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# Evaluation of New Zealand's Country Programme in PNG

Part IV Renewable energy – expanding access to  
reliable, clean energy

New Zealand Ministry of Foreign Affairs and Trade

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## 4. Renewable energy – expanding access to reliable, clean energy

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The provision of energy in Papua New Guinea is of critical importance for economic development and for the delivery of health and education services. The Joint Commitment for Development signed between the Governments of Papua New Guinea and New Zealand in September 2015 prioritised New Zealand support for the energy sector. New Zealand committed to expand access to affordable, reliable and sustainable clean energy, including generation of electricity from renewable resources, connecting communities without a supply and improving energy sector planning and asset management. The following sections review the performance of New Zealand's support in this important area. It begins with an overview of the energy sector context, followed by assessments of New Zealand's investments in specific activities.

### 4.1. Energy context

The energy sector in PNG is dominated by PNG Power Limited (PPL), a state owned enterprise within Kumul Consolidated Holdings (KCH), and regulated by the Independent Consumer and Competition Commission (ICCC) with policy developed by the Department of Petroleum and Energy, which was recently replaced by the Department of Communication, Information Technology and Energy. There are numerous other actors who play a role in the investment, maintenance and delivery of energy infrastructure and generation including the Department of Works, the ADB, WB, IFC, and New Zealand.

PPL manages generation of approximately 300 MW, transmission, distribution and retail. The system consists of three main electricity grids and numerous mini (or off grid) systems supplying consumers in PNG. PPL manages the three main grids: Port Moresby Grid, which is the largest by peak demand and annual energy but geographically compact; Ramu Grid, the second largest grid but most geographically spread, servicing the most populated area of PNG with plans for an extensive grid rollout and the connection of large mining loads; and Gazelle Grid, the third biggest grid supplying parts of East New Britain Province<sup>1</sup>. There are also approximately 30 Isolated Large Generators and mini-grid (or "C" Centres) generating units, mainly at mines or other sites of industrial enterprise<sup>2 3</sup>.

There are a number of National level strategic documents that provide high level guidance to the energy sector, including the Alotau Accord 2, *PNG Medium Term Development Plan 2* and the *National Strategy for Responsible Sustainable Development for PNG (2<sup>nd</sup> edition)*. These documents are high level, aspirational and largely unfunded. At the sector level there is a well-documented energy policy framework for PNG, this includes:

- › the PNG National Energy Plan 2015-2020;
- › the National Electrification Rollout Plan (NEROP), with a focus on expanding the distribution grid and establishing mini-grids to increase electricity access from 12% to 70% of households by 2030<sup>4</sup>;
- › PPL's Power Development Plan 2016-2030 (updated every two years to account for costs, demand and investment options); and,

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<sup>1</sup> ECA (2016), Papua New Guinea: Grid Development Rapid Review and Action Plan, London

<sup>2</sup> ADB (2009), Power Sector Development Plan: Main Report.

<sup>3</sup> ADB (2011)

<sup>4</sup> World Bank (2013)

- › the Grid Development Action Plan which details how the Government will expand the grid to rural communities around PPL's 34 provincial grids<sup>5</sup>.

The Government will also progress the implementation of the APEC Agenda on Structural Reforms (RAASR), which deals with reforms around competition policy, ease of doing business initiatives, financial inclusion, energy policy reform and telecommunications infrastructure reform<sup>6</sup>.

The most influential policy documents are those owned by the political leadership, they include the Alotau Accord 2 and the 2018 National Budget (noting that this is the only document that has legislated funding attached).

Energy sector priorities identified in the Alotau Accord 2 include:

- › Maintenance of all public infrastructure, including national buildings, utilities (Electricity, Water and Communication), institutional properties, roads, sea and airport infrastructures;
- › Completing the hydro electricity supply projects for Hela Province, Popondetta, Buka and the Ramu Grid Phase II; and,
- › Continue and complete the rural electrification project.

Energy sector priorities identified in the 2018 National Budget include:

- › The development and consumption of renewable and clean energy. Energy provides the fuel for productivity and to improve living standards, therefore the Government is committed to encouraging the production and consumption of renewable energy such as biofuels, thermal and solar which is also critical in efforts to mitigate the effects of climate change;
- › The focus of the PNG Government in the utilities sector is to embrace the Sustainable Development Goals and to increase access to clean energy and create an enabling environment for business activity; and
- › The National Energy Policy will focus on developing the renewable energy sources such as hydro, solar, wind, and geothermal and PPL with the support of ADB, the New Zealand Government and the World Bank will continue to roll-out its Electricity Rollout Plan to achieve the PNGDSP target.

There are a significant number of challenges that PNG faces in the achievement of these priorities, which have been determined in consultation with energy sector stakeholders in PNG, these include:

- › No transmission, distribution or consumer metering data is available;
- › Pre-pay meters are widely used however not read, with pre-paid receipts acting as the metric;
- › Unknown line losses, including from theft, errors and tampering with meters;
- › Load estimation is unreliable due to the use of low-accuracy generation meters and poor understanding of losses;
- › Frequent load shedding further distorts the data available to estimate the load;
- › Difficulty in forecasting demand due to uncertain economic growth, future grid extensions, large mines, uncertain current demand data;
- › Insufficient and short-term capital budget allocations have undermined PPL's ability to increase capacity in the sector, with the private sector unable to develop capacity due to no long-term investment signals;
- › Electricity tariff levels are below cost of delivery, further undermining PPL's revenue;
- › Poor regulation and political interference has led to an inefficient allocation of resources.

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<sup>5</sup> ADB (2016)

<sup>6</sup> PNG Treasury (2017)

To address these challenges a range of investment opportunities were identified in discussions with energy sector experts in PNG during the field work, these included:

- › Providing core funding for energy infrastructure investments, leveraging other funding sources;
- › Demand forecasting to aid investment decisions for grid extension;
- › Analysis of the drivers of economic growth to inform energy demand forecasting; and,
- › Development of investment plans for both generation and transmission.

## 4.2. Overview of New Zealand’s Investments

In the Joint Commitment for Development (JCfD) between New Zealand and PNG the priorities of the aid programme are: agriculture, energy, Bougainville, scholarships and training, public sector strengthening and partnerships. Over the next Triennium energy investments are currently planned to make up approximately 50% of total aid allocation to PNG.

In response to a large volume of plans and strategies that have been developed to guide energy investments in PNG the New Zealand government focused on the development of specific energy infrastructure. New Zealand has deployed three different delivery modalities: partnering with the PNG Government; partnering with the ADB; and delivery through a managing contractor which also trials different financing mechanisms. The JCfD as a target of 50,000 people to be connected under the current electrification activities in implementation. There are three projects currently in implementation, and one in late stages of design. All are progressing but have experienced delays due to limited implementation capacity in PNG, slow PNG government systems, land issues, bad weather, and cost overruns. This section will predominantly draw on the activities being undertaken directly with the PNG Government.

**Table 4.1: New Zealand’s energy investments in PNG**

Project	Start date	Whole of life (NZD)	Expenditure to date	NZ share	Partner	Region (Province)	Status
<b>Enga Hydro Project (A11630)</b>	Aug 2013	7.8m	6.6m	50%	PNG (PPL, DNPM)	Highlands (Enga)	Stalled – limited progress
<b>Rural Electrification Project – ADB Three Towns Project (A10868)</b>	July 2011	10.1m	10.1	70%	ADB, PNG (PPL)	Islands (West New Britain, Oro Province, Bougainville)	Progress with household connections have been delayed due to slow progress with transmission lines
<b>Rural on Grid Extension – Central (A12136)</b>	Dec 2014	24.7m	10.3m	100%	PNG (PPL)	Papua (Central)	Initial slow progress due to capacity constraints in PPL and the private sector
<b>Increasing Access to Renewable Energy</b>	2016	Up to 56m			To be decided	To be decided	Scoping and design work for initial project is on-track

## 4.3. Activity Assessments

### 4.3.1. Enga Hydro Project

Relevance	Efficiency	Effectiveness	Sustainability	Impact
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This was New Zealand's first attempt at implementing an energy investment directly in partnership with the PNG Government. The activity, located in PNG Foreign Minister Pato's home province started in August 2013 following appraisal and approval of a scoping study recommendation to proceed. The goal of the activity was to increase social and economic benefits from the use of electricity through a replicable model of a community owned off-grid electricity system.

New Zealand is providing NZD7.5 million of the total project budget of NZD15 million, with the balance to be covered by PNG. An additional \$325,000 is set aside for feasibility and scoping. The implementing partners are PNG Power Limited (PPL) and the Department of National Planning and Monitoring (DNPM)<sup>7</sup>, with SMEC as the managing contractor.

This activity has faced a large number of constraints and related delays, not uncommon in infrastructure development in PNG. A number of key informants noted that there was, potentially, an overreliance on the ability of the activity's political patron to fix problems as they arose. This approach may have delayed necessary changes to the way in which MFAT managed the activity, as it was hoped that the political fix would eventuate. While political patronage could possibly be an effective strategy for overcoming capacity issues at the bureaucratic level there was no evidence provided that would support such a view in PNG. It is well understood that unless operating outside of the bureaucratic system, for example utilising the Tax Credit Scheme which allows for the private delivery of state funded infrastructure projects, the same constraints are faced by all actors including politicians. This project has been further delayed due to weather, national elections and significant cost increases.

After a long delay there has been progress over the last 12 months, which includes:

- Design of the hydro generation plant is underway now that the ground survey and the geotechnical investigations are completed. The LiDAR mapping has started and updated scheme parameters were approved;
- Work has commenced on environmental permitting;
- Financing options analysis completed;
- Survey for 4km of HV/LV lines completed with associated materials procured and transported to Wapanemanda;
- Text for Implementation Agreement between DNPM/PPL has been finalised. This is significant as it has taken 20 months to achieve; and
- Land access issues resolved through an MoA agreed and signed with landowners. PPL has started work on land acquisition.

This activity has highlighted a limited understanding at inception of the political and bureaucratic systems in PNG and the, at times, deep divide between the two. The approach to activity management, plus the limited technical capacity available to MFAT, was slow to respond to the capacity constraints evident in PPL and DNPM. The activity was very ambitious from the start, noting the well-known difficulties in operating in PNG and in particular in the Highlands. In addition, the co-contribution from the PNG Government of 'hard cash', and not just in-kind support, has further complicated and delayed implementation. There are limited examples of an arrangement of this

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<sup>7</sup> Enga Hydro, Activity Monitoring Assessment, November 2017

nature being successful in PNG. The current economic challenges and related revenue pressures being faced by the PNG Government is likely to further delay the co-contribution and therefore implementation.

This activity was initially established to demonstrate New Zealand’s capability in developing renewable energy and to implement a new and potentially replicable model for energy investments in PNG. The concept was very high risk from the outset. There are many things that have been learnt from this activity, some of which were evident at the outset, with a number that will assist in the future implementation of energy activities in PNG. Key informants noted that regardless of success or failure an important outcome from this activity will be the sharing of lessons to improve future implementation in the sector. One important lesson has been the benefit of sharing information between energy activities, for example cost estimates have been improved by working with the Rural on-grid Extension Project<sup>8</sup>.

Sustainable (including affordable) solutions for renewable energy generation are going to be critically important if PNG is to achieve its goal of 70% of the population with access to energy by 2030, this activity will be an important lesson as the sector moves towards this target. While many informants indicated their frustration with this activity on grounds of both financial and asset management sustainability, this activity may still be able to provide important lessons. Robust data collection, detailed evaluation, and wide dissemination of lessons learned must be a priority so that this activity can play its role in providing lessons to other stakeholders in the sector.

#### 4.3.2. Rural on-Grid extension Project (ROGEP)

Relevance	Efficiency	Effectiveness	Sustainability	Impact
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This is New Zealand’s single largest aid activity in PNG. The activity involves the construction of 86kms of lines to extend the Central Province grid to 4 areas – Brown River; Ower’s Corner; Kwikila; and Hula. Through this investment New Zealand hopes to connect 5,500 households, 19 schools, 15 health clinics, and 58 stores. In 2017 the activity budget was increased by NZD13 million to extend the grid to Hula to supply an additional 3,000 households; included in the goal of 5,500 households. Due to the expansion of the activity the completion date has been extended by 12 months to June 2019. New Zealand is the sole funder, now providing up to NZD24.7 million with PPL providing limited in-kind contributions. The implementing partners are PPL and Geoff Brown & Associates Ltd, a power engineering management consultancy based in Auckland.

This activity is highly relevant as it aligns directly with the PNG Government’s National Electrification Rollout Plan (NEROP), working directly with PPL as the implementing partner. However, progress has been very slow. Between December 2014 and end 2016 only NZD0.8 million of the original NZD11.7 million was spent with limited to no progress against all outputs and outcomes<sup>9</sup>. Delays have, in part, been due to delays in establishing the program management unit in PPL; and limited space and recruitment issues have been blamed for this delay. Another issue has been the lack of technical capacity and low contractor productivity in the local market to construct HV and LV reticulation efficiently. However, since 2017 there has been a rapid increase in the rollout of this activity with almost NZD10 million spent in the 12 month period. Specific progress includes:

- › establishment of the Program Management Unit in PPL;
- › completion of surveys for the HV and LV lines in Owers’ Corner and Brown River sites;
- › construction of 12.5km+ of HV lines at Owers’ Corner;
- › HVL material procured and delivered to sites.

<sup>8</sup> Enga Hydro, Activity Monitoring Assessment, November 2017

<sup>9</sup> Rural On-Grid Extension Project, Activity Monitoring Assessment (2016)

While progress has not been in line with initial targets it does provide a positive indicator that a number of key constraints have been overcome and there is confidence that the results will be achieved, albeit somewhat slower than expected. There is an expectation amongst key stakeholders that the activity will now experience rapid progress. PPL is confident that this extension of the network will be profitable, providing PPL with additional resources that can be used across its network, helping to improve the financial sustainability of its broader operations. That alone is a strong argument for an activity that increases access to energy while improving efficiency of the grid. Cross cutting issues, including gender, have not been a focus of operations to date and little is known about the impact the provision of energy will have on gender outcomes at the household level in PNG. However, there is ample case study literature pointing to a positive relationship between household level energy provision and improved outcomes for women<sup>10</sup>. Issues arise around the ability of households to invest in the necessary items that improve household efficiency and health, for example, electric stoves, heaters, etc.

### 4.3.3. Rural Electrification Project – ADB

Relevance	Efficiency	Effectiveness	Sustainability	Impact
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New Zealand is providing NZD10 million in grant funding, alongside Japan providing (USD2.5 million), to support the implementation of a USD120 million loan from the ADB under the Town Electrification Investment Program (TEIP)<sup>11</sup>. The activity outcome is to achieve increased renewable generation capacity and improved access to electricity for rural beneficiaries in Bougainville, West New Britain and the Northern Province of PNG. Contributing to the replacement of diesel generation with renewable hydro generation, rehabilitation of the Lake Hargy hydro in West New Britain and providing connections to over 5,000 households. The funding is administered through the ADB and implemented by PPL. New Zealand's funding has increased the scale and scope of the project without adding an additional administrative burden on stakeholders, especially PPL. In a sector with limited investment and capacity a coordinated approach by donors lowers implementation risk and should ultimately decrease the cost per kilowatt of energy provision.

New Zealand's involvement in this activity is very limited as the ADB is the lead stakeholder working directly with the PNG Government and implementation actors. This activity is 100% reliant on progress under the larger ADB activity.

Progress to date identified in the activity management assessments includes:

- Household connections commenced in January 2017 but are progressing at a slower rate than expected. The slow progress is due to PPL's lack of resources to progress the work under the larger Town Electrification Improvement Programme (TEIP) as the household connections are dependent on the main lines being constructed;
- 142km of high voltage lines and 22 km of low voltage lines have been constructed, resulting in 600 households (target 5140) connected since January 2017.

During the reporting period PPL had made a decision to include the low voltage lines work that was to be carried out by PPL in-house staff under the TEIP construction contract in West New Britain and Oro Province. This means PPL staff can focus on household connections which should see an increase in the number of connections in the coming months.

The community outreach programme is being delivered, however, it is not clear how individuals are selected for the training. Also, more focus should be on safe use of electricity and turning electricity access into income generation opportunities. Only 67 people have done the financial literacy training.

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<sup>10</sup> Kohlin (2011)

<sup>11</sup> ADB (2010)



The project has rolled out a community awareness programme that includes HIV/AIDS; Gender; Safe use of electricity; and financial literacy.

## 4.4. Conclusion

There is evidence linking increased supply and improved quality of electricity and economic growth<sup>12</sup>. Therefore, improved infrastructure can benefit business by reducing the operating costs of capital from connections to stable lines, reduce the need for business to invest in expensive backup and self-generation capacity and increase labour productivity through less downtime and greater uptake of technology. While there is evidence globally for a productivity response to improved electrification, Edquist (2006) notes that there is an approximate time lag of 40 to 50 years for productivity growth. In fact, agricultural research and development have higher productivity effects than electrification (Fan 2004). There is evidence to support the relationship between investment in electricity infrastructure and growth but the impact is lower than other forms of infrastructure, depending on the quality of that infrastructure<sup>13</sup>. Kohlin (2011:47) found that when households first receive electricity the most common use is for lights and televisions (and possibly now phone and internet, noting the increase in smartphones since the case studies were undertaken). Lighting is shown to free up people's time, especially women's, to undertake leisure and additional productive activities, which may lead to increased household incomes. Further research is needed to understand the role that increased access to television and the internet will play in development at the household level. There are suggestions that gender equity will be improved as television conveys pro-gender equity messages, it's less clear if this extends to the internet.

MFAT's energy investments are being made on resilience, sustainability and cost grounds, with a possible link to improving economic growth. But electricity is not an end in itself; its primary function, like any infrastructure investment, may not be to directly increase economic growth but rather to overcome constraints to growth. Other factors like business development services and access to finance can increase the probability that improved access to electricity will have a positive impact on economic activity, private sector employment, incomes and poverty reduction. Therefore, the allocation of PNG's and donors' scarce fiscal resources needs to be done in the most efficacious manner. Sustainability and efficiency considerations need to be taken seriously and any projects undertaken on the basis of 'demonstration' like Enga Hydro need to have a robust approach for how learnings will be captured and shared especially in a situation where a project, like this one, has no prospect of being replicated purely on the basis of cost.

PPL has a focus on grid connectivity, extension and improving efficiency and see small scale off-grid generation as unsustainable in the current environment, this was a view supported by PNG-based stakeholders. PNG wants to see post evaluation and maintenance built into projects, and the issue of recurrent budget impact addressed. Renewable energy projects need a sustainability plan built in up front or they can't succeed. An enormous amount can be achieved by improving and extending the current infrastructure, building on the approach of providing energy to main centres and not households in the first instance. Key informants indicated that the establishment of mini off-grid energy infrastructure, unless backed by a major resource/economic project, is not a feasible approach in PNG. Donors have learnt the hard way that implementing first class infrastructure in rural PNG is not sustainable or replicable. It diverts scarce resources both from the private sector and public sector away from the core approach of improving and extending the existing network, as outlined in NEROP. Through the pursuit of high risk, and potentially unsustainable projects on financial and technical

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<sup>12</sup> See Morimoto, R., and Hope, C., (2001) The impact of electricity supply on economic growth in Sri Lanka, The Judge Institute of Management Studies. Cambridge.

<sup>13</sup> Attigah, B. and Mayer-Tasch, L. (2013): "The Impact of Electricity Access on Economic Development - A Literature Review", in: Mayer-Tasch, L. and Mukherjee, M. and Reiche, K. (eds.), Productive Use of Energy (PRODUSE): Measuring Impacts of Electrification on Micro-Enterprises in Sub-Saharan Africa, Eschborn.

capacity grounds, the risk profile of PPL's existing work and well documented energy sector plans have been increased.

The issue of ownership is a significant one in the PNG energy sector context. There is a view amongst PNG stakeholders that they have very little control and influence over what donors are investing in with the sentiment conveyed that 'we must take whatever we're given'. As has been well documented in PNG it is important to make investment decisions based on all available knowledge and to not rely on unrealistic expectations in overcoming well known constraints. The constraints in the energy sector in PNG (such as capacity constraints in PPL) are well known to experts with knowledge of PNG. It was foreseeable that New Zealand would face challenges implementing energy projects in areas that are new or that require significant inputs and management from PPL. Projects that are not designed or supported with these constraints in mind will continue to be inefficiently delivered within the PNG context. New Zealand has extensive experience working across the Pacific in the energy sector. Success has been achieved through a wholelistic approach that includes coordination, capacity building, planning, technical advice and investing in physical infrastructure. PNG would be well served by New Zealand applying what has worked so well in other countries it supports.



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