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Electric vehicle adoption in small island economies: Review from a technology transition perspective

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Abstract

Small Island States present features, such as compact road networks, low com-muter distances, and often large tourism service sectors, that could make the adoption of electric vehicles for transportation which is an attractive way to reduce their costly dependence on imported fossil fuel and their greenhouse gas emissions. Through the transition theory lens, we review the national pol-icy measures and broad clean transportation targets that small island countries are implementing to encourage electric mobility deployment. From informa-tion compiled for 18 small island countries, we find a growing trend in electric vehicle and infrastructure development incentives among broader clean trans-portation transformation policies and nationally determined contribution tar-gets; and large country-to-country variations in enabling conditions to smoothen EV transition. Small island countries are not uniform but instead are very dispersed across the transition S-curve. The review, therefore, finds that the mobility transition requires island-specific approaches and solutions that will accentuate critical policy and management elements for fostering transitions.

Keywords

electric vehicles, energy security, energy transition, small islands, sustainable development, transportation

1 | Introduction

The transportation sector was responsible for 24% of global energy-related carbon dioxide emissions in 2019.[1] By 2050, under a Business-as-Usual case scenario, carbon emissions from transport are projected to nearly double (Sims et al., 2014). In order to curb global warming to 1.5°C and mitigate all avoidable negative impacts, greenhouse gas (GHG) emissions, including carbon dioxide, must be significantly reduced. One of the prioritized technology fields that holds promise for reducing GHG emissions is electric vehicles (EVs) to replace traditional gasoline-based combustion engine vehicles (internal combustion engines, ICEs). If powered using renewable energy (e.g., solar, wind), EVs produce no GHG emissions and will dramatically reduce the amount of anthropogenic atmospheric CO_2.

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While far from being homogeneous, Small Island States (SIS) are characterized by their small populations with the majority of them being developing economies highly dependent on their tourism industry. We draw on the definition of small islands as used by the Intergovernmental Panel on Climate Change (IPCC) which group them together given their similarities in potential impacts and adaptive capacity. These nations, especially the Small Island Developing States (SIDS), contribute a minute proportion to the global GHG emission but are highly vulnerable to the impacts of climate change as seen by the devastation of Caribbean islands by hurricanes and storms; the impact of Hurricane Maria (2017) in the Virgin Islands; the impacts of Hurricane Irma (2017) in Antigua and Barbuda, British and United States Virgin Islands, Turks and Caicos Islands, Haiti, and the Dominican Republic; the impacts of El Nino Southern Oscillation (ENSO) (1997–1998) on Pacific islands, and severe drought experienced in Trinidad and Tobago between 2009 and 2010, just to mention a few examples of recent climatic catastrophes (Shah et al., 2020). SIS do not just experience the highest frequency of natural disasters globally, the potential for damages of nationally significant proportion is extremely high (Mycoo, 2018).

Among other factors, a relatively compact road network and low commuting distance can contribute to a faster take-off of EVs in a country, conditions that exist in SIS (UN-OHRLLS, 2013), Moreover, a majority of SIS have energy systems that are very dependent on imported fossil fuel (oil) (Gay et al., 2018; Viscidi et al., 2020). Thus, the adoption of EVs, in addition to transitioning to an energy system that is powered by renewable energy sources, will not just help these nations achieve energy independence, consequently stimulating their economies but also help address the climate change crisis by reducing GHG emissions (Timilsina & Shah, 2016). EVs allow for an increased percentage of local renewable energy, increasing energy security, and decreasing costs of fuel. EVs also improve the quality of the environment, allowing for less national GHG emissions, lower vehicle noise, better air quality, and less environmental degradation. In addition, most SIS have economies that are dependent on the tourism industry. The mainstreaming and integration of EVs into the tourism industry will not just make for a green economy but will also influence transport behavior and mobility consumption beyond their borders as travelers and tourists experience the sustainable transportation system (Soomauroo et al., 2020). Furthermore, a transition to EVs will help foster the development of vehicle-to-grid (V2G) technology, an energy storage technology that is essential for a transition to a renewable energy-powered grid by allowing for better utilization of intermittent energy sources. A combination of both transitions will make the SIS less vulnerable to energy shocks through their lesser dependence on imported energy sources that are susceptible to the impacts of the fluctuating global energy market and thus have better negotiating power in the international energy market (Shah et al., 2016).

By utilizing several transition process lenses (Markard et al., 2012), we review the trajectories of the transport sector through country policy and management strategies that lead to a paradigm change, lock-in, or system breakdown. These include the National Energy Policies (NEPs); the Nationally Determined Contributions (NDCs); and other policy declarations made by governments. Importantly, we re-iterate that the subject of this review is primarily predicated on the fact that these island countries have the opportunity to reduce their expensive, GHG heavy, fossil fuel import bills by transitioning to EVs, but the other side of the equation to achieve this depends on the broader country transition to renewables. We focus on the former here. There are unique conditions that exist in SIS that can facilitate the transition that we illuminate through a sample of 18 such countries for which relevant information is accessible and span a

FIGURE 1 Locations of small island countries included in the study

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diversity of geographical and economic conditions; with similar social, economic, and environmental vulnerabilities (see Figure 1).

In this review, we provide an overarching database of SIS with EV policies in place, looking at 18 island nations (15 SIDS and SIS).[2]We focus on the adoption potential of EVs in these states, and the broader societal transition of island transportation regimes in a bid to reduce imported fossil fuel dependency, energy costs, and GHG emissions. We conclude by discussing whether the current EV landscape within the broader concept of societal transition allows for understanding the scope and direction of SIS' electrification transition policies. With EVs, we refer to individual mobility as well as fleets and public transit.

2 | SOCIOENVIRONMENTAL BACKGROUND OF SIS

SIS are potentially ideal locations for ICE to EV transitions. The high costs of fossil fuel imports stand in stark contrast to the high potential of RE generation, especially for the islands located in the equatorial region. Both these factors feed into each other for pushing for an accelerated transition (Gay et al., 2018; Viscidi et al., 2020). High costs of imported fuels can be substantially reduced through a transition to renewable energy-powered EVs. Furthermore, the small size of island nations leads to decreased range anxiety (UN-OHRLLS, 2013). Range anxiety is a large concern for current EV technology as drivers fear being stranded as a result of inefficient distribution for charging stations and the inability of the EV's battery to power the car for the total distance of a journey. There are also concerns about the long recharge time for EVs and their slightly shorter travel allowance compared to contemporary ICE vehicles.

From a global perspective, small island nations can be interpreted as micro-level niches as they are geographically separated from continental peers. They also have particularly attractive physical conditions for EVs, making them ideal places for EV market development and large-scale adoption. From a "test-bed" perspective, small islands represent demarcated, bounded areas (both geographically and politically) that allow in-depth observation of the experimental space of EV policy interventions and systems transition. In many ways, the island space allows transition management actions and policy interplays influencing EV transitions to be experimented with, in efforts to improve the circumstance and learn lessons for application elsewhere. Within the climate change discourse, decarbonization efforts rightfully target the transportation sector among others. Several SIS have stated their intentions to decarbonize their transportation sectors, which in many cases includes increasing EV penetration. For example, Jamaica has an established target of 30% renewables in the energy mix by 2030 with an interest in EVs. Barbados has an ambitious green goal of running on 100% renewable energy by 2030, again with a need for EVs (Viscidi et al., 2020).

The policy to planning/management interface also requires attention since several difficulties to deploying EVs on islands can arise. The first issue is demand-side-based as getting citizens to purchase EVs is still considerably hard. Compared to ICEs, EVs are more expensive and purchase may need to be incentivized (Wong et al., 2010). Also, taxes from gasoline and diesel purchases that fund government expenditures would be lost in the transition to EVs, a situation that can, in turn, affect the transition as it requires government investment in infrastructure like charging stations. This could lead to a dependence on foreign sources of funding for such infrastructural projects although the deficit can be mitigated by the lesser expenditure on imported fuel. In general, it is important to note that SIS may have small budgets (or economies) which makes it difficult to initiate large infrastructure projects (Dulal & Shah, 2014). Another issue to resolve is the lack of experience with EVs in SIS. There are very few mechanics and vehicle specialists on islands who can deal with the evolving EV technology at the moment, which may lead to issues as more EVs are purchased. However, these issues may be resolved over time as knowledge is dispersed.

Once a large share of citizens owns private EVs, SIS with isolated grids of below 200 MW installed capacities can experience increased strain on their electricity grid especially as the conventional energy demand of EVs are between 10 and 100 kWh per charge (Gay et al., 2018). On small islands with limited grid infrastructure like Tenerife Island (Spain), these strains may lead to outages if the electricity demand is not managed properly (Díaz et al., 2015; Mahadeo et al., 2017). The optimal solution would be expanding the installed capacities of isolated grids using renewable energy technologies but a V2G structure (technology or system) in which power stored in the batteries of plugged-in EVs can be sent back to the electric grid can help mitigate the impacts for the meantime (Kempton & Tomić, 2005). V2G has shown great promise for electricity management and comes with the added benefit of increased resilience to electric shocks caused by natural disasters. EVs can also act as mobile electrical power sources in disaster areas providing crucial electricity for emergency services (Noel et al., 2018).

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3 | APPLICATION OF TRANSITIONS THEORY LENS

Transitions are periods of time between two stable states of a society (Meadowcroft, 2005). During a transition, a societal transformation occurs when a deeply embedded custom or technology is significantly altered. One can surmise such for animal-hauled transport to gas- and diesel-driven modes and now toward EVs. Fischer-Kowalski and Rotmans (2009) conceptualized social transitions based on the notion that changes which lead to transitions are complex, evolutionary, and multiphased (Holling, 1973) as opposed to the previously mainstream idea that changes are linear, incremental, predictable, and controllable (Stockholm Resilience Centre, 2008). These perspectives are actually complementary but turn on the time scale applied. On longer time scales, transition appears as linear and continuous while from a shorter time scale, it is unpredictable and fluctuating. One way to understand the EV transitions in SIS is through a combination of four transition theory concepts: policy-enhanced transition, multilevel transition, transition management, and the S-Curve interpretation.

The multidimensional nature of transition processes means that they are influenced by a multitude of diverse, fragmented sectoral policies. *Policies for transitions* have to be horizontally coordinated across intersecting policy arenas to advance transitions (Weber & Rohracher, 2012). Fiscal "carrot or stick" policies are also often in play. "Carrots" are fiscal policies that incentivize investments and such policies include subsidies, tax breaks and exemptions, and rebates; while "sticks" are policies like taxes that disincentivize investments. In many island nations, for example, new policy measures that reduce import taxes on EVs compete with existing measures that reduce duties on less-efficient foreign-used ICE vehicles, in efforts to increase affordability and access to private transport by the public. Care must be taken to align fiscal policies aimed at stimulating sustainability transitions. Workforce and training policies, accreditation of workers, and skills development to service EV vehicles and infrastructure require policy modernizations in alignment with expanded EV purchase incentives. Workforce shortage and skill gaps in the workforce can reduce the speed with which transitions progress. Policy change is less often the igniting fire for sustained societal transitions but does strongly affect the rate at which a transition occurs (Shah & Rivera, 2007). The broad policy vision serves to orient society as to when the transition ends are met, which is a new steady-state commences (Pettifor et al., 2017).

Multilevel transitions in island transport systems can be initiated where conditions are conducive and harmonious enough to initiate and scale-up transition, respectively (Geels, 2002, 2014). Here, transitions systematically occur as interference of established processes at three scale levels: micro, meso, and macro. Symbolic of the bottom-up approach, the micro-level refers to transport transition initiated within technological niches (areas where specialized innovations like EVs can prosper and permeate to idealized markets) that are outside the existing regime. It is at this level that island transitions, as "idealized" markets for EVs, could take hold. The existing regime is eventually overtaken by a new regime as a result of the scaling-up of the developments within the technological niches. At the meso-level, transition occurs when the existing transport regime evolves due to the gradual incorporation of the emerging EV niches that form within it. This is less likely in islands except where some public transport transitions have been noted and represent a foothold. Transition at the macro-level depicts the top-down governance approach in which the development of technological niches is not required for initial transition, as change arises via policy changes that influence the socio-technical and market landscapes. This level aligns well with the traditionalist top-down governance most often observed in island nations; and the point that most island nations, like other developing countries, assign minimal investments to local research, development and innovation processes compared to industrialized country counterparts (Rodríguez et al., 2019).

Given the complexity of the systems within which transitions occur, the challenges that instigate transitions and the problems encountered in situ transition, Fischer-Kowalski and Rotmans (2009) rationalized a set of conditions for "smoothening" transitions. *Transition management* suggests: (1) "Establishing space for niches in the transition arena" based on the notion that minute initial change(s) in a system can affect the whole structure. (2) "Focus on frontrunners" which are agents that are not just capable of generating dissipative structures but also operate within the resulting structure because of their lack of dependence on structure, culture, and practices of the regime. (3) "Guided variation and selection" which guarantees that systems will be diverse, coherent, and flexible enough to effect changes in the search for the optimal solution. (4) "Taking radical changes in incremental steps" which guard against pushbacks because of the shock from implementing radical changes occurring at a very fast pace that are essential for changing incumbent regime. (5) "Empowering niches" which refers to the provision of resources that facilitates innovations; and "anticipation and adaptation" which based on understanding of the dynamics of a complex system will help anticipate

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and adapt to the unpredictability of the systems. (6) "Transition experiments" are to be conducted examining feasibility and infrastructure requirements; while monitoring and evaluation are needed for effective scale-up. In the context of island EV transitions, such conditions influence the setting boundaries and end goals without which transitions could end prematurely, rebound, or overshoot the idealized steady state (Geels, 2002).

However, whatever level the transition might occur, it happens in a sequence of four phases—predevelopment, take-off, acceleration, and stabilization. A manifestation of these phases is what Rotmans and Kemp (2003) coined as The S-curve. The predevelopment occurs before the precipice of the transition during which there are little to no visible changes but there are underlying tones that suggest an imminent change such as unrest or a call to action. The take-off point denotes where the system begins to alter and the structural changes needed for transition gather momentum. Acceleration occurs where the system rapidly shifts and the structural changes become obvious while the final stage of stabilization is where the new dynamic state is achieved and steadied. Importantly, the pace and completion of all four phases or passage from one phase to the other is dependent on the alignment of several conditions (policies for transition and transition management) and the timeframe it takes to achieve this alignment differs based on the situation and location being assessed. Thus, it is difficult to ascribe a timeframe for the completion of a transition or the passage from one phase to another.

4 | POLICY-ENHANCED TRANSITIONS

4.1 | The national level policy environment for EV transitions

Many island nations recognize the need for an EV transition in addressing GHG emission mitigation goals and achieving energy independence. Several SIS have developed comprehensive EV goals and visions for an EV transition. One proactive example is Malta, where a detailed EV policy programs in the form of its National Electromobility Platform is being implemented. In developing this platform, Malta is poised to create one of the fastest EV transitions in the island world. However, many island nations have not yet set EV objectives or released formal policy while others have outdated energy policy programs, which should be updated (Shah et al., 2021). Below are the profiles of the SIS we are focusing on in this review (Table 1).

4.1.1 | Antigua and Barbuda

This island state possesses a Sustainable Energy Action Plan (SEAP) and a NEP that includes a plan for the implementation of fiscal policies that would help the nation transition to a green economy while also embarking on institutional reforms that would make the transition feasible—creation of the Energy Unit that is responsible for the implementation of the other Energy-Uses Policy under the Office of the Prime Ministry, enabling the Ministry of Finance and the Economy to establish required financial and tax incentives, and enabling local educational institutions to keep abreast of sustainability research (United Nations, 2012).

4.1.2 | Bahamas

According to its NEP for the 2013–2033 period, fiscal policies that will discourage the importation of inefficient vehicles by "linking the tax regime to mileage per gallon and the engine capacity" and reduce the import duties on hybrid and EVs will be implemented. Also, policies that encourages efficient traffic management like carpooling, flexi-work hours, tele-commuting, and use of public/urban mass transit transport system will be created and implemented. Other polices that would prompt EV transitions in Bahamas include directing the Finance Ministry to fund programs that encourages innovation and facilitating private sector investments in such programs, directing the Ministry of Education to facilitate the infusion of energy conservation and efficiency across the curricula in all levels of the educational system, and the review and amendment of appropriate governance, institutional, legal, and regulatory framework in order to make all of the above policies legally applicable (Bahamas Ministry of the Environment and Housing & Bahamas Ministry of Works & Urban Development, 2013).

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TABLE 1 National level policy declarations on EVs and clean transportation

SIS	Most recent EV-related National Level Policy Document	Notable EV relevant points made in the National Policy Documents	Year developed	Implementation years
Antigua and Barbuda	SEAP and NEP	-Developing a sustainable energy action plan to lower overall cost and environmental damage	2010	2012–2030
Bahamas	NEP	-Fiscal policies that will discourage the importation of inefficient vehicles -Reduce the import duties on hybrid and EVs -Traffic management like carpooling, flexi-work hours, telecommuting, and use of public/urban mass transit transport systems will be created and implemented. -Fund programs that encourage innovation and facilitate private sector investments	2010	2013–2033
Barbados	NEP	-Goal to reach 100% reliance on renewable energy and carbon neutrality by 2030 -Goal of 100% electric bus and government fleets by 2030 -Reduced EV Duties -Working with local university to make EV maintenance part of auto maintenance course -Constructed 45 public chargers	2018	2019–2030
Belize	—	-Created a National Energy Policy with a dominant vision to increase renewable energy dependence in the region	—	—
Bermuda	IRP	-Eliminated duties on EVs, EV batteries, charging stations and accessories -Hosted EV-Vender Showcase	2019	2020–2040
Cabo Verde		-Publicly recognize that renewable energy is a method to reduce dependence on imported fuel and resolve to make goals to increase renewable energy percentage.		
Cayman Islands	NEP	-Goal to reach 70% reliance on renewable energy by 2037 -Goal to convert 10% of public fleet to electric	2016	2017–2037
Dominica	Draft NEP	-Studying the feasibility of integrating electric vehicles into the transport sector, including exploring partnerships with electric vehicle manufacturers	2011	-
Dominican Republic	NEP	-Goal to reach 25% reliance on renewable energy by 2025 50% reduction on duties for EV registration fees Promoting public awareness showcases	2010	2010–2025
Fiji	NEP	-Placed zero duty on EVs, hybrid vehicles, LPG, CNG and solar powered vehicles -Placed zero duty on EV-related items, including solar and electrical charging stations and energy storage systems that are imported by companies involved in renewable energy	2013	2013–2020
Grenada	NEP	-Vision to achieve 20% Market Penetration with Hybrid and Electric Vehicles -Preparing a pilot EV program for public fleets	2011	2012–2030
Guyana	Draft NEP	-Placed tax exemption on EVs -Devoted to determining the infrastructure and grid integration needs for EV implementation -Facilitating the adoption of EVs in the private sector by demonstrating feasibility -Encourage the adoption of electric vehicles through education and awareness.	2016	2016–2025

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TABLE 1 (Continued)

SIS	Most recent EV-related National Level Policy Document	Notable EV relevant points made in the National Policy Documents	Year developed	Implementation years
Jamaica	-	-Goal to reach 50% reliance on renewable energy by 2030 -Policy states a single electric company is licensed to sell electricity	-	-
Maldives	—	-Project to accelerate private investments in renewable energy -Project to support ongoing climate neutrality strategies in several sectors of the Maldives government	—	—
Malta	National Electromobility Action Plan	-Launched the Malta National Electromobility Platform consisting of 19 unique objectives to carry out a comprehensive electric vehicle transition program -Previous goal to put 5000 BEVs on Maltese Roads by 2020 -Construct a Demo-EV project to showcase electric vehicles -Plans to construct over 100 charging ports and related EV infrastructure -Launched Hotel e-car sharing project to market EVs to tourists -Launched e-car sharing program to encourage carpools	2013	2014–2020
Mauritius	Long-Term Energy Strategy	-Priority given to potential project on using alternative fuels derived from sugar-cane by-products for transportation	2009	2009–2025
Saint Lucia	NEP	-Goal to reach 30% reliance on renewable energy by 2020	2010	2010–2020
Saint Kitts and Nevis		- Stimulate and guide the adoption of alternative-powered vehicles - Promote the continued cost–benefit analysis of replacing gasoline or diesel-fueled transportation with natively-powered alternative fuel transportation - Minimize the import of low-efficiency or outdated vehicles		
Singapore	Climate Action Plan	-Program to construct 2000 charging kiosks -Preparing a pilot EV program for public fleets -Launching a EV car-sharing pilot program	2016	2016–2050
Trinidad and Tobago	—	-Set in place physical goals and objectives to reduce carbon emissions and take tangible action against climate change -Agreed to reduce 15% of total emissions as part of Nationally -Determined Contribution (NDC) to the Paris Agreement -Developing Electric Vehicles Pilot Program as part of The Private -Investment Mobilization Training Program	—	—

Abbreviations: EV, Electric Vehicles; IRP, Integrated Resource Plan; NEP: National Energy Plan; SIS, Small Island States; SEAP: Sustainable Energy Action Plan.

4.1.3 | Barbados

Already considered as a regional leader in EV deployment with 1.28% of the 2018 new car sales in the nation being EVs (Viscidi et al., 2020), Barbados has an NEP developed by the Ministry of Energy and Water Resources for the 2019–2030

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period. This includes policy measures that would provide tax incentives to vehicle dealerships that provide training for their mechanics in the maintenance and repair EVs, remove duties, and value-added taxes (VAT) on EVs, and increase the number of EVs in the national transportation fleet with a goal of making the fleet 100% electric by 2030. While integrating them with existing gas stations, more charging stations are to be constructed. In addition, policies that will encourage investment in EV infrastructures and develop standards and regulatory framework for EV infrastructures will be implemented (Barbados Ministry of Energy & Water Resources, 2019).

4.1.4 | Belize

With no specific mention of policies that will promote EV transition, Belize's proposal for a NEP document suggests that policies that will encourage the development of subsectors concerned with other forms of transportation to be implemented (Government of Belize, 2011).

4.1.5 | Bermuda

Although Bermuda is yet to set specific long-term targets for EV adoption, it has implemented polices that encourage EV transition such as making EVs, EV batteries, and EV charging stations (including their parts and accessories) duty-free since 2012, 2017, and 2018, respectively. Additionally, the country also embarked on public education of the benefits or EVs, and partially electrifying the public transport fleet (Viscidi et al., 2020). The above goals are based on the country's energy vision detailed in its Integrated Resource Plan (IRP) that aims to have 85% renewables on its electricity grid by 2035 (Regulatory Authority of Bermuda, 2019). The 2019 Transport Green Paper (Government of Bermuda Ministry of Tourism and Transport, 2019) also examines concrete potential solutions toward the EV transition, with an added focus on the barriers.

4.1.6 | Cayman Islands

With a goal of increasing the fraction of Cayman Islands' fleet of vehicles that are fuel efficient, electric, or hybrid according to the nation's NEP, policies to be implemented include ensuring that 7%–10% of the fleet of car owned by the government are EVs by 2022, put 0% and 10% duties on EV and hybrids, respectively, until 2022, and mandate vehicle dealers and resellers to inform prospective buyers of vehicle fuel efficiency (Cayman Islands Government, 2017; Viscidi et al., 2020).

4.1.7 | Dominica

This island nation will study the feasibility of integrating EVs into its transport sector while exploring potential partnerships with EV manufacturers in a bid to promote efficient vehicles according to its 2011 draft NEP (Department of Sustainable Development of the General Secretariat of the Organization of American States, 2011).

4.1.8 | Dominican Republic

Based on its 2010–2025 NEP, policies in this island nation that would promote EV transition include the development of regulatory frameworks for EV infrastructure especially the location, installation, supervision, and quality of service charging stations, removal of half of the duties and registration fees for EVs. However, the duty reduction is redundant and has a very minute impact on the national EV market as they are mostly imported from the United States and are thus duty-free due to the Dominican Republic-Central America-United States Free Trade Agreement (CAFTA-DR) (Viscidi et al., 2020).

4.1.9 | Fiji

Although, the nation is in the process of developing a new NEP, the NEP developed in 2013 for the 2013–2020 period aims to "explore the potential for introduction of hybrid and electric vehicles." (Government of Fiji, 2013).

4.1.10 | Grenada

With a goal of 20% electric and hybrid vehicles market penetration by 2020 according to the nation's NEP, policies that would be implemented to promote EV transition include the introduction of annual quota for EVs, hybrids, and other alternatives that are energy efficient and develop pilot programs for introducing EVs into the public transport fleet (Government of Grenada, 2011; Nachmany et al., 2015).

4.1.11 | Guyana

According to Guyana's draft NEP green paper, one of the objectives for the transportation sector is to foster the development of an EV industry, which will replace the current fossil fuel-dependent transportation industry (Clarke, 2017). To achieve this objective, the government will investigate the infrastructural needs for EV ownership, grid integration requirements and standards, and training requirement of personnel for EV maintenance. In addition to providing tax exemption for EVs (Guyana Revenue Authority, 2020), the government will facilitate private sector procurement of EVs and charging stations as part of feasibility studies to demonstrate to the general public that EVs can be used in the country while also educating and spreading awareness of the benefits of EVs.

4.1.12 | Jamaica

Although the nation's NEP for the 2009–2030 period aims to encourage energy conservation in the transportation sector, a transition to EVs was not included in this plan (Jamaica's Ministry or Energy and Mining, 2009). However, there exist fiscal policies that could ignite the EV market in this island nation like exemption of EVs from special consumption tax (about 10%–20%) and the general consumption tax (about 21.5%) (Viscidi et al., 2020).

4.1.13 | Maldives

The 2016 NEP also aims to promote energy conservation and efficiency in the transportation sector by regulating vehicle exhaust emissions but made no mention of transitioning to EVs. However, import duties on EVs will be removed to the mark of 200% compared to gasoline and diesel vehicles (Republic of Maldives Ministry of Environment and Energy, 2017).

4.1.14 | Malta

With the most robust plan documented in the Malta National Electromobility Action Plan for the 2014–2020 period, this island nation's goal is to put 5000 EVs on its road by 2020 while making sure that 25% of all annual vehicle purchases by the government are EVs. These goals are to be achieved through the implementation of transition policies which include fiscal policies like direct payments, scrappage schemes, subsidies on car batteries and charging; public funding of charging stations; creation of demonstration projects, enable knowledge transfer of innovations in the EV industry, and facilitate informative and educational campaigns targeted at potential users (Malta National Electromobility Platform, 2013).

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4.1.15 | Mauritius

This island nation's long-term energy strategy (2009–2025) indicates that fiscal incentives (0% excise duty, reduced registration duty and reduced road tax) that would promote the use of hybrid and EVs will be implemented (Republic of Mauritius Ministry of Renewable Energy & Public Utilities, 2009).

4.1.16 | Saint Lucia

To achieve an energy-efficient transport sector, the government of Saint Lucia plans on maintaining "a level of adequate taxation on motor vehicles as well as take measures to ensure improved vehicle maintenance" (Government of Saint Lucia, 2010).

4.1.17 | Singapore

With the goal of increasing the carbon efficiency of the transport sector, EV pilot programs were implemented in phases—an initial deployment of 89 EVs in the first phase between 2011 and 2013 followed by subsequent deployment of 1000 EVs and 2000 charging stations. Also, private and public sector living labs are facilitated for creation of innovations purposes (the Eco Campus program at Nanyang Technological University and the Campus for Research Excellence and Technological Enterprise) (Government of Singapore, 2016).

4.1.18 | Trinidad and Tobago

In a bid to encourage the adoption of EVs, the nation's Financial Act of 2020 mandated that no import duty or motor vehicles tax be levied on EVs (Republic of Trinidad and Tobago, 2020).

4.2 | EV transition policies in relation to NDCs

To ensure that countries take on greater climate action over time, the 2015 Paris Agreement requires each country to prepare and communicate NDCs every 5 years. This provided countries to independently shape their international climate commitments based on their national priorities. In 2015, 172 countries identify transport as an important source of emissions and area of action, 14 countries specify a transport-section GHG emission reduction target, and 119 countries define mitigation actions in the transport sector. The SIS are among the countries that are ready to enhance their NDCs, yet the first round of NDCs failed to connect between climate actions that also strengthen their sustainable development agendas, which would in turn incentivize their implementation going forward. Otherwise, given the relatively smaller economies and their resource constraints of the SIS, the alignment of their national and international agenda and goals become highly essential in light of the domestic issues faced, priorities, and getting the needed international support (both structural and financial). We reviewed the NDCs of the studied SIS to see the role transport, and specifically, electric mobility is playing in meeting their targets.

Like in the NEPs of the reviewed island nations, the planned actions for the transition to EVs in their NDCs fall under two major categories—fiscal policies and set targets for EVs. Barbados, Malta, Singapore, and Trinidad and Tobago have NDCs with specific planned actions and targets that will facilitate the transition to EVs and are aligned with the actions specified in their most recent EV-related national level policy document. For the case of Maldives and Mauritius, both nations' NDCs and national level documents are aligned in their lack of specific actions for EV transition. Antigua and Barbuda, Belize, and Dominica have NDCs with more specific planned actions for the transition to EVs compared to their SEAP or NEP while Fiji and Grenada have less specific planned action for the transition to EVs compared to their NEPs (Table 2).

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TABLE 2 SIS NDCs and relevant defined EV/clean transport statements therein

SIS-NDC cycle	Transport identified as an important source of emissions and area of action and	Defined mitigation actions in the transport sector
Antigua and Barbuda 2015	Yes	a) Establish efficiency standards for the importation of all vehicles and appliances by 2020 b) Change fiscal policies on fossil fuel by 2025 to enable transition to 100% renewable energy generation in the transportation sector 2025
Antigua and Barbuda 2021	Yes	a) Ban on the importation of new ICE vehicles by 2030 b) 100% of government vehicles will be electric by 2035
Bahamas 2015	No	No specific

Abbreviations: EV, Electric Vehicles; ICE, Internal Combustion Engines; NDC: Nationally Determined Contributions; SIS, Small Island States.

5 | MULTILEVEL TRANSITION TO EVS

The sequence of the four phases of transition can be used in evaluating the level of implementation of EV transition policy as each stage requires increasing levels of policy implementation. The predevelopment phase does not require the existence of any form of transition policy as it is the time before the start of the transition itself. The emergence of the take-off phase during which the system starts to change is dependent on the introduction of policies, ideally at the national level. This can take the form of a national action plan that not just articulates the need for a transitioning to EV but also how the transition is to be achieved. Also, the initial implementation of the policies that incentivize the adoption of EVs starts in the take-off phase thereby rocking the vehicle markets in the nations. In the acceleration phase comes the maturity of the EV incentivizing policies, a feat that is achieved after rounds of monitoring, evaluation, and adjustment of the EV transition policies. During the acceleration phase, the public transportation sector and all levels of government would have majorly, if not totally, bought into the use of EVs and the private sector is not far behind but still requires some incentives (Shah, 2021). In the final stage of stabilization, all EV transition policies have been successfully implemented, EVs are capable of winning in the market, and incentives are no longer required.

The multilevel perspective of transitions is typically used to analyze past episodes of transformational innovation (Genus & Coles, 2008). However, several indicators can be used in predicting which level transition is to be initiated—technology adoption capacity, governance system, economic system, human capital, and many more. The World Intellectual Property Organization's yearly Global Innovation Index (GII) provides estimates that incorporated some of these indicators. The GII comprises of two subindices: the first is the innovation input subindex that is comprised of a measure of the existing institutions (government, political stability, and rule of law), human capital and research (education and R&D), infrastructure, market sophistication (credit availability and private sector investment), and business sophistication (knowledgeable workforce and innovation linkages). The second subindex is the innovation output subindex that comprises of a measure of knowledge and technology outputs (knowledge creation, impact, and diffusion), and creative outputs (intangible assets and services) (World Intellectual Property Organization, 2021).

Transition at the meso-level will require a medium score for all the subindexes while a high score for institutions and infrastructure is essential for transition at the macro-level. Transition at the micro-level, however, will require a high score for human capital and research, market sophistication, business sophistication, and knowledge and technology outputs. Among the nations profiled in the 2021 GII report are Dominican Republic, Jamaica, Malta, Mauritius, Singapore, and Trinidad and Tobago and Table 3 shows these Island Nations' sun-index scores and the probable level transition will be initiated.

6 | EV TRANSITION MANAGEMENT

The scholarly literature points out several actions being taken by island nations that represent aspects of active transition management. Using Fischer-Kowalski and Rotman's nomenclature of such transition management conditions (Section 2), we summarize the evidence below.

TABLE 3 Transition level in selected island nations based on the global innovation index (GII) scores

Island nation	Institutions score	Human capital and research	Infrastructure	Market sophistication	Business sophistication	Knowledge and technology outputs	Creative outputs	Transition level
Dominican Republic	55.1	18.5	39.6	35.5	21.8	11.7	19	Macro
Jamaica	71.6	25	29.9	36	26	13.5	29.6	Macro
Malta	73.9	39.3	56.4	47	53.7	28.3	52	Meso
Mauritius	81.2	30.6	42.4	55.5	17.1	13.6	36.3	Macro
Singapore	95.1	58.7	57.8	75.9	62.7	48.1	42.9	Micro
Trinidad and Tobago	62	19.2	33.8	35.8	18.3	15.8	15.6	Macro

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Radical change in incremental steps is evident in some SIS (i) *comprehensive energy strategies* and (ii) *public awareness promotion initiatives*. The use of EVs could increase electricity demand and risk grid damage. This has to be placed in the context of larger national energy strategies as noted in several islands such as Barbados and Malta (Chae et al., 2020; Clairand et al., 2020; Neofytou et al., 2019). If a goal is to reduce GHG emissions and imported fuel costs, renewable energy generation must be implemented (Pina et al., 2014). SIS including, for example, Jamaica and Antigua and Barbuda have already set renewable energy targets. Additionally, the use of V2G would be highly beneficial to SIS as the system would reduce strain on the electricity grid, assist in peak demand shift, and add additional battery storage. Investments being made in V2G infrastructure include charging stations, and technical training for maintenance (Taibi & Fernandez del Valle, 2017).

One of first and highly visible steps being taken in some SIS is active promotion of private EV vehicles often in conjunction with vehicle distributorships operating in the islands. But more efforts are needed to increase public knowledge of EVs, dispelling misconceptions and promoting benefits of the technology. Studies have found that by supplying additional information to citizens, there is an increased chance that these citizens will purchase EVs (Díaz et al., 2015). Nations such as Bermuda, the Dominican Republic, and Malta have held EV showcases to increase awareness (Malta National Electromobility Platform, 2013; Viscidi et al., 2020). In addition to showcases, informational campaigns in collaboration with auto distributors can be designed to promote EVs.

Establishing space for and empowering EV niches is evident in some SIS that have (i) *Set ambitious transportation sector vision* and (ii) *acted to remove any negating policies*. Pointed government efforts to carve a local EV market (e.g. Mauritius, Singapore) may be stronger precursors to EV diffusion than general policy declarations for clean transportation. Visions provide a target to aim for when making policy; the more ambitious the better, especially when accompanied by documented goals. Goals such as those articulated by Barbados and the Cayman Islands are realistic, incremental and come with specific, actionable, and measurable steps to completion. There should be regular reassessment and readjustment of goals and steps.

We also note that apart from the NEPs and NDCs, a few countries have also considered how other related policy and regulations might inadvertently reverse or impede the transition. SIS can be particularly vulnerable in providing large concessions to traditional vehicle distributors and local ICE business interests, with those special interests in opposition to an EV transition. Policies giving monopolies to EV or electric companies may also slow the transition by preventing decreased prices due to natural competition (Mitchell, 2016). Further policy to avoid involves increasing the difficulty in obtaining an EV including taxes, import fees, and lack of focus on EV infrastructure. Rebound effects could lead to unnecessary strain on the electric grid. SIS such as Trinidad and Tobago are considering removal of special concessions afforded for the import of used ICE vehicles. Any policy deemed to be negating the transition should immediately be refined or revoked (Bridgman & Davis, 2003).

Focusing on 'frontrunners' is evident in some SIS that (i) *Encourage the purchase of private EVs* and (ii) *Coordinate horizontally and specifically with the tourism sector*. A study conducted on the island of Tenerife in the Canary Islands found that only 4.4% of the population was willing to buy EVs without government subsidized support (Ramos-Real et al., 2018). Therefore, it is essential that policy incentives be used for upscaling EV proliferation. Incentives may include purchase subsidies, battery warranties, decreases on taxes, in home charger installations, free parking, and special lanes. It is good practice to survey the community prior to planning incentives. Wang et al. (2019) found financial incentives were less impactful in some countries than factors such as fuel price and road priority, and Kwon et al. (2018) determined EV ownership benefits on one island nation were preferred over purchase subsidies on Jeju island. It is recommended that early adopters be targeted first for EV uptake. These individuals are found to have a high level of environmental concern, are middle-aged, and are in the upper middle class (Ramos-Real et al., 2018).

Tourism accounts for large portions of island mobility in many SIS as tourists rent vehicles for their stay, there are tour operators and hotel and hospitality business fleets to bring their personal vehicles on vacations to the islands, on-island rental services must be used. Due to large amounts of tourist transportation, island nations face environmental degradation and pollution which could be reduced with a shift to EVs (Kempton & Tomić, 2005). For these reasons some SIS including Jamaica and Malta work alongside hotels and car rental services to provide affordable EVs to tourists in place of the contemporary ICEs. Malta has launched a hotel e-car sharing project to encourage EV usage among tourists (Malta National Electromobility Platform, 2013). Furthermore, public transportation routes should be optimized to serve prime tourist locations, giving tourists an option to travel which does not involve private vehicles (Martín Martín et al., 2019).

Guided variation and selection is emerging in some SIS through *(i) Increasing efficiency standards of EVs*. To decrease the amount of energy needed per vehicle, efficiency standards for EVs should be set and periodically raised. In

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doing so less electricity is needed per vehicle, leading to less strain on the electricity grid. Such goals can be accomplished by methods similar to current ICE fuel standards (Lutsey, 2017; Reczek, 2017), in which limits for energy consumption are set and cannot be surpassed. Some SIS such as Bermuda and Trinidad and Tobago have vehicle efficiency standards in place that can be updated to accommodate EV vehicle standards. Many other SIS however, do not have such regulatory systems and rely solely on vehicle manufacturer guarantees. When considering efficiency standards policymakers should be aware of the rebound effect (Gillingham et al., 2016), in which a decrease in energy consumption per mile encourages vehicle owners to drive more, nullifying the attempt to decrease electricity use. Such effects should be carefully and constantly monitored, and policy should be regularly revised.

Experimentation with approaches is becoming more evident in (i) *Promoting public transport* and (ii) *constructing charging stations*. Public transportation fleets are ideal for EV technology as they have consistent routes and centralized areas to construct charging ports. Nearly every SIS studied has at least a pilot EV in its public sector fleets, from public transport buses to hospital, police or emergency vehicles. However, this experimental stage has not yet borne fruit of full-fledged EV fleets. Often, these pilots have been co-sponsored by external funding such as from donor or multilateral agencies, with expectations that national governments expand the programs (Deenapanray & Khadun, 2021; Martín Martín et al., 2019).

Constructing charging stations and EV infrastructure at strategic locations is imperative to EV uptake. Simultaneously, the charging stations must be powered by renewable energy sources, as both the transport and energy transition need to occur hand-in-hand. This is feasible in certain islands, as is the case of Barbados. Charging stations should be planned for locations where EV owners find it convenient to plug in their vehicles. Doing so will reduce range anxiety and make EVs more appealing (Kwon et al., 2018). Additionally, copious EV infrastructure will serve as a form of advertisement for EVs as seen in Porru et al. (2020) model of a Multistage Design Procedure for planning charging stations on islands. Already nations such as Barbados and Malta have constructed public charging stations (Malta National Electromobility Platform, 2013; Viscidi et al., 2020). Lastly charging stations for large public fleets must be constructed.

Table 4 illustratively summarizes the transition management conditions that exist or are enabled through national policies/plans/strategies or NDC declarations in each SIS context. This qualitative estimation is developed by the authors based on the publicly available documentation available.

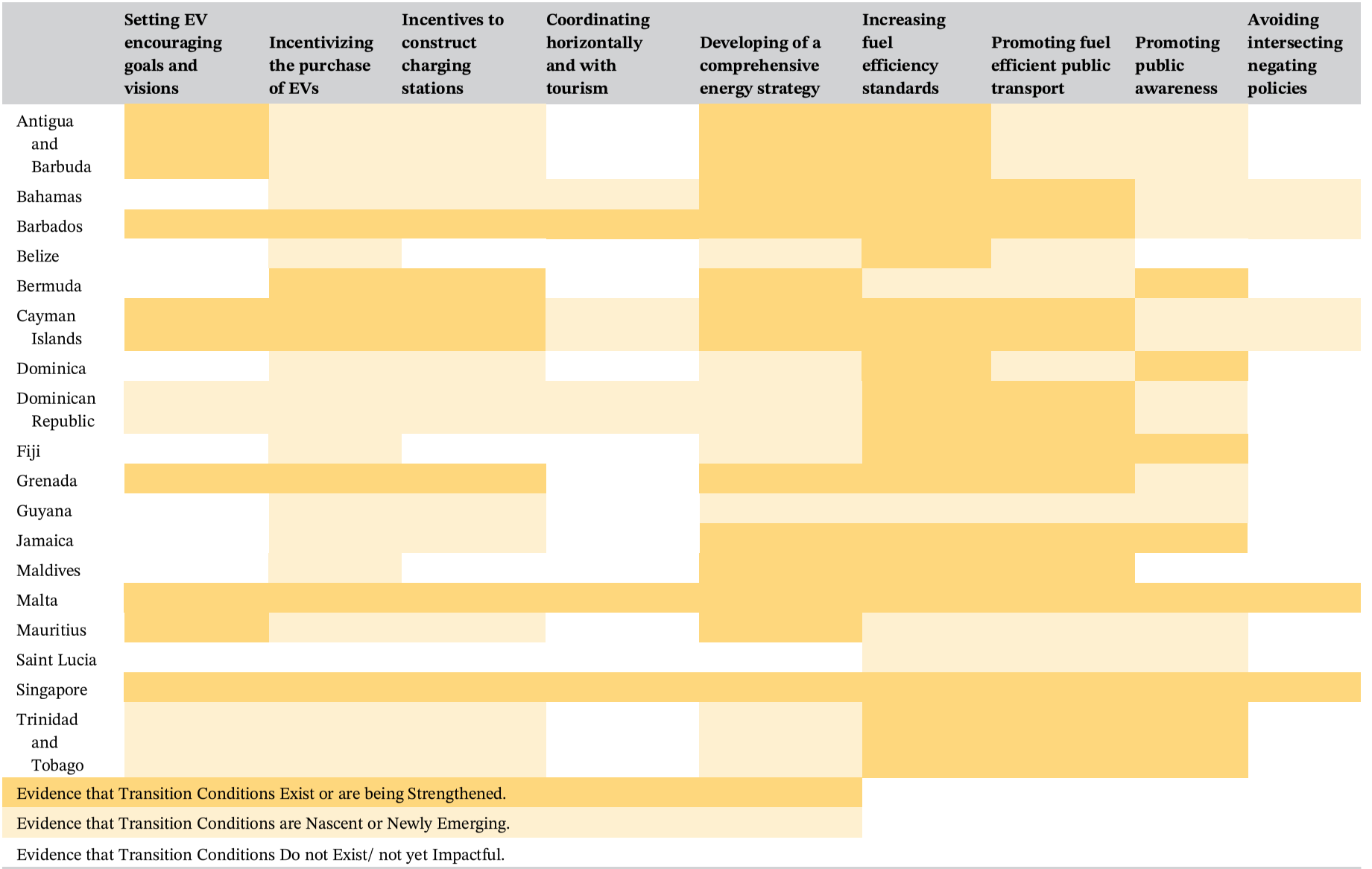
7 | ISLAND TRANSITIONS: THE S-CURVE INTERPRETATION

Based on current national EV transition policies highlighted in national policy documents and their NDCs, we are able to qualitatively plot an S-Curve of transition (see Figure 2) based on Rotmans and Kemp (2003). Jamaica and Maldives are in the pre-development stage as there is no recognition of the need for EV transition in both their national action plan and NDC. Although both nations have a few incentives that could help with the adoption of EVs, their impact is very minuscule. Belize and Trinidad and Tobago are at the early stage of the take-off phase though both nations also did not recognize the need for EV transition in both their national action plan. But the adoption of EVs is part of Belize's NDC while Trinidad and Tobago has fairly new legislation that encourages the adoption of electric vehicles. The other island nations are in the take-off phase because they recognize the need for EV transition in their national action plan or have EV adoption as part of their NDC or both and have started implementing policies that will effect structural changes that enables the transition to EV except for Barbados, Cayman Islands, Malta, and Singapore. These remaining group of island nations are in the acceleration phase as they are rapidly transitioning to EVs with just more scaling up required for the transition to be complete (see Figure 2).

8 | CONCLUSIONS

SIS are primed to be ideal locations for the first national EV transitions due to their reliance on imported fuels, high potential for renewable energy generations, and low levels of range anxiety. Transitioning from ICEs to EVs is greatly beneficial for both the island nations and the global community. By understanding why and how transitions occur, policy makers of the island nations can best manage the shift from one steady state to the other. By setting goals and visions for the implementation of EVs, encouraging purchase of EV's through incentives and infrastructure, and ensuring the electricity grid can manage an increase in electricity use, SIS may smoothly transform from a reliance on imported, carbon-based fossil fuels to a cleaner, electricity-driven society.

TABLE 4 Transition management conditions[a]



[a]Evidence of conditions are listed as a way of stocktaking and understanding the literature more than declaring clearly siloed delineations of conditions.

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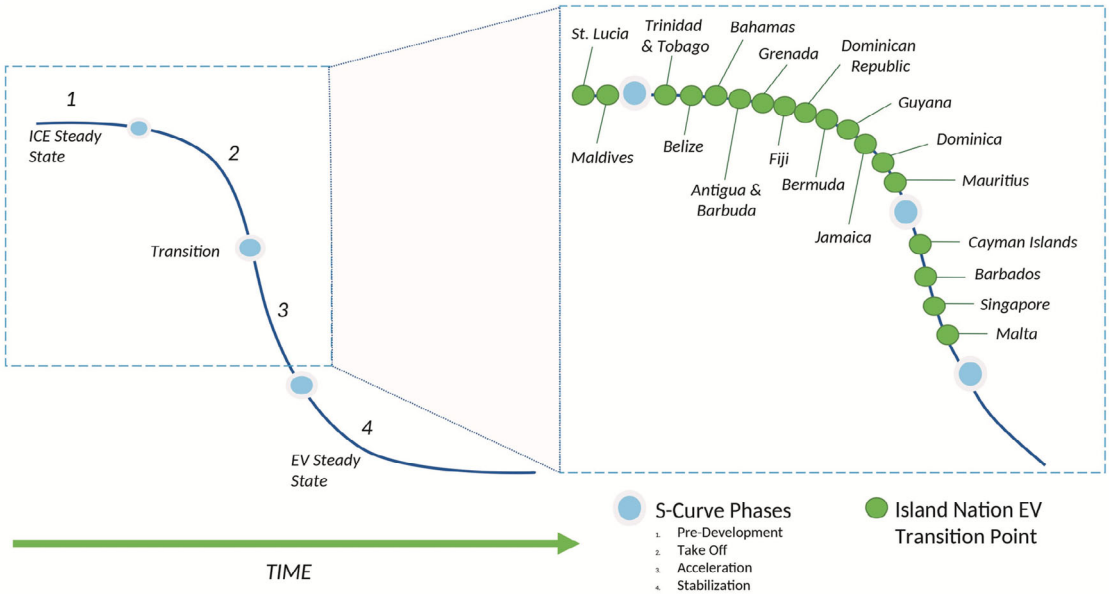

FIGURE 2 An EV transition S-curve based on qualitative review of Small Island states

Since long-term strategies span a longer time horizon, it needs to provide synergies with short-term targets, including the 5-year cycle of NDC updates. Ideally, energy plans, especially for the islands whose energy plans predates 2015, should be developed simultaneously with an NDC cycle update. Opportunity to include island-specific opportunities in the current revisions of NDCs and sustainable national roadmaps or long-term planning. Specific targets need to factor in the lack of charging infrastructure, technical support capability and capacity and standards. National policies incentivizing EVs and limiting imports of ICEs in the NDCs then align with long-term goals of achieving decarbonization and help islands transition from the Take-Off stage to Acceleration. This way, more alignment between islands' energy roadmaps and long-term planning with the NDCs to bring about synergies and fully utilize the relatively smaller resource pool of small island economies.

Electrifying public transport has huge potential—with their high kilometers traveled per day, lower fuel economies, resulting in higher carbon reduction per vehicle. Public transport on SIS in seen as a social good, and bus transport is the most dominant form of public transit on the majority of SIS. Being regulated by the government, electrifying the fleet becomes simplified from a regulatory point of view. For instance, Fiji will be trialing a 20 e-buses program to assess and model the technical and financial options while Bermuda has ordered 30 e-buses to replaced aged diesel buses. Pilot projects such as these are ideal for islands currently in the take-off stage to demonstrate how a rapid transition is possible, and help in public acceptance and perception for electric mobility, a considerable hurdle that must be overcome to increase EV uptake. Islands in the acceleration stage such as Barbados and Singapore have already started their e-bus trials. Barbados has deployed 33 electric buses and installed all the necessary infrastructure such as charging stations and there are currently 60 electric buses in Singapore serving commuters, part of a longer-term goal for all of Singapore's 5800 public buses to be electrified by 2040. Other SIS, such as Mauritius, are also including the integration of electric buses into a transit-oriented restructuring of the urban settlement areas with easier connectivity to various transport hubs.

Many SIS have already started this transition, with pilot projects on the rise in a number of islands. However, transitioning requires necessary policy frameworks. A faster upscale of EVs on islands will far outweigh climatic benefits, and increase impacts such as reducing air pollution, alleviating congestion, and improving energy security. We recommend more targeted regulations and concrete goal settings; low-carbon infrastructure and regulatory capacity; using collective actions and support (need for stronger regional and SIS-SIS cooperation and scale-up existing initiatives). Also, SIS have repeatedly stated that they need accessible climate funding for a low-carbon transport transition. Therefore, there is a need for the international climate arenas, such as the UN Climate Action Summit and the United Nations Framework Convention on Climate Change (UNFCC) to significantly support the SIS' sustainable development goals.

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CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

ENDNOTES

[1] An exception was due to to the COVID-19 pandemic and the ensuing economic crisis, which led to an approximately 14% decrease in the sector's emission levels in 2020 (IEA, 2020, 2021; Le Quéré et al., 2020).

[2] The SIDS are recognized by the United Nations as a special group of countries which share similar development challenges (https://unohrlls.org/about-sids/). Singapore is included in our analysis despite its high-income classification due to its frontrunner status with the SIDS group and its participation within the SIDS negotiation bloc AOSIS at global climate negotiations. The three SIS, Bermuda, Cayman Islands, and Malta are included to provide non-SIDS island comparison. States such as Belize and Guyana are also included in the study as they have been designated SIS on a political level, rather than based on geographical factors.

AUTHOR CONTRIBUTIONS

Kalim U. Shah: Conceptualization (lead); data curation (lead); formal analysis (lead); investigation (lead); methodology (lead); project administration (lead); validation (lead); writing – original draft (lead); writing – review and editing (lead). **Mohammed Awojobi:** Data curation (supporting); formal analysis (supporting); visualization (equal); writing – original draft (supporting); writing – review and editing (supporting). **Zakia Soomauroo:** Formal analysis (supporting); visualization (supporting); writing – original draft (supporting); writing – review and editing (supporting).

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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FURTHER READING

Brown, R., Webber, C., & Koomey, J. G. (2002). Status and future directions of the energy star program. *Energy*, *27*(5), 505–520. https://doi.org/10.1016/S0360-5442(02)00004-X

Edenhofer, O., Flachsland, C., Wolff, C., Schmid, L. K., Leipprand, A., Koch, N., Kornek, U., & Pahle, M. (2017). *Decarbonization and EU ETS Reform: Introducing a price floor to drive low-carbon investments*. 20.

Geels, F., Turnheim, B., Asquith, M., Kern, F., & Kivimaa, P. (2019). *Sustainability transitions: Policy and practice* (EEA Report No. 9/2019). European Environmental Agency.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417. https://doi.org/10.1016/j.respol.2007.01.003

Mazzucato, M. (2018). *Mission-oriented research & innovation in the European Union: A problem-solving approach to fuel innovation-led growth*. Publications Office of the European Union.

Schot, J., & Steinmueller, W. E. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy*, *47*(9), 1554–1567. https://doi.org/10.1016/j.respol.2018.08.011

REFERENCES

Bahamas Ministry of the Environment and Housing, & Bahamas Ministry of Works & Urban Development. (2013). *The Bahamas National Energy Policy 2013–2033*. https://eh.gov.bs/wp-content/uploads/2016/10/Bahamas-National-Energy-Policy-2013-2033.pdf

Barbados Ministry of Energy & Water Resources. (2019). *Barbados National Energy Policy 2019 – 2030*. https://sandbox.7scorp.com/nrd2020/download/national-energy-policy-2019-2030/?wpdmdl=3330&refresh=6101f685f09f91627518597

Bridgman, P., & Davis, G. (2003). What use is a policy cycle? Plenty, if the aim is clear. *Australian Journal of Public Administration*, *62*(3), 98–102. https://doi.org/10.1046/j.1467-8500.2003.00342.x

Cayman Islands Government. (2017). *National Energy Policy 2017-2037*. https://cnslibrary.com/wp-content/uploads/National-Energy-Policy-of-the-Cayman-Islands-2017.pdf

Chae, S. H., Kim, G. H., Choi, Y.-J., & Kim, E.-H. (2020). Design of isolated microgrid system considering controllable EV charging demand. *Sustainability*, *12*(22), 9746. https://doi.org/10.3390/su12229746

Clairand, J.-M., Álvarez-Bel, C., Rodríguez-García, J., & Escrivá-Escrivá, G. (2020). Impact of electric vehicle charging strategy on the long-term planning of an isolated microgrid. *Energies*, *13*(13), 3455. https://doi.org/10.3390/en13133455

Clarke, R. (2017). *Draft National Energy Policy of Guyana – Report 2—GREEN PAPER. 38*.

Deenapanray, P. N. K., & Khadun, N. A. (2021). Land transport greenhouse gas mitigation scenarios for Mauritius based on modelling transport demand. *Transportation Research Interdisciplinary Perspectives*, *9*, 100299. https://doi.org/10.1016/j.trip.2021.100299

Department of Sustainable Development of the General Secretariat of the Organization of American States. (2011). *Dominica: Draft National Energy Policy*. http://www.oas.org/en/sedi/dsd/Energy/Doc/OAS-DominicaNEP_web.pdf

Díaz, A. R., Ramos-Real, F. J., Marrero, G. A., & Perez, Y. (2015). Impact of electric vehicles as distributed energy storage in isolated systems: The case of Tenerife. *Sustainability*, *7*(11), 15152–15178. https://doi.org/10.3390/su71115152

Dulal, H. B., & Shah, K. U. (2014). Climate-smart'social protection: Can it be achieved without a targeted household approach? *Environmental Development*, *10*, 16–35.

Fischer-Kowalski, M., & Rotmans, J. (2009). Conceptualizing, observing, and influencing social–ecological transitions. *Ecology and Society*, *14*(2), 1–18. https://doi.org/10.5751/ES-02857-140203

Gay, D., Rogers, T., & Shirley, R. (2018). Small Island developing states and their suitability for electric vehicles and vehicle-to-grid services. *Utilities Policy*, *55*, 69–78. https://doi.org/10.1016/j.jup.2018.09.006

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy*, *31*(8), 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8

Geels, F. W. (2014). Regime resistance against low-carbon transitions: Introducing politics and power into the multi-level perspective. *Theory, Culture & Society*, *31*(5), 21–40. https://doi.org/10.1177/0263276414531627

Genus, A., & Coles, A.-M. (2008). Rethinking the multi-level perspective of technological transitions. *Research Policy*, *37*, 1436–1445. https://doi.org/10.1016/j.respol.2008.05.006

Gillingham, K., Rapson, D., & Wagner, G. (2016). The rebound effect and energy efficiency policy. *Review of Environmental Economics and Policy*, *10*(1), 68–88. https://doi.org/10.1093/reep/rev017

Government of Belize. (2011). *Proposal for a National Energy Policy in Belize*. http://www.oas.org/en/sedi/dsd/energy/doc/proposalnationalenergypolicyforbelize.pdf

Government of Bermuda Ministry of Tourism and Transport. (2019). *2019 Transport green paper*. https://www.gov.bm/sites/default/files/Transport-Green%20Paper-version-1.1-May-14.pdf

Government of Fiji. (2013). *Fiji National Policy 2013-2020 final draft*. https://policy.asiapacificenergy.org/sites/default/files/Fiji%20National%20Policy%202013-2020%20%28Final%20Draft%29.pdf

Government of Grenada. (2011). *The National Energy Policy of Grenada: A low carbon development strategy for Grenada, Carriacou and Petite Martinique*. http://www.oas.org/en/sedi/dsd/Energy/Doc/OASGrenada_HRprint.pdf

Government of Saint Lucia. (2010). *National energy plan*. http://www.oas.org/en/sedi/dsd/Energy/Doc/NEP_StLucia_web.pdf

Government of Singapore. (2016). Take action today: For a carbon-efficient Singpaore. https://sustainabledevelopment.un.org/content/documents/1545Climate_Action_Plan_Publication_Part_1.pdf

Guyana Revenue Authority. (2020, May 26). *Exemptions on electric motor vehicles*. Guyana Revenue Authority. https://www.gra.gov.gy/exemptions-on-electric-motor-vehicles/

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, *4*(1), 1–23. https://doi.org/10.1146/annurev.es.04.110173.000245

IEA. (2020). *Transport: Improving the sustainability of passenger and freight transport*. IEA. https://www.iea.org/topics/transport

IEA. (2021). *Global energy review: CO2 Emissions in 2020*. IEA. https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020

Jamaica's Ministry or Energy and Mining. (2009). *Jamaica's Energy Policy 2009-2030*. https://www.mset.gov.jm/wp-content/uploads/2019/07/National-Energy-Policy_0.pdf

Kempton, W., & Tomić, J. (2005). Vehicle-to-grid power fundamentals: Calculating capacity and net revenue. *Journal of Power Sources*, *144*(1), 268–279. https://doi.org/10.1016/j.jpowsour.2004.12.025

Kwon, Y., Son, S., & Jang, K. (2018). Evaluation of incentive policies for electric vehicles: An experimental study on Jeju Island. *Transportation Research Part A: Policy and Practice*, *116*, 404–412. https://doi.org/10.1016/j.tra.2018.06.015

Le Quéré, C., Jackson, R. B., Jones, M. W., Smith, A. J. P., Abernethy, S., Andrew, R. M., De-Gol, A. J., Willis, D. R., Shan, Y., Canadell, J. G., Friedlingstein, P., Creutzig, F., & Peters, G. P. (2020). Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement. *Nature Climate Change*, *10*(7), 647–653. https://doi.org/10.1038/s41558-020-0797-x

Lutsey, N. (2017). *Integrating electric vehicles within U.S. and European efficiency regulations*. https://doi.org/10.13140/RG.2.2.33048.80640

Mahadeo, G. E., Bahadoorsingh, S., & Sharma, C. (2017). Analysis of the impact of battery electric vehicles on the low voltage network of a Caribbean Island [Conference Presentation]. 2017 IEEE Transportation Electrification Conference and Expo (ITEC), Chicago, IL, 364–369. https://doi.org/10.1109/ITEC.2017.7993298

Malta National Electromobility Platform. (2013). *Malta National Electromobility Action Plan*. https://electromobility.gov.mt/en/Policies/Documents/The%20Malta%20National%20Electromobility%20Action%20Plan.pdf

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, *41*(6), 955–967. https://doi.org/10.1016/j.respol.2012.02.013

Martín Martín, J. M., Guaita Martínez, J. M., Molina Moreno, V., & Sartal Rodríguez, A. (2019). An analysis of the tourist mobility in the Island of Lanzarote: Car rental versus more sustainable transportation alternatives. *Sustainability*, *11*(3), 739. https://doi.org/10.3390/su11030739

Meadowcroft, J. (2005). Environmental political economy, technological transitions and the state. *New Political Economy*, *10*(4), 479–498. https://doi.org/10.1080/13563460500344419

Mitchell, S. (2016). *Monopoly power and the decline of small business*. Institute for Local Self Reliance, 28.

Mycoo, M. A. (2018). Beyond 1.5°C: Vulnerabilities and adaptation strategies for Caribbean Small Island developing states. *Regional Environmental Change*, *18*(8), 2341–2353. https://doi.org/10.1007/s10113-017-1248-8

Nachmany, M., Fankhauser, S., Davidová, J., Kingsmill, N., Landesman, T., Roppongi, H., Schleifer, P., Setzer, J., Sharman, A., Singleton, C., Sundaresan, J., & Townshend, T. (2015). *The 2015 global climate legislation study—A review of climate change legislation in 99 countries (summary for policymakers)*.

Neofytou, N., Blazakis, K., Katsigiannis, Y., & Stavrakakis, G. (2019). Modeling vehicles to grid as a source of distributed frequency regulation in isolated grids with significant RES penetration. *Energies*, *12*(4), 720. https://doi.org/10.3390/en12040720

Noel, L., Zarazua de Rubens, G., Kester, J., & Sovacool, B. K. (2018). Beyond emissions and economics: Rethinking the co-benefits of electric vehicles (EVs) and vehicle-to-grid (V2G). *Transport Policy*, *71*, 130–137. https://doi.org/10.1016/j.tranpol.2018.08.004

Pettifor, H., Wilson, C., McCollum, D., & Edelenbosch, O. (2017). Modelling social influence and cultural variation in global low-carbon vehicle transitions. *Global Environmental Change*, *47*, 76–87. https://doi.org/10.1016/j.gloenvcha.2017.09.008

Pina, A., Baptista, P., Silva, C., & Ferrão, P. (2014). Energy reduction potential from the shift to electric vehicles: The Flores Island case study. *Energy Policy*, *67*, 37–47. https://doi.org/10.1016/j.enpol.2013.07.120

Porru, M., Serpi, A., Mureddu, M., & Damiano, A. (2020). A multistage design procedure for planning and implementing public charging infrastructures for electric vehicles. *Sustainability*, *12*(7), 2889. https://doi.org/10.3390/su12072889

Ramos-Real, F., Ramírez Díaz, A., Marrero, G., & Perez, Y. (2018). Willingness to pay for electric vehicles in Island regions: The case of Tenerife (Canary Islands). *Renewable and Sustainable Energy Reviews*, *98*, 140–149. https://doi.org/10.1016/j.rser.2018.09.014

Reczek, K. (2017). *A guide to United States electrical and electronic equipment compliance requirements*. https://www.nist.gov/publications/guide-united-states-electrical-and-electronic-equipment-compliance-requirements-0

Regulatory Authority of Bermuda. (2019). *Bermuda integrated resource plan*. https://www.ra.bm/documents/bermuda-integrated-resource-plan-irp-2019/?wpdmdl=13822&refresh=614c967e2e2f31632409214

Republic of Maldives Ministry of Environment and Energy. (2017). *State of the Environment 2016*. https://www.environment.gov.mv/v2/wp-content/files/publications/20170202-pub-soe-2016.pdf

Republic of Mauritius Ministry of Renewable Energy & Public Utilities. (2009). Long-Term Energy Strategy 2009–2025. https://sustainabledevelopment.un.org/content/documents/1245mauritiusEnergy%20Strategy.pdf

Republic of Trinidad and Tobago. (2020). *Act No. 30 of 2020*. http://www.ttparliament.org/legislations/a2020-30g.pdf

Rodríguez, A. G., Rodrigues, M. D. S., & Sotomayor Echenique, O. (2019). *Towards a sustainable bioeconomy in Latin America and the Caribbean: Elements for a regional vision*.

Rotmans, J., & Kemp, R. (2003). *Managing societal transitions. Dilemmas and uncertainties. The Dutch energy case-study*. https://www.osti.gov/etdeweb/biblio/20475228

Shah, K. (2021, February 28). *Science, Technology & Innovation for sustainability in Small Island states: Key implications for policy and practice*.

Shah, K. U., Blechinger, P., Furlonge, H., Philippidis, G., Surroop, D., & Singh, A. (2016). Special issue on energy policy for the future of Small Island developing states (SIDS). *Energy Policy*, *100*(98), 650–652.

Shah, K. U., Raghoo, P., & Surroop, D. (2021). An institutional-based governance framework for energy efficiency promotion in Small Island developing states. *Climate*, *9*(6), 95.

Shah, K. U., & Rivera, J. E. (2007). Export processing zones and corporate environmental performance in emerging economies: The case of the oil, gas, and chemical sectors of Trinidad and Tobago. *Policy Sciences*, *40*(4), 265–285.

Shah, K. U., Roy, S., Chen, W. M., Niles, K., & Surroop, D. (2020). Application of an institutional assessment and design (IAD)-enhanced integrated regional energy policy and planning (IREPP) framework to Island states. *Sustainability*, *12*(7), 2765.

Sims, R., Schaeffer, R., Creutzig, F., Cruz-Núñez, X., D'Agosto, M., Dimitriu, D., Meza, M. J., Fulton, L., Kobayashi, S., Lah, O., Mckinnon, A., Newman, P., Ouyang, M., Schauer, J. J., Sperling, D., & Tiwari, G. (2014). Transport. In O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel, & J. C. Minx (Eds.), *Climate change 2014: Mitigation of climate change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://doi.org/10.1017/CBO9781107415416.005

Soomauroo, Z., Blechinger, P., & Creutzig, F. (2020). Unique opportunities of Island states to transition to a low-carbon mobility system. *Sustainability*, *12*(4), 1435. https://doi.org/10.3390/su12041435

Stockholm Resilience Centre. (2008). Annual report 2007. https://www.stockholmresilience.org/download/18.aeea46911a31274279800066843/1459560385655/Annual_Report_2007.pdf

Taibi, E., & Fernandez del Valle, C. (2017). The *impact of electric vehicles deployment on production cost in a Caribbean Island Country*.

Timilsina, G. R., & Shah, K. U. (2016). Filling the gaps: Policy supports and interventions for scaling up renewable energy development in Small Island developing states. *Energy Policy*, *98*, 653–662. https://doi.org/10.1016/j.enpol.2016.02.028

United Nations. (2012). *Stock taking report Rio+ 20 Antigua and Barbuda*. https://sustainabledevelopment.un.org/content/documents/518Antigua%20Report.pdf

UN-OHRLLS. (2013). *Small Island developing states in numbers*. https://wedocs.unep.org/bitstream/handle/20.500.11822/9271/-Small%20Island%20Developing%20States%20in%20numbers-2013SIS_IN_NUMBERS_121813_FA_WEB.pdf?sequence=3&isAllowed=y

Viscidi, L., Graham, N., Madrigal, M., Masson, M., Prado, V. R., & Monticelli, J. C. (2020). *Electrified islands: The road to E-mobility in the Caribbean*. 28.

Wang, N., Tang, L., & Pan, H. (2019). A global comparison and assessment of incentive policy on electric vehicle promotion. *Sustainable Cities and Society*, *44*, 597–603. https://doi.org/10.1016/j.scs.2018.10.024

Weber, K. M., & Rohracher, H. (2012). Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework. *Research Policy*, *41*(6), 1037–1047. https://doi.org/10.1016/j.respol.2011.10.015

Wong, Y. S., Lu, W.-F., & Wang, Z. (2010). Life cycle cost analysis of different vehicle Technologies in Singapore. *World Electric Vehicle Journal*, *4*(4), 912–920. https://doi.org/10.3390/wevj4040912

World Intellectual Property Organization. (2021). *Global innovation index 2021: Tracking innovation through the COVID-19 crisis*. World Intellectual Property Organization.