ANTIGUA AND BARBUDA

TECHNOLOGY NEEDS ASSESSMENT

REPORT III

TECHNOLOGY ACTION PLAN

FOR

CLIMATE CHANGE ADAPTATION & MITIGATION

- WATER, BUILDING AND TRANSPORT SECTORS -

MARCH 2022

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EXECUTIVE SUMMARY

The Technology Action Plan (TAP) is the final step in the Technology Needs Assessment (TNA) process. Sectoral TAPs presented in this report were developed from the results of the two previous steps and consultations held with Technology Working Groups (TWGs). In the first step, a list of adaptation and mitigation technologies were selected, prioritized and presented in the TNA Report. Barriers to increased diffusion of prioritized technologies were identified through research and stakeholder consultations, and overcoming measures were outlined in the **B**arrier **A**nalysis and **E**nabling **F**ramework (BAEF) Report. Each TAP serves as the roadmap for the deployment of the prioritized technologies.

The three sectors selected for Antigua and Barbuda's TNA process were **water**, **building** and **transportation**, and a total of ten (10) technologies were approved. These included *solar pumping systems, rainwater harvesting, water saving devices, climate-proofing assets, stormwater reclamation and reuse and atmospheric water generators* – for the water sector; *Light Emitting Diodes (LED) bulbs and best pitch roof angle* – for the building sector; and *efficiency in transportation, solar charging stations and electric vehicles (EVs)* – for the transport sector. However, to achieve the low emission benefits of EVs, renewable energy systems must be used to charge them; therefore, electric vehicles and solar charging stations were combined for deployment as a single technology in the TAP.

The complete list of technologies prioritized for Antigua and Barbuda identified the State's need for increased research, education and awareness, financing, cross-sectoral reform and/or collaboration and technical training. The measures in the BAEF step broadly addressed these needs and the enabling framework outlined potential actions that were further developed into sub-activities during consultations for the TAP. Where the framework included overlapping actions, efforts were combined into activities that would maximize human and financial resources.

The TAP followed a similar participatory process as the two preceding TNA steps. Multiple stakeholders, public and private sector representatives and the TNA Steering Committee all weighed in to ensure that the roadmaps were appropriate for the Antiguan and Barbudan context and would achieve successful widescale adoption. Sectoral TWGs were reassembled to re-examine the full range of enabling measures and determine viable, concrete actions for the TAP. A three-point rating system (1 = High; 2 = Medium; 3 = Low) was used to categorize the measures and decide where focus should be given for developing activities for technology deployment. The main guiding criteria used to rate the measures were:

a. *cost and benefits* – do the expected benefits outweigh the proposed social, environmental and economic costs*;*
b. *effectiveness* – how well does the actions contribute to the implementation target; and
c. *suitability for the Antiguan and Barbudan context* – what is the anticipated level of acceptability in the local context.

The highest ranked measures were redefined as concrete actions and each was broken down into a series of timebound and costed sub-activities.

Water Sector

The Action Plan developed for the six (6) water sector technologies is summarized in the Table below.

ACTIONS	SCOPE / TARGET	TIMELINE	APPROXIMATE INVESTMENT
SOLAR PUMPING SYSTEMS			
Establish a Solar Water Professionals Business Association to promote commercial interest and provide a pool of specialists; Launch special incentive periods for local suppliers to invest in solar pumping business opportunities; Launch a special incentive period for the private and public sector to acquire solar pumping equipment; and Develop upskilling programmes for plumbing and electrical technicians	5% of population | 1,500 households AND 10 small to medium sized farms	Forty-eight (48) months	USD 1 500 000 | XCD 4 032 300,(project costs) AND USD 550 000 | XCD 1 478 510 (private sector investment)
RAINWATER HARVESTING			
Pilot up to five (5) new rainwater storage options; Launch an Innovators Competition to design and demonstrate novel low-cost rainwater storage options; Strengthen technical capacity of registered NGOs and community groups in proposal preparation, project planning, design, coordination, and financial management; and Rehabilitate community cisterns with storage,	10% of population | 3,000 households AND 10 derelict community cisterns	Sixty (60) months	USD 3 500 000 | XCD 9 408 700 (project costs)

ACTIONS	SCOPE / TARGET	TIMELINE	APPROXIMATE INVESTMENT
distribution, and income generation streams			
WATER SAVING DEVICES			
Develop and implement a water efficiency labelling system that rates devices based on volumes of water saved; and Design an educational *W*ater *U*sage *C*hart that shows indicative uses of water around the property and complementary water conservation tips	5% of population | 1,500 households AND 25% of businesses (opting to invest in water efficient equipment / devices on their next purchase)	Thirty-six (36) months	USD 165 000 | XCD 443 553
CLIMATE-PROOFING ASSETS			
Develop a longterm climate change **R**isk **M**anagement **P**lan (RMP) for the Water Utility; Promote greater financial independence of Utility, training the Utility's **P**roject **M**anagement staff in project proposal preparation, and Develop a GIS map of Utility dependent zones / communities across Antigua and Barbuda	Climate-proof six (6) reverse osmosis facilities	Sixty (60) months	USD 2 000 000 | XCD 5 376 400 (project costs) AND USD 3 000 000 | XCD 8 064 600 (rehabilitating RO facilities)
STORMWATER REHABILITATION AND REUSE			
Partner with local heavy equipment / earthworks companies; Provide training and certification for local heavy equipment operators; and Develop a comprehensive sustainable procurement plan for equipment and materials	Create the enabling environment to allow the Water Utility to extract an additional 0.3mgd of groundwater	Forty-eight (48) months	USD 500 000 | XCD 1 344 100 (project costs) AND USD 3 000 000 | XCD 8 064 600 (construction works)
ATMOSPHERIC WATER GENERATORS			
Incentivise local businesses to establish partnerships with manufacturers; Conduct an education, awareness campaign to engage the general public; Design training to increase capacity in service technicians	Pilot 150 AWG units in educational and health institutions	Sixty (60) months	USD 3 500 000 | XCD 9 408 700 (project costs)

Building Sector

Similarly, the Action Plan developed for the two (2) building sector technologies is summarized in the Table below.

ACTIONS	SCOPE / TARGET	TIMELINE	APPROXIMATE INVESTMENT
LIGHT EMITTING DIODES (LED)			
Launch a LED distribution drive; and Conduct a public awareness program	Replace 20,000 incandescent light bulbs and 10,000 CFLs in 5,000 homes	Twenty-four (24) months	USD 245,000 | XCD 658,610 (distribution drive) AND USD 45,000 | XCD 120,700 (public awareness)
ROOF PITCH ANGLES			
Pilot implementation of roof pitch angles in small scale residences; and Conduct public awareness campaigns and training programs to promote adoption	Pilot the implementation roof pitch angles in 20% of new small scale residential buildings	~Target is 2030	USD 103,260 |XCD 277,585 (project costs)

Transport Sector

The Action Plan developed for the two (2) transport sector technologies is summarized in the Table below.

ACTIONS	SCOPE / TARGET	TIMELINE	APPROXIMATE INVESTMENT
ELECTRIC VEHICLES AND SOLAR CHARGING STATIONS			
Retrain a minimum of 10 existing mechanics and teachers to repair and service EVs; and Develop an installation and maintenance training program for EVs and renewable energy technologies	Annual savings of approximately 56.15 t CO_2 eq	~Target 2035	USD 1.462M | XCD 3.95M (project costs)
EFFICIENCY IN TRANSPORT			
Provide concessionary financing for low emission vehicles; and Establish standards and policies necessary to scale up the use of low emission vehicles	Annual savings of approximately 133,300 tCO_2 eq	~Target is 2030	USD 1 222 750 | XCD 3 287 000 (project costs)

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ABICE:	Antigua and Barbuda Institute of Continuing Education
AF:	Adaptation Fund
APUA:	Antigua Public Utilities Authority
ASC:	Antigua State College
BAEF:	Barrier Analysis and Enabling Framework
CBO:	Community-Based Organization
CDB:	Caribbean Development Bank
DC:	Direct Current
DCA:	Development Control Authority
DoE:	Department of the Environment
DTU:	Technical University of Denmark
EDP:	Entrepreneurial Development Programme
EV:	Electric Vehicle
GCF:	Green Climate Fund
GEF:	Global Environment Facility
GoAB:	Government of Antigua and Barbuda
INDC:	Intended Nationally Determined Contributions
IPCC:	Inter-governmental Panel of Climate Change
LED:	Light-emitting Diode
MoF:	Ministry of Finance
NGO:	Non-Government Organization
MoEST:	Ministry of Education, Science and Technology
MoLA:	Ministry of Legal Affairs
MoPCE:	Ministry of Public Utilities, Civil Aviation and Energy
NODS:	National Office of Disaster Services
PV:	Photovoltaic
RWH:	Rainwater Harvesting
SGP:	Small Grants Programme
SIDS:	Small Island Developing States
SIRFF:	Sustainable Island Resource Framework Fund
SWG:	Sectoral Working Group:
TAP :	Technology Action Plan
TNA:	Technology Needs Assessment
UDP:	UNEP-DTU Partnership
UNEP-CCC	UNEP Copenhagen Climate Centre (formerly UDP)
UNEP:	United Nations Environment Programme
UNFCCC:	United Nations Framework Convention on Climate Change
UWI:	University of the West Indies

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SECTION 1: WATER SECTOR

1.1 TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR WATER SECTOR

1.1.1 WATER SECTOR OVERVIEW

Antigua and Barbuda's water sector is being severely impacted by climate change and variability. These impacts have widescale knock-on effects, but more specifically on the key sectors of tourism, agriculture, health and education. Therefore, addressing climate change vulnerabilities in the water sector will in turn positively impact the nation's triple bottom line, thereby providing social, economic and environmental benefits.

Limited freshwater resources have contributed to widescale water-stress, and climate-induced impacts will continue to exacerbate the effects. According to the Intended Nationally Determined Contributions (INDCs), published in 2015, tourism and related services account for ~70% of national GDP (GoAB 2015). Agriculture, another major water consumer has experienced a rebirth in the last decade as the Government undertook to promote food security through increased production *at home*. Farmlands are traditionally located near ponds, dams and naturally occurring waterways and farmers are allowed unmetered access to irrigation volumes. However, in recent years, drought conditions have left these sources dry, significantly lowering productivity (GCF 2017).

Similarly, health and education are two essential services severely affected by water shortages. While, the country's hospitals, clinics and schools cannot be closed for extended periods due to lack of water; the quality of their service, hours of operation and number of nationals served daily are adversely impacted during periods of prolonged shortages. This results in shortened school days forcing households to accommodate children being out of school for unscheduled periods (O'Garro & Speek-Warnery 2009; UNICEF 2017). These concerns are heightened in low-income, single parent and female-led families, where decisions are often made around water collection and use. Thus, productivity, education and other vital activities tend to be limited until the *water problem* is solved (UNICEF 2017).

Table 1 summarises the diffusion targets for water sector technologies as selected by the TNA process.

Table 1: Quantitative Targets for Diffusion of Water Sector Technologies

TECHNOLOGY	SCALE OF DIFFUSION
Solar Pumping Systems	1,500 households (5% of population) | 10 small to medium sized farms
Rainwater Harvesting	3,000 households (10% of population) | 10 community cisterns
Water Saving Devices	1,500 households (5% of population) | 25% of private sector businesses
Climate-Proofing Assets	6 Reverse Osmosis Plants
Stormwater Reclamation and Reuse	Christian Valley well fields
Atmospheric Water Generators (Commercial)	50 private offices | 50 schools | 25 clinics and doctors' offices| 20 government offices

1.1.2 GENERAL BARRIERS AND PROPOSED MEASURES

The recurring barriers for water sector technologies were primarily linked to *cost* - capital, implementation and operation. These include cost to consumer for procuring goods and the cost to the government or water utility for acquiring, implementing and sustainably operating publicly provided goods. The need for increased *education and awareness* was also common across the entire group of technologies. This included educating the public about new products and bringing about awareness of the need for undertaking larger scale projects in order to improve national water security in the longer term.

Common barriers in the group of consumer technologies were related to *market availability* and *incentives* for acquiring new goods. Transfer of these technologies will be best achieved when new products are market tested and made available by local retailers. This would necessitate incentive programmes that promote technology uptake. By contrast when examining the publicly provided goods, *institutional reform* within the public sector to better streamline implementation for larger-scale projects, was deemed a necessity to achieve successful technology transfer.

1.2 ACTION PLAN FOR SOLAR PUMPING SYSTEMS

1.2.1 INTRODUCTION

Solar pumping systems substitute grid electric- and diesel-powered water pumps, for specialized equipment using power generated by solar photovoltaic (PV) panels. Systems often vary in size and complexity, depending on the scale of operation and the end user's needs. In simpler systems power requirements for pumping are met by solar generation; while in larger more complex systems power can be supplemented by back-up generators or the grid. Solar pumping systems facilitate a range of activities including extraction, distribution and treatment.

Antigua and Barbuda's conditional adaptation targets to 2030 outlined in the INDCs, indicate that 100% of power demand for water generation, distribution and usage is to be met by off-grid renewable resources. This would ensure limited interruptions to water distribution when the power grid is down, particularly following extreme climate events (GoAB 2015b). To accomplish this target, residential and commercial properties are encouraged to install on-demand pumping systems that utilize battery storage, while resorts, private residential developments and the Utility are encouraged to invest in systems that invert solar power to alternating current (AC) for continued use of standard equipment (WorldBank 2018). In addition, incorporating solar pumps into ultrafiltration (UF), nanofiltration (NP) and reverse osmosis (RO) systems can promote fully offgrid water treatment for both potable and non-potable operations.

1.2.2 AMBITION FOR THE TAP

The diffusion of solar pumping systems is expected to impact the residential, commercial and agricultural sectors, with up to 1,500 households or 5% of population and 10 small to medium sized farms being targeted to transition their pumping, distribution and filtration equipment to solar. Table 2 below outlines the applications that have been identified to reach these targets.

Table 2: Solar Pumping Applications for the Antigua and Barbudan Market

TYPE	DESCRIPTION	APPLICATIONS
Potable	▪ Retrofit existing water distribution systems with *solar options* to replace or supplement grid power.	▪ Homes ▪ Schools ▪ Clinics, Hospitals
	▪ Design systems for water distribution from community reservoirs to homes/standpipes; OR to lift water up to elevated storage tanks.	▪ Community-scale water supply
Non-potable	▪ Design systems to extract and distribute raw surface or groundwater for use on farm.	▪ Livestock watering ▪ Agriculture irrigation

1.2.3 ACTION AND ACTIVITIES FOR THE TAP

The full range of enabling measures outlined in the BAEF were examined to determine viable, concrete actions for the TAP. A three-point rating system (1 = High; 2 = Medium; 3 = Low) was used to catergorize the measures and decide where focus should be given for developing activities for technology dissemination. Table 3 shows the final ratings and key points that led to the choice of actions.

Table 3: Final Ratings of Enabling Measures for Solar Pumping Systems

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
High initial capital investment for system components, design and installation services.	▪ Establish specialist cooperatives [solar energy specialists and water equipment service providers] to investigate and promote the expansion of commercial interests to include solar water solutions	▪ *A key step in identifying the agents that consumers could rely on for expert advice and service*	1*
	▪ Provide access to public sector solar specialists – Pro Bono or at minimum market rate – to advise interested residents on sizing and design	▪ *Essential for targeting the socially vulnerable.* ▪ *Best combined with the private sector cooperatives for cohesivity*	1*
	▪ Provide tax exemptions and access to funds (e.g. through the Entrepreneurial Development Programme) to incentivize local suppliers to invest in solar pumping business opportunities, such as partnering with overseas manufacturers / suppliers and assembling equipment locally	▪ *Necessary for a new market item. Establishing a partnership with EDP (and other pending government initiatives) will be helpful*	1
	▪ Facilitate upskilling opportunities for local plumbing and electrical technicians to increase local capacity and availability of technical skills	▪ *Sustainability of this technology is hinged on in-country technical capacity*	1
Limited established retailers and package systems on island	▪ Incentivize local retailers to purchase, stock and market small scale, package solar pumping systems for residential and commercial	▪ *A single incentive programme will achieve greater buy-in at the government level*	1*

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
	applications, by zero-rating import duties and taxes for all solar equipment and accessories ▪ Facilitate quick repairs and limited system downtime by having adequate stock of essential replacement parts and a reliable network of technicians available on island [by partnering with regional suppliers / manufacturers]	▪ *Paired with the preceding measure. Retailers should be encouraged to import and stock replacement parts*	1*

* The measures were deemed complementary and combined into a single *Action*.

The measures prioritized above were refined into the following concrete actions:

1. Establish Solar Water Professionals Business Association to promote commercial interest and provide a pool of specialists on solar pumping systems.
2. Launch special incentive periods for local suppliers to invest in solar pumping business opportunities.
3. Launch a special incentive period for the private and public sector to acquire solar pumping equipment.
4. Develop upskilling programmes and train plumbing and electrical technicians.

The timeline for completion of the four actions is forty-eight (48) months, with a total project budget of approximately USD 1 500 000 | XCD 4 032 300, and an expected private sector investment of USD 550 000 | XCD 1 478 510 to achieve the quantitative target for diffusion outlined in Table 1.

Table 4 further develops these actions into activities that would aid in their implementation.

Table 4: Action and Activities for Solar Pumping Systems

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
Action 1: Establish *Solar Water Professionals Business Association* to promote commercial interest and provide a pool of specialists on solar pumping systems. **[Month 1 – Month 12]**	*Activity 1.1:* Establish local *Solar Water Professionals Business Association*	GCF, GEF	**Focal Point:** DOE; **Partner/s:** A&B Chamber of Commerce; *Chairman*	6 months	Lack of interest by professionals and businesses	Association established	Minutes from planning meetings between Chamber / DOE Association registration certificate from Intellectual Property Draft By-laws of Association	USD 1 500
	Activity 1.2: Create register of authorized business entities and individuals specializing in *solar water* systems design and installation	GCF, GEF	**Focal Point:** DOE; **Partner/s:** A&B Chamber of Commerce; *Chairman*	3 months	Lack of interest by professionals and businesses Slow registration process	Register published	Registration platform designed and Beta tested Online registration platform published	USD 6 500
	Activity 1.3: Create register of public sector specialists designated to work with low income and vulnerable groups	GCF, GEF	**Focal Point:** DOE; **Partner/s:** A&B Chamber of Commerce; *Chairman* Energy Desk	3 months	Lack of interest by public sector professionals in pro-bono work	Register published	Minutes from inter-ministerial meetings Regulations for accessing public sector assistance [based on size and cost of systems and applicants' income bracket] Online registration platform published	USD 5 000
Action 2: Launch special incentive periods for local suppliers to invest	*Activity 2.1:* Engage and sign MOU with the EDP to	GCF, GoAB	**Focal Point:** DOE; **Partner/s:** A&B Chamber of Commerce; *Chairman*	6 months	Length negotiation process with EDP	MOU signed	MOU drafted and legal review undertaken	USD 1 500

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
in solar pumping business opportunities. **[Month 7 – Month 36]**	promote the special tiered incentive programme.		MoF; *EDP Chairman*					
	Activity 2.2: Launch Tier 1[1], Tier 2[2], Tier 3[3] incentive periods	GCF, GoAB	**Focal Point:** DOE; **Partner/s:** A&B Chamber of Commerce; *Chairman* OPM; *EDP Chairman*	24 months[4]	Limited capacity within EDP to process applications Lengthy processing time Fatigue / frustration by businesses	3-tiered Incentive system launched	# of applications received in each Tier # of applications approved Volume of Units, parts and materials imported	USD 105 000 *[Table 5]
Action 3: Launch a special incentive window for the private and public sector to acquire solar pumping equipment. **[Month 10 – Month 40]**	*Activity 3.1:* Define incentive 'bands' for *residential* and *commercial* customers	GCF, GoAB	**Focal Point:** DOE; **Partner/s:** MoF; *Permanent Secretary*	6 months	Lengthy negotiation process with Finance Delays in Cabinet approval Poor 'band' design	Types of incentives approved for *residential* and *commercial* customers	# of planning meetings between DOE and Finance Residential / Commercial incentives defined and documented Cabinet paper drafted	USD 2 500
	Activity 3.2: Roll out phased incentive programme	GCF, GoAB	**Focal Point:** DOE *SIRFF* **Partner/s:** MoF; *Permanent Secretary*	18 months	Limited capacity to rapidly process applications Lengthy processing time Fatigue / frustration by applicants Publicity of programme fails to reach public	Incentive programme implemented	# of applications received (disaggregated by residential / commercial / public sector) # of application approved and approvals published	USD 1 000 000

[1] Tier 1: Registered businesses interested in supplying *'off-the-shelf'* units of solar pumping equipment ONLY
[2] Tier 2: Registered businesses interested in supplying *'off-the-shelf'* units along with replacement parts
[3] Tier 3: Registered business entities interested in partnering with Solar Pumping Equipment suppliers to import materials and assembling units in-country.
[4] Each Tier incentive window can run for 12 month period with a 6 month overlap

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
	Activity 3.3: Conduct post-programme market analysis and develop scenarios for scaling up	GCF	**Focal Point:** DOE *SIRFF*	6 months	Adequate data not collected	Market study published	Survey instrument developed # of post-installation surveys conducted Draft results shared in public consultation	USD 20 000
Action 4: Develop upskilling programmes and train plumbing and electrical technicians. **[Month 21 – Month 48]**	*Activity 4.1:* Complete curriculum	GCF, GEF	**Focal Point:** DOE **Partner/s:** MoEST; *Director of Education* ASC Engineering Department; *Principal* ABICE; *Principal* UWI Five Islands; *Campus Principal*	6 months	Lengthy curriculum development and approval process Prolonged curriculum approval / accreditation process	Curriculum developed	Minutes from inter-institutional collaboration meetings MOU established between DOE and institutions	USD 10 500
	Activity 4.2: Upgrade teaching staff qualifications to cover new curriculum [Training-of-trainers]	GCF, GEF	**Focal Point:** DOE **Partner/s:** MoEST; *Director of Education* ASC Engineering Department; *Principal* ABICE; *Principal* UWI Five Islands; *Chancellor*	3 months	Difficulty in scheduling training Delays in accessing or importing equipment / materials for in-class practical training	Educators trained	# of educators selected from each institution Report from Training-of-Trainers programme	USD 20 000
	Activity 4.3: Pilot curriculum with Professional Associations	GCF, GEF	**Focal Point:** MoEST; *Director of Education* **Partner/s:** ASC Engineering Department; *Principal*	6 months	Difficulty in scheduling training Limited interest by technicians	Plumbing and Electrical Technicians trained and certified	# of technicians trained for each module # of completion certificates	USD 15 000

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
			ABICE; *Principal* UWI Five Islands; *Campus Principal*			MOUs with professional associations to promote practical training		
	Activity 4.4: Launch new course/s in tertiary intuitions	GCF, GEF	**Focal Point:** MoEST; *Director of Education* **Partner/s:** ASC Engineering Department; *Principal* ABICE; *Principal* UWI Five Islands; *Chancellor*	12 months	Difficulty in scheduling training Limited interest by students	Course added to curriculum Students successfully matriculate through 1st year	# of institutions adopting curriculum in 1st year # of students registered in each institution in each institution	USD 75 000

It is proposed that *Activity 2.2* be delivered through a public sector collaboration between the Department of Environment (DOE) and the Entrepreneurial Development Programme (EDP) within the Office of the Prime Minister/Finance. The DOE has a working project management relationship with Finance and the EDP; however, since the EDP is a newly established Unit it would be necessary to provide project funding to successfully deliver this activity. Table 5 outlines the project cost breakdown for *Activity 2.2*.

In addition, to achieve the full scale of diffusion, an estimated private sector investment of USD 550 000 | XCD 1 478 510 is anticipated if local suppliers are granted waivers on import duties, revenue recovery charge (RRC) and sale tax (ABST) to stock solar pumping equipment and spares.

Table 5: Cost Breakdown for Activity 2.2

DESCRIPTION	TOTALCOST (USD)
Designated EDP Staff	40 000
Project Management (equipment, supplies, communication)	15 000
Media and PR	5 000
Workshops and Training	15 000
In-store Displays (units and sinage)	25 000
Contingency	5 000
TOTAL	**105 000**

While **Actions 1, 2, and 4** would establish the enabling environment and systems to support diffusion and future sustainability of solar pumping systems; **Action 3** directly addresses adoption of the technology by households and the farming community. *Activity 3.2* provides up to USD 1 000 000 | XCD 2 688 200 in concessional financing for private citizens to purchase and install solar pumping equipment on their properties. The low-interest loan scheme will be administered by the DOE's Sustainable Island Resources Framework (SIRF) Fund. It should be duly noted that these four (4) actions and corresponding activities would likely form part of a larger Water / Energy Sector project designed to attract GCF grant funding.

1.3 ACTION PLAN FOR RAINWATER HARVESTING

1.3.1 INTRODUCTION

Rainwater harvesting ('RWH') is the diversion, capture, storage, and treatment of precipitation for potable and non-potable uses. All systems typically include catchment surface, transport, storage, treatment, and distribution. At present rainwater harvesting is supported by the Building Code (1993) and Physical Planning Act (2003). The Development Control Authority (DCA) guidelines dictate that all newly constructed buildings must include rainwater capture and storage for the architectural plans to be approved.

Greater adoption of rainwater harvesting would occur if additional cost-effective storage options, that rival reinforced concrete in-ground cisterns, were available on the local market. Providing feasible storage options that specifically target the agricultural sector will also be beneficial in increasing on farm storage for irrigation. Further, harvesting at the community level would contribute to greater resilience for vulnerable people who cannot invest in adequate at home storage.

1.3.2 AMBITION FOR THE TAP

Improved diffusion of residential rainwater harvesting systems can aim to target 3,000 households across Antigua and Barbuda, enabling them to add or increase at-home storage capacity. While, at the community scale, diffusion will target the rehabilitation of up to ten (10) community cisterns with capacities of 50,000 to 125,000 U.S. gallons.

1.3.3 ACTION AND ACTIVITIES FOR THE TAP

The enabling measures outlined in the BAEF Report were examined to determine the best combination of concrete actions for the TAP (UDP, 2021). As with previous technologies a three-point rating system (1 = High; 2 = Medium; 3 = Low) was used to catergorize the measures and decide where focus should be given for developing activities for technology dissemination. Table 6 shows the final ratings and key points that led to the choice of actions.

Table 6: Final Ratings of Enabling Measures for Rainwater Harvesting

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
Cost and availability of unconventional rainwater storage options	▪ Provide financial incentives for retailers to import, market-test, stock and retail a wider range of rainwater storage options	▪ *Reserve incentives for solar technologies. The government is more likely to support incentives that aid in reaching renewal energy targets*	2

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
	▪ Promote a range [max. 5] of new storage options and encourage consumers to examine and compare costs and applicability [versus concrete in-ground cisterns]	▪ *Critical to expand the market options. Good for a pilot study, the results of which could be used to encourage retailers to invest.*	1
	▪ Stimulate local interest in designing and demonstrating novel low costs storage by increasing access to financing and lowering investment risks	▪ *Excellent action that should be promoted in collaboration with the private sector, educational institutions and service organizations*	1
High costs to refurbish community reservoirs or install community tanks and catchments	▪ Target donations [from business community, overseas residents, local government etc.] to accumulate seed funds to jumpstart refurbishment projects	▪ *Good sub-activity during the refurbishment projects*	2
	▪ Organize community workdays to elicit volunteer labour from community residents [and the willing public] to assist with renovations	▪ *Good sub-activity during the refurbishment projects*	2
	▪ Hire skilled labour where necessary	▪ *Good sub-activity during the refurbishment projects*	2
	▪ Strengthen technical capacity within community groups for planning/design, project coordination and financial management	▪ *Excellent option to build community adaption*	1*
	▪ Strengthen proposal writing capacity by seeking training opportunities for community NGO members	▪ *Another worthwhile capacity building action*	1*
	▪ Improve collaboration between community NGO and schools, and utilize the school as a channel for executing small scale project activities	▪ *Good sub-activity during the refurbishment projects*	2
	▪ Create opportunities for income generation in early phases of refurbishment project to promote various sources	▪ *Good sub-activity during the refurbishment projects*	2

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
	of income [thus limiting reliance on free money]		
No incentives that encourage pairing RWH with solar pumping systems	▪ Promote solar pumping systems as a complementary technology to rainwater harvesting for residential and community storage systems	▪ *Good sub-activity during the refurbishment projects*	2
	▪ Increase awareness about potential uses of solar pumping along the rainwater harvesting chain – specifically treatment and distribution	▪ *This will be done inadvertently once solar pumping options are on the market*	3
	▪ Create a program/s that provide financial incentives to individuals and groups interested in acquiring solar pumping equipment	▪ *Incentive program already established in the solar pumping systems technology roll-out*	2

The measures prioritized above were refined into the following concrete actions:

1. Pilot a range of up to five (5) new rainwater storage options for consumers.
2. Launch an *Innovators Competition* to design and demonstrate *novel* low-cost rainwater storage options [by increasing access to financing and lowering investment risks].
3. Strengthen technical capacity of registered NGOs and community groups in proposal preparation, project planning, design, coordination, and financial management.
4. Rehabilitate [up to 10] community cisterns with storage, distribution, and income generation streams.

Table 7 further develops these actions into activities that would aid in their implementation.

The timeline for completion of the four actions is sixty (60) months, with a total project budget of approximately USD 3 500 000 | XCD 9 408 700 to achieve the quantitative target for diffusion outlined in Table 1.

Table 7: Action and Activities for Rainwater Harvesting

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
Action 1: Pilot a range of up to five (5) new rainwater storage options for consumers. [Month 1 – Month 28]	*Activity 1.1*: Conduct market study to determine the best options	AF, GEF	**Focal Point:** DOE	6 months	Lengthy data collection and analyses	Market study report published	Survey instrument developed # of surveys / interviews completed	USD 20 000
	Activity 1.2: Pilot each new storage option	AF, GEF	**Focal Point:** DOE **Partner/s:** GEF SGP	18 months	Lengthy importation / assembly	Pilot organizations / sites selected	# of pilot sites for each technology Total # of storage options installed	USD 150 000
	Activity 1.3: Develop scenarios for scaling up	AF, GEF	**Focal Point:** DOE **Partner/s:** GEF SGP	3 months	Insufficent data collected during pilot phase Delays in procurement of Expert to develop scenarios	Up-scaling models	Technical paper on pilot study drafted Up to 3 scenarios developed for nationwide diffusion	USD 10 000
Action 2: Create an Innovators Competition to design and demonstrate novel low-cost rainwater storage options [Month 3 – Month 30]	*Activity 2.1*: Develop TORs for Innovators Competition.	AF, GEF	**Focal Point:** DOE **Partner/s:** GEF SGP	6 weeks	Need to develop effective and transparent scoring criteria	TORS finalized	TORS drafted and reviewed	USD 500
	Activity 2.2: Establish MOUs with local sponsors, e.g., businesses and service organizations	AF, GEF	**Focal Point:** DOE **Partner/s:** GEF SGP	3 months	Lengthy negotiations Limited interest from key stakeholders	MOUs signed	# of private sector and service organizations engaged	USD 1 500
	Activity 2.3: Launch Call for Applications with national Innovators Workshop	AF, GEF	**Focal Point:** DOE **Partner/s:** GEF SGP	6 months	Lengthy design process Limited access to industry partners	Design applications received	Innovators Workshop held # of applications received	USD 3 000

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
	Activity 2.4: Award designs and select demonstration projects	AF, GEF	**Focal Point:** DOE **Partner/s:** GEF SGP	3 months	Delays in evaluation process	Demo projects selected	# of viable designs Completed scoring sheets	USD 1 500
	Activity 2.5: Provide business and finance training for Innovators	AF, GEF, Private Sector	**Focal Point:** DOE *SIRFF* **Partner/s:** GEF SGP UWI Five Islands *Business Management* *Banking and Financial Institutions*	3 months	Lack of commitment by Innovators to follow through process (without certainty of funding)	Business Training and Certification of Innovators	# of attendees at training sessions # of one-to-one mentoring sessions held	USD 10 500
	Activity 2.6: Promote access to financing for eligible Innovators	AF, GEF	**Focal Point:** DOE *SIRFF* **Partner/s:** GEF SGP *Banking and Financial Institutions*	12 months	Delays in disbursements	Grants funding awarded Loans funding allocated	# of collaboration meetings with local financiers # of grants / loans applications received	USD 50 000 (grants) USD 500 000 (loans)
Action 3: Strengthen technical capacity of registered NGOs and community groups in proposal preparation, project planning, design, coordination and financial management. [Month 5 – Month 18]	*Activity 3.1*: Procure consulting services for Needs Assessment and Training	GEF	**Focal Point:** DOE **Partner/s:** GEF SGP	3 months	Limited qualified in-country consultants Lengthy procurement process	Consultant engaged	RFP published # of applications received Consultancy contract awarded	USD 2 500
	Activity 3.2: Conduct Capacity Needs Assessment	GEF	**Focal Point:** DOE **Partner:** *Consultant*	3 months	Accessibility to NGOs / Community groups	Capacity Needs Assessment Report published	Survery instrument developed # of NGOs / CBOs engaged Post-assessment consultation	USD 15 000
	Activity 3.3: Develop Project Management training programme	GEF	**Focal Point:** DOE **Partner:** *Consultant*	1 month		PM training programme and tools finalized	Programme outline drafted	USD 5 500

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
							Training tools developed	
	Activity 3.4: Conduct capacity building exercises	GEF	**Focal Point:** DOE **Partner:** *Consultant* GEF SGP	6 months	Difficulty scheduling training Limited interest by NGO / CBO members	Training and Certification completed	# of training sessions held # of NGOs / CBOs participated in training	USD 30 000
Action 4: Rehabilitate up to ten (10) community cisterns with storage, distribution system and income generation streams. [Month 6 – Month 60]	*Activity 4.1*: Competitively select community cistern projects	AF, GEF	**Focal Point:** DOE *SIRFF* **Partner/s:** GEF SGP Community Development Division	12 months	Limited number of organized NGOs / CBOs capable of spearheading rehalibitation projects Lengthy evaluation process Potential land ownership complications	Projects selected and contracts signed	Selection criteria developed # of applications submitted # of successful applicants awarded and awards published	USD 18 000
	Activity 4.2: Procure equipment and materials from local / regional network of suppliers	AF, GEF, Private Sector	**Focal Point:** DOE **Partner/s:** NGOs / CBOs	12 months	Lengthy procurement (importation) process Lack of access to secure storage (resulting in loss to theft)	Equipment and materials available	# of duty / customs / CABI waivers granted	USD 1 500 000
	Activity 4.3: Complete rehabilitation	AF, GEF, Private Sector	**Focal Point:** DOE **Partner/s:** NGOs / CBOs	36 months	Implementation delays Inclement weather halting project Increased pandemic related restricitions / delays	Community cisterns inaugurated	# of progress reports received % of funding disbursed Certification of completion & community handover ceremony	USD 1 000 000

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
	Activity 4.4: Develop Management Plan with income generation streams	AF, GEF	**Focal Point:** DOE **Partner/s:** NGOs / CBOs	6 months	Limited capacity to develop viable managements plans Procurement delays for experts	Management Plans approved	Plan drafted # of community consultations held	USD 30 000

The costs outlined in Table 7 do not address the private sector investment associated with importation and resale by local suppliers, or the consumer costs associated with purchase and installation of new rainwater storage options. The Technical Paper produced at the end of *Activity 1.3* will provide scenarios for scaling up the pilot programme to achieve adoption of new and/or improved rainwater storage for up to three thousand (3,000) households across Antigua and Barbuda. While it is premature to determine the exact number of *new* rainwater storage options that will be adopted during the pilot, a target of at least three hundred (300) households or ten percent (10%) of the overall goal would be appropriate to provide the relevant results to develop scaling up scenarios.

1.4 ACTION PLAN FOR WATER SAVING DEVICES

1.4.1 INTRODUCTION

Water efficient appliances, fixtures and devices, are used to augment in-home conservation efforts. These water savers have a variety of commercial and residential applications within buildings. In the Antiguan and Barbudan water sector technologies will focus on widescale diffusion in residential and commercial buildings.

A range of water efficient fixtures and appliances are available in local hardware stores across the country, some of which can be identified by the *water saving* green tag. Consumer choice is typically governed by budgetary constraints, and property owners determine how much to invest based on disposable income. It should be noted however, that some high efficiency devices are sold only fractionally more expensive than their less efficient counterparts, and a prudent consumer could be guided to make a better choice if armed with additional information.

1.4.2 AMBITION FOR THE TAP

Increased education and awareness of the water saving benefits of appliances and devices is necessary to promote increased diffusion of the technology. The TAP will target specialized messaging that increase consumer awareness of the value of opting for water efficient options with the goal of influencing up to 1,500 households (5% of population) and 25% of private sector businesses in switching to water efficient devices on their next purchase[5]. Particular focus would be placed on persuading property owners and managers to concentrate on major water loss/usage devices like washing machines, taps and shower heads.

1.4.3 ACTION AND ACTIVITIES FOR THE TAP

The enabling measures outlined in the BAEF were examined to determine the best combination of concrete actions for the TAP. The resulting categorization shows which measures were prioritized to develop concrete actions and activities for technology dissemination. Table 8 shows the final ratings and key points that led to the choice of actions.

Table 8: Final Ratings of Enabling Measures for Water Saving Devices

[5] Focus will be on *formal* business in the health, education, retail and tourism sectors, that routinely purchase trucked water to maintain their operations.

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
Low awareness about the water saving benefits of WSDs	▪ Develop a water efficiency labelling system that can be utilized to rate devices based on volumes of water saved, and partner with retailers to use labelling in store	▪ *Excellent action for raising consumer awareness*	1
	▪ Design a charting system that shows indicative uses of water around the property, coupled with water conservation tips	▪ *Great option for an educational drive.* ▪ *Excellent opportunity to include educational institutions*	1
	▪ Develop water efficiency standards for devices and work with the authorities [and Bureau of Standards] to promote as system of tax breaks for imports based on water savings	▪ *Standards should adhere to regional or international regulations* ▪ *Greater potential as a regional / OECS level undertaking*	2

The measures prioritized above were refined into the following concrete actions:

1. Develop and roll-out a water efficiency labelling system that rates devices based on volumes of water saved [and partner with retailers to use labelling in store].
2. Design an educational ***W***ater ***U***sage ***C***hart that shows indicative uses of water around the property and complementary water conservation tips.

The timeline for completion of the two actions is thirty-six (36) months, with a total project budget of approximately USD 165 000 | XCD 443 553 to achieve improved education and awareness relating to the water saving benefits of household appliances and devices. The timeline for attaining the quantitative target for diffusion outlined in Table 1 is undetermined.

The DOE has received climate finances from the Adaptation Fund (AF) to implement projects where some sub-activites may lay the foundation for the education and awareness needed for deployment of this technology. Hence, the activities described in Table 9 may be adapted in the future to build on the outcomes and lessons learned from the AF projects and scaled accordingly to achieve greater impact.

Table 9: Action and Activities for Water Saving Devices

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
Action 1: Develop and roll-out a water efficiency labelling system that rates devices based on volumes of water saved. [Month 1 – Month 28]	*Activity 1.1:* Develop branding guidelines for water efficiency labels	GEF SGP	**Focal Point:** DOE **Partner/s:** Bureau of Standards	3 months	Delays in finalizing guidelines	Guidelines finalized	Guidelines drafted Consultations held	USD 5 000
	Activity 1.2: Launch national competition to design water efficiency labels.	GEF SGP	**Focal Point:** DOE **Partner/s:** Bureau of Standards	6 months	Lack of interest from stakeholders	Water Efficiency Labels selected	# of applications received Shortlisted Label designs Sample labels produced	USD 15 000
	Activity 1.3: Pilot labelling programme with select retailers	GEF SGP	**Focal Point:** DOE **Partner/s:** Bureau of Standards	12 months	Limited capacity to monitor in-store roll out Complaints of unfair selection process	Pilot Programme Data Report MOUs with selected retailers	# of retailers registered in pilot # of units labelled In-store surveys completed	USD 50 000
	Activity 1.4: Develop a National Implementation Scheme for scaling up water efficiency labelling to all retailers	GEF SGP	**Focal Point:** DOE **Partner/s:** Bureau of Standards *Private Sector*	6 months	Lengthy process of engaging all retailers Delays in Cabinet approval	National Scheme approved at Cabinet	Register of all local retailers # of retailers contacted Cabinet paper drafted	USD 55 000
Action 2: Design a educational *W*ater *U*sage *C*hart that shows indicative uses of water around the property and complementary water conservation tips.	*Activity 2.1:* Establish MOU with Ministry of Education	GEF SGP	**Focal Point:** DOE	6 weeks	Lengthy inter-ministerial collaboration	MOU signed	MOU drafted Collaboration meetings held	USD 1 000
	Activity 2.2: Procure consulting services to develop educational module on *W*ater *U*sage	GEF SGP	**Focal Point:** DOE	3 months	Delays in procurement	Water Usage Module developed	RFP drafted and published	USD 5 500

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
[Month 28 – Month 36]							# of applications received Educational module and tools drafted	
	Activity 2.3: Pilot module in select high school Science classes	GEF SGP	**Focal Point:** DOE **Partner/s:** MoEST; *Director of Education*	3 months (selected school term)	Difficulty scheduling classroom time for module	Module taught in public and private schools	# of classroom hours logged # of students participated	USD 10 500
	Activity 2.4: Launch inter-school *W*ater *U*sage *C*hart design competition	GEF SGP	**Focal Point:** DOE **Partner/s:** MoEST; *Director of Education*	3 months (following school term)	Competing school activities	Winning charts selected	# of participating schools (disaggregarted by public and private)	USD 12 500
	Activity 2.5: Publish select charts and promote in national media campaign	GEF SGP	**Focal Point:** DOE **Partner/s:** MoEST; *Director of Education*	6 weeks	Insufficient access to continuous air time Poor reception by the public	Media blitz successful	Award ceremony held # of print, social media, television adverts published	USD 10 000

1.5 ACTION PLAN FOR CLIMATE PROOFING ASSETS

1.5.1 INTRODUCTION

Resilient infrastructure can significantly reduce but may not fully eliminate climate-related disruptions to APUA's service. Climate-proofing can improve reliability of service and increase asset life, by addressing the extent to which climate change translates into risks to infrastructure. The critical characteristic of climate-resilient infrastructure is that it is *planned*, *designed*, *built* and *operated* in a way that anticipates, prepares for, and adapts to changing climate conditions (OECD 2018). The process of climate-proofing involves assessing *exposure* and *vulnerability*, developing risk management plans and systematically de-risking (building resilience in) the Utility. Thus, enabling it to withstand, respond to, and recover rapidly from disruptions caused by extreme climate conditions. (ADB 2016; OECD 2018).

Comprehensive and proactive risk management requires making trade-offs between risk minimization and cost, resulting in a more resilient Water Utility where major climate-related risks have been considered and managed. It also assumes that the capacities to withstand and recover from shocks are in place (OECD 2014, 2018). A 2019 project funded by the Caribbean Development Bank (CDB) as part of the ACP-EU-CDB NDRM[6] assessed the existing climate-related vulnerabilities in APUA's infrastructure and presented an *Investment Plan for climate resilient water supply services.* The TAP will consider key actions that would enable APUA to commence the process of de-risking at crucial stages of the water supply process. Hence, managing physical assets – desalination facilities, pump stations, pipelines etc. – will be part of a more globally dynamic process within APUA's overall operations.

1.5.2 AMBITION FOR CLIMATE PROOFING ASSETS

Climate-proofing APUA's most critical investments would involve years of costly infrastructural work to retrofit, relocate and improve current facilities. Building on the critical measures identified in the BAEF process, the TAP will address non-starter barriers in an effort to position the Utility for a successful climate-proofing journey.

The high capital cost of de-risking the Water Utility was cited as the greatest constraint; hence, the actions considered in the TAP will address the design and financial management phases of the de-risking process. This approach makes the assumption that if APUA is equipped with a comprehensive risk management plan, improved capability to generate higher volumes of revenue

[6] African Caribbean Pacific – European Union – Caribbean Development Bank National Disaster Risk Management

and technical capacity to access external funding; it would be positioned to systematically implement the necessary infrastructure works. The overall timeline for completely de-risking APUA is estimated at a minimum of five (5) years depending greatly on the availability of financial resources.

1.5.3 ACTION AND ACTIVITIES FOR CLIMATE PROOFING ASSETS

The enabling measures identified in the BAEF were revisited and rated to determine the best combination of concrete actions that would serve the purposes outlined above. Table 10 shows the ratings that each measure received that led to the final selection of key actions to be implemented.

Table 10: Final Ratings of Enabling Measures for Climate-Proofing Assets

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
High costs of the phased implementation of [risk management] Plan	▪ Prioritize proactive management by providing adequate technical and financial resources to Utility	▪ *The Utility should be financially independent, hence the focus should be placed on increasing revenue so that key management processes can be implemented*	3
	▪ Promote greater financial independence of Utility by supporting greater revenue generation [through tariff reform, reducing NRW[7] etc.] and increasing the budget allocation [to offset consumption by public sector]	▪ *Improved revenue generation will contribute to better management planning and aid in the de-risking process*	1
	▪ Promote increased awareness about climate-proofing as a means to protect investment / assets and limit longer term expenditure by Utility	▪ *Levels of awareness are high;* ▪ *The Utility should keep iterating this messaging year round.*	3
	▪ Provide necessary support for Utility's staff in preparing technically sound and competitive proposals for international financing bodies	▪ *Critical to accessing donor financing*	1
	▪ Encourage government to allocate funding for necessary upgrades to water infrastructure	▪ *GoAB is aware and funding streams are In the pipeline*	3

[7] NRW: Non-revenue Water – water that is produced but *lost* alone the distribution line before it reaches the customer (such as through pipeline leaks or inaccurate metering).

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
	[considered national development initiatives], thus strengthening the applications for climate financing		
Increased levels of public concerns about the lengthy project timeline	▪ Develop a comprehensive communication plan with a range of communication tools to keep public updated about progress, delays and service interruptions [using diverse communication channels]	▪ *The Utility has a Comms Plan which can be updated include targeted messaging with re-risking activities have commenced.*	2
	▪ Outline [and update] a pragmatic project schedule and communicate changes in a timely manner	▪ *To be included in the updated Comms Plan*	2
	▪ Schedule and publicize shorter periods of network outages, and focus on limited rationing mitigate against anxiety about network outages	▪ *To be included in overall planning and the most vulnerable should be prioritized*	2
	▪ Map out Utility dependent zones / communities and ensure scheduled outages have limited impacts on the most vulnerable	▪ *Critical to aid in the implementation process*	1

The measures prioritized above were refined into the following concrete actions:

1. Develop a ten (10) year Climate Change ***R***isk ***M***anagement ***P***lan for the Utility that defines the technical and financial resource needs.
2. Promote greater financial independence of Utility through improved revenue generation through tariff reform and reducing NRW[8].
3. Train the Utility's ***P***roject ***M***anagement staff in preparing technically sound and competitive project proposals [for international financing bodies].
4. Map out Utility dependent zones / communities to ensure that scheduled network outages have limited impacts on the most vulnerable.

It was determined that the comprehensive Climate Change ***R***isk ***M***anagement ***P***lan should encompass all the climate related water risks. Hence, the Terms of Reference for the ***P***lan should not only include a scope that would cover actions and activities to climate proof the six (6) reverse

[8] NRW: Non-revenue Water – water that is produced but *lost* alone the distribution line before it reaches the customer (such as through pipeline leaks or inaccurate metering).

osmosis facilities, but should also be extended to include the development of a ***G***roundwater ***R***echarge ***M***ap for the Christian Valley watershed[9].

The timeline for completion of the four actions is sixty (60) months, with a total project budget of approximately USD 2 000 000 | XCD 5 376 400. Further costs for*proofing* the six (6) reverse osmosis facilities and pumping stations are estimated at approximately USD 3 000 000 | XCD 8 064 600 – the timeline for which would be determined by the availability of finances.

Table 11 further develops these actions into activities that would aid in their implementation.

[9] **G**roundwater **R**echarge **M**ap is necessary for implementation of Stormwater Reclamation and Reuse discussed in the next chapeter.

Table 11: Action and Activities for Climate Proofing Assets

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
Action 1: Develop a comprehensive ten (10) year Climate Change *R*isk *M*anagement *P*lan for the Water Utility that defines the technical and financial resource needs. [Month 1 – Month 18]	*Activity 1.1:* Develop TORS for *R*isk *M*anagement *Plan*	GoAB, APUA	**Focal Point:** APUA Water Business Unit; *Water Manager*	3 months	Availability of adequate technical historical data; Competing priorities with Water Business Unit	Request for Proposals document	Project Development Team assembled; Historical studies and climate change data for Utility identified; TORS drafted and finalized	USD 1 500
	Activity 1.2: Competitively procure consultancy to develop *P*lan	GCF, GoAB	**Focal Point:** APUA Water Business Unit; *Water Manager* **Partner/s:** MoF - Tender's Board; *Chairman*	6 months	Lengthy procurement process; Lack of local / regional qualified consultants; Inadequate proposals	Consulting Contract awarded	Number of *complete* proposals received; Tender's Board Evaluation Report; Contractual Agreement drafted	USD 3 500
	Activity 1.3: Develop *R*isk *M*anagement *P*lan	GCF, UNEP	**Focal Point:** APUA Water Business Unit; *Water Manager* **Partner/s:** *Consultant*	9 months	Availability of and accessibility to adequate technical data; Stakeholder participation and input; Cost and timeline for complementary technical feasibility studies	*R*isk *M*anagement *P*lan completed, approved by the APUA Board and disseminated to public	Number of stakeholder consultation held; Internal review notes for Draft *P*lan; Technical Feasibility Study/ report	USD 60 000
Action 2: Promote greater financial independence of Utility through improved revenue generation through tariff	*Activity 2.1:* Procure financial and technical consultants	CDB	**Focal Point:** OECS Commission; *Procurement Unit* **Partner/s:** APUA Water Business Unit; *Water Manager*	6 months	Lengthly procurement process; Lack of local / regional qualified consultants;	Consulting Contract awarded	Number of *complete* proposals received; Commission's Procurement Report; Contractual Agreement drafted	USD 7 500

reform and reducing NRW[10]. [Month 6 – Month 60]	*Activity 2.2:* Define new water tariff structure for residential and commercial customers	CBD	**Focal Point:** APUA Water Business Unit; *Water Manager* **Partner/s:** *Consultant*	12 months	Lack of political will; Low stakeholder interest / buy-in	Revised water tariff and phased implementation plan; Increased revenue of Water Utility	Number of stakeholder consultations; Number of media appearances / briefs published; Water Utility financial projections [post-reform]	USD 75 000
	Activity 2.3: Design and Implement NRW Plan	CBD	**Focal Point:** APUA Water Business Unit; *Water Manager* **Partner/s:** *Consultant*	48 months	Availability of GoAB co-funding for NRW reform; Frequent network outages during implementation; Decline in water quality during implementation	Phased NRW Plan; Increased revenue of Water Utility	Number of technical workshops with Water Utility technical teams; % reduction in NRW; Annual % increase in Water Utility revenue	USD 1 500 000
Action 3: Train the Utility's *P*roject *M*anagement staff in preparing technically sound and competitive project proposals [Month 12 – Month 30]	*Activity 3.1:* Procure consulting services for Capacity Needs Assessment and Training	GCF	**Focal Point:** DOE	3 months	Lack of local / regional qualified consultants;	Consulting Contract awarded; Consultant workplan approved	Number of proposals received; Procurement Report; Contractual Agreement drafted	USD 3 000
	Activity 3.2: Conduct Capacity Needs Assessment for Water Utility's project management unit	GCF	**Focal Point:** DOE **Partner/s:** *Consultant*	6 months	Access to technical staff with competing responsibilities;	Capacity Needs Assessment Report; Technical Workshop	Capacity Needs Assessment Survey Instrument; # of completed surveys;	USD 10 500

[10] NRW: Non-revenue Water – water that is produced but *lost* alone the distribution line before it reaches the customer (such as through pipeline leaks or inaccurate metering).

					Limited understanding of Antiguan context [by external consultant]		# of completed formal / semi-formal interviews;	
	Activity 3.3: Develop and deliver training programme	GCF, APUA, GoAB	**Focal Point:** DOE **Partner/s:** *Consultant*	9 months	Staff turnover rate during training period	Training programme developed; Staff trained	Training programme curriculum and tools; # and mode of training activities # for staff trained and certified;	USD 20 000
Action 4: Map out Utility dependent zones / communities to ensure that scheduled network outages have limited impacts on the most vulnerable. [Month 12 – Month 24]	*Activity 4.1:* Update Water Utility network map	APUA, GoAB	**Focal Point:** APUA Water Business Unit; *Water Manager* **Partner/s:** DOE*; DMU*	6 months	Availability of finances; Limited in-house technical capacity Lack of equipment and instruments	Updated water network map, zoned by dependence on access to piped water	Expertise, equipment, instruments sourced; # of field investigations completed; Digital and physical maps produced	USD 100 000
	Activity 4.2: Develop service plan to limit network interruptions through a consultative process	APUA, GoAB	**Focal Point:** APUA Water Business Unit; *Water Manager*	6 months	Low interest and stakeholder buy-in	Service plan developed and disseminated publicly	# of community visits and consultations held; Report of stakeholder input; # of media appearances / briefs of public disclosure	USD 15 000

1.6 ACTION PLAN FOR STORMWATER RECLAMATION AND REUSE

1.6.1 INTRODUCTION

Stormwater reclamation involves the collection, accumulation, treatment and storage of precipitation for reuse. Runoff is typically collected from *storm* drains, waterways and roadways instead of rooftops. A series of micro-catchments can be used to divert or slow runoff so that it can be stored before entering receiving waters. Across Antigua and Barbuda, extreme rainfall and seasonal weather events cause local watersheds to be inundated with flash flood waters that quickly drain into the marine environment. Hence, harvesting this water for non-potable uses, like groundwater recharge, agricultural irrigation or to replenish natural wetlands, could provide social, environmental and economic benefits – combating flooding and soil erosion and lessening nutrient loads discharged to marine waters (Pavelic et al. 2010).

In Antigua, diffusion of this technology will be focused in *C*hristian *V*alley *W*atershed on the south-west coast of the island. Christian Valley was chosen because it is the most productive in terms of annual yield of groundwater in cubic feet per year (Cooper & Bowen 2001; GENIVAR 2011; HRW 2019). Stormwater reclamation and reuse would achieve the following key results in the Christian Valley watershed:

i.) accumulation of surface water stores to accommodate groundwater recharge;
ii.) provision of additional volumes for crop irrigation and watering livestock in the local area; and
iii.) contribution to better overall watershed management through flood mitigation and soil erosion control – this would be particularly beneficial to vulnerable communities in the lower watershed.

1.6.2 AMBITION FOR THE STORMWATER RECLAMATION AND REUSE

Groundwater recharge will potentially increase the productivity of the Water Utility, with the co-benefit of lessening the island's dependency on seawater desalination for potable water supply. APUA aims to increase groundwater extraction of an additional 0.3mgd to offset demands on desalination. Secondary benefits to this technology include permitting neighbouring farmers to access microcatchments / dams for crop irrigation; while also lessening flash flooding downstream in the Jennings and West Palm Beach areas.

1.6.3 ACTION AND ACTIVITIES FOR STORMWATER RECLAMATION AND REUSE

The enabling measures identified in the BAEF were revisited and rated to determine the best combination of concrete actions that would enable APUA to create a series of micro-catchments in the Christian Valley area. Table 12 shows the ratings that each measure received that led to the final selection of key actions to be implemented.

Table 12: Final Ratings of Enabling Measures for Stormwater Reclamation and Reuse

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
High costs of civil works for construction of check dams and micro-catchments	▪ Promote expansion opportunities for local heavy equipment / earthworks companies by providing them with construction contracts; thus, eliminating public sector purchase of equipment or employment of skilled workers	▪ *Critical to support timely micro-catchment construction through public-private partnerships*	1
	▪ Partner with tertiary institutions and equipment suppliers to provide training and certification for local heavy equipment operators to avoid outsourcing specialized jobs	▪ *Excellent option to support preceding action*	1
	▪ Increase production at local quarries to offset the demand for increased volumes of materials during project implementation	▪ *Procurement constraint to project implementation*	1*
	▪ Reduce material costs and delays by procucuring imported materials in bulk	▪ *Procurement constraint to project implementation*	1*

***** The two measures were combined into Action 3 listed below.

The measures prioritized above were refined into the following concrete actions:

1. Partner with local heavy equipment and earthworks companies to offset public sector purchase of equipment.
2. Train and certify local heavy equipment operators through collaboration with tertiary institutions and equipment suppliers to avoid outsourcing specialized jobs.
3. Develop comprehensive sustainable procurement plan for equipment and materials.

The timeline for completion of the three actions is forty-eight (48) months, with a budget of approximately USD 500 000 | XCD 1 344 100 to create the enabling environment necessary for the successful construction of micro-catchments in the Christian Valley watershed to achieve the outcomes listed in Section 6.1. The costs for the construction works is estimated at an additional USD 3 000 000 | XCD 8 064 600, with the expectation that the Utility will eventually benefit from

an additional 0.3mgd in groundwater extraction. The timeline for the construction works would be determined by the availability of finances.

Table 13 further develops these actions into activities that would aid in their implementation.

Table 13: Action and Activities for Stormwater Reclamation and Reuse

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
Action 1: Partner with local heavy equipment and earthworks companies to offset public sector purchase of equipment[11] [Month 1 – Month 20]	*Activity 1.1:* Create register of local equipment / earthworks companies *(willing to pursue public sector contracts)* [Issue Expression Of Interest]	GoAB, APUA	**Focal Point:** APUA Water Business Unit; *Water Manager and* MoW; *Director of Public Works* **Partner/s:** MoF/Tenders Board; *Permanent Secretary*	3 months	Lack of interest from private sector companies in working on government issued contracts;	Register of Companies	Criteria guidelines drafted; Registration call promoted in media; Registration portal opened online	USD 2 500
	Activity 1.2: Sign MOUs with successful companies	GoAB, APUA	**Focal Point:** APUA Water Business Unit; *Water Manager and* MoW; *Director of Public Works* **Partner/s:** MoF/Tenders Board; *Permanent Secretary* MoLA; *Attorney General*	3 months	Lengthy negotiation process;	MOUs signed	# of companies shortlisted; MOU draft by Legal Affairs;	–
	Activity 1.3: Promote procurement of equipment needed for micro-catchment construction [Duty free waivers to be provided for import under the MOU]	GoAB, APUA	**Focal Point:** APUA Water Business Unit; *Water Manager and* MoW; *Director of Public Works* **Partner/s:** MoF/Tenders Board; *Permanent Secretary*	12 months	Accessibility to finance by companies for equipment purchase; Lengthy procurement process; Expiration of duty free waiver	Updated inventory of earthworks equipment on island	List of equipment; # of authorized duty free waivers; # of waivers surrendered at Customs	USD 10 000
Action 2: Train and certify local	*Activity 2.1:* Complete training curriculum	GEF, UNEP	**Focal Point:** DOE	6 months	Accessibility of skilled expert teachers / trainers	Curriculum developed	Draft curriculum	USD 10 000

[11] Local companies to be provided with construction contracts for implementation works, in an attempt to eliminate public sector purchase of equipment or employment of skilled workers.

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
heavy equipment operators through collaboration with tertiary institutions and equipment suppliers to avoid outsourcing specialized jobs. [Month 12 – Month 48]						Training programme initiated		
	Activity 2.2: Secure institutions and equipment suppliers to conduct training	GEF, UNEP, GoAB	**Focal Point:** DOE **Partner/s:** MoW; *Director of Public Works* ASC Engineering Department; *Principal*	6 months	Lack of trained technical experts in country; High cost of procuring overseas experts	Heavy equipment operators from private and public sectors registered	# of public sector operators registered for training; # of private sector operators registered for training	USD 100 000
	Activity 2.3: Implement training programme	GEF, UNEP, GoAB	**Focal Point:** ASC Engineering Department; *Principal;* **Partner/s:** *Specialist Trainers*	18 months	Lack of commitment by operators; Cost of training;	Heavy equipment operators from private and public sectors trained and certified	Total # of operators trained;' # of scholarships	USD 150 000
Action 3: Develop comprehensive sustainable procurement plan for equipment and materials. [Month 9 – Month 30]	*Activity 3.1:* Develop TORS for sustainable procurement	APUA	**Focal Point:** DOE **Partner/s:** MoW; *Director of Public Works*	3 months	Inadequate levels of interagency collaboration	TORS finalized	TORS drafted	USD 2 000
	Activity 3.2: Update procurement plan to include increased quarry production	GCF, UNEP, GoAB	**Focal Point:** DOE	6 months	Varying levels of commitment between government and private quarries	Procurement Plan finalized	# of collaboration meetings; Draft Procurement Plan;	USD 6 500
	Activity 3.3: Develop bulk procurement policy guidelines	GCF, UNEP, GoAB	**Focal Point:** DOE	6 months		Policy guidelines adopted by private and public sector	Draft policy guidelines; # of consultations with public and private sector agents	USD 10 500

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY

1.7 ACTION PLAN FOR ATMOSPHERIC WATER GENERATORS

1.7.1 INTRODUCTION

Atmospheric Water Generators (water makers) produce potable water by extracting vapour from humid, ambient air – either by condensation or exposing the air to hydroscopic substances (drying agents) called desiccants. In modern water makers, vapour from the air is drawn into the external/roof-mounted unit and adsorbed into a specialized desiccant. Water is then desorbed and condensed into droplets. The liquid is piped into a tank where it can receive up to three levels of treatment before the purified drinking water is dispensed at a tap or cooler. Some water makers are solar powered and can even be fitted with network-connected water quality monitoring systems (Watergen 2018; ZeroMassWater 2018).[12,13]

1.7.2 AMBITION FOR ATOMOSPHERIC WATER GENERATORS

The TAP will focus on piloting *roof* units on private or public buildings that provide drinking water dispensed at a cooler throughout the day, with specific focus on offices, schools and health facilities. The diffusion targets for the pilot phase is to install AWG units in 50 private offices, 50 schools, 25 clinics and/or doctors' offices and 20 government offices.

1.7.3 ACTION AND ACTIVITIES FOR ATMOSPHERIC WATER GENERATORS

The enabling measures identified in the BAEF were rated to determine the best combination of concrete actions that would result in successfully piloting AWGs as alternative water coolers. Table 14 shows the ratings that each measure received that led to the final selection of key actions to be implemented.

Table 14: Final Ratings of Enabling Measures for Atmospheric Water Generators

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
Consumers apprehensive to make the higher initial investment in comparison to traditional water coolers	▪ **Establish partnerships between local retailers and AWG manufacturers [e.g. leveraging multilateral relationships established through the Chamber of Commerce]**	▪ ***Key to procurement of units for pilot phase***	**1**
	▪ **Incentivize local retailers to purchase and stock AWG**	▪ ***Priority should be given to introducing the technology through a pilot programme.***	**2**

[12] SOURCE Perfect water for every person, every place. Zero Mass Water, www.zeromasswater.com
[13] Genius Technology Energy efficient heat transfer and dehumidifying technologies. Watergen USA, https://www.watergenusa.com/technology-2/technology/

CRITICAL BARRIER	ENABLING MEASURES	STAKEHOLDER COMMENTS	RATING
	units by zero rating import duties and taxes ▪ Design a robust education and awareness campaign to educate consumers about the technology and help them understand the longer term benefits	▪ *Incentives may not be required after the pilot* ▪ *An education campaign is very necessary for such a new technology*	1*
	▪ Encourage bottled water business to enter the market and provide rental or rent-to-own options to consumers [e.g. through avenues like the entrepreneurial development programme]	▪ *This action can be explored as a scenario to scale up the diffusion of the technology after the pilot*	3
High consumer concerns about system's performance and reliability	▪ Design a robust education and awareness campaign to educate consumers about the technology and help them understand the overall process	▪ *An education campaign is very necessary for such a new technology*	1*
	▪ Provide training and certification for technicians	▪ *Specialist technicians will be needed during the pilot phase and more importantly when diffusion is scaled up*	1
	▪ Pilot technology [e.g. in government buildings] and dessimate results to engender consumer confidence	▪ *Excellent way to introduce the technology*	1

* The measures were deemed complementary and combined into a single Action.

The measures identified for development into concrete actions are:

1. Incentivise local businesses to establish partnerships with AWG manufacturers and market cooler units. [e.g. leveraging multilateral relationships established through the Chamber of Commerce and working with bottled water businesses]

2. Design a robust education and awareness campaign to teach consumers about AWGs and help them understand the longer term benefits.

3. Develop programmes to train and certify specialist technicians.
4. Pilot technology in government buildings and use results scale up dissemination.

The timeline for completion of the four actions is sixty (60) months, with a total project budget of approximately USD 3 500 000 | XCD 9 408 700 to achieve the quantitative target for diffusion outlined in Table 1.

Table 15 further develops these actions into activities that would aid in their implementation.

Table 15: Action and Activities for Atmospheric Water Generators

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
Action 1: Incentivise local businesses to establish partnerships with AWG manufacturers and market cooler units. [Month 1 – Month 18]	*Activity 1.1:* Engage and sign MOU with MoF to promote incentive programme	GoAB	**Focal Point:**DOE **Partners:** MoF; *Permanent Secretary* MoLA; *Attorney General*	6 weeks	Delays in finalizing agreement	Financial incentives approved MOU signed	MOU drafted and legal review undertaken	USD 500
	Activity 1.2: Establish partnerships between local businesses and AWG manufacturers	GCF, Private Sector	**Focal Point:**DOE **Partner/s:** A&B Chamber of Commerce; *Chairman*	6 months	Accessibility to AWG manufactures	Partnerships established	# of AWG manufacturers engaged Partnership agreements drafted	USD 4 500
	Activity 1.3: Launch incentive programme to allow local businesses bulk imports	GCF	**Focal Point:**DOE **Partner/s:** A&B Chamber of Commerce; *Chairman* *Economic Consultant*	12 months	Delays in incentive roll out Lengthy importation process	Customs & Excise Div Report Post-incentive economic study	# on AWG units imported	USD 22 500
Action 2: Design a robust education and awareness campaign to teach consumers about AWGs and help them understand the longer term benefits [Month 12 – Month 24]	*Activity 2.1*: Procure consulting services to develop education and awareness campaign	GCF	**Focal Point:**DOE	3 months	Delays in procurement Availability of quailed consultants	Consulting Contract signed	RFP published # of applications received Contract drafted	USD 2 500
	Activity 2.2: Design campaign and tools	GCF	**Focal Point:**DOE	2 months	Challenges with making activities and tools specific to Antiguan & Barbudan context	Education campaign and tools finalized KAP study to show positive/negative reception	Campaign activities drafted for approval Campaign and tools tested in small groups	USD 12 500
	Activity 2.3: Launch nationwide campaign	GCF	**Focal Point:**DOE	6 months	Limited feedback on success of messaging	Education campaign successful	# of media, training and public events held Feedback surveys	USD 20 500

ACTION	ACTIVITIES TO BE IMPLEMENTED	SOURCE OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIMEFRAME	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY
Action 3: Develop programmes to train and certify specialist technicians [Month 12 – Month 36]	*Activity 3.1*: Procure services of AWG manufacturers to conduct in-country trainings	GCF	**Focal Point:**DOE	6 months	Lengthy procurement process with overseas entities	Contractual agreements signed	Contract drafted Training outline and materials developed/approved	USD 5 500
	Activiyt 3.2: Conduct training for educators in technical and vocational institutions [Training-of-Trainers]	GCF	**Focal Point:**DOE	3 months	High cost of training	Educators trained and certified	# of training hours logged # of educators certified (disaggregated by institutions)	USD 25 500
	Activity 3.3: Launch training course in select institutions	GCF, GoAB	**Focal Point:**DOE **Partner/s:** ASC Engineering Department; *Principal* ABICE; *Principal*	12 months		1st cohort of students trained	# of courses run in Yr 1 (disaggregated by institutions) # of students enrolled and successful	USD 45 000
Action 4: Pilot technology in government and private sector buildings and use results scale up dissemination [Target: 150 AWG Units] [Month 37 – Month 60]	*Activity 4.1*: Competitively select schools and government/private sector offices for pilot	AF, GCF	**Focal Point:**DOE	6 months	Limited capacity in government agencies to apply for pilot scheme Limited interest in private sector participation	Selection Report	# of application received Types of AWG units requested	USD 6 500
	Activity 4.2: Launch public/private sector AWG unit installation sub-project	AF, GCF	**Focal Point:**DOE	12 months	Delays in importation	Pilot project Report	# of units installed	USD 400 000
	Activity 4.3: Collect data and develop scenarios for scaling up	AF, GCF	**Focal Point:**DOE	18 months	Inconsistent water quality tests Accessibility to relevant data Malfunctioning units	Up-Scaling Report	# of units with data collection function # of functional units at end of pilot Water Quality testing and maintenance checklist/logs	USD 36 000

1.8 PROJECT IDEAS FOR THE WATER SECTOR

A list of project ideas was generated for each prioritized technology, and a single project was selected for further development. Table 16 shows the actions that would facilitate effective implementation of the chosen project.

Table 16: Project Ideas for the Water Sector

TECHNOLOGY	ACTIONS	PROJECT IDEAS
Solar Pumping Systems	▪ Establish Solar Water Professionals Business Association to promote commercial interest and provide a pool of specialists on solar pumping systems. ▪ Launch special incentive windows for local suppliers to invest in solar pumping business opportunities ▪ Launch a special incentive window for the private and public sector to acquire solar pumping equipment Develop upskilling programmes for plumbing and electrical technicians. ▪ Develop upskilling programmes and train plumbing and electrical technicians.	Residential solar distribution pump installation scheme Solar filtration / desalination scheme for agriculture irrigation
Rainwater Harvesting	▪ Pilot a range of up to five (5) new rainwater storage options for consumers. ▪ Launch an Innovators Competition to design and demonstrate novel low-cost rainwater storage options [by increasing access to financing and lowering investment risks]. ▪ Strengthen technical capacity of registered NGOs and community groups in proposal preparation, project planning, design, coordination, and financial management. ▪ Rehabilitate [up to 10] community cisterns with storage, distribution, and income generation streams.	Community cistern rehabilitation schemes
Water Saving Devices	▪ Develop and roll-out a water efficiency labelling system that rates devices based on volumes of water saved [and partner with retailers to use labelling in store]. ▪ Design a educational Water Usage Chart that shows indicative uses of water around the property and complementary water conservation tips.	Inter-school Water Usage Chart design competition coupled with media information drive
Climate-Proofing Assets	▪ Develop a ten (10) year Climate Change Risk Management Plan for the Utility that defines the technical and financial resource needs.	Water Utility Climate Change Risk Management Plan with comprehensive GIS piped-water network map, zoned by socio-economically vulnerable communities

TECHNOLOGY	ACTIONS	PROJECT IDEAS
	▪ Promote greater financial independence of Utility through improved revenue generation through tariff reform and reducing NRW[14]. ▪ Train the Utility's Project Management staff in preparing technically sound and competitive project proposals [for international financing bodies]. ▪ Map out Utility dependent zones / communities to ensure that scheduled network outages have limited impacts on the most vulnerable.	
Stormwater Reclamation and Reuse	▪ Partner with local heavy equipment and earthworks companies to offset public sector purchase of equipment. ▪ Train and certify local heavy equipment operators through collaboration with tertiary institutions and equipment suppliers to avoid outsourcing specialized jobs. ▪ Develop comprehensive sustainable procurement plan for equipment and materials.	-
Atmospheric Water Generators	▪ Incentivise local businesses to establish partnerships with AWG manufacturers and market cooler units. ▪ Design a robust education and awareness campaign to teach consumers about AWGs and help them understand the longer term benefits.	Pilot cooler units in the health and education sectors

[14] NRW: Non-revenue Water – water that is produced but *lost* alone the distribution line before it reaches the customer (such as through pipeline leaks or inaccurate metering).

SECTION 2: BUILDING SECTOR

2.1 TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR BUILDING SECTOR

2.1.1 BUILDING SECTOR OVERVIEW

Climate change has led to an increase in the occurrence of high-intensity hurricanes making landfall on the small island developing state (SIDS) of Antigua and Barbuda. Historically, most tropical depressions impacting the islands were of low intensity, usually tropical storms, or Category 1–3 hurricanes. Nine Category 4 and two Category 5 hurricanes have been recorded since 1850[15], with eight of these more intense storms occurring in the last 15 years. Before 2017, there was no Category 5 hurricane formed in the Eastern Caribbean. Given the history of major hurricanes, the country's current infrastructure is designed to minimally withstand the impacts of hurricanes up to Category 3. However, continuing warming conditions over the Atlantic Ocean are resulting in an increased intensity of hurricanes in the Caribbean, with Antigua and Barbuda experiencing its first recorded Category 5 hurricane which was Irma in 2017[16].

Since existing building codes in Antigua and Barbuda have not accounted for Category 4 and 5 hurricanes, the impacts of such events have been severe, causing significant damage to houses and infrastructure, as well as disrupting basic services such as health, education, telecommunications, electricity, water, sewage, and waste systems.

Category 4 and 5 resiliency standards can be incorporated into new buildings much easier than existing structures. The challenge of upgrading existing buildings to be Category 4 and 5 resilient is the cost which is estimated to be over US$ 6.4 billion[17]. In 2020, the GDP of Antigua and Barbuda was US$1.42B, a 14.86% decline from 2019 (US$1.66B)[18].Therefore, to transition the building sector alone to withstand climate change impacts, will require the generation of the funds needed.

The Government of Antigua and Barbuda (GoAB) is currently implementing a project entitled Building Climate Resilience Through Innovative Financing Mechanisms for Climate Change Adaptation (2016–2020; SCCF; US$ 11,390,000), funded by a grant of US$ 5 million from the Special Climate Change Fund (SCCF) and co-financing from the GoAB. Among its primary focus areas are:

[15] Antigua and Barbuda Meteorological Services. Antigua Tropical Cyclones 1851–2018. Available at: http://www.antiguamet.com/Climate/HURRICANE_SEASONS/AntiguanStorms.txt
[16] Antigua and Barbuda GCF Funding Proposal
[17] Resilience cost data from applications to the Sustainable Island Resource Framework (SIRF) Fund.
[18] https://www.macrotrends.net/countries/ATG/antigua-and-barbuda/gnp-gross-national-product

i) developing innovative financing mechanisms to fund adaptation interventions through the Sustainable Island Resource Framework Fund (SIRF Fund) established under section 91 of the Environmental Protection Act, 2019, including for the building sector; and

ii) strengthening national policies and plans to promote adaptation to climate change through *inter alia* updating the national building code, which includes considerations for Category 4 and 5 hurricanes.

In its current form, the SIRF Fund is optimised for small grants and a revolving loan program. Small grants are provided to vulnerable community buildings in vulnerable areas of the country such as churches, schools, and community centres. The revolving fund program offers highly concessional non-collateralized loans to individual homeowners. The loan portfolio for individual applications is capped at 5% of the total funds available at a given time. The loans are to be used for the incremental cost of the climate interventions only and cannot be used for normal construction costs. The incremental cost is calculated by identifying the agreed adaptation interventions compared to normal construction cost. The SIRF Fund is the only funding mechanism of this type in Antigua and Barbuda and is designed to not compete with the local private financial sector[19].

Antigua and Barbuda currently has the highest per capita consumption of electricity of all Eastern Caribbean states[20]. Additionally, the country has one of the highest domestic electricity tariffs in the Caribbean region. Domestic consumption of electricity accounts for some 40% of all national consumption and the percentage of the population not consuming energy is equivalent of 0.48%[21].

In terms of energy consumption for households in Antigua and Barbuda, there is an estimated total of 30 000 households with an average household electricity consumption of 8.25 kWh/day or just above 3 000 kWh/year[22]. Due to its relative flatness and ease of access to almost all areas, Antigua and Barbuda has electricity penetration to 95.4% of the country. In fact, only 1.2% of households were identified as not having access to any form of lighting[23].

The Department of Environment conducted a socio-economic study in 2020, including a national survey of 1100 people in Antigua and Barbuda to evaluate the costs and effects of climatic events on households. The survey found that the average household in the country typically pays approximately 7-10% of its monthly income on electricity. The survey targeted persons with an income of less than XCD1,500 monthly.

[19] Antigua and Barbuda GCF Build Funding Proposal
[20] https://antiguaobserver.com/500-led-lights-arrive-for-roadways/
[21] Antigua and Barbuda's Third National Communication
[22] Antigua and Barbuda Renewable Energy Roadmap, IRENA, 2021.
[23] 2011 Population and Housing Census of Antigua and Barbuda

The actions and projects mentioned in the building sector segment of this document aim at assisting with the development of building resilience and lowering building energy consumption in Antigua and Barbuda.

2.2 ACTION PLAN FOR LIGHT-EMITTING DIODES (LED)

2.2.1 INTRODUCTION

A light-emitting diode (LED) is a semiconductor that emits light when an electric current is passed through it[24]. LEDs have several benefits compared to other lighting technology such as CFL and incandescent, which includes longevity, brightness, and electrical cost. In terms of longevity, LEDs can last up to 25,000 hours. Putting this into perspective, if you were to use a LED bulb 24/7, you would have to replace the bulb every 15 years. Compact fluorescent lamp (CFL) bulbs tend to have a lifetime of about 8,000 hours and incandescent 750 hours[25]. Incandescent light tends to emit 15 lumens per watt, whereas CFL emits 60 lumens per watt. However, LEDs emit 72 lumens per watt. A 40sq ft living room would require approximately 800 lumens. In order to reach a brightness of 800 lumens, an incandescent bulb would require 60 watts, CFL about 14 watts and an LED, 10 watts[26]. This makes LED highly efficient lighting technology. Those that are "ENERGY STAR" rated use up to 75% less energy[27].

The drawback of LEDs is that it is more expensive relative to the other technologies. Given the fluctuations in the electricity supply in Antigua and Barbuda, bulbs tend to blow regularly and must be replaced more often than normally would be required. As a result, the citizens bear this cost and therefore choose the cheapest option available. Nevertheless, the price of LEDs has been decreasing rapidly over the years due to the improvement in manufacturing and increased demand. In 2011, LED bulbs cost between USD45-50, which fell to less than USD 10 by 2018[28].

Less energy consumed by LEDs means that there would be reduction for the consumer on their energy bill. Table 17 below gives a breakdown of the possible saving annually by switching to LED technology. Based on the table below, by converting from incandescent to LED, one can reduce lighting energy cost by 85% and by switching from CFL to LED, would reduce it by 36%.

[24] https://www.ledsmagazine.com/leds-ssl-design/materials/article/16701292/what-is-an-led
[25] https://www.nopec.org/blognewsroom/blog/comparing-led-vs-cfl-vs-incandescent-light-bulbs/
[26] https://www.homelectrical.com/cfls-vs-halogen-vs-fluorescent-vs-incandescent-vs-led.6.html#:~:text=Traditional%20incandescent%20light%20bulbs%20emit%20about%2015%20lumens%20per%20watt.&text=CFL's%20or%20fluorescent%20light%20bulbs,as%20a%2060%2Dwatt%20bulb
[27] https://www.energy.gov/energysaver/save-electricity-and-fuel/lighting-choices-save-you-money/led-lighting
[28] https://www.ledinside.com/news/2018/8/global_led_lighting_products_price_trend

Table 17: Annual Saving by Switching to LEDs

LIGHTING TECHNOLOGY (800 LUMENS)	DAILY KWH CONSUMED @ 8HRS	ANNUAL KWH CONSUMED (@8HR/DAY)	ANNUAL COST (XCD 0.9/KWH)
Incandescent (60 Watts)	0.48	175.2	$157.68
CFL (14 Watts)	0.11	40.15	$36.14
LED (9 Watts)	0.07	25.55	$23.00

Apart from financial saving, the use of LED can also assist in the reduction of GHG emissions into the atmosphere. Table 18 below provides a breakdown of the CO_2 emissions annually by various lighting technologies.

Table 18: Annual CO_2 Emissions of Lighting Technologies

LIGHTING TECHNOLOGY (800 LUMENS)	DAILY KWH CONSUMED @ 8HRS	ANNUAL KWH CONSUMED (@8HR/DAY)	CO_2 PRODUCED ANNUALLY (HEAVY FUEL OIL POWER GENERATION)[29] (KG)
Incandescent (60 Watts)	0.48	175.2	47.30
CFL (14 Watts)	0.11	40.15	10.84
LED (9 Watts)	0.07	25.55	6.90

On a national scale, Antigua and Barbuda has started implementing LED technology. In 2017 the Government of Antigua and Barbuda in collaboration with the Caribbean Development Bank started a project of replacing 14,000 high-pressure sodium and mercury vapor lamps with LEDs. According to Antigua Public Utilities Authority (APUA), street lighting accounts for 10% of the country's demand and the conversion would reduce the consumption by 75%[30]. The project aimed to reduce street lighting consumption by 4,900MWh and 3,200 tonnes of carbon dioxide emissions by 2019[31]. The CDB financed this project through a loan of US$5.9 million as well as an additional grant of a US$1million. No projects of this type have been implemented on household, commercial and public buildings.

Country Economic Development Economic Benefits

- Large-scale implementation of the product can reduce the cost for electricity usage at the consumer level which when accumulated would decrease the country's energy consumption. This would assist in the reduction of the energy demand of households,

[29] https://www.engineeringtoolbox.com/co2-emission-fuels-d_1085.html
[30] https://antiguaobserver.com/500-led-lights-arrive-for-roadways/
[31] https://www.caribank.org/newsroom/news-and-events/over-14000-streetlights-antigua-barbuda-be-replaced-leds

public and commercial buildings, thereby reducing the amount of energy needed to be generated by APUA from fossil fuels.

- Entrepreneurial benefits as persons can import and resell variations and variety of LED fixtures for households, commercial and other buildings.
- Savings to the customers can be re-invested in other sectors of the economy.

Social Benefits

- LED technologies enhance health and living conditions for building occupants especially as it relates to the eyes. The use of high-frequency electronic ballasts helps reduce eyestrain and fatigue, increase productivity in workplaces and provide a better quality of life.[32]
- Society would gain an understanding of energy-efficient technology available for buildings which they can implement to assist in reducing their energy demand and consumption.

Environmental Benefits

- Energy-efficient lighting such as LED can contribute to the decrease in energy demand of the country, consequential less heavy fuel oil used for energy production and ultimately, reduction in GHG emissions.

2.2.2 AMBITIONS FOR LIGHT-EMITTING DIODES

Replacing 20,000 incandescent light bulbs and 10,000 CFL over 2 years in 5000 homes.

This action would reduce the capital investment required for the purchasing of the technology. With access to the technology, homeowners will gain an appreciation for energy-efficient technology and its ability to reduce their energy consumption along with benefitting from the financial saving that would incur as a result. The replacement of the 20,000 incandescent bulbs is expected to reduce 808 tonnes of CO_2 emissions annually whilst the replacement of the 10,000 CFL would save 39.4 tonnes of CO_2 annually.

2.2.3 ACTIONS AND ACTIVITIES FOR LIGHT-EMITTING DIODES

The economic and financial barriers for LED technology are that it is the most expensive lighting technology on the market, in terms of capital investment. Therefore, most people tend to purchase the cheaper options of incandescent and CFL. The measure to overcome this is bulk buying and distribution of LEDs with a low-interest financial payback scheme through billing. This would allow

[32] https://www.eaton.com/sg/en-us/company/news-insights/lighting-resource/trends/4-major-health-benefits-of-led-lighting.html

the consumer to afford the technology without having to pay a higher upfront cost and using a fraction of the savings for the payback.

From information gained in the stakeholder consultations regarding public awareness, it was mentioned that most of the public of Antigua and Barbuda know of the technology, but they are unaware of how LEDs can assist in reducing their energy consumption and by extension decrease their monthly electricity bill. Therefore, public awareness campaigns are needed to help the public understand the advantages of these technologies compared to the others on the market.

Table 19 below summarised the identified barriers and measures to overcome for LED technology.

Table 19: Summary of Barriers and Measures to Overcome Barriers for LEDs

CATEGORIES	IDENTIFIED BARRIERS	MEASURES TO OVERCOME BARRIERS
ECONOMIC AND FINANCIAL	High capital cost of the technology as compared to other options available such as CFL and incandescent	LED Distribution Drive with structured financial payback mechanism for consumers
INFORMATION AND AWARENESS	Lack of public awareness on the energy and monetary saving from using the technology	Public Awareness campaigns, events and workshops

Table 20 below gives an assessment for the measures to be implemented to overcome the barriers for LED technology.

Table 20: Assessment of Measures for LEDs

MEASURES TO OVERCOME BARRIERS	ASSESSMENT	RANKING
1. LED Distribution program with structured business model for payback by the customers	This measure would make the technology more affordable for the consumers as the initial cost is high compared to the other technologies available. Creating an avenue where the public would be able to afford energy-saving technology for their homes and other buildings. Considering the cost of technology and lack of diffusion of the technology, this measure would assist with higher diffusion of the technology with ease of affordability. The initial cost of the technology would be reduced for the consumers with an easier method to payback	High
2. Public Awareness campaigns and outreach	This measure is relatively inexpensive as it requires mostly data collection and educating the public on the technology. Once accurate data is collected and case studies developed relating to the applicability of the technology in Antigua and Barbuda, there is a	High

MEASURES TO OVERCOME BARRIERS	ASSESSMENT	RANKING
	possibility of persuading the population to adopt the technology. Data for this program can be collected from the LED Distribution program. From the distributions, case studies can be created to share with the rest of the population. Not much of the population understands the pertinence and saving of this technology. Therefore, this measure would increase the knowledge capacity of the public on the technology. With the information shared with the public, they would have a better understanding of the applicability of this technology and the potential saving.	

Table 21 describes the actions of implementation based on the measures for LED technology

Table 21: Description of the Selected Actions for project ideas for LEDs

Action 1:	LED Distribution Drive: This (1) involves the bulk procurement of the LED technologies and creating a mass distribution of the technology and (2) the development of a financial payback scheme for the customers to ease the burden of the high initial cost.
Action 2:	Public Awareness of the Energy and Cost Saving of LED would surround the collection of the energy-saving potential of the LED technology specific to Antigua and Barbuda. This information would be shared with the public through workshops and other campaigns.

Table 22 provides a breakdown of the activities related to the actions in Table 21 above.

Table 22: Activities for Actions for LEDs

ACTIVITIES FOR ACTION IMPLEMENTATION	
Action 1: LED Distribution Drive	
Activity 1.1	Procurement of LEDs
Activity 1.2	Develop business model for payback
Activity 1.3	Launch, advertise and promote LED Distribution Drive
Activity 1.4	Distribution of LEDs
Activity 1.5	Monitoring and Updating of Payback system
Action 2: Public Awareness of the Energy and Cost Saving of LED	
Activity 2.1	Gather data on LED energy and cost savings in Antigua and Barbuda
Activity 2.2	Create action plans for Public Awareness
Activity 2.3	Schedule and Execute Events and Workshops
Activity 2.4	Create advertising material for public sharing

ACTIVITIES FOR ACTION IMPLEMENTATION	
Activity 2.5	Evaluate Campaign

2.2.4 STAKEHOLDERS AND TIMELINE FOR IMPLEMENTATION OF TAP

Table 23 below provides a breakdown of the role that stakeholders would play for the activities mentioned in Table 22.

Table 23: Role of Stakeholders for LED

NAME & ACTION	ROLE OF STAKEHOLDER
Ministry of Energy	• For action 1, review and finalise the draft procurement and payback system drafted. • For action 2, assist in the creation of the analysis of the data and creating the content to share with the public.
Department of the Environment	• The DoE would be the primary entity involved in the procurement and distribution of the LEDs for Action 1. The DOE would also help in the advertising and promotion of the program. • For Action 2, the Data Management Unit of the DoE would play a consultancy role on providing guidelines for the collection and analysis of the data pertaining to LED viability in Antigua and Barbuda.
Antigua and Barbuda Public Utilities (APUA)	• As the main utility company in Antigua and Barbuda, APUA would play the secondary role in the procurement and distribution of the LEDs for Action 1. Additionally, they would assist in the development of the payback system for the customers and monitor and update the system accordingly. • For Action 2, APUA would be secondarily responsible for data collection and developing case studies for public sharing. • They would also assist in scheduling the workshops for the public to share the findings and case studies. Finally, it would be the responsible entity for evaluating the public awareness program.
Antigua and Barbuda Bureau of Standards (ABBS)	• Quality control and assessment of the LED technology being procured in Action 1. • For Action 2, the ABBS input would be needed for the content to be shared with the public. Considering its assistance in the development of the CARICOM Energy Efficiency Labelling Standards for refrigerators, air conditioners, CFL and LEDs that was completed in November 2020[33], it would be able to advise on the energy efficiency content to share with the public.
Attorney General Chambers	• Review and sign off on the financial payback mechanism. They would also create the contractual agreement between APUA and the customer.

[33] https://energy.crosq.org/antigua-and-barbuda-bureau-of-standards/

2.2.5 SCHEDULING AND SEQUENCING OF SPECIFIC ACTIVITIES

Action 1: LED Distribution Drive

The procurement phase will be over a 6-month period, along with the development of the financial payback mechanism and the launch and advertising of the project. The distribution and monitoring and evaluation would start after the launch and run for 18 months. Therefore, the overall period for this action will be 2 years.

Action 2: Public Awareness of the Energy and Cost Saving of LED

This project would run over a period of 2 years. The first year would incorporate the collection of data for LED saving in Antigua and Barbuda and creating the action plans for the awareness campaign. The second year would entail the scheduling and hosting of the workshops, events, programs for the public along with the creation and distribution of informational material. In the final 3 months of year 2, the evaluation of the program would occur.

2.2.6 ESTIMATION OF RESOURCES NEEDED FOR ACTION AND ACTIVITIES

2.2.6.1 Capacity Needs

The capacity needed for Action 1 would be the development of the financial payback system and the monitoring and updating of the payback system. However, the capacity needed for this is available within the Ministry of Energy and its subsidiary APUA. Therefore, these stakeholders would be able to complete these activities without having to hire external capacity.

The capacity required for Action 2, , collection of data and the evaluation of the public awareness project, currently exists within the Department of the Environment's has a Data Management Unit. The DMU has the capacity required for the data collection of energy and financial saving of LEDs, with the aid of the Ministry of Energy and APUA.

2.2.6.2 Cost Estimation

The total cost for Action 1 is estimated to be around USD 245,000. Most of the cost would be in the procurement phase of the LEDs. Due to the minimal capacity needed, the cost of the other activities is relatively inexpensive, and the cost needed would be for products, resources, and indirect services such as media promotions.

Action 2 is straightforward and another low-cost action that can be implemented. The total cost for this action is USD 45,000. Similar to Action 1, most of the capacity needed to fulfil this action is

readily available from the stakeholders, therefore the costing would be for products and services to execute this action.

Table 24 show the human resources that would be needed for the completion of the activities.

Table 24: Human Resources Capacity Needed for LED Actions

ACTION	CONSULTANTS/ LEAD MEMBERS	# OF PERSONS	# DAYS	DAILY RATE (USD)	COST (USD)
Action 1	Procurement of LEDs	1	60	$100	$6,000
	Develop of business model for payback	4	60	$100	$24,000
	Launch, advertise and promote LED Distribution Drive	2	120	$50	$12,000
	Distribution of LEDs	10	180	$50	$90,000
	Monitoring and Updating of Payback system	3	60	$50	$9,000
				Total	**$141,000**
Action 2	Gather data on LED energy and cost savings in Antigua and Barbuda	5	40	$50	$ 10,000
	Create action plans for Public Awareness	2	40	$50	$4,000
	Schedule and Execute Events and Workshops	2	120	$50	$12,000
	Create advertising material for public sharing	2	20	$50	$2,000
	Evaluate Campaign	2	40	$50	$4,000
				Total	**$32,000**

Table 25: Summary of Additional Cost

	LIST ITEMS	UNIT COST (USD)	QUANTITY	TOTAL (USD)	TOTAL + CONTINGENCY (15%) (USD)
Action 1	Procurement of LEDs	$4	20,000	$80,000	$92,000
	Advertisement	$3,000	3	$9,000	$10,350
Action 2	Advertisement	$2000	2	$4,000	$4,600
	Workshops	$3,500	2	$7.000	$8,050

2.2.7 MANAGEMENT PLANNING

Table 26 provides a breakdown of the risk and contingency plans for the implementation of the TAP for LED technology.

Table 26: Risk and Contingency Analysis for LEDs

TYPE OF RISK	DESCRIPTION OF RISK	CONTINGENCY ACTIONS
Performance Risk	The technology does not perform as expected.	Ensure bidders during the procurement phase produced performance reviews and ratings of the technology being supplied. Also, ensure there is a performance warranty from the supplier. Compare data collected to performance data
Financial Risk	Lack of financing for the bulk procurement of the technology.	Apply to international donors for external funding for the project
Behavioural Risk	Persons are not willing to change from the technology that they currently use.	Data Collection regarding public's reluctance to adopt the technology. Based on the analysis of this data implement strategies that would increase the adoption by these citizens. This data can also be used to determine the design and implementation of policy tools
Scheduling Risk	Delays in procurement delivery and distribution of the LEDs to the public.	Enforce a strict delivery timeframe for the supplier. Keep abreast with the delivery to the public and assign more personnel to assist with the deliveries if delays incur.

2.2.8 NEXT STEPS

Table 27 show the immediate requirements and next steps in order to initiate the activities for the implementation of the TAP for LED technology.

Table 27: Immediate Requirements and Critical Steps for LEDs

Immediate requirements	• Access funding for the procurement phase to bulk purchase the technology
Critical steps	• Drafting of the financial payback scheme and contract for public agreement • Distribution plan for the technology • Monitoring strategies for the distribution and payback systems • Ensuring the technology being procured is of acceptable manufacturing standards. • Monitoring and updating of the payback financial system to ensure is up to date • Evaluation of the campaign to determine the outreach achieved.

2.2.9 TAP OVERVIEW

Table 28: Overview of TAP for LEDs

SECTOR	BUILDING SECTOR
Sub-Sector	
Technology	LED
Ambition	Replacing 20,000 incandescent light bulbs and 10,000 CFL over a 2-year period in 5,000 homes
Benefits	With access to the technology, homeowners will gain an appreciation for energy-efficient technology and its ability to reduce their energy consumption along with benefitting from the financial saving that would incur as a result. The replacement of the 20,000 incandescent bulbs is expected to reduce 808 tonnes of CO_2 emissions annually whilst the replacement of the 10,000 CFL would save 39.4 tonnes of CO_2 annually.

ACTION #	ACTIVITIES TO BE IMPLEMENTED	SOURCES OF FUNDING	RESPONSIBLE BODY AND FOCAL POINT	TIME FRAME (MONTHS)	RISKS	SUCCESS CRITERIA	INDICATORS FOR MONITORING OF IMPLEMENTATION	BUDGET PER ACTIVITY (USD)
Action 1: LED Distribution Drive	Activity 1.1: Procurement of LEDs	GCF, GEF	Ministry of Energy/ APUA/ Department of Environment/ Bureau of Standards	6	Delay in Procurement timeframe, damage during transport, theft, (where will they be stored?)	Bulk arrival of the LED technologies Safe storage	Procurement documents, customs clearance, delivery receipt and storage confirmation	$200,000
	Activity 1.2: Develop payback business model for the customers	GoAB	Ministry of Energy/ APUA/ Attorney General Chambers	6	Delay in finalizing mechanism	Financial mechanisms signed off and agreed upon	Signed and approved financial document to be shared with the public	$10,000

	Activity 1.3: Launch, advertise and promote LED Distribution programme	GCF, GEF	Ministry of Energy/ APUA/ Department of Environment/ Bureau of Standards	6	Lack of interest from the public and other stakeholders	High public interest and other stakeholders Awareness strategy developed	Development of communication plan. Launching of the campaign	$10,000
	Activity 1.4: Distribute LEDs	GCF, GEF	Ministry of Energy, APUA, Department of Environment	12	Delays in distribution timeframe Failure to deliver working bulbs	Efficient distribution of LED to public	Number of LEDs distributed monthly	$20,000
	Activity 1.5: Monitoring and Updating of Payback system	GoAB	Ministry of Energy, APUA	6	Delay in updating system Malfunctioning bulbs	System updated on-time monthly	Monthly report on payback system	$5,000
							Total	**$245,000**
ACTION #	**ACTIVITIES TO BE IMPLEMENTED**	**SOURCES OF FUNDING**	**RESPONSIBLE BODY AND FOCAL POINT**	**TIME FRAME**	**RISKS**	**SUCCESS CRITERIA**	**INDICATORS FOR MONITORING OF IMPLEMENTATION**	**BUDGET PER ACTIVITY**
Action 2: Public Awareness of the Energy and Cost Saving of LED	Activity 2.1: Gather Data on LED energy consumption and cost savings	GoAB	Ministry of Energy/ APUA/Department of Environment	6 months	Insufficient and inaccurate data collected	Sufficient data collected to share with the public regarding the efficiency of the technology	Average energy saved per household per month due to conversion to LED technology	$20,000

	Activity 2.2: Create Action plans for the Public Awareness Campaign	GoAB	Ministry of Energy/ APUA/ Department of Environment	6 months	Action plans not aligned with Campaign goals	Action plan in line with goals of the campaigns	Accomplishment of each action plan	$5,000
	Activity 2.3: Schedule and Execute events and workshops	GoAB	Ministry of Energy/ APUA/ Department of Environment	12 months	Poor stakeholder response to the events, programs and workshops	High stakeholder participation and interest	Number of stakeholders attending events	$10,000
	Activity 2.4: Create and distribute advertising and informational material for public sharing	GoAB	Ministry of Energy/ APUA	3 months	Insufficient data was provided to the citizens	Ads created Public gains a better understanding of the technology.	Increase diffusion of the technology.	$5,000
	Activity 2.5: Evaluate Public Awareness campaign	GoAB	Ministry of Energy, APUA, Department of Environment	3 months	Inadequate feedback data for accurate analysis	Feedback and understanding from the public regarding information shared	Post-workshop reports and events surveys	$5,000
							Total	**$45,000**

2.3 ACTION PLAN FOR ROOF PITCH ANGLE

2.3.1 INTRODUCTION

Antigua and Barbuda has historically been impacted by hurricanes. Due to climate change, the frequency of high-intensity storms has increased[34]. This includes category 5 hurricanes with wind speed of 252 km/h and above. Damages amounted to US$ 136 million with US$ 52.2 million in infrastructure alone, due to 2017 Hurricane Irma. This event caused 45 % of houses in Barbuda to experience roof damage. The roof pitch angle is traditionally 25 degrees in the Caribbean. The pitch of the roof is indirectly proportional to the resistance against wind forces. The steeper the pitch, the less atmospheric pressure changes forces on it. The increased pitch roofs resist uplift, with 30 ° or 7/12 pitches being the best performers in storms[35] . In addition, when planning for storms, Gibbs (2000) advises steep pitches of 30° and 40°[36]. There is evidence that the roof-pitch angle can have a great influence on the resilience of roofs.

2.3.2 AMBITION FOR ROOF PITCH ANGLE

The 30° and 40° roof pitch angle will be implemented as a pilot project for small scale residents. Public awareness campaigns will be carried out to 20% of new buildings incorporate technology by 2030.

2.3.2 ACTIONS AND ACTIVITIES FOR ROOF PITCH ANGLE

The general barriers and measures to overcome these barriers to diffuse the 30° and 40° roof pitch angles were considered in the 'Barrier Analysis and Enabling Framework Report. The economic and financial barrier identified revolved around the current need to reduce the price of current pitch angle infrastructure and materials and spread more awareness to the roofing technique.

Table 29 gives an overview of the barriers and potential measures to overcome the deployment and diffusion of roof pitch angles. Based on the desk study carried out and stakeholder engagement for the BAEF, the expense of the steep roof pitch building materials, lack of information, awareness and benefits of roof pitch angles, in addition to lack of expertise and experience in roof framing are the overall barriers associated with this technology. A steeper roof

[34] https://www.climate.gov/news-features/understanding-climate/climate-change-probably-increasing-intensity-tropical-cyclones
[35] Taher, R. (2007). Design of Low-Rise Buildings for Extreme Wind Events. *Journal of Architectural Engineering. 13: 1*
[36] Gibbs, T (2000) Detaining for hurricanes

angle requires a higher cost associated with safety as more materials and measures as it requires harnesses and more scaffolding.

Table 29: Summary of Barriers and Measures to Overcome Barriers for Roof Pitch Angles

CATEGORIES	IDENTIFIED BARRIERS	MEASURES TO OVERCOME BARRIERS
Economic and financial	Steep roofs are more expensive than regular roofs due to the larger surface area, which requires additional construction materials	The cost for constructing roofs can be offset by reducing insurance premiums for homes
Information and awareness	Lack of awareness and benefits of steeper roof pitch angles	Informative seminars and public media campaigns
Technical	The lack of expertise and experience in this roof framing	Training for younger contractors can be administered as a component of the TVET programme.

Table 30 provides an assessment of the measures and barriers considered for the inclusion of the TAP. These measures are based on the Barrier Analysis Enabling Framework (BAEF) Report of Antigua and Barbuda. According to the TAP Guidelines, the variables utilized to evaluate each measure include cost-effectiveness, efficiency, interactions with other measures, sustainability and benefits and cost. The final selected measures were selected along with the actions and activities under each measure were described as seen in Table 31- 33.

Table 30: Assessment of Measures for Roof Pitch Angles

MEASURES TO OVERCOME BARRIERS	ASSESSMENT	RANKING
Public Awareness raising Campaigns	This measure will be in support of education initiatives to raise awareness to construction and builders of the importance of roof pitch angle techniques. This usually includes promoting and broadcasting the campaign materials through radio, newspaper, and television advertisements. Informing and educating the public will facilitate the buy-in and diffusion of this technology into the market. This measure will be related to the training of the public and campaigning will shed a light on various roof pitch angles and benefits to small island developing states (SIDs).	High
Training programme and seminars for contractors	This is an important measure to bring across a clear understanding of the construction techniques utilised for hurricane resistance and climate change events. Training programmes and seminars would increase the knowledge of builders and eventually this roofing technique will become more prominent.	High

Table 31: Final Selection of Measures to be Included as Actions in TAP for Roof Pitch Angles

CATEGORIES	IDENTIFIED MEASURES TO OVERCOME BARRIERS	MEASURES SELECTED AS ACTIONS FOR INCLUSION IN TAP
Information and awareness	Informative seminars and public media campaigns	Public awareness campaign
Technical	Training for younger contractors can be administered as a component of the TVET programme	Training Programmes

Table 32: Description of the Selected Actions for Project Ideas for Roof Pitch Angles

Action 1:	**Public Awareness campaign: Informative seminars and public media campaigns can be used to inform the public on the advantage of this design style. This public media campaign can include radio, newspaper and television advertisements and interviews. Targeted seminars for industry professionals can facilitate buy-in and diffusion of this framing style in the market. For these seminars to reach the right audience, they can reach out to construction companies with ongoing building projects.**
Action 2:	Training Programmes: Training for younger contractors can be administered as a component of the TVET programme, which will include an assortment of trade and technical training opportunities. However, this training programme will need to be integrated into a larger project for certifying construction workers and tradespersons. A special workshop will be administered to large contractors who can bring on smaller-scale contractors.

Table 33: Activities for Actions for Roof Pitch Angles

ACTION 1: PUBLIC AWARENESS CAMPAIGNS	
Activity 1.1	Campaign design and planning
Activity 1.2	Community seminars
Activity 1.3	Media engagements
ACTION 2: TRAINING PROGRAMMES	
Activity 2.1	Redevelop vocational construction curriculum at tertiary institutions to include roof pitch angles designs
Activity 2.2	Implementation of programme
Activity 2.3	Hosting workshops

2.3.3 STAKEHOLDER AND TIMELINES FOR TAP IMPLEMENTATION

The responsibilities of the key stakeholders for the implementation of the roof pitch angle TAP can be seen in Table 34.

Table 34: Role of Stakeholders for Roof Pitch Angles

KEY STAKEHOLDERS	ROLE OF STAKEHOLDERS
Department of the Environment (DOE)	The department would coordinate and facilitate the project's workshop and training
Development Control Authority (DCA)	This organisation would assist the DOE with data collection of roofs damaged by hurricanes and local stakeholders' assistance for the workshop.
Ministry of Works and Housing (MOWH)	This organisation would assist the DOE in sourcing interested stakeholders for workshops and training for roof pitch angles
Antigua & Barbuda Institute of Continuing Education (ABICE)	This is a Technical and Vocational Education and Training (TVET) institution that will be a central part of developing the curriculum and training programme for roof pitch angles construction.

2.3.4 SCHEDULING AND SEQUENCING OF SPECIFIC ACTIVITIES

Table 40 has a more comprehensive timetable for the activities. This TAP is planned for implementation over the period 2023- 2025. However, for the two actions envisioned under this TAP for rooftop pitch angle the sequencing would be approximated as follows:

Action 1: Public awareness campaign

This action would take place over two years. The advertisement phase would be over 12 months, along with gathering the materials and media for advertisement. The second year would entail the scheduling, implementation, and hosting of community seminars for the public.

Action 2: Training programme

These activities would take place over three years. The first year the relevant stakeholders and institutions along with DOE would develop a syllabus for the roof pitch angles techniques. This process would take an estimated 2 years to complete for research, materials, and expertise for activities. The implementation of the training program and hosting of the workshops and programs would be carried out in the third year.

2.3.5 ESTIMATION OF RESOURCES NEEDED FOR ACTIONS AND ACTIVITIES

2.3.5.1 Capacity Building Needs

For action 1 from Table 33 above highlights the need for media engagement and campaigns for the public. This can be done through social media, print media, radio and television advertisement in partnership with relevant institutions relating to construction. These campaigns and engagement will need to continue throughout the timeframe envisioned for the TAP.

As for Action 2, there is a need to build capacity for training programmes and curriculum for schools. This can be done through the hiring of consultants and the creation of software design simulations for roof pitch angles.

2.3.5.2 Cost Estimation

Table 35: Breakdown of Human Resources Needed

LIST	UNIT COST (USD)	QUANTITY	TOTAL (USD)	TOTAL +CONTINGENCY (15%) (USD)
Host event	5,000	4	$20,000	$23,000
Workshop	3,000	1	$3,000	$3,450
Advertisement	6,000	1	$6,000	$6,900

Table 36: Breakdown of Additional Cost

ACTION	CONSULTANTS/ LEAD MEMBERS	# OF PERSONS	# DAYS	DAILY RATE (USD)	COST (USD)
Action 1	Campaign design and planning	4	20	$200	$16,000
	Community seminars	1	5	$200	$1,000
	Media engagements	5	20	$200	$20,000
Action 2	Redevelop vocational construction curriculum at tertiary institutions	3	30	$200	$18,000
	Implementation of programme	2	20	$200	$8,000

Table 37: Summary of Cost and Resources for Roof Pitch Angles

ACTIONS	ACTIVITIES TO BE SUPPORTED	TOTAL COSTS (USD)
Public awareness campaign	Experts implement all activities and planning for Campaign design	$16,000
	Community seminars	$4,450
	Media engagements	$26,900
Training Programmes	Redevelop vocational construction curriculum at tertiary institutions to include roof pitch angles designs	$41,000
	Experts to host and plan workshops	$6,900
	Implementation of programme by experts	$8,000
Total		**$103,260**

2.3.6 MANAGEMENT PLANNING

Table 38 below shows the risk involved with the activities for roof pitch angle technology and the contingency plan for the risk.

Table 38: Risk and Contingency Analysis for Roof Pitch Angles

RISK ITEM	DESCRIPTION	CONTINGENCY PLAN
Financial risks	Insufficient funds for materials and advertisement	The total cost indicated in the table summary above has a range of $103, 260. This range of funds may mitigate any fluctuations in cost for materials and consultants or team leads.
Scheduling risk	The training programme and campaign may overrun the scheduled time for implementation due to time delays in carrying out workshops and advertisement and non-performance of consultants. Additionally, the pandemic has to be considered when scheduling, lead to possible delays, as only vaccinated persons are allowed to travel and at public functions.	To mitigate this issue, adequate planning must be implemented especially for workshops and hosting events. Consultants that are hired should be aware of the culture of the island, in other words, including locals to mitigate delays in activities. In terms of the pandemic, classes and workshops can be scheduled online so there can be a greater outreach while abiding to health restrictions.
Operational Risk	Poor design of the system leading to poor results.	Ensure that the roof system is designed and implemented optimally

2.3.7 NEXT STEPS

Table 39 shows the next steps for the roof pitch angle technology

Table 39: Immediate Requirement and Critical Steps for Roof Pitch Angles

Immediate requirements	**The key implementation steps must be to hire a consultant to collect data on the percentage (%) of roofs in Antigua and Barbuda that can withstand hurricanes.**
Critical steps	The key to the success of this activity is public awareness campaigns, training programmes and ensuring individuals understand the concept and technicalities of choosing and building the correct roof pitch angle.

2.3.8 TAP OVERVIEW

Table 40: Overview of TAP for Roof Pitch Angles

SECTOR	BUILDING SECTOR							
Sub-sector								
Technology	30-40 degree [minimum] Roof pitch angles							
Ambition	The best roof pitch angle will be implemented as a pilot project in small scale residents. Public awareness campaigns will be carried out for 20% of new buildings incorporating the technology by 2030							
Benefits	Increasing climate adaptation technologies would lower the probability of damages as a result of high intensity storms such as Cat 5 hurricanes -Roof pitch angles reduce the economic losses from hurricane.							
ACTION	**ACTIVITIES TO BE IMPLEMENTED**	**SOURCES OF FUNDING**	**RESPONSIBLE BODY AND FOCAL POINT**	**TIME FRAME (MONTHS)**	**RISKS**	**SUCCESS CRITERIA**	**INDICATORS FOR MONITORING OF IMPLEMENTATION**	**BUDGET PER ACTIVITY**
Public awareness campaign	Campaign design and planning	GEF	DOE, DCA, NODS	36	High cost of consultancy/ available expertise, insufficient funding Ineffective design	# Of persons attending, Quality programs and campaigns	Positive feedback from stakeholders	$16,000
	Community seminars				Available expertise, insufficient funds, poor timing for residents	Positive feedback from stakeholders	Document report & feedback from public	$4,450
	Media Engagements				Availability of funding for media coverage,	# Of stakeholders	Surveys of public feedback	$26,000

					inability to develop appropriate campaigns for evolving [social] media landscape Covid 19 limiting persons present at a facility	at the training workshop		
Training programmes	Redevelop vocational construction curriculum at tertiary institutions to include roof pitch angles designs	GEF	DOE, CHAPA, ABICE	40	Available expertise, funding, issues relating to schools, overload curriculum, Vocational schools agree to the programme	# Of resources produced, # of trained teachers in institutions	Curriculum material & training of teachers	$41,000
	Implementation of programme				Timing & getting participants, programme can fit into training schedule/format of school	Number of participants, feedback report	Quality of programme, feedback from the public	$6,900
	Hosting workshops				Timing and getting participants. Pandemic limiting the amount of person in a public space.	Number of participants, feedback report and minutes for workshop	Workshop report, workshop media coverage	$8,000
							Total	**$102,350**

SECTION 3: TRANSPORT SECTOR

3.1 TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR THE TRANSPORT SECTOR

3.1.1 TRANSPORT SECTOR OVER

In 2015, the national greenhouse gas inventory reported that 76% of the country's emissions were generated by fuel consumption in the energy sector due to the burning of heavy fuel oil by the power producers[37]. The West Indies Oil Company (WIOC) is responsible for the importation of all the fossil fuel that is utilized on the islands. A high percentage of the fuel is used in the transportation and energy sector. The Department of Environment and the Ministry responsible for Energy, through a directive from the GoAB, is working on implementing technologies that will reduce the fossil fuel dependence and reduce GHG emissions of the country to uphold its obligations to the Paris Agreement. Table 41 lists other policies that are driving the transition. The electric vehicle and photovoltaic system are technologies that can be deployed in the country to accomplish the directive of the GoAB as they will reduce the oil importation and GHG emission if used in tandem.

Table 41: Policy and Laws for Driving to a Cleaner Sustainable Sector

NAME	YEAR ADOPTED	MAIN CONTENTS
Environmental Management and Protection Act	2019	Established the Environment Registry which will undertake to monitor pollutants and support GHG inventories through continued data collection
Sustainable Energy Action Plan	2013	Renewable energy developments to reduce fossil fuel dependence, high energy costs, and energy import bills
Environmental Levy Act 2002	2003	Outlines the tariffs for vehicles imported into the country
Renewable Act	2015	A legislation drafted to promote the use of renewable energy resources and technologies such as solar PV, wind, biomass, hydropower, geothermal, and wave/tidal. The act established the responsibilities to be carried out by the Minister Responsible for Energy. It also established APUA's net billing policy and energy wheeling policies.

The Department of Environment is currently embarking on the Sustainable Low Emission Island Mobility (SLIM) project which was launched in April 2021. This project will run until 2024 and is

[37] Antigua and Barbuda's national greenhouse gas reduction report / Climate Analytics

focused on the increased adoption of electric vehicles and charging station infrastructure in Antigua and Barbuda. The TAPs for the transport sector that are recommended in this document would be in tandem with this project.

3.2 ACTION PLAN FOR ELECTRIC VEHICLES AND SOLAR CHARGING STATIONS

3.2.1 INTRODUCTION

The TAPs for Electric Vehicles (EVs) and Solar Charging Stations are presented together due to the mutually inclusive relationship that exists between the technologies. Solar charging stations are needed to experience the zero-emission feature/characteristics of electric vehicles; therefore, it is a measure to overcome one of the barriers to the widespread diffusion of EVs.

Electric vehicles were included in the TNA as a mitigation technology due to their potential to reduce GHG emissions in the transportation sector and reduce the country's dependence on oil importation. The EV market in Antigua and Barbuda is small, with approximately 40 EVs reported as a part of the vehicle fleet (54,891 ICE vehicles) as of 2021[38]. Six of the 40 EVs (2 sedans and 2-panel van, 2 SUV) are located at the Department of Environment in Antigua along with 3 charging stations.

The adoption of Electric vehicles is also in line with Antigua and Barbuda's Nationally Determined Contribution, which describes a transition away from new internal combustion vehicles to electric vehicles by 2030. To lead by example the Government intends to transition its 1,100 vehicles to electric by 2035.

The TNA committee highlighted that access to inexpensive ICE vehicles from international markets is the greatest barrier to the uptake of the more expensive electric vehicles. Furthermore, the committee acknowledged that the environmental benefits of EVs needed a supportive solar charging infrastructure to be realized. This resulted in the two technologies being merged for the TAP.

3.2.2 AMBITION FOR ELECTRIC VEHICLES AND SOLAR CHARGING STATIONS

The ambitions would be to increase the capacity of the country to maintain and operate the electric vehicle by upgrading the educational institutions to deliver the necessary courses and embark on various public awareness campaigns to accelerate the uptake of the technology. Additionally, "train, the trainer" programs for electric vehicles and solar systems to transform the workforce and

[38] Antigua and Barbuda Renewable Energy Roadmap, IRENA 2021.

social development in the country. Therefore the re-training of at least 10 existing mechanics and teachers to repair and service EVs. Finally, increasing the number of public solar charging stations to meet the EV demand. A pilot study of 50kW of solar panels to serve 10 level-2 chargers for 20EVs of the government fleet. This project could reduce GHG emissions by 56.15 tCO_2e using an electricity conversion factor of 0.6154 tCO2e/MWh[39].

3.2.2 ACTIONS AND ACTIVITIES FOR ELECTRIC VEHICLES AND SOLAR CHARGING STATIONS

Table 42 shows the barriers to overcome and the measures to over the barriers for EVs and solar charging station technology.

Table 42: Summary of Barriers and Measures to Overcome Barriers for EVs and Solar Charging Stations

CATEGORIES	IDENTIFIED BARRIERS	MEASURES TO OVERCOME BARRIERS
Electric Vehicle		
Economic and financial	High capital cost	Supply access to public charging infrastructure and expand access to finance
Market conditions	Only one EV car dealer on the island with limited car options	Car dealerships increasing their availability of electric vehicles.
Legal and regulatory	Access to unregulated importation of used ICE vehicles	Phased ban of the importation of ICE vehicles in the future as described in the NDCs
Human skills	Educational institutions are not equipped to train persons to repair and maintain technology	Establish a national education programme with Tertiary Institutions to train Electric vehicle mechanics Provide technical resources,
Information and awareness	Limited information about costs and benefits of technology. Information on technology is not widespread	Conduct adequate public awareness campaigns through print, electronic media and test-driving car shows to dispel fears
Solar Charging stations		
Economic and Financial	High capital cost. Earning potential is low for the high upfront cost for the system	Bulk purchase of the systems to reduce the initial cost of constituent components Design the systems to be multi-purposed to not only serve for charging vehicles but to supply electricity to loads in buildings to increase the utilization of the system
Human skills	Limited local experts for installation, operation and maintenance	Develop a national education programme at Tertiary Institutions

[39] Antigua Grid, CM 2017 - 2019

CATEGORIES	IDENTIFIED BARRIERS	MEASURES TO OVERCOME BARRIERS
Legal and regulatory	Prohibitive net billing legislation	Evaluate and update policy to allow for off-grid systems and size limitations. Also, regulate price paid at charging stations.

Table 43 summarizes the barriers to the diffusion of EVs and solar charging stations and potential measures to address each barrier. From consultation with several stakeholders, access to an unregulated ICE vehicle market is the critical barrier to the uptake of EVs. For instance, used ICE vehicles less than 5 years old cost approximately USD 15,000, while vehicles over 10 years are less than USD 3,000. An equivalent used EV costs USD 25,000, while new EVs available locally cost upwards of USD 40,000. A similar challenge is observed for solar charging stations, where a level two charging station (without infrastructure or battery storage) costs 35% - 45% of a new EV. Furthermore, the revenue returns on large systems are impacted by the present net billing tariff system which specifies that electricity generated from solar systems over 5kW must be sold to APUA and then purchased back at 0.37 USD/kWh.

The size of the present electric vehicle workforce is not sufficient to meet the demands of a fully transitioned vehicle fleet with a large public solar charging infrastructure, requiring the strengthening of the country's institutional capacity to meet this new demand. It is imperative to develop the capacity to charge the EVs by renewable energy systems to achieve the zero-emission benefits of EVs and reduce the GHG emission in the transport sector. Lastly, there was a consensus amongst participants in the workshop that public awareness was low regarding EVs and their benefits. Table 43 outlines further analysis of selected measures.

Table 43: Assessment of Measures for EVs and Solar Charging Stations

MEASURES TO OVERCOME BARRIERS	ASSESSMENT	RANKING
Ban the importation of ICE in the future	This is a very effective measure because the cost of importing used ICE vehicles is too low for EVs to be competitive. The high capital cost of EVs will outweigh its benefits. Regulating the used car market, however, must be done strategically as it will result in a cultural shift in the type of vehicles purchased and who can afford vehicles. Moreover, it can negatively affect the quantity of tax revenue collected from vehicle importation. Therefore, this tax structure would have to be reviewed. This measure is in line with the new NDC targets for the country and will provide an indirect benefit to the increased uptake of the technology. Potential to improve ambient air quality. Might reduce private vehicle ownership.	High
Establish a national education programme with University/TVET schools to train Electric vehicle mechanics and Solar Installers	This is an important measure to ensure the sustainability of the technology deployment in the country. The technology cannot be successful without having the necessary workforce to repair and maintain the technology. Building local capacity by equipping training institutions with the necessary tools to transition the present and future workforce is the most efficient solution. A subset of the	High

MEASURES TO OVERCOME BARRIERS	ASSESSMENT	RANKING
	workforce can be involved in a "train the trainer" program to build local capacity for the technology. One benefit of this measure is that it would give consumers peace of mind that several qualified persons are available to repair their vehicle or the public charging station infrastructure. Another benefit is that it would create a competitive market, giving people options other than the dealership for repairs.	
Provide access to public charging infrastructure and expand access to finance	Not everyone will be able to purchase an electric vehicle and charging stations for their home; therefore, providing a reliable public charging infrastructure will reduce the capital cost of the system making it more affordable to consumers. Moreover, increasing access to financing of EV vehicles would assist in the transition. This will require several stakeholders to participate in the installation and maintenance of the system. This will be a moderately costly endeavour; however, it will be able to generate revenue to pay for itself over time. There are corelations with the measure above for increasing the country's educational capacity on the technology. Benefits to technology implementation are mostly indirect. It is expected that consumers will transition faster if public charging stations are available, but we cannot guarantee when they will; Likewise with the financiers when they will provide increased access to financial instruments. Public charging stations could alleviate public range fear while commuting.	Medium
Conduct adequate public awareness campaigns through print, electronic media and test-driving car shows to dispel fears	Increasing knowledge about electric vehicles would greatly aid individuals in their assessment of whether to buy an EV and mitigate doubt about the technology. This is a low-cost measure that needs only a few personnel to coordinate the awareness campaign. Providing a first-hand experience with the electric vehicle is expected to directly impact individuals' willingness to purchase vehicles coupled with the requisite information on the technology	Medium
Opening the market to encourage increased EV importation	There is only one EV car dealership presently on the island. Increasing the number of local dealerships can create a competitive market and increase the variety of vehicle choices and access to vehicle parts. These are solutions that should only take a few consultations with dealerships to include them in the transition. The banning of ICE vehicle importation directly interacts with this measure. The benefit from this measure is direct, as it will increase access to the technology and can capitalize on the relationship that several people already have with local car dealerships increasing their confidence in the technology	Low

The measures that represented the mutually inclusive nature of the two technologies were chosen to be moved forward as actions, using the EV as the foundation for merging the measures for the two technologies, see Table 44. It is believed that the implementation of legislation to restrict the importation of ICE vehicles would encourage more persons to consider EVs, provided that a supportive public awareness campaign is done simultaneously. Additionally, an EV test driving campaign would be an effective method to persuade current ICE vehicle owners to transition.

During this time, the introduction of local training facilities to create the necessary workforce to establish a functional EV market is required. The demand for solar charging stations would now be established and the technology will be able to flourish. Lastly, the transition of the government fleet would stimulate the market and galvanize the private sector in participating in the transformation of the transportation sector to low emission vehicles. The action and associated activities for the technologies are summarized in Tables 45 – 46.

One of the project ideas selected for the TAP will demonstrate the environmental benefits and cost-saving potential of an EV vehicle powered by solar systems to contribute to the reduction in greenhouse gas emissions. It is expected to provide opportunities to increase the experience of the first-generation EV workforce and allow for research to be done on performance to develop a sustainable framework for the local context.

Table 44: Measures to be taken forward as Actions to Implement EVs and Solar Charging Stations

CATEGORIES	IDENTIFIED MEASURES TO OVERCOME BARRIERS	MEASURES SELECTED AS ACTIONS FOR INCLUSION IN TAP
Economic and financial	Provide access to public charging infrastructure and expand access to finance	Develop a demonstration project for solar charging EVs using the Government's Fleet
Legal and regulatory	Ban the importation of ICE in the future. May also consider increasing tariffs on ICE.	Amending External Trades Act to regulate importation of ICE vehicle
Human skills	Establish a national education programme with tertiary institutions to train electric vehicle mechanics and solar systems	Develop a training module for EVs and solar system
Information and awareness	Conduct adequate public awareness campaigns through print, electronic media and test-driving car shows to dispel fears	EVs test driving campaign

Table 45: Actions for Implementing EVs and Solar Charging Stations

SUMMARY OF ACTIONS	
Action 1	Develop a demonstration project for solar charging EVs using the Government's Fleet
Action 2	Develop a training module for EVs and solar systems
Action 3	EVs test driving campaign
Action 4	Amend External Trades Act to regulate the importation of ICE vehicles

Table 46: Activities for implementation of EVs and solar charging stations

ACTION 1: DEVELOP A DEMONSTRATION PROJECT FOR SOLAR CHARGING EVS USING THE GOVERNMENT'S FLEET

Activity 1.1	Develop a demonstration project for solar charging EVs using the Government's Fleet
Activity 1.2	Develop a training module for EVs and solar system
Activity 1.3	EVs test driving campaign
Activity 1.4	Amend External Trades Act to regulate importation of ICE vehicle
ACTION 2: DEVELOP A TRAINING MODULE FOR EVS AND SOLAR CHARGING STATIONS	
Activity 2.1	Consult key stakeholders on the needs for training
Activity 2.2	Design program and identify a list of supporting infrastructure needs such as equipment, lab space upgrades and teaching material
Activity 2.3	Procure material and equipment
Activity 2.4	A pilot program with scholarships
Activity 2.5	Course evaluation and revision
ACTION 3: EVS TEST DRIVING CAMPAIGN	
Activity 3.1	Engage stakeholders in the development of a project plan
Activity 3.2	Create advertising material for the driving campaigns
Activity 3.3	Host test driving campaigns
Activity 3.4	Conduct surveys pre and post the campaign for persons that participated
ACTION 4: PASS LEGISLATION TO REGULATE IMPORTATION OF ICE VEHICLE	
Activity 4.1	Review of tax structure
Activity 4.2	Draft and adopt legislation for the banning of ICE vehicles.
Activity 4.3	Other identified policy and enabling environment activities to disseminate the information

3.2.4 STAKEHOLDER AND TIMELINE FOR IMPLEMENTATION

Table 47 details the roles and function of the different stakeholders needed to accomplish the goals of the TAP.

Table 47: Role of Stakeholders for EVs and Solar Charging Stations

KEY STAKEHOLDER	ROLE OF STAKEHOLDER
Department of Environment (DoE)	The DoE will be coordinating all actions for this TAP. It will provide project management, procurement and technical support.
Antigua Public Utility Authority (APUA)	APUA is the local utility company that is responsible for internet services and connection to the electricity grid. It will be included in the development and maintenance of the solar charging infrastructure.
Antigua and Barbuda Bureau of Standards	Responsible for creating the standards for the importation of electric vehicles. It would play a role in the amending of the External Trades Act.
Antigua and Barbuda Institute for Continuing Education (ABICE)	ABICE is a Technical and Vocational Education and Training) (TVET) institution that will be integral in the capacity-building aspect of the TAP.

Renewable Energy Companies	These companies will play an integral role in the installation of solar charging stations.
Gas Station Owners-	The increased use of solar charging stations will affect this market, therefore including these stakeholders is essential in the just transition of the workforce.
Car Dealerships and Current Automotive Technicians-	The development of a local EV market will need the involvement of car dealerships to procure, stock vehicles and spare parts and provide servicing. Mechanics will also participate in servicing and repairing vehicles.
Ministry of Finance (MoF)	Responsible for the fiscal policies in Antigua and Barbuda
Ministry of Energy (MoE)	MoE work with the DoE in overseeing the execution of the TAP and lead the development of the necessary legislation to increase the uptake of electric vehicles.
West Indies Oil Company (WIOC)	This company is responsible for all the oil imported on the island. Their inclusion is essential as the government transitions the vehicle fleet from fossil fuel-driven to electricity generated from solar panels
Ministry of Education (MoEST)	Assist in the development and execution of the capacity building activities of the TAP
Customs and Excise Division	They are responsible for the import and export of goods in Antigua and Barbuda and would be instrumental in the evaluation of the policies to ban the high emission vehicles
Transport Board	They will be valuable in the drafting of the policy for banning internal combustion vehicles

3.2.5 SCHEDULING AND SEQUENCING OF SPECIFIC ACTIVITIES

A more detailed timetable for the activities can be found in the TAP overview table (Table 52). This TAP is planned for implementation over the period 2022-2030. However, for the four actions listed under this TAP, a summary is provided below:

Action 1 Increase the number of public EV charging stations through collaborations with various stakeholders such as gas stations, supermarkets and the utility company. Explore the use of solar-powered stations and develop a strategic roll-out plan. The estimated timeframe for completing this task is 3 years.

Action 2 Through engagement with the training schools and international accredited institutions to develop the curriculum. Provide scholarships to train present and future mechanics. A total of 3-5 years for developing the curriculum and revising it to achieve accreditation.

Action 3 Through collaborations with EV car dealerships locally and international, targeted advertisement to stimulate interest over 1-2 years.

Action 4 through an informed decision based on feasibility and economic impact study on the implementation of a ban, is expected to take 4-5 years to be completed.

3.2.6 ESTIMATION OF RESOURCES NEEDED FOR ACTION AND ACTIVITIES

The completion of the TAP for EVs and solar charging stations requires the purchasing of different assets and coordination of various consultants/stakeholders to deploy these assets to realize the objectives of the TAP. Table 48 and 49 summarizes the cost for these activities.

Table 48: Breakdown of human resources needed for EVs and Solar Charging Stations

	CONSULTANTS	# PERSONS	# DAYS	DAILY (USD)	COST (USD)
Action 1	Feasibility study	3	20	$250	$15,000
	Project design and development of scope of work	2	10	$200	$4,000
	Document project findings	1	10	$200	$2,000
Action 2	Stakeholder engagement	1	10	$200	$2,000
	Design training program	2	30	$250	$15,000
	Course evaluation and revision	2	5	$250	$2,500
Action 3	Stakeholder engagement	1	5	$200	$1,000
	Content creator	1	15	$200	$3,000
	Survey taker	5	10	$100	$5,000
Action 4	Stakeholder engagement	2	30	$200	$12,000

Table 49: Breakdown of items to be Purchased for EVs and Solar Charging Stations

	LIST ITEMS	UNIT COST (USD)	QUANTITY	TOTAL (USD)	TOTAL + CONTINGENCY (15%) (USD)
Action 1	Solar system	23,000	10	$230,000	$264,500
	Electric vehicle	50,000	20	$1,000,000	$1,150,000
Action 2	Equipment & lab upgrade	500,000	1	$500,000	$575,000
	Scholarships	10,000	10	$100,000	-
	Workshops	3000	2	$6,000	$6,900
Action 3	Host event	5,000	4	$20,000	$23,000
	Workshop	3,000	1	$3,000	$3,450
	Advertisement	6,000	1	$6,000	$6,900
Action 4	Advertisement	6000	1	$6,000	$6,900

3.2.7 MANAGEMENT PLANNING

Table 50 summarizes the two inherent risks associated with the execution of the activities for the TAP. The procurement of items on the island is severely impacted by the time it takes to purchase and transport items to the island. For example, items from China can take upwards of 3 months to arrive via sea. Furthermore, the limited number of direct shipping routes to the island, often requires a freight forwarding company, in the United States to consolidate items before arriving in Antigua and Barbuda, at additional cost.

Table 50: Risk and Contingency Analysis for EVs and solar charging stations

RISK ITEM	DESCRIPTION	CONTINGENCY ACTION
Financial Risk	The prices detailed above are estimates, therefore are prone to price fluctuations that could increase the cost of implementing actions	A contingency markup applied to several of the activities that require the purchase of goods and services
Schedule Risk	Unforeseen challenges may delay the implementation of several of the activities requiring additional time such as procurement and disbursement delays	Project planning can be used to mitigate the risk of the project requiring additional time to complete the project. Consulting with experienced procurement personnel is essential to ensure adequate lead time is given for the purchase of items especially for those being imported.

3.2.8 NEXT STEPS

To create the environment needed for the electric vehicles to be successfully deployed in Antigua and Barbuda, Table 51, highlights steps that are needed to overcome the critical barriers to EVs which will lead to the development of a public solar charging infrastructure.

Table 51: Immediate Requirements and Critical Steps for EVs and Solar Charging Stations

Immediate Requirements:	**The key Department responsible for the implementation needs to be adequately staffed to acquire the necessary funding required for the project. Engagement with key stakeholders to inform them of project objectives.**
Critical Steps:	Implementation of the requisite legislation to regulate the importation of internal combustion vehicles is critical to the diffusion of EVs.

3.2.9 TAP OVERVIEW

Table 52: Overview of TAP for EVs and Solar Charging Stations

SECTOR	TRANSPORTATION							
Sub-sector								
Technology	Electric vehicle and solar charging station							
Ambition	The GoAB, in the NDCS, indicates its desire to transition the transportation sector to Electric vehicles by 2045. Moreover, the GoAB intends to convert its vehicle fleet by 2035, leading the transition. Increase capacity of the country to maintain and operate the new vehicle by upgrading the educational institutions to deliver the necessary courses and embark on various public awareness campaigns							
Benefits	10 persons trained to repair EVS and install solar charging stations, Teachers at TVET schools trained to deliver the new automotive curriculum and solar systems. 10 level 2 (50kW) solar charging stations, 20 EVs added to the Governments Fleet							
ACTION	**ACTIVITIES TO BE IMPLEMENTED**	**SOURCES OF FUNDING**	**RESPONSIBLE BODY AND FOCAL POINT**	**TIME FRAME (MONTHS)**	**RISKS**	**SUCCESS CRITERIA**	**INDICATORS FOR MONITORING OF IMPLEMENTATION**	**BUDGET PER ACTIVITY (USD)**
Action 1 Develop a demonstration project for solar charging EVs using the Government's Fleet	1.1 Conduct a feasibility study on large scale EV adoption	GCF	DoE MoE	6	High cost of consultancy	Large scale EV adoption is favourable	Report completed on schedule	$15,000
	1.2 Design the project, develop TORs and Scope of Work	GCF	DoE	6	High cost of consultancy Poor performance of the consultant	Detailed TOR and work adequately scoped	Completion of TOR and scope of work document	$2,000
	1.3 Procure and install solar charging stations	GCF	MoF DoE	12	High cost of items Scheduling risk	No additional time or funds are required	Delivery schedule for items, Workplan, # of persons using stations	$264,500

					Vandalism	Equipment is installed and working		
	1.4 Procure Electric vehicles	GCF	MoF DoE	12	High cost of item Scheduling risk Destabilization of car dealerships	No additional time or funds are required Vehicles are purchased	Delivery schedule for purchased items Invoices # of vehicles purchased	$1,150,000
	1.5 Document and publish Project Results and findings	GCF	MoF DoE APUA	6	Not written to acceptable standard Insufficient data collected	Document Publishable	Updates from review committee/stakeholder	$4,000
Action 2 Develop a training module for Evs and solar system	2.1 Consult key stakeholders on the needs for training	GCF	DoE MoF ABICE	6	Timing/getting participants	# Participant's feedback	Scope of training to be done	$8,900
	2.2 Design program and identify a list of supporting infrastructure and technical needs such as equipment, lab space upgrades and teaching material	GCF	DoE MoEdu ABICE	18	Funding, overbearing curriculum, resources available on time	# Resources produced in used, upgrade of lab facilities	Equipment purchased and material developed is sufficient for Curriculum	$15,000

	2.3 Procure material and Equipment	GCF	DoE MoF	12	Time scheduling, availability of funds	List of Equipment and software	Equipment in use	$575,000
	2.4 Pilot program with scholarships	GoAB	DoE MoF	36	Availability of funds Interested applicants	# Scholarship given	Scholarship programme launched	$100,000
	2.5 Course evaluation and revision	GoAB	MoEdu ABICE Accreditation Board	6	Bureaucracy in the evaluation	Reviewers' evaluation documents	Improved teaching modalities International recognition of program	$2,500
Action 3 EVs test driving campaign	3.1 Engage stakeholders in the development of a project plan	GEF	DoE Min Transport	6	Timing/getting participants, limited stakeholder response	A project plan from derived from consulting with stakeholders	List of stakeholder's inputs and different drafts of the projects plan	$4,450
	3.2 Create advertising material for the driving campaign	GEF	DoE Min Transport	6	A small number of persons see advertisements	A variety of materials are created and advertised on a different platform	copies of media coverage documented	3,000
	3.3 Host Event	GEF	DoE Transport Board	3	Low stakeholder participation	#Participant's feedback	Media coverage, report	$29,900
	3.4 Conduct surveys pre and post the campaign for	GEF	DoE, Transport Board	3	Lack of participants	Number of surveys completed	Data collected	$5,000

	persons that took part							
	4.1 Review of the Tax Structure	GoAB	DoE, Customs and Excise Division, Mo, ABBS	3	Public outcry-loss of political support	Drafted amendment to be implemented	Annual financial figures based on new tax structure	$3,000
Action 4 Pass legislation to regulate the importation of ICE vehicles.	4.2 Draft edits to Amending External Trades Act for the banning of ICE vehicles.	GoAB	DoE, Customs and Excise Division, Mo, ABBS	48	Insufficient local expertise Resistance from the national assembly Public outcry-loss of political support	Draft notes of input from stakeholders, Gazette copy of law/regulation	Regulations drafted with input from stakeholders	$12,000
	4.3 Other identified policy and enabling environment activities to disseminate the information	GoAB	Customs and Excise Division, DoE	12	Lack of coordination between laws and policies	Survey pre- and post-adoption of legislation	new regulations developed and passed; increased public awareness and approval	$6,900
							Total	**$1,462,400**

3.3 ACTION PLAN FOR EFFICIENCY IN TRANSPORT

3.3.1 INTRODUCTION

The transportation sector accounts for approximately one-quarter of all energy-related carbon dioxide emissions, with this number anticipated to rise by 2050. Antigua and Barbuda's scenario exemplifies the worldwide issue. As a small island developing state (SIDs), its GHG emission is 0.0015 per cent of the global total.[40]

Efficiency in the transport sector was proposed in the TNA as a viable option to reduce the GHG emission on the island by implementing emissions policies, standards, and regulations for the importation of used internal-combustion vehicles on the island. These technologies would be able to assist in the transition of electric vehicles.

3.3.2 AMBITIONS OF EFFICIENCY IN TRANPORT

The overall intention of the Government of Antigua and Barbuda (GOAB) is to revise the vehicular emission standards and import regulations for the new and used car market to reduce annual GHG emissions by 2030. The island is in the progress of reducing its GHG emissions by revising their conditional NDC mitigation targets, which include establishing efficiency standards for imported vehicles and ban of internal combustion engine vehicles as the country transitions to electric vehicles. A reduction of 133,300 tCO2 eq year is expected.

3.3.3 ACTIONS AND ACTIVITIES FOR EFFICIENCY IN TRANSPORT

The second step of the TNA, the Barrier Analysis and Enabling Framework (BAEF) introduced the barriers to the introduction of efficiency in the transport sector, as well as relevant and viable measures to overcome these barriers. These barriers and measures are listed in the table below.

Table *53* provides a summary of the identified barriers and measures for efficiency in transport. The table summarizes the barriers to the diffusion of efficiency of the transport sector and potential measures to address each barrier. Antigua and Barbuda has a large fleet of 54,891 vehicles. Most of the vehicles were manufactured more than ten years ago. New vehicles especially electric vehicles are inherently more expensive than older cars as they meet new emissions standards in Antigua and Barbuda. To combat this barrier, the island could provide tax support for those who wish to transition to meet the NDC mitigation goal of a full fleet of electric vehicles by 2045.

[40] CO_2 emissions from fuel combustion - Highlights (2019 edition), IEA 2019.

In addition, Antigua and Barbuda has no policy regulating the emissions from vehicles entering the country. There are no restrictions on the age of the vehicles being imported, making them high emitters of CO_2. The government is considering introducing new laws to address the issue.

Table 53: Summary of Barriers and Measures to Overcome Barriers for Efficiency in Transport

CATEGORIES	IDENTIFIED BARRIERS	MEASURES TO OVERCOME BARRIERS
Economic and financial	Low emission vehicles are inherently more expensive than ICE vehicles	Providing concessionary financial support to aid in the transition to low emission vehicles.
Legal and regulatory	• Lack of policies to monitor the emission from vehicles • No restriction on the age of vehicles being imported	Restriction/limit on vehicle importations based on age and enforce emission standards on vehicles

Table 54 shows the evaluation of the measures considered in the TAP. These measures are based on the Barrier Analysis Enabling Framework (BAEF) Report. The factor used to assess each barrier is benefits and cost, sustainability, cost-effectiveness and interaction with other measures. From the measures selected a final selection of measures were presented in the TAP as seen in Table *55* 54. The action and activities for each measure were explained and identified as seen in Table 56 and 57.

Table 54: Assessment of Measures for Efficiency in Transport

MEASURES TO OVERCOME BARRIERS	ASSESSMENT	RANKING
Providing concessionary financial support to aid in the transition to low emission vehicles.	One of the key priorities of this measure is to support the transition to a cleaner, affordable, and more sustainable transport sector in the form of funding for low emission vehicles. This is expected to make the imports of ICE vehicles and dependency on fossil fuel less. The scale-up of concessionary financing for low carbon and energy-efficient vehicles would shift the population from buying ICE vehicles and move into a more affordable low emission vehicle market.	High
Restriction/limit on vehicle importations based on age and enforce emission standards on vehicles	This measure is crucial to aid the government in how to manage used and new ICE vehicles importation into the island. In addition, creating regulations that reduce the importation of used vehicles into the island would reduce the GHG emission.	High

Table 55: Final Selection of Measures to be Included as Actions in TAP for Efficiency in Transport

CATEGORIES	IDENTIFIED MEASURES TO OVERCOME BARRIERS	MEASURES SELECTED AS ACTIONS FOR INCLUSION IN TAP
Economic and financial	Providing concessionary financial support to aid in the transition to low emission vehicles.	Concessionary financing for low emission vehicles

Legal and regulatory	Restriction/limit on vehicle importations based on age and enforce emission standards on vehicles	Establish standards and policies needed to scale up the use of low emission vehicles

Table 56: Description of the Selected Actions for Project ideas for Efficiency in Transport

Action 1:	**Concessionary financing for low emission vehicles: Funds will be provided to the public and private consumers through external agencies and banks.**
Action 2:	Establish standards and policies needed to scale up the use of low emission vehicles: This entails regulation for the used car market such as age restriction of used cars, emissions standards and vehicle screening and inspections.

Table 57: Activities for Actions for Efficiency in Transport

Action 1: Concessionary financing for low emission vehicles	
Activity 1.1	Creation of an electric mobility funding and incentivize adaptation of electric vehicles, for example, SIRF Fund.
Activity 1.2	Create a long-term financial plan for implementation for other sources of funding streams such as banks
Action 2: Establish standards and policies needed to scale up the use of low emission vehicles	
Activity 2.1	Conduct a feasibility study and data collection on the used and new vehicles fleet
Activity 2.2	Draft a report to Implement age restriction limit on used car imports less than 5 years
Activity 2.3	Draft a report to enforce emission standards
Activity 2.4	Draft report on disposal of ICE vehicles
Activity 2.5	Draft a report to ban imports of used ICE vehicles
Activity 2.6	Draft policies and submit them to the government

3.3.4 STAKEHOLDERS AND TIMELINES FOR IMPLEMENTATION

Table 58 gives shows the role of the various stakeholders for the efficiency in transport TAP.

Table 58: Role of Stakeholders for Efficiency in Transport

NAME & INSTITUTE	ROLE OF STAKEHOLDER
Customs and excise Division	This government body is responsible for regulating importation of used and new ICE vehicles and low emission vehicles into the island. It would also assist with the procurement of low emission vehicles.
Ministry of Finance	This ministry would assist in developing a financial plan for the low emission uptake into the island.

Department of Environment (DOE)	This department would assist in the procurement of low emission vehicles and also draft policies and regulations for the importation of the used car market.
Car dealerships (new and used markets)	Private companies are responsible for manufacturing and disbursing low emission vehicles to public and private consumers.
Antigua and Barbuda Transport Board:	The main government body is responsible for the transport sector. The main role of this stakeholder will be regulating the use of new and used ICE vehicles.
Antigua and Barbuda Bureau of Standards (ABBS)	Create standards and limits for vehicle emssions.

3.3.5 SCHEDULING AND SEQUENCING OF SPECIFIC ACTIVITIES

Actions 1: Concessionary financing for low emission vehicles

These activities would take place over 3 years. funding would have to be sourced from various funding institutions and agencies. Following this, a financial plan would have to be carried out.

Action 2: Establish standards and policies needed to scale up the use of low emission vehicles

These activities would take 6 years to be implemented. An in-depth feasibility study would have to be carried out to assess the current used and new vehicle fleet in Antigua. For the second to fifth year, various legislation would have to be drafted and reported to the necessary governmental institutions and if successful be implemented to the public. This action would take the longest amount of time due to the fact; all policies and regulations go through a rigorous process to be implemented into the island. Policymakers, institutions, public consultants and governmental members would have to be on the same accord for standards and to be implemented.

3.3.6 ESTIMATION OF RESOURCES NEEDED FOR ACTION AND ACTIVITIES

Table 59 breaks down the human resources that would be required.

Table 59: Breakdown of Human Resources Needed

ACTION	CONSULTANTS	# OF PERSON	# DAYS	DAILY RATE (USD)	COST (USD)
Action 1	Develop electric mobility funding and incentivize adaptation of electric vehicles, for example, SIRF Fund	2	730	$250	$365, 000
	Create a long-term financial plan for implementation for other sources of funding streams such as banks	3	365	$200	$219,000

Action 2	Conduct a feasibility study and data collection on the used and new vehicles fleet	1	365	$250	$182,500
	Draft legislation to enforce emission standards	1	365	$250	$91,250
	Draft a legislation to Implement age restriction limit on used car imports less than 5 years	1	365	$250	$91,250
	Draft report on disposal of ICE vehicles recommendations	1	365	$250	$91,250
	Draft legislation to ban imports of used ICE vehicles	1	365	$250	$91,250
	Review standards and policies and submit them to the government	1	365	$250	$91,250
				Total	**$1,222,750**

3.3.7 MANAGEMENT PLANNING

Table 60 show the risk and contingency planning associated with the efficiency in transport technology.

Table 60: Risk and Contingencies Analysis for Efficiency in Transport

RISK ITEM	DESCRIPTION	CONTINGENCY ACTION
Scheduling Risk	Activities may take longer than expected to complete. Also, there can be a delay in the implementation of policies and regulations and feasibility studies and data collection	High level of discussion with the Policymakers of the country and the Prime minister to support the intervention of restriction limits on car imports, emission standards, and ban importation to push for these policies. Proper research and development to ensure the timely delivery of feasibility studies.
Financial Risk	The expenses of carrying out the aforementioned actions and activities may rise as a result of reasons such as the cost of consultants' fees rising.	Apply to international donors and sponsors for external funding for funding that supports e-mobility research and uptake.
Behavioural **Risk**	There could be a lack of commitment and political support to implement policies. Persons are not willing to convert to low emission vehicles and accept policies.	Strong coordination and Data Collection regarding participants' reluctance to adhere to the policies Sharing of knowledge and awareness with stakeholders to increase the buy-in for the uptake of electric mobility policies and technologies.

3.3.8 NEXT STEPS

Table 61 outlines the next steps for the implementation of efficiency in transport technology.

Table 61: Immediate Requirements and Critical Steps for efficiency in transport

Immediate Requirements:	**Funding from external agencies would be sourced. A consultant should be appointed along with the necessary material, monitoring and evaluation mechanism, budget and finally reviewing and improving the potential policies.**
Critical steps:	Legislation and supportive standards and regulations must be drafted, endorsed, and passed to enable the potential policies to the necessary Ministries.

3.3.9 TAP OVERVIEW

Table 62: Overview of TAP for Efficiency in Transport

TAP OVERVIEW TABLE								
Sector	Transport sector							
Sub-sector								
Technology	Efficiency in transport							
Ambition	The overall intention of the Government of Antigua and Barbuda (GoAB) is to revise the vehicular emission standards and import regulations for the new and used car market to reduce annual GHG emissions by 2030.							
Benefits	Climate change mitigation	133,300 t CO_2 eq/ year						
	Economic development	Reduced oil import bills and overall energy costs substantially by exploiting and developing indigenous resources more vigorously						
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame (months)**	**Risks**	**Success criteria**	**Indicators for Monitoring of implementation**	**Budget per activity**
Action 1: Concessionary financing for low emission vehicles	Creation of an electric mobility funding and incentivize adaptation of electric vehicles, for example, SIRF Fund	GoAB, GEF	DoE, Ministry of Finance	24	Funds not secured from internal agencies, lack of technical expertise to write the proposal	# Of proposals formulated and approved and submitted for funding consideration	Grant funding approval	$365,000
	Create a long-term financial plan for implementation for other sources of funding streams such as banks.	GEF	Ministry of Finance	12	Funds not secured, available expertise	# Of interested agencies and institutions	Funding proposal, funds	$219,000

Action 2: **Establish standards and policies needed to scale up the use of low emission vehicles**	Conduct a feasibility study and data collection on the used and new vehicles fleet	GEF	DoE	12	High cost of consultancy	Large scale implementation of policies	Report completed on time	$182,500
	Draft a report and legislation to Implement an age restriction limit on used car imports less than 5 years.	GEF	DoE/ ABBS/ Transport Board	12	Legislation may prove difficult to implement and enforce, Delay in funding	Drafts, and notes from feedback from stakeholder	Legislation drafted with feedback from stakeholders	$91, 250
	Draft a legislation to enforce emission standards	GEF	DoE/ ABBS/ Transport Board	12	Legislation may prove difficult to implement and enforce	Legislation drafted with feedback from stakeholders	Drafts, and notes from feedback from stakeholder	$91, 250
	Draft a report on the disposal of ICE vehicles recommendations	GEF	DoE/ ABBS/ Transport Board	12	Cost for implementation of recommendations	Recommendations of disposal strategies applicable to Antigua and Barbuda	Drafts, and notes from feedback from stakeholder	$91,250
	Draft a legislation to ban imports of used ICE vehicles	GEF	DoE/ ABBS/ Transport Board	12	Legislation may prove difficult to implement and enforce	Legislation drafted with feedback from stakeholders	Drafts, and notes from feedback from stakeholder	$91,250
	Submit legislation draft to the government	GEF	DoE/ ABBS/ Transport Board	12	Lack of commitment and political support from government Legislation may prove difficult to implement and enforce,	Regulations are laws	Adoption and implementation of laws.	$91,250

					Resistance from government			
							Total	**$1,222,750**

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