



Regional Electric Mobility Policy for Pacific Island Countries and Territories (PICTs)

Prepared as follow-up to the decisions of the Fourth Pacific Regional Energy and Transport Ministers' Meeting, held from 18 to 20 September 2019, in Apia, Samoa



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Abbreviations and Acronyms

Ax	Policy Action x
BAU	Business as Usual
CO ₂	Carbon dioxide
CO _{2e}	Carbon dioxide equivalent
e-	Electric (e.g., e-bus)
EV	Electric vehicle
FAESP	Framework for Action on Energy Security in the Pacific
FATS	Framework for Action on Transport Services
FRDP	Framework for Resilient Development in the Pacific
GGGI	Global Green Growth Institute
GHG	Greenhouse gas or greenhouse gases
kW	Kilowatt
kWh	Kilowatt-hour
NDC	Nationally Determined Contribution
PCREEE	Pacific Centre for Renewable Energy and Energy Efficiency
PICT	Pacific Island Countries and Territories
PV	Photovoltaic
RE	Renewable Energy
RMI	Republic of the Marshall Islands
SPC	Pacific Community
TOR	Terms of Reference
TOU	Time of use (metering)
UNIDO	United Nation Industrial Development Organization
UNDP	United Nations Development Programme
V2H	Vehicle-to-home
V2G	Vehicle-to-grid

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1 Introduction

1.1 PICTs and global EV deployment

Advances in electric vehicle (EV) technology have seen all forms of electric vehicles become noticeable in the transport systems of many countries. For some countries, electric passenger cars are normal and the uptake of new e-mobility forms such as electrically-assisted push-scooters and bicycles is occurring at an accelerating rate. Electric buses in China are now normal. And the global market is starting to see the beginning of the electrification of heavy trucks and marine vessels. Further advances in technology are expected, particularly with respect to batteries, and these (and the associated reductions in cost) stand to accelerate the uptake of e-mobility, in its various forms, still further.

The availability of this technology presents new opportunities for Pacific Island Countries and Territories (PICTs) on many fronts: the use of EVs can reduce net greenhouse emissions even when the vehicles are charged from grids where most of the electricity is supplied by petroleum-derived generation (which in turn will help meet Nationally Determined Contributions); some of the new e-mobility options could provide some people with more mobility, with beneficial social and other effects; and far from being an extra burden upon electricity supply arrangements, EV batteries may even be used to complement the supply of electricity, particularly where generation is intermittent (as is the case for wind and solar).

1.2 Regional Policy Response for National Acceleration

To better harness the EV opportunities for the region, the Fourth Pacific Regional Energy and Transport Ministers' Meeting, held from 18 to 20 September 2019, in Apia, Samoa, requested the Pacific Centre for Renewable Energy and Energy Efficiency (PCREEE)¹ and the United Nations Industrial Development Organization (UNIDO) to assist Pacific Island Countries and Territories (PICT) in the development of a regional electric mobility (e-mobility) policy document and a regional e-mobility program².

A harmonized regional approach can help to address some of the existing barriers more effectively and, regionally, at lower cost. It can promote equal progress and standards among PICTs and create the needed economies of scale to influence international vehicle supply chains and investments in charging infrastructure and e-mobility-based business models.³ Regional actions can complement and accelerate national efforts in line with the principle of subsidiarity.

When deployed, the EV efforts would contribute to the 100% renewable energy vision of the region and extend the "climate leadership" of PICTs also to the transport sector, and developed policy would integrate with important regional policies already in place, such as the forthcoming 2020-2030 regional energy framework, the Framework of Action on Transport Services (FATS) and the Framework for Resilient Development in the Pacific (FRDP).

¹ www.pcreee.org

² Specifically, the Energy Ministers:

- Requested SPC/PCREEE, UNIDO and SIDS DOCK to develop a regional policy document outlining the short-term and long-term vision of PICTs with regard to integrated e-mobility and renewable energy power markets. It will propose regional e-mobility targets for the PICTs region by 2030 and 2050 and include a regional implementation framework with concrete priority actions. (E11 (iv) of the Resolution of Ministers, Apia, Samoa, 19 September 2019);
- Requested SPC/PCREEE, UNIDO and SIDS DOCK to develop a regional e-mobility program. The program will address existing barriers by promoting regional interventions in the areas of policy and regulation, knowledge management, qualification/certification, as well as the promotion of investment, entrepreneurship and innovation, and to promote SIDS-SIDS cooperation and exchange on integrated e-mobility and renewable energy power systems under the umbrella of the Global Network of Regional Sustainable Energy Centres (GN-SEC). (E11 (iv) of the Resolution of Ministers, Apia, Samoa, 19 September 2019).

³ See also UNIDO GN-SEC theory of change for regional sustainable energy acceleration at: www.gn-sec.net

The Ministers also called for SIDS-SIDS cooperation on EV issues and solution under the umbrella of the Global Network of Regional Sustainable Energy Centres (GN-SEC⁴) some members of whom are also working on similar initiatives.⁵

With the deployment of the EV policy and program, PICTs will also contribute to global EV initiatives operating under the Paris Declaration on Electric Mobility and Climate Change. For example, the Clean Energy Ministerial's Electric Vehicles Initiative (EVI) supported by Canada, China, Finland, France, India, Japan, Mexico, Netherlands, Norway and Sweden aims to reach a 30% sales share for EVs by 2030. This EV30@30 campaign sets ambitious targets for electric vehicle (EV) sales that, combined with decarbonisation of the power sector, will move the world towards meeting our shared climate goals.

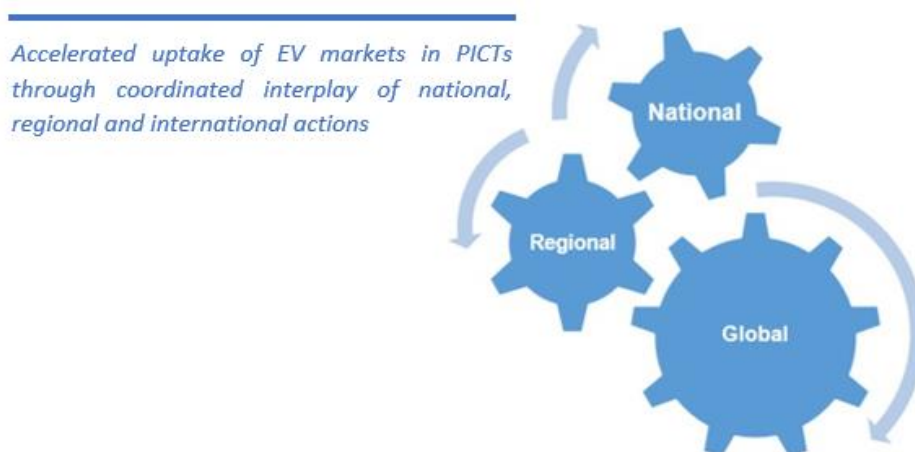


Figure 1: Regional Cooperation as an Accelerator for the EV Market Uptake in PICTs (GN-SEC/UNIDO).

2 Addressing the Ministers Requests

This draft policy document follows on from the Technical Report *“Options for Integrated Electric Mobility and Renewable Power Markets in the Pacific Island Countries and Territories (PICTs)”*, to provide the basis for the envisaged *Regional Program to Promote E-Mobility Markets in PICTs*.

Based on the technical findings, a regional PICTs vision on EVs has been prepared in the form of this policy document. Also based on the global review of the EV sector that was carried out, the four areas that the PICT Energy and Transport Ministers requested to be addressed by the proposed e-mobility study were broadened with the aim of capturing a wider set of EV-related considerations. In this respect:

- The subject area of “Policy and Regulation” was broadened to “Central Policy and Administration”, to incorporate the governance and administration of the e-mobility program;
- The subject area of “Knowledge Management” was broadened to “Awareness and Promotion” to align with global trends in this respect, to mention a significant target outcome (regional “awareness”) and also to reflect the importance of promotional activities;
- The subject area of “Qualification/Certification” was broadened to “Standards and Guidelines” to incorporate a far wider range of quality measures of which qualification and certification is but one component; and
- The subject area of “Investment, Entrepreneurship and Innovation” was broadened to “Demonstration and Upscale”, to capture a wider range of EV-related deployment projects, from first demonstration through to national scale up (again, which investment, innovation, etc. is one component).

Thus, in line with the Ministers’ resolutions, but taking this broader approach, this document:

- Proposes regional e-mobility targets for the PICTs region for 2030 and 2050;

⁴ www.gn-sec.net

⁵ For example, the Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE) is working on the Caribbean Community (CARICOM) Electric Vehicle Strategy Framework.

- Identifies the main barriers for the uptake of EVs in PICTs. It then draws up thirty-eight (38) concrete policy actions to address these barriers, with the policy actions stretching across the four broad themes outlined above (namely the beforementioned themes: “Central Policy and Administration”, “Standards and Guidelines”, “Awareness and Promotion”, and “Demonstration and Upscale”). These policy actions aim to best prepare PICTs for their respective EV futures and to lead them through those futures.

3 Structure of this Policy Document

This policy document is structured as follows:

- Section 4 summarises the technical background report, and considers the ways in which EVs might compliment the supply of electricity;
- Section 5 describes the policy context of the PICTs, with particular regard for what must be considered when thinking about how to introduce policy related to EVs;
- Section 6 combines the findings of Sections 4 and 5 to identify medium- and long-term targets for the EV sector;
- Section 7 combines the findings of Sections 4 and 5 to identify potential barriers to EV uptake, in order to determine ways to manage these barriers and to suggest the policy actions that will best prepare PICTs for their respective EV futures;
- Section 8 provides the conclusions to this work; and
- Appendices A through C provide the working tables and list developed as part of the policy action identification work described in Section 5.

4 Key findings of the Technical Report on EV Options

The first stage of the project comprised preparing a technical report aimed at informing PICTs decision-makers on e-mobility options and their potential to benefit renewable energy-based power systems of PICTs. The report provided a “realistic view” of opportunities, barriers, as well as potential risks, benefits and limitations. It provided an overview on the suitability, feasibility and economic viability of various types of EVs, from push e-scooters to heavy trucks, when considered in the PICT environment. The report found potential for most forms of EVs.

Consideration was also given to charging EVs and, rather than simply treating them as a demand on the local grid, the possibilities for integrating them with the supply of electricity by using the capacity of their batteries to support supply were explored. This work found that the capability for in-service EVs to support the supply of electricity was emerging and this capability was expected to grow, but that there are cheaper and more convenient options to achieve the same effect. However, significant benefit is expected from managing the charging of EVs in coordination with the supply of electricity, rather than EV charging presenting itself as an uncontrolled demand.

The main findings of the technical report can be summarised as follows:

- There are large differences across and within PICTs with respect to urbanisation, relative wealth, road infrastructure, the vehicle fleet, electricity and fuel markets, and accessibility to main island markets. Such diversity not only makes it difficult to generalise across PICT contexts, but also near-impossible to prescribe one-size-fits-all solutions.
- The availability of advanced battery technologies has presented the market with many electric vehicle options, from electric push scooters to large trucks:
 - Larger-sized electric **push-scooters** are featuring in daily personal mobility in large cities around the world. They have also been introduced to PICTs where they are used, for example, by tourists. This provides an example of where new mobility options can appear almost overnight, and illustrates the need for policy to be nimble to keep up with new technology.
 - **E-bikes** may offer a new mobility solution for PICTs. There is already some take-up in the PICT tourism sector. Their low voltage (typically less than 50V) and simplicity might make them suitable for use in remote locations.
 - **e-Two-wheelers** (i.e. electric motorcycles and scooters) that compete with petrol-fuelled two-wheeler motorcycles on price and quality have only recently emerged in the global market. There are many ways in which these could provide new, affordable mobility. They could also replace their petrol-fuelled counterparts. In many parts of the world, where

- two-wheelers are ‘the people’s car’, their electrification has become a major focus by governments.
- **Motorised tricycles** are the backbone of transport services in many Asian countries and e-trikes have been deployed in several in an attempt to begin the electrification of this market. By contrast, petroleum-fuelled, motorized tricycles hardly feature in the PICTs, which arguably stands to make the uptake of e-trikes difficult.
 - Apart from the e-buses that have recently become common in China, most EV programmes around the world have largely concentrated on the uptake of **electric passenger cars**. The technologies involved are now well developed and EV passenger cars are normal in many countries. However, they are still very new to PICTs and lack of awareness is still a major obstacle to their uptake. What’s more, private cars travel relatively small distances each year in PICTs, which means that EVs, which currently cost more to purchase and depend upon savings from use to recompense this, are relatively unattractive. Use for taxi and ride-hail vehicles offers a far better proposition.
 - Globally, the technology supporting **electric trucks** is still emerging, but the electrification of this sector is worth considering as the technology matures, as although trucks are a small proportion of the fleet, they consume a large amount of fuel. The upfront cost of electric trucks is currently very high, but it is expected to become more manageable as the market sees the expected fall in the price of batteries. However, getting local technical support would also be a significant barrier to their uptake in the PICTs.
 - **Electric bus** technology is more advanced than for trucks due to the impetus provided by the Chinese market. The availability of ultra-fast charging means that individual buses can get away with smaller onboard batteries, which means projects involving multiple buses are less expensive. Projects involving small numbers of buses are costly on a per-bus basis for several reasons, which means this technology would only be viable for the largest of cities in the PICTs. Even then, any such project would need to be heavily subsidised in its early years.
 - The electrification of **marine vessels** does not appear financially attractive in the short-term apart from small, slow-speed vessels operating in close, inshore waters. There is, however, an opportunity to retrofit small fishing vessels with electric propulsion and to charge these using simple, low-voltage solar generation systems. The kind of small vessels used to ferry tourists could also be electrified.
 - The electrification of aircraft is emerging on the globe scene, but it is unlikely to feature in the PICT market in the short- to medium-term.
- While unmanaged charging could add pressure to already stressed and finely balanced electricity supply networks, electric vehicles might actually de-stress or otherwise support the supply of electricity. Six main ways were identified that could do this:
 - **Vehicle-to-Grid (V2G)**, where the electric vehicle is plugged into a device that connects the electric vehicle’s propulsion battery with the grid and allows the electricity supplier to control the import and export of electricity to and from the electric vehicle’s battery. This could aid balancing of supply and demand on the grid and could bring about a small increase in the proportion of renewable generation incorporated in the grid. However, V2G technology is still a long way from being perfected, and it is too difficult to plan and prepare for V2G integration at this early stage. As far as an action is concerned, it is therefore recommended that only a watching brief is kept on V2G until there is more certainty around the technology.
 - **Vehicle-to-home (V2H)** is a simpler arrangement, where the vehicle is plugged into a device that allows electricity to be exported from the vehicle to an isolated or local electricity circuit (instead of right through to the grid, as in the case of V2G). This technology is available in the global marketplace and could be installed by individuals, providing them with a short-term backup electricity supply when the grid is down. However, standalone battery systems and standby generators may provide more cost-effective and convenient power supply when grid supply is not available. Given only little effort would be required to make V2H options more accessible in PICTs, and given the potential benefit that might be realised to individuals, it is proposed that V2H be supported to some degree.
 - **Grid-scale managed charging**, where the electricity supplier has control over when and/or at what rate charging of an electric vehicle occurs. This has the advantage of

shifting demand from electric vehicle charging to times when it is more beneficial to the grid supply — for example, when there is excess renewable energy available, or when there is spare capacity in the distribution network. Some form of grid-scale managed charging will be necessary when there are enough EVs charging to place a significant demand on the grid. However, the technology involved is still evolving and it is far from market-ready. For this reason, it is recommended that a watching brief be maintained on developments in grid-scale managed charging so that PICTs can begin to prepare for the day when its introduction can be considered.

- **Local-site managed charging**, where charging of a vehicle is managed according to other demands for electricity on the site and/or what local electricity generation is available (e.g. from on-site solar PV or wind generators). This requires far simpler systems than grid-scale managed charging and uses technology that is already available in the global marketplace. Like V2H, it promises to benefit individuals, but offers little on a national scale unless it were part of a national initiative to promote, say, distributed solar photovoltaic (PV) generation. Considering the small effort required to make on-site managed charging more accessible — mainly through awareness and information initiatives — it is proposed that on-site managed charging is supported at some level.
- **Time of use (TOU) electricity pricing**, which is used to encourage customers to shift demand to periods that suit the electricity supplier by advertising lower cost electricity for these times (and benefiting EV owners if they choose to charge when electricity is cheapest). TOU pricing doesn't only benefit those charging vehicles, as it can direct customers' choice as to when they use household appliances and other electrical equipment. TOU pricing requires the use of TOU or "smart" meters. The tools to implement TOU pricing are commercially available, and it is within the capability of PICTs both to install and support the technology. The benefits of doing so would be both significant and on a national scale in practically every case. TOU pricing may also be used in a way that results in a net reduction in GHG emissions.
- **Low voltage systems**, which use voltages under 50V (nominal⁶), direct current (DC) battery systems for e-mobility and for low-power circuits such as those providing lighting and basic utilities in remote locations. Combined with solar generation, these can be operated in isolation from the grid supply. Because of the many benefits to be realised from the uptake of low-voltage systems, and the significant improvements that should be realised through providing guidance to the sector, it is recommended that the development of low-voltage e-mobility and electrification sectors is supported.

As pointed out earlier, none of these EV-electricity supply combinations amount to a reason to promote the use EVs to support the supply of electricity: there are cheaper options to achieve the same effect. These EV-electricity supply combinations should be thought of more as opportunities to be considered if electric vehicles are introduced, or as ways of minimising or exploiting the effect that the charging of EVs might have on electricity supply systems.

5 Context for Developing EV Policy in the PICTs

5.1 Introduction

This section examines the context in which proposed EV policy and actions are to be deployed in PICTs. This includes consideration of the ways in which EVs have already been explicitly treated in policy and activities in the PICTs to date, and also in policy that may have indirectly (and inadvertently) affected them — energy and transport policies and strategies, for example — and any other relevant guidelines, frameworks and/or agreed principles that exist in the PICT policy landscape.

"Policy" refers to the kind of higher-level principle that sets direction and guides and influences decision-making. An example of a high-level policy might be a stated ambition to reduce the emissions of carbon that are associated with climate change. Beneath this, there may be more specific policies, such as measures to decarbonise transport emissions. And beneath these again, there may be other guidelines designed to meet the goals of the higher-level policies. This report refers to such lower-order measures as "policy actions". Policy actions tend to guide activities taken in the short term, and

⁶ Compared to household grid supply, which is normally around 110V and 60Hz AC for northern PICTs and US territories, and 230V and 50Hz AC, for the others.

are of particular interest to this report because these describe what PICTs can start to do, to best prepare for and encourage the uptake of those EV technologies that are desirable.

5.2 PICT EV-Related Policy and Activities

Over the last decade, many PICTs have devoted some attention to developing energy- and transport-related strategies, frameworks and policies and activities. Most of these have had little to say about electric vehicles, although EVs could be included where they speak in broad terms of “low emission transport technologies”. Some are also outdated, possibly due to the rapid advances that have been made in the EV sector.

Notable exceptions to this include the following:

- Fiji’s Low Emission Development Strategy 2018-2050, which views EVs as an important tool to meet future emissions targets, and EVs feature strongly in the scenario modelling undertaken to support this strategy. This work also recommended the development of “an EV roadmap for Fiji that identifies which vehicle segments and areas to focus on and details the intervention strategies and financial means,” suggesting that EV roadmapping is still at an early stage.
Fiji has also been encouraging the uptake of EVs (and non-plug-in hybrid electric vehicles also) through reducing the duties and taxes that apply to them,⁷ and has been active in considering the future of EVs in transport planning work (for example: including the 6 August 2019 workshop “Electrification of Transport Sector: Data Audits and Strategies & the Potential of Electric Vehicles in Fiji”⁸).
- In its Marshall Islands Electricity Roadmap (December 2018), RMI has noted the potential to integrate the demand from EVs with grid supply.⁹ Their NDC report (The Republic of the Marshall Islands Nationally Determined Contribution, 22 November 2018¹⁰) also indicates that consideration will be given to providing tax incentives for the importation of electric vehicles; transitioning the Government fleet to electric vehicles; transitioning the taxi fleet to electric vehicles; and the use of golf carts.

But there are also secondary consequences to be considered. For example, where PICTs have high proportions of diesel-generated electricity in the grid mix (which is the case for most), increased demand from EV charging might increase diesel consumption for the electricity sector, increasing carbon emissions from electricity production and decreasing the proportion of renewable generation, and this may not fit well with targets set by the particular government. For example, the effect of charging EVs is not necessarily a good fit with Tonga’s NDC target to increase the proportion of renewable generation to 70% by 2030. All the same, EVs may present an inconsequential new demand for Tonga even as far out as 2030.

This potential for conflict appears well understood by some. Fiji’s Low Emission Development Strategy 2018-2050¹¹ remarked that *“To achieve maximum emission mitigation, all new EVs should be charged using electricity from renewable sources. If this were not the case, GHG emissions in the electricity sector would continue to increase”*.¹²

Transport energy use also features in many PICT NDC commitments. However, there is little mention of how EVs may play a part in meeting the targets apart from a recommendation by RMI to “consider

⁷ The duty rate applying to EVs and hybrid-EVs is 0% compared to 32% for ordinary vehicles, the excise rate 0% compared to 15%, and the VAT 9% compared with 15%.

⁸ <https://www.unescap.org/sites/default/files/Reportofthe2ndStakeholderConsultationWorkshop-ElectrificationofTransportSector.pdf>

⁹ <https://islands.irena.org/-/media/Files/IRENA/Sids/NavigatingourEnergyFutureMarshallIslandsElectricityRoadmapDecem.ashx>

¹⁰

<https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Marshall%20Islands%20Second/20181122%20Marshall%20Islands%20NDC%20to%20UNFCCC%2022%20November%202018%20FINAL.pdf>

¹¹ https://gggi.org/site/assets/uploads/2018/12/Fiji-LEDS-2018_DIGITAL.pdf

¹² Although this is not necessarily true if an electric vehicle were replacing a petroleum-fuelled vehicle with high fuel consumption.

policies to require Government departments and agencies to transition to electric vehicles”.¹³ In this regard, apart from the examples provided above, most electricity-, transport- and NDC-related targets appear to neither support the uptake of EVs nor oppose it.

Overall, apart from activity in Fiji supported by GGGI, the incorporation of EVs in planning, policy work or policy actions in its infancy, which means that anyone providing EV policy recommendations is presented with almost a blank canvas.

5.3 Other Regional Initiatives and Strategies

Other strategies and frameworks that require consideration include the following:

- **Framework for Action on Energy Security in the Pacific (FAESP):** FAESP was launched by SPC in 2010 with the aim of improving energy security among the Pacific island states through coordination, cooperation and collaboration among CROP agencies and development partners. From a review of FAESP “Review of the Framework for Action on Energy Security in the Pacific (FAESP): 2010 – 2020”¹⁴ it appears that much effort went into developing the FAESP framework and deployment mechanisms, but it seems its effectiveness for improving the energy security of the PICTs has been questioned. The update of FAESP is currently under development.
The original FAESP included six areas of regional responsibility that are applicable to any EV planning and policy work. These are: i) Matters dealing with economies of scale, ii) Development of harmonised standards; iii) Regional leadership, strategy and advocacy; iv) Capacity development; v) Policy analysis and development; and vi) Data collection, analysis and reporting. Consideration of these has been provided in the EV policy development work described in the next section.
- **Framework for Action on Transport Services (FATS):** FATS was formulated in response to calls from Pacific Forum Leaders for improved coordination and delivery of safe, secure and competitive transport services as articulated in a 2004 declaration entitled “Forum Principles on Regional Transport Services”. The resulting FATS framework was published in 2011. FATS “aims to enhance the social and economic well-being of people in the Pacific by supporting the efforts of PICTs to work towards ensuring that all their people, at all times, have access to safe, secure and competitive air and sea transport services that are regular, reliable and affordable.”¹⁵ FATS does not appear to have been updated since its 2011 launch (whether it remains current is open to question). In 2019 PICT Transport Ministers “agreed to continue implementation of the Framework for Action on Transport Services until a new framework is adopted.”¹⁶
- **Framework for Resilient Development in the Pacific (FRDP):** FRDP is a voluntary guideline for the Pacific Islands Region aiming to support the building of resilience to climate change and disasters in the region (and succeeding two separate regional frameworks on climate change and disaster risk management that were in place before this). The FRDP makes no specific mention of EVs or ways in which EVs might support the building of resilience. However, the FRDP does provide valuable guiding principles, which have been considered in the EV policy development work described in the next section. These include instructions to:
 - Integrate climate change and disaster risk management (where possible) and mainstream into development planning including policy making, planning, financing, programming and implementation, to build resilience.
 - Strengthen and develop partnerships across countries and territories, including sharing of lessons learned and best practices.
 - Prioritise the needs and respect the rights of the most vulnerable, including, but not limited to, women, persons with disabilities, children, youth and older persons, and facilitate their effective participation in planning and implementation of all activities.

¹³

<https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Marshall%20Islands%20Second/20181122%20Marshall%20Islands%20NDC%20to%20UNFCCC%2022%20November%202018%20FINAL.pdf>

¹⁴ <http://prdrse4all.spc.int/data/review-framework-action-energy-security-pacific-faesp-2010-2020>

¹⁵ <https://edd.spc.int/en/document-download/finish/60-reports/606-frameworkforactionontransportservices>

¹⁶Resolution of Transport Ministers, Fourth Pacific Regional Energy and Transport Minister’s Meeting, Sept 2019: http://prdrse4all.spc.int/sites/default/files/4_pretmm_transport_ministers_resolution_final.pdf

- Advocate open and ready access to reliable sources of traditional and contemporary information.¹⁷

Considered overall, these strategies and frameworks provide guidance for how to structure potential EV policies and actions but do not direct what those policies or actions might be.

6 High-Level Electric Vehicle Policies and Targets for PICTs

As has been mentioned, high-level policy targets can be considered a statement of the significant need for a particular outcome. For example, the response of many countries in the world to the desire to reduce carbon emissions from the transport sector (a high-level policy), has been the introduction of fuel consumption standards for vehicles entering the fleet (a next-level-down policy) to ensure that lower-emission vehicles enter the market. Avoiding prescribing the technology type required to do this leaves it up to the market to choose how best the policy target might be met (an approach that may also avoid unintended consequences¹⁸).

In the SIDS context, the priority high-level policy targets include reducing fossil fuel dependence and related spending, and mitigating local pollution. There is also regional interest in improving access to safe, reliable, convenient, affordable and comfortable (when involving passengers) transport, and in reducing greenhouse emissions. EVs should be regarded more as a tool to be used to achieve the desired high-level outcome, which recognises that there are other tools that might be deployed to bring about the same effect. Examples of high-level policy targets are:

- Amsterdam: Zero-emissions transport within the city by 2025;
- London: 70,000 ultra-low emission vehicles sold by 2020; 250,000 by 2025;
- Oslo: Zero-emissions transport within the city by 2030;
- Shenzhen: 120,000 new energy vehicles sold by 2020.

By their very nature, these zero-emissions targets (coupled with well-considered definitions of what “zero-emission” is) provide for a more enduring future target than if a particular technology was stipulated.

However, these higher-level targets neither give direction to, nor inspire, an emerging EV industry. For this, we need to work at a lower level of policy target. At this point, it is necessary to be careful to identify an enduring target, given that the technology involved is rapidly evolving, particularly when considering the long timeframes under consideration (the PICT Energy and Transport Ministers’ request was to provide e-mobility targets for the PICTs region for 2030 and 2050). It is also important to remember that the technology is only one option of many, and also to note:

- “Zero¹⁹” through to “third-generation” biofuels may also provide contribution to PICTs meeting higher-level targets – and EV-related targets should accordingly allow for multiple technology approaches;
- Non-plug-in hybrid vehicles might provide PICTs with a more affordable, more accessible and more easily supported solution in the earlier years, depending upon what level of capacity building can be introduced across any given PICT;
- The economic situation of the region has yet to reflect the impact of the Covid-19 crisis (the Covid-19 situation had just begun at the time of writing this report and many PICTs are highly reliant on income from tourism which is near zero levels). The short- and medium-term affordability of passenger car and larger EVs could be significantly affected – providing an additional reason to avoid targeting the deployment of a certain number of EVs by a certain time.

¹⁷ http://tep-a.org/wp-content/uploads/2017/05/FRDP_2016_finalResilient_Dev_pacific.pdf

¹⁸ For example, tax incentives on plug-in EVs in Malaysia aimed at reducing transport emissions stimulated a growth in the luxury plug-in hybrid market but many of these vehicles are believed to not make full use of the plug-in capability.

¹⁹ “Zero-generation” is where raw feedstocks such as coconut oil are used directly in engines. This tends to be limited to use in older, larger diesel engines. “First-generation” are fuels derived from esterification/simple alcohol derivation methods and can be used in normal petroleum-fuelled engines, with suitable quality controls of the fuels used. “Second-generation” are fuels involving more complex processes which may include enzymic alcohol production, sub-critical water processing and complex chemical processes (and nowadays tend to target the conversion of waste streams). And “third-generation” refers to a level beyond this again. Although the contribution of these may be small in the short- to medium-term, there is potential for them to provide commercial and beneficial “island-applicable” solutions in the long-term future.

- Well before 2050, EVs are expected to be lower cost than their petroleum- (or biofuel-) fuelled counterparts and also lower cost to operate and maintain. By this stage, the position of EVs in the market should be market-driven and less influenced by policy interventions. Adding the unknown status of other technologies that might be developed in the interim, it seems unwise to target a certain EV penetration or population as far out as 2050.

Considered overall, the important status to achieve by 2030 is:

- Setting EV enabling systems in place so that there are no significant barriers to the uptake of EVs. These include ensuring systems are in place for enabling the introduction and use of low-voltage EV technologies (which require special mention, as such technologies and the opportunities for their use in the PICT region appear to be even less known than for passenger car and larger EVs).
- A degree of “normalisation” of EVs²⁰ (i.e., with EVs considered a normal mode of transport), as judged by attaining a certain level of public awareness of EVs.
- Promoting understanding within the electricity sector of the merits of coordinating the charging of EVs with the supply of electricity and realising a reasonable proportion of charging through devices that are capable of managed charging.

And for 2050, the important status to achieve is:

- Passenger car and larger EVs, and low-voltage EVs are normalised technologies and provide integral components of the transport systems across the PICT region, and the use of EVs is well-supported by appropriate infrastructure and industry-wide capability and capacity.
- The vast majority of EV charging is provided through managed charging so that it is coordinated with the supply of electricity.

Visionary targets stand to be more powerful and more meaningful if they capture the attention of a wide audience. For example, few (beyond those working in the area of policy development) will be inspired by a target that merely comprises ensuring that a list of enabling policy is in place by 2030 (as required by the first bullet-point in the 2030 status achievement list above). By contrast, stipulating that ten different (manufacturer-supported) models of mainstream EVs be available to the market by 2030 is a target that might not only capture the public imagination, but would also send a powerful message to the various EV-related sectors – those in the industry who are better informed would understand that this would require working, enabling policy to be in place and that the supporting service industries would also need to be in place for suppliers of mainstream EVs to operate in the regional marketplace.

Similarly, instead of an uninspiring list of the enabling policies that must be attended to, the provision of a commercial battery swapping scheme widens the vision of what might be achieved in the low-voltage mobility and power supply markets. If achieved by 2030, then it is likely that standards would be in place for batteries and devices using them, and for charging. Such a target also provides a vision for a wholly novel form of energy service provision, giving food for thought both to the mobility and the electricity supply industries.

In line with this discussion, Table 1 (over) proposes a number of visionary e-mobility targets for the PICTs region for 2030 and 2050, and describes how meeting these targets might be assessed. These policy targets are important not only because they provide guidance to countries themselves, but also because they help new vehicle suppliers to direct forward orders. After all, with current global demand much higher than supply, there is little sense in vehicle suppliers considering sales of EVs to countries that do not have supporting policy. For this reason it will be important for PICTs to offer policy in order to stake their claim on future supply of new EVs. For the same reason, these policies must be credible to be taken seriously.

The regional position on EVs might also be strengthened through alliances with an international electric vehicle coordination initiative such as the International Energy Agency’s “Electric Vehicle Initiative”. Examples of such initiatives are provided in Appendix D. It is recommended that any such alliances are coordinated with other SIDSs, to provide for better alignment within any joint SIDS-SIDS initiatives that develop.

²⁰ Noting that gaining normalisation is a vital step in readiness for national-scale uptake.

	Proposed 2030 Regional E-Mobility Target	Proposed Assessment Methodology
1.	Ten different models of manufacturer-supported, mainstream EVs are available in the marketplace.	The number of manufacturer-supported, mainstream EVs models is 10 or more.
2.	Battery swapping for low-voltage mobility use is available on a commercial scale in the marketplace.	There exists at least one party providing battery swapping services involving a cluster of rechargeable batteries, with combined energy capacity of at least 1,000 kWh, that can be used for low-voltage e-mobility.
3.	There is good public awareness of EVs.	Survey – 50% of randomly selected survey participants can describe what an EV is and can describe some of their attributes.
4.	50% of all four-wheeled EVs are charged through devices that are managed-charging enabled.	Survey – of charging arrangements. Note that this target does not require charging to be third-party managed at this stage, only that the devices used to charge EV have the capability. This prepares the industry for when it makes sense to switch to managed charging.
	Proposed 2050 Regional E-Mobility Targets	Proposed Assessment Methodology
5.	Services provided by EVs are an integral and significant component of transport within the region and include single-person electrically assisted mobility options through to electric trucks, buses, and boats.	There is widespread use of EVs throughout the transport sector.
6.	90% of grid-supplied charging of mainstream EVs is provided through managed-charging systems.	The grid-supplied power metered through managed-charging devices accounts for at least 90% of the estimated grid-supplied power provided for EV charging.

Table 1: Proposed 2030 and 2050 E-Mobility Targets and Method to Access their Achievement

Finally, amongst high-level policy options, it is worth noting that a total ban on petroleum-fuelled vehicles — a policy that has been used overseas to encourage market movement to the use of electric vehicles — might be short-sighted in the PICTs context, as there is potential for biofuels to feature in future mobility in the region. A goal for zero-emissions (based on net carbon emissions) or zero-imported fuel goal is expected to be far more fitting for PICTs.

7 Electric Vehicle Policy Actions

“Policy actions” lie a level or more below high-level policy/policy targets and are the working face of policy – they are the collection of activities that aim to deliver the targets set by high-level policy.

There is now plenty of information available and lessons learned to draw from with respect to identifying and developing policy actions to support the uptake of EVs. The International Council on Clean Transportation (ICCT) publication “Electric Vehicle Guidebook for Indian States”²¹ is a good example of how these global learnings can be brought together to inform the development of policy actions. However, care is required when applying the learnings to such different settings as many PICTs present. The relevant features of the PICTs are:

- There is great diversity across and within PICTs – EVs will be a better “fit” with some PICT markets than others and hence a careful balance will need to be struck between developing regional programs and systems while allowing for variations amongst programs in individual PICTs.
- Apart from some smaller, low-voltage mobility options, EVs currently attract a premium price compared with their petroleum-fuelled counterparts which, on the face of it, makes purchasing an EV unattractive. This upfront price disparity is expected to be resolved over time. However, some EVs are already attractive when considered on a total cost of ownership basis – where the costs to operate the vehicle are also taken into consideration and not just the purchase price – and the market needs to be educated accordingly.

²¹ https://theicct.org/sites/default/files/publications/India_EV_State_Guidebook_20191007.pdf

- EVs are new to PICTs and there are many barriers with associated with this “newness” including:
 - A lack of mandate to drive EV policy (some form of high-level policy directive is required as in the absence of public demand, there is no reason for government to support the EV work);
 - A lack of supporting institutional and regulatory framework (for example, for some countries, EVs do not fall into any of the vehicle categories, making it difficult to register them. Also, the absence of standards leaves the potential for safety hazards and could result in the use of many different charging connectors, with the risk of increased inconvenience and cost to users),
 - A lack of charging infrastructure, and possibly the lack of the types of generation that are wanted to provide electricity to it;
 - A lack of technical support capability and capacity;
 - A general lack of awareness of EVs; and
 - Fundamentally, the low levels of deployment of policies that are put in place in the PICTs.

These present barriers to the uptake of EVs that will take time to address. Given that the market is likely to be slow to take up EVs due to the premium on their purchase price, the various sectors involved will have the benefit of a period in which they can coordinate and upskill so that the market is “EV-ready” and primed for the point where the price premium has reduced and the use of EVs has popular appeal.

And there is also a strong case to not wait until the price premium disappears before introducing EVs: some form of “EV readiness” transition period — awareness raising, the normalisation of EV technology, and the building-up of industry capability and capacity — is inevitable. Waiting to introduce EVs until it is financially attractive will delay the start of this transition period, and also delay the “EV uptake S-curve”, postponing the time at which total economic benefits realised from electrification²² become significant (i.e., a relatively small early investment should pay good dividends through bringing forward significant economic returns²³).

Lastly, a business or action plan will be needed in order to coordinate and manage the deployment and ongoing operation of the policy actions. And following good management practice, that plan would need to be supported by appropriate monitoring and evaluation, and kept current and periodically tested for relevancy.

8 Identification of Policy Actions

Sections 4 and 5 set out the context for the uptake of EVs in PICTs and introduced the types of policy targets and policy actions that are often used when deploying and promoting EVs. This section now develops and identifies the policy actions that make most sense for PICTs.

Two processes were used for this:

- Identifying the potential barriers to progress through “life” for an EV and the charging infrastructure that supports them (with the “life” broken down into phases beginning with initial design and progressing through to retirement).
- A risk analysis to identify potential “show-stoppers” or other eventualities that could harm the industries involved or otherwise hinder progress through the lives of EVs and supporting systems.

For the first, the barriers associated with “mainstream” electric vehicles (e.g., passenger cars), low-voltage e-mobility options, electric buses, trucks and marine vessels, and different charging and electricity supply connection options, were considered across the following “life stages”:

- Design (which may include design to standards and/or to meet minimum performance);

²² The electrification of mobility is expected to be a vital tool in achieving individual country NDCs. What’s more, the uptake of electric vehicles will reduce reliance upon the import of refined oil products and, for some PICTs, there will be economic benefits from reducing local air quality-related emissions

²³ For example, from reduced fuel imports, lower air quality-related emissions, and lower carbon emissions.

- Build and supply (including the ability to meet demand, customised production to meet local requirements, certification, etc.);
- Customer purchase (which may include providing information and promoting awareness to support the purchase decision process, as well as ensuring availability of fit-for-purpose product);
- Installation (which for EVs may include insurance, warranty, service personnel capability and certification, and for charging infrastructure may include site works, etc.);
- In-service use (which may include monitoring, charging in the case of electric vehicles, servicing and maintenance, checks, breakdown and repair, and accident and repair);
- Retirement (which for electric vehicles would likely include re-purposing through to scrapping of the propulsion battery; and, for grid-related components, potential to upgrade, recycle or scrap).

Appendices A to C provide the workings for this process, comprising:

- Appendix A: Tables providing the detailed results of the described stage-of-life barrier analysis; and
- Appendix B: Tables providing the detailed results of the risk and risk management analysis.

These were then used to develop policy actions, aimed at managing the identified barriers and risks. Appendix C provides the resulting list of 38 policy actions, still divided into vehicle and charging-type categories.

Focusing on those recommended policy actions to which electric vehicles are central (i.e., and not focusing on those such as the introduction of TOU electricity pricing that are more likely to be driven by non-EV-related initiatives) and organising these into the themes “Central Policy and Administration”, “Standards and Guidelines”, “Awareness and Promotion”, and “Demonstration and Upscale” resulted in the matrix of policy actions provided in Table 2. For this, “A1” refers to Policy Action number 1, etc., as listed in (and provided with more detail in) Appendix C.

Because of the structure of Table 2, if this structure were placed in a regional office management scenario, each column represents a desk staffed by a person or persons with quite different skill sets.

Table 2: Recommended Regional and National EV Policy Actions (in summarised form)

Central Policy and Administration	A1: Develop high-level targets and mandates concerning EV uptake.		
	A2: Form a staffed and funded Regional EV Hub with regional representatives responsible for coordinating national programs and collecting and sharing information, and international links including those related to SIDS-SIDS cooperation.		
	A3: Support PICTs in developing and implementing EV roadmaps.		
	A4: As appropriate, set tax levels or other to encourage import of desired goods.		
	A5: Develop and set minimum specifications, including for imports.		
	A6: Develop and deploy a monitoring and evaluation system.		
	A7: As appropriate, introduce/amend the regulatory framework to provide for EVs, their charging, and other		
	A38: Maintain a watching brief on global EV-related developments.		
	Standards and Guidelines	Awareness and Promotion	Demonstration and Upscale
Light EVs	Part A5: Develop and set minimum standards for vehicles at time of entry and at time of in-service fitness testing. A17: Ensure appropriate standards are in place for the retirement of EVs.	A9: Undertake social marketing research. A10: Develop and deliver an awareness, information and promotion campaign supporting the uptake of EVs.	A12: Demonstrate Government leadership through purchase of appropriate EVs.
Heavy and Marine EVs	Part A5: Develop and set minimum standards for vehicles at time of entry and at time of in-service fitness testing.	Part A10: Provide information and promote.	A24: Consider supporting electric bus demonstrations. Consider supporting the demonstration of other EV projects if there is a good case for them.
			A25: Consider methods to share technical support capability across fleets and PICTs.
			A27: Consider opportunities for the electrification of small marine vessels.
Charging	A7: Set guidelines for charging including the specification of charging connectors	Part A10: Develop, publish and promote guidelines.	A11: Facilitate or co-invest in public charging infrastructure.
	A16: Require new buildings to be "EV-ready".		A14: Support inspection of existing electricity supply circuits.
	A35/36: Develop guidelines for the use of V2H and on-site managed charging.		Part A35/Part A36: Support the demonstration of V2H and on-site managed charging. Show leadership by deploying these options for some Government vehicles.
Servicing and Support		Part A10: Provide information and awareness.	A11: Develop EV service industry and encourage retention of capability and capacity.
			A12: Support inspection of charging cables, particularly those supplied with used imports.
Other Support		Part A6/Part A38: Collate and distribute global and PICT EV information.	A28: Support the introduction of TOU electricity pricing.
Low-Voltage Systems	A18/A34/A35: Develop (at least voluntary) standards for use across vehicles, the charging of them, and the use of "mobility batteries" for local power supply circuits.	Part A19: Promote systems that encourage the industry's adoption of quality product and services.	A19: Develop and introduce a system that encourages the industry to adopt quality product and provide quality services.
	A20: Develop and introduce technical courses on low-voltage technologies.	Part A20: Publish and promote low-voltage guidelines	A23: Provide facilities in support of e-mobility options, beginning with facilities at public offices.
	A21: Develop guidelines for the use of e-mobility options targeting safety.	Part A22: Publish and promote e-mobility buyer and user guides.	
	A22: Provide buyer and user guides on low-voltage e-mobility options.		

As has been mentioned, there are large differences between PICTs and deploying this full set of policy actions may not be a good match for a particular PICT. For example, for the next five years, in the absence of benefactors or other abnormal market forces, the deployment of electric buses is likely to only make sense for major cities such as Suva, Port Moresby and Noumea. However, the deployment of low-voltage systems would be expected to be applicable across all PICTs. This suggests a "pick-and-mix" approach of applying the recommended EV policy actions to any one PICT. For this, it is suggested that all PICTs adopt the bundle of policy actions A1 through A7 listed across the "Central Policy and Administration" row. The following table offers guidance criteria on the relevance of policy actions for a particular PICT, for the others.

Vehicle Type that Policy Action is to be Applied	Relevancy When Looking at a 5-Year EV Plan
Low-voltage mobility	All PICTs.
Light passenger EVs	PICTs with islands that have first-class roads.
Electric buses	PICTs with major cities, possibly Suva, Port Moresby and Noumea only.
Electric trucks	Leave to Regional EV Office to maintain watching brief, possibly with policy actions added as appropriate projects present themselves.
Electric marine vessels	PICTs with small fishing vessels operating in remote locations. Leave to Regional EV Office to maintain watching brief on other possibilities.

Table 3: Guidance to the Relevancy of Proposed Policy Actions to a Particular PICT

9 Conclusions

The recommended policy targets and policy actions drew from the findings of the technical report on EV options for PICTs (which found that there are many opportunities where PICTs and individuals stand to benefit from the introduction and use of EVs) to consider what policy and policy actions would best prepare PICTs for their respective EV futures. This work found:

- Overall, apart from action in Fiji supported by GGGI, there seems to be little in the way of planning, policy work or policy actions in place for EVs across the PICTs, providing something of a blank canvas upon which EV policy recommendations may be drawn.
- There is the potential for conflict between the uptake of EVs and some specific NDC targets for a very small number of PICTs. However, the uptake of EVs would be expected to reduce emissions overall, meeting each PICT's high-level goal of emissions reduction.
- Policy in PICTs is subject to several strategies and frameworks that target coordinated approaches, among others. None of these presented barriers to EV uptake. Rather, they provide guidance on how a regional EV programme could be structured.
- Six policy targets to support the uptake of EVs were identified. These were:
 - For 2030:
 - Ten different models of manufacturer-supported, mainstream EVs are available in the marketplace;
 - Battery swapping for low-voltage mobility use is available on a commercial scale in the marketplace;
 - There is good public awareness of EVs;
 - 50% of all mainstream EVs are charged through devices that are managed-charging enabled.
 - For 2050:
 - Services provided by EVs are an integral and significant component of transport within the region and include single-person electrically assisted mobility options through to electric trucks, buses and boats;
 - 90% of grid-supplied charging of mainstream EVs is provided through managed-charging systems.
- 38 policy actions to support the uptake of EVs were identified. Those that were central to developing an EV culture across PICTs included:
 - Putting in place high-level targets and mandates concerning EV uptake;
 - Forming a regional EV hub with regional representatives providing the conduit between local and regional programs;
 - Developing EV roadmaps for PICTs;
 - As appropriate, set tax levels to encourage import of desired goods;
 - Developing standards and guidelines for the various industries involved;
 - Providing awareness and promotion of EVs and related actions, including watching overseas developments and keeping up to date with relevant global technologies.
 - Providing regional and local support to appropriate EV actions and programs.

Appendix A: Potential Barriers to the Deployment of Electric Vehicles and Related Technologies, and Management Strategies for these, Table 1a.

Stage in Life	Mainstream Electric Vehicles	Low Voltage E-Mobility	Other mobility (including buses, trucks and boats)	TOU Pricing
Design	Unlikely to have any influence on global market.	Significant benefits expected from standardisation of voltages, components and connectors. --> standardisation plus customer protection against poor quality and un-fit product. Includes for small marine vessels. PICTs will need to lead, but expect global support.	May be able to reduce battery size for heavy vehicles, otherwise expect little influence on market. Maintain watching brief on the specification of batteries for marine applications.	There is global experience to draw on for TOU electricity price/smart metering --> carry out techno-economic analysis of options and identify those PICTs/islands which to target first, and specification of system.
Build	Unlikely to have any influence on global market.	Influence through minimum design specifications.	May be able to reduce battery size for heavy vehicles, otherwise expect little influence on market. Maintain watching brief on the specification of batteries for marine applications.	Unlikely to have influence on build. Rather, supply likely to be from global market specification. Hence not a barrier.
Purchase	Require familiarization with EVs throughout sales process, from sales staff to customer, which would be supported with easy access to quality trusted (and therefore likely third-party verified) information. First-hand experience (self-drive, expo and taxi fleet), normalisation and others found to be beneficial to purchase decision. Lack of local information introduces questions --> fill gaps with local demonstrations. Opportunity for govt. leadership. Consider tax and other incentives to reduce premiums. Tourism may also offer good early target. Cost of charging equipment adds to vehicle cost.	Require awareness program supported with quality information including that derived from local use. Hence may require early (and possibly iconic) demonstrations to produce material. Tourism may offer a good, early target. Potential for service providers to provide early access to some forms.	Electric truck and bus projects are unlikely to be financially viable in near future, making it difficult for private parties to demonstrate the technology without backing from other sources. --> look at options to finance demonstration projects for joined PICT collective, that stand to result in multiple vehicle projects in due course. Cost of charging adds to vehicle cost premium.	Likely to be by open, international tender, possibly with supporting aid monies. This is a standard procedure. However, decision to purchase would be significant to the electricity supplier and international support likely required.
Supply	Supply from a range of countries and supply agencies, including of used vehicles. May be difficult to get sufficient orders to make supply economical to importer. Hence look at consolidation. Some OEMs already supplying. Ensure supply of used charging cables is suitable for local voltage.	Require border checks to avoid non-compliance with build standards/guidelines. Consider tax incentives to encourage product registration, if applicable.	Would likely require partnership with supplier for the supplier to be interested. May require consolidation across PICTs to get sufficient numbers to warrant setting up support services.	Technology available in global marketplace and supply unlikely to be a problem.
Install	PICTs may not have category to register EVs, or to monitor population and use --> check and introduce new vehicle category, as required	May not have category to register 2- or 3-wheelers --> check and introduce new category, as required.	May not have a suitable definition/vehicle category --> develop as required.	Likely provided through open, international tender on grid supply side. May require training on meter installation to provide short-term capacity (and capability). Also requires awareness and advertising of service, rates, and benefits to customers. Govt leadership for uptake.

Cell colour scale

Little to no barrier

Straight forward to manage, low consequence, or work required small.

Moderate focus required

Requires focused management

Significant barrier. Requires significant work.

Appendix A continued: Potential Barriers to the Deployment of Electric Vehicles and Related Technologies, and Management Strategies for these, Table 1b.

Stage in Life In-service	Mainstream Electric Vehicles	Low Voltage E-Mobility	Other mobility (including buses, trucks and boats)	TOU Pricing
Use/Charging, if Applicable	Little difference/improvement in vehicle operation compared with conventional vehicles. However, require new charging infrastructure. Need for public charging facilities will vary with PICT - where needed facilitate/co-invest ahead of demand. Make it easy/nil- to low-cost to have existing circuits checked for compatibility for charging.	Some e-mobility options are new and some development may be required to arrive as fit-for-purpose solutions --> support early developments. Slow charging rate may need management/guidance to manage.	Normally improved driver experience. Likely conventional charging due to low range requirements.	Robust technology.
Monitoring	Difficult to plan when little information on vehicle type and use --> improve upon monitoring.	Difficult to monitor as many types do not require registration --> monitor at time of import. Consider health benefits.	Require monitoring as part of project and a requirement of any govt./aid related financial support.	Required to understand dynamics of market, particularly if variable TOU pricing is used.
Periodic inspection	Require guidelines for road-worthiness inspection and training of inspection staff.	May need to develop road-worthiness specification. Likely need to train inspection staff.	Require guidelines for road-worthiness inspection and training of inspection staff.	Part of install - BAU, no barrier.
Insurance	Insurers may require support to avoid excessive premiums --> information provision from global experience.	May be difficult to insure or high premiums. Work with insurers to reduce unknowns and risk to them.	Insurers may require support to avoid excessive premiums --> information provision from global experience.	NA
Warranty	Third-party insurers may require support to avoid excessive premiums --> information provision from global experience.	Risk of no warranty on product --> Encourage minimum of 12-month warranty through incentive measures, to avoid low-quality product	Third-party insurers may require support to avoid excessive premiums --> information provision from global experience.	NA
Servicing and maintenance	Require local support by trained personnel --> new tooling and training of local support staff plus deployment of remote servicing where appropriate. (OEMs already providing this, but require support). Look at methods to retain trained personnel.	Risk of poor serviceability in PICTs --> provide guidance for industry so that more likely to have interchangeable parts. Encourage repair facilities on major islands. Introduce technical institute/school training programs.	Require local support by trained personnel --> new tooling and training of local support staff plus deployment of remote servicing where appropriate. Look at methods to retain trained personnel.	Requires in-service calibration - use of customer surveys and recalibration of pricing and provision of awareness to gain required shifts in demand.
Accident	Require awareness by first responders, service personnel and EV operators at the very least --> information provision.	Require awareness by first responders, service personnel and EV operators at the very least --> information provision.	Require awareness by first responders, service personnel and EV operators at the very least --> information provision.	BAU
Repair	Require local support by trained personnel --> new tooling and training of local support staff plus deployment of remote servicing where appropriate. (OEMs already providing this but require support).	Risk of poor serviceability in PICTs --> provide guidance for industry so that more likely to have interchangeable parts. Encourage repair facilities on major islands.	Require local support by trained personnel --> new tooling and training of local support staff plus deployment of remote servicing where appropriate. Look at methods to retain trained personnel.	BAU - likely replace meter.
Post-repair certification	Require guidelines for post-repair inspection and training for inspectors.	Risk of poor level of repair ---> develop guidelines and develop mechanism to reflect and advertise customer feedback.	Require guidelines for post-repair inspection and training for inspectors.	BAU
Retirement	Require appropriate measures in place for scrapping of EV including re-purposing of battery (or arrangements for recycling, if not re-usable, likely a responsibility of importer). Maintain watching brief on ownership tracing of batteries.	Require appropriate measures in place for end-of-life of EV including re-purposing of battery (or recycling, if not re-usable, likely a responsibility of importer).	Require appropriate measures in place for end-of-life of EV including re-purposing of battery (or recycling, if not re-usable, likely a responsibility of importer). Maintain watching brief on ownership tracing of batteries.	BAU - although this might require accessing and upgrade to avoid BAU issue of "warehousing" of waste.

Cell colour scale
Little to no barrier
Straight forward to manage, low consequence, or work required small.
Moderate focus required
Requires focused management
Significant barrier. Requires significant work.

Appendix A Continued: Potential Barriers to the Deployment of Electric Vehicles and Related Technologies, and Management Strategies for these, Table 1c

Stage in Life	Low Voltage Electricity Supply	V2H	On-site managed charging
Design	Many systems available globally. But need to adopt robust systems that make it easy to "plug-and-play" and make it difficult to link non-compatible systems --> development of guidelines through standards on specification and minimum specification for safety, compatibility, ease of servicing, cost and consumer protection (quality).	Developments are expected to continue in global marketplace providing improved performance and low cost solutions, hence --> specify minimum specification to avoid limiting the introduction of new technology, as it becomes available. Become more prescriptive, as required, to avoid compromise in safety, compatibility and quality.	Developments are expected to continue in global marketplace providing improved performance and low cost solutions, hence --> specify minimum specification to avoid limiting the introduction of new technology, as it becomes available. Become more prescriptive, as required, to avoid compromise in safety, compatibility and quality.
Build	Likely sourced from mass production in global market - BAU.	Likely sourced from mass production in global market - BAU.	Likely sourced from mass production in global market - BAU.
Purchase	Require awareness of options and clear guidance to avoid poor purchase decisions by those unable to understand technology and systems Need to make it easy for individuals to take up technology (--> provide marketplace guidance), to get access to it (--> provide supplier lists), to purchase quality, serviceable product (only list product and suppliers that meet minimum criteria). Note, suggest greater focus than for V2H and on-site managed charging as more likely low voltage a do-it-yourself (DIY) resource and requires added information.	Require awareness of options and clear guidance to avoid poor purchase decisions by those unable to understand technology and systems Need to make it easy for individuals to take up technology (--> provide marketplace guidance), to get access to it (--> provide supplier lists), to purchase quality, serviceable product (only list product and suppliers that meet minimum criteria).	Require awareness of options and clear guidance to avoid poor purchase decisions by those unable to understand technology and systems Need to make it easy for individuals to take up technology (--> provide marketplace guidance), to get access to it (--> provide supplier lists), to purchase quality, serviceable product (only list product and suppliers that meet minimum criteria).
Supply	Many sources in global market. Need access to quality product in PICTs --> tax incentive or publish lists of product/suppliers meeting minimum criteria. Require added focus over V2H due to DIY nature.	Many sources in global market. Need access to quality product in PICTs --> tax incentive or publish lists of product/suppliers meeting minimum criteria.	Many sources in global market. Need access to quality product in PICTs --> tax incentive or publish lists of product/suppliers meeting minimum criteria.
Install	Want to minimise costs of installs and maximise robustness --> guidelines for the marketplace plus consider maintaining accredited list of installers, supported by fast-track applications/permitting if required. Consider free govt inspection as quality assurance method, to provide advice.	Want to minimise costs of installs and maximise robustness --> guidelines for the marketplace plus consider maintaining accredited list of installers, supported by fast-track applications/permitting. Require training of installers and inspectors.	Want to minimise costs of installs and maximise robustness --> guidelines for the marketplace plus consider maintaining accredited list of installers, supported by fast-track applications/permitting. Require training of installers and inspectors.

Cell colour scale

Little to no barrier

Straight forward to manage, low consequence, or work required small.

Moderate focus required

Requires focused management

Significant barrier. Requires significant work.

Appendix A Continued: Potential Barriers to the Deployment of Electric Vehicles and Related Technologies, and Management Strategies for these, Table 1d.

Stage in Life	Low Voltage Electricity Supply	V2H	On-site managed charging
Use/Charging, if Applicable	Expect simple plug-and-play experience for well-specified equipment. Best utilisation will come from good system specification and awareness of how best to operate --> guidelines.	Expect simple plug-and-play experience for well-specified equipment. Best utilisation will come from good system specification and awareness of how best to operate --> guidelines.	Expect simple plug-and-play experience for well-specified equipment. Best utilisation will come from good system specification and awareness of how best to operate --> guidelines.
Monitoring	Difficult to monitor. Look at time-of-import monitoring and village surveys.	Important for understanding the market and planning. Use permitting to monitor V2H grid installs, imports to monitor isolated-circuit V2H.	Important for understanding the market and planning. Use permitting to monitor on-site managed charging installs.
Periodic inspection	None required, but consider free govt service at time of first installation.	Part of initial inspection --> require list of approved appliances. Require trained inspectors.	Part of initial inspection --> require list of approved appliances. Require trained inspectors.
Insurance	Likely under threshold value to require reporting.	BAU - if pass on inspection (requiring use of approved appliances).	BAU - if pass on inspection (requiring use of approved appliances).
Warranty	Risk of poor quality product - provide minimum performance specification and encourage minimum of 12 months warranty (e.g., to be listed on published supplier list).	Risk of poor quality product - provide minimum performance specification and encourage minimum of 12 months warranty (e.g., to be listed on published supplier list).	Risk of poor quality product - provide minimum performance specification and encourage minimum of 12 months warranty (e.g., to be listed on published supplier list).
Servicing and maintenance	Encourage service representative in PICT, or equivalent capability (e.g., a minimum requirement to be on published supplier list).	Encourage service representative in PICT, or equivalent capability (e.g., a minimum requirement to be on published supplier list).	Encourage service representative in PICT, or equivalent capability (e.g., a minimum requirement to be on published supplier list).
Accident	Low voltage therefore limited consequence.	Ensure safety systems in place for the event of an accident. Likely in existing rules (if followed).	Ensure safety systems in place for the event of an accident. Likely in existing rules (if followed).
Repair	Encourage service representative in PICT, or equivalent capability (e.g., a minimum requirement to be on published supplier list).	Encourage service representative in PICT, or equivalent capability (e.g., a minimum requirement to be on published supplier list).	Encourage service representative in PICT, or equivalent capability (e.g., a minimum requirement to be on published supplier list).
Post-repair certification	NA	Require inspection - and trained inspectors.	Require inspection - and trained inspectors.
Retirement	Disposal uncertain in PICTs. Encourage appropriate measures (e.g., through requirement that supplier to provide disposal plan and accept disposal of panels/electronics as minimum requirement to be on published supplier list).	Disposal uncertain in PICTs. Encourage appropriate measures (e.g., through requirement that supplier to provide disposal plan and accept disposal of panels/electronics as minimum requirement to be on published supplier list).	Disposal uncertain in PICTs. Encourage appropriate measures (e.g., through requirement that supplier to provide disposal plan and accept disposal of panels/electronics as minimum requirement to be on published supplier list).

Cell colour scale
Little to no barrier
Straight forward to manage, low consequence, or work required small.
Moderate focus required
Requires focused management
Significant barrier. Requires significant work.

Appendix B: Potential Risks to the Deployment of Electric Vehicles and Related Technologies, and Management Strategies for these

Table 2a.	Mainstream Electric Vehicles	Low Voltage E-Mobility	Other mobility (including buses, trucks and boats)	TOU Pricing
Risks	Lack of supply from OEMs resulting in limited EV models --> encourage uptake with policies such as vehicle fuel efficiency standards and targets for transport sector CO2 reduction, including through supporting tax incentives for special tooling and EV-related equipment, and other.	Import and early failure of low quality product harming reputation of sector/viability of option --> guidelines through minimum specifications for import and service backup.	Uneconomic resulting in little penetration --> look at reduced battery size and/or demonstration for future uptake, but consider delaying introduction until more financially feasible.	Poor understanding of mechanism by customers resulting in little change in behaviour/demand profile --> awareness campaign.
	Lack of and poor information preventing robust assessment of EVs --> awareness campaign provided by credible third party.	Connection of incompatible components leading to personal and/or product damage --> standards for connectors, chargers and battery systems. Guidelines for operation.	High cost to tool up for heavy vehicles --> consolidate orders, link service centres, remote diagnostics and services.	Costly for smaller PICT to implement --> consider consolidation of order to attract competitive international supplier.
	Failure of EVs due to improper work on them --> awareness of potential for personal and equipment harm, encourage training of service industry.	Poor purchase choices leading to purchase of product that is not fit-for-purpose --> early failure and poor reputation --> guidelines for low voltage e-mobility.		
	Premature battery failure due to exposure to high temperatures --> guidelines for charging and parking EVs.	Unsafe use of e-mobility options resulting in personal harm accidents --> guidelines for use of e-mobility options and import restrictions on power/speed.		

Table 2b.	Low Voltage Electricity Supply	V2H	On-site managed charging
Risks	Risk of early failures of low quality product not suitable for PIC-marine environment harming industry --> minimum specifications/guidelines.	Poor quality product and poor quality (and DIY) installations resulting in poor performance and possibly personal and product harm --> guidelines including clarity on qualifications required to install systems.	Poor quality product and poor quality (and DIY) installations resulting in poor performance and possibly personal and product harm --> guidelines including clarity on qualifications required to install systems.
	Risk of failure due to mis-match of voltages/systems --> minimum specification for product and guidelines/standards to avoid connection of incompatible components.	Lower benefits realised than expected due to low vehicle availability --> demonstration to provide real data and case studies for awareness material.	Lower benefits realised than expected due to low vehicle availability --> demonstration to provide real data and case studies for awareness material.

Appendix C: Recommended Regional and National Policy Actions

The policy measures identified to overcome barriers and risks to the increased uptake of electric mobility and integrated electricity supply are listed below, organised into the vehicle and charging arrangement type, and numbered for ease of reference. Notably absent from the list are purchase price subsidies on electric vehicles. While this is a policy tool that is in use in many countries, the policy has not been recommended here. This is because of a number of factors:

- Subsidies are expensive policies and can distort a market such that vehicles unsuited for electrification, such as very low mileage vehicles, are incentivised to switch;
- The size of the markets in PICTs is very small on a global scale, and at that scale there is little transparency about whether subsidies will be passed through to consumers;
- Future removal of purchase price subsidies, as the premium on electric vehicles reduces, can crash a market that would be otherwise poised to take off.

The New Zealand Government is currently considering an alternative to this with the use of a “clean car discount” scheme that would price-penalise those vehicles with high fuel consumption and price-subsidise those with low fuel consumption (including those that do not use fuel at all, as is the case with battery-electric vehicles). The scheme is expected to be designed to be revenue neutral and take into consideration the large proportion of used vehicles that are imported into the country – a feature that is in common with PICTs. It is recommended that PICTs maintain a watching brief on developments in case such a scheme might work for some PICTs.

Recommended Policy Actions:

Central Policy

- | | |
|------------------|---|
| Policy Action 1. | Develop and put in place high-level targets and mandates concerning EV uptake. |
| Policy Action 2. | Form a Regional EV Coordination Hub and Working Group comprising national, regional and international key stakeholders responsible for quality assurance, harmonisation, coordination and implementation of work packages as well as information sharing. A regional monitoring framework to track progress will be operated by the Regional EV Coordination Hub. |
| Policy Action 3. | Develop EV roadmaps for PICTs. |
| Policy Action 4. | Consider import tax relief for compliant products, if applicable. Also consider the use of minimum specifications at the time of import to avoid the proliferation of poor-quality or unsupported product. |
| Policy Action 5. | Develop and set minimum specifications for goods, to be applied at the time of import (which may be linked to the tax levels applied). These are to include minimum standards for EVs, chargers and battery systems. |
| Policy Action 6. | Develop and deploy a monitoring and evaluation (M&E) system (likely on the back of a system already in place) with the intent to keep the policy current with changes in the political landscape, and with developments in technology. These management systems must also allow for re-evaluation and pivoting of action direction and goals, if required to achieve the desired outcomes. Good governance is also required to instil efficient deployment and to also to prevent fraud, corruption and other damaging actions. |
| Policy Action 7. | As required, introduce and/or amend the regulatory framework to provide for EVs, including the registration of them for use on the roads, the charging of them, and other associated actions. |

Mainstream (Passenger Car) Electric Vehicle Uptake:

- | | |
|-------------------|---|
| Policy Action 8. | Set guidelines or requirements for charging including the specification of charging connectors and public charging guidelines to facilitate interoperability of electric vehicle charging (both fast and slow) and communicate these to vehicle suppliers and potential charging providers. |
| Policy Action 9. | Undertake social marketing research to identify existing attitudes, level of understanding and information gaps around electric vehicles. |
| Policy Action 10. | Awareness, information and promotion campaign: based on the findings of research, develop and deploy a campaign to inform all parties who will be |

involved in electric vehicle uptake, from potential purchasers and users through to service providers. This campaign is to include the development of information and guidance materials and provide the opportunity for people to experience and drive electric vehicles, particularly in areas where the technology is wholly novel. The tourist sector is an obvious target for these actions. These initiatives will require at least oversight by an independent authority to provide the necessary quality and robustness to gain the trust of those receiving the information. Ultimately, the goal of this phase is the “normalisation” of electric vehicles. Among other methods, information and data will be disseminated through a PRDR-PCREEE Knowledge Hub with SIDS-SIDS cooperation on EV island issues facilitated through the GN-SEC;

- Policy Action 11. Facilitate or co-invest with providers of public charging infrastructure to develop this ahead of demand from EVs. The extent to which public charging infrastructure is required, and what type of infrastructure (fast or slow) is needed will vary with the circumstances of individual PICTs. For example, where levels of solar PV uptake are high, daytime charging could be encouraged by providing slow public charging where people park during the day.
- Policy Action 12. Provide leadership by purchasing appropriate electric vehicles for use in government and local government fleets.
- Policy Action 13. Support the development of EV service industries and include consideration of methods to retain capability in the PICTs. Included in this, ensure that first responders are aware of correct procedures.
- Policy Action 14. Support inspection of existing electrical supply circuits (for example, socket outlets that will be used at home and at work) before they are used for charging electric vehicles.
- Policy Action 15. Support inspection of charging cables supplied with used EV passenger car imports to ensure they are compatible with the local electricity network (noting that in Japan, charging cables are typically designed to operate at the local residential electrical supply of 110V, whereas residential electrical supply in many PICTs operate at the higher 220-240V, and an influx of used EVs from Japan will potentially introduce chargers that are not approved for use in PICTs).
- Policy Action 16. Require new buildings with parking facilities to be “EV-ready” by ensuring sufficient capacity at switchboards and easy routes for cabling.
- Policy Action 17. Ensure appropriate plans are in place for the retirement of EVs and associated componentry, including maintaining a watching brief on global developments concerning tracking the ownership of propulsion batteries, their repurposing and recycling.

Low Voltage E-Mobility

- Policy Action 18. Develop and introduce standardisation measures, ranging from guidelines through mandatory standards, including minimum performance specifications and/or standards aimed at making e-mobility easier to access, lower cost and more convenient; to ensure product quality and reliability; and avoid incompatibility issues leading to product failure.
- Policy Action 19. Encourage the industry to provide quality, well-supported product through promotion of suppliers and product, possibly including the use of quality marks and customer feedback forums.
- Policy Action 20. Develop and introduce technical courses on low-voltage technologies (these also supporting greater understanding of mainstream EV technologies).
- Policy Action 21. Provide guidance and/or develop regulations to manage the maximum speed/power of low voltage e-mobility devices that can be imported, and which types of roading/footpaths/cycleways they can operate on, to manage road safety.
- Policy Action 22. Provide guidance on hiring/buying and using low voltage e-mobility options to promote fit-for-purpose user selection and effective use of e-mobility options.
- Policy Action 23. Demonstrate leadership by providing facilities where government and local government staff can park and charge their e-mobility devices, and promote these to staff. Also provide public facilities.

Other Electric Vehicle Uptake:

- Policy Action 24. Support PICT-relevant, heavy electric vehicle demonstrations, but carefully consider target applications (should be scalable) and timing (a delay of 2-3 years may not have a significant effect on the five-year outcome for PICTs, but would carry far less risk and likely require less financial support).
- Policy Action 25. Consider amalgamating various heavy vehicle projects or otherwise to share set-up costs.
- Policy Action 26. Provide leadership by demonstrating appropriate heavy electric vehicles where government or local government operates heavy vehicles.
- Policy Action 27. Work with tourism operators and national park authorities to identify opportunities to demonstrate electric marine vessels, particularly in environmentally sensitive areas, and support such demonstration projects. Also consider the (low voltage) electrification of small fishing vessels.

TOU Pricing:

- Policy Action 28. Facilitate the introduction of TOU pricing, including supporting techno-economic assessments of TOU pricing use for grid supply on PICT main islands, a workshop on TOU pricing delivered by overseas- and PICT-based experts, and follow-up support to electricity supply companies that are expected to benefit from deploying TOU pricing systems.
- Policy Action 29. Consider amalgamating orders for TOU equipment and services to attract more favourable responses to tenders.
- Policy Action 30. For locations enabled through the deployment of TOU- or smart-meters, support the development and deployment of awareness campaigns to electricity consumers so that they are aware of how best to use TOU charging.
- Policy Action 31. Provide guidance on monitoring customer response and use of data to manage pricing and the need for ongoing customer education.
- Policy Action 32. Provide leadership by government and local government being early adopters of smart meters and time of use pricing in its facilities as this becomes available.

Low-Voltage Power Supply:

- Policy Action 33. Develop guidelines for system design, component specification, installation and use of low-voltage electricity generation for various PICT scenarios.
- Policy Action 34. Develop voluntary standards and support service requirements, and encourage compliance with them. Options for the latter include a compliance- and/or a customer feedback-rating system, and support and advertising provided where the equipment, supplier and/or service providers meet minimum requirements.

V2H and on-site managed charging:

- Policy Action 35. Develop guidelines for the use of V2H and on-site managed charging that includes descriptions of case-study systems and the performance achieved with these (which will thus require a number of demonstration V2H and on-site managed charging projects to be undertaken). Also include the obligation that installers must meet wiring regulations and any post-works inspection requirements.
- Policy Action 36. Develop voluntary standards for minimum specifications and encourage the use of them through advertising equipment or service providers that meet the standards and/or through use of quality marks for compliant product and service providers.
- Policy Action 37. Show leadership by deploying on-site managed charging where there are government and local government fleets with electric vehicles.

V2G and grid-scale managed charging:

- Policy Action 38. Maintain watching briefs on global developments concerning grid-scale managed charging and V2G technologies, with the possibility to upgrade this status should developments in these sectors get to the stage where the technologies might be applicable to the PICT environment.

Appendix D: International Electric Vehicle Coordination Initiatives

Initiative name	Coordinating organisation	Website link	Membership	Summary description
Electric Vehicle Initiative	International Energy Agency	https://www.iea.org/programmes/electric-vehicles-initiative	National governments	Multi-government policy forum dedicated to accelerating the introduction and adoption of electric vehicles, launched under the Clean Energy Ministerial, a high-level dialogue among Energy Ministers
ZEV Alliance	International Council on Clean Transportation	http://www.zevalliance.org/members/	National and local governments	Juristictions working together to make all passenger vehicle sales within the jurisdictions Zero Emission Vehicles as fast as possible, and no later than 2050.
Global EV Association Network	Global EV Association Network	http://www.globalev.org/	Government agencies, associations, institutions, business entities	Shares information and best practices in the areas of government policies, business models, and public relations.
EV100	The Climate Group	https://www.theclimategroup.org/project/ev100	Private sector fleet owners	Companies around the world making a commitment to EV uptake in their fleets
World Electric Vehicle Association	World Electric Vehicle Association	http://www.worldelectricvehicleassociation.info/members	Three regional groups (including EV Association Asia Pacific) whose members are national EV associations, institutes, NGOs, industry suppliers and others	Non-profit organization with the objective of promoting the research, development and deployment of electric drive vehicles