TETRA TECH
International Development

Evaluation Report

Strategic Evaluation of MFAT's Energy Programme

Submitted by

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List of acronyms

4YP	Four-Year Plan
ACA	Activity Completion Assessment
ADB	Asian Development Bank
AFREC	African Energy Commission
AMA	Activity Monitoring Assessment
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of South-East Asian Nations
AU	African Union
AUD	Australian Dollar
CARICOM	Caribbean Community
CARILEC	Caribbean Electric Utility Services Corporation
CCP	Climate Change Programme [MFAT]
COVID-19	Novel coronavirus
DFAT	Australian Department of Foreign Affairs and Trade
EE	Energy Efficiency
EI	Energy Intensity (in energy units/GDP)
EPC	Electric Power Corporation
ESCAP	Economic and Social Commission for Asia and the Pacific (UN)
FAESP	Framework for Action on Energy Security in the Pacific 2010-2020 (SPC)
FESRIP	Framework for Energy Security and Resilience in the Pacific: 2021-2030 (SPC)
GDP	Gross Domestic Product
GEDSI	Gender Equality, Disability and Social Inclusion
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationalle Zusammenarbeit
GW	Gigawatt; 1,000 MW (unit of electrical power)
GWh	Gigawatt hour; 1,000 MWh (unit of electrical energy)
HIES	Household Income and Expenditure Survey
ICESD	International Cooperation for Effective Sustainable Development [MFAT]
IEA	International Energy Agency
IME	Insights, Monitoring and Evaluation Unit [MFAT]
IPP	Independent power producer
IRENA	International Renewable Energy Agency
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MFAT	New Zealand Ministry of Foreign Affairs and Trade
MW	Megawatt; 1,000,000 watts (unit of electrical power)
MWh	Megawatt hour 1,000,000 watthours (unit of electrical energy)
NDC	Nationally Determined Contributions (carbon emission reductions)

NZD	New Zealand Dollar
NZAGF	New Zealand Africa Geothermal Facility
NZSTIGS	New Zealand Support for Training in the Indonesia Geothermal Sector
OECD	Organisation for Economic Co-operation and Development
PCREEE	Pacific Centre for Renewable Energy and Energy Efficiency
PGK	Papua New Guinea Kina
PIC	Pacific Island Country
PICT	Pacific Island Countries, Territories and Dependencies
PRIF	Pacific Regional Infrastructure Facility
PNG	Papua New Guinea
PV	Photovoltaic (solar electrical energy)
RE	Renewable Energy
RELEC	Promoting Rural Electrification in Myanmar
RME	Research, Monitoring and Evaluation
SDG	Sustainable Development Goals
SHP	Small Hydro Plants
SIDS	Small Island Developing States
SPC	The Pacific Community
ToR	Terms of Reference
USD$ or $	United States Dollar
USAID	United States Agency for International Development
VOCTEC	Vocational Training and Education for Clean Energy
WB	World Bank
WTO	World Trade Organisation

Introduction

The New Zealand Ministry of Foreign Affairs and Trade (MFAT) commissioned Tetra Tech International Development to undertake a strategic evaluation (the evaluation) of the Energy Programme (the Programme). The evaluation was conducted from October 2020 to May 2021. This report presents the evaluation findings and considerations for future directions of the Programme. The purpose of the evaluation was to gather information to determine the contributions of the Programme over the period 2012 to 2019 and assess if expected results are being achieved as well as to inform future strategy and policy direction of the Programme.

Evaluation purpose, scope and methodology

The evaluation is a strategic evaluation focused primarily on assessing the Programme broadly across the suite of activities to inform how they have collectively contributed to achieving the objectives of the Programme. The key evaluation objectives were as follows:

1. To examine the relevance, significance and coherence of the Programme
2. To examine the extent to which the Programme achieved, or is expected to achieve, its objectives and results
3. To review the effectiveness of MFAT's approach and ways of working [e.g. internal roles and responsibilities and resource allocation, funding, contracting and delivery (management and governance) modalities] to deliver expected results
4. To assess the sustainability [e.g. physical, operational, economic, social and environmental] and resilience of the Programme
5. To use the evaluation findings to inform the future direction of the Programme.

The evaluation covered the Programme's activities over the period from 2012 to 2019 and focuses on energy assistance provided to both the Pacific and Global (ASEAN, Caribbean and East Africa) Programmes. Deep dive analysis was undertaken through six-country/activity case studies (Cook Islands, Samoa, Tonga, Tuvalu, PNG and Indonesia). The evaluation utilised a mixed-methods approach combining different forms of data collection (primary and secondary) in a phased manner and combining both qualitative and quantitative data sources. Evidence from multiple data sources was then triangulated to inform the evaluation's findings and considerations.

Summary of key findings

The Programme remains relevant to the strategic objectives, priorities and intentions of the New Zealand Aid Programme and consistent with partner countries' policies and priorities. The Programme is focused on achieving New Zealand's, regional and global priorities for energy, which all emphasise reducing dependence on fossil fuels through an increased supply of renewable energy. The Programme was highly relevant when Renewable Energy was a flagship investment priority (from 2015 to 2019) and still maintains high relevance under MFAT's Strategic Intentions 2020-2024. Most activities within the Programme are relevant and consistent with the policies, priorities and ambitions of the partner governments to secure affordable, reliable, clean and renewable energy.

It is expected that the Programme will continue to be relevant and coherent to the New Zealand Aid Programme and New Zealand's interests, especially given energy's widely recognised and critical role as a key enabler of broader development efforts (e.g. provision of health, education, infrastructure and economic resilience). Affordable, reliable and clean energy supply is at the core of sustaining and improving the living standards of billions of people. Efforts to understand regional, national and community contexts as well as facilitate continuous and effective dialogue with key internal stakeholders (i.e. MFAT bilateral, regional and thematic programmes) and external partners, donors and beneficiaries will help maintain the relevance and coherence of the overall Programme and its activities.

The Programme has achieved its overall long-term outcome of increased and equitable access to affordable energy, and to some extent achieved its second long-term outcome of more reliable and resilient energy supply. The Programme has contributed to reduced reliance on fossil fuels, particularly in the outer islands of Pacific countries through renewable energy generation and ramped up investments in geothermal energy production in Africa, Latin America, the Caribbean, and Indonesia. There is evidence that the Programme contributed to more efficient energy supply by investing in the equitable expansion of electricity supply through grid extensions and increased overall electricity supply. To some extent, the Programme has supported private sector participation in the energy sector through contracting private companies to design and construct energy systems and enhanced public-private partnerships for generating, operating and distributing energy. Further efforts are required to achieve greater private sector participation as well as to strengthen energy sector planning and more effective operation, maintenance, and renewal of assets.

Improving the capability and performance of utility companies as well as the reliability of critical network infrastructure can lead to further funding for sustainable sector development. Findings indicate that the Programme's continuous funding and support to some utility companies have resulted in dual benefits of enhancing reliable energy and improving the efficiency of the networks and also attracting additional funding from other development agencies. This is evident in Tonga where the Programme's investments for more than ten years have enhanced stability and resilience of the upgraded network and resulted in further investments from other donors.

Overall, a clear commitment to renewable energy investments and considerable attention to climate-resilience energy infrastructure / systems contributed to effective achievement of outcomes. Close partnerships and working relationships with partner governments, utility companies, other development partners and/or communities also strongly enhanced ownership and effectiveness. In contrast, delivering rapidly during the period when renewable energy was a flagship investment priority resulted in inadequate time for planning, activity design and building relationships and led to reduced effectiveness and longer-term issues in some cases. Feasibility studies and more carefully planned activity designs, coupled together with time to build relationships and obtain relevant buy-in from key local stakeholders, can enhance effectiveness beyond achieving increased access to clean and reliable energy supply, but also to achieving more resilient and sustainable energy that supports broader development needs.

The Programme has supported technically sustainable and resilient energy infrastructure. Evidence shows robust and resilient designs / infrastructure, that have and can withstand current conditions and adverse changes in the climate. The Programme's technical designs appear to be suited to the Pacific (i.e. relatively simple control systems, battery protection, etc) compared to some other systems. The renewable energy systems (solar PV and small hydro plants) appear to be well designed and constructed for climate resilience with some PV systems reportedly more resilient to cyclones and flooding. While resilience was evident, sustainability of the investments after activity closure (through appropriate operations and maintenance) and affordability (to governments to cover ongoing costs and to consumers if full costs are passed down) remains a big challenge.

Factors adversely affecting the sustainability of investments include poor governance and management of energy supply and the reluctance of partner governments (in response to consumer needs and wishes for low energy costs) to seek full cost recovery through tariffs. Evidence shows the absence of workable mechanisms for full cost recovery to finance capital costs, capital replacement and operations and maintenance (O&M) by most of the utility companies. It is unclear whether this is due to a possible expectation that donors will rehabilitate failed systems and support O&M costs. Financial sustainability of assets is a significant hurdle to overcome – especially in places where there is no commercial entity to manage this. Improving the sustainability of energy infrastructure requires sustained engagement beyond implementation, and often working with authorities external to the direct recipient (e.g. finance ministries, energy regulators) to improve asset management, revenue and general governance.

Considerations for future efforts

Clearly articulate the mandate, interventions and outcomes of the Programme and how it contributes to MFAT's strategic intentions and priorities by: (1) facilitating internal discussions to agree objectives and outcomes of the Programme; (2) developing a Programme-level strategic and engagement framework to articulate the shared understanding of objectives, outcomes and interventions; and (3) developing an external-facing capability statement to clearly and concisely demonstrate objectives, services, capabilities and potential areas for collaboration.

Enhance holistic integration of the Programme with MFAT's other thematic areas / sectors and highlight the critical role of energy as an enabler of broader development outcomes. A priority should be better integration with MFAT's Climate Change and Infrastructure teams. Integration can be enhanced through regular and targeted collaboration at the Programme / team level and activity level to increase opportunities for energy components to be factored into MFAT's investments across the Aid Programme and contribute to the achievement of the socio-economic development efforts.

Leverage soft power and MFAT's reputation as an approachable and nimble partner in the Pacific energy sector to influence regional and partner countries' priorities. There are opportunities to leverage MFAT's soft power and influence at existing forums such as the Pacific Regional Infrastructure Facility (PRIF) energy working group. Opportunities also exist to influence regional and national priorities (in alignment with New Zealand's interests) through closer collaboration with Post / bilateral teams who hold the diplomatic mandate, implement regional and country strategies, and drive MFAT's investment decisions.

Advocate for and facilitate the development of a common suite of regional model approaches for the energy sector in the Pacific. Working collaboratively with regional organisations and development agencies can help embed common approaches and standards that will in turn support the sustainability of investments and more effective outcomes. For instance, MFAT could support standardisation through regional models for negotiations of Power Purchase Agreements (PPAs), Independent Power Producer (IPP) agreements and model agreements covering renewable energy, energy efficiency, battery services and Energy Service Companies.

Future energy sector assistance should consider and prioritise resilience (climate, economic, environmental and social) in its programming. The Programme's investments should prioritise resilience through innovative, adaptive and smart designs that are future proofed for variations to the climate. Further, efficient energy use through design, regulations, pricing, policy and reduction of systems losses) should be a core consideration for energy supply initiatives.

Consider resourcing for Monitoring, Evaluation, Research and Learning (MERL) for the Programme to enable better and ongoing assessments of effectiveness and impact. Assessing the effectiveness of the Programme and/or its activities is highly dependent on having fit-for-purpose measurement frameworks in place, support, and incentives to ensure they are measured and reported against. The Programme should consider investing in technical capability to support the Programme with aligning activities to the overarching Programme results framework/indicators. Doing so will help improve consistency of reporting, aggregation of results and outcomes, and inform early evidence-based course corrections.

Strengthen inclusive development in its programming. Activity designs, informed by gender and inclusion analysis, will help to deliver better results and support a clearer understanding of the distribution of activity benefits and limit negative unintended consequences.

Consider options for improving the sustainability of energy investments and infrastructure. This could include undertaking tariff modelling and studies on lifeline tariff approaches to inform technical advice to utility companies and partner governments on sustainable tariffs. Workable mecahnisms for sustainable tarrifis will contribute to the financial sustainability of investments and support long-term reliable energy supply while also keeping energy costs affordable to support consumers' social and economic participation. Further, the Programme should consider cost-effective ways to improve the efficiency of energy end-use within projects (i.e. through better design, regulations, pricing, policies, etc). Improved energy efficiency and reduced system losses should be considered in activity design and implementation.

2 Background on MFAT's Energy Programme

The Energy Programme (the Programme) represents a significant and long-term investment by the New Zealand people to generate concrete, positive outcomes for partner countries, and the communities within them. The New Zealand Government has invested over NZD 275 million in development assistance across energy activities since 2012, making the Programme one of the largest within the New Zealand Aid Programme. MFAT is committed to spending NZD 370 million in development assistance towards energy activities over an extended period from 2000 to 2021. This funding has seen a significant increase in average annual assistance from 2012 onwards, making it important for MFAT to understand if expected results are being achieved.

This section provides an outline of the Programme, key areas of focus, its policy and governance framework, key modalities and delivery mechanisms, and its key partnership structures.

2.1 Focus areas of the Programme

The Programme works to advance energy policy, energy (electricity) generation, and energy distribution in partner countries across the Pacific, ASEAN states, East Africa, several eastern Caribbean states, and several other partner countries globally. Renewable Energy (RE) activities under the *New Zealand Aid Programme Strategic Plan* 2015-19 had the overarching goal of "expanding access to affordable, reliable and clean energy", which comprised of three focus areas:

- Improve access to reliable and renewable energy through new infrastructure and technical assistance
- Identify and support greater private-sector participation in the energy sector
- Strengthen sector planning and asset management to improve service quality and efficiency.

It is important to understand and appreciate the difference between expanding access to energy, and expanding access to *affordable, reliable, and clean* energy. The Programme is committed to expanding energy access in a sustainable manner by incorporating cross-cutting considerations including gender equality, climate change and emissions mitigation as well as strengthening the adaptive capacity of local energy systems (e.g. in the wake of natural disasters). In this context, it is also important to highlight energy's critical role as an enabler of other sectoral activities and priorities (e.g. provision of health, education, infrastructure and economic resilience).

From 2019, RE activities no longer had 'flagship status' as an investment priority under the New Zealand Aid Programme. Nonetheless, the essential lifeline services that energy provides, such as electricity, household services (e.g. cooking and illumination), commercial/industrial uses, transport of both goods and people, and broader infrastructure and development (e.g. powering health services), mean that energy will continue to have an important place in development going forward. The broader benefits of affordable energy, reducing emissions, and reducing the economic vulnerability created by the dependence on imported fossil fuels, will be especially important in the context of a changing climate.

The Programme still works towards the goals and focus areas identified above. New developments over recent years have included the increasing imperative of addressing climate change resilience in energy-related activities. The Programme seeks to contribute to the following outcomes:[1]

- *Affordable and Clean Energy,* in support of SDG7 to ensure universal access to affordable, reliable, sustainable and modern energy
- *Expanded Access* to modern energy services and electricity
- *Reduced energy emissions,* as part of a wider 'roadmap' or 'low emissions strategy' for cost effective reductions across the economy
- *Economic and social benefits* such as education, health and business opportunities through access to modern energy services and minimising the environmental impact of energy services
- *Human resource development* by supporting effective and efficient capacity building within countries and regional agencies (where efficient to do so).

[1] Note: This stems from an internal document, 'Framework for Energy Sector Development Assistance and Investment in the Pacific and Globally', which is currently in draft form. It was provided by an internal Programme stakeholder for the explicit purpose of the evaluation. Any information or content outlined from this document should be understood to be indicative and evolving.

2.2 The Programme's Policy framework

There are numerous MFAT policies, systems and commitments which underlie and inform the Programme. This section summarises the key and relevant policy framework and governance systems through which the Programme is delivered. Table 1 below outlines the Programme's policy framework.

Table 1: MFAT Energy Programme's Policy Framework

Key internal policies and frameworks	
Policy on International Cooperation for Effective Sustainable Development (ICESD Policy)	MFAT's ICESD Policy outlines four principles underpinning the New Zealand Aid Programme – *effective, inclusive, resilient, sustained.* Further detail is provided below.
Framework for New Zealand Government Engagement in the Pacific 2016-2035 ("The Pacific Framework")	The Pacific Framework contains nine thematic areas, including Economic Development, Climate Change and Disaster Risk Management. The Programme seeks to align with these thematic areas wherever possible.
Pacific Reset	The Pacific Reset cabinet paper included an emphasis on climate change and the deepening of bilateral and regional relationships in the Pacific. The Programme seeks to reorient and align with these priorities.
Framework for Energy Sector Development Assistance and Investment in the Pacific and Globally	This is an internal document, currently in draft form. It was provided by an internal MFAT Energy Programme stakeholder for the explicit purpose of the desktop review. It should be noted this was marked "in confidence", and content outlined from this document below should be understood to be indicative and evolving.
Key internal plans	
New Zealand Aid Programme Strategic Plan 2015-2019	Along with Agriculture, Renewable Energy was one of two Flagship Investment Priorities under this strategic plan.
MFAT Strategic Intentions 2020-2024	The Programme contributes to efforts to advance New Zealand's interests and opportunities to sustain and encourage international cooperation on climate change, including through investment in low-emissions energy.
Bilateral and Regional Programme Four Year Plans (4YPs)	The Programme contributes to bilateral and regional 4YPs through core and non-core activities.
Thematic areas	The Programme falls under MFAT's Infrastructure and Energy thematic area, which also includes Transport and ICT, though it seeks to contribute to other thematic areas within MFAT.
Relevant international commitments	
Sustainable Development Goals	In particular, SDG7: *Affordable and Clean Energy* – "Ensure reliable access to affordable, reliable, sustainable and modern energy for all".
Other	New Zealand is party to several international treaties such as *United Nations Framework Convention on Climate Change* and *Paris Declaration Commitments,* which guide action of the broader New Zealand government and include domestic responsibilities.

The ICESD policy contains four key foundational principles underpinning all international development activities conducted by MFAT, including the Energy Programme. These principles are:

2.3 The Programme's investments and activities

The Programme is implemented through the funding, design and/or delivery of distinct activities. Activities vary in design, delivery, funding amounts and sources, geographies and location, timescale, implementation methodology and partnership structures. These activities are often distinctly separate from one another. All activities collectively make up the Programme. Between 2012 and 2019, the Programme funded, designed or delivered 84 activities, committing a total of NZD 274,529,000.

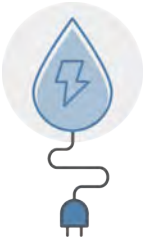
In broad terms, Programme activities have largely supported electricity generation, distribution and capacity development through activities focused on:

Solar energy

Solar photovoltaic (PV) power, together with significant investments in battery technology, has been a significant pillar of the Programme. In particular, increased solar PV generation in the Pacific is especially important to reduce the dependency on diesel and other fuels, having far-reaching effects, including reducing fuel emissions but also reducing exposure to international diesel price fluctuations and dependence on delivery systems.

Geothermal energy

New Zealand has strong expertise in geothermal energy. This expertise provides a strong value-add to development and climate change outcomes. The Programme has many geothermal energy activities, predominately in South East Asia, the Caribbean and East Africa.



Hydropower

Hydropower is another area of energy generation supported by the Programme. This is particularly an area of focus in high rainfall areas in the ASEAN region such as Laos and Myanmar.

2.4 Geographic distribution of the Programme

The Programme spans numerous geographic areas across the globe. The 84 activities conducted from 2012 to 2019 were dispersed across 25 distinct countries and five regional areas (the Pacific, Africa, Central America, the East Caribbean States and Worldwide). Most of these activities have been in the Pacific (spanning 15 countries) and amounting to NZD 219,511,000 of assistance through 53 activities. This contrasts with 31 activities in the Global Programme, spanning ten countries and amounting to NZD 55,018,000 of assistance. Notably, in addition to the ten country-discrete activities, many activities in the Global Programme are multi-country. For example, geothermal facilities in the Caribbean and East Africa provide services to multiple partner countries. The table below shows the distribution of Programme activities and expenditure from 2012 to 2019.

Activities (Count)	FY2012-14	FY2015-19	Total
Pacific	19	34	**53**
Global	12	19	**31**

Expenditure (NZD)	FY2012-14	FY2015-19	Total
Pacific	125,470,000	94,041,000	**219,511,000**
Global	17,646,000	37,372,000	**55,018,000**

Photo credit: Tetra Tech International Development taken for the Australian Government's Kiribati Education Improvement Program

2.5 Delivery modalities, approaches and partnerships

The main delivery modalities utilised by the Programme include:

- Direct procurement of projects and services (e.g. directly engaging contractors)
- Provision of technical advice (e.g. policy development, strategic planning, institutional strengthening and technical studies) to partner governments, regional agencies and utility companies
- Grant-funding arrangements, including co-funding multilateral development projects.

The approach adopted by the Programme is summarised below, and is consistent with the following key themes and principles:[2]

- *Be responsive to country priorities and meeting their outcomes*, working closely with MFAT bilateral teams who hold these relationships and build long term partnerships.
- Particularly in the Pacific, *reflect the approach of the Pacific Reset*, which includes an increased emphasis on climate change, deepening bilateral and regional relationships, and seeking more innovative approaches to development.
- *Build local capability development* into programme design, incorporating training and development.
- *Build a sustainable approach* at the outset, such as resilience to climate change and natural events, consider asset management and maintenance.
- Provide support for the development of *long-term strategies* and energy sector plans.
- Improve data and information for better decision making.
- Promote successes in the energy sector to *amplify the Pacific and regional voices* on climate change.
- Contribute to *improving development partner coordination* at both a country level and at a regional level. This recognises the increasingly crowded space, requiring clear needs assessments and gap analysis at programme design, and championing development partner coordination at every opportunity.
- Leverage the unique value-add New Zealand can bring.

Much of the Programme is conducted in collaboration with, support of, or through internal and external partners. Key internal partners include MFAT bilateral and Post in-country staff from other thematic areas. Key partners include in-country partners, including but not limited to national Ministries (e.g. energy and finance); public energy corporations; and private sector actors. In addition, the Programme partners with other development partners and donors (e.g. Asian Development Bank and the European Union) and regional bodies (e.g. the Pacific Power Association [PPA], the African Union Commission [AUC] and the Caribbean Development Bank [CDB]). It is important to highlight that partners are highly context-based and can vary greatly depending on the specific country, regional, operational and technical contexts as well as the specific objectives of a given activity.

MFAT has also provided support to the International Renewable Energy Association (IRENA), and co-funded other donor's training programs. MFAT has played a key advocacy role promoting renewable energy in the Pacific region, for example, convening the 2013 Pacific Energy Summit and the 2016 Pacific Energy Conference. It should also be noted that renewable energy promotion runs throughout the New Zealand Aid Programme in a broader sense. For example, New Zealand scholarships promote academic studies and research including renewable energy.

[2] MFAT, *Framework for Energy Sector Development Assistance and Investment in the Pacific and Globally (Version 2, Draft in Confidence).*

3 The strategic evaluation

This section describes the evaluation, its purpose, scope and key evaluation questions. It covers the methodological approach underpinning the evaluation, the main types of data sources, the approach to analysis and triangulation, and the key challenges and limitations faced during the evaluation.

3.1 Purpose and use of the evaluation

By commissioning the evaluation, MFAT is addressing a responsibility to account for the NZD 275 million in development assistance across energy activities since 2012, and to demonstrate what has been achieved. In line with MFAT's strategic priorities and intentions, programming in the energy sector is likely to continue as a significant part of the Aid Programme. As MFAT approaches the next triennium of funding, programming decisions must be informed by a solid evidence base about what works. The evaluation seeks to consolidate and triangulate an evidence base to provide an assessment of the whole Programme.

The evaluation aims to serve MFAT's dual key purpose: to account for New Zealand's investment through the Programme and to improve what future investment can achieve. To achieve this, the evaluation has been both backwards-looking to provide evidence of the outcomes achieved by the Programme and understand factors contributing to or hindering the achievement of outcomes, and forward-looking to provide considerations for the future direction of the Programme's policy and strategy.

The key objectives of the evaluation are to contribute to a stronger evidence base and deeper understanding of the Programme. The findings from the evaluation will be used to:

- Identify improvements that can be made to the planning and delivery of the Programme
- Inform future strategy, policy and practice for the Programme, particularly in a post-COVID-19 environment
- Demonstrate achievements to New Zealand's partners, stakeholders and taxpayers.

The evaluation sought to answer the 13 key evaluation questions set out in the Evaluation Terms of Reference (ToR), which are organised under the objectives to understand the relevance and coherence, effectiveness, efficiency and sustainability of the Programme over the period from 2012 to 2019; and inform future strategic directions and approaches for the Programme and related activities. The first four objectives align with MFAT's aid effectiveness criteria, and assessment against these serves the evaluation's accountability purpose. The last objective is specifically to serve the evaluation's improvement purpose. A full list of the evaluation's objectives and key evaluation questions is provided at Annex B.

3.2 Evaluation scope, approach and methodology

The evaluation covered the Programme's activities over the period from 2012 to 2019. Specifically, the evaluation:

The evaluation took a **realist approach**—that is, understanding what mechanisms have worked in which contexts, and what outcomes have resulted. Through the realist approach, the evaluation sought to not only answer whether the Programme has achieved outcomes as a whole but also explored mechanisms behind the achievement of those outcomes, in what contexts and the reasons why. The mechanisms supporting the achievement of outcomes will enable MFAT to choose future investments based on their likely effectiveness within

specific contexts. Primarily, the evaluation sought to understand how the whole Programme *contributes to outcomes*, rather than seeking to attribute specific outcomes to the Programme activities alone.

The evaluation adopted a *mixed-methods approach* combining different forms of data collection in a phased approach. The evaluation, therefore, collected both *qualitative and quantitative data* and integrated them into analysis and synthesis. Examples include expenditure and outputs (quantitative), interviews and case studies (qualitative). The evaluation's Analytical Framework (found at Annex C) guided analysis for the evaluation. The analysis adopted a **deductive approach** which is to say, the documents were assembled and analysed using the pre-determined criteria (relevance and coherence, effectiveness, efficiency, sustainability, lessons learned and future directions). Once data was gathered under the different criterion themes, a more **inductive approach** was then employed where findings within that theme were assessed without pre-determined criteria so that other emerging themes were discovered and described under it.

Observations from each data source were triangulated with other relevant information and data sources before forming explanations or conclusions about the observations or claims made. From the triangulated data, findings, trends, gaps, opportunities and considerations were drawn. Triangulation was done throughout the evaluation phases, building iteratively, and showing how layers of data and analysis built towards the findings. This approach enabled an assessment of the strength of the evidence base and in the process identify the best evidence that responds to the evaluation questions. For example, findings from the case studies were triangulated against other evidence sources and used to inform some of the final findings in this report.

The evaluation was structured in six phases, presented in Figure 1 below. Each phase had a specific objective, approach, and set of methods, outlined in Table 2 below.

Figure 1: Overview of evaluation phases

Table 2: Objectives and methods of evaluation phases

Phase	Objectives	Methods
1: Inception	Develop a methodological design and Analytical Framework, identify data sources and data collection methods, and map out the diverse stakeholders to be interviewed	• Interviews with MFAT stakeholders to understand expectations and identify areas of interest for the evaluation • Key document review • Stakeholder mapping
2: Desktop research and analysis	Undertake a literature scan and present a brief snapshot of the global energy sector and context of the case studies countries, as well as explore data gaps and where primary data collection should focus	• Review MFAT's strategic-related documentation, Programme documentation and activity reporting to conduct an initial analysis on how the Programme has performed in line with the evaluation objectives • Conduct a context analysis of the energy sector at the global, regional (within the Pacific) and national (case study countries) levels, where applicable to MFAT
3: Interviews and interim analysis	Undertake primary data collection, and present preliminary findings and considerations on what the Programme should focus on moving forward	• Interviews with MFAT stakeholders and regional stakeholders • Interviews with Suppliers • 40 stakeholders interviewed
4: Deep dive case studies[3]	Undertake data collection for the six case studies and present brief reports on the key findings and considerations for future efforts for the country/activity and broader Energy Programme	• Document review and analyses of the six selected activities as part of the national case studies • Interviews with national stakeholders in six countries • Validation workshop with MFAT stakeholders, including stakeholders for specific activities
5: Analysis and presentation	Analyse and triangulate the different evidence sources and identify emerging themes along the evaluation objectives	• Triangulate findings from the desktop research, interim analysis and stakeholder interviews during the initial and case study phases • Validation workshops with MFAT stakeholders
6: Reporting	Drafting the evaluation report, presenting the key findings, lessons learned and considerations for future Programme efforts	• Validation workshops with MFAT stakeholders • Thematic analysis according to the evaluation objectives

A more detailed summary of the primary and secondary data sources reviewed are provided at Annex D.

[3] Cook Islands: Renewable Energy Northern Group (Ref: ACT-0A11954); PNG: ADB Improved Energy Access for Rural Communities Project (Ref: ACT-0A10868); Samoa: Renewable Energy Partnership, Phase 1 (Ref: ACT-0A11720); Tonga: Tonga Village Network Upgrade Project (TVNUP), Stages 2 & 3 (Ref: ACT-0K11589); Tuvalu Renewable Energy Projects (Ref: ACT-0A11720); and Indonesia: New Zealand Support for Training in the Indonesia Geothermal Sector (NZSTIGS), Phase 1 (Ref: ACT-0A12573).

3.3 Limitations and challenges

Below are some of the key challenges and limitations faced during the strategic evaluation.

Challenge / Limitation	Details
Inadequate Programme and activity-level secondary data	• Sparse documentation relating to the Programme itself limited the ability to draw high-level findings of the Programme at the initial evaluation phases. The evaluation addressed this by drawing common themes and insights from the case studies and aggregating the common findings up to the Programme-level. • Lack of activity reporting (AMA and ACAs) and results frameworks limited more detailed or aggregate assessments of effectiveness and achievement of outputs/outcomes. From 2012 to 2019, only 29 AMAs were received from 27 activities (32.1 per cent of all activities). Further, only eight Activity Completion Assessments (ACAs) were received, representing 9.5 per cent of all activities.
Challenges in accessing regional, country level and other development partners data	• Gathering this data was challenging especially for countries that were not part of the case studies. This challenge was also experienced while accessing data from international/regional organisations. The evaluation addressed this by reviewing MFAT documents related to countries not part of the case studies to provide information for countries where it was challenging to access the data. • Inability to travel to case study countries due to COVID-19 restrictions was a limitation - country visits often result in highly beneficial serendipitous meetings, meetings with a wider range of well-informed key players (e.g. power utility staff, NGOs, energy regulators) and access to unpublished data. The evaluation addressed this by scheduling more remote interviews (than anticipated) with relevant stakeholders and conducted follow-up interviews where further information was required.
Remote interviews	• Remote interviews were at times challenging to conduct due to the lack of face-to-face interaction. Remote/virtual interviews limit the ability for the interviewer to read non-verbal clues, probe further and build rapport with respondents to undertake deeper conversation. Face-to-face engagement is especially important in the Pacific Islands. • Language barrier issues were present with some interviews (i.e. for the Indonesia case study). While this was generally well-mitigated through the inclusion of Tetra Tech staff speaking the respective language, the depth of discussion and information gathered may have been limited by this barrier.
Data quality	• Accessing and verifying the authenticity of energy data was a challenge. Some data sources did not provide up-to-date data and some data points were missing limiting the ability to assess trends. In many cases, there was no baseline data which limited the evaluation ability to assess targets achieved.

The following section, Section 4, of this evaluation report presents the evaluation findings according to the key evaluation objectives: Relevance & coherence; Effectiveness; Efficiency; Sustainability; and Future Direction. The key findings, lessons learned and considerations for future direction from the six deep dive case studies (see Annex A) are captured in the evaluation findings as they are relevant to the broader Programme, and in accordance with the analysis and triangulation process described above.

4 Evaluation findings

4.1 How relevant, significant, and coherent is the Energy Programme? (Relevance & coherence)

This section presents the key findings on how relevant, significant and coherent the Programme is. It responds to Objective One of the evaluation. In the context of an evaluation, relevance assesses the extent to which the Programme's objectives and design respond to the priorities, policies and needs of beneficiaries as well as to global, regional, country and partner institutions, while coherence assesses the compatibility of the Programme with other interventions in a country, sector or institution.

4.1.1 Programme and Policy coherence

The Programme remains relevant to the strategic objectives, priorities, and intentions of the New Zealand Aid Programme. The Programme is focused on achieving New Zealand's, regional and global priorities for energy, which all emphasise reducing dependence on fossil fuels through an increased supply of renewable energy. The Programme was highly relevant when Renewable Energy was a flagship investment priority (from 2015 to 2019) and still maintains high relevance under MFAT's *Strategic Intentions 2020-2024*. In particular, the Programme is aligned and coherent with New Zealand's current interests as a Pacific country to contribute to a resilient, sustainable, and prosperous Pacific.

The Programme was relevant to the objectives of the New Zealand Aid Programme Investment Priorities 2015-19, and contributed to three focus areas by:

Supporting improved access to affordable, reliable, and clean energy through new infrastructure and investments in renewable energy as well as technical assistance and on-ground support

Supporting greater private-sector participation in the energy sector

Strengthened sector planning and asset management to improve service quality and efficiency

By facilitating increased access to affordable, reliable, and clean energy, the Programme is contributing to MFAT's aspiration of leaving no one behind. It is expected that the Programme will continue to be relevant and coherent to the New Zealand Aid Programme and MFAT's broader strategic intentions, especially given energy's widely recognised and critical role as a key enabler of broader development efforts (e.g. provision of health, education, infrastructure and economic resilience).

The Programme is aligned with MFAT's International Development Principles, though there are opportunities to further align efforts. Four principles underpin New Zealand's international development cooperation: effectiveness, inclusiveness, resilience, and sustainability.[4] The Programme's investments and activities are generally aligned to these principles, particularly thro ugh contributions to climate-resilient infrastructure and renewable energy activities which support greenhouse gas emission reductions and climate change mitigation efforts. Overall, the Programme's investments were effective in supporting the achievement of its overarching goal and partner countries' targets.

[4] These four development principles are also affirmed in MFAT's Policy Statement for International Cooperation for Effective Sustainable Development (ICESD).

However, opportunities exist to improve the inclusiveness, resilience, sustainability of the Programme's investments and activities. Supporting inclusiveness is both a challenge and an opportunity for the Programme. For instance, a process evaluation[5] of MFAT's 2011-2015 renewable energy investments conducted in 2015 found that nearly all renewable energy activities included screening and scoping of cross-cutting issues during the design phase, but roles and responsibilities for their management and implementation were not generally identified and outcomes were not reported in activity results frameworks. Further evaluation findings on the effectiveness and sustainability of the Programme's investments and activities are found at Section 4.2 and Section 4.4 respectively.

Internally within MFAT, the Programme is relevant and aligned to MFAT's bilateral and regional Four Year Plans (4YPs) objectives. A review of available activity reporting indicates good alignment of the Programme's activities to MFAT's bilateral 4YPs priorities, the Pacific Reset, and the Pacific Regional Programme's 4YP's objectives. The Pacific Reset (2018) cabinet paper included an increased emphasis on climate change as an area of focus and the need to deepen bilateral and regional relationships in the Pacific.

The evaluation found that the Programme has reoriented and aligned to these priorities. For example, there is great interest and effort to integrate with partner country priorities in the Pacific. The Pacific Reset has provided a fundamental shift for advancing relevance and coherence. There is now increased focus on working with local partners, aligning with local priorities and solutions which is being facilitated through local ownership and direction via MFAT Posts. Considerations for future ways of working with other bilateral and regional programmes are explored in Section 5.

The Programme is relevant and coherent to MFAT's other thematic priorities, though opportunities exist for closer integration and collaboration between thematic programmes to maximise development outcomes for partner countries/regions. While internal stakeholders noted having a strong understanding and acknowledgement of energy's critical role as an enabler of broader development outcomes, most stakeholders also reported knowing little about the overall Programme, its strategic objectives, and how it works with other programmes within MFAT at a strategic-level. The evaluation found little evidence to show close alignment and collaboration with other thematic areas such as social inclusion (including gender and human rights), infrastructure (especially transport infrastructure) and climate change. This is likely due to the absence of a strategic framework to guide engagement and collaboration with other thematic areas and mechanisms to capture and disseminate information about engagement and outcomes.

Powering communities and other social amenities to enhance community ownership and development outcomes

The Programme enhanced PNG's broader development efforts through the electrification of numerous education, health, policing, and church facilities across the three project sites. This included 364 community centres with connections to church (69), police (55), education (190) and health (50) facilities.

Photo credit: Kumul Lodge cabins, by gailhampshire licensed under CC BY 2.0

Country: Papua New Guinea

At an activity-level, internal stakeholders who worked on specific activities with the Programme team indicated good working relationships and acknowledged the strong technical skills and knowledge of the team. Evidence of broad contributions towards other thematic areas is somewhat evident, though not consistently reported, in existing Activity Monitoring Assessments (AMAs) and Activity Completion Assessments (ACAs). It appears that collaboration with other thematic areas / programmes is happening at an individual level and ad hoc basis, rather than at a Programme level and systematically. Considerations for future ways of working with other thematic areas/programmes are explored in Section 5.

[5] MWH New Zealand (2015), Renewable Energy Investments in the Pacific: A Process Evaluation New Zealand Aid Programme, Renewable Energy Sector, 2011-2015 https://apo.org.au/sites/default/files/resource-files/2015-12/apo-nid122676.pdf.

Supporting efforts to increase renewable energy and private sector participation as a response to mitigating climate change impacts in the Pacific region

The Programme, through the ADB Pacific Renewable Energy Guarantee Program and the Pacific Infrastructure Technical Assistance Fund (PITAF), contributes directly to MFAT's Climate Change Initiative and New Zealand's Paris Agreement obligations to increase climate finance from all sources. The Programme assists Pacific Island countries to increase private sector participation in their energy sectors and achieve their renewable energy targets. The program contributes to the Strategic Infrastructure Initiative, with the core objective of crowding in high-quality finance, which has been identified as a strategic priority for the New Zealand Aid Programme.

Region: The Pacific

4.1.2 *National and regional-level relevance and coherence*

Most activities within the Programme are relevant and consistent with the policies, priorities, and ambitions of the partner governments to secure affordable, reliable and clean energy. All activities are in line with partner governments' policies, plans, and energy roadmaps/sector plans. Though MFAT's internal policies and priorities for energy have changed over the evaluation period, the Programme itself and its specific activities are still relevant for partner countries (particularly in the Pacific). Examples, from the six case studies undertaken as part of the evaluation and from other multi-country activities, are provided below to demonstrate how the Programme was relevant to partner countries' priorities and policies.

Partner country	How the Programme was relevant and coherent
Samoa	The Programme provided renewable energy infrastructure development assistance and helped address the electricity needs of over 97 per cent of Samoan households and virtually all businesses. This was in line with the Government of Samoa's targets to increase renewable electricity, increased efficiency of power generation and distribution, and more efficient use of electricity by consumers and achieve 100 per cent renewable electricity generation by 2025.
Cook Islands	The Programme provided direct support to specific islands (in the Northern Group), which had previously been earmarked by the Cook Islands Government as high priorities for solar energy systems. The Programme supported universal access to affordable, reliable, sustainable and modern energy which led to 100 per cent of the Northern Group islands population having access to renewable energy and increased the Cook Islands national generation from renewable sources target by 25 per cent by 2018.
Tonga	The Programme improved the resilience of Tonga's network in 38 project villages providing 9,586 connections, 16 line technicians trained, and reduced energy losses from 12 per cent to 5 per cent. This was in line with the Government of Tonga's target to achieve 70 per cent renewable energy by 2030. By upgrading an inefficient, unsafe, and unreliable network, the renewable energy generated electricity is being distributed with minimal losses and wastages.
Tuvalu	The Programme provided direct assistance to support the implementation of the Government of Tuvalu's 2012 Renewable Electricity and Energy Efficiency Master Plan (REEEMP) and to support progress toward its target of 100 per cent renewable electricity.
PNG	The Programme connected 4,390 households to increase rural electrification, and support the Government of PNG's vision to have 70 per cent of the country having access to electricity by 2030, and 100 per cent of the population having access to electricity from renewable and sustainable energy sources.
Indonesia	The Programme is providing training in technical skills highly consistent with the needs and priorities of the Indonesian geothermal industry. New Zealand is viewed as having especially high-quality expertise in this sector, and the sharing of this knowledge and expertise is both desired and appreciated by the Indonesian geothermal sector.

Contributing to renewable energy and greenhouse emission targets in the North Pacific

The Programme's renewable energy investments in the North Pacific contribute directly to national renewable energy targets and greenhouse gas emission (GHG) targets across the region. These include:

- The Republic of Marshall Island's goal of reaching 20 per cent RE production by 2020 as detailed in the National Energy Policy and Energy Action Plan, and the targets of 32 per cent reduction of GHG below 2010 levels by 2025, and 45 per cent below 2010 levels by 2030 with a long-term goal of net-zero emissions by 2050 as detailed in the Nationally Determined Contribution.
- The Federated States of Micronesia's goal of reaching 28 per cent (unconditional) or 35 per cent (conditional on international support) reduction greenhouse emissions by 2025.
- Palau's Nationally Determined Contribution targets 45 per cent renewable energy and 22% per cent energy sector emissions reductions by 2025.

Countries: Palau, the Republic of the Marshall Islands, and the Federated States of Micronesia

Some activities demonstrated appropriate government consultation as part of the project inception and implementation, but there were instances where community contexts were not well understood. Consultations with national governments affirmed that project designs and implementation reflect partner countries' needs but also drove the ownership of the investments. In some cases, there was a change in interventions from those previously approved (i.e. in Samoa where the energy infrastructure which was built differed slightly from initial proposals - changing locations of small hydro plants (SHPs) due to environmental and land access issues). In such cases, continuous consultations helped ensure that investments were relevant to the needs and priorities of the country and communities. In contrast, in PNG, the implementing partner's failure to understand communal land ownership and late consultations with local communities and leaders led to implementation delays due to land tenure challenges in the regions of operation. This observation indicates that the Programme's (and the implementing partner's) strong understanding of the national contexts does not necessarily translate to understanding community contexts reiterating the need to continuously build relationships with local communities at the design/inception phase and work with those knowledgeable of the local context.

Even though the Programme and numerous activities were relevant and aligned with national priorities, the coherence of the interventions with some recipient countries' considerations were not always sufficient, particularly for early fast-tracked PV energy initiatives during the flagship period. At times, the emphasis on rapid construction negatively affected project designs and increased risks (e.g. rushed contracting, inadequate economic and financial analysis, limited local capacity assessment to maximise local involvement, limited capacity development for O&M, no environmental, gender or other social assessment) and this resulted in some outcomes that were constrained or hard to assess.

The Programme's ability to influence and set the agenda for regional and national energy priorities was evident when renewable energy was a flagship priority, and opportunities exist to strengthen MFAT's current influence and advance New Zealand's interests more strategically. During the period when renewable energy was a flagship investment priority, MFAT leveraged existing political will and its regional convening power to bring together Pacific leaders and other development partners for a Pacific Energy Summit (PES). The Summit facilitated discussion on renewable energy priorities for the region, giving rise to the roll-out of many renewable energy investments in the Pacific. The Summit also facilitated an alignment/coordination of energy investments by the different development partners. There are opportunities for the Programme to leverage soft power and diplomacy to influence regional and partner countries' priorities further. This could be done through Post who hold the diplomatic mandate as well as through country/regional strategies and investments. Evidence from PES shows that demonstrating leadership on regional (and in effect national) energy priorities is likely to be well-received given stakeholder views of MFAT a nimble and approachable donor and respect for MFAT's expertise in the energy sector.

COVID-19 has not affected the relevance and coherence of the Programme and its activities in the short-term, but has brought to the fore the energy's critical role as an enabler of broader development outcomes. Energy fuels global economic activity from the developed to the least developed countries and is a crucial ingredient for most goods and services of the present day. Affordable, reliable and clean energy supply is at the core of sustaining and improving the living standards of billions of people. As populations continue to grow and living standards improve (though not equally), so does consumption and the total demand for energy which is expected to increase by 21% by 2030 (IEA, 2015).[6]

[6] IEA (2015), World Energy Outlook 2015, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2015.

The COVID-19 pandemic has further elevated the critical role of the energy sector in developing countries, emphasising the need to increase energy investments but also for the Programme to have a strong collaboration with other thematic areas and sectors such as health, education, water, and national planning, economic resilience, etc. Literature shows that access to energy is a prerequisite for quality health care and is fundamental to the achievement of universal health care coverage and the Sustainable Development Goals.[7] The future of primary health care in developing countries must include energy and energy efficiency considerations (i.e. designing energy-efficient health equipment and infrastructure, innovation in the way off-grid health facility electrification projects). Working with other thematic areas and sectors will not only help ensure the Programme's relevance and coherence into the future but also lead to tangible results and contributions towards sustainable development.

Factors enhancing relevance and coherence

The evaluation found high-level factors that enhanced the relevance and coherence of the Programme in responding and aligning to the global, country, and partner/institution needs, policies, and priorities. Factors contributing to the overall relevance and coherence of the Programme and indirectly to its activities include:

- **Aligning with partner countries' development plans** and getting the government to promote planned activities enhances national ownership and likely success of the implementation of the activities. This was seen in Tonga, Samoa, Cook Islands, and PNG where respective governments promoted the activities as a key prerequisite for achieving their renewable energy targets
- **Understanding both national and community contexts and holding continuous consultations** with the relevant communities. There was evidence in the Cook Islands, where considerable consultation with the island beneficiaries by the Cook Islands Government before implementation enhanced community understanding of the activity and hence local ownership. Also, discussions with island communities in the Cook Islands enhanced understanding of the need to keep tariffs high enough to provide not only O&M funding, but also for capital replacement at end of life.
- **Establishment of Project Coordination Committee or Project Management Units** with high-level representation from key related sectors enhances dedication and coordination of the activity implementation. Effective project management and coordination committees were reported in Samoa, the Cook Islands and Tonga and findings show that consistent meeting of the project management units enhanced activity implementation and supported quick decision making.
- **Donor coordination is important for identifying and aligning interventions to national priorities** and avoiding duplication of interventions/efforts. For instance, in the Cook Islands, key development agencies (MFAT, EU, ADB) coordinated their efforts to systematically address the government's priorities for renewable energy. Close collaboration ensured that investments were shared across partners which facilitated quick implementation and delivery.

Factors hindering relevance and coherence

The following factors hindered the relevance and coherence of the Programme and/or its activities:

- **Lack of momentum and significant time lapses between project scoping, design, and implementation**. Big time lapses from scoping to implementation can undermine relevance, especially where national priorities, partners, and government change. There was a reported delay in Indonesia of more than 12 months and when the Activity did start, the government leadership was reported less engaged. This observation doesn't suggest that the Programme rush a project but reinforces the need to continuously engage with the partners during delays and maintain open communication channels.
- **Loss of internal profile and visibility** due to the Programme no longer being a flagship investment priority within the New Zealand Aid Programme in 2018. This challenge is further exacerbated by the change in funding infrastructure within MFAT. To retain the important role of the Programme, future considerations should support holistic integration of energy with other sectors and highlight the critical role of energy as an enabler of broader development outcomes.

[7] https://www.seforall.org/news/energy-and-health-making-the-connection

4.2 To what extent did the Energy Programme achieve, or is expected to achieve, its objectives and results? (Effectiveness)

This section presents findings and analysis on the effectiveness of the Programme. The section also uses examples from the six case studies to provide further evidence and support in understanding of the factors contributing and hindering the effectiveness of the Programme's investments and activities. This section first explores the extent to which the Programme was expected to, and did, achieve its objectives and results (Objective Two of the evaluation), and then discusses the factors that contributed to effectiveness as well as opportunities for improving effectiveness.

4.2.1 Achieving the goal and expected outcomes of the Programme

The Programme was successful in achieving the overarching goal and some of the desired outcomes. The overarching goal of the Renewable Energy Investment Priority was to "expand access to affordable, reliable and clean energy". Under this goal, the Programme had two long-term and six medium-term outcomes (as presented in the Renewable Energy (Flagship Investment Priority) results framework) shown in Table 3 below.

Overall, the evaluation found that the Programme has achieved its overall long-term outcome of increased and equitable access to affordable energy, and to some extent achieved its second long-term outcome of a more reliable and resilient energy supply. The Programme achieved this by contributing to:

Questions and uncertainty remain about the affordability and commercial viability of investments/systems. For example, case studies undertaken on renewable energy generation activities in Samoa and Cook Islands revealed that the real cost of production is higher than the prices charged. The long-term affordability of the investments does not appear to be factored into activity designs. This will likely have impacts on the long-term sustainability and resilience of the investments and energy systems. Issues pertaining to affordability and considerations for future efforts are explored further in Sections 4.4.2 and 5.

Table 3: Renewable Energy Investment Priority Outcomes and Indicators (2015-19)

Long-term outcome	Medium-term outcomes	Selected Indicators
Increased and equitable access to affordable energy	• Reduced reliance on fossil fuels • Increased renewable energy production • More efficient energy supply (production and delivery) • Increased private sector participation in the energy sector	• People provided with new or improved electricity supply (No., M/F) • Installed renewable energy capacity of new or upgraded infrastructure (MW) • Renewable energy generated/produced per annum (MWh)
More reliable and resilient energy supply	• More effective operation, maintenance, and renewal of assets • Improved energy sector planning	• Energy supplied through the main grids produced from RE sources (%) • Installed RE capacity (MW) • RE generated/produced per annum (MWh)

As only a small number of activities had ACAs during the period covered by the evaluation (2012 to 2019), the evaluation team could not reliably quantify the aggregate outputs and outcomes (against the indicators listed in the table above) for the Programme as a whole. Instead, the evaluation team presents examples (from activity reporting and other case study documentation received) in the table below to demonstrate how the Programme achieved expected outputs and outcomes.

Overall, the Programme's investments and activities largely increased solar energy and RE capacity and reduced reliance on imported fossil fuels. The examples also show how activities contributed to a more reliable and resilient energy supply through network upgrades and grid connections.

Table 4: Examples of how the Programme met or exceeded expected targets

Country	How targets were met or exceeded
Samoa	• The solar PV systems met between 85 to 102 per cent of quantified targets. The SHP considerably larger overall in capacity and energy, achieved between 140 to 150 per cent of the four key targets. MFAT's short-term fuel savings goal (PV and hydro) was exceeded by 25 per cent.
Tonga	• The Programme supported an upgraded network which led to: Reduced losses were achieved as planned (100 per cent); reduced faults in the network were exceeded (113 per cent), reduced accidents due to faults in the house wiring was exceeded (111 per cent), while the reliability of the network was exceeded (135 per cent).
Cook Islands	• The target of 100% of the Northern Group population having access to renewable energy was achieved in 2014 while the targets of 0.83 MW of new renewable energy mini-grids in the Northern group and 0.9 MW generation Airport West array were also achieved.
Tuvalu	• The Programme supported a reduction in reliance on diesel for power generation. The target of a 90 per cent reduction in the generation of power using diesel at Nanumea, Nanumaga, Niutao, and Vaitupu was fully achieved.
PNG	• The Programme contributed to the grid connection of 4,390 households in three provincial capitals (Buka – North Bougainville District, Popondetta – Oro Province, Kimbe - West New Britain). This represents 87.8% of households across the three towns.
Marshall Islands & the Federated States of Micronesia	• The Programme supported the installation of over 600 solar PV modules. These solar modules are producing 338 MWh of energy annually in the Federated States of Micronesia and 200 MWh of production in the Republic of Marshall Islands. This contributes to annual fuel savings of 89,000 L in the Federated States of Micronesia and 53,000 L in the Republic of the Marshall Islands.

Reducing reliance on fossil fuels and expanding access to affordable, reliable, and clean energy in East Africa

The New Zealand East Africa Geothermal Assistance Facility Activity, in partnership with the African Union, has established a Geothermal Facility to support the development of the geothermal sector in 11 East African countries. The Activity aims to reduce reliance on fossil fuels and expand access to affordable, reliable, and clean energy in East Africa through the provision of targeted technical assistance for geothermal energy development and distribution. The Facility is building MFAT's profile as a leading partner in geothermal energy amongst key stakeholders in East Africa through technical support and pipeline geothermal projects.

Photo credit: Belikova Oksana/Shutterstock.com

Region: Africa

Some activity targets were not achieved. For example, in Tonga, the target to improve the financial health of Tonga Power Limited (TPL) and lowering the power tariff was not achieved. In Samoa, the target for energy produced for the Solar PV system to 3,683 MWh was not achieved with the activity achieving 3,296 MWh, 90 per cent of the target set. In PNG, 13 per cent of the targeted households were not connected to energy in the Buka, Popondetta, and Kimbe. Some reasons for failure to meet some of the targets included: inability by utility companies to apply tariffs as planned; activity inception delays; low staffing levels and capacity of partner governments; weak local capacity; and financial resource constraints. These reasons are common in international development, highlighting the value of activity managers remaining flexible, seeking local solutions and continuing to providing a range of technical assistance to build local capacities and a better understanding of local contexts to achieve outcomes and more efficient activity management.

Across the Programme's activities, inconsistency in results measurement frameworks makes it challenging to assess the effectiveness of the activities and the Programme as a whole. For the six case studies reviewed, the Tonga results framework was detailed whereas Tuvalu was not. Also, for similar activities, baselines vary across countries or are absent making it challenging to measure outcomes achieved. Additional measurement challenges were present for activities that focused on technical assistance and partnerships, such as the Global Programme activities. Assessing the effectiveness of activities is highly dependent on having fit-for-purpose measurement frameworks in place, support, and incentives put in place to ensure they are measured and reported against.

Overall, Programme activities are particularly weak in terms of attention to gender equality and other social inclusion dimensions. From activity reporting, it seems most activities assume that energy investments will have social inclusion benefits, and in particular equal benefits for women and other vulnerable groups but have no means to formally assess this. Findings indicate that some activities claim to have achieved gender and inclusion outcomes and other development outcomes, but there is no clear approach on how the Programme plans and measures for inclusive development. Below are some examples of gender and development outcomes achieved by the Programme's activities.

Achieving social inclusion and development outcomes in the Pacific

Samoa: A review conducted by ADB found that access to continuous electricity appeared to reduce the time spent on housework. It also increased women's working hours, which reduces time poverty and creating additional or new income, as well as enabling them to assist children with school homework. Some women benefitted from working closer to home, with a more balanced life overall [and] opened up new businesses or expanded existing businesses.

Tonga: Through the Tonga Village Network Upgrade Programme, a total number of 2,482 connections were upgraded. Based on anecdotal evidence, this increased economic productivity for some women who have more time in the night to make handicrafts for sale.

Vanuatu: In Vanuatu, through the rural electrification project, the extra income gained in some instances from being able to keep shops open longer, or being able to undertake activities for longer periods (i.e. weaving, cooking, etc). Some people are also charging people's phones for a small fee which has increased daily income.

Solomon Islands: Installation of solar power in primary schools in the Solomon Islands led to improved education outcomes because pupils were able to attend daily evening classes, had access to study sessions before the exam and teachers reported spending additional 6.7 hours on school-related activities due to lighting in the school buildings and staff houses.

Photo credit: Jantira Namwong Shutterstock.com

Country: Samoa, Tonga, Vanuatu and the Solomon Islands

MFAT's investments in Samoa achieves the unintended (positive) benefit of enhanced donor coordination

The Programme contributed roughly 30 per cent of the cost of an ADB-led USD 25 million hydro development and rehabilitation programme, which was operationally part of a larger US 125 million ten-year power sector development programme. Overall, the project showed how donor coordination in Samoa has directly influenced and financed power sector development with a stronger focus on renewable energy and climate change resilience than would have been the case under typical project designs. The Samoa donor coordination effort has become an example to the wider Pacific of what can be done to genuinely address resilience to climate change within energy infrastructure through a coordinated and complementary approach.

Country: Samoa

The Programme achieved some unintended outcomes. Like many development activities, the Programme's activities led to both positive and adverse unintended outcomes. For example, activities designed for climate mitigation also had climate adaptation/improved resilience benefits. For instance, in Samoa, energy activities had a strong element of climate adaptation, through the Programme's PV & SHP investments. While this may have been implicit in the activity design document, improved adaptation was not a specific planned outcome but an intended positive outcome. In contrast, in Tuvalu and the Cook Islands, increased energy demand as a result of renewable energy supply had an unintended negative outcome of increased use of energy-inefficient appliances. It is important to note that unintended outcomes such as these could also be less of an observed unintended outcome, but rather a result of activity design documents not being explicit on the full set of outcomes to be achieved or risks that would be encountered.

Factors contributing to effectiveness and achievement of outcomes

The evaluation found that there were both higher-level and activity-level factors that contributed to the achievement of outcomes and the overarching objective to increase access to affordable, reliable, and clean energy. Factors contributing to the overall effectiveness of the Programme and indirectly to each of the energy investments and activities include:

- **The commitment to renewable energy as a flagship priority and signalling this priority to partners,** drew attention to the underinvestment in renewable energy solutions – and helped crowd in technical support, interest, and funding. The clear commitment, advocacy and interest from the New Zealand Government, partner governments and donors gave rise to momentum and more investments being delivered quickly and efficiently through replicable modular services.
- **Considerable attention to implementing climate-resilient infrastructure/systems,** which is contributing to more consistent and reliable output and resilience to natural disasters – examples from climate robust designs in Samoa and Tonga are shown to the right.
- **MFAT's contributions and partnership with the International Renewable Energy Agency (IRENA)** encouraged IRENA to maintain a focus on the Pacific region. An outcome of this includes IRENA highlighting the success of the Pacific's transition to renewable energy. It has also proven to be a strong channel for demonstrating New Zealand's renewable energy credentials on the global scale and has served to strengthen the broader political relationship regarding the global energy sector.

Climate-resilient infrastructure contributing to increased access to reliable energy supply

In Samoa, the new and rehabilitated hydro systems are climate robust and are supporting more consistent, reliable output. For example, the Tafitoala-Fausaga SHP has a dual-intake system tapping into two tributaries, contributing to a higher capacity factor (42 per cent compared to typically 35 per cent). For resilience to natural disasters, the penstock was built underground, pipes were sturdy glass-reinforced plastic, and the powerhouse waterproofed to one metre above floor level. Also, intakes were located above expected flood levels.

In Tonga, the Programme's investments have led to a resilient and upgraded network that has withstood two cyclones (Tropical Cyclone Gita in 2018 and Tropical Cyclone Harold in April 2020). In both instances, damages to the distribution network were less and it was much faster and easier for TPL to fix the damages to the upgraded network and to restore power.

Countries: Samoa and Tonga

Factors that contributed to the overall effectiveness of investments at the activity level included:

- **Feasibility studies provided evidence for better programming and likely results**. For example, reports produced from the Wind and Biomass Feasibility Activity in Tonga provided clear direction and detailed information to enable Tonga Power Limited to make informed decisions about wind and biomass power generation - including giving confidence to Tonga Power Limited and the Government of Tonga to proceed with the wind power projects.
- **Close partnerships and working relationships with the partner government, utility companies, other development partners and/or communities strongly enhanced ownership and effectiveness**. For instance, in PNG, the eventual support from provincial/local members of government and the Chiefs, in facilitating information dissemination and taking the lead in clarifying landowner-related issues enabled a more efficient Activity roll-out and for more household to be connected to the grid. In contrast, for activities within the Global Programme, the lack of an in-country presence hindered progress and required greater effort and time to form and maintain good relationships to achieve effectiveness.
- **For geothermal energy activities, partnerships across the energy sector, buy-in from the utility companies and a political champion is vital for effectiveness.** Analysis shows that geothermal energy is a disruptor in the energy sector and is likely to face resistance from utility companies and other energy stakeholders. Creating partnerships with relevant sectors in the energy sector is vital so activities get the concessions needed as well as an enabling policy and legal framework. Though this observation is about geothermal activities, the lesson is relevant when engaging with governments and other stakeholders for infrastructure and energy projects.
- **Improving the capability and performance of the utility companies and improving the quality and reliability of critical network infrastructure can be key enablers of further funding for sustainable sector development.** Findings indicate that the Programme's continuous funding and support to some utility companies have improved the efficiency of the networks which has had dual benefits of enhancing reliable energy supply but also attracting funding from other development agencies. For instance, the continuous support of the Programme to Tonga for more than ten years is bearing fruits. Through the continuous support of Tonga Power Limited (TPL), there is a reported increase in donor and investor confidence. For instance, there was the signing of a 6 megawatt (MW) solar power purchase agreement with Synergise NZ Ltd in 2019, the commissioning of a Japan-funded 1.3 MW wind farm in 2019, the signing in 2020 of the construction of a 2.2 MW wind farm by the China Energy Engineering Group and the plan to invite a wind independent power producer to generate electricity in Tonga.

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Opportunities to address factors that hindered effectiveness

Most factors that hindered progress on effectiveness or the achievement of outcomes related to missed opportunities during the activity design stage. Delivering rapidly can lead to activities developed without adequate preparation and design, and lead to reduced effectiveness and longer-term issues in some cases. Feasibility studies and more carefully planned activity designs, coupled together with time to build relationships and obtain relevant buy-in from key local stakeholders, can enhance effectiveness beyond increased access to clean and reliable energy supply and contribute to more resilient and sustainable energy that supports broader development needs.

This section highlights the opportunities that were missed, and if acted upon could have led to greater effectiveness and development outcomes. Opportunities to enhance effectiveness include are described in more detail below.

- **Incorporating energy efficiency to reduce the impact of increasing energy demand and inefficient energy supply.** In the Cook Islands, there were missed opportunities to incorporate more efficient use of energy into the activity through appliance restrictions and cooperation with an ADB project subsidising efficient appliances. This could have reduced the growth in electricity demand, reducing stress on the PV systems, lowering diesel fuel use, and improving the likelihood of sustainable electricity supply. Evidence shows that when renewable energy and energy efficiency are pursued together, they result in higher shares of renewable energy, a faster reduction in energy intensity, and lower energy system[8] costs which not only brings environmental benefits but social and economic benefits as well.
- **Maximising synergies through adopting a system-wide perspective, taking into account potential interlinkages between technologies and sectors.** Energy systems should not be developed in isolation but should be part of a wider effort to improve power sector management, planning, maintenance, and grid stability. Overall, renewable energy into an inefficient grid leads to inefficient supply, and the future of the global energy sector shows that renewable energy and energy efficiency will work in synergy to drive global energy decarbonisation. From the case studies, the activity in Tonga addressed energy efficiency by upgrading lines which in effect reduced losses from 20 per cent to 5 per cent respectively.
- **Governance mechanisms should be established before investment in energy systems begins.** Challenges with partner governments (e.g. setting aside land and resources, lack of follow-through) and changes in key priorities cause delays have significant implications on costs and efficiency to maintain effectiveness. For the Northern Cook Islands RE Activity, technical assistance to establish mechanisms for governance including management and tariffs was agreed concurrently with implementing PV systems. In future similar projects, careful consideration should be given to pre-existing management capacity of the intended recipient organisation, with implementation conditional on an acceptable governance approach.
- **Ensuring appropriate and complementary interventions and efforts to prioritise sustainability and affordability** aspects of the overarching Programme objective. This can be partly accomplished by supporting (when requested and agreed to) partner governments, utility bodies and regulators to implement tariff methodologies that support affordable and sustainable energy supply. For instance, in Samoa, the Electric Power Corporation (EPC) had the capacity for effective maintenance and was assessed by ADB to be financially sound in 2019. However, the tariff determination methodology did not include the cost or replacement of grant-funded capital assets. If the tariff methodology remains unchanged, EPC income may be insufficient for adequate expansion of generation and maintenance if grants for energy infrastructure significantly decline.
- **Prioritising technical assistance from the early activity stages to post-completion stages for countries experiencing more difficulties implementing activities and requiring additional support.** Some countries experienced more difficulties in implementing activities, mostly due to insufficient national capacity/capability, competing priorities, poor capacity/capability of the utility companies, lack of political will or ownership, funding and other resource constraints as well as difficult and remote operating environments. There are opportunities for the Programme to identify those countries that have difficulty designing and implementing projects and provide additional support. Further support could range from provision of

[8] https://www.irena.org/publications/2017/Aug/Synergies-between-renewable-energy-and-energy-efficiency

technical assistance and supplementation, more oversight and a more active role in project design decisions, governance and procurement processes as well as more frequent field visits, and mentoring and coaching.

- **Having adequate Results Frameworks at the Programme- and Activity-level that focus on both outputs and outcomes and incorporate potential outcomes in other sectors.** Missing or inadequate results frameworks constrained reporting above output level for activities and the whole Programme, making it difficult for investment managers to ascertain whether outcomes are being achieved or not and implement course corrections where needed. MERL frameworks are also further constrained by having indicators focused on measuring outputs from tangible investments, rather than indicators to measure capacity-building, policy integration, institutional strengthening. Potential Programme shifts in direction from more tangible investments to intangible capacity-building interventions will make measurement more challenging. This will likely need extended activity design processes, effective MERL tools, frameworks and training to capture progress and results and evaluations to supplement evidence.
- **Embedding inclusion into activities can contribute to effectiveness and broader development outcomes.** It appears that the principle of inclusiveness is not yet well-grounded across the Programme. There are opportunities for the Programme to drive and facilitate a shared understanding of inclusiveness in activity design, implementation, and management. Development practice shows that targeted gender and inclusion interventions coupled with gender-specific outcomes and indicators go a long way in supporting achievement and measurement of gender outcomes.
- **Expanding the focus on resilience beyond physical resilience to contribute to other forms of resilience and broader development outcomes.** With countries in the Pacific facing adverse effects of climate change, there is the opportunity for the Programme to broaden the scope of resilience beyond physical resilience to other forms of resilience. By broadening the resilience scope with the understanding of the energy's critical role as an enabler of broader development outcomes, the Programme will contribute to community resilience ranging from climate, community, environmental and social resilience. Further discussion on how the Programme can extend and expand its focus on resilience to climate adaptation and resilience is in Section 4.4.
- **Broadly, increasing influence and advocacy for energy assistance through more effective collaboration and ways of working within MFAT.** Following the implementation of new funding infrastructure that came into effect for the current triennium, stakeholders reported the Programme has lost some influence and significance in terms of advocacy in the energy space in the Pacific and noted the potential for this to continue given the current funding infrastructure and the absence of clear linkages and ways of working between MFAT's bilateral, regional and thematic teams. Opportunities exist to increase influence and advocacy through more general and targeted collaboration within MFAT, and collectively with its external stakeholders.

4.3 How effective is MFAT's approach and ways of working to deliver expected results? (Efficiency)

This section presents evidence and commentary on the efficiency of the Programme and responds to Objective Three of the evaluation. Specifically, it explores questions related to MFAT's approach and ways of working (e.g. internal roles and responsibilities and resource allocation, funding, contracting and delivery [management & governance] modalities) to deliver expected results.

4.3.1 Utilising different modalities in different contexts to enhance the efficiency of the Programme

The Programme's activities are delivered through different modalities which are appropriately selected for different contexts. The Programme delivers activities through partner governments, third-party managing contractors, grant funding, facility model, participation in large multi-donor projects/programmes and through the provision of technical assistance. The most appropriate modality depends considerably on the country context, partner capability, existing relationships and available resources. Overall, evidence indicates fit-for-purpose and appropriate modalities were adopted.

For instance:

- partner-led implementation was adopted where partner countries had good power utility management (i.e. in Tonga and Solomon Islands)
- grant funding was used where partners had limited capacity and capability (i.e.Tokelau)
- the facility model was used where the implementing partner had good technical capability and where there were good relationships exist with the Programme, while use of in-country agents seems effective where MFAT has limited presence (i.e. Caribbean).

For example in Samoa, for PV implementation, there was a joint project arrangement with MFAT facilitation and contracting and construction supervision by Electric Power Corporation (EPC) assisted by consultancies. Hydro implementation was through a partnership arrangement led by the Asian Development Bank (ADB) with MFAT and the European Union (EU). Both arrangements were appropriate considering time constraints, EPC's capabilities, and the ADB's long-term role in energy sector development in Samoa.

The geothermal sector investments have proved to be unique in the Caribbean and Africa and significantly raised MFAT's profile

MFAT's investments in geothermal power provide strategic positioning in the development of a thriving renewable energy source which is important for spurring economic growth across regions. By funding a Caribbean Geothermal Adviser based in the region and implementing technical assistance activities to support geothermal development in the Eastern Caribbean, MFAT has positioned itself as the key technical resource for geothermal development in the Caribbean. Also, MFAT has leveraged significant complementary funding from other donors which is being used to scale up investments in the sector and achieving good results and visibility for MFAT.

Region: The Caribbean and Africa

For Small Island Developing States (SIDS), a single managing contractor model can be efficient for infrastructure investments, though time is still required for relationship building with partner governments. Evidence shows that using a single managing contractor (i.e. in the North Pacific and the Caribbean) can result in better coordination and implementation, reducing pressure on SIDS' government staff. Findings indicate that for the Caribbean, this approach resulted in a single source of the broad range of advice across technical, commercial, regulatory, legal, environmental, and social impact areas in the geothermal sector. It was suggested that pooling resources through a single contract (for the managing contractor delivering services in several countries) would have allowed for more flexibility in financing, as having separate contracts led to overspend in some countries and underspend in others.

Lessons indicate that though there can be efficiencies by using a single third-party managing contractor, it still takes time for them to build trust and relationships with partner governments and key agencies. This observation reiterates the need for positive working relationships to realise efficiencies and enable MFAT to focus on high-level governance monitoring instead of day-to-day management (where appropriate).

The use of direct contracting, where MFAT directly engages a contractor to deliver services in-country, can be effective and appropriate where partner governments have low capacity to undertake procurement and ongoing contract management themselves. For example, when the Cook Islands Government was unable to successfully tender for the installations, MFAT was flexible and responsive and agreed to directly contract a supplier, resulting in the delivery of high-quality PV systems. It is important to note that this is context-specific and the use of direct contracting is most appropriate when the activity has technical and logistical complexities and/or weak local project management capacity. Several benefits relating to direct contracting were observed, including: a greater pool of contractors (known to MFAT) increasing the quality of technical expertise available; and the reduced need for partner governments' financial and human resources to undertake ongoing contract/project management and quality assurance.

However, a key disadvantage was also noted - the potential exclusion of appropriately-skilled local labour to undertake certain services which could have led to flow-on economic benefits and upskilling of local capacity. This is primarily due to MFAT often having less engagement with or knowledge of smaller scale in-country contractors. Should direct contracting be explored in future, consideration should be given to how smaller and suitable in-country contractors could be identified and contracted to deliver relevant services.

4.3.2 *Strong governance, adaptive management and relationships strengthened the effectiveness and efficiency of modalities selected*

Most Programme activities adopted appropriate governance and management mechanisms, although this too is largely context-based, and highly dependent on activity objectives, operating environment, modality employed, and the composition of partnerships and relationships in activity design and delivery. In particular, MFAT's direct membership in steering committees is reported as an ideal approach to coordination and management, underscoring the importance of having the right governance structures in place. There is evidence that use of Joint Project Steering Groups, where various in-country partners are comprehensively integrated, can facilitate more efficient project delivery and oversight of progress.This is especially important in contexts with diverse stakeholder interest groups (e.g. various community groups) and where high-level political buy-in is crucial for effective delivery and sustainability (e.g. PNG).

New Zealand Support for Training in the Indonesia Geothermal Sector (NZSTIGS), Phase 1

It is important that both flexible and adaptive management approaches are based on a strong and shared understanding of long-term objectives and the operating environment, and that respective partner roles and responsibilities as well as results management frameworks are designed accordingly.

On NZSTIGS, a lack of clarity about in-scope services and agreement about the responsibilities and inputs of the partner government are contributing to poor relationships between in-country partners and the Supplier. Without clearly agreed objectives about what the partner government should be doing and a clear scope of services it can expect to receive from the Supplier within the current phase, tensions arise and make it more challenging and time intensive to manage existing delivery and negotiate new requests.

Photo credit: em faies/Shutterstock.com

Country: Indonesia

The flexibility of the Programme to adopt various modalities according to partner capability and changing contexts was important. Efficiency gains were made where the Programme was flexible to scale up or down activities, where MFAT staff at Post maintained good relationships and continued communications with an in-country partner, and where the Programme was quickly responsive compared to other donors. For example, MFAT was responsive in addressing low voltage issues affecting the MFAT/EU Kiritimati project compared to the EU that had to deal with cumbersome bureaucracy.

Adaptive management processes were seen to be effective for activity implementation and management. This was observed in instances where the activity managers and implementing partners agreed on common objectives and developed agile approaches while remaining open to new ideas (e.g. used in Myanmar/Laos with Facility Manager approach). This approach helped develop activities fit for the changing contexts but also enhanced relationships and partnerships. In contrast, some activities (NZSTIGs) delivered against unclear and poorly communicated objectives led to reduced efficiency arising from misaligned expectations, damaged relationships, potential poor targeting of methodologies and resourcing, and generally increased administrative burdens. This underscores the importance of clearly understood and shared objectives for activities and good communication of these agreed-upon objectives to all partners.

COVID-19 has presented an opportunity to invest in local people and institutions. There are cost efficiencies in employing and empowering local implementing partners (institutions and people) which have been brought to the fore during the COVID-19 pandemic. Evidence shows that local partners were instrumental in business continuity and were supported to continue with implementation on the ground (such as in PNG during Activity closure in 2020). This highlights the importance of deepening relationships with local government institutions and other development partners on the ground.

Factors enabling efficiency

In addition to the identified factors in Section 4.3.2 that evidently supported efficiency, the following factors were also found to enhance efficiency at the Programme and/or Activity levels:

- **Careful planning and design of activities proved essential to effective delivery and targeting the most appropriate modality, partners and mechanisms for the regulatory and policy contexts.** There is evidence that planning and strong design contributed to both the efficiency and effectiveness of activities, together with strong integration with partner country and other donor activities. This highlights the importance of strong activity scoping accompanied by in-country presence and shared understanding of the activities' objectives, timelines and risk to support efficiency.
- **Having in-country partners as key leaders and decision-makers can drive efficiency.** In-country partners are often better placed to lead the direction of in-country discussions and engagements rather than MFAT or other remote contractors. There is evidence this is recognised within the Programme and this was adopted by many activities (e.g. in PNG). Partnerships with relevant national, provincial, and local government representatives were particularly useful for generating integration and buy-in from broader local stakeholders. Where the partner government is the implementing partner, the evaluation identified a range of actions that enhanced effective activity implementation, including: identifying political champions to advocate for reforms; obtaining broad endorsement from within government and other development partners so that reforms are not derailed if leadership changes; providing sufficient time to develop capacity and institutionalise reforms; and holding regular meetings with the responsible government ministries.
- **A coordinated approach to stakeholder engagement at both the national and regional level can improve efficiency of energy programming.** Effective, targeted, and well-coordinated partnerships are highly important to deliver effective development outcomes. Energy and climate change mitigation are becoming increasingly crowded spaces with high numbers of development partner activity. Increasingly proliferation of projects and actors can create fragmentation of activity and high transaction costs. It can also spread capacity thinly, and in particular the absorptive capacity of vital in-country partners. There was evidence that efficiencies could be gained through greater integration and partnership with existing regional institutions and other development partners. For example, coordination in Samoa between the ADB, EU and MFAT with ADB leading the implementation of an Activity led to efficient outcomes, and likely more efficiency than if MFAT were acting alone. As MFAT is generally seen as a trusted partner in the Pacific, there is potential for MFAT to play a greater role in advocating for and driving donor and regional coordination to improve development outcomes. This is explored further in Section 5.1.

Factors hindering efficiency

The following factors were found to hinder efficiency at the Programme and/or Activity levels:

- **Lack of in-country presence and poor engagement with local stakeholders,** which was exacerbated by MFAT's staff rotation system for bilateral teams, led to the loss of institutional knowledge in some instances and the ability to sustain and better leverage in-country relationships.
- **Limited partner country capability and capacity** can be a key constraint in effective delivery, especially when project timeframes are tight, and momentum is challenging to maintain. It is crucial that initial activity planning and design accounts for these factors, and plan for capacity building and institutional strengthening considerations to achieve efficiency, effectiveness and sustainability.
- **Poor Programme documentation and the lack of embedded mechanisms to share and disseminate lessons learned** affected how knowledge is retained but also shared to ensure issues and challenges were not repeated. Sharing information and lessons is critical for maximising cohesion of actors for an activity and for designing course corrections where approaches are not working or presenting value-for-money. The appropriate systems and tools to capture data, process data and shared data are prerequisites to realising these improvements.
- **Clear leadership on activity implementation and management was not always present, primarily due to the absence of clearly articulated roles and responsibilities.** Ambiguity of roles can create significant inefficiencies in delivery. Clear activity management leadership and decision making powers can be vital for effective delivery and for shared strategic direction and coordination as well maintaining project momentum and ensuring activities are delivered both efficiency and effectively.

4.4 To what extent are the Energy Programme investments sustainable and resilient? (Sustainability)

This section presents findings and analysis on the sustainability and resilience of the Programme's investments. Specifically, this section explores questions relating to the extent to which the Programme's investments and systems are likely to be sustained over the lifetime of the investment, are resilient and will continue beyond the lifetime of the investments.

Overall, the sustainability of energy investments appear to be a widespread concern across the globe not unique to the Programme. Building effective sustainability measures into activities is difficult, making it unlikely that issues will be addressed in the short-term. Financial sustainability of assets is a significant hurdle to overcome – especially in places where there is no commercial entity to manage this. Improving the sustainability of energy infrastructure requires sustained engagement beyond implementation, and often working with authorities external to the direct recipient (i.e. finance ministries, energy regulators, etc) to improve asset management, revenue and general governance (i.e. for the Cook Islands & Tuvalu PV but also many projects managed by utilities or island councils). Ongoing capacity building and operations & maintenance (O&M) support from MFAT is needed for some years after project implementation to enhance sustainability.

Systems designed for sustainability and climate resilience

In Samoa, renewable energy infrastructure was designed and implemented for sustainability and resilience. The PV and SHPs were robustly planned, designed, and built for climate change resilience, particularly for cyclone winds and flooding. With appropriate operations and maintenance, they should continue to operate for many years.

While in the Cook Islands, the hybrid PV/diesel generating infrastructure was well designed and implemented for physical sustainability. The systems were robustly built for climate change resilience, particularly for high winds and flooding. With appropriate O&M, they should continue to operate for some years, and the Rarotonga electric power utility appears to have sufficient capacity to undertake satisfactory maintenance.

Photo credit: "Hybrid solar PV system, Pukapuaka" Source: MFAT

Region: Samoa and the Cook Islands

4.4.1 Technically sustainable and resilient energy systems

In general, the Programme has supported technically sustainable and resilient energy infrastructure, though climate resilience is mostly not factored as an outcome of the investments. Designs have been robust and resilient, to withstand current conditions and adverse changes in the climate that can reasonably be expected over the decade or two beyond implementation. Also, the Programme's technical designs appear to be suited to the Pacific (i.e. relatively simple control systems, battery protection, etc) compared to some other systems. The RE systems (PV and SHP) appear to be well designed and constructed for climate resilience (i.e. Samoa PV and SHP). The PV systems have reportedly been more resilient to cyclones and flooding. Though the RE infrastructure has been designed to be resilient to weather and disasters and this is presumably intended, it is not explicitly specified in activity design documents (i.e Samoa).

4.4.2 Considering the financial sustainability of investments and affordability of energy supply

Climate-resilient and robustly designed renewable energy systems maybe physically sustainable but not necessarily financially sustained. While resilience was evident, sustainability of the investments after activity closure (through appropriate operations and maintenance) and affordability (to governments to cover future capital and ongoing costs and to consumers if full costs are passed down) remains a big challenge. Factors adversely affecting the financial sustainability of investments include poor governance and management of energy supply and the reluctance of

partner governments (in response to consumer needs and wishes for low energy costs) to seek full cost recovery through tariffs.

Electrical energy supply will not be financially sustainable over time unless there is a workable mechanism for full cost recovery to cover capital costs, capital replacement and O&M whether through tariff reform (i.e. most consumers pay the full cost with lifeline tariffs for low-income consumers) and/or explicit subsidies from the national budget (perhaps with short-term donor support). This will require careful fiscal planning (i.e. government budget for replacing key components explicitly allocated and ring-fenced) and enabling regulatory frameworks / environments for implementing workable mechanisms. Evidence shows the absence of workable mechanisms and regulatory and political environments for full cost recovery to finance capital costs, capital replacement and O&M. It is unclear whether this is due to a possible expectation that donors will rehabilitate failed systems and support O&M costs.

Energy subsidies are creating distortive price signals and are generally implicit or hidden in government budgets. Evidence shows that energy subsidies create distortive price signals and result in higher energy consumption, which can be unsustainable. In the Pacific, subsidies are widespread and often accounting for well over half of full costs but are generally implicit or hidden in national budgets. Where governments are unable or unwilling to eliminate or substantially reduce subsidies, enabling regulatory and policy frameworks could encourage governments to make subsidies explicit in national budgets and increase visibility, which may in turn result in discussions and agreement to raise tariffs over time to more fully recover costs.

Lifeline tariffs can help make electricity affordable. They support low-income households, or remote consumers where electricity costs are very high, through subsidised rates for modest basic needs consumption (lighting, fans, radio, etc.), typically restricted to about 50-60 kWh/month. Consumption above the lifeline level is charged at full cost.[9] It is suggested that MFAT support studies of a lifeline approach in countries with highly subsidised electricity (nationally or in specific remote areas), assessing the social and financial impacts of various lifeline models. If appropriate, MFAT could encourage adoption of lifeline pricing.

Demand-side management can reduce costs of electricity to consumers. There were missed opportunities (e.g. within the Northern Cook Islands RE Activity) to implement cost-effective demand-side (consumer) energy efficiency measures to reduce demand and growth in demand, and thus electricity costs. For future activities, particularly for remote electricity generation, MFAT should incorporate energy efficiency into project design and implementation. This could include supporting governments in restricting energy-intensive appliances to highly efficient designs (perhaps incorporating a government subsidy for the purchase price), requiring energy-efficient internal and street lighting (e.g. LEDs), installing load-limiters at buildings, and charging full costs for air conditioning or inefficient refrigeration and freezing or banning them.

Rehabilitating a deteriorating RE system may be more expensive than effective initial governance. In the Northern Cook Islands, six years after implementation, about NZ$5.5m is required for battery system replacement (the highest cost component). Although the information was not available on the cost of a well-functioning management system with utility income covering O&M and component replacement, rehabilitation of the systems will likely be costlier to the government than a properly-run northern island electricity programme would have been. MFAT should consider a retrospective study of the respective costs of rehabilitation now compared to effective management from 2014/15.

Most, if not all, systems implemented have been economically viable, based on RE choices that could be justified based on expected capital and operating costs. However, it is not clear that initial costs and economic feasibility were always sufficiently assessed beforehand, particularly for some early PV investments (the flagship period). In some cases, MFAT assessed risks and provided technical assistance or guidance to overcome them, but often power utility income has been insufficient to cover full costs, undermining sustainability.

For sustainability and equitable access to energy, the Programme should consider affordability to the consumer and affordability to the utilities to maintain and sustain the investments. Findings indicate that the Programme has done well in addressing affordability through investments in renewable energy as shown by the renewable energy activities in the Pacific. Findings further indicate that an area not well addressed by the Programme is addressing system losses. Though the Activity in Tonga addressed system losses by upgrading the existing network, there are opportunities for more investments to address losses.

[9] Consumption above the monthly lifeline limit might be charged full cost. In some countries, all consumption is charged at full cost if consumption exceeds the limit.

4.4.3 Building capacities for sustainability and resilience

Effective provision of physical assets often requires strong capacity-building support to improve expertise, capacity, and resources of local partners for ongoing O&M and integration of the assets into national systems. The importance of strong consultation, integration and collaboration with local counterparts is key for effective capacity-building. In the Pacific, for example, **the resources for effective O&M are unlikely to be available in small, isolated islands and can be better managed at less cost by a single utility or well-resourced service covering all the remote islands.** Assisting national and island authorities to develop effective mechanisms for funding remote island O&M for electricity systems is likely to be a long-term effort, with no easy solutions. Mechanisms for operational support and training should be built into future outer island energy projects.

Learning-by-doing approaches and train-the-trainer model adopted by the geothermal facilities technical assistance programmes have increased technical knowledge, improved human capacity and likely enhanced sustainability. Findings indicate that facilities in East Africa, the Caribbean and Indonesia have been providing specialist technical training and capacity building to geothermal professionals. To enhance knowledge and skills transfer, the activities have been facilitating training through a learning-by-doing approach where participants bring their geothermal data for instance and during the training, they develop models specific to their country's geothermal resources. From the training, trained participants went on to train others from their countries. This approach is in line with the andragogy principles of adult learning where adult participants learn better if they are seen as a valuable resource during the training process, where they identify something they want to know or become proficient at, or when they experience something that connects with their own life. By adopting this approach, reporting shows that the investment gains will be more sustainable because there is a pool of engaged and competent trainers both at the country and regional level.

With support from MFAT for over 10 years, Tonga Power Limited has improved capacity and capability and likely sustainable

Tonga Power Limited has performed very well as an implementer, with strong implementation and operational capability and capacity.

The long-term technical sustainability of the activity is supported by an upgraded and resilient network, a highly trained power utility technical staff with practical hands-on experiences and equipped with specialised equipment and vehicles. TPL has been empowered with specialised tools and equipment to effectively monitor the performance of the Activity and to maintain it. The high level of standards adopted in the design, installation and training ensure the durability of the network.

Photo credit: "Tonga Power Ltd" by Vilimaka Foliaki licensed under CC BY 2.0

Country: Tonga

Internet-based monitoring can be effective over extended periods if used and maintained. In the Northern Cook Islands, Internet-based RE system data-logging has generally allowed remote access to detailed operational data for the past six years, with some lapses due to Internet problems. In principle, with robust computers and adequate Internet service, this can allow remote determination of problems quickly at little cost, so problems can then be addressed before there is serious damage requiring expensive repairs. In practice, it is not obvious that this was used to improve O&M and thus sustainability but MFAT should nonetheless consider similar systems for other remote RE installations, but perhaps with more training, funding for occasional site visits and longer O&M support.[10]

Sustainability can also be enhanced by leveraging other donors. This could be achieved by either further funding the same utility and interventions (e.g. other donors picking up from MFAT in Tonga with the network upgrade Activity -NNUP phase 1 that began in 2018 that builds on TVNUP) or leveraging other donors to invest where the Programmes investments are relatively small (e.g. the Programme has leveraged significant complementary funding from other donors which is being used to scale up investments in the geothermal sector in the Caribbean).

[10] Technical advice to island councils was limited to a 12-month period, and any visits to the site entailed additional charges.

Factors enabling sustainability and resilience

The evaluation found high-level factors that enhanced the sustainability and resilience of the Programme's investments to facilitate sustainability of the investments over the lifetime of and beyond the investment. Factors contributing to the sustainability and resilient of the Programme's investments include:

- When capacity building and technical assistance has a strong component of local partner capacity building. In Tonga, Tonga Power Limited was empowered with specialised tools and equipment to effectively monitor the investments and to maintain them. Also, TPL was also empowered by having line mechanics trained to NZ Standards. The high level of standards adopted in the design, installation and training ensure the durability of the network.
- When activities closures are accompanied by a comprehensive staff handover especially for activities where new investments build on previous phases of implementation as well as for activities with high staff turnover.
- Workable mechanisms for cost recovery accompanied by a budget for replacing key components. Sustainability is enhanced in contexts where an increase in demand is offset by increased revenue from sales which provide necessary revenue for O&M.

Factors hindering sustainability

Overall, risks weakening sustainability have been social (the desire to keep costs to the consumer low) and/or political (poor governance of electricity supply management; reluctance to cover full cost of supply, possible expectation that donors will rehabilitate failed systems). Sustainable energy systems have technical, economic, financial, and social/political aspects, and these tend to overlap. All requiring different approaches and mechanisms by the Programme to address with partner countries.

Factors hindering the sustainability and resilient of the Programme's investments include:

- Contexts where tariffs are far below costs to recover capital and O&M costs and where utility companies are constrained to raise revenue from tariffs due to political reasons. For example, PNG's regulatory environment failure to allow the setting of electricity tariffs linked to costs of PNG Power Ltd.
- Lack of ongoing technical support for in-country partners and a short-term approach to technical advice. Provision of technical advice to local counterparts within a specific project-lifetime window with no mechanisms to provide support post-activity completion hampers sustainability. The example in Tonga where the Programme has invested in the energy systems for more than 10 years is a good example of a long-term approach to technical assistance.

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5 Future directions: Emerging areas of consideration

Emerging areas for consideration by and for the Programme are summarised below and respond to Objective Five of the evaluation. Emerging areas of consideration are based on the evaluation findings, lessons learned as well as recommendations from internal and external stakeholders consulted on the future strategy and policy direction of the Programme. These considerations are intended to inform the future directions of future MFAT energy programming.

Considerations have been categorised as high, medium and low priority (using varying colours demonstrated below), giving recognition to current operating environment for the Programme team and MFAT's existing funding infrastructure and strategic intentions.

Priority		Description
	High Priority	Considerations for the Programme in the short-term (over the next 12 months following the evaluation) to enhance the strategic relevance of the Programme and achieve 'quick wins'
	Medium Priority	Considerations for the Programme in the medium-term (within two to four years following this evaluation) to increase programming effectiveness and support broader development outcomes
	Low priority	Though important, these considerations are low priority and can be implemented when resources are available.

5.1 Considerations for future programmatic approach and ways of working

Clearly articulate the mandate, interventions and outcomes of the Energy Programme and how it contributes to MFAT's strategic intentions and priorities

A key consideration for future programming is clearly understanding and articulating what it means to work programmatically and function as the 'Energy Programme'. Findings indicate that the Programme's objectives and how it intends to achieve these objectives in practice have not been clearly articulated or communicated. While renewable energy was a flagship investment priority, there was an overarching strategic framework for the Programme (accompanied by a results framework) that articulated the Programme's goal, intended outcomes and potential indicators for measuring progress. Findings suggest this guided the Programme's investments in the Pacific. However, there is no current overarching strategic framework to guide investments and decision-making at the Programme level, taking into account the Programme and MFAT's existing operating environment.

Development practice views programmatic approaches as a long-term and strategic arrangement of individual yet interlinked projects/activities that aim to achieve large-scale impacts in their areas of focus.[11] Programmatic approaches should seek to maximise impact (i.e. through leveraging relationships, replicating successes and innovations in a context-specific manner) and increase synergies between activities and relationships with key actors (i.e. partner countries and other donors). For a programmatic approach to succeed, literature indicates that it should provide a clear mandate and value-add, be guided by an overarching strategic framework (including a strategic results framework) and be guided by clear and sound governance mechanisms.

Considerations for the future include:

- **Facilitate internal discussions to develop a common understanding and agreement of the objectives and desired outcomes of the Energy Programme,** taking into account MFAT's Strategic Intentions and priorities for the new triennium. Discussions should include consultations first with the core Energy Programme Team and then relevant bilateral (including staff at Post), regional programme teams and relevant thematic areas/programmes (i.e. climate change, inclusive development, economic resilience). As the different stakeholder groups have varying priorities and interests, it is suggested that a series of discussions are held to more fully understand the priorities of each of the stakeholder groups and explore how energy assistance can support relevant development outcomes and the potential joined-up approaches that will contribute to sustainable development.
- **Develop a Programme-level strategic and engagement framework to articulate the shared understanding of objectives, outcomes and suite of interventions**. It is timely for the Programme team to develop a new Strategic Framework that reflects the current objectives and outcomes of the program, the core interventions utilised to achieve these outcomes and measures/indicators for tracking progress against agreed-upon outcomes. This involves understanding the current theory of change, which could be demonstrated through a programme logic within the Strategic Framework to support shared understanding and agreement between existing and new team members. This should be accompanied by a stakeholder engagement strategy/plan to support ways of working within the current operating context. This internal facing document will be a first step for supporting clear communication with other teams in MFAT and external stakeholders.
- **Develop an external-facing capability statement to clearly and concisely demonstrate objectives, services, capabilities and potential areas for collaboration.** This brief capability statement should communicate the objectives of the Energy Programme, service offerings / interventions and capabilities of the Programme team. It could also draw on the findings of this evaluation to provide case studies of how energy assistance contributes to improved development outcomes and development principles (i.e. efficiency, reliability, resilience, etc.). The statement could also include an overview of anticipated energy issues at the global and bilateral/regional levels, to support discussions with relevant bilateral/regional programme teams of ac country's/region's energy need and priorities.

[11] Global Environment Facility, Adding Value and Promoting Higher Impact through the GEF's Programma ic Approach.

Enhance holistic integration of the Programme with MFAT's other thematic areas / sectors and highlight the critical role of energy as an enabler of broader development outcomes

Given the critical role of energy as an enabler of broader development outcomes, future considerations should support holistic integration of energy assistance within the New Zealand Aid Programme. This could be achieved through strategically communicating how affordable, reliable and clean energy supports broader development outcomes across sectors, regions and countries, and through greater collaboration across MFAT's bilateral, regional, thematic and cross-cutting teams. Priority should first be given to improving integration with MFAT's Climate Change and Infrastructure teams given the impact that energy has on the work and objectives of these thematic areas, and then later on to better integration with other areas that are a priority within the Aid Programme and COVID-19 recovery efforts.

There is consensus that energy is "more relevant than ever" for climate change. The International Energy Agency (IEA) states that, "promoting sustainable development and combating climate change have become integral aspects of energy planning, analysis and policymaking. Energy accounts for two-thirds of total greenhouse gas, so efforts to reduce emissions and mitigate climate change must include the energy sector".[12] Further, infrastructure investments (i.e. buildings, water supply, health, education facilities) have energy and climate change implications that should be jointly understood. The evaluation found little evidence on how the Programme is aligned with and collaborates with MFAT's Climate Change Programme and Infrastructure teams.

Considerations for the future include:

- Integration can be enhanced through regular and targeted collaboration at the Programme / team and activity levels to increase opportunities for energy components to be factored into MFAT's investments across the Aid Programme and contribute to the achievement of the socio-economic development efforts.
- Consideration should be given to interventions and results measurement that achieve and demonstrate outcomes against collective MFAT objectives and meet the countries' priorities and needs. For example, future energy or climate change activities with a carbon emissions reduction goal should include an emissions factor (CO_2 equivalent/litre of fuel) in the Results Framework. For future electricity projects with a strong focus on GHG reductions, supporting improved diesel systems should be considered if the cost/kg of emission reductions is appreciably lower than that of renewable energy investments.

Strengthen inclusive development in programming

Findings from the evaluation indicate that embedding inclusion into activities can contribute to the effectiveness and achievement of broader development outcomes. As analysis indicates, inclusiveness is not yet well-grounded across the Programme. There are opportunities for the Programme to strengthen gender equality and social inclusion in its programming and help to deliver better results and support a clearer understanding of the distribution of activity benefits.

Considerations for the future:

- With support from MFAT's Inclusive Development Team, ensure activity designs are informed by gender and inclusion analysis. This will ensure that the right approaches are selected and negative unintended consequences are limited.
- Develop gender and inclusion-sensitive MERL frameworks. MERL frameworks should identify inclusive outcomes and appropriate indicators that go beyond counting women's participation to measuring the change and impact of gender equality and other social inclusion efforts.
- Strengthen reporting for gender outcomes by having gender-specific indicators, disaggregation of data and exploring results of the gender interventions beyond indicating that gender equality is included in activities.

[12] International Energy Agency, *Climate Change*, https://www.iea.org/topics/climate-change.

Leverage soft power to influence regional and partner countries' priorities and facilitate development of regional model approaches for the Pacific energy sector

Evidence from the case studies suggests that some outcomes might be improved with regional standards for component specifications, common Power Purchase Agreements (PPAs) and Independent Power Producer (IPP) templates, renewable energy training and accreditation for design and installations, quantifying emissions, and savings, possible mechanisms for tariff reform to cover full costs, etc. For instance, Tonga's adoption of the New Zealand and Australia standards for the network upgrade and line technicians training provided consistency on how network upgrade and line technicians training will be conducted in the future.

There are opportunities for MFAT to leverage its soft power and good reputation as an approachable and nimble partner with the large development agencies in the Pacific (i.e. ADB, World Bank and EU) and the PICs to influence regional and partner countries' priorities. This could be through existing forums such as the Pacific Regional Infrastructure Facility (PRIF) energy working group, where MFAT has a leadership role. Opportunities also exist to influence regional and national priorities (in alignment with New Zealand's interests) through closer collaboration with Post / bilateral teams who hold the diplomatic mandate, implement regional and country strategies, and drive MFAT's investment decisions.

Considerations for the future:

- To better understand where common standards and approaches are needed and would support improved outcomes for the region and countries, the Programme should first conduct a review of what model agreements, templates and standards are needed and beneficial across the Pacific.
- Working with regional organisations and development agencies, the Programme can support more effective outcomes and help embed common approaches and standards that will in turn support the sustainability of investments. For instance, MFAT could support standardisation by facilitating the development regional models negotiations of PPAs and IPP agreements, model agreements covering renewable energy, energy efficiency, battery services and Energy Service Companies (ESCOs).
- The Programme could enhance its collaboration with regional organisations (i.e. PPA, SPC) and development agencies (through PRIF) on developing, and in some cases (e.g. accreditation for RE installations) requiring common approaches and standards (based on New Zealand or Australia standards or Pacific PPA) in the energy sector.
- The Programme could consider working with PRIF's energy working group, to share internally and with recipient countries and regional organisations its proposed, planned and actual energy projects and further support improved, regularly updated energy data for the Pacific region (which is currently led and held by SPC).

Consider resourcing for Monitoring, Evaluation, Research and Learning for the Programme to enable better and ongoing assessments of effectiveness and impact

Findings across the Programme shows inconsistency in results measurement frameworks, making it difficult for activity managers to ascertain whether outcomes are being achieved and implement course corrections where needed. Monitoring, Evaluation, Research and Learning (MERL) frameworks are also further constrained by having indicators focused on measuring outputs from tangible investments, rather than indicators to measure capacity-building, policy integration, institutional strengthening.

While the Programme team has a good understanding of lessons learned, there is little evidence that these have been inadequately documented, shared and contributing to improvements in practice or informing decision-making.

Considerations for the future:

- Invest in technical capability to support the Programme with aligning activities to the overarching Programme results framework/indicators and improve consistency of reporting across the Programme. This will also support aggregation of results up to the Programme-level and enable broader communication of the outcomes and impact achieved by the Programme's investments. MERL efforts need to be adequately resourced from the beginning, including through access to timely technical capability.
- In collaboration with MFAT's Insights, Monitoring and Evaluation (IME) Unit, support activities to develop robust monitoring systems that include activity MERL frameworks from activity inception. This will enable capturing results from early implementation as well as inform early evidence-based course correction.
- Where appropriate and for larger/longer activities, utilise mid-term reviews and evaluations to supplement evidence and strengthen weak MERL frameworks. Evaluations can help assess the achievement of outcomes and impact. The Programme could draw on joint evaluations for activities implemented in partnership with other donors to assess the achievement of outcomes and the Programme's contribution to the outcomes.
- Embed mechanisms to share lessons learned across activities and within the Programme itself. Structured and consistent reflection and learning workshops will provide spaces to reflect on what is working well and what is not working well, and inform decision making.
- Should the Programme invest in additional technical MERL capability, the Programme could hold periodic reflection and learning sessions (i.e. bi-annually) to understand how and whether the Programme is achieving intended outcomes. Learning sessions should be structured, consistent and facilitated in a manner useful to draw out key lessons learned, challenges experienced and adaptations that were made across the different activities. Learning sessions could have a focus based on technical areas (RE, geothermal energy, energy efficiency); regional focus (Pacific, Global); or country focus (Tonga, Samoa, Tuvalu etc).
- Formalising peer review of activity reporting can also support the ongoing sharing of lessons learned and discussions about improvements to achieve intended outcomes more effectively and efficiently.

Plan and manage for adaptive management

Evaluation findings indicate that MFAT as a development partner remains flexible and responsive to partner countries' needs and priorities, and more so for countries in the Pacific. Analysis shows various instances of responsiveness, flexibility and adaptation, which appear largely due to good project management practices and stakeholder relationships rather than intentional inclusion of adaptive management practices into activity design and implementation by the Programme.

Findings from the case studies reviewed show how activities have adapted but there is little to no evidence on whether adaptive approaches are formally embedded within activity management or reflect ad hoc practice. In some instances, flexibility and adaptability were evident when responding to challenges and weaknesses that could have been avoided or minimised through stronger and/or more realistic designs.

Considerations for the future:

- Embed governance structures in activity management with clear roles and responsibilities. Analysis shows that activities with clear governance structures and roles and responsibilities helped facilitate adaptive management. Governance mechanisms such as steering groups that convene regularly should be encouraged, particularly when operating contexts were changing during activity implementation.
- Invest in building relationships as part of activity inception. The Programme should factor in time (at inception), intention, and systems to build and maintain relationships as part of activity design and management focused on all levels of government and partners in the implementing countries. Enhanced relationships not only support better understanding of national and community contexts and changes, but also enhances activity ownership and greater sustainability of the investments.
- Redesign activities or consider changing scope when local priorities change so markedly that the original design is no longer appropriate. In highly uncertain contexts, phased activities, or sectors where the Programme is innovating, clear stop-go points informed by timely evaluation may be helpful.

5.2 Considerations for future energy strategy and policy direction

Future energy sector assistance should consider and prioritise resilience (climate, economic, environmental and social) in its programming

At present, there is no credible evidence that the major world economies will achieve the limit of a 1.5oC (or even 2.0o) temperature rise by 2050. Since the 2015 Paris Agreement, fossil fuel subsidies have grown substantially, huge new investments continue for large coal-fired power generation and the fossil fuel industry continues to undermine significant action to reduce climate change and its impacts. It is expected that 2021 will see the second-biggest annual CO2 emissions rise in history (IEA, 2021). As a result, the maximum remaining 1.5oC emissions limit is expected to be breached before 2030[13], in which case some countries will require substantial levels of assistance to be resilient to the effects of adverse climate change. Data shows that the impacts of gradual climate change will mostly affect the resource base of renewable energy sources such as changes in water availability for hydropower, wind for wind energy and insolation/cloudiness for solar energy.[14] However, the projected impacts of gradual climate change on most parts of the energy supply chain are expected to be modest and easy to cope with in the investment and renewal cycles of several energy technologies.

Therefore, energy investments should be designed to reduce vulnerabilities and enhance resilience of the systems themselves as well as for the people that use them (i.e. governments and community members), irrespective of whether the activity's fundamental aim is climate mitigation or adaptation. These investments should also consider projected future changes in climate and weather, especially for long-lived assets. New facilities should be designed to be 'climate proof' with a view to projected future climate and weather characteristics and should follow the ensuing new design requirements. Robust climate-resilient RE infrastructure is highly relevant for any future energy assistance as well as for climate change mitigation and adaptation today and even more so in the decades to come.

Considerations for the future:

- The Programme's investments should prioritise resilience through innovative, adaptive and smart designs that are future proofed for variations/changes to the climate, environment and socio-political contexts in partner countries.
- Energy assistance should prioritise improved services to consumers, expansion of clean renewable energy supply and sustainability.
- Efficient energy end-use (through design, regulations, pricing, policy and reduction of systems losses, etc) should be a core consideration for energy supply initiatives.

[13] Even if all na ional IPCCC pledges were achieved (noting no country is on track to do so), emissions would decrease from 2010 levels by only 1% in 2030, whereas 45% is needed to meet the 1.5oC goal, Global Energy Review (IEA, April 2021), https://www.iea.org/reports/global-energy-review-2021.
[14] https://www-pub.iaea.org/MTCD/Publications/PDF/P1847_web.pdf

Consider options for improving the sustainability of energy investments and infrastructure

Questions and uncertainty remain about the long-term commercial viability of investments/systems. The costs (to partner governments and to end users if and when fully passed down) of capital costs, replacement and O&M to ensure investments continue to provide optimal outputs do not appear to be factored into activity designs. This will likely have impacts on the long-term sustainability and resilience of the investments and energy systems. Findings indicate that electrical energy supply will not be financially sustainable over time unless there is a workable mechanism for full cost recovery (covering capital costs, capital replacement and O&M) whether through tariff reform or explicit subsidies from the national budget.

It is important to note though energy subsidies may seem beneficial to the consumer, they have adverse effects of higher energy consumption which can be unsustainable in the long-term. Therefore, issues of energy costs and sustainability of energy investments for the future should also be seen not only in what the Programme can do but also on how the Programme works with other donors to support tariff reforms and create an enabling regulatory environment to improve sustainability over time. The issue pertaining to the sustainability of energy investments cannot be resolved by the Programme alone and requires buy-in and effort from partner governments, utility companies and donors alike.

Considerations for the future:

- The Programme should invest in sustained engagement beyond implementation and work closely with authorities external to the direct recipient (e.g. finance ministries, energy regulators) to improve asset management, revenue and general governance.
- The Programme could undertake tariff modelling and studies on lifeline tariff approaches to inform technical advice to utility companies and partner governments on sustainable tariffs, that will contribute to the financial sustainability of investments and support long-term reliable energy supply while also keeping energy costs affordable to support consumers' social and economic participation. Where appropriate, MFAT could encourage the adoption of lifeline pricing and/or broader tariff reform.
- The Programme could work in collaboration with other donors and regional organisations to support the development of regulatory and policy frameworks to support tariff reforms and making energy subsidies explicit in national budgets, which will in turn support efforts for workable mechanisms for full cost recovery.
- For future activities, the Programme should incorporate energy efficiency into project design and implementation, particularly for remote electricity generation. This could include restricting energy-intensive appliances to highly efficient designs (perhaps incorporating a government subsidy for the purchase price), requiring energy-efficient internal and street lighting (e.g. LEDs), installing load-limiters at buildings, and charging full costs for air conditioning or inefficient refrigeration and freezing or prohibiting them.
- The resources for effective O&M are unlikely to be available in small, isolated and outer islands and can be managed more cost-effectively by a single utility or well-resourced service covering all the remote islands. Therefore, the Programme could assist national and island authorities to develop effective mechanisms for funding remote island O&M for electricity systems that incorporate operational support and training for outer island energy projects.
- There are numerous cost-effective ways to improve the efficiency and effectiveness of energy end-use within both energy and non-energy activities (through better design, regulations, pricing, policies etc). Opportunities for improved energy efficiency should be a consideration in all project design and implementation. Overall, the Programme should focus on reducing systems losses through network upgrades and other energy-efficient interventions.

Focus and invest in transport energy in the Pacific

There is scope and demand for a focus on energy efficiency as well as an expansion into transport energy (an area that is generally underfunded by the broader donor community). For example, it may be appropriate for the Programme to support improved liquid-fuelled ground transport and transport energy efficiency. The Pacific will remain highly dependent on liquid fuels (80 per cent of the region's commercial energy use from 2000 to now) for some years to come.

Considerations for the future:

- In collaboration with other donors, support review and documentation of the land, sea, and air-related transport technologies and considers which might be suitable for PICs and when it will be useful to implement them. This should provide a suite of interventions areas/projects fit and practical for the Pacific setting.
- Local mechanics know how to maintain internal combustion engines and many buses and cars have considerable remaining life. Consider support for a transition from petroleum fuels to local biofuels and policies to support O&M (which improves operating efficiency), noting this will not require major upskilling of O&M skills.

Enhancing capacity building and technical assistance efforts through accredited training, mixed modalities and effective training approaches

Capacity building and technical assistance remains a big component of the Programme's support to partner countries. Global practice shows that learning-by-doing training approaches are effective in facilitating knowledge transfer, improving human capacity and ensuring sustainability. Train-the-trainer models are also proven and effective means of ensuring sustained knowledge and skills transfer.

Localisation of capacity building has become particularly important in the COVID-19 environment and likely for periods following the pandemic. Future efforts should endeavour to include more local contractors, where they are suitable and there are less intense time constraints.

Considerations for the future:

- Enhance institutional strengthening and capacity building efforts for utility companies, partner governments, regulators and local contractors to improve the long-term sustainability of energy systems.
- Consider accredited qualifications which are more likely to be sustained than non-accredited training. Accredited training provides more value to the individual and sector than unaccredited training.
- Adopt learning-by-doing training approaches and train-the-trainer models to support improved human capacity and sustained knowledge and skills transfer.
- Embed post-training support, participant follow-up and mentoring and coaching as part of training and technical assistance initiatives. This would ground training efforts within a broader capacity-building framework and package of support, reflecting good practice on sustainable capacity development and allowing assessment of training impact.

Continue to support the role of the local private sector / contractors through enhanced public-private partnerships

To some extent, the Programme has supported private sector participation in the energy sector through contracting private companies to design and construct energy systems and enhanced public-private partnerships for generating, operating and distributing energy. Further efforts are required to achieve greater private sector participation as well as to strengthen energy sector planning and more effective operation, maintenance, and renewal of assets. In particular, evaluation findings indicate a low representation of local consulting or engineering firms. Some stakeholders reported that interested local contractors were unable to bid for MFAT contracts or parts of contracts.

Considerations for the future:

- MFAT should continue to assess the appropriateness and use of local contractors on a case-by-case basis. Future efforts, with less intense time constraints, of the Programme should endeavour to include more local contractors (i.e. where they have the necessary skills and experience). This should improve local O&M capability, and skills for refurbishment, replacement or new construction as well as benefit the local economy.
- For training and other capacity building initiatives that the Programme supports, consider training the private sector together with the public sector and/or utility company staff. This will provide a pool of trained private sector staff who will be available to provide services to the public utilities when needed to support business continuity and sustainability.

Investing in clean cooking devices and fuels

A significant longstanding energy and health issue (across the Pacific, Africa, ASEAN and Caribbean) is high levels of cooking on solid biomass devices that emit dangerous smoke which affects the health of large numbers of women and children. Past efforts (donor and national) with 'improved' wood-burning stoves have been largely ineffective but programmes to provide clean devices and fuels have had better outcomes. Replacing traditional fireplaces with cleaner fuels and more energy-efficient cooking solutions can reduce smoke emissions, provide cost savings and reduce the time and resources needed to procure fuel.

Considerations for the future:

- MFAT could work with other teams in MFAT or with other development partners/agencies to either provide or fund clean devices and fuels to support improved health and wellbeing.
- In general, MFAT should continue to advocate for and support initiatives that promote efficient energy use and restricting energy-intensive appliances, including energy-efficient cooking solutions.

Annex A – Case studies

Case Study – Cook Islands
Strategic Evaluation of MFAT's Energy Programme

Renewable Energy Northern Group (Ref: ACT-0A11954)

Photo credit: "Hybrid solar PV system, Pukapuaka" Source: MFAT

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List of abbreviations and acronyms

ADB	Asian Development Bank
ADD	Activity Design Document
CIG	Cook Islands Government
CO_2	Carbon dioxide
EU	European Union
GHG	Greenhouse Gas
GPEDC	Global Partnership for Effective Development Cooperation
kW	kilowatt
kWh	kilowatt-hour
MFAT	Ministry of Foreign Affairs and Trade (New Zealand)
MFEM	Ministry of Finance and Economic Management (Cook Islands)
MoU	Memorandum of Understanding
MW	Megawatt (million watts)
MWh	Megawatt-hours
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution (for GHG emission reductions)
NZD	New Zealand dollar
O&M	Operations and Maintenance
OECD DAC	Organisation of Economic Cooperation and Development, Development Assistance Committee
OPM	Office of the Prime Minister (Cook Islands)
Pa Enua	the outer Islands of the Northern and Southern Groups
PIC	Pacific Island Country
PV	Photovoltaic
REDD	Renewable Energy Development Division (OPM)
RE	Renewable Energy
SDG	Sustainable Development Goal
TA	Technical Assistance
TAU	Te Aponga Uira O Tumutevarovaro (Rarotonga electric power utility)

Map of the Cook Islands

Green shading = land mass White shading = lagoons within atolls

Source: *Cook Islands Country Infrastructure Profile* (Pacific Region Infrastructure Facility (PRIF), 2020)

1 Objective, key findings and considerations for future direction

The New Zealand Ministry of Foreign Affairs and Trade (MFAT) commissioned Tetra Tech International Development to undertake a Strategic Evaluation of the Energy Programme (the Programme). The aim of the strategic evaluation is to serve MFAT's dual key purpose: to account for New Zealand's investment through the Programme, and to improve what future investment can achieve. The scope of the strategic evaluation involves assessing Programme performance as a whole from 2012 to 2019 and undertaking case studies for six activities (five in the Pacific and one in Indonesia) to generate a solid evidence base about what works and lessons learned.

The objective of the six case studies is to garner further detail to support strategic level findings, but also provide evidence to support and meet independent evaluation requirements for the activities themselves. This report presents the key findings from the case study undertaken of the Renewable Energy Northern Group project (Ref: ACT-0A119540), referred to hereafter as the 'Activity'. The findings within this report are based on analysis of evidence gathered from document reviews and consultations with internal and external stakeholders. These findings contribute to the broader strategic evaluation and are intended to inform future programming decisions.

This Activity financed the design and implementation of solar photovoltaic (PV) generating systems, whereas a very closely related activity (ACT-0A10786) provided enabling assistance for northern island PV governance such as tariff setting, management, and funding arrangements and mechanisms for operations and maintenance (O&M). Some of the outcomes and targets for this construction-focused Activity depended on the results of the enabling assistance so there is some coverage in this case study of both the entwined activities, especially given the MFAT activity report combined reporting of both activities into a single report.

Key findings and lessons learned

The Activity was highly relevant and consistent with the policies and priorities of the Cook Islands. The specific islands in the Northern Group were already identified by the Cook Islands Government (CIG) in 2012 as high priorities for solar energy systems. Considerable consultation with island beneficiaries prior to implementation as well as coordinated donor effort in the Cook Islands supported the Activity's relevance to development needs and priorities. The Activity was also consistent with New Zealand, regional and global priorities for energy, which all emphasise reducing dependence on fossil fuels through increased supply of renewable electrical energy.

MFAT effectively delivered all expected short-term outcomes. By mid-2015, hybrid PV/diesel systems had been commissioned as planned at eight sites in six northern islands, at the time delivering nearly 100 per cent renewable electricity for 24 hours daily, reducing diesel fuel use for electricity on the islands by 96 per cent. Effective delivery was supported by clear objectives for the Activity and a Joint Project Steering Committee fostering a strong partnership between MFAT and the CIG.

The Activity's achievement of medium- and long-term outcomes were mixed. Progress towards CIG RE targets, 20% of national generation from RE sources, was exceeded in 2018. However, improved CIG capacity to operate and manage RE infrastructure is yet to be achieved. Effectiveness in terms of longer-term outcomes could have been improved by including an adequate demand-side energy efficiency component.

The Activity was efficiently managed by MFAT. When the CIG was unable to successfully tender for the installations, MFAT was flexible and responsive, directly contracting and delivering PV systems of high quality. MFAT efficiently chaired a Joint Project Steering Committee, resolving infrastructure-related issues as necessary. In addition to effective governance arrangements, pre-Activity work by the CIG, such as Northern Island energy surveys, preliminary design and consultations with beneficiaries contributed to efficiency.

Twelve-months of on-line technical support was innovative to support sustainability but insufficient for a remote island environment, with limited local technical skills. On-site support was needed to supplement the training of operators and on-line technical support should have been available until a permanent O&M mechanism was in place.

There is a high risk in the near future of failed systems. MFAT had a sound understanding of risks of inadequately managed rural RE facilities and there was a concerted effort to mitigate those risks through the enabling activity (ACT-OA10786), but good planning and technical assistance was insufficient to secure successful outcomes. The absence of central and island government agreement on PV system governance has contributed to inadequate maintenance, failing batteries and associated components, which is estimated by the CIG to cost over NZ$5.5 million to rectify. Consumers are contributing little if anything to O&M costs and thus to expected sustainability. Long-term sustainability requires a capital replacement budget and improved O&M.

There were missed opportunities to incorporate more efficient use of energy into the Activity through appliance restrictions and cooperation with an ADB project subsidising efficient appliances. This could have reduced the growth in electricity demand, reducing stress on the PV systems, lowering diesel fuel use, and improving the likelihood of sustainable electricity supply.

Considerations for future energy sector assistance

For the Cook Islands:

- MFAT could consider continuing to assist outer islands tariff setting, management, and O&M, and these efforts should be flexible and involve:
  - working initially with the new regulator, Ministry of Finance & Economic Management (MFEM), Office of the Prime Minister (OPM), Te Aponga Uira O Tumutevarovaro (the Rarotonga electric power utility) and island councils on practical approaches for a central support mechanism
  - acknowledgement of possibly intractable differences between central and island governments, and if necessary, consider mechanisms whereby island councils coordinate as a group to achieve sustainable outcomes.
- Technical support could be strengthened by including training in O&M and in-country support for considerably longer than 12 months.

For Pacific Islands Countries (PICs) generally:

- MFAT could consider assisting PICs to develop a least cost renewable energy (RE) implementation framework including, where appropriate, revised practical national RE targets and energy efficiency measures.
- There should be explicit goals and indicators for Greenhouse Gas (GHG) emission reductions for any Activity in which climate change mitigation is a principal or significant issue. This could include water infrastructure, health, and buildings (homes, government and commercial).
- Project designs should clearly state the intended beneficiaries, and include mechanisms for monitoring and reporting social impacts, including gender impacts.
- MFAT should continue to assess the appropriateness and use of the direct contracting modality as well as use of local contractors on a case-by-case basis. Analysis shows that:
  - Direct contracting has proven to support effective and efficient delivery of infrastructure-related activities, particularly when there is a focus on quick implementation
  - A focus on quick implementation, though, could result in less involvement of potential local contractors than warranted. Future efforts, with less intense time constraints, could endeavour to include more local contractors, where they are suitable. This should increase local capability for subsequent O&M and possibly refurbishment or replacement, and benefit the local economy.
- Future partnerships among development agencies (or similar work in the same country by one or more development agencies) should strive, to the extent practical, to consider tendering requirements for common components within the country.
- MFAT should consider prioritising robust climate-resilient RE infrastructure within any future energy assistance. This is highly relevant for climate change mitigation and adaptation today and will be even more relevant to the PICs in the decades to come.

2 Background – the Activity and Case Study

2.1 Background on the Renewable Energy Northern Group project (the Activity)

The Cook Islands[1] has a land area of 237 km,[2] and a population of 15,281 (2020). Gross National Income per capita is US$18,538 (2018), the highest of the PICs. In 2017, 100 per cent of the population had access to electricity. There are twelve inhabited islands and atolls, of which seven are in the Northern Group. About 75 per cent of the population (2016 census) live on the main island of Rarotonga, 19 per cent in the Southern Group and only 6 per cent in the Northern Group. The main direct beneficiaries of the Activity were those in Northern Group.

As shown in the map (page i), all but one of the islands in the Northern Group are considerably more isolated than the Southern Group. They also have infrequent and expensive sea transportation links, no regularly scheduled flights, and relatively poor telecommunications links compared to islands in the Southern Group. Further, as atolls, the northern islands are highly vulnerable to climate change.

Since 2010, development of RE has been a top priority for the CIG. The policies and plans effective in 2012[2] included a goal of 50 per cent of the islands to be provided with renewable electricity by 2015 and 100 per cent by 2020,[3] reduced energy sector carbon dioxide (CO_2) emissions, and improved efficiency of electrical energy use. Under the more recent policies, specific goals were modified, and emissions reduction aspirations quantified, with growth in sustainable RE embedded in all of the recent policy documents.

In 2013, when New Zealand committed to helping develop and expand renewable energy in the Cook Islands, the key national development policies were:

- Cook Islands Renewable Electricity Chart (Te Atamoa o te Uira Natura, 2011)
- Cook Islands National Sustainable Development Plan 2011-2015 (NSDP, 2011)
- Cook Islands Renewable Electricity Chart Implementation Plan: Island-Specific 2012-2020 (2012)
- Cook Islands Climate and Disaster Compatible Development Policy 2013-2016 (2013)
- Cook Islands Nationally Appropriate Mitigation Action (NAMA, 2013).[4]

Relevant additional policies and updates since 2013 are:

- Cook Islands National Infrastructure Development Plan (CINIDP, 2015)
- Cook Islands Intended Nationally Determined Contributions (2016) for GHG emission reductions
- Cook Islands National Sustainable Development Plan 2016-2020 (2016)
- Cook Islands Second Joint National Action Plan for Climate Change and Disaster Risk Management 2016-2020 (JNAP II, 2016)
- Strategic Roadmap for Emergency Management 2018-2023 (2018)
- Cook Islands Economic Development Strategy 2030 (January 2021)
- Cook Islands Utilities Regulation Policy 2021: Electricity, Water & Sewerage Services (Consultation Draft; February 2021).

2.2 Activity objective, rationale, and interventions

New Zealand committed to support RE in the Cook Islands at the Pacific Energy Summit in March 2013, alongside the European Union (EU) which proposed to undertake RE activities in the Southern Group in partnership with the Asian Development Bank (ADB). However, planning for RE support to the Cook Islands began well before the summit. An Activity Design Document (ADD) in 2012 stated that "the focus of this activity is to help [the CIG] make progress towards the 50% target … through … direct assistance to the CIG and to support it to coordinate the efforts of other donor partners" through "two components: 1) Strategy, Policy, Enabling Renewable Electricity Development; and 2) Project Design and Deployment".[5]

[1] Sources: PRIF, 2020 op.cit. except 2020 population is from the Secretariat of the Pacific Community (SPC) https://sdd.spc.int/ck and 2016 census percentages by island group are from https://sdd.spc.int/digital_library/cook-islands-2016-census-report.
[2] Prior to this Activity, MFAT assisted the CIG with the preparation of its 2011 *Renewable Energy Chart* (essentially the national energy plan) and its 2012 implementa ion plan (for the outer islands).
[3] Some CIG documents express the goal as 50% of all electricity to be renewable by 2015 and 100% by 2020, but the text details clarify that the intention was 50% of all islands to have near 100% renewable electricity by 2015 and 100% of islands by 2020.
[4] Cook Islands commitment under the Nations Framework Convention on Climate Change.
[5] *Activity Design Document: Cook Islands Renewable Electricity* (MFAT, June 2012).

According to the ADD, the full cost of electricity generation at the time was estimated to exceed NZD 2.50 per kilowatt-hour (kWh) for the small diesel systems of the Northern Group, with consumers then paying NZD 0.60-0.80/kWh, well under a third of the cost. At the time, consumers in Rarotonga paid about NZD 0.61/kWh.[6] The full cost of remote PV systems was expected to be considerably lower than diesel gensets, allowing a reduced central government subsidy, but "it is not expected that existing tariffs could decrease because the costs of the operations and maintenance need to be covered." It was generally accepted that the outer islands lacked the financial and human resources to effectively maintain and operate their electricity generation equipment and it was hoped that legislative changes would extend the mandate of the Rarotonga power utility (TAU) to the outer islands (the Pa Enua). Therefore, TAU was to be involved in analysis and strategies for Pa Enua electrification, with the Energy Commissioner at the OPM coordinating CIG procedures to resolve issues of Pa Enua management, tariffs and O&M.

The rationale for supporting the Activity was that energy is a key building block for economic development. The goal was to encourage economic development in the Cook Islands by reducing vulnerability to volatile and (at the time) increasing international oil prices. It was understood that the Activity would have minimal direct impact on achieving national RE targets because of a focus on developing an enabling environment, and on energy generation in outer islands which had, and have, very low electricity demand. The Activity's broad expected outcomes and outputs are listed below, with the specific targets and achievements discussed in section 3.2.

Expected key long-term outcomes were:

- Improved energy security

Expected key medium-term outcomes were:

- Progress toward Cook Island Governments RE targets
- Improved Cook Island Government capacity to operate & manage RE infrastructure

Expected key short-term outcomes were:

- Increased electricity generation from RE sources

Expected outputs include:

- Output 1: Outer Islands operation and maintenance costs plan
- Output 2: Outer islands stakeholder engagement mechanisms agreed

Other than PV systems in Rarotonga,[7] the PV generation as eventually financed by MFAT within the Activity are those proposed by the CIG in its 2012 implementation plan, summarised in Table 1. At the time under 1,350 people in 360 households on the six atolls consumed roughly a million kWh per year, paying on average[8] NZ¢ 65/kWh (domestic households) and 69¢/kWh (commercial/business rate).

Table 1: PV Systems Proposed by the Cook Islands Government for the Northern Atolls (2012)

Island / Atoll	Population (2012)	Households (2012)	Electricity Sales (kWh) (2011)	(2015)	(2020 est)	2012 Tariff (NZ¢/kWh) Homes	Business	2021 Tariff (NZ¢/kWh) Homes	Business
Manihiki (two systems)	370	97	300,000	to be determined		56	78	30	N/A
Nassau	120	32	39,000	to be determined		95	75	30	N/A
Palmerston	60	18	28,700	to be determined		58	74	50	71
Penrhyn - Omoka Tetautau	260	66	N/A	79,000	96,200	54	58	30	N/A
Pukapuka	450	97	N/A	20,900	25,500	95	75	30	65
Rakahanga	77	50	N/A	64,400	78,300	42	62	30	N/A

Source: Renewable Electricity Chart (2011) & its Implementation Plan Island-Specific 2012-2020 (2012)
Notes: Charges exclude 12 5% VAT. Some reports show different tariffs but approximately the same as shown above. N/A = Not Available

[6] Source: *Performance Benchmarking for Pacific Power Utilities Dec 2011* (PPA, 2012) https://www.ppa.org.fj/publications/ converted from US$ at prevailing exchange rates.
[7] On Rarotonga, PV systems were installed at Avatiu power station, the TAU administra ion building, Ministry of Education headquarters, the OPM building and the Rarotonga airport. However, other than the airport PV, the only information located on these is the *Certification of Handover and Acceptance* (MFEM to MFAT, June 2015). These were presumably funded outside of this Activity.
[8] Costs are averaged by island, not total northern group population.

The Manihiki, Nassau, Pukapuka and Rakahanga PV systems were originally to be funded jointly by New Zealand and Japan. Detailed designs were undertaken based on agreed common design principles using funding provided to the CIG by the *Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project* (PIGGAREP).[9] These projects were unsuccessfully tendered twice by the CIG, with bids deemed unacceptable due to high costs and non-compliance of some components. The CIG and New Zealand then agreed to transfer funding and procurement to the NZ Aid Programme.[10]

The original project design was modified with component 1) 'enabling assistance' becoming a separate technical assistance (TA) Activity (0A10786). Component 2) 'project design and deployment' became this Activity (0A11954) for implementing PV systems for the Northern Group and Rarotonga. This case study concentrates on the Northern Group, with limited observations on the enabling activity as it affected Northern Group energy outcomes.

The 'Te Huira Natura Ki Te Tokerau', or Northern Group Renewable Energy Project provided solar mini-grid systems designed to meet the entire 24 hours per day electricity demand of the six islands listed in Table 1. The Activity was reportedly expected to reduce annual diesel consumption by about 230,000 litres per annum initially and up to 436,000 litres with the PV potential fully realised, reducing annual GHG emissions by 620 tonnes and 1,170 tonnes respectively.[11]

2.3 Methods for undertaking the case study

The case study report is based on the analysis of both primary and secondary data. The evaluation team first reviewed relevant Activity-related documentation to understand how the Activity was designed, implemented and what results were achieved in line with the Activity objectives. To complement this, consultations with relevant internal and external stakeholders were conducted to gain deeper understanding and nuance of the Activity implementation, results and lessons learned to inform findings on the relevance, coherence, effectiveness, efficiency and sustainability of the Activity as well as future directions of the Energy Programme.

Documentation reviewed for the case study consisted of MFAT activity-specific documents, other MFAT or MFAT-supported documentation, numerous CIG policy documents, data from the Cook Islands MFEM, the OPM, Cook Islands reports and data from the International Renewable Energy Association (IRENA), on-line monitoring reports of monthly performance from most Northern islands, and miscellaneous documents. Those interviewed included senior staff of the MFEM, OPM, TAU and a range of contractors who were involved in the Activity. Interviews were frequently followed up by email or phone to clarify issues, outcomes and inconsistencies, and to address and incorporate new findings. Annex 1 lists the documents reviewed and stakeholders consulted.

The main challenge in undertaking the case study was acquiring accurate and up-to-date information without visiting Rarotonga and the northern Pa Enua. When evaluating or reviewing projects, in-person discussions lead to serendipitous meetings with valuable new informants and the review of documents leads to other unknown but valuable documentation. Other challenges include the following:

- Available written documentation was quite limited. No final version of the ADD (if there was one after June 2012) was found. There were no Activity Monitoring Assessments available. Only one CIG progress report was located. The final CIG *Cook Islands Renewable Energy Closing Report* was not available. The 2017 Activity Completion Assessment combined coverage of this Activity with that of the closely related Enabling Environment Activity (A10786), and provided no information on apparent Activity PV installations on Rarotonga other than the airport system. Nonetheless, interviews, email exchanges and follow-up provided considerable additional information.
- Four Northern Group Island mayors and four Executive Officers were contacted, but only three of the eight contacted have responded. It has not been possible to interview the others or other beneficiaries from the islands.

[9] PIGGAREP was a United Nations Development Programme (UNDP) / Global Environment Facility (GEF) Pacific regional project implemented by the Secretariat of the Pacific Environment Programme (SPREP).
[10] Source: *Cook Islands Renewable Electricity Closing Report: Progress 1 August 2012 - 20 February 2014* (OPM, October 2014).
[11] *Evaluation of New Zealand's Aid Programmes in the Cook Islands, Niue, Samoa and Tokelau* (Adam Smith International, December 2015). https://www.mfat.govt.nz/assets/Aid-Prog-docs/Evaluations/2015/Dec-2015/Evaluation-of-New-Zealands-Aid-Programmes-in-the-Cook-Islands-Niue-Samoa-and-Tokelau-A-Synthesis-Report.pdf quoting an internal MFAT document *IRENA Cook islands Renewable Energy Notes* (undated) which was unavailable. These fuel and emissions goals have not been found in MFAT documents.

3 Case study findings and lessons learned

The key research questions for the case study are based on the Organisation of Economic Cooperation and Development's Development Assistance Committee (OECD DAC) criteria (shown in the table below). As such, the findings presented in this report are structured by the DAC criteria. Though the case study relates specifically to this Activity, the primary purpose of this case study is to inform the broader strategic evaluation. It is not intended to be a comprehensive evaluation of the Activity itself. Findings, lessons learned, and considerations for future efforts should be read in this context.

Objective	Description
Relevance and coherence	To examine the relevance, significance, and coherence of the Activity.
Effectiveness	To examine the extent to which the Activity achieved, or is expected to achieve, its objectives and results.
Efficiency	To review the effectiveness of MFAT's approach and ways of working i.e. internal roles and responsibilities and resource allocation, funding, contracting and delivery (management and governance) modalities to deliver expected results.
Sustainability	To assess the sustainability - physical, operational, economic, social, environmental and resilience of the Activity investments.
Future directions	To document lessons learned from the Activity that can inform strategy, policy and improved ways of working for the Activity and the Energy Programme as a whole.

3.1 Relevance and coherence

Relevant and consistent with Cook Island's policies, priorities and actions

The Activity was highly relevant and consistent with the policies, priorities and actions of the Cook Islands, which were listed in section 2.2. These include among others:

- The goal of 50 per cent of all islands with 100 per cent renewable-sourced electricity by 2015, and 100 per cent by 2020 (sustainable development plan, 2011 and renewable energy chart, 2012).
- Reiteration of the above goals in the NAMA (2013) and the CIG's Nationally Determined Contribution (NDC) (2016).
- Secure and reliable energy services, expansion of RE and a well-regulated energy sector have consistently been key objectives of successive national development plans (2011, 2016, 2021).
- There were quite specific CIG plans for 24-hour PV systems with customers connected through mini-grids with battery storage and diesel backup for each of the northern atolls (RE implementation plan, 2012).

In 2012, the CIG surveyed the energy needs of each Northern Group island. As shown in Table 1, this included electricity consumption in kilowatt hours (kWh), projected demand through 2020 and the tariffs (NZ¢//kWh) then prevailing at each island. Each PV system was to be a standardised solar / diesel hybrid with nearly all energy provided by PV. The design was to include demand-side (consumer) energy efficiency measures and appliance controls to reduce demand growth, although no details or enforcement mechanisms were specified. The Activity as described here, and as implemented, was more than just relevant and coherent with CIG policies; it was identical.

Some CIG energy sector goals and objectives differ within the current development strategy (2021), but remain consistent with the Activity:

- The current revised national target is 60 per cent renewable electricity by 2030, which might be adjusted pending the results of an energy sector review[12] in early 2021, plus actions to increase energy use efficiency.

[12] This is a *Status of Energy Sector Stocktake and Review* for which consultants have been engaged. Details are available at http://procurement.gov.ck/tender=3293.

- It is planned that new governance and pricing arrangements will be developed over the next two years to "ensure the sustainable provision of affordable renewable electricity across the Pa Enua".

Relevant and consistent with New Zealand, regional and global priorities

The Activity is also well aligned with New Zealand, regional and global priorities for energy. The Activity was compatible with, and aligned with, those of other development partners with RE initiatives in the Cook Islands particularly those of the EU, with whom there was an EU/NZ Energy Access Partnership for the Pacific. There was also a cooperative understanding with the ADB regarding RE assistance to the PICs including the Cook Islands.

The *New Zealand International Development Policy Statement* (March 2011) recognised the importance of investing in RE as a key development enabler; the *New* Zealand *Aid Programme Strategic Plan* (2012-2015) identified increased access to clean, efficient and affordable energy as a critical activity; and *New Zealand Aid Programme Sector Priorities* (2012-2015) identified RE as a key aid priority, particularly in the Pacific. Pacific leaders had earlier agreed on the need to reduce dependency on fossil fuels through developing indigenous RE sources, improving access to electricity, and developing whole-of-energy-sector strategic plans.[13] Current New Zealand development priorities include "a climate resilient and environmentally sustainable Cook Islands".[14] All of these were, and remain, well aligned with the objectives of the Activity.

The Activity design was consistent with global priorities, including those of Sustainable Development Goal (SDG) 7 which aims "to ensure access to affordable, reliable, sustainable and modern energy for all" with universal access to affordable electricity and increased clean RE. SDG7 goals include improved energy efficiency. The Activity supported all SDG7 goals except demand-side (consumer) energy efficiency[15] which was a specific CIG design objective in 2012 for new Pa Enua energy investments. The Activity was also consistent with the Global Partnership for Effective Development Cooperation (GPEDC) principles: country ownership; a focus on results; inclusive partnerships; and transparency and mutual accountability.

New Zealand's 'flagship' investment priorities for RE from 2015 to 2019 focussed on: a) improved access to reliable and renewable energy through new infrastructure and TA; b) strengthening sector planning and asset management to improve service quality and efficiency; and c) identifying support for greater private sector participation in the energy sector. These are relevant to the Cook Islands, consistent with its national policies and plans, and (except for private sector participation) had earlier been incorporated into the Activity.

MFAT's strategic goals for climate change focus on an effective global response to climate change with improved climate resilience in the Pacific, which is well-aligned to the Activity. The Pacific Reset, announced in early 2018, focuses on working with local partners, aligning with local priorities and local ownership. All Cook Islands PV was commissioned nearly three years before the Reset was announced but the Activity is consistent with it. Though New Zealand's Policy for International Cooperation for Effective Sustainable Development[16] was approved by Cabinet long after the Activity concluded, the Activity is consistent with the policy and its principles of effectiveness, inclusiveness, resilience and sustainability.

In brief, the Activity is highly relevant to the Northern islands, the Cook Islands overall, and New Zealand, regional and international assistance objectives and priorities. Activity outcomes were equitable and inclusive, addressing the needs of all electricity consumers in the communities for reliable, clean and affordable energy.

Factors enabling relevance and coherence

- The specific Northern Group PV systems had earlier been identified as high priority by the CIG.
- There was considerable consultation with the island beneficiaries by the CIG prior to implementation.
- There was a coordinated effort among development agencies (MFAT, EU, ADB) for systematically addressing CIG priorities for developing renewable electrical energy in the Pa Enua.

[13] These were endorsed by leaders at the 2011 Pacific Islands Forum.
[14] *Our Development Cooperation with Cook Islands* (MFAT undated; accessed 27 Feb 2021) https://www.mfat.govt.nz/en/countries-and-regions/pacific/cook-islands/our-development-cooperation-in-cook-islands/
[15] A 2015 review for MFAT noted that none of its Pacific energy activi ies "aimed to improve the efficient use of energy." This was *Renewable Energy Investments in the Pacific: A Process Evaluation* (MWH, December 2015).
[16] *See* https://www.mfat.govt.nz/assets/Aid-Prog-docs/Policy/Policy-Statement-New-Zealands-International-Cooperation-for-Effective-Sustainable-Development-ICESD.pdf.

- There was a coordinated approach within the CIG involving island governments, OPM, MFEM, the Cook Islands Investment Corporation and the Pa Enua
- Project ownership was high as the CIG was initially the lead in design and procurement through national systems, and remained high after MFAT took over implementation.
- The northern Pa Enua are especially vulnerable to adverse climate change impacts, especially sea-level rise. Robust low-emissions RE infrastructure is highly relevant for climate change mitigation and adaptation today and will be even more relevant in the decades to come.

Factors hindering relevance and coherence

- An unsuccessful CIG tendering process reportedly led to pressure from New Zealand for quicker CIG action, briefly straining the relationship.
- Changes in funding arrangements led to delays, and criticisms of contracting arrangements that reportedly effectively excluded local contractors.

3.2 Effectiveness

Overall, the Activity effectively achieved all expected short-term outcomes and some medium-term outcomes. The outputs (of the closely-related governance Activity) have not been achieved and progress remains slow, although with improvement in early 2021.

In the Cook Islands as a whole (2019), RE accounted for 25 per cent.[17] The table below presents indicative PV output based on limited available data and published MFEM data. There is very limited written material on annual energy production and the reliability of supply from the eight PV hybrid systems commissioned from November 2014 to May 2015 in the Northern Group. MFEM publishes quarterly electricity generation for each island from diesel fuel and PV (some of which is estimated), currently through mid-2020. In addition, the Activity provided Internet-linked dataloggers that provided a wide range of information on performance since commissioning. Six of the eight are still online with computer screen prints of sample outputs presented in Annex 2.

Table 2: Indicative PV Output (% of Total Electricity)

Island	Years	% by PV (2017-2019)	On-line since commissioning	Current operations (March 2021)
Penrhyn (2 PV systems)	2017- 2019	90.5	Both Omaka & Te Tautua 100%	Unknown
Rakahanga	2019	94.8	100%	Unknown
Manihiki (2 PV systems)	2017-2019	77.2	Tukao 100%; Tauhunu offline since Oct 2019	Unknown
Palmerston	2018, 2019	80.9	Nearly 100%	100% PV 24/7
Pukapuka	2017-2019	87.2	100%	100% PV 24/7
Nassau	Not available	Not available	Intermittent since 2016	Unknown
Cook Islands Total	2019	25.6		Not applicable
Rarotonga	2019	14.0		Not applicable

Calculated from data in MFEM electricity spreadsheet (Table 7.2) (accessed 1 March 2021) and available at http://www.mfem.gov.ck/statistics/social-statistics/miscellaneous-statistics 24/7 = 24 hours per day (Note: Table 2 will be revised / updated assuming sufficient input from northern islands on current operations)

The percentages of renewable electricity shown in the table above may be underestimated as some PV systems were presumably generating electricity, but some data may not have been logged to the computers. In the past years, two Northern islands have had about 90 to 95 per cent of electricity from solar PV, and the others (conservatively) between 77 per cent and 87 per cent. After about five years of operation, at least six of the eight PV systems appear to be operating reliably, producing the expected design output. A seventh may be producing as planned but data are not available. The eighth appears to be performing more poorly.

[17] Overall, RE has steadily increased from 4.2% of the total in 2014 to 16.0% in 2016 and 25.6% in 2019. This is consistent with International Renewable Energy Associa ion (IRENA) data at https://www.irena.org/IRENADocuments/IRENA_Stats_Tool.xlsb

However, whereas the PV systems are generally producing sufficient energy to meet the design specifications, generation has not been able to match growing demand. In Rakahanga[18] for example in 2019, "increased usage has resulted in capacity issues with the current system not being able to keep up with demand; as a result generators are running 4-6 hours daily utilising 1,000 litres of fuel per month." There are reports of similar issues in other islands. Battery (and other) components have failed in at least several other islands such as Pukapuka[19] and have been replaced (or require replacement) at high cost, with replacements from Germany requiring six months lead time. Inspections and analysis of the data available from the dataloggers should allow more accurate estimates of current performance and the condition of the batteries. TAU and OPM staff have recently begun to do this.

In 2017, MFAT assessed this Activity and A10786 (associated enabling environment assistance) jointly[20] because of the large degree of overlap and complementarity between the two. No separate Results Framework was available for this Activity alone, so achievements are assessed below in Table 3 based on the "Activity Results: Outcomes and Outputs" appendix of the combined assessment, as it does not differentiate among Renewable Energy (Northern Group), Renewable Energy for Rarotonga Airport West and the Enabling Environment. Some of the achievements, or lack thereof, in Table 3 thus extend beyond the Activity but overlap with it.

As Table 3 indicates the effectiveness in achieving targets has been mixed:

- All short-term targets (the PV systems and associated grids) were achieved satisfactorily and on time.
- Medium-term results are mixed: three achieved or surpassed targets (of which one was slightly delayed); two are unknown (lack of data, poor indicator); and one significant outcome (sustainable O&M) was not achieved.
- Recent data are unavailable for two long-term (2020) diesel-fuel reduction targets but by 2016, diesel fuel use for electricity had dropped by 96% compared to 2013.
- The two outputs were not achieved (O&M, sustainability). *Note that the outputs are associated with the enabling Activity for RE in the Northern Group, not this Activity*, but results are highly relevant to later coverage in section 3.4 on sustainability. As a 2016 evaluation[21] noted, "There is no clear central monitoring of the impact or effectiveness of the power systems, the island councils have little technical support if they encounter maintenance issues, and funds are not being set aside for capital replacement. This last point is crucial, as the new power systems have very low running costs but the capital replacement costs (in particular the batteries after 10 years of operation) are expensive." This remains the case in 2021.

Table 3: Achievements for Expected Outcomes and Outputs by 2020

Expected Outcomes		Targets	Achievements
Short-Term (2015)	• Increased RE electricity generation	• 100% of Northern Group population have access to RE • 0.83 MW of new RE mini grids in the Northern group • 0.9 MW generation Airport West array	• Achieved by May 2015 • Achieved (0.85 MW installed) • Achieved (0.96 MW installed)
Medium-Term (also 2015)	• Progress toward CIG RE targets	• 20% of national generation from RE sources • 6 Northern Group islands with fully operational RE generation	• 10.4% in 2015, 16.0% in 2017 Exceeded 20% in 2018 (25.4%) • Achieved by 2015
	• Improved CIG capacity to operate & manage RE infrastructure	• 100% of new RE facilities with sustainable O&M • No new RE facility exceeds 5% down time • Number of significant system failures per year (unquantified)	• Not achieved as of early 2021 • Down time data unavailable • 'Significant' failures undefined and data unavailable • Network delivery losses of 7% in 2016 & 2017

[18] The source is the summary report of *Pa Enua Consultation: Economic Development Conference (2019)* www.mfem.gov.ck/images/EDS_Pa-Enua-Consultations-Summary_Final.pdf

[19] Pukapuka has experienced battery cell failures since 2019 but returned to nearly 100% PV in February 2021. 5% of the 384 battery cells failed and were replaced (9) or remain in danger of failure (10) but this was sufficient to greatly increase the time that gensets (and diesel fuel) had to be used. Source: communications from island council (March 2021) and *Pukapuka Battery Replacement Report* (REDD, OPM, March 2021).

[20] *Activity Completion Assessment (ACA) for: Renewable Energy (Northern Group); Rarotonga Airport West and Enabling Environment* (MFAT, Final, 31 March 2017).

[21] *Cook Islands Northern Group Renewable Energy Evaluation* (ITP Renewables, 27 June 2016), unavailable online

		• Rarotonga system losses of 15% of generation	
Long-Term (2020)	• Improved energy security	• Net diesel fuel volume for electricity reduced 5% per annum • Diesel imports for electricity reduced to 1% of GDP	• National data unavailable. For Northern Group, annual diesel fuel use (litres & $) dropped by 96% from 2013-2016, saving 257,000 litres/year • Data unavailable but overall diesel imports grew significantly by value *
Expected Outputs		**Targets**	**Achievements**
Output 1	• Outer Islands O&M cost plan	• Coordination of all RE sector activities within CIG agencies	• Not achieved and hard to assess the extent of coordination
Output 2	• Outer islands stakeholder engagement mechanisms agreed	• Stakeholder engagement on the outer islands institutional arrangements including capacity and capability to deliver sustainable operations including final legislation	• Not achieved and draft utility legislation (2021) excludes the outer islands. However, 7 of 8 Northern islands have signed MoUs with TAU, focussing on data exchange

Progress toward CIG RE goals was calculated from MFEM data as for Table 2

TAU system losses are from *Pacific Power Utility Benchmarking Report 2018* (Pacific Power Association, 2019)

Diesel fuel decline for electricity in Northern Group from 2013 to 2016 from *RE initiatives for the Cook Islands* (OPM, 2017)

* Diesel fuel imports nationally (for all uses) increased by 47% by value from 2016-2019. Source: http //www mfem.gov ck/statistics/economic-statistics/overseas-trade-stats

There was no gender analysis undertaken within the Activity but beneficial outcomes for women and children were reported by MFAT in 2017:[22] For example, new street-lights make night-time activity safer; children are able to study at night using lights; cooking at night is easier; and communications are more reliable. It has not been possible to confirm these but gender impacts in the northern islands are likely to be similar to those of the southern island PV systems for which the ADB[23] reported some empowerment of women through income generation, improved quality of life, expanded access to modern communications, and employment in the local solar industry.

While understanding the impacts and flow-on effects of reduced diesel consumption on outer island supply chains would be beneficial, there was no up-to-date data on the actual decline in diesel fuel use in the Northern Group and no information on the impact of less diesel fuel use on outer island supply chains. There are no published statistics on changes in number or frequency of cargo/passenger vessels travelling to the northern islands, quantity of cargo carried, or changes since 2015.

Factors enabling effectiveness

- There was a generally cooperative working relationship between MFAT and the CIG. MFAT staff were approachable and said to be easy to work with.
- The CIG and MFAT had clear objectives for Northern Group RE development.
- A Joint Project Steering Committee chaired by MFAT was effective in fostering a strong partnership between New Zealand and the CIG and in resolving issues.
- The consultants, contractors, suppliers, and project managers performed satisfactorily.
- The PV arrays used well-proven technologies and were appropriate for the locations. MFAT's support for Renewable Energy Mini-grid Common Design Principles and Specifications contributed to effectiveness.

Factors hindering effectiveness

- There were no obvious factors seriously affecting short-term effectiveness.
- Better long-term fuel savings may have been achieved at less cost if the Activity had included an adequate demand-side energy efficiency component.
- Medium- to long-term effectiveness regarding expected outcomes has been hindered by the inability of the CIG to develop permanent funded mechanisms for effective outer islands electricity management and O&M.

[22] *ACA*, op. cit.
[23] *Pacific Energy Update 2020* (ADB 19 January 2021): https://www.adb.org/documents/pacific-energy-update-2020

3.3 Efficiency

Initially, the CIG was to directly manage the northern islands design and contracting. After difficulties in securing acceptable bids, the CIG requested MFAT to take over construction contracting, and this was agreed upon. Led by the Sustainable Economic Development Division (SED), MFAT used a project modality of engaging an engineering company as a project manager to manage the construction contractor. A third contractor carried out commissioning verification and quality assurance reporting. These arrangements were efficiently carried out. MFAT Post chaired the Joint Project Steering Committee, which also performed efficiently. The Activity management structure was effective in construction implementation, although MFAT staff turnover, and unclear budget management responsibility between Post and SED, contributed to some early over-expenditure.

After the slow start, MFAT was efficient, delivering the PV systems on time to remote islands[24] with irregular shipping and on budget. The short timeframes may have resulted in less involvement of local contractors than they had expected, though there was no further evidence to specifically suggest how local contractors could be used.

The CIG is currently (2021) reconsidering its highly ambitious goals for RE deployment,[25] which they feel may not be an efficient use of resources or financially viable. This could have implications for any future MFAT energy sector support to the Cook Islands. "Independent advice [to the CIG] indicates that 100% RE may not be economically efficient or financially viable as it requires substantial investment in battery storage and/ or a range of alternative renewable generation sources (including biodiesel) to achieve renewable energy penetration beyond 50 or 60%. These … lower rates will still allow for zero-diesel generation, albeit not 100 per cent of the time." There will be a review of the 100 per cent RE target, including least cost ways to achieve a revised target. In the interim, the target is now 60% by 2030. "the Government will implement an action plan to introduce new governance and pricing arrangements that will ensure the sustainable provision of affordable renewable electricity across the Pa Enua."

Factors enabling efficiency

- The Joint Project Steering Committee efficiently furthered the group's decision-making.
- The revised contracting modality, with MFAT direct management, was appropriate and effective in delivering the expected short-term results.
- Pre-Activity work by the CIG (supported by PIGGAREP), such as northern island energy surveys, preliminary design and consultations with beneficiaries, provided essential information that contributed to efficiency.

Factors hindering efficiency

- Inability of the CIG to manage initial tendering for the PV system designs and installation.
- Inability of the CIG to develop acceptable governance and management mechanisms for the Pa Enua electricity systems.

3.4 Sustainability

Efforts to build sustainability. MFAT was well aware of the risk of inadequately managed rural RE facilities that might not be sustainable. Early steps were taken to mitigate these risks through a standardised rugged cyclone resistant design,[26] and the enabling environment assistance to the CIG for the development of clear tariff mechanisms, management systems and effective O&M with appropriate power utility legislation, initially expected to be finalised prior to construction of the RE systems. Construction clearly began when the governance issues had not been resolved. The 2021 utility regulation legislation, in its current draft form, may allow the electricity regulator to determine actual supply costs for each island, and MOUs between most northern island councils and TAU may help in collection of the necessary information. However, there are no plans to enable the regulator to determine tariffs in the Pa

[24] Most are about 1200-1300 km from Rarotonga, except for Palmerston which is 500 km distant.
[25] *Cook Islands Economic Development Strategy 2030* (22 January 2021) http:mfem.gov.ck/images/ECON/1-EDS_Final_for-publication_Op imized.pdf
[26] MFAT developed design principles and specifications for the Cook Islands based on experience with a Tokelau 100% solar initiative.

Enua and they are likely to remain far below cost as there is no incentive for the island councils to increase tariffs.

Costs of supply are far higher than charge to consumers. Prior to the commissioning of the PV systems, the charge for electricity to consumers varied by island but was on average about NZ 65¢/kWh. As expressed in the ADD, it was expected that charges would not decrease after PV implementation, but rather remain at the same level to provide additional funding for O&M. The current charges (with the exception of Palmerston, as shown in Table 1) are reportedly NZ 30¢/kWh for domestic users, less than half of the pre-PV level (which were already well below full costs). Consumers are contributing little if anything to O&M costs and thus to expected sustainability.

Lack of a capital replacement budget undermines sustainability. Capital cost replacement (primarily for new battery systems and related components) is on the order of[27] NZ$0.61/kWh. Long term sustainability requires both regular capital replacement and improved operations and maintenance. Where affordability of electricity is an issue and the cost is heavily subsidised, as in the Northern Group, a sustainable electricity supply requires some other financial mechanism, such as perhaps a ring-fenced national budget allocation, to replace old components. No such budget is in place.

CIG difficulties in developing outer island electricity governance mechanisms. MFAT's completion reporting, the 2017 ACA, observed that the CIG has struggled to address "governance arrangements, asset ownership, operation and maintenance plans and financial tariff settings to help ensure the physical and financial sustainability of assets." In early 2021, the CIG itself noted that "while the Government has made substantial progress towards its 100 per cent renewable energy target, … there are concerns about the sustainability of the investments made in the Pa Enua."[28] Governance issues remain unresolved.

Designing for sustainability. The hybrid PV/diesel generating infrastructure was well designed and implemented for physical sustainability. The systems were robustly built for climate change resilience, particularly for high winds and flooding. With appropriate O&M, they should continue to operate for some years,[29] and TAU appears to have sufficient capability for satisfactory maintenance.

At the time of commissioning, energy use was expected to remain reasonably efficient, but more could have been done to safeguard this. During 2011/2012 consultations, the CIG promoted RE combined with improved energy efficiency in the islands, and this was reportedly supported by the people until free cargo freight was provided during the 50th anniversary of self-government in 2015. This resulted in the purchase in Rarotonga of many energy-intensive electrical goods and appliances which were sent to most of the islands, resulting in rapid unexpected growth in demand, beyond the PV array's capacity. Without effective management and O&M, this could, and did,[30] lead to further deterioration of the system, particularly the batteries, and/or far more use of back-up diesel gensets, and thus diesel fuel, than expected.

Considering the known risks regarding sustainability, and no control of imported appliances, it would have been prudent to specifically include load limiting devices at the consumer premises and better battery protection to protect against over-discharging. In addition, from early 2012 to early 2015 an ADB-funded energy efficiency programme in Rarotonga provided subsidised energy-efficient lighting, refrigeration and freezers, and this could have been extended to the Pa Enua.[31] This would not have solved the problem of massive imports of new appliances, but may have largely restricted them to energy-efficient models (at little or no higher cost to islanders) reducing the growth in electricity demand.

Limited Technical Skills. Some of those interviewed noted the lack of sufficient skilled locals in general, and in the Pa Enua in particular, for adequate O&M and this can undermine efforts to sustain operations of remote electricity systems. The national population has steadily declined since the early 1970s and is not

[27] The data for Northern Group generation from RE are incomplete and for some islands estimates. For 2017-2020, with some data missing, 700,00 kWh/year were generated on average. Assuming the actual generation was 900,000 kWh/year, well-maintained & operated batteries last 10 years, and the current cost of their replacement is NZ$5.5m, as estimated by the CIG, replacement cost is NZ$0.61/kWh. ITP Renewables (op.cit 2016) noted that this was MFAT's es imate back in 2014. However globally battery costs are declining so longer-term costs (for batteries) are likely to decrease. The actual current capital replacement and opera ing costs will require analysis by the CIG.

[28] From the new CIG national development strategy (2021)

[29] One caveat is the data-logging and reporting system at each island. The dataloggers and computers were reportedly 'ruggedised' and most are reportedly still operating well. A high-quality laptop or desktop lifetime of 4-5 years is reasonable but a high-temperature, sandy environment can reduce this considerably and viruses can be a growing issue over time if software is not updated. The systems may need replacement soon.

[30] A report on *System Inspection & Maintenance Report Northern Cooks PV System* (Vector PowerSmart, September 2019) noted battery degrada ion or failure in Rakahanga, Penhryn – Omoka, Manihiki and Pukapuka due to excessive demand, poor maintenance, and other factors.

[31] This was the ADB/GEF project *Promoting Energy Efficiency in the* Pacific (PEEP phase 2) that provided analysis, advice, and free or subsidised energy efficient lighting and air conditioning to government facilities and private citizens in the Cook Islands, PNG, Samoa and Tonga. PEEP2 managers would have been quite willing to assist with improved EE in the Pa Enau. There were PEEP2 energy-efficient street lighting initiatives in Aitutaki and Mangaia but no EE assistance in the northern islands.

expected to grow in the future. The International Monetary Fund[32] notes, "With a small population, a rapidly growing economy, and the migration of many younger inhabitants to New Zealand, the Cook Islands faces shortages of both skilled labor and unskilled labor."

Stakeholder consultations. The stakeholders listed in the ADD were the CIG, OPM, which had recently established a Renewable Energy Development Division (REDD), TAU, and MFEM. The ADD did not specify the beneficiaries but these were implicitly the people of the Northern Group, and they had been extensively consulted by REDD staff prior to the start of the Activity.[33] There is no cause to speculate that lack of consultation may have affected sustainability.

Current status. TAU and REDD have recently begun inspections and repairs of the Pa Enua PV systems, and this is currently planned from March to December 2021,[34] so short term prospects for sustainability have improved but a long-term solution is needed. Demand in some islands exceeds PV capacity so some systems are restricted to fewer daily hours, or back-up diesels are used frequently, or both. A system with limited maintenance but protection of the batteries should be operating well today (after five years) but can be expected to deteriorate unless the maintenance visits underway in 2021 become regular and permanent. Some disagreement has been expressed on the seriousness of the problem. Several knowledgeable people say the situation is a disaster, and expect widespread deterioration in the near future, with massive future battery replacement and repair costs.[35] Others say it is not too late to implement measures for sustainability, but changes remain politically intractable.

Factors enabling sustainability

- The PV systems were well designed and implemented for adverse climate change.
- Operational data (output, battery charge status, periods off-line) allowed PV performance to be monitored remotely via the Internet, potentially with follow-up assistance when required by technical staff in Rarotonga or overseas.
- Initially energy efficiency mechanisms were incorporated (or at least planned) to restrain growth in demand, extending the likely period of near 100% RE.
- TA (external to the Activity) was planned, and provided to the CIG, from the conceptual stage to address sustainability concerns including responsibility for management and O&M, tariff setting, and sufficient funding for O&M.
- There were extensive consultations in the island communities by CIG prior to project design and implementation.
- Common design principles and specifications were developed for the CIG by MFAT based on earlier positive experiences in Tokelau.
- Maintenance and repair visits to the Northern Group began in early 2021 and are scheduled to continue throughout 2021.

Factors hindering sustainability

- Technical advice to island councils was limited to a 12-month period, and visits to the site entailed additional charges.
- Internet-based monitoring relies on data-logging, adequate Internet connections and robust computer systems at each island, which will fail over time without component replacement.
- There may have been a lack of clarity and enforcement of policies to restrict high-energy use appliances in the Northern islands.
- Apparent lack of load-limiting at the consumer's meter, allowing large demands that could damage battery systems over time.
- The lack of standard components (especially batteries) for the Northern (MFAT-funded) and similar Southern (EU/ADB-funded) projects increased the need and cost of replacement parts and repairs.
- The lack of an agreed mechanism for good management and O&M for remote island energy systems has been a serious deterrent to sustainability.
- Tariffs far below costs do not contribute to the O&M funds required for sustainability and encourage wasteful electricity use.
- As elsewhere in the Pacific, there is considerable out-migration of technically skilled people exacerbating O&M challenges.

33[32] *Cook Islands: Technical Assistance Report – Macroeconomic, Financial and Structural Policies* (IMF, August 2020); https://mfem.gov.ck/economic-planning/economics-team#imf-technical-assistance-report

[33] Consulta ions in the north were supported by PIGGAREP. In Palmerston, the surveys were carried out in only a day.

[34] *Cook Islands Renewable Energy Sector Project, Operations and Maintenance contract* for March – December 2021 (OPM, undated)

[35] The cost of the battery systems alone in 2014 exceeded NZD 3 million, even without transport to Rarotonga and the islands.

4 Overall lessons learned

4.1 Overall lessons learned for the Activity

There are several lessons that could be derived from the Activity.

Overall lessons learned for the Activity

- The initial intention was to delay infrastructure investment until governance issues (tariff setting, management, O&M) had been resolved, involving TAU and new utilities legislation. This was probably unlikely and alternative mechanisms with less central control (by CIG, TAU) may have been more acceptable to island communities and should be considered in the event of similar future support to the Cook Islands.
- The PV system design assumed relatively low load growth and could not cater for the unexpected import from 2015 of high-energy use appliances. Although the CIG intention was to limit appliances to high-efficiency devices, there was no effective mechanism to do so, and this will likely result in battery system deterioration and the need for replacement considerably sooner than anticipated. It is too late to restrict appliances (refrigerators and freezers) to high-efficiency models but efficiency and load-liming should be considered for similar future projects.
- The EU/NZ Energy Access Partnership, and a NZ/ADB agreement, apparently did not specify common designs within the country, resulting in some different components for the NZ-funded Northern Islands and EU/ADB-funded Southern Group. O&M would have been easier with common components. Future partnerships among development agencies should strive, to the extent practical, to consider differing tendering requirements for common components within the country.

4.2 Overall lessons learned for the Energy Programme

The lessons learned below relate to lessons drawn from the Cook Islands case study to inform the broader strategic evaluation.

Overall lessons learned for the Energy Programme

- Robust RE infrastructure is highly relevant for climate change mitigation and adaptation today and is expected to be even more relevant in the decades to come. It is suggested that all MFAT-supported energy systems be explicitly designed and implemented for robust operations and climate resilience.
- The resources for effective O&M are unlikely to be available in small, isolated islands and can be better managed at less cost by a single utility or well-resourced service covering all the remote islands. Assisting national and island authorities to develop effective mechanisms for funding remote island O&M for electricity systems is likely to be a long-term effort, with no easy solutions. Mechanisms for operational support and training should be built into future outer island energy projects.
- National Least Cost Renewable Energy Investment Plans or frameworks are important. Where there is likely to be a long-term national effort for RE and increased energy security, and planning is weak, least cost RE plans should be supported, include clear non-technical financial guidance, and explicitly include cost-effective demand-side energy efficiency costs and opportunities.
- In several PICs, local consulting or engineering firms have expressed concern that they were unable to bid for MFAT contracts or parts of contracts. It is suggested that local companies be offered opportunities for engagement in projects where they have the necessary skills and experience, and sufficient time be provided for them to prepare bids.
- Future energy initiatives with a carbon emissions reduction goal should include an emissions factor (CO_2 equivalent / litre of fuel) in the Results Framework. For future electricity projects with a strong focus on GHG reductions, supporting improved diesel systems should be considered if the cost per unit of emission reductions is appreciably lower than that of renewable energy investments, supply side EE, demand side EE and transport energy.
- Even where Activity beneficiaries are implicitly understood, project designs should clearly state the intended beneficiaries, and include mechanisms for monitoring and reporting social impacts, including gender impacts.

Annex 1: Documentation reviewed and stakeholders consulted

Documentation reviewed

Documentation reviewed for the case study consisted of:

MFAT project-specific documents	• Design, financing, and completion reporting • 2014-2015 commissioning and quality assurance reports for Northern islands • 2015 enabling activity evaluation • Post commissioning inspections and assessments (ITP renewables, 2017; CAT Projects 2017; Vector PowerSmart, 2019) • Various NZ government aid policy statements
Other MFAT or MFAT-supported documentation	• 2015 process evaluation report by MWH consultants of MFAT RE investments in the Pacific • 2017 IFC guide to investing in renewable energy in the Pacific • ADB's Pacific Energy Sector Profiles for 2013, 2016 & 2020 • EU-New Zealand Energy Access Partnership for the Pacific reports • 2018 Cooks Core sector support evaluation report
Global policy documents	• A wide range was consulted including SDGs, OECD DAC guidelines
Cook Islands Government policy documents	• National plans, strategies or policies for national development (2011, 2016, 2021), energy (2011, 2012), infrastructure (2015), climate change/GHG emissions (2013, 2016), disaster management (2013, 2018) and utilities regulation (draft 2021), and 2019 Pa Enua consultations
Miscellaneous material	• The Pacific Power Association's annual power utility benchmarking reports • A draft of the Pacific Region Infrastructure Facility's 2020 Pacific infrastructure performance indicators for energy • 2013 Pacific Energy Summit reporting • Other: IRENA data, SPC population data, MOU between TAU and island councils

Stakeholders consulted and contacted

Primary Stakeholders	Names of stakeholders
Energy Programme team	• Catherine Maclean, SPO, Cook Islands • Martin Garrood, Lead Adviser, Energy, formerly Activity Manager for A11954, Rarotonga
Posts, Activity Managers and Programme teams for case study countries	• Okensene Moananu, First Secretary (Development), Rarotonga • Andreas Demmke, NZHC, Rarotonga • Joseph Mayhew, Deputy head of mission, Vietnam; formerly Activity Manager for A11954, Rarotonga

Secondary Stakeholders	Names of stakeholders
Partner governments and other counterparts	• s9(2)(a) Ministry of Finance & Economic Management (MFEM) • s9(2)(a) MFEM • s9(2)(a) Office of the Prime Minister (OPM) • s9(2)(a) OPM • s9(2)(a) OPM
Direct implementing partners (e.g. technical advisers or contractors)	• s9(2)(a) ITP Renewables • s9(2)(a) formally ITP Renewables • s9(2)(a) BECA International • s9(2)(a) Ekastica/CAT consultants
Other	• s9(2)(a) TAU (Rarotonga power utility) • s9(2)(a) TAU (outer island O&M)
Beneficiaries	• s9(2)(a) Pukapuka • s9(2)(a) Palmerston • s9(2)(a) Manihiki

The following stakeholders were contacted but were not interviewed. Questionnaires were emailed to the northern islands listed below:

Primary Stakeholders	Names of stakeholders
Partner governments	• s9(2)(a) (OPM)
Island: • Penrhyn • Pukapuka • Rakahanga • Manihiki • Palmerston	**Executive Officer**: • s9(2)(a) • • • • **Mayor**:

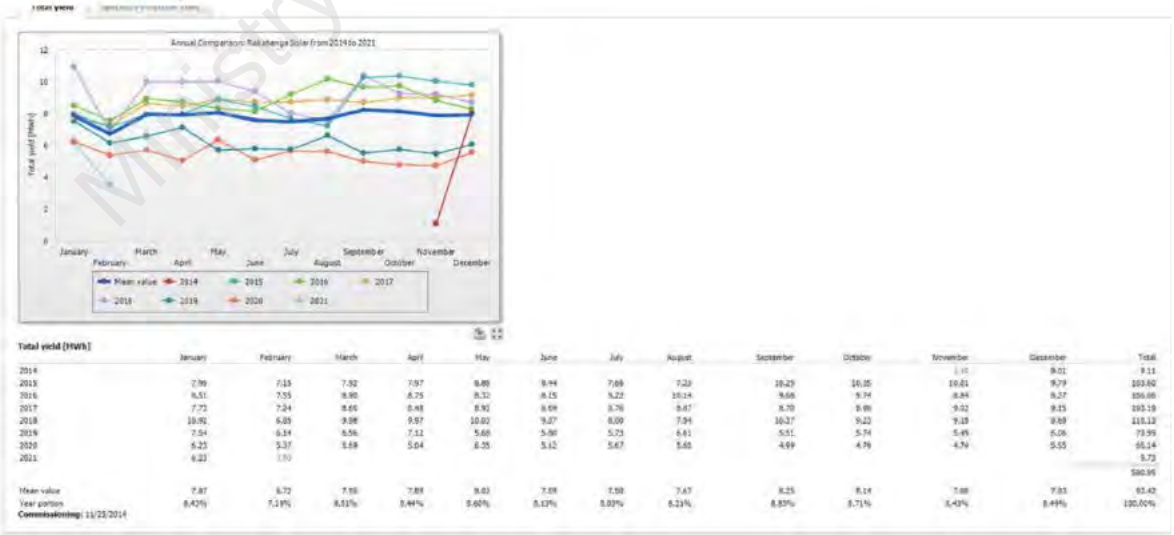
Annex 2: Solar energy output for the northern islands (2014 / 2015 – early 2021)

The Northern Group's data-logging system in principle provides annual and monthly power system yield from solar PV and diesel for every month since the systems were commissioned. However, two of the eight systems are off-line, with the other six reporting. Information was provided by s9(2)(a) of Ekistica, Australia and can be found at https://www.sunnyportal.com/Templates/Start.aspx?ReturnUrl=%2fPlants.

System	Commissioned	Data Gaps	Status (as of 19 February 2021)
Manihiki – Tauhunu	8 May 2015	Jan-April 2017; Oct 2019 to present	OFFLINE since October 2019
Manihiki – Tukao	22 April 2015	None	Online
Rakahanga – Tukao	25 Nov 2014	None	Online
Nausau	21 Feb 2015	Much of 2016, Apr-Aug 2017, Jan-Apr 2018, Jan – May 2019	OFFLINE since Oct. 2019, with intermittent connection from 2016
Pukapuka	20 Dec 2014	None	Online
Palmerston	3 May 2015	Aug 2020	Online
Penrhyn - Omaka	22 May 2015	None	Online
Penrhyn – Te Tautua	23 May 2015	None	Online

Manihiki – Tauhunu

Manihiki – Tukao



Rakahanga

Annual Comparison | Rakahanga Solar

Total yield | Specific PV System Yield

Total yield [MWh]

	January	February	March	April	May	June	July	August	September	October	November	December	Total
2014											1.35	8.01	9.11
2015	7.96	7.15	7.92	7.97	8.88	8.44	7.66	7.23	10.25	10.35	10.01	9.79	103.60
2016	8.51	7.55	8.90	8.75	8.32	8.15	9.22	10.14	9.68	9.74	8.84	8.27	106.06
2017	7.73	7.24	8.65	8.48	8.93	8.69	8.76	8.87	8.70	8.98	9.02	9.15	103.19
2018	10.92	6.85	9.98	9.97	10.03	9.37	8.00	7.54	10.37	9.23	9.18	8.68	110.13
2019	7.54	6.14	6.56	7.12	5.68	5.80	5.73	6.61	5.51	5.74	5.49	6.06	73.99
2020	6.23	5.37	5.69	5.04	6.35	5.12	5.67	5.60	4.99	4.79	4.74	5.55	65.14
2021	6.23	3.50											9.73
													580.95
Mean value	7.87	6.72	7.95	7.89	8.03	7.59	7.50	7.67	8.25	8.14	7.88	7.93	93.42
Year portion	8.43%	7.19%	8.51%	8.44%	8.60%	8.13%	8.03%	8.21%	8.83%	8.71%	8.43%	8.49%	100.00%

Commissioning: 11/25/2014

Nassau

Annual Comparison | Nassau Solar

Total yield | Specific PV System Yield

Total yield [kWh]

	January	February	March	April	May	June	July	August	September	October	November	December	Total
2015		1105.56	3804.92	2519.63	2742.71	2572.35	2374.51	2776.89	2869.88	3360.73	3268.79	1001.55	28397.52
2016				1883.04			1757.24			987.88	3307.06	3468.06	11403.27
2017	3478.19	4158.70	326.01						1273.72	3773.87	2108.28		15118.76
2018					2404.54	4473.06	3969.68	3997.27	4725.24	4974.83	4608.64	642.05	29795.31
2019						1062.33		3163.56	226.71	1857.78			6310.37
													91025.22
Mean value	3478.19	4158.70	2065.47	2201.33	2573.62	2702.58	2700.48	3312.57	2273.89	2991.02	3323.19	1703.88	33484.91
Year portion	10.39%	12.42%	6.17%	6.57%	7.69%	8.07%	8.06%	9.89%	6.79%	8.93%	9.92%	5.09%	100.00%

Commissioning: 2/21/2015

Pukapuka

Annual Comparison | Pukapuka Solar

Total yield | Specific PV System Yield

Total yield [MWh]

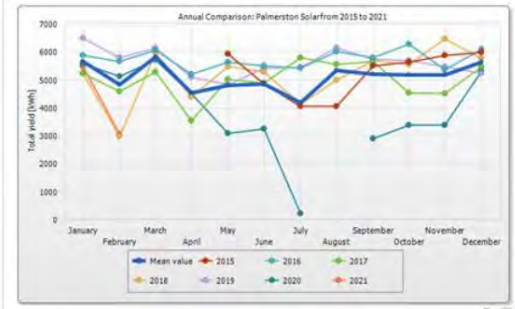
	January	February	March	April	May	June	July	August	September	October	November	December	Total
2014												3.65	3.65
2015	10.59	8.92	10.54	10.52	11.06	10.78	8.77	10.18	10.65	12.06	11.50	11.89	127.48
2016	11.15	11.52	12.40	12.22	12.71	11.96	11.37	10.99	10.63	11.02	12.68	13.48	142.12
2017	13.74	12.29	13.20	13.48	14.48	13.48	14.40	15.11	14.94	13.35	13.80	14.41	166.68
2018	14.20	12.21	14.57	13.79	16.47	16.37	13.62	13.06	15.19	14.21	15.23	7.60	166.51
2019				8.24	17.22	15.77	15.94	17.65	15.98	16.11	16.37	12.38	135.66
2020	11.51	11.46	13.02	12.17	13.38	10.96	10.59	11.21	10.46	9.87	12.40	11.14	138.16
2021	12.65	7.45											20.10
													900.35
Mean value	12.31	11.28	12.74	11.74	14.22	13.22	12.45	13.03	12.97	12.77	13.66	11.82	152.21
Year portion	8.09%	7.41%	8.37%	7.71%	9.34%	8.68%	8.18%	8.56%	8.52%	8.39%	8.98%	7.76%	100.00%

Commissioning: 12/20/2014

Palmerston

Annual Comparison | Palmerston Solar

Total yield | Specific PV System Yield



Total yield [kWh]

	January	February	March	April	May	June	July	August	September	October	November	December	Total
2015					5940.30	4853.67	4052.19	4048.32	5502.89	5632.88	5864.86	5992.81	41887.92
2016	5882.14	5653.74	6056.71	5198.30	5636.55	5492.51	5426.42	6003.52	5801.16	6264.16	5373.58	6084.80	68873.58
2017	5239.48	4578.02	5283.34	3528.78	5007.52	4883.98	5800.97	5540.79	5657.29	4537.34	4516.85	5474.56	60048.92
2018	5239.28	2986.94	5942.68	4395.52	5473.07	5271.01	4118.44	4992.51	5687.37	5548.72	6475.63	5772.13	61903.32
2019	6497.80	5797.54	6151.25	5086.91	4819.56	5418.16	5438.21	6139.86	5737.94	5697.98	5476.65	5238.41	67500.26
2020	5573.01	5123.47	5712.78	4504.72	3085.26	3245.38	215.07		2899.15	3383.43	3379.73	5297.45	42419.46
2021	5460.00	3047.31											8507.31
													351140.76
Mean value	5648.62	4827.94	5829.35	4542.85	4804.39	4860.78	4175.22	5345.00	5214.30	5177.42	5181.22	5643.36	61250.45
Year portion	9.22%	7.88%	9.52%	7.42%	7.84%	7.94%	6.82%	8.73%	8.51%	8.45%	8.46%	9.21%	100.00%

Commissioning: 5/3/2015

Penrhyn – Omaka

Annual Comparison | Penrhyn Omoka

Total yield | Specific PV System Yield

Total yield [MWh]

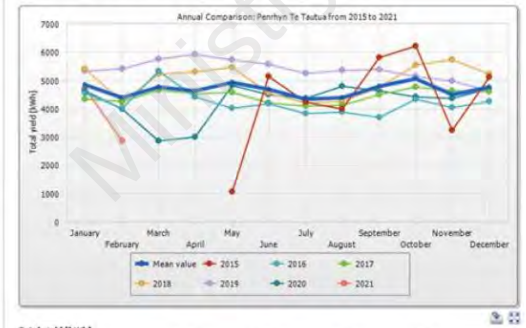
	January	February	March	April	May	June	July	August	September	October	November	December	Total
2015					5.28	13.88	11.45	10.85	16.23	16.39	13.42	14.50	102.01
2016	12.08	11.06	14.57	13.39	13.55	12.79	12.38	15.44	14.99	14.45	14.28	14.79	163.79
2017	13.71	13.21	14.54	13.60	15.13	14.29	15.21	15.39	14.68	14.75	15.08	14.71	174.30
2018	15.97	12.76	15.87	16.08	17.06	15.53	14.78	14.78	15.44	16.50	16.80	16.63	188.22
2019	16.02	14.95	16.17	16.34	15.96	14.76	15.40	16.21	15.43	16.05	15.66	15.79	188.75
2020	15.73	14.22	16.31	15.97	16.05	14.83	16.12	16.74	17.26	17.70	17.55	17.45	195.93
2021	17.88	9.55											27.43
													1040.43
Mean value	15.23	13.24	15.49	15.08	15.55	14.35	14.22	14.90	15.67	15.97	15.47	15.65	180.82
Year portion	8.42%	7.32%	8.57%	8.34%	8.60%	7.93%	7.87%	8.24%	8.67%	8.83%	8.55%	8.65%	100.00%

Commissioning: 5/22/2015

Penrhyn – Te Tautua

Annual Comparison | Penrhyn Te Tautua

Total yield | Specific PV System Yield



Total yield [kWh]

	January	February	March	April	May	June	July	August	September	October	November	December	Total
2015					1066.97	5160.84	4233.95	3984.02	5824.49	6227.97	3254.27	5126.28	34878.79
2016	4556.82	4012.94	5332.38	4435.43	4018.75	4175.15	3847.35	3880.67	3710.14	4336.60	4063.16	4263.62	50632.99
2017	4342.41	4252.21	4667.33	4532.88	4589.03	4200.87	4113.47	4130.79	4517.58	4776.87	4639.30	4621.58	53384.32
2018	5410.71	4237.53	5224.44	5322.20	5480.49	4947.58	4210.43	4275.11	4785.55	5554.19	5747.31	5220.15	60035.88
2019	5342.66	5429.43	5764.17	5927.55	5732.45	5565.54	5249.49	5354.24	5393.57	5151.84	4983.03	4631.85	64525.83
2020	4644.48	4006.80	2857.95	3004.01	4824.20	4501.15	4379.15	4813.77	4641.23	4431.24	4379.16	4727.34	51210.47
2021	4731.76	2876.09											7607.85
													322276.11
Mean value	4841.47	4387.78	4769.25	4644.42	4928.98	4691.85	4338.97	4406.43	4812.09	5079.78	4511.07	4765.14	56177.25
Year portion	8.62%	7.81%	8.49%	8.27%	8.77%	8.35%	7.72%	7.84%	8.57%	9.04%	8.03%	8.48%	100.00%

Commissioning: 5/23/2015

Case Study – Samoa
Strategic Evaluation of MFAT's Energy Programme

Samoa Renewable Energy Partnership, Phase 1
(Ref: ACT-0A11720)

Photo credit: "Samoan PV Installations" Source: Samoa Electric Power Corporation

Submitted by
Tetra Tech International Development Pty Ltd
ABN 63 007 889 081

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List of abbreviations and acronyms

ADB	Asian Development Bank
ADD	Activity Design Document
CO_2	Carbon dioxide
DAC	Development Assistance Committee (of OECD)
DFAT	Australian Department of Foreign Affairs and Trade
EPC	Electric Power Corporation
EU	European Union
GCF	Gross Calorific Value
GHG	Greenhouse Gas
GoS	Government of Samoa
GPEDC	Global Partnership for Effective Development Cooperation
IMF	International Monetary Fund
IPP	Independent Power Producer
JICA	Japan International Cooperation Agency
kt	kilo-tonnes
kWh	kilowatt-hour
LCIP	Least-Cost Renewable Energy Investment Plan
MFAT	New Zealand Ministry of Foreign Affairs and Trade
ML	Millions of litres
MoF	Samoan Ministry of Finance
MOU	Memorandum of Understanding
MW	Megawatt
MWh	Megawatt-hours
NCV	Net Calorific Value
NDC	Nationally Determined Contribution (for GHG emission reductions)
NZ	New Zealand
OECD	Organisation of Economic Cooperation and Development
O&M	Operations and Maintenance
PIC	Pacific Island Country
PMU	Project Management Unit (EPC)
PSEP	Power Sector Expansion Project (ADB-led)
PV	Photovoltaic
RED&PSRP	Renewable Energy Development and Power Sector Rehabilitation Project
SDG	Sustainable Development Goal
SEP	Samoa Renewable Energy Partnership
SHP	Small Hydropower Plant
TA	Technical Assistance
USD	United States Dollar

1 Objective, key findings and considerations for future direction

The New Zealand Ministry of Foreign Affairs and Trade (MFAT) commissioned Tetra Tech International Development to undertake a Strategic Evaluation of the Energy Programme (the Programme). The strategic evaluation aims to serve MFAT's dual key purpose: to account for New Zealand's investment through the Programme, and to improve what future investment can achieve. The scope of the strategic evaluation involves assessing Programme performance as a whole from 2012 to 2019 and undertaking case studies for six activities (five in the Pacific and one in Indonesia) to generate a solid evidence base about what works and lessons learned.

The objective of the six case studies is to garner further detail to support strategic level findings, but also provide evidence to support and meet independent evaluation requirements for the activities themselves. This section presents the key findings and considerations for future efforts from the case study undertaken of the Samoa Renewable Energy Partnership, Phase 1 (ACT-0A11720), referred to hereafter as the 'Activity'. The findings within this report are based on analysis of evidence gathered from document reviews and consultations with internal and external stakeholders. These findings contribute to the broader strategic evaluation and are intended to inform future programming decisions.

Phase 1 of the Activity consisted primarily of renewable energy infrastructure development and some Technical Assistance (TA), including: the development of a least-cost planning framework for the Electric Power Corporation (EPC); electricity tariff advice; and support for EPC asset management. Phase 2 (from 2017) included: TA to EPC; continuation of tariff and asset management advice; and capacity building (e.g. linesmen training). While only Phase 1 is within scope for this case study, the case study makes references to Phase 2 activities that may have affected the effectiveness and sustainability of Phase 1 activities.

Key findings and lessons learned

The Activity was highly relevant and consistent with Samoa's needs, policies and priorities. The solar photovoltaic (PV) and small hydropower plant (SHP) investments were identified as high priority by the Government of Samoa (GoS) and were strongly supported by the GoS. The Activity was compatible with, and aligned, with those of other development partners, contributing to what was effectively a consistent whole-of-sector approach. A range of development partners, the GoS and EPC cooperated closely for over a decade on aligned and comprehensive support for Samoa's power development.

The Activity was efficient, and in particular solar PV projects were of high quality and completed quickly under considerable time pressure by 2014 as planned. SHP rehabilitation and construction was completed within project timeframes between 2017 and 2019. While two projects were dropped due to environmental and land access issues, they were replaced by new ones as well as another SHP. Overall, MFAT was flexible and responsive, and provided supportive technical assistance to EPC in a timelier manner than project partners may have delivered. In general, all parties (i.e. consultants, contractors, suppliers and project managers) performed well.

The delivery modalities were appropriate and effective. The joint project arrangement for PV (with MFAT contracting and EPC supervising construction) and partnership arrangement for SHP (led by the Asian Development Bank with MFAT and the European Union) were appropriate considering time constraints, EPC capabilities, and ADB's long-term role in Samoa's power sector. PV and SHP were not developed in isolation but within a wider effort to improve power sector management, planning, maintenance, and grid stability. The cooperative working relationships between MFAT, the GoS, EPC and ADB contributed to the overall effectiveness of the Activity.

Most targets were significantly exceeded by 2020. The solar PV systems met between 85 to 102 per cent of quantified targets. The SHPs, considerably larger overall in capacity and energy, achieved between 140 to 150 per cent of the four key targets. MFAT's short-term fuel savings goal (PV and hydro) was exceeded by 25 per cent.

Nearly all anticipated long-term outcomes were realised by 2020. Planned outcomes for reduced dependence on petroleum, reduced consumer cost of electricity, improved energy efficiency, increased clean energy access, and increased EPC management capacity were all comfortably met through the Activity and related efforts. Drivers that led to positive outcomes include the selection of high-priority power systems which were all grid-connected, strong support from the GoS, the establishment of a dedicated Project Management Unit (PMU) at the EPC, investments and a coordinated power development effort among the development partners.

A long-term Activity aspiration for increased least-cost renewable energy is unlikely to be achieved. A 2015 MFAT-supported least-cost investment plan (LCIP) concluded that a least-cost approach would increase diesel generation from 2020 through 2027. The LCIP was not adopted by EPC, as the national goal of 100 pe cent renewable energy took precedence.

Renewable energy infrastructure was designed and implemented for sustainability and resilience. The PV arrays and SHPs were robustly planned, designed and built for climate change resilience, particularly for cyclone winds and flooding. With appropriate operations and maintenance, they should continue to operate for many years. All systems are grid-connected and maintained by the national power utility, EPC, which eases operations and maintenance (O&M).

Long-term sustainability is uncertain. EPC has the capacity for effective maintenance and was assessed by ADB to be financially sound in 2019. However, the tariff determination methodology does not include the cost or replacement of grant-funded capital assets, and these are a very significant percentage of EPC assets. If the tariff methodology remains unchanged and grants for energy infrastructure decline significantly, EPC income may be insufficient for adequate expansion of generation and its maintenance.

Considerations for future energy sector assistance

For Samoa:

- MFAT could, if requested, continue to assist the Samoan Ministry of Finance (MoF), EPC and the Regulator on tariff setting mechanisms that better reflect the full costs, including replacement of grant-funded assets.
- MFAT could, if requested, continue to enhance sustainability and local capacity building in Samoa, including working with national authorities to develop and support mechanisms that provide long-term funding for O&M and relevant capability/capacity building and/or training.

For Pacific Islands Countries (PICs) generally (including Samoa):

- MFAT should consider continued support for LCIPs and to help embed these as part of economy-wide Low Emissions Development Strategies/Long term Strategies that countries are developing to meet their NDCs. These should include clear non-technical financial guidance based on different options (including grid stability and reliability) and explicitly include cost-effective demand-side energy efficiency opportunities.
- A focus on quick implementation can increase costs and risks, and result in less involvement of potential local contractors than warranted. Future efforts, with less intense time constraints, could endeavour to include more local contractors, where they are suitable. This should increase local capability for subsequent O&M and possibly refurbishment or replacement, and benefit the local economy.
- Future opportunities for the Programme may not primarily be in supporting new generation facilities, and will very likely intersect with climate change and infrastructure efforts. Working closely with the Climate Change Programme and other relevant MFAT teams could help ensure that energy considerations are addressed in climate change and infrastructure activities, and improve the long-term costs and reliability of infrastructure for services (buildings account for 40 per cent of PICs electricity use) as well as energy efficiency.
- MFAT should consider prioritising robust climate-resilient RE infrastructure and low-emissions energy infrastructure within any future energy assistance. This is highly relevant for climate change mitigation and adaptation today and will be even more relevant to the PICs in the decades to come.

- Climate-resilient and robustly designed renewable energy systems for which O&M is provided through income from the electricity tariff may be physically sustainable but not necessarily sustained, without a tariff that covers full costs. MFAT should continue to work with local authorities in developing mechanisms to provide long-term funding for O&M (including local capacity building).
- Future energy initiatives with a clear link to climate change mitigation should explicitly include a carbon emissions reduction goal, with an appropriate Carbon dioxide (CO_2) emissions factor (CO_2 equivalent / litre of fuel) in the Results Framework.
- For proposed energy projects with a strong focus on Greenhouse Gas (GHG) reductions, project design should consider options other than, or additional to, RE generation. Examples include supporting improved diesel systems where the cost per unit of emission reductions is appreciably lower than that of renewable energy investments, supply side EE; demand side EE and transport energy.

2 Background – the Activity and Case Study

2.1 Background on the Samoa Renewable Energy Partnership, Phase 1 (the Activity)

The Independent State of Samoa[1] has a land area of 2,934 km^2, and a population of 197,000 (2019), of which 18 per cent is considered to be urban. Gross National Income per capita is USD$4,020 (2018). In 2017, 96.8 per cent of the population had access to electricity. In 2012, an overall energy sector goal was set that there would be 100 per cent renewable energy by 2017.

The key national development policies were:
- Samoa National Infrastructure Strategic Plan 2011 (2011)
- Strategy for the Development of Samoa, 2012-2016 (2012)
- Samoa Energy Sector Plan, 2012-2016 (2012)
- Electric Power Corporation Corporate Plan, 2013-2015 (2013).

Key policy updates since then are:
- Samoa's Intended Nationally Determined Contribution (NDCs, 2015) for reductions in GHG emissions
- Samoa Energy Sector Plan 2017-2022 (2017)
- Samoa National Environment Sector Plan 2017-2021 (2017)
- Strategy for the Development of Samoa 2016-17 - 2019-20 (2016).

All of the strategies, policies and plans over the past decade prioritise developing indigenous and renewable energy resources to improve energy security and reduce petroleum fuel as a national development objective.

The March 2013 Pacific Energy Summit identified needs and opportunities for renewable energy development in Samoa, and proposed specific solar photovoltaic (PV) systems, small hydropower plants (SHP) and wind energy investment projects for the islands of Upolu and Savai'i.[2] By early 2013, prefeasibility studies (technical, economic and environmental) had been completed for a number of the identified projects, indicating that large-scale grid-connected PV and a number of hydro projects were practical.[3] MFAT and the European Union (EU) announced up to NZ$26.5 million (NZ$14.5 million from New Zealand and NZ$12 million from the EU) in grant funding to support a range of proposed renewable energy (electricity) developments in Samoa.[4]

2.2 Activity objective, rationale, and interventions

Phase 1 of the Activity consisted of two separate components: a) grid-connected solar PV systems which were implemented by MFAT with the GoS; and b) input, with the EU, to an ADB-led project[5] to rehabilitate damaged hydropower systems and develop new SHP infrastructure. The Activity Design Document (ADD)

[1] Sources: *Samoa Country Infrastructure Profile* (PRIF, 2020); https://theprif.org/document/samoa/samoa-country-profile except renewable electricity from EPC's annual report for the year ending June 2012. (There was no report for the year ending June 2013.)
[2] *Pacific Energy Sector Profiles* (Pacific Energy Summit, MFAT et. al., March 2013).
[3] *Towards 100 Per Cent Renewable Energy: A Roadmap for Samoa* (ITP, March 2013) prdrse4all.spc.int/system/files/pes_samoa_re_roadmap_it_power_final_v1.pdf.
[4] *Activity Design Document - Samoa Renewable Energy Partnership* (SEP, MFAT, November 2013)
[5] *Proposed Grant and Administration of Grants to the Independent State of Samoa Renewable Energy Development and Power Sector Rehabilitation Project.* (Project 46044-002, ADB, August 2013).

was finalised in November 2013, the Grant Funding Arrangement in December 2013, and a Partnership Framework between MFAT and the GoS in December 2013.

New Zealand agreed to provide up to NZ$14.5 million towards the construction of solar PV facilities near Apia and in Savai'i, capacity building for the Electricity Power Corporation (EPC), the rehabilitation of hydro-electric power stations damaged after a 2009 tsunami and Cyclone Evan in 2012, and the construction of new SHP systems. New Zealand's contribution for SHP rehabilitation and construction was through the ADB-led RED&PSRP, which was entirely grant financed with an approximate total cost of USD 26.76 million, of which New Zealand contributed 9.3 per cent. Further information on estimated Activity expenditure is shown at Annex 2.[6]

The long-term goal of the Activity was "efficient, reliable, safe, affordable and sustainable electricity supply for Samoa".[7] The rationale for the Activity's approach was improved effectiveness, efficiency, and sustainability through:

- the design and implementation of all renewable energy infrastructure with a high degree of climate resilience (the "build back better" approach)
- MFAT facilitation and contracting for the grid-connected solar PV systems, as EPC and its PMU were heavily engaged with implementing a major ten-year power sector expansion project, had limited experience with PV system construction. This was also to support a tight timeframe at the request of the Government of Samoa (GoS)
- partnering with, and aligning with, ADB's larger small hydropower construction and rehabilitation effort
- TA to address the risks regarding sustainability (on-going GoS ownership and management of renewable energy infrastructure) and various planning and tariff issues.

The Activity's expected outputs and short-, medium-, and long-term outcomes are shown below. The Activity was subsequently divided into two phases, and some proposed investments dropped (e.g. wind generation) and some activities amended and/or reallocated to Phase 2.

Expected key long-term outcomes were:

- Greater efficiency and security, through reduced reliance on imported diesel fuels
- Increased least-cost energy generated through renewable energy
- Reduction in cost of electricity (to households, government, businesses and EPC)
- Improved energy efficiency and reduced total system losses.

Expected key medium-term outcomes were:

- Improved electricity generation and distribution system reliability and efficiency
- Cost effective electricity generation with reduced diesel fuel usage.

Expected key short-term outcomes were:

- Overall efficiency of Samoa electricity sector improved
- Increased capability in EPC to plan, project manage, operate, and maintain electricity generation plant
- RE generation capacity increased.

Expected outputs include:

- Least-cost Investment Plan completed and approved by GoS
- Pricing review with office of Energy Regulator
- Energy Sector strengthened through provision of TA
- PMU established within EPC
- Hydro-power projects commissioned – new and rehabilitated
- Wind energy generation installed on Upoly
- PV energy generation installed on Upolu and Savai'i

[6] ADB has not finalised accounts for the hydro component. MFAT initially allocated 'up to NZ$6.6m' for the hydro component (NZ High Commissioner letter to CEO, Finance, 3 April 2014) but this was later reduced. Some Phase 1 TA activities are included in the total.
[7] The source is the SEP ADD, final version November 2013.

The activities' Results Framework[8] included specific targets for fuel savings in millions of litres (ML), Megawatts (MW) of new or repaired generation capacity, and Megawatt hours (MWh) of energy production from renewable energy investments (solar PV, hydro, and possibly wind and biomass). The ADB-led component included quantified objectives for installed capacity, fuel savings and GHG emission reductions for new and rehabilitated SHP systems.

The energy infrastructure which was built differed slightly from initial proposals.[9] Three damaged hydro systems were rehabilitated (Alaoa, Fale ole Fee and Samasoni) all in north-central Upolu (roughly inland of Samoa's capital Apia). The new hydro systems are located in north-central (Fuluasou) and south-central Upolu (Fausaga-Tafitoala) and at Faleata in south-eastern Savai'i. Two PV systems were built near Apia (Faleota racecourse and Gym 3) and a third at Salelologa power station (southeast Savai'i).

Energy from all Activity investments was fed into EPC grids, one each in Upolu and Sava'i. The project targeted essentially the total population of Samoa's two main islands and aimed to provide more reliable, affordable and clean energy.

2.3 Methods for undertaking the case study

The case study report is based on the analysis of both primary and secondary data. The evaluation team first reviewed relevant Activity-related documentation to understand how the Activity was designed, implemented and what results were achieved in line with the Activity objectives. To complement this, consultations with relevant internal and external stakeholders were conducted to gain a deeper understanding and nuance of the Activity implementation, results and lessons learned to inform findings on the relevance, coherence, effectiveness, efficiency and sustainability of the Activity as well as future directions of the Energy Programme.

Documentation reviewed for the case study consisted of MFAT activity-specific documents, other MFAT or MFAT-supported documentation, ADB documents on the SHP rehabilitation and development component, EPC, reports prepared during or related to the activity (i.e. least-cost electricity plan, an IRENA Samoa grid stability study), GoS policy documents, and several other miscellaneous documents. Those interviewed include current and former staff of the EPC who were involved in the project, current and former GoS staff, ADB staff managing the hydro component, and a range of contractors who have been involved in the early project design, economic analysis of components, energy planning in Samoa, and supervision of project components. An interview questionnaire was regularly modified for subsequent interviews, incorporating possible new issues. Interviews were frequently followed up by email or phone to clarify inconsistencies, and to address and incorporate new findings. Annex 1 lists the documentation reviewed and stakeholders consulted.

The main challenge in undertaking the case study was acquiring accurate and up-to-date information without visiting Samoa. When evaluating or reviewing projects, in-person discussions lead to serendipitous meetings with valuable new informants and the review of documents leads to other unknown but valuable documentation. Other challenges include the following:

- no formal project reports later than 2017 for the PV component and only 2016 (Q1, Q2) and 2020 (Q1) for the hydro component (although interviews provided considerable additional information). No commissioning reports were located
- the slow acquisition of reports and contact details for key informants
- no opportunity to interview key stakeholders in the MoF or current key staff of the EPC
- EPC has provided unpublished data on generation, diesel fuel use, and GHG emissions but 2019 PV (and possibly) hydro data may be inconsistent so reported project achievements may be inexact and are not final.

Further, it is not possible to effectively evaluate the Activity in isolation from closely integrated assistance to Samoa. EPC treated the Renewable Energy Development and Power Sector Rehabilitation Project (RED&PSRP, the hydropower component) as a continuation of, and a supplement to, a larger ADB-led 2008-2018 USD119 million Power Sector Expansion Project (PSEP) and some hydro work initially planned

[8] SEP ADD, op. cit..
[9] A poten ial wind system was uneconomic and dropped. Tiapapata SHP was dropped due to environmental concerns (risks to the native *manumea* bird) and Faleaseela due to land access issues. These were replaced by other SHPs.

for the PSEP and in part designed under it, was shifted to RED&PSRP. Investments and TA partly carried out under the PSEP (e.g. battery storage, grid stability studies, improved transmission and distribution losses, a micro-grid system) improved the capacity of EPC to integrate intermittent renewable energy (PV, run-of-river hydro) while addressing grid stability concerns. It is impractical to estimate RED&PSRP benefits in isolation from these wider efforts to improve EPC's performance. There was effectively a single decade-long coordinated effort involving ADB, the Australian Department of Foreign Affairs and Trade (DFAT), Japan International Cooperation Agency (JICA), the EU and MFAT, of which the PV and RED&PSRP project components were a key element.

3 Case study findings and lessons learned

The key research questions for the case study are based on the Organisation of Economic Cooperation and Development's Development Assistance Committee (OECD DAC) criteria (shown in the table below). As such, the findings presented in this report are structured by the DAC criteria. Though the case study relates specifically to this Activity, the primary purpose of this case study is to inform the broader strategic evaluation. It is not intended to be a comprehensive evaluation of the Activity itself. Findings, lessons learned, and considerations for future efforts should be read in this context.

Objective	Description
Relevance and coherence	To examine the relevance, significance, and coherence of the Activity.
Effectiveness	To examine the extent to which the Activity achieved, or is expected to achieve, its objectives and results.
Efficiency	To review the effectiveness of MFAT's approach and ways of working i.e. internal roles and responsibilities and resource allocation, funding, contracting and delivery (management and governance) modalities to deliver expected results.
Sustainability	To assess the sustainability - physical, operational, economic, social, environmental and resilience of the Activity investments.
Future directions	To document lessons learned from the Activity that can inform strategy, policy and improved ways of working for the Activity and the Energy Programme as a whole.

3.1 Relevance and coherence

Relevant and consistent with Samoa's needs, policies, priorities

The Activity was highly relevant and consistent with Samoa's needs, policies, priorities and actions listed in Section 2.2. These include among others:

- increased renewable electricity, increased efficiency of power generation and distribution, and more efficient use of electricity by consumers (National Infrastructure Plan, 2011)
- increased sustainability of energy supply (National Development Strategy, 2012)
- a 10% increase in the contribution of renewable energy to total energy consumption by 2016 and promotion of electricity generation from proven renewable energy technologies[10] (Energy Sector Plan, 2012)
- 100% renewable electricity generation by 2025, or by 2017 assuming sufficient international assistance (Samoa's Intended Nationally Determined Contribution, 2015)
- sustainable and environmentally sound renewable energy sources, generation and distribution (EPC Corporate Plan, 2013).

[10] There is no specific goal for renewable electricity as a percentage of total supply, but one of the indicators is the approval of at least three renewable electricity projects.

Although the Activity is relevant to a very high percentage of Samoa's population, the Activity design does not identify communities, electricity users, landowners or other affected parties as beneficiaries or stakeholders. Discussions appear to have been limited to government agencies and the EPC. Nonetheless, Activity outcomes were equitable and inclusive, addressing the needs of all electricity consumers for reliable, clean and less expensive energy, over 97 per cent of households and virtually all businesses.

Relevant and consistent with New Zealand, regional and global priorities

The Activity is also well aligned with New Zealand, regional and global priorities for energy. The activity was also compatible with, and aligned, with those of other development partners with renewable energy initiatives in Samoa including those of the ADB, JICA and DFAT. There was a cooperative agreement with the EU and a Partner Project arrangement with the ADB.

The rationale for this Activity was supporting Samoa's goal of reducing high dependence on imported petroleum fuels for the energy sector; the New Zealand International Development Policy Statement (March 2011) which recognised the importance of investing in renewable energy as a key development enabler; the New Zealand Aid Programme Strategic Plan (2012-2015) which identified increased access to clean, efficient and affordable energy as a critical activity over the next three years; and New Zealand Aid Programme Sector Priorities (2012-2015) in which renewable energy was identified as a key aid priority, particularly in the Pacific. Pacific leaders had earlier agreed on the need to reduce dependency on fossil fuels through developing indigenous renewable energy sources, improving access to electricity, and developing whole-of-energy-sector strategic plans.[11] The support aligned with Samoa's 2012 National Energy Policy.

The Activity design was consistent with global priorities, including those of Sustainable Development Goal (SDG) 7 which aims "to ensure access to affordable, reliable, sustainable and modern energy for all" with universal access to affordable electricity and increased clean renewable energy. SDG7 goals include improved energy efficiency. The Activity, through the ADB-led component, addressed improved supply-side efficiency (e.g., within EPC), but not demand-side efficiency (consumer energy efficiency).[12] New Zealand is a member of the Global Partnership for Effective Development Cooperation (GPEDC) which aims to contribute to the achievement of the SDGs through four principles: country ownership; a focus on results, inclusive partnerships; and transparency and mutual accountability. The Activity is consistent with the GPEDC principles.

New Zealand's 'flagship' investment priorities for renewable energy from 2015-2019 focussed on: a) improved access to reliable and renewable energy through new infrastructure and technical assistance; b) strengthening sector planning and asset management to improve service quality and efficiency; and c) identifying support for greater private sector participation in the energy sector. All of these are highly relevant to Samoa, consistent with Samoa's policies and plans, and were incorporated into the Activity. Alignment and coherence to MFAT priorities and plans may have been stronger (within MFAT and with Samoa) prior to 2017 and from 2015-2017 when renewable energy had flagship status, but it has been strong throughout this Activity.

MFAT's strategic goals for climate change focus on an effective global response to climate change with improved climate resilience in the Pacific. The Activity and its component investments are all aligned to increased Pacific climate resilience.

The Pacific Reset, announced in early 2018, focuses on working with local partners, aligning with local priorities and local ownership. The Activity was designed some years earlier with implementation well underway by 2018. The reset was broadly consistent with the Activity but did not directly affect it.

In late 2019, New Zealand approved a new *Policy for International Cooperation for Effective Sustainable Development* [13] confirming a primary focus on the Pacific region, including sound stewardship of the environment and climate. This was approved by Cabinet long after the Activity was developed, but the Activity is consistent with the policy and its principles of effectiveness, inclusiveness, resilience and sustainability.

[11] These were endorsed by leaders at the 2011 Pacific Islands Forum.
[12] A 2015 review for MFAT noted that none of its Pacific energy activities "aimed to improve the efficient use of energy." This was *Renewable Energy Investments in the Pacific: A Process Evaluation* (MWH, December 2015).
[13] *See* https://www.mfat.govt.nz/assets/Aid-Prog-docs/Policy/Policy-Statement-New-Zealands-International-Cooperation-for-Effective-Sustainable-Development-ICESD.pdf.

Factors enabling relevance and coherence

- The specific PV and SHP investments were identified as high priority by the GoS and were strongly supported by the GoS.
- All PV arrays and SHPs were connected to either the Upolu or Saviai'i grids allowing centralised control and (in Upolu) balancing of intermittent power sources with diesel generation.
- The establishment of a dedicated PMU at EPC, allowing a dedicated team to concentrate on the design and implementation of a significant number of new renewable power plants.
- A range of development partners, the GoS and EPC cooperated closely for over a decade (about 2013-2020) on aligned and comprehensive support for Samoa's power development.
- Samoa's population is overwhelmingly concentrated on two islands, with nearly 100% of households connected to a grid, and power supply managed by a single national power utility. This makes planning, finance, construction, operations and maintenance easier than in most PICs.
- Samoa and the Pacific islands, in general, are highly vulnerable to a range of adverse climate change impacts. Robust low-emissions energy infrastructure is central for climate change mitigation today, and adaptation efforts will be even more relevant in the decades to come.

Factors hindering relevance and coherence

- There was apparently little or no consultation with beneficiaries, as all electricity users were assumed to benefit from the Activity.
- The 2013-2014 emphasis on rapid construction of renewable energy systems reduced the available time for analysis (e.g. economic viability of proposed PV), availability of suitable local contractors, and considering and responding to some local concerns of a donor-led approach.

3.2 Effectiveness

Activity outputs (from Figure 1 and the Results Framework) and results are summarised in Table 3. There were no quantified targets and no attempt has been made to judge the effectiveness of a wide range and number of different activities, some of which took place partly or entirely under phase 2, not the Activity.

Table 1: Expected Outputs and Actual Results

Outputs from the Results Framework	Activities to Delivery Outputs	Results
Output 1		
Least-cost Investment Plan completed and approved by GoS	1. TA provided to EPC for development of Least Cost Investment Plan. 2. GoS approval of Plan.	1. Plan developed. 2. Not accepted by GoS or EPC or being used to guide investments.
Output 2		
Pricing review with Office of the Energy Regulator	Technical Assistance to provide advice and assistance as required.	TA and tariff pricing advice provided.

Outputs from the Results Framework	Activities to Delivery Outputs	Results
Output 3		
Energy Sector strengthened through provision of technical assistance	Technical Assistance/Capacity Building provided to GoS/Energy Regulator/EPC as required including: • Implementation of the least-cost investment plan (LCIP). • Monitoring and management of energy projects. • management of tender processes. evaluation of proposals, and • Development of a model Power Purchase Agreement.	Considerable TA was provided but the LCIP was not implemented, and status of specific actions is not known.
Output 4		
PMU Established in EPC	Technical Assistance to provide advice and assistance as required.	PMU established within EPC and was judged by ADB to be effective.[14]

Most quantified targets were significantly exceeded by 2020. The solar PV component (see Table 4) of the Activity has achieved its target for new capacity, and nearly attained targets[15] for fuel savings and energy production. There may be anomalies in draft EPC reporting to ADB for some PV data so this is a preliminary conclusion, although it is not expected to change appreciably. For PV, the achievements can be attributed to MFAT as the systems were fully MFAT-funded. For the hydro investments, the objectives have been substantially exceeded, about 40 to 50 per cent above the targets.[16] Details by the specific generating plant are provided in Annex 3. Hydro results are for the overall ADB/MFAT/EU RED&PSRP for which MFAT was a significant contributor. MFAT's short term goal of 5.2 ML/year of total (hydro & PV) fuel savings was exceeded by 25 per cent in 2020.

Table 2: Power Installed, Fuel Savings, Energy Generated and GHG Reductions in 2020

Energy system	Capacity Added (MW)	Fuel Savings (ML)	Energy Produced (MWh)	GHG Reduction (kt CO_2 Equivalent
Solar PV – Systems implemented directly under MFAT SEP				
Target	2.55	0.964	3683	Not quantified
Achieved	2.60	0.824*	3296*	2.18*
% of target achieved	102%	85%	90%	N/A
Small hydro – New and rehabilitated SHP under the RED&PSRP				
Target	5.5	3.63	15,980	11.44
Achieved	8.24	4.82	24,639	16.06
% of target achieved	150%	140%	154%	140%

*For PV this is average of 2015-2020 neglecting 2019 which appears to be wrong. Source for achievements is preliminary EPC data for ADB RED&PSRP final reporting, which may change. Source for hydro targets is RED&PSRP design document for 2019.[17] kt = kilotonnes or thousand metric tonnes. The emission factor of 2.65 kg of CO2 / litre of diesel fuel may differ from some RED&PSRP reporting[18]

[14] *Project Completion Report, Samoa: Power Sector Expansion Project* (ADB, November 2019)

[15] The targets for PV are from the ADD and its Results Framework. The targets for hydro are from ADB documentation and are consistent with the ADD for which targets are identified (e.g.. hydro capacity additions).

[16] It is noted that about 24% of capacity and 22% of fuel savings are attributed to a 2 MW generator at Taelefaga that was added late in the project. It is not included in the ini ial MFAT or ADB targets. However, overall targets would have been comfortably exceeded even without this addition.

[17] *Report and Recommendation to the President: Proposed Grants and Administration of Grant - Independent State of Samoa: Renewable Energy Development and Power Sector Rehabilitation Project* (ADB, Project 46044-002, October 2013) https://www.adb.org/sites/default/files/project-document/79519/46044-002-rrp.pdf

[18] This assumes full combustion and the Net Calorific Value (NCV) of the fuel. For Gross Calorific Value (GCV) claimed emission reductions are about 5% higher. Source: *Gas Inventory Management Systems, and the Use of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, Lesotho, March 2016).*

Specific targets for individual PV systems have been largely achieved, and for hydro exceeded. The longer-term (or more accurately medium-term) expected outcomes are also thus far quite positive, as shown in Table 5. Samoa has appreciably reduced its dependence on petroleum within the energy sector, the cost to consumers of electricity has declined, power system efficiency has improved markedly, and EPC has improved planning and management. There are, however, concerns that near future growth in diesel-based electricity may outpace growth in affordable new renewable energy systems. This is clearly beyond the control of the project.

The Activity may have had potential to achieve considerably more in long-term fuel savings and emissions reductions at less cost[19] if it had included demand-side energy efficiency, in the Activity's Least-Cost Investment Plan (which is discussed in section 3.4).

Table 3: Achievement of Activity's Expected Longer-term Outcomes

Outcomes	Results by 2019-2020
Reduced dependence on petroleum fuel	• Petroleum fuel accounted for about 81% of EPC's energy production (generation and purchases from Independent Power Producers (IPPs) in 2014 declining to 57% in 2020. However, this rate of decreased dependence may not continue.
Reduced cost of electricity	• In real terms (constant 2009 tala) a consumer using 200 kilowatt hours (kWh)/month would have paid 146 tala in 2009 (when most were post-pay). This dropped by 2019 to 135 tala (post-pay) or 123 tala (pre-pay), about a 16% decline. Most consumers use pre-pay meters. • Overall in current USD terms, the average charge dropped from $0.2873 in 2015 to $0.2014 in 2018 (with declines for all tariff categories).* • By 2020, Project funded renewable energy contributed 17% of total electricity generation (PV 2%, hydro 15%), enough to contribute to the tariff reduction.
Improved energy efficiency & reduced system losses	• Supply-side energy efficiency improved by 40% from 2012-2019; system losses dropped from 18% to 9.8% during the same period There was no activity to address demand-side energy efficiency.
Increased access to clean, reliable, affordable electricity[20]	• Overall, renewable energy accounted for 19% of EPC's supply in 2014, increasing fairly steadily to 43% in 2020. In Savai'i, customer supply from renewables was 1% in 2014 increasing to 9.4% in 2020.
Increased EPC capacity to plan, manage, operate and maintain power plants.	• The bulk of stakeholders report that EPC capacity has improved considerably.
Increased least-cost renewable energy	• A least-cost plan was developed in 2015 under Phase 1 but is not being used to inform investment choices.

Sources: Calculated from data from EPC (February 2021 and *Samoa Power Sector Expansion Completion Report* (ADB, Nov 2019) except * = *Pacific Infrastructure Performance Indicators* (draft, Pacific Regional Infrastructure Facility and SPC, 2021)

In addition to expected outcomes within the Activity, the overall financial performance of EPC improved during the PSEP (with the apparent achievement by 2019 of overall financial sustainability), the power sector came under formal regulation, and investment planning capacity has reportedly improved.[21]

New Zealand's investment priorities for renewable energy from 2015-2019 (improved access to reliable and renewable energy, strengthening sector planning and asset management, and supporting greater private sector participation) are included in the Activity, which included effective interventions in the first two of

[19] "Energy efficiency potential, if captured, would ***be a more cost-effective way of meeting a country's energy requirements*** than building new generation. However, addressing the barriers to energy efficiency is a substantial exercise in its own right, and outside the scope of this least-cost planning exercise" Emphasis added. Slightly paraphrased from *Least-cost planning framework and planning tool for the Samoan electricity sector* (version 08; Concept Consultants for MFAT, July 2015).

[20] Primarily from new Fiaga diesel station in Upolu, build within the ADB-led Samoa Power Sector Expansion Programme (2008-2018).

[21] Discussions with ADB and ADB's *Project Completion Report, Samoa: Power Sector Expansion Project*, op. cit.

these areas. Encouraging private-led investment in renewable energy through IPPs has been a key component of Samoa's approach. The Activity has provided some limited advice on improving Samoa's capacity to negotiate and implement Power Purchase Agreements with IPPs but has not directly contributed to IPP implementation.

There was no gender analysis undertaken within the Activity or the RED&PSRP hydro component. However, ADB did carry out a rapid gender review[22] of the associated PSEP in 2016 and staff feel it remains relevant to the SEP:

> "The review found that access to continuous electricity appeared to reduce the time spent on housework. It also increased women's waking hours, which contributes to relieving time poverty and creating additional or new income, as well as enabling them to assist children with school homework…. [It] has resulted in some sound practical gender benefits for women in the form of improved, cheaper, and reliable supply of electricity, including reduced time poverty and increased economic empowerment. Some women benefitted from working closer to home, with a more balanced life overall [and] opened up new businesses or expanded existing businesses. The review witnessed some strategic benefits in improved power in the households and increased coverage, with the potential for increased control, power and autonomy."

Factors enabling effectiveness

- There was a cooperative working relationships between MFAT and the GoS, EPC and the ADB. MFAT staff were approachable and easy to work with.
- In general, the consultants, contractors, suppliers and project managers performed well.
- The PV and hydro installations used well-proven technologies which were designed for relatively straightforward maintenance (e.g. no batteries needed for the initial grid-connected PV; lower maintenance hydro intakes).
- PV and SHP were not developed in isolation but within a wider effort to improve power sector management, planning, maintenance, and grid stability.

Factors hindering effectiveness

- Pressure for rapid implementation may have affected Activity design.
- There have been reports of possible quality, and perhaps safety, issue with a SHP dam but this has not been confirmed and may be external to Activity investments

3.3 Efficiency

MFAT was efficient, working quickly under pressure to design and deliver the three PV systems on time. The very short timescales for tender may have resulted in higher-than-normal risk to contractors, higher costs and less involvement of Samoan contractors than warranted. Some stakeholders felt that several MFAT personnel and contractors were unduly assertive but that this was understandable considering Samoa's insistence on rapid completion. This was not mentioned as an issue in the subsequent hydro component, for which alternative SHPs were quickly identified to replace two which were dropped for environmental and land issues.

MFAT was actively involved with the GoS and development partners (EU, ADB) in the initial hydropower concepts and preliminary designs but reportedly considerably less proactive within the RED&PSRP (hydro) activities and review meetings but this can be considered normal as ADB led the activity and was trusted by MFAT and the GoS to deliver results. However, some stakeholders felt the NZ High Commission could, and should, have played a stronger role in dealing with several New Zealand contractors who may have underperformed.

For the solar PV systems, the agreed modality was a joint project arrangement with the GoS with facilitation by MFAT (from Wellington) which handled contracting, while EPC's PMU supervised

[22] Source: Annex 13 of *Project Completion Report, Samoa: Power Sector Expansion Project* (November 2019).

construction, led by a New Zealand Project Management Consultant, supported by Quality Assurance / Quality Control consultancies. Considering strong pressure from the GoS to complete and commission at least the largest PV system before early September 2014 (the date of an international Small Island Developing States conference in Apia), and the substantial commitments of EPC's PMU in managing the largest ADB project in the Pacific outside PNG (the complex USD117m PSEP with many sub-projects), this modality was appropriate and effective, with construction completed on time with high quality results.

For the hydro component, MFAT contributed to a USD26.76 million Partner Project arrangement led by ADB (71.8 per cent of funding), with the EU (18.9 per cent) and MFAT (9.3 per cent). It was an effective and reasonable approach to contribute to a multi-agency effort in an area in which ADB had considerable previous and ongoing experience in Samoa, with the GoS, EPC and a range of contractors. The financing arrangements are summarised in Annex 2.

Through a flexible allocation for technical assistance during both Phase 1 and Phase 2 of the Activity, primarily to the EPC, MFAT provided a least-cost renewable energy power investment plan, some PPA negotiation advice, input into grid stability and battery stage studies, training in PV system O&M, linesman training, improved asset management, and other practical services which would have been less quickly arranged through the more bureaucratic systems of its development agency partners.

Factors enabling efficiency

- The different modalities used for the PV and SHP components were efficient, effective and appropriate.
- Coordination with ADB and the EU in the SHP component within an ADB-led effort was far more efficient than a stand-alone MFAT effort would have been.
- Flexible and responsive TA assistance to EPC was more efficient than the alternative of relying on the administrative systems of MFAT's development partners in the Activity
- In-country presence of both MFAT and ADB in Samoa for the SHP component eased cooperation.

Factors hindering efficiency

- There were no apparent factors that significantly hindered efficiency of the specific Activity but gaps in documentation could hinder dissemination and future use of some lessons learned.

3.4 Sustainability

The renewable energy infrastructure was designed and implemented for sustainability, though long-term sustainability is not beyond doubt. The PV arrays and SHPs were robustly designed and built for climate change resilience, particularly for cyclone winds and flooding. With appropriate operations and maintenance, they should continue to operate for many years. EPC has the capacity for effective maintenance and was assessed by ADB to be financially sound in 2019. However, the tariff determination methodology does not include the cost or replacement of grant-funded capital assets, and these are a significant percentage of EPC assets. If the tariff methodology remains unchanged and grants for energy infrastructure decline significantly, EPC income may be insufficient for adequate expansion of generation and its maintenance.

Prior to the Activity, the GoS was already committed to robust energy systems which were resilient to flooding and climate and designed for improved sustainability. Examples include the underground transmission line from Fiaga power station to Apia, the relocation of the main diesel power station to a higher flood-free location, and flood resistant power stations. Under the Activity, the solar PV arrays were designed and built to be cyclone and flood resistant, with components that should have long lives if properly maintained.

There was considerable attention to climate-robust design for the new and rehabilitated hydro systems within the SEP / RED&PSRP. The Tafitoala-Fausaga SHP,[23] for example, has a dual-intake system tapping into two tributaries, contributing to a higher capacity factor (42 per cent compared to typically 35 per cent)

[23] Source (among others) *Samoa Leads Renewable Energy Efforts* (Hydro Review 26 June 2019; Andrew Bird and Alfred Mata ia) https://www.hydroreview.com/world-regions/hydro-review-small-islands-of-samoa-lead-renewable-energy-efforts/

for more consistent, reliable output. For resilience to natural disasters, the penstock was built underground, pipes were sturdy glass-reinforced plastic, and the powerhouse waterproofed to one metre above floor level. Intakes were located above expected flood levels. Sustainability was enhanced by screening sediments at the intake (instead of traditional sanding basins which require frequent flushing), reducing O&M costs. All RED&PSRP SHPs had to undergo environmental screening based on ADB standards, include a resettlement plan for any displaced people, and meet ADB's poverty/social criteria. To improve long term sustainability, MFAT financed an EPC asset management study and an assessment management system. All interventions were aligned to Samoan and international endeavours to mitigate or adapt to climate change, including the successful SEP efforts to reduce GHG emissions.

The Activity's generating systems have been completed too recently to judge whether they will be sustainably managed. The grid-connected PV arrays (commissioned in late 2014) would be expected to be producing nominal designed output in early 2021 and beyond, even with minimal maintenance. The hydro systems, commissioned in 2017 (rehabilitated SHP) and late 2019 - early 2020 (new SHPs), should also be running well in 2021 and afterwards even with minimal maintenance.

A 2015 study for MFAT[24] expressed concern that "the conflation of strategic mixed messaging, project proliferation and a lack of clarity on different roles in the sector has the potential to affect the sustainability of New Zealand's investments in a number of areas like underinvestment in O&M, bypassing solar energy with other lower cost sources, inappropriate pricing models, and a lack of technical capability and training. The Least-Cost Investment Plan (LCIP for renewable energy) [meant] to add some structure and clarity to decision making in the renewable energy sector and this is a welcome step. However, GoS decisions regarding renewable energy are reportedly being made without reference to this document or to sector-wide financial analysis." Overall, the lack of clarity on roles has not changed and the LCIP analyses have not informed new investment decisions. The 2015 report also noted that the LCIP should include clear non-technical financial guidance based on the different options as it may not provide sufficient clarity for the Ministry of Finance (MoF) policymakers.

ADB concluded in 2019 that EPC is financially sustainable, with sufficient current resources for adequate O&M[25] but also notes that the tariff determination by the Office of the Regulator does not include initial capital costs or future replacement costs of grant-funded investments (e.g. all those funded through the SEP including the RED&PSRP). The tariff may not be sufficient to provide adequate funds for long-term maintenance and asset replacement. [26]

In 2021, the International Monetary Fund (IMF)[27] expressed concerns regarding the liabilities of state-owned enterprises and the need for careful monitoring and analysis by the Ministry of Finance and effective coordination between the MoF and the Ministry of Public Enterprises (although it did not specifically mention EPC).

The IMF also noted that real GDP declined in the third quarter of 2020 to its 2014 level, plus an additional projected contraction of 7.8% in fiscal year 2021, with a bumpy road ahead with unprecedented uncertainty, including a high risk of disorderly migration. Relative to domestic population, the Samoan diaspora is one of the largest not only in the Pacific but in the world.[28] There were 124,400 migrants in 2019, some 60% of its domestic population, growing steadily. There are concerns of further loss of skilled Samoans through migration during a difficult period.

[24] *Samoa Programme Evaluation Report* (Adam Smith International, 2015)
[25] *Project Completion Report (Samoa Power Sector Expansion Programme* (ADB, November 2019)
[26] Over the last decade, PSEP and SEP / RED&PSRP investments were over USD152 million, of which 27% were in grants (excluding loans to the GoS that were on-lent to EPC).
[27] *Samoa 2021 Article IV Consultation and Staff Report* (IMF, March 2021); https://www.imf.org/-/media/Files/Publica ions/CR/2021/English/1WSMEA2021001.ashx
[28] *The NZ pathway: how and why Samoans migrate to Australia* –Part one https://devpolicy.org/the-nz-pathway-how-and-why-samoans-migrate-to-australia-part-one-20210201-1/?print=pdf; part two https://devpolicy.org/the-nz-pathway-how-and-why-samoans-migrate-to-australia-part-two-20210201-2/?print=pdf

Factors enabling sustainability

- Both PV and SHP were well designed for adverse climate change and for ease of maintenance within a utility that has improved climate residence across its generation and transmission over the past decade.
- The increased capacity of EPC over the Activity life in planning, managing, operating and maintaining renewable energy infrastructure.
- All systems are grid-connected and maintained by the national power utility, EPC, which eases operations and effective maintenance.
- The PV and SHP operate in an environment of diverse supply (including diesel, battery storage and wind), and both publicly and privately owned generation, which could improve sustainability but can also stress the grid.

Factors hindering sustainability

- The mechanism for establishing EPC's tariff does not reflect full costs of supply of electricity.
- Energy investment decisions and climate change, although intertwined, tend to be treated as distinct by governments and development assistance programmes.

4 Overall lessons learned

4.1 Overall lessons learned for the Activity

Samoa, with development partner support including through this Activity, has done a commendable job in developing energy infrastructure over the past decade that is more reliable, diverse, renewable, fuel saving, resilient to climate change and (with effective operations and maintenance) in principle more sustainable. It is a success that should be more widely known within the region. Some lessons are provided below.

Overall lessons learned for the Activity

- MFAT's pragmatic, nimble, and efficient outcome-driven approach (as opposed to output/process-driven approach of some donors) has been very efficient, in quickly delivering the solar PV systems in Samoa, but perhaps the quick PV delivery resulted in higher costs.
- Future efforts, with less intense time constraints, should endeavour to include more local contractors, where they are suitable. This should improve local O&M capability, and skills for refurbishment, replacement or new construction, as well as increasing money flows through the economy.
- MFAT collaboration and coordination with ADB and the EU appears to have helped foster a genuine sector-wide approach to electrical energy in Samoa. A Partner Project arrangement led by ADB for the Samoa hydropower component was very effective in delivering excellent short-to-medium term results.
- The Activity's distinct and separate delivery modalities for solar PV and SHPs were effective, suggesting that a single modality for a future Activity may not always be the best approach.
- Samoa has significantly increased solar PV and hydropower energy to the EPC grids under the Activity but this is unlikely to continue at recent growth rates. Given the declining costs of RE and storage, should the 2015 LCIP be used for future investment decisions, it should be updated to reflect current cost-effective opportunities, provide clear non-technical financial guidance for various options (including for grid stability and reliability) and include cost-effective demand-side energy efficiency opportunities (which was absent from the existing LCIP).
- In Samoa, improvements to diesel system efficiency have accounted for about 80 per cent more GHG emission reductions than investments in renewable energy. For future energy projects (or climate change projects with an energy input) with a focus on GHG reductions, opportunities other than RE should be assessed where the cost per kg of emission reductions may be equal to or lower than that of RE. This could include improvements in diesel generation, demand-side (consumer) energy efficiency, supply-side EE or transport energy.
- For future projects with a clear link to climate change mitigation, measuring success will be easier with an explicit carbon emissions reduction goal. The Results Framework should include a standard emissions factor (CO2 equivalent generation or savings/litre of fuel) unless reliable project-specific data are available.

- Climate-resilient and robustly designed renewable energy systems for which O&M is provided through income from the electricity tariff, as in Samoa, may be physically sustainable but not necessarily sustained, without a tariff that covers full costs. MFAT should continue to work with local authorities in developing mechanisms to provide long-term funding for O&M.
- For future projects feeding electricity through a large grid, it would be useful to explicitly identify beneficiaries and consult those who represent various consumers. This could improve both project design and measuring effectiveness.

4.2 Overall lessons learned for the Energy Programme

The lessons learned below relate to lessons drawn from the Activity Case Study to inform the broader strategic evaluation. However, it should be noted that some lessons from this Activity may not be applicable to the overall Programme and all PICs as solar PV and SHPs in Samoa are unique in that, there is: a genuine commitment to expanding renewable energy; a compact population essentially fully connected to the grid; close ties to New Zealand; and national utility supporting O&M.

Overall lessons learned for the Energy Programme

- A recurring issue for electrification assistance in the Pacific is tariff levels not adequately covering the full cost of supply, meaning insufficient funds from consumers for long-term replacement of equipment and at times even for essential O&M. Where a tariff appears to cover costs, as in Samoa, the methodology often excludes the initial and replacement cost of grant-funded capital assets, which can be a high percentage of total assets. For political and/or social reasons, this has been difficult for development agencies to effectively address. Where higher tariffs are unaffordable or unacceptable, whether for national or remote supply systems, it may be appropriate for MFAT to work with recipient countries and development partners to develop mechanisms that might be more acceptable to governments to address the issue. Approaches that could be considered include:
  i) Adopting 'lifeline tariffs', which are designed to support low-income household consumers through reduced (subsidised) rates, generally for a modest consumption level sufficient for basic needs (e.g. lighting, fans, radio, sometimes TV, etc) with higher consumption charged at full cost. This allows full cost recovery from those who can afford it[29]
  ii) Government budgets could include explicit 'ring-fenced' allocations for subsidising electricity supply overall or for higher-cost remote island supply, possibly with development assistance for an initial period.[30]
- As with Samoa, many PICs have energy targets for maximising electrical RE, generally associated with NDC commitments, which are not linked to Least-Cost Renewable Energy Investment Plans (LCIPs) or detailed analysis. This can lead to high costs and in some cases sub-optimal development of IPPs. For well-planned RE development, LCIPs are important.
- Future opportunities for the Programme may not primarily be in supporting new generation facilities and will very likely intersect with climate change and infrastructure efforts. As such, the Programme team should work closely with the Climate Change Programme and other relevant Programme teams so that energy considerations are addressed in all climate change and infrastructure activities.
- MFAT collaboration and coordination with development partners provide opportunities for influencing a genuine sector-wide approach to energy and leveraging limited funding.
- Samoa's energy sector development in the past decade has had a strong and successful element of climate adaptation. PICs in general face similar adverse climate impacts. Future energy initiatives should have a robust climate adaptation component.
- As there may be fewer future cost-effective renewable energy investment opportunities in some PICs, MFAT could consider future support for cost-effective demand-side energy efficiency improvement. Buildings, for example, account for about 40 per cent of PIC electricity use and there are practical, low-cost means for improving building energy efficiency.[31]

[29] PPA's 2012 benchmarking report (https://www.ppa.org.fj/publications/ 2011 data) shows 7 of 21 PIC power utilities with lifeline tariffs, typically applying to consumption of 50 kWh/m or less. Two of the seven capped subsidised consumption at 300 kWh or more, which is far too high to be effective in supporting low-income households; effectively the mechanism was used by 24% of utilities. Subsequent PPA reporting does not indicate lifeline tariffs but it is understood that many u ilities no longer use them. In some PICs, consumers who exceed the limit are charged full cost for all consumption. A benefit of this approach is that it does not encourage excessive use of underpriced electricity.

[30] This has an additional benefit of quantifying he subsidy for electricity supply, which is often implicit.

[31] *Energy Efficiency: Residential and Small Commercial Applications* (Sustainable Energy Industry Association of the Pacific for the Pacific Power Association and the World Bank, 2019) https://www.seiapi.com/guidelines

Annex 1: Documentation reviewed and stakeholders consulted

Documentation reviewed

Documentation reviewed for the case study consisted of:

MFAT project-specific documents	• Design, design appraisal, progress reports, financing, Memoranda of Understanding (MOUs) There are no completion reports yet
Other MFAT or MFAT-supported documentation	• (a 2015 Adam Smith International Samoa programme evaluation report, a 2015 process evaluation report by MWH consultants of MFAT renewable energy investments in the Pacific, a 2017 IFC guide to investing in renewable energy in the Pacific, ADB's Pacific Energy Sector Profiles for 2013 and 2016, EU-New Zealand Energy Access Partnership for the Pacific reports, ITP Renewables 2013 renewable energy roadmap for Samoa, a 2015 least-cost renewable electricity investment plan
ADB documents on the SHP rehabilitation and development component	• Project design, project finance, some quarterly progress reports, poverty and social analysis, environmental monitoring) and the completion report for ADB's closely linked Samoa Power Sector Expansion Project of 2008-2018
EPC documents or documentation	• Annual reports and detailed data on specific PV and hydro system project performance
GoS policy documents	• National plans and policies for national development, energy, infrastructure, environment and energy-sector GHG reductions) and the Finance Ministry's 2015 Samoa energy review
Miscellaneous material	• a 2017 United Nations Development Programme project document on improving performance and reliability for renewable energy in Samoa, the Pacific Power Association's annual power utility benchmarking reports, IMF's 2019 and draft 2021 Article IV consultation mission reports for Samoa, a draft of the Pacific Region Infrastructure Facility's 2020 Pacific infrastructure performance indicators for energy, 2013 Pacific Energy Summit reporting, an IRENA Samoa grid stability study

Stakeholders consulted and contacted

Primary Stakeholder groups	Persons consulted
• **Energy Programme team**	• Martin Garrood, Lead Adviser, Energy
• **Posts, Activity Managers and Programme teams for case study countries**	• Situfu Salesa, Senior Development Programme Coordinator, MFAT, Samoa • Catherine Maclean, SPO (Cook Islands), Samoa, 2015

Secondary Stakeholder groups	Persons consulted
• **Partner governments and other counterparts**	• s9(2)(a) Programme Management Unit (PMU), Electric Power Corporation (EPC) about 2012– early 2021 • s9(2)(a) EPC PMU 2011-2015
• **Implementing agencies**	• s9(2)(a) Programme Management Unit (PMU), Electric Power Corporation (EPC) about 2012– early 2021 • s9(2)(a) EPC PMU 2011-2015

Secondary Stakeholder groups	Persons consulted
• **Direct implementing partners (e.g. technical advisers or contractors)**	• s9(2)(a) EPC hydro supervision, Asia-Pacific head of hydro, Santec consultants • s9(2)(a) ITP Renewables, Canberra • s9(2)(a) Energy consultant, formerly ITP Renewables • s9(2)(a) New Zealand
• **Multilateral implementing partners (e.g. ADB)**	• s9(2)(a) Asian Development Bank (ADB Apia); Officer Responsible, Renewable Energy Development and Power Sector Rehabilitation Project • s9(2)(a) ADB financial evaluation consultant, Samoa Power Sector Expansion Project
• **Other**	• s9(2)(a) Pacific NDC Hub, SPREP Apia; s9(2)(a) s9(2)(a) Ministry of Natural Resources and Environment, Samoa (until late 2020
• **Beneficiaries**	• The Electric Power Corporation and its customers) was the direct beneficiary

The following stakeholders did not respond to invitations for consultations or could not be contacted:

- s9(2)(a) Electric Power Corporation, Samoa
- s9(2)(a) Electric Power Corporation, Samoa (and former renewable energy coordinator, EPC)
- s9(2)(a) EPC, Samoa
- s9(2)(a) Office of the Regulator, Samoa
- s9(2)(a) Ministry of Finance

Annex 2: Estimated Activity expenditure

Table 1: Estimated Activity expenditure by 2020

Activity components	NZD million	%
Solar PV systems	9.24	63.7
Small hydropower plants (SHPs)	3.76	26.0
Phase 2 Technical Assistance	1.50	10.3
Total	**14.50**	**100%**

New Zealand's contribution for SHP rehabilitation and construction was through the ADB-led RED&PSRP, which was entirely grant finance with an approximate total cost of USD$26.76 million (Table 2 below), of which New Zealand contributed 9.3 per cent.[32]

Table 2: Financial Components of Renewable Energy Project & Power Sector Rehabilitation Project

Components	USD million	%
Asian Development Fund (grants of USD$10m & USD$8.21m)	18.21	68.0
Clean Energy Fund - Clean Energy Financing Partnership Facility	1.00	3.7
European Union	5.06	18.9
Government of New Zealand (NZD$3.76 m)	2.49	9.3
Total	**26.76**	**100.0**

Source: Asian Development Bank, https://www.adb.org/projects/46044-002/main#project-pds, accessed February 2021

[32] Draft EPC reporting indicates USD27.17m which includes Green Climate Fund, EPC & GoS support. The total may not include the Taelefaga SHP, a late addition, which could increase the total to about USD30m

Annex 3: New PV and Hydro Capacity, Energy & Estimated GHG Reductions in 2020

The first two tables provide the targets for hydro capacity increases and emissions reductions, and achievements in 2020. The bottom (PV) table shows reported generation of Project-funded PV systems in 2020, adjusted for apparent errors in 2019 data. The average for 2014 to 2020 (minus apparent misreporting in 2019) is more indicative of actual PV output.

Capacity addition in MW	Target	Achieved
New hydropower schemes capacity		
(i) Upolu Island		
a. Faleaseela SHP (cancelled)	0.19	-
b. Tafitoala-Fausaga SHP	0.46	0.65
c. Fuluasou SHP		0.70
d. Taelefaga hydro 3rd generator set		2.00
(ii) Savai'i Island		
a. Faleta, Vailoa	0.16	0.20
Total Capacity of new hydropower schemes	0.81	3.55
Rehabilitation of existing hydropower		
(i) Upolu Island		
a. Fale ole Fee SHP	1.74	1.74
b. Alaoa SHP	1.05	1.05
c. Samasoni SHP	1.90	1.90
Total capacity of rehabilitated hydropower schemes	4.69	4.69
Total capacity of new & rehabilitated hydropower	**5.50**	**8.24**
Percentage Increase, relative to target		**50%**

Note: Targets from ADB Results Framework Indicators

Hydropower Reduction in GHG Emissions (metric tons CO_2 equivalent per year) (calendar year 2020)	Target Avoided GHG (tons CO_2)	Energy Production (kWh)	Diesel Fuel Saving (litres)	Actual Avoided GHG (tons CO_2)
(i) Upolu Island SHPs				
a. Faleaseela (cancelled; due to land access)	856			
b. Tafitoala-Fausaga	1,333	2,267,765	566,941	1,478
c. Fuluasou		1,348,000	337,000	879
d. Taelefaga hydro 3rd genset		5,366,400	1,341,600	3,498
e. Fale ole Fee	2,699	4,846,446	1,211,612	3,159
f. Alaoa hydro	2,575	3,368,875	842,219	2,196
g. Samasoni	3,127	6,812,038	1,703,010	4,441
(ii) Savai'i Island SHP				
a. Faleata, Vailoa	848	629,112	157,278	410
Total Energy (kWh) & fuel reduction (litres)		629,112	157,278	
Total GHG reduction; tons CO_2 equivalent	**11,438**			**16,062**
Increase in avoided CO_2 end of project				***40%***

Notes: 1) Assumes CO_2 emissions from diesel generators: 2.65 kg CO_2/litre of distillate
2) Fuluasou SHP was a late addition to the Project
3) CO_2 reductions from improved diesel efficiency from 2014-2020 were 82% higher than for new RE. In terms of CO_2 per litre saved, diesel showed a 40% improvement.
4) Based on preliminary information prepared by EPC for final project reporting to ADB, 16 February 2021.

PV System Generation Estimate for 2020	MWh
Gym3 roof mounted 250 KW Upolu)	289.389
Race course 2.2 MW (Upolu)	2,377.245
Salelologa power station 125 KW Savai'i	151.940
Actual generation 2020 (MWh)	2,818.574
Average generation 2014-2020 (except 2019)	3,300

Case Study – Tonga
Strategic Evaluation of MFAT's Energy Programme

Tonga Village Network Upgrade Project (TVNUP), Stages 2 & 3
(Ref: ACT-0K11589)

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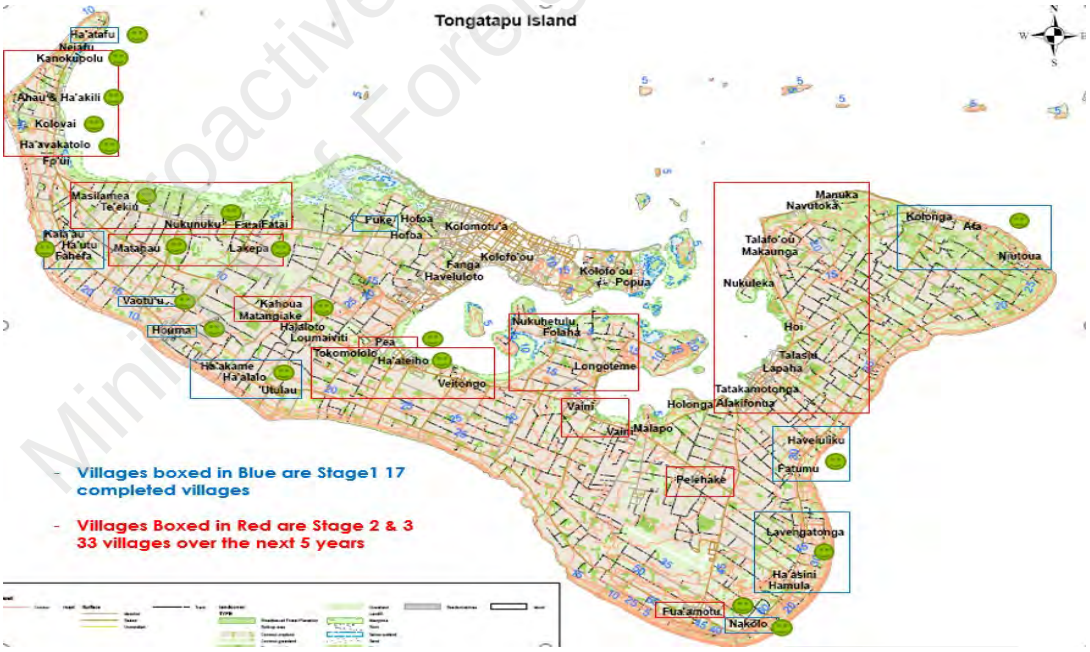
List of abbreviations and acronyms

ESITO	Electricity Supply Industrial Training Organisation
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhous Gas
GoT	Government of Tonga
kWh	kilowatt hour
MFAT	New Zealand Ministry of Foreign Affairs and Trade
MW	megawatt
NDC	Nationally Determined Contributions
NNUP	Nuku'alofa Village Network Upgrade
NZQA	New Zealand Qualification Authority
PES	Pacific Energy Summit (2013)
SDG	Sustainable Development Goal
TERM	Tonga Energy Road Map
TPL	Tonga Power Ltd
TVNUP 1	Tonga Village Network Upgrade – Stage 1
TVNUP 2 & 3	Tonga Village Network Upgrade – Stages 2 & 3
US	United States
USD	United States Dollars

Geographical location of project villages



1 Objective, key findings and considerations for future direction

The New Zealand Ministry of Foreign Affairs and Trade (MFAT) commissioned Tetra Tech International Development to undertake a Strategic Evaluation of the Energy Programme (the Programme). The aim of the strategic evaluation is to serve MFAT's dual key purpose: to account for New Zealand's investment through the Programme, and to improve what future investment can achieve. The scope of the strategic evaluation involves assessing Programme performance as a whole from 2012 to 2019 and undertaking case studies for six activities (five in the Pacific and one in Indonesia) to generate a solid evidence base about what works and lessons learned.

The objective of the six case studies is to garner further detail to support strategic level findings, but also provide evidence to support and meet independent evaluation requirements for the activities themselves. This report presents the key findings from the case study undertaken of the Tonga Village Network Upgrade (TVNUP) Stages 2 & 3 (ACT-0K11589), referred to hereafter as the 'Activity'. The findings within this report are based on analysis of evidence gathered from document reviews and consultations with internal and external stakeholders. These findings contribute to the broader strategic evaluation and are intended to inform future programming decisions.

Key findings and lessons learned

The Activity was highly relevant and consistent with Tonga's development aspirations, needs and priorities. The Activity was highly complementary to past, current and future development partners' efforts to support Tonga to meet its target of 70 per cent renewable energy by 2030. The Government of Tonga's consistency in promoting the Activity as the key prerequisite for achieving its renewable energy target gave a very strong and consistent message about its priorities. The improved resilience of the network and staff capability enabled Tonga to quickly recover from two recent tropical cyclones and contributed to minimal disruption to service delivery in the health and hospitals sector.

The recipient communities were highly satisfied with the Activity and 68 per cent of households considered their electricity supply as either reliable or very reliable. Almost all (95 per cent) households and businesses surveyed rated the cost of connecting to the electricity service as very affordable, and all (100 per cent) stated the service is very accessible. All respondents noticed changes in the service provided by Tonga Power Ltd (TPL) since the upgrade and 73 per cent perceived the network as being safer.

The Activity was highly effective in achieving its outputs and outcomes targets, and exceeded set targets in many instances. Reduced losses were met as planned (100 per cent), reduced faults in the network were exceeded (113 per cent), reduced accidents due to faults in the house wiring were exceeded (111 per cent), while reliability of the network was also exceeded (135 per cent). Thirty-eight villages and four schools were upgraded, compared to a target of 33 villages. A total of 3,000 prepayment meters were installed, as planned. Sixteen line technicians were trained to NZ Level 4 standards compared to a target of 13. The Activity was implemented to New Zealand standards by a highly skilled, trained, and motivated local work force.

Achievement of financial and tariff-related targets are more complicated and require more time for the Activity to make an impact, noting that the financial health of the TPL can be easily derailed by natural disasters and external factors that are outside TPL's control. The Activity's target of improving the financial health of TPL in terms of improved return on assets, improved net cash from operation and reduced maintenance expenditures were not achieved primarily due to the impacts of Cyclone Gita on TPL's assets and costs. At the same time, diesel prices were increasing, while the tariff remained unchanged as part of the economy's post-cyclone recovery, and therefore the target of reducing the tariff by 2.6 cents / kWh was not achieved.

The Activity was efficiently managed and was completed on time and within budget due to an effective Project Steering Committee and close collaboration between the MFAT, authorities as well as local stakeholders and communities in the villages. TPL's financial management of the Activity was highly satisfactory and exceeded all expectations. There were savings in the overall Activity budget which allowed additional villages and schools to participate in the network upgrade. A specialist energy economist was hired early in the Activity implementation to review the results framework, and helped to produce realistic outcomes measures and collect the baseline data.

There are promising signs about TPL's ability to manage the Activity in a financially sustainable manner. TPL has the ability to adjust its tariff to reflect rising costs. It is motivated by a concession contract that would provide a financial gain for improved efficiency and has budgeted sufficiently for the maintenance of the network during the next five years.

Long-term technical sustainability of the Activity is supported by an upgraded and resilient network, a highly trained power utility technical staff with practical hands-on experiences and equipped with specialised equipment and vehicles. TPL has been empowered with specialised tools and equipment to effectively monitor the performance of the Activity and to maintain it. The high level of standards adopted in the design, installation and training ensure the durability of the network.

Effective Activity management (showcasing accountability and compliance to Agreements) and project delivery led to increased donor and investor confidence in Tonga's energy sector and to additional donor funding. The increased confidence contributed to additional donor-funded power projects including: a 6 megawatt (MW) solar Power Purchase Agreement with a Sunergise NZ Ltd in 2019; the commissioning of a Japan-funded 1.3 MW wind farm in 2019; the signing in 2020 of the construction of a 2.2 MW wind farm by the China Energy Engineering Group; and a plan to invite a wind independent power producer to generate electricity in Tonga.

Considerations for future energy sector assistance

For Tonga:

- MFAT should consider leveraging its partners to document and widely share the experiences from the TVNUP and other similar upgrades in the country, using these activities for hands-on training and empowering trained TPL staff as coaches/trainers to continue building and maintaining local capacity.
- Consideration should be given to whether tariff reduction targets are appropriate and/or meaningful given they are influenced by external factors outside of the Activity's control. For example, tariff reduction may not be an acceptable or appropriate policy intervention during economic or post-disaster recovery periods.

For Pacific Islands Countries (PICs) generally (including Tonga):

- The PICs have similar ambitious renewable energy targets such as Tonga's and they have similar inefficient, unsafe and vulnerable electricity distribution networks. MFAT could use its experiences from the Activity to leverage development partners' support to address similar challenges, including the maintenance of large quantities of new assets in other PICs.
- "Reducing fossil fuel dependence", "reducing GHG emissions" and "improving affordability of energy" are appealing high-level outcomes that address both energy security and climate change priorities. However, they should only be selectively applied to projects where their impacts can realistically be measured. Where these outcomes are applied, a counterfactual could be selected to account for matters such as changes in fuel price and increase energy demand/use.
- "Reducing fossil fuel dependence" and "reducing GHG emissions" cannot be the determining factor for funding an energy project in the PICs. MFAT and development partners should also consider the trade-offs with increased efficiency as well as improved safety, reliability and resilience.
- There is good value for money from investments focusing on utilising the local workforce, adopting recognised and higher standards of training, equipment and installation, and engaging independent specialists to provide a third-party view of specific issues of the investment.
- The use of an effective high-level project oversight group, in the form of Project Coordination Committee or Project Management Unit, can drive momentum in activity implementation.

2 Background – the Activity and Case Study

2.1 Background on the Tonga Village Network Upgrade Project (TVNUP) – Stages 2 & 3

Tonga comprises 176 islands, spread over a total of 749 km^2 covering the five island groups of 'Eua, Ha'apai, Niuas, Tongatapu, and Vava'u. Tongatapu is the main island, accounting for about 70 percent of the total population of 105,000. Tonga has a small open economy that is vulnerable to external shocks and is

heavily reliant on remittances from Tongans working overseas as well as foreign aid. The United States is the main source of remittances, followed by New Zealand and Australia. Foreign development assistance in the form of loans, grants and direct aid is an important component of the Tongan economy. In 2019, the Gross Domestic Product (GDP) per capita was US$4,794.

Tonga is heavily dependent on imported fuel, with about 90 per cent of power generation coming from diesel while transport is 100 per cent dependent on fossil fuel. About 86 per cent of the electricity demand goes to Tongatapu, the main island and economic centre. Ninety-nine per cent of the population have access to electricity. With its vulnerability to climate change and the economic impacts of the volatility of fossil fuel prices, Tonga adopted its Energy Road Map (TERM) 2010 – 2020) as a ten-year road map to reduce Tonga's vulnerability to oil price shocks and achieve an increase in quality access to modern energy services in an environmentally sustainable manner.

The TERM recognised that Tonga's sustainable energy efforts are heavily leaning towards renewable energy. It acknowledged that energy efficiency is a promising low hanging fruit and the significant level of losses in its power distribution network. The TERM appreciated the need for very effective coordination between the various arms of government and with development partners too.

The Government of Tonga (GoT) hosted the inaugural Pacific Leaders Energy Summit in March 2013 and shared its TERM model with other PICs. The Summit called on the World Bank and Development Partners to assist PICs' progress in the implementation of national energy sector plans, and to strengthen coordination of their financing and resource mobilisation.

The Pacific Energy Summit (PES), co-hosted by New Zealand and the European Union (EU), was held in Auckland, straight after the Summit in Tonga. The PES noted that many PICs have outdated technology, including in some cases overloaded electricity transmission and distribution systems which require modernisation and/or expansion. Tonga reported its priority investment concepts to the PES and these included the Tonga Village Network Upgrade Project – Stages 2 & 3 (Activity). As part of the PES Tonga package, New Zealand's Minister of Foreign Affairs approved the concept note for the Activity. The Activity then became the first deliverable under the portfolio of 18 projects New Zealand announced for indicative support at the PES.

The Activity was built on TVNUP Stage 1 which was signed in 2011 and which proved to be a resounding success delivering significant improvements to electricity safety, reliability and accessibility in Tongatapu. The Nuku'alofa Network Upgrade Project (NNUP) was signed in May 2018 and was to upgrade the network for the 12 villages of Kolomotu'a and Kolofo'ou respectively.

Table 1: Stages of the Village Network Upgrades

Network Upgrade Project (NUP) Phase	Start Date	End Date	NZ Assistance (NZD)
TVNUP 1	March 2011	March 2013	$5.8 million
TVNUP 2 & 3	September 2013	December 2018	$26 million
NNUP	May 2018	March 2021	$11 million

2.2 Activity objective, rationale, and interventions

Tonga's electricity sector was clouded with ageing and poorly maintained infrastructure. The power utility did not have a strong financial position, and therefore maintaining and upgrading existing infrastructure was severely affected. As a result, the generation and supply of electricity to rural villages in Tonga was inefficient, unreliable and unsafe too. Public safety had become a high-profile issue for the power utility due to the dilapidated network's insulated low hanging wires and faulty or illegal connections. The poor state of the network had raised major public concerns about safety, illegal connections had been made undetected and had led to significant efficiency losses and higher diesel usage. It was also a major risk to future investors [and the 70 per cent renewable energy by 2030 target] who may wish to generate electricity and distribute it through this network.

The goal of the Activity was to create an environment for sustainable economic growth through improved electricity accessibility, reliability and safety. Outcomes sought for the Activity are shown below.

Expected key long-term outcomes were:

- Improved economically productive use of electricity in villages.

Expected key medium-term outcomes were:

- Improved financial health of Tonga Power Ltd
- Improved perception of value of electricity supply
- Reduced accidents caused by poor household wiring in villages
- Delivery of safe and reliable electricity to village households and businesses
- Lower electricity tariff.

Expected key short-term outcomes were:

- Reduced disconnections and reconnections for prepay customers
- Increase in electricity demand in villages
- Reduced energy losses
- Reduced faults and accidents caused by poor condition of High Voltage and Low Voltage village networks
- Project delivered by dedicated TNVUP team.

Expected outputs include:

- Upgraded electricity networks in 33 villages in Tongatapu
- 3,000 pre-pay meters installed across Tongatapu
- 13 lines technicians trained and qualified to New Zealand Qualification Authority (NZQA) Level 3 standard.

The activities carried out under the Activity were generally to upgrade low voltage and high voltage power distribution networks in the villages of Tongatapu to increase safety, efficiency and accessibility. More specifically, it was to:

- Upgrade village power distribution networks in 33 villages in Tongatapu, and replace overhead low voltage (400/230 Volts) distribution systems in villages with new systems designed and constructed in accordance with New Zealand standards. An estimated 7,640 service connections from the overhead systems to the customer's premises (commercial and households) was to be installed underground. The upgrades associated with the high voltage (11 kV) network were to be done to NZ standards at GoT's costs.
- Install 3,000 pre-pay meters at selected household connections in conjunction with the network upgrading.
- Build and maintain capability within TPL and increase individual skill level in the installation and maintenance of village electricity distribution networks and ensure TPL's staff are trained to Level 4 by trainers from New Zealand in accordance with the Electricity Supply Industry Training Organisation (ESITO) standards.

The Activity was generally targeting the following groups with the following influence and designed change:

- The current and future electricity consumers in the target 33 villages were the target of the Activity. These included households, churches and community-related premises as well as the commercial and business community too. The Activity was aimed at providing them with a more efficient, reliable and safer source of electricity to give them more confidence and appreciation of the value of improved electricity services, and enable them to go about their daily business and productive activities.
- This target group included customers with bad payment records and this included consumers who are continuously disconnected because of failure to pay their bills and on time too. It also included low income customers who are likely to fail to make full and timely payments of bills. These customers were to be provided with prepayments meters allowing them to continuously monitor their consumption and to regularly top up in advance.
- TPL was the ultimate beneficiary of the Activity through the ownership of an upgraded safer, more resilient and more efficient network plus equipment and vehicles that were transferred from TVNUP 1 and bought under the Activity. TPL systems were improved by the intervention by way of its ability to effectively manage major procurement and tenders [by island scale]. The extra staff recruited

strengthened TPL's project management and technical capacity as well as training its lines people to NZ accredited standards.

- The setting took place at the target 33 rural villages in Tongatapu. These were later varied to include five other villages plus three boarding schools and the prison. The boarding schools included Tupou College - a 155 years old boys-only school with a student roll of close to 1,500. Population size and land area vary among the villages. The number of connections per village that were upgraded was within the range of 43 to 883, and the number of connections closely relates to the number of households in each village. The villages share similar characteristics with regards to the old poles, conductors and fuses used in the network and the efficiency of the network in each village vary.
- The major electricity consumers in the villages are the households – mostly for lighting, refrigeration, laundry and entertainment. Major economic activities that are powered with electricity include tourism-related activities, small retail shops, handicraft making and light construction, and industrial and manufacturing activities.

2.3 Methods for undertaking the case study

The case study report is based on the analysis of both primary and secondary data. The evaluation team first reviewed relevant Activity-related documentation to understand how the Activity was designed, implemented and what results were achieved in line with the Activity objectives. To complement this, consultations with relevant internal and external stakeholders were conducted to gain deeper understanding and nuance of the Activity implementation, results and lessons learned to inform findings on the relevance, coherence, effectiveness, efficiency and sustainability of the Activity as well as future directions of the Energy Programme.

The data collection for this case study was mostly based on project reports and documentation. These were then corroborated against data from non-project documents and reports, as well as interviews with stakeholders who were either involved in the implementation and management of the project or were beneficiaries. The non-project documentation reviewed included: Pacific Power Utilities Benchmarking Reports from 2012 and 2018; ADB's annual Pacific Energy Updates; the Tonga Energy Roadmap; and Tonga Electricity Commission documents. Annex 1 provides a list of the documentation reviewed and the stakeholders consulted for the case study.

Those interviewed included former and current project managers at TPL, school principals (beneficiaries), the Director of Energy (coordinator of the TERM) and the electricity regulator. It was not possible to reach out to a large number of the beneficiary household customers, but the outcome of the independent customer survey provided a very good snapshot of their perceptions of the project (see Annex 4).

The main challenge in undertaking the case study and data collection was the inability to visit Tonga and conduct the interviews face-to-face and visit the project sites, TPL's store houses and maintenance sheds, etc. While consumer satisfaction surveys were conducted, speaking to villagers and businesses owners may have contributed to richer findings. Obtaining independent data to corroborate against data from the project reports was also a challenge in some instances. For example, while the school principals said that the reliability of their power supply has improved, they were not able to offer any recorded data to verify their claims.

There was not an opportunity to interview key Project Coordination Committee members such as the Ministry of Public Enterprises and the Ministry of Finance and National Planning. It was not possible to interview management of TPL and current and past TPL Project Managers of the Activity within the evaluation timeframe.

3 Case study findings and lessons learned

The key questions for the case study are based on the Organisation of Economic Cooperation and Development's Development Assistance Committee (OECD DAC) criteria (shown in the table below). As such, the findings presented in this report are structured by the DAC criteria. Though the case study relates specifically to this Activity, the primary purpose of this case study is to inform the broader strategic evaluation. It is not intended to be a comprehensive evaluation of the Activity itself. Analysis undertaken for this case study relied heavily on document reviews and stakeholder interviews held remotely due to COVID-19. Findings, lessons learned, and considerations for future efforts should be read in this context.

Objective	Description
Relevance and coherence	To examine the relevance, significance, and coherence of the Activity.
Effectiveness	To examine the extent to which the Activity achieved, or is expected to achieve, its objectives and results.
Efficiency	To review the effectiveness of MFAT's approach and ways of working i.e. internal roles and responsibilities and resource allocation, funding, contracting and delivery (management and governance) modalities to deliver expected results.
Sustainability	To assess the sustainability - physical, operational, economic, social, environmental and resilience of the Activity investments.
Future directions	To document lessons learned from the Activity that can inform strategy, policy and improved ways of working for the Activity and the Energy Programme as a whole.

3.1 Relevance and coherence

Relevant and consistent with Tonga's development aspirations, needs and priorities

The design of the Activity was directly relevant and in line with the GoT's priorities. The GoT's vision under its Strategic Development Framework II: 2015-2025 is for more inclusive and sustainable growth and development. This is supported by two outcomes that are directly related to the Activity: (i) successful provision and maintenance of infrastructure; and (ii) effective environment management and resilience to climate and risks. The Activity is essentially about the investment in and maintenance of infrastructure (power distribution network) and the resilience of the network to natural disasters and climate risks.

The TERM 2010 – 2020 is Tonga's ten-year road map to reduce Tonga's vulnerability to oil price shocks and achieve an increase in quality access to modern energy services in an environmentally sustainable manner. The TERM sets a national energy target of 50 per cent renewable energy to be achieved by 2020. This has been revised to 70 per cent by 2030 and is reflected in its Nationally Determined Contributions (NDCs) too. The TERM, however, recognised that if losses in its power distribution network (above 20 per cent) are not addressed, achieving the target would become more difficult due to losses, wastages, thefts and unaccounted consumption. Upgrading the network was therefore a priority activity of the TERM and raised as a priority initiative in Tonga's dialogue with its development partners.

The TERM, the Tonga NDCs and the Tonga Energy Efficiency Master Plan: 2020-2030 all list the upgrade of the electricity distribution network as a national priority. The Activity was therefore strongly relevant and coherent with the GoT's, policies and priorities.

Relevant and consistent with New Zealand and global priorities

The Activity was highly relevant to the strategic objectives and vision of the New Zealand Aid Programme Renewable Energy (Flagship) Investment Priority (2015-2019) and Strategic Plan (2015-2019).

The Flagship Programme aimed to reduce poverty and had a goal of expanding access to affordable, reliable and clean energy. The goal of the Activity was to create an environment for sustainable economic growth through improved electricity accessibility, reliability and safety. The Activity directly addressed poverty alleviation by providing an environment for economic growth. It also addressed two of the four (50 per cent) elements of energy security in the Flagship programme – accessibility and reliability. The Activity also directly addressed four out of the eight (50 per cent) Flagship programme outcomes:

- More reliable and resilient energy supply
- Increased renewable energy production
- More efficient energy supply (production and delivery)
- More effective operation, maintenance and renewal assets.

The Activity supported MFAT's aspiration to leave no one behind. It was a continuation of MFAT's support to the TVNUP Stage 1 which upgraded 2,482 connections in 17 villages from 2011 to 2013. The activity was designed to upgrade 7,640 additional connections in the remaining 33 villages of Tongatapu, and to provide everyone with the equal benefits of a more reliable, efficient, accessible and safer supply of electricity. It covered every electricity customer who was connected to the grid and no one was left behind. Indirectly, older persons, people with special needs, children and women were all covered in and benefitted from the Activity. Even future customers who will be connected to the network will also enjoy the benefits of MFAT's assistance. Even the more vulnerable and marginalised sections of the communities, whose electricity supply was often disconnected, were supported with the provision of pre-payment meters to ensure they enjoy the benefits of MFAT's assistance.

MFAT undertook its role as donor for this Activity in accordance with MFAT's international development cooperation principles (effectiveness, inclusiveness, resilience and sustainability) as well as the Global Partnership for Effective Development Cooperation (country ownership, a focus on results, inclusive partnerships, and transparency and mutual accountability). Tonga's profile in the Global Partnership for Effective Development Cooperation acknowledged New Zealand as their major Development Partner in 2018 (accounting for 48 per cent of the country's development assistance) and also highlighted New Zealand's commitment to Tonga's reform of its energy sector. The implementation of the Activity was also in line with the five key principles of the Paris Declaration on Aid Effectiveness, and in particular the: anchoring of the support on the TERM which is a national priority; close coordination of the project with other donor efforts in Tonga's energy sector; and the open and consultative process adopted in managing the Activity.

The Activity is also closely aligned with Sustainable Development Goal (SDG) 7 - 'Ensure access to affordable, reliable, sustainable and modern energy for all', and in particular Target 7.1 - 'By 2030, ensure universal access to affordable, reliable and modern energy services' and Target 7.3 - 'By 2030, Double the global rate of improvement in energy efficiency'. It is also closely aligned to SDG 13 - 'Take Action to combat climate change and its impacts' and Target 13.1 - 'Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries'. New Zealand is a party to the UNFCCC and the Kyoto Protocol and is therefore guided by these two instruments with regards to its climate change responsibilities. As an Annex 1 Party, it is supposed to provide financial support and technology transfer to Non-Annex 1 parties. In its 7th National Communication to the UNFCCC and Kyoto Protocol covering the period 2014 to 2017, New Zealand listed the Activity as part of its contributions as an Annex 1 Party.

Factors enabling relevance and coherence

- The relevance of the Activity benefitted from Tonga's aggressive promotion of its TERM and its ambitious renewable energy target, which has been a common agenda in Tonga's dialogues with its development partners, including its hosting of the Pacific Leaders Energy Summit in 2013.
- Tonga's consistency in promoting the Activity as the key prerequisite for achieving its renewable energy target gave a very strong and consistent message about its priorities. Achieving the 70 per cent renewable energy target by 2030 would be extremely difficult if grid-integrated renewable energy is to be distributed in a network where losses are more than 20 per cent, is unsafe or unreliable.
- The establishment of an effective Project Coordination Committee with high level representation from key related sectors such as the Power Utility, Energy, Climate Change, Public Enterprises and Finance and National Planning in addition to MFAT ensured collective support to the Activity by the relevant local authorities.
- The consistency of allocating one donor (New Zealand) to lead in the upgrade of the electricity network over a period of 10 years ensured the same experts, equipment and approach was consistently applied across the stages of the network upgrade.

Factors hindering relevance and coherence

- While the Activity resulted in increased efficiency, safety and resilience of the network, it also led to increased consumer demand (inherent to the design of the Activity) and as a result greater diesel consumption and GHG emissions. This may be perceived as lacking coherence to climate change mitigation efforts.

3.2 Effectiveness

The Activity has fully delivered and exceeded the achievement of its outputs in terms of: the number of villages networks upgraded; the numbers of prepayment meters installed; and number of line technicians trained to New Zealand's Level 4 qualification. This is largely due to the effective management of the project by a highly dedicated and skilled staff of the TPL and their very close and effective relationships with the target village communities. The effective project oversight by MFAT and its Project Coordination Committee contributed to the achievement of the project outputs.

The Activity has not achieved its improved financial health and lower power tariff targets. This was mostly due to external factors that are beyond the TPL's control. Tropical Cyclone Gita hit Tonga towards the end of the Activity and therefore more of TPL's financial and technical resources were diverted to cyclone recovery efforts. At the same time and during a period of increasing fossil fuel prices, decisions were made to maintain (and not reduce) tariffs to support economic recovery efforts.

Table 2: Achievement of the Activity's Short-term Outcomes and Outputs

Outputs & Short-term outcomes	Indicator	Baseline	Target	Achievement	% of target achieved
Upgraded village network	No. of villages & connections	0	33 villages 7,700 connections	38 villages & 4 schools 9586 connections	127% 125%
Prepayment meters installed	No. of prepayment meters	0	3,000	3,000	100%
Lines technicians trained to NZQA	No. of trained technicians	0	13	16	123%
Reduced disconnections and reconnections for prepay customers	No. of disconnections & reconnections	1,500 or both per month	800 per month	1194 per month	Not yet achieved. Remote & automatic disconnection & reconnection
Increase in electricity demand in villages	Metered consumption	0	7.5%	12.8%	170%
Reduced energy losses	Average LV feeder losses	12%	5%	Average of 5%	100%
Reduced faults and accidents caused by poor condition of HV and LV village networks	Faults from HV & LV network problems	TBC	75%	83%	113%
Project delivered by dedicated TNVUP team	Staff seconded to the project	0	0	0	100%
	No. of women in the project	2 in the field / 2 in the office	Retention of baseline (4)	10	250%

The Activity has also delivered and exceeded its long-term outcome targets, particularly with regard to the house wiring faults, safety and reliability of electricity and the consumers' perception of the value of electricity. These were mostly the result of the excellent and close working relationship between TPL, consumers and beneficiaries of the Activity.

The Activity has not achieved its improved financial health and lower power tariff targets. This was mostly due to external factors that are beyond the TPL's control. Tropical Cyclone Gita hit Tonga towards the end of the Activity and therefore more of TPL's financial and technical resources were diverted to cyclone recovery efforts. At the same time and during a period of increasing fossil fuel prices, decisions were made to maintain (and not reduce) tariffs to support economic recovery efforts.

Table 3: Achievement of the Activity's Long and Medium-term Outcomes

Long & mid-term outcomes	Indicator	Baseline	Target	Achievement	% of target achieved
Improved productive use of electricity	No. of new and expanded businesses	5%	10% increase	33% of people surveyed run a business powered by electricity & of the 13 businesses surveyed, 10 planned to expand their business because of the upgraded network.	Achieved
Improved Financial Health of TPL	• RoA • Net cash • Maintenance expenditures	• 3.1% • T$11.5m • T$1.5m	• 4% • T$13m • T$.8m	• 3.3% • T$11.7m • T$1m	Not achieved due to TC Gita & tariff remain unchanged during fuel price increase
Improved perception of the value of electricity supply	No. satisfied customers	10%	25%	• Reliability – improved • Safety – 100% • Reliability – improved • Accessibility - increased from 19 – 22%	Achieved
Reduced accidents	Faults in house wiring	46%	66%	73%	111%
Safe & reliable electricity	Reliability stats	SAIDI – 1139 minutes	20% reduction	27%	135%
	Claims for damages	T$40,000 per annum	T$30,000 per annum	No claims	Achieved
Lower power tariff	Tariff impact of TVNUP	0 cents / kWh	2.6 cents / kWh	No tariff decrease	Not achieved

The Activity has effectively addressed the ambition of the Tonga Energy Roadmap to achieve a target of 70 per cent renewable energy by 2030. It has upgraded an inefficient, unsafe and unreliable network so that renewable energy generated electricity can be distributed through it with minimal losses and wastages.

The network upgrade by itself has increased donor and investor confidence in Tonga's Energy Sector. Power Purchase Agreements have been signed with Independent Power Producers in solar and wind. Further donor-funded wind power projects have been commissioned and a new one is under construction.

Factors enabling effectiveness

- There was very close and effective collaboration among the project partners. The Project Coordination Committee was effective in its oversight role too.
- TPL was engaged in a major promotional drive, including a village beautification competition and the villages and communities actively participated. Community buy-in for the Activity was very high and encouraging.
- A specialist energy economist was hired early in the Activity implementation to review the results framework. This exercise helped to produce realistic outcomes, collect the baseline data as well as the appropriate metrics for the performance verification.
- The early assessment of the Procurement Policy used by the Activity and the confirmation of its compatibility with international best practices cleared the way for an acceleration in the implementation.

Factors hindering effectiveness

- Tropical cyclones redirected TPL's effort and resources to the post cyclone recovery effort.

3.3 Efficiency

The Activity was efficiently managed and it was completed on time and within budget. The Grant Funding Agreement was signed in September 2013 and completed in December 2018. Below is an illustration of the financial savings from the Activity.

Table 4: Summary financial update as at project completion

Description	Amount received (TOP)	Total expenditure (TOP)	Total savings (TOP)
Tranche received	30,606,346.26		
GITA replenish fund	4,454,342.98		
CT refund	515,283.02		
Total Gain in Exchange rate	1,438,048.89		
Total	**37,014,021.15**	**33,101,258.29**	**3,912,762.86**

Tonga's and New Zealand's commitment to the Activity contributed to its efficiency. Their commitment was outlined in a clear and practical Grant Funding Agreement which had the flexibility to be varied to accommodate changing circumstances. A Project Coordination Committee (the Committee) composing of representatives from Finance (chair), TPL, Energy and Climate Change, Public Enterprises and MFAT were the core members of the Committee. The participation of the CEOs of Public Enterprises and Finance enabled TPL to raise the issues of one Public Enterprise charging consumption tax to the Activity to be resolved quickly. The sharing of the project governance between the Committee, TPL and MFAT contributed to the effective management of the Activity. The regular Committee monthly meetings and the six-monthly Committee Leadership meetings all contributed to the effective oversight to the Activity, the timely address of implementation of challenges as they arose, and the timely reconciliation of the Activity progress and expenses, and the approvals of project work plans with the associated downloads of Activity funds.

The original Grant Funding Agreement included a description of the Activity and the overarching goal and the intended outcomes to be achieved. In order to make the Activity more realistic and practical, the Agreement directed that these would be reviewed during the first six months of the Activity. The review took place and a Letter of Variation was later signed to reflect the amendments. This was a very important step from a Monitoring and Evaluation (M&E) perspective because the goal and outcomes became more realistic and they can practically be verified too. The performance-based Agreement (further strengthened by the Letter of Variation), incorporated measures such as payment and reporting milestones, requirements

for satisfactory Progress Reports, costed workplans and Annual Audit Reports. This contributed to the success of the Activity and kept the Activity moving so that Activity funds could be released.

MFAT actively participated in the management of the Activity, always participating in the Project Coordination Committee meetings and articulated New Zealand's interests and promoting high standards and levels of professionalism in the Activity. The Activity benefitted from benchmarking the upgraded network to the NZ standards in terms of products, work ethic and practice. The training of the line technicians was according to NZQA Level 4, which made it possible for some of these trained technicians to be sent to Fiji to support their recovery from Tropical Cyclone Winston in 2016.

Given how hardware-intensive the Activity was, it was important to ensure that procurement was done to the highest standard. The consultancy to assess the compatibility of the Tonga government's procurement policy with international best practices contributed vastly to the effective management of the Activity. To highlight the importance of the procurement aspects of the Activity, purchases of more than $100,000 were required to be approved by the Project Coordination Committee first.

As a hardware-intensive Activity, the success and sustainability of the Activity depends on the quality and standards of the goods purchased and installed, but also more importantly on the allocation for the project management as well as the human development. For this 5-year Activity in a small island country such as Tonga, the allocation of 14 per cent of the budget [$3.1 million] to project management and work upgrades, and staff training is considered reasonable or even generous.

Factors enabling efficiency

- The GoT was able to exempt the consumption tax of locally purchased goods, particularly the wooden electric poles. This saved the Activity close to $0.5 million.
- The efficient management of the Activity by TPL enabled a timely submission of the required progress report as well as costed work plans for approval by the Project Coordination Committee, and subsequently allowed MFAT to dispense the corresponding tranche of funds.

Factors hindering efficiency

- Several tropical cyclones affected Tonga during the Activity period. These included Ian (2014), Winston (2016) and Gita (2018). TPL's technical capacity and resources were stretched and diverted to the recovery required following these disasters.

3.4 Sustainability

The Activity has certainly strengthened TPL's technical capacity to sustainably manage the investment. There are also promising signs that TPL will be capable of managing the Activity in a financially sustainable manner into the future.

The reported results from the installations in terms of the new power poles installed and lengths of low voltage and service lines upgraded showed reduced losses and faults. These and related benefits associated with safety, reliability and accessibility can only be maintained based on the longevity of the upgraded network. The Activity was able to identify technical baselines prior to the upgrading of the network. It has also identified the corresponding performance indicators after the installations. With these performance data and the additional data loggers and metering used, TPL's capacity to identify any unusual decline in performance, beyond the usual wear and tear, has been strengthened and it can accordingly respond.

The Activity was able to support TPL's technical capacity by purchasing pole trailers, line and bucket trucks as well as mounted crane trucks plus double cabs vans which should allow it to respond effectively and efficiently to the monitoring and maintenance of the upgraded network.

The durability of the upgraded network is assured by TPL adopting New Zealand Standards with regard to the design and construction of the low voltage (400 / 230V) distribution systems and the upgrades of the high voltage (11 kV) network. Furthermore, TPL line staff were trained to Level 4 by NZ trainers in accordance with the Electrical Supply Industry Training Organization (ESITO).

In terms of the improved resilience of the network due to the investment, Tropical Cyclone Gita hit Tonga in February 2018. Also, Tropical Cyclone Harold hit in April 2020. In both instances, damages to the distribution network were less and it was much faster and easier for TPL to fix the damages to the upgraded network and to restore power. In fact, when Harold hit, the Vaiola Hospital was thankful that it lost power for only a day rather than weeks. There was minimal disruption to service delivery and minimal stress for staff and far fewer power surges.

The Activity employed 43 people, 35 of whom are currently working on the NNUP. Furthermore, 13 people who have been trained on NZQA Level 4 for line technicians are currently being employed under the NNUP. These are additional technical expertise within TPL to maintain the investment.

There are promising signs that TPL will be able to manage the investment in a financially sustainable manner.

TPL has been able to regularly adjust its tariff and pass on extra costs to its consumers, despite natural disasters and the COVID-19 pandemic. In November 2020, TPL announced a 4.6 per cent increase to accommodate the rising diesel costs. TPL usually get a subsidy from GoT if the tariff was to remain unchanged despite rising costs. For instance, from November 2019 to March 2020, GoT paid a subsidy to TPL in order to hold the tariff still over that period. In December 2020, TPL approved to absorb 2.47 cents / kWh out of a 4.47 cents / kWh increase to the non-fuel component of the tariff.

TPL is well positioned to benefit financially from the 3rd Electricity Concession Contract. The Electricity Concession Contract between TPL and the Tonga Electricity Commission for 2021-2025 is based on expected losses during the concession period. While the levels of the distribution losses have been agreed to, it is in TPL's interest to continue to improve on its efficiency and thereby earn extra revenue to assist it to be able to manage the investment in a sustainable manner.

The Activity will be a net benefit to TPL rather than a financial liability. The Activity was designed for TPL to increase diesel consumption and fossil fuel costs too. This increase in fuel costs is not seen as affecting TPL's financial health in a major way. The increased diesel costs are expected to be easily offset by the increased revenue from the increased new connections and demand and from the benefits of the improved safety, improved accessibility, reliability and resilience of the network plus the improved consumer satisfaction and confidence in the electricity sector.

TPL is well prepared to maintain the investment. TPL's forecasted capital expenditures for Distribution Network Equipment for the period 2016-2020 was a total of T$27.8 million. This has decreased by T$7 million for the period 2021-2025. While this may reflect the improved network requiring less maintenance, it demonstrates TPL's financial preparedness to look after the investment.

Factors enabling sustainability

- TPL has a good understanding of the baselines and targets of the Activity and being equipped to be able to monitor future performance and to deal with challenges in a timely manner as they arise.
- The adoption of the New Zealand standards for the network upgrade and line technicians training provides reassurance regarding the durability and resilience of the upgraded network and its benefits.
- The transfer of ownership of the specialised equipment, tools and vehicles, which should last another 10 years if properly maintained, helped to strengthen TPL's technical support capacity for the maintenance of the investment.
- The 3rd Electricity Concession Contract provides an incentive to TPL to continuously improve on its efficiency and reap the additional financial gains and improve its financial health.
- The increased diesel consumption as a result of the Activity is capably offset by the increase in revenue due to the increased electricity demand and the benefits of the improved accessibility, safety, reliability and resilience.
- Maintenance of the upgraded network is assured for the next 5 years as TPL has allocated the largest portion of its forecasted capital expenditures to the distribution network.

Factors hindering sustainability

- Natural disasters such as tropical cyclones can easily affect TPL's maintenance budget and cash reserves, and it can be difficult introducing tariff increases during post-disaster or economic recovery periods.
- The uncertainties surrounding the COVID-19 pandemic and its continuing adverse impacts on the tourism sector in Tonga may decrease power demand and TPL's revenue in the future.

4 Overall lessons learned

4.1 Overall lessons learned for the Activity

There are several lessons that could be derived from the Activity:

Overall lessons learned for the Activity

- The Grant Funding Agreement spelt out the goal and outcomes of the investment based on the understanding and agreement between the two governments. The results of the investment would have been different and a few key outcomes would not have been achieved nor able to be measured if it proceeded on the basis of the original Agreement. The recruitment of an independent energy economist within the first 6 months of Activity implementation to review the results framework and identify more nuanced metrics to measure the economic benefits and success of the investment made a large and positive difference. Unlike most donor-funded energy projects, the Activity did not have the traditional "reduce fossil fuel dependence", "reduce GHG emissions" and "improve affordability of energy" outcomes because of the review of the results framework. It should be added that the inclusion of customer surveys assisted in identifying the socio-economic impacts of the investment.
- The close alignment of the Activity with the national priorities of the donor as well as the recipient government contributed not only to the relevance and coherence of the Activity, but also the effectiveness, efficiency and sustainability of the Activity. The Activity was directly related to Tonga's primary guiding document for its energy sector (TERM: 201-2020). It was also directly related to New Zealand's Renewable Energy Flagship programme as well as its commitments made at regional energy summits / conference with Pacific Leaders. Given this, it was easy for Tonga to put in $6 million co-financing and have representation within the Project Coordination Committee at senior levels (i.e. CEO / Director levels). On New Zealand's side, MFAT worked diligently to achieve the goal and outcome of its flagship programme.
- Procurement is a key element of any major donor-supported project like this where most of the budget was to be spent on acquiring goods and services. The project engaged the services of an expert to assess the compatibility of the GoT's procurement policy with international best practices. The fact that the compatibility was confirmed early in the project implementation helped to build confidence and accelerate the Activity's momentum.
- The training of project staff was conducted by New Zealand trainers and towards a New Zealand qualification. Furthermore, the design and construction of the low and high voltage lines were in accordance with New Zealand standards too. This proved to improve the quality of the installations and their resilience to the impacts of climate change and natural disasters too.
- The Activity benefitted from the provision of open opportunities to both males and females in terms of people employed and trained, particularly the line technicians, as well as in terms of registered power consumers and steering committee members.
- Allowing a sufficient portion of the Activity budget to support project installation, equipment, project management, and staff upgrade and training contributed to the sustainability of the Activity. About 20 per cent of the Activity budget was allocated for this purpose, with 10 per cent for work upgrade and staff training. Part of the accomplishments of the investment was to do with investment in TPL's human resources and development.
- Activities with a longer lifecycle supports the embedding of technical capability in the country, and allows sufficient time for technical experts from overseas to support local staff through on-the-job learning and empowering them to provide training to others and institutionalise new capabilities.

4.2 Overall lessons learned for the Energy Programme

There are lessons learned for the Energy Programme and they include the following:

Overall lessons learned for the Energy Programme

- Importance of having independent and early advice on the setting of the Results Framework as well as an organisation to undertake Customer Satisfaction Surveys. This early review of the results framework identified socio-economic metrics for collection through the customer surveys.
- Building resilience by ensuring high training standards for the local workforce and providing required supplies in ahead of anticipated disasters to support quick recovery from shocks and disasters. Having pre-positioned supplies in Tonga after TC Harold meant that after the cyclone there were materials available to immediately fix the damage, which was done by locally trained staff (some of whom were sent to assist with an earlier recovery effort in Fiji).
- "Reducing fossil fuel dependence", "reducing GHG emissions" and "improving affordability of energy" are high level outcomes of most donor-funded programmes. However, these should be selectively applied to projects where their impacts can realistically be measured. Affordable electricity, reduced diesel consumption and reduced emissions were in the original results framework but were later removed after the independent review.
- Importance of the consistency in donor efforts: New Zealand funded the first major grid-connected renewable energy system in Tonga in 2011 [1.3 MW Maama Mai solar farm]. Recognising the key role of the distribution network in the integration of renewable energy, New Zealand began funding the TVNUP Stage 1. The Activity began in 2013 and NNUP began in 2018. To date, New Zealand has focused on upgrading the network over a period of 10 years and has built a strong reputation for itself in Tonga's energy sector.
- Firm local commitment and high-level participation: It is important to obtain commitment from the recipient government in terms of financial support. The TPL put in its own funding [approx. $6 m) to support the Activity. The GoT was able to exempt locally purchased goods from the consumption tax, approximated at more than $0.5 m. With this level of contribution, it would be in GoT's best interest to make the Activity a success.
- Value for money specialist services: The project benefitted from a highly skilled and experienced project team at TPL who were supported by an International Line Mechanic Specialist, a specialist that reviewed the Result framework, a specialist that reviewed the procurement practice, and a specialist that conducted the consumer surveys.
- Functional Project Coordination Committee: It is crucial to have strong coordination established for every Activity and to have representatives at levels who can make important decisions and contributions to the Activity. For instance, the exemption of the consumption tax from locally purchased goods was the result of the participation of the CEO of Finance in the Project Coordination Committee.
- Independent certification of the completed project: There is often the need for commissioning of the installed hardware energy systems by an expert that is independent of the contractor that did the installation. In the TVNUP, the installation was done by a team within the beneficiary (TPL). It is crucial for independent verification that the equipment and the installation were completed according to the New Zealand standards and as planned.

Annex 1: Documentation reviewed and stakeholders consulted

Documentation reviewed

Documentation reviewed for the case study consisted of:

MFAT project-specific documents	• Grant Financing Arrangement, EIA, Results Framework Review Report, Progress Reports, Activity Completion Assessment & Completion Report
NZ Government Report	• NZ Seventh National Communication report to the UNFCCC and Kyoto Protocol, Ministry for the Environment (2017)
ADB documents	• Pacific Energy Update 2018, ADB (2019) • Pacific Energy Update 2019, ADB (2020) • Pacific Energy Update 2020, ADB (2021)
TPL & Regional Benchmarking documents	• Annual Reports of the Power Ltd, TPL (2017, 2018 & 2019) • Minutes of the meetings of the Project Coordination Committee • Post Upgrade Perception Survey • Pacific Power Utilities Benchmarking Report 2012, Pacific Power Association (2013) • Pacific Power Utilities Benchmarking Report 2018, Pacific Power Association (2019)
GoT policy documents	• Tonga Energy Road Map, MEIDECC (2010) • Tonga Strategic Development Framework: 2015-2025 • Tonga intended Nationally Determined Contributions (2015) • Tonga Energy Road Map Review / Implementation Report 2010-2014, MEIDECC (2015) • The Third Electricity Concession Contract: 2021-2025, Tonga Electricity Commission (2021)

Most of the Activity documentation reviewed were either produced by TPL or by MFAT, and the level of detail and quality of data presented are to be commended. There were also project-related reports produced by consultants engaged by the project. The data collection and interviews were then framed to obtain some independent verification of what was reported and documented.

Stakeholders consulted and contacted

Primary Stakeholders	Names of stakeholders
Energy Programme team	• Owen Pau'u
Posts, Activity Managers and Programme teams for case study countries	• Owen Pau'u, Activity Manager • Faka'iloatonga Taumoefolau, former Activity Manager

Secondary Stakeholders	Names of stakeholders
Partner governments and other counterparts	• s9(2)(a) Tonga • s9(2)(a) Tonga • s9(2)(a) Tonga Electricity Commission • s9(2)(a) Finance and National Planning [no response] • s9(2)(a) Public Enterprises [responded but not yet available]
Direct implementing partners (e.g. technical advisers or contractors)	• s9(2)(a) TPL [responded but not yet available] • s9(2)(a) TVNUP [no response]
Beneficiaries	• s9(2)(a) Tupou College • s9(2)(a) Beulah College • See Annex 4 for the discussion and conclusions of the Customer Satisfaction Survey

Annex 2: Analysis of project expenditure

The table below shows project expenditure according to the Activity outputs, tranches received and other additional funds to the Activity.

Table 1: Donor funding

#	Output against Budget	Total Budget (NZD)	Total Expenditure (NZD)	Total Variance (NZD)
0	Project Management and Administration	899,620.00	328,243.99	571,376.01
1	Work Upgrade and Staff Training	2,223,100.00	2,213,141.17	9,958.83
2	Pre-pay Metering	807,950.00	807,950.00	0.00
3	Procurement of Plant & Equipment	1,252,000.00	1,234,027.89	17,972.11
4	Procurement of Tools & PPE	248,015.00	267,094.43	(19,079.43)
5	Materials Supplied to Villages	16,152,044.42	18,982,448.49	540,629.71
	Other funding received	*3,578,130.72		
	Total	**25,160,860.14**	**23,832,905.97**	****1,327,954.17**

**Refer to Table 3 in this Annex for the gain in exchange rate from the GITA materials replenish fund.*
***This variance is not the saving. Saving = Variance + Gain on exchange rate (refer to Table 2)*

Table 2: Tranches received

Date Registered	Tranche amount (NZD)	Tranche amount (TOP)	Exchange rate
21/10/2013	4,360,758.00	6,020,011.00	1.38
17/07/2014	484,528.00	701,222.00	1.45
01/09/2015	2,401,044.00	3,666,479.00	1.53
16/06/2015	1,301,542.00	1,750,413.84	1.34
25/09/2015	358,264.00	466,114.00	1.30
15/02/2016	2,600,794.00	3,699,074.31	1.42
30/06/2016	682,311.00	978,681.90	1.43
30/06/2016	193,454.00	284,903.40	1.47
4/01/2017	4,850,000.00	7,201,400.51	1.48
30/06/2017	1,075,000.00	1,619,135.00	1.51
31/03/2018	2,873,924.00	4,224,920.67	1.45
Total	**21,181,619.00**	**30,612,355.63**	**1.45**

Table 3: Other funds provided

Date Registered	Funding	Amount (TOP)	Amount (NZD)
14/06/2018	TVNUP Stage 1 CT	72,485.73	52,189.73
16/05/2018	TVNUP Stage 2&3 CT	442,797.29	318,814.05
	GITA materials replenish fund	4,454,342.98	3,207,126.95
Total		**4,969,626.00**	**3,578,130.72**

Note: Exchange rate in this table is 1.39 for conversion.

Annex 3: Breakdown of project villages and sites

The table below provides a breakdown of the original 33 villages, as well as the additional five villages and four schools where upgrades occurred. It also shows the completion date of upgrades for each of the villages / schools.

	#	Village	Completion Date
Year 1	1	Kanokupolu	March, 2014
	2	'Ahau	April, 2014
	3	Kolovai	June, 2014
	4	Ha'avakatolo	July, 2014
	5	Masilamea	August, 2014
	6	Te'ekiu	September, 2014
	7	Nukunuku	December, 2014
Year 2	8	Fatai	December, 2014
	9	Lakepa	December, 2014
	10	Matahau	April, 2015
	11	Liahona	April, 2015
	12	Matangiake	May, 2015
	13	Kahoua	May, 2015
	14	Pea	July, 2015
	15	Tokomololo	August, 2015
Year 3	16	Ha'ateiho	December, 2015
	17	Veitongo	April, 2016
	18	Nukuhetulu	April, 2016
	19	Folaha	May, 2016
	20	Longoteme	June, 2016
Year 4	21	Vaini	December, 2016
	22	Pelehake	January, 2017
	23	Fua'amotu	April, 2017
	24	'Alaki	May, 2017
	25	Tatakamotonga	July, 2017
Year 5	26	Lapaha	November, 2017
	27	Talasiu	November, 2017
	28	Hoi	December, 2017
	29	Nukuleka	April, 2018
	30	Makaunga	May, 2017
	31	Talafo'ou	May, 2018
	32	Navutoka	May, 2018
	33	Manuka	April, 2018
Variation Villages	34	Holonga	July, 2018
	35	Malapo	July, 2018
	36	Lomaiviti	August, 2018
	37	Makapaeo	August, 2018
	38	Fo'ui	August, 2018
Variation Schools	39	'Atele	September, 2018
	40	Piula	September, 2018
	41	Hu'atolitoli	September, 2018
	42	Toloa	September, 2018

Annex 4: Conclusions from the final Customer Satisfaction Survey Report

A customer perception survey was conducted annually by Ayala Consulting to examine, evaluate and enumerate the levels of awareness and local support for the outcomes of the TVNUP. Below is an extract from the Survey Report, which summarises the discussions and conclusions from a Survey conducted in July 2018.

Discussion and Conclusions (Extract from the Survey Report)

The overall analysis of the survey indicated that customers' perceptions of quality and value with regards to their electricity supply have been positively impacted by the TVNUP. However, this survey considers post-upgrade respondents over a range of timeframes to ascertain that the improved service has met or exceeded their expectations. It is obvious that those more recently connected have a more favourable perception than those connected from 2014 to 2017. This is not unusual as positive perceptions are based on and related back to improvements in product quality. When considering an overall perception, certain elements have been perceived to have deteriorated over time. The rationale pertaining to those neutral and less positive responses may include the following reasons:

- The service has already been upgraded to a higher standard and further improvements are likely to be less obvious than the original upgrade;
- Some respondents may have had unrealistic expectations, such as a price drop in the cost of electricity; and
- Some respondents are likely to have combined service deficiencies; household electricity wiring and whitegoods faults; as well as poor personal management of household electricity supply. Subsequently, there are a number of household practices that can be better managed, which will then contribute to an improved perception of the electricity service by the respondents.

When broken into the components that comprise the perceptions of quality and value of the electricity service, a number of findings were isolated through the comparative surveys analysed within this report. A summary of the key findings from this survey are as follows:

- While **accessibility** in terms of connectivity to the electricity service has improved as augmented through free connections to new customers, under the normal rates connections fees are considered unaffordable for most customers. This is substantiated by 22 percent in the current survey from a previous 19 percent of respondents in the 2017 Report 2, who indicated that the cost of setting the household/business connection to the TPL network is affordable. What has decreased from the second report is the number of respondents who identified connectivity as unaffordable, from 42 percent to 13 percent. What is perplexing and not readily explained, is why 65 percent responded with a neutral response. It could either mean they did not understand the question, or their perceptions are clouded by unmet expectations or other associated costs;
- Accessibility has also been considered in terms of perceived cost of the electricity service. While affordability perceptions have dropped significantly in the post-upgrade period, this is no surprise given that the average cost already exceeded the affordability 'rule of thumb'. Only 27 percent of respondents considered the electricity supply is affordable, slightly higher than the Report 2 response rate (20%);
- Perceptions of **reliability** of the electricity service continue to be inconclusive in this survey with 61 percent of respondents providing a neutral response. What may have encouraged this level of neutral responses is the significant level of outages, whereby 50 percent respondents indicated that they experienced outages, 35 percent of these reportedly were unplanned. It is beneficial to inform consumers of reasons for outages, and where pertinent indicate those that may be caused by faulty appliances or internal wiring. This will provide them with the information on the importance of better maintaining appliances and managing electricity. It will also provide a better perception of TPL service quality;
- While service utilisation data indicates an increase in the **demand for electricity**, the perception of respondents (158 out of 200 respondents) overwhelmingly consider that their electricity use remains the same. This averaged at the same amount reported in Report 2. Slightly less (12%) of respondents in the current report compared to Report 2 (14%) suggested that their electricity has increased;
- Respondents associated **service support** to the friendliness of TPL staff as well as the resolution of issues and complaints when dealing with the electricity service provider. Satisfaction with service support remains high with 92 percent of respondents connected since December 2017 indicating that the service support is good or very good, dropping significantly to 50 percent of respondents connected prior to this. However, the level of dissatisfaction with the quality of support service is very low identifying a general level of satisfaction with the support service provided by TPL. Once again, the response 'neutral' was prevalent among those upgraded prior to November 2017, which may need to be investigated further to provide a more comprehensive understanding of consumer perception to service support; and
- Perceptions of **economic growth or development** suggest that a better-quality electricity service is only one of a number of favourable conditions required to stimulate the generation of new businesses or the expansion of existing ones, both in the immediate post upgrade and longer period. With only one percent of respondent households (over both short and longer time frames post-upgrade) indicating that they have set up a business, it can be concluded that despite access to more reliable electricity to help existing business in conducting their activities, there are other constraints impacting the creation or expansion of businesses which will need to be addressed, such as the size of the market, location of the proposed business site, a number of 'cost' related factors and the local relevance of products and services that are sold.

Case Study – Tuvalu
Strategic Evaluation of MFAT's Energy Programme

Tuvalu Renewable Energy Projects (Ref: ACT-0A11720)

Photo credit: "PV installation at Nanumea Atoll" Source: Mafalu Lotolua

Submitted by
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List of abbreviations and acronyms

ADB	Asian Development Bank
AUD	Australian Dollar
CEC	Clean Energy Council (Australia)
EU	European Union
GDP	Gross Domestic Product
GFA	Grant Financing Agreement
GHG	Greenhouse Gas
GoT	Government of Tuvalu
GPEDC	Global Partnership for Effective Development Cooperation
JCfD	Joint Commitment for Development
kL	kilolitre
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
kWp	kilowatts-peak
MFAT	New Zealand Ministry of Foreign Affairs and Trade
MSQA	Monitoring Surveillance and Quality Assurance
MW	megawatt
NEP	National Energy Policy
NDC	Nationally Determined Contributions
NZD	New Zealand Dollar
OECD DAC	Organisation of Economic Cooperation and Development's Development Assistance Committee
PES	Pacific Energy Summit (2013)
PICs	Pacific Island Countries
PV	Photovoltaic
RE	Renewable energy
REEEMP	Renewable Energy and Energy Efficiency Master Plan: 2012-2020
SDG	Sustainable Development Goal
TEC	Tuvalu Electricity Corporation
TISIP	Tuvalu Infrastructure Strategy and Investment Plan
TK II	Te Kakeenga II - Tuvalu's 8th National Sustainable Development Strategy
TNEP	Tuvalu National Energy Policy
TREP	Tuvalu Renewable Energy Project
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollars
WB	World Bank

1 Objective, key findings and considerations for future direction

The New Zealand Ministry of Foreign Affairs and Trade (MFAT) commissioned Tetra Tech International Development to undertake a Strategic Evaluation of the Energy Programme (the Programme). The aim of the strategic evaluation is to serve MFAT's dual key purpose: to account for New Zealand's investment through the Programme, and to improve what future investment can achieve. The scope of the strategic evaluation involves assessing Programme performance as a whole from 2012 to 2019 and undertaking case studies for six activities (five in the Pacific and one in Indonesia) to generate a solid evidence base about what works and lessons learned.

The objective of the six case studies is to garner further detail to support strategic level findings, but also provide evidence to support and meet independent evaluation requirements for the activities themselves. This report presents the key findings from the case study undertaken of the Tuvalu Renewable Energy Projects (Ref: ACT-0A11720), referred to hereafter as the 'Activity'. The findings within this report are based on analysis of evidence gathered from document reviews and consultations with internal and external stakeholders. These findings contribute to the broader strategic evaluation and are intended to inform future programming decisions.

The Activity was designed to support the achievement of Tuvalu's target of 100 per cent renewable electricity generation by 2020. Specifically, it involved upgrading the electricity supply of the Northern outer islands of Nanumea, Nanumanga, Niutao and the second largest island, Vaitupu, through mini-grids – photovoltaic/diesel hybrid systems. It also involved increasing the renewable energy capacity on the main island of Funafuti through roof-mounted grid-connected solar PV systems.

Key findings and lessons learned

The Activity was highly relevant and consistent with Tuvalu's development aspirations, needs and priorities. It provided target atolls with a more resilient electricity system that could better withstand the forces of tropical cyclones as well as greater reliability enabling 24 hours electricity supply and less interruptions to services. The Activity was highly complementary to past, current and future development partners' efforts to support Tuvalu's target of 100 per cent renewable energy by 2025. The Activity also directly contributed to New Zealand's support to, and obligations under, regional and international priorities and goals on energy and climate change.

The Activity's outputs and outcomes targets were essentially achieved. The Activity exceeded the target solar capacity installed at Vaitupu, while missing out by 1 per cent on the total installed solar capacity at Nanumea, Nanumaga and Niutao. However, the target solar roof capacity at Funafuti was not met given that only two government buildings met the criteria to hold the photovoltaic (PV) panels. Effective delivery and achievement of outputs and outcomes was largely due to implementation being carried out by highly experienced firms that were directly contracted by MFAT who worked to New Zealand and Australian standards as well as appropriate engagement of the Islands Councils and GoT from the scoping study stage and as needed.

The effectiveness and impacts of the Activity could have been better captured if a detailed Results Framework was prepared for the Activity and there were indicators and baseline data available to measure how the Activity contributed to efficient, reliable, safe, affordable and sustainable electricity supply.

The Activity was efficiently managed by MFAT largely due to the direct contracting modality adopted and receiving full support of the GoT, the power utility and the Island Councils. The Activity was completed on time and within budget despite a cyclone that delayed implementation. MFAT's approach in terms of being very responsive, flexible and accommodating to the changing environment of the Activity was a significant factor contributing to efficiency.

The Activity supported the long-term technical sustainability of the electricity supply infrastructure in the target atolls through new solar PV installations and diesel generators that were designed, supplied and installed according to New Zealand and Australian standards. This was further supported by theoretical and hands-on training for Tuvalu Electricity Corporation (TEC) staff, toolkits for the operators as well as spare parts for maintenance.

Other donors have committed to Tuvalu's energy sector, and to complement and build on the Activity. The EU and MFAT covered eight atolls between them. Facilitated by Ambassadors to the United Nations, the Italian Government stepped forward in 2017 to cover the remaining atolls of Niulakita and Funafala to the value of USD 25,000. The World Bank (WB) is currently working on introducing smart meters. In November 2019, TEC and the Asian Development Bank (ADB) signed a USD 6m project to "increase access to renewable energy in Tuvalu".

Considerations for future energy sector assistance

For Tuvalu:

- MFAT should consider continuing engagement in some form to support and/or leverage partnerships to ensure the long-term technical and financial sustainability of investments. This could include continuing to assist outer islands tariff setting, management, and O&M and working with the power utility, the Ministry of Energy and island councils.

For Pacific Islands Countries (PICs) generally, including Tuvalu:

- MFAT has built itself a reputation as an understanding, flexible and accommodating donor for renewable energy initiatives in the Pacific Islands. MFAT could benefit from still being seen to have a role in leveraging support to the sustainability of their investments throughout the Pacific region.
- Comprehensively capturing the socio-economic impacts of investments made by donors is critical to facilitate better awareness and understanding of the effectiveness and impacts of investments.
- MFAT should continue to assess the appropriateness and use of the direct contracting modality as well as use of local contractors on a case-by-case basis. Analysis shows that:
  - Direct contracting has proven to support effective and efficient delivery of infrastructure-related activities, particularly when there is a focus on quick implementation
  - A focus on quick implementation, though, could result in less involvement of potential local contractors than warranted. Future efforts, with less intense time constraints, could endeavour to include more local contractors, where they are suitable. This should increase local capability for subsequent O&M and possibly refurbishment or replacement and benefit the local economy.
  - The use of direct contracting modalities should be complemented by capacity-building activities of local contractors and staff to support O&M efforts and sustainability.
- Resilience and energy efficiency should be part and parcel of energy sector assistance to the PICs. Resilience could be specifically mentioned in activity documents rather than being implied or assumed to be covered under "reliability." Efficiency is important across all aspects of energy, including generation, distribution and consumption.
- MFAT could consider assisting PICs to develop a least cost renewable energy (RE) implementation framework including, where appropriate, revised practical RE targets and energy efficiency measures.

2 Background – the Activity and Case Study

2.1 Background on the Tuvalu Renewable Energy Projects (the Activity)

Tuvalu is composed of nine small coral islands scattered in a chain over a distance of 676 kilometres. It is made up of both atolls and reef islands that are barely four to five meters above sea level. The atolls have islets encircling a shallow lagoon and these include Nanumea, Nui, Nukufetau, Funafuti, and Nukulaelae; while the reef islands are compact with a fringing reef and these include Nanumanga, Niutao, Vaitupu, and Niulakita. Tuvalu has a population of about 12,000 residing within a total land area of 26 km^2. Tuvalu has a GDP per capita of USD 4,059 (2019), and as of 2018 all the people of Tuvalu had access to electricity.

In 2009, Tuvalu continued to face the serious dilemma of being very vocal at regional and global forums about its vulnerability to the impacts of climate change, yet at the domestic level, continuing to rely heavily on fossil fuels for its energy needs. Only five per cent of Tuvalu's electricity generation was met by renewable energy resources, and transport was 100 per cent reliant on fossil fuels. With a small, fragile economy and environment, consuming 1.6 million litres of diesel per year at an approximate cost of AUD 2.4 million was not considered sustainable.

The Government of Tuvalu (GoT) then adopted its National Energy Policy (TNEP), which highlighted an ambitious energy target of 100 per cent renewable energy for power generation by 2020. In implementing the TNEP, an Energy Strategic Action Plan was developed as a guide to ensure that the target of the TNEP could be achieved by 2020. The GoT made a strategic move in 2012 and adopted its Renewable Electricity and Energy Efficiency Master Plan (REEEMP) 2012-2020, as a more action-oriented and comprehensive plan for achieving the 2020 target. This REEEMP outlines a strategic approach to generating Tuvalu's power supply from renewable energy and to develop an energy efficiency programme in Tuvalu over a period of eight years. It's two key goals were to: generate electricity with 100 per cent renewable energy by 2020; and increase energy efficiency on Funafuti by 30 per cent.

To meet these ambitious targets, the REEEMP stated that Tuvalu must develop 6 MW renewable energy electricity generation capacity within its eight-year timeframe. The initial capital costs were estimated to be AUD 52 million. The REEEMP noted the promising experience the Tuvalu Electricity Corporation (TEC) had with 106 kWp of grid – connected solar funded by Japan and Russia. It highlighted the priority it is giving to the outer islands in the roll out of its renewable energy programme, for the following reasons:

- Transporting diesel fuel used for electricity generation was expensive as it had to be transported in drums
- The risk of diesel spills during the ship to shore handling process was high
- To reduce the cost of generation, the supply was now turned off overnight.

The GoT wanted to evenly spread the benefits of development among its people and appreciated the central and enabling role of an efficient, reliable, safe, affordable and sustainable supply of electricity in its endeavour. It appreciated what a difference 24 hours of continuous supply of electricity can make to the education of its people, their health and their livelihoods. It acknowledged its land shortage problem and the opportunities for roof mounted solar installations to meet the growing demand on Funafuti. Appreciating the complexity of dealing with the communal ownership of land in Tuvalu and the scarcity of land for ground-mounted solar photovoltaic (PV) installations in Funafuti, a 1,000 Solar Roof Programme was adopted as a central component of the REEEMP.

At the same time, the GoT fully appreciated the risks climate change can have on itself and other Small Islands Developing States. It therefore wanted to demonstrate political courage and global leadership on the fight against climate change. Tuvalu was therefore among the first five countries in the world to sign and ratify the Kyoto Protocol in 1998 as well as the Paris Agreement in 2016.

Tuvalu participated in the inaugural Pacific Leaders Energy Summit in March 2013, hosted by Tonga, and joined Pacific leaders in reaffirming their commitment to renewable energy and the promotion of energy efficiency and acknowledged the need to make significant progress in developing credible whole-of-sector plans such as "energy roadmaps" and appropriate structures to improve energy security. They also noted the importance of effective political leadership in realising the benefits of national efforts to mitigate barriers and challenges to promote energy efficiency.

Tuvalu also participated at the Pacific Energy Summit (PES), co-hosted by New Zealand and the EU in Auckland, straight after the Summit in Tonga. At the PES, New Zealand announced that it intended to allocate NZD65 million to the Pacific through the New Zealand Aid Programme over the three years to dramatically boost investment in renewable energy project, thereby reducing reliance on imported fossil fuels and increasing access to clean, efficient and affordable energy. The focus was on 18 projects in six countries which included Tuvalu, subject to final design and feasibility. Annex A shows the priority projects Tuvalu proposed to the PES, which included the Activity.

Another outcome of the PES was the launch of the EU-NZ Energy Access Partnership for the Pacific, when the EU pledged an additional €25 million for energy access projects in the Pacific countries within the framework of the EU's objectives under *Sustainable Energy for All*. The Partnership was to then translate the EU's €25 million and New Zealand's contribution into renewable, efficiency and access projects across the Pacific in cooperation with the European Investment Bank and the Asian Development Bank (ADB).

New Zealand and Tuvalu signed a Joint Commitment for Development (CD) in 2013. This document sets out the shared vision of the two governments, five priority areas and associated expected outcomes, and the activities that MFAT would invest in to achieve these outcomes. The five priority areas were: Lifting economic performance; Workforce skills development; Renewable energy; Strengthening water security; and Partnerships.

In February 2014, New Zealand and the GoT signed the Grant Funding Arrangement (GFA) for a project life of two years and 10 months (31/12/2016) and a maximum funding amount of NZD19.8 million. The GFA noted that due to the tight timeframes Tuvalu had agreed for MFAT to lead on the design, tendering and contracting of the PV installations.

2.2 Activity objective, rationale, and interventions

The goal of the Activity was "efficient, reliable, safe, affordable and sustainable electricity supply for Tuvalu". The rationale for the Activity was to activate and deliver on the EU-NZ Energy Access Partnership for the Pacific in Tuvalu, which was driven by Tuvalu's 2012 REEEMP and to achieve its target of 100 per cent renewable electricity generation by 2020.

The general activities that were carried out under the Activity were generally to upgrade the electricity supply to the Northern outer islands of Nanumea, Nanumanga, Niutao (three atolls that are furthest to the North for the mini-grid systems) and Vaitupu (second largest island) as well as to increase the renewable energy capacity on the main island of Funafuti (through roof-mounted grid-connected solar PV systems). This was to be done through mini-grids – photovoltaic/diesel hybrid systems, in which photovoltaic arrays are accompanied by battery storage and diesel back up to ensure grid stability and supply reliability.

The intended outcomes of the Activity were:[1]

- Greater efficiency and security through reduced reliance on diesel fuels
- Increased electricity generation from renewable energy (RE)
- Improved electricity generation and distribution system reliability
- Plan for implementation of Energy Master Plan in place and commenced.

The Activity aimed to deliver:

- 630 kWp installed in PV/diesel hybrid systems at Nanumea, Nanumanga and Niutao
- 400 kWp of PV generation capacity at Vaitupu
- Subject to agreement by both parties, upgrading the roof of government building and ready for roof mounted PV
- Subject to grid stability and agreement of both Parties, approximately 300 kW of grid-connected PV generation capacity installed on seven suitable Funafuti government buildings.

The Activity was generally targeting current and future electricity consumers in the four atolls - these included households (mostly for lighting and refrigeration / cooling), churches and community-related premises as well as the commercial and business community too. Among the customers were the "Kaupule" – the Island Council or Traditional Assembly on each atoll, who were responsible for all local government functions in each atoll including development projects such as the Activity. In Funafuti, the consumers include the government offices, the Vaiaku hotel and a few lodges, shops and restaurants and was also intended to support light construction, industrial and manufacturing activities.

While the target group included all consumers to improve living standards and wellbeing, TEC was targeted as the ultimate beneficiary of the recipient (GoT) from the Activity through their ownership of an upgraded efficient, reliable, safe, affordable and sustainable electricity generation and distribution systems. Technical staff at the TEC are the target audience and participants of the training and hands-on capacity building events to be conducted by the Activity.

Under the EU-NZ Energy Access Partnership, the EU funded a like, project "Improving reliable Access to Modern Energy Services through Solar PV Systems", for three other Outer Southern Islands of Tuvalu (Nukufetau, Nui and Nukulaelae)". The three outer islands covered in this initiative are closest to Funafuti.

2.3 Methods for undertaking the case study

The case study report is based on the analysis of both primary and secondary data. The evaluation team first reviewed relevant Activity-related documentation to understand how the Activity was designed,

[1] This information on outcomes and outputs is sourced from the Grant Funding Agreement established for this Activity. There was no available Results Framework or Monitoring & Evaluation Framework detailing the outputs as well as short-, medium- and/or long-term outcomes. This impacted on the assessment and presentation of findings of effectiveness (in this case study) in terms of achievement of outputs and outcomes.

implemented and what results were achieved in line with the Activity objectives. To complement this, consultations with relevant internal and external stakeholders were conducted to gain deeper understanding and nuance of the Activity implementation, results and lessons learned to inform findings on the relevance, coherence, effectiveness, efficiency and sustainability of the Activity as well as future directions of the Energy Programme.

The data collection for this case study was mostly based on project reports and documentation. These were then reconciled and validated against data from non-project documents and reports, as well as interviews with stakeholders who were involved in the implementation and management of the project or were beneficiaries. The non-project documentation reviewed included: Pacific Power Utilities Benchmarking Reports from 2012 and 2018; ADB's annual Pacific Energy Updates, the Tuvalu REEMP and a 2017 Evaluation of New Zealand's Development Cooperation in Tuvalu.

Those interviewed included the MFAT Activity Manager, General Manager of TEC, the Acting Energy Planner, some of the beneficiaries and two of the main project contractors – INFRATEC and IT Power. There was not an opportunity to interview people from the four atoll communities.

The main challenge in undertaking the case study and data collection was the absence of key documents such as the logframe matrix or a Results Framework (indicators, baselines and targets) for the Activity to adequately capture the impacts of the installations according to the qualities stated in the goal - *efficient, reliable, safe, affordable and sustainable.*

3 Case study findings and lessons learned

The key research questions for the case study are based on the Organisation of Economic Cooperation and Development's Development Assistance Committee's (OECD DAC) evaluation criteria (shown in the table below). As such, the findings presented in this report are structured by the DAC criteria. Though the case study relates specifically to this Activity, the primary purpose of this case study is to inform the broader strategic evaluation. It is not intended to be a comprehensive evaluation of the Activity itself. Findings, lessons learned, and considerations for future efforts should be read in this context.

Objective	Description
Relevance and coherence	To examine the relevance, significance, and coherence of the Activity.
Effectiveness	To examine the extent to which the Activity achieved, or is expected to achieve, its objectives and results.
Efficiency	To review the effectiveness of MFAT's approach and ways of working i.e. internal roles and responsibilities and resource allocation, funding, contracting and delivery (management and governance) modalities to deliver expected results.
Sustainability	To assess the sustainability - physical, operational, economic, social, environmental and resilience of the Activity investments.
Future directions	To document lessons learned from the Activity that can inform strategy, policy and improved ways of working for the Activity and the Energy Programme as a whole.

3.1 Relevance and coherence

Relevant and consistent with Tuvalu's development aspirations, priorities and needs

The Activity was directly relevant and consistent with the priorities and strategies of Tuvalu in content and spirit, and in particular to the:

- Key guiding documents for Tuvalu's energy sector development at the time – the TNEP and REEEMP. The REEEMP was the go-to-action document that was consultatively developed and adopted by the GoT. It is a visionary document that accurately reflects its sustainable development and climate change challenges. It is a national pride that the GoT always referred to in support of its positions on regional and global discussions regarding sustainable development and climate change.

- Te Kakeenga II (TKII), Tuvalu's 8th National Sustainable Development Strategy, to achieve a healthy, educated, peaceful and prosperous Tuvalu." TKII reaffirmed "Falekaupule" and Outer Islands have always been regarded as the heart of the nation but has become weaker as outer island populations have declined and production in the traditional subsistence economy has fallen. The TKII identified better infrastructure (including power and renewable energy technologies) and ensuring health facilities and schools are adequately supplied and equipped as priorities and strategies. Further, the TKII emphasised prominent regional and international roles the GoT has in climate change advocacy, and therefore, the importance for the country to minimise its impact on climate change. As such, the Activity was directly and highly relevant to the TKII.
- Tuvalu Infrastructure Strategy and Investment Plan (TISIP) 2012 was based on the theme Fakafoou – To Make New. It identified the needs and priorities for investment in economic infrastructure and assess financial resources to support implementation. The TISIP is closely linked to achieving the economic and social strategies of the TKII.
- Majuro Declaration for Climate Leadership is a Forum (singed in 2013) initiative to highlight the commitment of the Leaders of the Pacific Islands forum nations to the reduction and phasing down of greenhouse gas pollution worldwide, with leaders wanting to spark a "new wave of climate leadership". The Activity was consistent with Tuvalu's commitment to implement power generation of 100 per cent renewable energy (between 2013 and 2020), through Solar PV (95 per cent of demand) and biodiesel (five per cent of demand).

As a later policy document of the GoT, its Nationally Determined Contributions (NDCs) (2015) further extended its commitment to reduce emissions of greenhouse gases from the electricity generation (power) sector, by 100 per cent, i.e. almost zero emissions from 2020 to 2025. The Activity, through developed ahead of the NDC, was still consistent with and relevant to Tuvalu's NDCs.

With regard to Tuvalu's energy needs, the atolls and islands covered within the Activity were targeted due to their identified energy needs. These are summarised below, with further information about the islands and atolls' energy needs provided at Annex 2.

- Funafuti is the main island and the national seat of government and hosts the airport, wharf and the main hospital. Funafuti has a population of 5,156. The electricity generators at Funafuti were the largest among the atolls and the newest (at only eight years old). With the Tuvalu Electricity Corporation (TEC) headquarters in Funafuti, both stand alone and grid-connected solar PV systems were installed and closely monitored. Electricity demand continued to rise in Funafuti, and TEC and the Energy Unit of the Ministry of Works, Transport and Utilities were implementing energy efficiency awareness programmes to slow down electricity demand. Funafuti is home to most of the government, commercial, church and private buildings with roof space for roof-mounted solar PV installations.
- Vaitupu is a big outer island, by Tuvalu standards, with a population of 1,863. Electricity supply at Vaitupu was met only through diesel generators though it has promising solar radiation potential averaging 5.35 kWh/m2/day. The diesel generators were still in good condition with one generator (32% of total capacity) less than 10 years old, resulting in an energy efficiency of 3 to 3.5 kWh/L. Power was often rationed according to the available fuel supply but under normal operation when fuel was not as scarce; power was available from six in the morning until midnight.
- Nanumea is a medium-sized outer island, by Tuvalu standards, with a population of 779. Peak loads occur in the evenings and rolling blackouts are a very common occurrence at Nanumea, averaging four to five hours each day.
- Nanumanga is another medium-sized outer island with a population of 687. Peak loads occur in the evenings and rolling blackouts are a very common occurrence at Nanumanga, averaging four to five hours each day.
- Niutao is another medium-sized outer island with a population of 772. Peak loads occur in the evenings and rolling blackouts are a very common occurrence at Niutao, averaging five to six hours each day.
- In Nanumea, Nanumanga and Niutao, electricity supply was met only through diesel generators though the islands had promising solar radiation potential averaging 5.44 kWh/m2/day. The diesel generators were near the end of their useful lives and had very low energy efficiency of ranging from 2.2 to 2.6 kWh/L.

Relevant and consistent with New Zealand, regional and global priorities

The Activity was highly relevant to the strategic objectives and vision of the New Zealand Aid Programme Renewable Energy (Flagship) Investment Priority (2015-2019) and Strategic Plan (2015-2019). The Flagship Programme aimed to reduce poverty and had a goal of expanding access to affordable, reliable and clean energy.

The goal of the Activity was *"efficient, reliable, safe, affordable and sustainable electricity supply for Tuvalu"*. Though it was not specifically spelt out in the GFA, it is widely accepted in small islands developing states that better electricity services are a catalyst for economic growth and prosperity. The Activity therefore directly addressed poverty alleviation by providing an enabler for better health and education services, income generation activities, innovation, etc. The Activity directly addressed one of the three focus areas of the Flagship Programme – "*Improve access to reliable and renewable energy through new infrastructure and technical assistance*". It addressed both long-term outcomes of the programme – "*Increased and equitable access to affordable energy*" and "*More reliable and resilient energy supply*".

The Activity supported MFAT's aspiration to leave no one behind. Among the nine atolls of Tuvalu, the EU came to Tuvalu under the NZ-EU Pacific Energy Access Partnership and provided solar mini-grids and 24 hours electricity supply to the atolls of Nui, Nukufetau and Nukulaelae. The Activity covered the remaining four atolls including Funafuti. The Activity covered every electricity customer on the target atolls and no one was left behind. New customers who were beyond the settlement centre of the atolls were connected to the system. Indirectly, older persons, people with special needs, children and women were all covered in and benefitted from the Activity. Even future customers who will be connected to the grid will also enjoy the benefits of MFAT's assistance.

MFAT undertook its role as donor for this Activity in accordance with MFAT's international development cooperation principles (effectiveness, inclusiveness, resilience and sustainability) as well as the Global Partnership for Effective Development Cooperation (country ownership, a focus on results, inclusive partnerships, and transparency and mutual accountability). The implementation of the Activity was also in line with the five key principles of the Paris Declaration on Aid Effectiveness, and in particular the: anchoring of the support on the REEEMP which is a national priority; close coordination of the project with other donor efforts (EU and World Bank) in Tuvalu's energy sector; and the open and consultative process adopted in managing the Activity.

The Activity is also closely aligned with Sustainable Development Goal (SDG) 7 - 'Ensure access to affordable, reliable, sustainable and modern energy for all', and in particular Target 7.1 - 'By 2030, ensure universal access to affordable, reliable and modern energy services' and Target 7.2 - 'By 2030, increase substantially the share of renewable energy in the global energy mix.' It is also closely aligned to SDG 13 - 'Take Action to combat climate change and its impacts' and Target 13.1 - 'Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries'.

Factors enabling relevance and coherence

- Tuvalu's regional and global leadership on pushing for accelerated efforts to combat climate change; Tuvalu has been very vocal at all levels on highlighting the vulnerability of itself and fellow small island developing states to the impacts of climate change and the need for acceleration actions to reduce GHG emissions.
- The GoT's consistency in promoting its outer atolls as the heart of its sustainable development effort, as reflected in its TKII, TISIP and REEEMP, and strong stance equitably sharing the fruits of development among its atolls.
- The GoT wanted to be seen as taking action and actually delivering on the ground.
- The responsiveness of New Zealand's Aid Programme to the renewable energy needs and elevating a specific Pacific Islands priority (renewable energy) to flagship status helped to maintain the priority status of renewable energy on both sides.
- The Activity effectively complemented efforts of other development partners in the energy sector of Tuvalu, in particular, the EU's similar infrastructure on the Southern Outer islands of Nukufetau, Nui and Nukulaelae.

Factors hindering relevance and coherence

- The Activity has far reaching social, environment and economic implications if *efficient, reliable, safe, affordable and sustainable electricity supply* were to be captured but these that were not sufficiently addressed in the GFA or a monitoring and evaluation / results framework.

3.2 Effectiveness

The Activity effectively delivered on its intended outputs and outcomes. In terms of the reduced reliance on diesel for power generation, the target of a 90 per cent decline in the generation of power using diesel at Nanumea, Nanumaga, Niutao and Vaitupu was fully achieved. For the increased electricity generation from RE outcome, the target for Nanumea, Nanumaga and Niutao narrowly missed its target by 1 per cent, while it exceeded its target for Vaitupu by 3 per cent. In terms of the outcome relating to the reliability of electricity generation and distribution, the Activity fully achieved its target and provided 24 hours power supply in Nanumea, Nanumaga, Niutao, Vaitupu and Funafuti.

With regard to increased electricity generation from RE for Funafuti, it was only 57 per cent achieved and this was essentially due to a factor beyond the control of MFAT and the contractors. The target PV generation capacity (300 kW) was an approximation subject to other factors that were not confirmed at the time of activity design. These factors included grid stability as well as finding the appropriate roof space and strength. Only two government buildings met the requirements and could only hold the installed 170 kW. This was a reflection of the project implementation environment and was independent of the capabilities and effectiveness of the delivery partners. The savings from the reduced installation enabled the contractor to cope with the additional clearance and construction costs due to the cyclone that hit Tuvalu during project construction and replace the aging diesel generators with new ones.

In the absence of a Results Framework for the Activity, outcomes and outputs in the GFA have been used to construct one (see Table 1). As a result, analysis of the effectiveness is restricted due to absence of many critical indicators, baselines and targets which could have been used for the assessment of the effectiveness of the Activity and on aspects of safety, affordability and efficiency of electricity supply.

Table 1: Achievement of the Activity's Goal, Outcomes and Outputs

Goal, Outcomes & Outputs	Indicator	Baseline	Target	Achievement	% of target achieved
Goal					
Efficient, reliable, safe, affordable and sustainable electricity supply for Tuvalu					
Outcomes					
Greater efficiency and security through reduced reliance on diesel fuels	% of power generation from diesel generators	• 100% diesel at Nanumea, Nanumanga,Niutao & Vaitupu • 157 kW PV at Funafuti	• 10% diesel at Nanumea, Nanumanga, Niutao & Vaitupu • Rooftop PV to provide additional 300 kW at Funafuti	**2015 Data** • 10% diesel at Nanumea, Nanumanga, Niutao & Vaitupu • Funafuti-170	•100% for Nanumea, Nanumaga, Niutao & Vaitupu •57% for Funafuti
Increased electricity generation from RE	kW of installed renewable energy generation	• Nanumea • Nanumanga • Niutao Sub-total - 0 • Vaitupu • Funafuti **Total - 0**	• Nanumea- • Nanumanga • Niutao Sub-total – approx. 630 • Vaitupu approx-400 • Funafuti approx-300 **Total – approx. 1330**	• Nanumea-195 • Nanumanga-195 • Niutao-232 Sub-total - 622 • Vaitupu-410 • Funafuti-170 **Total - 1202**	•99% for Nanumea, Nanumaga and Niutao •103% for Vaitupu •57% for Funafuti •90% Total

Goal, Outcomes & Outputs	Indicator	Baseline	Target	Achievement	% of target achieved
Improved electricity generation and distribution system reliability	Average hours of electricity supply per day	• 4-6 hrs of blackout / day in Nanumea, Nanumanga & Niutao due to under capacity • Power rationing when short of fuel at Vaitupu & Funafuti	• 24 hrs power supply to Nanumea, Nanumanga & Niutao from • 24 hrs supply to Vaitupu and Funafuti from diversification	24 hrs power supply in Nanumea, Nanumaga, Niutao, Vaitupu, Funafuti	100%
Plan for implementation of Energy Master Plan in place and commenced	Implementation Plan for Master Plan is adopted	No adopted plan	Adopted plan		
Outputs					
630 kWp to be installed in PV/diesel hybrid systems at Nanumea, Nanumanga and Niutao	kWp of installed PV	• Nanumea • Nanumanga • Niutao **Total - 0**	• Nanumea • Nanumanga • Niutao **Total - 630**	• Nanumea-195 • Nanumanga-195 • Niutao-232 **Total - 622**	99%
400 kWp of PV generation capacity at Vaitupu	kWp of installed PV	0	400	410	103%
300 kWp of rooftop PV generation capacity at Funafuti	kWp of rooftop installed PV	0	300	170	57%

In 2016, data collected by TEC showed a quarter (25 per cent) of Tuvalu's electricity generation was from RE. That is a 20 per cent increase from its share in 2013.

The effectiveness of the Activity's delivery is largely to do with the contracting arrangements and methodology for implementation. Due to the tight timeframes for the implementation of this two-year Activity, MFAT and the GoT agreed that MFAT will enter into a Construction Contract with a Construction Contractor to complete the design and construction of the Activity. Furthermore, MFAT was to contract an Engineer to oversee the Construction Contractor including monitoring progress, issuing variations to the Construction Contract as required and signing off progress payments.

A separate firm was also hired as project manager and another to conduct the feasibility studies and the management surveillance and quality assurance (MSQA). These were all done in recognition of the very high level of technical and logistical expertise that was required, the challenging environment of the project sites, and the need to engage highly trained and experienced people in the project. Power Smart and IT Power were key partners in the project implementation and both have had prior experience working on similar projects for MFAT at Tokelau and Samoa too. Beca Consulting was the Project Manager. McConnell Dowell is well known in NZ and the region for its engineering expertise was sub-contracted to undertake the civil works.

The agreed delivery methodology also allowed for the MSQA to be conducted at the end of each installation plus a one-year design liability period in which the contractor would return for a final check on the installations and their performance. Both events resulted in minor changes to the installation and an improvement in their performance. The agreed methodology also stated that MFAT would directly pay the contractors that it hires and that no funding will be paid to the GoT. MFAT was only to consult GoT on the design and construction process, as appropriate.

Factors enabling effectiveness

- The contracting arrangements for Activity implementation and the courteous working relationship between MFAT and the GoT contributed to the effectiveness of its delivery. MFAT and the GoT agreed for MFAT to carry out a direct contracting of the PV installations.
- The engagement of very high level technical and logistical expertise that had prior working experience with MFAT at Tokelau, Samoa and other PICs contributed to the effective delivery of the Activity.
- The use of high and respected standards and guidelines as the basis for the inspection of the mini-grids installations was also noted. The main purpose of the visual inspection conducted as part of the MSQA were to confirm that the PV systems were installed as per the specification, the supplied drawings, and the relevant AS/NZS standards. Elements of the Australian Clean Energy Council (CEC) guidelines were also used as a basis for inspection.
- The Islands Council or Kaupule has strong social and political influence in the outer atoll communities of Tuvalu, in particular, the access to land. For the Activity, the Kaupule were engaged right throughout, from the scoping study stage to the completion of the installation and handover.

Factors hindering effectiveness

- The absence of a comprehensive results framework that would enable capturing of socio-economic impacts of the Activity on the community, the value they placed on safe and reliable electricity, and the likely impacts on their livelihoods.
- The output that was estimated for Funafuti (300 kW) was based on an estimate that was subject to many other technical and engineering factors. However, the project implementation environment meant that this was not possible and eligible buildings could only hold the 170 kW that was installed.

3.3 Efficiency

The Activity was efficiently managed and it was completed on time and within budget. The Grant Funding Agreement was signed in February 2014 with the completion date set as 31 December 2016. Table 2 below shows that the installations were all completed before December 2016.

Table 2: Summary financial update as at project completion

Island	Installed Capacity	Practical Completion Date	% of demand met by PV
Niutao	232 kW	21st December 2015	90% of demand
Nanumaga	195 kW	7th September 2015	90% of demand
Nanumea	195 kW	31st July 2015	90% of demand
Vaitupu	410 kW	21st December 2015	90% of demand
Funafuti	170 kW	30 June 2015	5% of demand

The direct contracting modality, that was agreed between MFAT and the GoT, together with the contracting of known and reputable companies greatly assisted with the efficiency of managing and delivering on the Activity. The Activity certainly required significant project management that was way beyond the technical and project management capacity of the TEC. While it may have been possible for TEC to hire the contracting companies, and procure the supplies etc, it would be a momentous effort and all local technical experts would have been stretched, resulting in possible disruptions and delays too. The direct contracting modality was the right choice given the context, including the lack of adequate and available local technical capacity and the short two-year timeframe for the Activity.

The transfers and the acquittal of project funds has been a major problem with development partner funding. Part of the funds are usually advanced at the beginning and then progress reporting and acquittals take place before the next advance according to satisfactory progress and an approved future work plan. The process can be very lengthy and frustrating when progress reporting is not done in a timely manner and when the acquittals takes too long to be cleared. The weak local capacity was identified as a risk for

the Activity. The fact that the GFA clearly spelt out that no project funds will be paid to the GoT was to mitigate this risk and it assisted with the efficiency of the Activity.

The direct contracting model also meant efficiencies and high standards were maintained for payments and acquittals as well as for procurement. Further, a substantial amount of the funds would have been lost through exchange rates if funds were advance to Tuvalu. New Zealand dollars (NZD) would be converted to Tuvalu's currency (AUD) and then the AUD would then be converted again to the currency of the service provider / contractor. Given how hardware-intensive the Activity was, it was also important to ensure that procurement was done efficiently and to accepted norms and standards. The fact that the procurement was done by MFAT according to New Zealand standards, provided some confidence as to the compliance and efficiency of the process.

While the Activity was completed on time, there was a significant delay in the construction, due to Tropical Cyclone Pam in March 2015. Large swells from Tropical Cyclone Pam hit Tuvalu and delayed progress of the construction. The worst affected were the reef channels, wharves and landing facilities on the islands of Nanumaga and Niutao and this slowed down the delivery of project supplies and personnel. The Construction Contractor assisted with immediate emergency relief and negotiated and agreed to clear the channels. Though there were additional costs and time delays, the Activity was still completed on time.

The flexibility of MFAT to quickly enter into a Variation with the Construction Contractor ensured that the Activity did not experience any unnecessary delays. This happened during the damages caused by cyclone PAM. It also happened when the solar installations were completed and the Construction Contractor recommended putting in new diesel generators given the old and unreliable state of the existing generators. Additional solar panels and batteries were suggested too. This recommendation was critical to support the longevity of the solar installations and the feasibility of the Activity. MFAT considered the recommendation thoroughly and responded positively and in a timely manner. Contractors engaged in the Activity shared the same praise of MFAT as being caring, willing to listen, flexible and accommodating too.

Another factor supporting efficiency in Activity implementation was the effective navigation of the land tenure system. The land tenure system can be a barrier to the efficient delivery of development assistance on the ground, particularly in places where land is communally owned. For the Activity, the responsibility for securing the land was part of the GoT's obligations. Given the transformative and game changing impacts of having 24 hours per day of electricity on the lives of all Tuvalu citizens, the land issue was efficiently resolved and this contributed to the efficient delivery of the Activity.

Factors enabling efficiency

- The GoT taking on the cumbersome and time-consuming responsibility of securing land for the Activity.
- The direct contracting modality for the implementation of the Activity in recognition of the technical and logistical complexity of the Activity and the weak project management capacity at the TEC.
- The adoption of a simple arrangement for the disbursement of project funds from one central point, i.e. MFAT and following a credible procurement and financial policies.
- The hiring of capable and experienced contractors to play the key role of project management, construction and installations as well as management surveillance and quality assurance.
- The responsiveness of MFAT to enter into variations of existing contracts to accommodate unforeseen circumstances such as cyclone and gaps in the Activity design was a major contribution to the efficiency of the Activity's delivery.
- MFAT's reputation as flexible, understanding and efficient was equally shared by the major partners in the Activity.

Factors hindering efficiency

- Natural disasters such as Tropical Cyclone Pam that struck the atolls during the project construction, affecting the delivery of materials and personnel.
- Transportation and logistics can be quite expensive in the outer islands of Pacific Islands. For the four atolls of Nanumea, Nanumaga, Niutao and Vaitupu, there was just about a 50/50 split between the equipment and the installation and other costs of the Construction Contractor. In fact, mobilisation, construction and installation accounted for 34 per cent while shipping and transport was at 13 per cent.

3.4 Sustainability

The Activity has certainly supported TEC's capacity to deliver efficient, reliable, safe, affordable and sustainable electricity to the people of Tuvalu. Given that new diesel generators and new solar PV systems were constructed, the supply of electricity is regarded as more efficient, more reliable, safer and affordable too. The Activity and installations were conducted according to New Zealand and Australian standards and compliant with the Australian Clean Energy Council (CEC) guidelines. It is therefore reasonable to assume that the electricity generation and distribution infrastructure in Tuvalu has become more resilient because of the Activity.

In ensuring the new installations will be sustainable, the Activity was able to support TEC's technical and maintenance capacity by providing training to its staff after each installation. The training covered key areas of Activity such as system start-up and shutdown, system operation and functionality, fault finding, preventative maintenance and system reporting and monitoring. The Activity also provided a toolkit for operators to be able to troubleshoot, maintain, or replace equipment as required. These included meters, screwdrivers, spanners, cutters, strippers, infrared thermometer, etc. In terms of future maintenance, the absence of a long-term asset maintenance plan at TEC is an area that needs attention. Such a plan should account for natural disasters and shocks such as cyclones and the COVID-19 pandemic, and their likely adverse impacts on the movements of people and goods.

Realising that reliability and access to spare parts will be a cornerstone of the Activity's sustainability, spare parts were provided to allow local operators to replace faulty equipment and keep the system running while warranty replacements are organised. The spare parts included panels, controllers, inverters, bolts, contractors, connectors, etc for each atoll. A lift truck for accessing the rooftop PV installation was handed over to the GoT's heavy machinery pool.

It is estimated that the Activity provided TEC with installed assets valued at approximately NZD 8 million. TEC must therefore be prepared to sustainably maintain these assets, particularly their replacement after the warranty periods. Table 3 is the manufacturer's warranty on the key components in the installations.

Table 3: Manufacturer's Warranty on the key PV system components

System Parts	Manufacturer's Warranty (yrs)	Others
Panels	10	25 yrs linear power (83%)
Batteries	2	8 yrs pro rata
Grid connect inverters	10	
Battery inverter / chargers	5	
Multi-cluster controller	5	

A major threat to the sustainability of the Activity may arise should electricity demand increase rapidly, forcing TEC to use more of the diesel generators thereby reducing the savings on fossil fuels and potentially prematurely reducing the useful life of the assets. It has been observed from the monitoring of the Activity in later years that after commissioning the solar outputs increased but later decreased in the next two years. The excitement of 24 hours of continuous electricity supply has increased demand such that the diesel generators would be used more to meet demand. As a result, there is need for some demand-side management awareness raising to be conducted. Similarly, the situation calls on TEC to fully activate the monitoring of the system's performance and conducting the appropriate maintenance measures, in particular, the cleaning of the panels, ensuring there are no shades on it and to ensure the battery banks are not subject to excessive heat.

One of the key factors influencing the sustainability of the Activity would be the financial health of the TEC. The TEC has been under various forms of pressure to reduce the uniform tariff that it was applying throughout the atolls because the solar is free. TEC has remained steadfast, and was supported by the GoT, to maintain the tariff as it was. It was early days to reduce the tariff and this needs to be monitored over a sufficient period of time before any tariff adjustment takes place. Given this position, TEC is still well positioned to take care of and maintain the systems in the short-term.

In the long-term, TEC will need a general tariff review that examines the long-term financial health of the corporation and develops a business model that incorporates actual performance of all its assets as well as true replacement and maintenance costs.

Factors enabling sustainability

- The Activity was implemented to New Zealand and Australian technical standards and guidelines and this supported the quality of the materials installed and their resilience, safety and ability to withstand disasters / adverse climate change events. Further, the Activity provided both theoretical and hands-on training to staff of the TEC at Funafuti and the atolls.
- The inclusion of a one-year design liability period in the construction contract allowed Contractors to return and conduct a final check on the performance of the installed systems.
- TEC's ability to fend off calls for the power tariff to be reduced immediately and to have GoT support has helped.
- TEC's continuous discussions with development partners and community (through Island Councils) to assist with pursuing Tuvalu's 100 per cent renewable energy by 2025.

Factors hindering sustainability

- The Activity was somewhat rushed to meet MFAT's timelines without a proper feasibility study and detailed analysis of the long-term socio-economic and financial implications on the communities and the TEC too. As a result, a proper Results Framework and relevant socio-economic indicators were not agreed and no baseline data was collected to demonstrate the impact of the Activity on the lives of Tuvaluans.
- The contract for the mini-grids was based on the capacity of RE generation installed. Given the declining outputs from the systems, it may have been better from the recipient's perspective to inherit electricity supply systems with guaranteed performance outputs. This could be achieved by drawing up contracts where the contractor is compensated based on the energy outputs of the system installed.
- The absence of a long-term asset maintenance plan at TEC to account for natural disasters and shocks such as cyclones and the COVID-19 pandemic, and its adverse impacts on the movements of people and goods.

4 Overall lessons learned

4.1 Overall lessons learned for the Activity

There are several lessons that could be derived from the Activity:

Overall lessons learned for the Activity

- The Grant Funding Agreement spelt out the general goal, outcomes and outputs of the Activity. Regrettably, there was no further effort to develop a more detailed Results Framework that would capture all the socio-economic benefits of the investment. Efficient, reliable, safe, affordable and sustainable electricity supply for Tuvalu could have been measured in different ways. With such a broad goal, the Activity would have surely impacted many lives in the target atolls. The absence, therefore, of any community surveys before and after the completion of the Activity did not help reveal the full impact and benefits of the Activity.
- The training of TEC staff was conducted by New Zealand trainers and towards New Zealand and Australian standards. Further, the design and construction of the mini-grids and rooftop PV were in accordance with similar standards too. This provided confidence to the safety and resilience of the installed energy systems.
- Firm local commitment and high-level participation: The project benefitted from obtaining early buy-in of an institution with significant socio-political influence. The early buy-in of the Kaupule – Island Council assisted to address land access issues and paved the way for quick installation of the electricity systems.

4.2 Overall lessons learned for the Energy Programme

The lessons learned below relate to lessons drawn from the Tuvalu case study to inform the broader strategic evaluation.

Overall lessons learned for the Energy Programme

- Ensuring fit-for-purpose modality and implementation: The direct contracting arrangement for the Activity was appropriate for the short timeframe as well as the weak local capacity in Tuvalu. Credible and experienced firms were contracted and this supported both effective delivery and efficiency of the Activity.
- Conducting a thorough feasibility study: It is crucial to conduct a thorough feasibility study and to openly present the long-term technical and financial scenarios to the recipient agencies. For a very small and fragile economy and environment, the outcome of the feasibility study would have given GoT more energy options to consider.
- Unidentified socio-economic benefits: The Activity would have had significant socio-economic benefits for the people in Tuvalu, particularly in the target atolls which did not previously have access to 24 hour electricity supply. Detailed Results Framework can help capture these socio-economic benefits and activity designs should clearly state the intended beneficiaries, and include mechanisms for monitoring and reporting social impacts, including gender impacts.
- Importance of close collaboration among donors' efforts: Both MFAT and the EU were doing similar Activities but at different sites. TEC was involved in both activities. There are notable differences in the equipment used and this was observed in their performance too. For a small power utility such as TEC, the differences would have presented challenges for sustainably managing different mini-grids installations.
- Importance of planning for resilience and sustainability: Resilience and energy efficiency should be part and parcel of energy sector assistance to the PICs. Efficiency should be considered across all aspects of energy, including generation, distribution and consumption. Where there is likely to be a long-term national effort for RE and increased energy security, and planning is weak, least cost RE plans or frameworks should be supported, include clear non-technical financial guidance, and explicitly include cost-effective demand-side energy efficiency costs and opportunities.
- Undertaking O&M and mechanisms for funding: Consideration should also be given to the capacity of small outer islands to undertake effective O&M and whether O&M can be better managed at less cost by a single utility or well-resourced service covering all the remote islands.

Annex 1: Documentation reviewed and stakeholders consulted

Documentation reviewed for the case study consisted of:

MFAT project-specific documents	• Feasibility Studies, Grant Financing Arrangement, Monitoring Surveillance and Quality Assessment Reports, Progress Reports, Activity Completion Assessment & Completion Report
NZ Government Report	• New Zealand Seventh National Communication report to the UNFCCC and Kyoto Protocol, Ministry for the Environment (2017) • Evaluation of New Zealand's development cooperation in Tuvalu (2017)
ADB documents	• Pacific Energy Update 2018, ADB (2019) • Pacific Energy Update 2019, ADB (2020) • Pacific Energy Update 2020, ADB (2021)
Regional Benchmarking documents	• Pacific Power Utilities Benchmarking Report 2012, Pacific Power Association (2013) • Pacific Power Utilities Benchmarking Report 2018, Pacific Power Association (2019)
GoT policy documents	• Tuvalu Renewable Energy & Energy Efficiency Master Plan (2014) • Te Kakeenga II (TKII) - Tuvalu's 8th National Sustainable Development Strategy: 2005 – 2015 (2005) • Tuvalu Nationally Determined Contributions (2015) • Tuvalu Infrastructure Strategy and Investment Plan, Government of Tuvalu (2012) • Tuvalu MDG Acceleration Framework, Government of Tuvalu and United Nations (2013)

Most of the Activity documentation reviewed were either produced by the GoT, TEC and MFAT. There were also project-related reports produced by consultants engaged by the Activity. The data collection and interviews were then framed to obtain some independent verification of what was reported and documented as well as further explore project implementation and the performance of the upgraded electricity system.

Stakeholders consulted

Stakeholders	Names of stakeholders
Posts, Activity Managers and Programme teams	• Samantha Morris
Partner governments and other counterparts	• s9(2)(a) Energy and Tourism (MTET) • s9(2)(a) - Local Consultant for Energy Bill Developer • s9(2)(a) MTET • s9(2)(a)
Direct implementing partners (e.g. technical advisers or contractors)	• s9(2)(a) Power Smart • s9(2)(a) INFRATEC • s9(2)(a) IT Power • s9(2)(a) TEC • s9(2)(a) TEC
Beneficiaries	• s9(2)(a) – Niutao Is Council • s9(2)(a) – Nanumaga Is Council • s9(2)(a) – Vaitupu Is Council • s9(2)(a) – Nanumea Is Council

Annex 2: Further information about village network upgrades

Table 4 shows the priority projects Tuvalu proposed to the PES, which included the Activity (shaded).

Table 4: Stages of the Village Network Upgrades

Project	Indicative Capacity (MW)	Cost (NZD$m)
Outer Islands mini-grids (Nukulaelae, Nukufetau & Nui)	0.3	3.8
Outer Islands mini-grids – (Niulakita)	0.004	0.5
Outer Islands mini-grids (Nanumea, Nanumaga & Niutao)	0.5	4.0
Funafuti (PV)	0.6	4.5
Outer Islands mini-grids – Vaitupu	0.3	3.6
Funafuti Wind	0.3	2.2
Energy sector enhancement & efficiency		3.7
Rural PV		5.4
TOTAL	**2**	**27.7**

Table 5 provides more information on the target atolls and larger islands (shaded) covered as part of the Activity.

Table 5: Population, Land Area and the Energy Infrastructure in the target atolls (2010)

Atoll	Population	Land Area-km^2	Generation Capacity-kW	Generators Age - yrs	Diesel Use p.a (kL)	Distribution Network
Funafuti	5,156	2.79	1000	8	1423	11 kV & 230/400V AC
Nanumea	779	3.87	37	15	45	230/400V AC
Nanumaga	687	2.78	37	15	45	230/400V AC
Niutao	773	2.53	39	14	49	230/400V AC
Vaitupu	1,863	5.6	95	15	81	11 kV & 230/400V AC
Nui	618	2.83	31	15	47	230/400V AC
Nukufetau	688	2.99	38	15	42	230/400V AC
Nukulaelae	457	1.28	20	15	31	230/400V AC
Niulakita	41	.42				230/400V AC
Total	**11,062**	**25**	**1,297**			

Case Study – Papua New Guinea
Strategic Evaluation of MFAT's Energy Programme

ADB Improved Energy Access for Rural Communities Project (Ref: ACT-0A10868)

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List of abbreviations and acronyms

ADB	Asian Development Bank
ARB	Autonomous Region of Bougainville
CBC	Community-Based Contracts (Japan Fund for Poverty Reduction)
CCDA	Climate Change and Development Authority (GoPNG)
CEO	Chief Executive Officer
COVID-19	Coronavirus Disease 2019
CO2	Carbon Dioxide
DSP	Development Strategic Plan: 2010-2030 (GoPNG)
EIB	European Investment Bank
EU	European Union
GAP	Gender Action Plan
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GoPNG	Government of Papua New Guinea
GPEDC	Global Partnership for Effective Development Cooperation
HH	household
IEARC	Increased Energy Access in Rural Communities (Phase 1 & 2)
IPP	Independent Power Producers
IRENA	International Renewable Energy Association
kV	kilovolt
kWh	kilowatt hour
LV	low voltage
MFAT	New Zealand Ministry of Foreign Affairs and Trade
MFF	Multi-tranche Financing Facility
MW	megawatt
MWh	Megawatt hour
NDC	Nationally Determined Contributions
NEA	National Energy Authority
NEP	National Energy Policy: 2017-2027 (GoPNG)
NEROP	National Electrification Rollout Plan (GoPNG)
NZ	New Zealand
NZD	New Zealand Dollars
PES	Pacific Energy Summit (2013)
PIC	Pacific Island Country
PPL	PNG Power Ltd
PPP	Public-private partnership
PMU	Project Management Unit
PNG	Papua New Guinea
PSC	Project Steering Committee
RE	Renewable Energy
ROGEP	Rural On-Grid Extension Project
SDG	Sustainable Development Goal
T&D	Transmission and Distribution
TEIP	Town Electrification Investment Programme
TL	Transmission Lines
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	United States Dollars
WNB	West New Britain

Map of PNG and the project sites

1 Objective, key findings and considerations for future direction

The New Zealand Ministry of Foreign Affairs and Trade (MFAT) commissioned Tetra Tech International Development to undertake a Strategic Evaluation of the Energy Programme (the Programme). The aim of the strategic evaluation is to serve MFAT's dual key purpose: to account for New Zealand's investment through the Programme, and to improve what future investment can achieve. The scope of the strategic evaluation involves assessing Programme performance as a whole from 2012 to 2019 and undertaking case studies for six activities (five in the Pacific and one in Indonesia) to generate a solid evidence base about what works and lessons learned.

The objective of the six case studies is to garner further detail to support strategic level findings, but also provide evidence to support and meet independent evaluation requirements for the activities themselves. This report presents the key findings from the case study undertaken of the Asian Development Bank (ADB) Improved Energy Access for Rural Communities Project (IEARC) (Ref: ACT-0A10868), referred to hereafter as the 'Activity'. The findings within this report are based on analysis of evidence gathered from document reviews and consultations with internal and external stakeholders. These findings contribute to the broader strategic evaluation and are intended to inform future programming decisions.

Key findings and lessons learned

The Activity was highly relevant and consistent with Papua New Guinea's (PNG) ambition to address one of its root developments challenge - limited access to electricity. There are known development challenges in PNG, and these include poverty, low literacy rates, poor health outcomes, etc. Addressing these challenges will involve increased access to reliable electricity. PNG's acceptance that access to electricity is central to addressing its other socio-economic challenges has contributed to the relevance and coherence of the Activity with its national priorities.

The Activity did not fully achieve what it set out to, with some targets and expectations not met and only 88 per cent of the targeted households connected to the grid and energised. Overall, 75 per cent of the Activity's planned activities were achieved. This included 364 community centres with connections to church (69), police (55), education (190), and health (50) facilities. The inability to achieve the targets was in part due to the rugged and physical difficulties of the project sites, coupled with the weak project management capacity at PNG Power Limited (PPL).

The effectiveness and efficiency of project delivery were affected by the low capacity of PPL and long processes for settling land issues. A major factor affecting the efficiency and timely implementation of the Activity was the capacity of PPL to manage the funding and prescribed activities, primarily due to a shortage of resources and logistics support at PPL. This was further exacerbated by the increased burden on PPL of managing multiple funding streams from various donor agencies, and the fact that PPL co-funding was not provided on time leading to delayed supply deliveries. In addition, long processes for settling land issues delayed Activity implementation. However, the support received from provincial / local members of government and Chiefs with resolving issues relating to landowners and land clearance enabled PPL to connect more households more effectively and efficiently.

The efficiency of the Activity could have been improved if the Project Steering Committee (PSC) was more active and effective in its oversight and advisory role and if activities were outsourced to a more capable (human resources and technical capability) implementing partner. While PPL is the sole entity mandated by the Government of PNG (GoPNG) to manage and/or implement transmission and distribution projects, a rigorous capacity assessment (i.e. such European Union's 7-pillar assessment) would have highlighted areas where the PPL did not have adequate capacity. Certain activities could have been outsourced (i.e. line clearance and construction) to ensure more efficient and timely Activity implementation.

The sustainability of the Activity is likely to be a challenge for PPL. It is important to keep the institutional memory of the Activity within PPL and it is positive that staff employed at the Project Management Unit were PPL staff and will be retained by PPL. The training provided through the Activity should be repeated and be institutionalised within PPL's capacity-building strategies. The adoption of a long-awaited National Energy Policy, together with proposed legislation reforms within the power industry, provides some optimism about the sustainability of PNG's energy sector.

PPL has learned a lot from the Activity in terms of its human resourcing, procurement, financial, and project management. This Activity presented a good opportunity to work with PPL, understand and share lessons learned to undertake future energy-related activities more effectively and efficiently.

Considerations for future energy sector assistance

For PNG:

- There is a need to fully understand the constraints in PNG's rural areas in terms of the rugged physical environment, the irregularity of transport, poor management, the lack of skilled manpower and also low literacy rates when planning rural construction and hardware projects. Future energy assistance or similar projects should consider improving local private sector capacity by outsourcing some project activities.
- Ongoing training at all levels is needed in PNG, particularly for consumers / rural communities on how to productively use electricity and the new technologies that come with increased access to electricity.
- It is important to continue hiring rural communities to contribute to electrification projects where feasible. This could increase community buy-in and minimise vandalism and also have indirect economic flow-on benefits.
- The Activity attempted to address a key challenge in PNG's sustainable development, a very low percentage of the population with access to electricity, but there is still a lot to do. Going forward, MFAT could identify interventions most likely to sustain the gains from this Activity but also support GoPNG to improve sustainable access to energy for a higher percentage of its population.

For Pacific Islands Countries (PICs) generally (including PNG):

- Donor coordination will continue to be important to ensure that activities are complementary and effective. For this Activity, the construction of hydropower plants was complemented with transformers, transmission/distribution lines, and household connections to the electricity supply. Also, increased donor coordination on the provision of funding could reduce the burden on in-country partners to navigate the financial management of various funding streams.
- PICs should assess, and where necessary upgrade, their power transmission and distribution (T&D) networks as part of their renewable energy (RE) development. Where T&D are inadequate, the power generated will be underutilised and the reliability, stability, quality, and safety of the power supply will be compromised.
- It is generally important to conduct a rigorous capacity assessment of local agencies, such as the EU's 7 pillar assessment, before they are selected as implementation partners. This would help improve project delivery and effectiveness within the expected timeframe and budget.
- Project Steering Committees (PSCs) can play a crucial role in monitoring and guiding the delivery of important national projects and help rectify issues hindering implementation progress. They generally require regular meetings with representation from senior levels of government.

2 Background – the Activity and Case Study

2.1 Background on the ADB Improved Energy Access for Rural Communities Project (Ref: ACT-0A10868)

The Papua New Guinea (PNG) energy sector

Papua New Guinea (PNG) is the land of the unexpected and is home to about 9.3 million people, 87 per cent of whom live in rural areas. There are approximately 600 islands within four regions and 22 provinces, with a total land area of 462,840 km^2, by far the largest of the PICs. The landscape consists of a vast physical variety of mountainous areas and coastal lowlands.

PNG's social environment is based on three key elements: (i) the traditional land tenure system whereby 97 per cent of land is in customary tenure; (ii) the "wantok" system whereby family and clan members

support each other; and (iii) service delivery by churches and community groups which provide around 50 per cent of all health and education services in the rural sector.[1]

In terms of primary energy supply, in 2011, petroleum products accounted for approximately 57 per cent, biomass 37 per cent, and hydro, gas, and geothermal power the remaining 6 per cent of the energy supply. The natural gas resource is huge and is estimated to be equivalent to at least 2,700 million barrels of oil (perhaps far more), over ten times PNG's remaining recoverable oil reserves.

The Renewable Energy (RE) potential in PNG is vast,[2] with most in remote locations with limited demand, so it is not readily exploitable. There are at least 55 known geothermal sites with 56 MW developed. The estimated technically feasible hydropower potential is 14,000 MW and 122,600 GWh/year, with about 4,200 MW (37,000 GWh/year) economically feasible, excluding a large rural micro- and mini-hydro resource. There is large solar energy potential. Further, about two-thirds of PNG is forested and logging, palm oil, copra, coffee, tea, and sugar production offer promising bioenergy.

PNG energy sector policies and strategic priorities

Despite these vast resources, PNG has a GDP per capita of USD 2,678, lower than most neighbouring PICs. In 2010, only 14 per cent of the population had access to electricity so the GoPNG has adopted increased access to electricity as a strategic priority. The GoPNG's Development Strategic Plan (DSP: 2010-2030) envisions that seventy percent of the country will have access to electricity by 2030. Vision 2050 targets one hundred percent electricity from renewable and sustainable energy sources.

Various attempts were made to develop and adopt a national energy policy for PNG, but this has been delayed and complicated by the need to carefully balance the development of its rich mineral potential and its abundant RE resources. In 2017, the PNG National Energy Policy (NEP: 2017-2027) was finally approved by the GoPNG. The NEP has the vision to improve the quality of life for every citizen and provide a platform for strong economic growth through sustainable development of the energy sector in line with Vision 2050. Goals include sufficient, accessible, reliable, and affordable energy in a manner that is competitive, sustainable, and environmentally friendly.

PNG has no national power grid, only islanded networks in more populated areas and industrial sites. The NEP acknowledged the key statutory role of PPL is to plan, develop, generate, transmit, distribute, and retail electricity throughout PNG. Of 580 MW installed capacity, PPL has about 300 MW within two main grids (Port Moresby and Ramu) and 19 small, isolated grids servicing provincial centres. The remaining 280 MW is self-generated by industry, including mines and the private sector. With 87 per cent of the population in rural areas with difficult terrain, there is less than 1 per cent access to electricity by most people in the outer provinces.

PNG participated in the March 2013 Pacific Energy Summit (PES) in Auckland, co-hosted by New Zealand and the EU. Participants agreed that investment in clean, affordable, and efficient energy should fit within partner country priorities, infrastructure investment plans, energy sector targets and roadmaps, and timeframes. Collectively and individually Pacific countries and development partners identified many opportunities for enhancing access to clean and affordable energy services and the proportion of energy use from renewable sources.

The ADB Improved Energy Access for Rural Communities Project (IEARC)

To contribute to these strategic priorities, in 2010, the Asian Development Bank (ADB) approved a loan of USD 120 million for a Town Electrification Investment Program (TEIP), which was financed through a Multi-tranche Financing Facility (MFF). ADB was to explore and pursue viable co-financing opportunities (e.g. Japan and the European Investment Bank (EIB) during TEIP implementation. TEIP Tranche 1 was to support the construction of facilities at three isolated provincial grids:

- Divune Hydropower Plant, Northern Province (3 MW run-of-river)

[1] United Nations and government, 2004. Millennium Development Goals. Progress Report for Papua New Guinea 2004.

[2] RE issues and potential are discussed in Geothermal Mapping in PNG (Post-Courier 11 Feb 2020) https://postcourier.com.pg/geothermal-mapping-in-png/, Bringing geothermal back into the energy discussion in Papua New Guinea Think GeoEnergy (February 2021) https://www.thinkgeoenergy.com/bringing-geothermal-back-into-the-energy-discussion-in-papua-new-guinea/, Interna ional Hydropower Association Country Profile: Papua New Guinea (2019) https://www.hydropower.org/country-profiles/papua-new-guinea

- Kimbe to Bialla interconnection, West New Britain (WNB) approximately 150 km of 66 kV transmission line
- Ramazon Hydropower Plant, Autonomous Region of Bougainville (ARB), 2.5 MW run-of-river hydro.

In 2012, New Zealand and ADB signed a co-financing Arrangement for the Improved Energy Access for Rural Communities (IEARC) Project, an extension of TEIP, with amendments in 2015, 2016 and 2017. The GoPNG provided an additional USD 30 million for the TEIP to be used in the larger transmission and distribution lines and USD 1 million under the IEARC to support the household connections funded under New Zealand and Japan.

In 2012, New Zealand and Japan each provided NZD3.1 million (Grant 1-288 NZL) to *Phase 1* of the ADB-led IEARC to provide 2,640 rural connections along new transmission corridors in Bougainville, Northern Province, and WNB. This was administered by the ADB and implemented by PPL as part of the TEIP. The IEARC funding mechanism was a Donor Funding Arrangement with the ADB managing and disbursing funds on New Zealand's behalf, an effective and efficient approach considering the ADB's deep involvement in PNG's power sector and a town electrification project complementing the Activity.

New Zealand and the ADB also signed a co-financing agreement in 2015 for NZD 7 million to be implemented from July 2015 to June 2018 as Phase 2 of the IEARC (Grant 2-469 NZL). The funds were to complement and scale up TEIP Tranche 1 subprojects to reach more households. ADB continued as overall manager, with the existing TEIP Project Management Unit (PMU) and Project Coordination Committee responsible for the project implementation. Phase 2 financing was to cover:

(i) extension of the grids to connect 2,500 additional households: Northern Province (700 households), WNB (1,200 households), and ARB (600 households); and

(ii) rehabilitation of the Lake Hargy Hydropower Plant, including minor refurbishment control systems and mechanical equipment to increase generation capacity from 600 kW to 1,500 kW to supply the additional connections.

Transformers were to be installed at various points before supplying electricity via low voltage distribution lines and prepaid meters. In short, IEARC Phase 2 was to expand the social and economic benefit of TEIP and scale up the project benefits to reach more households. The sites were based on their potential to connect the largest number of households to the grid at the least cost, technical and economic feasibility, and readiness of ADB project processing.

Affordability for poor households was supported through prepayment meters which can improve household budget management and avoid disconnections. The rehabilitation works and distribution extensions were to be constructed in parallel with transmission lines. The implementing agency (PPL) had been assessed as having sufficient capacity for operation and maintenance of the expanded grid.

The case study acknowledges that the bulk (80 per cent) of the TEIP was funded by ADB, but it included MFAT funds from IEARC Phases 1 & 2, Japan funds, and the (20 per cent) partner government funding by the PNG government. While there were specific targeted activities for each source of fund in the TEIP, for the convenience of the implementation these funds were combined and used on certain activities to move the implementation forward.

2.2 Activity objective, rationale, and interventions

In provincial urban centres not connected to the main power grids, a relatively low percentage of urban residents are connected, and distributed power is rarely available outside the centres. Power to business and industry is unreliable, with regular power outages and demand that at times exceeds capacity. As a result, many businesses in the provinces self-generate using diesel generators, at a high cost. Lack of access to affordable, reliable power is limiting economic provincial centre growth.

The activities carried out under the Activity have been provided above in section 2.1. The Activity was to provide 2,500 distribution connections to villages, vocational and community schools, and mission stations along the route of the TEIP Tranche 1 transmission lines. Despite some recent gains in the economy, the lives of those living in poverty have changed little during the last two decades with 30 per cent of the population continuing to live below the 1996 criteria of K400 per year. As stated in the DSP, access to electricity was expected to trigger economic activities.

The Activity was expected to contribute to improving the average life expectancy (54 years) and national literacy rate (62 per cent). WNB was to receive 1500kW of generation capacity replacing diesel generation with cheaper and more efficient RE generation. The low voltage (LV) distribution was to allow connection of rural households living alongside the transmission line at the three hydropower sites. A significant social benefit to the communities was expected from the availability of reliable and economic electricity. Employment opportunities were expected during construction and operation with vegetation maintenance carried out through community contracts.

The Activity had one expected impact, one outcome, and five outputs, as below[3]:

Impact

- Improved economic conditions in target provincial centres not connected to the main grids

Expected outcomes were:

- Improved utilisation of reliable, clean power by PPL to about six provincial urban centres

Expected outputs include:

- About six renewable energy projects, including hydropower plants put into operation by PPL
- Transmission systems / lines constructed and operated by PPL
- Capacity building undertaken for the implementing agency and project beneficiaries
- Efficient project management services rendered by the PMU

2.3 Methods for undertaking the case study

The case study report is based on the analysis of both primary and secondary data. The evaluation team first reviewed relevant Activity-related documentation to understand how the Activity was designed, implemented and what results were achieved in line with the Activity objectives. To complement this, consultations with relevant internal and external stakeholders were conducted to gain a deeper understanding and nuance of the Activity implementation, results and lessons learned to inform findings on the relevance, coherence, effectiveness, efficiency, and sustainability of the Activity as well as future directions of the Energy Programme.

The data collection for this case study was mostly based on project reports and documentation. These were then corroborated against data from non-project documents and reports, as well as interviews with stakeholders who were either involved in the implementation and management of the project or were beneficiaries. The non-project documentation reviewed included:

- PNG Vision 2050
- PNG Development Strategic Plan: 2010-2030
- PNG Intended Nationally Determined Contributions (2015)
- PNG National Energy Policy: 2017-2027
- International Renewable Energy Association's (IRENA) Pacific Lighthouses – Renewable Energy Opportunities and Challenges in PNG
- Pacific Power Utilities Benchmarking Reports from 2012 and 2018
- ADB's annual Pacific Energy Updates; PNG Development Strategic Plan 2010 – 2030.

Those interviewed included MFAT and ADB staff in Port Moresby, a PNG freelance consultant, and the Senior Mitigation Officer at the PNG Climate Change and Development Authority (CCDA). Annex 1 provides a list of the documentation reviewed and the stakeholders consulted for the case study. The main challenges in undertaking the case study and data collection were the inability to visit the project sites and environment in PNG and to conduct face-to-face interviews with the beneficiaries and visit the project sites. The recent surge of COVID-19 infections in PNG also contributed to lack of stakeholder availability.

The quality of the documentation for the Activity was a challenge. It was not possible to assess the following Activity targets from the available documentation:

[3] TEIP Co-financing Agreement signed by MFAT and ADB in June 2015.

- Target 25 per cent increase in PPL customers (business and industrial) as a result of the Activity by 25 per cent in target provinces by the end of 2018
- Avoided Greenhouse gas (GHG) emission
- Reduced power outages
- Reduced fuel costs
- GWh of renewable energy generated.

It was extremely difficult to follow the sequence of projects New Zealand supported in PNG - TEIP Tranche 1, IEARC Phase 1 and IEARC Phase 2, the Enga Hydropower Project, and the Rural on-grid Extension Project (ROGEP), etc. Minutes from PSC meetings were not available and a key stakeholder confirmed that PSC meetings were not held regularly.

It is also important to note that though the TEIP has been financially and operationally closed in 2020 (from the ADB, New Zealand, and Japan funding perspectives), implementation is still ongoing based on the PNG counterpart financing and this will be completed in June 2021. Therefore, the final reporting on the Activity and its impacts will not be completed until June 2021.

3 Case study findings and lessons learned

The key research questions for the case study are based on the Organisation of Economic Cooperation and Development's Development Assistance Committee (OECD DAC) criteria (shown in the table below). As such, the findings presented in this report are structured by the DAC criteria. Though the case study relates specifically to this Activity, the primary purpose of this case study is to inform the broader strategic evaluation. It is not intended to be a comprehensive evaluation of the Activity itself. Findings, lessons learned, and considerations for future efforts should be read in this context.

Objective	Description
Relevance and coherence	To examine the relevance, significance, and coherence of the Activity.
Effectiveness	To examine the extent to which the Activity achieved, or is expected to achieve, its objectives and results.
Efficiency	To review the effectiveness of MFAT's approach and ways of working i.e. internal roles and responsibilities and resource allocation, funding, contracting, and delivery (management and governance) modalities to deliver expected results.
Sustainability	To assess the sustainability - physical, operational, economic, social, environmental, and resilience of the Activity investments.
Future directions	To document lessons learned from the Activity that can inform strategy, policy, and improved ways of working for the Activity and the Energy Programme as a whole.

It should be noted that as the Activity is still underway, analysis and findings were more focused on *relevance and coherence* and *efficiency*, rather than *effectiveness* and *sustainability*.

3.1 Relevance and coherence

Relevant and consistent with PNG's development aspirations, needs, and priorities

The design of the Activity was directly relevant and in line with the GoPNG's priorities. PNG's Development Strategic Plan 2010-2030 (DSP) has a goal of "high quality of life for all Papua New Guineans" and a vision to be a prosperous middle-income country by 2030. The DSP specifically acknowledges that energy plays a very important role in development as it provides the foundation for which chains of development activities in all sectors can take place. For Energy Development, the DSP has a goal that "all households have access to a reliable and affordable energy supply, and sufficient power is generated and distributed to meet future energy requirements and demands". This is to be achieved mostly from renewable and

hydropower generation, reduced diesel generation, the establishment of a national grid, and the use of prepayment meters – all of which are directly related to the impact and outcome of the Activity.

PNG's Vision 2050 outlines the strategies by which PNG will shift from an economy that is currently dominated by the mining and energy sectors, to one that is dominated by agriculture, forestry, fisheries, eco-tourism, and manufacturing. Among the identified strategies is the need to increase the availability of rural electrification from about 15 per cent of the population in 2010 to 100 per cent in 2050. GoPNG fully appreciates the enabling role of electricity and therefore seeks to provide electricity to its rural communities in an attempt to ignite improved social and economic development at the project sites.

Relevant and consistent with New Zealand and global priorities

The Activity was highly relevant to the strategic objectives and vision of the New Zealand Aid Programme's Renewable Energy (Flagship) Investment Priority (2015-2019) and Strategic Plan (2015-2019). The Activity falls within one of New Zealand's 12 investment priorities (Renewable Energy). It is also in line with the Renewable Energy Flagship Programme's goal of expanding access to affordable, reliable, and clean energy. It, therefore, fits in well with one of the Programme's Key Focus Areas - improve access to reliable and renewable energy through new infrastructure and technical assistance.

New Zealand's Aid Programme is aimed at reducing poverty. The Activity's goal of improving economic conditions for the population in the target provincial centres is directly consistent with the Aid Programme's poverty reduction effort. About 30 per cent of the people in PNG live below the poverty line and live below the 1996 criteria of K400/yr. The Activity provided new connections to electricity which would lead to and generate business opportunities and improve rural people's earnings. The Activity supported MFAT's aspiration to leave no one behind.

The Activity also directly addressed four out of the eight (50 per cent) Flagship programme outcomes:

- Increased and equitable access to affordable energy
- More reliable and resilient energy supply
- Increased renewable energy production
- Reduced reliance on fossil fuel.

The Global Partnership for Effective Development Cooperation (GPEDC) promotes development effectiveness to accelerate the implementation of the 2030 Agenda. The Activity as a partnership between New Zealand, PNG, Japan, and ADB was conducted according to the GPEDC's four principles: country ownership; a focus on results, inclusive partnerships; and transparency and mutual accountability. New Zealand did not feature in PNG Monitoring Profile for 2016 but its partner on this Activity, ADB, featured with a contribution of 20 per cent but was reduced to 16 per cent in 2018 as China contributed 11 per cent while Australia continued to lead with 64 per cent and 51 per cent respectively. The Activity is also closely aligned with Sustainable Development Goal (SDG) 7 target 7.1 and 7.2. It is also closely aligned to SDG 13 and target 13.1.

Factors enabling relevance and coherence

- There are known development challenges in PNG, and these include poverty, low literacy rates, malaria, HIV AIDs, etc. Addressing these challenges will involve increased access to reliable electricity, therefore, PNG's acceptance that access to electricity is central to addressing its other socio-economic challenges has contributed to the relevance and coherence of the Activity with its national priorities.
- PNG has high ambitions to be a middle-income country by 2030 and to be among the first 50 countries on the UN Human Development Index. These ambitions cannot be achieved without increased access to electricity to improve the economic condition of its population. PNG's acceptance that access to electricity is central to achieving its Vision 2050 has contributed to the relevance and coherence of the Activity with its vision for 2050.

3.2 Effectiveness

The assessment of the Activity is based on the revised results framework for the TEIP[4] but highlighting where the additional New Zealand funding was to be used (see Table 2). The outputs of TEIP are:

- six renewable energy power plants put into operation by PPL
- transmission lines constructed and operated by PPL
- capacity building undertaken for implementing agency and project beneficiaries
- the PMU renders efficient project management services.

The additional financing provided by MFAT did not significantly change the TEIP outputs, however, it added one additional output consisting of distribution lines constructed and operated by PPL, with a performance indicator of connecting 2,500 households, businesses, schools, and clinics to the grid by December 2018.

By the end of 2020, the Activity had largely delivered on its expected outputs of 5,000 new connections to electricity. A total of 4,390 (88 per cent) households/facilities were connected and 3,240 (66 per cent) were energised. Of the 4,390 that were connected, 364 (8 per cent) were at community centres, police, health, church, and education facilities. The delivery on the high voltage transmission lines was on average 85 per cent achieved while the low voltage lines strung was an average of 68 per cent, of which 61 per cent was energised.

For Kimbe, there was 100 per cent delivery on the poles erected and strung (1,469), high voltage lines (142km), and low voltage lines strung and energised (50km). It achieved 91 per cent of the households connected, 82 per cent of which were energised. For Popondetta, it was 86 per cent delivered on the high voltage lines, 60 per cent on the low voltage lines of which 41 per cent was energised and 77 per cent on the households connected, 43 per cent of which were energised. For Buka, it was 68 per cent delivered on the high voltage lines, 45 per cent on the low voltage lines of which 41 per cent was energised and 99 per cent on the households connected, 72 per cent of which were energised. The overall achievement of the high voltage, low voltage, and household connections component of the Activity at the end of 2020 was 75 per cent.

In general, the limited and weak project management capacity of PPL affected the effectiveness of the Activity and full achievement of outputs and outcomes, primarily through causing delays to Activity implementation. The issues and challenges affecting both effectiveness and efficiency are presented in Section 3.3.

However, it should be noted that the flexibility afforded through the pooling of funds for various Activity components enhanced effectiveness and supported continued activity implementation. The support from the provincial/local members of government and the Chiefs, in facilitating information dissemination and taking the lead in clarifying issues related to landowners and land clearance and in some instances taking on some of the costs during the initial stages of the project relative to ceremonies, also enhanced effectiveness and enabled PPL to roll out the project and connect more households in the communities.

Table 1: Household connections by grant as of 30 December 2020

SITE	Original Grant 1 + JFPR (HH)	Grant 1 + JFPR Adjusted (HH)	Grant 2 Targeted (HH	G1+JFPR+ G2 Targeted (HH)	Additional 708 procured (HH)	Total Connected to date (HH)	Connected HHs (%)
Buka	2,040	500	488	988	1,224	1,220	99.67
Popondetta	1,452	1,000	643	1,643	1,879	1,450	77.54
Kimbe	564	282	1379	1,661	1,897	1,720	90.67
Total	**4,056**	**1,782**	**2510**	**4,292**	**5,000**	**4,390**	**87.80**

It should be noted that the Activity generated increased demand for electricity such that many people moved and lived closer to the distribution lines. This increased demand plus the availability of funds

[4] TEIP Co-financing Agreement signed by MFAT and ADB in June 2015.

allowed an additional 708 households to be connected taking the planned total to 5,000. This increased demand created further challenges in terms of prioritising those that will be connected to the power supply.

Factors enabling effectiveness

- The pooling of funds from Japan, New Zealand, PNG, and ADB together under one PMU provided flexibility to use whichever fund best suited a particular activity and context.
- The support from the provincial/local members of government and the Chiefs helped to resolve land-related issues more quickly and enabled greater connections by PPL.

Factors hindering effectiveness

- Weak project management capacity of PPL led to delays in Activity implementation, and affected the Activity's ability to fully achieve output targets.
- The long process for settling land issues also caused delays to the implementation of the Activity.
- Inability by the GoPNG to pay land compensation and honour co-financing obligations as agreed also delayed implementation of the Activity.

3.3 Efficiency

Evidence shows it was a challenge to manage the Activity efficiently and complete it on time and within budget. Table 2 below shows a summary of the co-financing amounts agreed and the original and revised closing dates for the Activity phases. The TEIP was originally signed in 2010 to be implemented over six years. A co-financing agreement was signed in 2012 (Grant 1) and there was another in 2015 (Grant 2). Beginning of 2015, variations were signed and again in 2016 and 2017 too pushing the completion date to a year later. Subsequent variations were signed pushing the implementation completion date to 2018 and 2019 respectively. The TEIP was officially closed on ADB's and New Zealand's books in 2020 but the full delivery of the Activity and budget spending is continuing until June 2021 and funded by just the PNG counterpart funding towards the TEIP loan.

The changes in completion dates in 2015 were not so much to do with the additional funding put into the TEIP but a clear reflection of the complexity of the Activity's implementation. The inability of PPL and GoPNG to remit the foreign currency government counterpart payments under the contracts. A 7-month delay was a setback to the implementation when a supplier withheld shipments due to the inability of PPL and GoPNG to remit the foreign currency government counterpart payments under the contracts. This difficulty led to a restructuring of the ADB TEIP loan so that PPL/GoPNG would be responsible only for PNG Kina payments under counterpart funds with all foreign currency payments covered under the ADB loan.

Further, costs estimates were not done properly. The initial scoping of the rehabilitation of the Lake Hargy hydropower plants estimated a cost of USD 0.4 million, however, due to some savings in the New Zealand grant, the need for a comprehensive rehabilitation was deemed necessary. A more detailed study was therefore conducted on Lake Hargy and the Ruu Creek hydropower plant with the costs being three times more (USD1.2 million) than the original estimate. The time taken for the study as well as the necessary approval of ADB, MFAT, and GoPNG took a toll on the implementation of the Activity.

Table 2: Japan and New Zealand co-financing and their original and revised closing dates

	9163-JFPR	Grant 1 0288-NZL	Additional Financing Grant 2 0469-NZL
Total Amount	USD2.5 million	USD2.5 million	NZD7.0 million equivalent to USD4,766,300
Amount Utilised:	$2,355,000+$145,000 ADB mgmt cost	$2,375,000+$125,000 ADB admin costs	$4,527,341.16+$238,315 ADB admin costs
Approved:	19 Apr 12	19 April 2012	09 December 2015
Signed:	31 Oct 12	24 June 2013	22 January 2016

Effective:	31 Oct 12	04 October 2013	15 April 2016
Original Closing:	30 Jun 15	30 June 2015	30 June 2017
Revised Closing:	**31 Dec 19**	**01 Jun 18** (closed)	**31 Dec 19**

PPL's limited capabilities for financial management and procurement

A major factor affecting the efficiency of the Activity's deliveries was the capacity of PPL to manage the four sources of funds and the detailed activities. This was already identified as a risk in the signed Activity documents. The receipt of funds from various partners increased the burden on PPL to manage multiple transaction and delivery streams, further burdening already limited capacity. It was reported that the main challenge to the timely implementation of the Activity was the long-standing and continuing shortage resources at PPL. There was a shortage of casual workers, trainers, and inspectors who were needed to complete the distribution networks that connect to the households. PPL's supervision of the casual staff doing the erection of the distribution poles was required but there was a shortage of skilled personnel within PPL. PPL inspectors were needed for the installation of meters too.

At one point, PPL had a serious cash-flow problem and PPL management issued a directive to recall staff in the field to significantly curb spending. This was the case as supervisors and inspectors were paid for their flights and were given allowances and accommodations. This directive, though lifted three months later, contributed to slowing down the implementation.

While full accountability for the funds was paramount at all times, some PPL financial procedures were seen as a stumbling block. For instance, while PPL preferred to remit operating expenses through the banks, locals did not patronise the local banks. Local banks were understaffed and there were daily long queues monopolized by staff and personnel of the palm oil growers and manufacturers in Oro and WNB. Furthermore, banks often run out of cash. A petty cash arrangement was later agreed on to move the implementation forward.

Furthermore, PPL had several in-house layers of scrutiny before approval of payments. This scrutiny significantly delayed payments such as the reimbursement of petty cash, payment of the CBCs, and salaries for construction work on the sites. The result at the end was the workforce refusing to work when the payment of allowances was delayed.

Procurement is always central to projects involving the purchase of supplies, equipment, and civil works, and construction. The PMU and PPL have been using their own Procurement Policy which while complying with PNG standards, fell short of ADB's. The transition took time and for the PMU/PPL to be able to apply the ADB procurement policies to perfection.

Travel restrictions and logistics challenges caused significant delays

Transportation challenges also affected the Activity. There were no construction equipment and materials at the sites, and therefore these would have to be shipped from Port Moresby. Unfortunately, there was no regular shipping schedule to the project sites. For instance, for Buka, ARB the ships sailed once in a quarter and materials had to wait in port for months. Furthermore, the logistics of the supplies were so complicated that transformers and LV hardware may arrive a couple of months earlier before the meters.

The restrictions on both local and international movements due to COVID-19 impacted heavily on the TEIP grants' winding down period. It caused significant delays due to the declaration of the state of emergencies and the resulting impacts of the travel restrictions on PPL's personnel, consultants, and technical experts. The transport of materials and equipment to the project sites and the vetting and clarification of claims for CBCs reimbursement from the sites were all affected. The delay in the installation and commissioning of Divune hydropower plant has affected the rollout of the civil works for household connections in Oro since it was expected that Divune was to be commissioned in 2020.

COVID-19 also resulted in PPL management reducing the number of casual labour engagements at the 3 TEIP sites as part of the safety protocols and 'work from home' schedules for PPL employees throughout the country. It should however be noted that after several delays and a lot of paperwork, 76 contract workers from China finally made it across to undertake the final installation and commissioning of the Divune hydropower plant.

Ineffective implementation of governance and project management arrangements

The project management arrangement included the formation of a Project Steering Committee (PSC) to oversee the implementation of the whole TEIP. The PSC was chaired by the Department of National Planning and Monitoring with members from Departments of: (i) Petroleum and Energy; (ii) Treasury; (iii) Environment Conservation; (iv) Public Enterprises; and (v) Public Business Corporation and PPL. The PSC did not meet regularly as planned. Furthermore, the representation was supposed to be at the influential and respected Chief Executive Officer level, but it ended up with lower-level representation who did not regularly attend the PSC meetings. The Department of Petroleum and Energy was tasked with overseeing the implementation, support the institutional strengthening and capacity building activities and coordinate the steering committee meetings. From the reports, the Department did not provide the leadership and coordination needed for the effective running of the PSC.

The implementation of the Activity (and the TEIP as a whole) was led by a Project Management Unit (PMU) with staffing largely seconded from PPL in addition to new recruits. The PMU was housed within PPL and had access to other expertise within PPL. Among the staff were hydropower, electrical and civil engineers as well as lines people, land officers as well as a gender specialist too. As it happened, the PMU relied on PPL expertise to carry out work at the remote project sites. The reliance of key project activities on PPL staff did not only prove to be very expensive it also created delays due to PPL's own internal processes and procedures.

There were supposed to be five staff members in the PMU. One of the staff was a national gender officer to look after the implementation of the Activity's Gender Action Plan (GAP). The officer was to be responsible for incorporating the gender mainstreaming measures into project planning and implementation, including awareness activities and the establishment of sex-disaggregated indicators for project performance and monitoring. The PMU was supposed to report the progress of gender activities in its quarterly progress reports on overall project activities to the ADB and the Government. While the report of the PMU showed some reference to gender, it was not specific to a GAP indicating that the capacity at the PMU had its challenges given the magnitude of the work that they were to conduct.

Despite all the identified physical and operational constraints to the delivery of the Activity and the continuous shifting of the completion date, Activity expenditure was not too far off from their targets. Tables 3 and 4 show that the disbursement on New Zealand's first grant was about 95 per cent and was a percentage lower (94 per cent) for the second grant.

Table 3: Status of Utilisation of Grant 1-0288 NZL Funds*

Description	Allocation	Contracts Awarded	Disbursed	Undisbursed	Uncommitted
ÁDB Mgmt	125,000	125,000	0	125,000	0
Eqpt & Mat	2,250,000	2,351,953	2,350,350	1,602.96	-101,953
Contingency	125,000	0	0	125,000	
Total	**2,500,000**	**2,476,953**	**2,350,350**	**126,602.96**	**23,047**
		99.08%	**94.89%**	**5.06%**	**0.92%**

* At the time of financial closing on 30 Sept 2018, and 3 months after grant closing date on 30 June 2018, in USD.

Table 4: Status of Utilisation of Grant 2 – 0469 NZL Funds as of 31 December 2020 (USD)

Description	Allocation	Contracts Awarded	Disbursed	Undisbursed	Uncommitted
Grant Admin	238,315	238,315	**238,315.00**		
Eqpt & Mat	4,527,985	4,484,341	4,484,341.16	**.07**	**643.77**
Total	**4,766,300**	**4,722,656**	**4,484,341,16**	**238,315.07**	
		99.08%	**94.08%**	**5%**	**.013%**

Total undisbursed contract amount of USD238,315 (5%) plus Uncommitted Amount of USD643.77 (0.01%), totals USD238,958.84 (5.01%).

Factors enabling efficiency

- The parties to the Activity were always flexible and appreciated the challenges faced by the project implementation and were always willing to move the completion dates.
- The Activity benefitted from the CBCs and the engagement of people from the communities in paid jobs related to the Activity. The locals were in full support of the Activity and assisted in promoting the Activity to others in their communities.

Factors hindering efficiency

- Importance of arrangements for smooth financial partnerships. The non-observance of the agreed contracts affected the efficiency of the Activity. The counterpart local co-funding was not provided on time leading to a hold up of supply deliveries and a restructure of the loan agreement which took up seven months.
- The PSC did not function as planned to guide and advise the PMU, monitor its progress, and rectify issues with Activity management and implementation.
- The failure of the PMU to engage the private sector in PNG to carry out certain activities of the project rather than relying on PPL's staff was an obstacle to the efficiency of the Activity's delivery. Engaging PPL's staff, and with the cash flow problems at PPL, caused delays and extra costs to the Activity.

3.4 Sustainability

The Activity addressed sustainable development challenges through the electrification of police, health, church, and education facilities in the 3 project sites. Vandalism was identified as a challenge in the Activity documents and the presence of these community services might help in the medium- to long-term.

Table 5: Number of community free connections in the TEIP

Community Centres Connected	Buka	Popondetta	Kimbe	Total
Police Station and Police residences	0	20	35	**55**
Health Centres / Clinics	5	5	40	**50**
Church and church workers residences	11	28	30	**69**
Schools and Teachers Accommodation	30	40	120	**190**
Total per Site	**46**	**93**	**225**	**364**

PNG had been without a National Energy Policy for more than 10 years. The adoption of the National Energy Policy in 2017 and the recent endorsement by the National Executive Council of a National Energy Authority (NEA) Bill 2020, offers some hope and confidence in the energy sector of PNG. Even implemented as planned, this might translate to an energy sector whose infrastructure is well maintained and where the institutional, financial, and regulatory environments support the sustainability of investments made in the electricity sector.

The Activity provided for some capacity building support for the implementing agency and the project beneficiaries. These were in safety, maintenance as well as budgeting and business skills training, 50 per cent of whom were to be women. A total of 8,236 people were trained on HIV / AIDS, electrical safety, and financial literacy (41.2 per cent were women). These were one-off pieces of training, and it does not appear that the training was institutionalised into PPL's overall capacity building and training programme.

Factors enabling sustainability

- The recent adoption of the National Energy Policy and other reform strategies in the sector offer a lot of optimism for the future sustainability of the electricity sector.
- The Activity provided much needed technical experience to PPL's human resource, finance, and technical teams in terms of recruiting, project management, and managing complex supply contracts as well as monitoring and reporting according to the ADB Standards and Guidelines. While it may not have been the optimal experience, it was a rare hands-on capacity-building opportunity that could benefit the sustainability of similar projects in PNG in the future.

- The PMU was mostly from PPL's technical staff and will be retained by PPL after the TEIP. This will support PPL still retain the institutional memory of the TEIP.

Factors hindering sustainability

- There is yet to be a firm commitment from PPL in terms of its maintenance schedules and a budget that would be sufficient to cover the installed infrastructure.
- There was a limited engagement of the local private sector and companies in the Activity which might lead to continuous dependence on foreign expertise and companies to perform future monitoring and maintenance.
- While PPL inspectors were engaged to carry out the final checks before energising household connections, it does not appear that full commissioning of the hydro generation and the high and low voltages components was conducted to provide confidence on compliance with the designed standards.

4 Overall lessons learned

4.1 Overall lessons learned for the Activity

Lessons derived from the Activity include:

Overall lessons learned for the Activity

- Procurement is a key element of any major donor-supported project such as this where most of the budget is for procuring goods and services. The Activity relied on PPL's procurement team, but efficiency would have been enhanced if it had its own procurement expert.
- The Activity could have engaged the private sector in PNG by tendering out activities like the construction of the transmission and distribution lines. This could have provided efficiencies of cost and effort when compared to the use of PPL's in-house staff and expertise that caused major delays. Greater engagement of the private sector and locals should however be supplemented with dedicated capability building efforts to support effectiveness and sustainability.
- PNG's counterpart financing covered the final labour costs involved in the final connection and energising of electricity. New Zealand's and ADB's funds were spent on buying the equipment and materials. As it turned out, the TEIP was operationally and financially closed in 2020, however, given the materials and equipment were already procured and there is no restriction on PNG's counterpart funding, PPL is still able to continue doing the final round of connecting customers to electricity until June 2021.

4.2 Overall lessons learned for the Energy Programme

The broader lessons learned for the Energy Programme include:

Overall lessons learned for the Energy Programme

- This was a good demonstration of a partnership between ADB, New Zealand, Japan, and the GoPNG. It demonstrated how the co-financing from Japan and NZ complemented a loan programme from the ADB and how to manage such a financing agreement. It is important to ensure strong coordination of partnerships and respective funding contributions to in-country counterparts managing project finances, so as to minimise the financial administrative burden on often resource- and capacity- stretched stakeholders.
- The advantage of having the grants integrated with the loan was that they did not alter the TEIP very much. It only added an extra Output to the results framework. The combined results framework was therefore convenient from an operational perspective given the complementarity of the hydropower plant construction and the actual connection of households to electricity. To have separate project documents and separate result frameworks (and possibly a separate PMU) would have been challenging operationally and also expensive.
- This Activity demonstrated that the transmission and distribution lines are among the priorities in trying to improve energy access and energy security. If the transmissions and distribution lines are not good, the power generated will be wasted and the quality and safety of the power received by the consumers would be compromised.

Annex 1: Documentation reviewed and stakeholders consulted

Documentation reviewed

Documentation reviewed for the case study consisted of:

MFAT project-specific documents	• Grant Financing Arrangement, EIA, Results Framework Review Report, Progress Reports, Activity Completion Assessment & Completion Report
New Zealand Government Report	• New Zealand Seventh National Communication Report to the UNFCCC and Kyoto Protocol, Ministry for the Environment (2017)
ADB documents	• Pacific Energy Update 2018, ADB (2019) • Pacific Energy Update 2019, ADB (2020) • Pacific Energy Update 2020, ADB (2021)
PPL & Regional Benchmarking documents	• Pacific Power Utilities Benchmarking Report 2012, Pacific Power Association (2013) • Pacific Lighthouses: Renewable Energy Opportunities and Challenges in PNG, IRENA (2013) • Pacific Power Utilities Benchmarking Report 2018, Pacific Power Association (2019)
GoPNG policy documents	• PNG Vision 2050, Government of PNG (2009) • PNG Development Strategic Plan: 2010-2030, Dept of National Planning & Monitoring (2010) • PNG Intended Nationally Determined Contributions (2015) • PNG National Energy Policy: 2017-2027, Dept of Petroleum & Energy (2017)

Most of the Activity documentation reviewed was either produced by the PMU or by MFAT.

Stakeholders consulted and contacted

Primary Stakeholders	Names of stakeholders
Posts, Activity Managers and Programme teams for case study countries	Viola Digwaleu

Secondary Stakeholders	Names of stakeholders
Partner governments and other counterparts	s9(2)(a) former ADB staff (no response) s9(2)(a) Dept of Petroleum & Energy (no response) s9(2)(a) Climate Change & Mitigation Authority Alicia Kotsapas, First Secretary - Development
Direct implementing partners (e.g. technical advisers or contractors)	s9(2)(a) TEIP, PPL
Beneficiaries	s9(2)(a) Freelance Consultant

Annex 2: Amended TEIP Results Framework with the additional New Zealand funding

Design Summary	Performance targets & indicators	Achievement	% of target achieved
Impact The economic condition of the population in the target provincial centres has improved.	Increase in PPL customers (business & industrial) by 20% in target provinces by the end of 2016	Unable to assess from available documentation.	
	Reduced self-power generation by customers (business & industrial) by 20% in target provinces by the end of 2016 (measured in MWh)		
	With additional NZ financing Increase PPL customers (business and industrial) by 25% in target provinces by the end of 2018		
Outcome Improved utilisation of reliable, clean power to six provincial urban centres	**All indicators are relative to the baseline of Jan 2010** Installation of 15MW of additional hydropower capacity in target provincial areas by 2016	• 3 MW Divune Hydropower plant to be completed early 2021 • 3 MW Ramazon hydropower project was cancelled • Completed rehabilitating Lake Hargy Hydropower plant [1.5MW]	30% [4.5 MW/15MW]
	Avoid production of an additional 100,000 of CO^2 equivalent p.a. by end of 2016	Unable to assess from available documentation.	
	Reduce power outages by 20% in target provincial urban areas by end of 2016		
	Reduce fuel costs for PPL power generation by 60% in target provincial urban areas by end of 2016.		
Outputs 1. Six renewable energy power plants put into operation by PPL	**All indicators are relative to baseline on Jan 2010** Generation of 60 GWh per annum of RE by end of 2016	Unable to assess from available documentation.	
	Provide power and water connection to villages adjacent to power generation project sites		

Design Summary	Performance targets & indicators	Achievement	% of target achieved
2. Transmission lines constructed and operated by PPL	Transmission of 60 GWh of power p.a. to provincial urban areas by 2016	• Completed 142 km HV & 50 km LV Kimbe-Bialla transmission line • Completed 60 km HV and 42 km LV for Popondetta • Completed 39 km HV and 30 LV for Buka	• 100% HV / 100% LV / 100% energised • 86% HL / 60% LV / 41% energised • 68% HV / 45% LV / 41% energised
With additional NZ financing 3. Distribution lines constructed and operated by PPL	**With additional NZ financing** Connect 2,500 [in addition to an earlier 2,500] households, businesses, schools, and clinics to the grid by Dec 2018 Buka: 1,224 Popondetta: 1,879 Kimbe: 1,897 **Total: 5,000**	**With additional NZ financing** PPL GIS Database **As of Dec 2020** Buka: 1,220 Popondetta: 1,450 Kimbe: 1,720 **Total: 4,390 (364 were for community centres)**	**As of Dec 2020** Buka: 97% Popondetta: 77.54% Kimbe: 90.67% **Total: 87.80%**
4. Capacity building undertaken for implementing agency and project beneficiaries	1. Conduct capacity building training for PPL in procurement and financial management by June 2011 2. Conduct training for villages adjacent to project sites, including (i) maintenance skills for power & water supply (at least 4 volunteers /village at least 50% women); and (ii) power safety, h'hold utility budget, and business skills training for each village, at least 50% women.	**PPL/TEIP has conducted the following training:** • HIV/Aids - 3,769 • Financial Literacy - 67 Safe Electricity training 4,000 persons Total 8,236 / 3,395 (41.2%) were women	41.2%
5. The PMU renders efficient project management services	PMU meets annual target contract awards and disbursements Conduct training activities for PMU staff and PPL management, including gender awareness training.	Unable to assess from available documentation.	

Annex 3: Progress of High Voltage, Low Voltage, and Households connections in each site (as of 31 December 2020)

Site	Village	High Voltage Construction		Low Voltage				Household Connection			
				LV strung		LV lines energised		Meters Installed		HH Energised	
			%	km	%	km	%	HH#	%	HH#	%
Buka Poles: 360/531 Erected; 272/531 strung	Bonus Hantoa	39/67 km	67.80	29.92/ 67	44.66	27.61/ 67	41.21	1220/ 1,224	99.67	885/ 1224	72.34
Popondeta Poles: 585/667 erected; 570/667 strung	Pop Huvivi	60.2/70km	86.06	42/70	60.00%	28.37 / 70	40.71	1,450/ 1,879	77.17%	810/ 1,879	43.11%
Kimbe Poles: 1,469/1,469 erected. 1,469/1,469; strung	Mai Buluma	142/ 142km	**100**	50/50	**100**	50/50	**100**	1,720/ 1,897	90.67%	1,548/ 1,897	81.60
		Averages:	84.62%		68.22%		60.64%	4,390/ 5,000 HHs	87.8%	3,243/ 5,000 HHs	65.67%
		Weights:	40%		40%		10%	5 %	5%		
		Weighted Value	33.85%		27.29%		6.06%	4.39%	3.28%		
		Overall Progress	74.87%								

Case Study – Indonesia

Strategic Evaluation of MFAT's Energy Programme

New Zealand Support for Training in the Indonesia Geothermal Sector (NZSTIGS), Phase 1 (Ref: ACT-0A12573)

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List of abbreviations and acronyms

4YP	Four Year Plan
ADD	Activity Design Document
AMA	Activity Monitoring Assessment
ASEAN	Association of South East Asian Nations
BPSDM	Indonesian Ministry of Energy and Mineral Resources Human Resources Development Agency
EOPO	End-of-program outcome
G2G	Government-to-government
GDS	Global Development and Scholarships Division (MFAT)
GOI	Government of Indonesia
ICESD	International Cooperation for Effective Sustainable Development (MFAT)
INAGA	Indonesia Geothermal Association
IT	Information Technology
Kemerinstekdikti	Higher Education Directorate in Ministry of Education
PEM Akamigas	Politeknik Energi dan Mineral Akamigas (BPSDM)
PPSDM KEBTKE	Directorate for Renewable Energy and Energy Conservation (BPSDM)
PPSDM Migas	Directorate of Oil and Gas (BPSDM)
MFAT	New Zealand Ministry of Foreign Affairs and Trade
NZD	New Zealand Dollar
NZSTIGS	New Zealand Support for Training in the Indonesia Geothermal Sector
OECD	Organisation for Economic Cooperation and Development
OECD DAC	OECD Development Assistance Committee
OTJ	On-the-job
PMU	Project Management Unit
PGE	Pertamina Geothermal Energy
PLN	Perusahaan Listrik Negara
PNJ	Politeknik Negeri Jakarta
PNP	Politeknik Negeri Padang
RE	Renewable Energy
SECO	Swiss State Secretariat for Economic Affairs
SOE	State-owned Enterprise
STO	Short-term outcome
TA	Technical Adviser
TTPO	Trades, Technicians and Plant Operators
TTT	Train the Trainer
Wintec	Waikato Institute of Technology
UGM VS	University of Gadjah Mada Vocational School

1 Objective, key findings and considerations for future direction

The New Zealand Ministry of Foreign Affairs and Trade (MFAT) commissioned Tetra Tech International Development to undertake a Strategic Evaluation of the Energy Programme (the Programme). The aim of the strategic evaluation is to serve MFAT's dual key purpose: to account for New Zealand's investment through the Programme, and to improve what future investment can achieve. The scope of the strategic evaluation involves assessing Programme performance as a whole from 2012 to 2019 and undertaking case studies for six activities (five in the Pacific and one in Indonesia) to generate a solid evidence base about what works and lessons learned.

The objective of the six case studies is to garner further detail to support strategic level findings, but also provide evidence to support and meet independent evaluation requirements for the activities themselves. This report presents the key findings from the case study undertaken of the New Zealand Support for Training in the Indonesia Geothermal Sector (NZSTIGS) Phase 1 (Ref: ACT-0A12573), referred to hereafter as the 'Activity'. The findings within this report are based on analysis of evidence gathered from document reviews and consultations with internal and external stakeholders. These findings contribute to the broader strategic evaluation and are intended to inform future programming decisions.

The Activity responds to the identified training needs within Indonesia's geothermal sector through training, coordinated technical assistance and capacity building. It also seeks to address some of the institutional, capability, and access-related barriers constraining the Indonesian geothermal sector. The Activity has two separate phases: Phase 1 which focuses on core training delivery to address immediate skills shortages; and Phase 2 which intends to focus on initiatives that address longer-term sustainability and capability issues in the sector. The Activity is being delivered by the Waikato Institute of Technology (Wintec), and is still in Phase 1.

Key findings and lessons learned

The Activity is highly relevant to Indonesia's geothermal development needs and for addressing capability gaps in technical skillsets within the country's geothermal sector. Industry partners, polytechnics and Government of Indonesia (GOI) partners alike deemed support to Indonesia's geothermal sector as highly relevant and noted its utility for not only growing the sector but also contributing to economic development, electricity generation, and environmental benefits. Strong in-country scoping (prior to Activity design) conducted with industry partners to understand capability and capacity gaps contributed to the Activity's high relevance.

Though relevant and coherent with geothermal development needs and priorities, Activity implementation has not kept pace with the partner government's vision and changing priorities. GOI partners have had evolving interests and priorities making the operating environment challenging to navigate, and this has been exacerbated by changes in leadership. The absence of a clear and agreed roadmap as well as clearly defined responsibilities of the GOI's in its role as an Activity partner has contributed to a lack of coherence and harmonisation to the partner government's vision and priorities for this sector. The Activity would benefit from stronger local integration to build coherence to the GOI's priorities.

Beneficiaries are highly satisfied with the quality of training material and delivery provided by the Supplier. While the Activity is still underway, beneficiaries report strong satisfaction with the quality and content of training. Course materials and hands-on training (currently restricted due to COVID-19) were reported to be highly effective for building technical skills. Reporting does indicate, however, that the delivery of capacity building outputs is lagging. While it is too early to assess and report on short-term outcomes comprehensively, there is some emerging evidence that certain outcomes are progressing well and others are lagging.

The efficiency of delivery and activity management is hampered by the complex political and cultural operating environments, and lack of an appropriate project management model. The requisite time and resourcing for activity management and effective stakeholder engagement was inadequate during both activity design and during implementation as well. Noting restraints and challenges imposed by COVID-19, the Supplier has yet to establish an in-country Project Management Unit (PMU) and adequately invest in an optimal project management model to improve efficiency in delivery and activity management. Successful partnerships with GOI partners are more difficult to cultivate and maintain without in-country activity management. Given the

current environment and resourcing, support from MFAT staff at Post has been influential in facilitating engagement with GOI partners.

There is a clear lack of trust and communication between the Supplier and the partner government. Effective communication and engagement between the parties was not established from outset, and this has resulted in rising tensions and challenges impacting on effective and efficient delivery of the Activity. Differing expectations of the Activity's scope as well as cultural interpretations and understanding of engagement protocols are contributing to this. High staff turnover at key partner institutions and beneficiaries also means that relationships need to be developed regularly and shared priorities agreed and collectively understood repeatedly.

The risks highlighted in the Activity Design Document (ADD) are occurring, and the mitigation measures are not being implemented effectively. Evolving partner government priorities and motivations are not being effectively managed through flexible and adaptive approaches and adequate engagement. The absence of an in-country Project Management Unit (PMU) is limiting the ability for engagement and productive dialogue to manage risks and challenges.

The lack of clarity and agreement about in-scope services and the responsibilities of the partner government are contributing to poor relationships. Without agreement about what the partner government should be doing and clear scoping of capability building services the partner government can receive from the Supplier within the current phase, managing tensions and new requests are challenging and will likely continue to be. It is important to build from a clear shared understanding of what the end objectives and priorities are. Development and implementation of a roadmap (i.e. as originally envisaged to be produced by the embedded TA), could help build agreement on the emerging priorities and service delivery.

The long-term sustainability of the Activity is limited given the focus of the current phase. While the existing methodology embeds some sustainability mechanisms (i.e. train the trainer approach and reusable curricula), enduring sustainability will require more targeted integration of training delivery into national training systems and increased capacity building. The absence of capable and empowered in-country partners to take ownership of Activity (resulting primarily from high staff turnover at partner institutions) makes long-term sustainability more challenging.

Considerations for future energy sector assistance

For NZSTIGS and/or Indonesia:

- There is merit in continued support to Indonesia's geothermal sector, as New Zealand is well positioned to provide the desired support and opportunities exist for Indonesia's considerable geothermal resources to contribute to sustainable energy development.
- Consideration should be given to embedding dedicated support and resources (i.e. through the development of the geothermal roadmap / capacity building plan and in-country PMU) to respond to the GOI partner's changing interests and priorities and enhance overall Activity effectiveness, efficiency and sustainability.
- Further inclusion of GOI partners in Activity design, implementation and monitoring will be critical for ensuring that capacity building outputs in both Phases 1 and 2 are effective.

For energy sector assistance generally:

- Consider investing effort to clarify and seek agreement on respective Activity partners' roles and responsibilities and incorporate the agreed inputs/outputs into the design of results management frameworks.
- For activities focused on capacity building, finding the right in-country personnel with the appropriate mix of technical and stakeholder engagement skills is critical. Where appropriate in-country personnel are not incorporated into activity design or there are no suitable candidates, the role of staff at Post (where applicable) should be explicitly factored into activity design.
- Promote adaptive management approaches that are based on a strong shared understanding of long-term objectives and the operating environment.

2 Background – the Activity and Case Study

2.1 Background on the Activity and Phase 1

NZSTIGS is an MFAT activity that responds to the identified training needs within Indonesia's geothermal sector through training, coordinated technical assistance and capacity building. The Activity seeks to address the current skills shortage of Trades, Technicians and Plant Operators (TTPOs) required to meet the demand for significant geothermal generating capacity expansion in Indonesia. It also seeks to address some of the institutional, capability, and access related barriers constraining the Indonesian geothermal sector. The Activity employs a flexible delivery modality, intended to be responsive to evolving partner needs and changing planning, policy and operating environments. The Activity is being delivered by the Waikato Institute of Technology (Wintec), a New Zealand-based research and learning institution.

NZSTIGS is a five-year activity with a lifetime budget of NZD10 million, across two separate phases. Phase 1 (NZD6.5 million) has a focus on core training delivery to address immediate skills shortages. Phase 2 (NZD3.5 million) intends to focus on initiatives that address longer-term sustainability and capability issues in the sector. Phase 1 was initially scheduled to begin in July 2017, but took more than a year to get underway, and therefore started in 2018. NZSTIGS, in its first and current phase, is scheduled to end in November 2021, with the possibility of being extended for a few months beyond this.

2.2 Activity objective, rationale, and interventions

The overarching goal of the Activity is to "increase skills/capabilities/capacity of Trades, Technicians and Plant Operators (TTPOs) in the geothermal sector in Indonesia". In short, the Activity has the broad mandate to upskill existing geothermal companies, work with the Indonesian education system to produce better geothermal graduates in the future as well as assist GOI partners to coordinate or undertake this.

The Activity has four separate workstreams (A, B, C and D). Workstreams A (relating to advancing opportunity and equity) and D (relating to educational infrastructure and government agencies) are not within the scope of Phase 1, with the exception of one output from Workstream D.[1] As such, these workstreams were not in scope for this case study. The results diagram for all workstreams across both phases is shown at Annex 2. Outputs and outcomes planned for Phase 1 (Workstreams B and C, with one individual output from Workstream D) are shown in the diagram below.

Expected key long-term outcomes:

- Increased skills/capabilities/capacity of TTPOs in geothermal sector (B & C)

Expected key medium-term outcomes:

- Improved quality of applied training delivery at polytechnics to deliver work-ready geothermal TTPOs (B)

Expected key short-term outcomes:

- Leadership and stewardship roles established and leading TTPO development (B)
- Local institutions delivering TTPO programs using effective applied learning modalities (B)
- Short course programs address core advanced skills gaps of existing TTPOs in sector (C)

Expected outputs:

- Geothermal curricula developed, applied/being taught in local institutions (B)
- Programmes to build local institution capability delivered (B)
- Geothermal Skills short course programs developed and delivered by trained tutors (C)
- Capacity building approach to support sector skills, competency and pathways implemented (D)

[1] Pg.8 & Pg.26, Activity Design Document – March 2018.

More specifically, Phase 1 outputs include the following activities and sub-outputs:[2]

- Course design and curricula developed for 4-week block course to augment D3[3] diploma at in course years 1 and 3
- Delivery of the new D3 curricula in the current academic year at University of Gadjah Mada Vocational School (UGM VS), Politeknik Negeri Jakarta (PNJ) and Politeknik Negeri Padang (PNP)
- Design and develop 6-week practical On-the-job (OTJ) training programme for Semester 1 Graduates for applied application of theoretical knowledge in geothermal power plants
- Develop a Train the Trainer (TTT) program for Politekniks Tutors from UGM, PNJ and PNP, at basic, skilled and mastery levels
- Delivery phase of the TTT program - first half of a 2-year process
- Develop industry specific TTT program for industry stakeholders and commence delivery
- Develop geothermal related short courses for industry and delivery
- Develop an online English language program based on technical language supporting existing English language programs
- Develop and implement an open source learning management system
- Develop graduate profiles for all programmes.

2.3 Methods for undertaking the case study

The Activity has a complex and diverse range of stakeholders spread across several provinces. Understanding the complexities of stakeholder relationships is both critical for the purpose of this case study, as well as for delivery of the Activity. Table 1 below outlines the key stakeholder groups and a simplified summary of their roles in the Activity. Please note lists of specific stakeholders named is not exhaustive. A summary diagram of the relationships is at Annex 3.

Table 1: NZSTIGS key stakeholders

Stakeholder	Description	Role
MFAT	MFAT Post; MFAT Wellington	• Contract owner and Activity management • Partner engagement and negotiation
Supplier	Waikato Institute of Technology (Wintec); sub-contractors	• Oversight, planning and delivery of NZSTIGS services
Contractual GOI Partner	Indonesian Ministry of Energy and Mineral Resources - Human Resources Development Agency (BPSDM) – includes PPSDM KEBTKE, PPSDM Migas & PEM Akamigas	• Indonesian "owner" of NZSTIGS through partnership agreement with MFAT • Governance and direction • Recipient of capacity building services
Other key government stakeholders	PPSDM KEBTKE Geothermal Directorate; Kemerinstekdikti Higher Education Directorate in Ministry of Education	• Key BPSDM training institute allocated for heavy involvement in NZSTIGS – as beneficiary and partner • Support for development of formal curriculum and integration
Beneficiaries (Training providers)	PP KEBTKE; PPSDM Migas UGM VS; PNJ; PNP; others	• Recipients of NZSTIGS services – predominately for curricula and TTT
Beneficiaries (State Owned Enterprises [SOEs])	Perusahaan Listrik Negara (PLN); Pertamina Geothermal Energy (PGE); Geo Dipa Energy	• Recipients of NZSTIGS services
Beneficiaries (Private sector companies)	Companies working in geothermal continuum (e.g. Star Energy, Supreme Energy, Sarulla)	• Recipients of NZSTIGS services
Beneficiaries (Other)	Indonesia Geothermal Association (INAGA) - Non-profit organisation.	• Receive Wintec services (e.g. TTT course for their Subject Matter Experts).

[2] Pg.8, ADD.
[3] Diploma III – Equivalent to a three-year Bachelor's degree

The purpose of this case study is to understand progress, and take stock of, the current status of the Activity, understand if the Activity is still fit-for-purpose in its current form as well as generate lessons for the future direction for the Activity and the Energy Programme more broadly. The case study is a forward-looking exercise to consider how geothermal training fits into MFAT's future renewable energy (RE) programming in Indonesia and inform the anticipated upcoming Phase 2 of NZSTIGS.

The NZSTIGS case study is expressly not an end-of-activity evaluation aimed at accounting for outcomes, investments and compliance. Examination of commercial and management factors is therefore not central. Due to the complex results measurement framework and limited time available for this case study, this case study report does not report on detailed progress toward Activity outputs and outcomes.

The specific objectives of the case study include (but are not limited to):

- Generating evidence to inform Phase 2 of NZSTIGS specifically – e.g. capturing emerging evidence on longer-term sustainability and key remaining capability issues within the sector
- Assessing the modality adopted by NZSTIGS, and understanding the extent to which this approach has strengthened NZSTIGS' ability to remain relevant to partner government priorities and changing operating environments
- Understanding the impact an in-country presence (or absence of) has had on NZSTIGS; and generating recommendations to inform future practice
- Understanding forms of engagement with key partners - assessing if the most relevant partners were engaged; if the methods of engagement were appropriate and effective; and lessons for increased engagement
- Generating evidence to inform future RE programming in Indonesia in general.

MFAT are to undertake a strategic review of MFAT's support to the renewable energy sector in Indonesia. This case study will contribute to the evidence base for the review.

The case study findings are based on analysis of both primary and secondary data. The evaluation team first reviewed relevant Activity-related documentation to understand how the Activity was designed and implemented, and what results were achieved in line with the Activity objectives. To complement this, consultations with relevant internal and external stakeholders were conducted to gain deeper understanding and understand nuances of the Activity implementation, results and lessons learned to inform findings on the relevance and coherence, effectiveness, efficiency and sustainability of the Activity as well as future directions of the Energy Programme.

Table 2 below provides a brief overview of the primary and secondary data collected and analysed for this case study. More detailed information can be found in Annex 1.

Table 2: Summary of data sources

Data source	Examples
Secondary - Documentation	
MFAT documents	• Activity Design Document (ADD), 2020 Activity Monitoring Assessment (AMA), ADD Appraisal
Supplier documents	• Quarterly Reports, Forward Work Plans and other technical content
Primary - Stakeholders consulted	
MFAT	• Staff at MFAT Post (Jakarta), Sustainable Development and Thematic Division (DST) and Global Development and Scholarships (GDS) team
Supplier	• Staff of Wintec
GoI Partners	• Staff of BPSDM ESDM, PPSDM KEBTKE, PPSDM Migas, PEM Akamigas
Training providers	• Staff of PNJ and UGM VS
SOEs	• Staff of PLN and GeoDipa
Private sector	• Staff of Star Energy
Other	• Previous NZSTIGS staff; Staff of Swiss State Secretariat for Economic Affairs (SECO), previous MFAT staff

The main challenge in undertaking the case study and data collection was the clearly different views and priorities held by the various key stakeholder groups. Having only conducted a limited number of stakeholder interviews (i.e. 1-3 interviews per stakeholder group), the findings of the case study may therefore not be representative, and findings and considerations should be read in this context. Given the complexity of the stakeholder environment and the limited scope of this case study (i.e. not a full activity evaluation), considerations for future efforts should not be read as conclusive but rather options for MFAT to consider and validate through both internal and external consultative processes.

It should be noted that many interviews were conducted as group interviews, where specific individuals may have been hesitant of presenting perspectives divergent from those of their entity's most senior representatives present. In addition, many stakeholders were seemingly very cautious of providing any overly critical perspectives. Most grievances and suggested improvements were given cautiously, while stressing that the existing programme is well-received. This could in part be because the Activity is still underway. Almost all beneficiaries, however, strongly stated their support and gratitude for the services, both from New Zealand and for the effectiveness of the Supplier's content and delivery.

3 Case study findings and lessons learned

The key research questions for the case study are based on the Organisation of Economic Cooperation and Development's Development Assistance Committee (OECD DAC) criteria (shown in the table below). As such, the findings presented in this report are structured by the DAC criteria. Though the case study relates specifically to this Activity, the primary purpose of this case study is to inform the broader strategic evaluation. It is not intended to be a comprehensive evaluation of the Activity itself. Findings, lessons learned, and considerations should be read in this context.

Objective	Description
Relevance and coherence	To examine the relevance, significance, and coherence of the Activity.
Effectiveness	To examine the extent to which the Activity achieved, or is expected to achieve, its objectives and results.
Efficiency	To review the effectiveness of MFAT's approach and ways of working i.e. internal roles and responsibilities and resource allocation, funding, contracting and delivery (management and governance) modalities to deliver expected results.
Sustainability	To assess the sustainability - physical, operational, economic, social, environmental and resilience of the Activity investments.
Future directions	To document lessons learned from the Activity that can inform strategy, policy and improved ways of working for the Activity and the Energy Programme as a whole.

It should be noted that as the Activity is still underway, analysis and findings for this case study were more focused on *relevance and coherence* and *efficiency*, rather than *effectiveness* and *sustainability*.

3.1 Relevance and coherence

Relevant and consistent with Indonesia's development aspirations and needs

The Activity is highly relevant and consistent with Indonesia's development aspirations and needs – there is significant potential and growth in demand for exploiting Indonesia's vast geothermal resources. Indonesia is one of the world's most volcanic countries, with an estimated 40 per cent of the world's geothermal energy potential, yet currently using only an estimated 4 to 5 per cent of its full geothermal potential.[4] The potential for increased availability and accessibility of electricity, associated stronger economic development, environmental and climate change related advantages are substantial and highly aligned.

[4] Nasruddin, Alhamid, M., Daud, Y., Surachman, A., Sugiyono, A., Aditya, H. & Mahlia, T. (2016). 'Poten ial of geothermal energy for electricity generation in Indonesia: A review', *Renewable and Sustainable Energy Review*, Vol.53, pp.733-740.

Support to Indonesia's geothermal sector was deemed highly relevant and appreciated by industry partners, polytechnics and government partners alike. All parties strongly communicated the strong utility of assistance to grow geothermal development in Indonesia and generate further benefits (e.g. economic development and jobs, electricity generation, and environmental benefits, etc).

Though relevant and coherent with Indonesia's development needs and priorities, Activity implementation has not kept pace with the partner government's vision and changing priorities. Government partners have flagged strong concerns of not being engaged well in existing delivery. As there are two components of the GOI role (i.e. Partner and Beneficiary), there is a sensitive navigation regarding the extent to which they drive the demand and direction of NZSTIGS services, as well as influence the receipt of services. GOI partners want to be involved in both receipt of training (i.e. capacity building), but also want to be better included in the planning and coordination of training to other stakeholders.

As a partner, the GOI stakeholders reported they are not being sufficiently included as a partner in the delivery of services to other organisations and as a *beneficiary*, the GOI stakeholders reported that they are not being sufficiently included or prioritised as a recipient of services. The mismatch of expectations as a partner and beneficiary has led to the GOI misunderstanding of the Activity's scope and objectives. For instance, there appears to be a misunderstanding between partners as to the scope, extent and type of services to be provided to GOI partners in Phase 1. GOI partners appeared to consider Phase 2 capacity building services as within scope for Phase 1, and are actively pushing for receipt of services beyond what the Supplier has been mandated to supply in the current phase.

As a way forward in ensuring that the Activity remains relevant, GOI stakeholders noted:

- **The need to broaden the scope of the Activity to provide more support beyond TTPOs**, also stating they require more engineering/ mainstream and downstream support – e.g. train their supervisors to a higher quality, and across a greater breadth of expertise. GOI are pushing for this type of support because they see strong value in building the capability/expertise within Indonesia to the standards of New Zealand. Going into Phase 2, this observation indicates the need for MFAT to address the scope and objectives of the Activity with the GOI to ensure that they are and feel included in the leadership and delivery of the Activity.
- **Their desire to be centrally involved in Activity planning, coordinating all other partners, and in the delivery of services**. As the key national government agency with the mandate for renewable (including geothermal) energy training, they desire more influence and authority to engage stakeholders and build a strong system with more coordinated oversight. They expressed that this would help ensure they are better placed to integrate with other skillsets (e.g. drilling, geochemical engineering, etc.) provided by other BPSDM training institutes (e.g. PPSDM Migas). They shared their aspirations regarding NZSTIGS supporting them to become Indonesia's "Geothermal Centre of Excellence". The GOI partners reported wanting to undertake industry engagement alongside the Supplier so they can better monitor progress of Indonesia's industry partners and plan for the future
- **KEBTKE also reported a strong desire to be more integrated into the delivery of services,** being involved in joint-class teaching, workshops, using their lecturers and doing joint-training with the Supplier. They emphasised that they have the assets and budget to support the Activity (e.g. providing classrooms and equipment etc) and that broader inclusion will create more frequent exposure, increasing their agency and capability of their trainers through experiential learning by doing.

Highly relevant and consistent with geothermal industry, training and private sector stakeholders' needs and priorities

The Activity is highly relevant and consistent with Indonesia's geothermal industry, educational institution and private sector stakeholders' needs and priorities. The significant growth (and anticipated future growth) of the Indonesian geothermal sector has seen a corresponding increase in demand for trained staff to work in the industry. While academic qualifications of adequate quality (e.g. mechanical engineering) exist in-country, the related technical skillsets (e.g. plant operations and maintenance) in-country to serve this increase in demand for geothermal energy generation is significantly lacking, and the targeted provision of these skillsets as per Phase 1 is highly appropriate.

All interviewed stakeholders highlighted their need for the practical operational skillsets that NZSTIGS is developing. Industry groups highlighted their strong demand for these technical skillsets and difficulty

sourcing them, and educational institutions highlighted their current lack of expertise to increase the practical and vocational elements of their geothermal teaching programs. Training institutions reported that short courses and curriculum provided through the Activity were generally very well aligned with their needs. Stakeholders also indicated a desire to know how good their staff/students measure up to the New Zealand standards in their technical skillsets. It is important to note that demand for this Activity came from Indonesian geothermal industry stakeholders – the design was informed through a large in-country, on-the-ground scoping process. The Activity was therefore designed to be, and remains, very aligned with these industry needs.

Several respondents stated they are engaged well before the start of each year about what they need, and this collaboration works well, with the Supplier generally being responsive to their needs. Yet, others suggested this engagement and alignment could be strengthened, and that there is no consistent communication around curriculum development. Some polytechnics also stated they need more support for other related areas to help them realise a more comprehensive training program (e.g. mechanical engineering training for piping and steam etc. related to the initial construction of geothermal facilities).

Relevant and consistent with New Zealand and global priorities

The Activity is highly relevant to the strategic objectives and vision of the New Zealand Aid Programme's Renewable Energy (Flagship) Investment Priority (2015-2019) and Strategic Plan (2015-2019). The goal of the Activity is to expand access to affordable, reliable and clean energy, through the delivery of niche geothermal human resource development support. It is improving access to reliable and renewable energy through technical assistance to Indonesian geothermal stakeholders, supporting greater private sector participation in the energy sector through targeted provision of technical skill training, and (to a much lesser degree) strengthening sector planning and asset management to improve service quality and efficiency.

Further, it contributes to the delivery of MFAT's Strategic Intentions 2019-2023, embedding New Zealand as an active and integral partner in building Asia-Pacific architecture in support of regional stability and economic integration, and promoting sustainable international solutions to global environment and natural resource challenges that impact on New Zealand. The Activity has also relevance and alignment to MFAT's International Cooperation for Effective Sustainable Development (ICESD) principles, and in particular to Principle 3: "Resilient" given the Activity's focus on establishing Indonesia for future environmental and economic resilience and transition away from fossil fuels.

The Activity is also relevant to New Zealand's priorities through its support of the ASEAN Regional Programme's 4YP outcomes of improved workforce skills and capabilities supporting development in South East Asia; aligning to the South-East Asia 20 Year Development Strategy of contributing to regional integration, prosperity and stability.

There is a clear fragmentation between key stakeholder levels in the Indonesian geothermal sector – and strong demand for a system-wide approach

There is an evident lack of coherence and engagement between and within the various stakeholder groups within the Indonesian geothermal sector as a whole. GOI partners are relatively disconnected from private industry, and training institutions are largely disconnected from both policy (i.e. GOI) and industry. There is demand for a system-wide approach, with a clear roadmap for geothermal sector development, and roles for collaboration between the different institutions. Several respondents hoped the Activity could play a role in better connecting them into other institutions within the Indonesian geothermal sector, to have more collaboration (e.g. link polytechnics with industry better, to understand their requirements in graduates, etc). Similarly, there was strong interest in being better connected to other NZ institutions working in the geothermal sector.

As the key national entity for renewable energy training, KEBTKE are best placed to lead and own such a system-wide approach, but there is room for valuable, and much needed, support. NZSTIGS could be well-placed to support the development of such a roadmap going forward, but the specific skills and resources required to do so effectively should not be underestimated.

Factors enabling relevance and coherence

- Strong in-country scoping processes with industry partners before Activity design, to understand capability and capacity gaps.
- Time spent *being in-country* feeds directly into better relevance and coherence to local systems and stakeholders and builds the profile of NZSTIGS. This is constrained now due to COVID-19.

Factors hindering relevance and coherence

- Numerous stakeholder groups create an operating environment where relevance to and coherence to the countries' aspirations and priorities is challenging to navigate.
- Government partners have changing and evolving interests and priorities (exacerbated by changes in leadership).
- No clear collective roadmap on geothermal development – which means that goalposts are moving. This is leading to confusion and changing priorities, and in turn damaging relationships.
- A significant time period between the original Activity design and then implementation, coupled together with new staff at partner governments institutions and MFAT.
- GOI partners have limited connections and relationships with private industry. Without which it is difficult to build sector-wide relevance/coherence– GOI feel trust in them is being further undercut by NZSTIGS bypassing them in engagements with other stakeholders.
- A lack of initial design stage being comprehensively planned with government partners. This was then further exacerbated by a 12-month+ wait time post-ADD, by which time GOI leadership was reportedly less engaged.

Considerations for improving relevance and coherence

- There are opportunities for MFAT to support the development of a roadmap for the geothermal sector in Indonesia; to help facilitate a system-wide approach.
- Targeted, regular and consistent meetings between key Activity delivery stakeholders (e.g. GOI, MFAT and Supplier), ideally led by BPSDM. This is especially challenging now due to COVID-19 travel restrictions.
- MFAT could find ways to encourage BPSDM (e.g. KEBTKE) to engage more effectively with non-BPSDM institutions and/or better include BPSDM in existing engagements with non-BPSDM institutions. This could be achieved in part by clarifying roles and responsibilities of Activity partners; seeking formal agreement on how BPSDM together with the Supplier will undertake industry engagement collaboratively.
- There is a clear need for a stronger in-country presence to build coherence and relevance with in-country partner priorities. MFAT should consider options for finding appropriate personnel with the right skills mix to effectively engage key Activity partners and support effective collaboration and capacity building, especially in Phase 2.

3.2 Effectiveness

This section provides an overview of what the Activity has achieved and is expected to achieve. As the Activity is still in progress and there were several initial delays arising from staff turnover at the partner organisation, comprehensive reporting on outputs and outcomes is not yet possible. Further, a comprehensive evaluation of the Activity's progress towards outputs and outcomes, involving an assessment of outputs and outcomes against the detailed and complex results measurement framework, is not within the scope of this case study and was not undertaken.

Delivery of outputs is progressing well

Despite initial delays, the delivery of most Phase 1 outputs (e.g. Output 2 – curriculum development and implementation, Output 3 – local institution capability programs, and Output 4 - short course development and implementation) is progressing effectively. The exception to this is the delivery of capacity building outputs for BPSDM (Output 5), which is lagging.

In terms of key outputs achieved, most notable was that 39 technical short courses were delivered with 560 total participants by the end of 2020.

Short-term outcomes are seeing results but early to confirm

While it is too early to assess and report on short-term outcomes comprehensively, there is some emerging evidence that certain outcomes are progressing well and others are lagging.

For example, Workstream C's short-term outcome (STO) "Short course programs address core and advanced skills gaps of existing TTPOs in sector", appears to be well on track. Without exception, training recipients reported high quality training content and strong satisfaction with the types of skills their TTPOs were learning. Private companies, polytechnics and government training institutions alike report useful and effective training that is filling a gap in Indonesia and appreciate the access to New Zealand geothermal knowledge – which is viewed extremely favourably. The use of practice-based learning and modules (which has been impacted by COVID-19) to provide technical training is proving highly effective, as it helps participants become more job-ready and respond to non-standard plant scenarios.

With regard to Workstream B's STO "Leadership and stewardship roles established and leading TTPO development", there are indications that outputs are lagging in terms of support for local key stakeholders responsible for leading development. Some government stakeholders expressed their dissatisfaction at the current levels of support received. However, other stakeholders such as polytechnics reported they received adequate and effective capacity building support. A more thorough evaluation is required to fully understand the effectiveness of this Workstream and issues resulting in lagging outputs.

In terms of unintended outcomes, stakeholders reported the positive impact arising from the Activity contributing to broadening their New Zealand networks (i.e. with groups such as Wintec, Jacobs, University of Auckland) and with other alumni in-country. For example, one company reported that through their broadened networks, they were able to hire more engineers from New Zealand.

While stakeholders all found that training was effectively delivered and of high value to them, there was demand from some stakeholders for additional mechanisms to build their skillsets and capacity, including:

- Incorporating more learn-by-doing/experiential learning approaches (i.e. polytechnics, government groups and trainers teaching together with the Supplier; being taken into geothermal plants to observe how things work in practice)
- More continuous and long-term coaching to support training institutions to deliver short courses for training institutions (i.e. more integrated development of semester curriculum; more reference materials such as handbooks, guidelines, and other tools in written format)
- Enabling stronger industry connections and pathways for graduates (i.e. by inviting Indonesia geothermal practitioners into classrooms).

Factors enabling effectiveness

- Course materials are viewed as highly effective for addressing skill gaps shortages. The instructors are generally viewed favourably and are knowledgeable.
- Hands-on training is effective and acknowledged as a key element for building technical skills. In-country and New Zealand-based mentors providing live training helps to contextualise academic learning (*noting this has been restricted by COVID-19 restricted)*.

Factors hindering effectiveness

- Integration of training with Indonesia's education system is challenging and requires significant time and resources.
- Staff at key partner institutions participating in TTT often have limited time available to complete the full training, making it challenging to develop expertise in this area.
- Current mechanisms for selecting participants may mean that some contractors operating in the field are missing out. For example, for the private sector, training is targeted at the main contract holding companies, who may then sub-contract operations out to other companies.
- COVID-19 has impacted on the provision of in-person training as well as hands-on training components. It has also made it challenging for the Supplier to observe and assess how skills and knowledge is being applied in practice.

3.3 Efficiency

Pedagogical delivery model for training is effective though accessibility can be improved

The Activity's pedagogical delivery model adopts effective practice-based approaches for teaching technical skills and is largely efficient. However, access to the training can be enhanced through having some training delivered and materials in Bahasa. The language in which training is delivered remains a barrier to many staff (and participants) who do not have adequate English language skills to fully absorb technical concepts. This language barrier was exacerbated by COVID-19 with stakeholders noting that remote learning in a foreign language made it difficult for some of the staff. While it is understood that training is delivered in English, there may be value in increasing the language accessibility of technical training content. For example, a summary of course and module/chapter learnings could be translated into Bahasa to support understanding. This could also contribute to the sustainability and reusability of course content. It should also be noted that language barriers can present a barrier beyond the delivery of training, extending to the engagement and relationships at the Activity governance level and beyond.

Remote learning as a result of COVID-19 is proving to be efficient

COVID-19 related travel restrictions forced the Supplier to deliver most of its training modules online and with increased creativity and innovation. This delivery of online learning modules provides more flexibility for participants to learn content, and helps them fit training requirements around work commitments (which are even more important now with increasing financial pressures). This new delivery model was viewed as a key success by many interview participants. While COVID-19 restrictions meant that hands-on training methods (which are also desired) are not currently possible, maintaining learning online will ensure participants are more prepared for hands-on training elements when they are again possible.

Efficiency of Activity implementation is adversely impacted by a multitude of challenges

Efficiency of Activity implementation is hampered by the complex political and cultural operating environment, communication and sectoral coordination challenges, and competition for receipt and provision of services. The time and resources spent by both MFAT and the Supplier to effectively navigate these challenges is significant. This could pose a challenge for effective delivery of systemic capacity building to be delivered in Phase 2.

Political and cultural challenges include cultural and diplomatic norms and protocols, high rotation of individuals in partner government institutions, training institutions and the private sector. Another political

challenge noted was the education system within Indonesia where there are challenges in shifting from academic and certification-based to practical, problem-solving based learning modalities. Further, there are reportedly cultural/socio-economic differences in the establishment of geothermal plants in Indonesia, compared to New Zealand. For example, where New Zealand might have one highly trained operator for a plant, there may be multiple people sharing a similar range of duties in Indonesia, allegedly due to the higher population and need to provide employment opportunities.

There are also several challenges around communication and broader sectoral coordination which are limiting the efficiency of the Activity. There are numerous stakeholders to engage within a currently fragmented system, and multiple training institutions within BPSDM alone. This contributes to the existing challenges of building and maintain stakeholder engagements and partnerships effectively. These challenges extend to a lack of consistent and agreed direction between various stakeholders, and the ineffectiveness of the Activity Steering Group's coordination and inclusion of appropriate stakeholders (e.g. PEM Akamigas) as well as bi-annual meetings and high-level reports.

Competition for receipt and provision of services is another challenge. There are many separate entities in Indonesia's geothermal sector. For example, training institutions are generally in competition with each other and have different interests and ideas for future directions. Due to competition among stakeholders, finding suitable local partners can be challenging as stakeholders reportedly over-promote themselves, leading to difficulties in making accurate assessments of partner strengths. This is made even more challenging due to not being able to undertake assessments in-country due to COVID-19.

Some training institutions aspire to be considered as Indonesia's premier geothermal experts. For example, KEBTKE want to be known as Indonesia's "Geothermal Centre of Excellence", to coordinate the national geothermal process and serve as the national reference point for geothermal. Other training stakeholders also expressed their strong desire to be leaders in this sector. This competition is also evident amongst donors, where it was reported that a polytechnic eager to participate in this Activity was offered other free services by another donor, and therefore did not have adequate resources to partner with this Activity also.

The Supplier's "Work with the willing" approach is somewhat appropriate in Phase 1

As a result of the identified challenges and varying levels of stakeholder engagement, the Supplier has adopted a "work with the willing" approach to minimise time spent on navigating relationship management. In practice, this approach means the Supplier is choosing partners carefully, undertaking appropriate due diligence, and only engaging with those who are strongly and eagerly engaging with them. This approach is appropriate in the context of both the Supplier's resourcing, skills and the mandate of Phase 1 mandate, and is a resource-efficient approach to managing the complex stakeholder environment.

Many educational institutions and industry partners have clear needs which are aligned to what the Activity is offering, and are therefore visibly willing and engaged. However, issues remain with GOI partners and stakeholders who are willing and eagerly wanting to be engaged, but have less clearly articulated needs and priorities, and are yet to adequately engage. The reasons for this are complex and are highlighted in the sections above and below. While the current "work with the willing" approach has supported efficiency to date and in the current phase, it is not adequate for building longer-term partnerships or system capacity.

There is a clear lack of trust and communication between Supplier and GOI partners

This lack of trust and communication between the Supplier and GOI partners is a significant hindrance to the Activity's efficiency, relevance, effectiveness and sustainability. Both parties suggest the other is primarily responsible for the current lack of engagement and communication. The situation is very complex, and it is beyond the scope of this case study to attempt to assess or report on causes contributing the issues identified. Nevertheless, some observations can be made.

There are several factors contributing to poor trust and communication between the Supplier and GOI stakeholders, including: 1) different cultural expectations of engagement styles; 2) Supplier's size and limited ability to scale up and/or respond to requests from across the sector in a timely manner (which in part is driven by the scope/services agreed between MFAT and the Supplier); 3) Supplier's limited capability to manage stakeholder relationships in a cross-cultural and complex political setting; 4) lack of

close in-country presence and engagement; and 5) lack of scope specificity for GOI to fully understand and receive services desired from this Activity.

A key factor in the apparent poor relationship appears to be different cultural expectations around norms and rules for engagement between GOI stakeholders and the Supplier (e.g. appropriate amount of time before invitations to meetings, and the expectation for regular face to face senior level interaction between Supplier and GOI). Interestingly, a visible difference in expectation is the perception of onus on re-engagement through staff rotations. The Supplier stated the challenges in repeatedly re-engaging GOI through various staff rotations, whereas GOI partners showed apparent frustration that the Supplier was not sufficiently reaching out and re-engaging after their own staff rotated, almost indicating an expectation that the onus for this renewed engagement was on the Supplier.

Much of the current relationship management is led by MFAT staff at Post, who are significantly better placed to manage the political challenges and understand the local context. While MFAT staff are hugely influential in facilitating engagement (and praised by GOI partners for this), the current levels of engagement were not planned for during the Activity design processes and staff at Post do not have the requisite technical skills to support integration of the training into the Indonesian education and geothermal sectors. The relationship management required for effective partnerships, as well as successful delivery of capacity building outputs, now and in the future, should not be understated.

A key factor driving the misalignment of expectations is that BPSDM conceive the Activity contract as a government to government (G2G) initiative – they have KEBTKE as their implementing agency – MFAT have Wintec. Key GOI stakeholders want Wintec to go through formal MFAT (and by extension BPSDM) channels when making decisions and implementing the Activity. Should this perception remain, a strong and continued role for MFAT staff at Post will likely be required into the future.

Risk mitigation strategies are not being implemented effectively

The Activity Design Document (ADD) highlighted the key risks including: potential for changing motivations and priorities of GOI stakeholders; risks to ensuring alignment of the Activity and BPSDM priorities; and the potential for BPSDM efforts to be centred on establishing KEBTKE as a full Polytechnic entity (i.e. their Geothermal Centre of Excellence).[5] These risks have come to fruition.

The key mitigation measures prescribed against these risks involved having a strong presence on the ground (largely through an in-country PMU with a full-time Technical Adviser [TA]) and adopting a flexible approach to implementation accompanied by regular dialogue to navigate and accommodate changing partner priorities. Overall, these measures have not been implemented effectively and evidence shows insufficient engagement to effectively navigate evolving partner government priorities and motivations. This is in part due to COVID-19 travel restrictions and the difficulty in identifying suitable in-country resources with the right mix of technical (e.g. geothermal), cultural and diplomatic skills as well as a specific understanding of national education / vocational and geothermal policy and legislation.

The absence of an in-country presence was explicitly raised by GOI partners as a challenge for engaging with the Activity. GOI partners highlighted the positive nature of Swiss SECO engagement, who are undertaking a similar capacity-building project with BPSDM – pointing out that they have appointed a clearly identified a consultant in-country, they have a clear agenda and structured timeline for activity over longer periods, a clearly-defined working group who get together and plan together more frequently than the Activity, and that this increases integration. A conversation with SECO reinforced the difficulties in sourcing the right mix of professional experience, and how integral this and interpersonal relationships are for effective integration of donor activities into partner government planning.

[5] Page.10. ADD

Factors enabling efficiency

- MFAT staff at Post are influential in facilitating engagement, especially with GOI partners. The time and resources required for relationship management and effective capacity building should not be understated.
- Identification of engaged and knowledgeable individuals to work with is vital, and can play a large role in developing successful partnerships and facilitating buy-in. However, it is significantly harder to identify such individuals without being in country.
- Some beneficiaries highlighted that having a schedule communicated well in advance by Wintec was appreciated and useful because it helped them better plan who should attend the training.

Factors hindering efficiency

- Poor relationship and a breakdown in communication between GOI partners and the Supplier. Differing expectations of the Activity's scope as well as cultural interpretations and understanding of engagement protocols are contributing to this.
- High staff turnover at key partner institutions and beneficiaries means that relationships need to be developed regularly and shared priorities agreed and collectively understood repeatedly. Turnover in leadership positions can also alter engagement, priorities and resourcing profiles devoted to the Activity and related efforts.
- BPSDM and other key partners can be too busy and under-resourced to engage sufficiently and effectively. There is a need to get more creative and flexible in engagement styles. This warrants much earlier and stronger integration.
- Lack of an in-country presence from the Supplier is undermining engagement with local stakeholders.
- The language barrier undermines accessibility of the training and gives rise to further challenges relating to building and maintaining in-country stakeholder relationships (e.g. Supplier and GOI) more generally.

Considerations for improving Activity Efficiency

- It is important to build from a clear shared understanding of what the end objectives and priorities are. As such, it is worth considering the provision of support to develop and implement a roadmap (i.e. as originally envisaged to be produced by the embedded TA[6]). While flexibility is positive and desirable, it is not advisable for goalposts to change regularly without serious evidence or consideration as it can cause damage to relationships.
- Strongly pursue the engagement of an in-country Activity staff member for better integration with the national systems, greater efficiency in existing and future outputs, and coherence with the partner government's evolving vision and priorities. As KEBTKE have explicitly asked for an in-country individual placed within their office in Jakarta for improved coordination and communication, co-location of the in-country staff could be a suitable option.
- The Activity Steering Group should consider more frequent and structured engagement, and ensure they leave room for discussing evolving stakeholder priorities and implications of this on the Activity, either in current or future phases.
- Considerations for Phase 2 of the Activity should include mapping the required supplier capability to meet Activity objectives and undertaking an assessment of how the Supplier currently meets the capabilities and what gaps exist. Criteria for Supplier capability could include, but not be limited to: (1) appropriate and adequate personnel to engage key government partners in a cross-cultural setting and navigate through political complexities (together with MFAT Post); (2) ability to effectively deliver technical aspects / all workstreams (i.e. modify curricula and deliver training); and (3) develop and maintain an in-country presence, including staff with appropriate geothermal sector knowledge and Bahasa skills, to build on current successes and address identified issues. It should be noted that any one Supplier may not have all the skills and capabilities outlined (given the geothermal / training expertise required for this Activity) and the Supplier may need to consider various modes of contracting appropriate personnel to fill identified gaps, both remotely and in-country.

[6] Pg.34 – ADD.

3.4 Sustainability

While the Activity's sustainability is considered as part of the overall Activity design, it is incorporated primarily as part of the design of Phase 2 rather than Phase 1. As such (and given that Phase 1 is still underway), an assessment of Activity sustainability is not possible at this time. This section, however, does provide some emerging findings that should be read in the context of these limitations.

In Phase 1, the methodology of training the trainers and building the capabilities of local institutions is important for sustainability. Some beneficiaries and industry groups expressed a desire to have more detailed tracking of learned skillsets and progress towards various competencies to enable them to better plan for sustaining training outcomes and for participant learning progressions. Some stakeholders also added that the production of some materials (i.e. at least reference/course guides) could be developed in Bahasa.

It should also be noted that effective relationship-building and integration of training into Indonesian systems in Phase 1 will support sustainability-related efforts in Phase 2. The Activity is unlikely to be sustainable until it is strongly integrated into the Indonesian education system and aligned with the direction and efforts of the Indonesian geothermal sector. A more comprehensive practice-based training system established in-country – with in-country local trainers – will likely support better integration.

In addition to this, improved integration and engagement with key government stakeholders will be especially critical to ensure that training is embedded into the system and that they are being empowered to have strong ownership and demonstrate leadership in-country. In-country presence of MFAT and Supplier personnel may contribute strongly to building ongoing engagement with key stakeholders. Finally, an agreed roadmap could serve to institutionalise key next steps and build a system collaboratively.

Factor enabling sustainability

- The development and implementation of training methodologies (e.g. train the trainer) and reusable materials (e.g. curricula) helps support ongoing benefits

Factors hindering sustainability

- The absence of capable and empowered in-country partners to take ownership of Activity (resulting primarily from high staff turnover at partner institutions)
- COVID-19 impacts on restricting mobilisation New Zealand-based staff and trainers to establish more practice-based, hands-on and learn-by-doing training approaches.

4 Overall lessons learned

4.1 Overall lessons learned for the Activity

There are several lessons that could be derived from the Activity:

Overall lessons learned for the Activity

- Effective engagement of GOI partners and integration with national systems is important for improving the relevance, efficiency and sustainability of the Activity.
- Further inclusion of GOI partners in Activity design, implementation and monitoring will be critical for ensuring that capacity building outputs in both Phases 1 and 2 are effective and captured. This means that the design of Phase 2 would benefit from being updated to reflect these considerations.
- Ensuring risk mitigation strategies are implemented as planned and/or are effective is also key. For this Activity, risk mitigations strategies identified (i.e. having a strong in-country PMU with appropriate skills and capability to engage with GOI partners) will likely help resolve the breakdown in communication and trust breakdown between the Supplier and GOI partners.
- The substantial involvement of MFAT staff at Post are hugely influential in facilitating engagement with GOI stakeholders. Given the desire for and upcoming focus in Phase 2 on capacity building, involvement of staff at Post will remain important.
- Supporting BPSDM to create a roadmap / capacity development plan for the broader development of the national geothermal system, that clearly articulates the broader strategy,

components and key stakeholders, is likely to increase Activity relevance and reduce misalignment in expectations and relationship breakdowns. This could start through discussions at the Activity Steering Group and then expand to include broader groups of relevant stakeholders (e.g. Indonesian geothermal industry and education institution stakeholders).

Various stakeholders provided specific suggestions for amendments, additions and other changes to the scope and content of the Activity and further New Zealand geothermal support in general. These have been captured here for MFAT's reference only, and do not necessarily constitute recommendations by the part of the evaluation team. It should be noted, these were offered as polite suggestions and not demands. Without exception, every suggestion was prefaced by acknowledgement and appreciation of existing support.

Capture of specific requests from stakeholders consulted

- Specific requests for improvements from GOI included:
  - More direct support for delivery of GOI's own training courses.
  - More support beyond trainers and engineering staff, but also economists, supervisors, managerial level, broader HR, finance and procurement.
  - Support with IT and LMS (Learning Management Systems) to help take stock and plan future progressions and training.
  - Further investments in classrooms and the requisite training equipment.
  - More support for qualitative / quantitative research for broader development of their geothermal sector. For example, for upstream exploration.
  - Support on revenue generation for training and certification.
  - Generally, assistance which provides the latest technology and cutting-edge knowledge.
- Private companies and polytechnics also have further requests for specific support, which included:
  - More support for training of engineers, in addition to TTPOs.
  - Certification and/or reporting systems to better measure individual training participants' progress on technical skill development.
  - Further curriculum development highlighted by polytechnics as key area of future support.
  - More support in the East and in the Far-West of Indonesia; areas closer to geothermal activity.
  - Integrating training for drilling, a key gap in the Indonesian geothermal sector affecting well quality.

4.2 Overall lessons learned for the Energy Programme

There are broader lessons learned for the Energy Programme as a whole and they include the following:

Overall lessons learned for the Energy Programme

- For activities focused on capacity building, finding the right in-country personnel with the appropriate mix of technical and stakeholder engagement skills is critical. Where appropriate in-country personnel are not incorporated into activity design or there are no suitable candidates, the role of staff at Post (where applicable) should be explicitly factored into activity design.
- All activities, and in particular activities with capacity building elements, will benefit from clear and embedded adaptive management approaches. Amongst other things, this will require a strong shared understanding of long-term objectives and support to Activity partners to agree and undertake purposeful changes (i.e. in response to shorter-term objectives/outputs and/or issues arising and affecting effectiveness). This does not mean changing long-term objectives of Activities, but rather establishing processes and support to allow for planned changes of specific tools and methodologies, timeframes, resourcing profiles and partnerships to ensure effective and efficient delivery of outputs and outcomes in response to changing contexts.
- While it can be challenging to provide adequate hands-on training from afar, online learning for less practical "hands-on" components are efficient teaching modalities and offer flexibility to students and staff.
- The time and resources required for strong program design and effective monitoring and evaluation should not be underestimated, especially for capacity building initiatives where outputs and outcomes are often less tangible and thus more difficult to measure and track.

Annex 1: Documentation reviewed and stakeholders consulted

Documentation reviewed

Documentation reviewed for the case study consisted of:

MFAT project-specific documents	• NZSTIGS Activity Design Document • NZSTIGS Results Framework • NZSTIGS Activity Monitoring Assessment 2020 • NZAID AMS – Programme Activity Authority – Crown Expenditure
Supplier Reports	• NZSTIGS Annual Progress Report: No. 1 • NZSTIGS Annual Progress Report: No. 2, Indonesia • NZSTIGS Quarterly Progress Report, #7 • NZSTIGS Forward Work Plan –23 July 2018 – 31 December 2018 Draft v2 • Supplier progress updates (e.g. 26 Jan 2021)

Stakeholders consulted

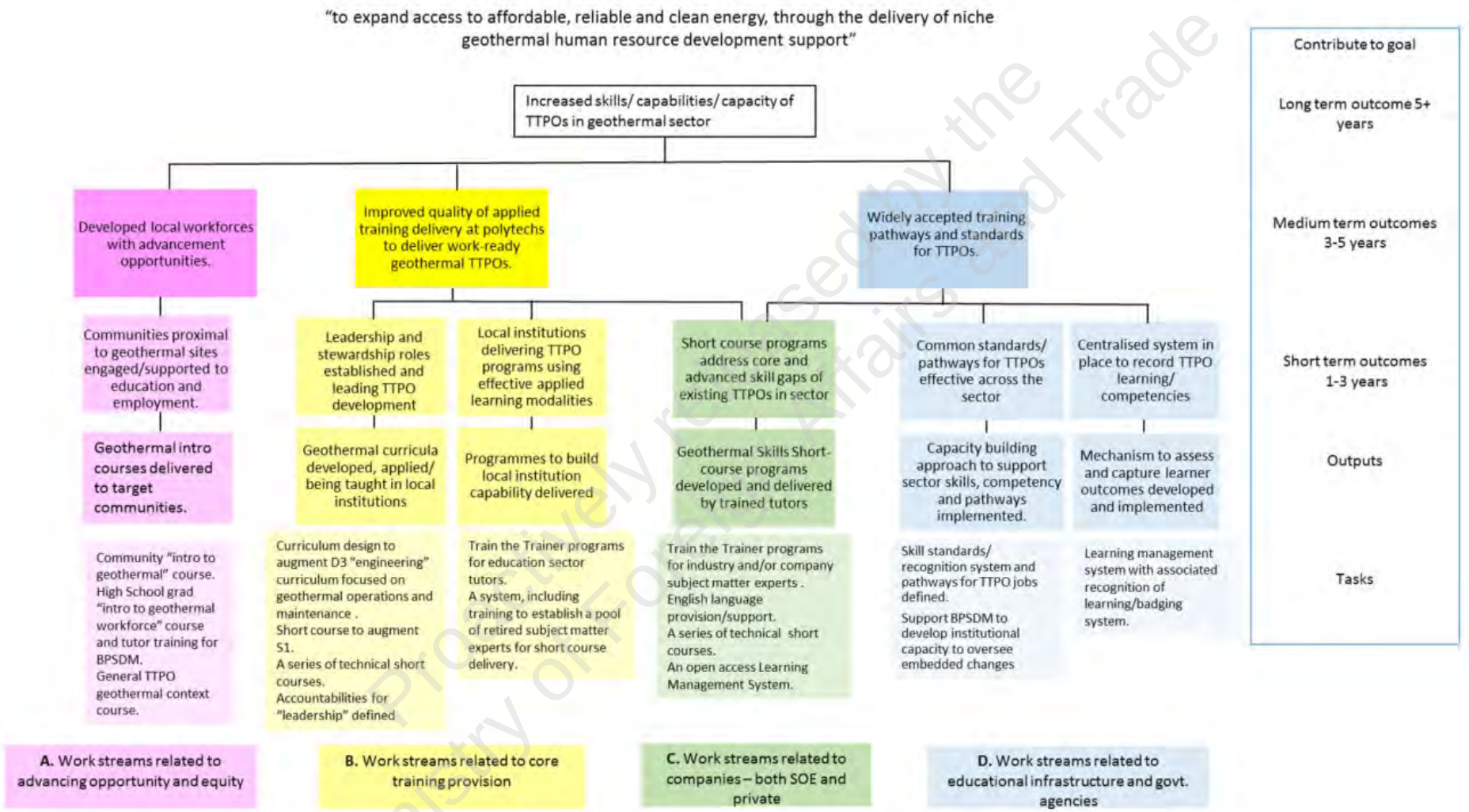
Primary Stakeholders	Names of stakeholders
• MFAT Staff and former staff	• S. Subramaniam, I. Indirawati, A. Riley, O. Philpott, B.White
• Supplier (incl. former staff and consultants)	• s9(2)(a)

Secondary Stakeholders	Names of stakeholders
• **Partner governments and other counterparts***	• BPSDM EDSM – s9(2)(a) • PPSDM KEBTKE – s9(2)(a) • PPSDM Migas – s9(2)(a) • PEM Akamigas – s9(2)(a)
• **Beneficiaries – Training Institutions**	• UGM – s9(2)(a) • PNJ – s9(2)(a)
• **Beneficiaries – SOE and private sector**	• PLN – s9(2)(a) • Star Energy – s9(2)(a) • Geodipa – s9(2)(a)
• **Other**	• SECO – s9(2)(a)

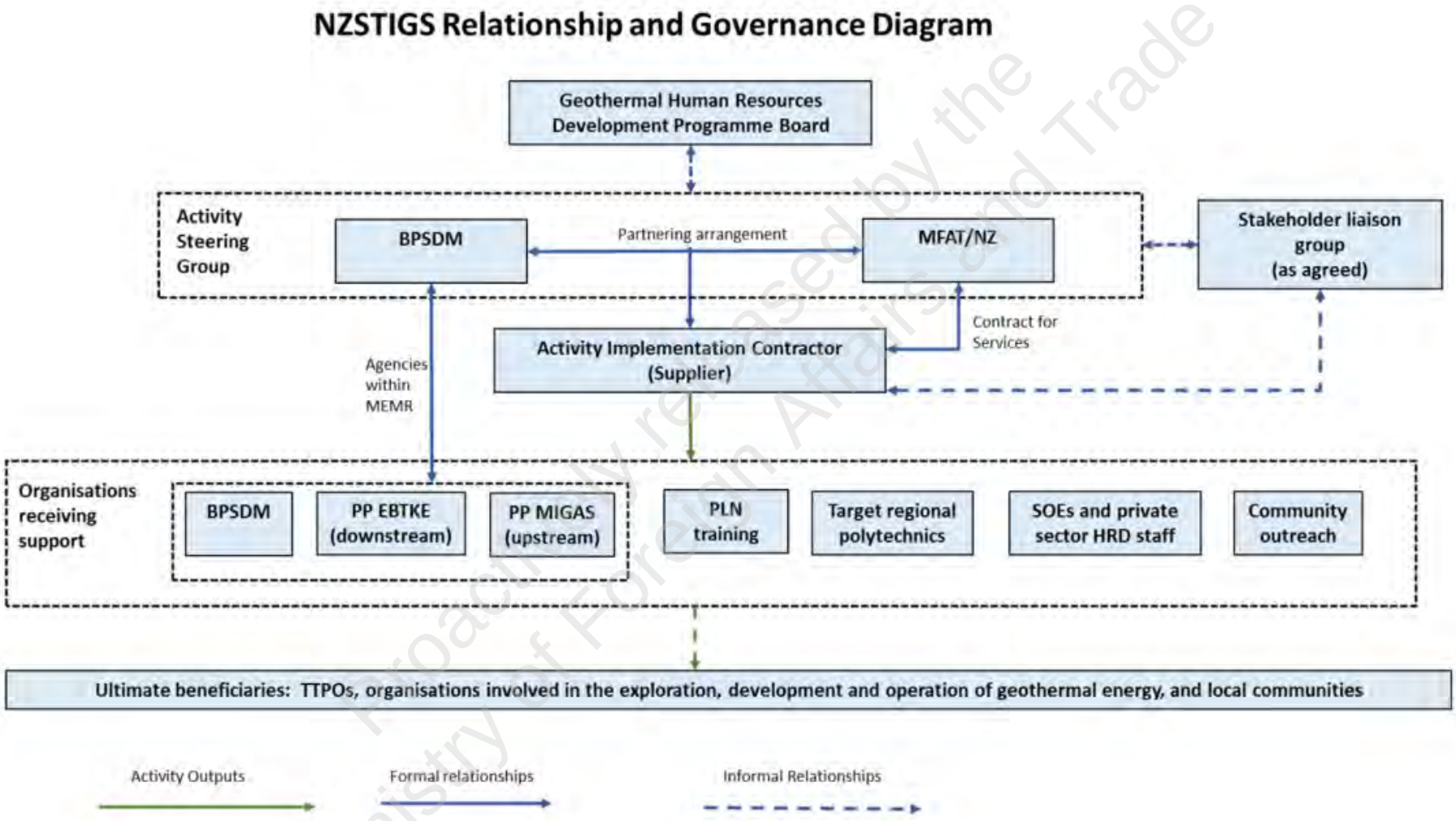
* Also beneficiaries.

Various other stakeholders were invited for comment, but did not respond or were otherwise not available.

Annex 2: NZSTIGS Results Framework



Annex 3: NZSTIGS Relationship and Governance Diagram[7]



[7] Pg.39. Activity Design Document.

Annex B – Key evaluation objectives

Objective 1: To examine the relevance, significance and coherence of the Energy Programme (Relevance & coherence).

1.1 How well does the objectives and design of the Energy Programme respond to and continue to remain relevant to:

a. the strategic objectives and vision of the New Zealand Aid Programme Renewable Energy (Flagship) Investment Priority (2015-19) and Strategic Plan (2015-2019).
b. Partner Governments' needs, policies and priorities.
c. Development outcomes that are equitable, inclusive and meets MFAT's aspirations to 'leave no one behind', and
d. Global priorities including international commitments [as expressed in the Global Partnership for Effective Development Cooperation; Paris Declaration on Aid Effectiveness and the United Nations Sustainable Development Goals]?

1.2 How coherent and well aligned is the Energy Programme to maximise achievement of:

a. New Zealand's strategic vision and priorities; and
b. Partner Governments' vision and priorities?

Objective 2: To examine the extent to which the Energy Programme achieved, or is expected to achieve, its objectives and results (Effectiveness).

2.1 What have been the short, medium and longer-term outcomes achieved for the:

a. Renewable Energy (Flagship) Investment Priority (2015-19); and
b. Individual energy activities that have been implemented within the Programme?

2.2 To what extent has the Energy Programme contributed to the broader achievement of:

a. New Zealand's strategic objectives;
b. Partner or beneficiary priorities; and
c. Impacts beyond New Zealand's Official Development Assistance [e.g. policy, coordination and advocacy work facilitated through the summits; regionally through investment in the Pacific Regional Infrastructure Facility; and internationally through IRENA etc.]?

2.3 What has constrained or enhanced the Energy Programme's achievement of the desired results?

Objective 3: To review the effectiveness of MFAT's approach and ways of working [e.g. internal roles and responsibilities and resource allocation, funding, contracting and delivery (management and governance) modalities] to deliver expected results (Efficiency).

3.1 To what extent has the Energy Programme:

a. Utilised the most effective and efficient modalities to achieve desired results in a timely way;
b. Successfully engaged with and influenced Partners on key issues; and
c. Effectively prioritised and balanced investment to achieve desired results?

3.2 What has constrained or enhanced the Energy Programme's ability to deliver the desired results?

Objective 4: To assess the sustainability [e.g. physical, operational, economic, social and environmental] and resilience of the Energy Programme (Sustainability)

4.1 What evidence exists to demonstrate that the development outcomes achieved by the Energy Programme are, or is likely to be:

a. Sustained over the lifetime of the investment;
b. Resilient i.e. withstand shocks and protects the environment, ecology and resource base; and
c. Continued beyond the lifetime of the investment?

4.2 To what extent has the Energy Programme been:

a. of a high quality; and
b. associated with the delivery of high-quality aid, in Pacific Countries in particular?

4.3 To what extent has the Energy Programme been implemented in ways that are cognisant of or consistent with the New Zealand Aid Programme's climate change priorities and ambitions?

4.4 What has constrained or enhanced the sustainability of the Energy Programme's desired results?

Objective 5: To inform future direction

5.1 What are the lessons learned from the Energy Programme that could inform its future:

a. strategy and policy direction; and
b. approach and ways of working?

5.2 What could be done better or differently to maximise achievement of the desired results for the Energy Programme moving forward including integrating MFAT's policy on International Cooperation for Effective Sustainable Development (ICSED) principles?

Annex C – Overview of Analytical Framework

Question area	Components	Data sources						Analytical processes								
		Activity documents	Programme Documents	Contextual analysis	MFAT Staff perspectives	Government perspectives	Other Partner perspectives	Beneficiary perspective	Expenditure Data	Results reporting	Benchmarks / success criteria	Map of policy priorities	Programme Theory	Pacific Case Studies	Global Case Studies
1. Relevance, significance and coherence of the Energy Programme **2. The extent to which the Energy Programme achieved, or is expected to achieve, its objectives and results**	Activity level	✓		✓	Data source for all question areas	Data source for all question areas	Data source for all question areas	✓		✓	✓	✓	✓	Analysis responds to all question areas	Analysis responds to all question areas
	Country level	✓	✓	✓				✓		✓	✓	✓	✓		
	Programme goal	✓	✓	✓				✓		✓	✓	✓	✓		
	Programme outcomes	✓	✓	✓				✓		✓	✓	✓	✓		
	MFAT policy priorities		✓	✓						✓	✓	✓	✓		
	Regional goals		✓	✓						✓	✓	✓	✓		
	Global goals		✓							✓	✓	✓	✓		
	Un / intended impacts	✓	✓	✓				✓		✓	✓	✓	✓		
	GESDI / Inclusion	✓	✓	✓				✓		✓	✓	✓	✓		
3. Effectiveness of MFAT's approach and ways of working to deliver expected results	Modalities	✓	✓	✓					✓				✓		
	Partnering & influence			✓							✓	✓	✓		
	Prioritised investment			✓					✓			✓	✓		
	Intervention types	✓	✓	✓					✓	✓	✓	✓	✓		
4. Sustainability and resilience of the Energy Programme	Sustained & resilient	✓		✓				✓	✓		✓		✓		
	Quality aid	✓	✓	✓				✓		✓	✓	✓			
	Climate change	✓	✓	✓								✓			
5. Inform future direction	Barriers / enablers			✓				✓			✓		✓		
	Lessons learned							✓			✓				
	Improvements							✓			✓	✓	✓		

Annex D – Primary and secondary data sources

The evaluation drew on both primary and secondary data to gather evidence and for analysis and triangulation, and present findings and lessons learned. The table below provides a summary of the primary data sources.

Summary of primary data sources

Data source	Description and examples
MFAT stakeholders	• Energy Team • Former Energy Team members • Senior Managers • Pacific Polynesia and French Pacific - PACPF • Pacific Melanesia and Micronesia - PACMM • Global Development and Scholarships Division • Country Strategies • Economics, Inclusive Development and Climate Change • MFAT Post (for case studies and the overall evaluation)
Regional and development partner stakeholders	• Asian Development Bank (ADB) • Global Green Growth Institute (GGGI) • The Pacific Community (SPC) • Pacific Power Association (PPA) • Energy stakeholders from the Solomon Islands and the Marshall Islands • Suppliers, Contractors
Partner governments	• Relevant country stakeholders familiar with the Programme's activities in the six case studies countries e. government staff, utility companies' staff and outer islands representatives

Secondary data was used to inform and strengthen findings, to inform contextualising and validate primary data sources. The table below provides a summary of the secondary data sources.

Summary of secondary data sources

Data source	Description and examples
MFAT documents	The documents reviewed included the Programme reports, Evaluation Reports, Activity Monitoring Assessments (AMAs), Activity Completion Assessments (ACAs), Activity business cases, Activity Design Documents (ADD), MFAT policy documents, Strategic Results Framework and Implementing Partner reports
MFAT strategic-level documents	MFAT's key strategic policy documentation and those specific to the Programme were reviewed to provide a high-level outlook of the Programme
Other New Zealand documents	These were documents from New Zealand other than MFAT departments. They included peer-reviewed articles on New Zealand's energy investments, policy papers, reports, and grey literature
Pacific Regional documents	These were documents specific to the Pacific region that included regional frameworks on energy, regional frameworks on climate change, conference papers, conference outcomes statements, regional roadmaps for energy, media articles, policy papers and policy briefs
Other Regional documents	These included reports, regional frameworks on energy, policy briefs on the energy sector in the ASEAN, African and Caribbean regions
Global energy documents	These documents provided information on the energy sector at the global level. They included global frameworks on energy, policy papers briefs from international energy actors, United Nations (UN), International Energy Agency (IEA), International Renewable Energy Agency (IRENA), among others
Case study country documents	These documents provided energy sector information for the six case studies countries (Tonga, Samoa, Tuvalu, Cook Islands, Papua New Guinea and Indonesia). They included their energy policy and frameworks, Energy Roadmaps, power utilities' reports and data, Nationally Determined Contributions (NDC) reports, and other related documents
Expenditure data	Depending on the information available, expenditure data to inform high-level analysis of how much was invested in each area and what the returns on investment were
Other	E.g. AMA/ACA spreadsheet