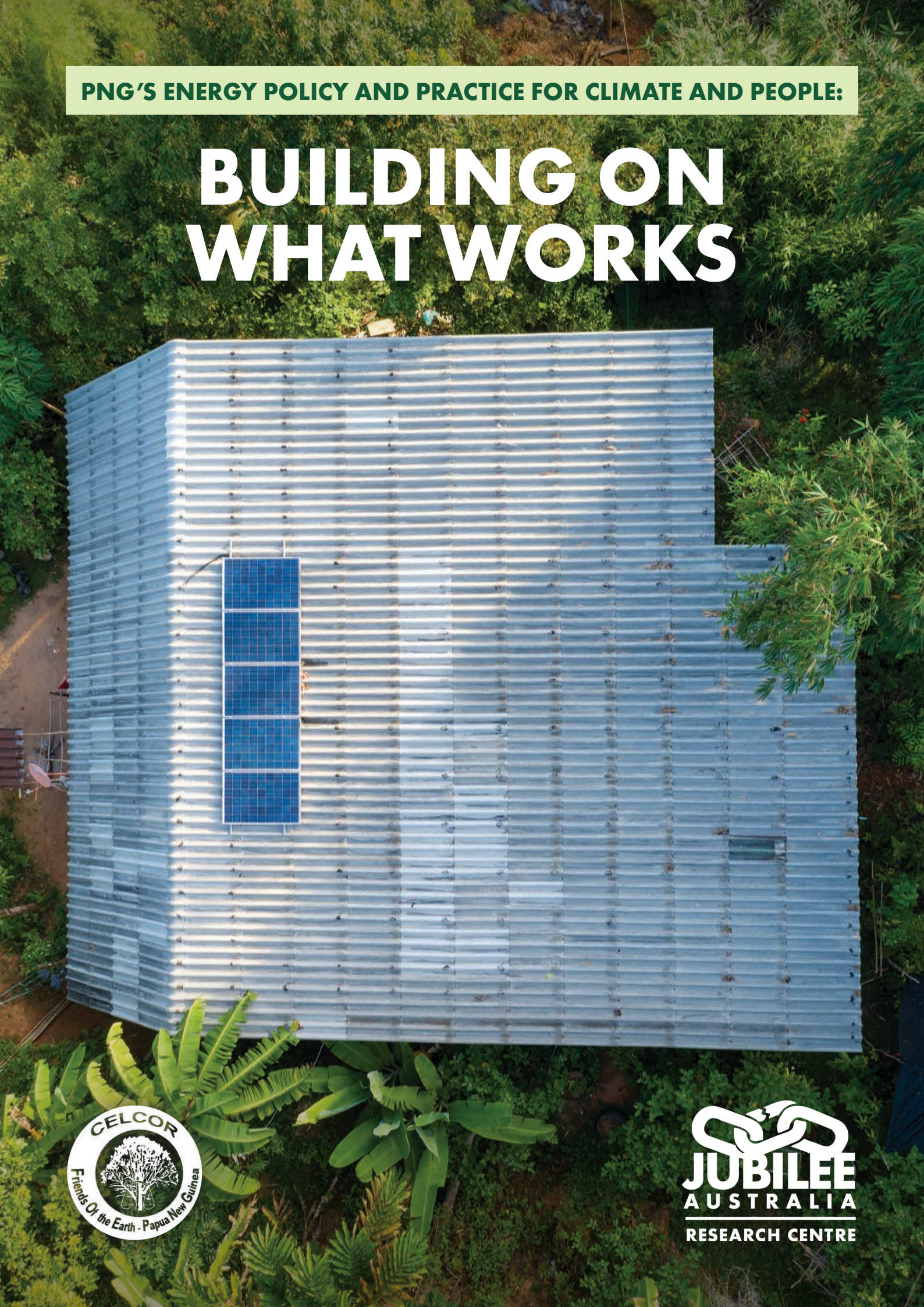
PNG'S ENERGY POLICY AND PRACTICE FOR CLIMATE AND PEOPLE:

BUILDING ON WHAT WORKS



CELCOR
Friends Of the Earth - Papua New Guinea

JUBILEE AUSTRALIA
RESEARCH CENTRE

CENTRE FOR ENVIRONMENTAL LAW AND COMMUNITY RIGHTS (CELCOR)
AND JUBILEE AUSTRALIA RESEARCH CENTRE, NOVEMBER 2022

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JUBILEE AUSTRALIA RESEARCH CENTRE

Jubilee Australia Research Centre is a not-for-profit research centre based in Sydney, Australia. We engage in research and advocacy to promote economic justice for communities in the Asia-Pacific region and accountability for Australian corporations and government agencies operating there.

We are an independent and not-for-profit organisation and donations are tax deductible.

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The Centre for Environmental Law and Community Rights (CELCOR) Inc, is a not for profit, Papua New Guinean public interest environmental law firm. The fundamental purpose of CELCOR is to provide legal advice, legal education and assistance to landowners, Community Based Organizations and NGOs involved in community based natural resources management, environmental policy research and development and advocate for human rights and environmental justice.

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ACKNOWLEDGMENT OF COUNTRY

We acknowledge and pay our respects to the Gadigal people of the Eora Nation as the Traditional Custodians of the land on which our office sits. We pay our respects to First Nations peoples of all the lands on which we work, live and play, their culture and Elders past and present. We recognise that this land was and always will be Aboriginal and Torres Strait Islander land, because sovereignty was never ceded.

Cover photo: XXXX

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GLOSSARY OF TERMS

Abbreviation	Terms	Definitions
	1.5C	Based on current scientific projections of the impacts of climate change, international efforts are focused on trying to limit global temperature increases to 1.5C from pre-industrial levels. This also aims to avoid runaway climate change, where the breakdown of climatic systems themselves drive rising temperatures. International temperatures have already risen by 1.1C.
ADB	The Asian Development Bank	Refers to gas produced from renewable resources.
	Climate change	Climate change is a change in the pattern of weather, and related changes in oceans, land surfaces and ice sheets, occurring over time scales of decades or longer. Human-induced greenhouse gas emissions from fossil fuels are a key contributor to climate change.
CCDA	Climate Change and Development Authority	The CCDA coordinates the climate change efforts of the Government of Papua New Guinea.
	Fossil fuel	Energy sources derived from burning fossilised hydrocarbons. Fossil fuels are non-renewable and a key contributor to climate change.
	Fossil gas	Fossil gas is a term that may refer to gas or natural gas, or treated products such as Liquified Natural Gas (LNG). The term 'fossil gas' is used here to distinguish it from gas produced from other sources, such as biogas.
DSIP	District Support Improvement Programme	A PNG Government established programme to provide minimum service delivery standards through re-establishment of basic infrastructure and facilities to support infrastructures, health, education, law and justice, economic, and administration with a budgetary allocation of PGK15m per year.
GoPNG	Government of PNG	
GCF	Green Climate Fund	The world's largest climate fund, mandated to support developing countries raise and realize their Nationally Determined Contributions ambitions towards low-emissions, climate resilient pathways.
IPP	Independent Power Producer	A non-state energy company which generates power, typically to sell to PPL to expand the capacity of the grid. IPPs operating within a 10 kilometre of PPL's exclusive zone, can also approach PPL to contract to sell energy into the grid.
IPCC	Intergovernmental Panel on Climate Change	The world's foremost international body for assessing the science of climate change.
IEA	International Energy Agency	One of the foremost international bodies on energy policy.
MW	Megawatt	
NDC	Nationally Determined Contribution	Under the Paris Agreement on climate change, each 5-years countries are to set an increasingly ambitious target for climate action. These plans for climate action are known as nationally determined contributions. PNG's Enhanced NDC 2020 refers to its most recent NDC.
NEA	National Energy Authority	A newly instituted body which will be the central policy-making and planning entity for the energy sector in PNG. This includes having oversight of the development of renewable energy resources and efforts to expand on-grid electrification.
NEP	National Energy Policy 2017-2027	The National Energy Policy is the basis of policy for the energy sector to meet national and provincial development needs. It aligns with the goals of Vision 2050 and draws on support from NEROP. It builds on previous policies and development plans, such as the Electricity Industry Policy 2011 and the PNG Development Strategic Plan 2010-2030. The NEP also identified the need for a National Energy Authority. The work of CCDA heavily complements the NEP, by providing further detail and opportunities for renewable energy.
NEROP	National Electrification Rollout Plan	Drawing on in-depth technical and geospatial analysis, NEROP identifies how PNG can rollout electrification.
	Paris Agreement	The Paris Agreement is a legally binding international treaty on climate change. It was adopted on 12 December 2015 and entered into force on 4 November 2016. Currently 93 states and the European Union are signed up – accounting for 98% of the world's carbon emissions. The Paris Agreement sets the pathway for international action to combat climate change.
PPL	PNG Power Ltd	PNG's state-owned power company and retailer of on-grid energy. Until recently, PPL also had regulatory responsibilities which are now transitioning to the NEA.
SDGs	Sustainable Development Goals	A collection of 17 interlinked global goals designed to be achieved by 2030, they are a 'shared blueprint for peace and prosperity for people and the planet, now and into the future'.



Port Moresby Papua New Guinea

FOREWORD BY PETER BOSIP

Improving electricity access for our people has been a long term development challenge for successive governments. We are still a young country, faced economic, political and geographical challenges in ensuring access for many people.

At the same time, people in PNG and across the world are being increasingly made aware of the threats and impacts that a warming world will have. Although PNG and our Pacific neighbours have not caused this problem, we in the Pacific have a unique moral voice on the issue, given the devastating effect that the rising oceans will have on our way of life.

If PNG is able to take successful steps in cutting its own fossil fuel emissions, it will strengthen this strong moral voice of ours in regional and international climate negotiations. This will in turn put pressure on high-emitting countries to do better, and ultimately result in a more liveable planet for everyone, not least us here in PNG. The agreements made last month at the UN's COP 27 Conference in Sharm el-Sheikh are testament the influence that Pacific voices on climate matters continue to grow.

Some might think that it not possible for PNG to pursue these two goals at once: i.e. improving energy access and cutting emissions. We believe that the opposite is the case—that the expansion of renewable energy technologies in PNG will help us meet our energy access targets faster and cheaper. However, it means a significant change to our energy systems and to the ways in which we have been operating for many decades.

In recent years, the government has committed to facing this challenge head on. It has taken important steps towards increasing energy access such as the establishment of the NEA and the development of new energy projects for the grid. Nevertheless, as this report lays out, there are still many impediments and challenges when it comes to implementation: from ensuring effective and clear decision-making in the responsible government agencies, to the need to push back against a further expansion of fossil fuels in our economy, to the difficulties in finding the funding necessary to finance the renewable energy infrastructure that we will need.

Moreover, government cannot do all the work alone. It is up to civil society, to experts in academia and the media, and to business groups to help educate and inform the population about what a transition to renewable energy means and how we can accomplish it. This will help clear the way for our politicians and officials to continue to be bold in their ambition for confronting our climate and energy challenges. Moreover, these groups can help hold the government accountable to its commitments on energy access, and to assist it in helping solve the problems and roadblocks that are there.

The purpose of this report it to bring together and report on the actions that have already been taken, and to explore the practical steps that will continue this path forward. The report itself has been informed by the workshop that we organised on 27-28 September this year in Port Moresby. The workshop brought together colleagues from government, industry, donor institutions, civil society and think tanks/academia and saw many fruitful discussions on the topic of the energy transition. These discussions helped inform the final version of this paper which I am proud to endorse, and which I hope will be an important signpost on the way to a future characterised by clean energy and energy access for all of our people.



Mr Peter Bosip
Executive Director
CELCOR
December 2022

KEY MESSAGES

This report seeks to connect two vital issues facing PNG: first, the need to improve energy access for the vast majority of PNG's population, and second, PNG's response to climate change and meeting its commitments to the Paris Climate Agreement. Building energy access in a way that serves climate and people can, at times, appear to be an overwhelming challenge. However, in exploring the question 'Can Papua New Guinea develop an energy policy that both meets its Paris Climate Agreement obligations and the needs and desires for increased energy access?' – it is clear that PNG already has the critical ingredients it needs to build a climate conscious energy future. This report takes stock of the progress that has already been made and seeks to identify near-term actions and priorities that can help realise PNG's renewable energy future.

The report's key messages are:

- Papua New Guinea can, and should, build an energy policy and practice that both meets its Paris Climate Agreement obligations and the needs and desires for increased energy access. While legitimate challenges remain, there has been headway made in recent years and building on what works will be key.
- In PNG it is cheaper today to produce electricity from certain renewable energies – such as solar or hydro – than fossil fuels. While renewable energies can face higher initial upfront costs, their cheaper and less volatile energy prices could help the PNG government and communities meet their goals of increased energy access. Maintenance on existing renewable energy infrastructure such as hydroelectricity is also highly cost effective.
- There is significant interest from those working on climate and energy issues to bring these conversations together. It is also important that the lived experience of climate change facing PNG communities, and its broader threats to the PNG economy, are kept front-of-mind in energy policy discussions.
- New fossil fuel power plants will 'lock-in' PNG dependency on fossil gas, coal and other fossil fuels for decades to come. This would undermine PNG's renewable energy targets and contradicts international energy policy advice. The myth of fossil gas as a 'transition fuel' has distracted from its harmful climate impacts – which in the short-term can be more than two-thirds of those of coal. Internationally, fossil fuel firms – including some with operations in PNG – are facing investigations and legal action by governments over allegations that they misled or deceived the public over their contribution to climate change or what they knew of its likely impacts.
- PNG government agencies have already identified a host of renewable energy projects that, if all went ahead, could supply 78% of PNG's on-grid electricity by 2030. This is 78% based on PNG's highly ambitious target to expand electricity access from 13% to 70% households by 2030. Even if every project does not go ahead, this indicates that the government meeting its target of 78% of electricity coming from renewable energy by 2030 is viable and achievable.
- Finding appropriate financing models will be fundamental to PNG's energy outcomes. Development agencies and others are already financing a range of energy-sector activities in PNG, including renewables. However, more grant-based finance rather than loans is needed to meet the upfront costs of new infrastructure. This could include development finance and potentially climate finance – however climate finance should prioritise energy projects that contribute to community resilience in areas facing the greatest climate risks and impacts.
- Social equity is critical to both energy and climate outcomes. It is vital that people with little or no monetary income have fair and equal access to energy and participate in energy decisions. Off-grid energy access can also help support climate resilience and local economies but the economic benefits are often under-researched. It is also vital that the land and water rights of marginalized peoples are respected in energy planning.
- Strong attention to gender is needed to ensure that the renewable energy sector develops fairly and equitably. Women's energy needs, training and leadership should be in-built into all energy policy and discussions.
- There is a clear benefit in bringing together discussions about energy policy, planning and practice to share learnings, insights and challenges across local, provincial and national levels. This should bring together government agencies, practitioners, renewable energy businesses, researchers, community organisations, women's organisations and NGOs.



Village in Papua New Guinea

- It is also critical to train women, communities, workers and professionals in installing, maintaining and end-of-life recycling of renewable energy technology. This must include in-community and provincial training. Currently, various groups are trying to run or build training programs at community, provincial and national level. This includes learning from approaches developed overseas.
- PNG businesses that support a low carbon energy sector also have a role to play. This could include taking a leadership role in business associations and making public statements in support of renewable energy. If feasible, they should also consider contributing financially to business association events and other groups – to reduce the influence of fossil fuel companies through sponsorships.

1. INTRODUCTION

This report seeks to connect two vital issues facing PNG: first, the need to improve energy access for the bulk of PNG's population, and second, PNG's response to climate change and meeting its commitments to the Paris Climate Agreement. Building energy access in a way that serves climate and people can, at times, appear to be an overwhelming challenge. This report takes stock of the progress that has already been made and seeks to identify near-term actions and priorities that can help realise PNG's renewable energy future.

Poor electricity access is one of the most critical development issues facing PNG today. Only about 13-15% of the population have access to on-grid electricity.[1] Large parts of the country, particularly in rural areas – have poor electricity access. For those who do have access, supply can often be unreliable. It's anticipated that meeting the target of 70% of households having access to electricity by 2030 would require around 300 MW in extra capacity.[2]

In addition, approximately 60% of PNG's population have access to off-grid solar technologies, and it's likely several other renewable energy products.[3] This reflects rapid expansion in recent years and it's likely that many more gains could be made by ensuring rural communities and enterprises have access to off-grid energy choices.

Climate change is another crucial problem that PNG faces as it looks to the future of a warming world. Climate change is already impacting communities across PNG, and as detailed further in Section 2, climate change will have ever more severe impacts on PNG, something that PNG leaders have acknowledged.

PNG has already built a strong foundation in recent years in terms of a progressive climate policy and its connection to increased electricity access. PNG is well-versed in understanding the threats of climate change to its land, people and economy. It has invested significant resources in creating a coordinated whole-of-government approach to addressing climate change, creating a foundation to build an energy future in line with the climate future PNG citizens need.

This report aims to capture existing work and learnings about how PNG can grow energy access for everyday people and its broader economy in ways that align with its international climate commitments. The overriding research question is: 'Can Papua New Guinea develop an energy policy that both meets its Paris Climate Agreement obligations and the needs and desires for increased energy access?'. What emerges is that it is clear that PNG already has the critical ingredients it needs to build a climate conscious energy future. This report will further progress this process by identifying near-term efforts that can help PNG realise an environmentally sustainable energy future.

It begins by taking stock of progress already made to prove that a renewable energy future for PNG is viable, and commitments to step away from diesel power. Next, it summarises the risks to renewable energy of locking-in years long, or even decades long, reliance on new-build fossil fuel infrastructure that in filling an energy 'gap' would undermine momentum for resourcing renewable energy. It draws on significant international scientific and policy evidence since the Paris Agreement that shows that new fossil fuel energy infrastructure does not have a legitimate role in 'transition' away from fossil fuels, noting the significant role that misinformation has played in the discussion. The following section then acknowledges the question of how can PNG can further finance identified planned and proposed renewable energy projects? It takes stock of financial considerations before exploring further potential options for the types and sources of financing that can be explored. Then it takes a summary of off-grid energy. Lastly, it includes a section on 'next steps' with recommended actions for different stakeholders.

2. THE CLIMATE CRISIS AND PNG

A. THE IMPACT OF CLIMATE CHANGE

The world's foremost body for assessing the science of climate change – the Intergovernmental Panel on Climate Change (IPCC) – has shown that its impacts on climate systems, the atmosphere, oceans and land are 'widespread, rapid and intensifying'.[4] In 2018, the IPCC warned that the world needed to reduce its annual greenhouse gas emissions by 45% by 2030 if it is to avoid the most catastrophic climate scenarios and seek to contain global temperature rises to 1.5C above pre-industrial levels.[5] This makes this decade a critical one for climate action. The IPCC's 2021 report was described as a 'code red for humanity'.[6] It warned 'many of these changes are unprecedented, and some of the shifts are in motion now, while some - such as continued sea level rise – are already 'irreversible' for centuries to millennia, ahead'.[7]

The climate crisis has been described as 'the biggest global threat to human rights we've seen in our lifetime'.[8] Communities and countries hit hardest by the crisis are typically those which have contributed the least to it. By far, the greatest contributors to greenhouse gas emissions are long industrialised countries and the energy sector, especially fossil fuel producers. Key to addressing the climate crisis is mitigation – actions to avoid further greenhouse gas emissions, adaptation – building resilience to cope with the changes resulting from climate change, and reparations –calls for those most responsible for the climate crisis to remedy the loss and damage they have caused or contributed to.[9]

Oxfam Australia has written about the connection between climate, energy and poverty, noting that 'moving from fossil fuels to renewable energy is fundamental to ending poverty'.[10] It further notes that 'achieving universal access to affordable, reliable and clean energy is fundamental to ending global poverty.'[11] It highlights that, globally, 84% of energy-poor households live in rural areas far from the grid and that having access to cleaner fuels and more efficient stoves could also reduce air pollution and save lives. In 2022, the International Energy Agency has noted that while carbon dioxide emissions from fossil fuels are continuing to rise, new electricity generation is now being led by solar and wind.[12]

The climate crisis is already impacting Papua New Guinea. Many people in PNG have lived experience of these changes. Papua New Guineans are observing how shifts in the weather and the oceans are affecting humans, animals and landscapes, and changing everyday life such as growing food, access to drinking water, fishing, incomes, housing and kastom. As Papua New Guineans learn more about climate change, an increasing number of communities and government officials are interested in low carbon approaches of development.

> *"When the stormy weather sets in, we don't sleep at night. We sit up all night to keep watch in case the strong winds and rough seas destroy our houses. We also find it difficult to source food during the bad weather because it's difficult for us to paddle across to the bigger islands to buy food. Most times, whatever little food we gather is saved for the children and we adults can live on one meal per day." Samuel Gawa, a community leader on Upuas Island, New Ireland province.*
>
> **FROM 'CHANGING CLIMATE, CHANGING HOMES FOR ISLANDERS IN PAPUA NEW GUINEA'.[13]**

> *"The sea that we love, where we catch our fish every day and the island that we love because we grow up on that land - it's completely changing [and so are] our lives."*
>
> **URSULA RAKOVA, EXECUTIVE DIRECTOR OF TULELE PEISA, CARTERET ISLANDS. AS TOLD TO CARITAS[14]**

> *"Before, in the time of the bubus [grandparents], tides were their calendar and seasons. Now this isn't working like before. The tides don't follow the same patterns. The same is happening with the gardens and the times for planting."*
>
> **PEARCE, LAND-OWNER AND COMMUNITY LEADER, SILOSILO, MILNE BAY PROVINCE. AS QUOTED BY VISITING ACADEMICS.[15]**

"A lot of the beachfront has been washed away, the river banks have opened up, a lot of mangroves are now gone – much has been harvested by village people for firewood purposes and some of it has been washed away by the effects of the storms and rough seas... People have to look for land and go and put their homes on land. My village is one of those villages that stands on stilts and people have come to be accustomed to living over water. With our climate weather changes, the sea rising and the beachfront being driven further back people are left with no option but they just have to cope with the changes."

NANAI ARIAVAGO, FORMER COUNCILLOR OF GABAGABA VILLAGE, CENTRAL PROVINCE. FROM NEXTGENERATION RADIO[16]

"My village Veraibari, for half the year and especially between the months of June and August, we face the flooding Kikori River, the winds of the season and the wave action this causes. We are relocating our village for the fifth time in our history because of the rising sea and the destruction caused by waves."

ERIC WAREGE, COUNCILOR OF VERAIBARI VILLAGE, GULF PROVINCE. FROM 'CLIMATE CHANGE IMPACTS IN THE KIKORI RIVER DELTA'.[17]

B. THE ECONOMIC IMPACT OF CLIMATE CHANGE ON PNG

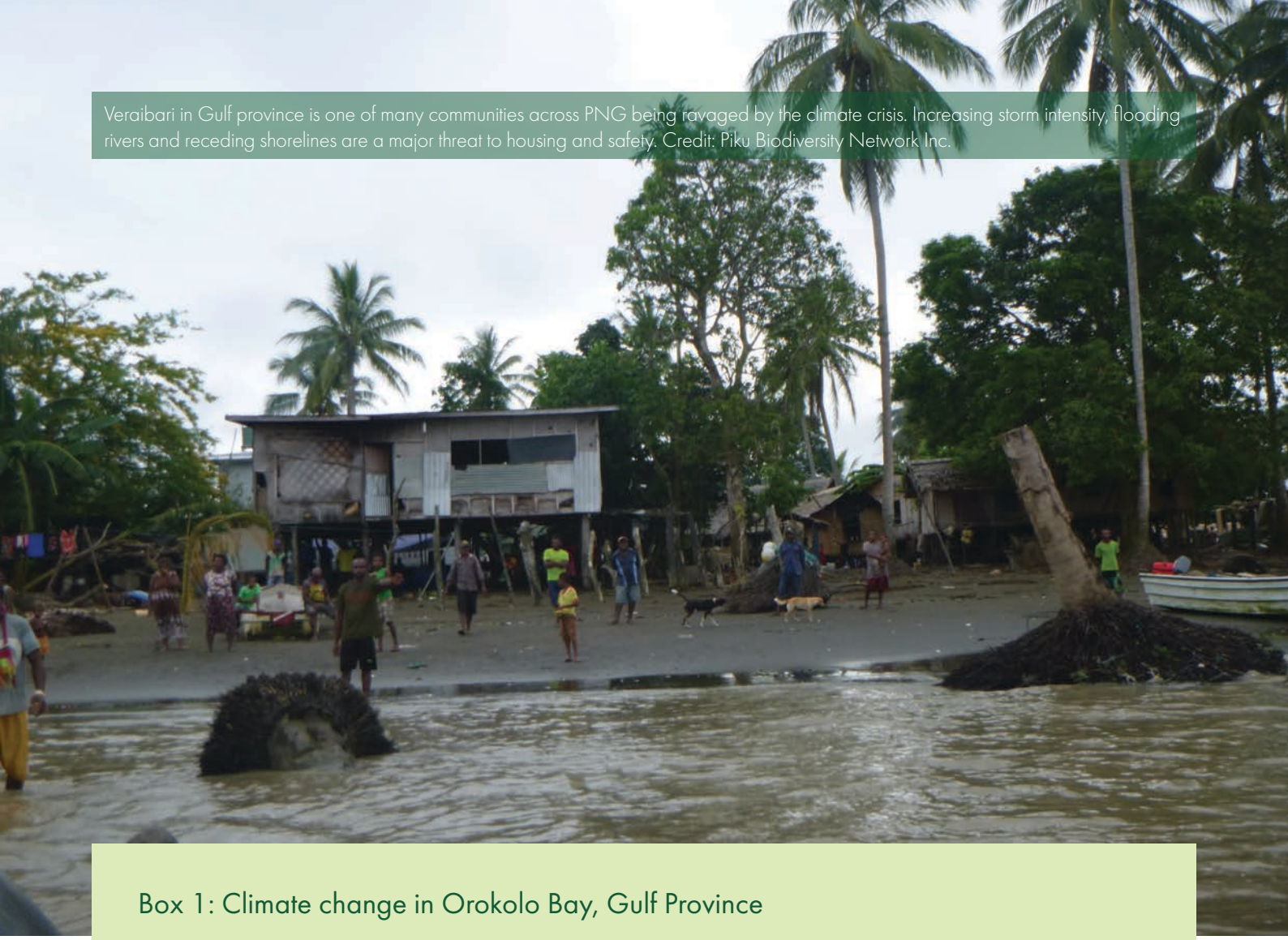
Each year, climate change is impacting thousands of people in PNG and costing tens of millions of dollars through increased natural disasters and impacts on agriculture and fishing.[18] Almost a decade ago, Asian Development Bank (ADB) climate projections estimated that by 2100 PNG could face an annual 15.2% loss in GDP.[19] The government has stated that the damage to water resources of a projected 2-4 degree Celsius rise in temperature is estimated to cause economic losses of USD$1 billion a year.[20] In 2022, the world mean temperature is already almost 1.2C above pre-industrial levels.[21] In a high emissions scenario, by 2090 PNG's temperatures could face a catastrophic increase of up to 3.4C.[22]

PNG, like almost all developing nations, bears little responsibility for the emissions that are placing the country under severe climate stress. Nevertheless, PNG has committed to address its own emissions, and there are two excellent reasons why PNG might want to do so. First, PNG is a leader in the region, and were PNG to implement low carbon development, it would inspire other Pacific neighbours to do the same. Moreover, it would help pressure larger neighbours (such as Australia and Indonesia) that are high emitters - and in Australia's case, the number one exporter of coal and gas in the world - of the need to quickly decarbonise and to severely reduce and ultimately phase-out fossil fuel exports.

C. PNG'S CLIMATE AND ENERGY TARGETS

PNG is well-versed in understanding the threats of climate change to its land, people and economy. PNG has a high literacy and sophisticated understanding of the climate crisis. PNG is ahead of many others in understanding it as an existential threat to day-to-day life but also an opportunity to re-tool development processes to better serve people and planet. PNG, alongside its island neighbours, is globally recognized as part of the Pacific islands international leadership in sounding the alarm on the climate crisis and calling for urgent action. In July 2022, the Pacific Island Forum leaders:

reconfirmed that climate change remains the single greatest existential threat facing the Blue Pacific, underscoring the urgency to limit global warming to 1.5 degrees through rapid, deep and sustained reductions in greenhouse gas emissions. In this respect, Leaders declared that the Pacific is facing a Climate Emergency that threatens the livelihoods, security and wellbeing of its people and ecosystems, backed by the latest science and the daily lived realities in Pacific communities.[23]



Veraibari in Gulf province is one of many communities across PNG being ravaged by the climate crisis. Increasing storm intensity, flooding rivers and receding shorelines are a major threat to housing and safety. Credit: Piku Biodiversity Network Inc.

Box 1: Climate change in Orokolo Bay, Gulf Province

The Orokolo Bay is situated along the coastal area of the Kikori district, in the Gulf Province of Papua New Guinea. In the course of its work, community legal organisation Centre for Environmental Law and Community Rights (CELCOR) has recently been visiting a community situated along the coast and between the mouths of two large rivers, the Vailala on the east and the Purari on the west. The community is landlocked, meaning no access roads. It is only accessible by sea travel or walking through the terrain in which the water table is very high, due to its location between two tributaries and smaller rivers and creeks. The main sources of food are sago, which can grow in swampy/high water tabled areas, and the marine food sources from the ocean and rivers. However not many other alternate crops can grow there. Fresh drinkable water is accessible through colonial-built water wells and rainwater. The main source of revenue is the betelnut and sago trade which locals take to the main town of Kerema, about two hours boat ride away.

Locals have observed over decades the receding of their shoreline which previously, stretched out at least two kilometres from where it is today. This area - rich in biodiversity, tributaries, flora, fauna and marine life — is now largely underwater. Even visiting CELCOR staff have observed the exponential rate of sea level rise and loss of buffer mangroves along the coastline due to coastal erosion within a 1-year period. Mangrove species at the forefront of the shoreline are in a decaying state due to the rising seas washing away the coastline. This threatens to bring saltwater inundation of the freshwater supply. Storms on the ocean are becoming more severe and unpredictable. In response, there is now migration from the coastline further inland.

The people of Orokolo Bay are also in a dire situation as the Ihu LLG (of which they are a part) is very rich in natural resources such as petroleum, and iron ore sand, coal and gas. There is much interest in extracting raw resources from their land with some projects being permitted and granted licenses already. Locals now fear that they will now have no place to migrate inland if needed, as their traditional land has been licensed for mining by Mayur Resources Ltd and earmarked for another project the Ihu Special Economic Zone.



Climate change and environmental sustainability are inherent in many of PNG's key planning documents. For example, they are one of seven strategic focus areas of PNG Vision 2050.[24] Climate change is one of eleven cross-cutting policies of the Papua New Guinea Development Strategy Plan 2010-2030.[25] PNG also has a comprehensive roadmap of 30 priority actions to implement between 2020 and 2030 to achieve Target 13 of the Sustainable Development Goals, which focused on climate action.[26] Five of these actions relate to climate governance, showing a sophisticated understanding of the role that investment, budgeting, planning and capacity-building play in acting on climate change.

Several years ago, PNG created the Climate Change and Development Authority (CCDA) which has taken a strong lead in addressing PNG's carbon emissions and meeting its Nationally Determined Contributions (NDCs) – its targets to meet its obligations under the Paris Agreement. The CCDA helped set an ambitious target to have 78% of PNG's grid electricity provided by renewable energy (at the moment renewables, via hydropower and geothermal, provide just under half of PNG's grid electricity). These proposed renewable energy projects align with PNG's broader targets to rapidly expand household access to electricity. This aims to see the percentage of PNG households with on-grid electricity raised to 70% by 2030, from approximately 13-15%. PNG Power Ltd (PPL) has noted that this target will require a seven-fold expansion of its customer base.[27]

In 2021, the PNG National Energy Authority (NEA) was established and it will play an increasingly pivotal role in creating the policy and regulatory frameworks governing the renewable energy sector, and power generation more broadly. It already has work underway to develop key regulations relevant to renewable energy, such as on small power systems and specific renewable energy sectors.

In addition to the planned and proposed renewable energy projects identified by government, there are a variety of independent businesses and non-government organisations working on expanding off-grid renewable energy. This spans everything from selling off-grid solar appliances, to incorporating renewable energy into rural livelihood programs.

In the early years of independence, Papua New Guinea was a leader in renewable energy. Its current use of diesel or fossil gas is not inevitable and strong planning could ensure a clear low carbon pathway for energy sector development. (Fossil gas is a term that may refer to gas or natural gas, or treated products such as Liquified Natural Gas. The term 'fossil gas' is used in this paper to distinguish it from gas produced from other sources, such as biogas.)

CONCLUSION

This section has outlined the risks and impacts communities across PNG and its economy more broadly are already facing as a result of a climate crisis that PNG did little to cause. It has shown that the PNG government has engaged thoughtfully with the issue of climate change, and sought to be seen as a climate leader on the international stage. This outlines the motivations that PNG has to invest in an energy policy that aligns with its climate outcomes. The following section gives an overview of relevant aspects of the state of play on energy issues in PNG.



Chuuk Lagoon - Weno - Micronesia - Marek Okon

TIMELINE OF KEY PNG AND INTERNATIONAL CLIMATE AND ENERGY MILESTONES

Year	Policy	Note
2009	Vision 2050	Outlines PNG's long-term strategy in seven focus areas. This includes setting a target for 100% of power generation to come from renewable energy by 2050.
2015	Sustainable Development Goals	The international SDGs are agreed and PNG then works to adopt them in its development planning. This includes a dedicated target on climate action.
2015	Intended Nationally Determined Contributions	PNG becomes one of the first countries in the world to submit an intended NDC ahead of the Paris Agreement being finalised. This states that PNG aims for 100% of its electricity to be produced from renewable energy by 2030. A target that is later revised down to 78%.
2015	Paris Agreement	A formative international treaty is agreed to address climate change. Countries will then set out their climate plans and commitments through five-yearly Nationally Determined Contributions.
2015	Climate Change (Management) Act 2015	This establishes PNG's Climate Change Development Authority.
2016	United Nations Paris Agreement (Implementation) Act	Passed in 2016, this provides the legal basis for PNG setting and implementing its Nationally Determined Contributions and climate targets.
	National Energy Policy 2017-2027	Aligns with the goals of Vision 2050 and draws support from NEROP. Also identifies the need to create a National Energy Authority.
2017	Preparation for the National Electrification Rollout Plan	Led by GoPNG, this was part of efforts to design a plan to reform and expand the electricity sector. This includes detailed spatial analysis of existing infrastructure and population distribution, as well as options to expand or intensify existing electricity grids.
2018	PNG Electrification Partnership	The 2018 Asia-Pacific Economic Cooperation (APEC) meeting is hosted in PNG. At the meeting, an electrification partnership is agreed with Australia, the United States, New Zealand and Japan to support PNG in its goal of electrification of 70% of households by 2030. This resulted in the creation of the PEP.
2019	National Electrification Rollout Plan Implementation Strategy and Investment Plan	
2020	Revised Enhanced NDC 2020[28]	PNG's 2nd Nationally Determined Contribution outlining further steps it will take to address climate change. This includes several energy-related actions.
2021	National Energy Authority Act[29]	The National Energy Authority is established in PNG.
2021	International Energy Agency Net Zero by 2050 report	This landmark report by the foremost international body on energy policy highlights that climate expectations are now mainstreamed into international energy policy. This sends a strong market and policy signal on the need to rapidly phase out fossil fuels.


Gas flaring

3. TAKING STOCK: THE STATE OF PLAY ON ENERGY

A. AN OVERVIEW OF ON-GRID ELECTRICITY

On-grid generation is managed by the state-owned enterprise PNG Power Limited (PPL), which is also responsible for managing electricity retailing. PPL manages approximately 300 MW of installed generation capacity.[30] Additionally, PPL has agreed contracts to buy energy from Independent Power Producers (IPP) who operate within 10 kilometres of its exclusive zone. Energy generated by IPPs may come from various sources.

PPL manages three major grids in PNG: Port Moresby, Ramu and Gazelle. The Port Moresby system serves the National Capital District and Central Province, the Ramu system serves most of the towns and centres on the mainland, including Lae, Madang, Goroka, Mount Hagen, Kainantu, Kundiawa, Yonki, Mendi and Wabag and the Gazelle system serves East New Britain Province.

As well as managing the three major grid systems, PPL manages 16 mini-grid based systems. 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, which mostly run on diesel. The 9 backup substations are on the Ramu system and peak load diesel- based power plants. 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 plantation sites). The mix includes hydropower (230 MW or 39.7%), diesel (217 MW or 37.4%), fossil gas-fired (82 MW or 14.1%) and geothermal (53 MW or 9.1%). In addition, hospitals, clinics and other facilities may have their own energy supplies.

It has also been identified that challenges in the stability and reliability of electricity access may lead individuals or organisations to use back-up diesel generations or even diesel generators full time. In addition, it appears that several major corporations in Port Moresby and Lae have gone off-grid in recent years which may also impact revenues for PPL.[31]

B. PNG IS COMMITTED TO MOVING AWAY FROM DIESEL POWER

Diesel fuel currently provides around 37.5 per cent of energy to the PNG grid. But diesel is a costly way to produce energy, particularly in comparison to renewables. Even when oil prices are low, there in the ongoing costs of acquiring fuel for the generators. Moreover, oil prices fluctuate widely, no more so than at the moment as a result of the global disruption of the war in Ukraine. A key catalyst for re-thinking PNG's energy sector was the phase down of crude oil production, which slowed in 2009 and ended in 2015.[32] As the National Energy Policy (NEP) acknowledges 'there are a number of geo-political issues that affect the oil prices in the international scene...this fluctuation of the international prices has caused shocks to domestic petroleum prices'.[33] In 2022, the PNG government has had to intervene to address the domestic impacts of an international rise in crude oil prices, and this also appears to have impacted the power sector.[34] Covid-19 also disrupted and delayed international supply chains.

As will be outlined in later sections, energy policy discussions appear to widely acknowledge the high cost of diesel-based energy generation compared to other energy sources. Even as far back as 2015, an analysis from ANZ noted: 'for agricultural processing our estimates suggest energy from diesel generation is 150% more expensive than from biomass generators. Similarly, diesel is 50% more expensive than a twinned solar/storage setup in village settings. In regional centres – for example, Wewak – diesel generation is 20% more expensive than micro-hydro and 150% more expensive than biomass.'[35] As renewable energy costs continue to become cheaper these figures would be even more stark today.

Burning diesel is also extremely polluting, leading to health and environmental impacts. Air pollution from diesel generators contains more than 40 toxic air contaminants, including cancer-causing substances. Greater exposure to these pollutants can increase respiratory illness and cardiovascular disease. It can also cause acid rain that harms plant growth.[36]

The strong recognition by PNG government and others of the need for PNG to transition away from costly diesel energy should therefore come as no surprise. While there is strong support for renewable energy to surpass diesel, a question remainsr whether the government will encourage further fossil gas power generating infrastructure that would lock-in a portion of domestic energy consumption to fossil gas and the attached carbon emissions for years to come. As the NDC Implementation Plan on Electrification notes, retiring diesel generators without adding any other non-renewable sources of generation will be crucial to meeting the renewable energy target. At the time the NEP was passed – shortly after the international Paris Agreement – the NEP referenced several policy levers to seek out alternative technologies to diesel.

C. PNG HAS FOCUSED SIGNIFICANT ATTENTION ON IDENTIFYING RENEWABLE ENERGY OPTIONS

In 2015, PNG established a Climate Change and Development Authority which was mandated 'with the responsibility to contribute toward global efforts in mitigating greenhouse gas emissions, through low carbon development that fosters economic growth and social welfare for the people's wellbeing and prosperity'.[37] This includes implementing the Paris Agreement including 'any relevant obligations of the State' and to 'promote the management and sustainable development of climate change mitigation and adaptation actions'.

By 2030, the PNG government aims to see 78% of its installed on-grid electricity supply come from renewable energy and 100% from renewable energy by 2050.[38] This target is also written into PNG's climate commitments expressed internationally via its most recent Nationally Determined Contribution. The 2030 target has been revised down from its earlier target of 100% renewable energy by 2030.[39] This was due to electricity supply contracts for independent producers to supply energy to PPL extending beyond 2030 – locking in PNG to use these fossil fuels for years, as well as expanding the use of fossil gas.[40]

The CCDA has so-far identified 15 planned renewable energy projects (totalling 427.275 MW) and 21 proposed renewable energy projects (45.15 MW). Theoretically, if all proved viable, achieved landowner support and could be funded and implemented on time this could see up to 78% of PNG's projected on-grid electricity supply come from by renewables by 2030.[41] Even if all these projects do not go ahead, they show the viability of PNG adopting renewables at scale, and there are ongoing efforts by various stakeholders to identify further potential projects.

Table 1: Planned Renewable Energy Targets

	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	Samarai	Solar	0.075	PPL	UNDP, CCDA	2022	Short-Term
3	Naoro Brown	Hydro	80	Independent Power Producer	World Bank	2023	Short-Term
4	Edevu-PNG	Hydro	51	Independent Power Producer	TE PNG; China Gezhouba Group	2023	Short-Term
5	Ramazon	Hydro	3	PPL	Hydro	2022	Short-Term
6	Rouna Hydro-additional (R1 & STOD)	Hydro	8	PPL	Dongfang (Engineer)	2021	Short-Term
7	Lower Lake Hargy Hydro (Biala)	Hydro	2	PPL	PPL	2022	Short-Term
8	Markham 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 (de. on solar project)	Medium-Term
11	Baime (IPP)	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	Warangoi 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

From Climate Change and Development Authority, 'Papua New Guinea NDC Implementation Roadmap Electricity Sector', October 2021

Table 2: Proposed Renewable Energy Projects

	Project	Proposed Capacity (MW)	Technology	Supporting Agencies	Proposed Timeframe for Implementation	Budget (Million Kina)	Budget (Million USD)	Timeframe
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	Aitape 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	Alotau 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	Kavieng Solar PV + ESS	1.5	Solar	NEA/CCDA	2023-2025	8.0	1.0	Medium-Term
11	Gumini 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	Butaweng	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 biomas fuel plant (PPA has been signed)	2	Biomass	NEA/CCDA/PPL	2026-2030			Long-Term

From Climate Change and Development Authority, 'Papua New Guinea NDC Implementation Roadmap Electricity Sector', October 2021

D. A RENEWABLE ENERGY FUTURE FOR PNG IS HIGHLY VIABLE

Over recent years, many parts of PNG government, as well as other actors, have identified the clear opportunities and benefits that a renewable energy-based energy sector could bring. CCDA has played a particularly active role in this process.

In 2016, the National Energy Policy explored a range of renewable and non-renewable energies and technologies. In recent years, the PNG government and others appear to have largely focused on cementing and consolidating policy, planning and regulatory frameworks on select renewable technologies, particularly hydro and solar. This wisely uses sequencing to ensure that capacity is not spread too thin by focusing on too many technologies at once. This follows the advice provided by a 2017 APEC peer group assessment.[42] Other potential sources of renewable energies may include wind, biogas, geothermal, ocean currents or green hydrogen (which is separate to 'grey' or 'blue' hydrogen which is produced from fossil fuels).[43]

The 2021 PNG NDC Implementation Roadmap for the Electricity Sector identifies that key to meeting PNG's renewable energy targets within its broader electricity expansion targets are comprehensive renewable energy resource mapping and an overarching renewable energy policy. Mapping will initially focus on hydro, solar and wind. Responsibility for these actions will sit with the National Energy Authority.

The National Energy Policy identified the need for a National Energy Authority (NEA) to have oversight of PNG's energy planning and regulatory processes.[44] Since being established in 2021, the NEA has been paying clear attention

to renewable energy discussions and multiple NEA staff and representatives were part of PNG's 2022 delegation to international climate talks held in Egypt in November.[45] In addition to identifying on-grid sources, various groups are working on programs, initiatives or business activities to support off-grid access to renewable energy technologies.[46]

CONCLUSION

This section has outlined, in concrete ways, the various work that has already been done to show that a renewable energy future for PNG is possible, viable and preferable. It shows that the country does not need to lock-in dependency on fossil fuel energy for years, even decades to come, by committing to new fossil-fuel reliant energy generation – but that it can progress towards meeting its energy and climate targets by focusing on new renewable energy and maximising the best use of existing renewable energy sources. A legitimate question remains as to how PNG can finance identified planned and proposed renewable energy projects – which will be explored further in Section 5.



Solar photovoltaic panels installed on Mining Haus as part of a PPL trial.

Case Study: PPL pilot program of on-grid rooftop solar

PPL is currently undertaking a 12-month rooftop solar photovoltaic (PV) pilot program in the Port Moresby grid.[47] There are 10 participants in the program, mostly commercial and industry customers in the Port Moresby system. As part of the pilot, PPL has worked with the Mineral Resources Authority (MRA) to install a 150kW rooftop PV system at its office, Mining Haus in Konedobu in Port Moresby. The pilot program aims to trial a total capacity of 2MW and will help to inform the development of an On-Grid Solar PV Connections Guideline to guide the development of Solar PV grid connections initiatives across the PPL system and network.



Energy discussions can often overlook women's energy priorities, such as ways to make cooking safe and more efficient. Photo: FORCERT

Box 2: What are women's energy needs?

A key question to ask of energy policy is energy for what and for whom? Women and girls account for half of PNG's population but appear largely overlooked in energy policy planning. In many countries energy policy, access to energy, energy related businesses and energy-related employment is male-dominated. This also appears to be the trend in PNG.[48] Women play a broad array of roles in their communities from entrepreneurs, to skilled agricultural producers, consumers, carers and household managers. Women's perspectives on their energy needs and opportunities from the energy sector will similarly be diverse.

While some energy needs, such as the benefits of solar products for women and students, are often discussed, others are not.[49] For example, energy to pipe water into the village for drinking and cooking or more efficient stoves which use less firewood and are safer are frequently absent from energy discussions. This is despite the fact that decisions to act on, minimise or ignore these needs affect hundreds of thousands of women and their families every day. Similarly, the need to address the health impacts of energy generation is often overlooked. This ranges from interventions that can help improve kitchen/hut ventilation from firewood smoke to avoiding the harmful community impacts of fossil fuel extraction. Climate breakdown can also be associated with increased gender-based violence.[50] Much of the PNG government and others' planned roll-out of energy technologies, particularly electrification, is based on commercial principles. Supporting a range of options – including one-off purchases of technologies or no-cost or low-cost options – is particularly important to ensure that rural women have fair and equal energy access.

Building a fair and gender equitable approach requires re-tooling processes so that they are fully and equally accessible to women. This will require community-led energy approaches to meet women where they are, and to create processes for their involvement, planning and inclusion that is culturally and physically safe. At the other end of the spectrum, the NEA could show leadership by developing a gender policy or roadmap to create a clear, accountable and long-term pathway for gender equity in all aspects of climate and energy policy and practice.

It is vital to address gender bias, so that women have truly equal opportunities to develop skills, work opportunities and leadership roles in the newly emerging economic sectors associated with renewable energies. This should include, for example, exploring gender targets, public reporting on gender participation in energy policy, undertaking gender-specific research and profiling the expertise of women leaders (from engineers, to community trainers, to those initiating and pursuing community-led projects). It is also critical that not only are women invited into energy discussions, but that those working on energy issues also attend the places and discussions where women are already convening. For example, by attending discussions and workshops related to women's economic empowerment or rural gender programs.

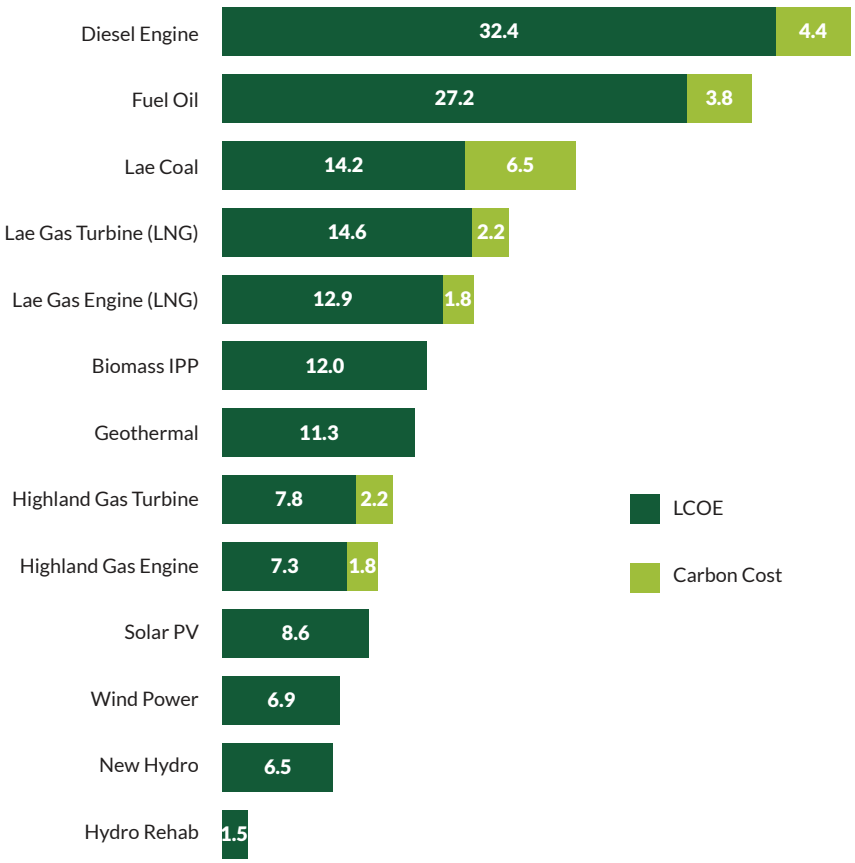
International research outlines the range of serious adverse impacts that women and girls face as a result of the climate crisis, and that they are more likely to consider sustainability in decision-making and can be particularly adversely impacted by fossil fuel projects.[51] This shows that ensuring that women and girls have a strong voice in energy processes is also key to maintaining momentum for PNG building a climate-friendly energy future.

4. PNG CAN TRANSITION DIRECTLY TO RENEWABLE ENERGY, WITH NO NEED TO LOCK-IN FOSSIL FUEL DEPENDENCY

A. RENEWABLES ARE CHEAPER THAN FOSSIL FUEL ALTERNATIVES

As outlined by a 2018 World Bank report and other research, the levelised cost of electricity for the Ramu and POM grids shows that energy generation costs for renewable energy are lower than fossil fuels – as seen in the graphic on the Ramu grid below.[52] While renewable energy generation overall may be cheaper in PNG, it can face larger upfront costs. This can be seen, for example, at the household level with the purchasing cost of a diesel generator lower than renewable energy alternatives. The World Bank and other analysis also shows that maintaining and rehabilitating existing hydroelectricity infrastructure is a highly effective cost and carbon efficient intervention. A recent climate change assessment of the PNG Power Sector Development Project estimates that poor maintenance of power lines is leading to lost efficiency of 2000 MWh annually, driving an estimated 589 tonnes of CO_2 per year.[53] While fossil gas costs have reduced since the period of World Bank's analysis as PNG expands fossil gas production, it is likely that renewable energy remains the most cost-effective option.

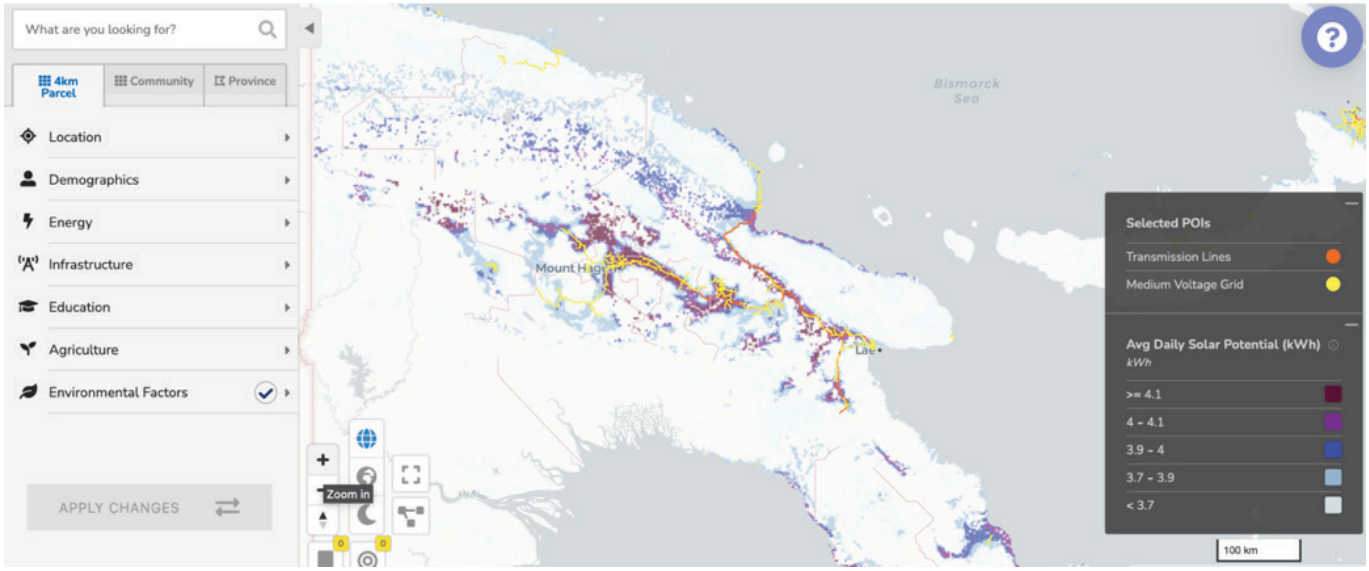
Figure 1: Levelised Cost of Electricity for the Ramu Grid (USC/KWh)



Source: The World Bank Group, Delivering Affordable, Sustainable and Reliable Power to Papua New Guineans, page 7.

The CCDA has already identified renewable energy projects that could, if all implemented, see 78% of PNG's on-grid energy be supplied by renewable energy. Even if not all projects are implemented, they show the viability of a renewable energy future and it is hoped that future work by the NEA to comprehensively map renewable energy sources could further expand and identify opportunities. This highlights that PNG can viably make the direct transition to renewable energy sources, without having to lock-in large-scale infrastructure on fossil gas. As explored in the following sections, a key risk to PNG's renewable energy future is that it will be undermined or over-shadowed by locking-in fossil fuel energy dependency – particularly fossil gas – through costly new infrastructure.

Figure 2: Level of Electrification vs Solar Potential



The PNG Electrification GIS Platform is one example of efforts to better collate and share information to help identify renewable energy potential. Image source: GIS

B. KEEP IT IN THE GROUND: THE SCIENTIFIC CONSENSUS

Since the 2015 Paris Agreement, and even before, there has been a rapid expansion in scientific and policy knowledge about the far-reaching impacts of climate change, what is required for a just transition and the factors that have slowed or prevented action internationally. In 2021 the International Energy Agency – one of the foremost international bodies on energy policy – issued a landmark report outlining that to achieve net zero emissions by 2050 requires that there be no new oil or fossil gas field developments.[54] This would include abandoning any current plans for new developments. This was perceived as a significant shift in the authority's policy, signalling the mainstreaming of climate expectations in energy discussions globally.

Coal

When it comes to coal, there is a significant scientific consensus that to meet international climate targets and commitments requires no new coal extraction and a phase out of existing coal infrastructure as a source of energy. Internationally, there has been a 76% drop in the number of new coal plants planned globally since the Paris Agreement was adopted in 2015. This equates to the cancellation of more than 1000 giga watts of new coal plants.[55] At the Glasgow 2021 climate talks dozens of countries, including emerging economies and small island states, made commitments to phase out, or end outright, their reliance on coal power.[56] Twenty-five countries and public finance institutions committed to ending international public support for the unabated fossil fuel energy sector by the end of 2022.[57]

The Nogat Coal campaign has opposed the development of a coal industry in PNG and highlighted the lack of Free, Prior and Informed Consent from local landowners and communities.[58] CELCOR has also highlighted the climate

science, noting that there is no such thing as 'clean coal'.[59] In July 2022, the National Energy Authority chairman was also reported as saying that he did not 'see the need for coal in PNG' as it was a dirty fuel and that 'we have many renewable sources of energy'.[60] As seen in the case of coal, the efforts of fossil fuel companies to try to convince PNG to commit to costly and harmful reliance on fossil fuels at the very moment when other countries are abandoning them show the importance of vigilance and evidence-based decision-making in energy policy. Wisely, it appears unlikely that PNG will pursue coal developments in the future as there is increased awareness of coal's poor environmental, social and economic viability (see Box 3).

Fossil gas

"Coal was once touted as clean, and we confronted this major myth. Gas as clean and as a transition fuel is another myth tailored to the interest of the industry."

GERRY ARANCES, CENTER FOR ENERGY, ECOLOGY AND DEVELOPMENT, THE PHILIPPINES[61]

Today, there is also widespread international scientific acknowledgement over the dangers of fossil gas for the climate. This notes that climate emissions of fossil gas have been largely underestimated. Fossil gas consists largely of methane. The contribution of methane to global warming potential is up to 87 times greater than CO2 (carbon dioxide) in the first 20 years after emission, up to 36 times greater in the first 100 years.[62] Today rapidly addressing methane emissions is increasingly seen as a critical part of climate mitigation efforts. Research shows that investments in fossil gas infrastructure, alongside other measures, are not 'transitional' but lock-in dependency on fossil gas for decades to come.

As noted in a recent June 2022 paper examining the science on fossil gas: 'In the public discourse, natural gas is often described as a climate-friendly alternative to coal that has a much lower negative climate impact than that of other fossil fuels. In fact, several studies show that this is only true under certain conditions and that the differences in climate impacts are small and depend on various factors.'[63] Adding that 'the latest research on methane emissions related to natural gas production and transport has found that the actual methane leakage rates far exceed previous estimates'. Some studies in Canada and the United States found methane emissions related to the oil and gas sector to be underestimated by 50-60%.[64] Globally, the leakage rate at which fossil gas escapes into the atmosphere before being burned is 2.2%, in some cases the rate can be many times higher. The difference between greenhouse gas emissions from fossil gas and coal emissions become marginal at leakage rates around 3.2%.[65]

C. SOME PROPONENTS ARE TRYING TO LOCK-IN PNG CONSUMERS TO FOSSIL FUELS

Despite the science, fossil fuel companies are resisting PNG's move away from fossil fuels. For example, the future outlook and planning of ExxonMobil – which operates in PNG –predicts that in 2050 fossil fuels will still provide over 70% of the world's primary energy.[66] Such an expansion would be completely inconsistent with the Paris Agreement climate goals of limiting temperature increases to 1.5°C. Instead, the expansion would allow a dangerous level of permissible emissions that would see global temperature rises to 2.7°C by 2100. A separate report outlines the various loopholes in the company's 'net zero' commitments, highlighting that in 2021 only 0.16% of the company's capital expenditure was spent on low carbon investments.[67] At the very least, this shows a mismatch between the company's goals and many countries' – including PNG's – climate aspirations.

In 2019, a power purchase agreement was signed between PPL and NiuPower related to a new 58 MW gas-fired power plant near Port Moresby. Development of the plant began in 2017, as it is self-described as PNG's 'first grid-connected gas-fired power plant'.[68] NiuPower was established in 2017 as a power generation company and is jointly owned by Kumul Petroleum Holdings and Oil Search Power Holdings Limited. Gas is sourced from the ExxonMobil PNG Limited operated PNG LNG project.[69] In addition, a 66MW fossil gas-fired power plant will be built in Hela province, drawing its gas from the nearby ExxonMobil gas conditioning plant.[70] Twenty20 have also signed a 20-year operations and maintenance contract - meaning that once the power plant is built it will be maintained for at least two more

decades, locking in PNG to gas-fired power to at least 2042. The 66MW gas-fired power plant will be built adjacent to the ExxonMobil Hides gas conditioning plant from where it will receive all gas supplies.

Research points increasingly to the fact that the narratives around fossil gas as a 'bridging' or 'transition fuel' did not arise from a lack of research, but were deliberately developed and promoted by fossil fuel interests.[71] At the international level, financial media such as Bloomberg have also slammed TotalEnergies - which operates in PNG - using such harmful greenwashing tactics as 'carbon neutral' fossil gas, which does not stack up in practice.[72] The Nogat Coal alliance have also warned that the expansion of fossil fuel extraction and power generation undermines PNG's actions on climate change.[73]

> *'Carbon lock-in mechanisms can, for instance, be of an infrastructural, institutional or behavioural nature. As gas pipelines, LNG terminals and gas-fired power plants have a technical lifetime of several decades, they pose a particularly great risk for carbon lock-ins.'*[74]
>
> **CLAUDIA KEMFERT, ET AL, 'THE EXPANSION OF NATURAL GAS INFRASTRUCTURE PUTS ENERGY TRANSITIONS AT RISK'. *NATURE ENERGY*.**

A potential risk to renewable energy expansion in PNG is that renewable energy may become 'locked-out' of markets or be less attractive to financing because fossil gas has already been 'locked-in'. For example, this could happen through the long-term contracting of the proposed Hela province gas-fired power plant that appears to extend to at least 2042.

Massive fossil gas expansion can also hinder renewable energy developments by poaching skilled workers. Solar industry experts have remarked that many people with technical skills have been recruited to work in PNG's fossil gas industry – exacerbating a skills shortage in a variety of areas, including those related to renewable energy.[75]

There is also a large difference between providing fossil gas to service pre-existing facilities, compared to planning to build new infrastructure that would lock in PNG dependency on fossil fuels for years to come. Sadly, research undertaken a decade ago predicted many of the harms to the country and local communities that have come to pass with the launch of huge fossil gas projects in PNG.[76] Research undertaken in 2018 suggests that the much-vaunted claims that the PNG LNG project would lead to a doubling of GDP did not materialise; on the contrary PNG had actually gone backwards on most economic indicators that relate to standard of living and livelihoods.[77]

D. OFFSETS

An aspect of PNG's NDC energy targets not so far explored in this paper is its action target on creating a framework for fossil fuels emissions offsetting. Exploring offsets is beyond the remit of this paper, beyond a brief note. There are nuanced and complex discussions about how to support fair and sufficient livelihoods for communities who protect and conserve PNG's critical rainforests and biodiversity. However, the UN Environment Programme has clearly warned that 'offsets are not our get-out-of-jail free card'.[78] At best, where there is climate action already underway, transitions to renewable energy in train and if companies have taken every possible step to reduce their emissions - such programs to store carbon can be seen as part of this transition commitment. However, PNG should be extremely wary of the misuse of offsets as a tactic to allay fears around, or even encourage, building new climate-harmful infrastructure that will tie PNG to fossil fuel dependence for its energy supply for years to come. For example, companies have used very concerning claims surrounding 'offsets' to justify pursuing new coal extraction in PNG, at a time where there is a widespread international discussion on the need to end coal extraction and production entirely. Moreover, strong research now exists to show that pursuing such projects could lead to assets being stranded i.e. infrastructure being abandoned or failing to provide a return on its investment, due to the overproduction of energy from harmful sources. Such tactics are often described as 'greenwashing' – i.e. tricking people into thinking a company's environmental practices are better than they are.

Various international analyses show that many projects that claim that carbon can be 'captured' in perpetuity do not hold up in practice (for example, due to carbon-capturing trees being logged, dying due to wildfires or simply dying with age).[79] In developing its offsetting framework, PNG has the opportunity to draw on the sizable evidence and scientific base regarding offsetting.

E. THE ALARMING TRACK RECORD OF FOSSIL FUEL COMPANIES IN UNDERMINING CLIMATE ACTION THROUGH DISINFORMATION AND LOBBYING

At the international level, new investigations have revealed the sophisticated PR strategies of fossil fuels companies to best advocate for their own interests and businesses, including in distracting from science-based policy and targets. These span efforts dating back many decades, including the activities of the fossil fuel backed 'Global Climate Coalition' in the early 1990s, to fossil fuel lobbyists attendance at the 2021 Glasgow climate talks outnumbering any national country delegation – with 503 lobbyists taking part. This was almost five times the size of PNG's delegation. In 2021, the United States' House Committee on Oversight and Reform began an investigation into the fossil fuel industry's role in climate misinformation. Their findings detail the various ways that fossil fuel companies have misled the public and continue to do so.[80]

In the U.S., states and cities are taking at least 20 legal actions against fossil fuel companies alleging that they misled the public on climate change.[81] Cases in other countries are expected to follow. NGOs and shareholders are taking similar legal cases against fossil fuel companies in countries such as France and Australia.[82] These legal developments include actions against fossil fuel companies that also have operations in PNG such as TotalEnergies, ExxonMobil and Santos.[83]

> *"Now nothing could be more clear or present than the danger of fossil fuel expansion. Even in the short-term, it doesn't make political or economic sense. Yet we seem trapped in a world where fossil fuel producers and financiers have humanity by the throat. For decades, many in the fossil fuel industry have invested heavily in pseudo-science and public relations – with a false narrative to minimise their responsibility for climate change and undermine ambitious climate policies. They exploited precisely the same scandalous tactics as Big Tobacco decades before...The argument of putting climate action aside to deal with domestic problems also rings hollow. Had we invested earlier and massively in renewable energy, we would not find ourselves once again at the mercy of unstable fossil fuel markets...Wind, sun and tides never run out. If we can successfully replace finite, polluting fossil fuels with infinite renewable resources, we can make the energy equation add up. We can put stable prices and sustainable economic growth within reach. These renewable energy sources are already cheaper than fossil fuels and create three times more jobs. Renewables not only fight the climate crisis, they support energy security."*
>
> **UN SECRETARY GENERAL ANTÓNIO GUTERRES[84]**

As in many other parts of the world, fossil fuel companies in PNG are active in amplifying their interests and seeking to gain the attention of policy makers. For example, ExxonMobil sits on the board, or leads, the Business Council of PNG, the Australia-PNG Business Council and the American Chamber of Commerce Coral Sea.[85] Similarly, in its promotional material the PNG 2022 Energy Summit offers the ability for participants to 'gain direct access to key government officials in the PNG energy industry'. The summit program is dominated by discussions about fossil gas. The US embassy has also actively supported the creation of the Coral Sea Chamber of Commerce - now headed by ExxonMobil - through a USAID program, and heavily marketed the company at embassy events. These efforts to promote, market and amplify fossil gas in PNG are disproportionate with the role that fossil gas is currently envisaged to have in PNG's 2030 energy goals, with fossil gas expected to have no significant role in energy supply by 2050.

CONCLUSION

PNG decision-makers should be wary of claims, not backed by science, which serve to justify locking-in PNG dependency on fossil fuels for decades to come. This not only exacerbates the risks to PNG's people and nature from the climate crisis, it also risks undermining and losing momentum for a true renewable energy future.

As we have seen, the CCDA appears to be playing an active role in liaising with various government departments in the energy sector, and helping to highlight and promote electrification via renewable energy. This shows that it is viable for PNG to directly transition from diesel fuel to renewable energy with no need for building or buying from new fossil gas-related infrastructure. The NEA also has the option to draw on, and learn from, experience overseas to ensure that PNG's policy and regulation frameworks are evidence-based, alert to the need to scrutinize fossil fuel company claims and efforts to shape national policy debates.



Coal plant

Box 3: The health impacts of fossil fuels

In June 2022, the international Centre for Research on Energy and Clean Air published an analysis of the potential health impacts of a proposal to build PNG's first coal-fired power plant in Lae.[86] This proposal anticipated having an initial 52MW capacity before expanding to 200MW. The analysis was based on the average life of a coal-fired plant in the region, which is 30 years.

If the plant were allowed to operate for 30 years, the impact of cumulative air pollution at 52MW capacity would include 30 premature deaths due to pollution increasing heart disease, diabetes, stroke, lung disease and other illness. Researchers estimate that there would be 25 cases of asthma in children, 890 years of life lost and 5,900 days of work absence taken due to sickness. At 200MW capacity, this would increase to 115 premature deaths, 100 new cases of asthma in children, 3,500 years of lives lost and 23,500 days of work absences. The air pollution would also have an economic cost due to increased healthcare spending and loss of economic productivity. At 52MW, this would be an estimated USD 7.5 million over 30 years, if the plant expanded to 200MW this would total USD 30 million – more than PNG's entire GDP in 2020. All this will be avoided if the plant is not built.

Based on their modelling, researchers estimated that an area of approximately 3.1 square kilometres with a population of 3,200 would be affected by potentially dangerous mercury depositions each year. At 200MW, this would expand to 12,100 people and 24.6 square kilometres of forests, waterways and farmland exposed. This does not include possible leakages or accidental discharges. At 52MW capacity the power plant was estimated to emit approximately 210 tons of sulfur dioxide, 460 tons of nitrogen oxides and 90 tons of particulate matter every year, with a roughly four-fold increase of each if capacity expanded to 200MW.

5. FINANCING PNG'S RENEWABLE ENERGY FUTURE

PNG's ability to realise a renewable energy future will depend largely on its capacity to secure financing for identified projects. As the NEP recognises, 'the development of the renewable energy sector requires investment to reshape the future energy mix, reduce the current volume of oil imports and address energy security'.[87] This has also been reaffirmed in PNG's revised 2020 NDC targets. In 2021, the CCDA noted that proposed renewable energy projects were in need of substantial support and required around K400 million in financing.[88]

This section seeks to examine key considerations for how PNG's renewable energy future can be financed. This seeks to take stock of what constraints should be taken into consideration, identify what types of financing arrangements are needed and then identify potential sources that can be further developed.

A. CURRENT FINANCIAL SITUATION OF PPL

Given PPL's central role in managing on-grid electrification, including transmission and retailing, the financial situation of PPL is highly relevant to considerations on what types of constraints should be taken into account in exploring financing options for renewable energy projects. PNG Power Ltd (PPL) is run on commercial principles and up to 97% of its gross revenues are generated from energy sales. The remaining 3% are derived from other revenues such as new metres and service fees, metre tests, reconnection and licence fees, and rental income.[89] The costs of supply power in some rural mini-grids is significantly higher than the electricity tariff PPL charges, with this difference being recovered from the main urban centres where costs are lower than the tariff.[90] The acting CEO of PPL previously noted that they hoped the situation to ease as new transmission lines allowed greater access to hydro and gas.[91]

2017 saw PPL face a drop in sales growth, with unbilled metered consumers in some areas contributing to this decline. Sales growth returned to previous levels in 2018. Energy sales growth averaged 3% annually over the 5 years to 2020. Increased costs such as significant increases in purchased electricity prices from independent power producers supplying into the grid, fuel costs and depreciation drove gross profits below 30% during 2018–2020.[92] This reiterates the economic benefits to PPL of shifting to cheaper and less financially volatile renewable energy sources. Maintenance activities are also critical to maximise benefits from existing infrastructure.[93] In 2020, PPL returned to positive earnings drawing on cost reduction strategies and improved billing efficiency.

In recent years there have been various efforts to help to improve the resilience and operations of PPL. This includes, for example, institutional reforms and strengthening and reducing its burden by transferring its regulatory functions to the National Energy Authority. Streamlining operations – for example, by proposing a streamlining of contract terms for Independent Power Producers who sell energy into the grid rather than individually negotiating each contract – is part of these efforts. Shifting regulatory and policy oversight functions to NEA may also bring greater benefits and focus to off-grid energy productions – as PPL did not generate revenue from these technologies it may have been harder to prioritise in its prior multi-functional role. PPL has also put significant emphasis on the additional burden that responding to unsolicited project proposals can take. This has likely driven the PNG government's efforts to proactively identify, and communicate priority renewable energy projects in order to attract financing. Development partners have also provided financing for various projects – such as the ADB's project to upgrade and extend power lines from the Ramu-Madang grid which will ensure that the whole grid is supplied by the Ramu-Madang hydro plant.[94]

Taken together, the above picture shows that, while progress in several areas has been made in recent years, PPL operates in a challenging economic environment especially in light of targets to massively expand on-grid electricity by 2030. It is clear that access to cheaper renewable energy sources and investing in maintenance would offer significant economic benefits to support PPL's operations. However, it also clear that the current structures and situation of PPL do not allow for a huge expansion of debt financing on commercial terms to finance new renewable energy infrastructure.

B. WHAT TYPES OF FINANCING WILL WORK BEST?

Financing is likely an issue for a broad array of other actors, not only PPL. This includes non-government organisations including renewable energy in their activities. The financing challenges for PPL also occur at a time where PNG faces a challenging financial context, particularly in light of the additional burden and instability of Covid-19. A September 2022 International Monetary Fund-World Bank analysis of debt sustainability lists PNG as at a high risk of debt distress.[95]

The development of the regulatory and policy environment for renewable energy in PNG will also provide the security and stability needed to help assist renewable energy businesses to invest in their business operations to further renewable energy provision. As will be discussed later in this paper, PNG communities, citizens and businesses themselves also invest every day in renewable energy products through their purchases – where accessible and fairly priced options are available.

Recent financing to PPL's renewable energy and grid consolidation processes has largely been provided by bilateral or multilateral loans, where the initial money and additional interest needs to be repaid. CCDA also notes that several planned projects - including PNG Biomass (Oil Search) and Edevu Hydro Project - have been driven by private sector actors in collaboration with central or provincial governments.

Based on PPL's current financial situation and debt ceiling, a question arises whether it – or the government more broadly – will face a natural limit on the extent to which it may be able to further borrow money with interest for expanding renewable energy infrastructure. This challenge is likely exacerbated by the additional uncertainty and costs generated through the Covid-19 pandemic.

The next section seeks to explore options for how to source finance for government-identified renewable energy projects.

C. FINANCING OPTIONS

Grant-based development finance

Much of the development finance for PNG's renewable energy sector, particularly government-identified priority projects, appears to be in the form of loans. It is clear that development partners are playing an important role in resourcing, supporting and proving the viability of a renewable energy future in PNG. Key development partners in the energy space include Australia, New Zealand, the United States, Japan, China, the ADB and the IFC. However, they should consider introducing, or expanding, their grant-based financing to ensure that PNG is able to finance its future renewable energy plans. A complementary step would be for countries to explore debt relief for previously funded renewable energy programs and to ensure that their own export finance programs are not used for fossil fuels. This avoids any further use of these programs to lock-in finance fossil fuel development in PNG.

Grant-based climate finance

It is clear that PNG is facing a debt ceiling in terms of its capacity to finance renewable energy projects and will need to prioritise grant-based financing. PNG should be able to receive grant-based or equity-based financing through international climate finance mechanisms. More broadly, there is critique of climate finance as being donor-driven and hard to access which is beyond the capacity of this paper to explore.[96] However, within the existing structures PNG CCDA can operate as a central point for coordinating efforts. The PNG NDC implementation roadmap for the electricity sector notes that in 2019 there was an assessment undertaken of options for strengthening climate finance coordination and accessibility in PNG. It observes that: '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.'[97] The roadmap urges CCDA, PPL and NEA to engage early on with the advisor to share project information and financing needs.

One such mechanism is the Green Climate Fund (GCF), 'the world's largest climate fund, mandated to support developing countries raise and realize their Nationally Determined Contributions ambitions towards low-emissions, climate resilient pathways'.[98] It is mandated to invest 50% of its resources to mitigation and 50% to adaptation. It can provide financing in various forms – such as grants, concessional debt (loans with lower interest rates than the market rate), guarantees or equity instruments. To date, only one project of USD $2.4 million has been financed by GCF in PNG.[99] By contrast, Fiji has secured funding of $50.6 million for projects.[100] CCDA is PNG's national designated authority to the GCF.

As of 2020, PNG has identified several priority projects to develop financing proposals for, with a view to submit individual proposals to GCF in the medium (2021-2023) or longer term (2023-2027).[101] This includes a proposed project for ten of the most drought-affected communities in the Oriomo-Bituri LLG of South Fly District in Western Province – which would integrate water supply and hybrid energy systems of up to 30MW per community. One proposal appears to focus on the development of the geothermal industry, particularly in New Britain and another on energy efficiency which appears to focus on large power customers. A third is focused on off-grid renewable energy development, such as trialling payment plan options for households and communities – citing providing the University of Papua New Guinea with a 1.5MW off-grid solar farm on campus. Another is focused on developing investment projects that could, for example, be co-financed by extractive industries – citing a 90MW Kaugel hydropower as a potential project and providing financing to New Britain Palm Oil Limited to develop biogas plants from its wastewater treatment processes. New Britain Palm Oil Ltd is a subsidiary of Sime Darby, a Malaysia-based company group which posted an annual profit in 2021-2022 of $251 million in its international operations.[102]

The first example listed appears to be a strong example of how PNG can use climate financing to integrate renewable energy into its climate adaptation work – focusing on concrete outcomes for climate-affected communities. However, several of these mitigation-focused proposals appear skewed towards government securing project or grant-based financing to subsidise projects by large foreign companies.

The NEA has also mentioned that it is considering the Global Environmental Facility as a funding option. The facility provides financing linked to the world's major international environmental agreements – and covers climate change adaptation and mitigation.[103] It is important for the government to align proposals with its own planning - such as in its NDC electricity sector implementation plan and climate adaptation work. A recent Jubilee Australia Research Centre and Caritas Oceania report focused on climate finance in the Pacific has also strongly recommended that climate funds should prioritise community-focused adaptation.[104] The NEA has also stressed the role that development partners and researchers in PNG can play in collating data and evidence to support project proposals.[105]

Guarantees

Another challenge perceived by business is that it may be unwilling to make large upfront investments in renewable energy projects because of an unreliable or unclear market environment. The work of the NEA and others to continue to develop regulations for the renewable energy industry will help contribute greater certainty. Avoiding any further commitments that would 'lock in' government to long-term use of fossil-gas power plants would likely also help to reassure business of the future of renewable energy markets. Another concern relates to potential Independent Power Producers – businesses wishing to build energy infrastructure to sell into the grid, which relies on securing a power purchasing agreement with PPL to buy the energy produced. The financial situation of PPL, and PNG more generally, is leading some businesses to hesitate to make such investments because of a perceived lack of security that a power purchasing agreement will be fully paid. One option that could be explored is for projects to apply to the Multilateral Investment Guarantee Agency – a member of the World Bank group – to secure a guarantee. The agency provides what it describes as 'political risk insurance' to safeguard against breach of contract, non-honouring of financial obligations, financial transfer restrictions and other factors.[106] This ensures that a business likely to profit from these activities is also responsible for managing its risks. By contrast, several experts have expressed strong opposition to any suggestion that the PNG government should bear financial responsibility for private-sector losses through providing a 'sovereign guarantee'.[107]

A related issue is to ensure that PPL itself is not financially over-committed to problematic projects or purchases. One concern raised is that some businesses are trying to press PPL to commit to power purchasing agreements that are highly financially disadvantageous – for example, by locking it into making power purchases many more times in excess of the power demand. One expert posited that Ramu 2 had tried to secure a purchasing agreement for PPL to buy 100% of power generated, with approximately 85% of this in excess of demand – which PPL did not adopt as it would have been an extreme financial risk.[108] Increased pro-active planning by the PNG government to identify its energy priorities, reduce unsolicited proposals and streamline purchasing agreements may assist with this. The Global Green Growth Institute has also cautioned that some mini-grid proposals rely on rural households having the means to purchase energy via PPL's uniform tariff, in such cases these are unlikely to prove financially viable and other options such as home solar installation are more feasible.[109]

More broadly, there is also a need to ensure that the NEA itself is adequately resourced and financed by PNG government. This is necessary for it to fully deliver on its mandate and so that the NEA becomes fully operational in 2023, rather than 2025 as is currently proposed.[110]

CONCLUSION

Financing is one of the key barriers that stands in the way of PNG scaling up its repair and roll-out of renewable energy technologies. While these challenges are daunting and complex, they are not insurmountable. Smaller-scale projects may also prove favourable – as these involve less upfront risks, are likely to have fewer environmental impacts and may be more attractive for those interested in grant-based financing.

Box 4: Not all renewable energy is equal

While fossil fuels produce generalised harm to all PNG citizens by exacerbating the climate crisis, they also cause very specific harms to the health of local people and to local environments. However, while renewable energy is favourable over fossil fuels, its environmental and social impacts can vary widely.

If planned carefully, it is possible for mini hydro projects to have minimal detrimental impact on a local river. However, a large hydroelectricity project can involve flooding large areas of land and high-biodiversity forests, drastically and irreparably damaging waterways and fish habitat, and cutting local people off from places important to their culture and livelihood.[111] In PNG, feasibility studies are currently underway into a mega dam hydro-project on the Purari river at a frighteningly large scale – with a capacity of 2500MW.[112]

Similarly, solar energy technologies require minerals such as nickel, copper and zinc. Mining these minerals is often environmentally harmful and can be socially exploitative.[113] Some companies are also proposing forms of mining such as deep seabed mining, which are extremely experimental and could put marine ecosystems at severe risk – which many in the Pacific have strongly opposed.[114] It is critical not to squander these materials and to promote solar units which are not only affordable but also long-lasting.[115] Experts have recommended for PNG to adopt international quality control standards for off-grid solar equipment.[116] While open market component-based solar systems are generally cheaper than plug-and-play options, these systems tend to have a high failure rate and are harder to install correctly. In its solar program, Tenkile Conservation Alliance is working to support community businesses that can source and supply spare parts, and set-up a recycling program so that precious metals can be reused.[117]

As PNG expands electrification it should aim for continuous learning about environmental and social impacts and best practice. More broadly, increasing energy efficiency and using less resources is also important. In some areas of PNG women are burning coconut husk for cooking and using stones to retain the heat, or burning shells.[118] They have found this to be more efficient than firewood, require less labour and create less smoke that is harmful to health. Increased electricity access can also contribute to local pollution, such as e-waste or light pollution. International research has found that light pollution is driving insect declines, impacting their capacity to reproduce and their lifespan.[119] Using red lights for street lighting could be one option to reduce these negative impacts.



Pollution from coal-fired power stations can have serious health impacts on local populations

Box 5: How can PNG skill up workers and communities to design, install or maintain renewable energy systems?

Key to supporting PNG's renewable energy future will be building community-level and professional-level expertise in designing, installing and maintaining renewable energy systems. The NEA has also acknowledged this issue and more broadly there are already various groups thinking through how to meet this challenge.[120]

Currently academics are working with PNG universities to build in renewable energy training into existing courses, such as those in engineering or science. They have prioritised universities as they are more centralised, making it quicker to influence courses. Although they are eager to work more with the technical and vocational education, as this is more practical and operate across provincial level. PNG Power Training College is also accredited to run training courses, which could play a role in addressing a shortage of specialist workers.[121] It provides electrical level 1, 2 and 3 training courses in-house and to companies. PNG Power also reports that females account for a significant portion of its engineering cohort.

An acknowledged challenge of city-based training and higher qualifications is that most skilled workers will choose to stay in or near cities. Community-level training is therefore key to building rural expertise and ensuring equal opportunities. Kumul Holdings has supported six rural women from West New Britain to attend the Barefoot College International in India.[122] The college's model could be highly instructive for PNG to learn from. It focuses on vocational and educational opportunities for women and girls from the most marginalized communities around the world. Internationally, it has trained 2,200 rural women to become solar engineers, even if they are illiterate or have no formal education, as they believe this builds rural resilience one village at a time. Its training programs use hand-on approaches and methods accessible to people who are not confident reading or do not share a common language. In Gulf Province, Piku Biodiversity Network is working with nine schools in the Gulf to do solar-based activities with students as part of science-based learnings. DFAT and USAID have also incorporated community-level training into its programs. The Global Green Growth institute has also worked in partnership with the CCDA and the Central Provincial Administration to train 750 people in rural communities – including 40% women – on green growth. This includes modules on solar and pico-hydro operations and maintenance basics.[123] All the training modules will be made publicly available online later this year.

6. EXPANDING OFF-GRID SOLUTIONS

A. HOW DOES ENERGY ACCESS DRIVE RURAL ENTERPRISE?

A key area of focus for energy agencies and development processes in PNG is the impact of energy access for economic development. However, the impact of energy access for rural enterprise and what forms of energy access are working best appear to be understudied. Existing research signals that there is much to be gained by working to better identify the economic and social benefits of rural energy access and the role that renewable energy, including off-grid options, can play.

For rural businesses and individuals, a lack of access to timely information has been found to contribute to missed income earning opportunities.[124] The combination of telecommunications services and energy to charge mobile phones is particularly important for rural business. A survey of 727 people across 7 provinces identified that mobile phones are playing a critical economic role. This survey noted that access to mobile phones has reduced business costs. Prior to having mobile phone access, rural businesses and individuals needed to make costly physical trips to towns to try to access phones – which may have been out of order. Rural enterprises, including farmers, are using their phones for mobile banking, including checking of balances, transferring funds, paying bills and topping up phone credits over the internet. Mobile phones are also key to identifying jobs or business opportunities.[125]

The research also noted that 'local farmers use mobile phones to coordinate delivery and sale of local fresh produce in markets. For example, in highland areas, farmers use mobile phones to coordinate potato production and transportation to attractive markets in the coastal cities of Lae and Port Moresby. Mobile phones help farmers to identify prices and demand conditions at major towns, and to finalise logistic decisions and supply quantum to those centres... On Bougainville Island, the main cash crops are cocoa and copra, whose prices fluctuate in response to external supply and demand conditions. Producers rely on market information gained via mobile phones to decide to which upstream buyer to sell their wet and dry beans. Upstream buyers also use mobile phones to attract producers by disseminating information on prices and incentives such as free nursery and packing bags among other accessories they offer. This exemplifies the bi-directional use of mobile phones by downstream and upstream cocoa and copra traders using up-to-date information, ensuring better deals.'[126] Hand-crank devices and other small devices to power mobile phones can therefore bring a critical economic benefit, especially where there is no other affordable or accessible energy generation options.

A 2022 recent report also described the range of off-grid renewable technologies that are being used to support income generating activities. It notes that according to 'the Brian Bell Group, one of PNG's leading distributors of solar products, has reported significant demand for solar sewing machines, refrigerators, and freezers. To date this demand reportedly has stemmed from small business owners like farmers, fishers and textile vendors. Some companies are starting to sell solar water pumps...for agriculture and solar poultry incubators...Meanwhile the company Agsol is supply solar-powered rice mills and processing equipment to farmers.'[127] These goods are mostly obtained through cash purchases.

The report also refers to the role that solar cold storage solutions play for rural healthcare services for storing medicines, blood and vaccines. Solar PB and battery storage could also provide reliable off-grid power. This may also help to reduce healthcare provision costs more broadly.

Communities and individuals – especially those in rural areas – are major investors in energy as a result of their lack of access to grid electricity. Everyday people in such communities make decisions about energy access – such as whether to buy a diesel generator, a solar-powered sewing machine or a solar powered torch. Understanding the needs and economic resources of communities, particularly those living in poverty or in remote and rural areas, is also key to PNG's energy future. For example, households may struggle to pay tariffs for on-grid electricity but may be able to make one-off purchases for household renewable energy products.[128]

As evidenced by CELCOR's work, and many others, decisions about land and water are also critical to determining PNG's energy future – both in consideration of non-renewable and renewable energy developments. Working with groups on land issues may include considering options that may appear more expensive in the short-term, but which

create ease, speed and security of renewable energy projects. For example, exploring on-roof solar options for rural renewable energy may be more easily welcomed by communities, as this does not involve a change in existing land use. Similarly, non-government organisations and local groups could play a role in helping to connect communities who are themselves eager for renewable energy projects in their area to relevant authorities. Also critical, is ensuring that local communities are fully and independently informed and educated on the environmental, social and economic impacts of non-renewable technologies.

B. PLANNING FOR RURAL ENERGY ACCESS

Strong planning processes will be key to identifying, prioritising and delivering improved energy access for the majority of PNG's population who live in remote and rural areas. This must include diverse stakeholders working together at the local, provincial and national level. Provincial governments play a particularly important role in energy planning, and in some cases may also contribute financing to capital expenditure costs. As in the case of planning and financing, the national government has established among other development strategies the Development Support Improvement Programme (SIP) for funding support to Provincial Government as PSIP, District as DSIP, and Local Level Governments as LLGSIP. The development support improvement programmes are to provide minimum service delivery standards through re-establishment of basic infrastructure and facilities to support infrastructures, health, education, law and justice, economic, and administration with a budgetary allocation of PGK15m per year. The provincial, districts and LLGs can utilise certain portion of the SIP allocations per year to support the cost of establishment and operation of a renewable energy project in their respective localities. There is a case example of such an arrangement where the West New Britain Provincial Government recently worked with the NGO FORCERT to fund two combination solar dryer fermentaries for two community cocoa businesses.[129] Due to PNG's geography and rural economy, off-grid options are certain to be the most accessible for many people.

The Global Green Growth Institute has also undertaken several provincial-level planning processes to help to bring together a range of stakeholders for green growth planning, including electricity access. The NEA has stated that it is also eager to coordinate at the provincial level, and to learn of the priorities and perspectives at community and provincial level, and notes that provincial perspectives can be vastly different on national energy policy issues.[130] International research has also found that linking local to national approaches to energy planning is critical to ensure energy justice.[131] For example, an energy justice approach would avoid projects that exploit poor or marginalized peoples by expecting unreasonable sacrifice by flooding their sacred sites or villages to create mega dams. Energy justice is also critical to ensure that energy planning does not overlook the rights of rural people or people on low incomes to have improved energy access. For example, ill feeling can arise if power lines run through local communities but they do not have electricity access – even if on-grid connections are not technically possible, off-grid options should be provided.

Rural communities should also be recognised as leaders, not just consumers. Tenkile Conservation Alliance has stressed the of holistic, long-term approaches to community-led sustainable development, into which energy programs can be integrated. FORCERT has also emphasized the importance of supporting communities to develop their own by-laws for sustainable development and land use – and ensuring that women have a strong and equal role in this. This can help identify women's energy needs, their current resource use and ensure that women's land-use is not undermined by future energy projects. It can also identify intersecting energy needs – such as transport, which is critical for people in rural areas but beyond the remit of this paper.

Greater attention to local, provincial and national level planning may also help to identify research or policy gaps. For example, it is not clear if, or how, improved energy access is seen as part of building resilience for communities in PNG already affected by climate change.[132] There is also a strong desire by many experts to bring together policy and planning discussions on climate and energy – which are often addressed separately.

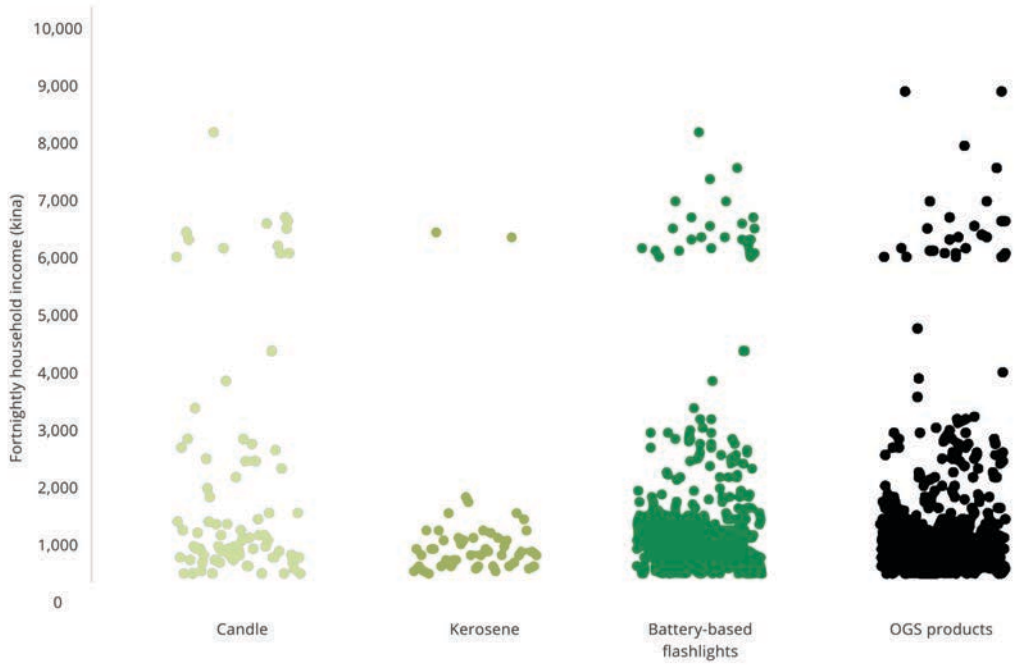
CONCLUSION

The economic benefits and impacts of increased off-grid energy access in PNG appear largely under-researched and could be much higher than anticipated. Similarly, the leadership of rural communities – from women solar engineers to community-led energy planning – appears underutilised, and much could be learned from experiences oversees and existing PNG case studies. Many successes have already been achieved – such as the large-scale shift to solar lighting. Going forward, it appears likely that many more energy discussions will be focused at the provincial level – or efforts to link up community, provincial and national level approaches.

Case study: The rapid expansion of off-grid solar lighting

According to a 2019 report, sixty percent of PNG households are now using off-grid solar lighting technologies.[133] Together with battery-based torches and lanterns, off-grid solar lighting products are effectively replacing kerosene lamps. The report by the International Finance Corporation (IFC) notes that 'six years ago, only two percent of the population used any type of solar product and relied on firewood, kerosene and other products harmful to people and the environment. It was a time when cellphone penetration was growing rapidly, but the means to charge those phones were lagging. Now kerosene has been usurped, and there's a prevalence of generic offerings, battery powered torches and lanterns, alongside quality-verified off-grid solar products – many with the ability to charge a phone.'[134] Its analysis suggests that households spend approximately 5% of their monthly income on lighting products, and that even poor households appear able to afford off-grid solar technology. Key to this shift was ensuring that local people could access affordable, relevant technologies.

Figure 3: Household Income and off-grid Solar lighting products owned (2018)



Source: Graph from International Finance Corporation (2019) 'Going the distance: Off-grid lighting dynamics in Papua New Guinea', page 20.



Wind farm panorama

Case study: Tenkile Conservation Alliance (TCA) solar project

The TCA is a long-term conservation project. Key to its approach is ensuring that local communities' themselves thrive by taking a holistic approach to supporting their sustainable livelihood priorities. It has worked with local villages for 20 years, and communities have identified access to water tanks, tin roofing and solar power as particular priorities.[135] Building strong, trusted relationships with local villagers is key to TCA's efforts to conserve three species of tree kangaroos found in the Torricelli Mountain Range in Sandaun Province, two of which are critically endangered.

The first phase of TCA's solar project is being rolled out to 43 villages. A total of 350 solar power street lights have been installed, and in 2021 2,690 solar power household units were installed. Every household in the village receives a solar unit. As a result, people are less likely to worry about their units being vandalised and stolen, which can lead to panel damage if people detach them to store inside overnight. TCA has also developed a solar app to help staff collate household survey data. Local energy business Solar Solutions is partnering on the project, including training local women and men in solar unit installation and maintenance. TCA is also working to create small businesses to source spare parts. The CEO of TCA has described benefits from the project as less domestic violence, more kids doing homework and fewer accidents among the elderly when going to the toilet at night. As well as increased access to rice milling machines and solar street lighting is particularly beneficial to women and children who feel safer walking within their villages at night. TCA plans a next phase to make thousands of solar units accessible to 100 villages. Financial support for TCA's solar energy and lighting programs come from DFAT's Pawarim Komuniti program, Perth Zoo, the Aitape/Lumi member the Honourable Patrick Pruaitch and Serge Foundation.

7. NEXT STEPS

The final section outlines some suggested steps that various actors can take to support PNG government at local, provincial or national level to grow reliable and accessible energy access for PNG communities without sacrificing its reputation and principals on strong climate action.

WHAT THE PNG GOVERNMENT CAN DO

These recommendations can be taken up by agencies such as NEA, CCDA or PPL.

- Do not commit to any power purchasing agreements or other support for new fossil gas-fired power plants or other new fossil fuel infrastructure that would 'lock-in' fossil fuel dependency. At the very minimum, put a moratorium on all such projects until renewable energy sources are secured in line with government targets – to avoid 'locking out' renewable energy and therefore expanding PNG's dependency on fossil fuels.
- Where possible, prioritise staff availability to attend or speak at events that bring together a range of people in the climate and energy sector. This helps to build awareness of government's work and priorities, and to identify how different stakeholders can support its efforts.
- Continue to capture and communicate successes, lessons learned and progress on expanding renewable energy and energy efficiency in PNG.
- Prioritise seeking grant-based financing for renewable energy projects, as well as climate finance – especially where it benefits climate-affected communities.
- Commit to develop a national policy on gender and energy to help ensure women's equal participation in all parts of energy policy and practice.
- Minimise the influence and power of fossil fuel companies in energy policy discussions and seek to learn more about legal developments and investigations overseas into fossil fuel company's efforts to negatively influence public policy or mislead on their climate impacts.
- Invite climate-affected communities to join and be part of energy policy discussions.
- Provide sufficient funding and support to the NEA so that it is able to deliver on its mandate.
- Make available funding support under the Provincial Support Improvement Programme (PSIP), District Support Improvement Projects (DSIP) and or LLG Support Improvement Programme (LLGSIP) to promote sustainable on and off-grid renewable energy projects in collaboration with development partners for all districts throughout PNG.
- Adequately fund and support the NEA so that it is able to deliver on its mandate and become fully operational in 2023, not 2025 as has been proposed.
- Audit the qualifications and capabilities of NEA senior staff and leadership, and make changes as necessary to ensure all are merit-based, rather than political, appointments.

WHAT DEVELOPMENT FINANCE AGENCIES AND OTHER FUNDERS CAN DO

- Provide grant-based funding for energy projects – recognising that PNG developing renewable energy benefits its own citizens but the climate more broadly.
- Consider debt relief – recognising that the climate crisis and COVID crisis are both taking a toll on Pacific economies, undermining resources for sustainable development.
- Provide long-term community-based energy projects and programs.
- Support community-level programs to integrate skills development on installing, maintaining and recycling of renewable technologies.
- Support communities most at risk of climate change.
- End concessional finance to fossil fuels, for example, via export credit agencies.

WHAT RESEARCHERS CAN DO

- Study, and report on, the economic impacts of rural electrification in PNG.
- Research, and report on, renewable energy projects in PNG to share lessons learned and help build knowledge about how best to implement renewable energy.
- Undertake research into women's participation and representation in energy discussions and planning – at local, provincial and national level.
- Undertake research into training programs on renewable energy internationally - and in PNG – to help inform training options and strategies.
- Promote to community-to-community learning, by supporting communities to document their own experiences with renewable energy.
- Provide research into the ecological, health and social impacts of fossil fuels in PNG, large-scale renewables and small-scale renewables.
- Publish and share information about overseas-based projects undertaken by foreign energy companies active in PNG – this will help to PNG citizens, civil society organisations and governments to have a better identify if a company has good, or poor, environmental and social practices.
- Create a central point - such as a website – to collate and publish research reports, data and other materials relevant to climate and energy policy in PNG.
- Provide, or make more accessible, a guarantee facility to insure private sector actors against the risks involved of renewable energy projects that require large upfront costs, and rely on stable income from long-term contracts with government (such as purchasing power generated) to recoup these initial costs.

WHAT BUSINESSES WHO SUPPORT CLIMATE ACTION CAN DO

Business leaders across a wide array of sectors have the opportunity to show their support for PNG's government's priority on renewable energy and the importance of climate action. Key among them is their role in business councils which is a central interface between companies and government officials. Currently, fossil fuel companies play a central role in business councils. Others engaged in economic development in PNG – such as groups working with workers, civil society organisations and journalists also have a role to play. Foreign embassies could also assist by ending support to market or promote fossil fuel companies, and adopting public positions that they will not promote fossil fuels.

On business councils, business action could include:

- Businesses that support climate action taking an active role in planning conferences and events to ensure that renewable energy is foregrounded.
- Members pressing for business councils to put forward policies to end fossil fuel sponsorship.
- Large businesses or industry groups offering alternate sources of sponsorship for annual industry events.
- Businesses supportive of climate action putting themselves forward for leadership roles in these organisations.
- Businesses showing why the climate crisis is bad for business, the economy and the communities they serve.
- Businesses adopting public positions outlining that they support decisive PNG Government action to recognize the climate crisis and build sustainable development.[136]
- Businesses setting their own internal targets for how they will reduce their emissions.

Fossil fuel companies themselves can also actively step back from lobbying and similar activities – which would help to build trust in their respect for PNG's climate targets. They can also step away from seeking to build fossil-gas infrastructure that would lock PNG into fossil fuel dependency for decades to come.

WHAT COMMUNITIES CAN DO

- Be alert to affordable and accessible products which may allow them to choose renewable energy options to meet their needs.
- Add their voices to calls for businesses or development projects in their area to use renewable energy resources.
- Discuss with local organisations or businesses options for ensuring community members, including women, can become trained up in how to maintain or repair renewable energy technologies.
- Identify the potential threats to land rights, or capacity to generate land-related conflicts, that may arise as a result of energy projects - including renewable energy, entering their area.
- Help to amplify calls that PNG's reputation as a climate leader will be undermined if it chooses to launch new fossil-fuel infrastructure that will lock it into fossil fuel dependency for years to come.
- Discuss with their Members of Parliament to provide funding support under the DSIP for renewal energy program implementation in every district.

WHAT WOMEN'S ORGANISATIONS CAN DO

Ultimately, the burden of building gender equality in PNG's energy discussions and sector should not fall to women's organisations. However, women's organisations could play an important role by outlining a short list of recommended measures that they believe should be adopted to ensure greater visibility of, and attention to, gender dynamics.

This may include:

- Ensuring that women's organisations and female leaders have a leading role in energy policy discussions.
- Requesting gender data from energy policy discussions and workshops, to capture women's attendance relative to men.
- Work for others to call for the NEA to develop a gender policy – to ensure that PNG's energy sector is built in a gender equitable way.
- Ensuring that women are equally trained and upskilled in training and maintaining renewable energy systems and technologies.
- Undertaking research to identify and understand women's energy needs.
- Undertake research to better understand interlinkages between rural access to energy and rural women's economic empowerment.

WHAT CIVIL SOCIETY ORGANISATIONS CAN DO

This may include:

- Monitoring the efforts of business organisations and encouraging businesses that support climate action to be vocal in their support for strong climate-friendly energy action.
- Promote the importance of gender equitable energy policy and outcomes, including equal opportunities for women and girls to be trained in maintaining and installing renewable energy technologies.
- Continuing to work to amplify the wishes, voices and concerns of rural communities potentially affected by renewable and non-renewable energy projects. This is needed to build just and equitable energy outcomes.
- Continue to amplify the voices of PNG communities and the climate outcomes they wish to see.
- Promote and share an understanding of climate science.
- Speak out in support of government efforts and actions to forward renewable energy targets and technologies.



Participants and presenters from CELCOR's September 2022 workshop which brought together people from government, civil society, academy and business to discuss PNG's climate and energy policy and practice.

APPENDIX: CELCOR'S 'BUILDING ON WHAT WORKS' WORKSHOP

A special thanks for the organisers of the workshop, which was held on 27-28 September 2022 in Port Moresby:

- Samantha Kuman, CELCOR
- Peter Bosip, CELCOR
- Shona Hawkes, Jubilee Australia
- Christian Lohberger, Solar Energy Association of PNG
- Josephine Mill, Consultant

Workshop presenters and participants:

- Dame Meg Taylor – Former Secretary for Pacific Island Forum
- Yolarni Amepou, Piku Biodiversity Network Inc
- Paul Barker, Institute of National Affairs
- Peter Baum, Asia Development Bank
- Roy Daggy, PNG Power Ltd
- Ivy Kiele, FORCERT Inc
- Garick Lee, USAID
- Watna Mori, Environmental Defenders' Office
- Rensie Panda, National Energy Authority
- Manu Ruwali, Center of Renewable Energy, University of PNG
- Jim Thomas, Tenkile Conservation Alliance
- Viola Digwale, New Zealand High Commission
- Murray Moraroa, CELCOR
- Freda Talau, Environmental Defenders' Office
- Kimberly Layton, Department of Foreign Affairs and Trade
- Reilly Kanamon, CPNG
- Lucy Vele, ESIP
- Walai Tongia. ESIP/PK
- Domitilla Warap, SSPNG
- Jon Pittar, SSPNG
- Rosemary Isicar, CIMCPNG
- Julinethe Bayking, USAID
- Andrew Molen, WntoNuis
- Chan Apekas, CIMCPNG
- Tobias Tourem, CIMCPNG
- Bensolo Ken, USAID
- Chalapan Kalawin, UPNG
- Conrad Kumul, Mineral Resources Authority
- Hercules Jim, CIMCPNG
- Martin Davies, Institute of National Affairs
- Randall Betuda, GHD
- Chris Apolas, CIMCPNG
- Kalia Naris, National Energy Authority
- Maino Virobo, Conservation and Environmental Protection Authority
- Janine Garap, Good Return
- Julie Hulana, USAID
- Garick Lee, USAID
- Duics Dabemot, USAID

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