DRAFT – Pre-decisional

Government of Tonga: Least-Cost Energy Efficiency and Transportation Policy Options

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1 Background

As a companion analysis to the baseline and benchmarking study conducted with and for the Government of Tonga, this document summarizes some high level opportunities for reducing imported fuel for Tonga's energy and transportation needs. The least cost options are presented by sector with policy or project options, along with the potential magnitude of impacts, upfront costs, time to implement, ancillary benefits and available support – all categorized as low, medium and high. These options are then ranked and some of the most favorable ones are described in greater detail. This document is meant to serve as a catalyst for discussion with the government of Tonga in order to set direction for the final deliverable of recommendations and action items.

1.1 Background and focus

Tonga has recently surpassed a per capita GDP of $Intl 5,000 , meaning that they have just entered the phase where countries typically see a rapid rise in Vehicle Kilometers Traveled (VKT). When considering efficiency improvements in Tonga's transportation sector, some of the lowest-hanging fruit consists of ways to make low-VKT forms of transportation that are already well-utilized in Tonga (such as walking and riding the bus) as convenient and safe as possible. This will reduce the marginal benefit of single occupancy vehicles and enable Tonga to develop in a way that minimizes VKT, petroleum use, and GHG emissions. In addition to retaining low-VKT forms of transportation, Tonga can also improve the efficiency of their vehicles and use alternative fuels such as electricity. Additionally, as GDP increases in Tonga it is assumed that more electronics and appliances will be purchased, especially as electrification in rural or remote areas of the islands occurs. Minimum energy performance standards (MEPS) are one way to improve efficiency of appliances and goods being imported into Tonga. This strategy has an impact on short-term and long-term energy consumption within end users. Another effective strategy is to implement building codes or standards for climate-appropriate, net-zero-energy, sustainable and resilient buildings. Improving building stock at the time of major renovations or new construction will have enduring effects on the energy consumption of the country as a whole. While these strategies require institutionalizing energy commitments within different government organizations and industries they will be beneficial to the citizens of Tonga for years to come.

All opportunities for energy and transportation are shown as heat maps in the following pages, then detailed more in Section 2.

Heat Map of Least-Cost Building/Appliance Energy Efficiency Policy Options

Policy Options / Projects	Impact	Upfront Cost	Time to Implement	Ancillary Benefits	Support Available	
Implement **building standards** for resilience and energy efficiency (e.g. passive ventilation and daylighting with appropriate external shading)	High	Low	Med	High	High	*Low Hanging Fruit*
Set **packaging and recycling standards** to limit the amount of waste imported to Tonga	High	Low	Med	High	Med	
Implement a **public awareness campaign** on energy efficiency and conservation	High	Low	Med	Med	Med	
Establish a demand-side management **revolving loan or rebate program** to aid in financing more efficient equipment (residential, commercial and industrial)	High	Med	Med	High	Med	
Prioritize **on-site RE** with islanding controls and energy storage within critical infrastructure	High	High	Med	High	High	*Energy Transformation Projects*
Implement **distributed energy generation** projects that incorporate RE and fossil fuels to enhance resilience and reduce emissions associated with diesel generation, particularly when electrifying new areas or islands	High	High	Med	High	Med	
Work with TPL to create an **integrated resource plan** to incorporate RE, EE, and more efficient reciprocating engines that can be dual fuel	High	High	High	High	High	
Work with TPL to **underground lines** along the coast that are susceptible to cyclone damage	High	High	High	High	High	
Work with TPL to ensure **grid hardening** is adequately carried out (e.g., pole depth and composition can impact survival rate of T&D lines during cyclones)	High	High	High	High	High	
Explore **waste-to-energy** options to reduce the landfill capacity challenges	High	High	High	High	Med	
Perform **energy audits** of buildings to create baselines and implement energy conservation measures	Med	Low	Med	High	Med	*Incremental Improvements*
MEPs for equipment and appliances	Med	Low	Med	Med	High	
Data collection exercise/database to manage energy data by sector	Med	Med	Low	High	Med	
Influencing the transportation sector: anti-idling legislation, vehicle registration fees, and electric vehicles PV charging stations	Med	Med	Med	Med	Med	
Continue to **reduce T&D losses**	Med	Med	Med	Med	Med	
Create or implement a **certification process for sustainable/green hotels** for the tourist industry	Med	Med	Med	Med	Med	
Continue the **street lighting upgrade** program and **using roundabouts** rather than traffic lights	Med	Med	High	Med	High	
Create a **cool roof program** to reflect heat from rooftops and save energy on air conditioning loads where buildings are air tight and have AC units installed	Med	Med	High	Med	High	

Heat-Map of Least-Cost Transportation Policy Options

Policy Options / Projects*	Impact	Upfront Cost	Time to Implement	Ancillary Benefits	Support Available
Use a platform such as NextBus to **track and coordinate busses**	High	Low	Low	High	High
Send a mechanic to EV maintenance training in Japan or New Zealand	High	Low	Low	Med	High
Enact a **3-foot minimum distance rule** for drivers passing cyclists or pedestrians	High	Low	Low	Med	High
Provide pedestrians (particularly school children) and cyclists with **safety lights and reflectors**	Med	Low	Low	High	High
Install **rumble strips** and painted lines demarcating lane boundaries parallel to sidewalks to increase pedestrian safety	High	Low	Low	Med	Med
Set **Vehicle Registration fee and/or import tariff according to fuel consumption**	High	Low	Low	Med	Low
Introduce **fuel economy standards** for vehicle imports	High	Low	Med	Med	Med
Begin a **water taxi in the laguna** (and some associated dredging)	High	Med	Med	High	Med
Build a **strategic parking lot and bus stop** at intersection of Taufa'ahau Rd. and Loto Rd.	High	High	Med	High	High
Fuel economy and fuel cost **labeling requirements**	Med	Low	Low	Med	Med
Implement **motorcycle/scooter safety program** and vest requirements	Med	Low	Low	Med	Med
Incentivize tuk tuks to queue at major bus stops in the countryside to **complete the last-mile travelled**	Med	Med	Low	High	Med
Construct **left hand turn lanes** at key intersections to improve traffic flow	Med	Med	Med	High	High
Introduce **rebates on EVs**, including low-speed electric vehicles such as **GEMs and EV scooters**	Med	Low	Low	High	Low
Rebates on the installation of public EV chargers with timers, then smart meters to smooth the load of 50% renewable	High	High	High	High	High
Construct **bus pull-offs** to improve traffic flow	Low	Med	Med	High	High
Construct a **toll bridge** across the top of the laguna, with parking lots at either end	High	High	High	High	Med
Coordinate taxis (with a common dispatch and/or coordination apps such as FlyWheel) to increase the convenience of not owning a vehicle	Med	Med	Med	Med	Med
Blend diesel fuel with **coconut biodiesel** at 5% blend	Med	Med	High	Med	High

*Projects were prioritized by allocating 1 point for green, zero points for yellow, and -1 points for red. Ties were broken by prioritizing attributes further left on the table before those on the right.

2 High-Priority Energy Efficiency Policy Options and Projects

1. Implement **building standards** for resilience and energy efficiency (e.g. passive ventilation and daylighting with appropriate external shading):
   - As GDP per capita increases, an increasing amount of power is used to supply load that could be better satisfied by mindful construction practices; such as orientating windows to optimize passive ventilation, strategic shading, and insulating building shells if air conditioning is to be installed. Additionally, reviewing building codes provides an opportunity to ensure that new construction is well-engineered to withstand the worsening effects of Tropical Cyclones. Tonga can learn best practices from international partners to develop standards that are both easy to interpret, and consistent with UN Sustainable Development Goals 7, 9, and 11.
   - *Ongoing Project: Review, Strengthening & Updating Of the Tonga Building Code*
   - *Example: Guidelines for Cyclone Resistant Construction of Buildings in Gujarat (India)*
   - *Resource: Mainstreaming Building Energy Efficiency Codes in Developing Countries*

2. Implement a **public awareness campaign** on energy efficiency and conservation:
   - Creating an energy-efficiency public awareness campaign focusing on both the environmental, and personal economic benefits to rate-payers who reduce their consumption. The introduction of an MEP program goes hand in hand with this; while 80% of Tongans said appliance running costs are important to them, only 34% plan on looking for an AUS/NZ MEPs label next time they are purchasing an appliance.[1] Introducing a program that is easy to understand and educating customers as part of a broader energy efficiency public awareness campaign is critical. Empower customs agents to halt any imports of inefficient appliances and establish packaging and recycling standards to ensure that any public awareness campaign is backed by meaningful action.
   - *Example: Raising Awareness of Energy Efficient Light Bulbs Pays off in Rwanda*
   - *Resource: Creating an Awareness Campaign*

3. Establish a demand-side management **revolving loan or rebate program** to aid in financing more efficient equipment (residential, commercial and industrial):
   - With a small initial investment—potentially funded in-part by development banks—the existing capabilities of the Tonga Development Bank could be leveraged to provide ultra-low interest loans to projects that demonstrate they can generate energy savings. These savings are used to pay off the full amount of the loan in a 5 to 10-year period, at which point the fund is redistributed to subsequent projects. Rebate programs similarly encourage customer uptake of efficient technologies.
   - *Example: The Thai Energy Efficiency Revolving Fund*
   - *Resource: Exploring the Case for Revolving Funds for Domestic Energy Efficiency Programs*

4. Work with TPL to create an **integrated resource plan** to incorporate RE, EE, and more efficient reciprocating engines that can be dual fuel:
   - While TPL is eagerly working towards Tonga's renewable energy goals, the company publishes little long-term planning detailing how these goals will be achieved. An integrated resource plan provides an opportunity for the company to lay out a long-term, realistic framework outlining how goals will be met in a scope not captured by annual reports. Use modeling such as PLEXOS or SAM to integrate cleaner energy generation sources to provide peaking power, and limit Tonga's exposure to fluctuations in the price of diesel.
   - *Example: Hawaiian Electric Companies IRP*
   - *Resource: Greening the Grid—Grid Integration Studies*
   - *Resource: Best Practices in Electric Utility Integrated Resource Planning*

[1] Tebbutt Research, "Survey of Consumer Awareness and Use of Energy Rating Labels in PICs: TONGA COUNTRY REPORT" (The Pacific Community (SPC)), accessed February 22, 2018, http://prdrse4all.spc.int/sites/default/files/09_pearl_-_tonga_country_report_d9.pdf.

5. Perform **energy audits** of buildings to create baselines and implement energy conservation measures:
   - According to one study, up to 3.5% of total consumption on Tongatapu originates from a Church of Later-Day Saints Temple, most likely a result of superfluous air conditioning.[2] Strengthening energy efficient building standards and performing audits on the largest consumers—including government buildings--can have a large role in reducing overall demand.
   - *Example: Caribbean Hotel Energy Efficiency Action Program*
   - *Resource: A Guide to Energy Audits*

6. **Data collection exercise/database** to manage energy data by sector:
   - Work with TPL, the Bureau of Statistics, the MOI, and the Public Service Commission to standardize annual reports, and increase reporting of data to include figures such as sectoral consumption and load profiles by source of generation.
   - *Example: Fiji Electric Authority, 2016 Annual Report*
   - *Resource: Energy Analytics for Development*

3 High-Priority Transportation Policy Options and Projects

1. Use a platform such as NextBus to **coordinate busses**:
   - Trackable buses greatly reduce time wasted due to arrival-time unpredictability, especially on routes such as those in Tonga, where buses don't circulate frequently. Reduced stress and lost time associated with riding the bus, encouraging more ridership. Census data indicates that a significant (and growing) portion of Tonga's population owns a cell phone, which can be leveraged to provide transportation data to customers on demand.
   - *Resource: How NextBus Works*
   - *Resource: Urban Bus Services in Developing Countries and Countries in Transition*

2. **Send a mechanic to EV maintenance training** in Japan or New Zealand:
   - This facilitates the adoption of both hybrids and EVs. Toyota operates a training program in Japan specifically for foreign nationals, and MITO is developing a similar technical program in New Zealand. Scholarships could be available through Toyota, MITO, or JICA to make this a low-cost option to ensure that Tonga has the technical capacity to repair and maintain new vehicle technologies.
   - *Resource: Toyota Tajimi Service Center*
   - *Resource: MITO Automotive Electrical Engineering Program*

3. Enact a **3-foot minimum distance rule** for drivers passing cyclists or pedestrians:
   - A minimum passing distance law sends a signal that pedestrians and bikers have the right to be on the road, and that it is the responsibility of drivers to avoid hitting them. Of course, the law is only effective if police actively enforce it. One study found that in a state with such a law, while violations were plentiful, enforcement was rare.[3]
   - *Resource: League of American Bicyclists--Model Safe Passing Law*

4. Provide pedestrians (particularly school children) and cyclists with **safety lights and reflectors**:
   - VKT will increase so long as pedestrians feel safer in cars than on foot. Travelling on foot at night is a particular concern as seventy-five percent of US accidents resulting in a pedestrian casualty occurred in the dark.[4] Various pilot programs to distribute lights or reflectors to school children

[2] "Kingdom of Tonga: Electric Supply System Load Forecast" (Asia Sustainable and Alternative Energy Program, March 2010), 19, https://www.astae.net/sites/astae/files/publication/Tonga-Electric-Supply-System-Forecasts%5B1%5D.pdf.
[3] David C. Love et al., "Is the Three-Foot Bicycle Passing Law Working in Baltimore, Maryland?," *Accident Analysis & Prevention* 48 (September 2012): 451–56, https://doi.org/10.1016/j.aap.2012.03.002.
[4] NHTSA, "2016 Pedestrian Saftey Data," February 2018, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812493.

have proven effective at mitigating accidents. Studies identify that reflector vests are the most effective option for increasing the visibility of cyclists to drivers.[5]
    - *Resource: A Road Safety manual For Decision-Makers and Practitioners (Pages 78-81)*

5. Install **rumble strips** and painted lines demarcating lane boundaries to increase pedestrian and biker safety:
    - As most countries develop, they initiate a negative feedback loop. Cars are prioritized, VKT increases, pedestrian and biker safety decreases, which incentives travel by car instead of walking or biking. Tonga therefore needs to safeguard pedestrian and biker space before this feedback loop commences. Rumble strips are a relatively inexpensive and effective way to keep drivers off the shoulder of the road, providing pedestrians with a reassurance of safety. In areas where the road is too narrow, "sharrows" reserve space for bikers and increase driver awareness.
    - *Resource: Decision Support Guide for the Installation of Rumble Strips on Non-Freeways*
    - *Resource: A Road Safety manual For Decision-Makers and Practitioners (Page 28)*

6. Set **Vehicle Registration fee and/or import tariff according to fuel consumption**:
    - People are most responsive to up-front costs when purchasing vehicles. Therefore, registration fees and import tariffs can be set to make efficient vehicles much less expensive than inefficient ones. Countries have implemented such registration fees that are based on CO2 emissions, fuel consumption, fuel economy, engine displacement, or vehicle size. Some have even implemented a "feebate" system that actually pays people that register the most efficient vehicles.
    - Resource: Vehicle Registration Fees Implemented by Countries

7. Introduce **fuel economy standards for vehicle imports:**
    - A fuel tax is the most direct way to reduce fuel usage. However, fuel taxes are generally unpopular and difficult to implement. Many countries around the world have implemented fuel economy standards (or the closely-related fuel consumption or GHG emissions standards). Used vehicle age requirements for import , when adequately enforced, are another policy to ensure that vehicles brought to Tonga are efficient and in proper working order.
    - *Tool: New Zealand Fuel Economy Rating Database*
    - *Resource: Fuel Economy State of the World 2016*

8. **Water taxi in the laguna** (and some associated dredging):
    - Transporting passengers via water taxis can be more efficient than road transportation on an energy per passenger-mile basis, depending largely on the size and occupancy of the vehicles[6]. Furthermore, the distance from Nuku'alofa to various towns lining the laguna is much shorter travelling across the laguna instead of around the laguna on Taufa'ahau Road. Ancillary benefits include time and traffic reductions. However, the laguna would likely require dredging in some locations.
    - Resource: Sarasota Water Taxi Feasibility Study
    - Resource: Forget Flying Cars: We Need Floating Ones

9. Build a strategic parking lot and bus stop at intersection of Taufa'ahau Rd. and Loto Rd.
    - Strategic parking lots are often located at bottlenecks where traffic gets worse or at confluences of roads. They provide good locations where people can park their vehicles and catch a bus or carpool into congested areas with limited parking. This intersection in Pea meets these requirements, with nearly 17,000 vehicles passing through it per day on their way to and from Nuku'alofa. Parking

[5] Joanne M. Wood et al., "Using Reflective Clothing to Enhance the Conspicuity of Bicyclists at Night," *Accident Analysis & Prevention* 45 (March 2012): 726–30, https://doi.org/10.1016/j.aap.2011.09.038.
[6] M Sc, "ENERGY CONSUMPTION AND ENVIRONMENTAL EFFECTS OF PASSENGER TRANSPORT MODES - A LIFE CYCLE STUDY ON PASSENGER TRANSPORT MODES," n.d., 15.

lots in this location could alleviate the need for additional parking in Nuku'alofa as vehicle ownership increases, and could enable the city to remain dense and pedestrian-friendly.
    - Resource: Washington DC Park & Ride System facilitates carpooling and mass transit

10. Introduce **Fuel economy and fuel cost labeling requirements**:
    - Economics provides a powerful reason for people to purchase more efficient vehicles. However, this is not clear unless people know the fuel economy of vehicles that they are considering purchasing. Stickers on vehicles at dealerships that clearly state the expected annual fuel cost of the vehicle further illustrate this point. Using fuel economy on the Japanese test cycle would be a good start or combining test cycles from multiple countries the way New Zealand does. However, to maximize accuracy Tonga could develop their own test drive cycle.
    - *Example: Fuel Economy Labeling, Focus on non-EU Countries*
    - *Review: Evaluation of Vehicle Fuel Efficiency Labeling and Consumer Information Programs*