



Papua New Guinea NDC Implementation Roadmap Electricity Sector



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Abbreviations

ADB	Asian Development Bank
APEC	Asia Pacific Economic Cooperation
BUR	biennial update report
BTR	biennial transparency report
CCDA	Climate Change and Development Authority
CCMA	Climate Change (Management) Act
CFAN	Climate Finance Access Network
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CO₂e	carbon dioxide equivalents
DFAT	Department of Foreign Affairs and Trade (Australia)
DNPM	Department of National Planning and Monitoring
ESTWC	Energy Sub-Technical Working Committee
GDP	gross domestic product
GHG	greenhouse gas
Gg	gigagram
GGGI	Global Green Growth Institute
GIS	geographic information system
GIZ	German Agency for International Cooperation
GoPNG	Government of Papua New Guinea
GW	gigawatt
ICCC	Independent Consumer and Competition Commission
IPP	Independent power producer
IRENA	International Renewable Energy Agency
JICA	Japan International Cooperation Agency
LCPDP	Least-Cost Power Development Plan
LNG	liquefied natural gas
MTDP	medium-term development plans
MW	megawatts
MRV	measurement, reporting and verification
NDC	Nationally Determined Contribution
NEA	National Energy Authority
NEROP	National Electrification Roll-Out Plan
PNG	Papua New Guinea
PPA	power purchase agreement
PPL	PNG Power Limited
TAC	Technical Advisory Committee
USAID	United States Agency for International Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

Papua New Guinea (PNG) has an opportunity to embrace its abundant natural resources to transition away from diesel and heavy fuels and reach its 2030 target of ensuring 78% of installed on-grid electricity capacity comes from renewable energy.

As a proactive member of the international climate change community, PNG signed the Paris Agreement in 2015 and ratified it in 2016. PNG published its first biennial update report (BUR1) in 2019 as part of its commitments under the United Nations Framework Convention on Climate Change (UNFCCC). Work to compile BUR2 is underway.

PNG's Enhanced Nationally Determined Contribution (NDC) 2020 builds on its first NDC, submitted to the UNFCCC in 2016. The Climate Change Development Authority (CCDA) is the lead coordinating agency for the country's climate change-related activities, including the Enhanced NDC. Due to data challenges, the energy targets in the Enhanced NDC, which was prepared and planned through a multistakeholder process involving government, private sector and development partner actors, are non-greenhouse gas (GHG) targets.

The targets outlined in the Enhanced NDC 2020 are fully conditional on international support and will be achieved by:¹

- Increasing the share of renewables in the energy mix for on-grid connection by raising installed renewable energy capacity **from 30% in 2015 to 78% in 2030** — this has been revised down from the previous 100% target, recognizing the role of liquefied natural gas in the energy mix and the number of independent power producer contracts that extend beyond 2030;
- Reducing energy demand;
- Establishing a framework for offsetting fossil fuel emissions; and
- Enhancing data collection.

Non-GHG targets also guide this NDC implementation roadmap for electricity. The stated goal of increasing

the share of on-grid renewable energy capacity acts as a foundation for the boundary of this electricity roadmap.

PNG Electricity Sector Activities

The PNG government has established a target to provide electricity to 70% of households by 2030.

Electricity currently reaches about 13–15% of the population,² and large parts of the country—particularly rural communities — face poor access to electricity. For those who do have access, supply is unreliable. It is estimated that reaching the electrification target would require around 300 megawatts in additional capacity.³

PNG's electricity sector comprises on- and off-grid systems. On-grid generation is managed exclusively by the state utility PNG Power Limited (PPL). There are three major grids in PNG: Port Moresby, Ramu and Gazelle. PPL manages around 300 megawatts of installed generation capacity, dominated by hydropower and diesel generators. Independent power producers generate electricity from various sources to supply to PPL.

Institutional strengthening and reform activities are underway to support more effective delivery in the electricity sector. PPL is working with development partners to improve its institutional resilience to address long-standing organizational challenges that have hindered technically competent staff's ability to carry out work. In February 2021, the National Executive Council endorsed the National Energy Authority Bill 2020. This carved the way for creating the National Energy Authority (NEA), which will assume responsibility for regulatory functions in the sector, creating a clearer delineation of responsibilities as PPL's technical regulatory function and the Independent Consumer and Competition Commission's economic regulatory function are moved over to the NEA.

1. CCDA, Papua New Guinea's Enhanced Nationally Determined Contribution 2020 (2020).

2. Various sources.

3. World Bank Group, DELIVERING AFFORDABLE, SUSTAINABLE, AND RELIABLE POWER TO PAPUA NEW GUINEANS – Key Challenges and Opportunities in the Power and Domestic Gas Sectors (2018). Accessed from: www.upngcore.org

Multilateral and bilateral development partners are actively supporting off- and on-grid improvements across the electricity value chain, and several activities to strengthen the electricity network and increase generation options are already planned or underway. Donor funding and technical assistance will continue to be imperative as PNG seeks to meet its renewable energy targets set out in the Enhanced NDC 2020. In parallel, private sector companies are supporting ongoing projects and actively looking to increase engagement.

Mitigation Actions

This electricity NDC roadmap and accompanying Electricity NDC database is intended to be a dynamic document that uses available information while recognizing that there is significant ongoing movement in the market. This includes institutional strengthening, creating the NEA, mobilizing development partner support, and readiness to implement the National Electrification Roll-out Plan (NEROP).

The renewable energy projects that will help move the country towards its 78% target fall into two groups: planned and proposed projects, spread across the short-term (2021–2023), medium-term (2024–2026), and long-term (2027–2030). The planned projects are in an advanced planning stage, have approval to proceed and have financing in place. At the time of writing, there are 15 planned projects. Proposed projects, on the other hand, are at an earlier stage of planning. They generally do not have a business case and require substantial preparatory work to build a business case and implement. At the time of writing, there are 22 proposed projects, all in need of substantial support and around K400 million in financing.

Hydropower will be the backbone of the planned increase in renewable energy, supported by solar and biomass power. Retiring diesel generators, without adding other non-renewable sources of generation, will also be crucial to meeting the renewable energy target. Wind and geothermal power may play a role in the future, but as both are in early stages of exploration and assessment, they are not reflected in the 37 planned and proposed projects. However, projects will be added and removed from the Electricity NDC database over time ensuring upcoming changes in the sector and projects being implemented are reflected and tracked.

Enabling Environment

PNG must continue to strengthen the enabling environment for developing planned and proposed projects, and renewable energy overall, to meet NDC targets. It can do this by:

- Further developing resource mapping information to better understand its renewable potential;
- Investigating a comprehensive renewable energy policy that brings together current pockets of policy development;
- Highlighting CCDA as the coordinating point for climate finance and establishing the electricity NDC database as a platform to communicate opportunities;
- Embedding governance structures to support NDC implementation including, strengthening the Energy Sub-Technical Working Committee (ESTWC) and establishing a Technical Advisory Committee (TAC); and
- Implementing processes to collect information to contribute to NDC monitoring and reporting requirements.

The Climate Change (Management) (Nationally Determined Contribution Regulations) 2021 have been prepared to provide a regulatory framework for the implementation of PNG's NDCs. Among other things, the regulation provides for the establishment of TAC and ESTWC; formal recognition of targets contained in the NDC; development implementation plan; Implementation Measures; and Monitoring, Reporting and Verification.

Moving Forward

In the short term, the NDC coordination team will need to continue engaging with key stakeholders, embedding process status updates, tracking project implementation, and working with partners to establish the foundations for accessing climate finance for energy projects. Immediate and short-term activities should include:

1. Ensuring ongoing alignment with policy and plans, particularly NEROP, the Least-Cost Power Development Plan, and the 15-Year Power Development Plan;
2. Reviewing and refining the proposed and planned project list in collaboration with PPL and NEA;
3. Working with Department of National Planning and Monitoring to refine and build information on international support in the electricity sector;
4. Leveraging existing governance structures — starting with ongoing engagement of the ESTWC — while other structures are developed; and
5. Highlighting renewable energy projects through the Climate Finance Access Network as the first step to attracting climate finance.

1

Background

1.1 Country Context

Papua New Guinea (PNG) is geographically and culturally diverse. The country lies in the southwestern Pacific, bordering Indonesia to the west and Pacific Island countries to the east. It has a population of over eight million people and over 800 spoken languages, making it one of the world's most culturally diverse countries. Its inhabitants are dispersed across 22 province-level divisions, including remote locations and far-spread islands. The capital, Port Moresby, is the largest city, with around 310,000 inhabitants. The second largest city, Lae, is the main port and an industrial hub with a population of 76,000.⁴

Its substantial natural resources drive a vibrant extractives sector, contributing 29% to gross domestic product (GDP) and 89% to exports in 2018.⁵ The main exports include gold, nickel, forestry products and liquefied natural gas (LNG). However, formal employment in these sectors remains relatively low. Most of the population lives in rural communities, undertaking smallholder agricultural and fisheries activities.

PNG has suffered economic and health shocks throughout the COVID19 pandemic. In 2020, real GDP was estimated to have contracted by 3.8%, largely due to the pandemic, related restrictions and weakened demand.⁶ Like many other countries, significant challenges lie ahead for the PNG government, private sector and communities, as they seek to rebuild as the COVID19 pandemic peaks. Decreases in domestic economic activity and export losses have led to increased supplementary budget support from development partners who were active in PNG through 2020. Significant resources will be diverted to the health response, which may push out infrastructure investment.⁷

Harnessing PNG's opportunities has always had its challenges. Although blessed with significant natural resources and fertile lands, its mountainous terrain, remote islands, dispersed populations and institutional challenges together create significant obstacles to effective service delivery and economic development. These challenges are cross-sectoral and will require collaborative efforts as the country seeks to translate climate change ambition into practical on-ground interventions.

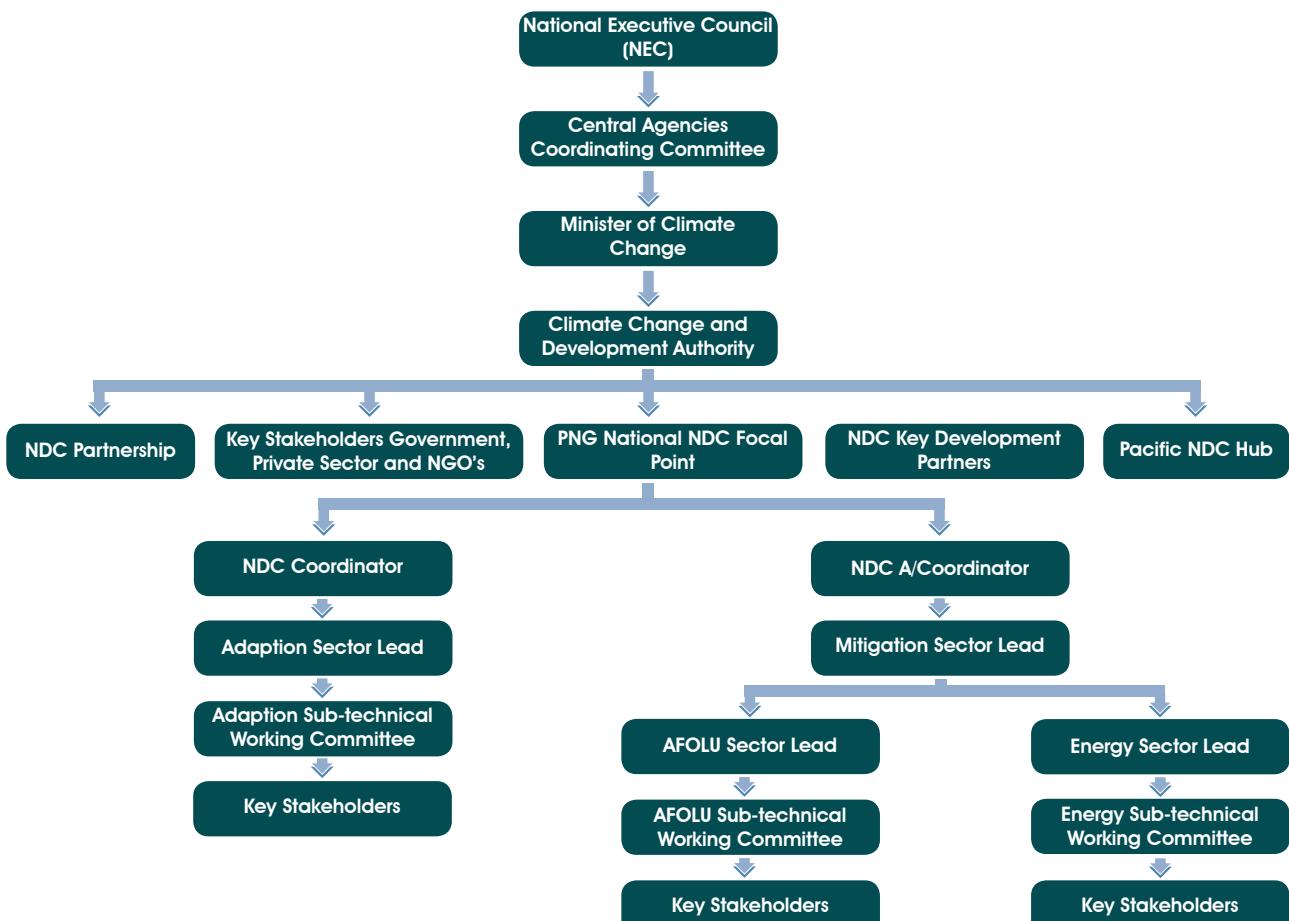


4. International Finance Corporation, Going the Distance: Off-grid Lighting Market Dynamics in Papua New Guinea (2019).
5. James, D. "Transparency report shines light on Papua New Guinea's extractive sector." Business Advantage PNG, January 20, 2021. <https://www.businessadvantagepng.com/transparency-report-shines-light-on-papua-new-guineas-extractive-sector/>.
6. World Bank Group, Dealing with a Triple Crisis (2020).
7. World Bank Group, Dealing with a Triple Crisis (2020).

1.2 Climate Change Context

The government of PNG (GoPNG) recognizes the need for action on climate change and is a proactive member of the international climate change community. It signed the Paris Agreement in 2015 and ratified it in 2016. The Climate Change Development Authority (CCDA) serves as the national designated authority to the United Nations Framework Convention on Climate Change (UNFCCC) and is the lead coordinating agency for climate change-related activities in PNG. CCDA provided the coordinating platform to bring together government and private sector stakeholders to prepare the country's Enhanced Nationally Determined Contribution (NDC) 2020, and leads work on monitoring and reporting PNG's emissions to the UNFCCC.

Figure 1. Institutional arrangement for NDC



Source : CCDA, NDC Implementation Plan 2020 (2021)

As part of commitments under the UNFCCC, the country's first biennial update report (BUR1) was published in 2019. Work to compile BUR2 is underway. BUR1 states that total greenhouse gas (GHG) emissions in 2015 were 15,193 gigagrams of carbon dioxide equivalents (GgCO₂e, Table 1), of which the energy sector contributed 11,806 GgCO₂e, thereby accounting for the bulk of PNG's GHG emissions. Within the sector, energy industries, manufacturing industries, and construction accounted for 5,596 GgCO₂e (47%), including emissions from on- and off-grid electricity generation and the operation of an LNG plant. A large component of off-grid electricity production is by mineral and agricultural industries that produce their own electricity for onsite consumption (captive generation).⁸

8. CCDA, Papua New Guinea's Enhanced Nationally Determined Contribution 2020 (2020).

Table 1 Papua New Guinea's emissions by sector, 2015 and 2000

Sector	GHG emissions 2015	Compared to 2000
Energy	11,806.28 GgCO ₂ e	Increase of 5,532.37 GgCO ₂ e
Industrial Process and Product Use	35.29 GgCO ₂ e	Increase of 1.38 GgCO ₂ e
Agriculture	796 GgCO ₂ e	Increase of 114 GgCO ₂ e
Forestry and Land-Use	Net removals: 1,716.46 GgCO ₂ e in 2015 (forestry is both a source and a sink)	-21,635.94 GgCO ₂ e in 2000, so total decrease of removals amounts to 19,919.48 GgCO ₂ e
Waste	872.5 GgCO ₂ e	Increase of 354 GgCO ₂ e
Total net GHG emissions	15,193 GgCO ₂ e	-14,179 GgCO ₂ e (emissions in 2000)

Source: CCDA, Biennial Update Report 1 (2019), <https://unfccc.int/documents/194974>.

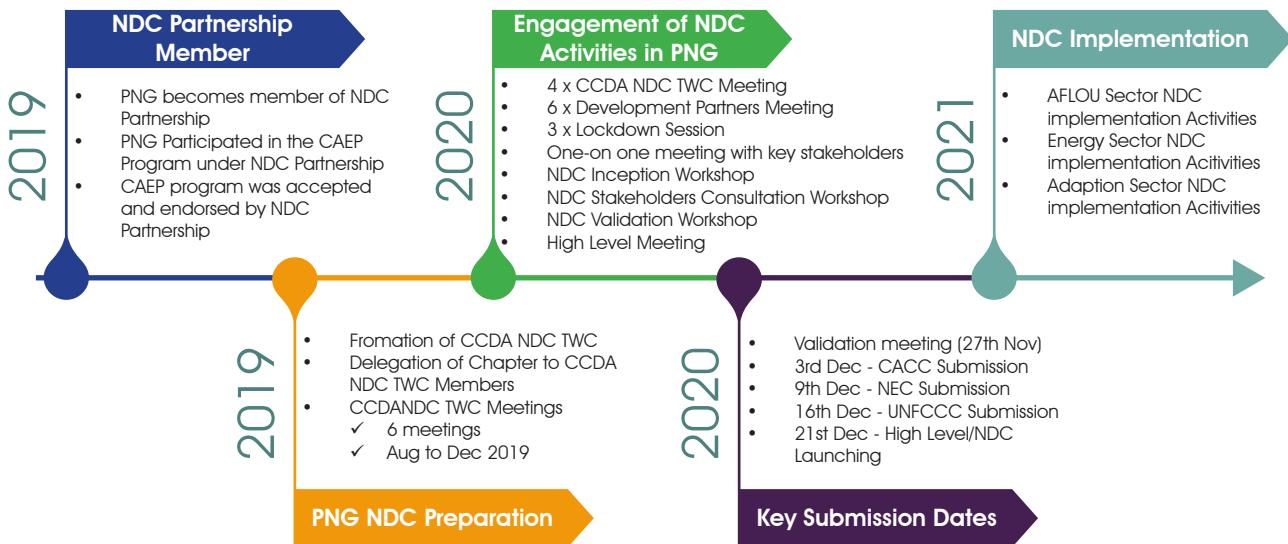


1.3

PNG's Nationally Determined Contribution

PNG's Enhanced NDC 2020 builds on the first NDC submitted to the UNFCCC in 2016. The preparation and planning process was a multistakeholder activity drawing on expertise of government, private sector and development partners (Figure 2). The Enhanced NDC 2020 sets out targets through the implementation period 2021–2030 and articulates measures and activities for achieving them.

Figure 2. Preparation and planning for PNG Enhanced NDC 2020



Source: CCDA, Papua New Guinea's Enhanced Nationally Determined Contribution 2020 (2020)

As noted, the revised submission uses a 2015 baseline for GHG data, using data gathered as part of the BUR1. Given the significant contribution of energy industries to PNG's emissions profile, relevant agencies decided to establish and include targets from this category into the Enhanced NDC 2020. These targets complement the government's short-to long-term goals and plans to address climate change and sustainable development as outlined in Vision 2050,⁹ the National Strategy for Responsible Sustainable Development for PNG, and in the country's five-year medium-term development plans (MTDPs). PNG is committed to a headline target of carbon neutrality in the energy industries subsector by 2050.

It is recognized that the historical fossil fuel consumption data used for estimating GHG emissions in the BUR1 is partially accurate. PNG does not have a national energy balance table and therefore used an international source — the Asia Pacific Economic Cooperation (APEC) energy balance table for PNG compiled by the Asia Pacific Energy Research Centre — to estimate emissions in the BUR1. While this table

used certain country-specific data, some areas, including end-use consumption and electricity, were based on estimates.

The Enhanced NDC 2020 does not outline specific GHG reduction targets for the energy sector. Due to the partially accurate GHG emissions used in the BUR1, the targets established in the Enhanced NDC 2020 were non-GHG. CCDA and its development partners are working to improve the accuracy of PNG's GHG emissions by developing a national energy balance table with country-specific data inclusive of electricity. Partners who have worked or are working on improving PNG's GHG inventory and data collection include Japan International Cooperation Agency (JICA), the German Agency for International Cooperation (GIZ) and the International Renewable Energy Agency (IRENA).¹⁰

The NDC also notes a need for financial and technical support to build capacity to enable relevant departments and agencies to collect and analyze data and establish GHG targets for upcoming NDCs.

9. DNPM, Papua New Guinea Vision 2050 (2021), <https://png-data.sprep.org/dataset/papua-new-guinea-vision-2050>

10. Development partner work programmes are under development. CCDA will provide updates upon request.

The targets outlined in the Enhanced NDC 2020 are fully conditional on international support and will be achieved by:¹¹

- Increasing the share of renewables in the energy mix for on-grid connection through increasing the share of installed capacity of renewable energy from 30 % in 2015 to 78 % in 2030 – a revision down from a previous 100% target, recognizing the role of LNG in the energy mix and a number of IPP contracts that extend beyond 2030;
- Reducing energy demand;
- Establishing a framework for fossil fuel emission offsetting; and
- Enhanced data collection.

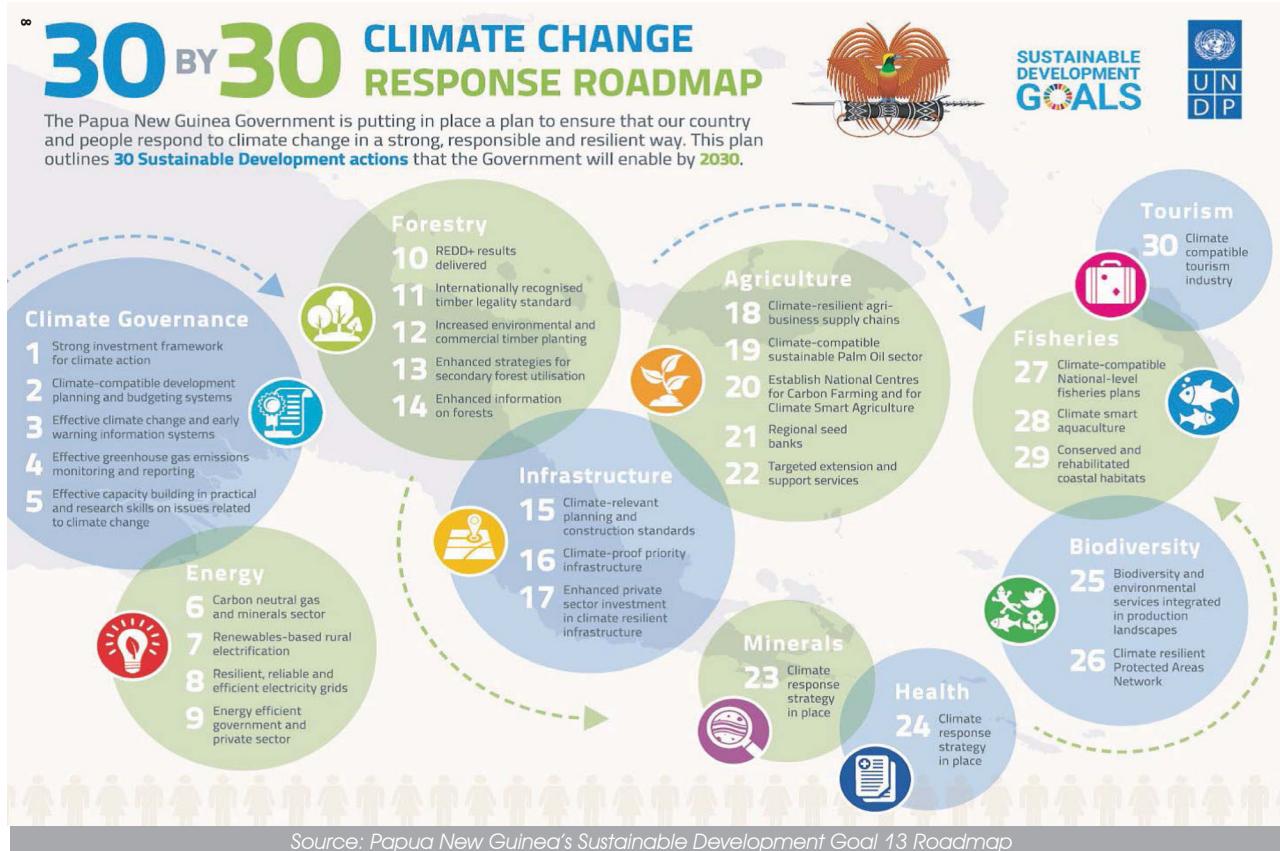
Non-GHG targets guide this NDC implementation roadmap for electricity. The stated goal to increase the share of renewable energy in the on-grid energy mix acts as the foundation for the boundary to this electricity roadmap and is further discussed in Section 2.1

NDC-related activity aligns with PNG's commitments under the Paris Agreement, the Climate Change Management Act (CCMA) 2015, and the broader Sustainable Development Goals. PNG signed the Paris Agreement in 2015 and passed the United Nations Paris Agreement (Implementation) Act in 2016, providing the legal basis for implementing the NDC in PNG.

The Paris Agreement comprises 29 articles, referred to in PNG's Paris Agreement (Implementation) Act 2016.¹² The NDC aligns with Article 4 and other pertinent articles of the Agreement and is an important component of fulfilling its commitments, covering aspects such as mitigation actions, finance flows (including developed country support), collaboration and communications.

This electricity implementation roadmap also aligns with stated plans and goals, such as PNG's Sustainable Development Goal 13 Roadmap, which introduces 30 actions to be implemented by 2030. These include increasing the share of renewable energy in the energy mix (particularly for rural electrification) and leverage existing activities that fit within the implementation timeframe (Figure 3).

Figure 3 Climate Change Response Roadmap



11. CCDA, Papua New Guinea's Enhanced Nationally Determined Contribution 2020 (2020).

12. GoPNG, United Nations Paris Agreement (Implementation) Act 2016, http://www.parliament.gov.pg/uploads/acts/16A_04.pdf

1.4 Electricity Sector

The government has established a target to provide electricity to 70% of households by 2030. Electricity currently reaches about 13–15% of the population,¹³ and large parts of the country — particularly rural communities — face poor access to electricity. For those who do have access, supply is unreliable. It is estimated that reaching the electrification target would require around 300MW in additional capacity.¹⁴

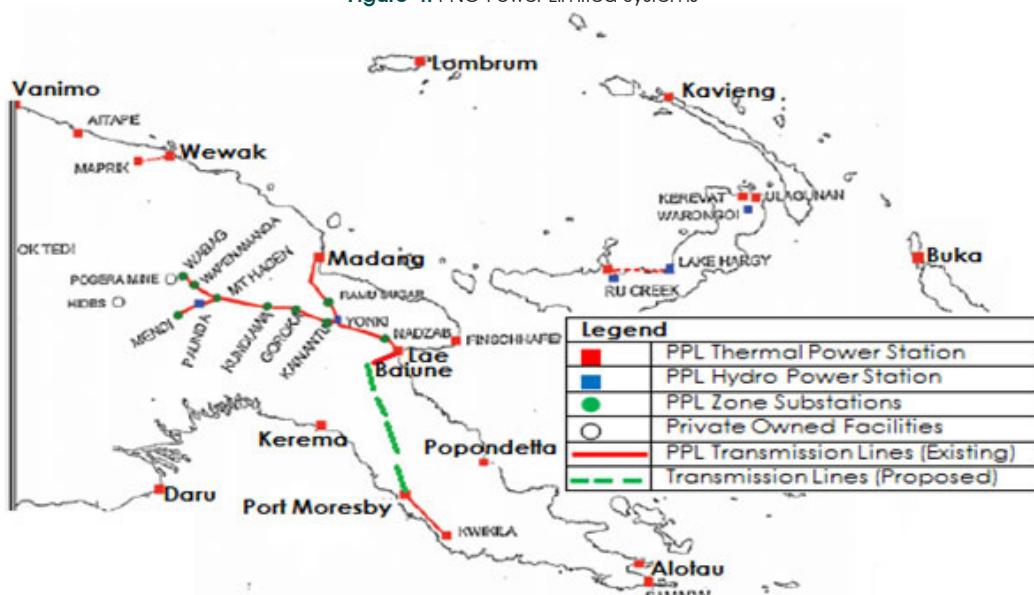
PNG's electricity sector comprises on- and off-grid systems. On-grid generation capacity includes government-owned plants and contracted IPPs. PNG's on-grid system (which includes generation, transmission and distribution) consists of three major grid systems and 16 mini-grid-based systems, all of which are managed by PNG Power Limited (PPL). The three major systems include Port Moresby, Ramu and Gazelle. The Ramu system is the largest and serves most of the towns and centers on the mainland, including Lae, Madang, Goroka, Mount Hagen, Kainantu, Kundiawa, Yonki, Mendi and Wabag. The Port Moresby system is the second

largest and serves the National Capital District and Central Province, and the Gazelle system serves East New Britain Province. The 16 mini systems are located in provincial centers and towns.¹⁵

All 19 systems are supplied with electricity generated from 26 power stations, with backup from 9 substations. There are 7 hydropower stations and 19 thermal power stations. The 9 backup substations are on the Ramu system and peak load diesel-based power plants.¹⁶

PNG has a mix of generation sources, with hydropower dominating the energy mix. Overall, there is approximately 580 megawatts (MW) of installed generation capacity, PPL manages about 300MW with the balance generated by Independent Power Producers for use as captive generation sites (eg. Mining and extractive sites). The mix includes hydropower (230 MW or 39.7%), diesel (217 MW or 37.4%), gas-fired (82 MW or 14.1%) and geothermal (53 MW or 9.1%).^{17,18,19}

Figure 4. PNG Power Limited Systems



Source: PNG Power Limited 15 Year Power Development Plan 2016-2030

13. Various sources.
14. World Bank Group, DELIVERING AFFORDABLE, SUSTAINABLE, AND RELIABLE POWER TO PAPUA NEW GUINEANS – Key Challenges and Opportunities in the Power and Domestic Gas Sectors (2018). Accessed from: www.upngcore.org
15. PPL, 15-Year Power Development Plan 2016–2030 (2016).
16. PPL, 15-Year Power Development Plan 2016–2030 (2016).
17. Asian Development Bank Sector Assessment Summary (2016) <https://www.adb.org/sites/default/files/linked-documents/cps-png-2016-2020-ssa-02.pdf> and Rawali et al, Electricity Access Challenges and Opportunities in Papua New Guinea (PNG) (2020). Accessed at: <http://apvi.org.au/solar-research-conference/wp-content/uploads/2020/02/Rawali-M-Electricity-Access-Challenges-and-Solar-Energy-Opportunities-in-PNG.pdf>
18. World Bank, Energy Utility Performance and Reliability Improvement Project (P167820): Project Information Document/Integrated Safeguards Data Sheet (PID/IDS) (2019), <https://documents1.worldbank.org/curated/en/909801547764581895/pdf/Concept-Project-Information-Document-Integrated-Safeguards-Data-Sheet-Energy-Utility-Performance-and-Reliability-Improvement-Project-P167820.pdf>.
19. PPL has provided additional figures which will be referred to during implementation, included in the Electricity NDC Database.

The following agencies support the electricity sector by providing an enabling environment or generation, transmission and distribution activities:

- PNG Power Limited (the utility) has exclusive rights for on-grid transmission and distribution;
- National Energy Authority (NEA), which will guide policy and oversee economic and technical regulations;
- Independent Consumer and Competition Commission (ICCC), which until recently played a lead role in economic regulation for the electricity sector; and
- Department of National Planning and Monitoring (DNPM), which oversees development partner investments in the sector.

Private sector companies and development partners also play a significant supporting role (*Table 2*).

Table 2. Organizations and their role in the PNG Electricity Sector

Organization name/type	Description	Role
PNG Power Limited	State-owned utility	Enabling environment, generation, transmission and distribution
National Energy Authority	Newly established through the NEA Act 2021, will take on regulatory functions from ICCC and PPL	Enabling environment
CCDA, DNPM, ICCC, Ministry of Finance	Supporting government agencies	Enabling environment
Development partners	Bilateral and multilateral development partners provide a supporting role; several donor-supported programs are underway or being rolled out	Enabling environment, generation, transmission and distribution
Private sector	IPPs in the country; increasing examples of overseas interests seek to play a role in developing power plants	Generation

PPL has exclusive rights on the transmission and retail electricity for on-grid systems. However, electricity generation within a 10 km radius of PPL's exclusive zone is open to IPPs to produce and sell electricity to PPL. This is done through a power purchase agreement (PPA) between PPL and the IPP. Seven IPPs currently sell electricity to PPL: four to the Port Moresby system, two to the Ramu system, and one to the Kimbe system.²⁰

Electricity generation and distribution beyond the 10 km radius of PPL's exclusive zone are classified as off-grid. This includes mining, oil and gas companies that produce their own electricity (captive generation) for their operations and to some extent supply to nearby communities. Some companies within the 10 km radius of PPL's exclusive zone produce their own electricity because the PPL supply is not reliable enough for their operations, while some district

centers, health centers and churches also produce their own electricity and supply to nearby villages.

Institutional strengthening and reform activities are underway to support more effective delivery in the electricity sector. PPL is working with development partners to improve its institutional resilience to address long-standing organizational challenges that have hindered the potential of technically competent staff to carry out work. One market structure issue —where PPL acted as technical regulator in a market it was participating in — is being addressed by creation of the NEA.

In February 2021, the National Executive Council endorsed the National Energy Authority Bill 2020, carving the way for the creation of the NEA, which will assume responsibility for regulatory functions in the electricity sector, creating a clearer

20. PPL, 15-Year Power Development Plan 2016–2030 (2016).

delineation of responsibilities. This will involve moving PPL's technical regulatory function and the ICCC's economic regulatory function to the NEA, enabling PPL to focus on core electricity provision responsibilities and removing its dual role of regulator and market participant. The process of creating the NEA has started, with initial budgets assigned and governance arrangements being developed with support from development partners.²¹

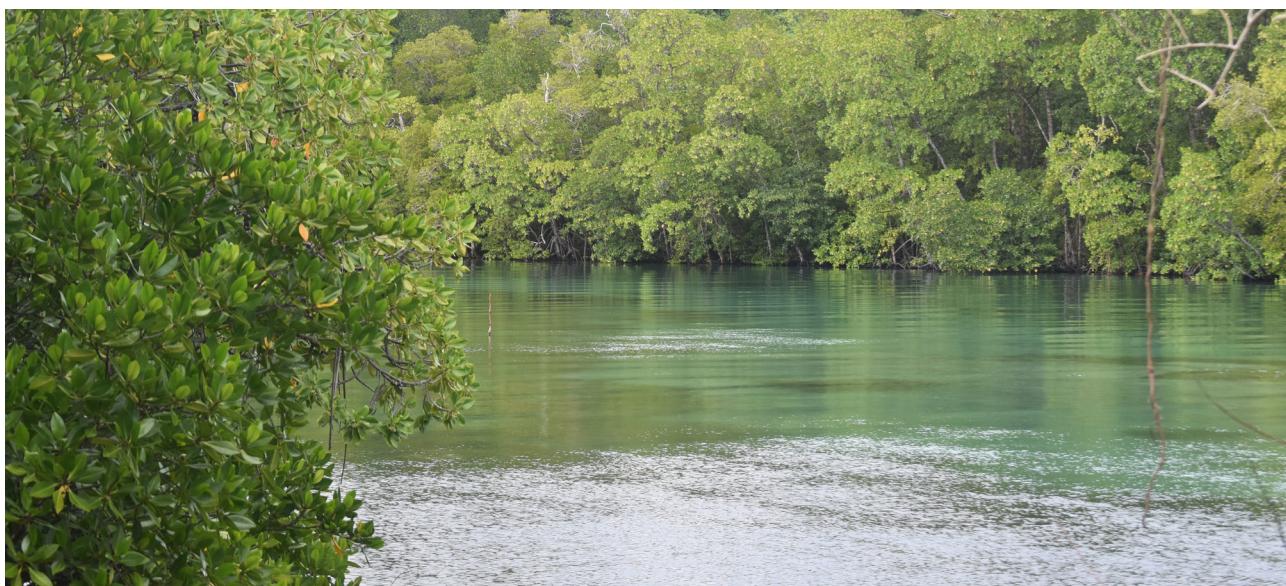
It is envisaged that the NEA's responsibilities will include:²²

- Recommending electricity and energy regulations, codes and guidelines;
- Reviewing and implementing the National Energy Policy 2017–2027;
- Implementing the National Electrification Roll-Out Plan (NEROP);
- Regulating regulated industries, including the electricity supply industry;
- Fixing standard terms and conditions for the sale or supply of electricity, including the service of making connections to a transmission or distribution network provided by the electricity undertaker;²³
- Establishing a tariff system for the electricity and energy supply industry;
- Receiving and administering the obligated domestic market gas supplies under the Act; and

- Issuing and monitoring licenses for electricity entities and undertakers.

This is a broad remit, and it will take time for the NEA to ramp up activities and execute all of its functions. All parties involved recognize the potential challenges to operationalization, which include budget allocations and the ability to attract staff.

Multilateral and bilateral development partners are actively supporting off- and on-grid improvement across the electricity value chain, with several activities to strengthen the electricity network and increase generation options already planned or underway. Following the APEC 2018 meetings in Port Moresby, Australia, Japan, the United States and New Zealand made commitments to support the strengthening of PNG's electricity sector. Activities and programs to fulfill these commitments are now progressing towards implementation, with planned support across the electricity value chain (generation, transmissions and distribution) and energy efficiency (demand side). However, this implementation roadmap is focused on renewable energy generation specifically. Donor funding and technical assistance will continue to be imperative as PNG seeks to meet its renewable energy targets set out in the Enhanced NDC 2020. With many donor-led activities underway, it will be important for government counterparts to maintain a coordinated view of in-country engagements (*Table 3*).



21. Department of Prime Minister and National Executive Council, GoPNG, Cabinet Endorses National Energy Authority Bill 2020, February 18, 2021, <https://www.pm nec.gov.pg/index.php/secretariats/pm-media-statements/255-cabinet-endorses-national-energy-authority-bill-2020>.
22. Kuman, S, Auru, E and Pogla, G, Changes in PNG's Energy Laws, Insight, May 13, 2021, <https://www.allens.com.au/insights-news/insights/2021/05/changes-in-pngs-energy-laws/#anchor1>.
23. The NEA Act specifies Undertakers as the 'developer, owner and operator of a power generation, transmission and distribution project

Table 3. Development Partner Activity - Summary

Organization type	Partner names and activities
Multilateral development agencies	<p>Asian Development Bank (ADB) – Involved in power sector development activities, including the recently concluded PNG Towns' Electricity Investment Project, and the recently initiated Power Sector Development Project, which will focus on strengthening transmission and distribution activity around PNG's main grids and includes grant and loan components.</p>
	<p>World Bank Group – Support for developing (and reviewing) the NEROP analysis and implementation plan; wind assessments; the recently approved US\$30-million PNG Energy Utility Performance Enhancement and Improvement Project.²⁴ Activities as part of a comprehensive sector enhancement program include developing a project database for PPL to support the progress of initial stage projects. The International Finance Corporation (IFC) also engaged consultants to provide advice on development of PPL mini-grids.</p>
	<p>United Nations Development Programme (UNDP): – Facilitating Renewable Energy & Energy Efficiency Applications for Greenhouse Gas Emission Reductions (FREAGER) program, including draft solar and wind policy and developing an off-grid code. Has also supported the development of an energy efficiency roadmap.</p>
Bilateral agencies	<p>Australia's Department of Foreign Affairs and Trade (DFAT): Supporting Pawarim Komuniti, a four-year off-grid energy program implemented by Cardno and grid-level interventions (including the possible refurbishment of Ramu 1 Hydro plant) through the Australia Infrastructure Fund Facility. Supported work to understand the potential for upgrading 16 provincial grids, and is looking to start with three smaller grids.</p>
	<p>Japan International Cooperation Agency JICA: Focused on transmission and distribution-oriented projects; has previously supported GHG inventory work, but did not cover the electricity sector.</p>
	<p>United States Agency for International Development (USAID): Recently launched the PNG Electrification Program, a five-year energy program being implemented by a consortium led by RTI International. Program activities include supporting the NEA structure and strengthening PPL.</p>
	<p>New Zealand Ministry of Foreign Affairs and Trade: Finalizing the Enga Electrification Project and assessing other support opportunities.</p>
	<p>IRENA, GIZ, and other agencies: Supporting climate change-focused activities such as GHG inventory strengthening.</p>

The DNPM maintains and will regularly update detailed information on international donor programs. Updates will be reflected in an Electricity NDC database, managed by CCDA. Development partners will continue to play a major role in increasing the reliance and reliability of PNG's electricity generation and distribution network through technical assistance, direct grant and loans access, and by facilitating additional finance to bridge any gaps. The CCDA Energy Technical Lead will need to continue tracking and highlighting project needs (capacity building and financial support) on an ongoing basis, through a standing item on the Energy Sub-Technical Working Committee (ESTWC) agenda.

²⁴. World Bank, "Papua New Guinea: Improved Access to Reliable, Affordable Energy." Press release, April 2, 2021, <https://www.worldbank.org/en/news/press-release/2021/04/06/papua-new-guinea-improved-access-to-reliable-affordable-energy>.

2

Context: Electricity Sector NDC Implementation Roadmap

2.1 Goals, Objectives, and Boundary of the Roadmap

This roadmap is intended as a dynamic document that builds on initiatives outlined in the NDC Implementation Plan. It illustrates a pathway for implementing outlined activities and articulates aspects of the enabling environment that may need strengthening to reach the targets set out in the Enhanced NDC 2020. It is important to note that this roadmap can be considered iterative, and any gaps may be addressed in future iterations.

Goal: Support PNG's aspiration for a 78% share of renewable energy in the on-grid system by 2030.

Objectives:

- Establish a temporal and spatial pathway to implementing targets set out on in the Enhanced NDC 2020;
- Prioritize types of electricity generation plant based on technology and cost (in line with existing work programs);
- Catalogue any newly emerging programs or activities; and
- Articulate challenges and barriers to implementing activities, and establish next steps.

Boundary: This electricity NDC implementation roadmap will focus on renewable energy contributing to 78% of a total installed (on-grid) capacity in 2030, as outlined in the Enhanced NDC 2020.²⁵ The boundary of this roadmap was shared with the ESTWC during a consultation meeting on March 23, 2021.

Although this roadmap focuses on the renewable energy target, other aspects of the energy sector will require attention through the implementation period. It has a pragmatic focus on achieving renewable energy targets over the 2021–2030 period. Significant activity is ramping up in the broader electricity sector as development partners mobilize resources to fulfil APEC 2018 commitments and multilateral institutions establish significant energy sector enhancement programs. These include greater efforts to reach off-grid populations through mini-grid and solar home systems solutions, increase grid densification and other grid enhancement activity, and strengthen institutions. Although these activities provide important context for this electricity NDC roadmap, they are not the focus of this document. However, it will be increasingly important to coordinate activities as they ramp up across the sector.²⁶

The Enhanced NDC 2020 also notes other opportunities for action, including reducing energy demand, establishing a framework for fossil fuel emission offsetting, and enhancing data collection. CCDA will plan and execute these other activities alongside relevant development partners as separate streams of work.

25. GoPNG, PNG NDC Implementation Plan 2021–2030 (A Living Document), Annex of CCDA Enhanced NDC 2020 (2020).

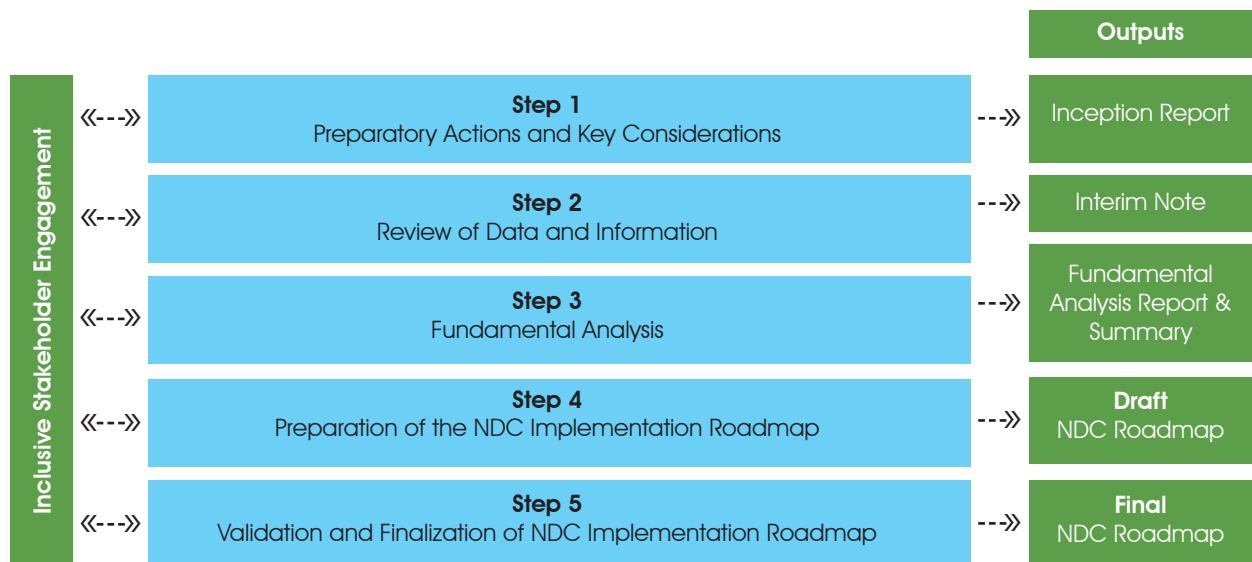
26. PPL has provided revised generation projections through to 2030, which are available in the Electricity NDC database. The CCDA NDC coordination team will need to ensure ongoing communications with PPL and NEA to discuss changes to the projected energy mix, and to review potential impact on the target.

2.2 Methodology and Approach (Including stakeholder engagement)

Best practice for development of implementation roadmaps is still emerging. The Electricity NDC Implementation Roadmap project has used elements of the methodology and process outlined in GGGI Technical Guideline No. 5 *NDC Implementation Roadmap Development: Guidelines for Small Island Developing States* (Figure 5) as well as other sources such as the Climate and Development Knowledge Network's NDC quick-start guide.

The GGGI guideline's five steps provide an incremental approach to compiling an NDC implementation roadmap. The guideline has been adapted to reflect the sub-sectoral scope, project timeframe, and ensure it is fit for purpose.

Figure 5. Methodology and Process for roadmap development



Source: GGGI, GGGI Technical Guideline No.5. *NDC Implementation Roadmap Development for Small Island Developing States* (2018)

Electricity sector activities included as an annex to the Enhanced NDC 2020, were the starting point for developing this roadmap. The projects were early stage and would help drive the country towards its 78% renewable energy target. Electricity project modeling work to develop the target included many 'planned' projects that were in a more advanced stage of development or implementation. Although not included in the Enhanced NDC annex, these have been subsequently added to the NDC Implementation Plan 2021 and to this implementation roadmap.

Developing this roadmap involved desk research, interaction with stakeholders in one-to-one settings, interaction through the ESTWC and a 'lockdown' session, which brought relevant stakeholders

together for 3 days of focused discussion. Through this iterative process, the electricity roadmap team has been able to take an inclusive approach and ensured strong stakeholder interaction through the project.²⁷

Considerable work was undertaken when preparing the Enhanced NDC 2020 to develop the basis for the 78% renewable energy target.²⁸ This roadmap draws on work done through that process and any additional project information from stakeholder discussions. A supporting spreadsheet - referred to the Electricity NDC Database - has been developed for the project, which will form the basis of a project repository that will be updated regularly and used for ongoing monitoring and reporting purposes.

27. Initial stakeholder interaction and data collection was carried out in April-June 2021, followed by group interactions through the ESTWC, and national consultations.

28. The CCDA technical lead can be contacted for additional information on the underlying work to establish the 78% target.

This roadmap has relied on engagement with key stakeholders in PNG from across government, the private sector and development partners. The project team had one-to-one conversations with several stakeholders to understand current and planned activities and perceived barriers to project implementation. Table 4 provides a list of stakeholders engaged during the development of this roadmap. The list is not exhaustive and CCDA will maintain open dialogue with stakeholders through the implementation period.

Table 4. Stakeholders engaged in developing this roadmap

Stakeholder type	Organization names
Government	Climate Change and Development Authority (CCDA); National Energy Authority (NEA); PNG Power Limited (PPL); Department of National Planning and Monitoring (DNPM; Independent Consumer and Competition Commission (ICCC)
Development Partners	United States Agency for International Development (USAID), Department of Foreign Affairs and Trade (DFAT - Australia), Japan International Cooperation Agency (JICA); UNDP - FREAGER Ministry of Foreign Affairs and Trade (NZ) - email World Bank Group (WBG) – email
Private Sector	Oil Search (PNG Biomass), Exxon Mobil
Others	University of PNG; Energy Sub-technical working committee members

2.3 Alignment with PNG Policies and Strategies

PNG is an active participant in international climate change negotiations and has undertaken domestic policy planning initiatives that have helped establish a solid reference base. Although ongoing work is required to strengthen data collection and reporting, several documents and policy statements have guided the development of this electricity roadmap. Relevant policies, plans, and strategy documents include high-level aspirational documents, such as Vision 2050, and more detailed, specific documentation, such as BUR1. Policies and strategy documents that are specific to the electricity sector will also have a major influence on PNG's progress towards its electrification target and renewables capacity addition. This includes the NEROP, Least-Cost Power Development Plan (LCPDP) and 15 year power development plan.^{29,30}



^{29.} The current 15 Year PDP is awaiting approval by the PPL board, and an updated NEROP Implementation Plan document has been created. Ongoing work will be required to ensure alignment with the 15 Yr PDP, NEROP Roll-out and LCPDP.

Table 5. Summary of relevant national strategies and plans

Type	Details
Overarching Strategy	<p>Papua New Guinea Vision 2050: A framework document that establishes a long-term strategy for the country, outlining seven key strategic focus areas (pillars), including one referring to environmental sustainability and climate change.</p> <p>MDTP III: A five-year planning document to support PNG's aims for "inclusive sustainable economic growth", with eight key result areas: increased revenue and wealth creation; quality infrastructure and utilities; sustainable social development; improved law and justice and national security; improved service delivery; improved governance; responsible sustainable development; and sustainable population.</p>
Climate Change Focused	<p>National Climate Compatible Development Management Policy (2014): Outlines a framework for climate-resilient and carbon-neutral sustainable economic development.</p> <p>Climate Change Management Act 2015: Currently under review, the CCMA establishes the mandate for CCDA to operate as the national designated authority, coordinating climate change-related activity.</p> <p>BUR 1: Submitted as part of PNG's obligations under the UNFCCC in 2019, it states PNG's emissions profile but does not go into detail on the electricity sector. BUR2 is under development.</p> <p>Sustainable Development Goal 13 Roadmap 2020: Outlines 30 sustainable development actions by 2030, four of which are for energy: 6. Carbon-neutral gas and minerals sector, 7. Renewables-based rural electrification, 8. Resilient, reliable and efficient electricity grids, 9. Energy-efficient government and private sectors.</p> <p>Enhanced NDC 2020: The Enhanced NDC was submitted to the UNFCCC in December 2020 with an implementation plan as an annex and provides base information for the creation of this roadmap</p> <p>NDC Implementation Plan 2021 A revised NDC Implementation Plan has been developed and will be submitted to the UNFCCC.</p>
Energy Focused	<p>National Energy Policy 2017–2027: Aims to ensure affordable, reliable, and accessible provision of energy in a competitive, sustainable, and environmentally friendly way.</p> <p>National Energy Roll-Out Plan: Provides a comprehensive scan of least-cost power development options, employing geographic information systems (GIS) mapping, focusing on grid extension and densification, and referencing the role of mini-grids and solar home systems for most difficult-to-access communities. Work is underway to accelerate NEROP implementation; any revised information should feed into ongoing electricity NDC discussions.</p> <p>PNG Power 15-Year Plan: Produced every two years, it outlines planned generation projects and asset retirements, acting as a guide to potential renewable energy projects for implementation. A revised 15-year plan is currently before the PPL Board for approval. Once approved, it should feed into ongoing electricity NDC discussions.</p>

Strong communication between government agencies is vital, to ensure alignment across policies and programs. Lead agencies — including CCDA as coordinating agency and PPL and NEA as leading implementation agencies — will play a central role, ensuring that projects coming on stream in the next 5–10 years remain in line with the renewable energy targets set out in the Enhanced NDC 2020 and support PNG's overall electrification and climate change aspirations.



3

Mitigation Actions

This section outlines proposed mitigation activities, timeframes for implementation and potential challenges to achieving targets.

It brings together projects articulated in the annex of the Enhanced NDC 2020 (now superseded by the revised NDC implementation plan), planned projects from the ‘Electricity NDC model’, and interactions with stakeholders to understand potential projects and funding routes. Stakeholders expressed keenness to implement renewable energy projects that add capacity and replace thermal generation assets (particularly diesel generator-driven mini-grids), but also noted many (often long-standing) challenges that hinder project development. This section notes some of the pertinent challenges, which provide context for required actions by CCDA, and key stakeholders such as PPL and NEA, to establish an environment that supports increased coordination and collaboration to achieve renewable energy capacity aspirations.

Although this electricity NDC roadmap provides a focused look at the projects that may help PNG achieve its 78% renewable energy target, ongoing work is required to track and update project information. The target was established through bottom-up collation of information on planned and proposed projects, scheduled retirement of existing diesel generation, and the contribution of natural gas in the energy mix. The work is detailed in an Electricity NDC Model, managed by CCDA.³¹ This type of information is dynamic, and there is significant activity in the sector, with numerous actors seeking to play a role. Strong coordination and engagement across PPL, NEA and CCDA will be crucial for enabling access to timely and accurate project information and tracking progress to achieve targets.³²

3.1 Identified Mitigation Actions

The Enhanced NDC 2020 development process identified two groups of renewable energy projects that help move the country towards its 78% target:

- **Planned projects:** These are under implementation, pre-feasibility, feasibility or being built; they are in an advanced planning stage, often have approvals to proceed and are likely have commitments for financing. At the time of writing, 15 projects are categorized as planned.
- **Proposed projects:** These are at an earlier planning stage, generally do not have a business case and require substantial preparatory-work to build a business case and implement. At the time of writing, 22 projects are categorized as proposed.

Overall, 37 projects are identified as either planned or proposed are spread across the short-term (2021-2023), medium-term (2024–2026), and long-term (2027-2030). Information about these projects will be maintained in an Electricity NDC database, and reported on at ESTWC meetings. CCDA’s role will focus on coordination and communicating progress. Implementation responsibility will sit with PPL and NEA.

31. NDC background model work may be available from CCDA on request at info@ccda.gov.pg
Subject: Átn Energy Technical Lead

32. Note that PPL has provided updated generation portfolio information but further detail is required and will form part of ongoing engagement through the ESTWC.

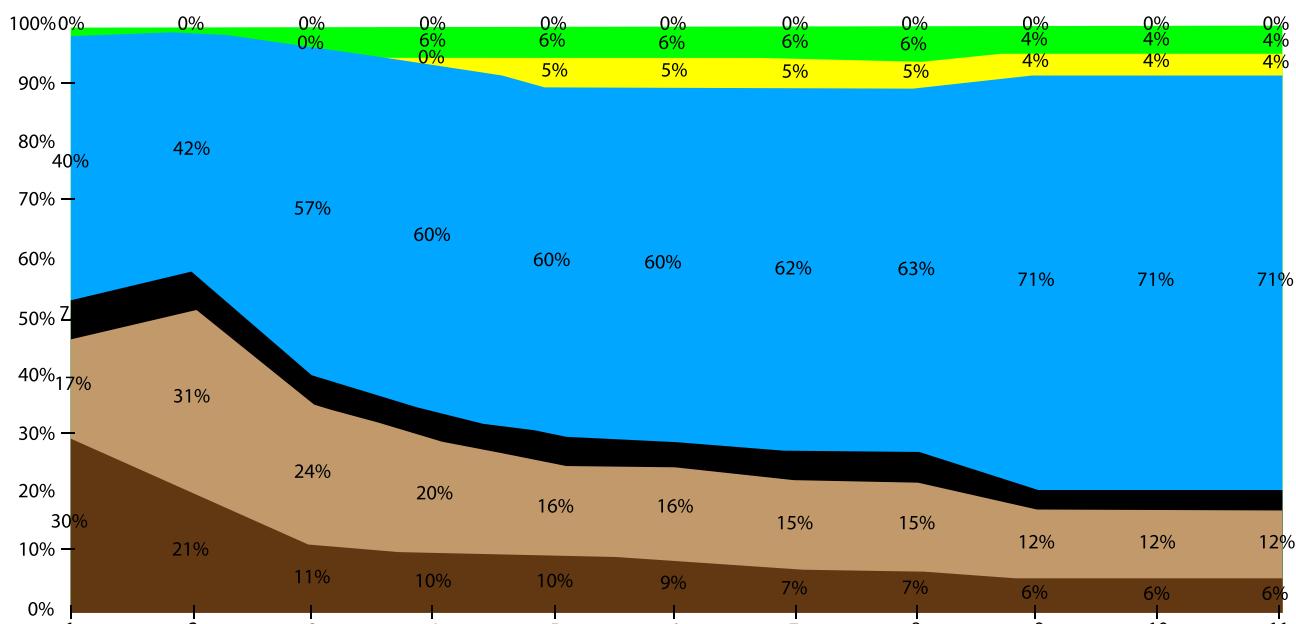
Although the NDC Implementation Plan 2020 highlights early stage proposed projects, the complete scenario includes both planned and proposed projects (Figure 6), which are included in this roadmap (Appendices A and B) and the revised implementation plan.^{33,34} The Enhanced NDC 2020 notes that project implementation is conditional on access to finance.

Hydropower dominates PNG's on-grid electricity portfolio and will continue to form the backbone of capacity addition. The hydro portfolio includes new projects coming on stream and three rehabilitation projects. A mix of other renewable energy sources —

particularly solar and biomass — will also form part of PNG's future on-grid energy portfolio. Wind power is at a relatively early stage of assessment and development, but may provide additional renewable energy generation capacity. Geothermal resources have also recently been assessed and opportunities to develop the sector and projects are being investigated.

Retiring diesel generators while also adding hydro and solar will be crucial to PNG's progress towards the 78% target. Stakeholders noted, however, that new fossil fuel-based electricity generation remains under consideration.³⁵

Figure 6. Planned and proposed on-grid projects, by subsector 2020–2030.



Source: GoPNG, Enhanced NDC Preparation – Electricity NDC Model (2020) (unpublished)

Table 6. Planned projects

	Short term (2021–2023)	Medium term (2024–2027)	Long term (2028–2030)
Number of projects	9: 2 solar, 7 hydro	5: 4 hydro, 1 biomass	1 hydro
Estimated installed capacity	176 MW	61 MW*	180 MW

Notes: *does not include Warangoi Rehabilitation due to limited available information. Updated financial information for the projects was not obtained, and will be continually updated through the ESTWC.

33. CCCD, NDC Implementation Plan (2020) (Annex).

34. At the ESTWC meeting on July 29 2021, there was mention of a potential 50MW coal plant in Lae. Further clarification is being sought from NEA on the status and details.

35. At the ESTWC meeting in July 2021, it was noted that a PPA for a 50MW coal plant is under consideration. No additional details are available at this stage, but this should be revisited in regular ESTWC meetings.

Although several projects are earmarked for short-term delivery, it is more likely that there will be a bulge of projects in the medium term. With several donor projects coming online and NEA establishment continuing through the end of 2021 and into 2022, planned delivery will take time to ramp up. It can be assumed that several projects scheduled for the short term may come to fruition in the medium term. Nonetheless, progress tracking should continue against the initial timeframes. Although several planned projects are tagged as in-progress it is important that the CCDA coordination team continue to track regulatory, operational and

financing status of the projects as these are subject to change.

Longer-term, Ramu 2, a large hydropower project, is marked to come online in 2028–2030. This is a large complex project, and discussions are ongoing; it may therefore be challenging to complete it within the NDC time period.³⁶ Although this would mean a reduction in overall capacity, it is possible to track towards the 78% target by implementing other planned and proposed projects. This will require ongoing progress reviews and updates to the projects listed in the Electricity NDC database.

Table 7. Proposed projects

Period	Short-term (2021 – 2023)	Medium-term (2024 – 2027)	Long-term (2028 – 2030)
Number of projects	6 Solar	7: 4 Solar, 3 Hydro	9: 8 Hydro, 1 Biomass
Estimated Installed Capacity	15MW	6.75MW	35MW
Approximate cost (Kina)	81 million	43 million	260 million

Note: *does not include Kavieng Biomass, as insufficient information was available.

Development partners will be crucial in moving forward with proposed projects. No finance has been identified for most projects and many require substantial work to undertake feasibility studies and develop business cases. The recently announced Energy Utility Performance and Reliability Improvement Project (EUPRIP) program includes an activity to help PPL further scope many early-stage projects.³⁷ The Electricity NDC database may be of use to PPL in holding those conversations. Given the need for detailed design and finance, several may shift from short-term to medium-term projects.

Planned and proposed projects will need ongoing review and adjustment to reflect on-ground reality. PNG's electricity sector is dynamic, with significant activity as government departments and development partners seek to address ongoing institutional challenges and implement projects that support the government's goal to provide 70% of the population with access to electricity by 2030.

This includes preparing for NEROP implementation, accelerating action to implement projects that were committed to at APEC 2018, and recently completed consultancy work to assess PPL's mini-grids.

As already noted, although the projects are spread over the time periods, many may tend towards the medium term due to implementation challenges. Progress will need to be updated and tracked through the Electricity NDC database. Although planned projects are in more advanced stages of preparation, barriers to implementation will still remain. The ongoing review of electricity NDC implementation activity will need to form a standing agenda item under the ESTWC meetings, and will require inputs from implementing agencies, particularly PPL and NEA. This process for ongoing review and escalation is discussed further in the Section 4.2.

36. PNG Business News, "The RAMU 2 hydro power project is one of the biggest projects to date, says Tuke," October 21, 2020, <https://www.pngbusinessnews.com/articles/2020/10/the-ramu-2-hydro-power-project-is-one-of-the-biggest-projects-to-date-says-tuke>.

37. EUPRIP, Social safeguard assessment accessed at: <https://www.developmentaid.org/api/frontend/cms/file/2021/04/Environmental-and-Social-Management-Framework.pdf#page=21&zoom=100,92,96>.

Table 8. Summary of planned and proposed projects

Timeframe	Number of projects	Commentary
Short-term (2021 – 2023)	15	<p>Significant focus on hydro (particularly existing hydro rehabilitation and enhancement), some solar, and existing biomass activity.</p> <p>Emerging projects will focus around the main grid areas. This includes several hydro rehabilitation projects and newer IPPs, such as Edevu Hydro. There is potential for DFAT implementation of three mini-grid projects across Daru, Finschaffen and Maprik.</p> <p>In the short term, CCDA, PPL and NEA should engage to ensure alignment of proposed approaches with upcoming planning document and strategies, particularly the NEROP Implementation Plan, LCPDP and revised 15-Year Power Development Plan. The CCDA team should ensure early engagement with the CFAN advisor to understand support opportunities.</p>
Medium-term (2024 – 2026)	12	<p>Potential for short-term projects to move into the medium-term period as projects are further refined during the period 2021-2023.</p> <p>Good potential to accelerate diesel replacement if initial projects to replace diesel generators with solar hybrids are successful. Will require significant donor support as PPL continues to strengthen operations and NEA is established.</p> <p>CCDA should work with PPL and NEA to enhance reporting on project progress and prepare for revisions to the NDC.</p>
Long-term (2027-2030)	10	<p>Includes some smaller projects as well as large hydro (Ramu 2), which may be challenging on several fronts and will require close coordination across government stakeholders and private sector. Appropriate demand centers (mining load) and careful consideration of financial sustainability will be required.</p> <p>CCDA will begin to collate information to report to UNFCCC.</p>



3.2

Implementation Challenges

Several recurring challenges emerge from desktop research and stakeholder engagement:

- **Regulatory Environment:** There is an element of regulatory uncertainty within the electricity sector, including institutional aspects, as the sector's past regulatory functions were split between PPL (technical regulation) and ICCC (economic regulation). With the passing of the NEA Act 2021, the regulatory aspects of the PPL's work will transfer to the NEA, removing a conflict of interest between the regulatory and provision functions of the sector cross-over. However, ongoing regulatory challenges — particularly in setting tariffs for mini-grids — hinder growth in the sector.
- **Covid-19 Recovery:** Competing pressure on government budgets may draw away from funds committed to the energy sector for infrastructure development and institutional strengthening. This could pose a challenge for developing, establishing and running the NEA, which will require significant financial and human resources.
- **Financing (sources of funds; counterparty challenges):** Many funding challenges could hinder the development of highlighted projects. The Enhanced NDC 2020 states that all action is contingent on necessary funding being in place, but significant gaps remain, particularly for proposed projects. In parallel, work is underway at CCDA to strengthen climate finance options and accessibility.
- **Demand centers:** Plans indicate a minimum 300MW capacity increase by 2030. Given PNG's dispersed demand, there must be enough demand for this energy to ensure economic viability of generation assets. Although this will be partly driven by potential mining loads, extending the grid in urban settings to enhance the number of connections will be an equally important and cost-effective approach for PNG as it moves towards its overall electrification target.
- **Landowner relationship management:** Ensuring fair and productive relationships with landowner groups to enable development remains a challenge. Early, comprehensive, engagement is imperative; there are several examples of projects being delayed due to challenges reaching agreement with landowner groups. The proposed NEA structure includes a group dedicated to engaging with landowners.
- **Communication and coordination:** Significant electricity market activities are planned and underway, involving government, international donors and the private sector and working on regulation, institutional strengthening, and project implementation (both on- and off-grid). Timely and accurate information access can be a challenge and must be addressed by enacting the NDC regulations and through ongoing collaborative engagement by key government agencies.



4

Enabling Environment

Table 9. Actions to support cohesive energy project implementation³⁸

Action	Commentary
Resource Mapping	<p>Lead: NEA Status: Scoping required, though some sectoral work has been undertaken, particularly in the wind sector. More potential for using GIS tools.</p> <p>Potential partners: IRENA, NEA, World Bank Energy Sector Management Assistance Program (which has supported off-shore wind potential assessment). Explore GIS capabilities of PNG Electrification Partnership countries.</p>
Renewable Energy Policy	<p>Lead: NEA Status: Standalone development activities. Hydro and solar policy development is underway through the UNDP and will be shared with stakeholders in the coming months. Will require further work on a broader renewable energy policy.</p>

The enabling environment for developing planned and proposed projects must continue to be strengthened. The Enhanced NDC 2020 outlines two actions that will help promote the cohesive implementation of renewable energy projects to support PNG's electricity requirements and meet targets: comprehensive renewable energy resource mapping and an overarching renewable energy policy. The former will develop the country's understanding of the long-term potential of renewable energy, while the latter will enable ongoing focus on renewable energy sources as part of PNG's push for 70% electrification by 2030.

Responsibility for implementing the two actions will eventually sit with the NEA. But, as it is still being established, there will likely be some delays to creating a comprehensive resource map for PNG, with an initial focus on hydro, solar and wind. However, there are pockets of activity across development partners that the NEA can consolidate and communicate in the short term.

Establishing a platform to communicate opportunities and support requirements will be important. Stakeholders have indicated a desire to establish a common platform to promote potential projects and communicate finance needs for projects that help achieve the renewable energy targets set out in the Enhanced NDC 2020.³⁹ Although several challenges are outside the direct control of CCDA as coordinating agency for NDC implementation, it has a clear role in helping to promote NDC support needs as part of its ongoing international climate change engagement.

The Climate Change (Management) (Nationally Determined Contribution Regulations) 2021 have been prepared to provide a regulatory framework for the implementation of PNG's NDCs. Among other things, the regulation provides for the establishment of TAC and ESTWC; formal recognition of targets contained in the NDC; development implementation plan; Implementation Measures; and Monitoring, Reporting and Verification.

38. Stakeholder discussions; CCDA, NDC Implementation Plan (2020) (Annex).

39. NDC Consultation Workshop, 20 August 2021.

4.1 Finance

Focusing on the proposed projects, there is an estimated funding gap of over 400 million Kina.

Although these projects are at an early stage and subject to revision, they still act as a guide to potential finance gaps. The Electricity NDC database will be used to keep track of project finance requirements, including updating finance information for planned projects.

Central government faces ongoing budgetary pressure and will need private sector and international donor community support to enable renewable projects. As already noted, there is significant donor engagement in PNG, much of it focused on enabling infrastructure support (transmission and distribution infrastructure strengthening), institutional strengthening and off-grid market development activities. There are some examples of electricity generation support activities, and the Electricity NDC database will provide a repository of potential renewable energy projects that can be built on and used to communicate funding needs to potential financiers. Possible sources of funding for project development include:

- **Development partners:** There is significant development partner interest in PNG, including the PNG Electrification Partnership (Australia, Japan, New Zealand and the United States), ADB and the World Bank Group. Potential areas of cooperation are in diesel generator replacement, hydro rehabilitation and advancing the PNG biomass solar component. Australia is PNG's largest bilateral funder.⁴⁰
- **Private sector:** Several planned projects — including PNG Biomass (Oil Search), Edevu Hydro Project — are primarily driven by private sector players in collaboration with central or provincial governments. Private sector-funded projects will require close engagement with government and should follow the requirements of PNG's LCPDP.
- **International climate finance:** To date, PNG has accessed climate funding from bilateral and multilateral sources. In 2019, CCDA, DNPM and the Pacific Islands Forum Secretariat carried out an assessment on options for strengthening climate finance coordination and accessibility in PNG. This identified several challenges, including the lack of a systematic or coordinated approach to access international climate change funding, limited understanding of climate finance and processes by central government agencies, and challenges navigating the reporting requirements of various climate funds. One step towards reducing bottlenecks for Small Island Developing States when accessing international climate finance was the announcement that PNG will be one of eight countries in the Pacific with an in-country Climate Finance Access Network (CFAN) advisor.⁴¹ CCDA, PPL and NEA should aim to engage with the advisor early on to share project information and financing needs.



40. Deloitte, Papua New Guinea Budget 2021: Consolidation for Growth. Budget Alert (2021), <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/financial-services/deloitte-pg-fs-papua-new-guinea-budget-2021-171120.pdf>.

41. RMI Climate Finance Access Network, "Climate Finance Access Network Announces 8 Pacific Countries Receiving Dedicated Climate Finance Advisors," August 18, 2021, <https://rmi.org/press-release/climate-finance-access-network-announces-advisors/>.

4.2

Governance

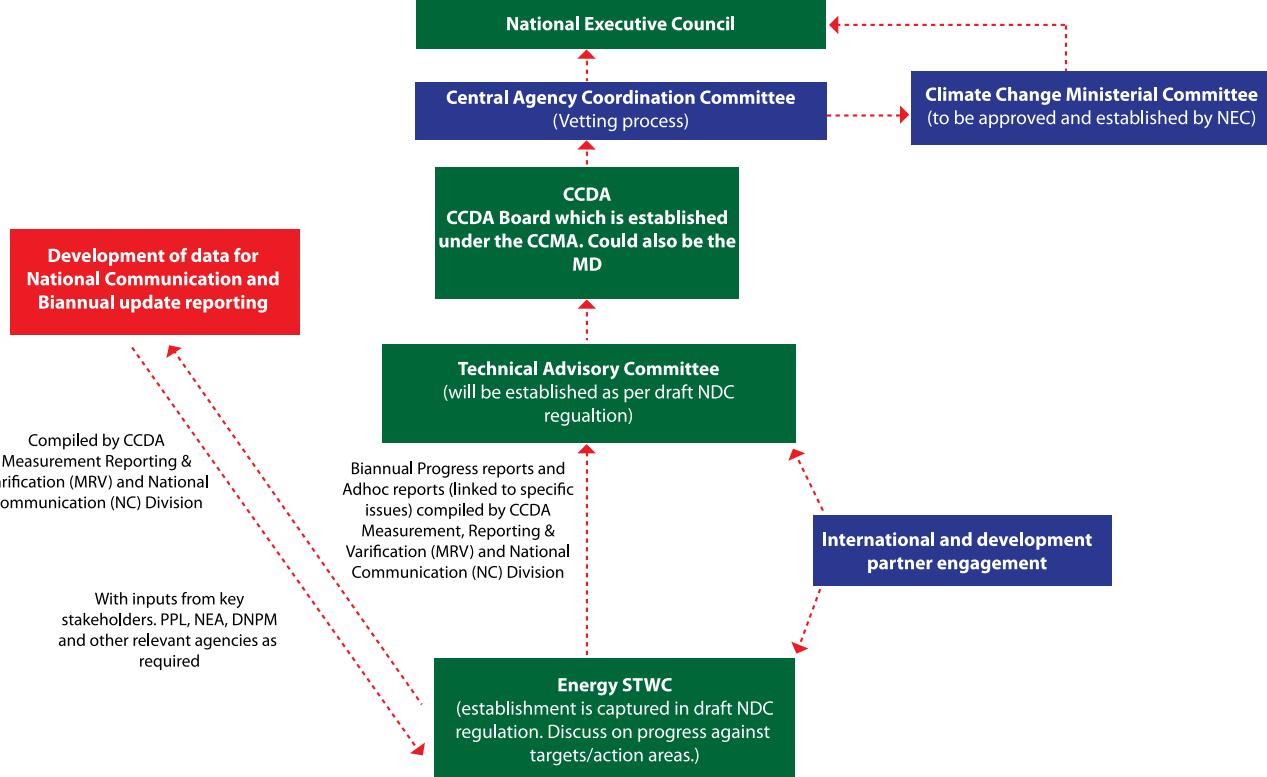
Effective governance will support the successful execution of this implementation roadmap. PNG's institutional framework has supported and facilitated the development of the Enhanced NDC 2020, with CCDA as the designated entity for coordinating activities. This framework provided the starting point for discussions with stakeholders on an appropriate governance framework for NDC implementation.

Governance implementation arrangements aim to align with existing governance mechanisms where possible. The updated governance structure for NDC implementation enables information flows between government departments — formally established through the creation of the NDC Regulations⁴² — and creates an escalation pathway for any decisions requiring ministerial decision making (Figure 7). In parallel, the NEA is developing its governance structures for overseeing electricity projects and NEROP rollout. It will be important that CCDA and NEA maintain close coordination as

the structure develops to ensure that the existing ESTWC, of which the NEA is chair, effectively helps oversee PNG's NDC commitments on electricity and deliver on electricity implementation plans. The NDC Regulations provide the foundation for a collaborative effort to ensure NDC implementation.⁴³

Key departments and agencies must have clear roles and responsibilities to enable NDC implementation. CCDA will continue to lead coordination activities for NDC progress, as well as monitoring, reporting and verification. Key stakeholders, particularly PPL, NEA and DNPM, will have critical roles providing information on implementation progress to support target achievement. Clear lines of communication, using existing governance bodies such as the ESTWC, will support cohesive information collation and communication. Over time, the ESTWC can act as a platform to communicate climate finance needs in the energy sector.

Figure 7. Proposed Governance Structure



42. GoPNG, Climate Change (Management) Nationally Determined Contribution Regulation (2021).

43. NDC Regulations were created during a CCDA-Office of the State Solicitor lockdown in July and circulated for discussion at the 3rd ESTWC.

Table 10. Governance roles and responsibilities

Governance Body	Background
Technical Advisory Committee (TAC)	<p>Established pursuant to the CCMA 2015. Comprising deputy secretary or equivalent level representatives, the committee's remit is outlined in the NDC Regulations. Its seniority will provide an escalation point for reporting on progress and issues discussed at ESTWC level.</p> <p>Chair: CCDA Frequency: to be confirmed (TBC) Data and inputs: TBC</p>
Energy Sub-technical Working Committee (ESTWC)	<p>Provides a senior working-level platform for discussion on progress against targets, updates on projects under implementation and discussion of challenges that may impact the achievement of NDC targets. It will broadly cover energy projects, and more specifically, the implementation of renewable energy projects as it pertains to this roadmap.</p> <p>Chair: NEA Frequency: Quarterly, with potential for ad hoc meetings as required. Data and inputs: Updates on project implementation; discussion of barriers and challenges; discussion on any items that require escalation to the TAC. CCDA energy lead will collect progress updates from NEA, PPL and DNPM to feed into the Electricity NDC Database.</p>

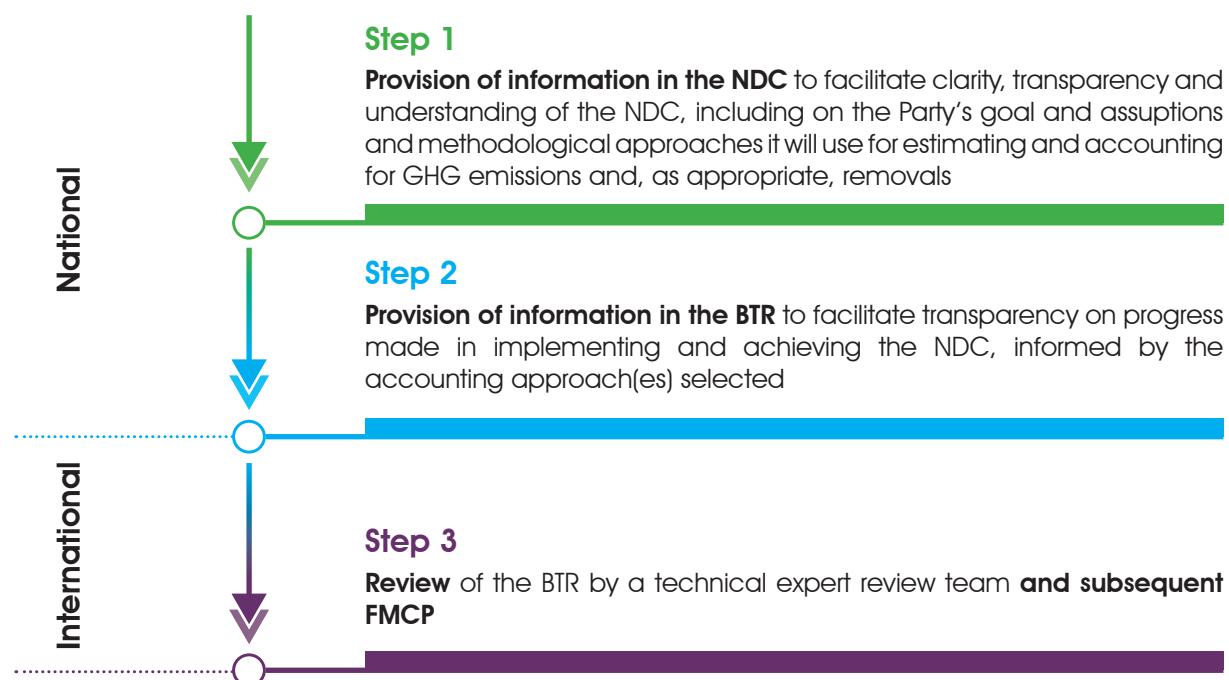


4.3 Measurement, Reporting and Verification

A measurement, reporting and verification (MRV) system is needed to assess the country's progress towards achieving its targets and help it prepare future NDCs. Building and implementing a transparent MRV system will not only enable PNG to meet its reporting obligations under the Paris Agreement but also strengthen its enabling environment so it can raise its mitigation ambition in future. A well-functioning MRV system will help build national and international confidence in the mitigation actions it undertakes and enhance its ability to prioritize actions and access climate finance.

Reporting obligations under the Paris Agreement will inform MRV activity. There are two major avenues where NDC actions and progress against targets are reported to the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA): in the NDC itself and its future iterations; and through its biennial transparency reports (BTRs), which Parties submit to the CMA every two years. The National Communications is a third avenue, though the interplay of information between these reports remains blurred.

Figure 8. Steps for accounting for NDCs within the Paris Agreement



Countries must provide necessary information to improve the clarity, transparency and understanding of the NDC. Decision 4/CMA.1 and its annexes provide guidance on what is needed.⁴⁴ This guidance will apply to all Parties when they submit their next revised NDC by 2025 (see Annex II of Decision 4/CMA.1 for details). It specifies the type of data and information countries must include in their NDC on each policy and action they undertake, to give readers a clear understanding of:

1. Quantifiable information on the reference point
2. Timeframes and/or periods for implementation
3. Scope and coverage
4. Planning processes
5. Assumptions and methodological approaches, including those for estimating and accounting for anthropogenic greenhouse gas emissions and, as appropriate, removals

Parties were strongly encouraged to submit this information in their 2020/2021 NDC submissions; it has now become an obligatory requirement for subsequent submissions, until they are revised by the CMA.



⁴⁴. Annex I to Decision 4/CMA.1, UNFCCC, (2019) "Information to facilitate clarity, transparency and understanding of nationally determined contributions" <https://unfccc.int/documents/193407>

4.3.1 Data and Information to be Provided in the BTR

Parties agreed on Decision 18/CMA.1⁴⁵ and its annexes — entitled Modalities, Procedures, and Guidelines of the Enhanced Transparency Framework of the Paris Agreement — at Katowice in 2018. This decision sets data and information requirements for Parties' first BTR, to be submitted by the end of 2024. The Annex, Part III outlines the standard requirements, which are:

1. National circumstances and institutional arrangements
2. Description of a Party's NDC under Article 4 of the Paris Agreement, including updates
3. Information needed to track progress made in implementing and achieving its NDC under Article 4 of the Paris Agreement
4. Mitigation policies and measures, actions

and plans, including those with mitigation co-benefits resulting from adaptation actions and economic diversification plans, related to implementing and achieving an NDC under Article 4 of the Paris Agreement

5. Summary of GHG emissions and removals
6. Projections of GHG emissions and removals, as applicable
7. Other information

Decision 18/CMA.1, Annex, III. D, paragraph 85 also indicates that each Party should provide "... to the extent possible, estimates of expected and achieved GHG emission reductions for its actions, policies and measures..."

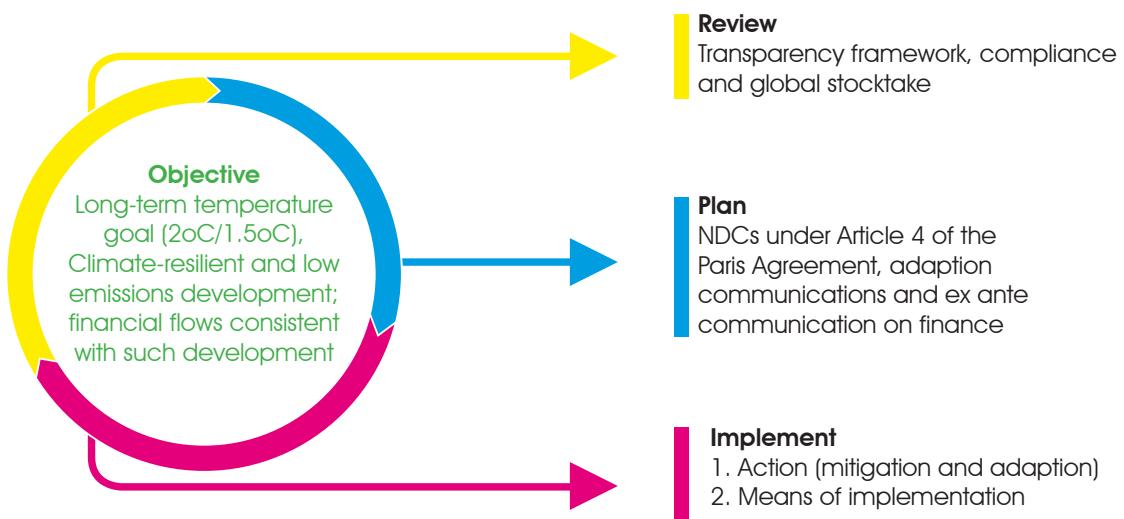
4.3.2 Timeframes

The UNFCCC provides flexibility to developing countries, as long as they clearly indicate their choice of flexibility, their capacity constraints and an improvement plan for overcoming these constraints.⁴⁶

CCDA is responsible for compiling reporting information, and eventually the GHG impacts of interventions, once appropriate supporting data

are available. The first annual report — an internal government document — is due in December 2021, with an interim evaluation in January 2024. The first formal report to the UNFCCC, the BTR, is due on December 31, 2024. Article 13 of the Paris Agreement establishes the Enhanced Transparency Framework, which seeks to develop common and open forms of communicating progress.

Figure 9. NDCs and the Enhanced Transparency Framework



Source: UNFCCC, Reference Manual for the Enhanced Transparency Framework under the Paris Agreement (2020)

45. Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, Decision 18/CMA.1, UNFCCC, (2019) <https://unfccc.int/documents/193408>.
46. Flexibility to those developing country Parties that need it in the light of their capacities, Decision 18/CMA.1, Annex I. C UNFCCC (2019) <https://unfccc.int/documents/193408>.

4.3.3 What should Countries Measure?

To measure progress towards achieving NDC targets under the energy sector, countries need to provide the following data:

1. Installed capacity of energy-providing stations at the end of a calendar year, by fuel source type, including both on-grid and off-grid systems, in MW or gigawatt (GW) units.
2. Energy generated and provided by these stations to the grid or consumers (in the case of off-grid systems) in a calendar year, in MW-hour or GW-hour units. In PNG, this will be important as several diesel generators may be displaced by solar/diesel hybrid systems.

Important aspects of measuring these parameters are:

- **Periodicity of primary measurement:** How frequently is the energy generated or supplied being measured? Hourly, daily, weekly or monthly?
- **Accuracy of data measurement:** The equipment used to measure these data must be calibrated at a certain frequency and have a cross-checking system to ensure accuracy of measurement. Countries must check the recordkeeping procedures followed by responsible entities to ensure data transfer consistency between records or other means of transmission of data.
- **Periodicity of data transmission to the coordinating entity:** The set frequency of submission of these monitoring reports can be agreed between the coordinating entity and primary data provider. This could be set at a frequency that is mutually convenient, without being considered an additional burden to regular reporting.
- **Data retention period and data retrieval methods:** While NDCs are forward-looking documents, impacts will materialize in the longer term. The data and information provided under the NDC and BTR will be analyzed by a team of technical experts, as detailed below. Countries must therefore retain these data for at least a decade, as this will enable potential future corrections and provide more reliable data to feed into models.

It is important to note that the coordinating entity does not need these primary data. However, it would be beneficial for primary data providers to have a high degree of confidence in the information provided, thereby increasing overall NDC accuracy. When such information is required to, say, participate in any international transactions under Article 6, accurate records will greatly enhance transparency and confidence in the entities involved.

Another aspect to be considered is the choice of emission factor chosen to convert these to GHG equivalents (tCO_2e). While PNG has set non-GHG targets in its NDC, GHG equivalents would be the basis for comparison at the Global Stocktake as one of the main inputs is the information necessary to track progress made in implementing and achieving its nationally determined contribution⁴⁷. The methodology used for determining the emission factor, including any relevant assumptions that determine its accuracy and the periodicity of its update, provide useful information to improve the transparency of information.

The total installed capacity as an indicator can be assessed over time measuring how the country has stepped up its yearly renewable energy capacity compared to conventional power capacity additions. A second parameter could be the energy these power projects generate and deliver to the grid. Another aspect to be considered is the choice of emission factor chosen to convert the energy generated to GHG equivalents (tCO_2e). While PNG has set non-GHG targets in its NDC, GHG equivalents would be the basis for comparison at the Global Stocktake as this is one of the main inputs to the information necessary to track progress made in implementing and achieving the country's nationally determined contribution. The methodology used for determining the emission factor, including any relevant assumptions that determine its accuracy, and the periodicity of its update, are all useful information to improve the transparency of the NDC.

While these indicators are for capacity additions that have already been implemented, a planning element to be included in both the NDC and BTR will enable PNG to assess whether it can meet its stated targets by 2030. For example, a country's choice of

47. Paragraph 36, Matters relating to Article 14 of the Paris Agreement and paragraphs 99–101 of decision 1/CP.21; FCCC/CP/2018/L.16, UNFCCC (2018) <https://unfccc.int/documents/187579>

renewable energy technology to prioritize to achieve these aims will be determined by:

- **Its proven technical capacity:** For example, although geothermal is technically feasible, each country should clearly establish its availability and relevance to the national context.
- **The enabling environment for implementing technology.** To be able to take up and implement technology, a country needs to have, as minimum:
 - Government ministries and departments with knowledge of the technology or other national and international bodies that can provide this capacity;
 - Laws, regulations and policies that encourage and support the technology;

- Financial systems and flows, including the ability of private and public sector entities to participate in technology implementation;
- Adequate workforce with the necessary skills to operate the technology during its lifetime, and systems that enable the provision and upgrade of workforce; and
- A support infrastructure for addressing the challenges encountered during technology maturation.

Measuring all these parameters can go under the umbrella of MRV of the support a country needs to continually assess the implementation of the actions indicated in its NDC. This information can be included under “planning processes” in the next NDC update and first BTR.

4.3.4. Reporting Schedule

In the initial stages of implementation, MRV will focus on tracking mitigation actions and support activities, including projects implemented and funds secured and disbursed. At a working level, countries will update implementation activities on a quarterly basis in the Electricity NDC database, the central repository for project reporting that will give ESTWC and TAC members a clear view of implementation progress. The energy technical lead will be responsible for managing and updating the database — which will include project information and international donor support as recorded by DNPM — and sourcing inputs from ESTWC members.

Table 11. NDC Reporting Schedule

Action	Timing	Responsible agencies
Status update for each activity	Biennially	Implementing government agencies, supporting development partners
Progress report	Biannual	CCDA, implementing agencies, stakeholders
Annual report	By December 2021 December 2022 December 2023	CCDA, implementing agencies, stakeholders
Interim Evaluation Report	January 2024	CCDA, implementing agencies, stakeholders
Final evaluation Report	January 2030	CCDA, implementing agencies, stakeholders

Source: CCDA, Enhanced NDC 2020 (2020)

Table 12 Reporting roles and responsibilities

Entity	Role
CCDA	Central coordinating agency for all NDC implementation activities, working with departments to collect and collate information on project implementation and prepare UNFCCC communications.
DNPM	Holding and tracking information on development partners engagements; sharing up-to-date information on planned and in-progress projects — including information on funds allocated and disbursed — with the CCDA technical lead.
NEA	Working closely with CCDA to ensure there is up-to-date information on policy settings and regulations as they pertain to the electricity sector. Current chair of the ESTWC.
PPL	Working with NEA and CCDA to communicate implementation progress, funding gaps and policy-related hurdles; providing updated information as the next iteration LCPDP is approved and NEROP implementation begins.

International reporting: As indicated in Table 11, the data and information collected through these processes and provided by these entities must be reported under the updated NDC and BTR.

Verification: At the international stage, verification will be through the technical expert review of the national GHG inventory and the information necessary to track progress made in implementing

and achieving its NDC as submitted in the BTR.⁴⁸ This is followed by a facilitative, multilateral consideration of progress,⁴⁹ where all countries have the opportunity to present their reports, including their GHG inventory, information necessary to track progress made in implementing and achieving its NDC as submitted in the BTR, and information on financial, technology transfer and capacity-building support needs and receipts.



48. Technical expert review, Decision 18/CMA.1, Annex, VII, UNFCCC (2019) <https://unfccc.int/documents/193408>

49. Facilitative, multilateral consideration of progress, Decision 18/CMA.1, Annex, VIII, UNFCCC (2019) <https://unfccc.int/documents/193408>

5

Moving Forward

In the short term, the NDC implementation team will need to continue to build engagement with key stakeholders, embed process status updates and project implementation tracking and work with partners to establish the foundation from which to access climate finance for energy projects. Immediate and near-term activities should include the following:

- 1. Ensuring ongoing alignment with policy and plans, particularly NEROP, LCPDP and 15 year PDP:** Work is underway to strengthen PPL and create an environment where least-cost power development planning drives electricity infrastructure investment decisions. As NEROP implementation preparation accelerates, it is important that the ESTWC is kept updated with progress and the potential impact of any decisions on PNG's ability to achieve its 78% renewable energy target. The CCDA technical lead will need to work with the PPL and NEA ESTWC members to ensure that up-to-date policy and planning information is reflected in the Electricity NDC database.
- 2. Reviewing and refining the proposed and planned project list in collaboration with PPL and NEA:** This implementation roadmap is intended to be dynamic. The Electricity NDC database provides flexibility to track progress on implementation of specified projects. Updated information from key stakeholders will form the basis for regular updates at the ESTWC. This should include the CCDA energy lead collecting information and updates on project status, barriers to implementation and funding requirements from PPL and NEA representatives two weeks ahead of ESTWC.
- 3. Working with DNPM to refine and build information on international support in the electricity sector:** Significant donor activity is taking place in PNG. Ongoing engagement is vital to ensure information on donor support activities — including planned and actual disbursement — is up to date. This information will eventually flow into PNG's reporting to the UNFCCC.
- 4. Leveraging the governance structure, starting with ongoing engagement of the ESTWC:** The ESTWC is an existing structure that brings together key stakeholders in the energy sector. The committee should continue to build momentum of the ESTWC and ensure it is utilized to review and support progress towards the NDC renewable energy target especially as it may take time for the Technical Advisory Committee to be formed. The NDC Regulations strengthen the ability for data collection to support progress tracking and reporting requirements, but it is critical that a strong collaborative approach is taken to collecting information and providing updates – particularly across CCDA, NEA and PPL. The ESTWC provides a platform for this engagement to take place.
- 5. Highlighting renewable energy projects as the first step to attracting climate finance:** There are several challenges to accessing climate finance. To address data gaps — particularly detail on avoided GHG emissions — PNG will need to continue collaborating with development partners. The in-country placement of a CFAN advisor would help strengthen PNG's readiness to access climate finance by enhancing the bankability of PNG climate-related projects. Enhancing the Electricity NDC database and the projects recorded in it would be a good starting point for engagement with the advisor.



Appendices

Appendix A. Planned Projects

Action or Activity	Technology	Proposed Capacity (MW)	Lead Implementing Agencies	Supporting Agencies	Year due to be commissioned	Timeframe
1 Divune-Popondetta/ Divune HPP	Hydro	3.1	PPL	ADB	2023	Short-term
2 Samardai	Solar	0.075	PPL	UNDP, CCDA	2022	Short-Term
3 Naoro Brown	Hydro	80	Independent Power Producer	World Bank	2023	Short-term
4 Edenvu-PNG	Hydro	51	Independent Power Producer	TE PNG; China Gezhouba Group	2023	Short-term
5 Ramazon	Hydro	3	PPL	Hydro	2022	Short-Term
6 Round Hydro-additional (R1 &STOD)	Hydro	8	PPL	Dongfang (Engineer)	2021	Short-term
7 Lower Lake Hartgy Hydro (Blaia)	Hydro	2	PPL	PPL	2022	Short-Term
8 Makham Valley Solar with Battery	Solar	17	PNG Biomass/PPL	AUSAID	2022	Short-term
9 Wabag Hydro (Wabag Provincial Gov)	Hydro	12	Wabag Provincial Gov/PPL/Enga Energy Investment Limited		2023	Short-term
10 Markham Valley Biomass (PNG Biomass IPP)	Biomass	30	PNG Biomass	Oil Search	19 Months (dep. On solar project)	Medium-term
11 Baime (IP)	Hydro	11.6	Independent Power Producer (PNGFP)	SMEC (engineer)	2024	Medium-term
12 Ru Creek 2 Hydro (Kimbe)	Hydro	2.5	PPL		2026	Medium-Term
13 Warangol Rehabilitation	Hydro	10	PPL	ADB		TBC
14 Ramu 1 (Refurbishments)	Hydro	17	PPL	AUS DFAT; WBG?	2023	Medium-term
15 Ramu 2	Hydro	180	PPL	Shenzen Hydro	2028	Long-term

Appendix B. Proposed Projects

Project	Proposed Capacity (MW)	Technology	Supporting Agencies	Proposed Timeframe for implementation	Budget (Million Kina)	Budget (Million USD)	Timeframe description
1 Kerema Solar PV + ESS	1.5	Solar	NEA/CCDA	2022-2024	8.0	1.9	Short-Term
2 Manus Solar PV + ESS	1.5	Solar	NEA/CCDA	2022-2024	8.0	1.9	Short-Term
3 Alotau Solar PV + ESS	1.5	Solar	NEA/CCDA	2022-2024	8.0	1.9	Short-Term
4 Saussia Solar PV	10	Solar	NEA/CCDA	2022-2024	54.0	12.9	Short-Term
5 Atitape Solar-PV + ESS	0.4	Solar	NEA/CCDA	2022-2023	2.2	0.5	Short-Term
6 Maprik Solar PV + ESS	0.2	Solar	NEA/CCDA	2022-2024	1.1	0.3	Short-Term
7 Daru Solar PV + ESS	1	Solar	NEA/CCDA	2023-2026	6.0	1.4	Medium-term
8 Daru Solar PV + ESS	1.5	Solar	NEA/CCDA	2024-2026	8.0	1.9	Medium-term
9 Fincshafen Solar PV + ESS	0.45	Solar	NEA/CCDA	2024-2026	2.4	0.6	Medium-term
10 KaviengSolar PV + ESS	1.5	Solar	NEA/CCDA	2023-2025	8.0	1.9	Medium-term
11 Gurnini Hydro	1.5	Hydro	NEA/CCDA	2023-2026	12.0	2.9	Medium-term
12 Kereu 1 Hydro	0.6	Hydro	NEA/CCDA	2022-2025	4.8	1.1	Medium-term
13 Butoweng	0.2	Hydro	NEA/CCDA	2024-2026	1.6	0.4	Medium-term
14 Murua Hydro	3	Hydro	NEA/CCDA	2025-2028	64.0	15.3	Long-Term
15 Damar/Mabam Hydro	3	Hydro	NEA/CCDA	2025-2028	64.0	15.3	Long-Term
16 Daundo Hydro	1.5	Hydro	NEA/CCDA	2025-2028	12.0	2.9	Long-Term
17 Lawes Hydro	2	Hydro	NEA/CCDA	2025-2028	24.0	5.7	Long-Term
18 Kimadan Hydro	1.5	Hydro	NEA/CCDA	2025-2027	12.0	2.9	Long-Term
19 Sohun hydro	0.3	Hydro	NEA/CCDA	2023-2025	2.4	0.6	Long-Term
20 Mavelo	10	Hydro	NEA/CCDA	2025-2029	80.0	19.2	Long-Term
21 Kavieng biomass fuel plant (PPA has been signed)	2	Biomass	NEA/CCDA/PPL	2026-2030			Long-Term



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