Government of Tonga

Tonga's NDC Implementation Roadmap and NDC Investment Plan with Project Pipeline

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Cover Image: Aerial view of Nuku'alofa, Tongatapu © 2021 Department of Climate Change, MEIDECC

Foreword

As a Small Island Developing State (SIDS) with a total population of just over 100,000, Tonga is at the forefront of the impacts of climate change and natural disasters which threaten the environment, socio-economic sectors, and livelihood of our people. Tonga's Third National Communication, 2020 reported its contribution to the global greenhouse gas emission is negligible as it compared to developed counties and large emitters of the world. Regardless, Tonga is a leader in taking ambitious climate action, and encourages other countries globally to follow suit.

In the face of a series of disasters that befell the people of Tonga with the eruption of the Hunga Tonga-Hunga Ha'apai volcano and the tsunami on the 15th of January 2022, followed by the COVID-19 outbreak in February, the nation has once again shown its true resilience and perseverance– united in resilience in the face of crisis. Driven by the belief that climate action of all scales is invaluable, especially in the quest to curb global temperature increase to 1.5°C, Tonga has been building resilience on the ground, and communicating the same to the world – simply because our future as one people is at risk.

As a Party to the Paris Agreement, and a developing nation of the Pacific, Tonga remains committed to limiting global temperature increase to 1.5°C, and therefore updated its Nationally Determined Contribution (NDC) and communicated its Second NDC to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2020. Further honouring the commitments under the Paris Agreement, Tonga took a step further and communicated its Low Emission Development Strategy (Tonga LEDS) 2021-2050 to the UNFCCC in 2021, charting a pathway to resilience, sustainable and inclusive growth for the nation. As a natural next step, Tonga is proud to have developed its NDC Implementation Roadmap and NDC Investment Plan including Project Pipeline.

Tonga has a strong focus on climate change mitigation and adaptation, increasing resilience to climate change and natural disasters therefore the NDC Implementation Roadmap and NDC Investment Plan including Project Pipeline encompasses the same mandate; it unpacks the high-level commitments made by Tonga into localized adaptation and mitigation projects, which need to be implemented to achieve Tonga's Second NDC targets.

Mobilization of resources is vital for Tonga to adapt to climate change impacts, amplifying climate resilient development, as well as to contribute to global greenhouse gas mitigation efforts. It is our vision that investors, the private sector, donors, and development partners can use project pipeline in the NDC Implementation Roadmap and NDC Investment Plan to support Tonga in meeting its NDC targets. Supporting Tonga's mitigation and

adaptation priorities, financing projects in the Energy, Agriculture, Forestry, and Other Land Use (AFOLU), Waste sectors and Marine areas have been identified.

As a Large Ocean State, surrounded by the vast blue Pacific Ocean, it is important to protect what we have today, so it can sustain us tomorrow.

I would like to extend my sincere thanks to the team from the Department of Climate Change, MEIDECC for their efforts in developing Tonga's NDC Implementation Roadmap and NDC Investment Plan including Project Pipeline, and also to all national and international stakeholders who have contributed to its development.

As the Deputy Prime Minister and Minister for the Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC), it is indeed an honour and a privilege to present Tonga's NDC Implementation Roadmap and NDC Investment Plan including Project Pipeline.

Honourable Poasi Mataele Tei

Deputy Prime Minister
Minister for the Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change, and Communications (MEIDECC)

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The development of Tonga's NDC Implementation Roadmap and NDC Investment Plan including Project Pipeline has been led by the Department of Climate Change (DCC) of the Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change, and Communications (MEIDECC). Notable contributions were also made by the members of the Joint National Action Plan on Climate Change and Disaster Risk Management (JNAP) Technical Team.

Sincere thanks are also conferred to all the national stakeholders who contributed their time to the workshops and consultations, and provided valuable insights and expertise into the development of the NDC Implementation Roadmap and NDC Investment Plan including Project Pipeline.

IMPLEMENTING PARTNERS

REGIONAL PACIFIC NDC HUB

GGGI

WITH FINANCIAL SUPPORT FROM

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Australian Aid

NEW ZEALAND
FOREIGN AFFAIRS & TRADE
Aid Programme

IN CONTRIBUTION TO

NDC PARTNERSHIP

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Abbreviations and Acronyms

4NC	Tonga's Fourth National Communication to the UNFCCC
ADB	Asian Development Bank
AFOLU	Agriculture, Forestry, and Other Land Use
AIIB	Asian Infrastructure Investment Bank
BAU	Business as usual
BTB	Back to business
BUR	Biennial Updated Report
CCMC	Coastal Community Management Committee
CO_2e	Carbon dioxide equivalent
DCC	Department of Climate Change
EE	Energy efficiency
ESS	Environmental and Social Safeguards
E&S	Environmental and Social
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ENSO	El Niño-Southern Oscillation
FAO	Food and Agriculture Organization
FHA	Fish Habitat Area
FHRs	Fish Habitat Reserves
FTE	Full-time staff equivalent
GCCA	Global Climate Change Alliance Plus Initiative
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Gigagram
GGGI	Global Green Growth Institute
GHG	Greenhouse gas
GIS	Geographic Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoT	Government of Tonga
GWh	Gigawatt hours
ha	Hectare

HDI	Human Development Index
ICE	Internal combustion engine
IFAD	International Funding for Agricultural Development
IFC	International Finance Corporation
INDC	Intended Nationally Determined Contribution
IRENA	International Renewable Energy Agency
ISA	International Solar Alliance
ISLAND	Implementing Sustainable Low and Non-Chemical Development in Small Island Developing States
IUCN	International Union for Conservation of Nature
JICA	Japanese International Cooperation Agency
JNAP 2	Joint National Action Plan 2 on Climate Change and Disaster Risk Management 2018-2028
JNAP 1	Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management 2010-2015
JPRISM-II	Japanese Technical Cooperation Project for the Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries Phase II
km_2	Kilometre square
LEDS	Low Emission Development Strategy
LULUCF	Land Use, Land-Use Change and Forestry
m^3	Cubic metre
MAFF	Ministry of Agriculture, Food and Forests
MESCAL	Mangrove Ecosystem for Sustainable Climate Change Adaptation and Livelihoods
MEIDECC	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change, and Communications
mm	milimeters
MLNR	Ministry of Lands and Natural Resources
MOF	Ministry of Finance
MOI	Ministry of Infrastructure
MORC	Ministry of Revenue and Customs
MOU	Memorandum of Understanding
MPAs	Marine Protected Areas
MSW	Municipal Solid Waste
MW	Megawatt
M&E	Monitoring and Evaluation
NBSAP	National Biodiversity Strategy and Action Plan 2030
NBSAF	Tonga National Biodiversity Strategy Action Framework 2018-2025

NDC	Nationally Determined Contribution
NIIP	National Infrastructure Investment Plan
NDC Hub	Regional Pacific NDC Hub
NGOs	Non-Governmental Organizations
NNUP	Nuku'alofa Network Upgrade Project
NSDS	Tonga National Strategy for the Development of Statistics 2019-2023
NZ MFAT	New Zealand Ministry of Foreign Affairs and Trade
PMO	Prime Minister's Office
PMUs	Project Management Units
PRIF	Pacific Regional Infrastructure Facility
PV IPP	Photovoltaic Independent Power Producer
RE	Renewable energy
REDD+	Reducing GHG emissions from Deforestation and Forest Degradation
SAPT	Strengthening Adaptation Planning in Tonga
SIDS	Small Islands Developing States
SMAs	Special Management Areas
SNC	Second National Communication to the UNFCCC 2012
SOE	State of Environment Report 2018
SPC	The Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
SUPA	Scaling up Pacific Adaptation
TASP	Tonga Agriculture Sector Plan 2016-2020
TDB	Tonga Development Bank
TCCP	Tonga Climate Change Policy
TCCF	Tonga Climate Change Fund
TEEMP	Tonga Energy Efficiency Master Plan
TERM-PLUS	Tonga Energy Road Map 2021-2035
TIURSP	Tonga Integrated Urban Resilience Sector Project
TNC	Third National Communication to the UNFCCC 2020
TPL	Tonga Power Limited
TSD	Tonga Statistics Department
TSDF II	Tonga Strategy Development Framework II 2015-2025
TWB	Tonga Water Board
UNDP	United Nations Development Programme

UNFCCC	United Nations Framework Convention on Climate Change
TWAL	Tonga Waste Authority Limited
WEGET	National Women's Empowerment and Gender Equality Tonga Policy and Strategic Plan of Action 2019-2025
WB	World Bank
WMPC	Waste Management and Pollution Control Division

Executive Summary

Context

Tonga seeks to accelerate the implementation of its Nationally Determined Contribution (NDC)[1] to global climate change mitigation efforts. The Global Green Growth Institute (GGGI), as part of its role as an implementation partner of the Regional Pacific NDC Hub, has engaged Castalia to develop this NDC Implementation Roadmap and Investment Plan with Project Pipeline.

The NDC Implementation Roadmap and an Investment Plan with Project Pipeline provide a plan for the Government of Tonga (GoT) to achieve its Second NDC targets through mitigation projects in the agriculture, forestry, and other land use (AFOLU), waste and energy sectors as well as adaptation projects in the marine sector[2].

For the energy sector, the GHG mitigation projects that will contribute to achieving the Second NDC targets while noted for clarity, are not covered in the same detail in this document. These are however, covered in the separate forthcoming Tonga Energy Roadmap 2021-2035 (TERM-PLUS) that provides the in-depth analysis of the energy sector including both electricity and transport sub-sectors.

Both these documents, the NDC Implementation Roadmap and Investment Plan, and the TERM-PLUS taken together provide a path towards achieving Tonga's Second NDC targets and are intended to help generate interest from potential implementation partners, including donors and private investors, to fund projects included in the NDC Implementation Roadmap and Investment Plan and other projects in Tonga.

Tonga's Second NDC

Tonga's Second NDC (submitted in 2020) includes both mitigation and adaptation targets. The mitigation targets focus on reducing greenhouse gas (GHG) emissions in the energy

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[1] Available at: https://www.unfccc.int/sites/ndcstaging/PublishedDocuments/Tonga%20Second/Tonga%27s%20Second%20NDC.pdf

[2] The marine sector includes:

- Marine protected areas (MPAs) are labelled as 'parks' or 'reserves' designated under the Parks and Reserves Act 1979 (Rev. 1988) and are exclusively 'no-take zones'. They are areas of marine protection that are remote from communities, where community management is not possible and are exclusively managed by government
- Special management areas (SMAs) are areas of marine protection that are located near island communities where they can be locally managed under government supervision
- Sustainable community-led non-fed marine aquaculture (mariculture).

MPAs are managed under the Department of Environment and SMAs are managed under the Ministry of Fisheries.

The energy sector is also included in this NDC Implementation Roadmap and NDC Investment Plan, but is covered in detail in the TERMPLUS. Existing parallel policy measures, that chart out the timely execution and implementation of various plans, concepts, and initiatives in the energy sector, are being planned for and carried out through different frameworks. These policy measures focus on all sub-sectors in the energy sector and seek to align the approved Tonga Energy Bill 2021 and contribute to achieving the 13% GHG emissions reduction target by 2030, outlined in Tonga's Second NDC.

sector. The NDC also includes non-GHG emissions targets for AFOLU and waste sectors[3]. Tonga's adaptation targets focus on coping with the impacts of higher temperatures and sea levels in the AFOLU and marine sectors. These mitigation and adaptation targets are conditional on financing, capacity building, and technology investment from external sources. This NDC Implementation Roadmap and Investment Plan with Project Pipeline identifies mitigation and adaptation projects and lays out the steps needed to achieve the targets in Tonga's Second NDC.

Tonga's GHG emissions profile

Tonga's GHG emissions profile is dominated by emissions from the AFOLU sector[4] and the energy sector. Tonga's most recent national inventory of GHG emissions was reported in Tonga's Third National Communication (TNC) 2020 to the United Nations Framework Convention on Climate Change. According to Tonga's TNC, Tonga's total GHG emissions were 310.4 $GgCO_2e$ in 2006[5]. 61% of this total comes from the AFOLU sector[6], while 39% comes from the energy sector[7]. Waste emits a comparatively small amount of GHG emissions in Tonga.

Constraints on NDC implementation and opportunities to strengthen the enabling environment

This NDC Implementation Roadmap and Investment Plan with Project Pipeline considers several key constraints to mitigation and adaptation projects across the sectors. Constraints include budget limitations and shortfalls in public awareness, coordination, and data. Constraints for each sector, and suggestions for strengthening the enabling environment, are discussed in section 4.

Mitigation and adaptation projects identified

This NDC Implementation Roadmap and Investment Plan with Project Pipeline identifies 24 mitigation and adaptation opportunities in Tonga. 15 identified directly in the development of the NDC Implementation Roadmap and Investment Plan with nine energy sector projects identified as part of either the TERM 2012-2020 or through the planning process for the upcoming TERMPLUS 2021-2035.

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[3] Tonga's Second NDC does not include a target for the industrial processes and product use (IPPU) sector. The document states this is because GHG emissions from IPPU make up a small amount of Tonga's total GHG emissions and because there is a lack of data on GHG emissions from the sector, which makes it challenging to set a verifiable target.

[4] GHG emissions for LULUCF and agriculture are reported separately in Tonga's TNC, however were combined under AFOLU in Tonga's Second NDC. Emissions from LULUCF are significantly higher than agriculture.

IPPU emissions were not included in Tonga's TNC.

[5] Tonga's most recent national inventory of GHG emissions was reported in Tonga's Third National Communication (TNC) (2019) and monitored GHG emissions in the years 2000 to 2006. GoT is seeking to update the inventory in Tonga's Fourth National Communication (4NC), however the baseline has not yet been determined.

[6] GHG emissions for LULUCF and agriculture are reported separately in Tonga's TNC, however were combined under AFOLU in Tonga's Second NDC. Emissions from LULUCF are significantly higher than agriculture.

IPPU emissions were not included in Tonga's TNC.

[7] These figures are rounded to the nearest whole number. GHG emissions from the waste sector also make up 0.3% of total GHG emissions in 2006. Table 2.2 provides a breakdown of Tonga's GHG emissions by sector (as at 2006).

Non-energy sector pipeline

Each non-energy sector has its own pipeline—the project pipelines comprise of five projects in the AFOLU sector, four projects in the waste sector, and six projects in the marine sector[8]. Projects in each pipeline were ranked using a multicriteria analysis considering mitigation and adaptation potential, cost effectiveness, capacity requirements, and the views of stakeholders in Tonga. The multicriteria analysis is outlined in section 5.

Energy sector pipeline

GHG mitigation actions corresponding to Tonga's Second NDC targets in the energy sector, including transport, has been analysed and assessed in the Tonga Energy Roadmap Plus (TERM-PLUS). Six projects have been identified in the electricity sub-sector, and three projects in the transport sub-sector. The execution of the pipeline of energy projects in the TERM-PLUS is being guided through prioritised technological options which will be implemented under parallel policy measure and frameworks. These policy measures and frameworks include the Tonga Energy Efficiency Master Plan (TEEMP) 2018, the Sustainable Development Goal (SDG) 7 Roadmap 2021, the Tonga Climate Change Policy (TCCP) 2016, the Joint National Action Plan 2 on Climate Change and Disaster Risk Management (JNAP 2) 2018-2028, the Tonga Power Limited (TPL) Business Plan, and the forthcoming Fourth National Communication (4NC). In addition to these, the 'key sector pathway actions over time' encapsulated in the Tonga Low Emission Development Strategy (Tonga LEDS) 2021-2050, and Technology Needs Assessment (currently in development) will also contribute to execution of GHG mitigation initiatives in the energy sector.

Additional management, monitoring, and evaluation costs of implementing pipeline projects will need to be considered. These costs should be built into funding applications and carefully scoped during the project design phase. Where funding for these additional activities may be a limiting factor, Tonga could consider proposing the establishment of donor-funded Project Management Units (PMUs) to relieve a proportion of the additional administrative burden on government agencies.

Table 0.1 details the GHG mitigation projects for each sector (in order of priority) and adaptation project (in order of priority), along with indicative investment needs to 2030, the annual GHG mitigation potential in 2030, and the cumulative GHG mitigation potential by 2030. The information detailed in this table provides summary information about each project and does not take into account implementation constraints[9]. This information is

[8] The energy sector is also included in this NDC Implementation Roadmap and NDC Investment Plan, but is covered in detail in the TERMPLUS. Existing parallel policy measures, that chart out the timely execution and implementation of various plans, concepts, and initiatives in the energy sector, are being planned for and carried out through different frameworks. These policy measures focus on all sub-sectors in the energy sector and seek to align the approved Tonga Energy Bill 2021, and contribute to achieving the 13% GHG emissions reduction target by 2030, outlined in Tonga's Second NDC.

[9] The information detailed in this table provides summary information about each project. This information is not the complete set of data used to prioritize projects—the methodology for pipeline prioritization is outlined in section 5.

not the complete set of data used to prioritize projects—the methodology for pipeline prioritization is outlined in section 5.

Table 0.1: GHG mitigation and adaptation projects in Tonga

	Opportunity	Pipeline priority rank	Indicative investment need to 2030 (US$)[10]	Annual GHG emissions reduction in 2030 ($GgCO_2e$)	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[11]	Adaptation potential (low/medium/high)
Mitigation	**Energy Sector[12]**					
	Electricity sub-sector*					
	Sunergise 6 MW Solar PV IPP	1	12.2mn (secured)	7	42	-
	6 MW of Solar PV IPP	1	Private Sector Secured	7	42	
	2.25 MW China Wind Farm	2	12.31mn (secured)	5	30	
	3.8 MW of Wind IPP	3	Private Sector Secured	8.5	51	-
	TPL 34-50 GWh RFP (technology agnostic)	4	Investment Secured Private Sector/Donor	~32	126	-
	Nuku'alofa Network Upgrade **	5	6.8mn (secured)	0.4	2.4	-
	Transport sub-sector					
	Improving Intake Quality of Vehicle	1	TBD	9.9	99***	
	Non-motorised Transport	2	TBD	2.2	22***	

The projects in this table are also not sequenced, i.e., taking into account capacity constraints in Tonga. Sequenced projects are detailed in section 5 and section 7.

[10] The indicative investment need mainly accounts for support programs, feasibility studies, and some capital costs for projects. Private sector investment may be much larger, but this investment is made on commercial terms.

[11] The GHG emissions reduction estimate calculations for the AFOLU, waste, and marine sectors are explained in the concept notes in Appendix A. The GHG emissions reduction estimate calculations for the energy sector is explained in 0.

[12] The energy sector projects are referenced from the TERMPLUS. Refer to the TERMPLUS for details on energy sector projects.

	Opportunity	Pipeline priority rank	Indicative investment need to 2030 (US$)[10]	Annual GHG emissions reduction in 2030 ($GgCO_2e$)	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[11]	Adaptation potential (low/medium/high)
	Low Emission Vehicles	3	TBD	17	165***	
	AFOLU Sector					
	Develop new forest plantations	1	50,000	131.61	789.65	-
	Establish new forest reserves on unused land[13]	2	1,233,000	16.1	96.6	-
	Agroforestry expansion programme	3	2,105,000	27.33	136.65	-
	Develop a commercial sandalwood industry	4	4,185,000	13.2	59.4	-
	Pasture improvement and fertilizer management	5	601,000	0.085	0.55	-
	Waste Sector					
	Moving towards zero waste	1	1,100,000	2.081	12.49	-
	Waste-to-energy	2	3,800,000	3.1	9.3	-
	Outer island waste management services	3	5,630,000	0.7	3.5	-
	Organic recycling	4	1,030,000	0.08	0.58	-
	Marine Sector					
Adaptation	Mangrove restoration and replanting	1	3,758,000	6.76	40.58	High
	Apply detached breakwaters	2	7,200,000	-	-	High
	Model Tonga's hydrodynamic connectivity	3	550,000	-	-	High
	Enhance community monitoring and enforcement of SMAs and FHRs	4	1,100,000	-	-	High

[13] Unused land is largely privately-owned land that is not used because it is inaccessible or slopy.

	Opportunity	Pipeline priority rank	Indicative investment need to 2030 (US$)[10]	Annual GHG emissions reduction in 2030 ($GgCO_2e$)	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[11]	Adaptation potential (low/medium/high)
	Optimisation of the size of MPAs, FHRs, and SMAs	5	500,000	-	-	High
	Review and update regulations for MPAs, FHRs, and SMAs	6	350,000	-	-	High

**All electricity sector projects are estimated to be operational by 2024.*
*** to provide an estimated 1% line-loss improvement to the Tongatapu network and keep total line-losses below 8% per year.*
**** TERMPLUS estimates by 2035.*
Note: Mitigation figures ($GgCO_2e$) are rounded to two significant figures after the decimal point; indicative investment needs are rounded to the nearest US$1,000.
Note: Recommended technology solutions in the energy sector for timely reducing emissions, saving energy, lowering costs, and improving access for all are outlined in the TERM-PLUS 2021-2030, SDG 7 Roadmap and Technology Needs Assessment Strategies.

Once implementation constraints are considered[14],Energy, AFOLU, waste, and marine sector pipeline projects have the potential to reduce GHG emissions by 1,728.66 $GgCO_2e$[15] by 2030, with an annual mitigation potential of 279.01 $GgCO_2e$ in 2030[16]. AFOLU, waste, and marine sector pipeline projects would reduce net GHG emissions in Tonga in 2030 by 61% relative to 2006 levels. Adaptation projects all have a 'high' potential adaptation benefit through a range of coastal management projects and through the optimisation and improvement of MPAs and SMAs. AFOLU, waste, and marine sector pipeline projects have an indicative investment need of US$30,306,000 by 2030[17].

The NDC projects included in this NDC Implementation Roadmap and Investment Plan should be seen as a provisional list of mitigation and adaptation projects. Tonga will continue to add to these projects as new projects arise, and new projects should be given

[14] Institutional capacity constraints, including human resource constraints, may mean that it is not feasible to run all projects concurrently.

[15] This figure includes potential emissions reductions from the mangrove restoration and replanting project. While this emissions reduction potential is a co-benefit of a marine sector project that focuses primarily on adaptation, the emissions reduction potential is included in the total emissions reduction potential figure for completeness.

[16] The GHG emissions reduction potential of the 'mangrove restoration and planting' project has been included in any annual and cumulative GHG emissions reduction potential figures, however, is not included in the total indicative investment need of mitigation projects.

The GHG emissions reduction estimate calculations for each project are explained in the concept notes in Appendix A.

GHG emissions reduction potential from energy sector projects are not included in the annual mitigation potential.

[17] Indicative investment need for energy sector projects are not included in this figure.

If implementation constraints are removed, these GHG mitigation and adaptation projects have the potential to reduce GHG emissions in Tonga by 1,149.28 $GgCO_2e$ by 2030, have an annual GHG mitigation potential of 201.048 $GgCO_2e$ in 2030, and are estimated to have an indicative investment need of US$33,192,000 by 2030. The figures reported in Table 0.1 indicate the theoretical potential of each project, assuming each project starts in 2022. GHG emissions reduction potential and indicative investment need for energy sector projects are not included in these unconstrained figures.

equal attention to those included in this NDC Implementation Roadmap and Investment Plan. Ministries and Implementing Agencies in each sector should be encouraged to continue innovating and to contribute to subsequent versions of this work.

Financing mitigation and adaptation projects

When planning projects, it is important to make a clear distinction between funding and financing[18]. Each of the opportunities included in the project pipelines requires funding arrangements that meet their full costs. Some of the projects included in the pipelines will require financing. The investment plan outlined in Section 6 aligns with the High-Level NDC Financing Pathways for Tonga 2021 report[19]. The Financing Pathways for Tonga report outlines high-level strategies for funding and financing mitigation and adaptation actions identified in Tonga's Second NDC, and it includes detailed information on the funding and financing instruments available in Tonga. Section 6 of the current report focusses on the principles of funding and financing the projects included in the project pipeline. Potential sources of funding for NDC projects in Tonga is shown in Table 0.2.

Table 0.2: Sources of funding available in Tonga

Donor Funding		
Name of donor	**Type of funding support**	**Type of Institution**
World Bank (WB) (International Development Association)	Grants, Technical Assistance (TA) and capacity building	Banks
Asian Development Bank (ADB)	Grants, TA, and capacity building	
Asian Infrastructure Investment Bank (AIIB)	Grants, TA, and capacity building	
Green Climate Fund (GCF)	Grants, TA, and capacity building	Funds
Global Environment Facility (GEF)	Grants, TA, and capacity building	
International Funding for Agricultural Development (IFAD)	Grants, TA, and capacity building	
UNDP[20]	Grants, TA, and capacity building	Multilateral agency
GGGI	TA and capacity building	Multilateral agency
New Zealand Ministry of Foreign Affairs and Trade (NZ MFAT)	Bilateral Official Development Assistance (ODA) grants	

[18] When planning projects, it is important to make a clear distinction between funding and financing:

- Funding refers to the need for the project to cover all costs over the life of the project, including the costs of financing. Funding could be provided by one or a combination of the following three sources:
  - Grants from international donors
  - Government funding (from the government's budgets – paid for by taxes or other government revenue sources)
  - User fees from those who benefit from the projects.
- Financing deals with the timing mismatch between when expenses are incurred and when revenues are received. For NDC projects, finance could be provided by one or both of the following two sources:
  - Commercial finance from private lenders (this can sometimes be coupled with credit enhancements such as credit guarantees or risk sharing facilities)
  - Concessional finance from international donors (these would be in the form of sovereign lending).

[19] The High-Level NDC Financing Pathways for Tonga report was developed by the United Nations Development Programme (UNDP) through its Climate Promise Initiative. The report provides the Government of Tonga with a map of past, current, and potential future pathways to fund and finance mitigation and adaptation activities identified in Tonga's Second NDC.

[20] UNDP provides financial and technical support to projects through Global Environment Facility (GEF) and Green Climate Fund (GCF).

Australian Department of Foreign Affairs and Trade	Bilateral ODA grants	Bilateral agencies
UK Department for International Development	Bilateral ODA grants	
People's Republic of China External Trade and Economic Cooperation Ministry	Bilateral ODA grants	
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	Bilateral ODA grants	
Japanese International Cooperation Agency (JICA)	Bilateral ODA grants	
European Union	Multilateral ODA grants	
International Union for Conservation of Nature (IUCN)—ORO/Italy/Austria	Grants, TA, and capacity building	International organization
International Solar Alliance—ISA	Grants, TA, and capacity building	International organization
SIDS Dock	TA and capacity building	Regional organization
International Renewable Energy Agency (IRENA)	TA and capacity building	International organization

Possible sources of Government Funding
Ministry of Finance (MOF)
Ministry of Agriculture, Food, and Forests (MAFF)
Ministry of Lands and Natural Resources (MLNR)
Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate change and Communications (MEIDECC)
Ministry of Fisheries
Ministry of Infrastructure (MOI)

Types of User Fees
Revenue from user tariffs
Avoided costs[21]

Potential sources of finance for NDC projects are shown in Table 0.3.

Table 0.3: Sources of finance available in Tonga

Concessional Finance	Commercial Finance
▪ World Bank ▪ Asian Development Bank ▪ European Investment Bank ▪ Australian Aid	▪ ANZ Bank Tonga Limited ▪ MBF Bank ▪ Tonga Development Bank

[21] Avoided costs is the incremental cost that is not incurred when the additional output is not produced. For example, the cost of paying for diesel for a generator may be avoided when a solar panel is installed.

Concessional Finance	Commercial Finance
▪ European Union ▪ Green Climate Fund ▪ Global Environment Facility	▪ Bank of the South Pacific Tonga[22]

Tonga's private financial sector is small, and experience with lending to businesses and households is limited. There are four commercial banks registered in Tonga[23]. Tonga does not have a sovereign credit rating. This makes it difficult for Tonga to access funding in international bond markets, because investors cannot see the level of risk associated with investing in the debt of Tonga.

However, the Tonga Development Bank (TDB) and the Ministry of Finance are currently in the process of applying for accreditation under the Green Climate Fund (GCF), which is likely to enable significant upscaling in the amount of funding and financial support available for climate change projects in Tonga[24].

Public and private financial institutions are increasingly opting to blend investments they make on commercial terms with various types of concessional support. Concessional support includes advice, funding, or non-grant instruments[25] such as debt financing, risk mitigation products, or equity investments with expectations of below-market returns[24]. Concessional support uses scarce public funding, so it must be used selectively. To access concessional support, activities or projects identified in Tonga's Second NDC and in Tonga's NDC Implementation Roadmap and Investment Plan with Project Pipeline will need to put forward strong evidence of potential mitigation or adaptation benefits. In many cases, they will also need to demonstrate potential co-benefits, including the following co-benefits outlined under Article 6.8 of the Paris Agreement:

- Promoting increased adaptation and mitigation ambition.
- Enhance public and private sector participation in the implementation of Tonga's Second NDC.
- Enable opportunities for coordination across instruments and relevant institutional arrangements.

[22] Bank of South Pacific Tonga is a 100% owned subsidiary of Bank of South Pacific.

[23] https://www.adb.org/sites/default/files/publication/530266/pacific-finance-sector-tonga.pdf

[24] For more detailed information on possible funding mechanisms in Tonga, see UNDP (2021) High-level NDC Financing Pathways for Tonga, United Nations Development Program.

[25] Non-grant instruments are preferable in many cases because they provide potential return flows to the donor, and they can be designed to target specific market barriers.

Tonga states in its Second NDC that it does not intend to use voluntary cooperation under Article 6 of the Paris Agreement. Therefore, this investment plan does not include the potential for voluntary cooperation[26].

A potential challenge of financing NDC projects is that some are likely to be too small to warrant engagement in the complex procurement and approval systems that international financing institutions and, in particular concessional financing institutions have. Tonga should think about how individual projects could be aggregated with other projects across sectors. This will allow organizations to support a single, coherent program in Tonga or the Pacific more broadly. It will be easier for Tonga to get financing and concessional support for larger programs of activities covering multiple NDC projects.

Implementation plan

Institutional capacity constraints may mean that it is not feasible to implement all of the primary mitigation projects concurrently. Therefore, in line with the advice of stakeholders, projects are sequenced in order of priority, ensuring that there are no more than three projects happening concurrently in any of the three priority sectors.

The prioritized sequencing of GHG mitigation and adaptation projects, taking into account stakeholders' advice on the number of projects that can happen concurrently in each sector, is shown in Table 0.4 below[27].

[26] Article 6 of the Paris Agreement enables Parties to engage in voluntary cooperation as they implement their NDC. Article 6 sets out three pathways for voluntary cooperation:

- Cooperative approaches through the use of internationally transferred mitigation outcomes (ITMOs) in Article 6.2
- A new crediting mechanism, sometimes referred to as the "Sustainable Development Mechanism", in Article 6.4; and
- A framework for non-market approaches in Article 6.8.

For more information, see: https://climate.mit.edu/posts/advancing-international-cooperation-under-paris-agreement-issues-and-options-article-6

[27] Stakeholders in Tonga were asked to identify how many projects can be implemented concurrently in each sector. This table shows the prioritized projects, taking into account stakeholders' views on how many projects can be run concurrently in each sector between 2022-2030.

Table 0.4: Timing and duration of project pipelines

Project	2022	2023	2024	2025	2026	2027	2028	2029	2030
AFOLU Sector									
Develop new forest plantations	■	■	■	■	■	■			
Establish new forest reserves on unused land	■	■	■	■	■	■			
Agroforestry expansion programme	■	■	■	■	■	■	■		
Develop a commercial sandalwood industry							■	■	■
Pasture improvement and fertilizer management							■	■	■
Waste Sector									
Moving towards zero waste	■	■	■	■					
Waste-to-energy	■	■	■	■	■	■	■		
Outer island waste management services	■	■	■	■	■				
Organic recycling					■	■	■	■	■
Marine sector									
Mangrove restoration and replanting	■	■	■	■	■				
Apply detached breakwaters	■	■	■	■	■	■			
Model Tonga's hydrodynamic connectivity	■	■	■	■	■	■			
Enhance community monitoring and enforcement of SMAs and FHRs						■	■	■	■
Optimisation of the size of MPAs, FHRs, and SMAs							■	■	■
Review and update regulations for MPAs, FHRs, and SMAs							■	■	■
Energy Sector[28]									
Sunergise 6 MW Solar PV IPP	■	■	■	■					
GET 6 MW of Solar PV IPP		■	■	■	■				
2.25 MW China Wind Farm	■	■	■	■					
3.8 MW of Wind IPP		■	■	■	■				
TPL 34-50 GWh RFP (technology agnostic)			■	■	■	■	■	■	■
Nuku'alofa Network Upgrade **	■	■	■	■	■	■	■	■	■
Improving Intake Quality of Vehicle	■	■	■	■	■	■	■	■	■
Non-motorised Transport	■	■	■	■	■	■	■	■	■
Low Emission Vehicles	■	■	■	■	■	■	■	■	■

*Note: ** to provide an estimated 1% line-loss improvement to the Tongatapu network and keep total line-losses below 8% per year.*

Monitoring and evaluation framework, and guidelines for promoting gender and social inclusion and environmental and social safeguards

Implementation of this plan will be guided by a monitoring and evaluation framework (M&E) that reflects the forthcoming NDC M&E Framework for Tonga. The NDC M&E Framework builds on the existing Tonga JNAP 2 M&E system to present an overarching M&E framework for Tonga's Second NDC.

The monitoring and evaluation framework has three components:

- A reporting structure that assigns responsibility over actions to specific government employees
- A monitoring structure that tracks progress in a transparent manner
- An evaluation structure that outlines the consequences for completing—or not completing—actions in time.

[28] The energy sector projects are referenced from the TERMPLUS. Refer to the TERMPLUS for details on energy sector projects.

Under the M&E Framework, government staff responsible for implementing the NDC projects should assign responsibility for each project in tiers:

- **NDC M&E Officer**—based in the Mitigation Division responsible for the NDC and coordinate with the JNAP Secretariat. This will be the person ultimately responsible for overseeing implementation of Tonga's Second NDC.
- **Sector Focal Points**—existing sector focal points responsible for implementing specific actions in the AFOLU, waste, marine, and energy sectors included in this NDC Implementation Roadmap and include the energy sector focal point for deliverables under the TERMPLUS to enable complete reporting on progress of all sectors to the NDC M&E Officer.
- **Executors (Implementing Agency)**—individuals responsible for carrying out the day-to-day tasks required to manage and implement the priority projects in each sector. Executors can include managers as well as line staff, who should make up the bottom tier of the structure, and reporting on the progress to the NDC M&E Officer. Section 7.2 outlines the implementing agencies that house the proposed executors responsible for delivery of each of the priority projects in Tonga's NDC project pipelines and supporting agencies for each project.

All sector Focal Points should meet weekly with their Executors to track day-to-day tasks and liaise with any external consultants involved in the projects in their sector. In addition, to ensure coordination between NDC projects in different sectors, the four Sector Focal Points should meet with each other once a month to discuss potential synergies and trade-offs between the projects they are responsible for. Sector Focal Points should give quarterly briefings to the NDC M&E Officer, updating them on progress on the NDC projects in their sector. The NDC M&E Officer should be responsible for reporting annually on NDC implementation progress and how the NDC projects are tracking to achieve the targets in Tonga's Second NDC.

Sector Focal Points should be responsible for recording progress on implementing the NDC in a centralized monitoring spreadsheet (held by DCC). This spreadsheet should also report on progress relative to the NDC M&E Results Framework, outlined in Section 7.2.

Gender and social inclusion and environmental and social safeguards (ESS) considerations should be integrated across all elements of project design and implementation. The NDC M&E Officer and Sector Focal Points overseeing NDC projects in Tonga should promote gender and social inclusion in these projects by implementing effective measures to limit occupational segregation and pay gaps, minimize health risks, and combat gender-based violence. Tonga is currently developing an NDC Gender Inclusion Document, which should be utilised once published. The International Finance Corporation's (IFC) Environmental and Social (E&S) Performance Standards should also be used to assist Tonga in managing key environmental and social risks.

1 Introduction

Tonga submitted its Second Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2020[29], which includes both mitigation and adaptation targets. The mitigation targets focus on reducing greenhouse gas(GHG) emissions in the energy sector. The Second NDC also includes non-GHG emissions targets for the Agriculture, Forestry and Other Land Use (AFOLU)[30] and waste sectors[31]. Adaptation targets focus on coping with the impacts of higher temperatures and sea levels in the AFOLU and marine sectors[32]. These targets are conditional on financing, capacity building, and technology investment from external sources.

Tonga seeks to accelerate the implementation of its Second NDC to contribute to global climate action and national adaptation efforts. As a member of the Regional Pacific NDC Hub (NDC Hub), Tonga requested technical assistance from the NDC Hub to support the Government of Tonga (GoT) to develop an NDC Implementation Roadmap and Investment Plan with Project Pipeline[33]. The Global Green Growth Institute (GGGI), as an implementation partner of the NDC Hub, engaged Castalia to assist with this objective. The NDC Implementation Roadmap and Investment Plan with Project Pipeline will support Tonga in achieving its NDC targets by setting out practical steps and tangible projects to mitigate GHG emissions in the AFOLU and waste sectors, and increase adaptation and resilience to climate change in the marine sector[34].

For the energy sector, GHG mitigation actions corresponding to Tonga's Second NDC targets, including transport, have been analysed and assessed in both the recently concluded Tonga Energy Road Map 2010-2020 (TERM) the Tonga Energy Roadmap Plus 2021-2035 (TERM-PLUS). The prioritization of the energy sector projects therefore has utilised a different approach to the other sectors and differs between those of the electricity and transport sub-sectors. The electricity sector projects noted here are those

[29] Available here: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tonga%20Second/Tonga%27s%20Second%20NDC.pdf

[30] GHG emissions from the AFOLU sector are broken down into: Land Use, Land-Use Change and Forestry (LULUCF), and Agriculture.

GHG emissions for LULUCF and agriculture are reported separately in Tonga's Third National Communicate (including GHG inventory), however are combined under AFOLU in Tonga's Second NDC.

[31] Tonga's Second NDC does not include a target for the Industrial processes and product use (IPPU) sector. The document states this is because GHG emissions from IPPU make up a small amount of Tonga's total GHG emissions and because there is a lack of data on GHG emissions from the sector, which makes it challenging to set a verifiable target.

[32] Tonga's Second NDC includes adaptation targets for MPAs and SMAs. NDC projects for MPAs and SMAs have been grouped under the marine sector.

[33] Tonga's NDC Implementation Roadmap and Investment Plan with Project Pipeline is being developed through close collaboration between Castalia, the NDC Hub, the Global Green Growth Institute (GGGI), Tonga's Department of Climate Change (DCC), and other key stakeholders in Tonga, with technical assistance of consultancy counterpart Castalia.

[34] The energy sector is being analysed separately by the Department of Energy, with support from GGGI, and will be reported in the Tonga Energy Roadmap Plus (TERM-PLUS).

that have at time of publication, already received funding or are entering procurement and implementation phases and were prioritised using the principles noted in the TERM 2010-2020. The transport sector project on the other-hand are the result of analysis undertaken for the TERMPLUS and have been prioritised utilising stakeholder consultation and a separate multicriteria analysis framework. Both prioritisation approaches are summarised in Appendix D and E for reference.

The NDC Implementation Roadmap and Investment Plan with Project Pipeline comprises two key strategic documents:

- An **Implementation Roadmap,** which includes information about Tonga's specific context, such as Tonga's GHG emissions profile, targets in Tonga's Second NDCs, as well as information about the priority sectors and institutional capacity. The roadmap also includes an implementation plan, which details a strategy for preparing and procuring projects and monitoring implementation.
- An **Investment Plan,** which includes a **project pipeline**[35] of promising mitigation and adaptation projects, outlining potential GHG emissions reductions, costs, co-benefits, capacity requirements, and potential to attract funding. The project pipelines are outlined in Section 5[36]. It also highlights funding and financing requirements for projects, supporting measures that may need to be put in place to attract finance, and environmental and social considerations.

The NDC Implementation Roadmap and Investment Plan with Project Pipeline sets out practical steps for the GoT to successfully implement the projects in the pipeline, and is also intended to help generate interest from potential implementation partners, including donors and private investors for implementing the pipeline of projects.

Successful implementation of the projects included in the NDC Implementation Roadmap and Investment Plan with Project Pipeline will help Tonga achieve the adaptation and mitigation targets set out in its Second NDC. Total GHG mitigation potential and investment need for each sector is included in Table 1.1[37].

Table 1.1: Sequenced cumulative GHG emissions reduction by 2030 and indicative investment need to 2030 for priority sectors

Sector	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[38]	Indicative investment need to 2030 (US$)
Energy	579.8	60,000,000[39]
AFOLU	1,025.16	5,695,000

[35] Key national documents, policies, and strategies were reviewed throughout developing the NDC Implementation Roadmap and Investment Plan with Project Pipeline. This review was key to ensuring synergies between different areas of government policy and targets.

[36] Each priority sector has a project pipeline.

[37] Further detail about the investment need and GHG mitigation potential in each sector is included in Section 5.

[38] The GHG emissions reduction estimate calculations are explained in the concept notes in Appendix A.

[39] Only confirmed cost estimates included Transport sector and TPL RFP investments not included.

Waste	25.53	11,560,000
Marine	40.58	12,902,000

Note: This table displays the sequenced cumulative GHG emissions reduction by 2030 and indicative investment need to 2030.
Note: The TERM-PLUS, the Tonga Energy Efficiency Master Plan (TEEMP), and Tonga Technology Needs Assessment outline various proof of concepts and technologies for achieving mitigating target in the energy sector.

Tonga's NDC Implementation Roadmap and Investment Plan with Project Pipeline has been aligned to the shorter-term and medium terms actions for AFOLU, waste, and marine identified in Tonga's LEDS work[40].

The NDC Implementation Roadmap and Investment Plan with Project Pipeline has also been developed in close collaboration with stakeholders in Tonga. This collaboration has helped to build consensus, ensure the plans were feasible, and provided momentum for implementation. Consultation can be grouped into four phases:

- **Phase one** involved three main parts: an initial project inception meeting with Tonga's Department of Climate Change (DCC), the NDC Hub, and the management consulting company Castalia; virtual meetings with sector experts[41]; and an Inception Workshop, during which participants from various ministries and other relevant institutions convened to discuss opportunities in each priority sector. This consultation phase informed the draft NDC Implementation Roadmap and Investment Plan with Project Pipeline.
- **Phase two** involved two main parts: comments from DCC and GGGI on the draft NDC Implementation Roadmap and Investment Plan with Project Pipeline, and discussion of the contents of this draft document. Feedback was received in written format as well as verbally during the workshop.
- **Phase three** involved a Validation Workshop, during which stakeholders in Tonga provided final feedback on the updated NDC Implementation Roadmap and Investment Plan with Project Pipeline.
- **Phase four** involved engagement with relevant ministries and institutions to gather additional information about national circumstances, sector context, and projects in the project pipeline.

[40] Tonga's LEDS 2021-2050 can be found here: https://unfccc.int/sites/default/files/resource/TON_LTS_Nov2021.pdf

[41] Sector experts were engaged by the consultants to help source information, get in touch with companies or other stakeholders in the sector, fact-check, and test ideas informally.

2 National circumstances, including NDC targets and GHG emissions profile

This section lays out Tonga's national circumstances and outlines the existing policy framework relevant to mitigation and adaptation projects. It also details Tonga's NDC targets, highlights on progress made towards meeting these targets, and outlines Tonga's GHG emissions profile.

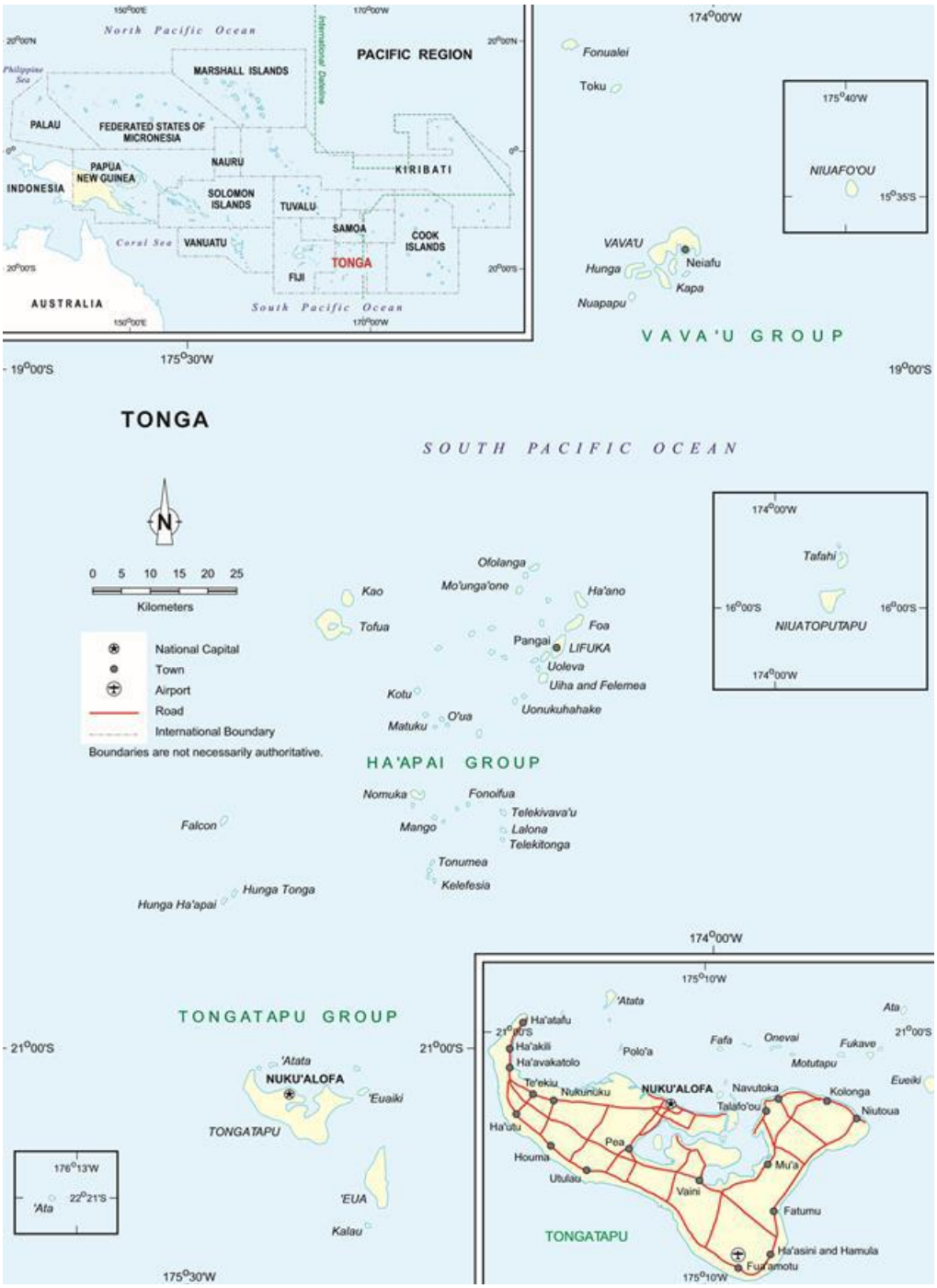
2.1 National circumstances

Geographical characteristics

Tonga is made up of four main island groups, which stretch over a total land area of 784 km^2—Tongatapu (260 km^2) and 'Eua (87 km^2), Ha'apai (109 km^2), Vava'u (121 km^2), and Niuafo'ou (15 km^2) and Niuatoputapu (71.7 km^2). The capital of Tonga, Nuku'alofa, is located on the main island of Tongatapu[42]. Figure 2.1 details a map of Tonga.

[42] Tonga's Third National Communication. Available at: https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/158047_Tonga-NC3-1-Final%20TNC%20Report_December%202019.pdf

Figure 2.1: Map of Tonga



Source: Third National Communication

Climate profile

Tonga's climate is tropical throughout the year, with two distinct seasons: the dry season (May—October) and the wet season (November—April). The northern islands of Tonga receive more rainfall than the southern islands. The driest month is July, and the wettest month is March. Over the dry season, rainfall averages 123.2 millimetres (mm), and

temperatures average between 18.5°C and 26.4°C[43]. Over the wet season, rainfall averages 188.3 mm, and temperatures average between 23°C to 29°C[44]. Southeast trade winds dominate Tonga, but winds are light to moderate, with an average wind speed of 7 to 9 kilometres per hour (km/hr). Tropical cyclones can occur in the wet season and are becoming more intense than those in historical records[45]. The El Niño-Southern Oscillation (ENSO) also plays a significant role in Tonga's climatic patterns[46].

Tonga is experiencing the impacts of climate change. For example, water temperatures and sea levels have increased by 0.0004°C and 7.3 mm per year, respectively, since 1993[47]. Tonga is also experiencing more frequent extreme weather events, and changing patterns of rainfall and drought[48]. Future impacts of climate change on Tonga include increased rainfall in the wet season and decreased rainfall in the dry season, increased ocean acidification, coastal erosion, and sea-level rise[49]. Tonga is vulnerable to the impacts of climate change. 80% of Tongatapu's infrastructure and population live and work in low-lying coastal areas[50]. The success of the country's primary industries—agriculture and fishing—are susceptible to environmental changes[51].

Environmental resources

Natural resources are the primary source of living for the people of Tonga. Forest area covers 12.5% of Tonga, while 43.1% and 44.4% is covered by agricultural land and settlement areas, respectively. Captured rainwater and underground aquifers are the main sources of water resources in Tonga. Demands for water in Tonga are high, however warmer temperatures and human activities are impacting the quality and quantity of Tonga's water[52].

Population profile

Tonga's total population is 100,651 as of 2016[53]. Tonga's population decreased by 2.5% between 2011 and 2016[54], predominantly due to emigration[55], Tongatapu is the most populated island, home to 74% of the population, followed by Vavaʻu, Haʻapai, ʻEua,

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43 Tonga's Third National Communication.

44 Tonga's Third National Communication.

45 Tonga's Third National Communication.

46 Tonga's Third National Communication.

47 Tonga's Third National Communication.

48 Tonga's Third National Communication.

49 Tonga's Third National Communication.

50 https://www.sciencedirect.com/science/article/pii/S2590061719300171

51 Agriculture contributes 20% of Gross Domestic Product (GDP), while fishing contributes approximately 5%. Agriculture: https://www.adb.org/sites/default/files/linked-documents/46351-002-ea.pdf; Fisheries: https://www.adb.org/sites/default/files/publication/27511/pacific-fisheries.pdf

52 Tonga's Third National Communication.

53 https://tongastats.gov.to/statistics/population-statistics/ The World Bank estimates Tonga's population as of 2020 is 105,697—https://data.worldbank.org/indicator/SP.POP.TOTL?locations=TO

54 https://tongastats.gov.to/statistics/population-statistics/

55 Tonga's Third National Communication.

Niuatoputapu, and Niuafoʻou[56]. Approximately 23% of Tonga's population live in urban areas[57]. The average population density varies across the islands—the average across Tonga is 155 people per km^2, however, population density is 286 people per km^2 in Tongatapu and 17 people per km^2 in Niuatoputapu and Niuafoʻou[58]. Tonga has a relatively young population, with a median age of 22 years. More than one-third of the population is aged 15 years and younger, while only 9% are 60 years and older[59].

Socio-economic background

Tonga has an estimated real GDP of US$455 million and a per capita GDP of US$4,354 as at 2019[60]. Tonga's GDP is made up of services (including tourism and personal remittances) (60%), agriculture (20%) and industry (20%)[61].

The COVID-19 pandemic has had a considerable impact on Tonga's socio-economic environment. The growth of the services sector was estimated to drop by 5.2% in the fiscal year 2019/20, largely due to the impact of the pandemic on tourism[62]. In addition, Tonga's unemployment rate has risen from 1.1% in 2019[63], to 4.4% in 2020[64]. Approximately 22% of the population lived below the poverty line in 2015[65]; however, this number is expected to increase. Tonga's Human Development Index (HDI) in 2020 was 0.725, which puts Tonga in the high human development category (rank 104 out of 189 countries and territories)[66].

2.2 Existing sectoral strategies, plans, policies, and laws relevant to mitigation and adaptation projects

There are a number of national and sectoral strategies, plans, policies, and laws that are relevant to climate change mitigation and adaptation efforts in Tonga, and which provide valuable context for and input to the NDC Implementation Roadmap and Investment Plan with Project Pipeline. Key documents are detailed in Table 2.1.

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56 Tonga's Third National Communication.

57 https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=TO

58 Tonga's Second NDC.

59 Tonga's Second NDC.

60 GDP (constant 2010 US$)—https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?locations=TO; GDP per capita (constant 2010 US$)—https://data.worldbank.org/indicator/NY.GDP.PCAP.KD?locations=TO

61 https://www.adb.org/sites/default/files/linked-documents/46351-002-ea.pdf

62 http://www.reservebank.to/data/documents/Publications/AnnualReports/NRBT%20AR%20201920%20-%20ENG.pdf

63 Asian Development Bank 2019, in Tonga's Second NDC.

64 https://www.adb.org/offices/south-pacific/poverty/tonga

65 https://www.adb.org/offices/south-pacific/poverty/tonga

66 http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/TON.pdf

Table 2.1: Key documents to mitigation and adaptation projects

Document title	Description	Relevant for priority sector
	Acts	
Agricultural Commodities Export Act 2002 (revised 2020)	Regulates the export of agricultural commodities from Tonga.	AFOLU
Climate Change Fund Act (2021)	Established a climate change fund for Tonga, through which Tonga could receive funding and financing from national and international sources to finance national climate change mitigation and adaptation projects. The Fund is supported by the Tonga Climate Change Fund Operational Manual.	AFOLU Waste Marine Energy
Tonga Energy Act 2022 (forthcoming)	Sets up the key governance structures to formalize the functions of Department of Energy and will authorize establishment of an Energy Commission to regulate petroleum, electricity, and renewable energy. It will repeal three existing Acts- Petroleum Act, Electricity and Renewable Energy Act	Energy
Public Enterprise Act 2002	Details the incorporation of all public enterprises under the Ministry of Enterprises, including Ports Authority Tonga and Tonga Airports Limited	Energy Waste Marine
Traffic Act 2020	Provides legislative provision regarding registration of vehicle, control of vehicles through permits, provision relating to use and user of vehicles and special provisions relating to transport undertakings like traffic regulation, insurance, liability, offences, and penalties, etc.	Energy
Environmental Impact Assessment Act 2016 (revised 2020)	Requires reporting for all major project proposals for an Environmental Impact Assessment (EIA).	AFOLU Waste Marine Energy
Environmental Management Act 2016 (revised 2020)	Coordinates the role of GoT in environmental management, including reporting on climate change issues and decision-making processes.	AFOLU Waste Marine Energy
Fisheries Management Act 2016 (revised 2020)	Involves the long-term conservation and sustainable use of the fisheries to protect Tonga's ecosystem and minimise pollution and waste.	Marine
Forests Act 1961 (revised 2020)	Provides for the setting aside of areas as forest areas or reserved areas and the control and regulation of such areas.	AFOLU
Land Act (1882) (revised 2020)	Stipulates that all land is the property of the crown and that it may be allocated or leased to hereditary nobles (chiefs), or allocated as 3-5 ha tax allotments to Tongan males upon reaching the age of 16.	AFOLU Marine Waste

Document title	Description	Relevant for priority sector
National Spatial Planning Act (2012) (revised 2020)	This act provides a framework for planning the use, development, management, and protection of land in Tonga in the public interest and for related purposes. Oceans 7 was established in 2015 as Tonga's marine spatial planning technical working group.	AFOLU Marine Waste Energy
Parks and Reserves Act 1988 (revised 2020)	Provided for the establishment of a parks and reserves authority, and for the establishments, preservation, and administration of parks and reserves.	Marine
Sandalwood Regulation 2016	These regulations aim to ensure the sustainable management of the sandalwood resource in Tonga and promote the planting of sandalwood to sustainably increase the size and value of the resource.	AFOLU
The Constitution of Tonga 1875 (revised in 2016)	The supreme law under which GoT operates.	AFOLU Waste Marine Energy
Waste Management Act 2005 (revised 2020)	Provides for the collection and disposal of solid waste and the management of all wastes in Tonga.	Waste
Tonga Statistics Act 2015	This act stipulates that TSD may collect from Tongan people, businesses, and other organisations information relating to their activities and economic and social situation. This information is allowed to be compiled, analysed, and published as official statistics relating to the condition of Tonga's commerce, people, communities, and the environment, as well as the activities, performance, and impact of the GOT.	AFOLU Waste Marine
Policies		
Tonga Strategic Development Framework 2015-2025 (TSDFII)	TSDFII present Tonga's national outcomes and organisational outcomes, setting out the high-level vision of the director that Tonga seeks to pursue over the ten-year period. It builds on Tonga Strategic Development Framework 2011-2014 (TSDF).	AFOLU Waste Marine Energy
National Forest Policy 2009	The objective of the policy is to support the sustainable management of the Tonga's forests and tree resources.	AFOLU
Tonga Climate Change Policy 2016	The policy established a framework for climate action and a policy goal for a 'resilient Tonga' by 2035. It also provides a clear vision, goal, and objectives to direct responses to climate change and disaster risk reduction. The policy is being revised in 2021.	AFOLU Waste Marine Energy
Plans, strategies, and frameworks		

Document title	Description	Relevant for priority sector
Gender Mainstreaming Handbook 2019	This handbook serves as an instructional tool to accompany gender mainstreaming training that targets gender focal points (GFPs), a reference document with guidance to help ensure the concerns of all males and females are included in policy, project and programme planning, implementation, and monitoring and evaluation.	AFOLU Waste Marine Energy
Joint National Action Plan 2 on Climate Change and Disaster Risk Management 2018-2028 (JNAP 2)	JNAP 2 is Tonga's strategic action plan for climate change and disaster risk management initiatives until 2028. Its overarching goal is to 'develop a resilient Tonga through an inclusive, participatory approach that is based on good governance, builds knowledgeable, proactive communities, and supports a strong, sustainable development pathway.'	AFOLU Waste Marine Energy
Tonga Low Emission Development Strategy (LEDS) 2021-2050	Tonga's LEDS details long-term, low GHG emissions actions and targets for each sector. The strategy details how sectors can work together to create resilience, autonomy, and self-reliance.	AFOLU Waste Marine Energy
MAFF Corporate Plan and Budget 2020/21–2022/23	This plan provides the framework to develop the agriculture sector in Tonga.	AFOLU
Management Plan for Forests and Tree Resources of Tonga 2017	The Plan prescribes the actions that will be taken to enhance the sustainable management of Tonga's forests and tree resources.	AFOLU
National Biodiversity Strategy and Action Framework 2018-2025 (NBSAF)	NBSAF covers eight thematic areas with planned strategies and actions for the conservation of biodiversity and its sustainable use.	AFOLU Marine
National Biodiversity Strategy and Action Plan 2030 (NASAP)	NASAP (currently in development) is a guide to capture the state of Tonga's biological resources and materialise actions to restore the environment, reduce degradation, promote sustainable development, and establish regional and global partnerships to fulfil Tonga's obligations under the Convention of Biological Diversity (CBD).	AFOLU Marine
National Women's Empowerment and Gender Equality Tonga Policy and Strategic Plan of Action 2019-2025 (WEGET)	WEGET is the mechanism for achieving National Outcome 3 in TSDFII, 'a more inclusive, sustainable and empowering human development with gender equality' and 'ensuring a more balanced and effective engagement by both men and women in decision-making and social, economic, and political institutions'. WEGET is supported by the Gender Mainstreaming Handbook 2019, which serves as an instructional tool to help ensure the concerns of all males and females are included in policy, project and programme planning, implementation, and monitoring and evaluation.	AFOLU Waste Marine Energy
Strategic Development Goals (SDGs)	Aligned with TSDFII, Tonga's SDGs highlights the country's national development agenda. The Voluntary National Review of SDGs 2019 provides information on key issues and selected priority programmes, and an update on Tonga's priorities.	AFOLU Waste Marine Energy

Document title	Description	Relevant for priority sector
Tonga Agriculture Sector Plan 2016-2020 (TASP)	The plan identifies Tonga's vision and priorities for maximizing contributions from the agriculture sector to Tonga's economic growth and to sustained food security.	AFOLU
Tonga Energy Road Map 2021-2035 (TERM-PLUS) Framework	TERM-PLUS Framework aims to guide efforts to develop the Tonga Energy Road Map 2021-2035 (TERM-PLUS 2021-2035). Once published, the TERM-PLUS will carry on the work of the TERM 2010-2020, while expanding implementation from the electricity sector to include transport, and integrating aspects of climate resilience and gender inclusion.	AFOLU Waste Energy
Tonga National Strategy for the Development of Statistics 2019-2023 (NSDS)	NDSD seeks to enable the building of a reliable statistical system that produces data necessary to design, implement, and monitor national development policies and programmes.	AFOLU Waste Marine
Tonga National Infrastructure and Investment Plan (NIIP)	NIIP outlines GoT's priorities and plans for major initiatives in economic infrastructure, including for energy, telecommunications, water, solid waste management, and transport.	Waste
SDG 7 Roadmap	Goal 7 Roadmap is intended to help Tonga achieve its SDG and NDC targets by providing a matrix of technological options and enabling policy measures. It recommends technology solutions and policy options for reducing emissions, saving energy, lowering costs, and improving energy access for all.	Energy
Other reports		
Sixth National Report to the Convention on Biological Diversity 2020	This report presents Tonga's progress towards its national targets and serves as a national benchmark for more urgent, effective, and scaled up action in the future.	AFOLU Marine
Special Management Area Report 2020	This report provides details on the current ecological status and impacts of Tonga's Special Management Area (SMA) program and an overview of the program on a national scale, including impact assessments of each SMA community. This report aims to help improve the future conditions of coast resources in Tonga.	Marine
State of Environment Report 2018 (SOE)	SOE discusses the key responses adopted by GoT and the private sector to sustainably manage the environment and reduce the negative impacts on seven thematic areas, and provides key recommendations to be carried out by government agencies to improve the status of the environment.	AFOLU Waste Marine

Document title	Description	Relevant for priority sector
Third National Communication (TNC) 2019	A national communication is a report that each Party to the UNFCCC prepares periodically according to the guidelines developed and adopted by the Conference of the Parties (COP), in accordance with its Convention. The TNC contains six thematic components including: national circumstances and institutional arrangements; national greenhouse gas inventory; programmes containing measures to facilitate adequate vulnerability assessment and adaptation to climate change; programmes containing measures to mitigate climate change; other information; and constraints and gaps, and related financial, technical, and capacity-building needs.	AFOLU Waste Marine Energy
Tonga NDC Review Report 2020	This report reviewed Tonga's Intended Nationally Determined Contribution (INDC) (2015) and provided recommendations for Tonga's Second NDC (2020).	AFOLU Waste Marine
Tonga's Second NDC 2020	Tonga's Second NDC outlines the mitigation and adaptation targets, as part of the terms under the Paris Agreement. The targets in Tonga's Second NDC are outlined in section 2.4.	AFOLU Waste Marine
Tonga's Progress on the Sustainable Development Goals 2020	This report provides an overview of Tonga's implementation efforts, highlighting areas of progress and areas where more action needs to be taken to ensure no one is left behind, in regard to the SDGs. It is planned to be annually updated.	AFOLU Waste Marine Energy

2.3 GHG emissions profile

Tonga's most recent national inventory of GHG emissions was reported in Tonga's TNC (2020) and monitored GHG emissions in the years 2000 to 2006[67]. GoT is seeking to update the inventory in Tonga's 4NC and initial Biennial Update Report (BUR 1); however, the baseline year has not yet been determined[68].

Table 2.2 summarizes GHG emissions by sector in 2006. The AFOLU sector was the largest source of GHG emissions, followed by energy. The waste sector emitted a comparatively small amount of GHGs.

[67] GHG emissions data published in Tonga's Third National Communication (TNC) are used throughout this report (rather than the GHG emissions data published in Tonga's INDC), unless stated otherwise. According to the Tonga Nationally Determined Contributions Review Report, GHG emissions data published as part of the TNC are more accurate.

[68] Communication with DCC.

Table 2.2: Summary of Tonga's GHG emissions by sector (2006)

Sector	GHG emissions (Gg CO_2e)	Percent of total GHG emissions (%)
AFOLU[69]	189.2	61%
Energy	120.4	39%
Waste	0.9	0.3%
Total GHG emissions	**310.4**	**100%**

Source: Tonga's Third National Communication to the UNFCCC
Note: Tonga states that the accuracy of AFOLU sector GHG emissions is limited because of uncertainty around the data and a lack of information on the assumptions and methodologies used to calculate GHG emissions and carbon sequestration from living biomass
Note: GHG emissions are rounded to 1 decimal place

Table 2.3 lists the top three sub-sector sources of GHG emissions in 2006. Forest and grassland conversion of biomass emitted the most GHGs, accounting for 60% of total GHG emissions.

Table 2.3: Top three sources of GHG emissions in Tonga (2006)

Source	GHG emissions (Gg CO_2e)	Percent of total GHG emissions
Land use, land use change, and forestry (LULUCF (specifically forest and grassland conversion of biomass))[70]	187.4	60%
Road transportation	72.3	23%
Energy industries and energy transformation	40.3	13%
Total	**300.0**	**96%**

Source: Tonga's Third National Communication to the UNFCCC
Note: GHG emissions are rounded to 1 decimal place

[69] GHG emissions from the AFOLU sector can be broken down into:

- Land Use, Land-Use Change and Forestry (LULUCF): 187.4 Gg (60%); and Agriculture: 1.8 Gg (0.6%).

GHG emissions for LULUCF and agriculture are reported separately in Tonga's Third National Communicate (including inventory), however were combined under AFOLU in Tonga's Second NDC.

[70] GHG emissions in the LULUCF sector are made up of three sub-sectors:

- Changes in forest and other woody biomass
- Forest and grassland conversation of biomass
- Abandonment of managed lands.

According to Tonga's TNC, 'changes in forest and other woody biomass' and 'abandonment of managed lands' remove CO_2, meaning that forest and grassland conversation of biomass is responsible for 187.4 Gg (60%) of GHG emissions.

2.4 Second NDC targets

Tonga's Second NDC includes both mitigation and adaptation targets. The mitigation targets focus on reducing GHG emissions in the energy sector. The Second NDC also includes non-GHG emissions targets for the AFOLU[71] and waste sectors[72]. Adaptation targets focus on coping with the impacts of higher temperatures and sea levels in the AFOLU and marine sectors[73]. These mitigation and adaptation targets are conditional on financing, capacity building, and technology investment from external sources. Figure 2.2 provides an overview of the targets in Tonga's Second NDC.

[71] GHG emissions from the AFOLU sector are broken down into:

Land Use, Land-Use Change and Forestry (LULUCF), and

Agriculture.

GHG emissions for LULUCF and agriculture are reported separately in Tonga's Third National Communicate (including GHG inventory), however are combined under AFOLU in Tonga's Second NDC.

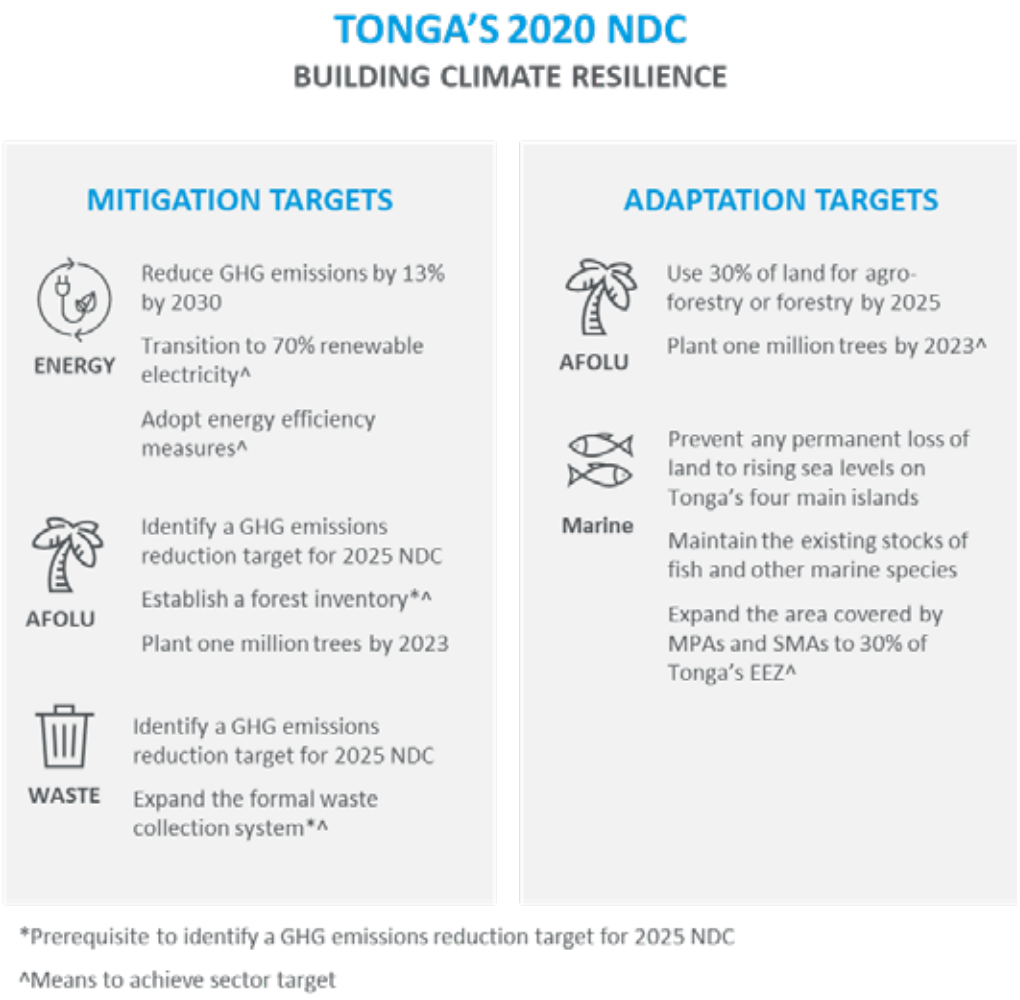
[72] Tonga's Second NDC does not include a target for the Industrial processes and product use (IPPU) sector. The document states this is because GHG emissions from IPPU make up a small amount of Tonga's total GHG emissions and because there is a lack of data on GHG emissions from the sector, which makes it challenging to set a verifiable target.

[73] The marine sector includes:

- Marine protected areas (MPAs) are labelled as 'parks' or 'reserves' designated under the Parks and Reserves Act 1979 (Rev. 1988) and are exclusively 'no-take zones'. They are areas of marine protection that are remote from communities, where community management is not possible and are exclusively managed by government
- Special management areas (SMAs) are areas of marine protection that are located near island communities where they can be locally managed under government supervision
- Sustainable community-led non-fed marine aquaculture (mariculture).

MPAs are managed under the Department of Environment and SMAs are managed under the Ministry of Fisheries.

Figure 2.2: Targets of Tonga's Second NDC



Understanding how the targets in Tonga's Second NDC align with the targets and objectives of other national documents is key to ensuring synergies between different areas of government policy. Table 2.4 provides more details of the targets of Tonga's Second NDC and maps them against targets and objectives in Tonga's key national documents[74].

[74] Key national documents reviewed to develop the NDC Implementation Roadmap and Investment Plan with Project Pipeline are detailed in section 2.2

Table 2.4: Targets of Tonga's Second NDC

Sector	Second NDC target or means to achieve target	Title of national document	National document target and means
		Mitigation targets	
Energy	Reduce greenhouse gas (GHG) GHG emissions by 13% (16 Gg) by 2030 compared to 2006	JNAP 1	Reduce GHG emissions by 10% by 2015 compared to 2000 levels through implementing renewable energy and energy efficiency programmes
	Generate 70% of electricity from renewable sources by 2030 through a combination of solar, wind and battery storage	TERM-PLUS Framework	Generate 70% of electricity from renewable sources by 2030
		National Energy Policy	Generate 70% of electricity from renewable sources by 2030, and 100% by 2035
		JNAP 2	Generate 100% of electricity from renewable sources by 2035
		Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as through promoting the use of renewable energy resources
		Tonga Climate Change Policy 2016	Generate 100% of electricity from renewable sources
		Tonga LEDS 2021-2050	Energy Action 1: Implement Standards and Regulations for renewable and energy efficient technologies imported into the country Energy Action 2: Draft regulation and policy paper for infrastructure developed using green infrastructure standards Energy Action 5: Increase access to finance for the private sector to fund demand-side renewable energy, projects, and green initiatives Energy Action 6: Increase access to finance for the private sector to fund supply-side renewable energy, projects, and green infrastructure

Sector	Second NDC target or means to achieve target	Title of national document	National document target and means
			Energy Action 7: Technologies like battery storage to upgrade, maintain and operate a renewable energy network
	Improve the efficiency of newly purchased light-duty vehicles by 2% per year through mandatory vehicle standards and/or incentives such as tax, fees, import tariffs	TERM-PLUS Framework	Limit the growth in oil consumption to 1% per year (based on a 3.1% business as usual) for the period 2021 to 2035 within the transport sector, through: 3% energy efficiency gain of cars and light-duty vehicles per year 8% replacement rate of cars and light-duty vehicles per year Reduce total diesel imports in 2035 by 10% compared to 2015 through mandatory vehicle standards and/or incentives through tax, fees, import tariffs, as well as by displacing diesel with electricity generated by renewable sources
		Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as through "cleaner" vehicles Enact and enforce regulations to prohibit human activities that are detrimental to the environment, such as "below par" vehicles
		Tonga LEDS 2021-2050	Transport Action 2: Mandatory vehicle standards and incentives for more efficient vehicles through tax, fees and import tariffs Transport Action 5: Low emissions vehicles Transport Action 6: Introducing electric vehicles (EVs) in the municipal government fleet Transport Action 6: Public adoption of 50% EVs
	Limit growth in grid-connected residential electricity end-use to 1% per year on average for the period 2021 to 2030 by adopting minimum energy	TERM-PLUS Framework	Limit growth in grid-connected residential electricity end-use to an annual average growth of 1% between 2021-2035 through:

Sector	Second NDC target or means to achieve target	Title of national document	National document target and means
	performance standards for appliances, lighting, and electricity equipment		Replacing 6% of appliances with energy-efficient appliances per year, supported by implementing the minimum energy performance standards labelling (MEPSL) regulation for electrical appliances Improving the energy efficiency of buildings by 2.5% per year, supported by an awareness programme to change people's energy behaviours and upgrading Tonga's building code with energy-efficient designs
		Tonga LEDS 2021-2050	Energy Action 1: Implement Standards and Regulations for renewable and energy efficient technologies imported into the country Energy Action 2: Draft regulation and policy paper for infrastructure developed using green infrastructure standards Energy Action 4: Draft regulation and policy paper to support roll out of light emitting diode (LED) streetlamps and interior LED lamps Energy Action 8: Government to provide a loan program to private sector for low energy buildings
Waste	Identify a GHG emission target for the 2025 NDC	Tonga Climate Change Policy 2006	Identify and measure levels of GHG emissions in the waste sector
		Tonga LEDS 2021-2050	Waste Action 2: More efficient data collection and consistent update of the database
	Expand the formal waste collection system, including collecting relevant data on waste amounts and waste composition	Tonga Strategic Development Framework 2 2015-2025	Cleaner environments and less pollution from household and business activities as a result of better waste management
		Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as through reducing waste generation and combustion

Sector	Second NDC target or means to achieve target	Title of national document	National document target and means
			Enact and enforce regulations to prohibit human activities, such as burning solid waste, that are detrimental to the environment Improve and strengthen the collection, storage, management, analysis, and use of data, including GHG emissions data
		Tonga Climate Change Policy 2016	Develop and implement a "zero waste" policy
		Tonga LEDS 2021-2050	Waste Action 1: Establish strong waste strategy and integrate the strategy into community development plans Waste Action 2: More efficient data collection and consistent update of the database Waste Action 3: Secure financing for outer island waste processing Waste Action 4: Developing/upgrading waste management facilities Waste action 7: Increased use of local and recycled construction materials Waste Action 8: Biogas generators to fuel villages; purchase best equipment and technology for waste sector; create waste disposal bins at village level Transport Action 1: Improved transport data collection and waste management
AFOLU	Identify a GHG emission target for the 2025 NDC	Tonga Climate Change Policy 2006	Identify and measure GHG emissions in the agricultural and forestry sectors
		Tonga LEDS 2021-2050	AFOLU Action 2: Improve coordination of public and private sectors to strengthen and harmonise existing data collections for improved data monitoring and information management

Sector	Second NDC target or means to achieve target	Title of national document	National document target and means
	Establish a forest inventory	Tonga Climate Change Policy 2006	Improve and strengthen the collection, storage, management, analysis, and use of data, including GHG emissions data
		NBSAF	By 2020, implement the national inventory on forest ecosystem By 2020, improve the GIS system to improve monitoring of land use and land cover changes
		Tonga LEDS 2021-2050	AFOLU Action 2: Improve coordination of public and private sectors to strengthen and harmonise existing data collections for improved data monitoring and information management
	Plant one million trees by 2023	Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as encouraging tree planting Enact and enforce regulations to prohibit human activities, such as deforestation, that are detrimental to the environment
		Tonga Climate Change Fund	Tonga's Climate Change Fund is eligible for activities that involve eco-system resilience, such as forest protection
		NBSAF	Reforest all deforested areas on public and private lands
		Tonga LEDS 2021-2050	AFOLU Action 1: Strengthen public private partnership to drive requirements of organisations with the aim of sharing responsibility to promote best practices in agriculture and forestry AFOLU Action 3: Support community nurseries to improve the productivity and diversity of agroforestry AFOLU Action 6: Empower women to sustain and enhance home gardening through commercialising their produce
		Adaptation targets	
AFOLU		Tonga Climate Change Policy 2016	Use 30% of land in Tonga for agro-forestry or forestry

Sector	Second NDC target or means to achieve target	Title of national document	National document target and means
	Use 30% of land in Tonga for agro-forestry or forestry by 2025	JNAP 2	Use 30% of land in Tonga for agro-forestry or forestry
		Tonga LEDS 2021-2050	AFOLU Action 1: Strengthen public private partnership to drive requirements of organisations with the aim of sharing responsibility to promote best practices in agriculture and forestry AFOLU Action 3: Support community nurseries to improve the productivity and diversity of agroforestry AFOLU Action 6: Empower women to sustain and enhance home gardening through commercialising their produce
	Plant one million trees by 2023[75]	Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as encouraging tree planting Enact and enforce regulations to prohibit human activities, such as deforestation, that are detrimental to the environment
		Tonga Climate Change Fund	Tonga's Climate Change Fund is eligible for activities that involve eco-system resilience, such as forest protection
		NBSAF	Reforest all deforested areas on public and private lands
		Tonga LEDS 2021-2050	AFOLU Action 1: Strengthen public private partnership to drive requirements of organisations with the aim of sharing responsibility to promote best practices in agriculture and forestry AFOLU Action 3: Support community nurseries to improve the productivity and diversity of agroforestry Human Settlements Action 9: Strengthen and refine current policy on coastal protection in order to strengthen Marine Protected Areas

[75] This is also a mitigation target (and project) in the AFOLU sector.

Sector	Second NDC target or means to achieve target	Title of national document	National document target and means
Marine	Prevent any permanent loss of land to rising sea levels on Tonga's four main islands (Tongatapu, Ha'apai, Vava'u, and 'Eua)	JNAP 2	Resilient coastal development, infrastructure, and integrated coast ecosystems management
		State of the Environment Report 2018 (SOE)	By 2020, the rate of loss of all-natural habitats, including forests, is at least halved and, where feasible, brought close to zero
		Tonga LEDS 2021-2050	Human Settlements Action 9: Strengthen and refine current policy on coastal protection in order to strengthen Marine Protected Areas
	Maintain the existing stocks of fish and other marine species	JNAP 2	Resilient fisheries and marine and coastal ecosystems
		JNAP 1	Improve fisheries and coral reef management in view of climate change
		SOE	By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably
		Tonga Climate Change Policy 2016	Native biodiversity is fully protected and enhanced
		NBSAF	By 2020, 60% of coastal marine ecosystems are monitored, and the status of depletion is identified By 2020, 100% of coastal terrestrial ecosystems such as mangroves are monitored, and changes over time are identified
		Tonga LEDS 2021-2050	AFOLU Action 5: Establish SMA association and ensure its maintenance through financial support and capacity, in order to support the expansion of MPAs and SMAs
		SOE	By 2020, at least 17% of terrestrial and inland water, and 10% of coastal and marine areas, are conserved
		Tonga Climate Change Policy 2016	Every coastal community has SMAs and protected coastal environment

Sector	Second NDC target or means to achieve target	Title of national document	National document target and means
	Expand MPAs[76] and SMAs[77] to 30% of Tonga's EEZ	Tonga Climate Change Fund	Tonga's Climate Change Fund is eligible for activities that involve eco-system resilience, such as reef protection and mangrove and coastal planning
		NBSAF	Expand the existing network of protected areas to effectively conserve major coastal and marine habitats of biological and socio-economic value by: Increasing total area of marine ecosystem under conservation management by 50% in 10 years Ensuring 30% of SMAs and MPAs are established and implemented by 2030
		Tonga LEDS 2021-2050	AFOLU Action 5: Establish SMA association and ensure its maintenance through financial support and capacity, in order to support the expansion of MPAs and SMAs Human Settlements Action 9: Strengthen and refine current policy on coastal protection in order to strengthen Marine Protected Areas

[76] Marine Protected Areas (MPAs) are areas of marine protected that are managed exclusively by GoT. MPAs can be used as a marine resource management tool that assists with the maintenance of the existing stocks of fish and other marine species. MPAs labelled as 'parks' or 'reserves' and are exclusively 'no-take zones'.

[77] Special Management Areas (SMAs) are areas of marine protection that are located near island communities and are managed by the community under the government supervision of the Ministry of Fisheries. The priorities of SMAs are to improve fish catch, improve livelihoods, increase fish abundance, and decrease environmental degradation. SMAs are divided into two parts: SMA, in which only registered members of that community are allowed to fish, and Fish Habitat Reserve (FHR), which is a permanent no-fishing zone within each SMA.

3 Institutional context

This section provides a general overview of the key institutions in Tonga that are likely to play a part in implementing the country's Second NDC. It also notes capacity constraints and institutional barriers that will need to be navigated in order to achieve Tonga's Second NDC targets.

Table 3.1 details the government line ministries and state-owned enterprises and their capacity for NDC implementation (in terms of the number of full-time staff equivalent (FTE) available to help implement and manage NDC projects)[78]. This information was gathered through consultations with, and a survey completed by, participants at the Consultation Workshop held on 26 August 2021.

Possible NDC implementing institutions in Tonga have at least some capacity to implement and manage climate change mitigation and adaptation projects. However, each institution faces barriers to NDC implementation. Overarching institutional barriers to NDC implementation include:

- Insufficient budget to fund and manage projects
- Lack of staff to implement and manage projects
- Limited experience in implementing and managing large investment projects
- Minimal experience managing environmental and social safeguards (ESS) (for example, noise during project construction, correct waste disposal, or impact on social well-being)
- Challenges coordinating with other ministries, organizations, or stakeholders (for example due to challenges with flow of information, institutional arrangements, and mandates)
- Limited engagement of communities with Government program activities.

[78] FTE is a metric used to understand how many resources an institution has. An employee is assigned an FTE value between 0 and 1 depending on the proportion of full-time hours worked. For example, an employee working full-time equals 1 FTE while an employee working 60% of full-time hours equals 0.6 of an FTE.

To calculate the number of FTE in key institutions in Tonga stakeholders were asked to detail how many staff members each institution has available to help climate change mitigation and adaptation projects, and how much of time (in hours) each available staff member has to help climate change mitigation and adaptation projects per week. These two figures were multiplied and then divided by 40 (indicating a 40-hour week).

Table 3.1: Key institutions and their capacity for NDC implementation[79]

Institution	Roles and relationship to NDC implementation and management	Number of FTE available for NDC implementation[80]
Ministry of Finance (MoF)	MoF provides high-quality and timely economic and financial policy advice to GoT and delivers high-quality and cost-effective public services. MoF includes the Aid Management Division and the Climate Change, Disaster Risk Financing and Resilient Development Unit, which are key entities for NDC implementation and management. The MoF will also soon become a GCF accredited entity, and it has an established Project Management Unit.	0.5
Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate change and Communications (MEIDECC)	MEIDECC is the ministry responsible for climate change mitigation and adaptation in Tonga. Its Department of Climate Change is coordinating the development of this NDC Implementation Roadmap and Investment Plan with Project Pipeline. MEIDECC is also Tonga's National Designated Authority under the Green Climate Fund (GCF), and is currently managing five AFOLU-related climate change projects and proposals to the CGF.	3.5[81]
Department of Climate Change (DCC) (MEIDECC)	DCC (within MEIDECC) aims to put effective systems in place for climate change mitigation, adaptation, and resilience. DCC is responsible for Tonga's obligations under the UNFCCC. Seven divisions have been established in the Department: climate finance, policy and planning, vulnerability and adaptation, mitigation, ozone layer protection, information and communication, and outer islands.	1.1[82]

[79] Institutions included in this table are those that are likely to play key implementing roles for NDC projects or will be required coordinate significant with the implementing institution (rather than all institutions that could support NDC project implementation.

[80] Number of FTE is based on the number of staff available to manage and implement climate change mitigation and adaptation projects and the amount of time (in hours) available by each available staff member to manage and implement climate change mitigation and adaptation projects per week.

[81] Combination of staff available from both DCC, Department of Environment, and Department of Energy

[82] Feedback from the Consultation Workshop survey included that the Mitigation Division of DCC requires more staff, or support from other ministries or international support, to support NDC projects.

Institution	Roles and relationship to NDC implementation and management	Number of FTE available for NDC implementation[80]
Department of Environment (MEIDECC)	The Department of Environment's mandate is to promote the conservation of biological diversity, sustainable use, and management of natural resources, and maintaining ecosystem services.	1.1
Department of Energy (MEIDECC)	The Department of Energy (within MEIDECC) is responsible for Tonga's energy planning and development, and works hand in hand with the Tonga Energy Road Map (TERM).	1.2
Ministry for Agriculture, Food and Forests (MAFF)	MAFF advises the GoT on how to strengthen the productivity and sustainability of the agricultural sector, and how to secure social, economic, and environmental benefits from careful use of Tonga's land and water resources. MAFF also administers programmes and enforces legislation in the agriculture and forestry sectors. It also regulates the export of agricultural and forest products and the import of food and other goods to protect Tonga against imported pests and diseases. MAFF has multiple divisions, including the forestry division, the research division, the extension division, the corporate service division, the policy and planning division, the livestock division, and the food division.	2.9
Ministry of Fisheries	The Ministry of Fisheries focuses on the sustainable management of Tonga's fisheries, supports the establishment of community-based special management areas, and fosters sustainable and profitable commercial fisheries and aquaculture.	1.7
Ministry of Infrastructure (MOI)	MOI manages Tonga's public works and transport, and aims to provide effective, efficient, and affordable services and infrastructure.	0.8
Ministry of Lands and Natural Resources (MLNR)	MLNR is responsible for managing lands and mineral resources in Tonga. Its activities include the management of technical support and information services relating to geographic and geological information.	1.1
Ministry of Tourism (MOT)	MOT is responsible for Tourism development in Tonga. It aims to support the sustainability and resilience of Tonga's tourism sector, while enhancing Tonga's culture and heritage and supporting a healthy, clean environment.	0.5

Institution	Roles and relationship to NDC implementation and management	Number of FTE available for NDC implementation[80]
Prime Minister's Office (PMO)	The Prime Minister's Office includes the National Planning Division, which is a key entity for NDC implementation and management.	Not applicable[83]
Tonga Statistics Department (TSD)	TSD is the principal authority of Tonga's Official Statistics and is the national coordinator of statistical activities. TSD's role includes: Clearing any censuses and surveys that have implications at the national level and approving results before release Coordinating national data collection, analysis, and sharing between stakeholders for national, regional, and international frameworks and agendas, such as SDGs Coordinating and collaborating with NDC data providers and users in-order to collect quality data, train on data collection and analyses, and promote evidence-based decision making while minimizing unnecessary and costly data activities duplication Proving baseline data or sampling frame for sector-related surveys.	1
Tonga Power Limited (TPL)	The utility is responsible for ensuring sufficient electricity supply to meet load. As such, TPL fulfils the role of transmission and distribution system operator. TPL maintains its own generation infrastructure or can purchase electricity through contracts with other suppliers.	10
Tonga Waste Authority Ltd (TWAL)	TWAL is responsible for waste management service delivery—waste collection, landfill operations and management, waste awareness, public bin services, liquid waste management (septic tank pumping and management of septage treatment beds), recycling including removal of end-of-life vehicles and bulky waste.	1.4

[83] Not included in the survey because the Prime Minister's Office is unlikely to be an implementing agency of an NDC project.

4 Sector context

This section outlines the context for each priority sector, including the key stakeholders, the specific NDC targets, and possible constraints on NDC implementation in each sector.

4.1 AFOLU sector

Agriculture and forestry play an important part in Tonga's economy and culture

About 75% of Tonga's population lives in rural areas, and 22% of households earn their livelihoods through agriculture[84]. Most land in Tonga is used for agriculture, in traditional agroforestry systems. According to Tonga's Agriculture Sector Plan (2016-2020), Tonga has one of the highest rates of subsistence food production of any Pacific Island Country (PIC). However, gradual rural outmigration, particularly by young adults, is leading to agricultural labour shortages, which may undermine staple food self-sufficiency in the longer term[85]. The agricultural sector's contribution to Tonga's GDP has declined from 26.3% in 2004/05 to 18% in 2013/14[86 87].

According to the Tonga Forest Management Plan (2017), more than 85% of Tonga's land area is covered by trees, however much of this is in sparsely planted coconut agroforestry holdings that fall outside the Food and Agriculture Organization of the United Nation's (FAO) definition of 'forests'. Primary forest covers less than 10% of Tonga's land area, and there is only one small commercial forestry plantation of 500 hectares (ha) (3.2% of Tonga's land area) on 'Eua. The contribution of forestry to Tonga's GDP has been growing, largely driven by export of sandalwood (santalum yasi)[88]. However, the forestry sector still contributes less than 1% of Tonga's GDP[89].

In addition to these two sectoral plans, Tonga's JNAP2 identifies the implementation of climate-smart agriculture as a key priority for Tonga. The AFOLU and Fisheries sector is also included in the Tonga LEDS, which identifies the following six sector pathway actions:

- Strengthen public-private partnerships to drive requirements of organisations with the aim of sharing responsibility to promote best practices in agriculture and forestry

[84] According to Tonga's most recent census from 2006 (available at: https://catalog.ihsn.org/index.php/catalog/3202)

[85] Tonga Agriculture Sector Plan 2016 – 2020.

[86] Tonga Agriculture Sector Plan 2016 – 2020.

[87] Tonga's Long-term Low Emissions Development Strategy (LEDS) 2021-2050.

[88] According to Tonga's LEDS, the export of sandalwood is currently banned in Tonga under the Sandalwood Regulations (2016).

[89] Kingdom of Tonga's Fifth National Report to the Convention on Biological Diversity. Available at: https://www.sprep.org/attachments/VirLib/Tonga/final-submission-review-nbsap-5threport.pdf

- Improve coordination of public and private sectors to strengthen and harmonise existing data collections for improved data monitoring and information management
- Support community nurseries to improve the productivity and diversity of agroforestry
- A proposal for low emissions, low cost, high productivity and sustainable AFOLU approach to be submitted to the Green Climate Fund for the next funding cycle
- Establish SMA association and ensure its maintenance through financial support and capacity, in order to support the expansion of MPAs and SMAs[90]
- Empower women to sustain and enhance home gardening through commercialising their produce.

Links between these Sector Pathway Actions and the NDC projects included in the Project Pipeline are highlighted in each of the project concept notes.

Tonga's land resources are governed by multiple sectoral strategies and policies

MAFF is the primary agency responsible for administering agriculture and forestry-related legislation in Tonga. MAFF is guided by the MAFF Corporate Plan and Budget 2020/21-2022/23, which sets out goals for the agriculture and forestry sectors, and outlines plans for achieving them over its three-year timeline.

Activities in the agriculture sector are guided by the Tonga Agriculture Sector Plan (2016-2020). This plan notes that there are about 60 regulations and laws governing how Tonga's agricultural sector is managed, and points out that many of these are out of date and need to be reviewed and revised. The Tonga Agriculture Sector Plan (2016-2020) is due for revision, and MAFF's Corporate Plan and Budget 2020/21-2022/23 will need to be revised before the end of next year.

The forestry sector is overseen by MAFF's Forestry Division, which is responsible for seedling nurseries, extension work, and monitoring of commercial forestry operations. Activities in the forestry sector are guided by the National Forest Policy for Tonga (2009), which sets the policy direction for Tonga's forestry sector, including on climate change mitigation. Guidance is also provided by the Management Plan for Forests and Tree Resources of Tonga 2017, which outlines the actions Tonga plans to take to enhance sustainable management of forest and tree resources.

The Ministry of Land and Natural Resources (MLNR) is charged with managing land and mineral resources for the benefit of all in Tonga. MLNR manages land use, and will likely be strongly involved in NDC projects in the land sector in Tonga.

4.1.1 Key national stakeholders in the AFOLU sector

Table 4.1 details the roles of the key national stakeholders in Tonga's AFOLU sector.

[90] While this action would fit within the 'Marine sector' in this NDC implementation Roadmap and NDC Investment Plan, it was included in the AFOLU sector in Tonga's LEDS.

Table 4.1: Key national stakeholders in the AFOLU sector

Key stakeholder	Role within the sector
Ministry of Agriculture, Food and Forests (MAFF)	MAFF advises the GoT on how to strengthen the productivity and sustainability of the agricultural sector, and how to secure social, economic, and environmental benefits from careful use of Tonga's land and water resources. MAFF also administers programmes and enforces legislation in the agriculture and forestry. It also regulates the export of agricultural and forest products and the import of food and other goods to protect Tonga against imported pests and diseases. MAFFF has multiple divisions, including the forestry division, the livestock division, and the food division.
Ministry of Lands and Natural Resources (MLNR)	MLNR is responsible for managing lands and mineral resources in Tonga. Its activities include the management of technical support and information services relating to geographic and geological information.
Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate change and Communications (MEIDECC)	MEIDECC is the ministry responsible for climate change mitigation and adaptation in Tonga, and it is coordinating the development of this NDC Implementation Roadmap and Investment Plan with Project Pipeline. MEIDECC is also Tonga's National Designated Authority under the Green Climate Fund (GCF), and is currently managing five AFOLU-related climate change projects and proposals to the GCF (detailed in Appendix A).
Tonga Statistics Department (TSD)	TSD is the principal authority of Tonga's Official Statistics and is the national coordinator of statistical activities. TSD's role includes: Clearing any censuses and surveys that have implications at the national level and approving results before release Coordinating national data collection, analysis, and sharing between stakeholders for national, regional, and international frameworks and agendas, such as SDGs Coordinating and collaborating with NDC data providers and users in-order to collect quality data, train on data collection and analyses, and promote evidence-based decision making while minimizing unnecessary and costly data activities duplication Proving baseline data or sampling frame for sector-related surveys.

4.1.2 Specific Second NDC targets for the AFOLU sector

Tonga's Second NDC does not include a specific quantitative target for reducing GHG emissions from the AFOLU sector. Instead, the focus is on identifying a GHG emissions target for Tonga's Third NDC to be published in 2025. AFOLU sector targets and actions in Tonga's Second NDC are described in detail and mapped against relevant national planning documents in Table 4.2.

Table 4.2: AFOLU sector targets and actions included in Tonga's Second NDC

	Second NDC target or means to achieve target	Title of national document	National document target and means
Mitigation Targets	**Identify a GHG emission target for the 2025 NDC**	Tonga Climate Change Policy 2006	Identify and measure GHG emissions in the agricultural and forestry sectors
		Tonga LEDS 2021-2050	AFOLU Action 2: Improve coordination of public and private sectors to strengthen and harmonise existing data collections for improved data monitoring and information management
	Establish a forest inventory[91]	Tonga Climate Change Policy 2006	Improve and strengthen the collection, storage, management, analysis, and use of data, including GHG emissions data
		NBSAF	By 2020, implement the national inventory on forest ecosystem By 2020, improve the GIS system to improve monitoring of land use and land cover changes
		Tonga LEDS 2021-2050	AFOLU Action 2: Improve coordination of public and private sectors to strengthen and harmonise existing data collections for improved data monitoring and information management
	Plant one million trees by 2023[92]	Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as encouraging tree planting Enact and enforce regulations to prohibit human activities, such as deforestation, that are detrimental to the environment
		Tonga Climate Change Fund	Tonga's Climate Change Fund is eligible for activities that involve eco-system resilience, such as forest protection
		NBSAF	Reforest all deforested areas on public and private lands
		Tonga LEDS 2021-2050	AFOLU Action 1: Strengthen public private partnership to drive requirements of organisations with the aim of sharing responsibility to promote best practices in agriculture and forestry AFOLU Action 3: Support community nurseries to improve the productivity and diversity of agroforestry AFOLU Action 6: Empower women to sustain and enhance home gardening through commercialising their produce

[91] This target is a prerequisite to identifying a GHG emissions target in the AFOLU sector in Tonga's Third NDC (2025). This is indicated as the means to achieve the target 'Identify a GHG emission target for the 2025 NDC'.

[92] This is also a mitigation target in the AFOLU sector. This is indicated as the means to achieve the target 'Use 30% of land in Tonga for agro-forestry or forestry by 2025'.

	Second NDC target or means to achieve target	Title of national document	National document target and means
Adaptation Targets	**Use 30% of land in Tonga for agro-forestry or forestry by 2025**	Tonga Climate Change Policy 2016	Use 30% of land in Tonga for agro-forestry or forestry
		JNAP 2	Use 30% of land in Tonga for agro-forestry or forestry
		Tonga LEDS 2021-2050	AFOLU Action 1: Strengthen public private partnership to drive requirements of organisations with the aim of sharing responsibility to promote best practices in agriculture and forestry AFOLU Action 3: Support community nurseries to improve the productivity and diversity of agroforestry AFOLU Action 6: Empower women to sustain and enhance home gardening through commercialising their produce
	Plant one million trees by 2023	Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as encouraging tree planting Enact and enforce regulations to prohibit human activities, such as deforestation, that are detrimental to the environment
		Tonga Climate Change Fund	Tonga's Climate Change Fund is eligible for activities that involve eco-system resilience, such as forest protection
		Tonga LEDS 2021-2050	AFOLU Action 1: Strengthen public private partnership to drive requirements of organisations with the aim of sharing responsibility to promote best practices in agriculture and forestry AFOLU Action 3: Support community nurseries to improve the productivity and diversity of agroforestry Human Settlements Action 9: Strengthen and refine current policy on coastal protection in order to strengthen Marine Protected Areas

4.1.3 Constraints on NDC implementation and opportunities to strengthen the enabling environment

Four overarching constraints limit NDC implementation in the AFOLU sector. These constraints were identified during research on the AFOLU sector, research on potential mitigation opportunities, as well as by stakeholders during the Consultation Workshop (held on 26 August 2021). Specific barriers to each of the AFOLU pipeline projects are also outlined in the project concept notes in Appendix A.

Institutional and financial capacity

At present, MAFF's budget is overstretched, and the Ministry is unable to provide extension services to landowners consistent with its charter[93]. This lack of institutional and financial capacity means that NDC projects in the AFOLU sector that require funding support, such as for initial capacity building activities, will likely need to find this from external sources[93].

Landowners have access to financial services provided by the Tonga Development Bank, South Pacific Business Development[94], and the GoT's Agricultural Development Fund. While in principle landowners can also access commercial banks in Tonga, in practice the willingness of commercial banks to lend to agricultural projects is limited, in part by the legacy of the collapse of the export market for squash[93]. Background work to develop Tonga's Agricultural Sector Plan (2016-2020) concluded that supply and availability of credit are not major constraints on agricultural sector development in Tonga, however many farmers and agricultural businesses do not understand how to engage with the financial services available to them. To address this problem, the Agriculture Sector Plan allocated budget to train farmers and agricultural business owners on accessing rural finance services.

There are numerous potential international funding sources for NDC projects in the AFOLU sector in Tonga. As well as bilateral donors, Tonga could seek support from sources including:

- The International Fund for Agricultural Development (IFAD)
- The World Bank (in particular through the Global Agricultural and Food Security Program (GAFSP))
- The United Nations Development Programme (UNDP)
- The United Nations Food and Agriculture Organisation (FAO)
- The International Union for the Conservation of Nature (IUCN)
- The Pacific Community (SPC)
- The Green Climate Fund (GCF)
- The Global Environment Facility (GEF)
- The Adaptation Fund
- GIZ
- UNEP
- USAID

[93] Tonga Agriculture Sector Plan 2016-2020. Available at: https://pafpnet.spc.int/resources/574-tonga-agriculture-sector-plan-2016-2020

[94] While South Pacific Business Development has focussed on lending to women for crop and handicraft production, it started lending to men as well under the Tonga Rural Innovation Project (TRIP).

Land system

Stakeholders in Tonga stated that Tonga's land system is complex. For example, Tonga's TNC states that there is limited land available, particularly on Tongatapu, for planting or conserving trees for reforestation purposes. Land tenure in Tonga is governed by the National Constitution (1875) and the Land Act (1882), which stipulate that all land is the property of the crown and that it may be allocated or leased to hereditary nobles (chiefs), or allocated as 3-5 ha tax allotments to Tongan males upon reaching the age of 16. More than half of agricultural land in Tonga is left fallow as a result of land rights issues or landowners residing overseas[95].

During consultation for the NDC Implementation Roadmap and Investment Plan with Project Pipeline, stakeholders suggested that awareness raising within the sector is required improve navigation of the land system. In addition, extensive dialogue, and careful deliberation with stakeholders, such as small landholders and large, land-owning stakeholders, such as the Royal Family, chiefs, and GoT, must also be undertaken to ensure that appropriate actions and implementation strategies are designed.

Governance

Stakeholders at the NDC Implementation Roadmap and Investment Plan with Project Pipeline Consultation Workshop emphasised the need for careful ownership and governance of all projects in the land sector. This is particularly important because of the many complex elements of Tonga's land tenure system (described above). In addition, stakeholders stated that what locals actually do for a living is not well-understood by the GoT. Therefore, it will be important to ensure that both the government and local communities have ownership of all new projects in the AFOLU sector.

Data

Data about Tonga's AFOLU sector is limited in places due to institutional capacity constraints. For example, establishing a forest inventory was included as a target in Tonga's Second NDC, and will take some more years to complete. This lack of information on forest areas in Tonga makes it difficult to estimate land-based GHG emissions and removals accurately, and complicates the planning and execution of climate change mitigation projects in the AFOLU sector. Data on Tonga's AFOLU sector can be improved by:

- Completing the forest inventory
- Improving the quality and coverage of Geographic Information Systems (GIS) data, and building domestic GIS analysis capacity
- Coordinating data collection efforts by both public and private stakeholders, including through enhanced digitalization

[95] IFAD. (2017). *Kingdom of Tonga: Country Strategy Note.* Retrieved from https://www.ifad.org/documents/38711624/40077965/Tonga%20Country%20Strategy%20Note_approved_0010-70-242_8412.pdf/cf2ef620-6d2e-4e41-b926-73a22fabff3e?1517984189473

- Increasing awareness of the importance of data collection
- Building capacity in data collection and management for Government institutions
- Incentivising data collection by landowners, such as by encouraging greater engagement in the periodic agricultural censuses.

Strengthening data collection in the AFOLU sector will also improve information about Tonga's land-based carbon removals. Tonga's TNC states that GHG emissions from land-use are entirely offset by carbon sequestration from Tonga's forests. However, estimates based on the available data do not confirm that Tonga has net zero GHG emissions from land use[96].

4.2 Waste sector

Waste policy and regulatory oversight is provided Department of Environment, with the regional strategic framework overseen SPREP

The Department of Environment (Waste Management and Pollution Control Division (WMPC)), provide national policy and oversight of waste management and pollution control in Tonga, including being the lead agency for enforcement of the Environment Management (Litter and Waste Control) Regulations 2016. The Department of Environment are actively engaged in regional dialogues and coordinate a range of projects to provide improved waste management for challenging waste streams such as asbestos, mercury, and chemical waste.

The Secretariat of the Pacific Regional Environment Programme (SPREP) is the regional organisation charged with protecting and managing the environment and natural resources of the Pacific. SPREP has the lead responsibility for regional coordination and delivery of waste management and pollution control actions, guided by the collaborative document, Cleaner Pacific 2025. This provides a strategic management framework to address waste, chemicals, and pollutants, providing both regional and country specific assistance for priority waste streams[97].

Waste services in Tonga are provided by the Tonga Waste Authority Limited

Tonga Waste Authority Ltd (TWAL) is a government-owned enterprise for delivering waste collection and disposal services to the people of Tonga. TWAL was established in 2006 under the powers established in the Waste Management Act 2005. This Act clearly outlines the functions of TWAL, including its powers to charge service fees. It also separates the functions of service delivery and regulatory oversight, with MEIDECC providing regulatory oversight to ensure TWAL provides waste management services that do not harm the natural environment. Quarterly groundwater monitoring is undertaken at the Tapuhia Landfill Site on Tongatapu, with the Natural Resources Division under MLNR

[96] Tonga Nationally Determined Contributions Review Report, Kingdom of Tonga, July 2020.

[97] Priority waste streams identified in the *Cleaner Pacific 2025: Pacific Regional Waste and Pollution Management Strategy 2016-2025,* are municipal solid waste, asbestos, e-waste, healthcare waste, chemicals, used oil, marine litter, disaster waste, and liquid waste.

undertaking testing and analysis and sharing this report with MEIDECC and TWAL. As a government-owned enterprise, the TWAL staff and Utilities Board come under the auspices of the Ministry of Public Enterprises, with obligations outlined in the Public Enterprise Act 2002.

Currently, an estimated 90% of people in the main islands of Tongatapu, Vava'u, Ha'apai and 'Eua receive waste collection services

In the last five years, Tonga has made significant progress to expand its formal waste collection system. A weekly waste collection system has been in place since 2007 in Tongatapu (where more than 70% of the population resides)[98]. In 2015, Tonga made a decision for TWAL to take over all waste management service areas in the Kingdom (previously under the jurisdiction of the Ministry of Health outside of Tongatapu). The aim was to expand TWAL's services in a staged approach, providing TWAL time to establish staff, facilities, and equipment in each of the main islands.

In April 2017, TWAL opened a branch in Vava'u and commenced a weekly waste collection service. This was expanded to 'Eua in October 2020 and Ha'apai in November 2020[99]. Currently, it is estimated that over 90% of households in Tongatapu, and the population living on the main island of Vava'u and the main islands of Ha'apai and 'Eua, receive a formal waste collection service[100]. The more remote outer islands and the Niua group do not receive waste collection services.

The sanitary landfill on Tongatapu, the Tapuhia Waste Facility, has approximately 20 years of further operational life

The Tapuhia landfill was designed in 2005 and opened at the end of 2006. It was constructed in an old quarry site located near the village of Vaini, designed with four major waste cells draining to a central wastewater collection sump. Two of the major cells have been constructed, using a geo-composite liner system, drainage layer, and slotted pipes for leachate collection and treatment using an on-site package wastewater treatment plant. Cell one is full, and cell two is heading towards the end of its current operational life. Cell three will be constructed in 2022, funded by the ADB under the Tonga Integrated Urban Resilience Sector Project (TIURSP). Once all four cells are filled, there will be further opportunity to build the waste into a mounded landform and extend its operational life. There is no landfill gas collection system at the site.

The landfill site at Vava'u is close to the end of its operational life, and the Ha'apai and 'Eua landfills are require upgrading to improve environmental controls

[98] World Population Review 2021

[99] WAL 2020: Annual Report for FY ending June 2020 stating planned timeframes. This was confirmed by WAL CEO, pers comm 2021

[100] Personal communication with CEO Waste Authority Ltd, June 2021

Landfills in 'Eua and Ha'pai will be upgraded and climate-proofed under the new Implementing Sustainable Low and Non-Chemical Development in Small Island Developing States (ISLAND) project funded by the Global Environment Facility (GEF) and partners. The project also seeks to raise awareness and improve opportunities for plastic recycling. The Department of Environment in MEIDECC is the lead agency for this project.

GoT has also identified a suitable site for the landfill at Va'vau but does not have the available funds to develop the facility[101]. The landfill design at Vava'u, and potentially the two upgrades at Ha'apai and 'Eua, utilise the Fukuoka Method. This method involves a semi-aerobic landfill structure to enhance the rate of stabilisation and reduce methane production through the collection and venting of CO_2 from the waste mass. GHG emissions are estimated to be 54% lower in semi-aerobic landfill compared to an anaerobic landfill[102].

Stakeholders in Tonga noted an increase in hazardous waste, which is challenging to manage[103]

Stakeholders noted that chemical waste, particularly surgical and other hospital waste, has increased, particularly since the beginning of the COVID-19 pandemic. Tonga has secured funding for new incinerators, which are being installed in the hospitals in the main and outer islands. Waste oil is also building up in Tonga. Petroleum import companies are only responsible for waste oil from their major clients, and not from small workshops and users. A recycling company is collecting the oil in Tonga, however, cannot keep up with demand. Waste from deep-sea mining has also been noted as a concern. Hazardous waste is challenging to manage, and can require specialised skills and equipment[104].

Co-billing between TWAL and Tonga Power Limited, as well as the combination of tariffs and levies, has provided a sustainable basis for ongoing service delivery

TWAL initially used a community-based tariff collection model, and then trialled a charge per bag service. The combined Utilities Board was formed in 2015, which merged the governance of Tonga Power Limited (TPL), TWB and TWAL. Co-billing between TPL, which has almost universal coverage and high payment compliance, and TWAL was established[105].

One of the key challenges for TWAL is customers' low willingness to pay for waste collection services, particularly in rural areas as burning or dumping waste is primarily viewed as free. Therefore, direct tariffs remain low (approximately US$4.50 per household

[101] A new landfill for Vava'u is identified as a priority project in the National Infrastructure and Investment Plan (NIIP).

[102] Tashiro Takeo, 2005, 'What is Fukuoka method – a case of Tafaigata landfill' SPREP

[103] Stakeholders in Tonga at the Validation Workshop for the NDC Implementation Roadmap and Investment Plan.

[104] Projects and recommendations for managing hazardous waste is included in the waste sector project concept notes in Appendix A.

[105] Co-billing between WAL and Tonga Water Board (TWB) had previously been established, but because TWB does not provide services to most rural villages, revenue collection remained challenging.

month)[106] compared with service delivery costs. In September 2019, the Utilities Board agreed to raise the tariff (currently approximately US$6.66 per household per month[107]), providing a move towards cost recovery for TWAL. In January 2021, Cabinet also approved a zero rate of Consumption Tax for waste collection and disposal services (previously the standard 15% was applied) to reduce financial pressure on TWAL[108].

Given the constraints on collecting revenue through user charges, TWAL have also introduced two important indirect levies:

- Plastics Levy, an import fee applied at customs for single use plastics, including shopping bags, disposable nappies, and plastic containers, paid as direct revenue to TWAL, as per the Waste Management (Plastic Levy) Regulations 2013. There is no differentiation of plastic bags based on microns, with the definition under the Regulation encompassing any synthetic plastic bag for use in commerce.
- Passenger Environmental Levy applied to all passengers who arrive on a cruise ship, and is used to pay for public bin collection, public toilet cleaning and maintenance, and general beautification work. With no cruise ships visiting Tonga since the outbreak of the COVID-19 pandemic, this income stream has ceased, and will not recommence until the national border re-opens and the GoT permits cruise ships in its port facilities.

TWAL's financial sustainability remains challenging and, whilst TWAL largely funds the cost of operations, it continues to rely on ongoing donor funds to support asset maintenance and replacement. As per the assessment of TWAL's capacity for self-funding infrastructure costs in the National Infrastructure Investment Plan (NIIP), they were rated as having medium capacity to fund operations, but low capacity to fund maintenance, and small, medium, and large CAPEX[109].

Incentives and penalties have been put in place to encourage sound waste management

A range of campaigns to harness pride in a clean, green, and healthy environment have been in place since early the 2000s, which are changing attitudes towards waste in Tonga. For example, village beautification competitions[110], promotional music jingles, theatre, social media[111], television and radio programmes, community-driven campaigns,[112] and business initiatives[113] all build momentum for change. TWAL conduct their community

[106] https://www.adb.org/sites/default/files/publication/42660/solid-waste-management-tonga.pdf

[107] Waste Authority Ltd 2020 Annual Report

[108] https://matangitonga.to/2021/01/29/waste-authority-ltd-revises-prices

[109] Government of Tonga (2020) NIIP

[110] Such as Tauhi ke faka'ofa'ofa contest or the ongoing Ministry of Tourism competition

[111] See https://www.facebook.com/cleangreentonga/ for ongoing campaigns and messaging for Clean Green Tonga

[112] Such as the No Pelestiki campaign and the Go Green youth initiative from the Tonga Youth Employment and Entrepreneurship programme.

[113] Such as the BSP Bank's Go Green Campaign which has funded public bins along with school and community clean-ups.

change initiatives under the banner of *Clean Green Tonga*, a message reinforced through branding on their trucks and vehicles, signage, and a range of promotional materials.

The Environment Management (Litter and Waste Control) Regulations were also introduced in 2016 to combat littering, dumping, and burning. Police, health inspectors, MEIDECC environment officers, and designated enforcement officers from TWAL empowered to issue written warnings, on-the-spot fines, or start court proceedings against offenders.

Stakeholders in Tonga noted that people in Tonga do not always abide by regulations and policies. Additional legally binding mechanisms, such as policies, regulations, and fines, may be required in future to ensure the sustainable management of Tonga's waste sector[114].

Tonga has taken valuable steps to understand waste sector GHG emissions better

The Pacific Regional Infrastructure Facility (PRIF) developed waste profiles for 15 Pacific Island Countries (PICs), including Tonga, in 2017. This project provided Tonga with a better understanding of its waste generation and composition and provides a methodology for collecting waste data. In 2021, PRIF engaged the Department of Environment under MEIDECC to conduct a more detailed waste composition study. This initiative is an important step in collecting the data required to set GHG emission reduction targets[115]. At this time, the data has not been published. Once available, the data will be published on the Pacific Environment Data Portal hosted by SPREP, under the category of Built Environment[116].

The Tonga Statistics Department (TSD) undertakes waste surveys and census, with some surveys issued monthly. TSD's ongoing data collection and survey work will be valuable to better understand behavioural changes directly related to the NDC projects. Collaboration with TSD will be crucial as NDC projects in the waste sector develop.

4.2.1 Key national stakeholders in the waste sector

Table 4.1 details the roles of the key national stakeholders in Tonga's waste sector.

Table 4.3: Key national stakeholders in the waste sector

Key stakeholder	Role within the sector
Tonga Waste Authority Limited (TWAL)	TWAL is responsible for waste management service delivery—waste collection, landfill operations and management, waste awareness, public bin services, liquid waste management (septic tank pumping and management of septage treatment beds), and recycling, including removal of end-of-life vehicles and bulky waste.
Department of Environment (MEIDECC)	The Department of Environment's is the regulator of waste management. The Waste Management and

[114] Stakeholders in Tonga at the Validation Workshop for the NDC Implementation Roadmap and Investment Plan.

[115] The data is not available as yet but is expected to be published in mid-2021.

[116] See https://pacific-data.sprep.org/

Key stakeholder	Role within the sector
	Pollution Control Division (WMPC) sits under the Department of Environment.
Waste Management and Pollution Control Division (WMPC) (Department of Environment, MEIDECC)	WMPC (under the Department of Environment) is responsible for establishing and enforcing waste policy, including hazardous waste, and has regulatory oversight of landfills and pollution control activities. WMPC implements the Cleaner Pacific Strategy and other relevant national treaties such as the Basel, Waigani and Stockholm Conventions. WMPC also represents Tonga within regional programmes such as PacWaste Plus and JPRISM II.
Town and District Officers	Town and District Officers are responsible for community level initiatives, such as public bins, waste awareness, and overall level of cleanliness in the village.
Water Resources Division (MLNR)	The Water Resources Division of MLNR have oversight of water resource management, and provide groundwater monitoring and longer-term analysis, including quarterly groundwater monitoring at the Tapuhia Landfill.
Ministry of Health	The Ministry of Health is responsible for the delivery of preventative and curative health services for the people of Tonga. The Ministry of Health deals with chemical waste, which is difficult to dispose of and has increased since the start of the COVID-19 pandemic.
Ministry of Infrastructure (MOI)	MOI manages Tonga's public works and transport, and aims to provide effective, efficient, and affordable services and infrastructure. The Building Division is responsible for oversight of building applications, including assessment of the design and inspections of septic tanks during the construction process.
National Spatial Planning Office (MLNR)	The National Spatial Planning Office has oversight of urban planning, including assessment of development applications. One of the sustainable development considerations is the adequacy of waste infrastructure within new developments.
Tonga Statistics Department (TSD)	TSD is the principal authority of Tonga's Official Statistics and is the national coordinator of statistical activities. TSD's role includes: Clearing any censuses and surveys that have implications at the national level and approving results before release Coordinating national data collection, analysis, and sharing between stakeholders for national, regional, and international frameworks and agendas, such as SDGs Coordinating and collaborating with NDC data providers and users in-order to collect quality data, train on data collection and analyses, and promote evidence-based decision making while minimizing unnecessary and costly data activities duplication Proving baseline data or sampling frame for sector-related surveys.
Private sector	The private sector provides a range of complementary waste services, particularly in the collection processing

Key stakeholder	Role within the sector
	and export of recycling. There are also companies that provide waste collection services, particularly to the commercial sector, as well as private septage pumping services. Private sector companies important to the waste sector include: GIO Recycling Waste Management Ltd Lisiate Raas
NGOs	There is a range of NGOs working in the waste sector, for example: The Tongan Red Cross regularly provides hard waste collection services as disease prevention measures (for example, during the Zika virus outbreak) or in preparatory or post-disaster context (for example, cyclones) Church and youth groups regularly organise and implement clean-up activities Leitis Association—provide waste awareness activities such as through a recycled fashion component in their annual Miss Galaxy pageant No Pelesitki Campaign—waste focused group demonstrating a community driven change initiatives

4.2.2 Specific Second NDC targets for the waste sector

Tonga's Second NDC does not include a specific quantitative target for reducing GHG emissions from the waste sector. Instead, the focus is on expanding the formal waste collection system as a prerequisite to identify a GHG emission target for the Third NDC in 2025. Waste sector targets and actions in Tonga's Second NDC are described in detail and mapped against relevant national planning documents in Table 4.4.

Table 4.4: Waste sector targets and actions included in Tonga's Second NDC

	Second NDC target or means to achieve target	Title of national document	National document target and means
Mitigation Targets	**Identify a GHG emission target for the 2025 NDC**	Tonga Climate Change Policy 2006	Identify and measure GHG emissions in the agricultural and forestry sectors
		Tonga LEDS 2021-2050	Waste Action 2: More efficient data collection and consistent update of the database
	Expand the formal waste collection system, including collecting relevant data	Tonga Strategic Development Framework 2 2015-2025	Cleaner environments and less pollution from household and business activities as a result of better waste management
		Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions such as through reducing waste generation and combustion Enact and enforce regulations to prohibit human activities, such as burning solid waste, that are detrimental to the environment

	Second NDC target or means to achieve target	Title of national document	National document target and means
	on waste amounts and waste composition[117]		Improve and strengthen the collection, storage, management, analysis, and use of data, including GHG emissions data
		Tonga Climate Change Policy 2016	Develop and implement a "zero waste" policy
		Tonga LEDS 2021-2050	Waste Action 1: Establish strong waste strategy and integrate the strategy into community development plans Waste Action 2: More efficient data collection and consistent update of the database Waste Action 3: Secure financing for outer island waste processing Waste Action 4: Developing/upgrading waste management facilities Waste action 7: Increased use of local and recycled construction materials Waste Action 8: Biogas generators to fuel villages; purchase best equipment and technology for waste sector; create waste disposal bins at village level Transport Action 1: Improved transport data collection and waste management

Tonga has made significant progress in expanding its formal waste collection system over the last five years, discussed in Section 4.2, above. Currently, over 90% of households in Tonga receive a formal waste collection service. Efforts to expand and strengthen Tonga's waste collection system are underway. Key projects in the waste sector are included in Appendix B, below.

4.2.3 Constraints on NDC implementation and opportunities to strengthen the enabling environment

Nine overarching constraints limit NDC implementation in the waste sector. These constraints were identified during research on the waste sector, research on potential mitigation opportunities, as well as by stakeholders during the Consultation Workshop (held on 26 August 2021). Specific barriers to each of the waste pipeline projects are also outlined in the project concept notes in Appendix A.

Financial

Design, implementation and management of new projects requires significant financial resources. For the waste sector, there is some financial capacity within TWAL and the private sector, but this is only for operational rather than development activities. MEIDECC's WMPC Division is similarly limited in resources for project design and

[117] This is indicated as the means to achieve the target 'Identify a GHG emission target for the 2025 NDC'.

implementation, usually hiring additional resources only on a project basis linked to attached funding resources. Without external donor support, it is unlikely that NDC projects could be initiated.

Institutional capacity
There is a small project team within TWAL allocated to special projects, with a manager, project officer, IT/support officer, and a project administrative assistant. This team also incorporates a role in ongoing education and community change campaigns. TWAL has limited technical resources and requires ongoing capacity building support, particularly in technical issues such as plant and machinery maintenance and management. With the existing projects being implemented by TWAL (TIURSP and JPRISM) and the GEF Island Project to be managed through the Department of Environment in MEIDECC, any additional projects would need to consider funding further positions and providing strong capacity support.

Experience
The waste sector has not had significant engagement in the NDC process to date. As such, a constraint is the lack of experience in the process. Consultation participants reported that the jargon seemed complex, and that they were not certain of how the waste sector sits within the overall climate change framework. Mentoring and support would be required.

Coordination
Coordination between TWAL and MEIDECC has improved, and they collaborate regularly on projects. With a clear delineation of roles, this simplifies project implementation. However, communication and ongoing joint management is a requirement, particularly when projects usually cross the operational and policy areas.

Market structure
Financing improved waste services has been a gradual process over a number of years, with lack of financial viability undermining potential for greater private sector involvement in service delivery. Expanding services to outer islands requires a certain amount of cross subsidy given the smaller population base. Developing new initiatives in the waste sector is challenging given this underlying issue. Geographic isolation provides additional challenges when looking at the export of materials for recycling or accessing remote islands with waste services.

Enabling improved waste services will require extensive community dialogue, along with implementing appropriate incentives and penalties to motivate change. Accessing markets for recycling materials must consider initiatives at the regional level, along with systems such as container deposit systems to encourage resource recovery efforts. Any organic waste programme will also be constrained by market, with building demand for end products critical to the sustainability of the initiative.

Public awareness and change
Public awareness campaigns over the last decade have seen significant growth in awareness of the benefits of sound waste management and demand for waste services. However, there is thought to be relatively low awareness about the impacts of GHG emissions from the waste sector, including the linkage between open burning of waste and

GHG emissions. Whilst there is a growing awareness of the problems with single use plastic and the benefits of recycling, change is challenging, as convenient alternatives for people are limited. A good example is how ubiquitous single use plastic containers are for takeaway food for meetings, events, feasts, and funerals. This has become firmly entrenched as a practice, and alternative options are not convenient or cost effective.

In the consultation process, the need to bring the community along was re-stated in relation to several proposed initiatives. In the waste sector, implementing change, particularly relating to zero waste initiatives or improved waste practices involves bringing every household, institution, and business on board. This moves beyond public awareness and into motivating change. The same applies to changing the way waste is managed on remote islands, with a major constraint being the social dynamics within communities who may not support externally imposed ideas, and will need to have clear ownership of any ideas to underpin sustainability.

Enabling environment

Strengthening the enabling environment is building the systems to support change, which encompasses policies and laws, national governance, and the use of information to inform ongoing decision making in the waste sector. Tonga's waste legislative and regulatory framework is sound, but an ongoing constraint is the resourcing of implementation. Enforcing the regulations to stop illegal dumping, burning of waste, and littering is constrained by availability of officers, uncertainty of evidence requirements, and, in some instances, cultural constraints about status. Policy decisions to move towards a zero-waste model or a circular economy will require enabling laws and implementation resources. Consultation with stakeholders stressed that any change would require careful consideration of how to bring the community along, and how to encourage better choices through incentives, and do not impose excessive costs on consumers. Strengthening the enabling environment is hand-in hand-with public awareness, and a growing demand for a clean environment.

Data

Data on Tonga's waste sector is limited due to the lack of resourcing and capacity to track waste generation over time. There have been previous waste audits funded under different projects, although the methodology has differed, particularly how the waste was sampled. The collection of Tonga's waste data can be strengthened and expanded through:

- With the PRIF regional waste audit undertaken in 2020/2021, there is a consistent methodology that was applied, allowing data to be tracked over time and compared with similar countries in the region. This data is yet to be published for Tonga but will provide a useful baseline for ongoing waste tracking
- Repairing the damaged load cells of the weighbridge at the Tapuhia landfill (installed in 2018) will help Tonga collect waste data
- Increasing the types of data collected in the waste sector to include baseline data on the incidence of open burning and amounts of septage waste received for treatment at Tapuhia.

Land access

This constraint applies specifically to locating a new landfill site in Vava'u, included in the 'outer island waste management services', but may be applicable to future waste projects Tonga undertakes. The outer island waste management services project has been prioritised by the GoT in the latest iteration of the National Infrastructure Investment Plan (NIIP). However, final siting has not been agreed, with the need to confirm an appropriate site an ongoing issue for Government, which can be challenging given limited land availability, customary ownership, and environmental constraints.

4.3 Marine sector[118]

The fisheries sector is productive and contributes significantly to Tonga's economy[119]

Inshore (shallow water and reef) and offshore (oceanic and deep-sea) fisheries contribute to food security, sustenance and, income earning of coastal communities and Tonga as a whole. More than 13% of Tongan households engage in fisheries for consumption and sale[120]. Tonga's State of the Environment Report[121] (SoE 2019) states that the inshore and offshore fishing and coral reefs are in good or fair, stable conditions. Fisheries, marine biodiversity, and coral reefs are estimated to contribute 7.7% of annual GDP, and are a critical part of Tonga's growing tourism industry[122].

Climate change and natural disasters, combined with a lack of effective legislation and regulations, has resulted in negative impacts on the fisheries sector. SoE 2019 considers the main risk to the marine environment is the loss of coral reefs due to a combination of rising ocean temperatures, ocean acidification, overfishing (seen as moderate-high risk)[123], exploration of deep-sea minerals, and pollution.

The Ministry of Fisheries and other government departments have been working to safeguard Tonga's marine environment. A key focus of this work is on establishing and expanding MPAs and SMAs. The Attorney General's Office (AGO) is responsible for the

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[118] The marine sector includes:

- Marine protected areas (MPAs) are labelled as 'parks' or 'reserves' designated under the Parks and Reserves Act 1979 (Rev. 1988) and are exclusively 'no-take zones'. They are areas of marine protection that are remote from communities, where community management is not possible and are exclusively managed by government
- Special management areas (SMAs) are areas of marine protection that are located near island communities where they can be locally managed under government supervision
- Sustainable community-led non-fed marine aquaculture (mariculture).

MPAs are managed under the Department of Environment and SMAs are managed under the Ministry of Fisheries.

[119] MEIDECC (2018). Joint National Action Plan 2 on Climate Change and Disaster Risk Management (JNAP 2) 2018-2028. Prepared by Department of Climate Change, the Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications in consultation with the JNAP task force and national stakeholders, May 2018.

[120] Tonga, Second NDC 2020.

[121] SPREP, 2019. Tonga: State of the Environment Report 2018. Secretariat of the Pacific Regional Environment Programme (SPREP). ISSN: 1562–675X.

[122] https://www.worldbank.org/en/news/press-release/2019/04/17/thousands-to-benefit-from-stronger-sustainable-fisheries-in-tonga

[123] Tonga's LEDS cites multiple reports that indicate coastal fisheries in Tonga are on the verge of being overfished and degraded.

provision of legal advice for the policies and regulations that are required to support the expansion of MPAs and SMAs.

It is recommended that MPAs and SMAs are 'mainstreamed' into climate change discussions, policies, plans, strategies, and programs. This will help emphasize the importance of adaptation in Tonga's climate change targets, and link the marine sector with other development and climate change priorities.

The number of MPAs is increasing through targeted activities

MPAs are areas of marine protection that are remote from communities and, therefore, cannot be managed by communities. They are instead managed by MEIDECC (the Department of Environment) for the GoT. MPAs are used as a marine resource management tool that assists with the maintenance of the existing stocks of fish and other marine species. As of July 2020, Tonga has 10 MPAs, listed in Table 4.5[124], MPAs labelled as 'parks' or 'reserves' are designated under the Parks and Reserves Act 1979 (revised 1988) and are exclusively 'no-take zones'[125],

Table 4.5: MPAs of Tonga as of July 2020

Number	Names of MPAs
1	Hakaumama'o Reef Reserve
2	Pangaimotu Reef Reserve
3	Monuafe Island Park and Reef Reserve
4	Ha'atafu Beach Reserve
5	Malinoa Island and Reef Reserve
6	Lualoli Island and Reef Reserve
7	Maninita Island and Reef Reserve
8	Taula Island and Reef Reserve
9	Fonualei Island and Reef Reserve

Note: One MPAs was not included in Department of Environment's presentation 'Current status on Tonga's MPA'.
Source: Department of Environment, 2020

Tonga set a target in its Second NDC to increase Tonga's MPAs to 30% of the country's Exclusive Economic Zone (EEZ)[126]. 17 offshore sites and 31 inshore sites have been proposed, which, once established, will achieve this target. New MPAs and no-take zones

[124] Department of Environment, 2020. Current status on Tonga's MPA. NDC: To double the 2015 number of Marine Protected areas by 2030. 23 July 2020

[125] No-take zones are a specific type of marine protected area (MPA). No-take MPAs prohibit the extraction or significant destruction of natural resources.

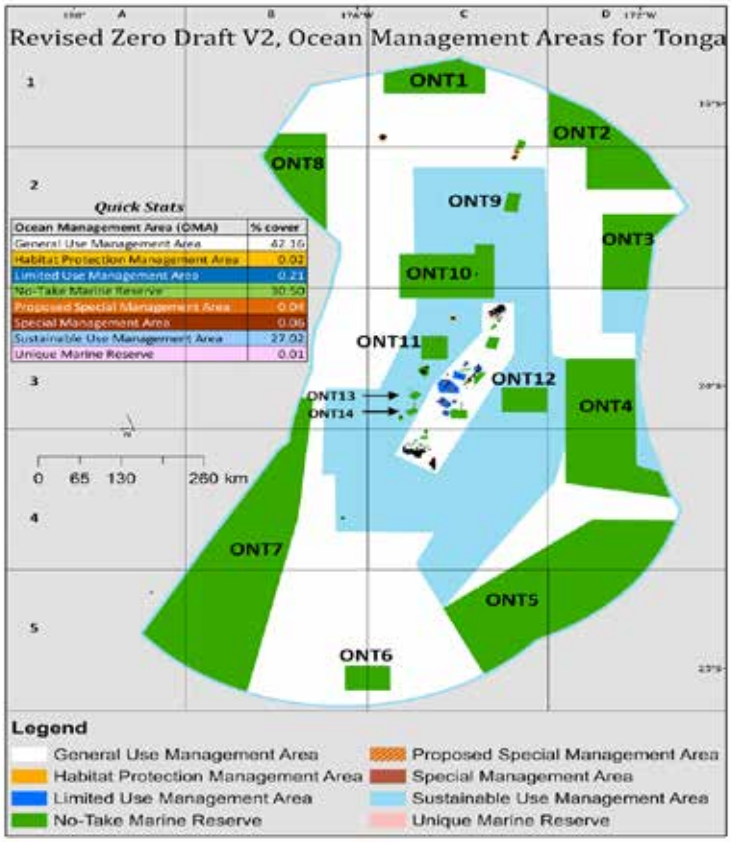
[126] A similar target is also included in SoE 2019, the Marine Spatial Plan, and NBSAF.

will also incorporate Tonga's historical maritime boundary (the country's EEZ), which was recently approved by Cabinet[127]. The proposed sites are detailed in Table 4.6 and Figure 4.1.

Table 4.6: Designated number of MPA sites, as of July 2020

Islands	Offshore Sites	Inshore Sites
Tonga	17	
Tongatapu		11
'Eua		1
Ha'apai		8
Vava'u		9
Niua Groups		2
Total (48)	17	31

Figure 4.1: Ocean management areas of Tonga, 2020



[127] https://www.gov.to/press-release/cabinet-approves-tongas-ocean-management-plan/

Source: Department of Environment, 2020

SMAs enable local communities to control the protection and productivity of marine resources

The Ministry of Fisheries and coastal communities sought to ensure inshore and offshore fishing were managed sustainably and wanted to improve the health of Tonga's coral ecosystem. This led to the implementation of SMAs in 2002[128]. SMAs are areas of marine protection that are located near island communities and are managed by the community under the supervision of the Ministry of Fisheries. The priorities of SMAs are to improve fish catch, improve livelihoods, increase fish abundance, and decrease environmental degradation. SMAs are divided into two parts:

- SMA, in which only registered members of a specific community are allowed to fish, and
- The Fish Habitat Reserve (FHR), which is a permanent no-fishing zone within each SMA.

All SMAs are designated under the Fisheries Management Act 2003. Almost all coastal communities in Tonga are located within an SMA or are requesting one. The number of SMAs has increased from 12 in 2015 to more than 45 in 2020.

Impact assessments and surveys on the eight oldest SMAs have been conducted through the Special Management Report 2020 (SMR 2020)[129]. This report highlights that recovery of fish abundance and diversity is occurring within some FHRs, but not elsewhere within the SMAs. This report indicates that:

- Recovery of reef ecosystems is occurring due to community management and the presence of no-fishing areas (FHRs).
- The level of fishing within the SMA areas (outside of the FHRs) may still be too high for fish stocks to recover.

[128] Communities must first submit a letter of interest, which is followed by meeting with the Ministry of Fisheries to decide on the Coastal Community Management Committee (CCMC) and the boundaries of the SMA and FHR. Additional consultations are then performed with both the SMA community and other nearby communities, as well as key stakeholders. Finally, the SMA is gazetted through parliament and the boundary markers added.

[129] Impact assessments and surveys were conducted inside the FHRs and SMAs of 49 communities throughout the whole of Tonga (nearly all SMAs in Tonga). Impact assessments and surveys were also conducted around non-SMA communities and in other areas open to fishing in order to compare between FHR or SMA areas and areas that were still open to fishing. A total of 1,686 transects at 383 sites were completed across Tonga's coral reefs and the size and identity of over 280,000 individual fish recorded as one of 510 separate species. While some areas are still incomplete (for example SMAs in Niuatoputapu, Niuafo'ou, and 'Eua), this is the largest dataset in existence on Tonga's nearshore marine environment.

- Additional regulations, such as size and catch limits, or limiting certain practices (for example night-time spearfishing) may be necessary to "revive the health and status of coastal fisheries resources"[130].
- If improvements inside the non-FHR SMA areas are not demonstrated, support for the SMA programme may erode.
- Marine management should be improved either as a part of, or in addition to, the SMA programme.

Coral bleaching and natural disasters such as cyclones are also impacting the health of SMAs. In addition, culturally significant periodic harvesting for the Royal Agricultural Show may also be undermining the effectiveness of FHAs[131].

Mangrove restoration is increasing climate change resilience and CO_2e sequestration

Mangroves are well-known to effectively protect coasts from wave action, wave set-up, storm surge, and tsunami, and have additional environmental benefits, including adding nutrients to coastal waters, increasing biodiversity and food security, enabling carbon sequestration[132], and helping communities adapt to sea level rise. Mangroves can reach maturity in approximately 20 years in favourable locations, which means mangroves have the potential to provide protection within timeframes of a few decades, as well as further into the future.

Tonga has targeted mangrove restoration to contribute to seawall and foreshore protection. Climate change resilience projects that have been implemented in Tonga include nature-based or hybrid solutions (two-lines of defence) that aim to re-establish lines of defence, such as through artificial coral and oyster reefs, renourished beaches and dunes, and planted saltmarshes and mangroves. A 'green belt' of replanted mangroves is being implemented in the northern coast of Tongatapu and mangrove restoration has also been undertaken in central Nuku'alofa and in the Vava'u group in northern Tonga. Some areas in Tonga have significant coastal defences in place to prevent coastal erosion and inundation[133], while other parts have little to no measures in place.

4.3.1 Key national stakeholders in the marine sector

Table 4.7 details the roles of the key national stakeholders in Tonga's marine sector.

Table 4.7: Key national stakeholders in the marine sector

Key stakeholder	Role within the sector
Attorney General's Office (AGO)	Attorney General's Office is responsible for the provision of legal advice for the policies and regulations that are required to support the expansion of MPAs and SMAs. The Oceans Bill will be lodged with the Maritime Spatial Plan).

[130] This is a key objective of the SMA programme.

[131] Special Management Area Report 2020.

[132] Mangals are up to 10 times more effective than terrestrial rain forests at sequestering CO_2.

[133] For example, the Nuku'alofa revetment; the revetment and 'living wall' between Ha'atafu and Ahau; and groynes on the north-eastern coast.

Key stakeholder	Role within the sector
Ministry for Agriculture, Food and Forests (MAFF)	MAFF advises the GoT on how to strengthen the productivity and sustainability of the agricultural sector, and how to secure social, economic, and environmental benefits from careful use of Tonga's land and water resources. MAFF also administers programmes and enforces legislation in the agriculture, forestry, and fisheries sectors. It also regulates the export of agricultural and forest products and the import of food and other goods to protect Tonga against imported pests and diseases. MAFF has multiple divisions, including the forestry division, the livestock division, and the food division.
Ministry of Fisheries	The Ministry of Fisheries focuses on the sustainable management of Tonga's fisheries, supports the establishment of community based special management areas, and fosters sustainable and profitable commercial fisheries and aquaculture.
Department of Climate Change (DCC) (MEIDECC)	DCC (within MEIDECC) aims to put effective systems in place for climate change mitigation, adaptation, and resilience. DCC follows Tonga's obligations under the UNFCCC. Seven divisions have been established in the Department: climate finance, policy and planning, vulnerability and adaptation, mitigation, national ozone layer protection, communication and information, and outer islands.
Ministry of Lands and Natural Resources (MLNR)	MLNR is responsible for managing lands and mineral resources in Tonga. Its activities include the management of technical support and information services relating to geographic and geological information.
Department of Environment (MEIDECC)	The Department of Environment's mandate is to promote the conservation of biology diversity, sustainable use, and management of natural resources, and maintaining ecosystem services.
Tonga Statistics Department (TSD)	TSD is the principal authority of Tonga's Official Statistics and is the national coordinator of statistical activities. TSD's role includes: Clearing any censuses and surveys that have implications at the national level and approving results before release Coordinating national data collection, analysis, and sharing between stakeholders for national, regional, and international frameworks and agendas, such as SDGs Coordinating and collaborating with NDC data providers and users in-order to collect quality data, train on data collection and analyses, and promote evidence-based decision making while minimizing unnecessary and costly data activities duplication Proving baseline data or sampling frame for sector-related surveys.
Community members	The SMAs and associated FHRs are managed by communities under the MAFF with support from the DoE. The SMA plans for each community state the community's regulation.

4.3.2 Specific Second NDC targets for the marine sector

Tonga's Second NDC set out three adaptation targets that focus on coping with the impacts of an increase in temperature and a rise in sea level. Marine sector targets and actions in Tonga's Second NDC are described in detail and mapped against relevant national planning documents in Table 4.8.

Table 4.8: Marine sector targets and actions included in Tonga's Second NDC

	Second NDC target or means to achieve target	Title of national document	National document target and means
Adaptation Targets	**Prevent any permanent loss of land to rising sea levels on Tonga's four main islands**	JNAP 2	Resilient coastal development, infrastructure, and integrated coast ecosystems management
		State of the Environment Report 2018 (SOE)	By 2020, the rate of loss of all-natural habitats, including forests, is at least halved and, where feasible, brought close to zero
		Tonga LEDS 2021-2050	Human Settlements Action 9: Strengthen and refine current policy on coastal protection in order to strengthen Marine Protected Areas
	Maintenance of the existing stocks of fish and other marine species	JNAP 2	Resilient fisheries and marine and coastal ecosystems
		JNAP 1	Improve fisheries and coral reef management in view of climate change
		SOE	By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably
		Tonga Climate Change Policy 2016	Native biodiversity is fully protected and enhanced
		NBSAF	By 2020, 60% of coastal marine ecosystems are monitored and the status of depletion is identified By 2020, 100% of coastal terrestrial ecosystems such as mangroves are monitored, and changes over time are identified
		Tonga LEDS 2021-2050	AFOLU Action 5: Establish SMA association and ensure its maintenance through financial support and capacity, in order to support the expansion of MPAs and SMAs
	Expand MPAs and SMAs to 30% of Tonga's EEZ[134]	SOE	By 2020, at least 17% of terrestrial and inland water, and 10% of coastal and marine areas, are conserved
		Tonga Climate Change Policy 2016	Every coastal community has a SMAs and protected coastal environment

[134] This is indicated as the means to achieve the other two targets.

Second NDC target or means to achieve target	Title of national document	National document target and means
	Tonga Climate Change Fund	Tonga's Climate Change Fund is eligible for activities that involve eco-system resilience, such as reef protection and mangrove and coastal planning
	NBSAF	Expand the existing network of protected areas to effectively conserve major coastal and marine habitats of biological and socio-economic value by: Increasing total area of marine ecosystem under conservation management by 50% in 10 years Ensuring 30% of SMAs and MPAs are established and implemented by 2030
	Tonga LEDS 2021-2050	AFOLU Action 5: Establish SMA association and ensure its maintenance through financial support and capacity, in order to support the expansion of MPAs and SMAs Human Settlements Action 9: Strengthen and refine current policy on coastal protection in order to strengthen Marine Protected Areas

As of July 2020, Tonga has 10 MPAs[135], and 17 offshore sites and 31 inshore sites have been proposed. Once established, this will increase MPAs to 30% of Tonga's EEZ. In addition, the number of SMAs has increased from 12 in 2015 to more than 45 in 2020. SMAs make up 0.06% of Tonga's EEZ[136].

Although Tonga is making considerable efforts to achieve its Second NDC targets, work is still required to help Tonga enhance its targets and ensure the success of MPAs project. For example, Tonga's Second NDC states that consensus on the definition of MPAs and SMAs (including if and how MPAs differ from SMAs), as well as strengthened enforcement, is required. In addition, ensuring that the proposed MPAs are the most beneficial location and size[137] is important, and other projects can be implemented which can help prevent permanent loss of land to rising sea level and can maintain existing stocks of fish and other marine species.

[135] See Table 4.6.

[136] Department of Environment, 2020.

[137] Consideration about the location and size of MPAs is crucial to ensuring the success of MPAs. MPAs should have some level of connectivity and represent all biogeographic regions and habitats in Tonga. The New Zealand Department of Conservation has recommended that 10% of Tonga's marine area be set aside for MPAs. However, research and consultation with stakeholders in Tonga indicates that the more open character of marine ecosystems requires that higher targets be set, with 20% most often cited as the appropriate range. At an individual scale, MPA size should include consideration of representing biogeographic regions, and ensuring that size of the MPA is sufficient to protect the target species. There are several methods that have been developed for the selection of MPAs and the development of networks. For example, Criteria for Selection of Ecological Reserve Sites and Development of Networks, available at: https://www.nap.edu/read/9994/chapter/8#111

4.3.3 Constraints on NDC implementation and opportunities to strengthen the enabling environment

Six overarching constraints limit NDC implementation in the marine sector. These constraints were identified during research on the marine sector, research on potential mitigation opportunities, as well as by stakeholders during the Consultation Workshop (held on 26 August 2021). Specific barriers to each of the marine pipeline projects are also outlined in the project concept notes in Appendix A.

Financial

Design, implementation and management of new projects requires significant financial resources. Within the marine sector, the Department of Environment, and the private sector both have some budget, but this is mostly for operational rather than development activities. Stakeholders have stressed the importance of external financial support to help Tonga implement and ensure the success of NDC-related marine sector projects. Stakeholders suggested that monitoring, enforcement, and awareness programmes all require financing.

Experience

The Ministries and other stakeholders involved have not had significant engagement in the NDC process to date. Mentoring and support would be required to help ensure NDC projects were successfully implemented and maintained.

External expertise can also be provided to help Tonga determine the locations and sizes of new MPAs to enhance MPAs' effectiveness. For example, the following should be considered:

- MPAs should ideally have some level of connectivity (that is, hydrodynamically through large- and small-scale currents)
- There should be more than one MPA representing each biogeographic region and habitat. MPAs have different biogeographic regions and habitat types—replication will capture superior data about regions and habitats, and will provide more robust information about Tonga's MPAs network[138]
- Individual MPAs should be of a sufficient size to protect the target species, especially for significant times in its life history (such as during spawning).

Institutional capacity

There is a small project team within The Ministry of Fisheries and limited staff in other government departments responsible for marine management. Marine management organisations in Tonga have limited technical resources and requires ongoing capacity building support, particularly in technical areas of marine management. NDC projects should consider funding further positions and providing strong capacity support.

Coordination

Coordination between public and private stakeholders in the marine sector is challenging

[138] The network will be more robust because similar habitats mean similar species, which can be connected with strategic positioning and provide increased positive 'spill-over' for the wider region.

because roles are not clearly defined. For example, stakeholders suggested that there is overlap between the DCC, the Department of Environment, and the Ministry of Fisheries. Local NGOs are also focused on MPAs. Communities also have their own objectives. Tonga requires support to improve the coordination between different stakeholders to ensure responsibilities are clearly mapped out, particularly with what organisations are enforcing and monitoring regulations. In addition, strengthening partnerships between government authorities and communities will help achieve local buy-in on the importance of MPAs and SMAs, which will help maximise effectiveness of regulation. Stakeholders also suggested that improved coordination between ministries will help ensure the success of NDC projects.

Public awareness

Regulations around MPAs and SMAs are not always well known for a range of reasons, including coordination and institutional capacity challenges (mentioned above), as well as because consultation usually involves fishers and elderly, which results in a general lack of awareness at high school and student levels. To help build public awareness, awareness-raising programmes for both public and private sectors and community groups, which target all ages, are built into NDC projects were appropriate. These aim to raise the awareness of the benefits of abiding by MPAs and SMAs regulations. Awareness-raising campaigns could focus on:

- Protecting MPAs to safeguard critical habitats and adult fish populations, which will result in 'spill-over' effects such as increased and sustainable catches outside of MPAs for recreational, artisanal, and commercial fisheries
- Increased tourism revenue from visitors to MPAs (diving, snorkelling, and potentially glass-bottom boats) and recreational fishing outside MPAs
- MPAs as part of Tonga's contribution to adapting to the impacts of climate change and increase Tonga's future resilience.

Data

Data about Tonga's marine sector is limited in places due to institutional capacity constraints. Limited data is particularly challenging when trying to design, implement, and monitor projects such as 'optimising the size of MPAs, FHRs, and SMAs' and 'modelling Tonga's hydrodynamic connectivity', which require significant detail and mapping of Tonga's MPAs. Data on Tonga's marine sector can be improved by:

- Improving the quality and coverage of Geographic Information Systems (GIS) data, and building domestic GIS analysis capacity
- Coordinating data collection efforts by both public and private stakeholders, including through enhanced digitalization
- Increasing awareness of the importance of data collection
- Building capacity in data collection and management for Government institutions
- Incentivising data collection by communities.

Data barriers can also be partly circumvented by the application of selection methods to identify important parameters and quantifying them or flagging them (e.g. yes/no). Parameters to consider include:

- Presence of vulnerable habitats
- Presence of vulnerable life-history stages
- Presence of exploitable species.
- Presence of species or populations of special interest.
- Ecosystem functioning and/linkages.

These parameters (and others) are included in the marine sector project concept notes where relevant.

4.4 Energy sector

Tonga's Energy sector development has been guided by the Tonga Energy Road Map (TERM)

From 2010-2020, the Tonga Energy Road Map (TERM) policies provided a least-cost approach and implementation plan to reduce Tonga's vulnerability to oil price shocks and achieve an increase in quality access to modern energy services in a financially and environmentally sustainable manner. Tonga has proven through the past decade of TERM implementation that it is serious about creating this future energy system. Some of Tonga's impressive accomplishments from period include:

- Achievement of 96% Energy Access for all of Tonga
- Transition to Cleaner & Safer Cooking Fuels on-track for 100% by 2030
- Energy Efficiency through reduction of electricity line losses from 18% to 9% by 2020
- On track to reach renewable electricity of 50%.

The TERMPLUS sets out the NDC implementation for the energy sector up to 2035

Following the completion of the TERM the TERMPLUS presents the key approaches, targets and prioritised actions needed to further decrease Tonga's dependence on fossil fuels and deliver an energy system, that by 2035 is secure, affordable, sustainable, accessible and enhances the livelihood and wellbeing of all Tongans.

This new energy roadmap serves to consolidate and rationalise the energy sector development policies set forth by the Government of Tonga (GoT) in the first TERM document, the Tonga Strategic Development Framework (TSDF II), Joint National Action Plan (JNAP 2), Sustainable Development Goal 7 (SDG 7), Tonga Energy Efficiency Master Plan (TEEMP), and Tonga Low Emission Development Strategy 2021-2050 (LEDS) as well as the 2022 Energy Act. The TERMPLUS also provides Tonga's energy strategy to meet its 2020 Nationally Determined Contributions (NDC).

4.4.1 Key national stakeholders in the Energy sector

Table 4.1 details the roles of the key national stakeholders in Tonga's Energy sector.

Table 4.9: Key national stakeholders in the Energy sector

Key stakeholder	Role within the sector
Department of Energy (MEIDECC)	The Department of Energy (within MEIDECC) is responsible for Tonga's energy planning and development, and works hand in hand with the Tonga Energy Road Map (TERM).
Land Transport Division under the Ministry of Infrastructure	All transport responsibilities come under the Ministry of Infrastructure (MOI), under which sit a number of entities managing land, maritime and aviation sub-sectors. The main actor in land transport is the Land Transport Division of MOI. The main actors in the maritime sector in Tonga are the Marine and Ports Division (MPD) of the MOI, Ports Authority Tonga (PAT),
Tonga Power Limited (TPL)	The utility is responsible for ensuring sufficient electricity supply to meet load. As such, TPL fulfils the role of transmission and distribution system operator. TPL maintains its own generation infrastructure or can purchase electricity through contracts with other suppliers.

4.4.2 Specific Second NDC targets for the Energy sector

The Third National Communication on Climate Change report (2019) states that the Tonga Energy sector (including transportation) emitted 39 percent of Tonga's GHG emissions, for a total of 121 Gg CO2-equivalent in 2006. Energy sector targets and actions in Tonga's Second NDC are described in detail and mapped against relevant national planning documents Table 4.10.

Table 4.10: Energy sector targets and actions included in Tonga's Second NDC

	Second NDC target or means to achieve target	Title of national document	National document target and means
Mitigation Targets	**Reduce greenhouse gas (GHG) GHG emissions by 13% (16 Gg) by 2030 compared to 2006**	JNAP 2	Resilient coastal development, infrastructure, and integrated coast ecosystems management
	Generate 70% of electricity from renewable sources by 2030 through a combination of solar, wind and battery storage	TERM-PLUS Framework	Generate 70% of electricity from renewable sources by 2030
		National Energy Policy	Generate 70% of electricity from renewable sources by 2030, and 100% by 2035
		Tonga Climate Change Policy 2016	Native biodiversity is fully protected and enhanced
		JNAP 2	Generate 100% of electricity from renewable sources by 2035

Second NDC target or means to achieve target	Title of national document	National document target and means
	Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as through promoting the use of renewable energy resources
	Tonga Climate Change Policy 2016	Generate 100% of electricity from renewable sources
	Tonga LEDS 2021-2050	Energy Action 1: Implement Standards and Regulations for renewable and energy efficient technologies imported into the country Energy Action 2: Draft regulation and policy paper for infrastructure developed using green infrastructure standards Energy Action 5: Increase access to finance for the private sector to fund demand-side renewable energy, projects, and green initiatives Energy Action 6: Increase access to finance for the private sector to fund supply-side renewable energy, projects, and green infrastructure ▪ Energy Action 7: Technologies like battery storage to upgrade, maintain and operate a renewable energy network
Improve the efficiency of newly purchased light-duty vehicles by 2% per year through mandatory vehicle standards and/or incentives such as tax, fees, import tariffs	TERM-PLUS Framework	Limit the growth in oil consumption to 1% per year (based on a 3.1% BAU) for the period 2021 to 2035 within the transport sector, through: 3% energy efficiency gain of cars and light-duty vehicles per year 8% replacement rate of cars and light-duty vehicles per year Reduce total diesel imports in 2035 by 10% compared to 2015 through mandatory vehicle standards and/or incentives through tax, fees, import tariffs, as well as by displacing diesel with electricity generated by renewable sources
	Tonga Climate Change Policy 2006	Formulate and implement programmes to reduce GHG emissions, such as through "cleaner" vehicles Enact and enforce regulations to prohibit human activities that are detrimental to the environment, such as "below par" vehicles
	Tonga LEDS 2021-2050	Transport Action 2: Mandatory vehicle standards and incentives for more efficient vehicles through tax, fees and import tariffs Transport Action 5: Low emissions vehicles

	Second NDC target or means to achieve target	Title of national document	National document target and means
			Transport Action 6: Introducing electric vehicles (EVs) in the municipal government fleet Transport Action 6: Public adoption of 50% EVs
	Limit growth in grid-connected residential electricity end-use to 1% per year on average for the period 2021 to 2030 by adopting minimum energy performance standards for appliances, lighting, and electricity equipment	TERM-PLUS Framework	Limit growth in grid-connected residential electricity end-use to an annual average growth of 1% between 2021-2035 through: Replacing 6% of appliances with energy-efficient appliances per year, supported by implementing the minimum energy performance standards labelling (MEPSL) regulation for electrical appliances Improving the energy efficiency of buildings by 2.5% per year, supported by an awareness programme to change people's energy behaviours and upgrading Tonga's building code with energy-efficient designs
		Tonga LEDS 2021-2050	Energy Action 1: Implement Standards and Regulations for renewable and energy efficient technologies imported into the country Energy Action 2: Draft regulation and policy paper for infrastructure developed using green infrastructure standards Energy Action 4: Draft regulation and policy paper to support roll out of light emitting diode (LED) streetlamps and interior LED lamps Energy Action 8: Government to provide a loan program to private sector for low energy buildings

4.4.3 Constraints on NDC implementation and opportunities to strengthen the enabling environment

As noted, the in-depth analysis of constraints and opportunities is presented in a separate document, the TERMPLUS. The TERMPLUS has identified targets and measures relating to transportation, energy efficiency, data management, resiliency, and gender-inclusion as well as identifying requirements and opportunities in each of these areas. This information was garnered through consultations with a broader range of stakeholders at workshops designed for the development of Tonga's Second Nationally Determined Contribution (NDC). The interim Framework document delivered in December 2020 was structured and aligned with Tonga's Second NDC to provide a solid foundation for the development of TERMPLUS.

5 Projects to help Tonga achieve its NDC targets

This section details the projects to help Tonga achieve its NDC targets in the AFOLU, waste, and marine sectors.

The mitigation and adaptation projects were prioritized using a multicriteria analysis and a survey of the views of key national stakeholders. Each priority sector has a separate pipeline:

- AFOLU sector mitigation projects—prioritised using a methodology that considers GHG emissions reduction potential ($GgCO_2e$) of each mitigation project
- Waste sector mitigation projects—prioritised using a methodology that considers GHG emissions reduction potential ($GgCO_2e$) of each mitigation project, and
- Marine sector adaptation projects—prioritised using a methodology that considers adaptation benefit potential (low, medium, high) of each adaptation project.

The methodologies used are described in section 5.1 and 5.2, respectively.

The multicriteria analyses do not explicitly account for ESS. However, stakeholders were encouraged to think about all the benefits and tradeoffs of the projects, including environmental and social considerations, when prioritizing projects. ESS guidelines have been added to the implementation plan, see section 7.3.2.

A concept note for each mitigation and adaptation project, which includes the project description, GHG emissions reduction potential, costs, procurement method, environmental and social considerations, and co-benefits, can be found in Appendix A. A detailed explanation of the terminologies and assumptions used in this section is provided in Appendix C.

The prioritization of the energy sector projects differs between the above three sectors as it has been undertaken under the separate TERMPLUS process. Furthermore, the TERMPLUS differs in its treatment of the prioritisation of electricity and transport sub-sectors. The electricity sector projects noted here are those that have at time of publication, already received funding or are entering procurement and implementation phases and were prioritised using the principles noted in the TERM 2010-2020. The transport sector project on the other-hand are the result of analysis undertaken for the TERMPLUS and have been prioritised utilising stakeholder consultation and a separate multicriteria analysis framework. Both prioritisation approaches are noted in Appendix D for reference.

5.1 Methodology of prioritising mitigation projects

Mitigation projects were prioritized using the following two method:

1. A multicriteria analysis which is a combined score evaluating three important aspects of each mitigation progress, namely:

a. GHG emissions reduction potential

b. Cost-effectiveness

c. Capacity required to implement[139]

The multicriteria analysis considered two positive criteria and one risk-related negative criterion listed in Table 5.1 below.

2. A survey that captured the priorities of stakeholders in Tonga. Stakeholders prioritized each project using a score from 1 to 5 (in which 1 indicates they think the project should receive the lowest priority and 5 indicates they think the project should receive the highest priority).

The combined score from the mitigation multicriteria analysis was then multiplied by the average score local stakeholders assigned to the project to reach an overall project priority score. The mitigation projects were then ranked according to their overall project priority score.

Table 5.1: Multi-criteria analysis for Mitigation Projects

Description	Unit or categorization	Scoring Protocol	Weighting
GHG emissions reduction potential before 2030	($GgCO_2e$) (+)	The largest mitigation project (the project with the highest GHG emissions reduction potential) was assigned a score of 1. Every other mitigation project was assigned a score below 1, based on its rank relative to other projects.	2
Cost-effectiveness of mitigation effort	($GgCO_2e$/US$) (+)	The most cost-effective project was assigned a score of 1. Every other project was assigned a score below 1, based on its rank relative to other projects.	2
Capacity required to implement	(High/Medium/Low) (-)	High = 1 Medium = 0.5 Low = 0	1

5.2 Methodology of prioritising adaptation projects

Adaptation projects were prioritized using the following evaluation method:

1. A multicriteria analysis which is a combined score evaluating three important aspects of each adaptation progress, namely:

[139] These aspects are explained in Table 5.1.

a. Adaptation benefit

b. Cost

c. Capacity required to implement[140]

The multicriteria analysis considered one positive criterion and two negative criteria listed in Table 5.2 below.

2. A survey that captured the priorities of stakeholders in Tonga. Stakeholders prioritized each project using a score from 1 to 5 (in which 1 indicates they think the project should receive the lowest priority and 5 indicates they think the project should receive the highest priority).

The combined score from the adaptation multicriteria analysis was then multiplied by the average score local stakeholders assigned to the project to reach an overall project priority score. The adaptation projects were then ranked according to their overall project priority score.

Table 5.2: Multi-criteria analysis for Adaptation Projects

Description	Unit or categorization	Scoring Protocol	Weighting
Adaptation benefit potential before 2030	(High/Medium/Low) (+)	High = 1 Medium = 0.5 Low = 0	2
Cost	(US$) (-)	The most expensive project was assigned a score of 1. Every other project was assigned a score below 1, based on its rank on cost relative to other projects.	2
Capacity required to implement	(High/Medium/Low) (-)	High = 1 Medium = 0.5 Low = 0	1

5.3 Mitigation and adaptation projects

Each priority sector has its own project pipeline. Together the AFOLU and waste sector pipelines contains nine mitigation projects, five in the AFOLU sector and four in the waste sector, and the marine sector pipeline contains six adaptation projects. The energy sector pipeline contains nine mitigation projects, which were identified as part of either the TERM 2012-2020 or through the planning process for the upcoming TERMPLUS 2021-2035 and the energy sector pipeline is included in Section 5.3.4 for completeness. GHG

[140] These aspects are explained in Table 5.2.

emissions reduction potential and indicative investment needs of energy sector projects are not included in the cumulative figures below.

Once implementation constraints are considered,[141] projects in the AFOLU, waste, and marine sector pipelines have:

- Potential to reduce GHG emissions by 1,728.68 $GgCO_2e$[142] by 2030[143]
- An annual mitigation potential of 279.01 $GgCO_2e$ in 2030[144]
- 'High' potential to increase adaptation from climate change
- An indicative investment need of US$30,157,000 by 2030.[145]

Emission reduction potential is heavily dominated by largescale reforestation projects in the AFOLU Sector. Figure 5.1 details the cumulative GHG emissions reductions per sector from mitigation projects between 2022-2030.

[141] As explained in section 3 and section 4, institutional capacity constraints mean that it is not feasible to run all mitigation projects concurrently. Therefore, projects are sequenced in order of priority ensuring that there are no more than three projects happen concurrently in the AFOLU sector, no more than three projects happen concurrently in the waste sector, and no more than three projects happening concurrently in the marine sector.

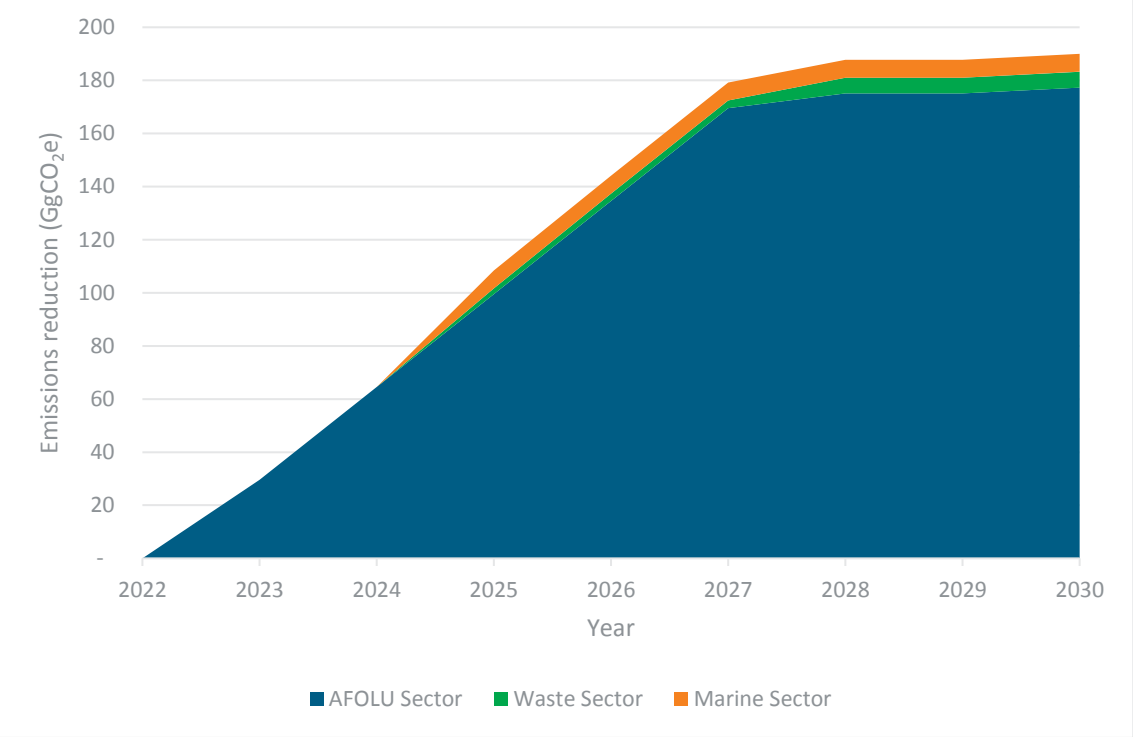
[142] This figure includes potential emissions reductions from the mangrove restoration and replanting project. While this emissions reduction potential is a co-benefit of a marine sector project that focuses primarily on adaptation, the emissions reduction potential is included in the total emissions reduction potential figure for completeness.

[143] Includes the GHG emissions reduction potential of the adaptation project 'mangrove restoration and planting'.

[144] Includes the GHG emissions reduction potential of the adaptation project 'mangrove restoration and planting'.

[145] GHG emissions reduction potential and indicative investment needs of energy sector projects are not included in these cumulative figures.

Figure 5.1: Cumulative GHG emissions reductions 2022-2030 from AFOLU, waste, and marine sector project pipelines in Tonga



Note: GHG emissions reductions displayed are cumulative GHG emissions reductions from NDC pipeline projects in each sector. The GHG emissions reduction estimate calculations are explained in the concept notes in Appendix A.

5.3.1 AFOLU sector

There are five mitigation projects that focus on AFOLU, outlined in Table 5.3 below. Once implementation constraints are considered[146], the mitigation projects have:

- Potential to reduce GHG emissions by 1,082.36 $GgCO_2e$ by 2030
- An annual mitigation potential of 188.33 $GgCO_2e$ in 2030
- An indicative investment need of US$8,179,000 by 2030.

[146] As explained in Section 3, institutional capacity constraints mean that it is not feasible to run all mitigation projects concurrently. Therefore, projects are sequenced in order of priority ensuring that there are no more than three projects happen concurrently in the AFOLU sector.

Table 5.3: Mitigation projects in the AFOLU sector

Opportunity	Pipeline priority Rank	Indicative investment need to 2030 (US$)[147]	Annual GHG emissions reduction in 2030 ($GgCO_2e$)	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[148]
Develop new forest plantations Support the expansion of commercial timber plantations in Tonga on private land as well as the Government Estate and the King's Estate on 'Eua	1	50,000	131.61	789.65
Establish new forest reserves on unused land Support the revegetation and protection of unused land[149] in Tonga by undertaking re-planting programmes and supporting the establishment and management of forest reserves	2	1,236,000	16.1	96.6
Agroforestry expansion programme Support the expansion of agroforestry in Tonga (including coconut, commercial timber species, and other traditional species planted for medicinal or ornamental value)	3	2,107,000	27.33	136.65
Develop a commercial sandalwood industry Support the expansion of a sustainable commercial sandalwood industry in Tonga through enhanced extension work and provision of seedlings, implementation of the Sandalwood Regulations (2016), and adoption of sustainability certifications	4	4,185,000	13.2	59.4
Pasture improvement and fertilizer management Strengthening the capacity of farmers in pasture improvement and fertilizer management	5	601,000	0.085	0.055

[147] The indicative investment need mainly accounts for support programs, feasibility studies, and some capital costs for projects. Private sector investment may be much larger, but this investment is made on commercial terms.

[148] The GHG emissions reduction estimate calculations are explained in the concept notes in Appendix A.

[149] Unused land is largely privately-owned land that is not used because it is inaccessible or slopy.

Note: Mitigation figures ($GgCO_2e$) are rounded to two significant figures after the decimal point; indicative investment needs are rounded to the nearest US$1,000

5.3.2 Waste sector

There are four mitigation projects that focus on waste, outlined in Table 5.4 below. Once implementation constraints are considered[150], the mitigation projects have:

- Potential to reduce GHG emissions by 25.85 $GgCO_2e$ by 2030
- An annual mitigation potential of 5.96 $GgCO_2e$ in 2030
- An indicative investment need of US$11,560,000 by 2030.

Table 5.4: Mitigation projects in the waste sector

Opportunity	Pipeline priority Rank	Indicative investment need to 2030 (US$)[151]	Annual GHG emissions reduction in 2030 ($GgCO_2e$)	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[152]
Moving towards zero waste Implementation of sustainable funding mechanisms and infrastructure to reduce waste and improve resource recovery throughout Tonga	1	1,100,000	2.08	12.49
Waste-to-energy Introduce a waste-to-energy project by first undertaking an up-to-date technology assessment, feasibility study, and development of the framework for the PPP engagement process, and then implementing the project.	2	3,800,000	3.1	9.3
Outer island waste management services Implement effective waste collection services and facilitate the disposal of waste from the outer islands	3	5,630,000	0.7	3.5
Organic recycling	4	1,030,000	0.08	0.56

[150] As explained in Section 3, institutional capacity constraints mean that it is not feasible to run all mitigation projects concurrently. Therefore, projects are sequenced in order of priority ensuring that there are no more than three projects happen concurrently in the waste sector.

[151] The indicative investment need mainly accounts for support programs, feasibility studies, and some capital costs for projects. Private sector investment may be much larger, but this investment is made on commercial terms.

[152] The GHG emissions reduction estimate calculations are explained in the concept notes in Appendix A.

Opportunity	Pipeline priority Rank	Indicative investment need to 2030 (US$)[151]	Annual GHG emissions reduction in 2030 ($GgCO_2e$)	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[152]
Reducing GHG emissions through avoiding decomposition in landfill, and utilising organic waste as a resource for the agricultural and forestry sectors				

Note: Mitigation figures ($GgCO_2e$) are rounded to two significant figures after the decimal point; indicative investment needs are rounded to the nearest

5.3.3 Marine sector

There are six adaptation projects that focus on marine, outlined in Table 5.5 below.

Once implementation constraints are considered[153], these projects have:

- Mitigation co-benefits have potential to reduce GHG emissions by 40.58 $GgCO_2e$ by 2030.
- 'High' climate change adaptation potential across all proposed pipeline projects
- An indicative investment need of US$13,460,000 by 2030.

Table 5.5: Mitigation projects in the marine sector

Opportunity	Pipeline priority Rank	Indicative investment need to 2030 (US$)[154]	Adaptation benefit (low/med/high)	Cumulative GHG emissions reduction in 2030 ($GgCO_2e$)[155]
Mangrove restoration and planting[156] Implement a large-scale program to plant or restore mangrove forests in Tonga's coastal wetlands	1	3,760,000	High	40.58
Apply detached breakwaters Apply detached breakwaters to prevent erosion and increase climate change and sea level rise resilience	2	7,200,000	High	-

[153] As explained in Section 3, institutional capacity constraints mean that it is not feasible to run all mitigation projects concurrently. Therefore, projects are sequenced in order of priority ensuring that there are no more than three projects happen concurrently in the marine sector.

[154] The indicative investment need mainly accounts for support programs, feasibility studies, and some capital costs for projects. Private sector investment may be much larger, but this investment is made on commercial terms.

[155] The GHG emissions reduction estimate calculations are explained in the concept notes in Appendix A.

[156] The 'mangrove restoration and planting' project has GHG emissions reduction potential.

Opportunity	Pipeline priority Rank	Indicative investment need to 2030 (US$)[154]	Adaptation benefit (low/med/high)	Cumulative GHG emissions reduction in 2030 ($GgCO_2e$)[155]
Model Tonga's hydrodynamic connectivity Consider how well the existing network of MPAs is connected, identify potential new MPA sites, and establish new MPAs in these areas	3	550,000	High	-
Enhance community monitoring and enforcement of SMAs and FHRs Build on recent successes with community management of SMAs to engage communities in monitoring fish stocks within SMAs and FHRs, leveraging local knowledge	4	1,100,000	High	-
Optimisation of the size of MPAs, FHRs, and SMAs Undertake a focussed review to consider whether the MPAs, SMAs and FHRs are large enough to be effective for their purpose; and, if found to be too small, then expand them	5	500,000	High	-
Review and update regulations for MPAs, FHRs, and SMAs Develop and implement new regulations, restrict certain practices, and/or establish new incentives for the conservation of marine resources within Tonga's SMAs	6	350,000	High	-

Note: Mitigation figures ($GgCO_2e$) are rounded to two significant figures after the decimal point; indicative investment needs are rounded to the nearest US$1,000

5.3.4 Energy sector

There are nine mitigation projects that focus on energy, outlined in Table 5.6Table 5.5 below, these projects have:

- Mitigation co-benefits have potential to reduce GHG emissions by 579.50 $GgCO_2e$ by 2030. This total comprises an emissions reduction potential of 323.1 $GgCO_2e$ by 2030 in the electricity sub-sector, and 256.4 $GgCO_2e$ by 2030 in the transport sub sector.
- An indicative investment needs of more than US$60,000,000 by 2030.

Table 5.6: Mitigation projects in the energy sector

Opportunity	Pipeline priority Rank	Indicative investment need to 2030 (US$)[157]	Annual GHG emissions reduction in 2030 ($GgCO_2e$)	Cumulative GHG emissions reduction in 2030 ($GgCO_2e$)[158]
Electricity sub-sector*				
Sunergise 6 MW Solar PV IPP	1	12.2mn (secured)	5.86	35
GET 6 MW of Solar PV IPP	1	9.3mn Private Sector Secured	5.86	35
2.25 MW China Wind Farm	2	12.31mn (secured)	6.4	38
3.8 MW of Wind IPP	3	19.9mn Private Sector Secured	11	66
TPL 34-50 GWh Tender (technology agnostic)	4	TBD Private Sector/Donor	~24.5	~147
Nuku'alofa Network Upgrade **	5	6.8mn (secured)	0.35	2.1
Transport sub-sector				
Improving Intake Quality of Vehicle	1	TBD	9.9	99***
Non-motorised Transport	2	TBD	2.2	22***
Low Emission Vehicles	3	TBD	16.5	165***

Note: Mitigation figures ($GgCO_2e$) are rounded to two significant figures after the decimal point; indicative investment needs are rounded to the nearest US$1,000

*Note: *All electricity sector projects are estimated to be operational by 2024.** to provide an estimated 1% line-loss improvement to the Tongatapu network and keep total line-losses below 8% per year. *** TERMPLUS estimates by 2035.*

[157] The indicative investment need mainly accounts for support programs, feasibility studies, and some capital costs for projects. Private sector investment may be much larger, but this investment is made on commercial terms.

[158] The GHG emissions reduction estimate calculations are explained in Appendix E. Detailed calculations are included in the TERMPLUS 2021-2035 and TERM 2010-2020.

6 Investment Plan

This section outlines the principles of project funding and financing. It also identifies possible funding structures for all projects included in the project pipelines and notes potential sources of finance for projects that are likely to require it. This investment plan aligns with the high-Level NDC Financing Pathways for Tonga report ,[159]. The Financing Pathways report outlines high-level strategies for funding and financing mitigation and adaptation actions identified in Tonga's Second NDC, and it includes detailed information on the funding and financing instruments available in Tonga. The current section of the NDC Implementation Roadmap and Investment Plan with Project Pipeline focusses on the principles of funding and financing the projects included in the project pipelines in Section 5.

An important distinction between the Financing Pathways Report and the current section of the NDC Implementation Roadmap and Investment Plan, is that this current section distinguishes between funding and financing, whereby:

- Funding refers to the need for the project to cover all costs over the life of the project, including the costs of financing and implementation
- Financing deals with the timing mismatch between when expenses are incurred and when revenues are received.

In this context, financing refers to exclusively to loans. To put it simply, funding is money that does not need to be repaid, while financing has to be repaid. There is a key linkage: the higher the cost of financing, the more funding is required.

There are three possible of funding for mitigation projects in Tonga

The costs of mitigation projects need to be met in full by money from one or a combination of the following three possible sources:

- Grants from international donors
- Government funding (from the GoT's budgets – paid for by taxes or other government revenue sources)
- User fees from those who benefit from the projects

Each of the mitigation opportunities in Tonga's project pipelines have different funding potential. Some projects are likely to be commercially viable – that is, they can be funded by users. Users may either be willing to pay more due to better service or fund the project because it delivers cost savings to them. Other projects are unlikely to lead to revenues that cover their costs, so they may need either government or grant funding to proceed. In practice, many mitigation projects in Tonga will need to leverage funding from international donors if they are to proceed. Tonga is a small island developing state, and it

[159] The High-Level NDC Financing Pathways for Tonga report was developed by the United nations Development Programme through its Climate Promise Initiative. The report provides the Government of Tonga with a map of past, current, and potential future pathways to fund and finance mitigation and adaptation activities identified in Tonga's NDC.

will need to carefully manage its domestic budget to maintain the capacity to deal with increasingly frequent natural disasters.

Projects that cannot meet their costs through one or a combination of these three sources of funding are not viable and will not proceed.

Projects that incur large up-front costs but have viable funding sources for recovering these costs over time require finance

For NDC projects, finance is likely to come in one of two forms:

- Commercial finance from private lenders (this can sometimes be coupled with credit enhancements such as credit guarantees or risk-sharing facilities)
- Concessional finance from international donors (these would be in the form of sovereign lending)

Concessional finance includes blended finance. Public and private financial institutions are increasingly opting to blend investments they make on commercial terms with various types of concessional support. Concessional support includes advice, funding, or non-grant instruments[160] such as debt financing, risk mitigation products, or equity investments with expectations of below-market returns. Concessional support uses scarce public funding, so it must be used selectively. To access concessional support, activities or projects identified in Tonga's NDC and in Tonga's NDC Implementation Roadmap and Investment Plan with Project Pipeline will need to put forward strong evidence of potential mitigation or adaptation benefits. In many cases, they will also need to demonstrate potential co-benefits, including the following co-benefits outlined under Article 6.8 of the Paris Agreement:

- Promoting increased adaptation and mitigation ambition
- Enhance public and private sector participation in the implementation of the NDC
- Enable opportunities for coordination across instruments and relevant institutional arrangements.

Tonga states in its Second NDC that it does not intend to use voluntary cooperation under Article 6 of the Paris Agreement. Therefore, this investment plan does not include the potential for voluntary cooperation.[161]

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[160] Non-grant instruments are preferable in many cases because they provide potential return flows to the donor, and they can be designed to target specific market barriers.

[161] Article 6 of the Paris Agreement enables Parties to engage in voluntary cooperation as they implement their NDC. Article 6 sets out three pathways for voluntary cooperation:

- Cooperative approaches through the use of internationally transferred mitigation outcomes (ITMOs) in Article 6.2
- A new crediting mechanism, sometimes referred to as the "Sustainable Development Mechanism", in Article 6.4; and
- A framework for non-market approaches in Article 6.8.

For more information, see: https://climate.mit.edu/posts/advancing-international-cooperation-under-paris-agreement-issues-and-options-article-6

A potential challenge of financing NDC projects is that some are likely to be too small to warrant engagement in the complex procurement and approval systems that international financing institutions and, in particular concessional financing institutions have. Tonga should think about how individual projects could be aggregated with other projects across sectors. This will allow organizations to support a single, coherent program in Tonga or the Pacific more broadly. It will be easier for Tonga to get financing and concessional support for larger programs of activities covering multiple NDC projects.

Table 6.1, below, identifies the likely funding sources for meeting the costs of each of the pipeline projects, states whether finance will be required, and identifies the most likely type of finance if so. The funding and financing sources were identified in consultation with stakeholders in Tonga. The details of the possible funding and financing structures for each of the pipeline projects are presented in the procurement method section of each of the concept notes in Appendix A.

In many cases, projects could rely on a combination of grant funding, user fees, and government funding. Many organizations that provide grants, as well as some lenders, require local communities to cover some of the costs of the projects. This approach aims to incentivize and ensure buy-in from the local community. Theis approach is often called 'co-financing'; however it is actually more like co-funding because the local community does not necessarily provide this money as a loan.

While government funding is indicated as a possible funding source for many of the projects in the pipeline, it would often be employed to leverage donor capital and it would generally account for only a small share of the overall costs of the project. Given the fiscal constraints identified by stakeholders, international development partners should remain careful not to overburden the fiscal budget in Tonga with climate change mitigation projects. It is worth noting that, given Tonga's limited fiscal headroom and risk of debt distress, most development partner support has been in the form of grant funding rather than loans (financing).

TERMPLUS Energy Sector

The energy sector estimates that have been included were committed under the TERM, that has been ongoing for over ten years with a number of projects underway or that have received funding commitment already. The TERMPLUS is the next iteration of the TERM to cover the period 2021-2035 and includes a much larger focus on the transport sector, however the development of an investment and implementation plan is not scheduled to begin until the later half of 2022.

Table 6.1: Likely funding sources and type of finance for project pipelines

Prioritization	Project name	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[162]	Indicative investment needs (US$)[163]	Funding sources			Is Finance Required?[164]	Type of finance		Likelihood of attracting private or donor funding	Capacity required to implement
				Grants from international donors	Government funding	User fees		Commercial finance	Concessional finance		
AFOLU sector											
1	**Develop new forest plantations**	789.65	50,000	✓		✓	Yes	✓	✓	Medium	Low
2	**Establish new forest reserves on unused land**	96.6	1,233,000	✓			No			Low	Low
3	**Agroforestry expansion programme**	136.65	2,105,000	✓		✓	No			Medium	Low
4	**Develop a commercial sandalwood industry**	59.4	4,185,000	✓		✓	Yes	✓		High	Medium
5	**Pasture improvement and**	0.55	601,000	✓		✓	No			Low	Medium

[162] Unsequenced total cumulative GHG emissions reduction by 2030

[163] Unsequenced total investment need required

[164] Finance refers to loans that have to be repaid. Projects that incur large up-front costs but have viable funding sources for recovering these costs over time require finance. For NDC projects, finance is likely to come in one of two forms: 1) Commercial finance from private lenders (this can sometimes be coupled with credit enhancements such as credit guarantees or risk-sharing facilities), and 2) Concessional finance from international donors (these would be in the form of sovereign lending)

Prioritization	Project name	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[162]	Indicative investment needs (US$)[163]	Funding sources			Is Finance Required?[164]	Type of finance		Likelihood of attracting private or donor funding	Capacity required to implement
				Grants from international donors	Government funding	User fees		Commercial finance	Concessional finance		
	fertilizer management										
					Waste sector						
1	Moving towards zero waste	12.49	1,100,000	✓			No			High	Medium
2	Waste-to-Energy	9.3	3,800,000	✓		✓	Yes	✓	✓	Low	High
3	Outer island waste management services	3.5	5,630,000	✓		✓	No			Medium	Medium
4	Organic recycling	0.56	1,030,000	✓			No			High	Low
					Marine sector						
1	Mangrove Restoration and Planting	40.58	3,758,000	✓	✓		No			High	Low
2	Apply detached breakwaters		7,200,000	✓	✓		No			High	Low
3	Model Tonga's hydrodynamic connectivity		550,000	✓			No			Medium	Low
4	Enhanced community monitoring and		1,100,000	✓			No			High	Medium

Prioritization	Project name	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[162]	Indicative investment needs (US$)[163]	Funding sources			Is Finance Required?[164]	Type of finance		Likelihood of attracting private or donor funding	Capacity required to implement
				Grants from international donors	Government funding	User fees		Commercial finance	Concessional finance		
	enforcement of SMAs and FHRs										
5	**Optimization the size of MPAs, FHRs, and SMAs**		500,000	✓			No			High	Medium
6	**Review and update regulations for MPAs, FHRs, and SMAs**		350,000	✓			No			High	High
					Energy sector						
	Electricity sub-sector*										
1	Sunergise 6 MW Solar PV IPP	35	12.2mn	✓	✓	✓	No	✓	✓	Secured	Low
1	GET 6 MW of Solar PV IPP	35	9.3mn	✓	✓	✓	Yes	✓	✓	High	Low
2	2.25 MW China Wind Farm	38	12.31mn	✓	✓		No		✓	Secured	Low
3	3.8 MW of Wind IPP	66	19.9mn	✓	✓	✓	No	✓	✓	Secured	Low
4	TPL 34-50 GWh Tender (technology agnostic)	~147	TBD	✓	✓	✓	Yes	✓	✓	High	Medium

Prioritization	Project name	Cumulative GHG emissions reduction by 2030 ($GgCO_2e$)[162]	Indicative investment needs (US$)[163]	Funding sources			Is Finance Required?[164]	Type of finance		Likelihood of attracting private or donor funding	Capacity required to implement
				Grants from international donors	Government funding	User fees		Commercial finance	Concessional finance		
5	Nuku'alofa Network Upgrade **	2.1	6.8mn	✓	✓		Yes		✓	Partially secured	Low
	Transport sub-sector										
	Improving Intake Quality of Vehicle	99**	TBD	✓	✓	✓	Yes	✓	✓	TBD	TBD
	Non-motorised Transport	22**	TBD	✓	✓	✓	Yes	✓	✓	TBD	TBD
	Low Emission Vehicles	165**	TBD	✓	✓	✓	YEs	✓	✓	TBD	TBD

*Note: *All electricity sector projects are estimated to be operational by 2024.** to provide an estimated 1% line-loss improvement to the Tongatapu network and keep total line-losses below 8% per year.*

Potential sources of funding under the three categories described above are listed in Table 6.2. Tonga is one of 74 low-income counties eligible to receive support under the World Bank's International Development Association. Tonga's classification as a developing country makes it eligible for support from a wide range of international donors.

Table 6.2: Sources of funding available in Tonga

Donor Funding		
Name of donor	**Type of funding support**	**Type of Institution**
World Bank (International Development Association)	Grants, TA, and capacity building	Banks
Asian Development Bank	Grants, TA, and capacity building	
Asian Infrastructure Investment Bank (AIIB)	Grants, TA, and capacity building	
Green Climate Fund	Grants, TA, and capacity building	Funds
Global Environment Facility	Grants, TA, and capacity building	
IFAD	Grants, TA, and capacity building	
UNDP[165]	Grants, TA, and capacity building	Multilateral agency
GGGI	TA and capacity building	Multilateral agency
New Zealand Ministry of Foreign Affairs and Trade	Bilateral ODA grants	Bilateral agencies
Australian Department of Foreign Affairs and Trade	Bilateral ODA grants	
UK Department for International Development	Bilateral ODA grants	
People's Republic of China External Trade and Economic Cooperation Ministry	Bilateral ODA grants	
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	Bilateral ODA grants	
Japanese International Cooperation Agency	Bilateral ODA grants	
European Union	Multilateral ODA grants	
Possible sources of Government Funding		
Ministry of Finance (MOF)		
Ministry of Agriculture, Food, and Forests (MAFF)		
Ministry of Lands and Natural Resources (MLNR)		
Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate change and Communications (MEIDECC)		
Ministry of Fisheries		
Ministry of Infrastructure (MOI)		
Types of User Fees		
Revenue from user tariffs		

[165] UNDP provides financial and technical support to projects through Global Environment Facility (GEF) and Green Climate Fund (GCF).

Avoided costs[166]

Potential sources of finance under the two categories described above are listed in Table 6.3. Tonga's private financial sector is small, and experience with lending to businesses and households is limited. There are four commercial banks registered in Tonga.[167] Tonga does not have a sovereign credit rating. This makes it difficult for Tonga to access funding in international bond markets, because investors cannot see the level of risk associated with investing in the debt of Tonga.

However, the Tonga Development Bank is currently in the process of applying for accreditation under the Green Climate Fund, which is likely to enable significant upscaling in the amount of funding and financial support available for climate change projects in Tonga.[168] Tonga's MoF is also applying for accreditation under the Green Climate Fund. MoF can also make use of an established and active Project Management Unit to increase the flow of climate finance to Tonga once accreditation is secured. It may be worthwhile establishing a dedicated division within Tonga's MoF Project Management Unit to focus on NDC implementation financing. Tonga's Development Bank and MoF should also consider applying for accreditation under the Adaptation Fund, which could provide substantial financial assistance for adaptation projects.

Table 6.3: Sources of finance available in Tonga

Concessional Finance	Commercial Finance
World Bank	ANZ Bank Tonga Limited
Asian Development Bank	MBF Bank
European Investment Bank	Tonga Development Bank
Australian Aid	Bank of the South Pacific Tonga
European Union	
Green Climate Fund	
Global Environment Facility	
Climate Investment Funds (World Bank)	

Once the projects are fully developed, the appropriate Implementing Agency should review each project against the criteria that funding and financing organizations have, and prepare multiple applications. Most projects will have to try different sources of funding before funding is secured. It will be beneficial for Implementing Agencies to become familiar with the application process and work with multiple funders and financiers.

Tonga has established the Tonga Climate Change Fund to increase the provision of funding and finance for climate change projects

[166] Avoided costs is the incremental cost that is not incurred when the additional output is not produced. For example, the cost of paying for diesel for a generator may be avoided when a solar panel is installed.

[167] https://www.adb.org/sites/default/files/publication/530266/pacific-finance-sector-tonga.pdf

[168] UNDC (2021) High-level NDC Financing Pathways for Tonga, United Nations Development Programme.

The Tonga Climate Change Fund (TCCF) was the Pacific region's first national fund with a specific focus on climate change. The fund comprises two elements:

- An endowment account (which holds 80% of the initial US$4 million endowment)
- An operational account which is used to fund and finance climate change projects.

This separation is designed to ensure that the fund is self-sustaining and can offer a long-term financing mechanism for climate change projects. The intention is that sound management and governance of this fund will help Tonga to build stronger relationships with development partners and potential donors, and may attract further contributions to the fund in the future.

7 Implementation Plan

This implementation plan shows the estimated timing and duration of each of the pipeline projects, and shows how the costs are distributed over time. Section 7.1 then outlines a monitoring evaluation framework to guide the implementation of Tonga's Second NDC. This monitoring and evaluation framework identifies the reporting, recording, and evaluation structures needed to manage implementation of the pipeline projects, and identifies the party that should be responsible for each.

7.1 Timings and costs of project implementation

The timings and durations of each of the mitigation projects included in Tonga's project pipelines are shown in Table 7.1. As explained in Section 3, institutional capacity constraints mean that it is not feasible to run all mitigation projects concurrently. Therefore, projects are sequenced in order of priority, ensuring that no more than three projects happen concurrently in each of the priority sectors.

Table 7.1: Timing and duration of project pipelines

Project	2022	2023	2024	2025	2026	2027	2028	2029	2030
AFOLU Sector									
Develop new forest plantations	■	■	■	■	■	■			
Establish new forest reserves on unused land	■	■	■	■	■	■			
Agroforestry expansion programme	■	■	■	■	■	■	■		
Develop a commercial sandalwood industry							■	■	■
Pasture improvement and fertilizer management							■	■	■
Waste Sector									
Moving towards zero waste	■	■	■	■					
Waste-to-energy	■	■	■	■	■	■	■		
Outer island waste management services	■	■	■	■	■				
Organic recycling					■	■	■	■	■
Marine sector									
Mangrove restoration and replanting	■	■	■	■	■				
Apply detached breakwaters	■	■	■	■	■	■			
Model Tonga's hydrodynamic connectivity	■	■	■	■	■	■			
Enhance community monitoring and enforcement of SMAs and FHRs						■	■	■	■
Optimisation of the size of MPAs, FHRs, and SMAs							■	■	■
Review and update regulations for MPAs, FHRs, and SMAs							■	■	■
Energy Sector									
Sunergise 6 MW Solar PV IPP	■	■	■	■					
GET 6 MW of Solar PV IPP		■	■	■	■				
2.25 MW China Wind Farm	■	■	■	■					

3.8 MW of Wind IPP									
TPL 34-50 GWh RFP (technology agnostic)									
Nuku'alofa Network Upgrade **									
Improving Intake Quality of Vehicle									
Non-motorised Transport									
Low Emission Vehicles									

Table 7.2 shows the timings of costs (including capital and implementation costs) associated with each of the pipeline projects.

Table 7.2: Timing of costs associated with project pipelines (US$)

Project	2022	2023	2024	2025	2026	2027	2028	2029	2030
AFOLU Sector									
Develop new forest plantations	$ 50,000								
Establish new forest reserves on unused land	$ 206,000	$ 206,000	$ 206,000	$ 206,000	$ 206,000	$ 206,000			
Agroforestry expansion programme	$ 301,000	$ 301,000	$ 301,000	$ 301,000	$ 301,000	$ 301,000	$ 301,000		
Develop a commercial sandalwood industry							$ 602,000	$ 602,000	$ 602,000
Pasture improvement and fertilizer management							$ 286,000	$ 105,000	$ 105,000
Waste Sector									
Moving towards zero waste	$ 275,000	$ 275,000	$ 275,000	$ 275,000					
Waste-to-energy	$ 400,000	$ 400,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000		
Outer island waste management services	$ 1,126,000	$ 1,126,000	$ 1,126,000	$ 1,126,000	$ 1,126,000				
Organic recycling					$ 206,000	$ 206,000	$ 206,000	$ 206,000	$ 206,000
Marine sector									
Mangrove restoration and replanting	$ 752,000	$ 752,000	$ 752,000	$ 752,000	$ 752,000				
Apply detatched breakwaters	$ 1,200,000	$ 1,200,000	$ 1,200,000	$ 1,200,000	$ 1,200,000	$ 1,200,000			
Model Tonga's hydrodynamic connectivity	$ 92,000	$ 92,000	$ 92,000	$ 92,000	$ 92,000	$ 92,000			
Enhance community monitoring and enforcement of SMAs and FHRs						$ 220,000	$ 220,000	$ 220,000	$ 220,000
Optimisation of the size of MPAs, FHRs, and SMAs							$ 100,000	$ 100,000	$ 100,000
Review and update regulations for MPSa, FHRs, and SMAs							$ 70,000	$ 70,000	$ 70,000

Note: Energy Sector cost and financing schedule not available.

7.2 Monitoring and evaluation framework

This section outlines a high-level monitoring and evaluation (M&E) framework for DCC to keep track of progress towards implementing Tonga's Second NDC. This framework reflects the NDC M&E Framework for Tonga, which is forthcoming. The NDC M&E Framework builds on the existing Tonga JNAP2 M&E system to present an overarching M&E framework for Tonga's Second NDC. One of the core goals of Tonga's NDC M&E Framework is to increase the rigour of M&E efforts in Tonga by focusing on results-based management that uses specific, measurable, achievable, realistic, and time-bound (SMART) indicators. This framework provides a transparent system to measure progress, while building accountability and encouraging government employees to take ownership of the actions. The monitoring and evaluation framework has three components:

- A reporting structure that assigns responsibility over actions to specific government employees
- A monitoring structure that tracks progress in a transparent manner
- An evaluation structure that outlines the consequences for completing—or not completing—actions in time.

Under the M&E framework, government staff responsible for implementing the NDC should assign responsibility for each project in tiers:

- **NDC M&E Officer**—based within an expanded NDC/JNAP Secretariat. This will be the person ultimately responsible for overseeing implementation of Tonga's NDC.
- **Sector Focal Points**—Individuals responsible for implementing specific actions in the AFOLU, waste, marine, and energy sectors, included in this NDC Implementation Roadmap, and reporting on progress to the NDC M&E Officer.[169]
- **Executors (Implementing Agency)**—Individuals responsible for carrying out the day-to-day tasks required to manage and implement the priority projects in each sector. Executors can include managers as well as line staff, who should make up the bottom tier of the structure.

Table 7.3 shows the implementing agencies that house the proposed executors responsible for delivery of each of the priority projects in Tonga's NDC project pipeline, and supporting agencies for each project.

[169] The Sector Focal Points under the JNAP 2 M&E framework can be utilised.

Table 7.3: Proposed executors responsible for priority projects

Pipeline Project	Executors (Implementing Agency)[170]	Supporting agency(ies)	Sector
Agroforestry expansion programme	MAFF	MLNR	AFOLU
Develop new forest plantations	MAFF	MLNR	
Develop a commercial sandalwood industry	MAFF	MLNR	
Establish new forest reserves on unused land	MAFF	MLNR	
Pasture improvement and fertilizer management	MAFF	MEIDECC	
Outer island waste management services	TWAL	MEIDECC (Department of Environment)	Waste
Moving towards zero waste	MEIDECC (Department of Environment)	• TWAL • Town and District Officers	
Waste-to-energy	Department of Energy	• MEIDECC (Department of Environment) • MOI • TWAL	
Organic recycling	TWAL	• MAFF, Department of Energy • MEIDECC (Department of Environment)	
Review and update regulations for MPAs, FHRs, and SMAs	Ministry of Fisheries MEIDECC (Department of Environment)	• MLNR • AGO	Marine
Enhance community monitoring and enforcement of SMAs and FHRs	Ministry of Fisheries MEIDECC (Department of Environment)	MAFF	
Optimisation of the size of MPAs, FHRs, and SMAs	• Ministry of Fisheries • MEIDECC (Department of Environment)	AGO	

[170] Implementing agencies were identified by stakeholders in their responses to the consultation survey distributed during the Consultation Workshop.

Model Tonga's hydrodynamic connectivity	MEIDECC (Department of Environment)	Ministry of Fisheries	
Apply detached breakwaters	MEIDECC (DCC)	MOI	
Mangrove restoration and planting	• Department of Environment • DCC	MLNR	
Sunergise 6 MW Solar PV IPP	Private Sector	TPL	**Energy**
GET 6 MW of Solar PV IPP	Private Sector	TPL	
2.25 MW China Wind Farm	TPL	MEIDECC (Department of Energy)	
3.8 MW of Wind IPP	Private Sector	TPL	
TPL 34-50 GWh Tender (technology agnostic)	Private Sector	TPL	
Nuku'alofa Network Upgrade **	TPL		
Improving Intake Quality of Vehicle	• Ministry of Infrastructure • (Land Transport Division)	MEIDECC (Department of Energy)	
Non-motorised Transport	Ministry of Infrastructure (Land Transport Division)	MEIDECC (Department of Energy)	
Low Emission Vehicles	• Ministry of Infrastructure (Land Transport Division) • MEIDECC (Department of Energy)	MEIDECC (Department of Energy)	

In many cases, there will be a need to invest in education, training, and awareness raising within implementing and supporting agencies running NDC projects. It is important that these activities are budgeted for. The Concept Notes in Appendix A identify education, training, and awareness raising requirements of each of the NDC Pipeline Projects, alongside high-level estimates of cost.

Where there is substantial sharing of responsibilities between implementing agencies and supporting agencies for delivery of an NDC project, formal agreements on the division of responsibilities may be required. This could take the form of a Memorandum of Understanding (MOU) between the two agencies concerned.

Communication is a vital part of the monitoring framework—the NDC M&E Officer, Sector Focal Points, and Executors should frequently discuss progress on the projects under their supervision. Sector Focal Points should meet weekly with their Executors to track day-to-

day tasks and liaise with any external consultants involved in the projects in their sector. In addition, to ensure coordination between NDC projects in different sectors, the three Sector Focal Points should meet with each other once a month to discuss potential synergies and trade-offs between the projects they are responsible for. Sector Focal Points should give quarterly briefings to the NDC M&E Officer, updating them on progress on the NDC projects in their sector. The NDC M&E Officer should be responsible for reporting annually on NDC implementation progress. This report should:

- Include an evaluation of progress on each of the pipeline projects against the Gantt chart shown in Table 7.1, and it should clearly mention if the timeline needs to be extended, or if resources need to be increased, to ensure pipeline projects are implemented
- Make note of how the NDC projects are tracking to achieve NDC targets, for example the cumulative GHG emissions reduction to date
- Detail the people responsible for each project at that point in time (as these people will likely change over the course of the NDC Implementation Roadmap and Investment Plan with Project Pipeline).

This report should be submitted to the JNAP Taskforce and the Department of Climate Change for review, and then finalised for submission to the National Climate Change Coordination Committee (NCCCC), chaired by the Minister for MEIDECC. The NCCCC and the Minister for MEIDECC will then approve the document before being released publicly.

Sector Focal Points should be responsible for recording progress on implementing the NDC in a centralized monitoring spreadsheet (held by DCC). This file should store quarterly updates on the implementation status of each of the pipeline projects, including the following information:

- Project status (Planning/Implementation/Complete)
- Funding status (Not Funded/Partially Funded/Fully Funded)
  - Target source(s) of funding (if not fully funded)
- Estimated GHG emissions reductions achieved
  - Assumptions and calculations used to estimate GHG emissions reductions
- Estimated adaptation benefits achieved
- Notes (e.g. description of new barriers encountered, or new technological developments)

This spreadsheet should be referred to by ministries and other institutions when designing new projects in Tonga. This will reduce the possibility of duplication and encourage synergies between projects. To promote transparency, the platform's information should be available to all levels of the implementation team, including Executors.

This spreadsheet should also report on progress relative to the NDC M&E Results Framework. While this framework has yet to be finalised, current draft versions comprise

four high-level Outcomes, 14 Outputs, and 45 Strategies/Activities. These Outcomes, Outputs, and Strategies/Activities are subject to further discussions and may change before the framework is finalised, so they are not reported here. However, the NDC M&E Officer, Sector Focal Points, and Executors should refer to this NDC M&E Framework to define the broader Outcomes, Outputs and Strategies/Activities once it is officially adopted.

DCC should also implement an evaluation structure that can help ensure projects are implemented on time. This evaluation structure integrates key elements from the reporting and recording structures. For instance, the evaluation structure is based on the meetings that are held to report on progress—that is, meetings between the Sector Focal Points and the Executors, and the Sector Focal Points and the NDC M&E Officer. The evaluation structure also uses the information that is recorded in the monitoring spreadsheet.

The evaluation structure forces the NDC M&E Officer, Sector Focal Points, and Executors to assess the progress being made on all actions. The NDC M&E Officer and Sector Focal Points must actively evaluate which individuals are meeting targets, which are excelling, and which may need further assistance. They must decide if it will be necessary to adjust the timeline or resources to ensure successful implementation. As part of this process, the NDC M&E Officer must establish clear consequences for failing to complete actions as planned. If an action cannot be completed, the Sector Focal Points—along with their Executors—must be held accountable.

7.3 Guidelines for promoting gender and social inclusion

Integrating gender and social inclusion and ESS[171] considerations in project design and implementation planning is essential to avoid negative impacts, ensure achievement of project objectives, and improve overall development outcomes. In addition, this allows citizens of Tonga to learn additional gender and social inclusion and EES skills. The guidelines presented in this section will help to achieve these objectives and help to ensure that the NDC Roadmap and Implementation Plan with Project Pipeline reflects and addresses relevant gender and social inclusion issues and promotes community rights, engagement, and consultation in Tonga.

7.3.1 Promoting gender and social inclusion

International experience suggests large infrastructure projects tend to employ mainly men, and offer women mostly self-employment opportunities in typically female-dominated areas (for example, hospitality services).[172] Pre-existing gender roles and social

[171] https://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Sustainability-At-IFC/Policies-Standards/Performance-Standards

[172] Energy Sector Management Assistance Programme (2018). *Getting to Gender Equality in Energy Infrastructure—Lessons from Electricity Generation, Transmission, and Distribution Projects*. ESMAP Technical Report 012/18.

norms, a lack of construction and engineering skills, occupational segregation by gender, and employer stereotyping are factors contributing to women's constrained ability to take advantage of new labour market opportunities in infrastructure. International evidence also suggests that safety can constitute a significant concern for women considering jobs in infrastructure.[173]

Promoting gender and social inclusion in capacity building and employment in NDC projects will allow developers to maximize their opportunity to employ local labour, to contribute to local development, and to foster social acceptance for their projects. The NDC M&E Officer and Sector Focal Points overseeing NDC projects in Tonga should promote gender and social inclusion in these projects by implementing effective measures to limit occupational segregation and pay gaps. Measures that could contribute to this include, but are not limited to:

- Equal-pay-for-equal-work policy clauses
- Monitoring pay rates for men and women to identify if a gap exists
- Career development programs
- Creation and support of women's groups/networks
- Women's mentoring/coaching
- Implementing effective measures to create working conditions attractive to women
- Providing social protection addressing women's specific needs (for example, maternity leave)
- Inclusion of vulnerable groups, such as persons with disabilities
- Promoting healthy work-life balance
- Providing vocational training
- Facilitating childcare arrangements
- Training and sensitization of human resource managers to eliminate gender bias (particularly for construction, operations, and management roles)
- Ensuring (and monitoring) appropriate safety and working conditions at project construction sites and in operational areas, particularly for women (e.g. through improved lighting)
- Collecting and publishing gender-disaggregated employment data.

[173] Energy Sector Management Assistance Programme (2018). *Getting to Gender Equality in Energy Infrastructure—Lessons from Electricity Generation, Transmission, and Distribution Projects*. ESMAP Technical Report 012/18.

International evidence also suggests that large infrastructure projects can increase exposure to health risks and gender-based violence.[174] In relation to these risks, the NDC M&E Officer and Sector Focal Points overseeing NDC projects should:

- Integrate the following as project design components: health education, gender-based violence prevention, and awareness campaigns on safety risks
- Consult with provincial-level authorities to discuss and agree on mitigating strategies
- Include women in all consultations and communication plans to create adequate mitigation mechanisms to protect families and promote health risk management.

7.3.2 Environmental and social standards

It is important that the potential environmental and social impacts of NDC projects are considered carefully, and measures are taken to avoid negative outcomes. The concept notes for each of the NDC projects included in the project pipelines include sections identifying possible environmental or social impacts. As these projects move from the concept note phase into the pre-feasibility and feasibility study phases, it is important that they undergo rigorous environmental impact assessment and social and cultural impact assessments. These assessments will help to develop a full picture of the environmental, social, and cultural impacts of the project, and will help the implementing agencies to minimize negative impacts where possible.

Tonga is currently developing an NDC Gender Inclusion document, which should be utilised once published. The International Finance Corporation's (IFC) Environmental and Social (E&S) Performance Standards also provide standards and guidelines for managing eight key environmental and social risks, such as land resettlement, biodiversity, and cultural heritage, and help ensure commitment to sustainable development[175] . Projects in Tonga's NDC Roadmap and Plan should use the NDC Gender Inclusion document and IFC's E&S Performance Standards. This will help Tonga to identify and manage environmental and social risks.

[174] Energy Sector Management Assistance Programme (2018). *Getting to Gender Equality in Energy Infrastructure—Lessons from Electricity Generation, Transmission, and Distribution Projects*. ESMAP Technical Report 012/18.

[175] https://www.ifc.org/wps/wcm/connect/24e6bfc3-5de3-444d-be9b-226188c95454/PS_English_2012_Full-Document.pdf?MOD=AJPERES&CVID=jkV-X6h

Appendix A: Project pipeline

AFOLU sector

Agroforestry expansion programme

Project name: Agroforestry expansion programme		
Sector: AFOLU	Sub-sector: Agroforestry	Project type: Awareness-raising and investment
Project description		
This project would support the expansion of agroforestry in Tonga (including coconut, commercial timber species, and other traditional species planted for medicinal or ornamental value).[176] Agroforestry expansion would be supported by extension work, provision of seedlings, and targeted investments in the timber value chain. This project would also seek to increase the use of high-value companion trees, such as fruit trees. This project will focus on engaging with private tax allotment owners, who often struggle to plant forestry because it is a long-term investment with no payoff until the timber is harvested. Therefore, the best way to promote forestry is through agroforestry which allows landowners to earn short-term income through agriculture and tree crop products and long-term income from timber. Care must be taken, however, to consult carefully with communities and include their views in the design of this project. There may also be benefit in trying to involve schools and young people in agroforestry expansion work, to enhance the reach of the project and improve community buy-in. Efforts should also be made to empower women in tree planting decisions to ensure that agroforestry enhances women's' abilities to commercialise produce. Secretariat of the Pacific Community (SPC) held a two-day agroforestry training programme in 2014, which included students from Hango Agricultural College, Petani Women's Food Security, and other stakeholders.[177] Lessons learnt from SPC's training programme should be implemented when further developing this project. According to Tonga's Forest Management Plan (2017)[178], the Forestry Division is actively encouraging agroforestry re-planting on areas previously cleared for squash production. While these efforts have focussed mainly on re-planting coconut palms, Tonga's Forestry Division wants to encourage the use of commercial timber species, and other traditional species in agroforestry systems. It is possible to use Caribbean pine, red cedar, white cedar, and Kauri Pine in agroforestry systems. This project would build on previous agroforestry work to support the increased use of valuable timber species in agroforestry systems in Tonga through awareness raising activities and targeted support. This project would also leverage, promote, and strengthen traditional knowledge of agroforestry practices in Tonga. Several valuable species, including red cedar, mahogany, teak, Caribbean Pine, and Kauri Pine grow well in Tonga, however there is currently only one small (500 ha) plantation on 'Eua. Limited harvesting and processing capacity mean that plantation timber is harvested at well below its sustainable yield. The low level of production means that the local timber industry has been unable to develop economies of scale and struggles to compete on cost with timber imported from Fiji and New Zealand. Tonga's Forest Management Plan (2017) notes that, while local timber is currently underutilised, there is potential to develop new processing industries for products including flooring and furniture. This project would therefore support investments in timber and wood processing and export facilities, and technical assistance and capacity building for the adoption of sustainability certifications. Specifically, this project would support investments in timber harvesting, processing, and export facilities, capable of processing		

[176] Stakeholders at the consultation workshop emphasised the need to include agroforestry species planted for medicinal and ornamental value, because these are predominantly planted by women.

[177] https://lrd.spc.int/our-work/forest-and-trees/52/spc-supports-agroforestry-in-tonga

[178] Tonga Forest Management Plan (2017). Available at: https://tonga-data.sprep.org/system/files/Management%20Plan%20for%20Forests%20Resources%20in%20Tonga%202017.pdf

12,000 m3 per year.[179] This could include viability gap funding for investments that are economically viable (considering the shadow price of carbon) but not commercially viable. This project would also support the planting of high-value companion trees, such as fruit trees. Stakeholders have noted the importance of promoting fruit trees in Tonga; some fruit trees have been dying off due to viruses, diseases, and changing weather patterns.[180] Tonga's Forestry Department has been pushing initiatives to help build fruit production, and MAFF is also running awareness and training programmes to help teach better fruit tree maintenance and protection in the community.[181] This project could support these efforts. This project would also include measures to safely manage and dispose of timber processing chemicals, and measures to develop a managed felling system. Efforts would also be made to manage agroforestry timber resources sustainably and capitalize on sustainability certifications where possible. Health and safety requirements for chemicals, including chemical disposal, will be important for this project and other AFOLU sectors projects. Training and awareness-raising activities will be required. Stakeholders in Tonga stated that Tonga is looking into building a technical devices hub. These devices can be made from plants and may therefore be a user of forestry products. It will be important to engage with developments with the technical devices hub as this project evolves.[182] An up-to-date and accurate inventory of lands and forests will be an important foundation for this project. This will require strengthening of GIS data and analytics capacity. It will also require education, training, and awareness-raising activities for staff within the implementing agency. It may be challenging for people with disabilities to engage with all aspects of this project, for example people with physical disabilities may find it challenging to take part in tree planting. Efforts should be made to include people with disabilities during project development and implementation (where possible). This project aligns with AFOLU Actions 1, 2, 3, 4, and 6 in Tonga's LEDS. It also aligns with target 7 in JNAP-2—30% of land in Tonga utilised for agro-forestry or forestry.
Estimated impacts (GHG emissions reduction and/or adaptation benefit)
This project would aim to increase the area of land under agroforestry by 10,511 ha (30% of the current agricultural land in Tonga).[183] According to IPCC Guidelines for National Greenhouse Gas Inventories (2006), coconut palms in cropland, grassland, and shrubland sequester carbon at between 0.0013 and 0.0039 $GgCO_2e$/ha/year.[184] Taking the mid-point of this range (0.0026 $GgCO_2e$/ha/year), and multiplying this by the target area (10,511 ha) indicates that this project would be capable of reducing GHG emissions by 27.33 $GgCO_2e$/year once fully implemented. Assuming that community outreach and consultation occurs in 2022 and 2023, and GHG emissions reductions increase in a linear fashion over the first five years of project implementation to reach 27.33 $GgCO_2e$/year in 2028, the cumulative GHG emissions reduction potential between now and 2030 would be 136.65 $GgCO_2e$.

[179] While it is not possible to estimate the proportion of timber tree species to coconut and other ornamentals in this agroforestry expansion project, the assumed additional timber processing requirement is equal to four times the capacity required to process the sustainable yield of the current 500 ha plantation in Tonga (3,000 m3). The sustainable yield of the current 500ha plantation was reported in the Tonga Forest Management Plan (2016-2020).

[180] https://www.rnz.co.nz/international/pacific-news/317012/tonga-look-to-revive-local-fruit-production

[181] https://www.rnz.co.nz/international/pacific-news/317012/tonga-look-to-revive-local-fruit-production

[182] Stakeholders at the Validation Workshop for Tonga's NDC Implementation Roadmap and Investment Plan.

[183] According to World Bank Data, Tonga had an agricultural land area of 35,036 ha in 2017. Source: https://data.worldbank.org/indicator/AG.LND.TOTL.K2?locations=TO

[184] Calculated using the default factor for annual above-ground net-biomass growth and the ratio of below to above ground biomass reported in Tonga's NDC Review Report. This is then multiplied by the default value for the carbon fraction of above ground forest biomass (0.00047 Gg of carbon per Gg of dry matter) reported in the IPCC Guidelines for National Greenhouse Gas Inventories (2006). Coconut palms are used as a proxy for commercial timber trees in these estimates because sequestration rates are estimated for low-density stands in grasslands and shrublands. It is expected that these estimates better reflect the sequestration rates of low-density agroforestry systems than species-specific estimates of high-density plantations would.

Cost estimates	*Estimated time scale*
The total cost of this project would be $2,105,000, comprising a support programme and efforts to adopt sustainability certifications. **Agroforestry support programme** Estimates of the cost of the support programme are based on a similar agroforestry support programme developed in Samoa, which included the following components: US$25,695 for managing the program and promoting agroforestry on community lands US$5,191 for awareness raising and extension services to support planting of agricultural trees[185] US$7,187 for distributing seedlings to landholders. The NDC project plans to plant approximately 630,660 trees (10,511 ha at a density of 60 stems per ha).[186] Tonga's Forestry Division can source seedlings at US$3 per stem. Therefore, the cost of distributing 630,660 seedlings under this project would be US$1,892,000. Assuming that the awareness raising and promotion programme costs for Tonga are the same as those estimated for the agroforestry support programme in Samoa, the total cost of this project would be US$ 1,923,000. **Adoption of Sustainability Certifications** It is estimated that the management of sustainability certifications for agroforestry timber would be equivalent to two full-time (established) staff members. Employing these two additional staff members would cost US$22,782 per year.[197] Assuming that these two additional staff members are required from 2023 onwards, the total cost of this measure would be US$182,000. **Timber processing investments** While it is difficult to estimate the commercial viability of timber harvesting, processing, and export facilities capable of processing 12,000 m3 per year without undertaking a full feasibility study, the GHG emissions reduction potential of this project can be multiplied by the shadow price for carbon to estimate the maximum viability gap funding this project might justify. Assuming a shadow price of carbon of	This project could be implemented over the course of seven years. According to Tonga's Agriculture Sector Plan (2016-2020), the building of community cohesion and capacity is a key element of successful projects in the AFOLU sector. Experience shows that it can take between 9 and 15 months to build community capacity and ownership, which will be an essential precursor for this project. While this project initially allocated one year for community engagement, stakeholders at the consultation workshop recommended increasing this. Therefore, two years is allocated to community outreach and consultation before this project enters its implementation phase. Once this project enters its implementation, it is expected to take a further five years to implement. This timeframe is in line with a similar agroforestry support project planned in Samoa.

[185] Lessons learned at SPC's two-day training programme in 2014 should be considered where when designing awareness raising, extension services, and training programmes.

[186] For the purposes of estimating project cost, it is estimated that commercial timber trees are planted at a density of 60 stems per hectare, in line with the density being targeted by current agroforestry support work in Tonga recorded in Taonga's Forest Management Plan (2017).

US$0.067/Gg$CO_2e$[187], and that commercial forestry species make up 30% of the trees planted under the agroforestry expansion programme, the maximum viability gap funding that harvesting, processing and export facilities would justify is US$5,916,000.	
Affordability	***Likely co-benefits (including link to SDG)***
At present, MAFF's budget is overstretched, and the Ministry is unable to provide extension services to landowners consistent with its charter,[188] meaning that initial capacity building activities and ongoing extension services for this project would require external financial support.	Potential co-benefits of expanding agroforestry in Tonga include: Reduced flood risk as forested catchments act like sponges and reduce flood peaks when there are heavy downpours. This will contribute to SDG 3 (good health and well -being), SDG 11 (sustainable cities and communities), SDG 13 (climate action), and SDG 15 (life on land) The expansion of habitat for native wildlife would contribute to SDG 15 (life on land) Soil management and improvement would contribute to SDG 15 (life on land) Increased production of commercial timber, and contribution to downstream timber processing industries will contribute to SDG 8 (decent work and economic growth).
Potential environmental or social impacts	
Negative Expansion of the timber processing industry would lead to an increase in the use of treatment chemicals, which pose local environmental and health risks Agroforestry may in some cases lead to a reduction in agricultural productivity, which may increase the demand for imported food in Tonga Positive Inclusion of women and youth in the design and implementation of this project will allow them greater influence over the management of land in Tonga	
Procurement method	***Likelihood of attracting private or donor funding***
Given the current strain on MAFF's budget, this project would require external grant funding for initial capacity building activities and ongoing extension services. In principle, there would be potential to collect user fees from farmers who see commercial benefits from coconut palms. However, in practice, developing a scheme to collect user fees from farmers would be complex and costly, and it is not likely to be justified in Tonga.	***Medium*** Given its small size, this project may struggle to attract funding from international donors if put forward in isolation. However, it may be possible to bundle this project with other forestry and agriculture-related projects to attract donors to fund a larger programme of agriculture and forestry sector development in Tonga. Donors may also be attracted to the multiple co-benefits of this and other AFOLU sector projects. Expanding the area under agroforestry can increase the productivity of Tonga's agricultural sector and increase resilience to weather-related disasters in Tonga.
Capacity requirement to implement	***Potential barriers***

[187] This is the mid-range estimate for recommended shadow price of carbon in 2025 from the World Bank's guidance note on shadow price of carbon in economic analysis (2017). Available at: https://documents1.worldbank.org/curated/en/621721519940107694/pdf/2017-Shadow-Price-of-Carbon-Guidance-Note.pdf

[188] Tonga Agriculture Sector Plan 2016-2020. Available at: https://pafpnet.spc.int/resources/574-tonga-agriculture-sector-plan-2016-2020

Low This project would be very straightforward to implement. It leverages traditional knowledge and builds on existing agroforestry extension work in Tonga.	Tax allotment holders may be reluctant to plant long-rotation timber species unless land leases are extended. Sawmill cutting of more than 2,000m^3 of timber requires an environmental impact assessment under the Environmental Impact Assessment Act 2003. Any person who wishes to export forest produce must apply for approval from the CEO of MAFF.

Develop new forest plantations

Project name: Develop new forest plantations		
Sector: AFOLU	**Sub-sector: commercial forestry**	**Project type:** Scoping and investment
Project description		
This project would support the expansion of commercial timber plantations in Tonga on private land as well as the Government Estate and the King's Estate on 'Eua. This would be facilitated by a feasibility study on commercial forestry expansion on these two estates, technical assistance, and capacity building for the adoption of sustainability certifications, and through targeted investments in timber and wood processing and export facilities. The project would aim to increase the area of commercial timber plantations 500 ha to 7,614 ha over the course of five years.[189] Several valuable species, including red cedar, mahogany, teak, Caribbean Pine, and Kauri Pine grow well in Tonga, however there is currently only one small (500 ha) plantation on 'Eua. Limited harvesting and processing capacity mean that plantation timber is harvested at well below its sustainable yield. The low level of production means that the local timber industry has been unable to develop economies of scale and struggles to compete on cost with timber imported from Fiji and New Zealand. The feasibility study would focus on assessing the commercial viability and estimating the investment required to expand commercial forestry in Tonga. This study would build on to findings of Tonga's study into the feasibility of extending land leases to allow longer-rotation land uses such as tropical hardwood production, signalled in the Tonga Agriculture Sector Plan (2016-2020). The feasibility study would also consider the technical assistance and capacity building requirements to adopt sustainability certifications for timber grown in Tonga. Finally, this project would support investments in timber harvesting, processing, and export facilities, capable of processing 46,000 m3 per year.[190] This could include viability gap funding for investments that are economically viable (considering the shadow price of carbon) but not commercially viable. An up-to-date and accurate inventory of lands and forests will be an important foundation for this project. This will require strengthening of GIS data and analytics capacity. Care must also be taken to consult carefully with communities and include their views in the design of this project. This project will also require education, training, and awareness-raising activities for staff within the implementing agency. Health and safety requirements for chemicals, including chemical disposal, will be important for this project and other AFOLU sectors projects. Training and awareness-raising activities will be required. It may be challenging for people with disabilities to engage with all aspects of this project, for example people with physical disabilities may find it challenging to take part in tree planting. Efforts should be made to include people with disabilities during project development and implementation (where possible).		

[189] This equates to 25% of the combined area of the King's estate (1,313 ha) and the government estate (29,413 ha). The area of these two estates was reported by MAFF during written consultations.

[190] This capacity would be required to process timber from 7,614 ha of plantation forestry in Tonga. This was calculated by scaling the sustainable yield of the current 500 ha plantation in Tonga (3,000 m3) to the new forestry area this project envisages. The sustainable yield of the current 500ha plantation was reported in the Tonga Forest Management Plan (2016-2020).

This project aligns with AFOLU Actions 1, 2, 3, 4, and 6 in Tonga's LEDS. It also aligns with target 7 in JNAP-2—30% of land in Tonga utilised for agro-forestry or forestry.	
Estimated impacts (GHG emissions reduction and/or adaptation benefit)	
This project would aim to increase the area of plantation forestry in Tonga by 7,114 ha.[191] According to IPCC Guidelines for National Greenhouse Gas Inventories (2006), plantation forestry sequesters carbon at between 6 and 0.031 $GgCO_2e$/ha/year.[192] Taking the mid-point of this range (0.019 $GgCO_2e$/ha/year), and multiplying this by the target area (7,114 ha) indicates that this project would be capable of reducing GHG emissions by 131.61 $GgCO_2e$/year once fully implemented. Assuming that the feasibility study is completed in 2022, implementation begins in 2023, and GHG emissions reductions increase in a linear fashion over the first five years of the project to reach 131.61 $GgCO_2e$/year in 2027, the cumulative GHG emissions reduction potential between now and 2030 would be 789.65 $GgCO_2e$.	
Cost estimates	***Estimated time scale***
A feasibility study that expands on previous work in Tonga is estimated to cost US$50,000. While it is difficult to estimate the commercial viability of timber harvesting, processing, and export facilities capable of processing 43,000 m3 per year without undertaking a full feasibility study, the GHG emissions reduction potential of this project can be multiplied by the shadow price for carbon to estimate the maximum viability gap funding this project might justify. Assuming a shadow price of carbon of US$0.067/$GgCO_2e$[193], the maximum viability gap funding that harvesting, processing and export facilities would justify is US$ 19,066,000.	This project could be implemented over the course of six years. This timeframe allows one year for completing the feasibility study, and a further five years for implementation (consistent with a tree planting program in Samoa). While some work will need to be done to build community cohesion, capacity, and ownership, this can be done in parallel with the feasibility study, and would be less onerous than for other projects looking to encourage land use change on land that members of the public have private leaseholds over.
Potential environmental or social impacts	
Negative Expansion of the timber processing industry would lead to an increase in the use of treatment chemicals, which pose local environmental and health risks Commercial forestry can have negative environmental impacts, including increased sedimentation during harvest, flows of forestry slash (debris), biodiversity impacts (particularly if monocultures are used) and increased fire risk The expansion of forestry may in some cases convert land previously use for agriculture, which may increase the demand for imported food in Tonga It may be challenging for people with disabilities to engage with this project. Social inclusion must be prioritised in this project to ensure disabled people are not left behind	
Affordability	***Likely co-benefits (including link to SDG)***
At present, MAFF's budget is overstretched, and the Ministry is unable to provide extension services to landowners consistent with its charter,[194] meaning	Potential co-benefits of developing commercial timber plantations on the Government Estate and the King's Estate in Tonga include:

[191] 25% of the combined area of the Government Estate and the King's Estate in Tonga minus Tonga's existing 500 ha plantation.

[192] Calculated using the default factor for annual above-ground net-biomass growth and the ratio of below to above ground biomass reported for plantation forestry in Tonga's NDC Review Report. This is then multiplied by the default value for the carbon fraction of above ground forest biomass (0.00047 Gg of carbon per Gg of dry matter) reported in the IPCC Guidelines for National Greenhouse Gas Inventories (2006).

[193] This is the mid-range estimate for recommended shadow price of carbon in 2025 from the World Bank's guidance note on shadow price of carbon in economic analysis (2017). Available at: https://documents1.worldbank.org/curated/en/621721519940107694/pdf/2017-Shadow-Price-of-Carbon-Guidance-Note.pdf

[194] Tonga Agriculture Sector Plan 2016-2020. Available at: https://pafpnet.spc.int/resources/574-tonga-agriculture-sector-plan-2016-2020

that the feasibility study and any viability gap funding would require external financial support.	Reduced flood risk for downstream communities as forested catchments act like sponges and reduce flood peaks when there are heavy downpours. This will contribute to SDG 3 (good health and well -being), SDG 11 (sustainable cities and communities), SDG 13 (climate action), and SDG 15 (life on land) The expansion of forest habitat for native wildlife may contribute to SDG 15 (life on land). However, extensive timber monocultures may only benefit a small number of species, and have the potential to harm species suited to current land uses, therefore biodiversity co-benefits would need to be carefully examined. Increased production of commercial timber, and contribution to downstream timber processing industries will contribute to SDG 8 (decent work and economic growth).
Procurement method	***Likelihood of attracting private or donor funding***
Given the current strain on MAFF's budget, this project would require external grant funding for the feasibility study and to close any viability gap for the timber processing infrastructure. However, the major investments in forestry plantation and infrastructure could be financed and funded commercially through the sale of timber products for domestic use and export.	***Medium*** Given its small size, this project may struggle to attract funding from international donors if put forward in isolation. However, it may be possible to bundle this project with other forestry and agriculture-related projects to attract donors to fund a larger programme of agriculture and forestry sector development in Tonga. Donors may also be attracted to the multiple co-benefits of this and other AFOLU sector projects.
Capacity requirement to implement	***Potential barriers***
Low This project would be straightforward to implement. It builds on existing experience with commercial plantation forestry on the King's Estate in 'Eua.	The proposal to plant forestry on the government estate and the King's estate may conflict with other objectives for this land. Sawmill cutting of more than 2,000 m^3 of timber requires an environmental impact assessment under the Environmental Impact Assessment Act 2003. Any person who wishes to export forest produce must apply for approval from the Director of Agriculture, Forests and Fisheries, or a duly authorised officer.

Develop a commercial sandalwood industry

Project name: Develop a commercial sandalwood industry		
Sector: AFOLU	**Sub-sector: Forest products**	**Project type:** Extension work and regulatory enforcement
Project description		
This project would support the expansion of a sustainable commercial sandalwood industry in Tonga through enhanced extension work and provision of seedlings, implementation of the Sandalwood Regulations (2016), and adoption of sustainability certifications. This project would aim to plant 600,000		

sandalwood seedlings in Tonga between 2023 and 2030.[195] It would also seek to increase the use of high-value companion trees. These could include commercially valuable trees such as citrus, or socially valuable ornamental species. Efforts should be made to empower women in tree planting decisions to ensure that this project enhances women's' abilities to commercialise produce.

According to Tonga's Forest Management Plan (2017), the sandalwood industry has significant growth potential in Tonga, but it is currently constrained by illegal poaching and trading. Tonga already has its own set of sandalwood regulations (2016) that include the following main elements:

> "(a) a sandalwood grower or trader must register with the Forestry Division.
>
> (b) a tagging system is established to provide for the tagging and identification of sandalwood trees in order to provide verification of a sandalwood source and to discourage theft.
>
> (c) a sandalwood exporter must apply to the CEO of the Ministry for a license to export sandalwood and certain fees apply.
>
> (d) a Sandalwood Appeals Tribunal is established to review decisions of the Chief Executive Officer relating to the issuance of a Sandalwood Export License.
>
> (e) a system for determining prescribed fines is established; and
>
> (f) offences and penalties for the violation of the regulations are established."

However, according to Tonga's Forest Management Plan (2017), limited public resources mean that management of the sandalwood resource would require Tonga to develop an 'enhanced co-regulatory model'. This model would build capacity for self-management and allow the government to focus its limited resources on enforcement.

This project would build on MAFF's current work to increase planting of sandalwood trees in Tonga, and would include community engagement and training of citizens on propagation and tree management. Tonga's MAFF Corporate Plan and Budget 2020/21-2022/23 includes a target to produce and sell more than 139,500 sandalwood seedlings between 2020 and 2023.

There are two sandalwood species in Tonga—one native species [Yasu] and one exotic species from India. The local species is unique to Tonga and Fiji, and the quality of the sandalwood products from this species is very high. However, the exotic species are outcompeting the local species in Tonga. A decision will need to be made by the government about whether to support the local or the exotic species, however, from a biodiversity and environmental perspective, it would be best to prioritise the local species.

This project would also seek to strengthen the use of sustainability certifications for Tongan sandalwood. International markets increasingly require evidence of sustainable forest management and verifications that timber traded has been harvested legally. These certifications can deliver price premia for sustainably managed sandalwood. According to Tonga's Forest Management Plan (2017), one option would be to work with other countries in the Pacific to adopt a regional framework for the verification of the legality and certification of sustainability of forest products and timber. This is the recommended option for this particular project, noting that Tonga will have to devote some staff time and expertise to developing this regional framework.

An up-to-date and accurate inventory of lands and forests will be an important foundation for this project. This will require strengthening of GIS data and analytics capacity. Care must also be taken to consult carefully with communities and include their views in the design of this project. This project will also require education, training, and awareness-raising activities for staff within the implementing agency. There may also be benefit in trying to involve schools and young people in sandalwood conservation to enhance the reach of the project and improve community buy-in.

Health and safety requirements for chemicals, including chemical disposal, will be important for this project and other AFOLU sectors projects. Training and awareness-raising activities will be required.

It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities during project development and implementation (where possible).

[195] According to Tonga's LEDS, the export of sandalwood is currently banned in Tonga under the Sandalwood Regulations (2016).

This project aligns with AFOLU Actions 1, 2, 3, 4, and 6 in Tonga's LEDS. It also aligns with target 7 in JNAP-2—30% of land in Tonga utilised for agro-forestry or forestry.	
Estimated impacts (GHG emissions reduction and/or adaptation benefit)	
This project would aim to increase the stock of sandalwood trees in Tonga by 600,000 trees by 2030, relative to a scenario without this project. Mature sandalwood trees sequester carbon at a rate of 0.000022 $GgCO_2e$ per year.[196] Therefore, this project has the potential to sequester carbon at a rate of 13.2 $GgCO_2e$ per year in 2030. Assuming that community outreach and consultation occurs in parallel with MAFF's current efforts to expand the planting of sandalwood in 2022 and 2023, implementation of this second phase of the project begins in 2024, and that GHG emissions reductions increase in a linear fashion over the next six years to reach 13.2 $GgCO_2e$/year in 2029, the cumulative GHG emissions reduction potential between now and 2030 would be 59.4 $GgCO_2e$.	
Cost estimates	***Estimated time scale***
This project has an estimated total cost of US$4,185,000, comprising: **Provision of Seedlings** The NDC project plans to plant approximately 600,000 sandalwood trees. Tonga's Forestry Division can source and distribute sandalwood seedlings at US$5 per stem. Therefore, the cost of distributing 600,000 seedlings under this project would be US$3,000,000. **Enforcement of the Sandalwood Regulations** While enforcement of the Sandalwood Regulations (2016) is expected to rely on an enhanced co-regulatory model that leverages self-regulation, it is estimated that full enforcement would require an additional [10] enforcement officers in MAFF's staff. Established staff members within MAFF earn an average of US$ 11,391 per annum,[197] meaning that employing a further 10 officials would cost 113,910 per year (or US$ 1,025,190 over the nine years from 2022 to 2030). **Outreach and training on propagation** It is estimated that the training of citizens of sandalwood propagation would require one full-time (established) staff member. Employing this additional staff member would cost US$11,391 per year.[197] Assuming that this additional staff member is required from 2023 onwards, the total cost of this measure would be US$91,000. **Adoption of Sustainability Certifications** It is estimated that Tonga's contribution to a regional framework for the verification of the legality and certification of sustainability of forest products and timber would be equivalent to two full-time (established) staff members. Employing these two	This project could be implemented over the course of eight years. According to Tonga's Agriculture Sector Plan (2016-2020), the building of community cohesion and capacity is a key element of successful projects in the AFOLU sector. Therefore, two years is allocated to community outreach, consultation, and training in parallel with MAFF's current efforts to expand the planting of sandalwood in 2022 and 2023 before this project enters its implementation phase. Once this project enters its implementation phase, it is expected to take a further six years to plant 300,000 sandalwood seedlings at a rate of 50,000 seedings per year.

[196] FAO (2011). Focus on Sandalwood and Teak – conference proceedings. Available at: http://www.fao.org/3/ap001e/ap001e15.pdf

[197] The MAFF Corporate Plan and Budget 2020/2021 – 2022/2023 estimates that MAFF had a total of 211 Established Staff in 2020, and that the expenditure on these staff totalled US$ 2,382,408.

additional staff members would cost US$22,782 per year.[197] Assuming that it takes three years to develop this regional framework, this exercise would cost Tonga US$ 68,346.	
Affordability	***Likely co-benefits (including link to SDG)***
At present, MAFF's budget is overstretched, and the Ministry is unable to provide extension services to landowners consistent with its charter,[198] meaning that the provision of seedlings, sandalwood regulation enforcement work, and work to develop a regional framework for sustainability certification would require external financial support.	Potential co-benefits of developing a commercial sandalwood industry in Tonga include: Reduced flood risk as vegetation helps to reduce flood peaks when there are heavy downpours. This will contribute to SDG 3 (good health and well -being), SDG 11 (sustainable cities and communities), SDG 13 (climate action), and SDG 15 (life on land) The expansion of habitat for native wildlife would contribute to SDG 15 (life on land) Increased production of sandalwood and sandalwood products will contribute to SDG 8 (decent work and economic growth).
Potential environmental or social impacts	
Negative Expansion of the sandalwood processing industry would lead to an increase in the use of treatment chemicals, which pose local environmental and health risks The expansion of sandalwood cultivation may in some cases convert land previously use for agriculture, which may increase the demand for imported food in Tonga It may be challenging for people with disabilities to engage with this project. Social inclusion must be prioritised in this project to ensure disabled people are not left behind Positive If developed in a socially inclusive manner, the expansion of the sandalwood industry could diversity income streams and improve the economic opportunities available to women	
Procurement method	***Likelihood of attracting private or donor funding***
Given the current strain on MAFF's budget, this project would require external grant funding for all additional activities, including the provision of seedlings, sandalwood regulation enforcement work, and work to develop a regional framework for sustainability certification. The costs of planting, managing, and processing sandalwood timber could be financed and funded commercially.	***High*** Given the large size of this project, the potential co-benefits for economic development, and its consistency with the objectives of the Government of Tonga, this project is expected to have a high likelihood of attracting donor funding. It may still be advantageous to bundle this project with other forestry and agriculture-related projects to attract donors to fund a larger programme of agriculture and forestry sector development in Tonga.
Capacity requirement to implement	***Potential barriers***
Medium While the distribution of seedlings would be straightforward and could build on existing work in Tonga, enforcement of the sandalwood regulations and contribution to a regional sustainability certification	Insecure land tenure means many landholders are wary of long-term investments in forestry planting and management and favour shorter-term agricultural investments. In many countries, the sandalwood industry is associated with high levels of illegal logging and

[198] Tonga Agriculture Sector Plan 2016-2020. Available at: https://pafpnet.spc.int/resources/574-tonga-agriculture-sector-plan-2016-2020

framework would require significant human resource capacity.	trade. Regulatory safeguards and enforcement will be required to develop a sustainable domestic sandalwood industry. Need to ensure sandalwood industry would not contribute to GHG emissions.

Establish new forest reserves on unused land

Project name: Establish new forest reserves on unused land		
Sector: AFOLU	**Sub-sector:** Protected areas	**Project type:** Regulatory and investment
Project description		
This project would support the revegetation and protection of unused land (such as privately-owned land that is not used, and on inaccessible, slopy land) in Tonga by undertaking re-planting programmes and supporting the establishment and management of forest reserves. The high-level aim of this project is to plant an additional 400,000 trees on unused land in Tonga. The MAFF Corporate Plan (2020/21-2022/23) includes an activity to "Revegetate and Establish Forest Reserves on unallocated land and ensure their management". The 2019/2020 'baseline' reported in this plan is '0', suggesting that this activity is not currently occurring. In its fourth policy statement, the National Forestry Policy for Tonga (2009)[199] states that Tonga will conserve carbon in its forests by establishing and managing forest reserves. An up-to-date and accurate inventory of lands and forests will be an important foundation for this project. This will require strengthening of GIS data and analytics capacity. Care must also be taken to consult carefully with communities and include their views in the design of this project. This project will also require education, training, and awareness-raising activities for staff within the implementing agency. The implementing agency should consider trying to involve schools and young people in forest restoration work, to enhance the reach of the project and improve community buy-in. Efforts should also be made to develop community nurseries that seed ownership of facilities to the local level. It may be challenging for people with disabilities to engage with all aspects of this project, for example people with physical disabilities may find it challenging to take part in tree planting, particularly on slopy land. Efforts should be made to include people with disabilities during project development and implementation (where possible). This project aligns with AFOLU Actions 1, 2, 3, 4, and 6 in Tonga's LEDS. It also aligns with target 7 in JNAP-2—30% of land in Tonga utilised for agro-forestry or forestry.		
Estimated impacts (GHG emissions reduction and/or adaptation benefit)		
It is assumed that this project progressively converts unused shrubland into dry tropical forest. Following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, converting one ha of tropical shrubland to tropical dry forest would sequester carbon at a rate of 0.0032 $GgCO_2e$/year.[200] According to Tonga's Geological Services,[201] there is 9,618 ha of unused/slopy land in Tonga. Based on advice given by stakeholders in the Consultation Workshop, this project assumes that it is possible to plant 400,000 trees (equal to 5,000ha at a density of 80 stems per ha).[202] Assuming that community outreach and consultation		

[199] National Forest Policy for Tonga (2009). Available at: http://extwprlegs1.fao.org/docs/pdf/ton202060.pdf

[200] According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tropical shrubland in Asia (insular) that is less than 20 years old has above-ground biomass growth of 2.0 tonnes of dry matter per hectare per year, while tropical dry forest in Asia (insular) that is less than 20 years old has above-ground biomass growth of 7.0 tonnes of dry matter per hectare per year. Multiplying these values by the default value for the carbon fraction of above ground forest biomass (0.47 tonnes of carbon per tonne of dry matter), and by one plus the default value for the ratio of below-ground to above-ground biomass (1 + 0.37 = 1.37) indicates that tropical shrubland sequesters carbon at 0.0012 $GgCO_2e$/ha, while tropical dry forest sequesters carbon at 0.00451 $GgCO_2e$/ha. Therefore, replanting unused shrubland would lead to a net increase in carbon sequestration of 0.0032 $GgCO_2e$/ha.

[201] Ministry of Lands and Natural Resources Fact Sheet issued on 13/7/2021. Provided by MAFF.

starts in 2022, implementation begins in 2023, and GHG emissions reductions increase in a linear fashion over the first five years of project implementation to reach 16.1 $GgCO_2e$/year in 2027, the cumulative GHG emissions reduction potential between now and 2030 would be 96.6 $GgCO_2e$.	
Cost estimates	***Estimated time scale***
Replanting program Estimates of the cost of the replanting program are based on a similar tree planting support program developed in Samoa, which included the following components: US$25,695 for managing the program and promoting tree planting on community lands US$7,187 for distributing seedlings to landholders The NDC project plans to plant 400,000 trees (5,000 ha at a density of 80 stems per ha).[202] Tonga's Forestry Division can source commercial timber seedlings at US$3 per stem. Therefore, the cost of distributing 400,000 seedlings under this project would be US$1,200,000. Assuming that the awareness raising, and promotion programme costs are those same as those estimated for the agroforestry support programme in Samoa, the total cost of this project would be US$1,233,000.	This project could be implemented over the course of six years. According to Tonga's Agriculture Sector Plan (2016-2020), the building of community cohesion and capacity is a key element of successful projects in the AFOLU sector. Experience shows that it can take between 9 and 15 months to build community capacity and ownership, which will be an essential precursor for this project. Therefore, 12 months is allocated to community outreach and consultation before this project enters its implementation phase. Once this project enters its implementation, it is expected to take a further five years to implement, as re-planting programmes progressively plant the 5,000-ha covered by the project.
Affordability	***Likely co-benefits (including link to SDG)***
At present, MAFF's budget is overstretched, and the Ministry is unable to provide extension services to landowners consistent with its charter,[203] meaning that the costs of this replanting program would need to be met using external financial support.	Potential co-benefits of replanting and protecting unused land in Tonga include: Reduced flood risk as vegetation helps to reduce flood peaks when there are heavy downpours. This will contribute to SDG 3 (good health and well -being), SDG 11 (sustainable cities and communities), SDG 13 (climate action), and SDG 15 (life on land) The expansion of habitat for native wildlife would contribute to SDG 15 (life on land) The provision of other ecosystem services contributing to eco-tourism and non-timber forest products. These benefits link to SDG 8 (decent work and economic growth), SDG 13 (climate action), and SDG 15 (life on land)
Potential environmental or social impacts	
Negative The expansion of forest reserves would limit the productive options of landowners in Tonga, and would likely include opportunity costs It may be challenging for people with disabilities to engage with this project (for example planting seedings on slopy or hard to reach land). Social inclusion must be prioritised in this project to ensure disabled people are not left behind Positive	

[202] For the purposes of estimating project cost, it is estimated that trees are planted at a density of 80 stems per ha. This is consistent with tree density found in young successional tropical dry forest by Chapman, C. A., and Chapman, L. J. (1990). Density and growth rate of some tropical dry forest trees: Comparisons between successional forest types. Bulletin of the Torrey Botanical Club. 117 (3). P. 226-231.

[203] Tonga Agriculture Sector Plan 2016-2020. Available at: https://pafpnet.spc.int/resources/574-tonga-agriculture-sector-plan-2016-2020

The expansion of forest reserves would improve native habitat and benefit indigenous biodiversity in Tonga Protection of native forest areas can have beneficial social and public health impacts. Stakeholders emphasised these benefits during the consultation workshop. Specifically, officials in Tonga emphasised the benefit of trees in protected areas as places of rest and calm for people with dementia.	
Procurement method	***Likelihood of attracting private or donor funding***
Given the current strain on MAFF's budget, this replanting program would require external grant funding to proceed. There are few credible opportunities to capture commercial benefits from re-planting unused land.	***Low*** This project is unlikely to attract private funding because there are few credible opportunities to capture commercial benefits from re-planting unused land. Given its small size, this project may also struggle to attract funding from international donors if put forward in isolation.
Capacity requirement to implement	***Potential barriers***
Low This project would be very straightforward to implement. It leverages traditional knowledge and builds on existing tree planting work in Tonga.	Some species may grow poorly on steep marginal land in Tonga Re-planting and protection may clash with other objectives for this land (such as for agricultural expansion) It may be difficult to identify land that is genuinely unused, and this may lead to land disputes

Pasture improvement and fertilizer management

Project name: Pasture improvement and fertilizer management		
Sector: AFOLU	**Sub-sector:** Agriculture	**Project type:** Extension services
Project description		
This project would involve strengthening the capacity of farmers in pasture improvement and fertilizer management. This project would increase the efficiency of livestock farming systems, yielding more animal products (meat and milk) from the same number of stock units. This project would include: The efficient use of fertilizer and organic fertilizers (this can be linked to increased organic recycling proposed in the waste sector pipeline projects) The use of improved pasture varieties The use of improved pasture management and crop rotation practices The use of rotational grazing practices Improvements to animal health through livestock disease surveillance Soil fertility monitoring and management and assessment of the benefits of organic farming Collection and mulching of slashed waste from land preparation (this waste can then be used as an organic fertilizer for either agriculture or forestry). This would align with circular and bioeconomy efforts promoted in the 'Organic recycling' project being developed in the waste sector. Project developers would need to consult carefully with communities and include their views in the design of this project. This will also require education, training, and awareness-raising activities for staff within the implementing agency. These elements will be essential to ensure community buy in and success. The main GHG emissions reductions would come from improving the efficiency of nitrogen fertilizer use by better matching nitrogen application with crop nutrient needs. This would be done by training extension workers in Tonga to advise farmers on: Adoption of plants that have been bred to increase the uptake of nitrogen so that the same yields can be achieved using less fertilizer Increasing the use of organic fertilizers to substitute for imported synthetic fertilizers According to Tonga's Agriculture Sector Plan (2016-2020) "Livestock productivity is very low, and cattle, in particular, suffer from inadequate supplies of feed and water. There are some opportunities in selected		

areas to increase productivity to improve food security and diversity, and to generate livestock for sale, provided production and husbandry constraints are overcome". This project would include a training and awareness raising programme for farmers, including efforts to build awareness of efficient nitrogen use and farming practices. It would also seek to build on existing work in Tonga's agricultural sector. For example, Tonga's Integrated Land and Agro-ecosystem Management Systems (ILAMS) project recently purchased a multispectral mapping drone, which can help map agricultural land and advise landowners on improving their pasture management practices. Stakeholders at the consultation workshop emphasised possible complementarities between efforts to improve livestock productivity and efforts to expand agroforestry, noting that the shade provided by trees in pastureland could improve animal welfare. Efforts should be made to combine this pasture improvement project with the agroforestry project in a large program of agriculture sector projects in order to capitalise on these possible synergies. Health and safety requirements for chemicals, including chemical disposal, will be important for this project and other AFOLU sectors projects. Training and awareness-raising activities will be required. It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities during project development and implementation (where possible). This project aligns with AFOLU Actions 1, 2, and 4 in Tonga's LEDS.	
Estimated impacts (GHG emissions reduction and/or adaptation benefit)	
The potential to reduce GHG emissions through precision fertilizer use will vary greatly by farming systems, and there are few data on the potential for efficiency gains in the Pacific Islands. According to the International Fertilizer Association's submission to the UNFCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA), most farming systems have the capacity to reduce GHG emissions from nitrogen fertilizer use by 15 to 25%.[204] Given low use of fertilizers in Tonga's agricultural sector, the potential for reducing GHG emissions from fertilizers is probably at the low end of this range (15%). In 2019, N_2O GHG emissions from synthetic fertilizer use in Tonga were 1.9 tonnes.[205] This is equivalent to 0.57 GgCO2.[206] Assuming that this project can reduce GHG emissions from fertilizer use in Tonga by 15%, this project would reduce GHG emissions in Tonga by 0.085 $GgCO_2e$ per year in 2030. Assuming that community outreach, awareness raising, and training occurs in 2022, and GHG emissions reductions increase in a linear fashion from 2023 to reach 0.085 $GgCO_2e$/year in 2026, the cumulative GHG emissions reduction between now and 2030 would be 0.553 $GgCO_2e$.	
Cost estimates	***Estimated time scale***
The total estimated cost of this project is US$601,000, comprising: **Outreach, extension, and monitoring** The estimated cost of community outreach, extension work, and monitoring under this project is US$451,000. This estimate is based on cost estimates of similar extension work reported in	This project could be implemented over the course of five years. According to Tonga's Agriculture Sector Plan (2016-2020), the building of community cohesion and capacity is a key element of successful projects in the AFOLU sector. Experience shows that it can take between 9 and 15 months to build community capacity and ownership, which will be an essential precursor for this project. Therefore, 12 months is allocated to community outreach, awareness raising,

[204] The International Fertilizer Association's submission to the UNFCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA). Available at: https://unfccc.int/files/documentation/submissions_from_non-party_stakeholders/application/pdf/598.pdf

[205] Using data on GHG emissions from nutrient nitrogen fertilizers in 2019 recorded on the FAO's FAOSTAT database. Available at: http://www.fao.org/faostat/en/#data/GY accessed on 7/7/2021.

[206] 1 tonne of N_2O has the equivalent global warming potential as 0.29 Ggs of CO_2. Reported in IPCC (2007) Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press. Cambridge, United Kingdom 996 pp.

Samoa's Agriculture Sector Plan,[207] including the following functions: US$31,616 for the initial community outreach, awareness raising, and training phase (equivalent to what was budgeted for a training programme on agricultural chemical use outlined in Samoa's Agricultural Sector Plan) US$158,080 for the training of extension workers over four years (equivalent to US$39,520 per year budgeted for a program to train extension workers on the principles of sustainable agricultural resource management outlined in Samoa's Agriculture Sector Plan) US$261,312 for a four-year programme of soil fertility monitoring and regional nutrient management planning (equivalent to US$65,328 per year budgeted for a program strengthen data collection and reporting capacity outlined in Samoa's Agriculture Sector Plan) **Industrial mulching equipment** The estimated cost of mulching equipment is US$150,000, comprising: US$50,000 for an industrial specification forestry and slash mulching attachment for a 100-150 horsepower tractor US$100,000 for a new 100-150 horsepower tractor While it would be possible to purchase this equipment for roughly 30% less than this in New Zealand, it is assumed that the cost of importing this equipment to Tonga could add up to 30% to the total cost.	and training before this project enters its implementation phase. After this community outreach, awareness raising, and training phase, the project is expected to take a further four years to implement.
Affordability	***Likely co-benefits (including link to SDG)***
At present, MAFF's budget is overstretched, and the Ministry is unable to provide extension services to landowners consistent with its charter,[208] meaning that the mulching equipment as well as the initial community outreach, awareness raising, and training work, the ongoing extension work, and the nutrient monitoring and planning work would require external financial support.	Potential co-benefits of pasture improvement and increased nitrogen use efficiency include: Reduced nitrogen leaching leading to improvements in water quality and reduced risk of algae blooms, contributing to SDG 6 (clean water and sanitation), SDG 14 (life below water), and SDG 15 (life on land) Reduced demand for the manufacture and import of chemical fertilizers, contributing to SDG 12 (responsible consumption and production) Reduced expenditure on agricultural inputs, contributing to SDG 8 (decent work and economic growth)

[207] In this case, the cost of extension work in Samoa's agricultural sector is expected to be a reasonable proxy for the cost of similar work in Tonga. Samoa's Agriculture Sector Plan 2016-2020 was used to form these estimates because it breaks down project costs at a level of detail sufficient to estimate the costs of this project. While in Tonga, MAFF's Corporate Plan and Budget 2020/2021 – 2022/2023 also includes budget estimates for the ministry as a whole, it does not break these costs down by activity, programme, or project. Samoa's agriculture sector plan is available at: https://www.mof.gov.ws/wp-content/uploads/2019/09/Agriculture-Sector-Plan-2016-2020-Vol-1.pdf

[208] Tonga Agriculture Sector Plan 2016-2020. Available at: https://pafpnet.spc.int/resources/574-tonga-agriculture-sector-plan-2016-2020

	Soil management and improvement would contribute to SDG 15 (life on land) Increased agricultural production and farmer revenues, contributing to SDG 1 (no poverty), SDG 2 (zero hunger) and SDG 8 (decent work and economic growth).
Potential environmental or social impacts	
Negative Shifting to lower chemical input farming or organic farming may undermine food production in Tonga, leading to greater demand for imported food It may be challenging for people with disabilities to engage with this project. Social inclusion must be prioritised in this project to ensure disabled people are not left behind Positive Reducing the use of chemical fertilizers will lead to improved water quality and improved freshwater and marine biodiversity Using agricultural, forestry, and other organic wastes as fertilizers demonstrates the potential value of these forms of waste and contributes to Tonga's circular economy efforts.	
Procurement method	***Likelihood of attracting private or donor funding***
Given the current strain on MAFF's budget, this project would require external grant funding for the initial community outreach, awareness raising, and training work, the ongoing extension work, and the nutrient monitoring and planning work. In principle, there would be potential to collect user fees from farmers who see the benefit of using nitrogen fertilizers more efficiently. However, in practice, developing a scheme to collect user fees from farmers would be complex and costly, and it is not likely to be justified in Tonga.	***Low*** Given its small size and modest GHG emissions reduction benefits, this project may struggle to attract funding from international donors if put forward in isolation. However, it may be possible to bundle this project with other forestry and agriculture-related projects to attract donors to fund a larger programme of agriculture and forestry sector development in Tonga.
Capacity requirement to implement	***Potential barriers***
Medium Expert advice would be needed to design and guide this project. This project would also require further development of technical and scientific capacity in Tonga's agricultural sector. However, many of the implementation tasks (such as agricultural extension work and soil fertility testing) are within the capacity of MAFF.	This project may encounter the following barriers: Difficulty engaging with the large number of people who would need to be involved to make this project successful A lack of engagement from farmers who may be sceptical of the benefits of nutrient management planning Competing demands on the time of agricultural extension workers and MAFF staff

Waste sector

Outer island waste management services

Project name: Outer Island Waste Management Services		
Sector: Waste	**Sub-sector:** Landfill management and collection services	**Project type:** Infrastructure
Project description		
This project would implement effective waste collection services and facilitate the disposal of waste from the outer islands. Improving outer island waste services is a critical component of achieving universal waste services and increasing the sustainability of the waste sector throughout Tonga, from an environmental and social perspective. This project would involve:		

Designing and constructing a new landfill for Vava'u

Develop waste collection systems for outer islands that are currently not receiving any services

Landfill for Vava'u

Waste collection services are now effectively implemented across the main islands of Tongatapu, 'Eua, the main island of Vava'u, and the main island of Ha'apai. The Waste Management and Pollution Control Division (WMPC) of the Department of Environment (within MEIDECC), have secured Global Environment Fund (GEF) support to fund the upgrade of the landfills in 'Eua and Ha'apai, including consideration of works for climate-proofing.

This leaves the Vava'u landfill as a critical infrastructure gap requiring attention. The current site, the Kalaka Landfill, under previous funding from the JPRISM programme, was upgraded to improve leachate management and operational site controls. Ongoing technical support for the operations at Kalaka site was provided to Tonga Waste Authority Ltd (TWAL) under JPRISM II. However, the site is now at capacity, and continual use presents a high environmental risk. The site is located on coastal land with mangrove eco-systems in the vicinity of the site. Whilst waste continues to be accepted and managed at Kalaka, it is urgent to commence planning for an alternative site, so that closure activities can commence once a new disposal site is developed.

Proper closure would include capping and revegetation of the area, with ongoing leachate management through the existing wetland system. In designing the new landfill for Vava'u, it is recommended that the design continue to use the Fukuoka method (semi-aerobic landfill) applied during the upgrade of the Kalaka Landfill, as this has demonstrated emission reduction benefits when compared to a standard sanitary landfill design.

The new landfill for Vava'u is identified as a priority project in the NIIP. The Government of Tonga has undertaken a process of suitable site identification and selection, but a new site is yet to be confirmed. However, there are no funds available for the design and construction of the new landfill site, or for the closure of the Kalaka site.

Key barriers are:

Identification of a suitable site

Opposition from local communities to siting

Lack of technical capacity for landfill closure and construction activities

Lack of technical capacity for ongoing landfill operations

This project would require GIS to identify siting options, with a study to compare advantages and disadvantages of sites from environmental, social, logistics and cost perspectives. An environmental impact assessment process would be required, with approval from the CEO of MEIDECC.

The project will also require community engagement and consultation, ensuring they are engaged in the siting process, to minimise the risk of community opposition.

Designing the landfill closure for Kalaka, and the development of the new landfill will be undertaken by a specialist waste management engineer. The works contracts need to be developed with very clear detail, and adequate supervision to provide oversight for the quality of work. The Tapuhia Landfill in Tongatapu was constructed by local contractors with sound supervision, and this same model is recommended for Vava'u.

Landfill operations require specialised knowledge and capacity. WAL staff received training through the previous JPRISM Project for the Kalaka Landfill, but given staff changes over time, it will be essential to include a capacity building component for WAL operational staff in landfill operations. This has been added to the costings, with an estimate for relevant staff to be trained on an ongoing basis, with specialised training for at least a fortnight per annum over the project timeframe.

Waste collection systems for outer islands

This will be largely in the form of Technical Assistance as a starting point, with additional funds allocated to pilot schemes. Islands would be prioritised based on ease of implementation (including community demand for services) and population numbers served. A Project Manager would work with communities to assess needs and develop local solutions.

It is recommended that in each outer island community, a baseline survey of behaviours is undertaken to establish percentage of people disposing of waste through burning, dumping to sea, dumping to land, or burial, as a baseline to estimate the emission reduction benefits of the pilot projects.

This project is likely to include some community bin infrastructure, and in some cases a small truck, or potentially a barge to service a group of islands. It needs to be noted that boats are common resources in outer islands and paying for the use of existing resources may be more cost effective than a TWAL owned and operated barge. However, this will be assessed in the outer island waste collection planning study. Approvals would be required from the Utilities Board and the CEO of TWAL.

Community engagement is fundamental to the success of this project. Without community ownership, the system will not be sustained, and behaviour will not change. As such, the engagement with communities will occur over four years, with regular follow up and support. This was a key lesson learned in the outer island renewable energy project, that ongoing dialogue and support are essential to sustainability. This will be a key role for the Project Manager, who will conduct site visits and community meetings, as well as engage on an ongoing basis through follow up discussions and promotion of successes between communities.

There is an opportunity to actively engage youth, working with local schools where available, or with formal youth groups to plan and implement initiatives. Buy-in from the youth is an important factor to consider, as often they will be supplying the labour and enthusiasm, as was the case when outer island waste collection services were first introduced in Vava'u.

All waste initiatives proposed will need to consider social and environmental factors as a key component of the process. This can be integrated into the community engagement process, with risks properly understood, and adequate responses developed.

Other considerations

It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities during project development and implementation (where possible).The Tonga Statistics Department (TSD) undertakes waste surveys and census, with some surveys issued monthly. Collaboration with TSD will be crucial as this project develops.

Project linkages

The Tonga Integrated Urban Resilience Sector Project is funding landfill construction activities and improved waste services for Tongatapu. The JPRISM II project is working with WAL to improve waste services in Vava'u, Ha'apai and 'Eua, and to improve technical knowledge. However, there is a gap in improving waste services in remote outer islands and to fund the capital works required for a new landfill in Vava'u.

Stakeholders in Tonga have stated that chemical waste, particularly surgical and other hospital waste, has increased since the beginning of the COVID-19 pandemic.[209] Tonga has secured incinerators to help destroy this waste, which will be installed in hospitals in the main and outer islands. Chemical waste can also be effectively used in waste-to-energy projects. Chemical waste from the outer islands could be utilised in the waste-to-energy' project in the NDC project pipeline.

This project aligns with waste Actions 1, 2, 3, 4, 5, 6, 7, and 8 in Tonga's LEDS.

Estimated impacts (GHG emissions reduction and/or adaptation benefit)

There are significant broader benefits for improved waste management in the outer islands; however, the linkage to emission reduction is difficult to quantify.

Landfill for Vava'u

Landfilling creates GHG emissions through the production of methane during the decomposition of waste. However, in a Fukuoka landfill design, such as the Kalaka Landfill, the semi-aerobic conditions create less methane emissions. A semi-aerobic landfill can reduce the generation of greenhouse gases by as much as 40% in a tropical environment, compared to an anaerobic landfill.[210]

It is currently estimated that Vava'u has a waste generation rate of 1.4 kg/person/day,[211] and has an estimated population of 13,738[212]. This equates to over 7,000 tonnes per year, although this is viewed as indicative data only. Assuming that 5,000 tonnes is landfilled, and comparing the estimated GHG emissions from a sealed anaerobic landfill versus a semi-aerobic landfill, it would be 1.75 $GgCO_2e$[213] versus 1.05 $GgCO_2e$ if the 40% emission reduction occurs by using the Fukuoka design; an estimated saving of 0.7 $GgCO_2e$ per annum once the scheme is fully operational in 2026. This calculation is indicative only, as GHG emissions will vary with waste composition and landfill conditions.

Moving to a new site will maintain the integrity of waste systems for Vava'u, and if the design of the new site can also use the Fukuoka method, the reduced GHG emissions will provide an ongoing emission reduction

[209] Stakeholders in Tonga at the Validation Workshop for Tonga's NDC Implementation Roadmap and Investment Plan.

[210] SPREP (2010): *A Practical Guide to Landfill Management in Pacific Island Countries and Territories.* Volume 1: Inland based waste disposal. Apia, Samoa: SPREP, 2010.

[211] JICA J-PRISM (2012): Vava'u Development Plan – Solid Waste Management

[212] Tonga Census 2016

[213] Using 0.00035 $GgCO_2e$ emissions per Gg landfill as per Waste Reduction Model (WARM) GHG emissions calculator Version 15 2019, US EPA

benefit. However, continuing to landfill at Kalaka will create more aerobic conditions as waste moves beyond the design boundaries, in addition to impacting the marine and mangrove system eco-systems.

Infrastructure development for disposal at Vava'u also creates an adaptation benefit, as the existing site is vulnerable to impacts from sea level rise, natural disasters, and increased extreme weather events. By properly closing the site, the risk of impacts in a changing climate scenario will be reduced.

Waste services

Introducing waste services on outer islands will reduce the incidence of open burning and dumping of waste to the marine or land environment. Proper waste management reduces GHG emissions from open burning. By implementing small scale village and household composting, there will be further emission reductions compared to the current scenario. This is difficult to quantify without data on the amount of waste captured in the proposed new system or having baseline data on current practices.

Whilst the IPCC provides a methodology to calculate GHG emissions from incineration or open burning, it requires location specific data, including an estimation of fossil carbon in the waste (i.e., waste of fossil origin, such as plastics, some textiles, rubber, liquid solvents, and waste oil). It is also acknowledged that moving from open burning to landfill may not realise significant GHG emission reductions given the relative increase in methane production from landfills, but it is a health and air pollution imperative given the toxic and particulate GHG emissions from low temperature of waste.[214]

Given the scarcity of data, and the potential for extra GHG emissions from transport of waste rather than in-situ burning, it is assumed that there would be no emission reduction from this activity, but increased health and environmental benefits.

The adaptation benefits of improved waste management are significant. In natural disasters, there is increased impact when waste is improperly disposed of, and remains either in-situ on someone's property or in community dumpsites. Poor waste management can also exacerbate flooding impacts, and create longer lasting health risks when pooled water remains in waste materials as a breeding ground for vectors such as mosquitos.

Cost estimates	*Estimated time scale*
US$5.63 million—this includes: Landfill design, safeguards, and construction—US$4.7[215] million Capacity building for WAL operational staff in landfill operations US$50,000 Closure and rehabilitation of Kalaka Landfill—US$400,000 Community based waste planning for remote islands. National position for 4 years, salary and costs—US$180,000 Remote island infrastructure fund—US$300,000	Five years

Potential environmental or social impacts
Potential environmental benefits Reduced dumping to land and sea and marine pollution from outer islands Reduced emissions from Kalaka landfill once closed and rehabilitated Reduced GHG emissions from landfill design using semi-aerobic method Potential environmental impacts Poor landfill siting resulting in contamination of groundwater or marine environment Poor design of landfill resulting in impacts such as leachate contamination of soil and water

[214] Bogner, J., M. Abdelrafie Ahmed, C. Diaz, A. Faaij, Q. Gao, S. Hashimoto, K. Mareckova, R. Pipatti, T. Zhang, Waste Management, In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[215] As per the costing for this project in the NIIP (Government of Tonga 2020)

Poor landfill operations resulting in impacts such as windblown litter, pollution from burning. Potential social benefits Reduced health impacts from burning waste Potential for employment on outer islands in waste services Community cohesion and pride from collaboration for a clean green environment Informed and educated youth engaged in environmental improvement Potential social impacts Community opposition to landfill siting creates project delays and community conflict Landfill siting resulting in inequitable burden by neighbouring communities/households	
Affordability	***Likely co-benefits (including link to SDG)***
In Vava'u, the existing costs of operating the Kalaka Landfill and waste collection services are largely paid for by the current user pays system, with waste charges co-billed with electricity accounts. Whilst this will pay for the ongoing operational costs of the proposed new landfill, it will not cover the design and capital costs, which will require external funding. In more remote outer islands, this is a more challenging circumstance, with some communities having no central power system, and therefore no bills, and also a lower capacity to pay. However, they may be able to implement a low-cost community-driven system using volunteer labour, and moving waste materials to the main islands with a small cross subsidy from TWAL revenue. The model would need to be developed during the outer island waste planning study, and be appropriate to each of the communities and their resourcing, whilst also being equitable for all communities in Tonga.	Potential co-benefits of this project include: Health—the impacts of poor waste management are well documented, with risks such as dengue fever or other mosquito-borne illnesses related to mosquito habitat in opportune places such as tyres and water collecting plastics. Poor waste management also includes open burning, which creates toxic smoke that has been linked to respiratory conditions (e.g., asthma) and longer-term impacts such as cancer. Water-borne diseases such as diarrhoea can also be more prevalent in households that have poor waste practices, and low hygiene. Improving these issues through improved waste management will contribute to SDG 3 (good health and wellbeing) Poor waste management also has an impact on economic opportunities, particularly in the tourism sector. Visitors to Tonga, particularly outer islands, have an expectation of pristine tropical environments, and visual impacts of dumping areas, litter, and marine pollution can directly impact the marketability of Tonga as an 'unspoilt paradise'. Marine pollution also impacts ocean eco-systems and marine resources, which is one of the mainstays of outer island economies. Improving these issues through improved waste management will contribute to SDG 8 (decent work and economic growth) and SDG 14 (life below water) Improved waste management can also have positive economic impacts that focus on entrepreneurial opportunities, often with a focus on women or youth. Making and selling compost on a small scale can provide income whilst improving organic matter and soil health, reducing the need for costly chemical inputs. Other livelihood opportunities such as making reusable shopping bags provide some potential income that can particularly target women. This can contribute to SDG 5 (gender equality), SDG 8 (decent work and economic growth), and SDG 9 (industry, innovation, and infrastructure)
Procurement method	***Likelihood of attracting private or donor funding***
Whilst the operating costs for the Vava'u landfill would be largely covered by the existing user fees collected by TWAL, the design and construction costs would require donor grant funding. The user fees are not high enough to also fund asset replacement, and as such, a concessional loan arrangement to be repaid from user fees is not viewed as realistic.	**Medium** The potential to attract donor funding is medium to improve services to outer islands, improve environmental outcomes, and sustain emerging tourism opportunities. Medium opportunity for the Vava'u landfill project (closing Kalaka and developing new site) as it meets a number of environmental and development objectives.

For the outer island waste management systems, this would rely on external donor funding for any infrastructure such as bins. However, the aim would be to utilise voluntary labour and existing trucks and boats as on-island resources, with a small fee paid by users to cover operational costs. TWAL may be able to provide some cross subsidisation of outer island services using funds collected from larger population centres. However, given the lack of operating capital this may not be realistic. The outer island waste planning process will provide detailed costing, including in-kind contributions, and then assess funding mechanisms.	The potential to attract private sector funding due to low waste volumes and remote locations. There is the potential to access philanthropic donations from outer island community members living abroad, although it is acknowledged that these resources are often heavily used for a range of obligations. However, they can be an opportunity for one off contributions such as bin donations if the process is community driven.
Capacity requirement to implement	***Potential barriers***
Medium TWAL have the capacity to expand and deliver services but would need technical support to design and build the new landfill in Vava'u, and to implement the remote island waste management planning. The external consultant would be required for the implementation, with a counterpart national staff member to be assigned for the development of outer island waste management plans (as it would need to be a Tongan speaker). The national position would also require resourcing from the project funds.	For the Vava'u landfill development, a potential barrier will be lack of support from surrounding landowners at the new site, lack of technical capacity for landfill closure and construction activities, lack of technical capacity for ongoing landfill operations. The social and environmental safeguards will be important for this project to ensure that there is no-one who is worse off from the development To implement outer island waste services, there may be cultural barriers in terms of expectations versus reality. Communities may expect a door-to-door collection service, and a regular barge collection. However, this is unlikely to be feasible without community volunteer inputs, and a greater capacity for self-reliance Outer island communities have demonstrated the required level of cohesion in some areas such as energy generation, but the benefits of improved waste management may not be so apparent, with a cultural barrier of unwillingness to change traditional disposal means (despite the nature of the rubbish changing and this being no longer benign). Pilot communities will need to be selected carefully to maximise chances of success and provide good case studies for other outer island communities. Limited financial resources to improve waste management solutions, and limited capacity for communities to pay due to their small size Lack of the proper technological equipment and infrastructure to properly dispose of waste Remoteness of outer island communities.

Moving towards zero waste

Project name: Moving Towards Zero Waste		
Sector: Waste	**Sub-sector: Recycling, circular economy**	**Project type: Infrastructure, policy / legislation, awareness-raising,**
Project description		
This project would involve the implementation of sustainable funding mechanisms and infrastructure to reduce waste and improve resource recovery throughout Tonga. During workshops for the Tonga's Low Emission Development Strategy (LEDS) currently under development, and the through the JNAP Technical Working Group, moving towards zero waste has been agreed as a unifying objective. However, to date, the pathway has not been clear, with waste volumes growing as lifestyles change.		

A circular economy model views materials as resources rather than waste. The key is to develop pathways to change what is brought into the economy, and methods to sustainably reuse or recycle products back into the economy through the use of innovation and incentives.

This project focuses on a range of mechanisms to move towards zero waste, taking advantage of opportunities as an island country to exercise greater import controls, and to harness innovations to create a more circular economy. It should assess waste streams and consumer habits from a whole life cycle perspective, often referred to as a circular economy perspective.

Potential Project Components:

Note that this project needs to be built up in dialogue with stakeholders and community, with a key role of the Project Manager to refine options and develop annual action plan.

Container Deposit Scheme

Review of case studies from the region, and implementation of container deposit scheme (CDS) which includes incentives for returning bottles and cans, and margin for processing and exporting

Of the estimated 22.7 tonnes (t) of plastics generated each day in Tonga, approximately 2.5 t is likely to be PET or high-density polyethylene (HDPE) plastic, which could be recovered through a container disposal scheme (CDS). Based on an average reduction in the mismanaged waste rate of 40% with a CDS in place, approximately 0.8 t of PET and HDPE plastic could be recycled each day, resulting in approximately 292 t per annum that does not become marine debris.[216]

The opportunity is increased recycling coupled with the social benefit of refund collection for people without work, or as fund-raisers for community groups and schools. The barrier is viable end use markets for the collected materials, and potential opposition from commercial sector.

End-of-life disposal levies

Review of case studies, and design of end-of-life import levies on items such as vehicles, tyres, batteries, and e-waste. A company in Tonga provides a battery collection service. Stakeholders in Tonga suggested that this service could be expanded to include other types of waste, or could be used as an example for future waste collection services.

SPREP will be undertaking a feasibility study to develop a National Used Oil Management Plan, with Tonga one of the selected countries. This Project could provide the implementation mechanism for recommended actions from this Plan. Stakeholders in Tonga stated that waste oil is a big concern and requires better management. Petroleum import companies are only responsible for removing waste oil from their major clients, and not from small workshops and other users. Although a recycling company is doing a good job collecting waste oil, further help is required. Stakeholders suggested two ways to help manage waste oil: Tonga could strengthen the capacity of the private sector (including recycling companies) to collect waste oil; or Tonga could amend the Petroleum Act to ensure that petroleum companies are required to take away all waste oil (currently the shipping container that delivers oil leaves Tonga empty).

Select products, and implement system through legislative reform, awareness raising, and resourcing the implementation steps.

This is an opportunity to sustainably fund export of materials such as car bodies or e-waste, with the barrier of increased consumer costs to be addressed.

Stakeholders stressed that it is important for policies in the waste sector and supporting policies to be legally binding, so that Tonga can enforce levies, penalties, or other mechanisms that may be introduced.[217]

Phasing out single use plastics

Review of case studies, and development of a pathway to phase out single use plastics in Tonga

If single use plastics are phased out, there needs to be affordable and convenient alternatives. Changing import tariffs on plastic containers compared to compostable containers is one mechanism to be explored. However, it needs to be carefully researched which compostable packaging can degrade with no residue, and how to enforce these standards. Local manufacture of alternatives from starch-based products is worthy to investigate as an

[216] Pacific Regional Infrastructure Facility (2018): *Solid Waste Management and Recycling. Pacific Country Profiles*

[217] Stakeholders in Tonga at the Validation Workshop for Tonga's NDC Implementation Roadmap and Investment Plan.

environmental business that would also be a source of revenue generation. Seeking opportunities for closed loop systems can make a significant change to material flows in Tonga

There may also be opportunities in the production of re-usable items such as shopping bags, menstrual hygiene products and nappies[218], that bring further benefits to health and livelihood programmes that target women

Development of an enabling legislative and policy environment

It is imperative that the programme works closely at the community and business level to ensure that the ideas gain support from the outset. With the high profile *No Pelesitiki Campaign*, which has received ongoing support from the New Zealand High Commission, there is existing momentum to be built on rather than duplicating efforts. Engaging with the Clean Green Tonga campaign is also an effective way to harness leadership and coordinate efforts.

The opportunity is to reduce pollution, particularly marine plastic pollution, but the barrier is to find affordable and convenient alternatives, and to win support from the community.

Strengthening markets for recyclable products

Coordination with SPREP and the lessons learned they have documented from elsewhere, and findings from PRIF/ADB Recycling Hub Project (at EOI stage)

Purchase of recycling equipment to produce end products from glass waste and plastic waste

Scale of recycling technologies to be adaptable for population centres and remote communities wherever practical

A major gap to date is the recycling infrastructure. TWAL have installed some pilot scale technologies at Tapuhia to demonstrate glass crushing and plastic shredding. Based on this pilot, assessing how to scale up the activities and find end-use markets will be critical to the sustainability of local resource recovery efforts. As per the recent study funded by PacWastePlus, there are a range of technologies now available for washing, sorting, shredding, and crushing of plastics, depending on end market use. Equipment for melting, moulding, extruding, and reforming open up a range of possibilities to create end-products such as bricks, tiles, posts, or piping. Glass can be reprocessed to manufacture sand or aggregate. These types of technologies usually fall below the price of US$200,000 per unit[219]

Local product and market development, making building materials such as pavers, tiles, blocks etc, with recycled glass or plastic content, and developing purchase incentives through mechanisms such as improved government procurement policies, or eco-certification (e.g., Clean Green Tonga business or project awards).

Implementation with Technical Assistance package (grant), working with TWAL counterpart staff and other relevant government agencies such as Climate Change Division, and Waste Management and Pollution Control Division of MEIDECC.

The opportunity is to improve recycling rates and create local employment, with the barrier finding feasible and cost-effective ways to recycle products, and developing sustainable markets through creating demand for the end products.

The following applies to the above initiatives:

Community behaviour change in consumption patterns must have support at all levels, along with appropriate incentives. Awareness is central to this process. Schools provide a platform for change, engaging the youth in entrepreneurial initiatives and community campaigns to make a difference.

The enabling environment is critical to change. Once priorities are identified, the policies, laws and regulations must be developed, along with incentives and penalties.

Capacity development of the TWAL special projects team will be a component of the work, ensuring that the project officer provides adequate support and mentoring to develop strategies and messages, testing and then rolling out effective community campaigns. Capacity development for any new recycling technologies would also be a critical component of any procurement, with the supplier to provide training, particularly in the maintenance and servicing aspects.

Other considerations

It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities during project development and implementation (where possible).

[218] See Mammas Laef in Vanuatu (mammaslaef.com) or Lalai & Sprout in Fiji

[219] PacWaste Plus (2020): Assessment of Small-Scale Technology Suitable for Waste Management in the Pacific and Timor Leste. Published by SPREP. Available at https://library.sprep.org/sites/default/files/2021-01/small-scale%20tech-report.pdf

The Tonga Statistics Department (TSD) undertakes waste surveys and census, with some surveys issued monthly. Collaboration with TSD will be crucial as this project develops. **Project linkages** The ADB / PRIF Study into Potential for Regional Recycling Hub may provide improved recycling market opportunities. The PacWastePlus project is also providing information and support for ways to implement initiatives such as container deposit legislation or technologies applicable to the PIC context. This project aligns with waste Actions 1, 2, 3, 4, 5, 6, 7, and 8, and transport Action 1 in Tonga's LEDS.	
Estimated impacts (GHG emissions reduction and/or adaptation benefit)	
Waste reduction initiatives have a number of environmental benefits, including the reduction of GHG emissions through avoidance of manufacturing and transport GHG emissions. Providing sustainable funding mechanisms for end-of-life resource recovery and disposal is a means to sustain recycling efforts over time. Reducing single use plastics can reduce the amount of litter within drainage systems, and reduce the impacts of flooding through improved drainage systems. Given the number of variables for this project, it is difficult to estimate a meaning GHG emissions impact. Moving products such as plastics out of the landfill and into a recycling scheme does not reduce landfill emissions given that inorganic materials do not produce GHG emissions through decomposition. However, at a larger scale, producing containers from recycled infeed compared to virgin materials gives a net reduction in energy consumption and associated GHG emissions. Having researched a number of regulatory impact statements for container deposit systems, calculating emission reductions is viewed as too complex as it is dependent on material type and transport distances, and life cycle analysis, and as such is stated as an unquantified benefit.[220] Likewise, any waste avoidance measures such as phasing out single use plastics reduces the emissions associated with the production of these materials. Waste avoidance creates the greatest gain in emission reductions, as it avoids the resource extraction, production, and transport of the goods, along with emissions from transporting to recycling markets. An estimate of total lifecycle emissions for plastics, including emissions from oil and gas production, is 0.005 $GgCO_2e$ per Gg of plastics.[221] An estimated 6% of Tonga's waste stream is made up of plastic, with an estimate of 22.7 tonnes generated each day.[222] If just 5% of this could be avoided through introducing ways to avoid waste creation (such as phasing out single use plastic), this project could reduce GHG emissions by an estimated 5.7 tonnes a day, or 2.081 $GgCO_2e$ per year in 2025 once fully implemented. Whilst these emission reductions are at the point of resource extraction, manufacture, and transport, rather than reducing emissions from Tonga, this still represents a worthwhile contribution to reducing global CO_2 emissions.	
Cost estimates	***Estimated time scale***
The total cost of this project would be US$1.1 million—this includes: Purchase of recycling infrastructure—US$800,000 National project officer for 4 years (salary and costs)—US$100,000 Technical assistance for legislative and policy review work—US100,000 Budget for community campaigns—US$100,000	Estimated four-year period. Ideally, the work would take place after the PRIF/ADB regional recycling hub feasibility work to enable alignment with these recommendations, as this work will address issues such as sustainable markets and transport logistics. It is expected that this work will be completed by mid-late 2022.
Potential environmental or social impacts	
Potential environmental benefits	

[220] Environmental Protection Authority of South Australia (2000): *Container Deposit Legislation Economic and environmental impacts. Available at https://www.epa.sa.gov.au/files/4771406_cdl_report.pdf*

Department of Primary Industries, Parks, Water and Environment (2021) *Regulatory Impact Statement Container Refund Scheme Bill 2021.* Available at https://dpipwe.tas.gov.au/Documents/CRS%20Regulatory%20Impact%20Statement.PDF

[221] Material Economics (2019) *Industrial transformation 2050: pathways to net-zero emissions from EU heavy industry.* Stockholm Available at https://materialeconomics.com/latest-updates/industrial-transformation-2050

[222] Pacific Regional Infrastructure Facility (2018): Tonga Country Profile. Available at https://www.theprif.org/sites/default/files/documents/tonga.pdf

Reduced GHG emissions from single use plastic production and transport to Tonga Reduced marine pollution from single use plastic Reduced pollution from inappropriately stored waste oil, or oil disposed of to the land/sea Improved recycling rates result in reduced resource use and reduced energy consumption compared to manufacturing from virgin materials Potential environmental impacts Potential for pollution impacts from recycling activities Potential social benefits Employment generation in recycling jobs and in potential entrepreneurial activities harnessing skills of women and youth Income from CDS for unemployed and community groups / schools who are fund-raising Promotion of Tonga as a clean and green country – a marketing asset for tourism Community cohesion and pride Potential social impacts Increased cost of living due to import levies.	
Affordability	***Likely co-benefits (including link to SDG)***
Any changes to import levies or introduction of end-of-life resource recovery and disposal levies will need to consider unintended consequences on the cost of living. However, the fees are likely to be commensurate with the value of the goods, for example, a mobile phone or vehicle have a high cost, and as such, a levy is unlikely to prevent the acquisition of the consumer good. A container deposit scheme does not put too much additional cost burden on the consumer, particularly when considering the benefits of removing the items from the litter stream and marine pollution. The same applies for the replacement of single use plastics with reusable or biodegradable alternatives. There may be an impact on cost per item, but this is unlikely to have a significant impact on the cost of living. Alternatives must be affordable, or there will not be adequate community support to drive the necessary change.	Potential co-benefits of this project include: This project will provide a focus for sustainable development, including circular economy, contributing to SDG 12 (responsible consumption and production) Fostering resource recovery or replacement of single use plastic products will generate business and economic opportunities, contributing to SDG 8 (decent work and economic growth Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all, contributing to SDG 9 (industry, innovation, and infrastructure) A container deposit scheme, whilst being paid for up front by the consumer, will partly re-distribute this money to charity groups, young people, or people experiencing poverty. This will contribute to SDG 10 (reduced inequalities) Collecting the refund on plastic, glass and aluminium products can drive an economic return at the community level. This will contribute to SDG 10 (reduced inequalities) Presence of container deposit schemes can significantly reduce marine and land litter, contributing to SDG 14 (life below water) and SDG 15 (life on land) Developing recycling and reuse enterprises will provide local economic opportunities, with a focus on women's business opportunities. This will contribute to SDG 5 (gender equality), SDG 8 (decent work and economic growth), and SDG 9 (industry, innovation, and infrastructure) Increased resource recovery will reduce marine plastic pollution, contributing to SDG 14 (life below water)
Procurement method	***Likelihood of attracting private or donor funding***
International donor funding (grant) will be required.	***High*** The potential to attract donor funding is high, given the potential to meet a number of strategic focal areas in

	environmental improvement, livelihoods and poverty reduction, gender equity, and innovation. Tonga provides a good case study to implement zero waste and circular economy initiatives, as the basic waste services, infrastructure and legislative frameworks are already in place. Also, given the behavioural change over the last decade, there is a community readiness to address broader issues on sustainable consumption and waste reduction and resource recovery.
Capacity requirement to implement	***Potential barriers***
Medium At the community level, there is existing momentum for change that can be built on. There is existing capacity in TWAL and the private sector (GIO Recycling) for recycling processes and access to markets. There is likely to be a requirement to change the policy and legislative environment to make substantial change.	Pacific island countries face many challenges when managing recyclable waste, given their: Limited ability to avoid importation of large quantities of material and packaging (given the low level of local manufacturing and production of local goods) High waste production from tourism sector Limited waste segregation Economic constraints to recycling, based on the small population base of countries Limited incentives to recycle and The relatively expensive transport costs to other markets[223] Access to recycling markets for Pacific Island Countries faces several barriers, including: Challenging to find viable solutions Lack of awareness and incentives to choose recycled products over 'new', with potential perception barriers in relation to quality Any efforts to improve resource recovery must have a market focus (whether individual waste streams are better suited to regional or local solutions) and must also include analysis of the potential to change the import patterns to reduce waste generation A barrier to end-of-life disposal levies is the perception that it is an unfair price increase and general revenue to the Government, which can be politically unpopular. As with the current plastic levy, it is recommended that any tariffs be spent directly on collection, disposal, and resource recovery, rather than going to general Government revenue.

Waste-to-energy

Project name: Waste to Energy		
Sector: Waste	**Sub-sector: waste management, alternative energy**	**Project type: infrastructure**
Project description		
This project would introduce a waste-to-energy project, implemented over two stages. The first is the up-to-date technology assessment, feasibility study (including social and environmental impact assessment), and development of the framework for the PPP engagement process. Stage two is the implementation phase, with the project funding		

[223] PacWaste Plus (2020): Ibid

technical support in the Owners Engineer role, and providing legal support for a practical and equitable PPP arrangement. One imperative will be the development of a contract that has long term sustainability built in from the outset. Ongoing operational and maintenance support will be critical.

Waste to energy is another means to utilise waste as a resource, albeit this must be undertaken as part of a broader context of waste avoidance, reuse, and recycling. In small island countries that face land constraints, combustion or pyrolysis of waste has the benefit of reducing the volume of solid wastes by up to 90%.[224] Combustion of municipal solid waste (MSW), or waste-to-energy (WtE) plants, transform solid waste into energy and are used in many parts of Asia and Europe. WtE plants are also being utilised in island countries, such as the Cayman Islands, Bermuda, and the Canary Islands. The ADB is currently funding an incineration plant in the Republic of Marshall Islands (RMI), where land pressures on a small atoll nation make landfilling extremely challenging. The technology is evolving rapidly, and whereas once it was viewed as unviable for small economies, this is changing as technologies become more tested, more scalable, and in some cases, more affordable.

Often the choice for WtE over landfill solutions is driven by other external factors. For example, in the Cayman Islands, visible waste sites were impacting on the cruise ship tourism economy, as visitors have an expectation of pristine environments rather than views of dumpsites.[225] Stakeholders in Tonga have stated that chemical waste, particularly surgical and other hospital waste, has increased since the beginning of the COVID-19 pandemic.[226] Tonga has secured incinerators to help destroy this waste, which will be installed in hospitals in the main and outer islands. However, chemical waste can also be effectively used in waste-to-energy projects.

In the short to medium term, there is enough landfill capacity for effective waste management in Tonga, particularly once the landfills in Ha'apai and 'Eua are upgraded, and a new landfill is developed for Vava'u. However, over the longer term, this may not be the optimal solution for Tonga, given pressures on land resources, ongoing landfill management and monitoring requirements, and the ongoing environmental legacy of landfills for future generations. In addition, the GHG emissions from landfills are a significant contribution to global warming, estimated at 1.9% of all global GHG emissions.[227]

Under PacWaste Plus, small scale waste management technologies have been recently assessed for their potential use in the Pacific, including some incineration technologies.[228] This work is being expanded, with a new study commissioned by PacWaste Plus to look specifically at WtE technology options and suitability for Pacific Island Countries (PICs). The Department of Energy is also undertaking a technology needs assessment and waste-to-energy is a priority area.[229] Stakeholders in Tonga also suggested that there is a feasibility study that has links to waste-to-energy and circular economy.[230] The research and assessments being undertaken by PacWaste Plus, Department of Energy, and other institutions will assist decision makers to understand which advanced waste technologies are applicable, and the associated benefits and risks of each type.

In Tonga, TWAL have undertaken their own research, and have support from Tonga Power Ltd[231] to pursue potential opportunities in using waste as an energy source as a part of the Tonga Energy Road Map. TWAL engaged Arup Consulting in 2018 to provide a high-level review of waste to energy options, and on this basis, then sought proposals from short-listed incinerator technology suppliers for small scale WtE technologies suitable for Tonga. Submissions were considered in early 2019, but negotiations were not pursued at that point. One of the constraints is the lack of technical capacity to review options and understand what presents the most benefit for Tonga.

To progress this further, TWAL requires technical support to ensure that decisions are informed by an understanding of technical options, including costs and benefits. Landfills will also be required for the safe disposal of ash and residues, but there may be an opportunity to co-locate a WtE facility to reduce GHG emissions in Tonga. It is important that this external advice is 'technology agnostic' and reviews options based on suitability for Tongan

[224] ADB (2014): *Solid Waste Management in the Pacific Appropriate Technologies.* Available at https://www.adb.org/sites/default/files/publication/42657/solid-waste-management-appropriate-technologies.pdf

[225] GHD (2020): *Sustainable Waste Management Project – Cayman Islands.* Project Summary Sheet.

[226] Stakeholders in Tonga at the Validation Workshop for Tonga's NDC Implementation Roadmap and Investment Plan.

[227] Ritchie, A (2020: *Sector by sector: where do global greenhouse gas emissions come from?* Our World Data. Available at https://ourworldindata.org/ghg-emissions-by-sector

[228] PacWaste Plus (2020): Assessment of Small-Scale Technology Suitable for Waste Management in the Pacific and Timor Leste. Published by SPREP. Available at https://library.sprep.org/sites/default/files/2021-01/small-scale%20tech-report.pdf

[229] Stakeholders in Tonga at the Validation Workshop for Tonga's NDC Implementation Roadmap and Investment Plan.

[230] Stakeholders in Tonga at the Validation Workshop for Tonga's NDC Implementation Roadmap and Investment Plan.

[231] Note that Tonga Power, Waste Authority Ltd and Tonga Water Board are under the common Utilities Board and are therefore well positioned to undertake joint initiatives.

context, market readiness of the technology, social and environmental benefits and impacts, and the capital and operating costs. Given the specialised knowledge in this type of facility, it is recommended that any initiative is designed with long term sustainability in mind. This is likely to include a Build, Own, Operate and Transfer contracting model, that fully supports operations in the initial years, knowledge transfer, and long-term maintenance and servicing arrangements. A private sector partnership approach that partners for longer term sustainability is viewed as the optimal pathway. To introduce an advanced waste technology, the community must support the initiative. As such, awareness raising, and provision of clear and factual information is essential. The community must be enabled to have input at the feasibility stage to ensure that there is broad support, and also that the technical team consider a broad range of social and environmental constraints. In summary, the opportunity is to utilise waste as a resource to provide energy for electricity or fuel. However, there are significant barriers with the requirement for stringent technology assessment and feasibility work that fully evaluates options, along with social and environmental impacts. Taking a staged approach to technology assessment, community consultation, and developing the right partnership and contractual terms for long term sustainability aim to address these barriers and risks. **Other considerations** It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities in aspects of project development and implementation (where possible). The Tonga Statistics Department (TSD) undertakes waste surveys and census, with some surveys issued monthly. Collaboration with TSD will be crucial as this project develops. **Project linkages** Depending on the technology, there may be linkages with the ALOFA sector, given the potential to produce end products such as bio-char. This project aligns with waste Actions 1, 2, 3, 4, 5, 6, 7, and 8, and energy Action 6 in Tonga's LEDS.	
Estimated impacts (GHG emissions reduction and/or adaptation benefit)	
When comparing the GHG emissions from WtE and landfill, the savings are estimated to be about 1 tonne of GHGs saved per tonne of MSW combusted.[232] The estimated amount of waste produced in Tonga is approximately 10,000 tonnes per annum.[233] The emission reductions are twofold, through avoidance of landfilling, and through further reduction in reliance on diesel generator power production. Waste-to-energy facilities can support Tonga's energy transition by providing a small amount of distributed, reliable, partly renewable energy.[234] It can be difficult to estimate the GHG emissions reductions from a WtE facility as this depends on what would have happened in the scenario of having no facility. The net impact on GHG emissions is technology and location specific, with calculations based on direct emissions from the WtE facility plus GHG emissions from transporting waste to facility and residual outputs to landfill minus avoided GHG emissions from not producing energy with fossil fuels and the avoided transport and decomposition GHG emissions from landfill. A conservative estimate would be a GHG emission reduction of 3.1 $GgCO_2e$ per annum once the project is fully implemented, but this would be refined based on the projected feedstock, location, and technology type. This reduction is approximately 1% reduction of the total GHG emissions for Tonga (calculated at 310.4 Gg of CO_2e in 2006).	
Cost estimates	***Estimated time scale***

[232] Maize K (2016): Energy from Waste. Greenhouse Gas Winner or Pollution Loser? Published in July 2016 edition of Power - News & Technology for the Global Energy Industry. Available at https://www.powermag.com/energy-waste-greenhouse-gas-winner-pollution-loser/

[233] ADB (2014): *Solid Waste Management in the Pacific: Tonga Country Snapshot.* Available at https://www.adb.org/sites/default/files/publication/42660/solid-waste-management-tonga.pdf

This figure will be updated once the results of the recent waste audit funded by the Pacific Regional Environment Facility (PRIF) are published.

[234] WtE is viewed as fully renewable if the feedstock is organic waste only, and partly renewable when using mixed waste derived materials such as plastics with fossil fuels the origin resource. EPA Victoria (2017): *Turning Waste into Energy. Join the Discussion.*

US$800,000 for Stage 1 US$3,000,000 for Stage 2	Seven years—Stage 1 would require approximately two years, with Stage 2 over five years. Note that ongoing support would be built into the PPP arrangement.
Potential environmental or social impacts	
Potential environmental benefits Reduced GHG emissions through converting waste to energy Reduced impacts from landfill, such as leachate contaminating groundwater Potential environmental impacts Potential for air pollution from inadequate technology or poor operational controls Potential to reduce reuse and recycling opportunities due to the need for minimum feedstocks Pollution from inappropriate ash disposal Potential social benefits Training and capacity development in emerging industry sector Potential social impacts Increased cost of waste services Community concerns or opposition creating tensions.	
Affordability	***Likely co-benefits (including link to SDG)***
This will need to be determined through the Feasibility Study. The costs per Gg could not be so prohibitive that the users are unable to pay.	Potential co-benefits of this project include: Industrial innovation and access to further sources or renewable energy, contributing to SDG & (affordable and clean energy) and SDG 9 (industry, innovation, and infrastructure)
Procurement method	***Likelihood of attracting private or donor funding***
This would be a staged procurement method—Stage 1 (the initial TA proposed as a donor grant) and Stage 2 (implementation phase) supported by a further donor grant for the TA package, and the construction and operation funded through the PPP. Some of the costs of the project could be funded through user fees. This project could use commercial finance, or possibly access concessional finance.	***Low*** At the initial feasibility stage, it is unlikely to attract private sector funds. However, if the feasibility work can demonstrate viability, this would move to moderate potential. Donors tend to view WtE as high risk at this time, until there is more demonstration of success on the ground, particularly for operations and maintenance. Also, given the existing landfill capacity in Tonga, this type of project may be more favoured in countries with greater pressures on land resources.
Capacity requirement to implement	***Potential barriers***
High Capacity to implement is significant, hence the recommended staged approach with detailed feasibility work, and then, if feasible, implementation support to ensure the resulting technology and PPP contractual details are favourable to the people of Tonga.	It is important that this type of technology does not 'lock out' other higher value resource recovery opportunities. For example, a WtE facility may preclude lower cost green waste recycling options as the waste stream is required for the WtE viability. The cost per Gg compared with landfill may not be a feasible alternative, with the people of Tonga unable or unwilling to shoulder a significant increase in waste service fees. There is a significant risk of poor maintenance or lack of technical capacity for operations, resulting in deterioration of the assets and poor investment outcomes. This needs to be a major component of the feasibility work. A build-design-operate-maintain PPP may overcome this but adds to operational costs.

Organic recycling

Project name: Organic Recycling		
Sector: Waste	Sub-sector: Resource recovery, agriculture	Project type: Infrastructure, market development, awareness
Project description		

This project would involve reducing GHG emissions through avoiding decomposition in landfill, and utilising organic waste as a resource for the agricultural and forestry sectors. Organic waste remains a significant portion of the waste stream, and the key contributor of GHG emissions from the waste sector. Rather than trying to capture landfill gas (high tech end-of-pipe solution), diverting, and utilizing the resource prior to the landfill stage provides a higher value output.

The main emission from waste is methane; a greenhouse gas that is 28 times more potent in global warming terms than carbon dioxide. When waste breaks down, particularly in anaerobic conditions such as a landfill, methane is released. Many landfills now have gas capture systems, with some utilising this gas for energy projects, although these systems are not in place in any landfills in Tonga. The active areas of landfills are where the most gas is released (in the initial waste breakdown process), whereas most gas capture systems only collect the gas from the completed and capped sections of a landfill where less gas is produced. In Tonga, completed areas of the landfill (cell 1 in the Tapuhia Landfill) do not have a capping and cover system applied due to lack of readily available clay materials, and lack of financial resources. A more direct, and likely more effective approach is to reduce the organic fraction of the waste that is brought into the landfill. By diverting organic waste into alternative systems such as aerobic composting, the emission reductions can be considerable.

In discussion with stakeholders, it was confirmed that food waste is not a significant issue in Tonga due to the high levels of reuse for animal food. With backyard piggeries a common feature of the Tongan lifestyle, particularly in the rural areas, most household food waste is fed to either pigs, dogs, or chickens. In restaurants, it is reported that farmers regularly collect food waste as a means to supplement feedstocks to livestock.235 However, organic waste from gardens makes up a substantial portion of the waste stream (51% of waste was classified as organic in a Vava'u waste audit conducted in 2012236). More recent waste composition data will be accessible in mid-2021, as a part of the regional waste composition study implemented by PRIF, which will provide a clearer picture of available resources.

Home composting

The project would provide a combined approach to address organic waste management. Firstly, it would look at ways to engage with the community and encourage home and school composting, and ways to sustain these systems. This may include initiatives such as identifying sustainable garden champions and supporting them to deliver training and support within their local communities. Having a small portable chipper for community groups or individuals to hire at a nominal rate (along with the operator) will provide further motivation to produce home compost.

Awareness campaigns are critical to this component, promoting success stories, and highlighting composting as part of a clean green and healthy lifestyle. Incentives are also successful, such as the Canada Fund co-financing of household water tanks, which could be applied to home composting bins. Schools are an important resource, with students learning about compost benefits and techniques, and bringing this knowledge to households and youth groups.

Commercial composting

The other component is to develop larger scaled composting enterprises, likely to be co-located at each landfill, where green waste can be segregated and chipped on site. To maintain a clean feedstock, site supervision of drop-off points would be required, along with awareness campaigns, and potentially financial incentives such as a reduced tipping fee for clean garden waste. Other resources, such as the dried sewage sludge from the septage treatment facility at Tapuhia could also be used as a feedstock.

At each landfill site (Tongatapu, 'Eua, Ha'apai and Vava'u), processing equipment would be required at an appropriate scale. There is also an opportunity to explore partnerships with the private sector or MAFF for the implementation of the composting process, quality control, product development and marketing. This is a particular area of technical expertise, and is better suited as a partnership arrangement, using existing relationships within the forestry and agricultural sectors. For example, Nishi Trading operate not only as an exporter of crops, but they also work with growers to improve the sustainability of farming practices. They are a trusted source of information and have existing

[235] Pers comm, Ms Mafile'o Masi, Waste management and Pollution Control Division, Environment Department, MEIDECC.

[236] ADB. 2014. Solid Waste Management in the Pacific: Tonga Country Snapshot. Manila: Asian Development Bank. https://www.adb.org/sites/default/files/publication/42660/solid-waste-management-tonga.pdf.

commercial relationships with potential buyers of agricultural products. Also, within MAFF, agricultural extension officers are a further potential resource for assessing the needs of the grower, and marketing soil enhancement products, particularly in areas where the organic content of soils may be depleted.

The project scope would include support for TWAL to pilot then implement a segregated clean organics collection service. Various cost models would need to be explored, including raised collection fees, or fee for service for those households opting in (maybe with incentives such as a 'gift' of compost for the home garden once a year). A system of divided collection trucks could also be trialled, as this would avoid duplication in running two trucks around each urban collection route. Introducing a clean green waste collection arrangement will rely on community support, which must be built on sound information and awareness campaigns.

Previous composting projects have not been sustainable. For example, Ma'ui'ui Organics operated a green waste composting site in Nuku'alofa, asking people to deposit their garden waste and selling a compost product. However, the market demand was not sufficient to cover operating expenses. This demonstrates that market development is critical to success, creating demand for the product and ensuring adequate amounts and quality of the feedstock.

The proposed approach of partnering with an entity embedded within the farming community is also an essential part of developing trust and building demand.

This project would benefit from GIS data, capturing main sources of organic waste generation, transport routes and potential sites for composting.

In summary, the potential opportunity is to reduce landfill and associated emissions through recycling organic waste, with the creation of jobs and improved soil conservation practices additional benefits. However, there are a number of barriers to be addressed by the project, namely:

Lack of sustained uptake of home or school composting due to the labour efforts and little perceived benefits

Poor quality end products may further erode markets

Lack of established market for compost product, which may include lack of farmer knowledge of benefits, and scepticism about something new

Transport costs and logistics of separate waste collection

Limited community support, particularly if it increases waste service costs or if services were unreliable

Low awareness leading to high levels of contamination in the feedstock

To overcome these barriers, sufficient time and resourcing have been included to develop and implement segregated waste collection, build community awareness and support, partner with agricultural sector stakeholder, develop sound techniques and quality control systems, and provide adequate time and resources to develop sustainable markets.

Other considerations

It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities in aspects of project development and implementation (where possible).

The Tonga Statistics Department (TSD) undertakes waste surveys and census, with some surveys issued monthly. Collaboration with TSD will be crucial as this project develops.

Project linkages

This project has linkages with the ALOFA sector, given the potential to produce end products as inputs into agriculture and forestry, reducing reliance on imported fertilisers, and potentially improving yields.

This project aligns with waste Actions 1, 2, 3, 4, 5, 6, 7, and 8, and AFOLU Actions 3 and 6 in Tonga's LEDS.

Estimated impacts (GHG emissions reduction and/or adaptation benefit)

Each tonne of organic waste disposed of at landfill and broken down by anaerobic fermentation releases about 1 tonne of carbon dioxide equivalents (CO_2e) of greenhouse gases, mostly in the form of methane.[237] To estimate emission reduction, factors such as the type of composting technology, transport of waste materials and end products, and comparison to the scenario of 'do nothing' or keeping the situation the same, need to be accounted for. In addition, further GHG emission reduction takes place if the locally produced compost can reduce the application rates of chemical fertilisers such as urea, which is imported from overseas and thus has a significant carbon footprint.

[237] Department Primary Industries and Regional Development (2018): Composting to Avoid Methane Production. https://www.agric.wa.gov.au/climate-change/composting-avoid-methane-production

Compost applied to soil can also provide a medium to long-term carbon store, although carbon storage potential is linked to farming practices, climate, and the properties of the compost. Estimates of net climate impact of composting organic waste in Europe provides savings of around 35 kg CO_2e per tonne of organic waste that is composted rather than landfilled.[238] With these considerations in mind, this project has the potential to reduce waste sector GHG emissions by approximately 11%, therefore reducing GHG emissions by approximately 0.08 $GgCO_2e$ per year once fully implemented. This assumes that half of the organic waste can be deferred from landfill. Assuming the project starts in 2022, and emissions reductions increase in a linear fashion over the first five years to reach 0.08 $GgCO_2e$ per year in 2030, the total emissions reduction potential of this project would be 0.24 $GgCO_2e$ by 2030. Adaptation benefits include this reduction in reliance on agricultural inputs from overseas, and building a more locally resilient agricultural sector to reduce vulnerability to climate shocks. Further to this, building the organic content within soils can reduce erosion during high rainfall events.[239]	
Cost estimates	***Estimated time scale***
Estimated total cost US$1,030,000 comprising: Capital costs—US$300,000: 4 chippers for 3 smaller sites and 1 as mobile plant in Tongatapu cost, on average, US$30,000 1 larger chipper for Tongatapu US$60,000, 1 small loader for larger site US$50,000, Compost testing equipment US$30,000, Small scale bagging plant US$40,000 TA to assist with planning and establishment phase—US$100,000 Funding to TWAL to implement separate collection service and to fund the associated equipment and the awareness and engagement campaign – US$300,000 National coordination position for 5 years US$30,000 per year—US$150,000 Labour allocation for first 2 years of US$10,000 per site; US$40,000 x 2—US$80,000 Operational funds—US$100,000	Recommended that a five-year timeframe is selected, given the time it takes for market development to build sufficient demand that will result in financial sustainability.
Affordability	***Likely co-benefits (including link to SDG)***
There is an existing cost with landfilling organic waste, which can be offset against the cost of organic recycling. Additional costs can be eventually re-couped through product sales, although this may take time to build the product demand. The project would fund some initial operational costs, but financial sustainability through eventual product sales would be the long-term goal.	Potential co-benefits of this project include: Agricultural productivity, contributing to SDG 2 (zero hunger) Health benefits of reduced chemical use, contributing to SDG 3 (good health and well-being) Enterprise development and work opportunities, contributing to SDG 8 (decent work and economic growth) and SDG 9 (industry, innovation, and infrastructure)
Potential environmental or social impacts	
Potential environmental benefits Reduced GHG emissions Reduced waste to landfill	

[238] UNEP (2010): Waste and Climate Change. Global Trends and Strategy Framework

[239] University of Georgia (2020): Compost Utilization for Erosion Control. Bulletin 1200 University of Georgia Extension https://extension.uga.edu/publications/detail.html?number=B1200

Improved soil structure and organic matter Improved soil fertility and reduction in reliance on chemical fertilisers Potential environmental impacts Poor quality compost leading to pollution (e.g., plastic within the compost, or contamination from materials such as household batteries Poor operational controls leading to odour impacts or nuisances such as mosquitos or vermin Leachate from composting impacting soil and running off into lagoon or marine environment Potential social benefits Job creation Increased community awareness on soil health and home gardening Potential social impacts Increased cost of waste services Community concerns or opposition creating tensions.	
Procurement method	***Likelihood of attracting private or donor funding***
International donor funding would be required to implement the infrastructure components and the Technical Assistance package, which would work with TWAL counterpart staff and potential private sector partner or MAFF. Donor funding would also be required to implement the national coordinator position (which could be split with 25% going to TWAL for community awareness and waste segregation, and 75% going to the private sector or MAFF operator, who would undertake the compost operations and market development). This position would be funded over 5 years. Additional support, such as labour and market development funding, would be provided by international donor funding in the initial 2-3 years, but would be phased out as income from product sales increases.	***High*** Given the resources required to develop compost systems and the required capacity for market development, this is unlikely to attract private sector funding. However, a private sector partnership is possible, with a business model to sustain over the longer term. The likelihood of attracting donor funding is high, as it provides a range of benefits aligned with many support priorities, including emission reduction, improved agricultural sustainability, and livelihood opportunities.
Capacity requirement to implement	***Potential barriers***
Low With the impetus of a TA package to drive the momentum, there is good capacity in both the waste and agricultural sectors to implement this initiative.	It takes significant time to build market demand for a compost product, with potential barriers to change including attitudes or lack of awareness of the benefits. The approach of using agricultural private sector or MAFF to undertake the composting and market development is a sound approach, but the risk remains that farmers may continue to use existing convenient practices rather than try something new. Demonstrations and promotions will be critical for change. Compared to a coral atoll island, the volcanic islands of Tonga have better quality soil, leading to perceptions that compost may not be needed. However, farming practices are changing soil structure, with organic content significantly decreasing over time.240

[240] Pers comm, Minoru Nishi, Nishi Trading.

	TWAL and the private sector or MAFF partnership may be challenging. Clear roles and responsibilities and ongoing communication will be essential to overcome issues as they arise. Clean feedstocks are critical for high-quality compost. Good supervision and separation of any contaminants prior to the chipping process is critical for market acceptance of the end product. Lack of sustained uptake of home or school composting due to the labour efforts and little perceived benefits. Poor quality end products may further erode markets Lack of established market for compost product, which may include lack of farmer knowledge of benefits, and scepticism about something new. Transport costs and logistics of separate waste collection. Limited community support, particularly if it increases waste service costs or if services were unreliable. Low awareness leading to high levels of contamination in the feedstock.

Marine sector

Review and update regulations for MPAs, FHRs, and SMAs

Project name: Review and update regulations for MPAs, FHRs, and SMAs		
Sector: Marine	**Sub-sector: Fisheries and Coastal Management**	**Project type: Improved Monitoring and Regulation of SMAs, and Awareness-Raising**
Project description		
This project would develop and implement new regulations (such as size and catch limits), restrict certain practices (such as night-time spearfishing), and/or establish new incentives for the conservation of marine resources within Tonga's Special Management Areas (SMAs). While the available monitoring data for SMAs indicates that fish stocks have improved inside some Fish Habitat Reserves (FHRs)[241], there is very little evidence for any improvements inside the SMAs, where fishing is still allowed. The 2020 SMA report[242] suggests it may be that current levels of fishing pressure inside the SMAs are preventing recovery in these areas. The development of new regulations (such as size and catch limits), restrictions of certain practices (such as night-time spearfishing), and/or the establishment of new incentives could help ensure that SMAs achieve their objectives. The objectives of the SMA program in Tonga are to: 1. Control fishing activities. 2. Restore fish stocks and habitat in no fishing areas (FHRs). 3. Raise community awareness and involvement on fisheries conservation and management. 4. Promote sustainable fishing practices. 5. Improve the living standards in the community. This can all be summarized in the long-term vision of the Special Management Area program, which is to "revive the health and status of coastal fisheries resources in Tonga for current and future generations".[243] A serious consideration is that if improvements inside the SMA areas (non-FHR) are not eventually demonstrated, support for the new and more stringent regulations may erode. Prevention of degazetting of SMAs (as recommended by the 2020 SMA study) should also be investigated.		

[241] Fish Habitat Reserves are no-take areas within the SMAs

[242] Ministry of Fisheries - Kingdom of Tonga. (2020). Special Management Area Report 2020.

[243] Fisheries Division, Ministry of Agriculture & Food, F., and F. (2010). Community-Managed Special Management Areas in Thighonga Brochure, p.1–2.

To determine new measures, appropriate monitoring will also be required. While the monitoring protocols could be developed in this project, given the large number of existing SMAs and additional SMAs being considered, the actual collection of monitoring data will need to be supported by the communities responsible for them. This is not a novel approach, and community-based monitoring is undertaken worldwide. This project would need to be implemented in conjunction with the project to further engage with communities in monitoring the impact of SMAs and FHRs. The costs of this monitoring effort are considered in this project. The following potential project addresses this: "Further engagement with communities in monitoring the impact of regulatory enforcement and the impact of SMAs and FHRs." It is recommended that MPAs and SMAs are 'mainstreamed' into climate change discussions, policies, plans, strategies, and programs. This will help emphasize the importance of adaptation in Tonga's climate change targets, and link the marine sector with other development and climate change priorities. The Ministry of Fisheries is developing a Fish Aggregating Policy. This policy should be utilised when further developing this project. It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities in aspects of project development and implementation (where possible). This project aligns with AFOLU Action 5 (and 'additional actions identified') in Tonga's LEDS.	
Estimated impacts (GHG emissions reduction and/or adaptation benefit)	
High Adaptation benefits would see increased fish biodiversity and stock within SMAs and are considered high given the current worldwide biodiversity crisis. High biodiversity means a healthy ecosystem and increased resilience to climate change, with one of the key objectives of the SMA program "to revive the health and status of coastal fisheries resources in Tonga for current and future generations".	
Cost estimates	***Estimated time scale***
This project would cost in the order of US$350,000. There are already a large number of SMAs, and more are proposed, meaning that significant collaboration between the Ministry of Fisheriesand coastal communities will be required to implement this project for compilation of information and community engagement Following the establishment of new regulations and restrictions, and/or new incentives for SMAs, ongoing monitoring and enforcement will also be required; noting that monitoring and enforcement are associated, but separate projects. Stakeholders identified the cost of enforcement (and monitoring) as a potential barrier. However, there is no large-scale capital expenditure required.	Due to the large number of existing and proposed SMAs, this project could be implemented over the course of 5 years, and would be undertaken in conjunction with community monitoring and consideration of the size of SMAs (both existing and new). Similar to the implementation of SMAs, significant community consultation will be required to develop new regulations and restrictions, and/or new incentives for the conservation of Tonga's marine resources within the SMAs. While some regulations, restrictions and incentives may be applicable to all SMAs, others will need to be developed for specific SMAs due to differences in characteristics including habitats/species present, size, and population pressure.
Potential environmental or social impacts	
Negative Stronger marine conservation regulations may impact the livelihoods of some fisher people in Tonga New regulations may cause tensions over traditional food gathering rights Positive Positive environmental and social impacts with clearer, better structured regulation of MPAs.	
Affordability	***Likely co-benefits (including link to SDG)***
Given the current strain on MAFF's budget, this project would require external grant funding for initial reviews and compilation of information, and ongoing extension services; there are a large number of SMAs, and this number continues to increase.	The potential co-benefits to improving SMAs are related to the primary objectives of these areas. These include: Increased and/or maintained biodiversity and stock, which contributes to SDG 14 (life below the sea)

Costs include community consultation and education surrounding development and implementing regulations and restrictions, and/or new incentives, as well as enacting/enforcing of regulations and restrictions.	Improved fish catch will mean food security for growing populations and contribute to SDG 2 (zero hunger) and SDG 3 (good health and well-being) Contributions to SDG 1 (no poverty) and SDG 8 (decent work and economic growth) by improving the livelihood of individual communities and potentially business associated with artisanal fishing. Contributions to SDG 11 (sustainable cities and communities) through decreased environmental degradation
Procurement method	***Likelihood of attracting private or donor funding***
Given the current strain on MAFF's budget, this project would require external grant funding for initial capacity building activities and ongoing extension services. Funding applications should focus on the conservation benefits of SMAs and their associated FHRs[244], as well as the various SDGs that they support which help to improve the environment through resource management, food security and livelihoods (biodiversity of the seas, zero hunger, no poverty, decent work and economic growth, sustainable communities).	***High*** Conservation of the marine environment, especially coral reefs[245] is increasingly being recognised as imperative for climate change resilience in small island nations. In addition, a number of SDGs are supported by the development and maintenance of SMAs. If incorporated with the other SMA projects included in the pipeline (monitoring and appropriate sizing) as part of a larger programme of marine sector development of SMAs in Tonga, this would likely attract donors.
Capacity requirement to implement	***Potential barriers***
High New regulations and restrictions will require additional 'rules' to SMAs and FHRs, with enforcement and policing potentially requiring legislation, as the existing SMAs are all self-governed and are community led projects. Regulation may require adjustment or removal of the self-governing process, which may be cause for concern for locals. Education and community outreach will therefore be important components of this project.	Lack of human resources in the Ministry of Fisheries Political uncertainty, such as changes in leadership leading to changes to priorities. Public awareness and education as to why and how people and the environment benefit from this project. Restricting night-time spearfishing may create resistance. The cost of enforcing the regulations/restrictions – checking how many fish are caught by each fisher, what size the fish are, etc. Financing is a barrier due to the large and increasing number of SMAs that need to be assessed. Lack of monitoring data is a barrier in the development of regulations and restrictions. Potential mitigation of barriers: Supporting activities, such as capacity-building and awareness-raising programs will be required for this project. These activities should be for all levels, starting from the grassroots. Education, training, and awareness-raising activities for implementing agencies. Awareness-raising programs, which address the whole community, will be important for dealing with potential barriers because: There is the potential for resistance to regulations and restrictions by some users. Therefore, increasing understanding about 'why' particular measures are important to the conservation of marine species and their environment will assist to break down this

[244] Based on experience related by stakeholders.

[245] 50% of the world's coral reefs have been lost in the past 30 years

	barrier. Stakeholder engagement identified that there are some issues that SMAs communities have raised from enforcement. The Ministry will need to work with these communities to solve these issues. Consultation involves fishers and the elderly, and so there is a lack of awareness among younger people at high school/student levels. Awareness programmes need to target schools and explain the importance of SMAs. Awareness raising is key to getting community buy-in because it facilitates and helps to lead to the enforcement of regulations.

Enhanced community monitoring and enforcement of SMAs and FHRs

Project name: Enhanced community monitoring and enforcement of SMAs and FHRs		
Sector: Marine	**Sub-sector: Fisheries and Coastal Management**	**Project type: Improved Monitoring of SMAs and Awareness-Raising**
Project description		
This project would build on recent successes with community management of SMAs to engage communities in monitoring fish stocks within SMAs and FHRs, leveraging local knowledge. This project would result in a better information base that could be used to assess the efficacy of Tonga's SMA program, as well as adaptively manage any new regulations and restrictions to ensure they are achieving their aims. Regulation or management of a resource requires an understanding of the resource (e.g., the standing stock of fish species, the health of the coral reef, etc.), which can be developed through appropriate monitoring. This project would use, promote, and strengthen traditional knowledge of marine practices in Tonga. If necessary, financial incentives could also be considered, such as buy-outs, conservation agreements and alternative livelihoods.[246] Since 2002 the Ministry of Fisheries has been heavily focused on expanding the SMA program, and communities throughout Tonga have been enthusiastic about introducing local marine management. However, the focus on implementation of SMAs came at the cost of monitoring, meaning the success of SMAs as fisheries and coastal management tools is ambiguous. From the limited monitoring data available, there is limited evidence of any recovery inside the SMA areas (outside the Fish Habitat Reserves (FHRs) within the SMAs), where fishing is still allowed by the community. The compilation of monitoring data for SMAs in 2018 found that fish stocks are improving in roughly half of the older FHRs in the country and the diversity of reef fish is also improving in roughly half of the older FHRs in the country. The 2020 SMA report recommends that "An ongoing national monitoring program should be implemented". This project is about monitoring, education, and supporting the communities to manage their resources well and with future generations in mind. An example that could be applied to the collection of monitoring data is Reef Check.[247] Teams of local volunteer citizen scientist divers are trained to collect data on reef health, as well as to assess climate change impacts on their reefs. Their work produces reliable information that is then used by marine resource managers, scientists, and policymakers to make science-based ocean management and conservation decisions. It is recommended that MPAs and SMAs are 'mainstreamed' into climate change discussions, policies, plans, strategies, and programs. This will help emphasize the importance of adaptation in Tonga's climate change targets, and link the marine sector with other development and climate change priorities. The Ministry of Fisheries is developing a Fish Aggregating Policy. This policy should be utilised when further developing this project. It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities in aspects of project development and implementation (where possible). This project aligns with AFOLU Action 5 (and 'additional actions identified') in Tonga's LEDS.		

[246] Niesten, E., and H. Gjertsen, 2010. Economic Incentives for Marine Conservation, Science and Knowledge Division, Conservation International, Alington, Virginia, USA.

[247] https://www.reefcheck.org/about-reef-check/

Estimated impacts (GHG emissions reduction and/or adaptation benefit)	
High The adaptation benefit is similar to the project to review and update regulations for MPAs, FHRs, and SMAs, with benefits including increases in fish biodiversity and stock within MPAs, FHRs, and SMAs; the adaptation benefits are considered HIGH given the current worldwide biodiversity crisis. High biodiversity means a healthy ecosystem. The monitoring will provide better baseline data for future reference and provide a quantitative means for determining the success/failure of the SMAs and FHRs. Furthermore, the results from the monitoring can be used to adjust fishing pressures on certain areas to allow for more sustainable harvesting and food security. By undertaking the monitoring, understanding the effectiveness of regulation and restrictions (and potentially incentives) the communities will obtain a further ownership of their resources.	
Cost estimates	***Estimated time scale***
This project would cost in the order of US$1.1 million. Cost of project design and coordination – US$100K Cost of community outreach, training, and education – US$750K Equipment and support to undertake monitoring – US$150K Cost of financial incentives – these costs range from simple compensation arrangements for changing fishing methodologies (US$10-20K per annum) to buying out areas for conservation (multiple millions of US$ (e.g., similar to fisheries waivers used in Fiji). For the purposes of comparison with other projects, it is assumed that the financial incentives is US$ 20,000 per year for each of the five years of the project (US$100,000 in total). Following the establishment of new regulations and restrictions, and/or new incentives for SMAs, ongoing monitoring and enforcement will also be required; note, review of regulations and updating, and enforcement are associated, but separate projects. Stakeholders identified the cost of monitoring (and enforcement) as a potential barrier. There is no large-scale capital expenditure required.	Due to the large number of existing and proposed SMAs, this project could be implemented over the course of five years, and would be undertaken in conjunction with the development of regulations and restrictions (and potentially incentives) and consideration of the size of SMAs (both existing and new). Training and ongoing support will be required to ensure that: a) monitoring surveys are carried out to collect the required data (e.g., fish counts, live coral cover, etc.), and: b) that monitoring is undertaken regularly and consistently.
Potential environmental or social impacts	
Negative Stronger enforcement of marine conservation regulations may impact the livelihoods of some fisher people in Tonga New regulations may cause tensions between community members over traditional food gathering rights Positive Positive environmental and social impacts by community buy-in through the use, promotion, and strengthening of traditional knowledge of marine practices in Tonga.	
Affordability	***Likely co-benefits (including link to SDG)***
Monitoring will also be required to determine the success of any new regulations and restrictions, and/or new incentives, which given the larger and increasing number of SMAs will need to incorporate community support (i.e., data collection). This means that much of the cost is borne by the communities; however, Government and	The potential co-benefits to improving SMAs are related to their primary objectives and include: Increased and/or maintained biodiversity and stock, which contributes to SDG 14 (life below the sea) Improved fish catch will mean food security for growing populations and contribute to SDG 2 (zero hunger) and SDG 3 (good health and well-being)

financial support will be required for training/teaching, tools to collect the data and tools to archive and transfer this data for analysis. MAFF's budget is already overstretched, meaning that funding for these project functions will need to come from external sources.	Contributions to SDG 1(no poverty) and SDG 8 (decent work and economic growth) by improving the livelihood of individual communities and potentially business associated with artisanal fishing. Contributions to SDG 11 (sustainable cities and communities) through decreased environmental degradation
Procurement method	***Likelihood of attracting private or donor funding***
Given the current strain on MAFF's budget, this project would require external grant funding for training/teaching, tools to collect the data and tools to archive and transfer this data for analysis. Grant funding applications should focus on the conservation benefits of SMAs and their associated FHRs, as well as the various SDGs that they support which help to improve the environment through resource management, food security and livelihoods (biodiversity of the seas, zero hunger, no poverty, decent work and economic growth, sustainable communities).	***High*** Conservation of the marine environment, especially coral reefs[248] (is increasingly being recognised as imperative for climate change resilience in small island nations. In addition, a number of SDGs are supported by the development and maintenance of SMAs. If incorporated with the other SMA projects included in the pipeline (regulatory development and appropriate sizing) as part of a larger programme of marine sector development of SMAs in Tonga, this would likely attract donors
Capacity requirement to implement	***Potential barriers***
Medium The capacity to implement this project is closely linked to the project to strengthen MPA regulations and in turn relies on legislation and the community willingness to participate. It is noted that the local communities are already strongly supporting of, and invested in, SMAs, as demonstrated by their continued growth over the past five to six years. Monitoring will also require adequate training and expert input to analyse this data to determine the success of any new regulations and restrictions, and/or new incentives. Regulations and restrictions, and/or new incentives may also require modification to ensure they are achieving their aim (i.e., adaptive management).	Potential barriers include: The cost of monitoring, both set-up and on-going. Financing could be a barrier, particularly for low-income communities. Management of the monitoring programmes. For monitoring to be of use, it needs to be undertaken using specific methods and be undertaken at regular intervals to build up a database that can be used to determine change. This will require a centralised management unit. Lack of human resources. Lack of qualified workers with the correct skills and experience. Political uncertainty, such as changes in leadership leading to changes to priorities. Potential methods to mitigate barriers: ▪ Supporting activities, such as capacity building and awareness-raising programs. ▪ Development of a memorandum of understanding (MOU) with the three ministries involved—Environment, Fisheries, and Land—to ensure they know their roles and responsibilities with implementing this project. ▪ Mainstream approved SMAs and MPAs.

Optimization the size of MPAs, FHRs, and SMAs

Project name: Optimization the size of MPAs, FHRs, and SMAs

[248] 50% of the world's coral reefs have been lost in the past 30 years.

Sector: Marine	Sub-sector: Fisheries and Coastal Management	Project type: Improving the function of existing community led projects

Project description

This project would undertake a focussed review to consider whether the MPAs, SMAs and FHRs are large enough to be effective for their purpose (for example, protection of habitats, spawning areas, or for particular species). Where these protected areas are found to be too small, this project would seek to expand them.

The question of how big no-take areas and fisheries management area should be is important to their success. The failure of some FHRs to increase fish stocks is potentially due to them being too small or being located in areas with unfavourable habitat. In addition, there are still open questions about how much area overall should be classified for MPAs and SMAs, and what types of marine areas they should include. For example, the New Zealand Department of Conservation has recommended that 10% of the country's marine area be set aside for MPAs. However, many think that the more open character of marine ecosystems requires that higher targets be set, with 20% most often cited as the appropriate goal. In addition, conserving the range of biogenic regions in Tonga needs to be considered.

At an individual scale, MPA size should include consideration of representing biogeographic regions (i.e., inclusion of representative habitat for each region), and ensuring that the size of the MPA is sufficient to protect the target species, especially for significant times in their life histories (e.g., spawning). This project would also consider the expansion of existing FHRs within SMAs, which the 2020 SMA report[249] found should be larger to function better. For example, measures such as increasing FHRs to 30% of the SMA and/or targeting the best quality habitat within each SMA would be considered.

The Ministry of Fisheries is developing a Fish Aggregating Policy. This policy should be utilised when further developing this project.

It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities in aspects of project development and implementation (where possible).

This project aligns with AFOLU Action 5 (and 'additional actions identified') in Tonga's LEDS.

Estimated impacts (GHG emissions reduction and/or adaptation benefit)

High

Adaptation benefits include increased areas of fishing relief (no-take zones) and better functioning fisheries management areas, which will increase the species populations and allow for greater overflow of species into the SMAs and the wider marine environment (i.e., greater ecosystem outcomes). The adaptation benefits are considered HIGH due to fostering increased biodiversity and species abundance.

Cost estimates	*Estimated time scale*
This project would cost in the order of US$500,000. There are already a large number of SMAs, and more are proposed, each with FHRs, and the number of MPAs is also increasing. This means that there are a significant number of fisheries management areas to consider in the reviews. Costs would be significant if each of these areas was to be studied in detail; however, there are a number of methodologies to assist with the understanding of the local marine environments and species that can be used to determine the appropriate size of fisheries management areas (as described in 'Further considerations for the marine sector NDC aims' and summarised in 'Potential barriers' below). There is no large-scale capital expenditure required.	This project could be implemented over the course of five years, and should be undertaken in conjunction with the review and update regulations and enhanced community monitoring and enforcement of SMAs (both existing and new). Important information could be gained during the consultation (which is necessary for the development of regulations and restrictions (and potentially incentives) and establishing an ongoing national monitoring program) with respect to habitat types, species present, etc., etc., that would be applicable to consideration of MPA and SMA size and function. This information would also support the range of methods that can be applied to this task.

Potential environmental or social impacts

[249] Ministry of Fisheries - Kingdom of Tonga. (2020). Special Management Area Report 2020.

Negative Expansion of marine protected areas may impact the livelihoods of some fisher people in Tonga New marine protected areas may cause tensions over traditional food gathering rights Positive Positive environmental and social impacts through the development of marine protected areas that have been optimised for functionality.	
Affordability	***Likely co-benefits (including link to SDG)***
Compiling, analysing, and developing recommendations for the sizes of particular MPAs, SMAs and the FHRs within them will require expertise in marine ecology and protected areas. This is likely to be partly affordable for Tonga (i.e. within the means of the Ministry of Fisheries), and would also utilise advice from international experts, which will require external funding.	Knowledge of whether the existing protected areas are functioning well is critical to safeguarding species diversity and population sizes, which in turn directly influences future fishing pressures and business potential. Thus, understanding the efficacy of these existing areas is important for the health of local communities and artisanal fishers. The potential co-benefits to improving SMAs are related to their primary objectives and include: Increased and/or maintained biodiversity and stock, which contributes to SDG 14 (life below the sea) Improved fish catch will mean food security for growing populations and contribute to SDG 2 (zero hunger) and SDG 3 (good health and well-being) Contributions to SDG 1(no poverty) and SDG 8 (decent work and economic growth) by improving the livelihood of individual communities and potentially business associated with artisanal fishing. Contributions to SDG 11 (sustainable cities and communities) through decreased environmental degradation
Procurement method	***Likelihood of attracting private or donor funding***
Given the current strain on MAFF's budget, this project would require external grant funding for initial capacity building activities and ongoing extension services. Funding applications should focus on the conservation benefits of MPAs, SMAs and their associated FHRs, as well as the various SDGs that they support, which help to improve the environment through resource management, food security and livelihoods (biodiversity of the seas, zero hunger, no poverty, decent work and economic growth, sustainable communities).	***High*** Conservation of the marine environment, especially coral reefs[250] is increasingly being recognised as an imperative to climate change resilience for small island nations. In addition, a number of SDGs are supported by the development and maintenance of SMAs. If incorporated with the other SMA projects included in the pipeline (regulatory development and community monitoring) as part of a larger programme of marine sector development of SMAs in Tonga, this would likely attract donors
Capacity requirement to implement	***Potential barriers***
Medium This project would require medium capacity to implement. Capacity within the communities (i.e., local knowledge) and the Ministry of Fisheries (i.e., knowledge of particular fisheries and the Tongan marine environment) would require augmentation from an expert(s) in	Potential barriers include: Limited marine data. Cost of funding and undertaking the research to determine the optimal sizes and distribution of MPAs and SMAs. Increasing size of no-take areas (MPAs and FHRs) may meet resistance of some fishers. Lack of human resources.

[250] 50% of the world's coral reefs have been lost in the past 30 years

marine protected areas design and management.	Potential mitigation of barriers: Data and research barriers can be partly circumvented by the application of selection methods to identify important parameters and quantifying them or flagging them (e.g. yes/no). Parameters to consider include: Biogeographic representation. Habitat representation and heterogeneity. Level of human threat. Level of threat from natural catastrophes. Size of site. Connectivity. Presence of vulnerable habitats. Presence of vulnerable life-history stages. Presence of exploitable species. Presence of species or populations of special interest. Ecosystem functioning and/linkages. Provision of ecological services for people. Supporting activities, such as capacity building and awareness-raising programs. Development of an implementation roadmap for the SMA Ocean Plan.

Model Tonga's hydrodynamic connectivity

Project name: Model Tonga's hydrodynamic connectivity		
Sector: Marine	**Sub-sector: Fisheries and Coastal Management**	**Project type: Improving the function of MAPs and SMAs at a regional, national, and local level.**
Project description		
This project would consider how well the existing network of MPAs is connected and identify potential new MPA sites. The project would then seek to establish new MPAs in these areas. There is only one ocean/sea that covers the planet. It is all connected, and the majority of the organisms that inhabit it produce eggs and larvae that spend some amount of time in the water column. During this stage they are passively distributed by currents until they are ready to settle/colonise suitable habitat (e.g., the nearshore reef systems that comprise MPAs and SMAs). By understanding the hydrodynamics/currents at a local, regional, and national level, MPAs can be strategically positioned so that the over-flow, or spill-over of eggs, larvae, and juvenile fish have connectivity with other MPAs and wider areas of the marine environment. This not only helps to improve and sustain the MPAs, but also leads to increased spill-over of fish and marine species into the wider environment and improvements in catch per unit effort. For example, creating an MPA at the head of a series of reefs/islands where the currents then flow and connect the islands downstream is far better than locating an MPA at the upstream end of the series of reefs/islands; the former produces spill-over that can colonise the series of islands, the latter's spill-over potentially disappears into open ocean without settling and colonising any reefs/islands. This approach has been advocated by the New Zealand government. This approach has also been successfully applied in the opposite direction to cull islands with Crown-of-Thorn[251] outbreaks that are seeding other islands with their spill-over to reduce the extent of outbreaks. Industry-standard numerical models can be applied to model the whole of the Tongan archipelago, with smaller and smaller model grids (nests) or reducing grid size (finite element grids) to zoom in at an island scale and then to		

[251] Crown-of-Thorn starfish outbreaks cause significant damage through over-grazing of coral cover (e.g., they have been attributed as one of the major causes of coral decline across the Great Barrier Reef over the past 40 years) and are caused by over-fishing of natural predators (e.g., the giant triton shell and the endangered humphead wrasse), increased larval survival due to fertilizer and other nutrient run-off, and following disturbance by tropical cyclones.

localities of existing and potential MPAs and SMAs. Tidal and wind-driven currents can be simulated to determine the connectivity between these aeras at a national, regional, and local scale.

It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities in aspects of project development and implementation (where possible).

This project aligns with AFOLU sector Action 5 (and 'additional actions identified') in Tonga's Long-Term Low Emissions Development Strategy.

Possible project extension

Stakeholders in Tonga stated that they are concerned with the impact of deep-sea mining, both in terms of waste and environmental impact.[252] Research suggests that sediment plumes and waste discharge from mining could disturb phytoplankton blooms and introduce toxic metals into marine food chains.[253] This project or, alternatively, a future project, could include investigating the impact of deep-sea mining on Tonga's marine areas. It will be important to collaborate with the Department of Environment and TWAL when exploring the impact of deep-sea mining.

This project aligns with the 'additional actions identified' in the AFOLU section of Tonga's LEDS.

Estimated impacts (GHG emissions reduction and/or adaptation benefit)

High

The adaption benefits include corridors of productivity connecting protected areas, which will allow species from various MPA/SMA locations to support each other (through spill-over and breeding). This provides greater biodiversity/a larger genetic pool to support ecosystem resilience. Furthermore, once the corridors are established, in addition to positive spill-over effects, species repopulate areas that have historically been over-exploited. This will further support the aims "to revive the health and status of coastal fisheries resources in Tonga for current and future generations"[254]. Increased biodiversity and populations of reef species also results in greater sediment production from coral grazing, which in turn results in healthier and more robust beaches that mitigate erosion and the effects of extreme events, climate change and sea level rise.

Cost estimates	*Estimated time scale*
This project would cost in the order of US$550,000 Numerical modelling Costs – US$250K. It will require international expertise to undertake the modelling, however, it is basically a desktop project. Costs to establish new MPAs (community consultation, mapping, gazetting, etc.) – US$250-350K Modelling Tonga's hydrodynamic MPA connectivity at this level can be driven by existing datasets and sources. For example, the world tidal model would drive the currents around and through the archipelago, long term hindcast wind and wave data is available for the majority of the planet dating back to 1979 at 3-hourly intervals. Similarly, there are existing models and oceanographic data for Tonga that can be utilised in the exercise.[255] There is no large-scale capital expenditure required.	The modelling component of this project could be completed within one year. Establishment of new MPAs (i.e., community consultation, mapping, gazetting, etc.) could take up to five years.

Potential environmental or social impacts

[252] Stakeholders at the Validation Workshop for Tonga's NDC Implementation Roadmap and Investment Plan.

[253] https://news.mongabay.com/2020/06/deep-sea-mining-an-environmental-solution-or-impending-catastrophe/

[254] Ministry of Fisheries - Kingdom of Tonga. (2020). Special Management Area Report 2020.

[255] Mead, S. T., R. McIntosh, D. Greer, and J. Davies-Campbell, 2020. *Fanga'uta Lagoon Bridge Flushing Modelling*. Prepared for the Asian Development Bank, TA-9331 REG: Strengthening Domestic Transport Connectivity in the Pacific -Marine/Aquatic Specialist (51065-001). September 2020

Positive impacts both environmentally and socially through improving fish stocks (and other marine species) by strategic placement of no-take zones.	
Affordability	***Likely co-benefits (including link to SDG)***
Numerical modelling would require international expertise and external fund. The Government of Tonga would be able to establish new MPAs with the assistance of external funding/organizations	Modelling the hydrodynamic connectivity of MPAs and potentially creating new ones and or corridors will provide greater marine resource opportunities on a national scale with respect to tourism and fishing, which will likely increase the number of job opportunities, thus potentially reducing poverty. The potential co-benefits to improving SMAs are related to their primary objectives and include: Increased and/or maintained biodiversity and stock, which contributes to SDG 14 (life below the sea) Improved fish catch will mean food security for growing populations and contribute to SDG 2 (zero hunger) and SDG 3 (good health and well-being) Contribute to SDG 1(no poverty) and SDG 8 (decent work and economic growth) by improving the livelihood of individual communities and potentially business associated with artisanal fishing- Contribute to SDG 11 (sustainable cities and communities) through decreased environmental degradation.
Procurement method	***Likelihood of attracting private or donor funding***
This project would require external grant funding for international expertise. Funding applications should focus on the conservation benefits of MPAs, SMAs and their associated FHRs., as well as the various SDGs that they support which help to improve the environment through resource management, food security and livelihoods (biodiversity of the seas, zero hunger, no poverty, decent work and economic growth, sustainable communities).	***Medium*** Given its small cost, this project may struggle to attract funding from international donors if put forward in isolation. However, it may be possible to incorporate this project with the three other projects focussing on marine protected areas, especially given the link to the size of MPAs and SMAs, which will benefit from this work.
Capacity requirement to implement	***Potential barriers***
Low If this project were done by ministries in Tonga, it would require substantial capacity building to develop the expertise to model hydrodynamic connectivity. . However, it is expected that an international expert(s) would undertake this project remotely, with the Ministries providing local support and knowledge.	Limited marine data at a local level (e.g., for model calibration). However, when flows are modelled at a wide-scale and used as a tool to inform on interconnectivity of the Tongan marine environment, calibration is not considered vital. Lack of human resources. However, if the project recruits a project team to manage and oversee the implementation, then this project should be achievable. Supporting activities, such as capacity building and awareness-raising programs, can assist with mitigating capacity constraints.

Apply detached breakwaters

Project name: Apply detached breakwaters		
Sector: Marine	**Sub-sector: Fisheries and Coastal Management**	**Project type: Infrastructure and Climate Change/Sea Level Rise resilience.**
Project description		
This project would involve applying detached breakwaters in Ha'apai and Vava'u and other locations to prevent erosion and increase climate change and sea level rise resilience.		

The application of detached breakwaters would protect four times the length of the coast in comparison to revetments, reducing quarry and transport GHG emissions by an estimated 75%. The cost of detached breakwaters cost is also approximately four times lower than revetments. Detached breakwaters also offer climate change resilience while maintaining the amenity of coastlines within Tonga by widening the coast (by up to 20-30 m) while still allowing access to the coast. Revetments do not provide these co-benefits. Trails with the application of detached breakwaters in north-eastern Tongatapu (at Manuka) have been extremely effective at widening the beach to provide a buffer zone and stop over-topping onto the road[256]. Prior to the construction of detached breakwater, the water came to the edge of the road and over-topping threw debris onto the road two or three times a year during storm events. Today there is 20-30 m of buffer zone and a series of crescent shaped beaches created by the detached breakwaters. This trial proved that detached breakwaters (in this case with sand transfer) are an effective solution to widening the beach to provide increased resilience and buy time to prepare for the impacts of sea level rise. There are many similar areas of coast through Tonga that could benefit from the application of detached breakwaters to increase resilience, buy time, and help protect land from erosion. It may be challenging for people with disabilities to engage with all aspects of this project. Efforts should be made to include people with disabilities in aspects of project development and implementation (where possible). Application detached breakwaters is linked to the project 'mangrove reforestation and planting' because both projects will be coastal. This project also aligns with AFOLU sector Action 5 (and 'additional actions identified') in Tonga's Long-Term Low Emissions Development Strategy. This project aligns with the 'additional actions identified' in the AFOLU section of Tonga's LEDS.	
Estimated impacts (GHG emissions reduction and/or adaptation benefit)	
High A large proportion of Tonga's population is currently vulnerable to erosion and inundation during extreme events, which will be exacerbated by climate change and sea level rise. Detached breakwaters will help to mitigate coastal inundation risk cost effectively.	
Cost estimates	***Estimated time scale***
This project would cost in the order of US$7.2 million. Detached breakwaters (including design studies) cost approximately US$800K per kilometre. The northern coast of Tongatapu is the most vulnerable and populated part of Tonga where detached breakwaters would be of benefit, with approximately 4 km of coast[257] (US$3.2M). It is estimated that approximately 5 km of low-lying coastal area in other parts of Tonga (i.e., the Ha'apai and Vava'a Islands) would benefit from detached breakwaters (i.e., US$4M).	This project could be implemented over the course of six years. Although breakwaters can be constructed relatively quickly, in many areas the studies required for design have yet to be undertaken, and sourcing rock and plant for construction represents time (and cost) challenges for the smaller islands.
Potential environmental or social impacts	
Negative Construction of detached breakwaters may cause local environmental disturbance, including noise pollution and increased sedimentation Alteration of sections of the coastline may have negative cultural impacts for local people Positive Detached breakwaters may provide new habitat for birds and marine species	

[256] Mead, S. T., 2019. Construction Evaluation of Western Tongatapu (Hihifo) Climate Change Resilience Trials. Prepared for MEIDECC, April 2019. And Mead, S. T., and E. Atkin, 2014. Final Design for Coastal Protection for Climate Change Resilience at Hihifo, Northwest Tongatapu, Tonga. Report prepared for MLECCNR, May 2014. Report prepared for MLECCNR, June 2014.

[257] Mead, S. T. and Manuofetoa, M., 2021. Coastal Protection Along the North Coast of Tongatapu, Tonga (RFP19/108) Report 2: Overall Concept Design and Small-Scale Sites for Implementation for Climate Change Adaptation. Prepared for the GCCA+ SUPA Project and the Kingdom of Tonga, February 2021

Detached breakwaters will help to protect natural coastal ecosystems from storm damage.	
Affordability	***Likely co-benefits (including link to SDG)***
This project would require substantial funding through international donors.	The potential co-benefits to improving climate change and sea level rise resilience along the coasts of Tonga through the application of detached breakwaters include: Increased infrastructure resilience (e.g., the protection of roads, property, and buildings) which contributes to SDG 9 (Industry, innovation, and infrastructure Reduces disconnection from the marine environment (which is caused by revetments), allowing all to access beaches and the marine environment, supporting mental health and wellbeing, which contributes to SDG 3 (good health and well-being) Contribution to SDG 15 (life on land) by protecting land degradation and loss. Contribution to SDG 11 (sustainable cities and communities) through making communities more resilient from climate change impacts and safer from extreme events.
Procurement method	***Likelihood of attracting private or donor funding***
This project would likely require a combination of donor funding and government funding.	***High*** Similar projects have been funded in Tonga for several decades. It is a high-cost project which has readily determined and relatively fast results.
Capacity requirement to implement	***Potential barriers***
Low This project would require low capacity to implement if funding can be found. Detached breakwaters have been successfully built around Tonga. A relatively small amount of international expertise will be required for design, although there is the potential for technology transfer in this area.	Potential barriers include: Limited data and investigations throughout Tonga to identify potential locations and provide appropriate designs. Lack of human capacity and limited technical staff. Sourcing rocks and plants for construction. The high cost of funding. Potential mitigation of barriers: Execute and plan awareness-raising activities before and during the implementation of this project so that people have a better understanding of the project. Supporting activities, such as capacity building and awareness-raising programs will be required for this project. Engage international technical for technical upskilling or support. Supporting activities, such as capacity building and awareness-raising programs, both before and during the implementation of the project, will assist with successful implementation.

Mangrove restoration and planting

Project Name: Mangrove Restoration and Planting		
Sector: Marine	Sub-sector: Coastal wetlands	Project type: Mitigation and Adaptation
Project description		
This project aims to implement a large-scale program to plant or restore mangrove forests in Tonga's coastal wetlands.		

Mangroves provide protection from coastal flooding, tsunamis, storm surges, and sea-level rise, and can reduce coastal erosion.[258] Mangrove forests can actively raise the intertidal seabed in response to sea-level rise, as their presence enables accumulation of sediment above the tidal range.[259] Mangroves are highly productive ecosystems rich in biodiversity that consist of a wide variety of plant species that provide important habitats for fauna, including mammals, birds, reptiles, fish, and molluscs.[260] Mangroves also contribute to local livelihoods by providing forest resources such as medicine, timber, thatching materials, and dye.[261]

Planting or restoring mangrove forests also removes significant amounts of carbon from the atmosphere and stores it as biomass or in coastal soils and sediments. Mangroves sequester carbon at similar rates to tropical humid forests, and are among the most carbon-rich biomes, containing more than 0.9 Ggs of carbon per hectare (ha), on average.[262]

In 2018, Tonga had a total mangrove area of 1,503 ha.[263] If the area of mangroves could be increased by a further 5%, this would be an increase of 75.15 ha of mangroves.

Community partnership will be important to ensure the success of this project. Stakeholders in Tonga also suggested that schools could be engaged for this project. This could help with implementation, and also ensure youths are involved and have buy-in to the project.

Planting mangroves aligns well with work MAFF is currently undertaking in Tonga. Specifically, this project can build on lessons learned from the two following projects:

Climate change resilience work on the northern Tongatapu coast funded by SPC-EU, GIZ and ADB. This project includes establishing a 'green belt' of replanted mangroves, coastal planting, and in some areas, beach renourishment on the northern Tongatapu coast. Project design for this component is already complete; however, funding has not yet been secured.

Mangrove Ecosystem for Sustainable Climate Change Adaptation and Livelihoods (MESCAL). This project was initiated in 2013 and aimed to restore mangroves in Tonga; however, there is little further publicly available information about progress on this objective.

Tonga is also part of the IUCN's Pacific Mangroves Initiative, which has been running since 2009 and aims to build awareness of the benefits of mangroves in the Pacific, conduct research and disseminate information, and coordinate sustainable management of existing mangrove areas.

This project will also be consistent with Tonga's National Forestry Policy (2009), which states:
"Where appropriate, mangroves and other tree species will be re-established within degraded ecosystems to promote foreshore protection and food security."

It may be challenging for people with disabilities to engage with all aspects of this project, for example physically disabled people may find it difficult to assist with mangrove planting. Efforts should be made to include people with disabilities in aspects of project development and implementation (where possible).

Mangrove reforestation and planting is linked to the project 'application detached breakwaters' because they are both coastal.

This project also aligns with AFOLU Action 5 (and 'additional actions identified'), and Human Settlements Action 9 in Tonga's LEDS.

Estimated impacts (GHG emissions reduction and/or adaptation benefit)

[258] Alongi, D.M.

[259] UNEP. (2010). Building Resilience to Climate Change: Making the Case for Ecosystem-based Adaptation. https://wedocs.unep.org/bitstream/handle/20.500.11822/13737/2010%20Mt%20EbA%20Making%20the%20case%20for%20EbA.pdf?sequence=1&isAllowed=y

[260] Spalding, M.; Kainuma, M.; Collins, L. (2010). World atlas of mangroves. Earthscan, London

[261] Mead, S. T. and Manuofetoa, M., 2021. Coastal Protection Along the North Coast of Tongatapu, Tonga (RFP19/108) Report 2: Overall Concept Design and Small-Scale Sites for Implementation for Climate Change Adaptation. Prepared for the GCCA+ SUPA Project and the Kingdom of Tonga, February 2021

[262] Alongi, D.M. (2014). Carbon Sequestration in Mangrove Forests. In Carbon Management (https://www.researchgate.net/publication/274116107_Carbon_sequestration_in_mangrove_forests)

[263] According to the FOA's FAOSTAT database, using calculated data from the MODIS land cover database. Available at: http://www.fao.org/faostat/en/#data/LC

Restoring and planting mangroves is expected to have **high** adaptation benefits in Tonga. Restoring and replanting mangroves would also contribute substantially to climate change mitigation. New mangroves sequester 0.9 $GgCO_2$ per ha over approximately 6–20 years.[264] On average, therefore, new mangroves can be expected to sequester carbon at a rate of 0.09 $GgCO_2e$ per hectare (assuming that mangroves take three years to start sequestering carbon at a meaningful rate). If Tonga were to increase the area of mangroves by 5% (75.15 ha), Tonga's GHG emissions could be reduced by an additional 6.76 $GgCO_2e$/year. Assuming that Tonga increases its mangrove area by 5% through a replanting campaign in 2022, and that it takes three years for new mangroves to start sequestering carbon at a meaningful rate, this project has the potential to sequester 40.58 $GgCO_2e$ by 2030.	
Cost Estimates	***Estimated time scale***
It costs approximately US$50,000 per hectare to plant or restore mangroves.[265] It would therefore cost US$3,758,000 to increase Tonga's total mangrove area by 75.15 ha (5%).	The planting phase of this project could be completed in five years due to the large number of seedlings required. Assuming mangroves start sequestering carbon at meaningful rates three years after planting, GHG emissions reduction benefits would be realized from 2026.[266]
Potential environmental or social impacts	
Negative Planting and restoring mangroves may impact local communities by inhibiting access to the sea or between access between households in estuarine areas Mangroves can be breeding grounds for mosquitos and may be associated with an increase in mosquito-borne diseases Positive Community replanting and community ownership of mangrove areas can contribute to community cohesion Mangroves contribute significantly to healthy ecosystem function, and can act as nurseries for fish, and habitat for invertebrates and birds	
Affordability	***Likely co-benefits***
It would cost approximately US$ 36 per head of population to implement this project in Tonga. While the impact of the GHG emissions reductions from this project are unlikely to meaningfully affect people in Tonga, the significant co-benefits from increased ecosystem services such as storm surge protection are likely to be significant. Therefore, this project is likely to be affordable for Tonga.	Mangrove forests are a valuable ecological and economic resource, providing food and fuel resources; nursery grounds for fish, mammals, and other fauna; depocenters for sediment and other elements. This will contribute to SDG 13 (climate action), SDG 14 (life below water), and SDG 15 (life on land) Mangroves provide protection from coastal flooding, tsunamis, storm surges, and sea-level rise, and can reduce coastal erosion.[267] Mangrove forests can actively raise the intertidal seabed in response to sea-level rise, as their presence enables accumulation of sediment above the tidal range.[268] This will contribute to SDG 11 (sustainable cities and communities), SDG 13 (climate action), SDG 14 (life below water), and SDG 15 (life on land)

[264] Alongi, D.M, p.316. Mangroves can sequester carbon effectively over a period of 100 years. Alongi, D.M, p.316.

[265] 2,500 mangroves can be planted in approximately 1 hectare (based on a study in the Philippines which planted 190,000 mangroves over 76 hectares – 190,000/76 = 2,500) (https://news.mongabay.com/2020/09/missing-mangroves-are-root-of-contention-over-philippine-airport-project/). In a project in Samoa, USAID budgeted US$49,500 to plant 2,500 mangroves.

[266] Alongi, D.M., p.316.

[267] Alongi, D.M.

[268] UNEP. (2010). Building Resilience to Climate Change: Making the Case for Ecosystem-based Adaptation. https://wedocs.unep.org/bitstream/handle/20.500.11822/13737/2010%20Mt%20EbA%20Making%20the%20case%20for%20EbA.pdf?sequence=1&isAllowed=y

	Mangroves are resilient to environmental changes, such as water and oxygen deficiency, changes in salinity, wave effects, and tidal shifts.[269] This will contribute to SDG 3 (good health and well-being), SDG 15 (life on land), and SDG 13 (climate action) The annual economic value of mangroves has been estimated to be US$200,000—$900,000 per hectare[270]. This will contribute to SDG 8 (decent work and economic growth).
Procurement method	***Likelihood of attracting private or donor funding (high, medium, low)***
Government funding and donor funding from international grants and are likely funding sources for this project.	***High*** Funding and support for mangrove restoration in Tonga is currently being provided by SPC-EU and GIZ The significant co-benefits of mangroves are likely to make mangrove restoration and planting particularly attractive to donors.
Capacity requirement to implement (high, medium, or low)	***Potential barriers***
Low Planting and maintaining mangrove forests is not technically difficult.	Locating suitable coastal wetlands in Tonga. Land ownership issues. Maintaining planted mangroves. Lack of human resources and lack of qualified staff for mangrove propagation. Potential mitigation of barriers: Supporting activities, such as capacity building and awareness-raising programs. ▪ Partnership with communities is crucial for this project. ▪ Supporting upskilling and training of staff (and possibly community members) for mangrove propagation and data collection and recording. ▪ Recording and filing of data—this skill can be strengthened through support activities. Engagement with NGOs. Community partnership.

[269] Ministry of Natural Resources, Environment and Meteorology (2006). Mangroves of Samoa (https://www.sprep.org/att/IRC/eCOPIES/Countries/Samoa/83.pdf)

[270] IUCN. (2006). Managing Mangroves for Resilience to Climate Change (https://portals.iucn.org/library/sites/library/files/documents/2006-041.pdf)

Appendix B: Current and planned projects

Table B.1 outlines existing GHG mitigation or adaptation projects or initiatives (either being developed or have been recently implemented) in the AFOLU, waste, marine, and energy sectors. Some projects have been delayed due to travel restrictions implemented during the COVID-19 pandemic.

Table 0.1: Existing GHG mitigation or adaptation projects or initiatives in priority sectors

Project name	Description	Project completion expectation	Organisation responsible
	Energy sector		
Sunergise 6 MW Solar PV IPP	6MW Solar Project is an Independent, 25-year Power Purchase Agreement between Tonga Power and Sunergise Ltd, to produce power and sell back on an agreed buying rate per unit by TPL. The project is divided into three project sites which located on the west of Tongatapu Island.	Implementation underway – one site completed, two expected to be completed by the end of 2022.	Private sector
GET 6 MW of Solar PV IPP	6MW Solar Project developer with a conditional PPA in place, in pre-financial close.	Fulfilling preconditions of Power Purchase Agreement	Private sector
2.25 MW China Wind Farm	The Government of China has agreed to commit RMB 87m to the installation of a wind farm on Tongatapu. MEIDECC as the co-signers of the implementation agreement will be responsible for the project preparations. Including, securing land, environmental and construction permitting, site leveling, site services (water, comms etc.), temporary facilities and road access.	Pre-Implementation planning – delayed due to border COVID-19 border closure	MEIDECC, Department of Energy TPL
3.8 MW of Wind IPP	Akuo Energy Wind Plant in Lapaha, Tongatapu.	Pre-feasibility stage	Private sector TPL
TPL 34-50 GWh Tender (technology agnostic)	In 2021 TPL requested Expressions of Interest (EOI)s from suitably qualified Independent Power Producers to	Ongoing—TPL has evaluated responses to the request for EOIs and is preparing the	TPL

Project name	Description	Project completion expectation	Organisation responsible
	design, finance, procure, fabricate, deliver, construct, test, commission, monitor, operate and maintain one or more Renewable Energy Generation Facilities (REGFs) under a 20+ year Power Purchase Agreement (PPA) with TPL. This project is intended to: • provide an environmentally responsible alternative to the predominantly fossil fuel-based electricity • generation in the Kingdom of Tonga. • provide a renewable energy source that supplies reliable electricity to the Tongatapu grid at a competitive rate; and • enhance reliability and cost-efficiency of the electrical network by including storage and dispatchability.	detailed tender for shortlisted firms.	
Nuku'alofa Network Upgrade (NNUP)	NNUP is the upgrade and modernization of the electricity network in the Nuku'alofa Area, in 5 phases covering the 5 areas of Nuku'alofa. NNUP will help to reduce network losses, increase access to electricity, provide safe and reliable electricity supply to approximately 8,472 households and businesses in the greater Nuku'alofa area, and improve TPL's operating and maintenance capability.	Ongoing – approximately two phases completed with some works undertaken in response to recent natural disasters.	TPL
AFOLU sector			
Promoting the benefits of tree planting and management	According to the Tonga Forest Management Plan (2017), this project comprises four actions: Better quantify and publish information on the effects of trees on agricultural productivity through ongoing research Disseminate information on the benefits, including effects on agricultural productivity and the financial returns from the use of trees for timber and carbon Develop and launch a program for landholders and lessees for the reforestation of abandoned allotments with native regrowth and/or high-value timber species such as sandalwood	Ongoing—the ministry will continue to pursue the objectives described in Tonga's Forest Management Plan.	MAFF

Project name	Description	Project completion expectation	Organisation responsible
	Enhance the capacity and motivation of landowners to plant and maintain trees for multiple purposes through education and information.		
Fostering community engagement in coastal forest management	According to the Tonga Forest Management Plan (2017), this project requires: "Foster[ing] the establishment of industry-based and community-based cooperatives for the establishment and management of forests and trees, including community coastal care committees to develop and implement management plans for the rehabilitation of degraded foreshores and for the improved management of foreshores, particularly in areas most vulnerable to rising sea levels and storm surges."	Ongoing—the ministry will continue to pursue the objectives described in Tonga's Forest Management Plan.	MAFF
Improving the legal and policy framework	Actions outlined in the Tonga Forest Action Plan (2017) include: "Ensure[ing] that the Forests Act recognises the need for timber harvesting to be covered by a certified Timber Harvesting Plan (THP) and for it to be an offence under the act to harvest timber without a THP or in contravention of a THP." "Appoint[ing] Forest Practices Officers (FPOs) to prepare, certify and monitor the implementation of timber harvesting plans for plantations."	Ongoing—the ministry will continue to pursue the objectives described in Tonga's Forest Management Plan. Tonga has already appointed Forest Practices Officers under the work to improve the legal and policy framework in Tonga. There has also been some progress on improving enforcement of forest laws, with updates to the existing legislation, including the Sandalwood Regulations.	MAFF
Improving the enforcement of forest laws	Actions outlined in the Tonga Forest Action Plan (2017) include: "Develop[ing] and implement[ing] enforcement protocols for the forestry framework, including legislation, sandalwood regulations, management plans and codes of practice."	Ongoing—Tonga is currently implementing the Sandalwood Regulations, but it is too early to measure the success of these efforts. The Forestry Division is seeking a consultant to update the wording in the regulation to make it more effective.	MAFF

Project name	Description	Project completion expectation	Organisation responsible
Replanting cleared coconut trees	According to the Tonga Forest Management Plan (2017): "The Forestry Division has an active program to encourage coconut replanting, particularly on sites previously cleared (e.g., for squash production). The nursery on Tongatapu provides coconut seedlings and technical advice and assistance to landholders at no cost." "The coconut replanting program has been a matter of importance to the government for three basic reasons: First, the production of copra has been an important industry for Tonga in the past, and whilst the sales are now significantly lower, there is a hope that the markets will improve again in the future with the opportunity of new markets, e.g., for biofuels. Second, the coconut resource is rapidly approaching senility. The population has a mean age of approximately 45 to 50 years and a few new palms in the younger age classes. New plantings will be necessary to maintain the population into the future. Third, whilst there is little local use of the timber, there is potential to develop new processing options and markets for products such as flooring and furniture."	Ongoing—in 2009, the Forestry Division aimed to replant about 250 ha with 15,000 seedlings. It achieved about one-third of this target.[271] The Forestry Division has raised 300,000 coconut seedlings over "the last decade or so". Targets for annual coconut planting are increasing every year, and the current target is to raise 100,000 seedlings per year. Tonga managed to raise 50,000 seedlings in 2020. Stakeholders indicated that meeting this target has been challenging because the Forestry Division does not have enough space for the seedlings and there has not been enough demand for seedlings. However, the Forestry Division is working with other departments to raise awareness of the availability of free seedlings. There is still a lot of tax allotments in Tonga (approximately 6,000 on Tongatapu) that need to be replanted with coconut trees.[272]	MAFF

[271] Tonga Forest Management Plan (2017).

[272] Reported by a representative of the Forestry Division during the AFOLU Sector consultation.

Project name	Description	Project completion expectation	Organisation responsible
Regulate the burning of crop residues	The National Forestry Policy for Tonga (2009) included the following objective within its climate change policy statement: "To help sequester carbon within soils, forests and tree resources, the Forestry Division, with the support of other relevant ministries and stakeholders, will strictly regulate the use of fire in agricultural and other land-use applications. Established fire management guidelines will be enforced."	Although there are no data on the burning of crop residues in Tonga in the FAOSTAT database. The AFOLU sector stakeholders confirmed that burning of crop residues is very uncommon in Tonga now, so it is unlikely to be a material concern.	MAFF
Piggery Biogas Digester	The MAFF Corporate Plan (2020/21-2022/23) included the following activity in the livestock division activities: "Facilitate implementation of MAFF-China Piggery-Biogas-Vegetable (PBV) Ecological Technologies Project: Tongatapu Phase V: Increase PBV farms from two demonstration farms (Tupou College, Liava'a farm) to 21 PBV farms." More information was given in the Tonga Agriculture Sector Plan 2016-2020: "The use of biodigesters[19] in Tonga to produce biogas and organic fertilisers is strongly aligned with the TASP goal to increase and sustain resilient agricultural livelihoods. The use of this technology in Tonga has so far been limited to a limited number of biodigesters involving piggeries… TASP will focus on the expansion of the work done by MAFF-China PBV Project (since 2010) to establish PBV production system in Tonga. Two biogas systems (30 cubic meter digester tank) were constructed for demonstration and training purposes, at the Vaini Research Station on Tongatapu and at the Vava'u Experimental Farm. Following training sessions for various groups of interested farmers in Tongatapu and Vava'u, 15 biogas systems (15 cubic meter digester tank) were constructed for 13 farmers in Tongatapu and two farmers in Vava'u. The PBV system provides gas for a household's stove, light, and water heating, together with pig meat and organic fertilizer for vegetables. FAO is also implementing a project on Tonga Integrated Land and Agro-Ecosystem Management System involving biodigesters. The TASP will support the expansion of these developments."	Ongoing—this project is well developed and there are currently about 35 biogas digesters in Tonga. These facilities have been working very well. However, further expansion has been happening slowly. AFOLU sector stakeholders suggested that there is a possibility to increase the number of biogas digesters to 40-50.	MAFF

Project name	Description	Project completion expectation	Organisation responsible
Integrated Land and Agro-ecosystems Management Systems (ILAMS)	This GEF-funded initiative includes efforts to manage the impacts of roaming livestock, increase the use of organic/animal fertilizer and increase the use of biogas. It also promotes tree planting via communal nurseries and improved extension services for women and youth.[273]	Ongoing	FAO
Tonga Rural Innovation Project (TRIP II)	The TRIP II project is run by Mainstreaming of Rural Development Innovation (MORDI) Tonga Trust, and it engages rural and remote communities to improve environmental management for food security. It has multiple objectives relating to ecosystems and ecosystem services, health, food and water security, and livelihood improvement in remote communities.[(ibid)]	Ongoing	MORDI Tonga Trust
Conservation of traditionally useful tree species and home gardening	The Tonga Community Development Trust (TCDT) is promoting conservation of traditionally useful tree species and home gardening.[(ibid)]	Ongoing	TCDT
Promotion of organic farming	The Tonga National Youth Congress is undertaking work on certifications and promotion of organic farming, and resilient farming practices.[(ibid)]	Ongoing	Tonga National Youth Congress
Climate Smart Approaches for sustainable food and nutrition, and secure livelihoods for Tonga in the Agricultural Sector	According to the GCF pipeline, this project aims to reduce GHG emissions and enhance the capacity to adapt to the impacts of climate change on vulnerable subsistence and semi-subsistence farming systems. It also aims to integrate climate-smart agriculture and fisheries for increased community resilience and sustainable food and nutrition security. Partners include FAO. The estimated cost of this project is US$10 million.	Concept Note development stage: Pre-feasibility study—Planned for 2022.	MEIDECC

[273] Reported in Tonga's Long-Term Low-Emissions Development Strategy (LEDS) 2021-2050

Project name	Description	Project completion expectation	Organisation responsible
Establishing resilient, low-carbon agricultural systems in Tonga, Vanuatu, and Samoa	According to the GCF pipeline, this project aims to address priority adaptation needs for enhanced food security that builds resilience and preserves ecosystem services associated with climate-sensitive agricultural resources and livelihoods. Partners include SPC.	Concept note second submission pending GCF review.	MEIDECC
Adaptation for Resilient Agriculture in Fiji, Kiribati, Samoa, Solomon Islands, and Tonga	According to the GCF pipeline, this project aims to restore resilient, regenerative smallholder farming involving Pacific Island national institutions and farming communities. Partners include the International Fund for Agricultural Development (IFAD).	Concept note development stage.	MEIDECC
Food security (Agriculture and Fisheries)	According to the GCF country program, this project aims to address and enhance climate change resilience and reduce disaster risk of agriculture and fisheries.	Full proposal developed and consultation and working with the GCF secretariat. Submission of the proposal was intended for 2019.	MEIDECC
Ecosystem Based Adaptation and Biodiversity Conservation	According to the GCF country program, this project aims to ensure resilience through managing biodiversity and promoting diversity of food sources and a healthy and green environment.	Project idea.	MEIDECC
PACSTAT-Tonga project: System of Environmental-Economic Accounting (SEEA) satellite account	TSD project includes the development and collection of data for the SEEA, which provides valuable links between environmental statistics and economic statistics. The SEEA satellite account applies the same industry classifications to environmental statistics with the goal of measuring sustainability and quantifying possible negative environmental impacts that may offset the economic expansion associated with certain industries. Priority in the environmental accounts in energy, water, and solid waste, with a target of consistently producing all three annually by project end.	Entire project timeline is 5 years (2020 – 2025). SEEA component is expected to take lesser time to complete.	TSD
Waste			
GEF Island Project	An approved project focussing on Ha'apai and 'Eua, including: ▪ Climate proofing and improvement in infrastructure and environmental safeguards at the landfill site at 'Eua (the existing landfill site at old quarry)	Project implementation was planned for 2021 but delayed due to COVID-19.	WMPC Division of Environment Department

Project name	Description	Project completion expectation	Organisation responsible
	▪ Climate proofing and improvement in infrastructure and environmental safeguards at the landfill site identified in Foa District at Ha'apai ▪ Equipment to address plastics recycling ▪ Awareness and improving waste behaviours ▪ Capacity building of staff The project will be implemented with technical support from JPRISM experts. Cost US$800,000		under MEIDECCC
Tonga Integrated Urban Resilience Sector Project (TIURSP)	This project has a climate change and resilience focus in the urban development sector. The waste sector sub-project involves: ▪ Upgrading the waste collection fleet ▪ Building capacity for vehicle maintenance ▪ Constructing Cell 3 at Tapuhia Waste Management Facility (WMF) ▪ Installing a weighbridge at Tapuhia WMF ▪ Reviewing tariffs and supporting financial sustainability ▪ Upgrading landfill operational equipment The goals of the project are to: ▪ Ensure reliable and sustainable waste collection services ▪ Improve the sustainability of landfill operations Increase and strengthen TWAL's capacity. Cost—total Project US$21.317 million (US$18.275 donor funds) Waste sector infrastructure investment US$3.934 million (with additional funds for capacity building and community engagement)	Ongoing—project commenced in February 2021 and is due to be completed in 2027	TWAL
J-PRISM Support to Tonga	JPRISM II—this project involves building capacity and providing technical support for the expansion of TWAL services to outer islands. The project aims to implement waste collection and disposal services in Vava'u, Ha'apai and 'Eua.	Ongoing—due for completion in 2020 but has been extended to 2021 as JPRISM III planning and implementation has been delayed due to COVID-19.	TWAL

Project name	Description	Project completion expectation	Organisation responsible
	JPRISM III—a third phase of the JPRISM assistance to improving waste management in the region is planned. Country-specific detail will be developed, with MEIDECC and TWAL to prioritise areas of support, particularly in capacity building. Total cost unknown, as the focus is on information sharing between the 11 participating countries, and technical assistance with in-country specialists provided by JPRISM II		
PacWaste Plus	This regional project involves: ▪ Supporting 15 participating countries (including Tonga) to improve their management of hazardous waste, solid waste, and water impacted by waste. The goals of the project are to: ▪ Improve economic, social, health, and environmental benefits for PICs through stronger regional economic integration and the sustainable management of natural resources and the environment ▪ Improve quality and/or availability of waste data across the region ▪ Improve policy and governance, market opportunities, and technical capacity to address specific waste streams Cost—Total project cost EUR16.5 million (approx. US$19.49 million)	Ongoing—the original PacWaste programme was implemented between 2013 and 2017. PacWaste Plus commenced in 2019 and will continue until 2024.	MEIDECC, DoE, Waste Management and Pollution Control Division
PRIF Waste Audit	This project involves: ▪ Documenting waste generation rates and composition across the Pacific, and using a consistent methodology to be applied across 14 participating PICs ▪ Includes waste audit in Tongatapu and outer islands, undertaken early 2021 The goals of the project are to: ▪ Gather data on waste generation rates and composition in Tongatapu and representative outer islands	Ongoing—waste audits have been completed with project reporting in the finalisation process. Tonga's waste audit results expected for publication in July 2021.	MEIDECC, DoE, Waste Management and Pollution Control Division

Project name	Description	Project completion expectation	Organisation responsible
	▪ Gather data to inform infrastructure investment decisions (such as regional recycling hub) Implement a methodology to collect data on an ongoing basis.		
Study into Potential for Regional Recycling Hub	Using data from the regional waste audits, and under the direction of the Cleaner Pacific Round Table, this project looks to explore opportunities to improve recycling markets. With all PICs struggling with distance to markets, economy of scale and lack of infrastructure, recycling is very challenging. This work will explore opportunities to establish at least one regional processing hub. Cost estimate US$ 300,000 (tender not yet awarded).	Planning—the Expression of Interest closed in early July 2021, with short-listed companies to undertake EOI. Project expected to commence in September 2021.	ADB will provide contract oversight
	Marine		
Tonga Coastal Resilience Project	This project aims to reduce the vulnerability of coastal systems and infrastructures to climate-driven sea level rise and extreme weather events. Partners include UNDP. The estimated cost of this project is US$33 million.	Proposal review stage: Feasibility Study—planned for 2021.	MEIDECC
Towards climate change resilient coastal fisheries and aquaculture in Tonga	This project aims to address the effects of climate change on coastal fisheries through integrated sustainable management to ensure food security. Partners include SPC. The estimated cost of this project is US$15 million, and it has an estimated timeframe of 5years.	Concept note review stage: Pre-feasibility study—planned for 2021 (2021-2026).	MEIDECC
Adapting tuna-dependent Pacific Island communities and economies to climate change	This project aims to make tuna-dependent Pacific Island economies and communities (including in Tonga) more resilient to climate change. This will be achieved by: ▪ Increasing the supply of tuna for domestic consumption as an adaption to degradation of coral reefs and the resulting food insecurity for vulnerable populations ▪ Ushering in the reforms needed to minimize the risks for citizens of countries with economies that are vulnerable to climate-driven redistribution of tuna. Partners include GCF and Conservation International Foundation.	Unknown	Ministry of Fisheries

Project name	Description	Project completion expectation	Organisation responsible
Extending the Fisheries Special Management Area (SMA) throughout Tonga	This project aims to increase food security and diversity through integrated and sustainable fisheries management, strengthening coastal systems against increasing temperature, and protecting calcareous species such as coral reefs and shellfish against ocean acidification. SMAs are administered under the Ministry of Fisheries, and the Department of Environment assists with their establishment. Partners include the World Bank Group. The estimated cost of this project is US$10 million.	Ongoing—current initiatives are being scaled up and replicated. There is potential to up-scale SMAs and/or FHRs to MPAs (i.e., larger protected areas).	Ministry of Fisheries, Department of Environment
Sustainable fisheries management—aquaculture	This project aims to help fisheries management become more sustainable. The fisheries sector is at risk from climate change and natural disasters which, in turn, pose risks to the health of the people of Tonga and may contribute to poverty and hardship. The estimated cost of this project is US$15 million.	Project idea—a pilot site is the Popua area to the east of Nuku'alofa, which is now planned to be rehabilitated as an eco-park to include mangrove planting and mullet pools[274]. This area has been cleared in recent years, although is very low (mostly below high tide).	Ministry of Fisheries, Department of Environment
Mangrove reforestation under SPC-EU, GIZ, and ADB funded climate change resilience projects	The SPC-EU, GIZ, and ADB are funding and currently undertaking climate change resilience efforts along the northern coast of Tongatapu, including funding large areas of mangrove reforestation. The SPC EU, GIZ, and ADB projects include: ▪ SPC Hahake coast work ▪ ADB revetment at Manuka ▪ GIZ/SPC Hihifo coast works ▪ SPC coastal protection assessment for the northern coast of Tongatapu, including Fanga'atu Lagoon	Ongoing—projects are underway. Another mangrove restoration project was submitted in February 2021. Funding has not been secured.	MEIDECC

[274] Mullet is a highly priced fish species in Tonga.

Project name	Description	Project completion expectation	Organisation responsible
	The estimated cost to implement coastal protection for climate change resilience along the northern coast of Tongatapu, including mangrove reforestation, is T$20,846,000 (excluding any large-scale reclamations to increase land levels).		
Mangrove restoration	This project aims to restore additional mangroves in central Nuku'alofa and in the Vava'u group in northern Tonga.	Completed.	MEIDECC
Mangrove Ecosystem for Sustainable Climate Change Adaptation and Livelihoods (MESCAL)	This project aims to restore mangroves in Tonga through the MESCAL project.	The MESCAL project was initiated in 2013. No further information about this project, other than classification of mangrove areas, has been identified.	MEIDECC
Tonga Coastal Resilience Project	This project aims to reduce the vulnerability of coastal systems and infrastructures to climate-driven sea level rise and extreme weather events. Partners include UNDP. The estimated cost of this project is US$33 million.	Proposal review stage: Feasibility Study—planned for 2021.	MEIDECC
Towards climate change resilient coastal fisheries and aquaculture in Tonga	This project aims to address the effects of climate change on coastal fisheries through integrated sustainable management to ensure food security. The estimated cost of this project is US$15 million, and it has an estimated timeframe of 5years.	Concept note review stage: Pre-feasibility study—planned for 2021 (2021-2026). The project will be implemented by the Ministry of Fisheries, MEIDDECC and SPC (Coastal fisheries and aquaculture division).	Ministry of Fisheries
Adapting tuna-dependent Pacific Island communities and economies to climate change	This project aims to make tuna-dependent Pacific Island economies and communities (including in Tonga) more resilient to climate change. This will be achieved by: Increasing the supply of tuna for domestic consumption as an adaption to degradation of coral reefs and the resulting food insecurity for vulnerable populations Ushering in the reforms needed to minimize the risks for citizens of countries with economies that are vulnerable to climate-driven redistribution of tuna.		Ministry of Fisheries

Project name	Description	Project completion expectation	Organisation responsible
	Partners include GCF.		
Extending the Fisheries Special Management Area (SMA) throughout Tonga	This project aims to increase food security and diversity through integrated and sustainable fisheries management, strengthening coastal systems against increasing temperature, and protecting calcareous species such as coral reefs and shellfish against ocean acidification. SMAs are administered under the Ministry of Fisheries, and the Department of Environment assists with the establishment of them. Partners include the World Bank Group. The estimated cost of this project is US$10 million.	Ongoing—current initiatives are being scaled up and replicated. There is potential to up-scale SMAs and/or FHRs to MPAs (i.e., larger protected areas).	Ministry of Agriculture, Food, and Forestry, Ministry of Fisheries
Sustainable fisheries management—aquaculture	This project aims to help fisheries management become more sustainable. The fisheries sector is at risk from climate change and natural disasters, which in turn pose risks to the health of the people of Tonga and may contribute to poverty and hardship. The estimated cost of this project is US$15 million.	Project idea—a pilot site is the Popua area to the east of Nuku'alofa, which is now planned to be rehabilitated as an eco-park to include mangrove planting and mullet pools[275]. This area has been cleared in recent years, although is very low (mostly below high tide).	Ministry of Agriculture, Food, and Forestry, Ministry of Fisheries, MEIDECC
Mangrove reforestation under SPC-EU, GIZ, and ADB funded climate change resilience projects	The SPC-EU, GIZ, and ADB are funding and currently undertaking climate change resilience efforts along the northern coast of Tongatapu, including funding large areas of mangrove reforestation. The SPC EU, GIZ, and ADB projects include: SPC Hahake coast work ADB revetment at Manuka GIZ/SPC Hihifo coast works	Ongoing—projects are underway. Another mangrove restoration project was submitted in February 2021. Funding has not been secured.	MEIDECC

[275] Mullet is a highly priced fish species in Tonga.

Project name	Description	Project completion expectation	Organisation responsible
	SPC coastal protection assessment for the northern coast of Tongatapu, including Fanga'atu Lagoon. The estimated cost to implement coastal protection for climate change resilience along the northern coast of Tongatapu, including mangrove reforestation, is T$20,846,000 (excluding any large-scale reclamations to increase land levels).		
Mangrove restoration	This project aims to restore additional mangroves in central Nuku'alofa and in the Vava'u group in northern Tonga.	Completed.	MEIDECC
Mangrove Ecosystem for Sustainable Climate Change Adaptation and Livelihoods (MESCAL)	This project aims to restore mangroves in Tonga through the MESCAL project.	The MESCAL project was initiated in 2013. No further information about this project, other than classification of mangrove areas, has been identified.	MEIDECC

Appendix C: Terminologies and assumptions used in Section 5

Determination of GHG Mitigation

GHG (expressed as CO_2) mitigation potentials outlined in this NDC Implementation Roadmap and Investment Plan with Project Pipeline are determined based on the available information gathered from stakeholders in Tonga, national documents such as plans, policies, and strategies as well as other sources, which take into account the IPCC 2006 guidance.

Determination of investment and support needs

Costs for investment and support needs are determined in US dollars and are based on estimated costs as incurred in the Pacific region up through 2030. These values are rounded to the nearest thousand US$. Cost estimates in this NDC Implementation Roadmap and Investment Plan with Project Pipeline should be seen as suggestive, due to the high degree of uncertainty caused by external factors, such as the economic downturn caused by the COVID-19 pandemic, and energy and commodity price changes.

Data

When data was not available or may be inaccurate or outdated, mitigation potentials and other conclusions (such as estimated cost of the project) were estimated based on various informed assumptions. All assumptions are included in footnotes.

To achieve more accurate data, additional research or an updated GHG inventory is required. In addition, capacity building and technical assistance activities (associated with the mitigation opportunities) could focus on improving data availability and accuracy—suggestions have been made for where this is promising. Updated data is likely to improve the accuracy of the mitigation and adaptation projects, cost estimates, and other conclusions outlined in this NDC Implementation Roadmap and Investment Plan with Project Pipeline.

Despite limitations in data, the data informing this report is sufficient to make decisions as to which opportunities shall be prioritized for Tonga.

Appendix D: Energy Sector Prioritisation

The prioritization of the energy sector projects differs between those of the electricity and transport sub-sectors. The electricity sector projects noted here are those that have at time of publication, already received funding or are entering procurement and implementation phases and were prioritised using the principles noted in the TERM 2010-2020. The transport sector project on the other-hand is the result of analysis undertaken for the TERMPLUS and have been prioritised utilising stakeholder consultation and a separate multicriteria analysis framework. Both prioritisation approaches are noted below for reference.

D.1 Prioritization of the Electricity Sector projects

The electricity sector projects were prioritised under the TERM and have been included in the TERMPLUS. The primary principles of the TERM under which the project concepts were approved are noted below for reference.

Principles of the TERM 2010-2020 were:

- least cost approach to meet the objective of reducing Tonga's vulnerability to oil price increases and shocks;
- managing risk including with respect to the sequencing and timing of new investments and to the extent feasible development of a portfolio of options to meet the demand for electricity;
- long term financial sustainability in the electricity sector;
- social and environmental sustainability; and
- clear, appropriate, and effective definition of roles for government, TPL, and the private sector.

The implementation of selected projects was then carried out in a three Phased Action Plan. The electricity sector projects listed in Table 0.1 represent those that will completed during the time horizon of the TERMPLUS.

D.2 Prioritization of the Transport Sector projects

Under the TERMPLUS, three broad potential transport interventions have been identified that could limit growth in oil consumption for road transport to 25% for the period 2019-2035 (an average of 1.4% per year). These interventions are show in Table D.1, below.

Table D.1: TERMPLUS transport sector interventions

Sr. No.	Interventions	Sr. No.	Sub-Interventions
1	Improving Intake Quality of Vehicle; Fuel efficiency; End-of-life	1.1	Motor industry quality assurance program
		1.2	Stricter emission standards for new/existing vehicles & fuel
		1.3	Shared Mobility
2	Non-Motorised Transport	2.1	Walkway and bicycling lanes expansion
		2.2	Pedestrianisation
		2.3	Public Bicycle Sharing (PBS)
3	Low Emission Vehicles	3.1	Electric Private Passenger Vehicles (2W, 4W, light pick-up truck)
		3.2	Electric Public Transportation (Bus)
		3.3	Electric Commercial Taxis (4W)
		3.4	Electric Vehicles in Government fleet (4W)
		3.5	Electric Freight Vehicle (Medium & Heavy-duty Trucks)
		3.6	Maritime Electrification (small vessels primarily used in tourism & fisheries)

The prioritisation of the above sub-interventions was done using the following criterion (categorise by importance. The main criteria being: Scale and scale up potential; Costs; Benefits; Strategic alignment and Implementation needs; the full framework is outlined in Table D.2 below.

Table D.2: TERMPLUS Transport Sector Multicriteria Analysis Framework (TERMPLUS 2021-2035)

Sr	Level 1 (L1)	Level 2 (L2)	Level 3 (L3)	Measurement
1	Scale and scale up potential	Project /system scale	Population served	Entire population (universal), some communities only
2		User impact	User frequency	Daily by users or occasional/ as needed
3		Scale up potential	Domestic Replic ability	Replicability in other regions/parts of Tonga
4			International replicability	Replicable in other jurisdictions
5	Cost	CAPEX	CAPEX Investment requirement	Capital Expenditure to government (till 2035)
6			Timing of capital costs	Upfront cost requirement

Sr	Level 1 (L1)	Level 2 (L2)	Level 3 (L3)	Measurement
7		OPEX	OPEX Investment requirement	Operational Expenditure to government (till 2035)
8	Benefits	Economic	Revenue potential	Potential income stream, like user charges and advertising space
9			Cost Savings	Non-fuel cost reductions per year, compared to BAU
10			Fuel cost savings	Fuel costs saved per year, compared to BAU
11		Social	Job creation/ Employment	Number of jobs, welfare impacts on existing jobs
12			Social inclusion	Ease of movement, connection opportunities, ac cessibility to disabled users
13			Gender Equality	Women's accessibility and welfare impacts
14		Environmental & Climate	Air pollution reduction potential	PM reduction compared to BAU (till 2035)
15			GHG reduction potential	GHG reduction (till 2035)
16	Strategic alignment	Policy alignment	Government's al ignment with budget priorities	Alignment with budget priorities or national development priorities
17			Government's alignment with sectoral policies	Alignment with sectoral policies
18			Existing Planning and Feasibility studies	Ability to build on existing /planned feasibility studies
19			Legal framework	Supportive legal framework, inclu ding vehicle regulations and standards

Sr	Level 1 (L1)	Level 2 (L2)	Level 3 (L3)	Measurement
20	Implementation needs	Complementary Infrastructure needs	Roads and transport	Investment or action required
21			Energy	Investment or action required
22		Local industry capability	Capacity of local skills to support	Skills needs and their local availability
23			Local availability of equipment	Availability of existing infrastructure
24			Local post sales services & spare parts availability	Existing local ecosystem availability for Repair & Maintenance
25		Local population support needed	People/citizen behavioural change	Degree of behaviour change required
26		Implementation funding	Ownership structure identified	Ownership or corporate structure identified
27			Domestic funding sources	Funding available or committed by government or private sector
28			International funding sources	Funding source/s identified, including donor and private sector
29		Implementation Management	Planning and Execution Capacity	Available R&D, Planning, and execution capacity

Appendix E: Methodology note for calculating GHG and Air Pollutant Emissions

Electricity Sector

Table 0.1 shows the assumptions used in the calculation of electricity sector emissions.

Table 0.1: Assumptions used in the calculation of electricity sector emissions

Description	Amount	Unit	Source
Operating Margin Grid Emission Factor, gCO2/kWh (including for use in PCAF GHG accounting)	753	gCO_2/kWh	The IFI Dataset of Default Grid Factors v.3 2021
2018 Global weighted average Capacity factor for Wind Turbines	34%		IRENA 2019, FUTURE OF WIND Deployment, investment, technology, grid integration and socio-economic aspects
Forecast output of the 1.375 MW Wind Farm at Niutoua, funded by Japan	3925	MWh/year	Environment Impact Assessment Proposed Wind Farm, Niutoua, Hahake Districts, Tongatapu Island, 2014
Nuku'alofa Network Upgrade Project (NNUP) Project Area Consumption Baseline 2016	33.22	GWh	TA-8345 REG: Due Diligence of Tonga Nuku'alofa Distribution Network Upgrade Project Due Diligence Report
Tonga Load Growth Rate to 2030	5%		TPL Projections in Tonga Energy Efficiency Master Plan

Transport Sector

Based on the estimated vehicle growth, the GHG (or CO_2 emission) and air Pollutant emission is calculated for the two scenarios (i.e., BAU and BTB). The parameters considered in sequence for calculation of emissions are shown in Table 0.2.

Table 0.2: Parameters considered in sequence for calculation of GHG emissions in the transport sector

Parameter	Emission Modelling[276]
Vehicle kilometers travelled (VKT) and Passenger kilometers travelled (PKT)[277]	For both scenarios • VKT (for each vehicle segment) = vehicle stock x annual distance travelled • PKT (for each vehicle segment) = VKT x Average occupancy of respective vehicle segment
Vehicle technology/ fuel mix (petrol, diesel, and electricity)[278]	Vehicle segment wise percentage distribution across fuel mix in base year
Vehicle fuel efficiency[279]	The efficiency of vehicle in each segment will see an improvement of 0.5% for ICEV and 0.2% for BEV across vehicle segments for every L/100km or kWh/100km
Well to wheel emission factor[280] by fuel type	To estimate the emissions caused by fuels (gasoline, diesel, and electricity) for the base year (2021), the emissions ($KgCO_2$) per unit (L/ kWh) is determined using the calorific value[281] for the liquid fuel (Gasoline and Diesel) and grid emission factor[282] for electricity. All the fuel types are converted to a single unit ($KgCO_2$/Lge), to bring all the fuel types to an equivalent unit

[276] All the data has been provided and validated by local experts

[277] VKT is the measure of the total annual distance travelled by the vehicle stock in a given year. PKT is the measure of total passenger kilometres travelled in a year. It is the product of the occupancy factor and the VKT of the vehicle segment.

[278] Vehicle fuel mix is the distribution of vehicle across various fuel types

[279] Vehicle fuel efficiency is a measure of average unit consumption (L or kWh) of a vehicle segment for every kilometre run

[280] Well-to-wheel emission factor is a combination of well-to-tank and tank-to-wheel efficiencies. Well-to-tank efficiency is an efficiency from fuel extraction to transportation to supply to storing in a fuel tank of a vehicle Both are considered in same units (i.e., $KgCO_2$/Lge)

[281] Calorific Value is the energy contained in a fuel, determined by measuring the heat produced by the complete combustion of a specified quantity of it. This is now usually expressed in joules per kilogram

[282] Grid emission factor refers to a CO_2 emission factor (tCO_2/MWh) which will be associated with each unit of electricity provided by an electricity system

Parameter	Emission Modelling[276]
Well to wheel emission factor by fuel type	**For Gasoline and Diesel** - The emission factor for the gasoline and diesel ($KgCO_2$/Lge) remains constant across all the years **For electricity** - The emissions due to electricity will vary based on the renewable and non-renewable share in the country. - As it is mentioned in TERMPLUS that Tonga is emphasizing to have 70% of electricity generated from renewable sources by 2030 and 100% by 2035, impact on grid emission has been calculated over year **Emission factor** - Fossil Fuel Emission Factors for Tonga are in accordance with methodology outlined in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories - The emission factors are given below: ***Tank to Wheel CO2 emission factor*** **Fuel Type** / **Emission factor** Diesel: 2.55 Kg CO_2e/Lge Gasoline: 2.35 Kg CO_2e/Lge Electric - Tonga: - **Fuel Type** / **Emission factor** Diesel: 0.26 Kg CO_2e/Lge Gasoline: 0.54 Kg CO_2e/Lge Electric – Tonga: 0.67 Kg CO_2e/kWh (2010)

Tonga's NDC Implementation Roadmap and NDC Investment Plan with Project Pipeline

Department of Climate Change Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications (MEIDECC)
Level 3, O.G Sanft Building Taufa'ahau Road, Nuku'alofa, Tonga
Tel +676 20 100 www.climatechange.gov.to