Consumption in Selected Cities in the Global North

Source: UN-HABITAT, 2008

In Asia, according to the predicted data mentioned above, building energy consumption is growing rapidly (See Figure 1-2). Although the existing building sector accounts for less energy consumption and fewer carbon emissions than the industrial and transportation sectors, Asian cities require more energy to meet their needs for space and water, heating/cooling, lighting, and operating appliances and equipment. These higher energy demands are due to rapid economic growth, an ongoing population explosion, increasing urbanization, increases in the standard of living, and changing lifestyles (ABC, 2007). It is expected that the building sector will surpass other sectors and account for most of the emissions in Asia unless significant action is taken to reshape the existing building energy consumption pattern towards a more sustainable one. It is significant that such an outcome be prevented; otherwise, urban Asia would simply follow a building energy consumption pattern similar to that of the urban North.

With the growing sustainability challenge and climate crisis, the building sector also provides energy saving potential and possibilities for mitigation of greenhouse gas (GHG) emissions. The IPCC report (2007) compares the energy savings potential of the building sector with that of other economic sectors. The findings suggest that the building sector has the greatest potential among all sectors, in all countries, and at all cost levels (See Figure 1-4, Metz, et al., 2007; UNEP, 2008). Developing countries represent the greatest opportunity for emission reductions. Further, according to the McKinsey Global Institute, the building sector contributes over one third of the energy efficiency opportunities to reduce global energy demand (MGI, 2009). Therefore, it is significant to strengthen building energy governance in both developed and developing regions.

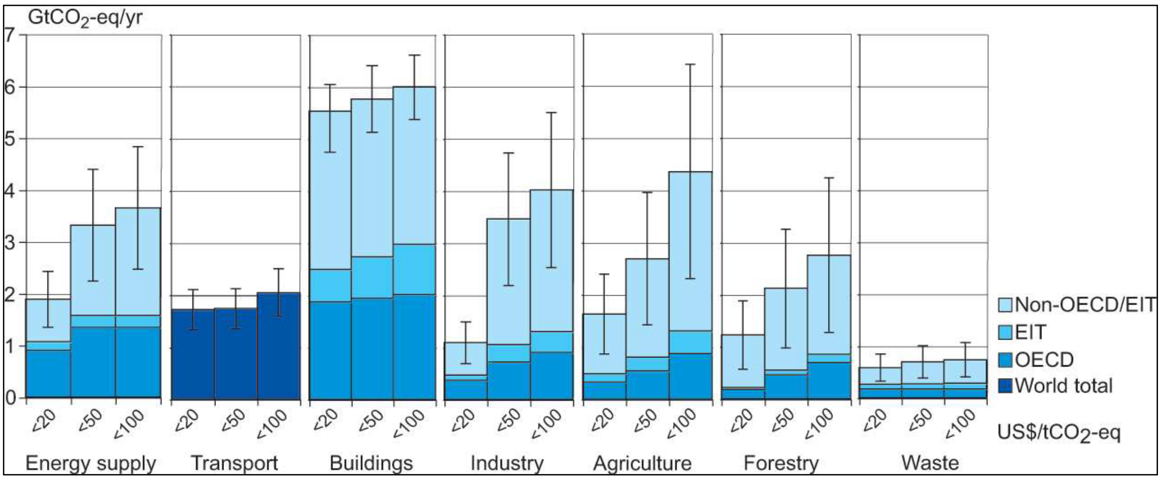

Figure 1-4: Potential Emission Reductions in Different Sectors in 2030

Note: Economies in Transition (EIT)[1]
Source: Metz, et al., 2007; UNEP, 2008

1.2 THE CONCEPT OF URBAN BUILDING ENERGY GOVERANCE

Approximately 70 percent of primary energy consumption is from urban areas, especially from the building sector. Building energy consumption accounts for a higher share in cities in developed economies. In developed economies, at least half of the buildings that will be in use in 2050 have already been built. With a small percent of commercial floor space newly constructed each year, the

[1] The ranges for global economic potentials as assessed in each sector are shown by vertical lines. The ranges are based on end use allocations of emissions. In the building sector, for example, emission reduction potential at the <100 US$/tCO2 cost category is from 5.3-6.7 Gt CO_2-eq/yr.

majority of opportunities to improve efficiency over the next several decades will be in existing buildings. Improved efficiency of existing buildings—through building retrofitting and other measures—represents a high-volume, low-cost approach to reducing energy use and greenhouse gas emissions. Meanwhile, with the global trend of urbanization, new buildings have been quickly constructed in rapidly growing cities in developing economies. Countless building energy savings opportunities exist in the form of improved maintenance and more efficient operation practices. Therefore, city governments have paid more and more attention to the sustainable energy challenges and the growing significance of building energy governance.

According to the United Nations' definition, the concept of "governance" is the process of decision making and the process by which decisions are implemented (or not implemented) (UNESCAP, 2012). Thus, the concept of "urban building energy governance" is the process of setting up building energy policy instruments and the process of how these policies are implemented in an urban setting. In addition, the governance process involves both formal and informal actors, which facilitate or constrain urban building energy practices. In terms of building energy policy instruments, the mosaic of current policy instruments affecting the building sector is complex and dynamic, ranging from national policies and regulations to local initiatives. It contains a mix of government regulations and policies to enhance the application of energy saving technologies and to foster more self-restraint in energy use behavioral patterns in everyday life, which can substantially reduce energy consumption and CO_2

emissions from the building sector. Along with these impacts, multifaceted building energy policy instruments are critical to strengthening policy compliance and facilitating the evolution towards more market-driven building energy governance.

Moreover, a range of actors and stakeholders are involved in urban building energy governance processes, including national governments, municipal governments, developers, property owners, commercial tenants, energy producers, energy saving companies, non-governmental organizations (NGOs), research institutions, and building industry associations. Urban building energy governance has involved different formal and informal policy actors from governments, the private sector and local institutions, and needs collective action under a holistic governance mode. These policy instruments and relevant policy actors and institutions can facilitate building energy market transformation and gradually change relevant stakeholders' behavior patterns. In sum, urban building energy governance plays a key role in addressing growing building energy issues in cities. Cities can play an important role in the application of sustainable building energy solutions and identify policy opportunities for reducing building energy consumption.

An effective urban building energy governance system must be able to respond to the total life cycle of buildings and improve building energy efficiency throughout building lifecycles. Moreover, the system should provide the array of actions and policies that have been recommended as desirable in the literature to address significant market, financial, technical, awareness and institutional barriers to building efficiency. These policies will help enable critical policy actors to make decisions to promote building energy efficiency and sustainable building practices.

1.3 Policy Importance of Understanding the Life Cycle of Buildings

For policy purposes, it is important to distinguish between new and existing buildings. The building energy policy dimensions of this study include energy conservation policies and regulations; energy efficiency policies and regulations; and renewable energy application policies and regulations applied to new buildings, existing buildings, and appliances and equipment (See Table 1-1).

Table 1-1: Building Energy Policy Dimensions

Building Type	Commercial Building
New Buildings	1.Energy Efficiency Policies and Regulations 2.Energy Conservation Policies and Regulations 3.Renewable Energy Application Policies and Regulations
Existing Buildings	
Appliances & Equipment	

New construction can more easily incorporate novel and low carbon technologies. In addition, innovative technologies are often introduced in the new construction market. However, the vast majority of the buildings that exist today will still exist in 2015, and at least half of the current stock will still be standing by mid-century. As a result, retrofitting structures and upgrading the efficiency and operation of their HVAC (heating, ventilation, and air-conditioning) systems offer an important opportunity to significantly reduce GHG emissions. With appropriate policy interventions, these improvements could be implemented quickly and could significantly reduce GHG emissions and energy consumption.

Different policy instruments should apply to different building types and different stages of building life cycle. Typically, more than 80 percent of total energy consumption takes place during the operation and maintenance stage of the life cycle of buildings (See Figure 1-5).

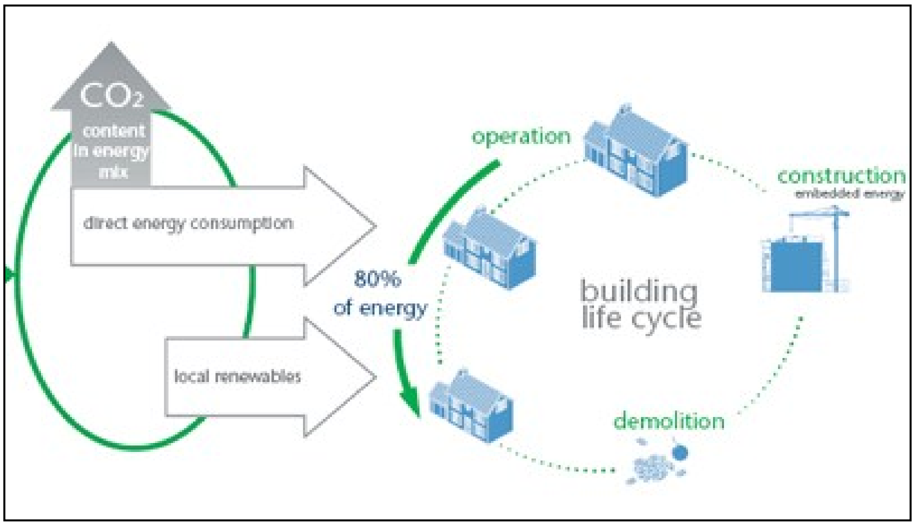

Figure 1-5: Building Life Cycle

Source: WBCSD, 2007

According to Jiang, three phases occur in a building's lifecycle: a) the production phase, b) the management/operational phase and c) the destruction phase. This is a complex process involving other industries. The energy flow runs through every phase of the lifecycle and GHGs and other pollutants are emitted as by-products. Figure 1-6 shows the lifecycle of a building related to energy consumption (Davies, 2006; Jiang, 2012). Theoretically, the three main kinds of energy consumption in the lifecycle of a building can be described as follows (Jiang, 2012):

- Embodied energy is the energy utilized during the production phase of the building, which includes the energy content of all materials used, transportation to the site, manufacturing, and construction/erection.
- Operational energy is consumed during the occupation/management period. It can be briefly described as the energy for HVAC, running appliances and indoor hot water (Jiang, 2012; Ramesh et al., 2010; Ramesh et al., 2010).
- Demolition energy is required to demolish the building and dispose of waste materials (Jiang, 2012).

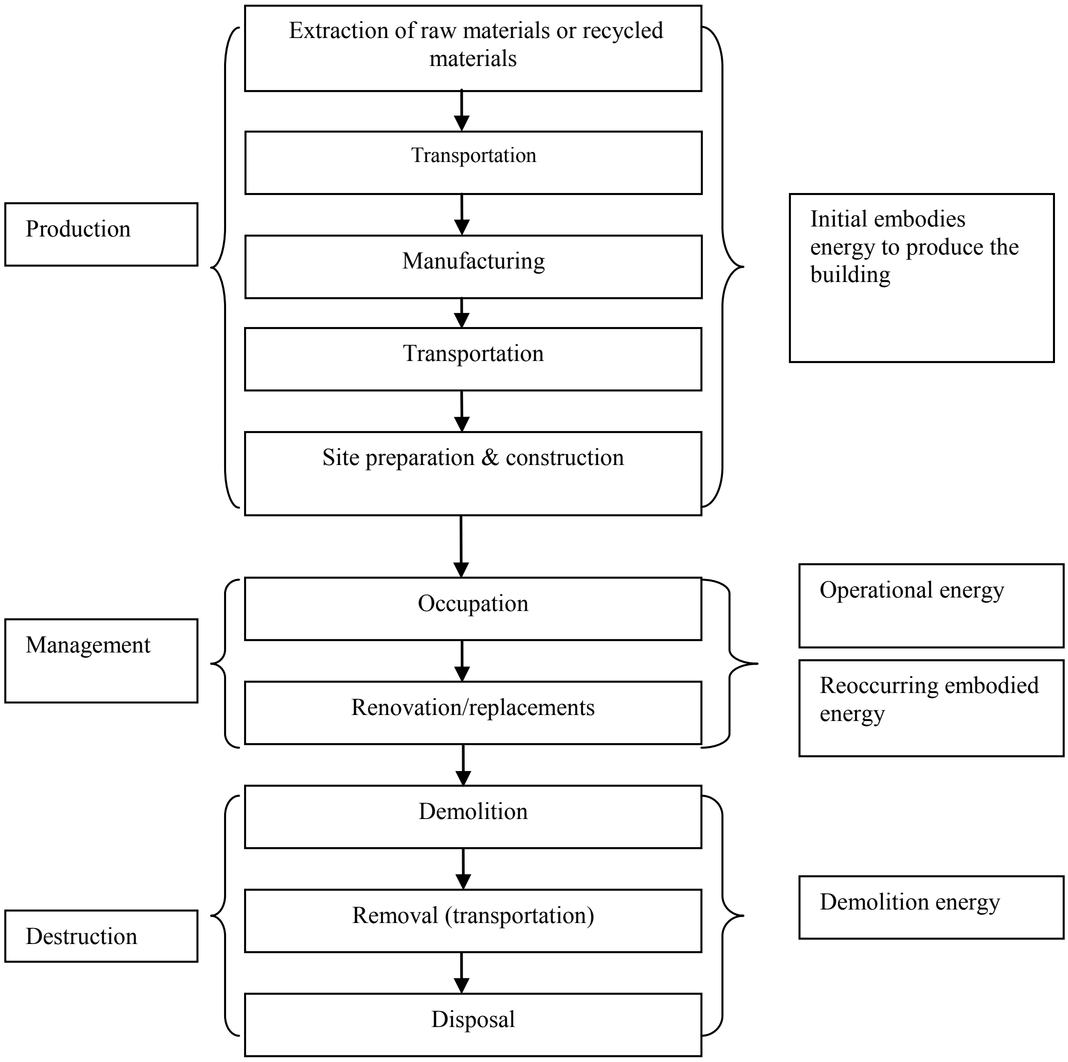

Figure 1-6: Lifecycle of the building related to energy consumption and GHG emissions

Source: Jiang, 2012

1.4 Building Energy Governance Policies

1. "Recommended" policies

The recommended policies are identified from the general literature and based on a synthesis of relevant criteria and policy instruments recommended by scholars and professional organizations. The research has categorized relevant policy instruments into three policy types regarding urban building energy policies. Regulatory and control instruments include building codes and standards and other mandatory programs and policies. Market-based instruments and fiscal incentives include an energy tax or carbon tax and other financial subsidies for promoting building energy savings. Support, information and voluntary action provide information and successful demonstrations to educate residents on changing their energy consumption behaviors. These policy instruments, listed in Table 1-2, can assist city governments in formulating policies in the building sector to realize reductions in energy consumption and greenhouse gas emissions.

The policy instruments suggested by this dissertation are drawn from several key pieces of literature. One is the report *Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions from Buildings* by the "Sustainable Buildings and Construction Initiative" of UNEP. Ürge-Vorsatz and Koeppel assess commonly used building energy policy instruments based on more than 80 case studies and evaluations of their implementations from over 50 countries (Ürge-

Vorsatz & Koeppel, 2007). Another one is from the *IPCC Fourth Assessment Report*. Levine and Ürge-Vorsatz (2007) propose a diverse portfolio of policy instruments to achieve CO_2 reductions and cost-effectiveness in the building sector. In addition, Brown et al. (2005) suggest public interventions that could overcome many of the market failures and barriers hindering widespread penetration of climate-friendly technologies and practices towards a climate-friendly built environment. The report also provided numerous policy innovations ranging from local and regional to national initiatives[2].

The details of these various policy instruments are as follows.

Table 1-2: Building Energy Policy Instruments

Regulatory/Control Instruments
• **Building Codes** • **Appliance Standards**

[2] Other relevant reports reviewed include: *Promoting Energy Efficiency in Buildings: Lessons Learned from International Experience* by the United Nations Development Program (UNDP, 2009); *The Kyoto Protocol, the Clean Development Mechanism, and the Building and Construction Sector* by the United Nations Environment Program (UNEP, 2008); *Energy Efficiency Policies around the World: Review and Evaluation* by the World Energy Council (WEC, 2008); *Residential and Commercial Buildings of the Fourth Assessment Report* by the Intergovernmental Panel on Climate Change (Levine & Ürge-Vorsatz, 2007); *Energy Efficiency in Buildings: Business Realities and Opportunities* by the World Business Council for Sustainable Development (WBCSD, 2007); *Buildings and Climate Change - Status, Challenges and Opportunities* by the United Nations Environment Program (UNEP, 2007); and *Towards a Climate-Friendly Built Environment* by the Pew Center on Global Climate *Change* (Brown et al., 2005). Moreover, some reports bring attention to the building sectors of Asia and China. These reports include *Building Energy Efficiency: Why Green Buildings Are Keys to Asia's Future* by the Asia Business Council (ABC, 2007); *Energy Efficiency in Buildings in China: Policies, Barriers and Opportunities* by the German Development Institute (Richerzhagen et al., 2008); and *Transforming Chinese Buildings* by the Natural Resources Defense Council (Goldstein & Watson, 2004).

• Procurement Regulations • Energy Efficiency Obligations (EEOs) and Quotas • Mandatory Certification and Labeling • Mandatory Audit Programs • Utility Demand-Side Management (DSM) Programs
Economic/Market-Based/Fiscal Incentives
• Energy Performance Contracting/ ESCO Support • Cooperative and Technology Procurement • Energy Efficiency Certificate/White Certificate Schemes • Kyoto Flexibility Mechanisms • Energy/Carbon Taxes • Tax Incentives • Public Benefits Charges • Rebates/Subsidies/Grants • Low Interest Loans and Guarantee Funds
Support/Information/Voluntary Actions
• Voluntary Certification and Labeling Programs • Voluntary and Negotiated Agreements • Public Leadership Programs • Awareness Raising/Education/Information Campaign • Disclosure Program • Research and Development

Source: Adapted from Brown et al., 2005; Levine & Ürge-Vorsatz, 2007; Ürge-Vorsatz & Koeppel, 2007;

2. "Operational" policies and criteria

Global cities represent sites of high energy and resource consumption and also high production of related greenhouse gas emissions and pollutions because of their crucial social-economic and political status to their nations. However, as capitals or major financial hubs of the state or region, global cities are also the hubs of ideas and policy diffusion. They are in a position to develop innovative approaches, initiatives and technologies for tackling climate change issues. Can these economic nodes become ecological nodes as well? In terms of CO_2 emissions, building sectors contribute the most emissions in New York, London, and Tokyo when compared to industrial and transportation sectors. In New York and Tokyo, commercial and institutional buildings account for the largest share of emissions, while residential buildings account for the most emissions in London. With long histories of urban development, these advanced cities have been facing serious building energy governance challenges, especially for their existing buildings. Hence, the operational policies and criteria are drawn from the building energy governance systems of New York, London, and Tokyo.

1.5 Barriers to Building Energy Efficiency Practices

It is not easy to attain sustainable urban building sustainability. These energy saving potentials and efficiency opportunities from the building sector are not being realized due to numerous barriers as summarized in Table 1-3 (Carbon Trust, 2005; Levine & Ürge-Vorsatz, 2007).

Table 1-3: Barriers of Building Energy Efficiency Practices

Barrier categories	Definition	Examples
Financial costs/benefits	Ratio of investment cost to value of energy savings	* Higher up-front costs for more efficient equipment * Lack of access to financing energy subsidies * Lack of internalization of environmental, health and other external costs

Hidden costs/benefits	Costs or risks (real or perceived) that are not captured directly in financial flows	* Costs and risks due to potential incompatibilities, performance risks, transaction costs, etc. * Poor power quality, particularly in some developing countries
Market failures	Market structures and constraints that prevent the consistent trade-off between specific energy-efficient investment and the energy saving benefits	* Limitations of the typical building design process * Fragmented market structure * Landlord/tenant split and misplaced incentives * Administrative and regulatory barriers (e.g., in the incorporation of distributed generation technologies) * Imperfect information
Behavioral and organizational Barriers	Behavioral characteristics of individuals and organizational characteristics of companies that hinder energy efficiency technologies and practices	* Tendency to ignore small opportunities for energy conservation * Organizational failures (e.g., internal split incentives) * Non-payment and electricity theft * Tradition, behavior, lack of awareness and lifestyle * Corruption

Source: Carbon Trust, 2005; Levine & Ürge-Vorsatz, 2007

1. **Fragmented building market structure**

The building market structure involves multiple stakeholders with a variety of incentives and motives for their energy saving behaviors. In addition, the building energy system has different stages: design, construction and operation. The whole building life cycle is not integrated into the building energy saving plan as a whole. Thus, it is difficult to assure long-term building energy performance follows (Levine & Ürge-Vorsatz, 2007; WBCSD, 2007; WEC, 2008).

2. Insufficient and imperfect information

Information about energy efficiency options is often insufficient, unavailable, expensive and difficult to obtain or rely on (Brown et al., 2005; Levine & Ürge-Vorsatz, 2007). A gap exists between the perceived energy savings of particular measures and actual savings. Without enough information and awareness, building users have unrealistic expectations about individual measures as well as an underestimated potential for energy savings with comprehensive measures.

3. Split incentives[3]

A split incentive can be a significant barrier in both residential and commercial buildings. The name "split incentive" means that the benefit of energy savings does not go to the person making the investment. For example, the building owner is likely to be responsible for energy efficiency investments, but the occupant of the building may receive the benefit of lower energy bills. This lowers the owner's willingness to invest in building retrofitting although landlords may benefit from higher rents. On the other hand, if the landlord is responsible for the energy bills, the tenant has no direct incentive to save energy. For example, many multi-tenant apartments and offices do not have individual heating systems or meters to measure consumption. Heating costs may be included in the rent or charged to tenants based on criteria such as floor space. Therefore, the tenants'

[3] This barrier is also called the "principal-agent problem" in the economic literature. The problem occurs when an agent has the authority to act on behalf of a consumer but does not fully reflect the consumer's best interest (Brown et al., 2005).

incentives to save energy are reduced. One study found that when tenants are billed for actual consumption, energy use for heating typically drops by 10 percent to 20 percent (WBCSD, 2007).

4. Regulatory barrier

Some existing regulations have inhibited building energy practices. For example, in China, public procurement regulations inhibit the involvement of energy service companies (ESCOs) or the implementation of energy performance contracts (Levine & Ürge-Vorsatz, 2007).

5. Lack of incentives for developers and investors

In many cases, there are not enough incentives for developers or investors who have the final decision-making authority on office building retrofitting or green building development. This hinders the adoption of energy efficient designs, technologies and practices. Moreover, energy efficient investment measures often require large amounts of capital or financing. Most developers or investors are pursuing short-term profit maximization. They tend to consider the initial cost rather than the building life cycle cost (Levine & Ürge-Vorsatz, 2007; WBCSD, 2007; WEC, 2008).

6. Lack of professional know-how, support and leadership

More energy auditors or engineers are active professionals in industrial structures, while fewer energy auditors or engineers are active in the building sector. Serious gaps in knowledge about energy efficiency exist among building professionals, and the industry suffers from a lack of leadership (WBCSD, 2007).

7. **Behavioral and organizational barriers**

This category refers to those behavioral characteristics of individuals and the organizational characteristics of companies that hinder energy efficiency technologies and practices. For example, building users have a tendency to ignore small opportunities for energy conservation; meanwhile, a lack of energy saving awareness and a tendency for energy-intensive choices often characterizes behavior in companies.

Along with the above common barriers to building energy saving practices, other challenges include financial shortfalls, the lack of availability of energy efficient technologies and relevant technology barriers, inadequate energy services and management, and insufficient local capacities for identifying, developing, implementing and maintaining relevant investments in developing countries and economies in transition (Levine & Ürge-Vorsatz, 2007). In order to remove these obstacles to building sustainability, various policy instruments such as regulatory & control instruments; economic/market-based/fiscal incentives; and support/information/voluntary actions are applied by governments worldwide.

1.6 ASIA'S BUILDING ENERGY GOVERNACE CHALLENGES

Looking at the future of urban building energy governance, Asia is particularly important because of its rapid economic and population growth in general and its concentration in large urban centers with extensive existing building and great need for new ones. These conditions have brought building energy governance challenges in this region of the world.

1.6.1 The Surge of Urbanization in Asia

Over the past half-century, the populations of urban areas in different parts of the world have grown rapidly. In 1950, 30 percent of the population lived in urban areas. This figure has increased to 50 percent in the year 2008 (translating to 3.3 billion people) and is expected to increase to 60 percent (or 5 billion people) by the year 2030 (UNHSP, 2008). The urbanization level has already reached around 80 percent in developed countries (Knox, 2009). Compared to the process of urbanization in developed countries, urbanization in the developing world, which began in the 20th century, follows a different trend and may be the most dramatic transformation in this century (Jiang, 2012). Half of the world's urban population has resided in Asian cities since 2007. Predictions to 2050 forecast a continuation of this trend (UNDESA, 2007; See Figure 1-7).

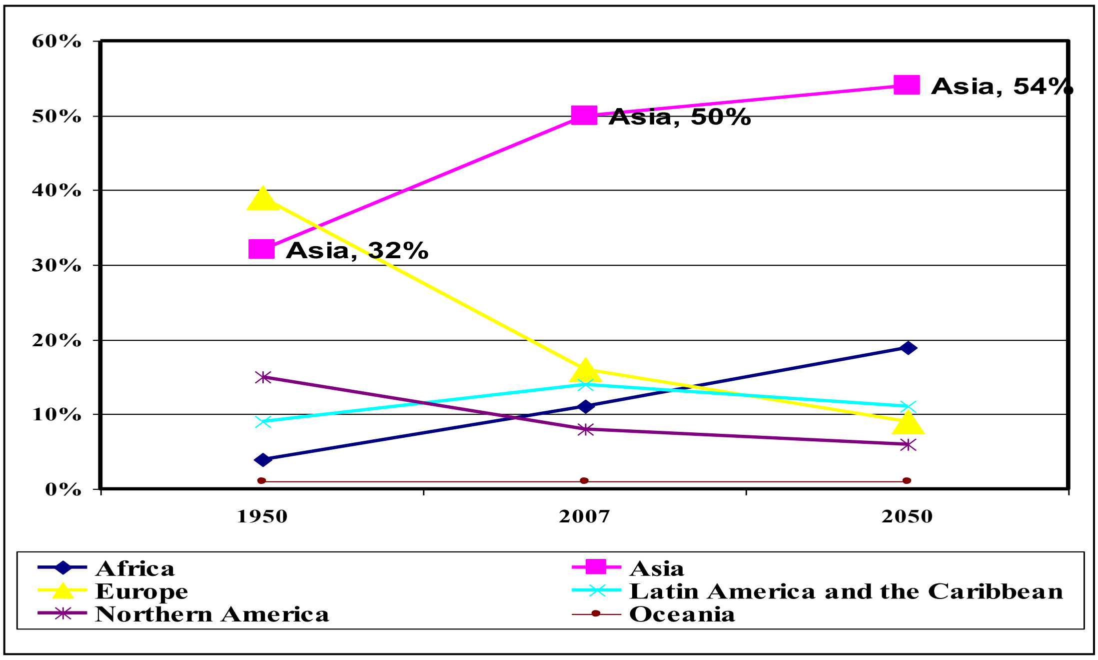

Figure 1-7: Trend for Percent of the World's Urban Populations by Region from 1950, 2007, and 2050

Source: UNDESA, 2007

In Asian countries, the urban population is expected to increase by 44 million every year between 2000 and 2030 (UNDESA, 2007). Meanwhile, more infrastructure and dwellings need to be built to match this urban expansion. Policies fostering economic growth have become a major factor in urban development in Asian countries. As a result, the contribution of urbanization to the Gross Domestic Product (GDP) in Asian countries is more than 60 percent (UNDESA, 2007; Jiang, 2012). Although urbanization in Asia has significantly enhanced economic development and social change, its environmental performance has not matched its economic or human development progress (ADB, 1997). In many cases, this unprecedented economic development has resulted in multiple urban sustainability challenges, including worsened environmental pollution, collapsing traffic systems, dysfunctional waste management, and a rapid increase in the consumption of energy, water, and other resources. As a result, the growth rates of Asia's per capita energy consumption and CO_2 emissions are much higher than the rest of the world's since 1990 (WRI, 2009; See Figure 1-8 and Figure 1-9). In addition, urban development heavily depends upon fossil fuels, which are finite; this causes a serious energy security issue surrounding the energy supply that supports Asia's rapid economic development (Jiang, 2012). Thus, according to Dhakal (2004), due to growing concerns about climate change impacts on cities, it is more and more important to understand the use of energy at the city level and to integrate energy analysis with urban development in Asia. In this way, the issues of local pollution, climate change, and energy security have become more and more significant issues accompanying Asian countries' urbanization.

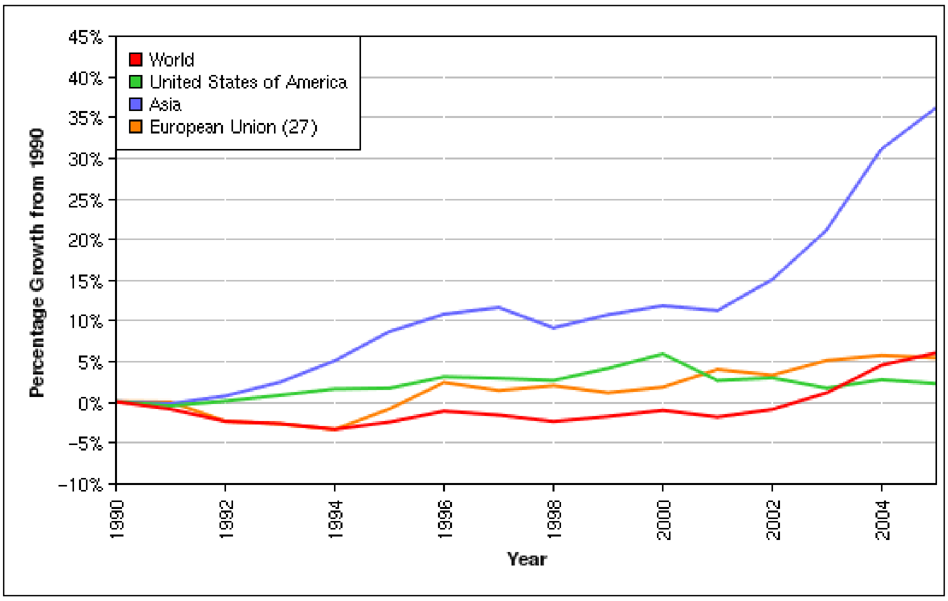

Figure 1-8: Per Capita Energy Use in Asia, 1990-2005

Source: WRI, 2009

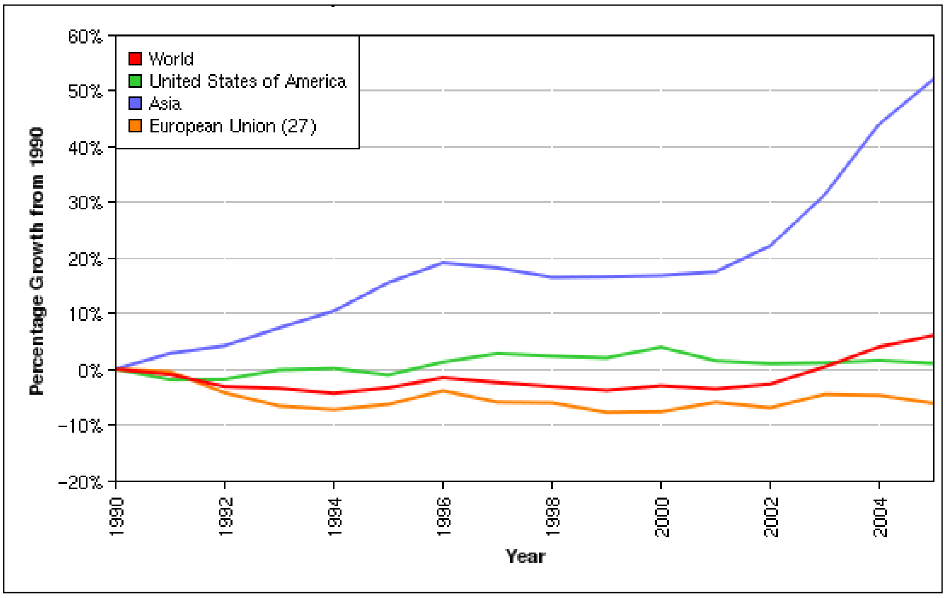

Figure 1-9: Per Capita CO_2 Emissions in Asia, 1990-2005

Source: WRI, 2009

1.6.2 Asia's Building Energy Consumption

With Asia's surging economies and urbanization, the region is adding to its built environment at an unprecedented rate, especially in the population centers of China and India. Every year, more than half of the world's new buildings are constructed in Asia (ABC, 2007). Asia will be the main driver of a 40 percent increase in global energy consumption. The building sector[4] currently accounts for about one-quarter of Asia's final energy consumption. From 1971 to 2004, total energy consumption in the building sector in Asia increased more than 26 percent, and it is predicted to reach one third of Asia's total final energy consumption by 2030 (See Figure 1-10). Asia's building sector in terms of the world's total energy consumption increased from 3.7 percent in 1971 to 7.3 percent in 2004, and is expected to increase to 11.2 percent in 2030 (See Figure 1-11). According to the Asia Business Council, the average annual growth rate of total building energy consumption in Asia[5] is predicted to be 5.7 percent compared to 3.9 percent in the U.S (ABC, 2007; See Figure 1-12). The Intergovernmental Panel on Climate Change (IPCC) has estimated that Asia is one of the regions expected to contribute

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[4] The building sector includes the residential building sector and the commercial building sectors. It refers to an end use sector that consists of living quarters for private households or service-providing facilities and equipment for businesses, governments, and other private and public organizations. In the residential sector, common uses of energy include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. The commercial sector includes institutional living quarters. Common uses of energy associated with the commercial sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a wide variety of other equipment (DECC, 2012).

[5] "Asia Total" includes the 11 Asian economies covered in this study: China, Hong Kong, India, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan and Thailand (ABC, 2007).

a substantial increase in CO_2 emissions from the building sector (Levine & Ürge-Vorsatz, 2007). If this pattern continues without the adoption of environmentally-related policies, Asia is likely to experience energy intensive and high CO_2 emission problems for years to come. Numerous existing buildings plus a new building boom in these Asian cities have caused sustainability challenges in terms of energy, the environment, and the economy, as well as safety issues.

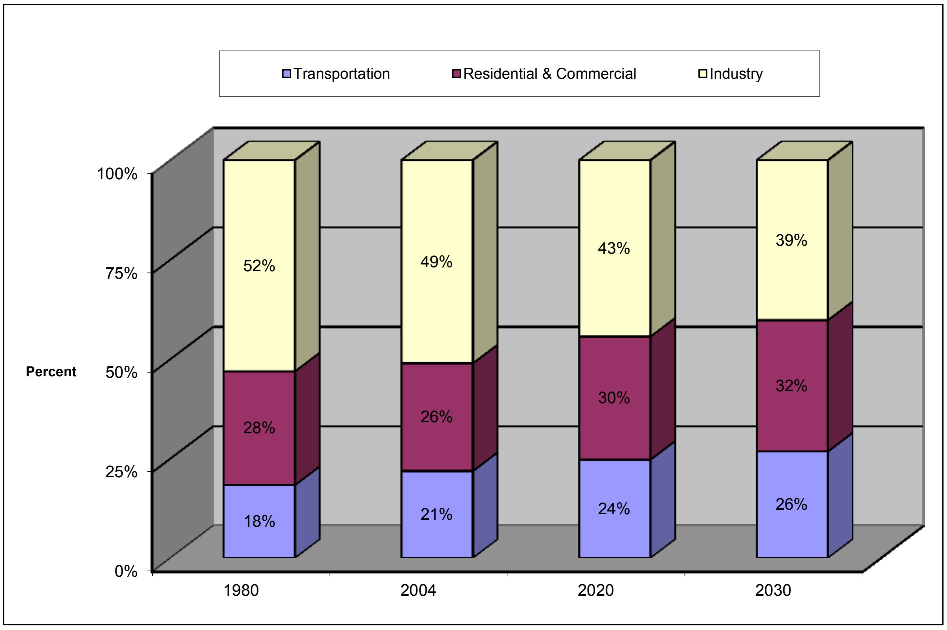

Figure 1-10: Asia's Final Energy Consumption by Sector

Source: ABC, 2007

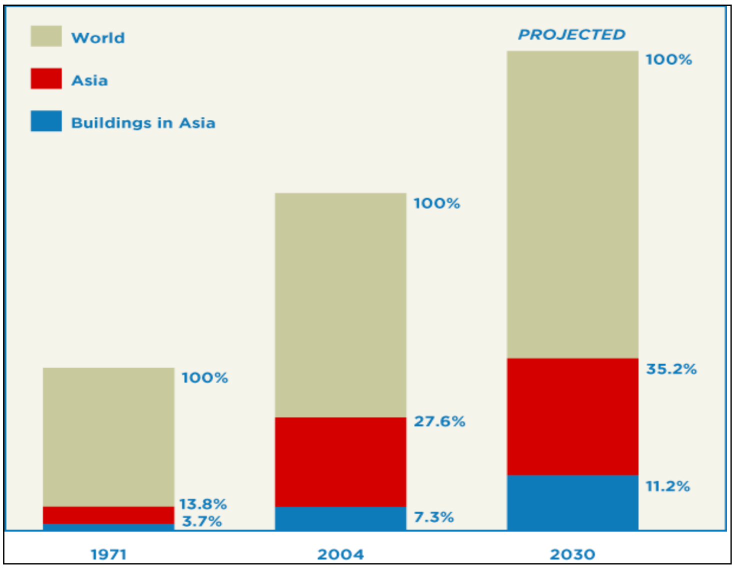

Figure 1-11: Total Final Energy Consumption

Source: ABC, 2007

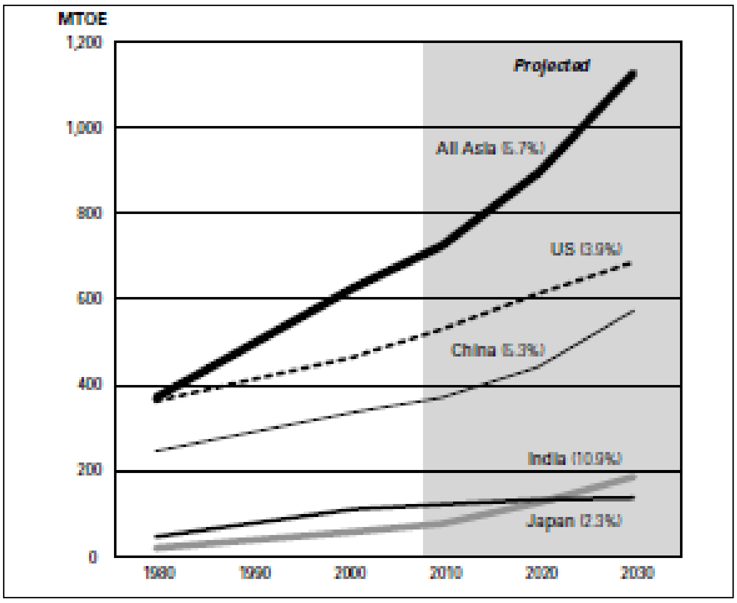

Figure 1-12: Final Energy Consumption by Buildings, 1980-2030

Note: MTOE refers to 'Million Tons of Oil Equivalent'.
Source: ABC, 2007

1.6.3 Building Energy Governance Challenges in China

China is not only the largest developing country (with a population of more than 1.3 billion), but also has had one of the fastest rates of economic growth in the world over the last three decades, following steps to reform the economic system towards a free market. Although China is still considered a "socialist market economy," it has become increasingly integrated into the world economy and trading system. It is also a recipient of very large flows of foreign direct investment (Yulong & Hamnett, 2002). China has been undergoing tremendous socioeconomic and political transformations since the late 1970s. As one of the world's most rapidly developing economies, China joins the United States and other industrial nations as a major consumer of resources and energy, as well as a major polluter of local and global ecosystems (Flavin & Gardner, 2006). According to preliminary estimates by the Netherlands Environmental Assessment Agency (MNP) in 2006, China topped the list of CO_2 emitting countries, surpassing the U.S. by an estimated 8 percent. In 2009, the International Energy Agency (IEA) announced that China had overtaken the U.S. as the world's biggest energy user, although China has expressed skepticism about the data utilized to form this conclusion. In addition, China has experienced rapid and widespread urbanization at a scale never seen before in history (Pearce, 2006). China's urban population is now 51.3percent, more than half of the country's total population. It is projected to be 1.2 billion by 2030 with an annual growth rate of 10 percent, which is higher than the expected global urban population growth rate of 8.1percent. Thus, 60 percent of China's population will be living in urban areas in

2030 (Jiang, 2012; Li, 2007; UNDESA, 2007; See Figure 1-13) and should rise to around 70 percent by 2050 (LBNL, 2008).

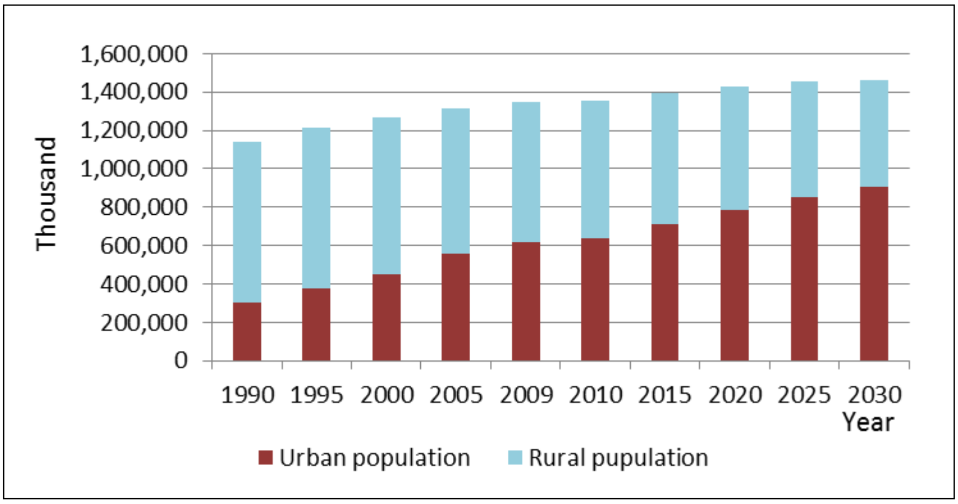

Figure 1-13: Urban and Rural Population in China 1990-2030

Source: Jiang, 2012

China's urbanization has significantly enhanced economic development and social change. However, according to Lin (2002), China's urban structural change is a dual track system of urban settlements, integrating large city dominance at the top with rapidly expanding small cities and towns at the bottom. Although large and extra-large cities have declined relatively in terms of the growing urban population in China, massive built-up areas and infrastructure development among those large and extra-large cities along the eastern coast have reconsolidated the dominance of China's urban development pathway. Among all cities, large and extra-large cities received more than 60 percent of all fixed asset capital invested in cities in the 1990s. More than 63 percent of fixed asset investment in cities was directed to the Eastern region. Among the special economic zones, open coastal cities, and open economic regions[6], Shanghai has been selected by the national Chinese government as a new growth center, thus receiving the largest increase in fixed asset investment during the period of 1990-1998 (Lin, 2002).

These Eastern cities contribute greatly to the Chinese national economy, but with massive commercial energy consumption and CO_2 impacts. Due to rapid urbanization, a considerable building boom and an increasing demand for higher living quality, the share of energy consumption in urban China is much higher than in rural areas. In 2006, Dhakal examined 35 cities in China that represented provincial capitals as well as cities mentioned in the national plan and found that they had a disproportionate influence on China's energy and economic activity. These highly urbanized and economically significant cities claimed only 18 percent of China's population but produced 41 percent of its GDP, consumed 40 percent of its commercial energy, and contributed 40 percent of its national CO_2 emissions. Therefore, a better understanding of urban energy use in these advanced cities is essential to adequately address energy security, climate change mitigation, and local pollution abatement (Dhakal, 2009).

As a consequence of a surging economy and ongoing urbanization, China is experiencing an extraordinary building boom (Lang, 2004). Urban buildings in

[6] In 1978, the Chinese government embarked on a policy of opening to the outside world. Since 1980, China has established special economic zones in some cities. In addition to special economic zones, 14 coastal harbor cities were designated as open coastal cities in 1984 for further promotion of the policy of opening the country to foreign business. Shanghai is the head of the 14 coastal cities. In 1985, the state decided to expand the open coastal areas, extending the open economic zones of the Yangtze River Delta and Pearl River.

China are expected to rapidly increase in the next 20 years and building energy consumption to rise accordingly. China's building sector currently accounts for 23 percentof the nation's total energy use. China's Ministry of Housing and Urban-Rural Development (MOHURD) estimates that China has 40 billion square meters of existing buildings and is adding an additional 2 billion square meters of floor area each year, a number that equals almost half the global total (ABC, 2007; Li, 2007). According to data from the World Bank (2001), more than half of China's urban residential and commercial building stock in 2015 will be post-2000 construction. In addition, the growth in urban building stock coincides with rising building energy consumption[7]. More than half of existing buildings in urban China consume at least two to three times more energy than buildings in developed countries under the same weather conditions (UNEP, 2007; Li, 2007). Approximately 25 percent of total energy is consumed in China's urban buildings. This figure is predicted to increase to 35 percent by 2030. Building energy use generated more than 5 billion tons of CO_2 equivalent (CO_2e) emissions in 2009 (See Figure 1-14; Jiang, 2012; Li, 2007; Qiu et al, 2007; NBS, 2010;).

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[7] If the urban building stock doubles, corresponding building energy consumption may undergo a twofold increase, with the potential for even greater growth (CCICED, 2009).

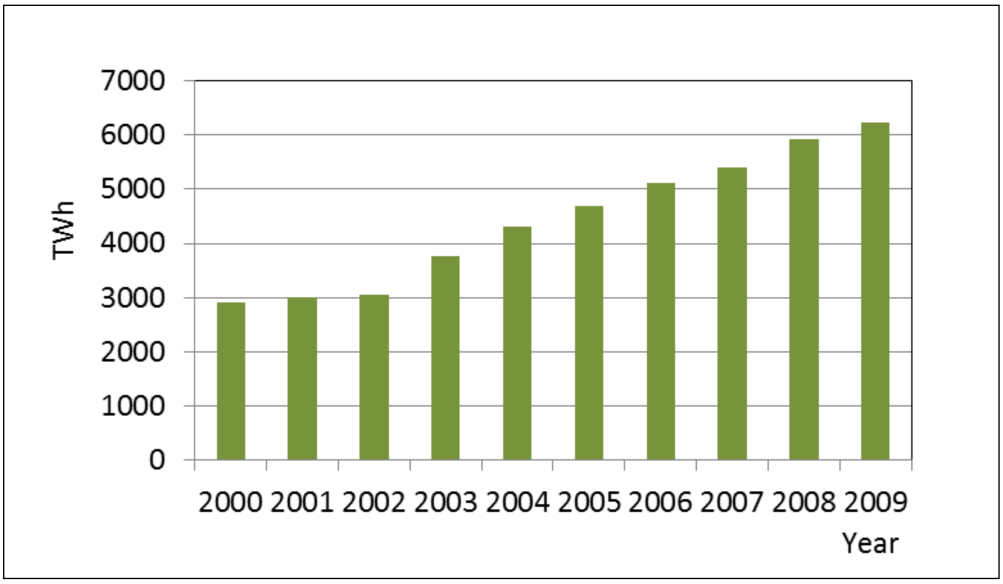

Figure 1-14: Building Energy Consumption in China 2000-2009

Source: Jiang, 2012

Moreover, urban buildings exhibit higher energy demand than rural structures (Li & Yao, 2009). Table 1-4 shows data from the period of the 11th and 12th Five-Year Plan (FYP)[8], indicating that urban buildings account for the most energy consumption within China's building sector.

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[8] China's Five-Year Plan for National Economic and Social Development is a critically important tool used by the government to achieve its development objectives by mapping out in five-year cycles the country's future progress via guidelines, policy frameworks, and targets for policymakers at all levels of government. The 1st Five-Year Plan ran from 1953-1957. The 12th Five-Year Plan (2011-2015) was hailed as the "Greenest FYP in China's History," and contains one-third of the social and economic objectives relating to natural resources and environmental issues, aiming to build sustainable development practices into Chinese industries.

Table 1-4: Building Energy Consumption & Projection (11^{th} FYP & 12^{th} FYP)

Year	2005	2006	2007	2008	2009	2010	2015 Projection	Growth (2010-15)
Urban Building	**1162**	**1250**	**1382**	**1570**	**1681**	**1821**	**2732**	**50%**
Rural Building	61	75	84	93	92	102	152	49%
Other	165	174	181	187	212	224	280	25%
Total	1388	1499	1647	1850	1985	2147	3165	47%

Unit: 10,000 ton Standard Coal

Source: Chen, 2010

Overall, economic expansion and migration from rural areas to cities has not only altered China's urban infrastructure and built environment, but has also caused urban building energy challenges for Chinese cities. The increasing urban population and its constantly growing demand for higher living conditions is a great challenge for long-term low carbon sustainable development in China's building sector (Jiang, 2012). Energy demand is rising with greater reliance on air-conditioning, lighting, electric appliances and power equipment in high-grade office buildings, hotels, large-scale shopping malls and integrated commercial buildings (UNEP, 2007). Although building energy efficiency efforts have been pursued by the Chinese government since the early 1980s (Lang, 2004), the enforcement of mandatory building energy policies is far from satisfactory. The low implementation rate of national and local policies on the local level also reveals the barriers and the enforcement gap that exist for urban building energy governance in China (Zhong, 2005). Besides these issues, local regulation follows the content of national law, and usually does not provide rules and guidance specifically tailored to the local jurisdiction (Yao, Li and Steemers, 2005). Further, some of the current national and local policies are not strong enough for continued reduction of GHG emissions and pollution as part of the process of urban development (Jiang, 2012). Moreover, energy efficiency and carbon reduction are always considered as “second issues” or “less important points” in the building sector (Jiang, 2012; Li & Yao, 2009).

Some barriers mentioned earlier exist in China’s building market and hinder the existence of effective building energy governance, including investment barriers, financial barriers, technology barriers, and capacity barriers (Jiang, 2012). Jiang (2012) pointed out that investors often make weak investment decisions with respect to energy efficiency improvements in the building sector because initiatives for energy conservation and environmental protection are often low on the list of priorities for investors unless legislative or particularly attractive financial incentives galvanize them to act. In addition, adopting new and advanced technologies for reduced energy consumption in buildings means that higher investment is needed with a higher chance of risk, compared to more mainstream measures with less investment needed. Thus, the cost of maintaining and operating these new energy efficient technologies and equipment is usually perceived as higher. Moreover, there is an absence of knowledge or experience in developing and utilizing energy saving technologies, alongside limited knowledge and information on the costs and benefits of energy saving and environmental protection in the building sector in China; all of the above reasons make investors or developers believe that the implementation of energy efficiency projects involves major investment and high risks. Furthermore, the lack of good energy management and professional staff causes the capacity barriers to increase in China.

To overcome the above barriers of China's building energy challenges, it is essential to investigate existing building energy policies and practices to reduce energy consumption and strengthen low-carbon management in modern urban China. However, there has been comparatively limited research on the importance of urban building energy governance for Asia and China. In order to meet the rising challenges in energy efficiency, research on the building governance in Asia and China should begin by analyzing important cities in the area such as Shanghai. The next section discusses why Shanghai is selected as the case study of the dissertation.

1.6.4 The Case of Shanghai

Shanghai is the lead globalizing city of China, and it is eager to prove its economic force and international competitiveness before the international community. The impact of globalization has provided Shanghai with considerable economic benefit, but it is also associated with massive environmental degradation and social tension. Shanghai's continuing expansion poses great challenges for our understanding of urban sustainability governance in these areas. Shanghai faces tremendous pressure for planning and development activities because the existing urban infrastructure cannot meet the explosive demands created by the influx of foreign and domestic investment, increases in wealth and urban consumption, and rural to urban migration. Other Chinese cities have faced similar challenges, but nowhere else has the urban built environment been so intensively exploited and heavily burdened as in Shanghai.

As the largest globalizing city in China, Shanghai is engaged not only in the construction of more office buildings, but also in constructing "image" buildings for city branding as a strategy for competing in the global market. Skyscrapers and glamorous towers have accordingly sprung up across Shanghai's skyline. With rapidly growing building stocks, relevant research has indicated estimates of Shanghai's commercial sector that could become key issues, in comparison to other major global cities in East Asia in terms of energy use and CO_2 emissions (Dhakal, 2009). Shanghai also is highly vulnerable to climate change impacts. In addition, there has been no comprehensive study to date on the implementation of energy efficiency policies in China's or Shanghai's building sectors, nor does an overview of existing policies and actors in this field exist. Most studies focus on certain policy instruments or emphasize the technical potential of various technologies in order to enhance building energy efficiency (Gu, 2007; Hogan et al., 2001; Richerzhagen, 2008).

A case study is undertaken that generally describes Shanghai's built environment and building energy use to describe and analyze (1) the structure and dynamics of the city's building energy governance system; (2) two major private sector-driven commercial building energy retrofits; and (3) an assessment of Shanghai's building energy governance system in relation to the recommended and operational building energy policies and criteria identified from the literature and selected world city practices. First, the case study explores the dynamic relationships that exist among relevant stakeholders who facilitate or hinder Shanghai's commercial building energy governance. This includes the Mayor's willingness and leadership; intergovernmental relationships between the national and municipal governments; and the relationship between local autonomy on commercial building energy governance and national government authority over local specific functions. How can the city government enable other local government sub-units under it, such as a counties or townships, to reduce emissions from buildings? In terms of interdepartmental relationships, which department or departments are in charge of building energy related issues? What conflicts occur? How adequate is inter-agency coordination, and is it necessary for building energy governance at the city level? Also, are other policy actors in the private sector or the voluntary sector involved? Other policy actors may include the influence from global and local ESCOs, environmental NGOs and advocacy groups, and research institutions and universities. Does the city government participate in any transnational urban networks for regional and global interaction and cooperation on climate change mitigation that bring positive influence to bear on building energy governance? Shanghai's case study is of particular value because of the limited research there has been on building energy governance in general and especially in Asia, where it will be of particular importance in the future.

Second, the usefulness of this case is further enhanced by being able to examine how two private sector corporations with branches in large buildings they own in Shanghai deal with building energy management in their buildings through internal corporate policy, and how they relate to the overall, government-run building energy governance structure. The study deals with the building energy management policies of two major commercial buildings in Shanghai, IKEA and Plaza 66, and how the role of private building management interacts with Shanghai's government and civil sectors in relation to building energy sustainability to form multi-sector networks in the governance structure.

The third aspect of the Shanghai analysis involves an assessment of Shanghai's building energy governance system in relation to the recommended and operational building energy policies and criteria identified from the literature and selected world city practices. The design of the study allows two types of evaluations of Shanghai's building energy governance system by comparing what it does in relation to what is recommended in the literature and the actual building energy governance frameworks in three major global cities. The first type of evaluation identifies major policy instruments that are recommended in the general literature. The second set of building energy policy instruments, or operational benchmarks, are drawn from those adopted in London, New York, and Tokyo (which are consistently identified as "world cities"). Therefore, Shanghai can be compared to operational benchmarks rather than only looking at recommended building energy governance from literature. Although it is not possible in this study to evaluate the actual performance of these instruments, assessing Shanghai in terms of the extent that it has or has not adopted these recommended and operational benchmarks offers a first step in that direction.

1.7 Methodology and Data Sources

The dissertation utilizes qualitative methodology in the form of a case study to explore, analyze, compare, and evaluate commercial building energy policies and practices in Shanghai. The sources of data applied to this study come from professional books, journal papers, official publications, the Internet, and interviews of relevant policymakers, professionals and researchers through email correspondence, telephone contact, and in-depth face-to-face interviews during a Shanghai field trip in the fall of 2011. Shanghai fieldwork and relevant interviews with national/local policymakers, professionals and researchers have been applied as background information and case study resources. Relevant interviewees include: Professor Fei Chen (Tongji University for Shanghai building energy policies); Mr. Jonathan Weng (IKEA Shanghai); Engineer Liu (Plaza 66 Shanghai); Ms. Qian Wang (WWF Shanghai); Ms. Michelle Bai (Johnson Controls); Mr. Lewis Liu (HuaMin Real Estate); Engineer Zhu (HongTai Real Estate); Dr. Fan (Shanghai Research Institute of Building Science); Director Yu (Shanghai Municipal Commission of Economy and Informatization for Shanghai building energy policies); Professor Yiqun Pan (Tongji University for Shanghai building energy policies); Professor Zheng-Rong Li (Tongji University for Shanghai building energy policies); Professor Xiangrong Wang (Fudan University for Shanghai building energy policies); and Professor Xingyi Dai (Fudan University for Shanghai building energy policies).

1.8 Outline of Chapters

Chapter Two: Building Energy Policy Instruments provides the building energy policy instrument framework as a benchmark against which to compare and evaluate the Shanghai case study of this dissertation. The set of policies has been recommended by the literature as desirable to enhance building energy efficiency and reduce energy use and pollution generation from the building sector.

Chapter Three: Commercial Building Energy Policies in New York, London, and Tokyo examines commercial building energy policy instruments from three global cities, London, New York, and Tokyo, as another practical comparative basis for evaluating the Shanghai case study. The benchmark provides the "operational" building energy governance and practices which can be added to the existing literature.

Chapter Four: Commercial Building Energy Policies in Shanghai reviews Shanghai's energy saving regulations and policies for reducing energy consumption and CO_2 emissions in commercial buildings at national and city scales. Moreover, the chapter investigates relevant policy stakeholders in Shanghai's commercial building energy governance.

Chapter Five: Case Analyses: Shanghai IKEA and Plaza 66 selects two large-scale commercial building sites to further evaluate Shanghai's existing building energy practices with the co-benefits approach. Detailed building energy savings, CO_2 reductions, and management cost reductions based on data availability and calculations are presented with the co-benefits approach. Additionally, the chapter presents relevant policy interventions and factors that facilitate or constrain the implementation process of co-benefit effectiveness in each case building.

Chapter Six: Policy Recommendations and Conclusions presents research findings and policy recommendations for Shanghai's commercial building energy sustainability. The chapter analyzes the comparison between Shanghai's commercial building energy policy instruments and the benchmark recommended by professional organizations and three major global cities. Major barriers regarding policy instruments and the implementation process are discussed, followed by relevant policy recommendations. Moreover, this chapter provides suggestions and directions for future research, including other dimensions of urban building sustainability that should be considered in relation to the case study, and how other major cities in rapid urbanization regions address their commercial building energy governance issues.

Chapter 2

BUILDING ENERGY POLICY INSTRUMENTS AND ANALYTICAL FRAMEWORKS

This chapter provides a set of benchmarks for building energy policy instruments based on the synthesis of relevant criteria recommended by professional organizations and research publications, which in turn can provide a basis for assessing the actual building energy governance in the three global cities and the Shanghai case study in the following chapters. Along with the static policy framework, this chapter provides a dynamic multi-scale analytical framework for further analyzing major factors that affect Shanghai's building energy practices.

2.1 Analytical Framework of Building Energy Policy Instruments

According to Capello et al. (1999), a central element in creating urban sustainability is the adoption and implementation of appropriate energy policies because most environmental factors in cities are directly or indirectly related to urban energy use. Nijkamp and Ursem (1998) also point out why there are good reasons to concentrate on the urban dimension of energy policy. First, a significant share of the world population and its activities are found in urban areas, so it makes sense to concentrate efficient energy initiatives in cities in order to benefit from agglomeration economies in the energy policy sector. In addition, the current national governance decentralization movement in many countries opens up possibilities for local authorities to be actively involved in building up effective and operational energy savings plans and related environmental quality improvement initiatives. Urban areas are becoming recognized institutional policy units with clear competences and with the possibility to operate in a flexible and innovative manner. Moreover, an urban energy and environmental policy may also encourage direct involvement of citizens because such policy initiatives are usually source-based, efficiency-oriented and visible, so that a sufficient local support base may be generated (Nijkamp & Ursem, 1998). Therefore, national and provincial governments should assess what powers might be devolved to or shared with the municipal level to enable cities to better cope with energy policies for urban sustainability (Rees & Wackernagel, 1996). The following section focuses on the building sector to explore and summarize a framework that can be used as a policy benchmark for analyzing and assessing urban building energy governance systems.

The benchmark framework applied to this research has categorized relevant policy instruments into three policy types regarding urban building energy policies. Regulatory and control instruments include building codes, standards and other mandatory programs and policies. Market-based instruments and fiscal incentives include an energy or carbon tax and other financial subsidies for promoting building energy savings. Support, information and voluntary action provide information and successful demonstrations to educate residents on changing their behaviors. These policy instruments assist city governments in formulating policies in the building sector to realize reductions of energy consumption and greenhouse gas emissions. The details of various policy instruments are summarized in following sections.

2.1.1 Regulatory and Control Instruments

Control and regulatory instruments are regarded as the most commonly used methods for energy efficiency improvements in the building sector. They can be defined as institutional rules that aim to directly influence the environmental performance of polluters by regulating processes and products used, by prohibiting or limiting the discharge of certain pollutants, and by restricting activities to certain periods or areas (Ürge-Vorsatz & Koeppel, 2007). Although control and regulatory instruments with corresponding penalties have been more effective than other types of instruments, their effectiveness can be hampered by poor enforcement and reduced motivation for innovation and flexibility to achieve higher performance (Lee & Yik, 2004; Richerzhagen, 2008; Ürge-Vorsatz & Koeppel, 2007). In addition, they result in high administrative costs to remain effective because they have to be monitored, evaluated, updated or revised regularly in accordance with technological developments and market trends (Ürge-Vorsatz & Koeppel, 2007).

Table 2-1 presents the emission reduction effectiveness and cost effectiveness of regulatory instruments (Ürge-Vorsatz, Czakó, & Koeppel, 2009). Most regulatory policy instruments achieve high emission reduction and cost effectiveness, except for “Public Leadership Programs/Procurement Regulations” and the “Mandatory Audit and Energy Management Requirement,” which might achieve high to medium levels.

Table 2-1: Summary Table of Regulatory Policy Instruments to Reduce GHG Emissions in the Building Sector

Policy Instrument	Emission Reduction Effectiveness	Cost Effectiveness	Conditions for Success
Regulatory Instruments			
Appliance Standards	High	High	Factors for success: periodic update of standards, independent control, information, communication and education.
Building Codes	High	Medium	No incentive to improve beyond target. Only effective if enforced.
Public Leadership Programs/Procurement Regulations	Medium/High	High/Medium	Success factors: enabling legislation, energy efficiency labeling and testing ambitious energy efficiency specifications.
Energy Efficiency Obligations and Quotas	High	High	Continuous improvements necessary: new energy efficiency measures, short-term incentives to transform markets, etc.
Mandatory Labeling and Certification Program	High	High	Effectiveness can be boosted by combination with other instruments and regular updates.
Mandatory Audit and Energy Management Requirement	High, but Variable	Medium	Most effective if combined with other measures such as financial incentives.
Demand-side Management Programs (DSM)	High	High	DSM programs for commercial sector tend to be more cost effective than those for residences.

Source: Ürge-Vorsatz, Czakó and Koeppel, 2009

Regulatory and control instruments can include the following types:

1. Building codes

Building codes involve standards that address the energy use of an entire building. The greatest opportunity to make buildings more efficient is during the construction phase. Therefore, in this case a set of minimum standards are adopted which address the energy use of an entire building or building systems, such as for heating or air conditioning. These standards require regular upgrades to remain effective (Birner & Martinot, 2002; Brown et al., 2005; Ürge-Vorsatz & Koeppel, 2007). However, Ürge-Vorsatz and Koeppel (2007) point out that the effectiveness of building codes varies significantly from country to country. Especially in developing countries, they are often ineffective due to insufficient implementation and enforcement.

2. Appliance standards

Appliance and equipment standards require all regulated products to meet minimum efficiencies. Thus, the least efficient products could be eliminated from the market (Birner & Martinot, 2002; Brown et al., 2005; Ürge-Vorsatz & Koeppel, 2007). However, standards do not provide incentives for innovation beyond the minimum targets. According to Ürge-Vorsatz and Koeppel (2007), they are usually combined with mandatory labeling for further innovation. Also, it is required to update the standards regularly and continue testing relevant products.

3. Procurement regulations

Energy-efficient procurement regulations are mainly used in the public sector. They are considered to be one of the most effective instruments. However, according to Levine and Ürge-Vorsatz (2007), procurement regulations need regular upgrades and an appropriate combination with other policy instruments, such as energy-efficient labeling.

4. Energy Efficiency Obligations (EEOs)

Energy efficiency obligations (EEOs) can be defined as legal obligations for electricity and gas suppliers to save energy in their customers' buildings or houses (Lees, 2006; Ürge-Vorsatz & Koeppel, 2007).

5. Mandatory certification and labeling

The purpose of a building certification and labeling program is to overcome barriers related to a lack of information and high transaction costs. Certification and labeling schemes can be either mandatory or voluntary (Levine & Ürge-Vorsatz, 2007). Mandatory certification and labeling programs provide information to end users about the energy-using performance of products such as electrical appliances, equipment, and even buildings (Crossley et al., 2000; Ürge-Vorsatz & Koeppel, 2007). To enhance effectiveness, they can be combined with other policy instruments such as financial incentives or voluntary agreements (Ürge-Vorsatz & Koeppel, 2007).

6. Mandatory audit programs

Mandatory energy audits for industrial and large commercial buildings are one of the most common policy instruments. However, these programs require financial incentives and capacity building of qualified auditors and energy service companies (ESCOs) (WEC, 2004; Ürge-Vorsatz & Koeppel, 2007).

7. Utility Demand-side Management (DSM)

Utility demand-side management (DSM) programs can be defined as planning, implementing, and monitoring activities of energy efficiency programs by utilities. Electricity and gas utilities are generally in a privileged position to advise their clients on energy efficiency in their buildings through DSM programs (Ürge Vorsatz & Koeppel, 2007).

2.1.2 Economic/Market-Based/Fiscal Incentives

Economic instruments are based on market mechanisms and usually contain elements of voluntary action or participation. They are initiated or promoted by regulatory policy and can be defined as tools that influence energy prices either by imposing a tax aimed at reducing energy consumption or by other financial support (Ürge-Vorsatz & Koeppel, 2007).

Table 2-2 presents emission reduction effectiveness and cost effectiveness of economic/market-based/fiscal incentives (Ürge-Vorsatz, Czakó, & Koeppel, 2009). This type of policy instrument presents varied effectiveness outcomes. Tax incentives can achieve high emission reduction and cost effectiveness, while taxation policy instruments and Kyoto Flexible Mechanisms have been rated low in both emission reductions and cost effectiveness. Subsidies, grants, and loans can bring high emission reduction effectiveness but low cost effectiveness. The rest of the policy instruments' effectiveness is rated between high and medium, as found with energy performance contracting (EPC), ESCO support, and energy efficiency certificates.

Table 2-2: Summary Table of Economic/Market-Based/Fiscal Incentives to Reduce GHG Emissions in the Building Sector

Policy Instrument	Emission Reduction Effectiveness	Cost Effectiveness	Conditions for Success
Economic/Market-Based /Fiscal Incentives			
EPC/ESCO Support	High	Medium/High	Strength: no need for public spending or market intervention; co-benefit of improved competitiveness.
Cooperative Procurement	High	Medium/ High	Success condition: energy efficiency needs to be prioritized in purchasing decisions.
Energy Efficiency Certificate /White Certificates Schemes	Medium/High	High/Medium	No long-term experience yet. Transaction costs can be high. Monitoring and verification crucial. Benefits for employment.
Kyoto Protocol Flexible Mechanisms (CDM and JI)	Low	Low	So far, limited number of CDM & JI projects in buildings.
Taxation	Low/Medium	Low	Effect depends on price elasticity. Revenues can be earmarked for further efficiency. More effective when combined with other tools.
Tax Exemptions/ Reductions	High	High	If properly structured, stimulate the introduction of highly efficient equipment and new buildings.
Public Benefit Charges	Medium	High	
Capital Subsidies, Grants, Subsidized Loans	High	Low	Positive for low-income households, but risk of free-riders; may induce pioneering investments.

Source: Ürge-Vorsatz, Czakó and Koeppel, 2009

1. EPC/ ESCOs support

Energy performance contracting (EPC) means that a contractor, typically an energy service company, guarantees certain energy savings for a location over a specified period, implements the appropriate energy efficiency improvements, and is paid either the estimated energy cost reductions or the achieved energy savings. The success of EPC and ESCOs needs a supportive legal system and mature financial mechanisms to remain effective (EFA, 2002; Ürge-Vorsatz & Koeppel, 2007).

2. Cooperative/Technology procurement

Cooperative procurement or technology procurement is a voluntary tool whereby customers from the private or the public sectors procure large quantities of energy appliances and equipment in order to transform the market by creating a demand for more energy efficient products. However, this requires a strong interaction between buyers and sellers, as well as sufficient funding to address demand-side barriers (Crossley et al., 2000; Ürge-Vorsatz & Koeppel, 2007).

3. Energy efficiency certificate/White certificate schemes

Similar to energy efficiency obligations, energy efficiency certificates (often referred to as "white certificates") for energy savings can be traded (Levine & Ürge-Vorsatz, 2007; Ürge-Vorsatz & Koeppel, 2007).

4. Kyoto flexibility mechanisms

The flexibility mechanisms of the Kyoto Protocol, i.e. Joint Implementation (JI) and the Clean Development Mechanism (CDM), can offer major benefits for building through the delivery of financing, know-how, sustainability benefits, and capacity building for GHG mitigation projects in developing countries and economies in transition. However, the effectiveness and use of the Kyoto Flexibility Mechanisms in the building sector are much lower than expected due to the very complicated pre-registration and approval-procedure currently in place and the lack of a methodology (Levine & Ürge-Vorsatz, 2007; Novikova et al., 2006; Ürge-Vorsatz & Koeppel, 2007).

5. Energy/Carbon taxes

Taxes are increasingly implemented, either as an energy tax or as a CO_2 tax (ECS, 2002). The effect is to increase the final price that end users pay for each unit of energy obtained from their supplier, although the tax may be levied at any point in the supply chain (Crossley et al., 2000; Ürge-Vorsatz & Koeppel, 2007). It is expected to decrease the end users' energy consumption by increasing energy costs.

6. Tax incentives

Tax incentives contain tax credits, exemptions and reductions. They are very important for stimulating the introduction and initial sales of energy efficiency technologies and new energy efficient homes and commercial buildings (Geller & Attali, 2005; Quinlan et al., 2001).

7. Public benefits charges

Public benefits charges are defined as raising funds from the operation of the energy market, which can then be directed into DSM programs and other energy efficiency activities (Crossley et al., 2000).

9. Rebates/Subsidies/Grants

Many governments use financial incentives to encourage building owners and occupants to invest in energy efficiency measures and equipment. Rebates and subsidies refer to financial support for the purchase of energy efficient appliances or buildings (Ürge-Vorsatz & Koeppel, 2007). Many countries have developed various subsidy schemes to overcome the barrier of high upfront costs of energy efficiency investments (United Nations Development Program, 2010).

10. Low interest loans and guarantee funds

Insufficient financing can be a major hurdle to the adoption of energy-efficient measures and practices. Financial institutions offering low-interest loans for building energy efficiency programs can also be supported through public guarantee funds that can reduce the risk for lenders (United Nations Development Program, 2010).

2.1.3 Support, Information and Voluntary Action

Support, information and voluntary action include a range of activities directed at improving the knowledge of the public and decision-makers about carbon reduction opportunities for the building sector and providing technical assistance with their implementation.

Table 2-3 presents emission reduction effectiveness and cost effectiveness of support/information/voluntary action. Most policy instruments can achieve medium to high effectiveness, while Detailed Billing and Disclosure Programs rank at medium levels and Awareness raising/Education/Information campaigns rank between low and medium.

Table 2-3: Summary Table of Support/Information/Voluntary Action to Reduce GHG Emissions in the Building Sector

Policy Instrument	Emission Reduction Effectiveness	Cost Effectiveness	Conditions for Success
Support/Information/Voluntary Action			
Voluntary Labeling and Certification Programs	Medium/High	High/Medium	Effective with financial incentives, voluntary agreements and regulations.
Voluntary and Negotiated Agreements	Medium/High	Medium	Can be effective when regulations are difficult to enforce. Effective if combined with financial incentives and threat of regulation.
Public Leadership Programs	Medium/High	High/Medium	Can be used to demonstrate new technologies and practices. Mandatory programs have higher potential than voluntary ones.
Awareness Raising/ Education/Information Campaigns	Low/Medium	Medium/ High	More applicable in residential sector than commercial sector.
Detailed Billing and Disclosure Programs	Medium	Medium	Success conditions: combination with other measures and periodic evaluation. Comparability with other households is positive.

Source: Ürge-Vorsatz, Czakó and Koeppel, 2009

1. Voluntary certification and labeling programs

Voluntary certification and labeling programs are used for appliances and buildings. These programs can be effective if they are designed well and updated regularly. Combinations with other financial policy instruments and regulation can enhance their effectiveness (Crossley et al., 2000; Ürge-Vorsatz & Koeppel, 2007).

2. Voluntary and negotiated agreements

Voluntary or negotiated agreements involve a formal agreement between a responsible government body and a business or organization which states that the business or organization will carry out specified actions to increase the efficiency of its energy use (Crossley et al., 2000; Ürge-Vorsatz & Koeppel, 2007). Voluntary or negotiated agreements cover actions in pursuit of stated environmental objectives that go beyond the requirements of the regulator or law. The regulator may be involved in monitoring progress, especially if regulatory action will be taken if the voluntary agreement fails to deliver the required improvement.

3. Public leadership programs

Public leadership programs refer to energy efficiency programs in the public agencies. These programs can significantly reduce energy consumption and costs in the public sector. In addition, they can demonstrate new technologies and thereby provide an incentive to the private sector to follow the example of the public sector (Harris et al., 2004; Ürge-Vorsatz & Koeppel, 2007).

4. Awareness raising, education and information campaigns

Lack of awareness of energy saving opportunities among different policy actors is a major impediment to achieve a lower carbon and higher energy efficient building sector (Levine & Ürge-Vorsatz, 2007). Public information campaigns can be described as policy instruments designed by government agencies with the intention to change individual behaviors, attitudes, values, or knowledge. These information programs can increase the effectiveness and long-term impact of most other policy instruments (Bender et al., 2004; Ürge-Vorsatz & Koeppel, 2007; Weiss & Tschirhart, 1994). For example, local energy efficiency centers can provide practical information and technical assistance for local needs, including building energy saving technologies. These centers are focal points that offer impartial information on energy conservation to the general public, including technical advice on projects and on useful contacts. They often have high rates of implementation of their advice, depending on the quality of the advisors and the accessibility of the network. These centers also implement demonstration projects and act as policy advisors to the government on energy efficiency matters (United Nations Development Program, 2010).

5. Detailed billing and disclosure programs

Detailed billing and disclosure programs involve the display of detailed information related to energy consumption to the user, either on the bill or directly on the appliance or meter (Ürge-Vorsatz & Koeppel, 2007). Effectiveness can be enhanced through information programs, free meters and regular evaluation. Incentive programs attempt to encourage large consumers to audit their buildings on a voluntary basis. The expectation is that the potential energy savings shown by the audits will convince building owners/users to invest in energy efficiency programs.

6. Research and development

The design of public policies to promote green buildings and sustainable communities needs to consider and anticipate the full range of technological possibilities. In addition, a broad array of accessible and cost-effective technologies and know-how that can abate GHG emissions in existing and new buildings to a significant extent already exists but has not been widely adopted yet. Therefore, research and development is necessary for technological improvements that are incremental and have a high probability of commercial introduction over the next decade. Other technology advances require considerable research and development before they can become commercially feasible (Levine & Ürge-Vorsatz, 2007; Ürge-Vorsatz & Koeppel, 2007).

Table 2-4: Barriers to Energy Efficiency and Policy Instruments as Remedies

Barrier Category	Instrument Category	Policy Instruments as Remedies
Economic barriers	Regulatory and control instruments Economic instruments Fiscal instruments	Appliance standards, building codes, energy efficiency obligations, mandatory labeling, procurement regulations, DSM programs EPC/ESCOs, cooperative procurement, energy efficiency certificates, taxation, public benefit charges, tax exemptions, subsidies/rebates/grants
Hidden costs/benefits	Regulatory and control instruments Economic instruments Support action	Appliance standards, building codes EPC/ESCOs, public leadership programs
Market failures	Regulatory and control instruments Economic instruments Fiscal instruments Support, information, voluntary action	Appliance standards, building codes, energy efficiency, obligations, mandatory labeling, procurement, regulations, DSM programs EPC/ESCOs, cooperative procurement, energy efficiency certificates, Kyoto Flexibility Mechanisms, taxation, public benefit charges, tax exemptions, subsidies/rebates/grants, voluntary labeling, voluntary agreement, public leadership programs, awareness raising, detailed billing
Cultural/behavioral Barriers	Support, information, voluntary action	Voluntary labeling, voluntary agreement, public leadership programs, awareness raising, detailed billing

Table 2-4 Continued

Barrier Category	**Instrument Category**	**Policy Instruments as Remedies**
Information barriers	Support, information, voluntary action Regulatory and control instruments	Voluntary labeling, voluntary agreement, public leadership programs, awareness raising, detailed billing, mandatory labeling, procurement regulations, DSM programs, mandatory audits
Structural/political barriers	Support, information, voluntary action	Public leadership programs

Sources: Adapted from Carbon Trust, 2005; Levine & Ürge-Vorsatz, 2007

In terms of policy effectiveness and cost-effectiveness, the highest GHG emission reductions have been achieved using appliance standards, building codes, utility DSM programs, tax exemptions and labeling. Appliance standards, energy efficiency obligations, DSM programs, public benefit charges and labeling were found to be the most cost-effective instruments. Regulatory and control instruments were revealed in the sample as the most effective and cost-effective category of instruments if enforced well. Economic and fiscal instruments and fiscal incentives lead to diverging results. The effectiveness of voluntary and information instruments is usually lower, but depends on the context as well as on the accompanying policy measures (Ürge-Vorsatz, Czakó, & Koeppel, 2009). Moreover, due to the large number of barriers, a single instrument will rarely reach ambitious energy saving targets, and thus combinations of instruments are necessary for progressive results (See Table 2-4). Packages of instruments also often achieve synergistic effects. Developing countries in particular require technical and financial assistance, demonstration and information programs and training. Other factors such as institutionalization of energy efficiency within the governmental structure, regular monitoring and evaluation and adaptation to local circumstances are relevant for the success of policies in all countries (UNEP, 2007).

The section reviews relevant literature and identifies building energy policy instruments that have been used to decrease CO_2 emissions from buildings through improved energy efficiency. In addition, their effectiveness and cost-effectiveness to overcome relevant barriers are explored. However, these studies are analyzed on the basis of national governance concerns. This dissertation aims to investigate the application of these building energy policy instruments on the basis of urban governance considerations. Moreover, what powers and resources are needed by a municipal government to carry out these policy instruments? The factors that facilitate or constrain the application of relevant policy at the city scale will be analyzed in the dissertation. The following section provides a multi-scale analytical framework to investigate relevant stakeholders, policy drivers and factors for urban building energy governance.

2.2 Multi-scale Analytical Framework for Urban Building Energy Governance

According to Alber and Kern (2009), four governing modes concern urban climate governance, which are also discussed in the case study of this dissertation:

1. **Self-governing**: Alber and Kern define self-governing as the capacity of local government to govern its own activities, such as the improvement of energy efficiency in governmental offices and other municipality-owned buildings.
2. **Governing through enabling**: This term refers to the role of local government in coordinating and facilitating partnerships with private actors and encouraging community engagement.
3. **Governing by provision**: This phrase means that practice is shaped through the delivery of particular forms of services and resources. This is accomplished through infrastructure and financial means.

4. **Governing by authority**: This can be characterized as the use of traditional forms of authority such as regulation and the use of sanctions.

Although these governing modes may overlap and individual policy instruments are often based on a combination of several modes, this differentiation provides a tool for the analysis of urban building energy governance and the policy instruments preferred by different municipalities (Alber and Kern, 2009). Overall, Table 2-5 represents the urban building energy policy analytical framework for this research.

Table 2-5: The Analytical Framework of Building Energy Policy Instruments & Governing Modes

<table>
<tr><th>Policy Types</th><th>Policy Instruments</th><th>Governing Modes</th></tr>
<tr><td>Regulatory/ Control Instruments</td><td>Appliance Standards/ Building Codes/ Procurement Regulations/ Mandatory Certification & Labeling/ Mandatory Audit Programs</td><td rowspan="3">1. <u>Self governing</u>

Improvement of energy efficiency in governmental offices and other municipality-owned buildings

2. <u>Governing through enabling</u>

Coordinating and facilitating partnership with private actors and encouraging community engagement

3. <u>Governing by provision</u>

Delivery of particular forms of services and resources; usually accomplished through infrastructure and financial means</td></tr>
<tr><td>Economic/ Market-based/ Fiscal Incentives</td><td>Energy Performance Contracting/ ESCO Support/ Energy Carbon Taxes/ Capital Subsidies Grants or Loans</td></tr>
<tr><td>Support/ Information/ Voluntary</td><td>Voluntary Certification & Labeling Programs/ Public Leadership Programs/ Awareness Raising Education & Information Campaigns/Disclosure Programs</td></tr>
</table>

		4. <u>Governing by authority</u> Traditional forms of authority such as regulation and the use of sanctions

Source: Alber & Kern, 2009

To be effective, urban building energy governance needs a strong consensus and synergy among all the stakeholders, ranging from political institutions to housing developers, as well as energy suppliers. To achieve this, new forms of city governance are needed with formal and informal governing arrangements; re-regulation across different scales and actors is also needed, where the global, the national and the local are mutually constitutive. Schroeder and Bulkeley (2009) also indicate that the competency and capacity of local government to address the climate change issue are largely determined by legal structures, but also determined by factors such as critical individuals, past successes, business consensus, public opinion, market opportunities, and environmental advocacy (Schroeder & Bulkeley, 2009).

Therefore, besides identifying policy options, this study explores the dynamic relationships that exist among relevant stakeholders who facilitate or hinder Shanghai's commercial building energy governance. Topics discussed include the Mayor's willingness and leadership; intergovernmental relationships between the national and municipal governments; and the relationship between local autonomy on commercial building energy governance and national government authority over local specific functions. How can the city government enable other local government sub-units under it, such as a counties or townships, to reduce emissions from buildings? In terms of interdepartmental relationships, which department or departments are in charge of building energy related issues? What conflicts occur? How adequate is inter-agency coordination, and is it necessary for building energy governance at the city level? Also, are other policy actors in the private sector or the voluntary sector involved? Other policy actors include the influence from global and local ESCOs, environmental NGOs and advocacy groups, and research institutions and universities. Does the city government participate in any transnational urban networks for regional and global interaction and cooperation on climate change mitigation that bring positive influence to bear on building energy governance? All of these factors are discussed in detail in the fifth chapter.

Chapter 3

COMMERCIAL BUILDING ENERGY POLICIES IN NEW YORK, LONDON AND TOKYO

As major producers and consumers of energy, global cities have entered the global climate change governance arena and play an emerging role in the governance of transitions to future low carbon economies (Hodson & Marvin, 2009). The research uses ‘global cities’ as general term for both world cities (Friedmann, 1986) and global cities (Sassen, 1991), which refers to the command centers of the global economy. The concept of the global city has emerged since the 1980’s, when the world economy underwent profound changes in the means of production and consumption. According to John Friedmann (1986), these cities are the command and control points of the global economy. However, the *Brundtland Report* pointed out that the wealthier the city and the more connected it is to the rest of the world, the greater the load imposed on the ecosphere by trade and other forms of economic development (Rees & Wackernagel, 1996). Moreover, Keil (1995) further points out that the “global city is a place where the global ecological crisis manifests itself concretely” (p. 282). While “global cities are places of exceptional wealth and affluence, they are also places of severe disadvantage and deprivation” (Clark, 1996, p. 139). Ng and Hills (2003) also indicate that while the term “global city” is appealing, the empirical findings suggest that such cities are just as vulnerable to developmental, ecological and social problems.

Most literature regarding global cities covers cities at the core of the world system, their global economic connections and characterizing and ranking these cities in the global economy (Clark, 1996; Douglass, 2000; Friedmann & Wolff, 1986; Godfrey & Zhou, 1999; Hill & Kim, 2000; Knox & Taylor, 1995; Lo & Yeung, 1996; Sassen, 1991; Sharpe, 1995; Short et al., 1996; Taylor, 2003). Research rarely touches on sustainability and quality of life issues (Ng & Hills, 2003). The lack of research on urban sustainability in global cities is one of the most disturbing gaps in our understanding of global cities (Short, 2004). It is important for global cities to use such research with the incorporation of resource endowments; this will give cities the ability to overcome ecological constraints in the economic and social competition among cities. Eco-competitiveness is also a profound indicator of the ability of cities to provide the conditions that can guarantee their social, economic, and ecological reproduction in this era of resource constraints and climate change (Hodson & Marvin, 2009).

As capitals or major financial hubs of the state or region, global cities are, on the one hand, places where the majority of commercial buildings and relevant building energy is consumed. On the other hand, global cities are also the hubs of idea and policy diffusion in the context of economic growth, technological advances, social dynamics, and cultural production [9]. Global cities offer important operational

[9] Economically, we have already witnessed an increasing concentration of transnational corporate headquarters, global financial services, foreign direct investment industries and leading professional service industries. Technologically,

governance frameworks including policies, initiatives, and technology. These frameworks address not only urgent local pollution issues, but also global climate change challenges. Relevant empirical findings have also been accompanied by suggestions that global cities could play a leading role in developing and implementing sustainable energy governance to reinforce existing models established by national governments.

Although the term “global city” is still ambiguous for classifying cities in the world economy, New York, London, and Tokyo are generally identified as the first-tier global cities because of their strong influences over both domestic and global commerce, finance, media, culture, and many other fields (Foreign Policy Group, 2010; Miwa et al., 2009; Sassen, 1991; WCC, 2008; GaWC, 2010). Therefore, the chapter centers on New York, London, and Tokyo and provides an analysis drawn from three global cities’ commercial building energy policies as a basis for comparison with Shanghai.

3.1 Global City Profiles: New York, London and Tokyo

Table 3-1 presents the basic demographics of New York, London, and Tokyo. New York has the highest population density among the three cities, both in the

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these cities offer an excellent setting for the development of information technology and innovative research. High technology industries are commonly found in these cities. Socially, these cities also demonstrate cultural leadership on a global scale, such as the spread of western thinking in the developing world as seen in the fast food culture and other ideological influences.

metropolitan area and the central business district. New York also has the highest per capita GDP along with the highest per capita CO_2 emissions (The City of New York, 2008).

Table 3-1: Basic Demographics of New York, London, and Tokyo

	New York	London	Tokyo
Leadership	Michael Bloomberg (2002-2012)[10]	Boris Johnson (2008-2012)[11]	Shintaro Ishihara (1999-2012)[12]
Land area (km^2)	789	1,707	2,188
Population (million)	8.39	7.55	12.99
Population Density (person/km^2)	10,634	4,428	5,937
CBD Density (person /km^2)	27,611 (Manhattan)	10,005 (City of London & Westminster)	14,152 (23 Special Wards)
GDP per capita (US$/year)	73,300	65,800	41,300
Electricity Consumed (MWh/per capita)	6.2	5.7	6.5
CO_2 Emissions (tons/per capita)	6.4	6.2	5.1

[10] Bloomberg assumed office as the 108th Mayor of NYC in 2002. He won the re-election in 2005 (his second term) and 2009 (he extended the term limits for his third term).
[11] Incumbent Johnson was elected Mayor of London in 2008 and is seeking re-election for a second term in the middle of 2012.
[12] Ishihara has served as the governor of Tokyo since 1999 and won his fourth term re-election in 2011.

Table 3-1 Continued

	New York	**London**	**Tokyo**
Reduction Targets	Reduce 30 percent By 2030 from 2005	Reduce 60 percent by 2025 from 1990 (20 percent by 2016)	Reduce 25 percent by 2020 from 2000
GHG/ CO2	GHG	CO_2	GHG
Source	2007 PlaNYC	2007 Mayor's Action Plan	2006 Tokyo 10 Years Plan

Source: City of New York, 2008; Tokyo Metropolitan Government, 2007; Office for National Statistics (UK), 2010

In terms of annual per capita electricity consumption, Tokyo ranks first, followed by New York and London. As for carbon reduction targets, London has set the most ambitious reduction target among the three cities, aiming to reduce 60 percent of CO_2 emissions by 2025 from the 1990 level of emissions. In terms of the current New York mayor's leadership role on low carbon management, his "PlaNYC" (2007), NYC's long-term plan for a sustainable future, seeks to strengthen the economy, combat climate change, and enhance the quality of life for all New Yorkers toward the vision of a greener, greater New York. Tokyo Mayor Shintaro Ishihara has initiated comprehensive initiatives to lead not only Tokyo but also Japan in combating global warming issues. "Tokyo's Big Change: 10 -YearPlan" (2006) set the major goal of reducing CO_2 emissions by 25 percent from levels in 2000. This reduction should be reached by 2020, and the plan introduced Tokyo's policy for changing the area's energy use structure by realizing a 10-year project for a Carbon-Minus Tokyo.

The previous mayor of London[13] set out the city's first comprehensive plan, titled "Mayor's Climate Change Action Plan- Action Today to Protect Tomorrow," to cut London's carbon emissions in 2007. Although there was a political party change in 2008, Boris Johnson, the current mayor, continues leading London towards a sustainable and green city. Johnson is also making efforts to tackle the climate change challenge and to achieve the goal set by Livingstone's plan, a 60 percent cut in CO_2 emissions by 2025.

In terms of energy consumption by fuel type (See Figure 3-1), electricity, natural gas, and gasoline are major energy sources in the three global cities. Electricity is the major energy source in Tokyo and New York, while gas dominates energy consumption in London.

[13] Ken Livingstone was Mayor of London from 2000 to 2008.

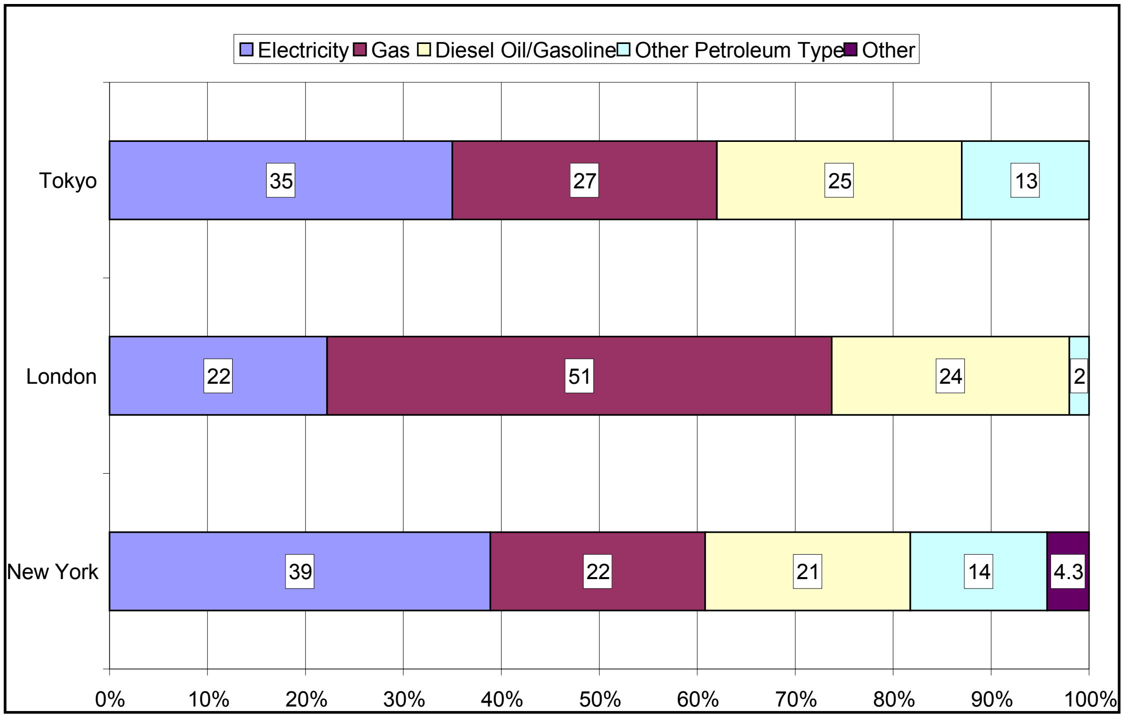

Figure 3-1: Energy Consumption by Fuel Type in New York, London and Tokyo

Source: TMG, 2006

In terms of CO_2 emissions by sectors, building sectors contribute the most in the three global cities (Tokyo Metropolitan Government, 2006; See Figure 3-2). In New York and Tokyo, commercial sectors (including commercial, institutional and governmental buildings) account for the major share of emissions, while the residential sector accounts 5 percent more emission shares than the commercial sector in London (See Figure 3-3).

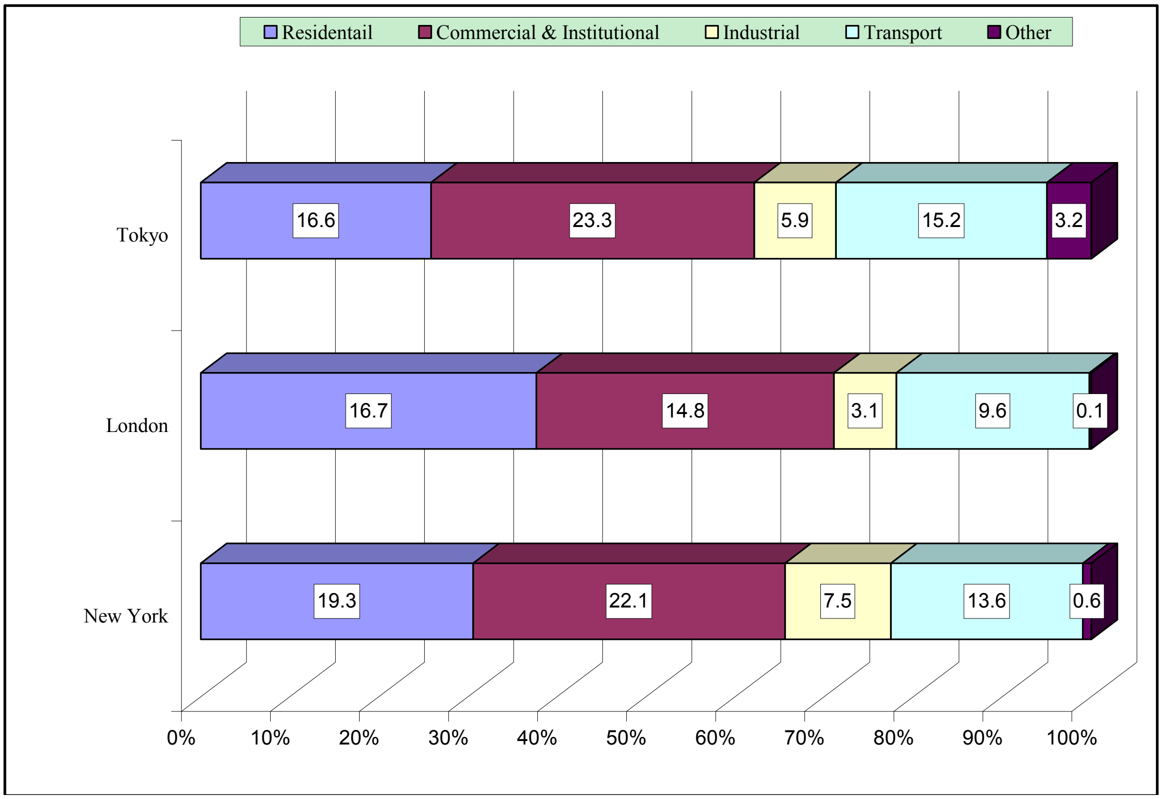

Figure 3-2: CO_2 Emissions in New York, London and Tokyo, 2005

Unit: Million CO_2 eq ton
Source: TMG, 2006

As mentioned above, the commercial sectors account for the major share of CO_2 emissions in New York, London and Tokyo. The following sections discuss the commercial building energy regulations and policy instruments adopted by the three global cities in order to reduce energy consumptions and CO_2 emissions. The operational policy benchmark drawn from the three global cities is used to assess Shanghai's commercial building energy policies in the following chapter.

3.2 Commercial Building Energy Policies in New York

3.2.1 Regulatory/Control Instruments

National Policies

The U.S. government began the development of energy codes and standards for buildings in response to the energy crisis in the 1970s. National building energy code was established by the Energy Conservation and Production Act of 1976 (ECPA). The ECPA established requirements for the development and implementation of performance standards for all new residential and commercial buildings. In addition, the Energy Policy Act of 1992 required the Department of Energy (DOE) to be actively involved in the development and deployment of building energy codes in close collaboration with states, local governments, and building code communities (Halverson, Shui, & Evans, 2009). Moreover, the DOE conducted its Targets Program in 1980s in order to develop whole building energy use targets for commercial buildings.

The DOE continued working on commercial building energy codes in the 1980s with technical support for American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). In the U.S., ASHRAE Standard 90.1 is viewed as a model energy standard for the commercial design community [14]. ASHRAE

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[14] ASHRAE Standard 90.1 served as the basis for the DOE's formal determinations of energy savings for commercial buildings as mandated by the Energy Policy Act of

standards and guidance to improve the built environment include "Standards for building energy efficiency," "Green Buildings," "Building Water Conservation," "New Guideline for Risk management of public health and safety in buildings," "Advanced energy design guides," and "Net-zero energy buildings." The DOE has been responsible for tracking progress in the application of ASHRAE Standard 90.1 and alerting states to adopt new commercial energy codes that meet or exceed the provisions of any version of Standard 90.1. Moreover, the Energy Policy Act of 2005 stressed energy efficiency in public buildings, including the "Federal building performance standards" and the "Energy efficient public buildings." The Federal Energy Independence and Security Act of 2007 underscored the important role of building energy codes in building energy efficiency; the act's subtitles include Residential Building Efficiency, High-Performance Commercial Buildings, High-Performance Federal Buildings, and Healthy High-Performance Schools.

In general, the development of building energy codes and standards is mainly driven by federal legislation, undertaken by private code developers, and supported by the DOE, states, and local governments. The DOE forms a regulatory infrastructure to promote the implementation and enforcement of commercial building energy codes, including the Building Technologies Program; Better Building Initiative; Commercial Building Partnerships; Building Energy Codes Program; Commercial Building Energy

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1992. The law also established a labeling program for commercial products. ASHRAE Standard 90.1 has been issued in 1980, 1989, 1999, 2001, 2004, 2007 and 2010 for commercial buildings energy codes through the Energy Policy Act of 1992.

Alliances; Commercial Building Initiatives and Appliances and Commercial Equipment Standards (DOE, 2012). The states and local governments work closely with the federal government and building code communities to adopt and customize the national model codes.

ASHRAE Standard 189 was developed in conjunction with the Illuminating Engineering Society of North America (IES) and the US Green Building Council (USGBC), and the standard is applicable to new commercial buildings and major renovation projects. This code addresses energy efficiency, a building's impact on the atmosphere, sustainable sites, water-use efficiency, materials and resources, and indoor environmental quality (DOE, 2012). The International Green Construction Code (IgCC), currently under development, will be applicable to all new construction and renovations to existing buildings other than residential structures. It is performance-based and allows adopting entities to determine which provisions of the code are applicable to their needs. Covered issues are siting, materials, energy, air quality, and water. The IgCC is applicable not only in the design and construction phase, but through commissioning and actual operation of the building (DOE, 2012).

State Policies

The direct implementation and enforcement of energy codes falls under the state and local jurisdictions, who must adopt the model energy codes (Halverson, Shui, & Evans, 2009). The state of New York is one of only five states with a commercial code that meets the Energy Policy Act of 1992 requirements. The latest state-wide commercial building code, the Energy Conservation Construction Code (ECCCNYS of 2010), is based on the 2009 International Energy Conservation Code (IECC)[15] with state amendments and ASHRAE 90.1-2007 (See Figure 3-3). Moreover, the ECCCNYS of 2010 has removed the “50 percent Rule,” which means that buildings do not need to comply with contemporary codes when renovating less than 50 percent of a building system. (Edwards & Zuck, 2010). Currently, the energy code requirements are applied to any relevant renovations.

[15] The first ASHRAE standard was carried out in 1977 by the National Council of States on Building Codes and Standards (NCSBCS) in its Model Code for Energy Conservation (MCEC) in 1977. ASHRAE standards were then carried out by the Council of American Building Officials (CABO) in its Model Energy Codes (MEC) of 1983 to 1995. Standards are currently carried out by the International Code Council (ICC) in its International Energy Conservation Code (IECC) from 1998 to the present.

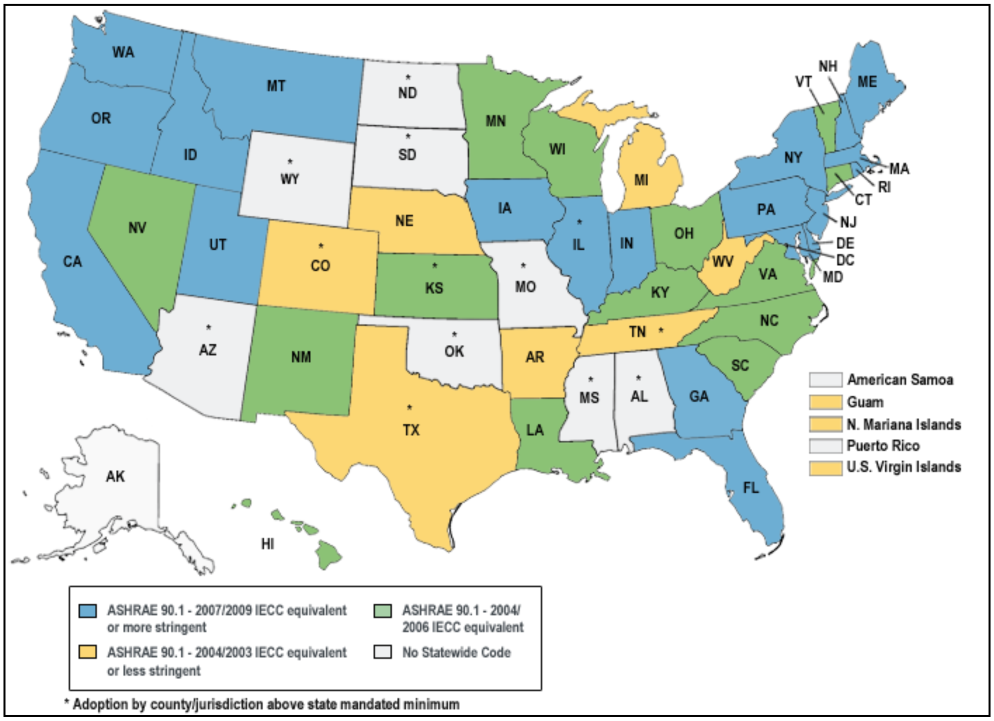

Figure 3-3: Current Status of Commercial Building Energy Codes

Source: DOE, 2012

The state of New York has its own Appliance and Equipment Energy Efficiency Standards for state-owned buildings. The Public Buildings Law and Public Authorities Law include green building construction requirements and energy efficiency and conservation improvements for public buildings and facilities in the state of New York. In addition, the state's Executive Order 111 requires all agencies and departments to reduce energy consumption by 35 percent (relative to consumption levels of 1990) in all buildings that they own, lease, or operate, by 2010. The order requires new state construction and substantial renovations to follow the U.S. Green Building Council (USGBC)'s Leadership in Energy and Environmental Design

(LEED)[16] green building guidelines. New state buildings should also exceed the state energy code by at least 20 percent and substantial renovations by at least 10 percent. Part four of Executive Order 111 directs state agencies to increase their purchases of electricity from solar, wind, photovoltaic, biomass, geothermic, and fuel cell sources. Moreover, the Green Building Construction Act signed by Governor Paterson in 2009 stipulates that new state buildings and major renovations of existing government buildings must comply with green building guidelines established by the Office of General Service (OGS) (BCAP, 2012). The OGS has recognized LEED, Green Globes,[17] and the American National Standards Institute as model green building programs. The State Public Service Commission (PSC) adopted a renewable portfolio standard (RPS) in 2004 and issued implementation rules in 2005. As originally designed, New York's RPS had a target of 25 percent of the state's electricity provided from renewable sources by 2013; however, this was expanded in January 2010 to 30 percent by 2015 by order of the PSC. Of this 30 percent, approximately 20.7 percent of the target will be derived from existing renewable energy facilities and one percent f the target is expected to be met through voluntary green power sales in 2015. Moreover, former Governor Spitzer (2007-2008) initiated

[16] Developed by the USGBC, LEED is a rating system for the design, construction and operation of high-performance green buildings, homes and neighborhoods.

[17] Developed by the Green Building Initiative in the US, the Green Globes is a building environmental design and management tool delivering online assessment protocol, a rating system and guidance for green building design, operation and management.

the "15 x 15" plan in order to reduce energy use by 15 percent by 2015. Following this plan, the Dormitory Authority of the State of New York, the agency responsible for libraries, classrooms, and other public buildings, is required to meet energy efficiency standards of the USGBC. Executive Order No. 4 of 2008 established a State Green Procurement and Agency Sustainability Program, which directs state agencies, public authorities and public benefit corporations to make heir procurements more eco-friendly and to implement sustainability initiatives.

New York City[18] Policies

On the city scale, according to the PlaNYC, the building sector accounts for 80 percent of city-wide CO_2 emissions (NYC, 2010). The PlaNYC was proposed by Mayor Bloomberg in 2007 to combat climate change and enhance the quality of life for all New Yorkers. The Plan brought together over 25 city agencies to work toward the vision of a greener, greater New York. It also outlined measures to reduce New York City's total carbon footprint by 30 percent by 2030 (NYC, 2010). Thus, building energy saving has become one of the city's major energy goalsThe energy goal of PlaNYC is to provide cleaner, more reliable power for every New Yorker by upgrading energy infrastructure. The goal has three components: energy becoming cleaner, buildings becoming more energy efficient, and the network becoming more reliable. To promote building energy efficiency is one of the energy goals of PlaNYC

[18] New York City is referred to as "New York" in this section.

(NYC, 2010). The plan pointed out that New York City's large existing buildings[19] account for approximately 45 percent of the city's total energy consumption, with heating and hot water at 21 percent; lighting at 11 percent; and appliances and cooling at 12 percent respectively. Due to large buildings consuming nearly half of New York's energy use, they require energy efficiency upgrades and energy transparency with annual benchmarking, energy audits, retro-commissioning, lighting upgrades, and sub-metering of commercial tenant space (See Table 3-2). More stringent than the state's ECCCNYS of 2007, the New York City Energy Conservation Code imposes energy standards to renovation projects at a lower threshold than the ECCCNYS of 2010 by lowering the threshold for renovation projects with the removal of "50 percent rule." By focusing primarily on 22,000 of the city's largest buildings (see Figure 3-4), the GGBP is expected to reduce almost 5 percent of citywide emissions and save energy costs by $700 million annually by 2030. This will also create 17,800 relevant green collar jobs over ten years (NYC, 2010). Moreover, the Urban Green Council (UGC) assembled the New York City Green Codes Task Force, consisting of more than 200 experts. The task force developed 111 proposals to green the city's codes. 22 proposals have already been adopted through law, rule, or practice (NYC, 2010).Under the umbrella of the PlaNYC, New York's City Council passed the four legislative components of the Greener, Greater Building Plan (GGBP) in the end of 2009.

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[19] Large buildings here indicate those buildings with areas larger than 50,000 square feet (around 4,645 square meters) (NYC, 2010).

Table 3-2: New York City's Greener, Greater Building Laws

Greener Greater Building Laws	Description
New York City Energy Conservation Code (Existing Buildings/Renovation)	The state of New York has adopted the standard energy code known as the International Energy Conservation Code (IECC). However, the New York State Energy Code includes a loophole that allows buildings to perpetuate non-compliant systems if they perform renovations on less than half of a given building system. This legislation loophole has led to a New York City energy code that requires all buildings to comply fully with the IECC for those portions of a system being renovated. In other words, any building renovation taken place in this city must conform to the full standards. This initiative will lead buildings to greater energy efficiency as renovations take place. The NYCECC is more stringent than the state energy code and applies to all new building and alteration projects filed on or after July 1, 2010.
Building Performance Benchmarking	Benchmarking is the practice of evaluating a building's energy efficiency so that a building owner can see how efficiently their buildings function and enable prospective buyers and tenants to better assess the value of a building. Benchmarking provides the basis for empowering building owners to take steps towards minimizing energy use and maximizing the economic benefits of energy conservation. Building owners will be required to use a free online tool provided by the Environmental Protection Agency (EPA) to track buildings' annual energy and water consumption. This legislation requires a benchmarking standard for all private buildings greater than 50,000 square feet or public buildings greater than 10,000 square feet.
Lighting Retrofits & Sub-Metering	In New York City, lighting accounts for approximately 20 percent of the energy used in buildings and roughly 20 percent of a building's carbon emissions. The legislation requires that lighting systems in commercial buildings over 50,000 square feet be upgraded to meet the requirements of the New York City Energy Conservation Code. The legislation also requires that large commercial buildings sub-meter electricity usage in certain large tenant spaces and that building owners provide these tenants with a monthly statement showing electric consumption and the amount charged for electricity. This addresses the majority of electricity use that takes place in tenant-controlled spaces.
Building Audit & Retro-Commissioning Measures	This legislation requires existing buildings over 50,000 square feet to undergo an energy audit and undertake retro-commissioning measures (e.g., properly calibrating heating and cooling systems, cleaning and repairing ventilation systems) once every ten years. This legislation would apply to all classes of buildings over 50,000 square feet and would cover nearly half of the built square footage of New York City. The bill contains exemptions for buildings that face severe financial hardship. To lead by example, city buildings will also perform any building retrofits (capital improvements) that pay for themselves within 7 years.

Source: NYC, 2010

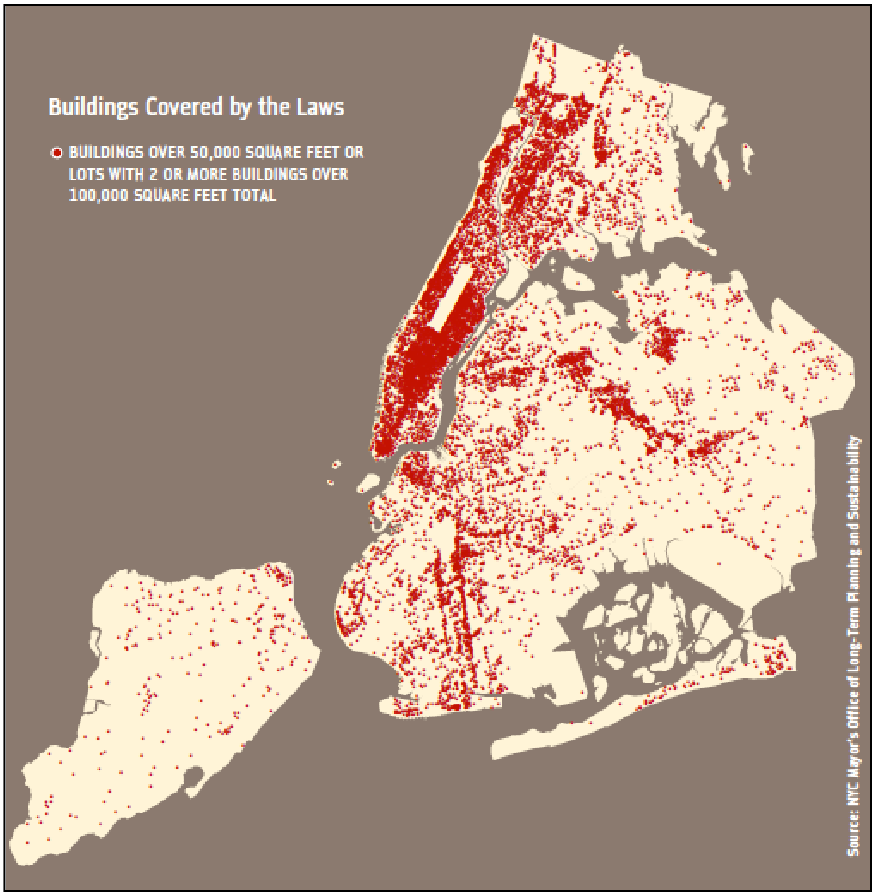

Figure 3-4: Buildings Covered by the Greener, Greater Buildings Laws in NYC

Source: NYC, 2010

Moreover, New York City passed the Green Building Law of 2005, making a variety of green building and energy efficiency requirements for municipal buildings. Along with the regulations mentioned above, the New York City Council introduced nine bills relating to lighting and water efficiency in 2010. The City Executive Order 109 is a short-term action plan for reducing energy consumption and greenhouse gas emissions of city's municipal buildings and operations.

3.2.2 Economic/Market-Based/Fiscal Incentives

National Policies

In the US, the Energy Policy Act of 2005 established a nation-wide tax deduction for energy-efficient commercial buildings from 2006-2007. The Federal Energy Improvement and Extension Act of 2008 extended the Energy Policy Act of 2005 for a tax deduction for energy efficient commercial buildings until 2013. The Energy Policy Act of 2005 also authorized the DOE to offer more than $10 billion in loan guarantees for energy efficiency, renewable energy and advanced transmission and distribution projects. In order to promote renewable energy application, the Federal Renewable Electricity Production Tax Credit (PTC) program and the American Recovery and Reinvestment Act of 2009 created a renewable energy grant program. Moreover, the DOE holds regular ESCO Public Forums to discuss energy savings performance contract (EPC) projects and processes.

State Policies

On the state scale, New York was among the first states in the U.S. to offer a tax incentive program for developers and builders of environmentally-friendly buildings since 1999 (NYEDC, 2012). The Green Building Tax Credit program, managed by the State Department of Environmental Conservation, provides an income tax to commercial developments and personal income taxpayers. The incentive applies to owners and tenants of eligible buildings and tenant spaces which meet certain green standards and can be applied against corporate taxes, personal income, insurance corporation taxes and banking corporation taxes. The original law provided for $25 million in credit certificates, and the 2005 legislation added another $25 million. These standards increase energy efficiency, improve indoor air quality, and reduce the environmental impacts of large commercial and residential buildings in the state of New York. Eligible commercial buildings include certain hotels and office buildings having at least 20,000 square feet of interior space. The Department of Environmental Conservation (DEC) is currently updating the regulations that govern the state of New York's Green Building Tax Credit Program.

The state of New York also offers many other incentive programs for greener buildings. The New York State Energy Law contained business energy conservation loan and energy performance contracts. The General Municipal Law also proposed sustainable energy loan programs. Property-Assessed Clean Energy (PACE) financing effectively allows property owners to borrow money to pay for energy improvements. In 2009, the New York legislature authorized counties, towns, cities and villages (collectively referred to as "municipal corporations") to offer sustainable energy loan programs. Loans may be used to pay for energy audits; cost-effective, permanent energy efficiency improvements; renewable energy feasibility studies; and the installation of renewable energy systems. The authorizing legislation does not limit the authority of local governments to provide loans to the commercial sector. Moreover, the Real Property Tax Law provides a 15-year real property tax exemption for solar and wind energy systems constructed in the state of New York. The New Construction Program and the Green Buildings Services program provide cost-shared funding and technical assistance to identify and assess energy efficiency improvements for the design and construction of new and major green building renovation projects. PV/Small Wind programs provide financial incentives and technical assistance for the installation of renewable energy sources for building energy use. The New York Power Authority (NYPA) offers low-cost loans to energy efficiency and onsite generation projects through its Energy Cost Reduction (ENCORE) Program. Through ENCORE, the NYPA finances energy audits, energy efficiency upgrades, and onsite generation.

New York City Policies

On the city level, New York City established the Green Building Financing mechanism under the GGBP with a revolving loan fund, using $16 million in federal money from the American Recovery and Reinvestment Act. Loans are offered to owners who demonstrate financial need or have already completed an energy audit. Collected energy savings data can encourage the private sector involvement in the long-term. Moreover, several cities' agencies participate in the Peak Load Management Program of the NYPA. The NYPA's ENCORE Program provides project financing to participating municipalities and assists municipal agencies in improving energy efficiency and reducing energy consumption. In New York City, ENCORE is administered by the Office of Energy Conservation in the Department of Citywide Administrative Services. Relevant projects carried out through this program save energy and reduce greenhouse gas emissions by increasing the energy efficiency of city buildings or by switching to cleaner fuels. The city's Buildings Department implemented rules to support state laws providing property tax abatements for the installation of green roofs and solar electric-generating systems (NYC, 2010).

3.2.3 Support/Information/Voluntary Action

National Policies

On the national level, the DOE's Building Technologies Program aims to realize marketable, net-zero energy buildings through the development of conservation technologies and practices for the building sector.[20] In addition, the Energy Star Program is a joint program of the DOE and the EPA that promotes building energy efficiency through energy efficient products and practices. The program includes Energy Star products and Energy Star buildings and plants related to the commercial sector. The DOE's Net-Zero Energy Commercial Building Initiative (CBI) is charged to develop and disseminate technologies, practices, and policies for the development and establishment of marketable net-zero energy commercial buildings.[21] Moreover,

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[20] Relevant key building programs include the Building Regulatory Program, Building America, Building Energy Codes, Commercial Building Energy Alliances, High Performance Commercial Buildings, and Appliances and Commercial Equipment Standards. In addition, the DOE supports a broad range of activities designed to facilitate widespread adoption and use of energy saving practices and technologies, such as EnergySmart Schools and EnergySmart Hospitals (DOE, 2012).

[21] The initiative aims to develop and establish of marketable net-zero energy in: commercial buildings in all climate zones by 2025; in commercial buildings for any commercial building newly-constructed in the U.S. by 2030; in 50 percent of the

the DOE has created the COMcheck online training software for assisting with commercial building code compliance. In terms of green building promotion, the EPA introduced Energy Star Labels for commercial buildings in 1999.[22] Along with the DOE energy labels, the LEED rating system, developed by the USGBC, is another voluntary labeling system for commercial buildings in the U.S.[23] Green Globes™ U.S., adapted from Green Globes™ Canada in 2004, offers an online assessment protocol, rating system and as guidance for green building design, operation and management.

State Policies

The state of New York has many policies and programs to promote energy conservation in buildings. Green Jobs - Green NY is a state-wide program to promote energy efficiency and the installation of clean technologies to reduce energy costs and greenhouse gas emissions. The program aims to support sustainable community development and create opportunities for green jobs. In addition, the New York State Energy Audit Program provides energy audits to small businesses and other facilities

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commercial building stock of the U.S. by 2040; and in all commercial buildings in the U.S. by 2050.

[22] Buildings achieving a score of 75 or higher (on a 1–100 scale) are eligible for the label, indicating that they are among the top 25 percent in the country for energy performance. The EPA reports that commercial buildings that have earned the label use on average 35 percent less energy than similar buildings without the label.

[23] LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

to help them make informed electrical energy decisions, implement energy efficiency strategies to lower their energy bills and improve energy performance.

New York City Policies

On the city level, under the GGBP, the Green Workforce Development Training Program aims to promote a green economy and improve the unemployment rate in New York City. To address the increased demand for energy auditors, contractors, construction workers, and other related professionals, New York City has been working with key stakeholders in the labor and real estate sectors, including the New York State Energy Research and Development Authority, the City University of New York, and the New York City Economic Development Corporation. The goal of this collaboration is to identify the workforce needs and opportunities created by the GGBP. This is meant to ensure that there is an adequate supply of skilled technicians to implement the legislation. The program is regarded as a key economic driver in the green economy, creating an estimated 17,880 construction-related jobs as part of the Five Borough Economic Opportunity Plan. The government of New York City has also started many other energy saving programs. New York City has initiated training programs to improve energy efficiency for municipal buildings. Energy Efficiency Training Programs require organizing formal energy efficiency training programs for agency representatives, including facility managers and building engineers. Moreover, the Long-Term Plan to Reduce Energy Consumption and Greenhouse Gas Emissions of Municipal Buildings and Operations includes relevant plans for reducing energy consumption and greenhouse gas emissions of municipal buildings and operations.

The New York City government has also developed energy-related educational pilot programs that can potentially be integrated into the curriculum of the New York City school system. Moreover, the city government has initiated innovative green and sustainable development projects to illustrate the ability to incorporate extremely high standards even in very large buildings in New York City. For example, New York's Empire State Building unveiled a new process for analyzing and retrofitting existing structures for environmental sustainability. As central elements of the $500 million upgrade program presently underway in New York City's tallest building, the program is expected to reduce energy consumption by up to 38 percent, providing a replicable model for similar projects around the world. With an initial estimated project cost of $20 million and additional alternative spending in tenant installations, the Empire State Building will save $4.4 million in annual energy savings costs and repay its net extra cost in about three years. In terms of renewable energy application, the city government has also initiated clean on-site generation strategies as part of a least-cost resource plan to supply the electricity needs of city agencies. Moreover, Mayor Bloomberg and Buildings Commissioner Robert LiMandri announced that the city and CUNY (The City University of New York) have created three Solar Empowerment Zones as demonstration projects. These zones are strategically selected areas where solar power systems are most beneficial and technically viable.

3.2.4 Summary

In terms of regulatory and control policy instruments, New York City basically follows national and state building energy codes and standards. The federal building codes and standards are 30 percent more stringent than the 2010 city codes. New York City plans to amend the existing building energy codes to meet national standards and incorporate national green building codes (NYC, 2010). However, as mentioned above, the city has removed the “50 percent rule” and set more stringent requirements for commercial building energy retrofitting. The city-led legislation even stimulates an amendment of the state’s regulation. Moreover, the New York City government has initiated four regulations of the GGBP targeting retrofitting projects in large-scale commercial and public buildings.

In terms of economic/market-based/fiscal incentives, federal and state governments have more tax incentives and rebates, subsidies, and grants for commercial building energy saving and renewable energy application. The New York City government can apply for those funds or join relevant projects. For instance, the state’s ENCORE Program provides project financing to participating cities and their agencies in improving building energy efficiency and reducing energy consumption.

In terms of support/information/voluntary action, the federal government has many relevant research and development programs to develop building energy efficient technologies. National green building labeling and certification systems are applied to state and city practices. Moreover, New York City has emphasized green workforce development to strengthen capacity building in hopes of building energy sustainability. The city-led Green Workforce Development Training program of the GGBP is expected to create 17,800 green collar jobs. There are also many relevant training programs in association with local universities and other relevant professional organizations in the city.

Generally, New York City has made efforts on mandatory building energy policy instruments in large-scale commercial and public existing buildings. The state government still dominates more relevant incentive instruments that can be applied to buildings within the city. New York City has followed national green building and building energy efficient technology programs and has further initiated its vibrant city-led workforce training and demonstration programs.

Table 3-3: Commercial Building Energy Policy Instruments in New York

Regulatory & Control Instruments		Federal	State	NYC
Appliance Standards	• The GGBP: Lighting Retrofits & Sub-Metering			●
	• The Energy Independence and Security Act of 2007: the Energy Star Programand the Federal Energy Management Program (FEMP)	●		
	• The Energy Policy Act of 1992	●		
	• Appliance/Equipment Efficiency Standards		●	
Building Codes	• The Energy Conservation and Production Act of 1976	●		
	• 2009 IECC / ASHRAE 90.1-2007	●	●	
	• The Energy Policy Act of1992	●		
	• The Energy Policy Act of 2005: Federal Building Performance Standards; Energy Efficient Public Buildings	●		
	• The Energy Independence and Security Act of 2007	●		
	• The Energy Conservation Construction Code (ECCCNYS)		●	

Table 3-3 Continued

Regulatory & Control Instruments		Federal	State	NYC
Building Codes	• The Uniform Fire Prevention and Building Code (Uniform Code)		●	
	• The Green Building Construction Act		●	
	• The Public Buildings Law		●	
	• The Public Authorities Law		●	
	• The "15 x 15" Plan : Public buildings are required to meet energy-efficiency standards of the U.S. Green Buildings Council		●	
	• The Urban Development Corporation Act		●	
	• The GGBP: New York City Energy Conservation Code			●
	• The Green Codes Task Force			●
Procurement Regulations	• The Green Power Purchasing Goal	●		
	• Executive Order No. 4: the Green Procurement and Agency Sustainability Program		●	
	• Executive Order No. 111: Green Power Purchasing		●	
	• The New York City Green Cleaning Products Procurement Law			●

Table 3-3 Continued

Regulatory & Control Instruments		Federal	State	NYC
Mandatory Audit Programs	• The New York State Energy Audit Program		●	
	• The FlexTech Energy Audit		●	
	• The Public Service Law		●	
	• The GGBP: Building Audit & Retro-Commissioning Measures			●
Renewable Portfolio Standards (RPS)	• The New York Public Service Commission (PSC) adopted a renewable portfolio standard (RPS) in 2004 and issued implementation rules in April 2005		●	
Green Building	• The Green Building Construction Act		●	
	• The Green Building Law			●
	• Local Law No. 86			●
Governmental Building	• Executive Order 13514	●		
	• The Energy Independence and Security Act of 2007	●		
	• Executive Order 13423	●		
	• The Energy Policy Act of 2005	●		
	• Executive Order 13221	●		
	• The Energy Policy Act of 1992	●		

Table 3-3 Continued

Regulatory & Control Instruments		Federal	State	NYC
Governmental Building	• Executive Order 111		●	
	• Executive Order 109			●
	• Local Law No. 86			●
Performance Benchmarking	• The GGBP: Building Performance Benchmarking			●
Economic/Market-based/Fiscal Incentives		**Federal**	**State**	**NYC**
Energy Performance Contracting/ ESCO Support	• ESCO Public Forums	●		
	• The Energy Cost Reduction Program			●
Tax Incentives	• The Energy Policy Act of 2005	●		
	• The Federal Energy Improvement and Extension Act of 2008	●		
	• The Federal Renewable Electricity Production Tax Credit (PTC)	●		
	• The American Recovery and Reinvestment Act of 2009	●		
	• The Better Building Initiative	●		
	• The Green Building Tax Credit		●	

Table 3-3 Continued

Economic/Market-based/Fiscal Incentives		Federal	State	NYC
Tax Incentives	• The Real Property Tax Law		●	
	• The Property Tax Abatement for Photovoltaic (PV) Equipment Expenditures			●
Rebates/Subsidies/Grants	• The American Recovery and Reinvestment Act of 2009	●		
	• The Better Building Initiative	●		
	• Commercial Energy Efficiency Rebate Programs		●	
	• The Solar Thermal Rebate Program		●	
	• The New Construction Program		●	
	• The Existing Facilities Program		●	
	• Green Buildings Services		●	
	• The FlexTech Program		●	
	• PV/Small Wind programs provide financial incentives		●	
	• Focus on Commercial Real Estate (Focus CRE)		●	
Low Interest Loans & Guarantee Funds	• The American Recovery and Reinvestment Act of 2009	●		

Table 3-3 Continued

Economic/Market-based/Fiscal Incentives		Federal	State	NYC
Low Interest Loans & Guarantee Funds	• The Energy Policy Act of 2005	●		
	• The New York State Energy Law		●	
	• General Municipal Laws		●	
	• Property-Assessed Clean Energy (PACE)		●	
	• The NYSERDA Financing Program		●	
	• The GGBP: Green Building Financing			●
Support/Information/Voluntary Action		**Federal**	**State**	**NYC**
Voluntary Certification & Labeling Programs	• Energy Star Products	●		
	• Energy Star Buildings and Plants	●		
	• Energy Star Building Labels	●		
	• Leadership in Energy and Environmental Design (LEED) Certification	●		
Workforce Training	• Green Jobs - Green NY		●	
	• Workforce Development and Training Programs		●	
	• The GGBP: Green Workforce Development Training			●

Table 3-3 Continued

Support/Information/Voluntary Action		Federal	State	NYC
Workforce Training	• Urban Green Council Education Programs			●
	• Energy Efficiency Training Programs”			●
Public Leadership Programs	• Executive Order 111		●	
	• The Long-Term Plan to Reduce Energy Consumption and Greenhouse Gas Emissions of Municipal Buildings and Operations	●		
Awareness-Raising/Education/ Information Campaign	• COMcheck online training software for assisting commercial building code compliance	●		
	• Green Globes™ U.S.	●		
	• Energy Education		●	
	• The Urban Green Council, USGBC New York			●
	• Energy-related Educational Pilot Programs			●
	• GreeNYC			●
Research & Development	• The Building Technology Program	●		
	• Building America	●		
	• Building Energy Codes	●		
	• Commercial Building Energy Alliances	●		

Table 3-3 Continued

Support/Information/Voluntary Action		Federal	State	NYC
Research & Development	• High Performance Commercial Buildings	●		
	• Appliances and Commercial Equipment Standards	●		
	• EnergySmart Schools	●		
	• EnergySmart Hospitals	●		
	• The Net-Zero Energy Commercial Building Initiative (CBI)	●		
	• Clean energy innovation and business development opportunities		●	
	• Building Research and Development		●	
Demonstration Projects	• Solar Empowerment Zones			●
	• New York's Empire State Building			●

3.3 Commercial Building Energy Policies in London

3.3.1 Regulatory/Control Instrument

Extra-National and National Policies

Similar to the context of energy policy in the U.S., energy efficiency requirements were first introduced nationally into the United Kingdom (UK)'s Building Regulations 1974 in response to the global energy crisis due to the Arab oil embargo. The revision, Building Regulations 1991, has the explicit goal of controlling CO_2 emissions from buildings (AGO, 2000). In addition, as a member of the European Union, the United Kingdom was required to comply with the Electronic Energy Performance of Buildings Directive (EEPBD) passed in 2002. The UK implemented the directive in 2005 by requiring all new and existing buildings to meet energy efficiency and CO_2 emissions standards in Part L of the UK's Building Regulation. Part L of the Building Regulation covers Conservation of Fuel and Power with stringent energy performance requirements in the building sector. The requirements include new buildings with a 25 percent more energy efficient standard. The regulation also needs to be updated every 5 years, and new buildings need 25 percent more stringent efficiency requirements with every revision. When buildings are being refurbished, approximately 10 percent of the value of the refurbishment works must be spent on upgrading the remainder of the building's energy efficiency. The 2010 revision of Building Regulation came with stricter CO_2 and thermal insulation controls (AGO, 2012). Further, it set an ambitious goal for all new developments to have zero carbon in 2011 (OCEAN, 2012).

Moreover, the UK also adopted mandatory certification and labeling for commercial buildings since 2008. All commercial buildings, whenever sold, built or rented, need an Energy Performance Certificate (EPCs). The certificate provides energy efficiency ratings (using an A to G scale) and recommendations for improvement. The ratings are standard, so the energy efficiency of one building can easily be compared with another building of a similar type. The certificates are valid for 10 years and are accompanied by a recommendation report outlining areas of improvement. The purposes of the certificate and report are to bring to the attention of the new owner or tenant the potential running costs and the estimated carbon impact of the buildings (BEP, 2012). In addition, large public buildings (greater than 1,000 square meters and partly or wholly publicly funded) need to have Display Energy Certificates (DECs) showing the public the building's energy efficiency rating and how efficiently the occupants are spending tax payer money on fuel (BEP, 2012a).

In terms of the energy supply side, the UK's Energy Bill (also known as the "Green Deal") focuses on how to promote low carbon energy production and secure energy supplies. It also aims to implement all the legislative aspects mentioned in the 2007 Energy White Paper, and provide the feed-in tariffs and relevant incentives for generating renewable electricity and heat. The Renewable Obligation came into effect in 2002, and it is the main support mechanism for renewable electricity projects in the UK. It places an obligation on UK electricity suppliers to source an increasing proportion of customers' electricity from renewable sources (DECC, 2012). In terms of appliance standards, air conditioning systems are required to ensure efficient operation through regular inspection (BEP, 2012b).

London Policies[24]

On the city level, the Mayor's London Plan has pushed developers to go beyond basic building regulation requirements to incorporate sustainability and low-carbon measures in new developments. Relevant carbon savings from new developments have increased from an average of 29 percent in 2006 to 34 percent in 2009 (EEN, 2010). In addition, the improvement in building performance sets higher building standards for 2010-2013, which includes a 44 percent reduction of carbon in new developments. The Mayor's London Plan also provides strategic planning guidance for large-scale projects to promote the use of on-site renewable energy generation (micro-generation) and Combined Heat and Power (CHP). Subsequent alterations to the London Plan in 2008 strengthened this approach, such as the stipulation that new developments must reduce CO_2 emissions by 20 percent through on-site renewable energy generation.

Moreover, Mayor Johnson expanded his Green Procurement Code to cut energy use and CO_2 emissions from the public sector. The Green Procurement Code currently promotes the use of products made from recycled materials. Mayor Johnson is also working with the London Development Agency (LDA) to help embed green purchasing into the private sector to improve its environmental performance.

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[24] "London" in the section means the "Greater London Authority".

3.3.2 Economic/Market-Based/Fiscal Incentives

National Policies

On a national scale, the UK's Climate Change Levy assesses a tax on the building sector. Eligible energy-intensive businesses can receive up to an 80 percent discount from the Climate Change Levy in return for meeting energy efficiency or CO_2 targets set under Climate Change Agreements. The Green Deal also created a Green Investment Bank to support investment in low carbon projects to transform the existing economy. Central to the Green Deal is a finance mechanism that allows building owners to pay back the cost of improvements in installments, which are added to energy bills. Underpinning the delivery of the Green Deal is the Energy Company Obligation (ECO). The ECO places more obligations on energy companies requiring them to generate a specific amount of credit by facilitating the installation of energy efficiency measures in British homes before a set deadline. The ECO has been designed to fit within the Green Deal framework and provide support where Green Deal financing alone is not enough (DECC, 2012). In addition, the Carbon Reduction Commitment Energy Efficiency Scheme (CRCEES) is a mandatory nation-wide trading scheme aimed at improving energy efficiency and cutting emissions in large public and private sectors by the application of financial and reputational drivers. The CRCEES requires businesses to report and pay a tax on energy used, and ranks businesses in a performance league table; this provides a further reputational incentive to improve building energy efficiency. The scheme is expected to deliver carbon savings of 21 MtCO2 by 2027 (DECC, 2012).

London Policies

On the city level, London's RE:FIT Program (formerly known as the Building Energy Efficiency Program, or BEEP) offers a cost-neutral means for the public sector to retrofit buildings with energy savings measures to reduce energy consumption and carbon emissions (London Development Agency, 2011). It provides a panel of energy service companies (ESCOs) that undertake audits of buildings, identifying and later installing potential energy saving measures. The London Development Authority also provides support and guidance to participating agencies to help them through the entire retrofitting process, from procurement and contracting to support on monitoring delivery. This program helps the public sector avoid lengthy and complex procurement processes (London Development Agency, 2011). Moreover, London ESCO is a joint venture with the London Climate Change Agency (LCCA) in order to deliver sustainable energy solutions in London and to achieve savings in CO_2 and energy costs. London ESCO designs, finances, builds, owns and operates local decentralized energy systems for both new and existing developments. In addition, London ESCO also set up the London Green Fund in 2001 to help promote the development and installation of renewable energy technology in the community.

3.3.3 Support/Information/Voluntary Action

National Policies

In terms of voluntary labeling systems, the Building Research Establishment's Environmental Assessment Method (BREEAM) is the leading and the most-widely used environmental assessment method for buildings in the UK. Assessments can be carried out on a single unit or on whole developments during four different stages in the building life cycle, including new building; major refurbishment; tenant fit-out; and existing building. In addition, the UK government encourages the use of Smart Metering systems to measure energy consumption from buildings. The smart meters are expected to provide consumers real time information on their energy consumption and help them control and manage their energy use, save money, and reduce emissions (DECC, 2012). The UK government has recently considered introducing the systems for commercial buildings. National Indicator 185 targets CO_2 emissions from local authority operations. Local authorities can choose to sign up for this indicator, which requires them to calculate and report CO_2 emissions from an analysis of energy and fuel use in their relevant buildings and operations, including where these services have been outsourced (DCLG, 2009). Moreover, the National Energy Foundation aims to raise public awareness to reduce carbon emissions through the use of energy efficiency measures and renewable energy sources. The British Council and the Ministry of Environment and Urbanisation have proposed the Tend Your Building, Save Money project for raising public awareness on energy efficiency in buildings.

London Policies

On the city level, the Greater London Authority (GLA) has initiated the London Climate Change Partnership (LCCP), assisting London in preparing for the impacts of climate change through raising awareness, developing adaptation guidance, and improving the built environment. Since 2004, London's Mayor has proposed the Energy Strategy combat climate change through promoting energy efficiency and applying renewable energy technologies across London. In 2009, under Local Energy Schemes- Powering Ahead with Decentralised Energy, Mayor Johnson unveiled plans for local energy schemes in 19 boroughs in London. These boroughs work with the LDA and London Councils to develop local energy generation supplies. This initiative aims to support the expansion of the decentralized energy market in London. Moreover, London City Hall has installed photovoltaic roof and solar shading as public demonstration for Londoners. Mayor Johnson has also announced funding of up to £3 million to develop 10 Low Carbon Zones across London in 2008. The zones are funded through the LDA's climate change budget as well as private sponsorship, and the zones have delivered a 20.12 percent reduction in carbon emissions by 2012. Johnson expects the zones act as a showcase for implementing energy efficient technologies such as home insulation, smart meters, retrofit packages for public and commercial buildings, and renewable and waste-to-energy sources. The zones are also expected to stimulate jobs and cut energy bills. Johnson has proposed creating a "retrofitting academy" to train unemployed Londoners as energy efficiency advisors to improve the energy efficiency of buildings in London.

Further, several energy saving programs through the form of public and private partnerships exist in London's building sector. The London Energy Partnership (LEP) aims to transform London into a global city for sustainable energy by bringing together a range of sectors and organizations to deliver energy action more effectively. The London Mayor works with the private sector and other public bodies to reduce CO_2 emissions from existing commercial and public buildings through the Green Organisations Program, which includes the Better Buildings Partnership (BBP) and the Green Organisations Badging Scheme.

The BBP is supported by the Mayor of London and the LDA in order to develop solutions to improve the sustainability of London's existing commercial buildings. The BBP scheme seeks to draw together London's leading commercial property owners and tenants to overcome split incentive barriers to the retrofitting work of office buildings through building users' behavioral changes. The initiative has resulted in green lease agreements with 14 of the largest commercial and public property owners in London. All members are working together to improve the sustainability of London's existing commercial building stock and accelerate the reduction in CO_2 emissions from those commercial buildings. The BBP was set up by the GLA to demonstrate leadership and best practices to the wider commercial property market by developing the full range of solutions to improve operational performance and sustainable retrofitting.

The Green Organisations Badging Scheme acts as an independent organization and uses the power of partnership to promote sustainable energy solutions in London.

It aims to work with tenants in both the private and public sectors to reduce emissions through staff behavioral changes and improved building operations. This includes providing information and support to deliver these changes and working together with existing initiatives, as well as a clear set of targets and associated green badging levels (GLA, 2007).

The BBP and the Green Organisations Badging Scheme are complemented by the Green500 Scheme, a program targeting occupiers of commercial property to improve sustainability and decrease carbon footprints. The Green500 Scheme is a carbon management service and a performance-based award scheme aimed at the largest 500 organizations in London. Each of these organizations is assigned a Carbon Mentor, who will design a unique, holistic, carbon management plan and carbon reduction target. The two programs (the BBP and the Green500) work together by driving carbon savings in commercial buildings both from the bottom up and from the top down.

Finally, London has launched a Buildings Energy Efficiency Program (BEEP). The BEEP is part of a global program led by the Clinton Climate Initiative, which brings together the world's most significant cities (called C40 cities) to tackle climate change. London is the first of the C40 cities to launch a BEEP program. It provides a mechanism to make it financially feasible for cities to radically cut emissions from their buildings. It is also enabling worldwide procurement collaboration on key technologies (LDA, 2009).

3.3.4 Summary

The UK's Part L of the Building Regulations followed the European Union's Building Directive and set more strict goals for reducing CO_2 emissions from buildings. The UK government has also adopted mandatory Energy Performance Certificates for commercial buildings. The mandatory disclosure program provides building users or potential users with more comprehensive energy consumption data and facilitates a more transparent building energy saving market. London has set higher building performance requirements for new buildings. In terms of economic, fiscal and market based policy instruments, the UK has a mandatory carbon trading mechanism (the CRCEES) to improve energy efficiency and reduce CO_2 emissions in large buildings. In London, the development of ESCOs receives support, guidance and funding from the GLA. Moreover, public and private partnership programs are the city's important policy instruments for delivering innovative energy solutions and improving building energy use in large commercial buildings. The GLA aims at not only commercial building owners but also aims at tenants through behavioral changes to reduce energy use in commercial buildings. London's Building Energy Efficiency Program is a flagship international initiative to reduce the carbon footprint of cities globally. (LDA, 2009).

Table 3-4: Commercial Building Energy Policy Instruments in London

Regulatory & Control Instruments		EU	UK	London
Appliance Energy Efficiency Standards	• British Standard 8207: 1985, the Code of Practice for Energy Efficiency in Buildings		●	
Building Energy Codes	• The Electronic Energy Performance of Buildings Directive (EEPBD)	●		
	• Part L of the Building Regulations: Conservation of Fuel and Power		●	
	• The Energy Bill		●	
	• The Planning and Energy Act		●	
Procurement Regulations	• The Mayor's Green Procurement Code			•
Mandatory Certification and Labeling	• Energy Performance Certificates (EPCs)		●	
	• Display Energy Certificates (DECs)		●	
Green Electricity Certification System	• Feed-in Tariffs (FITs) and Renewable Obligation Certificates (ROCs)		●	
Economic/Market-based/Fiscal Incentives		**EU**	**UK**	**London**
Energy Performance Contracting/ESCO Support	• Energy Company Obligations (ECOs)		●	
	• The RE:FIT Program, formerly known as the Building Energy Efficiency Program (BEEP)			●

Table 3-4 Continued

Economic/Market-based/Fiscal Incentives		EU	UK	London
Energy Performance Contracting/ESCO Support	• The Building Energy Efficiency Program (BEEP)			•
	• London ESCO			•
Kyoto Flexibility Mechanisms	• The CRC Energy Efficiency Scheme (formerly known as the Carbon Reduction Commitment)		•	
Energy/Carbon Taxes	• The Climate Change Levy		•	
Rebates/Subsidies/Grants	• Feed-in Tariffs (FITs)		•	
	• Green Deal Financing		•	
Low Interest Loans & Guarantee Funds	• Energy Savings Trust Feed-in-Tariffs		•	
	• Carbon Trust Feed-in-Tariffs		•	
	• The Green Investment Bank		•	
	• The London Green Fund			•
Support/Information/Voluntary Action		**EU**	**UK**	**London**
Voluntary Certification & Labeling Programs	• The Building Research Establishment's Environmental Assessment Method (BREEAM)		•	
Workforce Training	• Retrofitting Academies			•

Table 3-4 Continued

Support/Information/Voluntary Action		EU	UK	London
Public Leadership Programs	• Display Energy Certificates (DECs)		•	
	• London City Hall			•
Disclosure Programs	• Display Energy Certificates (DECs)		•	
	• National Indicator 185		•	
	• Smart Metering		•	
Demonstrations	• Low Carbon Zones			•
Public Private Partnership Programs	• The London Energy Partnership (LEP)			•
	• The London Climate Change Partnership (LCCP)			•
	• The Green Organisations Badging Scheme			•
	• The Better Buildings Partnership (BBP)			•
	• The Green500 Scheme			•
Global Influence	• The Building Energy Efficiency Program (BEEP)			•

Table 3-4 Continued

Support/Information/Voluntary Action		EU	UK	London
Awareness-Raising/Education/Information Campaigns	• The National Energy Foundation		•	
	• The Tend Your Building, Save Money Program		•	
	• The London Public and Private Partnership Programs			•

3.4 Commercial Building Energy Policies in Tokyo

3.4.1 Regulatory/Control Instruments

National Policies

Due to the dependence on imported energy, the Japanese government has been committed to making energy efficiency as its primary national development goal since an oil crisis hit its economy in 1973 (Evans, Shui, & Delgado, 2009). Japan's national Energy Conservation Law was first issued in 1979. The law served as the foundation of Japan's energy efficiency policies and was updated numerous times in 1983, 1993, 1998, 2002, 2005 and 2008 (Huang & Deringer, 2007). The 2002 revision required owners of new commercial buildings larger than 2,000 square meters to submit energy saving plans to the local government. Owners of buildings with over 2,000 square meters must also submit energy saving plans for renovation permits. The 2005 revision emphasizes that property owners should contribute to energy efficiency in buildings by properly implementing measures to prevent heat loss and to improve the energy efficiency of heating and air conditioning systems and other building equipment. The 2008 revisions require owners of small and medium-sized buildings (from 300 to 2,000 square meters) to submit energy saving plans before construction or renovations. If an owner does not follow the authority's advice and instructions for improvement, the authority can publicize the owner's name on a list for non-compliance. The 2008 revision of the law also added penalties for non-compliance of up to ¥1,000,000 or about $11,000 (The Energy Conservation Center, 2007).

Under the Energy Conservation Law, Japan has issued a set of building energy standards for commercial and residential buildings. The Criteria for Clients on the Rationalization of Energy Use for Buildings (CCREUB),[25] was first issued in 1979. The newest version was released in 1999 by the Ministry of International Trade and Industry (MITI) and the Ministry of Construction (MOC). The CCREUB provides information on the minimum required energy performance for commercial buildings.[26] The CCREUB specifies the actions required for rational use of energy in factories, buildings and equipment, and it specifies other actions necessary for comprehensively promoting the optimization of energy use in commercial buildings.

In terms of appliance standards, manufactures that produce or import energy consuming equipment have to ensure the rationalization of equipment energy consumption by improving the energy efficiency of the equipment which they produce or import. Japan has been implementing the Top Runner Program to set mandatory energy conservation standards for office appliances since 1998. The program searches for the most efficient model on the market and then stipulates that the efficiency of this "top runner model" should become the standard within a certain number of years. Equipment in the Top Runner Program must be marked to show its energy

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[25] The CCREUB is a performance standard that uses two indicators for assessing the energy performance of a building: the Perimeter Annual Load (PAL) for the performance of the building envelope, and the Coefficient of Energy Consumption (CEC) for the performance of the building equipment.

[26] The building code covers insulation of the building envelope as well as heating, ventilation and air conditioning (HVAC), lighting, the heating of water, and lifting equipment.

consumption efficiency, which helps consumers selectively purchase highly efficient equipment.

Tokyo Policies[27]

In the urban context, the Tokyo Metropolitan Government (TMG) launched a Green Building Program, also known as the TMG Environmental Security Ordinance, enacted in 2000 and started in 2002. This program included an environmental performance evaluation and a disclosure of new constructions and extensive reconstructions of large-scale buildings with over 10,000 square meters of total floor area in Tokyo. These large-scale buildings must submit plans indicating their measures on the environmental protection activity such as energy saving measures and effectiveness of the measures being taken (TMG, 2010).

In conjunction with the Green Buildings Program, the TMG launched the Green Labeling Program for Condominiums, which requires large condominium owners and sellers to display labels and explain the environmental performance of buildings in any advertisements for sale or rental. Building owners of mid-size or larger dwellings are mandated to submit plans on energy conservation for any new construction or planned extensions. Moreover, all building owners are encouraged to apply renewable energy technologies as building energy sources.

To improve energy conservation in commercial buildings, the TMG has introduced the Energy Efficiency Certificate Program (2010). The mandatory program

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[27] "Tokyo" in the section means the "Tokyo Metropolitan Government."

aims to issue an Energy Efficiency Certificate, which indicates the energy efficiency of the building. It needs to be issued when selling, renting or transferring the beneficiary right of large-scale office buildings and commercial buildings that are newly-built or expanded (TMG, 2010).

The TMG established its District Energy Program in 2010, which restructured the existing district heating and cooling program to realize higher energy efficiency in large-scale developments. The District Energy Program requires the development of one or more buildings (5,000 square meters total floor area or larger) to submit an energy plan for efficient use of energy in the district. Energy Conservation Specifications have been formulated for Tokyo's public buildings that are newly constructed, expanded or refurbished on a large scale in order to achieve substantial CO_2 reductions. The specifications are targeted for government buildings of more than 3,000 square meters and aims to reduce approximately 30 percent of CO_2 emissions from the levels in 2000.

3.4.2 Economic/Market-Based/Fiscal Incentives

National Policies

Japan's ESCO-related market has been growing rapidly. In 2007, the total amount of repair work for energy conservation increased by 30 percent compared to the previous fiscal year. The ESCO business substantially increased from ¥27.8 billion in the previous year to ¥40.7 billion (AEEC, 2012). In addition, the Japanese national government has provided partial subsidies or low-interest loans to private enterprises or local governments in setting up ESCOs from the Development Bank of Japan (ABC, 2012). Moreover, the 2008 revision of the Law for Energy Conservation and Recycling Support provides loans with special interest rates for small- and medium-sized companies with energy conservation and high energy performance equipment. In terms of tax incentive programs, when business operators purchase equipment that contributes to efficient energy use and utilize it for their business activities within a year, they can choose either one of the following options:

1) A tax exemption equivalent to 7 percent of the equipment acquisition cost (this applies only to small and medium-sized companies); or
2) A special depreciation of 30 percent of the equipment acquisition cost in the year of acquisition.

Tokyo Policies

In 2004, the Environmental Bureau of the TMG subsidized part of the costs of energy-saving measures implemented jointly by owners and tenants to reduce CO_2 emissions in small and midsize multi-tenant buildings in Tokyo. Through the subsidies, the TMG collects information on effective energy-saving measures and examples of successful collaboration between building owners and tenants to help spread information to promote measures against global warming. In addition, the TMG has encouraged the construction of green buildings by providing building owners and developers with lower interest rates. Moreover, the TMG has supported the businesses with the installation of solar power systems through the Tax Incentive Program for building energy conservation. Funding is being provided to local districts within

Tokyo to subsidize the installation of solar power equipment by small and medium-sized facilities.

The Tokyo Cap-and-Trade Program (Tokyo-ETS), which was enacted in 2008 and started in 2010, is the world's first urban cap-and-trade program to give an emissions limit to large-scale commercial buildings. In 2002, the TMG attempted to initiate a voluntary scheme called the Tokyo CO_2 Emission Reduction Program to implement emissions reductions and to set an emission cap (World Bank, 2010). For one building or facility that consumes more than 1,500 kiloleters of crude oil equivalent, a cap is set and the building must reduce emissions and also make a reduction plan. Tenants in buildings that rent/lease more than 5,000 square meters of space or consume more than 6 million kilowatt hours per year must create their own emissions reduction plan and submit it through the building owner; however, each tenant is not specifically required to cap their emissions. If no individual tenant exceeds these energy consumption limits but a single building as a whole does, the tenants are required by law to cooperate with the building owner in reporting emissions, although the final report is submitted by the building owner (World Bank, 2010). The Tokyo Cap-and-Trade Program requires mandatory CO_2 reductions from large-scale commercial buildings and sets up an emissions trading system with small- and medium-sized companies to report on their efforts to save energy, and the program enhances a series of measures for sustainable urban development. These are pioneering efforts in Japan, and also represent a cutting-edge initiative in the world. The first five-year compliance period is 2010 to 2014, with the second period from

2015 to 2019. Compliant businesses are able to trade green/renewable electricity certificates as well as green heat certificates derived from solar hot water. Fines will be imposed for noncompliance. The trading system has resulted in far-reaching effects throughout Japan.

Moreover, under the Project to Promote Energy-Saving and Creation of Carbon Credits for Small and Medium Facilities (2010), the TMG gave financial aid to install energy saving equipment as a supporting measure for small and medium facilities. The TMG offers tax breaks to small- and medium-sized enterprises for purchasing energy saving equipment and renewable energy equipment. Further, the TMG established the Eco-Finance Project, which utilizes a financial system in order to create opportunities for environmental protection activities involving the residents and companies of Tokyo (TMG, 2010).

3.4.3 Support/Information/Voluntary Action

National Policies

Japan's green building rating system, the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), was developed by the Japan Sustainable Building Consortium in 2001. It was originally a voluntary program, but it is now employed as a tool for developing and reviewing mandatory reports. The local CASBEE programs are made and administrated by local governments, while the Japan Green Build Council (JaBEC) administers the national program through the Institute for Building Environment and Energy Conservation (IBEC) with the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) support. Under local CASBEE programs, many local governments provide incentives for more efficient buildings. Highly-rated buildings in CASBEE may be allowed to have an additional floor or more floor space. Moreover, owners of such buildings may also be eligible for certain construction subsidies and low-interest loans. Building developers, architects and others can download the CASBEE tools to evaluate any new building or renovation to their own buildings. Building developers and owners can also hire trained architects to conduct the assessments (ABC, 2007).

In terms of relevant training and information dissemination, IBEC is active in providing training seminars and resources to support implementation of the Energy Conservation Law. The seminars cover issues such as building design, construction techniques, insulation and calculations of energy efficiency under the building energy codes. This institute also publishes detailed guidebooks on Japan's energy efficiency standards. In addition, the Energy Conservation Center of Japan (ECCJ) is also active in providing technical assistance in energy-efficient building construction and operations with numerous industrial partners. ECCJ is also in charge of free building energy audit programs.

The national government provides various awarding and awareness-raising programs towards building energy conservation efforts, such as the Awarding of Excellent Energy Conservation Factory & Building; the Awarding of Successful Cases of Energy Conservation in Factory & Building; the Awarding of Excellent Energy Conservation Equipment; the Awarding of Top Energy Efficient Product Retailing Promotion Store and the Awarding of Excellent ESCO Projects". To further promote energy-efficient products, an Energy Efficient Product Retailer Assessment Program has been implemented since 2003. The program acclaims retailers who actively promote energy efficient products or provide appropriate energy conservation information. In addition, there are programs to promote high-efficiency boilers, air-conditioning systems, and energy management utilizing information technology for commercial buildings. Furthermore, in order to spread net-zero energy buildings, the Japanese national government has promoted research and development on improving the efficiency of building equipment, has mandated energy conservation standards, and has given incentives for the adoption of energy conservation equipment and high-efficiency air conditioners with the aim of achieving substantial CO_2 reductions in buildings.

Tokyo Policies

On the city level, the Tokyo Renewable Energy Strategy of 2006 provided a potential target of 20 percent of the city's energy supply coming from renewable energy sources by 2020. This target level was chosen to be in alignment with other targets in OECD countries, and also to stimulate new opportunities for businesses (EIA, 2009). In addition, Tokyo's Green Power Purchasing Movement aims to change the structure of energy supply and demand through the city's purchasing power. The 10-year Project for Green Tokyo reinforced the requirements for greening in constructing, expanding and renovating buildings. In addition, the TMG introduced an evaluation system for promoting rooftop greening (TMG, 2007). The Tokyo Low Carbon Building Top 30 selected the top 30 low emission buildings as demonstrations to widely diffuse leading technologies of low emission buildings. Meanwhile, in order to develop human resources in a low-CO_2 society, the TGM reinforces the environmental and energy learning and training programs to encourage community and public participation in the development of an urban low-carbon economy.

3.4.4 Summary

In Japan, buildings over 2,000 square meters need to submit energy saving plans or retrofitting plans to the local governments. The requirement has applied to small- and medium-sized buildings since 2008. Building energy codes in Japan are technically voluntary and there are no checks on actual construction, but compliance appears to be relatively high. This might be related to Japanese culture, which has a tendency towards compliance. Japan is also adopting a penalty scheme to ensure that large buildings and houses are energy efficient. Local governments encourage more efficient building designs by giving owners incentives like access to relaxed building height and size restrictions and financial support for very efficient buildings. In addition, Japan's Top Runner Program is a regulatory scheme to improve energy efficiency of building appliances. It focuses on the supply-side and targets product manufacturers and importers. Products that meet the energy efficiency standard receive a Top Runner label; products that do not meet the baseline are labeled differently. This program drives product manufactures to make even more efficient models to compete, which in turn means the next time officials set standards, the best available products will be even more efficient. The TMG has initiated the Green Building Program, which includes an environmental performance evaluation and disclosure in large-scale commercial buildings (5,000 square meters). It also requires energy conservation design and renewable energy application in new constructions. To supplement the program, the Energy Efficiency Certificate Program has issued certificates as a rewarding mechanism. The District Energy Program has extended higher energy efficiency requirements to large-scale developments. Moreover, the TMG has initiated the first city-led cap-and-trade scheme (Tokyo-ETS) in the world, which targets building energy-related CO_2 reductions in existing buildings. The scheme covers over 1,000 commercial buildings. The TMG has tax incentives and financing support to promote building energy saving and renewable energy application. Finally, the Tokyo Low Carbon Building Top 30 selected the top 30 low emission buildings as demonstrations to widely diffuse leading technologies of low emission buildings.

Table 3-5: Commercial Building Energy Policy Instruments in Tokyo

Regulatory & Control Instruments		Japan	Tokyo
Appliance Energy Efficiency Standards	• The Top Runner Program	●	
	• The Energy Conservation Law	●	
Building Energy Codes	• The Energy Conservation Law	●	
	• The Criteria for Clients on the Rationalization of Energy Use for Buildings	●	
	• TMG Environmental Security Ordinances		●
	• Energy Conservation Specifications		●
	• The Tokyo Green Building Program		●
Mandatory Certification and Labeling	• The Energy Conservation Law	●	
	• The Tokyo Green Building Program		●
Mandatory Disclosure Programs	• Annual reports on commercial building energy use and investment plans	●	●
Economic/Market-based/Fiscal Incentives		**Japan**	**Tokyo**
Energy Performance Contracting/ESCO Support	• Local governments setting up ESCOs		●
Kyoto Flexibility Mechanisms	• Tokyo-ETS		●

Table 3-5 Continued

Economic/Market-based/Fiscal Incentives		**Japan**	**Tokyo**
Tax Incentives	• The Tax Incentive Program for Energy Conservation	●	●
Low Interest Loans & Guarantee Funds	• The Top Runner Program	●	
	• The Tokyo Green Building Program		●
Support/Information/Voluntary Action		**Japan**	**Tokyo**
Voluntary Certification & Labeling Programs	• The CASBEE Green Building Rating System	●	
	• The energy-efficient product retailer assessment system	●	
	• The Energy Conservation Performance Certificate Program	●	
Audits & Energy Use Reports	• The Sustainable Building Reporting System	●	
Local Energy Efficiency Information Centers	• The Energy Conservation Center of Japan	●	
	• The Institute for Building Environment and Energy Conservation	●	
Awareness-Raising/ Education/Information Campaign	• Tokyo's green power purchasing movement (Tokyo)		●

Table 3-5 Continued

Support/Information/Voluntary Action		Japan	Tokyo
Disclosure Programs	• The Tokyo Green Building Program		●
	• The Tokyo Climate Change Strategy (Tokyo) • Basic Policies for the 10-year Project for Green Tokyo (Tokyo) • The Tokyo Renewable Energy Strategy (Tokyo) •		●

Chapter 4

COMMERCIAL BUILDING ENERGY POLICIES IN SHANGHAI

The chapter explores Shanghai's growth in the commercial sector with corresponding energy consumption and CO_2 emissions. In addition, it reviews Shanghai's commercial building energy policies and regulations. They aim toimprove commercial building energy conservation and enhancing commercial building energy efficiency in national and urban contexts.

4.1 Shanghai's Growth and the Commercial Sector

With an area of 6,340 square meters, Shanghai is located on the Yangtze River Delta in the middle of China's east coast. Shanghai had grown from a small fishing village in the late 10th century to the largest city in China with almost 20 million people. Moreover, since the early 1990s Shanghai has experienced fast economic growth with a GDP growth rate of over 10 percent in the decade. Table 4-1 indicates that Shanghai has been experiencing rapid urbanization accompanied by large-scale economic development since 1990. From 1990-2005, urban area has increased from 750 to 5299 square meters, while population and GDP per capita have grown almost two times and four times respectively.

Table 4-1: Shanghai's Urban Statistics

Year	1990	1995	2000	2005	2025
Urban Area km^2	750	2,057	3,924	5,299	5,299
Urban Population (1,000)	9,206	11,103	14,349	17,130	25,075
GDP/capita (1,000 RMB[28])	12.30	19.15	28.56	45.19	157.72

Source: MGI, 2009; Ruet et al., 2010

Due to the influence of global and local factors, Shanghai has not only functioned as the most important center of the Chinese national economy, but it has also served as the most attractive locus for foreign investment in China. Since the implementation of economic reform in 1979, the "oriental pearl" has quickly emerged as the most important locale for many multinational corporations to set up their regional headquarters in China. Some studies have identified Shanghai as the leading Chinese city in the global economy (Godfrey & Zhou, 1999; Lin, 2004 ; Zhou, 2002). Following the national government's State Council policies, the Shanghai Municipal Government (SMG) has been attempting to build itself into global city status. The SMG continues working towards the goal of building and expanding its economic, financial, trading and shipping sectors by 2020. As stated in the 11th Five-Year Plan (2006–2010):

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[28] RMB stands for Renminbi which is the official name given to currency of the People's Republic of China.

> …Shanghai will make the efforts to enhance its international competitiveness as the main theme of development for the next five years and as a continuation of the theme of the Tenth Five-Year Plan to enhance the overall competitiveness of the city in the new era. The efforts will center on the goals of developing the Four Centers (an international economic center, an international financial center, an international trading center, and an international shipping center), and a socialist modern international metropolis, and represent the common aspiration of all the people of Shanghai to seize opportunities to achieve fast and sound development.

During the mid-20th century, Shanghai's major urban development focused on the Puxi area, which is on the west bank of Huangpu River. However, the central government announced a shift to the development of the Pudong New Area, the east part of the river, in 1991.

Shanghai's high urbanization rate of 81.2 percent has been exceeding other developed countries, and its total construction area has been growing rapidly (Long & Bai, 2006). For example, Pamela Yatsko, a journalist for the Far Eastern Economic Review, described Shanghai in 1996 as a city in which

> …whole blocks are being flattened, turning parts of the former 'Paris of the East' into huge construction sites- a chorus of cranes, jack-hammers and bulldozers chiselling out the foundations of skyscrapers, elevated expressways and subway tunnels. Architects are having their fling with modernism- designing huge glass-faced office complexes and luxury apartment blocks (Yatsko, 1996).

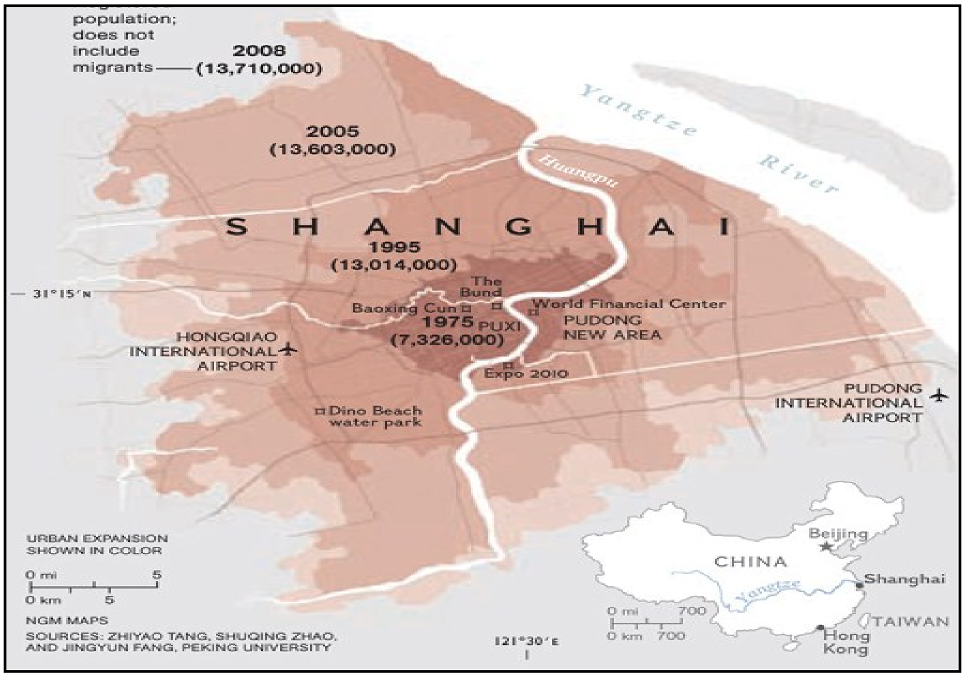


Figure 4-1: Shanghai's Urban Growth (1975-2008)

Source: Tan et al., 2011
Note: Population does not include migrants.

As a symbol of China's economic and social reform, the Pudong New Area (Pudong District) has rapidly developed since the 1990s. With support from the central government and the SMG, Pudong has emerged as China's financial and commercial hub. It produces almost one quarter of the GDP of Shanghai, generates half of Shanghai's export and import values and creates 1.1 million job opportunities (Yang, 2002). Moreover, the Pudong New Area skyline has been reshaped by the building boom that has lasted over 10 years. Figure 4-2 points out that the Pudong New Area accounts for the majority of new constructions and existing buildings, followed by Hongkou, Boshan, Changning, Putuo, and Songjiang.

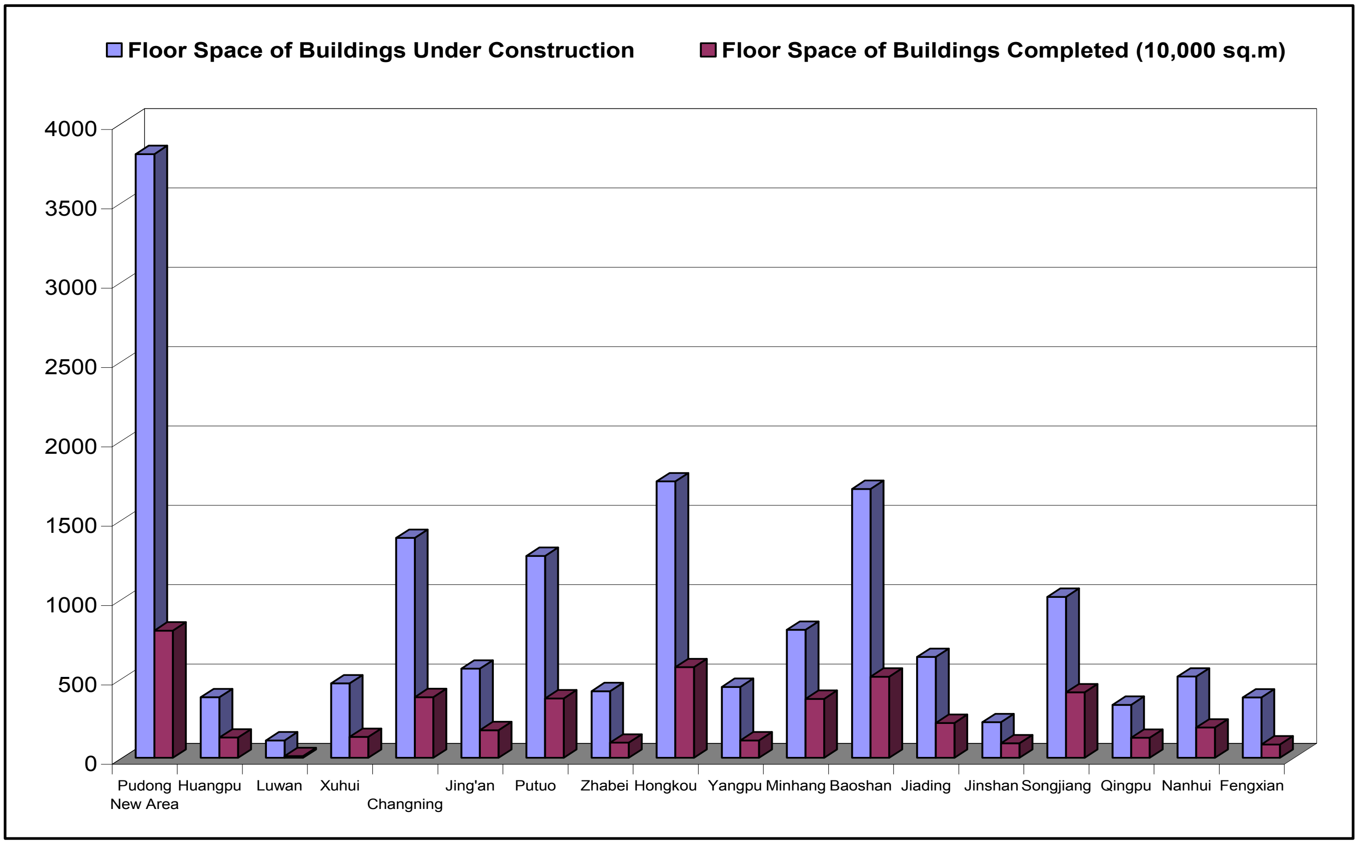


Figure 4-2: Floor Space of Buildings in Shanghai's Districts and Counties, 2008

Source: Shanghai Municipal Statistics Bureau*, 2010*

The following table presents socioeconomic and energy indicators for Shanghai vis-à-vis national data. Shanghai's social/economic force has surpassed the national average along with high energy consumption.

Table 4-2: Shanghai's Major Social/Economic and Energy Indicators as a Percentage of the National Total

Indicators	Shanghai	Percentage of the National Total (%)
Land Area (10,000 km^2)	0.62	0.1
Population (millions)	18.15	1.3
Gross Domestic Product (100 million yuan)	13,698.15	4.6
Primary Industry	111.80	0.3
Secondary Industry	6,235.92	4.3
Tertiary Industry	7,350.43	6.1
Total Fiscal Revenue (100 million yuan)	7,532.91	12.3
Total Port Exports and Imports (100 million USD)	6,065.57	23.7
Imports	2,129.07	18.8
Exports	3,936.50	27.6
Foreign Direct Investment (100 million USD)	100.84	10.9
Energy Use (ton sce)	89.67	3.6
Energy Use per capita (ton sce/person)	4.94 (Shanghai)	1.87 (China)
Energy Intensity (Energy Use/GDP)	0.87 (Shanghai)	1.16 (China)

Source: Shanghai Municipal Statistics Bureau, 2009; Hammer & Mitchell, 2009

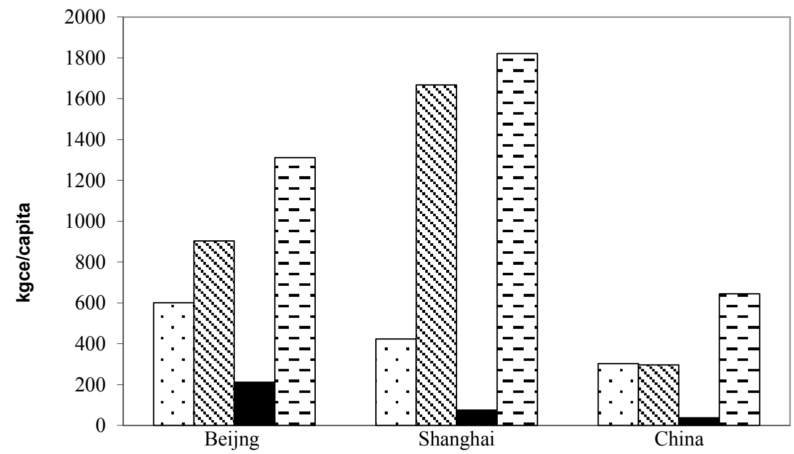
Compared to other local governments, Shanghai's total energy use and per capita energy use are higher than the other three municipalities directly under the central government, and Shanghai's usage also exceeds the national average (See Table 4-3).

Table 4-3: Energy Intensity in Chinese Major Cities

Municipality	**Population (millions)**	**Energy Use (ton sce)**	**Energy Use per capita (ton sce/ person)**	**GDP (billion RMB)**	**Energy Intensity (Energy Use/GDP)**
China	1314.5	2462.7	1.87	21,192.0	1.16
Shanghai	**18.15**	**89.67**	**4.94**	**1,036.6**	**0.87**
Beijing	15.81	59.04	3.73	787.0	0.75
Chongqing	28.08	47.23	1.68	345.2	1.37
Tianjin	10.75	45.25	4.21	434.4	1.04

Source: Hammer & Mitchell, 2009

In terms of per capita energy consumption by energy sources, Shanghai consumed more energy than Beijing and the national average (see Figure 4-3).



	Beijng	Shanghai	China
Total Coal	600	422.5	302.1
Total Petroleum	903.1	1668.1	296.9
Natural Gas	210.9	74.7	36.7
Electricity	1310.8	1820.9	643.9

Figure 4-3: Per Capita Energy Consumption by Energy Type

Source: *LBNL*, 2008

Figures 4-4 and Figure 4-5 reveal that both total energy consumption and CO_2 emissions are increasing in Shanghai. Moreover, with more and more energy demand and limited energy supply, Shanghai has recently faced serious energy challenges. Shanghai has an energy security problem because major energy resources need to be imported from other provinces and cities by train or ship. In addition, 2005 data indicates that the maximum electric power load in Shanghai was 16,682 MW, which was greater than the total electricity capacity of 13,368.4 MW (Long & Bai, 2006). Shanghai also ranks poorly in energy consumption and CO_2 emissions compared to other Asian cities, according to the Asian Green City Index published by the Economist Intelligence Unit (2011).

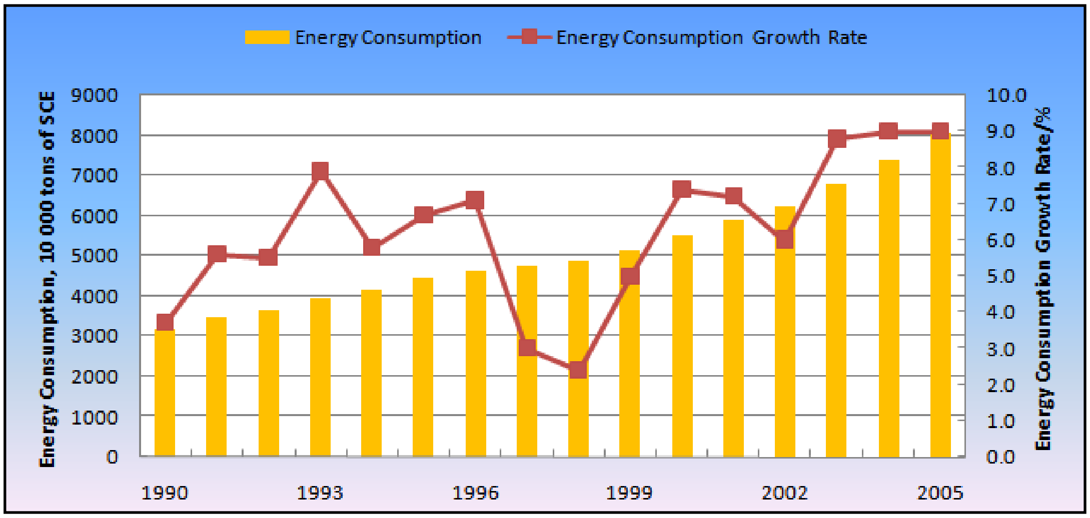


Figure 4-4: Energy Consumption in Shanghai (1990-2005)

Source: Shanghai Municipal Statistics Bureau, *2006*

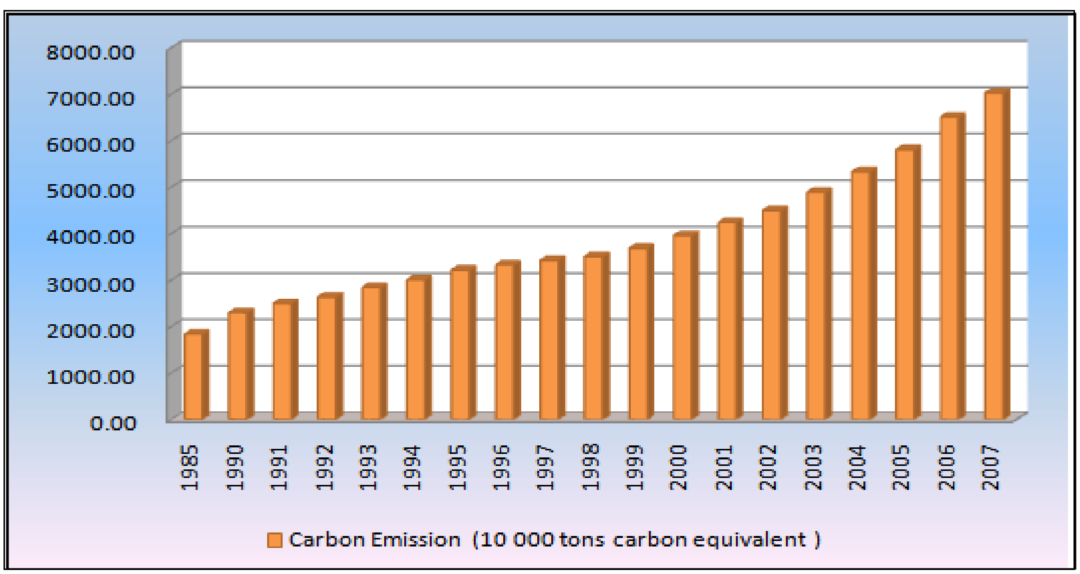


Figure 4-5: Carbon Emission in Shanghai (1985-2007)

Source: WEC, 2009

As part of its building boom, Shanghai is engaged in constructing giant iconic buildings and large development projects, enhancing city branding and creating a new city skyline for global competition. Figure 4-6 demonstrates the changing urban skyline of Shanghai from 1978 to 2009. Shanghai's building stocks are increasing exponentially.

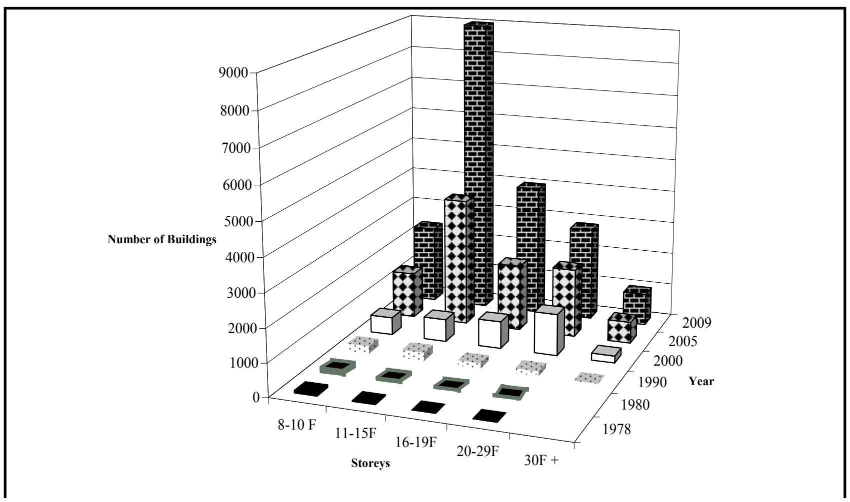


Figure 4-6: The Changing Urban Skyline of Shanghai (1978-2009)

Source: Shanghai Municipal Statistics Bureau*, 2010*

In national context, China's statistics show that the commercial sector accounted for around 20 percent of total urban energy consumption in buildings by the end of 2005. Energy consumption per square meter in public buildings is much higher than that in residential buildings. Moreover, China's commercial buildings consume on average three times of those in developed countries.

Moreover, Table 4-4 reveals a growth rate of 61percent in Shanghai's total commercial buildings from 2000-2008. Stores, warehouses, offices and other structures increased more than 50 percent during this time.

Table 4-4: Shanghai's Commercial Buildings in 2000, 2007, and 2008

Type of Structure	2000 (in 10,000 m^2)	2007 (in 10,000 m^2)	2008 (in 10,000 m^2)	Growth Rate from 2000-2008 (percent)
Commercial Buildings (Total)	13,341	31,590	33,926	61
Schools	1,417	2,562	2,699	47
Warehouses	650	1,342	1,374	53
Offices	2,416	4,972	5,269	54
Stores	1,191	4,029	4,355	73
Hospitals	367	602	630	42
Hotels	376	679	799	53
Theaters and Cinemas	47	72	73	36
Other	1,138	2,806	3,269	65

Source: Shanghai Municipal Statistics Bureau, 2009

According to Figure 4-7, the Pudong New Area has the most commercial buildings, followed by Songjiang, Jiading, Baoshan , Minhang and Qingpu. In the Pudong New Area, the most prominent examples of commercial buildings include the Jin Mao Tower, the Shanghai World Financial Center and the Oriental Pearl Tower.

With 127 floors and a total floor area of 380,000 square meters, the Shanghai Tower will be the tallest building in China upon its completion in 2014.

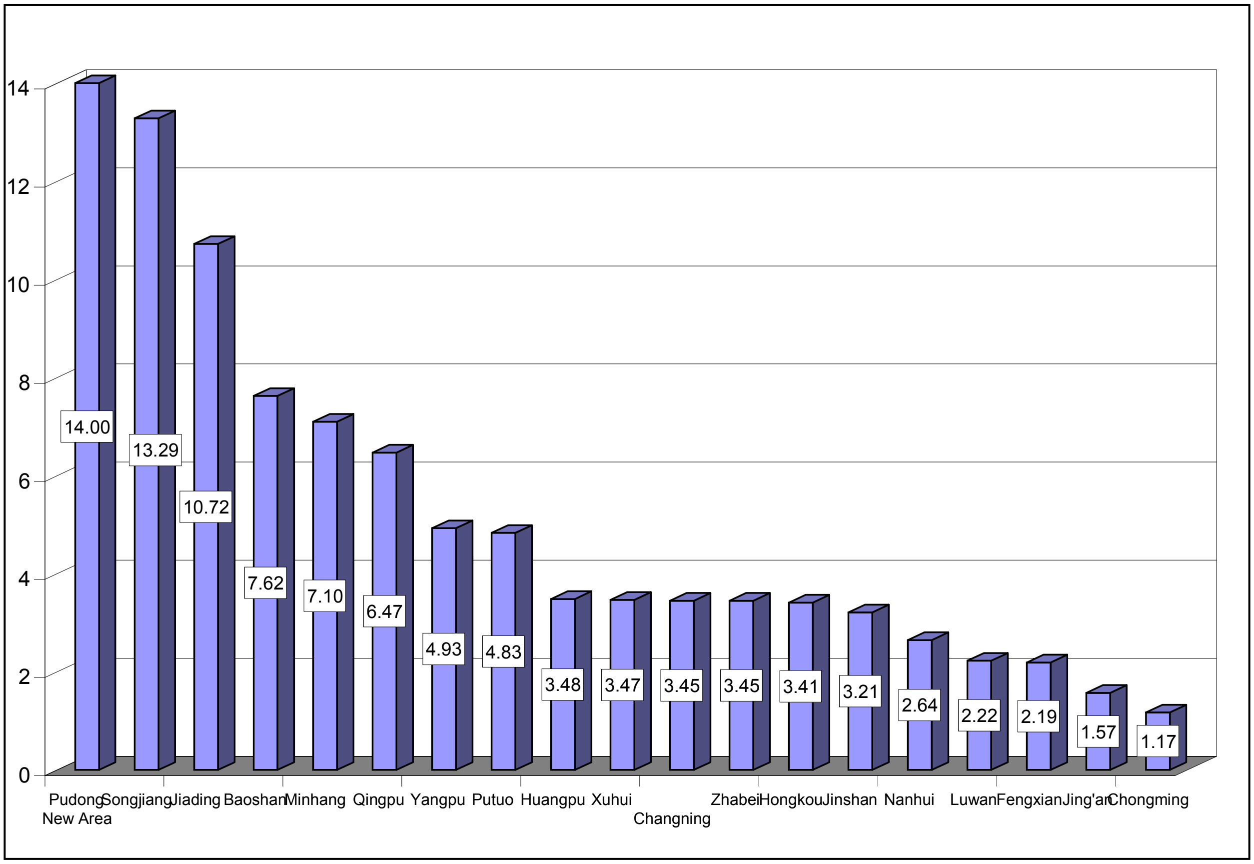


Figure 4-7: Distribution of Commercial Buildings in Shanghai's Districts and Counties

Source: Shanghai Municipal Statistics Bureau, 2009

Although the development of residential building construction has occurred very rapidly in Shanghai, energy consumption from commercial buildings is occurring at a faster rate than that of residential buildings in recent years (See Figure 4-8[29]). Commercial buildings also account for a higher share of electricity consumption in Shanghai; residential buildings account for a higher share at the national level (see Table 4-5).

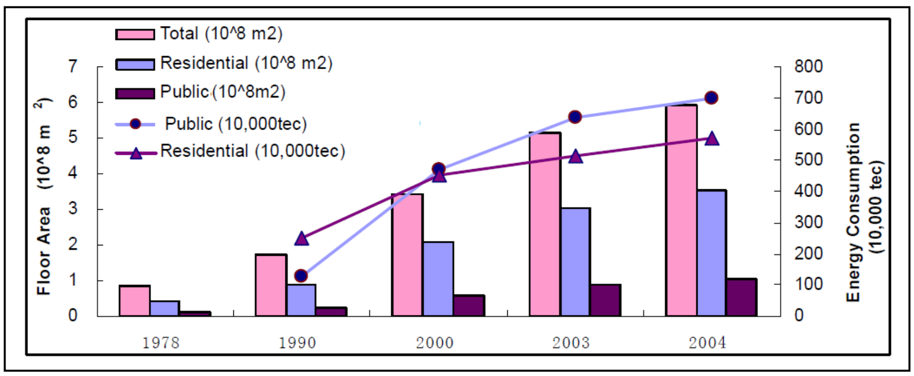


Figure 4-8: Building Floor Area and Energy Consumption in Shanghai

Source: Yang & Tan, 2006

29 Chinese regulations use the term "public buildings" instead of "commercial buildings." In practice, this is quite similar to the idea of commercial buildings in other countries. Public buildings in China include government buildings but also other private buildings used for commerce or services. The term "public buildings" in China does not include residential or industrial buildings (Shui et al., 2009).

Table 4-5: Commercial and Residential Buildings in Shanghai

Building Category	Energy Consumption (10,000 tec)				Electricity Consumption (billion kWh)			
	China		Shanghai		China		Shanghai	
Commercial	10,932.6	36.2%	700.7	55.0%	1,534	40.7%	169.2	65.1%
Residential	19,268.4	63.8%	573.2	45.0%	2,238	59.3%	90.6	34.9%
Sum	30,201.0	100%	1,273.9	100%	3,772	100%	259.9	100%

Source: Yang & Tan, 2006

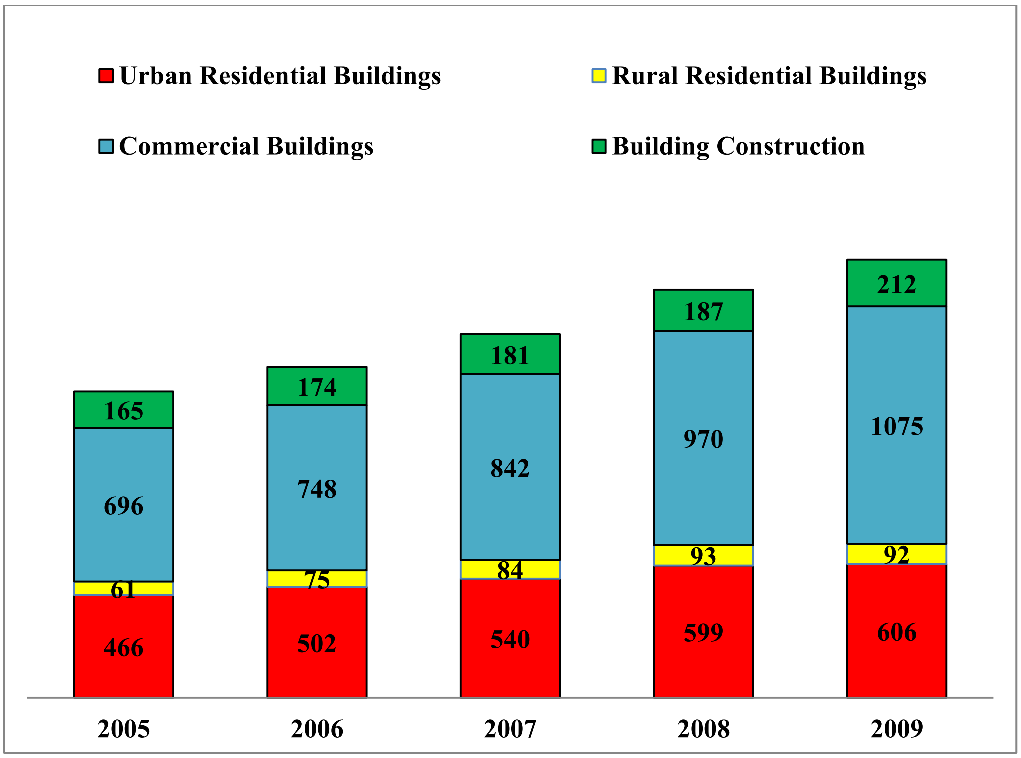
Table 4-6: Energy Consumption in Shanghai's Non-Residential Buildings

Total Building Area	703 million m^2
Total Non-Residential Building Area	294 million m^2
Percent of area classed as non-residential	42 percent
Consumption of energy in non-residential buildings as a percent of building sector	70 percent
Ratio of energy consumption in non-residential buildings to residential buildings	3.22

Source: Shanghai Statistical Bureau, 2007; Jiang & Tovey, 2009

According to Table 4-6, energy use per square meter in the non-residential sector is more than three times that of the residential sector in Shanghai. Figure 4-9 indicates that commercial buildings account for the most energy consumption in the building sector in Shanghai.

In Shanghai, energy use in commercial buildings is higher than in residential buildings, particularly in those buildings classed as large buildings (hotels, office buildings and shopping malls). Moreover, relevant research also projects that commercial buildings are key issues and challenges for energy use and CO_2 emissions in Shanghai.[30] With only 37 percent of the city's total area, this sector consumes around 70 percent of the total energy in the whole building stock in Shanghai (Jiang & Tovey, 2010; Shanghai Municipal Statistical Bureau, 2008).



Unit: 10,000 tec

Figure 4-9: Building Energy Consumption in Shanghai (2005-2009)

Source: Shanghai Statistical Bureau, 2007; Jiang & Tovey, 2009

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30 The Institute for Global Environmental Strategies also indicates estimates of Shanghai's commercial sector that stand to become key issues for energy use and CO_2 emissions in comparison to other major global cities in East Asia (IGES, 2003).

When one further analyzes different building types, it becomes evident that China's large-scale commercial buildings[31] account for 4percent of total building area but are responsible for 22 percent of total energy consumption (Chmutina, 2010). Table 4-7 and Figure 4-10 both indicate that large-scale commercial buildings have the highest energy consumption per square meter (70-300 kWh/m^2.a) among all types of buildings. Therefore, large-scale commercial buildings have become major targets of action for both national and local energy saving agendas.

Table 4-7: China's Building Energy Consumption

Building Type		Area (bm^2)	Annual Energy Consumption (10^4 tce)	kWh/m^2.a
BEC in Rural Area		24	19200	7.5 ~ 15
Heating in Northern Area		6.5	12740	57
BEC except Heating	Residential	10	7820	10 ~ 30
	Ordinary Commercial	5.5	9470	20 ~ 60
	Large Commercial	**0.5**	**1760**	**70 ~ 300**
	Urban Total	16	130Mtce	52
Total		40	51730	30

Source: Lin, 2008

[31] In China's building regulations, large-scale buildings refer to those with a minimum of 20,000 square meters of floor area and a central air-conditioning system.

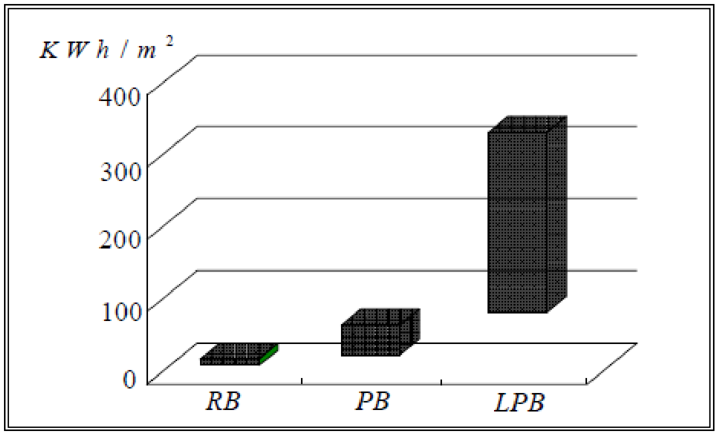

Figure 4-10: Electricity Consumption in Buildings

RB: Residential Buildings
PB: Public Buildings
LPB: Large-scale Public Buildings (Large-scale Commercial Buildings)

Source: Shanghai Statistical Bureau, 2009

In Shanghai, large-scale commercial buildings have been growing rapidly since 1990 (Li et al., 2005). Table 4-8 presents building energy consumption in Shanghai's large-scale commercial buildings. Among types of large-scale commercial buildings, average energy consumption is the highest in shopping malls. The following chapter selects two different types of shopping centers, Shanghai IKEA and Plaza 66, for an investigation and assessment of their retrofitting efforts on building energy saving measures. The next section investigates Shanghai's local administration followed by specific commercial building energy policy instruments in the national and urban contexts.

Table 4-8: Mean Energy Consumption in Shanghai's Large-scale Commercial Buildings

Building Type	Office	Hotel	**Shopping Mall**	Mix
Mean Energy Consumption (kWh/m^2)	114	169	**229**	154

Source: Xu et al., 2010

In terms of local governmental structure, Shanghai is one of the four municipalities directly under the central government along with Beijing, Tianjin and Chongqing. China's local governmental system divided into provinces, autonomous regions, and municipalities directly under the central government. Governments of municipalities directly under the central government are first-level local governments in China. Governments of these municipalities must accept the unified leadership of the State Council, which decides on the division of power and functions between the central government and local governments.

In China, the National People's Congress (NPC) and its Standing Committee, the highest legislative authority in China, are usually regarded as a symbolic legislature without power. The State Council[32], the President and the Premier own the real power of China's central decision-making, although the NPC has the power to

[32] The State Council is also tightly interlocked by the Communist Party of China. Most of the members of the State Council are also high ranking in the Communist Party of China.

elect the President of China and approve the appointment of the Premier of the highest administrative authority. The State Council directly oversees the various subordinate governments at the provincial level and below. The State Council also has the power to alter or annul decisions and orders made by governments of municipalities directly under the central government.

The governments of Shanghai and other municipalities directly under the central government implement local laws, regulations and decisions of the people's congresses and their standing committees of the municipalities. Municipal governments are responsible for and report on their work to the people's congresses and their standing committees. People's congresses and their standing committees in the municipalities have the power to supervise the work of the municipal governments, change decisions and annul inappropriate decisions and orders of municipal governments. Municipal governments have the right to exercise unified leadership over the work of the districts, cities, counties, townships and towns, and they have the power to exercise unified administration over the economic, social, and cultural affairs in areas under their respective jurisdictions.

Under the framework of the SMG, the mayor is elected indirectly by the Shanghai People's Congress and is the head of the municipal government and administration. The SMG is comprised of 21 government committees and departments and 23 offices, centers and administrations. These executive organizations establish, apply and enforce various policies, projects and initiatives for Shanghai. The Shanghai People's Congress exercises legislative functions in the municipality.

Responsibilities of the Shanghai People's Congress include approving the regulations and rules at the municipal level, as well as economic plans and budgets. The Shanghai People's Congress also reviews acts and agreements of the institutions at the corresponding administrative level and checks compliance with the laws and provisions in its territory. Members are nominated by the Communist Party for a five-year period (see Figure 4-4).

In Shanghai, there are 17 county-level divisions, including 16 districts and one county (see Figure 4-11). Although each district has its urban core, Shanghai's city center covers the Huangpu (merged with Luwan in 2011), Xuhui, Changning, Jingan, Putuo, Zhabei, Hongkou and Yangpu Districts. Pudong is a newer part of urban and suburban Shanghai on the east bank of the Huangpu River. The rest of the districts govern Shanghai's suburbs, satellite towns and rural areas. Table 4-9 and 4-10 represent Shanghai's local administrative structure, land areas and population density in Shanghai's local districts and county. The SMG has restricted authority for its jurisdiction's affairs. Due to China's "party-led" political system, the SMG's power is not only under the central government and the State Council but also under the Shanghai People's Congress and its standing committees.

Figure 4-11: Administrative Divisions in Shanghai[33]

Source: ChinaMaps, 2014

Table 4-9: Shanghai's Local Administrative Structure

District	Towns	Townships	Urban Sub-district Offices	Neighborhood Committees	Village Committees
Total	109	3	101	3 579	1 781
Pudong New Area	11		12	618	226
Huangpu			6	120	
Luwan			4	74	
Xuhui	1		12	301	10
Changning	1		9	174	5

33 The Pudong New District merged with the Nanhui District in 2009. The data in this research covers up to 2009, so the map still shows the Nanhui District. The Huangpu District merged with the Luwan District in 2011.

Jing'an			5	74	
Putuo	3		6	229	
Zhabei	1		8	211	7
Hongkou			10	237	1
Yangpu	1		11	306	
Baoshan	9		3	334	160
Minhang	9		3	277	111
Jiading	8		3	110	159
Jinshan	9		1	77	131
Songjiang	11		4	138	115
Qingpu	8		3	70	184
Nanhui	14		1	89	185
Fengxian	8			84	216
Chongming	15	3		56	271

Source: Shanghai Statistical Bureau, 2009

Table 4-10: Land Area, Population, and Density in Shanghai's Districts, 2009

District	Land Area (km^2)	Year-end Resident Population (10,000)	Floating People (10,000)	Density of Population (person/ km^2)
Total	6 340.50	1 888.46	517.45	2, 978
Pudong New Area	532.75	305.70	93.43	5, 738
Huangpu	12.41	53.89	9.15	43, 425
Luwan	8.05	27.45	4.16	34, 099
Xuhui	54.76	98.22	13.90	17 ,936
Changning	38.30	66.83	11.57	17 ,449
Jing'an	7.62	25.78	3.46	33 ,832
Putuo	54.83	108.71	18.25	19 ,827
Zhabei	29.26	74.50	10.35	25 ,461
Hongkou	23.48	78.11	9.41	33 ,267
Yangpu	60.73	119.48	13.63	19 ,674
Baoshan	370.75	180.47	74.06	4 ,868

Table 4-10 Continued

District	Land Area (km^2)	Year-end Resident Population (10,000)	Floating People (10,000)	Density of Population (person/ km^2)
Minhang	270.99	140.63	40.37	5 ,189
Jiading	464.20	103.42	45.97	2 ,228
Jinshan	586.05	64.56	14.02	1 ,102
Songjiang	605.64	107.42	51.74	1 ,774
Qingpu	670.14	78.98	32.92	1 ,179
Nanhui	677.66	106.21	32.81	1 ,567
Fengxian	687.39	80.84	28.84	1 ,176
Chongming	1 185.49	67.26	9.41	567

Source: Shanghai Statistical Bureau, 2009

After Shanghai-born Chen Liangyu took municipal leadership in 2002, Shanghai's economic development deviated from national policy considerably. Chen believed that wealth produced in Shanghai should stay in Shanghai and benefit only Shanghai citizens. Before Chen was charged with corruption in 2006, Shanghai's level of autonomy alarmed central authorities, as it surpassed that of many autonomous regions. The removal of Chen also reflected the continuing role of the central government in Shanghai’s urban governance (Wu, 2000). However, the SMG still has local administrative discretion on the following areas: infrastructure provision (highways, subway, bridges, airport, etc.), urban promotion (housing and offices), water management, port management, the environment, primary-school education, public health, economic promotion, industry, trade, tourism, science and technology, agriculture, healthcare and waste management. Although major building energy policies and regulations are still initiated by the central government and the National

People's Congress, the SMG still leads limited commercial building energy regulatory/control instruments. The SMG has also adopted market-based incentives alongside support/information/voluntary actions. The following sections review building energy regulations and policies in China and Shanghai.

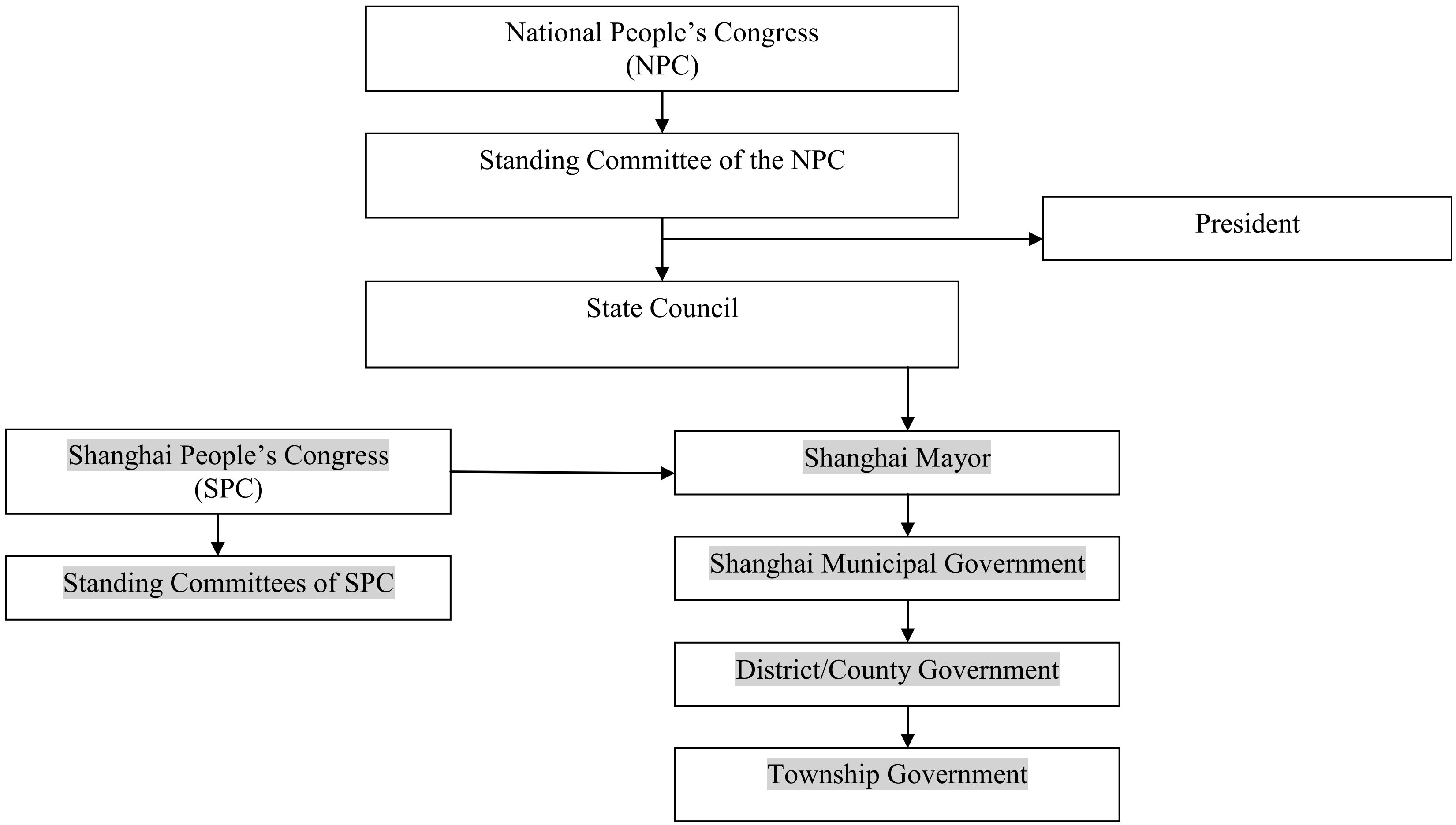

Figure 4-12: Local Governmental Structure in Shanghai

4.2 Commercial Building Energy Policies in China

China has a centralized building energy administration system. The Ministry of Housing and Urban-Rural Development (MOHURD) under the State Council coordinates and develops China's building energy policies and regulations (See Figure 4-14). Within the MOHURD, the Department of Standards and Norms is in charge of the development of building energy standards. The China Academy of Building Research (CABR) is the chief developer of nearly all of China's national building energy codes. On behalf of the MOHURD, the CABR is responsible for explaining and maintaining China's building energy codes (Shui & Evans, 2009).

The Department of Building Energy Conservation and Science & Technology is responsible for policy planning and implementation, research and development, and international collaboration related to building energy efficiency and conservation. For example, during the 11th Five-Year Plan, this department is responsible for energy efficiency retrofits of existing buildings, monitoring and energy management in government and large-scale public buildings and renewable energy application, while the Department of Urban Development is in charge of carrying out the heat supply system reform task (Zhou, Mcneil & Levine, 2011). Building energy institutes, universities, and industry representatives are in collaboration with the Department of Building Energy Conservation and Science & Technology for technical development of building energy standards.

According to the International Energy Agency (IEA), the high growth in China's energy use is primarily explained by its commercial sector. Its annual growth rate in commercial buildings in 2007 was 7.7 percent, compared to the world average of 2.4 percent (Evans et al., 2010). This section analyzes China's commercial building energy initiatives.

China's first building energy code for commercial buildings was released in 1993 for tourist hotels, entitled the Energy Conservation Design Standard for Building Envelope and Air Conditioning in Tourist Hotels.[34] The Design Standard for Energy Efficiency in Public Buildings, released in 2005, was implemented as a replacement for the Energy Efficiency Standard of Thermal Engineering and Air-Conditioning for Tourist Hotels. Within the broad category of commercial buildings, this standard focuses on the energy efficient design of new construction, additions and retrofits of existing public buildings. The purpose of the standard is to reduce new commercial buildings' annual energy consumption by 50 percent compared to buildings of the early 1980s; in developed cities like Beijing and Shanghai, energy consumption must be reduced by 65 percent to set an example for other cities (Chmutina, 2010).[35] The standard has been developed by the China Agency of Building Research and the Building Energy Efficiency Professional Committee of the China Construction

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[34] The Energy Conservation Design Standard for the Building Envelope and Air Conditioning for Tourist Hotels, the first energy code for tourist hotels (GB 50189-93), is a mandatory national standard and was developed primarily in response to the rapid growth of hotel buildings in many cities of China. The code specifies prescriptive requirements for the design of building envelope and air conditioning systems according to different classes and external climates of the tourist hotels.
[35] Building standards of 1980's China were relatively loose and did not meet international standards at all. Although the reduction targets look substantial and impressive, the standards actually fall short of international standards and are less stringent than those of EU countries (Chmutina, 2010; Yao, 2005).

Industry Association, which covers 21 organizations all over the country. The MOHURD is in charge of the interpretation of mandatory articles, and the China Academy of Building Research has provided detailed technical support (Hong, 2009). In addition, the MOHURD set several implementation goals, including the reduction of energy consumption in new construction by 50 percent and the completion of energy conservation retrofits for 25 percent, 15 percent and 10 percent of the existing buildings in big cities, medium cities and small cities, respectively, by 2010 (Shui et al., 2009).

The Design Standard for Energy Efficiency in Public Buildings, a mandatory national model energy standard, is also applicable to local governments and construction commissions. It does not, however, make the 50 percent reduction compulsory, and it states that energy savings may vary from climate to climate. Moreover, the standard also specifies the temperatures inside a building. In summer, the temperature in air-conditioned spaces is not allowed to be lower than 26°C; in winter, the temperature is not allowed to be higher than 20°C. However, indoor design temperatures are not mandatory and may vary depending on building type and space type. The mandatory requirements are those for roofs, opaque walls, floors, vertical fenestration, and skylights.

The National People's Congress also approved the Energy Conservation Law in October 2007, which also includes specific rules on energy saving in the building sector. Local energy saving regulations and design standards relevant to the building sector must be compliant to this law (Jiang, 2012).The Code for Acceptance of Energy

Efficient Building Construction, issued by MOHURD in 2007, covers construction quality and acceptance for the building envelope (walls, windows, doors, roofs and floors), heating, HVAC systems, lighting, monitoring and controls. It applies to new construction, additions and retrofits of existing buildings. The local construction administration department accepts a construction project after the building complies with the code.

The Regulations on Energy Conservation in Civil Buildings, developed by the MOHURD in 2008, was a recent governmental effort to promote building energy efficiency in residential and commercial buildings. The regulations clarify the national and local administrative roles in promoting building energy efficiency, and they specify the responsibilities of designers, builders, inspectors and the legal consequences of violating the regulations. The regulations also call for compliance with building energy codes, heat supply reform laws, local building energy conservation funds, the coordination of financing for existing buildings, the promotion of solar and other renewable energy sources, and the leadership of government buildings in energy conservation. Moreover, the regulations cover building energy management systems, energy efficiency rating systems, energy consumption statistics, energy-saving retrofits, construction practices, and the licensing of new buildings (Zhou et al., 2010). Government buildings and large commercial buildings are required to take the lead in energy retrofits. The law also encourages the use of renewable energy applications in local jurisdictions (Zhou, et al., 2010).[36]

In terms of mandatory certification and labeling, China has enacted regulations such as the Standardization Law; the Management Method of National Supervision and Random Inspection of Product Quality; and the Management Method of Energy Conservation Product Certification. Furthermore, China has government procurement policies linked to energy-efficiency labels, which require government departments to give preference to products with such labels.

In terms of economic and market-based policy instruments, the central government introduced the Corporation Income Tax Law in 2007, which includes preferential tax rates for manufacturers of energy efficient products. China has been working with the World Bank and the Global Environmental Facility (GEF) to promote the Energy Service Company (ESCO) business model in China since 1997 (Lin et al., 2004). China's first three officially recognized ESCOs were established in Beijing, Liaoning and Shandong by the China Energy Conservation Project, and endorsed by the International Finance Corporation and the Global Environment Facility in 1998 (CLP, 2010).[37] Meanwhile, Shanghai started its energy management

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[36] The Renewable Energy Law requires the MOHURD to develop standards enabling the use of renewable technologies in buildings.

[37] By 2009, China's ESCOs had grown to 502 and the number of their contracted projects had grown to 4,000; the value of these projects had grown to Rmb 28 billion (CLP, 2010). Most ESCOs are concentrated in a few big cities. Of the 984 approved

and services companies in 2002 (Lin et al., 2004). The National Development and Reform Commission (NDRC), the Ministry of Finance (MOF), the People's Bank of China (PBOC) and the State Administration of Taxation (SAT) are involved in providing incentives for ESCOs and their customers, including income tax deductions, value-added tax (VAT) and business tax (BT) exemptions, government-encouraged financing and direct government subsidies (CLP, 2010).

In terms of the Kyoto Mechanism, China has established an energy-saving trading market, which can lead to increased more trading by those commercial building users who save more energy than their quota requires. They can sell any excess energy savings to other commercial buildings whose energy consumption is higher than their set targets. This market mechanism of energy-saving trading could drive building owners and managers to upgrade the energy efficiencies in their buildings and to implement effective energy management (Energy Saving Association, 2011).

Moreover, the MOHURD and the MOF put forward the fiscal policy of using central budget funds as incentives for building energy efficiency renovations. In 2007, a total of 900 million yuan was earmarked for subsidizing the installation of heat metering devices. Fundamental work such as investigations into the energy consumption data and formulation of the renovation plans have been initiated in some

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ESCOs in 2011, 461 (47 percent) were located in northern and eastern China, with 153 in Beijing and 63 in Shanghai alone (Kostka & Shin, 2011).

regions. Tianjin, Dalian, Qingdao, Yinchuan and Tangshan have taken the lead, with a number of pilot projects launched in heat metering and energy efficiency renovations for existing buildings.

Moreover, there are some relevant policies under China's Five-Year Plan.[38] The 11th Five-Year Plan (2005-2010) required energy consumption per unit of GDP to be 20 percent by 2010 compared to the level of energy use in 2005 (Jiang, 2012). The following national plan, the 12th Five-Year Plan (2011-2015), has stricter and more specific objectives focused on GHG emissions reduction. This plan aims to reduce carbon emission density per unit of GDP by 17 percent by 2015 compared to the level of carbon emissions in 2010 (Jiang, 2012). China's 11th Five-Year Plan proposed high efficiency lighting systems for government facilities, hotels, shopping centers, and other commercial buildings. In order to promote green buildings, this national plan also proposed to construct 100 demonstrations nation-wide. In the 12th Five-Year Plan, China has set a target to reduce the energy use of public buildings by 10 percent per unit area in most buildings and by 15 percent in the largest buildings by 2015.

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38 China's Five-Year Plan for National Economic and Social Development is a critically important tool used by the government to achieve its development objectives by mapping out in five-year cycles the country's future progress via guidelines, policy frameworks, and targets for policy-makers at all levels of government. The 1st Five-Year Plan ran from 1953-1957. The 12th Five-Year Plan (2011-2015) was hailed as the "Greenest FYP in China's History," and contains one-third of the social and economic objectives relating to natural resources and environmental issues, aiming to build sustainable development practices into Chinese industries.

The Energy Efficiency Supervision (EES) system was developed to improve operation and maintenance practices and to promote energy efficiency in the public sector. The EES system includes five main sub-systems: energy metering, energy audits, energy use disclosure, energy quotas, and progressive energy pricing. Energy metering, energy audits and energy use disclosure have been implemented in provincial government office buildings so far.

Along with enhancing building energy efficiency, promoting green building is another important approach for China's building energy governance. The MOHURD released China's first green building standard in 2006. Called the Green Building Evaluation Standard, it is viewed as a counterpart to the LEED in China. The standard covers (1) land conservation, (2) energy conservation, (3) water conservation, (4) material conservation, (5) indoor environmental quality and (6) operation and management throughout the life cycle of residential and commercial buildings. Each section contains control items (requirements), recommended items, general items and preferred items. The MOHURD collects building energy consumption data, assesses energy performance based on standards and issues the three-star building certification to qualifying buildings. The local government is in charge of issuing lower level (one- or two-star) certifications. Moreover, the MOHURD has developed a series of regulations and programs to promote green buildings, such as the Green Building Demonstration Projects (2007) and Green Building Evaluation Labeling (2008).

4.3 Commercial Building Energy Policies in Shanghai

Although the MOHURD is responsible for directing and supervising national building energy policies and regulations, policy enforcement is undertaken by local governments through their construction administration departments. The construction administration departments simultaneously report to the local governments and to the local branches of the MOHURD. Local governments can choose to either comply with the national codes or adopt more stringent local codes (Lang, 2004).

The MOHURD supervises and oversees the Shanghai Municipal Urban and Rural Construction and Transportation Commission (URCTC) and the construction commission of districts and townships. The SMG and the URCTC must follow the MOHURD's policies and regulations. District/county construction bureau and township construction managers need to follow the URCTC's direction as well. A group of departments under the SMG is the reason for the horizontal interdepartmental relationship of Shanghai's building energy administration. The URCTC plays the largest role in Shanghai's building energy administration.

The other parts of Shanghai's government control their respective areas. The Finance Bureau initiates economic incentives and is responsible for energy use by financial institutions. The Education Commission accounts for schools, while the Tourism Association addresses hotels; the Health Bureau deals with hospitals and the Commission of Commerce covers stores and shopping centers, etc. The State-Owned Assets Supervision and Administration Commission and Government Offices Administration Bureau are in charge of public or municipality-owned buildings. The

Bureau of Quality and Technical Supervision is in charge of organizing and implementing the Energy Conservation Law of the People's Republic of China in relevant departments, and it implements the system of management of energy efficiency labeling. Moreover, central and local building science research institutions and universities, such as the Shanghai Research Institute of Building Science and Tongji University, have provided significant technical support and assistance for reducing building energy consumption in Shanghai.

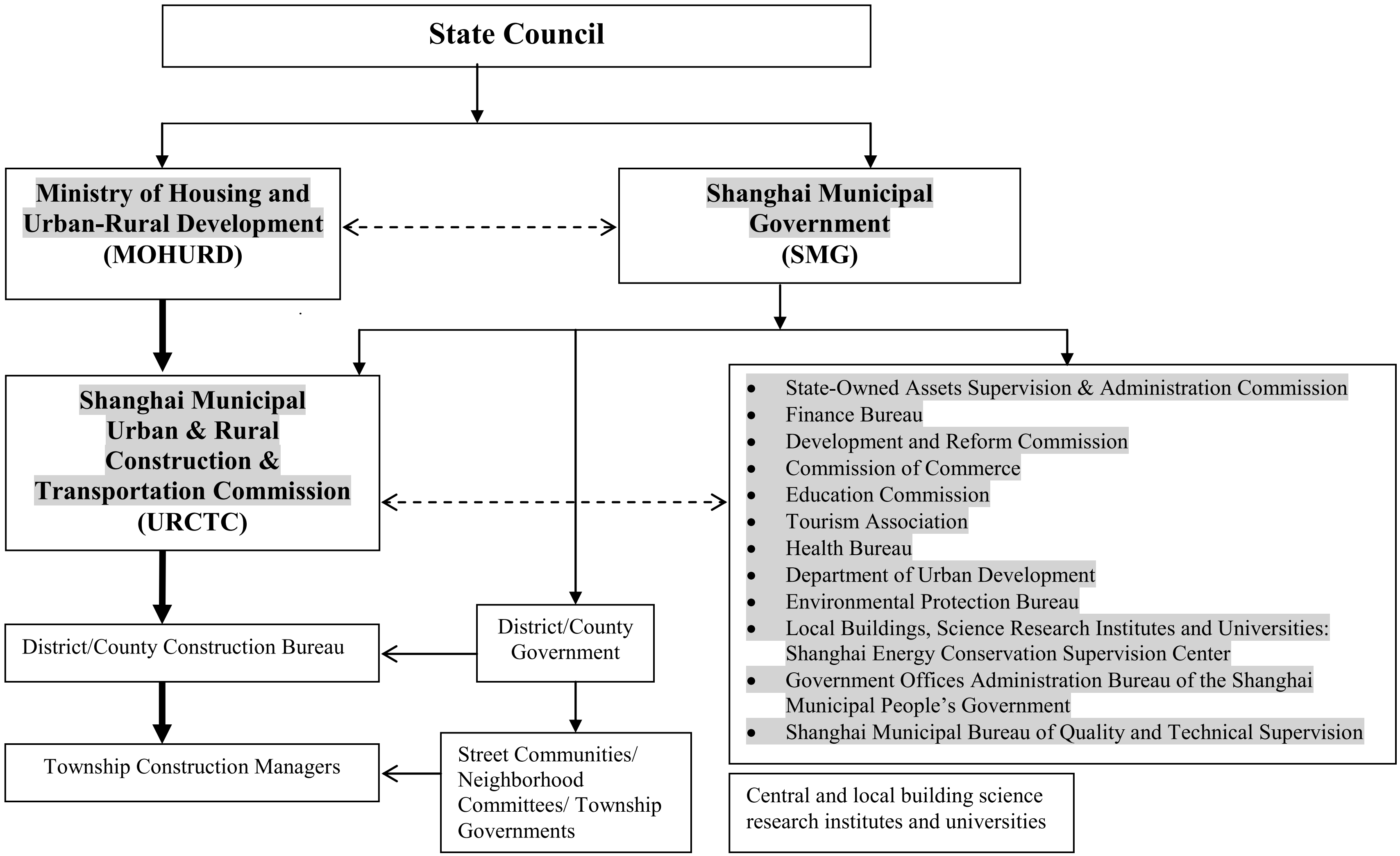

Figure 4-13: Shanghai's Building Energy Administration

The central government has played an important role in Shanghai's commercial building energy governance. Most relevant regulations and policies are drawn from the MOHURD or other departments of the central government. The competencies of municipal governments concerning their powers and duties are critical in shaping the capacity for urban energy governance (Betsill & Bulkeley, 2007). Shanghai is directly under the central government's rule as a level of government. The central government sets macro-policies and appoints top leaders under the hierarchy system. Because Shanghai is a leading city of China, the SMG has autonomy with respect to economic development, urban planning, infrastructure, civic facilities and budget support on urban building energy saving practices.

Moreover, the government leaders' will is an important factor for policy compliance. Current Shanghai Mayor Han Zheng, who took office in 2003, has announced a halt to the construction of projects with high energy consumption and has halted electricity and water supplies to block high-energy consumption projects under operation. Han urges for energy saving buildings and fosters the use of a market mechanism to support energy saving services for the building sector. Under the stable governance of Mayor Han, SMG building energy policies are relatively predictable and long-lasting when compared to the policies of some Chinese localities and mayors who have encountered varied institutional challenges within China's complex policymaking environment.[39]

China's existing form of urban governance is characterized by more decentralized, fragmented, ambiguous, and constantly redefined power relationships between various levels of government and stakeholders (See Figure 4-14).

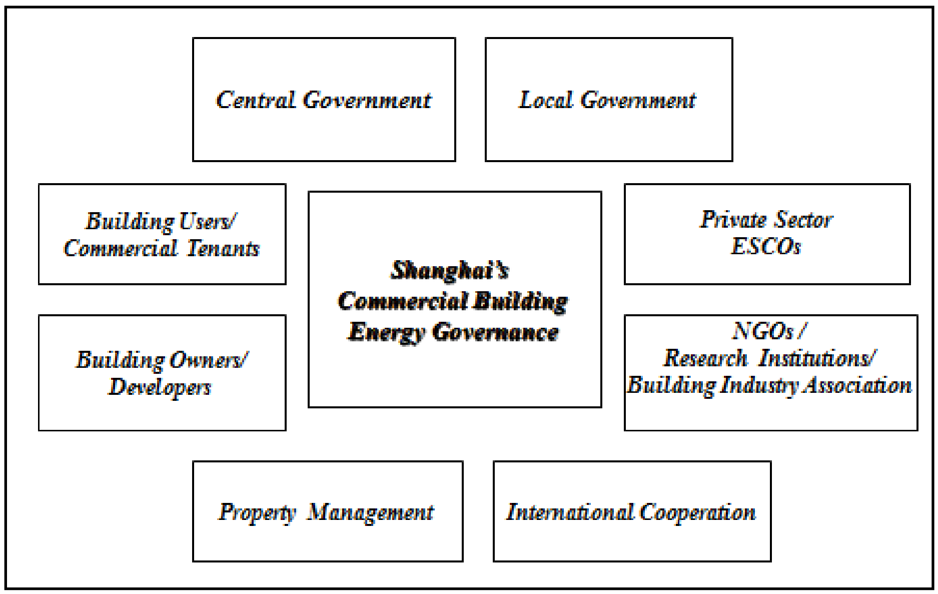

Figure 4-14: Relevant Stakeholders Analysis

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[39] Although mayors are appointed to five-year terms, many hold their posts an average of just 30 months before moving on to the next assignment (Landry, 2008; Hammer, 2009). This constant shift in mayors makes it difficult to sustain momentum on complex planning initiatives. It also forces mayors to focus on short-term victories, emphasizing progress on pressing daily challenges rather than strategies with a longer time horizon.

In terms of regulatory and control policy instruments, the SMG followed the MOHURD's guidelines and initiated the same or more ambitious targets for its building energy policies and regulations. In 2007, the SMG, as part of the Implementation Plan for Energy Conservation and Emission Reduction, committed to a binding energy saving standard for new buildings. The standard called for a 50 percent reduction in the energy used by new commercial buildings; this standard would gradually be raised to a higher standard of 65 percent. New construction failing to meet the standard would not receive a construction permit. In addition, the guide published by the Shanghai Energy-Efficient Building Design Standards requires contractors to use energy-efficient materials and to adopt energy saving technologies for heating, cooling, ventilating, and lighting public buildings.

Moreover, the SMG issued the Administration Procedures of Shanghai Municipality on Building Energy Conservation (Shanghai Procedures) to strengthen the administration of building energy conservation and to foster the use of energy efficient materials for buildings. The Shanghai Procedures issued mandatory energy conservation standards to be met in all stages of building construction, from design to supervision. The promotion of strengthened supervision and administration by municipal and district administrative departments of construction by the Shanghai Procedures demonstrates that Shanghai has sought to establish an energy efficiency supervision system for government office buildings and large public buildings (APERC, 2009). The newly released Regulation of Shanghai Building Energy

Conservation, put into effect in 2011, includes the most comprehensive energy policies for the building sector in Shanghai.

In terms of economic and market-based policy instruments, in 2008 Shanghai launched its own marketplace for environmentally-related financial products. The exchange initiates domestic trading schemes related to pollution discharge rights, starting with sulfur dioxide and chemical oxygen demand. The exchange hopes to soon expand to include carbon dioxide under a voluntary trading scheme in a pilot phase targeting the building sector. Further developments are likely under the 12th Five-Year Plan (World Energy Council, 2010). Moreover, the SMG has provided funding and subsidies for the development and application of renewable energy projects and energy efficiency technologies for buildings. For example, in Shanghai's Energy White Paper, the SMG financed building projects to install solar utilization facilitates (UNEP, 2010).

However, there remain limited commercial building energy regulatory/control instruments and market-based incentives, and the SMG has adopted many support/information/voluntary action building energy instruments. The SMG has proposed building energy efficiency and green building strategies for in the 12th Five-Year Plan. Building energy consumption should be controlled to under 8,000,000 tce. Average building energy consumption (per square meter of floor area) of commercial buildings should decrease from 10 percent to 8 percent. Besides that, the plan includes the following actions:

- Set up higher energy efficiency standards for new construction
- Complete energy retrofitting in existing buildings (of at least 40,000,000 square meters)
- Establish building energy supervision systems for large-scale buildings to realize better energy management
- Apply solar collectors and panels to buildings (of at least 600,000 square meters at a 25 MV capacity)
- Apply solar shading systems to buildings
- Green building demonstrations (for buildings of 3,000,000 square meters)

In order to achieve the quota control of building energy consumption, the SMG has attempted to set up its data center of building energy consumption as a building energy consumption evaluation standard and monitoring mechanism. Moreover, large-scale commercial buildings are required to install sub-metering systems for rational energy use. In order to facilitate the promotion of building energy efficiency, Shanghai was the first city in China to launch a green standard of construction measured by energy consumption per square meter according to the assessment of green building energy efficiency standards. This standard also grades buildings from one to five stars and on the application of renewable energy. Shanghai also initiated the Garden Lane Project, an urban renewal project based on energy efficiency building principles. Eighteen older factory buildings in the area were renovated with efficiency standards pursuant to the LEED international green architecture standards and the Chinese 3A

Green Building Efficiency Standard. The SMG also proposed a Green Lighting project for reducing electricity consumption by lighting in commercial buildings.

In terms of renewable energy applications, the Shanghai Green Electricity Scheme offers electricity consumers in Shanghai the opportunity to "green" their usage by buying some amount of renewable electricity. Moreover, the SMG organized its Action Plan for Solar Energy Development and Application 2005-2007 to build a solar power generation plant with a five-megawatt capacity and a photovoltaic cell manufacturing capacity of 150-200 megawatts; to the plan also adopts solar heating systems in buildings over 100,000 square meters Shanghai's 88-story skyscraper landmark, the JinMao building, aims to apply 20 percent of its total energy consumption from renewable energy.

The SMG also implemented measures to make the public aware of the problems of energy efficiency and energy conservation. The Shanghai Energy Conservation Supervision Center (SECSC), which is the first non-profit energy conservation administrative organization in China and is affiliated with the Shanghai Economic Commission, took an active part in the dissemination of energy conservation information. The SECSC also does case studies, technological consultation and energy conservation popularization and training. Shanghai was a pioneer in this public education process (Ruet et al., 2010).

4.4 Summary

This chapter discusses relevant commercial building energy policy instruments in China and Shanghai. China has established a set of policy instruments for commercial building energy saving since 1993. China's current building energy efficient certification system adopts five levels and is compulsory for all large-scale buildings or buildings reliant upon public funds for their construction. Despite the great potential and low cost of achieving significant energy efficiency in the building sector, little progress in this sector has occurred in China until recently (Jin and Rui, 2008). According to the Lawrence Berkeley National Laboratory, around 100 percent of new buildings are complying with the energy efficiency standards in the design phase and around 80 percent of new buildings are compliant after built-up. However, it is more challenging to meet the 50 percent energy reduction standard for existing buildings (LBNL, 2009). Moreover, in order to stimulate the domestic economy and increase the role of the market economy in improving building energy efficiency, the central government has also adopted a variety of fiscal incentives, tax rebates and subsidy programs to promote the commercialization of building energy saving. In terms of support and voluntary instruments, the central government has set up a non-compulsory labeling system for evaluating green buildings and efficient appliances. Some successful green building demonstrations are initiated by the central government as well.

Shanghai also has strong building energy saving policies. While the SMG has offered fewer control and regulatory building energy policy instruments, the recently passed and implemented Regulation of Shanghai for Building Energy Conservation reveals that the local authority has paid close attention to this pressing issue and has started to take mandatory action. The SMG also took the lead on the clean development mechanism for the building sector. Moreover, many support and voluntary plans as well as demonstrations relate to building energy governance in Shanghai. Recently, the SMG proposed different evaluation standards and incentives for the building sector to reduce energy consumption. Shanghai's building evaluation standard prioritizes considerations not only for the actual energy reduction amount but also for the social benefits regarding the demonstration/diffusive effects from the building's energy saving initiatives.

Table 4-11: Commercial Building Energy Policy Instruments in Shanghai

Regulatory & Control Instruments		China	Shanghai
Appliance Energy Efficiency Standards	• Energy Conservation Design Standard for Building Envelope and Air Conditioning in Tourist Hotels, 1993	●	
	• Management Method of National Supervision and Random Inspection of Product Quality	●	
	• Standard for Lighting Design in Buildings	●	
Building Energy Codes	• Energy Conservation Design Standard for Building Envelope and Air Conditioning in Tourist Hotels, 1993	●	
	• Energy Conservation Law, 1997	●	
	• Design Standard for Energy Efficiency in Public Buildings, 2005	●	
	• Code for Acceptance of Energy Efficient Building Construction, 2007	●	
	• Energy Conservation Law Amendment, 2007	●	
	• Standardization Law	●	
	• Regulation on Energy Conservation in Civil Buildings, 2008	●	
	• Regulation on Energy Conservation in Public Institutions, 2008	●	

Table 4-11 Continued

Regulatory & Control Instruments		China	Shanghai
Building Energy Codes	• Civil Building Energy Conservation Ordinance, 2008	●	
	• Design Standard for Energy Conservation in Civil Buildings	●	
	• Guidance to the Development of Energy and Land-efficient Residential Building and Public Buildings	●	
	• Ordinance for Energy Conservation in Public Institutions	●	
	• An energy-saving regulatory system for state organ office buildings and large public buildings	●	
	• Regulations of the Shanghai Municipality on Energy Conservation		●
	• Regulation of the Shanghai Building Energy Conservation		●
	• Design Standards of the Shanghai Municipality for Energy Saving in the Renovation of Existing Buildings		●
	• Shanghai Energy-efficient Building Design Standards (under draft)		●
	• Procedures of the Shanghai Municipality on the Administration of Building Energy Conservation		●

Table 4-11 Continued

Regulatory & Control Instruments		**China**	**Shanghai**
Procurement Regulations	• Energy Efficiency Labels with Government Procurement Policies	●	
Mandatory Certification and Labeling	• Management Method of Energy Conservation Product Certification	●	
Economic/Market-based/Fiscal Incentives		**China**	**Shanghai**
Energy Performance Contracting/ESCO Support	• Development of Energy Service Companies (ESCOs)/Energy Management Contracting (EMC)/ Energy Performance Contracting	●	
	• Energy Performance Certificates	●	
Kyoto Flexibility Mechanisms	• Energy Saving Trading Market	●	
	• Clean Development Mechanism for the Building Sector		●
Tax Incentives	• Corporation Income Tax Law, 2007	●	
	• Tax deductions	●	
Rebates/Subsidies/Grants	• Government subsidies	●	
	• Subsidies for demonstration projects of solar PV application in buildings	●	
	• Procedures of the Shanghai Municipality on the Administration of Special Funds for Energy Conservation and Emission Reduction		●

Table 4-11 Continued

Economic/Market-based/Fiscal Incentives		China	Shanghai
Rebates/Subsidies/Grants	• Shanghai government funding/subsidies for the development of networking equipment for renewable energy		●
	• Energy Efficiency Special Fund		●
Green Electricity Certification System	• Shanghai Green Electricity Scheme		●
Support/Information/Voluntary Action		**China**	**Shanghai**
Voluntary Certification & Labeling Programs	• Logo Identification for Building Energy Efficiency Assessment	●	
	• Promotion of Energy Efficient Lighting Products	●	
	• Green Building Rating Systems/Green Building Certificate Institution/Green Building Evaluation Standard, 2006	●	
	• Green Building Evaluation Labeling, 2008	●	
	• Green Olympic Building Assessment System (GOBAS)	●	
	• Green Energy Efficient Building Standards		●
	• Shanghai Green Lighting		●
Audits & Energy Use Reports	• Supervision and Inspection of Building Energy Conservation and Emission Reduction	●	

Table 4-11 Continued

Support/Information/Voluntary Action		China	Shanghai
Audits & Energy Use Reports	• Information Statistics Reporting System for Civil Building Energy Consumption and Conservation	●	
	• Guidance on Energy Audits for Governmental Buildings and Large-scale Public Buildings	●	
	• Energy Conservation Management in Government Office Buildings and Large-scale Public Buildings	●	
	• Energy Efficiency Supervision (EES) Programs	●	
Local Energy Efficiency Information Centers	• Management and Technical Guidance for Energy-efficient Campuses in Universities and Colleges	●	
Public Leadership Programs	• Notice on Effectively Strengthening Energy Conservation Management Work in Government Offices and Large Public Buildings, 2010	●	
Awareness Raising/Education/Information Campaign	• The Notice of Implementation Plan for Thousands of Companies Energy Conservation Action	●	
	• Shanghai Building Energy Saving Outline in the 10th Five-Year Plan		●
	• Shanghai Building Energy Saving Measures Management and Recognition		●

Table 4-11 Continued

Support/Information/Voluntary Action		China	Shanghai
Awareness Raising/Education/Information Campaign	• Shanghai Building Energy Management Approach		●
	• The 11th Five-Year Plan of the Shanghai Municipality for Environmental Protection and Eco-Construction		●
	• The 11th Five-Year Plan of the Shanghai Municipality for Energy Sources Development		●
	• The 11th Five-Year Plan of the Shanghai Municipality for Saving Energy		●
	• Implementation Plan for Energy Conservation and Emission Reduction in Shanghai		●
	• The Suggestion for Further Strengthening the Energy Conservation Work in Shanghai		●
Disclosure Program	• Energy Performance Disclosure Approach	●	
	• Schemes and Methods for Energy Saving Calculation Monitoring and Evaluation		●
Research & Development	• Management and Technical Guidance for Energy-efficient Campuses in Universities and Colleges	●	

Table 4-11 Continued

Support/Information/Voluntary Action		China	Shanghai
Demonstration Project	• Demonstration Buildings in China	●	
	• National Green Building Innovation Awards (China)	●	
	• Green Building Demonstration Projects, 2007 (China)	●	
	• Garden Lane (Shanghai)		●
	• Azia Center Green Building Demonstration (Shanghai)		●
	• Chongming Island – Low Carbon Eco-Practice Area (Shanghai)		●
	• Lingang New City – Low Carbon Development Practice Area (Shanghai)		●
	• Hongqiao Hub – Low Carbon Business Practice Area (Shanghai)		●
	• Key Work Arrangement for Energy Saving, Carbon Reducing, and Climate Change in Shanghai		●
	• Action Plan for Solar Energy Development and Application between 2005-2007 (Shanghai)		●

Chapter 5

COMMERCIAL BUILDING ENERGY GOVERNANCE IN SHANGHAI: THE IKEA XUHUI STORE AND PLAZA 66

The chapter provides a preliminary evaluation of Shanghai's commercial building practices according to data availability. Two commercial buildings are selected to further evaluate Shanghai's existing building energy practices. The IKEA Xuhui store and Plaza 66 are classified as the most significant large-scale retrofitting cases in Shanghai with advanced energy efficient technologies and innovative building energy management. Detailed building energy saving, CO_2 reduction, and management cost reduction based on data availability and calculation are presented with the co-benefits approach. This chapter also analyzes policy interventions and factors that facilitate or constrain the implementation process in each case building.

5.1 Case Selection

More than 80 percent of total building energy consumption takes place during the operation and maintenance stages of the life cycles of buildings. In addition, existing large-scale commercial buildings become key issues in major global cities' building energy governance. Major policy instruments adopted by New York, London, and Tokyo discussed in Chapter Three are focused on large-scale commercial buildings. Thus, how to retrofit existing buildings becomes crucial in an existing urban energy policy agenda. The SMG has been aware the potential urban energy crisis and has initiated relevant policies.

This section presents two commercial building sites, the IKEA Xuhui store and Plaza 66, along with relevant energy efficiency technology applications and building energy management measures. The IKEA Xuhui store's area is 35,000 square meters with one shopping center and a self-use office building, while Plaza 66 is 327,000 square meters with one shopping mall and two multi-tenant office buildings. Although both cases are classified as China's large-scale commercial buildings, they represent different building structures and energy management measures for further examining Shanghai's building energy practices. The two buildings also fit the dynamics of building energy governance framework proposed by the research to further assess Shanghai's building energy policies and practices.

5.2 IKEA Xuhui Store

The IKEA Group, based in the Netherlands, is identified as a leading international furniture and home products retailer owned by the Stichting INGKA Foundation and controlled by the INGKA Holding B.V. There are two IKEA shopping malls in Shanghai: the Xuhui store and the Beicai store. Being the first IKEA store in China, the Xuhui store was opened in 1998, while the Beicai store has been operating since July 2011. Therefore, the dissertation selects the Xuhui store as the case study. The total floor area of this store is 35,000 square meters, and includes a retail store with furniture and home products, a Swedish food restaurant and an office building for IKEA interior departments. Influenced by its Dutch owner, the Stichting INGKA Foundation, the Shanghai IKEA store has not only inherited the corporation's green and sustainable values, but has also developed its building energy practices as led by its interior energy management team instead of exterior property management companies[40] (see Figure 5-1).

Location: Xu-Hui District

Function: Retail Store

Area: 35,000 m^2

Owner: Stichting INGKA Foundation (Netherlands)

Energy management: Interior Energy Manager

Figure 5-1: Profile of Shanghai IKEA

Below are relevant building energy saving measures adopted by Shanghai IKEA:

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40 In China's building industry, some buildings are managed by exterior property management companies in charge of maintaining facilities and energy management. Property management companies have been evolving for over 20 years in China. They play important roles in China's building energy performance.

1. Corporate Values

The IKEA group values the relationship between humans and the environment and has pushed for sustainability and energy reduction as IKEA's pivotal and long-term corporate culture (Weng, 2011; See Figure 5-2). IKEA believes investments in more sustainable energy solutions often represent significant cost savings and relatively short payback periods (IKEA, 2012). Moreover, according to IKEA's Sustainability Direction, all IKEA stores must significantly reduce CO_2 emissions from their operations by being innovative, energy efficient and using more renewable energy. It is required to develop reduction goals for energy consumption and CO_2 emissions for their stores, distribution centers and factories (IKEA, 2012).

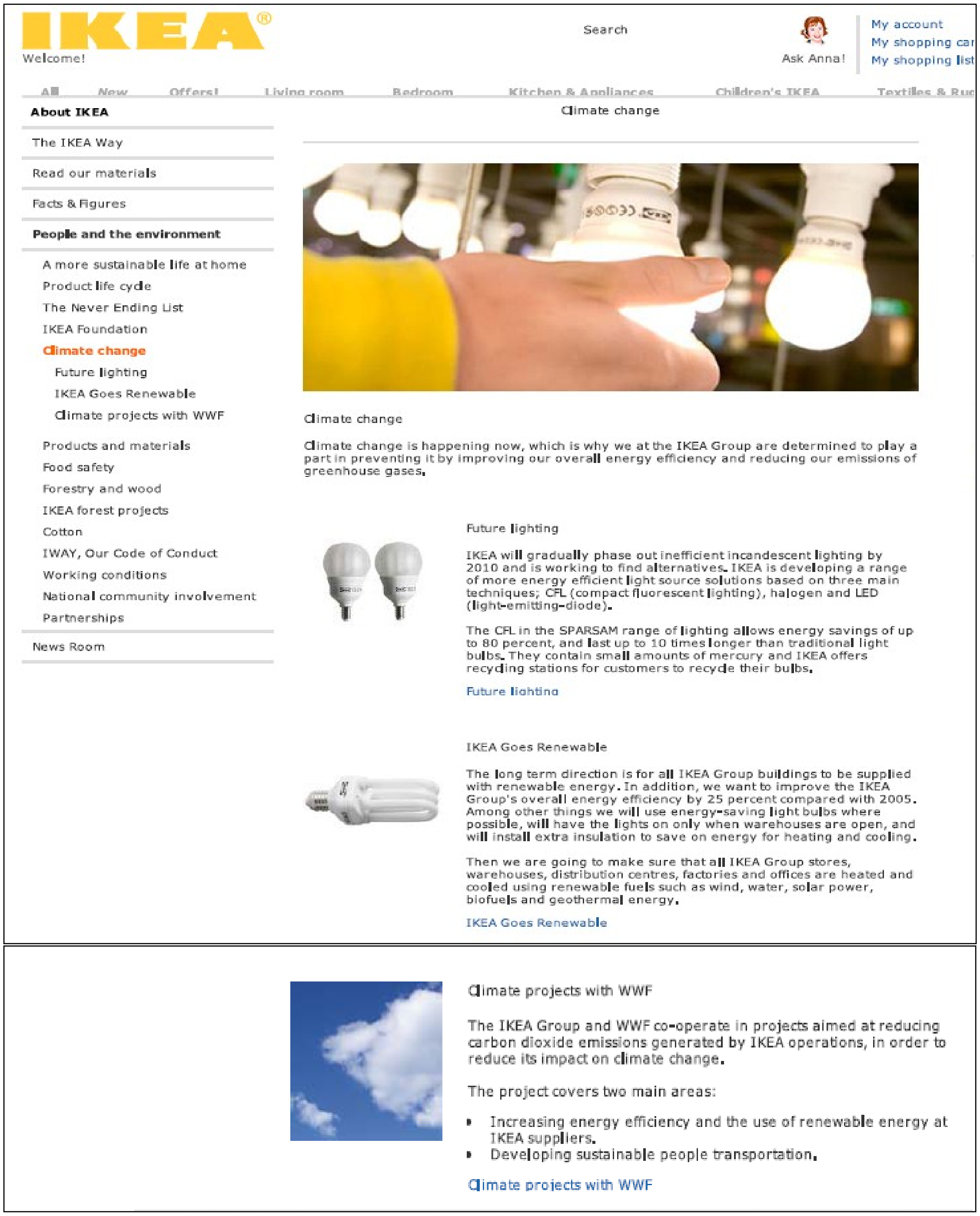

Figure 5-2: Web Info on IKEA's Sustainable Corporate Value

2. IKEA Goes Renewable (IGR) Program

IKEA has launched the IKEA Goes Renewable (IGR) program, which is mainly focused on reducing energy consumption and CO_2 emissions from IKEA buildings through enhancing energy efficiency by 25 percent compared to the 2005 level. The long-term goal is to operate 100 percent on renewable energy instead of fossil fuels in IKEA's buildings (Evans, 2009).

3. Energy Consumption Database (Webess)

IKEA follows a mandatory energy usage checklist introduced by its headquarters in 2006 to raise awareness of current energy use, to monitor work, and to enable internal energy audits to be conducted. The checklist, also known as Webess, makes it easier to compare energy usage among global IKEA buildings, exchange experiences and follow up on a regular basis (Evans, 2009). Webess is an IT application used by IKEA buildings for reporting energy consumption and emissions, and for benchmarking with other IKEA buildings. Webess records electricity, fuel/oil, gas, water and other types of energy consumption. It also provides information about how much renewable energy is used per cubic meter, as well as the level of CO_2 emissions caused by building operations. Electricity and heating costs are entered by the facility manager at each store, and comparisons are made over a three-year period. Store and facility managers review the information each month and discuss at store meetings. The goal is to gain an overview on the regional level by examining IKEA buildings in a specific country and on the global level by comparing results of current consumption levels, challenges and possible improvements across IKEA buildings worldwide. A third-party European company, Vitech, runs the program for IKEA stores around the world.

4. IKEA Building Standards

IKEA has developed a building standards document for renewable energy use and energy reduction in IKEA buildings. The aim of the building standards is to establish construction methods for new IKEA buildings that run solely on renewable energy. In addition, the standards document offers suggestions on how to replace traditional heating and cooling equipment with equipment adapted to renewable energy requirements for existing buildings (Evans, 2009). These standards are continuously updated (IKEA, 2012).

5. Energy Efficient Technology

To reduce energy consumption, Shanghai IKEA uses natural light whenever possible and turns off lights during non-business hours. The energy management team has replaced traditional lighting with energy efficient lighting in the shopping mall and the office building. Moreover, the office building has installed solar shading to control heat and light admitted to the building. It can cut the amount of energy required for lighting and reduce the need for heating or air-conditioning. From 2009-2010, Shanghai IKEA initiated several retrofitting projects to enhance building energy efficiency, including lighting, air-conditioning, and escalators. Table 5-1 represents project details, relevant energy reductions and CO_2 emission reductions. Figure 5-3 presents some ongoing retrofitting projects in the Shanghai IKEA Xuhui buildings.

Table 5-1: Co-Benefits Calculations (2009-2010)

Retrofitted Projects	Energy Reduction Benefit (MWh)	CO_2 Emission Reduction Benefit (tCO_2)
179 Metal Halide Lamp (400W) →Promise Light (200 W)	300	264.75
79 Metal Halide Lamp (250 W) →Promise Light (150 W)	38	33.54
2900 HID Spot Lights (20W) → Halogen Spot Lights (30W & 50W)	424	374.18
5 Escalator VVVF	196	172.97
Central Solar Hot Water Module on Roof (17→40 ton/day)	170	150.03
4 HCU and ERV for HVAC System	60	52.95
Split Circuit for Lamp Wiring	8	7.06
Improve Natural Ventilation	100	88.25
Lighting Retrofitting at Parking Lot	488	430.66
Light Control and Infrared Motion Sensor Switch for Lighting Retrofitting	11	9.71
Total	**1657**	**1462.30**

Source: Weng, 2011

Figure 5-3: Retrofitting Projects in Shanghai IKEA

Source: Weng, 2011

Upper left: The sub-metering system installed in the Shanghai IKEA buildings, which is supported by the SMG and Xu-Hui District government's policies and subsidies
Lower left: Shanghai IKEA has replaced traditional lighting with energy efficient lights
Upper right: Solar hot water module on the rooftop of the shopping center
Lower right: Solar shading of the office building

6. Renewable Energy Application

The IKEA group has decided to install solar panels to turn sunlight into electricity in around 150 stores and distribution centers over the next few years (IKEA, 2012). The panels are expected to provide these buildings with 10-25 percent of their electricity needs (Evans, 2009). To achieve this goal, Shanghai IKEA has installed a central solar hot water module on the rooftop for dishwashing in the restaurant and employees' bathing needs (Weng, 2011).

7. Internal Training and Education

The energy management team has regularly held internal staff training and environmental education sessions to raise employees' energy saving awareness. In addition, the IKEA Retail China Energy Efficiency Rewarding Program is an interior incentive that can promote each store's energy efficiency. Through this program, relevant energy efficiency improvement is recognized among all stores in China. The energy management team of each store is stimulated to invent more energy management measures. The program also provides an exchange platform of best practices and innovative strategies among different stores.

8. Government Relationships

Shanghai IKEA has a close relationship with the Xuhui District's government on energy and environmental policies. In terms of building energy saving, Shanghai IKEA has applied for relevant funding from the district government and the SMG for the store's retrofitting projects. In addition, Shanghai IKEA has been selected as a demonstration project to apply new policies and energy efficient technologies, such as sub-meter installment.

9. Engagement with NGOs and Local Community

Shanghai IKEA has cooperated with the World Wildlife Foundation's (WWF) low carbon projects to tackle climate change. For example, IKEA and the WWF run joint pilot projects with suppliers to support energy efficiency and encourage the use of renewable energy to reduce CO_2 emissions (IKEA, 2012). IKEA also strives to offer products and know-how that enable its customers to live a more sustainable life by saving energy and water and minimizing waste. Shanghai has made significant efforts on promotion of energy saving and low carbon value and action, and Shanghai IKEA has been actively engaging the efforts to support low carbon sustainability in the local community. Some events have been initiated by IKEA for raising environmental awareness in local schools, district centers, and youth centers. For example, Shanghai IKEA supports the WWF's annual Earth Hour, which promotes environmental awareness. Environmental protection and energy saving campaigns and advertisements have been undertaken in the store for encouraging more public engagement with IKEA (Jiang, 2012).

Through implementing these energy saving measures, Shanghai IKEA's energy consumption has decreased steadily.[41] The total energy consumption in the IKEA Xuhui store in 2011 was reduced by 3.2 percent, and the annual energy use has been reduced by 1.5 percent between 2004 and 2011(See Figure 5-4; Jiang, 2012).

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[41] In 2008, the energy use increased by 8 percent compared to the previous level because the store had increased its retail area by 2,000 m^2 between 2007 and 2008 (Jiang, 2012).

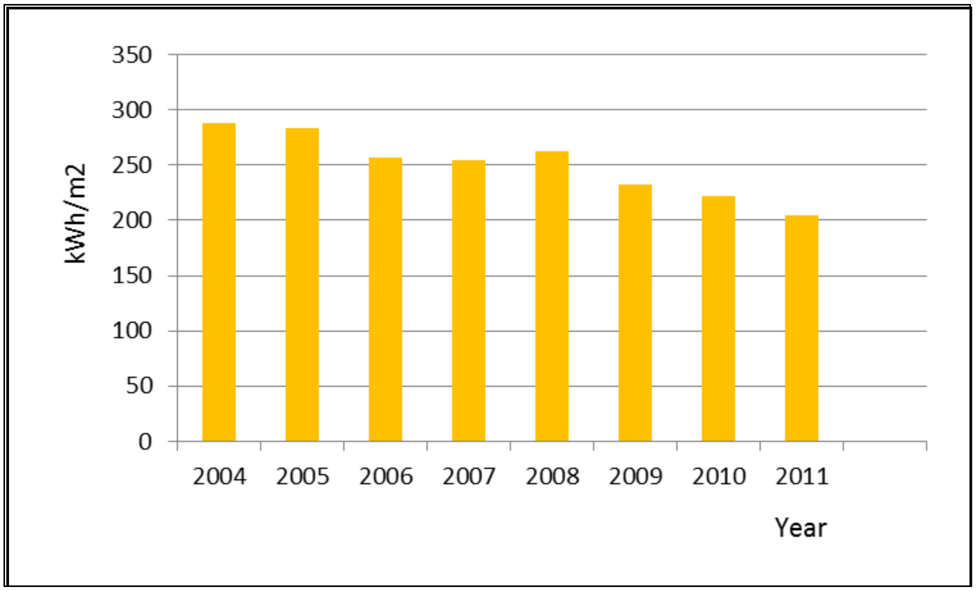

Figure 5-4: Energy Consumption in Shanghai IKEA (2004 -2011)

Source: Jiang, 2012; Weng 2011

Moreover, Shanghai IKEA's the total energy use per cubic meter of sold products in stores has also improved. Shanghai IKEA's energy efficiency has improved from 99 kWh/m^3 per sold product to 45 kWh/m^3 per sold product from 2004-2009. The growth rate of Shanghai IKEA's energy efficiency accordingly has increased from 16 percent to 33 percent (see Table 5-2).

Table 5-2: Shanghai IKEA's Energy Efficiency

Year	04	05	06	07	08	09
Electricity Consumption (10,000 kWh)	953	882	851	839	817	800
Energy Efficiency (kWh/m^3 sold)	99	67	60	54	49	45
Growth Rate of Energy Efficiency (Base year: 2005)			16%	19%	27%	33%

Source: Weng, 2011

5.3 Plaza 66

Located in the Jing-An District, the total floor area of Shanghai's Plaza 66 is 327,000 square meters, consisting of a shopping mall and two office buildings. The shopping mall has five levels with a total area of over 50,000 square meters, tower one has 66 levels and tower two has 48 levels. Thetotal area of the shopping mall is 260,000 square meters. In addition, tower one is regarded as the fifth-tallest skyscraper in Shanghai. Plaza 66 is owned and developed by Hang Lung Properties, a company based in Hong Kong. The group has built a high reputation as a top tier property developer in Hong Kong and for building, owning and managing world-class commercial complexes in key cities on the mainland. The group took its first steps into the mainland in Shanghai in 1992 with two landmark properties, Plaza 66 and Grand Gateway 66. Hang Lung's interior property management team is in charge of maintaining relevant building energy systems and improving building energy performance for Plaza 66 (see Figure 5-5).

Location: Jing-An District

Function: Shopping Mall/ Office Building

Area: 327,000 m^2

Developer: Hang Lung Properties (Hong Kong)

Energy management: Interior Energy Management

Figure 5-5: Profile of Shanghai's Plaza 66

Relevant building energy saving measures in Plaza 66 are as follows:

1. Corporate Values

Hang Lung aims to build low-carbon and sustainable buildings (See Figure 5-6). Senior management is actively engaged in determining and implementing corporate strategies for sustainable development. An Environmental Project Team (EPT) consisting of 40 cross-departmental representatives is set up to engage staff at different levels in environmental and energy efforts, including building energy efficiency (Hang Lung Property, 2009).

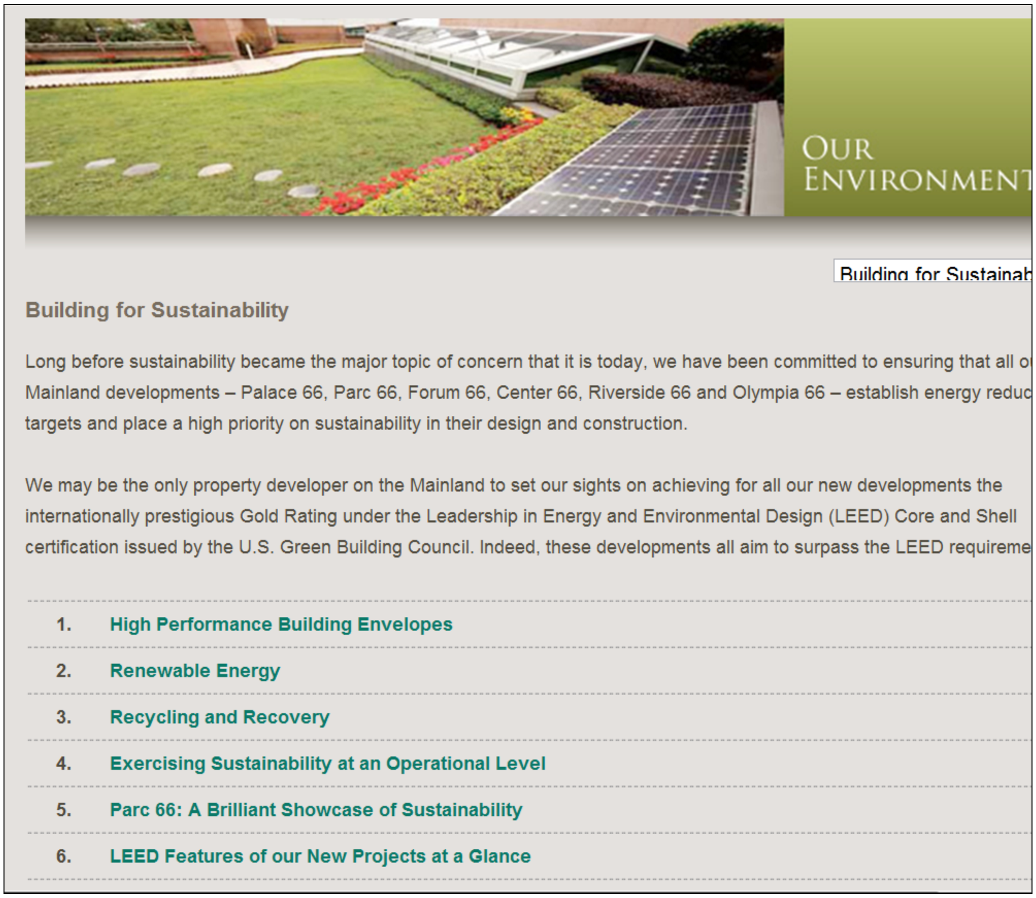

Figure 5-6: Web Info on Hang Lung Property's Sustainable Corporate Value

2. Energy Auditing & Monitoring System

Plaza 66 has invited a local research institution, the University of Shanghai for Science and Technology, to conduct a comprehensive energy audit report. Relevant analysis ensures Plaza 66's sustainable development and helps to formulate an action plan to further reduce its carbon footprint (Hang Lung Property, 2009). In addition, the Hang Lung group has set up guidelines and monitoring systems to promote using at least 20 percent recycled materials. Moreover, the target extends to the use of at least 20 percent locally produced materials in the construction process (Liu, 2011).

3. Energy Efficient Technology and Management

In order to lower management costs and reduce carbon emissions, Plaza 66 has developed several energy saving initiatives (see Table 5-3). These programs include the use of energy efficient lighting as well as the replacement of air-conditioning systems with more efficient water-cooled versions. Plaza 66 also maintains indoor temperatures of the shopping mall within a range of 23 to 23.5 degrees Celsius, with office buildings between 25 to 25.5 degrees Celsius. Figure 5-7 presents some energy saving initiatives in Plaza 66 in 2008 (Liu, 2011).

Table 5-3: Co-Benefits Calculations

Retrofitted Projects	Energy Reduction Benefit (kWh)	CO_2 Emission Reduction Benefit (kg)
Add Frequency Conversion of Chillers	765,336-803,023	535,735.2-562,116.1
Retrofitting Electric Heating System → Gas Boiler During Winter	1,083,184	758,228.9
Adjusting Frequency Conversion of Cooling Water Pumps	738,000-1,266,000	516,600-886,200
Regulate Water Flow	208,728	146,109.6
Retrofitting Lighting	3,321,000	2,324,700

Table 5-3 Continued

Retrofitted Projects	Energy Reduction Benefit (kWh)	CO_2 Emission Reduction Benefit (kg)
Improving VMC System and Surrounding Condition of Chiller Cooling Tower	1,232,673	862,871.3
Total	**6,441,387-7,007,073 kWh**	**4,508,971- 4,904,951 kg**

Source: Liu, 2011

Figure 5-7: Retrofitting Projects in Shanghai's Plaza 66

Source: Liu, 2011; Hang Lung Property, 2009

Upper left: Plaza 66 increased indoor green space for the Green is All Around campaign
Lower left: Plaza 66 has replaced traditional lighting with energy efficient lights in office buildings
Upper right: Plaza 66 has replaced traditional lighting with energy efficient lights in the shopping mall
Lower right: The Energy Saving Competition in Hang Lung Property

4. International Benchmarks and Certification

Hang Lung Property seeks a gold rating under the LEED core and shell certification issued by the U.S. Green Building Council for all developments.

5. The Green is All Around Campaign

Plaza 66 is one of the corporate buildings participating in the Green is All Around campaign, which aims at improving internal air quality while also providing tenants and shoppers with more pleasant and healthy surroundings. All buildings developed by the Hang Lung Property group are involved in this campaign. Plaza 66 allocates at least 17 percent of its area to the development of green spaces (Hang Lung Property, 2009).

6. Staff Awareness Raising

Hang Lung Property launched their internal Energy Saving Competition to promote sustainability and to look for innovative energy saving ideas among staff. Moreover, relevant and ongoing training is provided for all staff to equip them with the latest information and expertise and to build awareness of energy saving (Hang Lung Property, 2009).

7. Government Relationships

Hang Lung Property maintains ongoing dialogues with Chinese provincial, municipal, and district governments to enhance understanding in local regulations. Plaza 66 has applied for relevant funding from the Jing-An District's government and the SMG. In addition, the SMG has selected Plaza 66 as a demonstration project to apply new policies and energy efficient technologies. Plaza 66's sustainable practices have received an award from the Shanghai Municipal Commission of Economy and Informatization for being the "Leading Project in the Advancement of Energy Saving Technologies in Shanghai." Moreover, Plaza 66 has won the Outstanding Shopping Environment Award (2008) and has made the list of Top 100 Office Buildings in China. Plaza 66 serves as an example for other commercial buildings in Shanghai (Hang Lung Property, 2009).

8. Engagement with Environmental NGOs and Climate Change Initiatives

Hang Lung Property works with relevant organizations such as the WWF and the Jane Goodall Institute through sponsorships of sustainability projects. The Hang Lung group organizes and participates in a range of community events through a corporate sustainability program. Since 2009, the group signed the Copenhagen, Cancun and Durban Communiqués, a global initiative aimed at reaching a credible deal at the United Nations Climate Change Conference. The group is a major patron of the Climate Change Business Forum in Hong Kong. Moreover, as one of Hong Kong's Carbon Audit • Green Partners under the Hong Kong Government Environmental

Protection Department's Carbon Reduction Charter, the group has pledged to implement measures to reduce greenhouse gas emissions (Hang Lung Property, 2009).

As one of Shanghai's leading commercial landmarks, Plaza 66 is managed with sustainable building practices to optimize its resources and facilities while maximizing energy saving and CO_2 reduction. Table 5-4 indicates CO_2 emission reduction from 2005-2009. The property management team has focused on the issue of growing energy cost since 2006. For example, several retrofitting projects were undertaken in 2007 and relevant CO_2 emissions dropped from 170.03kg/m^2 to 135.38kg/m^2. Although CO_2 emissions have risen 5.1 percent due to the full space rental and the increase of the size and function of the shopping mall in 2008, Plaza 66 has continued making efforts in energy efficiency retrofitting to mitigate carbon emissions. The number dropped by 3.2 percent in 2009 as a result.

Table 5-4: CO_2 Emission Reductions in Plaza 66 (2005-2009)

Year	Building Area m^2	CO_2 kg/m^2	Emission Change %	Note
2005	200,000	161.83	-	Baseline
2006	200,000	170.03	+5.1%	
2007	310,000	135.38	-20.4%	* Retrofitting projects began this year
2008	310,000	142.23	+5.1%	* All stores at the shopping mall were fully rented this year; area of business function increased

Table 5-4 Continued

Year	Building Area m^2	CO_2 kg/m^2	Emission Change %	Note
2009	313,500	137.70	-3.2%	* Change of Building Function in 2009 changed the parking lot in the basement into stores. Business area increased, but efforts have continued for energy efficiency retrofitting work to mitigate carbon emissions

Source: Liu, 2011

5.4 Evaluation with the Co-Benefits Approach

Following the introduction of Shanghai IKEA and Plaza 66 building energy practices, this section provides a case analysis with the co-benefits approach according to data availability. Along with the actual co-benefits calculation, potential co-benefits are discussed as well. Moreover, relevant intervention and policy drivers and actors for the implementation process are discussed.

The co-benefits approach is emerging in sustainable development as a means to achieving more than one outcome with a single policy (UNU-IAS, 2011). The co-benefits approach refers to the development and implementation of policies which simultaneously pursue incorporation of both global climate and local environmental concerns into the development process. In terms of the building sector, local climate change mitigation through building energy efficiency can not only reduce energy use and CO_2 emissions, but may also improve local and regional air quality, particularly in large cities. Beyond the general synergies between improved air quality and climate change mitigation, improving building energy efficiency can further improve economic efficiency through increased productivity and retail sales (WBCSD, 2007). Moreover, enhanced building energy efficiency can reduce local governments' energy consumption as well as energy bills for residents and firms. Such benefits can be a good incentive to retain business and development in a particular locale. Improving end-use energy efficiency is also among the top priorities for increasing energy security (European Commission, 2005). Therefore, additional co-benefits of improved building energy efficiency and building-integrated distributed electricity generation include improved energy security and system reliability (IEA, 2004; WBCSD, 2007). Along with the above benefits, building energy efficiency and renewable energy technologies can substantially improve indoor air quality, contributing to public health.

5.4.1 Co-Benefits Calculation

In terms of energy reduction benefits and CO_2 emissions reduction benefits, Shanghai IKEA adopted several retrofitting projects from 2009 to 2010. Most of these projects are related to lighting, including energy efficient lighting replacement (promise lights and halogen lights) and lighting control systems. Lighting retrofitting projects are responsible for more than 75 percent of total reduction benefits (1,261,000 kWh in energy reduction and 1,113,000 kg in CO_2 emission reductions, respectively). In addition, escalator retrofitting and solar hot water module installment on the rooftop also contributed a 366,000 kWh energy reduction and a 323,000 kg CO_2 emission reduction. Overall, total retrofitting projects contributed to an energy reduction benefit of 1,657,000 kWh and a CO_2 emission reduction benefit of 1,462,300 kg, which are beneficial to local air quality and climate change mitigation. Moreover, in terms of economic benefit, relevant management costs savings were 1,022,369 RMB (see Table 5-5).

Table 5-5: Actual Co-Benefits from Case Buildings

Co-Benefits Effects	**Economic Benefit**	**Energy Reduction Benefit**	**GHG Reduction Benefit**
	Management Cost Reduction (RMB)	Energy Reduction (kWh)	CO_2 Reduction (kg)
Shanghai IKEA	1,022,369	1,657,000	1,462,300
Plaza 66	3,974,336~ 4,323,364	6,441,387~ 7,007,073	4,508,971~ 4,904,951

As for potential co-benefits, according to Shanghai IKEA's interior data, electricity consumption dropped from 9,530 MWh to 8,000 MWh. In terms of economic benefit, total energy use per sold cubic meter in Shanghai IKEA dropped from 99 kWh/m^3 to 45 kWh/m^3. This evaluation indicator, designed for measuring energy efficiency in each IKEA store, also presents Shanghai IKEA's enhanced productivity and retail sales. Furthermore, Shanghai IKEA has continuously improved end-use energy efficiency through energy efficient technologies and energy management mechanisms, which could contribute to energy security benefits in the long run. Building energy efficiency and renewable energy technologies applied to the Shanghai store can substantially improve indoor air quality as well.

In the face of soaring energy bills and management costs, Plaza 66 has started and continued energy efficiency retrofitting projects in order to reduce energy consumption, carbon emissions and management costs since 2007. Although the trend of total CO_2 emission reduction is not steady because of the completion and use of the second office building, the rental condition of office buildings and an area increase of business function, CO_2 emissions per square meter still dropped from 161.83 kg/m^2 to 137.70 kg/m^2 from 2005 to 2009. In 2008, Plaza 66 undertook six retrofitting projects, and actual co-benefits included 6,441,387~7,007,073 kWh of energy reduction, 4,508,971~4,904,951 kg of CO_2 emission reductions, and 3,974,336~4,323,364 RMB of electricity cost reductions (see Table 5-6). Similar to Shanghai IKEA, lighting retrofitting projects contributed the most towards reductions, followed by VMC system and heating system improvements.

Along with the actual co-benefits described above, potential co-benefit effects of Plaza 66 could generate the following energy saving measures:

Table 5-6: Potential Energy Saving Measures in Plaza 66

Energy Saving Measures	CO_2 Reduction (kg/year)
Improving Air-Conditioning System	
Add frequency conversion of chillers	679,815.5
Improve surrounding condition of chiller cooling tower	387,921.1
Adjust frequency conversion of cooling water pumps	238,700
Improve frequency conversion of cooling water system	356,300
Improving Heating System	
Retrofitting Electric Heating System in Winter	1,378,000
Indoor Green Space	
Green Vegetation	23,000
Improving Insulation	
Glass Windowsfilm	137,000
Total CO_2 Reduction	**32,000,737**

Source: Liu, 2011

Energy security benefits and indoor air quality are also potential co-benefits generated from Plaza 66's continuous building energy saving efforts.

5.4.2 Policy Drivers/Factors

Relevant policy drivers and factors regarding building energy measures and performance in Shanghai's commercial sector are analyzed in this section. The particular policy interventions and important factors implemented in the two case buildings are discussed.

In terms of policy intervention, both Shanghai IKEA and Plaza 66 were selected by the SMG to install sub-meters in the buildings for further measuring and establishing a building energy consumption database for Shanghai's large-scale commercial buildings. In addition, both buildings applied for energy efficiency special funding from the SMG and the Bureau of Finance of their district governments to subsidize building energy efficient technologies. Moreover, IKEA has its own auditing system, Webess, to facilitate the energy management team's recording of monthly energy consumption and periodic analysis of trends in energy use and CO_2 emissions. Plaza 66 utilized a local research institution to audit its building energy consumption and to provide energy savings and carbon reduction consultation. IKEA's IGR project also facilitates reducing its building energy consumption and enhancing renewable energy use. Higher energy efficiency further benefits Shanghai IKEA's productivity and brings economic benefits along with energy efficiency and CO_2 emission reduction benefits. Plaza 66's Energy Saving Competition promotes sustainability and innovative energy saving ideas among the staff.

The study also identifies important factors from the two case buildings that affect the implementation process of co-benefit effects. "Cost" refers to management costs (energy bills) and retrofitting costs (costs of energy efficient technologies). Property managers of both buildings pointed out that the major goal of their building energy practices was to lower energy management costs. Additionally, they will undertake more building retrofitting projects if the cost of energy efficient technologies becomes lower or more reasonable.

Capacity and willingness of the energy management team also plays an important role in energy efficiency. Capable energy management staff can develop sound building energy practices. Shanghai IKEA has an interior energy management team and the general manager of the store is also the leader of the energy management team. The annual energy saving objectives, feasibility studies and action plan are made by the team (Jiang, 2012; Weng, 2011). Plaza 66 also has its own energy management team under the Hang Lung group's property management department, which is in charge of facility and building maintenance as well as energy management. Related awareness raising, information sharing and basic training are undertaken regularly among the whole staff. Special training programs are also designed for the team members (Jiang, 2012). Moreover, leaders' willingness is a key to effective building energy practices. In China, fewer property managers and energy management staff are actively and continuously working for building energy management. They are afraid of complaints from building tenants in instances where some new technologies are not mature enough for the market or require a longer payback period (Liu, 2011; Weng, 2011). Therefore, corporate values and leader support are crucial factors for existing building energy practices in China.

Both the IKEA and Hang Lung Property corporations emphasize the value of sustainability and low-carbon practices to enhance their green branding. Relevant energy and environmental initiatives are supported by top management in both groups. Moreover, Shanghai IKEA has engaged with local environmental NGOs to promote low carbon activities for local communities as their corporate social responsibility (CSR). Plaza 66 has joined the worldwide climate change awareness campaign known as Earth Hour. However, Plaza 66 has not actively participated in local communities and NGOs for low carbon projects, although Hang Lung headquarters in Hong Kong has engaged with relevant stakeholders in energy and environmental sustainability and even committed to international climate change initiatives.

Chapter 6

CONCLUSION AND POLICY RECOMMENDATIONS

With rapid urbanization, Asia will be the main driver of a 40 percent increase in global energy consumption. In addition, buildings account for more than 50 percent of all national greenhouse gas emissions in most Asian countries. Asian urban building booms and urban dwellers' behavioral changes have brought significant energy and environmental impacts from the building sector. There is a great need for attention to and development of urban building energy governance in Asia because of the great urban growth that has occurred and will continue to occur. Furthermore, the problem is compounded by the limited amount of detailed research that has been undertaken on the building energy governance systems of major Asian cities and on energy retrofitting policies and actions in relation to the extensive amount of existing buildings.

As China's leading global city, Shanghai has been under tremendous pressure to set an example in the areas of planning and development to meet emerging needs. As is characteristic of global cities, more and more large-scale commercial buildings are being constructed in Shanghai; these buildings are following the Urban North models with central heating/air-conditioning systems. Shanghai and other first-tier cities have different problems than the second-tier or third-tier Chinese cities, which have booming new construction projects. First-tier cities like Shanghai need to address significantly growing energy consumption and CO_2 emissions from both new and existing commercial buildings. In particular, existing buildings comprise the largest segment of this global city. Retrofitting existing commercial buildings, especially large-scale public or commercial buildings, becomes an important issue for Shanghai's building energy governance.

The study explores Shanghai's building energy governance structure with a multi-scale governing framework that includes the dynamic relationships that exist among relevant stakeholders who serve to facilitate or constrain the effectiveness of the Shanghai Municipal Government (SMG) with regards to building energy governance. Moreover, the two case studies – Shanghai IKEA and Plaza 66 – provide important examples in terms of building energy management in existing commercial buildings. The interaction among the governmental agencies, the private companies and civil society has not only shaped the two private companies' building energy management mechanisms, but it has also created positive momentum for Shanghai's building energy governance. Further, the study identifies major urban building energy policies recommended in the literature and the building energy governance dimensions that have been adopted by three major global cities, New York, London and Tokyo. These three cities are then used to assess the status of Shanghai's building energy governance system. This chapter provides a conclusion and policy recommendations regarding commercial building energy policies and practices in Shanghai and directions for further research.

6.1 Shanghai Building Energy Governance Structure

Shanghai is directly under the Chinese central government's rule. The central government sets macro-policies and appoints top leaders under the hierarchy system. Overall, the SMG has restricted authority in its jurisdiction's affairs. However, the SMG has wide autonomy with respect to economic development, urban planning, infrastructure, civic facilities and the city's budget. The competencies of municipal governments concerning their powers and duties are critical in shaping the capacity for urban energy governance. As the government of a leading city of China, the SMG has enough autonomy and support from the central government on urban building energy saving practices.

The Chinese central government and the SMG have both contributed greatly to the development of Shanghai's building energy governance. In the national context, China has established a set of policy instruments for commercial building energy saving since 1993, while the SMG has only recently begun to offer control and regulatory building energy policy instruments The recently passed and implemented Regulation of Shanghai for Building Energy Conservation demonstrates that the SMG has paid close attention to this pressing issue and has started to take mandatory action. Moreover, in order to stimulate the domestic economy and increase the role of the market economy in improving building energy efficiency, the Chinese central government has also adopted a variety of fiscal incentives, tax rebates and subsidy programs to promote the commercialization of building energy saving. On the city level, the SMG took the lead on the clean development mechanism for the building sector. This initiative is even more ambitious than those of other advanced global cities. In terms of support and voluntary action instruments, the Chinese central government has set up non-compulsory labeling system for evaluating green buildings and efficient appliances. Some successful demonstration projects have been initiated by the central government as well. Similarly, Shanghai has many support and voluntary action plans and demonstrations relating to building energy governance.

In terms of Shanghai's building energy governance agencies, The Ministry of Housing and Urban-Rural Development (MOHURD) is responsible for directing and supervising national building energy policies and regulations. Policy enforcement is undertaken by the SMG through its construction administration departments. The MOHURD supervises and oversees the Shanghai Municipal Urban and Rural Construction and Transportation Commission (URCTC) and the Construction Commissions of Districts and Townships. In addition, the mayor's willingness is an important factor in Shanghai's building energy governance. Shanghai Mayor Han Zheng has encouraged and promoted building energy policies and implementation representing the importance of the mayor's role in urban building energy governance.

In order to improve building energy efficiency in existing buildings, the SMG has undertaken some specific policies. Shanghai has passed and implemented the Regulation of Shanghai Building Energy Conservation as a mandatory mechanism. Moreover, the SMG has followed the nation-wide energy efficiency supervision system to control the quota of building energy consumption. The SMG has mandatory audit programs targeting municipality-owned buildings and large-scale commercial buildings. Selected buildings need to install sub-metering system. Relevant building energy audit results will be stored in an information database, which is currently under construction. Moreover, SMG has provided energy efficiency special funding and subsidies for promoting energy efficient technologies and renewable energy applications for retrofitting existing buildings. There are many support and voluntary action plans and demonstrations in place related to building energy governance in Shanghai. Several low-carbon practice areas were built as demonstrations to raise awareness, educate the public, and provide information for better building energy saving performance.

Due to its global city status and important influence on the world stage, Shanghai has created a good foundation towards better building energy governance. After Beijing's Olympic Games, Shanghai's World Expo featured the "Better City Better Life" slogan, revealing the city's interest in the "green" wave of current global trends. In the process of holding the international event, Shanghai appeared more committed to building energy efficiency, energy saving regulations and supportive policies. Shanghai has also joined transnational municipal networks, such as the C40 and the United Cities and Local Governments for international cooperation and experience exchanges.

Shanghai has achieved more active public and private partnerships to enhance its building energy governance. In terms of public and private partnerships, the SMG has formulated additional local policies to support the energy service companies (ESCOs). In 2008, the SMG set up a special fund to promote ESCO projects (Chen &

Xu, 2010) and cooperated with ESCOs on large, existing office retrofitting projects as successful demonstrations. Along with the promotion of the ESCO system, the private sector also provides technical support for Shanghai's green building and energy efficiency projects through public-private partnerships.

Moreover, Shanghai has also fostered cooperation between the public and non-governmental organizations (NGOs). For example, the SMG partnered with the World Wildlife Fund (WWF) in 2008 to launch a Low Carbon City Initiative. Some international environmental and energy NGOs cooperated and participated in building energy saving policies and projects in Shanghai; These NGOs include the Energy Foundation, the Natural Resource Defense Council and the Joint US-China Collaboration on Clean Energy (JUCCCE), among others.

The Shanghai Energy Conservation Supervision Center (SECSC), affiliated with the Shanghai Economic Commission, is the first non-profit energy conservation administration organization in China. The SECSC has taken an active part in the dissemination of energy conservation information, best practices, technological consultation and energy conservation training. The SECSC has also undertaken major activities regarding the development and implementation of Shanghai's building standards and regulations. Central and local building science research institutions and universities have provided significant technical support and assistance for reducing building energy consumption in Shanghai. The University of Shanghai for Science and Technology assisted Plaza 66 with conducting energy auditing and formulating an action plan to further reduce its carbon footprint. Some local universities, such as

Tongji and Fudan Universities, are active in cooperating with the government for building energy efficiency projects that have further facilitated Shanghai's urban building energy governance.

Shanghai IKEA & Plaza 66

The study examines two major commercial building sites, Shanghai IKEA and Plaza 66, with their active private-driven building energy management and energy efficient technologies for better energy performance. As the major multinational firm and the developer, two groups have become positive forces in forming Shanghai's building energy governance through interaction with governmental agencies and local communities. The dissertation has provided a new dimension regarding the significant role of private building owners and their dynamic relationships with the government and civil society; this relationship has gradually shaped Shanghai's building energy governance. In addition, the sustainability commitment and spatial location of all Hang Lung and IKEA buildings indicate that the private sector plays an important role in retrofitting existing buildings.

It is significant and effective to diffuse the best practices regarding building energy management and retrofitting among all the buildings under the two groups, even though some may fall outside of Shanghai. Hang Lung Properties presents a model of how the private building has influenced Shanghai's building energy governance. As an important regional developer with a strong corporate value of sustainability, the Hang Lung Group has continued building low carbon and sustainable buildings. The group has a strong relationship with the Chinese government and been awarded for its sustainable construction practices. The SMG has selected its buildings and projects as demonstrations for the application of new energy policies and energy efficient technologies. Moreover, the company has organized and participated in community events through its corporate sustainability programs. In addition to retrofitting existing buildings, the Hang Lung Group has also built new green buildings. Shanghai Plaza 66's energy management has revealed the influences of the Hang Lung Group's corporate values and other best practices from green buildings located in different Chinese cities.

The IKEA Group has its own sustainable plans and initiates its own building energy practices for its global IKEA stores, distribution centers and factories. In addition, IKEA's IKEA Goes Renewable (IGR) program has set more ambitious targets for energy efficiency and renewable energy applications than Shanghai's targets. IKEA's global energy consumption database provides a basis of building energy benchmarks for all IKEA buildings, and the database can share data with different IKEA outlets for pro-active improvement in the energy performances of buildings and can measure the effectiveness of energy efficiency initiatives in different IKEA buildings at different locations. The multinational corporation has successfully diffused its building energy technologies and management system through its buildings worldwide. Moreover, the SMG has targeted the pioneer IKEA buildings to promote energy policies as demonstration projects. The cooperation between the government and the multinational corporation has brought more building energy management information to Shanghai, which can in turn facilitate the city's building energy governance. Moreover, IKEA has engaged with the WWF and local communities in raising environmental awareness through environmental protection and energy saving campaigns and advertisements. The interaction between IKEA and the civil sector has become the roots of Shanghai's building energy governance.

The research presents that these energy saving technologies and management mechanisms have achieved building co-benefit effectiveness, including economic benefits, energy reduction benefits, and greenhouse gas (GHG) reduction benefits. The IKEA Group and Hang Lung Properties have been collaborating with district governments closely. Along with mandatory sub-metering installation, both companies have applied for energy efficiency special funds from the Bureau of Finance of their district governments for supporting relevant technologies and measures in saving energy and reducing carbon emissions. In addition to their own energy management systems, which contain procedures and schemes for effectively managing energy performance, both companies have third parties serving as professional auditing teams to make sound energy performance evaluations. All relevant investment plans have been formed carefully and implemented based on local realities with reasonable and acceptable return periods.

It has further been revealed that the capacity and willingness of the energy management team plays an important role in existing commercial building energy practices. The annual energy saving objectives, feasibility studies and action plan are made by the team. Related awareness raising, information sharing and basic training are undertaken regularly among the whole staff. Special training programs are also designed for team members. All of these measures have strengthened the capacity of each building to implement energy saving and carbon reduction activities. Furthermore, both buildings are actively engaging the efforts for low carbon sustainability in local communities and schools.

In general, Shanghai has established a good foundation towards better building energy governance. This status has led to more active public and private partnerships as well as cooperation between the public and NGOs. Moreover, retrofitting existing commercial buildings, especially large scale public or government office buildings, has become an important issue in Shanghai's building energy governance due to the large number of existing buildings in Shanghai. Therefore, the two case studies provide good examples in terms of building energy management in existing commercial buildings. The interaction among governmental agencies, private companies and civil society has not only shaped the two private companies' building energy management mechanisms, but has also brought positive momentum for Shanghai's building energy governance.

6.2 A Comparative Assessment of Shanghai's Building Energy Policies

The dissertation initially reviews and identifies relevant criteria and building energy policy instruments as recommended benchmarks and examines the extent to which they have been adopted by Shanghai and the three global cities: New York, London, and Tokyo. Table 6-1 presents a comparative assessment of Shanghai and the three global cities in relation to building energy policy categories derived from general recommendations in the literature concerning building energy efficiency in both new and existing buildings. The comparison includes policies adopted by the city and national policies that they carry out. Through regulatory and control instruments, in addition to the powers provided by national and state governments, cities have additional authority that can be utilized to improve the implementation process of building energy governance. Along with government-based policies, market-based instruments and fiscal incentives provide important elements in building energy governance to mobilize the market and drive the involvement of relevant stakeholders. Support, information and voluntary action are engaged by different stakeholders in order to change the values held by society towards lower carbon and energy efficient building sectors. Sustainable urban building energy governance needs a comprehensive policy instrument framework based on local conditions.

Table 6-1: Commercial Building Energy Policy Instruments in Shanghai and Three Global Cities

Regulatory & Control instruments	Shanghai	New York	London	Tokyo
Appliance Standards	▲	√▲	▲	▲
Building Energy Codes	√▲	√▲	▲	√▲
Procurement Regulations	▲	√ ▲	√	
Mandatory Certification and Labeling	▲		▲	√▲
Mandatory Audit Programs	▲	√▲		√▲

Table 6-1 Continued

Regulatory & Control Instruments	Shanghai	New York	London	Tokyo
Utility DSM Programs		√▲		
Renewable Portfolio Standard (RPS)/ Feed-In-Tariffs (FITs)/ Green Electricity Certificates		▲	▲	
Economic/Market-based/Fiscal Incentives	**Shanghai**	**New York**	**London**	**Tokyo**
Energy Performance Contracting/ ESCO Support	√▲	√▲	√▲	√▲
Energy Efficiency Certificate/ White Certificate Schemes	√▲		▲	√
Kyoto Flexibility Mechanisms	√			
Energy/Carbon Taxes			▲	
Tax Incentives	▲	√▲		√
Rebates/Subsidies/Grants	√▲	√▲	√▲	
Low Interest Loans & Guarantee Funds		√▲	√▲	√▲
Support/Information/Voluntary Action	**Shanghai**	**New York**	**London**	**Tokyo**
Voluntary Certification and Labeling	√▲	▲	▲	▲
Green Electricity Certification System	√		√	
Workforce Training		√▲	√	
Public Leadership Programs	√▲	√▲	√	√▲
Awareness Raising/Education/ Information Campaigns	√▲	√▲	√	√▲
Disclosure Programs	√▲	√▲	√▲	√▲
Research and Development		▲		

√: City Policies or Projects
▲: National or Sub-national Policies or Projects

Based on the totals in Table 6-1, there is little difference between Shanghai and the three global cities. In the 21 categories of building energy policy instruments, Shanghai has 15 initiatives, New York and London have 16 initiatives and Tokyo has 13 initiatives. However, there are specific programs in New York, London, and Tokyo that more advanced than Shanghai's programs. Some policy implications can be derived from the comparative assessment between Shanghai and the three cities.

New York City has set more stringent requirements for commercial building energy retrofitting than national and state building energy standards. The city-led legislation even stimulates the amendment of the state's regulation. Shanghai, however, currently follows only basic national requirements. In addition, NYC has more stringent building auditing mechanisms than Shanghai. At the initial stage, both cities have targeted large-scale commercial buildings. However, NYC focuses on large-scale commercial buildings and municipality buildings over 50,000 square foot (around 4,600 square meters) while Shanghai defines "large-scale commercial buildings" as those over 20,000 square meters. NYC has set more stringent standard than Shanghai. Moreover, relevant building energy saving policies for large-scale commercial buildings in Shanghai are not compulsory, which affects policy enforcement. New York City has set up building performance benchmarking as a mandatory disclosure program for large-scale buildings while Shanghai's building energy consumption platform is still under construction. Although Shanghai has followed the national building energy code and standard, national building energy policy systems usually set up only principal guidelines and then expect local governments to enact more specific regulations tailored to local conditions. Moreover, workforce training is one of focal points in New York City's sustainable building policy agenda. New York City has a mandatory Green Workforce Development Training Law to provide more relevant employment opportunities and enhance its capacity for better performance on building energy saving, while Shanghai lacks relevant policies. In terms of promoting energy performance contract system, New York City's government has adopted more tax incentives, subsidies, rebates, and financing tools, while Shanghai has a small number of unstable energy efficiency special fund and subsidies for building energy efficient technologies and renewable energy application. While New York and Shanghai may have a similar amount of initiatives, a comparison between the two cities has exposed several gaps in Shanghai's policies.

A comparison between Shanghai and Tokyo has unearthed similar results. The Tokyo Metropolitan Government offers tax breaks to small and medium-sized enterprise for purchasing energy saving equipment and renewable energy equipment. Moreover, Tokyo has initiated the first city-lead cap and trade scheme (Tokyo-ETS) in the world, which targets building energy-related CO_2 reductions from existing buildings. The scheme covers over 1,000 commercial buildings. Shanghai's initiatives are not nearly as overarching as the policies in Tokyo.

Several energy saving programs through the private sector partnerships exist in London's building sector. The Better Buildings Partnership (BBP) aims to develop solutions to improve the sustainability of London's existing commercial buildings.

The BBP scheme seeks to draw together London's leading commercial property owners and tenants to overcome split incentive barriers to the retrofitting work of office buildings through behavioral changes. The initiative has resulted in green lease agreements with 14 of the largest commercial and public property owners in London. All members of the BBP are working together to improve the sustainability of London’s existing commercial building stock and accelerate the reduction in CO_2 emissions from those commercial buildings. The BBP is complemented by the Green500 Scheme, a program targeting occupiers of commercial property to improve sustainability and reduce carbon footprints. The Green500 scheme is a carbon management service and a performance-based awards scheme aimed at the largest 500 organizations in London, in which each member is assigned a Carbon Mentor who will design a unique, holistic, carbon management plan and carbon reduction target. The two programs (the BBP and the Green500) work together by driving carbon savings in commercial buildings both from the bottom up and the top down. Moreover, acting as an independent organization, the Green Organizations Badging Scheme uses the power of partnerships to promote sustainable energy solutions in London. It aims to work with tenants in both the private and public sectors to reduce emissions through staff behavioral changes and improved building operations. This includes providing information and support to deliver these changes, working together with existing initiatives and defining a clear set of targets and associated green badging levels (GLA, 2007).

Even though Shanghai's policies are not as advanced of those in New York, London and Tokyo, Shanghai has created some of its own innovative policies." the SMG proposed different evaluation standards and incentives for the building sector to reduce energy consumption. Shanghai's building evaluation standard prioritizes considerations not only for the actual energy reduction amount, but also for the social benefits regarding the demonstration and its diffusive effects from the building's energy saving initiatives. The SMG took the lead on the clean development mechanism for the building sector. The voluntary carbon-trading system and new energy performance contract model would bring hope for Shanghai's energy performance contract practice.

In summary, Shanghai and the other three global cities have targeted municipality buildings and large-scale commercial buildings as public leadership demonstrations and initial building energy saving targets. Shanghai is in the process of developing its building energy efficiency supervision system. Building energy disclosure programs in three global cities have been further developed, which could serve as a model for Shanghai to develop a more mature supervision mechanism.

6.3 Policy Recommendations for Shanghai's Commercial Building Energy Sustainability

Given the analysis of Shanghai's building energy governance system, the recommendations from the general literature and the operation policies of global cities, a number of recommendations can be made to enhance the Shanghai policies for commercial building energy sustainability. Some policy recommendations are provided in this section for Shanghai's commercial building energy sustainability.

- **Maintain Successful Policies and Initiatives**

It is important to maintain and strengthen the successful existing energy saving policies and programs. This process should include gathering and analyzing building energy consumption data; training personnel to track and manage energy use; developing implementation guidelines; and creating financial incentives for energy savings. These efforts can yield further benefits and should be continued. The energy management models of the two private buildings, Shanghai IKEA and Plaza 66, should be promoted in Shanghai.

- **Tighten Building Energy Policies and Regulations**

In terms of regulatory and control policy instruments, the SMG basically followed the national government and the MOHURD guidelines. However, laws, regulations, standards and implementation rules with more stringent energy saving requirements could be issued and enforced by the SMG to address the enforcement gap in urban building energy governance. In addition, there are insufficient mandatory policies and regulations for existing buildings. The government should formulate corresponding reward and punishment mechanisms. Moreover, it is important to strengthen monitoring mechanisms among all levels of government for stricter compliance and enforcement. New York City's regulatory policy instruments could be good references for the SMG to use in Shanghai.

- **Provide More Market-Driven Incentives**

Shanghai has limited municipal-led market-based incentives. Local demonstration projects often receive inadequate and unstable special funds and subsidies that have failed to promote long-term energy efficient building projects. Moreover, a lack of investment remains a major barrier to the implementation of energy efficiency projects in Shanghai. Although the building industry has become a key contributor to the whole urban economic development phenomenon in China with an approximate 30 percent annual growth rate (Jiang, 2012), energy efficiency and carbon reduction are always considered as "second issues" or "less important points" in the building sector (Jiang, 2012; Li & Yao, 2009). Moreover, developers, building owners, and building users have split incentives to improve energy savings and energy efficiency for buildings. Therefore, more market-based mechanisms are needed for Shanghai's commercial building energy governance, including further energy pricing reform, control of market access, and further changes in tax policies on energy-intensive products and industries. Although many international ESCOs are based in Shanghai, development of the ESCO system is still immature and needs more incentive instruments to spur its growth. The SMG should provide more incentives to overcome financing barriers in order to stimulate Shanghai's ESCO system towards a more market-driven one. The operational policy instruments from the three global cities could be followed by Shanghai. The growing energy conservation service industry should be encouraged continuously, and energy efficiency retrofitting projects for large-scale public buildings should be kept a priority. Finally, Shanghai should look to London for a good example on how to gather the private sector for better building energy practices.

- **Strengthen Building Energy Auditing and Supervision**

In terms of building energy auditing in Shanghai, insufficient energy consumption statistics exist. Yet, these statistics are required to enhance policy design and effectiveness. Shanghai should work on strengthening the quality of its data, which can be acquired through expanded surveys, monitoring and the establishment of meaningful baselines of building energy consumption and efficiency. Standardization of data gathering methodologies and greater public availability of data are needed to inform further policy design and monitoring. Moreover, building energy consumption data and data reporting methodologies should be made more transparent for better evaluation of policy progress, including analysis by outside independent organizations. Also, the SMG needs to strengthen building energy efficiency inspection and supervision patterns to establish a more reliable building energy consumption database from Shanghai's commercial sector and further report to the national government. Correspondingly, capacity building for relevant staff and institutions is needed.

- **Promote Work Training Programs and Local Energy Conservation Centers**

An analysis of the three global cities has proven that work training programs are important for building energy saving, but Shanghai has no work training programs in the commercial building energy industry. It is important to promote more work training programs in Shanghai to provide professional knowledge and cultivate more relevant human resources. Moreover, local energy conservation centers can facilitate information dissemination and training. Shanghai should also continue strengthening the capacity of local energy conservation centers. For example, the Shanghai Energy Efficiency Center plays an important role in disseminating advanced energy-saving technologies and managerial experience. The center is integral in releasing information about domestic and overseas energy consumption and efficiency, and it has pushed forward with the building of an energy efficiency testing system and a platform for energy-saving research, development and innovation of advanced technologies. As a result, the Shanghai Energy Efficiency Center has become the focal point for nationwide research, development and demonstrations on energy saving and substitution technology. The SMG should continue to support the Shanghai Energy Efficiency Center and should refer to New York City's mandatory Green Workforce Development Training Law to provide more relevant employment opportunities and enhance Shanghai's local capacity for building energy governance..

- **Encourage Comprehensive and Integrated Urban Planning**

Due to the fragmented process of the building lifecycle and the presence of multiple stakeholders, it is very difficult to assure long-term building energy performance and building sustainability. The SMG should encourage comprehensive and integrated urban land-use planning, while reducing reliance on coal by promoting high energy efficiency technologies and renewable energy applications. Comprehensive and integrated urban planning also can have a positive influence on the commercial sector. Such an approach can take the whole building lifecycle of energy consumption into account and further advance a more optimized total urban building energy system. For example, the Hong Qiao district has been selected as one of the low carbon commercial districts and already has built green commercial buildings that take the whole building lifecycle into consideration. Shanghai should consider adopting similar policies for comprehensive and integrated urban planning.

- **Continue Public Education for Green Mindset Transformations**

To further reduce urban building energy consumption in cities, greater emphasis should be placed on influencing social culture and values, individual choices and behaviors (CCICED, 2009). The SMG has started influencing values by promoting energy efficient buildings and green buildings as successful demonstrations. The SMG should continue to make a concerted effort to educate the public on energy management of large-scale public and governmental buildings. It is necessary to provide more commercial building energy saving training programs for relevant stakeholders and the general public in order to mobilize public participation. The public should be more informed and motivated about the need to take individual and collective action to reduce energy consumption and enhance energy efficiency in buildings. However, such a strategy takes time because it must change not only public consciousness, but also attitudes and behavior. Both the Hang Lung and IKEA groups have engaged with local communities for low carbon initiatives, and other groups should be encouraged to take steps in this direction. Although public consciousness about energy savings is still lagging and constitutes the most difficult obstacle for the

SMG, efforts should continue to accelerate transformations of urban dweller mindsets toward a green mindset, the foundation of a low carbon urban future.

- **Participate in International Municipal Networks**

Shanghai should consider participating in more international or regional networks dedicated to improving governance capacity for urban building energy governance. International municipal networks help facilitate information exchange and coordination between city governments on the enforcement of building energy policies and regulations, which fundamentally enhances governance capacity. Shanghai can benefit from the exchange of best practices in compliance and enforcement with other network members. Further evaluation is required on the effectiveness of joining these transnational municipal networks with regard to urban building energy governance.

6.4 Future Research

This research attempts to investigate major cities' increasing roles in the governance of transitions to a low carbon urban future from the perspective of building energy governance. Overall, building energy governance in Asian cities could be a significant research topic to prevent urban Asia from following the similar development and consumption patterns of the Global North. To facilitate Asia's strides towards a lower carbon future, the research provides a building energy policy instrument framework, a multi-scale governance analytical framework and a co-benefits approach.

In terms of case building selection, the dissertation selects two large-scale commercial buildings with advanced building energy technologies and management mechanisms. Both of them are classified as successful retrofit buildings. However, it is significant to compare unsuccessful retrofit case buildings with successful ones to find out which major obstacles and barriers exist in commercial building practices. Moreover, different types of building energy management/operations have different policy drivers and factors that affect their energy saving performance. As noted in the dissertation, Shanghai IKEA and Plaza 66 have interior energy management teams. The building owner, user and energy management team belong to the same party in both case buildings. This type of building energy management is not as complicated as those types with split incentives among different actors. Future research should select different types of building energy management to further analyze different policy interventions and factors that facilitate or constrain their building energy management efforts.

Additionally, compared with most local companies, international developers or external companies are keen to adopt new green technologies and innovative energy management. More external companies focus on building energy efficient saving measures than local companies. Therefore, it is important to diffuse the international-led trend to develop localized and internalized low carbon values throughout Chinese society. Future research could select buildings owned by domestic companies to investigate their building energy management systems and compare them with those owned by external companies.

In addition, it is important to diffuse building energy efforts from large scale commercial buildings to regular commercial buildings for the next stage of Shanghai's building energy governance. However, it is more challenging to address energy saving problems in regular commercial buildings because they have less energy saving motivation and incentives than large scale commercial buildings. This dissertation focuses on Shanghai's commercial building energy governance. However, building energy issues are intertwined with comprehensive urban low carbon development. Therefore, a future research framework could be extended to examine the policies and practices of Shanghai's urban low carbon development.

Finally, it is also essential to further analyze comparative research on building energy governance in major Chinese and Asian cities, especially in relation to existing buildings. For example, how multinational corporations like IKEA and the Hang Lung group deal with energy policy for their built facilities in various countries would be a useful study. In terms of data classification and sharing, relevant building energy use data nationwide and city-wide is cited in the research according to secondary data from some significant research institutions domestically and internationally. Also, building energy consumption auditing and metering policies are still in the midst of the testing phase. Relevant data is not easy to access. Moreover, most building energy saving policies and mechanisms have been announced by the government recently or are still in the process of policy formulation. It is difficult to evaluate their effectiveness at this stage. Further detailed studies with different methodologies are important as a follow-up to these issues in the future (Dhakal, 2009).

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