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# AN APPRAISAL OF PNG NATIONAL ENERGY POLICY 2018-2028

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**ABSTRACT:** *This policy paper investigates and analyses current and proposed levels of energy development and access in Papua New Guinea, with regards to the country's Vision 2050 and the United Nations' SDG Number 7. Despite the fact that Papua New Guinea is blessed with abundant natural resources of energy for domestic, commercial, industrial and mechanised agricultural uses, current levels of development and access have hovered around 13 percent of the GDP since political independence in 1975. Based on a structured interview of a random sample of 150 energy consumers in the various sectors of Lae industrial hub of PNG, aimed at promoting public participation in energy policy formulation, the paper analyses the perceptions of key energy stakeholders concerning published energy policy objectives for the period 2018-2028 for the country. After discussing findings from two research questions, strategic recommendations are made for achieving sustainable energy development, storage and distribution as well as for proper coordination of policies and implementation strategies across the country, in order for the country to meet the targets set out in the Energy Policy 2018-2028 and in Vision 2050 and to make the country economically competitive in the international arena.*

**KEYWORDS:** PNG Energy Policy 2018-2028, electricity access, PNG's Vision 2050, United Nations' SDGs, Sustainable Land Use Policy, PNG Government

## INTRODUCTION AND RATIONALE FOR THE PAPER

There is no doubt that energy is of vital importance for sustainable development of any country because without access to modern reliable energy sources, economic development is impossible (Aglanu, 2018; Wirth et al., 2003). As rightly observed by Hon. Samuel H Basil, MP, PNG Minister for Communications, Information Technology and Energy, in his foreword to the official PNG National Energy Policy 2018-2028, countries that have placed energy in the forefront of their policies continue to experience leaps and bounds in their economic growth and prosperity, thereby confirming that energy is the engine room for any nation's economic development. Furthermore, it is contended that renewable energy is key to sustainable development and has a high potential of servings as modern reliable energy sources (Aglanu, 2018). The problem, however, is that many energy dissemination programmes around the world appear to focus attention on the supply and technology aspects without adequate attention to the overall context of community life (Kaygusuz, 2011).

According to Renagi and Babarinde (2017), the Government of the Independent State of Papua New Guinea is currently pursuing the development of energy resources to guarantee the attainment of four key objectives. These are: (i) to ensure that PNG attains sustainable Energy exports (ii) to ensure that the cost of unit Energy is reduced for PNG (iii) to ensure that PNG is an

internationally competitive country to invest in, and (iv) to meet PNG's economic development goals while protecting and conserving the environment. The country is naturally endowed with most of the common natural resources of energy that are only waiting either to be tapped or properly harnessed in order to advance the economic growth, energy security, environmental sustainability and social welfare of the country and its people. In this regard, it is sad to note that since 1963 when electricity became publicly available for domestic and commercial use in the country, its development and access has reached a meagre 13% by 2017 (PNG National Energy Policy 2018-2028). The country's energy sector was developed through various Acts of Parliament but its development was not coordinated properly for a period of 43 years since attainment of political Independence in 1975. This situation is unacceptable and something drastic must be done and done quickly to address this energy situation in the country (Basil, 2018). According to the Honourable Minister for Energy, the newly crafted *National Energy Policy* is expected to provide the enabling environment for achieving the 2030 target of 70 percent electricity access to all households in PNG and 100 percent by 2050 using renewable clean energy resources.

Furthermore, the Honourable Minister believes that the new Energy Policy is on par with modern energy development practices across the globe, fully utilising all the nation's energy sources for domestic use and eventually for export. He argues that while the global energy sector is continually evolving, PNG must be at the forefront of utilising new technologies to harness local energy sources having due regard to the environment. Hence the new policy advocates a balanced approach to energy production and supply, using existing technologies where appropriate and deploying new technologies to drive economic growth through efficient, reliable and affordable energy access across domestic, commercial and industrial sectors. Meanwhile, the Hon. Minister has also announced that the National Electrification Roll-out Plan (NEROP) was at advanced stages of being finalised and that other sub-sector plans would be developed as soon as possible after the launching of the National Energy Policy. Finally, he affirmed that the energy policy will be the basis of energising and powering PNG to be a smart, happy, prosperous, wealthy and modern nation.

Therefore, the main purpose of this paper is to appraise the newly launched National Energy Policy 2018-2028 for Papua New Guinea, with a view to identifying the key components of the Policy, their strengths and weaknesses relative to global and regional best practices, and how the weaknesses can be reversed or ameliorated for the smooth sustainable development of the country. The paper is divided into eight sections. Following the introduction in the first section, the second section presents a review of external financiers' (e.g. ADB) involvement in promoting increased energy access in PNG. In sections 3 and 4, the paper presents the research problem (with two research questions) as well as the conceptual framework respectively, followed by the research method in section 5. The research findings and discussion are presented in section 6, while the conclusion and policy implications of the study are presented in the last section.

**A REVIEW OF EXTERNAL PARTNERS' INVOLVEMENT IN PROMOTING INCREASED ENERGY ACCESS IN PNG**

A review of the Pacific Energy Update (ADB, 2018) shows that the Asian Development Bank (ADB) is actively involved in strengthening communities across the Asia and Pacific region to improve lives by supporting governments, businesses, and infrastructure to operate more effectively. According to the bank, clean energy is an essential resource for driving low-carbon economic growth and for enhancing the quality of life for people in the region. Towards this end, the bank provides technical assistance for energy sector projects that are helping to build resilient, low-carbon economies, while increasing access to clean and reliable power in the Pacific region as part of the bank's vision of helping its developing member countries reduce poverty and improve the quality of life of their people through inclusive economic growth, environmentally sustainable growth, and regional integration. The bank's main instruments for helping its developing member countries, including Papua New Guinea, are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance (ADB, 2018).

Papua New Guinea enjoys abundant fossil fuel (oil and gas) and renewable energy (hydro, biomass, and geothermal) resources, but only 13% of its population has access to electricity (PNG Energy Policy, 2018). The national, state-owned PNG Power Limited manages electricity generation, transmission, and distribution over three main grids (Port Moresby, Ramu, and Gazelle), which serve the main urban centres, and 19 isolated independent power grids servicing provincial centres. PNG Power Limited installed capacity is approximately 260 MW (66% hydro, 44% thermal) with independent power producers adding 50 MW of thermal capacity. Approximately 280 MW is generated by the mining industry as captive power for their consumption.

The Papua New Guinea Development Strategic Plan 2010–2030 identifies the government's priorities of a 70% electrification rate and carbon neutrality by 2030. The 2011 Electricity Industry Policy focuses on (i) encouraging private sector participation, (ii) upscaling rural electrification, (iii) enhancing technical regulations, and (iv) sector coordination at the national level. In 2014, PNG Power Ltd. developed the 15-year Power Development Plan, which provides a road map for priority power infrastructure. In May 2016, the government developed a 15-year National Distribution Grid Expansion Plan under ADB's support, which covers the technical, financial, and economic aspects of distribution expansion in PNG Power Ltd. centres. In the 2018-2028 Energy Policy the government has set a target of 70% and 100% electrification by 2030 and 2050 respectively. ADB energy projects in Papua New Guinea cover an active portfolio of $240 million and proposed investments of $493 million (ADB, 2018). Some examples of ADB-financed power projects in the country include: the active Town Electrification Investment Program that will add renewable energy sources of generation and extend the distribution network; additional grid penetration to approximately 19% by 2028, and replacement of diesel generation with renewable clean energy sources in provincial centres. Furthermore, the ADB program will enhance the PNG Power Limited's operational efficiency and build institutional capacity in the Department of Petroleum and Energy, support renewable energy policy framework and create an enabling environment for the private sector to mobilize in off-grid areas. Tranche 1 of the program is

estimated at $221 million for 2019 approval with tranch 2 estimated at $272 million for 2021 approval. Co-funders of various tranches of this program are the ADB and the governments of New Zealand and Papua New Guinea and the Japan Fund for Poverty Reduction.

The ADB has also supported the Government of Papua New Guinea and the PNG Power Limited to construct a 150-kilometer high voltage transmission line linking the West New Britain provincial capital Kimbe and the township of Bialla. This transmission line will connect renewable energy from existing hydropower and biomass facilities and bring electricity to households, schools, and medical clinics along the alignment (ADB, 2018) and also replace expensive diesel-generated power. The project will also connect a palm oil plantation, which generates power from waste biomass (3 megawatts) for sale back to the grid. It is estimated that the project will replace between 60% and 80% of diesel-generated power in Kimbe with clean and reliable renewable energy, among others.

## NATURE OF PNG ENERGY PROBLEM AND RESEARCH QUESTIONS

Put succinctly, the level of energy generation and access in Papua New Guinea was only 13% by 2017, whereas it is projected that by Year 2030 a target of 70 percent electricity access to all households and 100 percent by Year 2050 are reached using renewable clean energy resources (PNG Energy Policy, 2018). The recently launched PNG Energy Policy 2018-2028 officially recognised the following energy resources as commercially viable options that have yet to be tapped or fully tapped by the country (PNG Energy Policy 2018-2028):

a) Refined Petroleum Products;
b) Gas to Households and Commercial Consumers;
c) Clean Coal Resources;
d) **Renewable Energy**:
    i. Geothermal Energy
    ii. Hydro Energy
    iii. Biomass
    iv. Bio Fuels
    v. Bio Gas
    vi. Solar Energy
    vii. Wind Energy
    viii. Municipal Waste
    ix. Co-Generation
    x. Recovered Energy Generation
e) **Other Renewable Energy Sources and Technologies**
    i. Ocean Energy;
    ii. Biomass Gasification;
    iii. Bio-refinery technologies

It is a paradox that given the above-outlined energy endowments of the country (PNG Energy Policy 2018-2028), Papua New Guinea still suffers from very low electricity access (13% as of 2017). Therefore, this paper argues that PNG has a long way to go to enjoy sustainable energy generation, distribution and delivery as envisioned by the PNG Vision 2050 and the United

Nations' SDG Number 7. The present study is long overdue and it is the first known attempt aimed at investigating and appraising the energy problem in Papua New Guinea. The need to resolve the huge gap between the existing and future needs (demand) and existing access (supply) of electricity in PNG is the rationale for the paper, which attempts to answer two research questions as follows:

i) How can we quantify the current gap between clean energy demand and supply in Papua New Guinea?; and

ii) How can PNG increase her clean energy generation, distribution and delivery from 13% to 70% by the Year 2030 and to 100% by the Year 2050 as proposed by the newly approved Energy Policy for the country?

## CONCEPTUAL FRAMEWORK

This paper is located within the theoretical lenses of the *General Systems Theory* (Kuhn, 1974). According to Kuhn, a system is any pattern whose elements are related in a sufficiently regular way to justify attention. "An *element* is any identifiable entity, while a pattern is any relationship of two or more elements." At a more practical level, *Systems Analysis* - a practical application of *Systems Theory* - is the study of sets of interacting entities with the aim of solving the multi-faceted problems of the system itself (http://www.swemorph.com/pdf/anaeng, 10 June, 2018). It is also "the process of studying a procedure or business in order to identify its goals and purposes and create sub-systems or networks of procedures that will achieve them in an efficient and sustainable way." The main system adopted in this paper is an integrated version of *PNG's Vision 2050 and the United Nations' Sustainable Development Goal Number 7*. According to Khennas (2012), efficient energy supply within the good governance subsystem of sustainability is an asset to building the needed infrastructure for sustainable development (Aglanu, 2018; Brundtland Report, 1986; World Bank, 1999). This interaction is reinforced by the interrelationship between energy use, industrialisation, economic growth and standard of living; which reflects the direct correlation between economic growth and electricity supply (Bugaje, 2006; Kebede et al., 2010; Greenstone and Looney, 2012; Castellano, Kendall, Nikomarov and Swemmer, 2015). Recently, arguments in support of climate change mitigation advocate pursuits of clean, economical and sustainable energy sources as a way of promoting sustainable development. Papua New Guinea, with its abundant natural resources, is bedevilled with a significantly underdeveloped power sector resulting in slow GDP growth.

The high cost associated with conventional energy sources and the associated environmental and climatic challenges, health hazards, foreign policy uncertainties, and national vulnerabilities to imported foreign goods in the midst of nationalistic taxation policies world-wide (Dincer, 2000; Omer, 2008; Greenstone and Looney, 2012) have spurred renewed calls for renewable energy innovations to advance sustainable development to meet the ever increasing demand for locally sourced energy (Painuly and Fenhann, 2002). To achieve this, there is the need to diffuse modern renewable energy policy innovations especially in developing countries where there are acute energy challenges (Hoekman et al., 2005).

Some significant improvements in the renewable energy sector which are largely driven by policy support include innovations in financing, falling prices and the use of renewables to advance technological developments (REN21, 2014). The current paradigm of renewable energy research has, therefore, focused on the importance and contribution of renewable energy innovations to the development of green economies and their minimal impact on climate change (Aglanu, 2018). Occupying a central position, PNG's Sustainable Development Goals embedded in Vision 2050 constitute the main system that relies on the efficient performance of eight subsystems (Figure 1). According to Renagi and Babarinde (2017), these subsystems (hard and soft variables) are interrelated and their healthy interactions can make or mar the success of the main system in the centre. The four equally important *hard* variables are: (i) Long-term Funding (ii) Competitive Capacity Building and Research (iii) National Energy Policy, and (iv) National REDD+ Strategy (NRS). **REDD+** refers to strategies to "**R**educe Emissions from **D**eforestation and forest **D**egradation, plus **(+)** conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks. The four equally important *soft* variables are: (i) Cultural Values and Public Participation (ii) Enforcement of Environmental Regulations (iii) EIA and Land-use Policies, and (iv) Sustainable Socio-Economic Opportunities. All the eight (8) subsystems should be accorded equal attention by the Government and other policy stakeholders when developing and funding a National Energy Policy for the country (Figure 1).

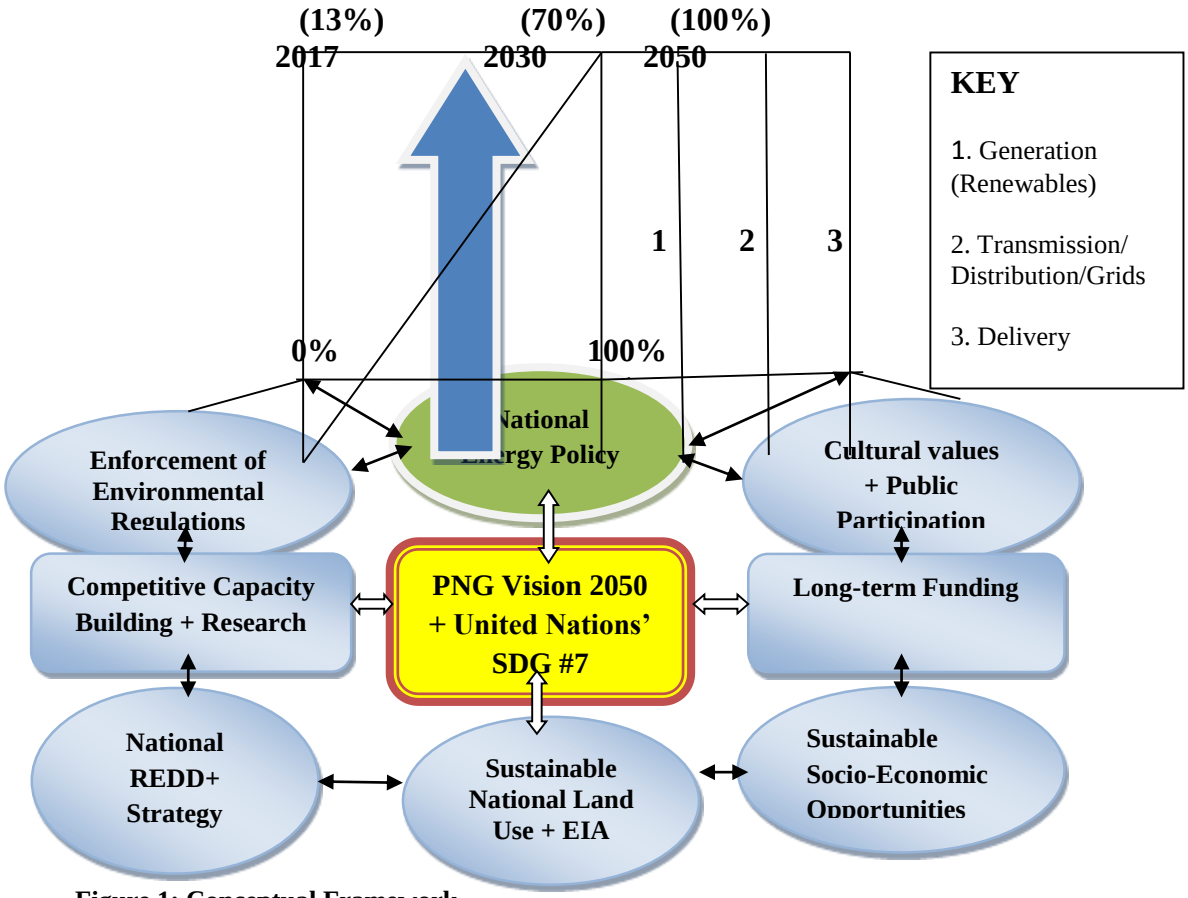


**Figure 1: Conceptual Framework**
**Sources: Authors, 2017 and 2018**

The PNG Energy Policy itself as a subsystem comprises three main sub-subsystems, namely: (i) Energy Generation (Renewables) (ii) Energy Transmission/Distribution/Grids Policy, and (iii) Energy Delivery. Invariably, all the eight sub-subsystems and the main system must be synchronised and strategically positioned to function harmoniously for purposes of city and national sustainability. Yet, a potential problem with this conceptual framework for PNG Energy System is that there is a huge gap between physical (urban and rural) planning legislation as presented by the PNG's Physical Planning Act 1989 on the one hand, and city liveability in the country on the other hand (Babarinde, Holis and Adu-Mcvie, 2016). In that recent study, empirical evidence supports the earlier finding in Mercer (2015) that had indicated that the cities of Port Moresby and Lae, which mirror other urban centres in PNG, have some of the lowest liveability rankings compared to other cities around the world. The lesson to be drawn from that important research finding about Port Moresby and Lae is that sustainable land use planning is a *sine qua non* for sustainable energy generation, distribution and delivery because good environmental planning promotes standard infrastructure design and management necessary for liveable towns and cities.

## METHOD

A total of 150 energy consumers in the various sectors of Lae industrial hub of PNG were orally interviewed in order to gather people's perceptions about energy supply in the country (Table 1). Oral interview was considered quicker and more suitable to this type of research as past experience has shown a usually very low response rate to survey questionnaires, which borders on apathy against public policies. Although respondents were asked to sum up their overall perception about their level of satisfaction with electricity supply or access, they were made to understand that their combined level of satisfaction in our context has seven components, namely: (i) Level of satisfaction with supply of electricity to their establishments/homes (ii) Affordability of energy tariffs (iii) Efficiency of power delivery (iv) Satisfaction with resolution of complaints (v) Sustainability of power options used in the country (vi) Adequacy of regulations and enforcement and (vii) Energy options currently available in PNG?. The consumer survey was considered particularly necessary in order to promote public and stakeholder participation in energy policy formulation. In addition, secondary data was obtained from a review of the literature on clean energy finance by international aid agencies, government policy documents and previous research findings relating to sustainable energy development in the Pacific region.

## RESEARCH FINDINGS AND DISCUSSION

The findings presented in this section of the paper mirror the perceptions of current consumers of electricity interviewed during our structured oral interviews, along with data on current energy situations in some similar Pacific Island nations. The Lae-PNG interviews targeted respondents' answers to the six satisfaction-related questions combined into a single composite question on *Level of Satisfaction* as listed in Table 1.

**Table 1: Electricity Consumers' Levels of Satisfaction with Current Energy Development and Access in Papua New Guinea (Note: *Level of Satisfaction* has five components as indicated in Table 1).**

| Overall Consumer Perception | Frequency | Percent |
|---|---|---|
| Very satisfied | 0 | 0.00 |
| Satisfied | 3 | 2.00 |
| Neither satisfied nor dissatisfied | 4 | 2.67 |
| Not satisfied | 23 | 15.33 |
| Very dissatisfied | 120 | 80.00 |
| **Total** | **150** | **100.00** |

**Source: Authors, 2018**

The findings in Table 1 indicate that the majority of electricity consumers interviewed (80%) are very dissatisfied with the current levels of energy development and access in the country. These findings are very consistent with previous findings (Tables 2, 3 and Figure 2), all of which indicate beyond any doubt that power development and access in PNG are less than optimal as only 20% of the total population in PNG (Table 2) have access to power supply.

**Table 2: Comparative Energy Access in the Pacific Island Countries, 2014**

| Country | GDP per capita (US$2010) | Electricity access (% population) | | | Access to modern cooking fuels (% population) |
|---|---|---|---|---|---|
| | | Total | Urban | Rural | |
| Fiji | 4,147 | 100 | 100 | 76 | 37 |
| Tuvalu | 3,619 | 99 | 99 | 97 | 30 |
| Samoa | 3,608 | 98 | 99 | 98 | 27 |
| Tonga | 3,588 | 95 | 100 | 91 | 63 |
| Marshall Islands | 3,329 | 90 | 94 | 81 | 41 |
| Vanuatu | 2,909 | 34 | 100 | 12 | 16 |
| Micronesia | 2,703 | 72 | 57 | 76 | 31 |
| **Papua New Guinea** | **1,784** | **20** | **76** | **12** | **25** |

**Source: PNG Energy Policy, 2018.**

In Figure 2, a World Bank study (World Bank, 2017) affirms that power consumers in Papua New Guinea experience power outages 42 times in a month on the average while Solomon Islands, another country in the same Pacific Islands Region, experiences power outages only five times in a month on the average.

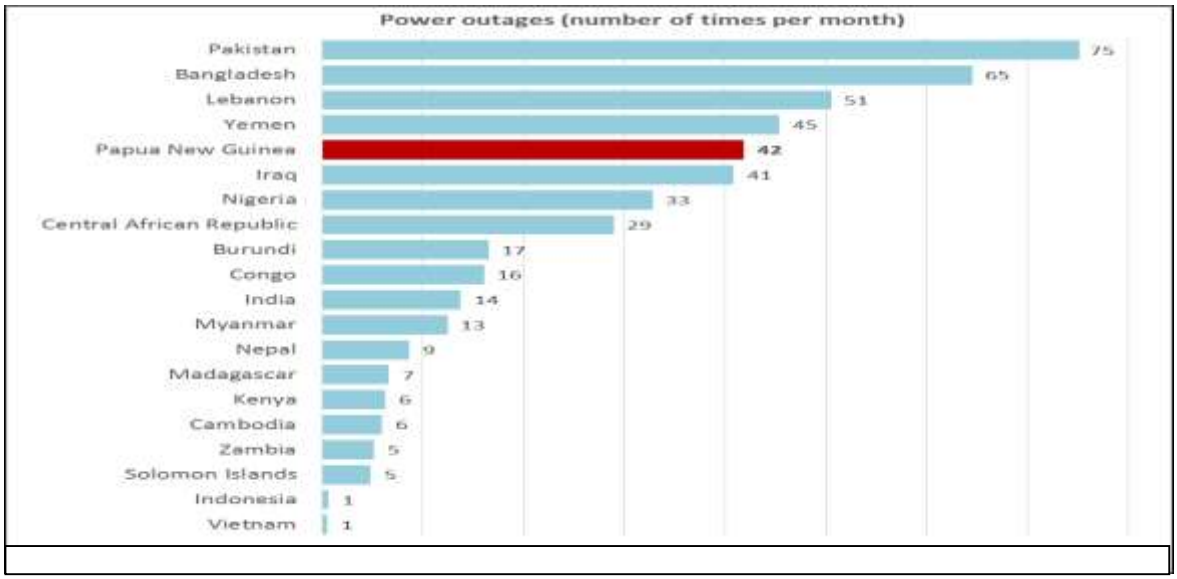


**Figure 2: Reliability of Energy Services in Selected Developing Countries: 2010-2015**
**Source: World Bank, 2017**

Yet, in the face of erratic power delivery to consumers, the affordability of power in Papua New Guinea is another troubling issue (Figure 3), which indicates that the country's energy consumers are charged about 39/kWh. Although the cost of electricity in PNG is less than those of Solomon Islands (94/kwh), Vanuatu (60/kWh) and Tonga (47/kWh), the cost is surprisingly higher than for Tuvalu (37/kWh), (Kiribati (33/kWh) and Samoa (33/kWh) that enjoy higher electricity access than PNG (PNG Energy Policy, 2018-2028).

| Price range (¢/kWh) | Country |
|---|---|
| >30 | **Solomon Islands**, **Vanuatu**, **Tonga**, New Caledonia, Jamaica, Niue, Cook Island, Belarus, American Samoa, **PNG**, **Marshal Islands**, **Tuvalu**, Denmark, **Kiribati**, **Samoa** |
| 20-30 | Belgium, Tahiti, Netherlands, Italy, Guyana, Portugal, Switzerland, Germany, Hungary, Chile, Ireland, **Palau**, Rwanda, UK, Japan, Uruguay, Canada, Finland, Australia |
| 10-20 | Spain, Mexico, New Zealand, Argentina, Jordan, Romania, Cambodia, Latvia, Philippines, Colombia, Croatia, UAE, Norway, Singapore, Israel, South Africa, France, **Fiji**, US, Taiwan, Lithuania, Uganda, Bulgaria, Moldova, Indonesia, Iraq, Iran |
| 5-10 | Peru, Turkey, Nigeria, Thailand, Nepal, Macedonia, Lao, Sweden, Russia, Vietnam, Georgia, Paraguay, Ethiopia, India, Ukraine, Kazakhstan, Bangladesh, Serbia, Iceland |
| <5 | Egypt, Uzbekistan, Brunei, China, Surinam, Trinidad & Tobago, Saudi Arabia, Myanmar, Bahrain, Kuwait |

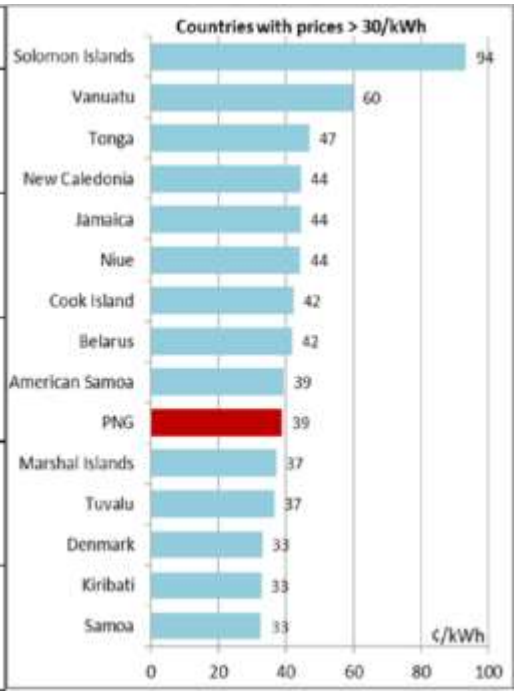


**Figure 3: Current Energy Affordability Levels in Selected Countries, including PNG.**
**Source: PNG Energy Policy, 2018**

**1.1 Research Question 1**: A reminder of our first research question: *How can we quantify the current gap between energy demand and energy access (supply) in Papua New Guinea?*

Going back to the research problem identified in this paper, we should be reminded that the level of energy generation and access in Papua New Guinea as of Year 2017 was only 13%, whereas it is projected that by Year 2030 a target of 70 percent electricity access to all households and 100 percent by Year 2050 will be reached using clean renewable energy resources. The findings in Tables 1 and 2 and in Figures 2, 3 and 4 unequivocally indicate that there is still a very huge gap between current level of energy development and desired level of energy access in PNG. For example, only 2 % of the respondents to our interviews are satisfied with the state of energy supply, while an alarming 80% are very dissatisfied in addition to another 15.33% who are not satisfied, giving a total of 95.33 % level of dissatisfaction with power service in the country. The same troubling picture looms large when Papua New Guinea is compared to most other countries in the Pacific region (Tables 2, 3 and Figures 2, 3 and 4).

**Table 3: Comparative GDP per capita, Electricity Access and Energy Affordability in Selected PICs, 2018**

| Pacific Island Country | GDP per capita (US$2010) | Total Electricity Access (Urban and Rural Areas) | Energy Affordability Level (c/kWh) |
|---|---|---|---|
| Fiji | 4,147 | 100 | 10-20 |
| Tuvalu | 3,619 | 99 | 37 |
| Samoa | 3,608 | 98 | 33 |
| Tonga | 3,588 | 95 | 47 |
| Marshall Islands | 3,329 | 90 | 37 |
| Vanuatu | 2,909 | 34 | 30+ |
| Micronesia | 2,703 | 72 | n.a. |
| Papua New Guinea | **1,784** | **20** | **39** |

**Source: Authors, 2018**

The scatter diagram in Figure 4 illustrates the linear relationship between GDP per capita and Electricity Access in selected Pacific Island Countries, including PNG, as of the Year 2010. The linear equation of $y = 0.038x - 47.58$ has a $R^2$ value of 0.785, which is a statistically significant coefficient of dual-variable determination and explanation of the positive correlation between "Electricity Access" and "GDP per capita." At this juncture, it is contended that even if "Quality of Life" index had been used in place of "GDP per capita" as argued by some people, there would be little or no change to this statistical finding because PNG's Quality of Life index is much lower than those of most, if not all, other countries in the Pacific Island region.

It is clearly visible on the scatter diagram that PNG has the lowest points of both variables, which also produce the fourth most expensive electricity cost of 39 /kWh (after Solomon Islands (94/kWh), Vanuatu (60/kWh) and Tonga 47/kWh) in the same Pacific region. Compared to the United Nations' Sustainable Development Goal #7 (Affordable and Clean Energy), which mandates every country (whether developed or developing) to "Ensure access to affordable, reliable, sustainable and modern energy for all" by Year 2030, it is indisputable that PNG's combined urban and rural electricity access of 20% is very low and unsustainable. The SDG targets for 2030 include access to affordable and reliable energy while increasing the share of renewable energy in the global energy mix. According to the UNDP (2015), the SDG 7 targets improving energy efficiency and enhancing international cooperation to facilitate more open access to clean energy technology and investment in clean energy infrastructure.

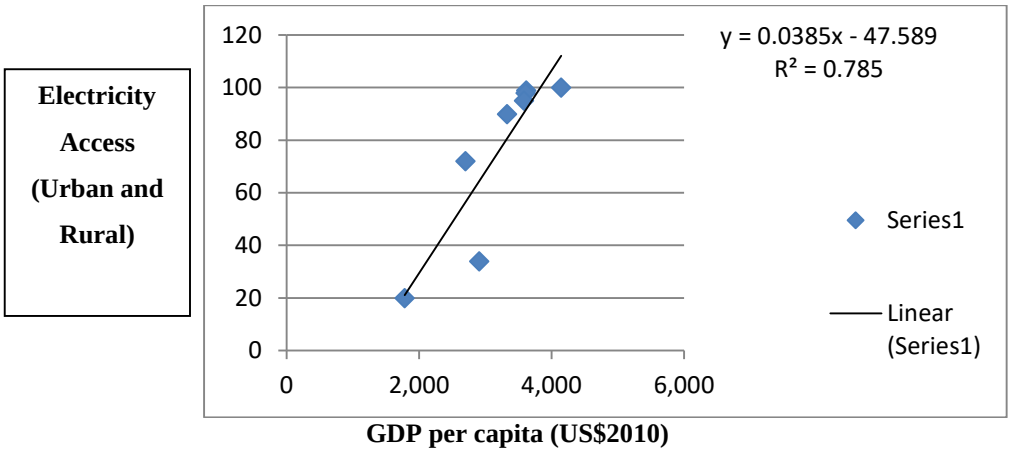


**Figure 4: Scatter Diagram of the Linear Relationship between GDP per capita (US$2010) and Electricity Access (Urban and Rural Areas) in Selected PICs, 2018**
**Source: Authors, 2018**

Furthermore, the United Nations' plans encourage particular attention to infrastructure support for the least developed countries, small islands and land-locked developing countries (UNDP, 2015). According to the UNICEF (2018), only 57% of the global population as of 2017 relied primarily on clean fuels and technology, falling short of the 95% target. Papua New Guinea is, no doubt, one of those countries that are yet to be relying primarily on clean fuels and technology. Therefore, in response to our first research question, there is still a considerably wide gap between clean energy demand and access (supply) in Papua New Guinea today.

**Research Question 2:** A reminder of our second research question: *How can PNG increase her clean energy generation, distribution and delivery from 13% to 70% by the Year 2030 and to 100% by the Year 2050 as proposed by the newly approved Energy Policy for the country?*

Based on our findings under the first research question, we must warn that the road to achieving the shortfall in clean energy generation, distribution and delivery in Papua New Guinea from 13% in 2017 to 70% in 2030 and then to 100% in 2050 will be a tough one, given the country's current economic hardship and the unresolved land use policy issues. However, all hopes are not lost because the government recently promised the nation that better times lay ahead (National Newspaper, 24 May, 2018, p.1), while the Department of Lands and Physical Planning has commenced serious work on designing a "Sustainable Land Use Policy" for the country (DLPP, 2017). Therefore, we have to lay aside all temptations of skepticism in answering our second research question.

Meeting future needs of power access in PNG boils down to budgetary and fiscal realities. In Section 1 of this paper, we outline twelve types of energy resources (PNG Energy Policy, 2018) currently being explored by the Government of Papua New Guinea to increase power generation and distribution to consumers in the country before the first magic Year 2030 (for 70% electricity access) and before the second magic Year 2030 (for 100% electricity access). The attainment of

these two milestones will require huge amounts of financial and manpower resources. In this section, we would like to explain some implications of the two milestones using available data as much as possible. In broad terms, we have permutated the budgets for electricity access up to 70% in 2030 and 100% in 2050. Let us assume that PNG's total expenditure including external grants for clean energy development, distribution and delivery since Independence in 1975 till 2017 was PNG Kina X. This combined expenditure has produced only 13% electricity access for the country as of 2017. Using simple algebra, we can interpolate as follows (Box 1):

**Box 1: Projected Expenditures on Provision of Electricity Access in Papua New Guinea in 2030 and 2050**

PNG Kina X spent on electricity access in 43 years = 13% (X includes external grants)
1 year electricity access = 13% ÷ 43 years = 0.3% per year (1975-2018)
Average yearly budget = X ÷ 43 years = PNG Kina X/43 per year since 1975
Assuming that the country can increase its expenditure by an average of 10% per year for the next 13 years (2030)
Then electricity budget per year for the next 13 years = X/43 + 0.1(X/43) per year till 2030
Needed electricity access before Year 2030 (13 years from 2018, inclusive) = 70% = 5.38% per year (70/13)
If the PNG's **Department of Finance** can confirm X, we would be able to determine the needed budget for electricity access of up to 70% by the Year 2030 as follows:

**Electricity Access (Year 2030) = PNG Kina 13[(X/43 + 0.1(X/43)(70/5.38)]** **Equation 1**

Similarly, the expenditure for electricity access of up to 100% by the Year 2050 (33 years hence) can be estimated:

**Electricity Access (Year 2050) = PNG Kina 33[X/43 + 0.1(X/43)(100/5.38)]** **Equation 2**

**Source: Authors, 2018**

In other words, PNG and its financial partners will have to be prepared to increase their combined expenditure on electricity generation, distribution and delivery and also explore the possibility of venturing into new sources of clean and renewable energy to reach the milestones of 70% and 100% access levels by the Years 2030 and 2050 respectively. Meanwhile, our two Equations 1 and 2 above could serve as a starting point in guiding the federal policy makers in the Departments of Finance and Energy who need to collaborate with all the relevant energy stakeholders in the country. It is to be noted that our equations are not prescriptive, but are rather meant to guide energy policy implementation in the years ahead.

The second strand of the initial preparations for reaching the two milestones is the need for the country to acquire the necessary technological manpower that will make its total energy access dream a reality. In line with our earlier advice (Renagi and Babarinde, 2017), following oral interviews held with a random sample of stakeholders of the PNG University of Technology, including PNG Power Limited (PPL), Government must partner with the universities, particularly Unitech and other research institutions, to continue to innovate appropriate curricula that are geared towards delivering quality graduates for immediate employment in the energy sector. "On their part, academic departments at Unitech must be diligent and proactive in conducting research programs in Energy Efficiency (using smart grids), Rural Electrification (using mini-grids), Solar Systems, Wind and Tidal Energy." "Their research should also focus on novel Energy Storage Systems, Biomass, Technology Transfer Centre for Renewable Energy, Patents, Innovations and an Entrepreneurial Hub for PNG" (Renagi and Babarinde, 2017).

Therefore, in order for us to answer the second research question, Papua New Guinea will need to proactively ensure that adequate financial and manpower resources are made available. The good

news is that the country is highly endowed with abundant natural resources needed to meet the necessary financial resources if it is really determined to do so. On the other hand, the reality on the ground is that the country has to start partnering proactively and diligently with the universities and research institutions in the country to develop suitable manpower and innovative researches that will make the electricity access dream a reality. Another good news is that the PNG Government's declaration of Lae City as an industrial hub for the country augurs well for the energy policy because the PNG University of Technology is located in Lae City. What needs to be done now is for both the Government and all the energy stakeholders to collaborate and map out strategies for empowering the Lae industrial hub to become an excellent centre and driver of innovations for achieving the country's clean energy goals for Years 2030 and 2050. The country certainly cannot afford to depend mainly on external aid and manpower resources to reach its SDG #7 and Vision 2050 goals if it truly wants to become an energy self-reliant and sustainable nation.

## CONCLUSION AND POLICY IMPLICATIONS

This paper is designed to appraise the recently lunched Papua New Guinea Energy Policy 2018-2028. In doing so the paper started with the overarching premise that energy is of vital importance to the sustainable development of the country because without access to modern reliable energy resources, economic development is impossible (Aglanu, 2018; World Bank and IEA, 2017; Wirth et al., 2003). Given this reality, the problem is that the level of energy generation and access in Papua New Guinea was only 13% as of 2017, whereas it is projected that by Year 2030 a target of 70 percent electricity access to all households and 100 percent by Year 2050 must be reached using renewable clean energy resources.

In order for us to critically examine the complex issues involved in reaching these two goals, we adopted the *General Systems Theory* to conceptualise the energy sub-system within a bigger system of an integrated PNG Vision 2050 and the United Nations' SDG #7. This is necessary because energy efficiency depends on its efficient interaction with complementary policy instruments in Papua New Guinea. In this direction, the United Nation's Sustainable Development Goal Number 7 and PNG Vision 2050 must be synergized with the four "hard" subsystems of (i) National Energy Policy (ii) Sustainable National Land Use and EIA Policy (iii) National REDD+ Strategy (NRS) and (iv) Long-term Funding. Simultaneously, the main system must also be in balance with the four "soft" subsystems of (i) Competitive Capacity Building and Research (ii) Enforcement of Environmental Regulations (iii) Cultural Values and Public Participation and (iv) Sustainable Socio-Economic Opportunities. We argue that for Papua New Guinea's Energy Policy to be successful, all of these eight subsystems and the main system (PNG Vision 2050 and the UN's SDG Number 7 for PNG) must work in unison.

Having analysed the survey interview responses obtained from 150 electricity consumers based mainly within the Lae industrial hub of the country, we proceeded to answer the two research questions in the paper. Our analysis of the first research question: *"How can we quantify the current gap between energy demand and energy access (supply) in Papua New Guinea?"* indicates that there is still a very huge gap between current levels of energy development and the projected levels of electricity access in PNG for Years 2030 and 2050. Only 2% of the respondents to our

survey are satisfied with the current level of energy access (supply), while an alarming 80% are very dissatisfied in addition to another 15.33% who are not satisfied, giving a total of 95.33% level of dissatisfaction with power service in the country. The same troubling picture looms large when Papua New Guinea is compared to most other countries in the Pacific Islands Region.

Analysis of our second research question – "*How can PNG increase her clean energy generation, distribution and delivery from 13% to 70% by the Year 2030 and to 100% by the Year 2050 as proposed by the newly approved Energy Policy for the country?"* - suggests that both the PNG Government and all the energy stakeholders and partners must collaborate and map out strategies for empowering the Lae industrial hub to become an efficient centre and driver of innovations for achieving the country's clean energy goals for Years 2030 and 2050. If this happens, it is contended that the two electricity access targets of 70% (2030) and 100% (2050) are achievable given the strengths of the country in terms of its natural resources endowment, and for the fact that the Lae industrial hub already possesses an enabling infrastructure base, including the PNG University of Technology, which can be harnessed as a centre and driver of technological innovations for achieving sustainable (affordable) clean energy for the country. Finally, the following are the key policy implications of the paper:

i) As implied by the conceptual framework, the first step towards ensuring the success of the PNG Energy Policy 2018-2028 is for the ongoing work by the Department of Lands and Physical Planning to design a Sustainable Land Use Policy for the country to be a huge success. This would involve a thorough review of the Physical Planning Act 1989 and all related Acts of Parliament and Government Policies dealing with customary land, land acquisition and compensation, including the Incorporated Land Groups Act 1974, as amended in 2009, etc. No Energy Policy can succeed where environmental planning is ineffective. Hence, huge government funding is needed to bridge the current gap between physical planning legislation and city liveability in PNG through urban renewal, legalisation and upgrading of all illegal settlements and installation of quality infrastructure services in villages, towns and cities.

ii) To close the gap between clean energy demand and supply (access) in Papua New Guinea, no effort should be spared by the Government to sustain and increase the existing levels of participation by international partners in proactively funding clean energy projects in Papua New Guinea, at affordable interest rates that would not enslave the country and its future generations under unbearable external "loan conditionalities;"

iii) Reliance on fossil fuels, such as coal, that would pollute the natural environment of Papua New Guinea, should preferably not be approved by the Government; and

iv) Active collaboration between the Government of Papua New Guinea and the academic and research institutions in PNG, particularly Unitech, should be encouraged to motivate the institutions to innovate appropriate curricula that are geared towards delivering quality graduates for immediate employment in the energy sector. On their part, academic departments at the universities as well as the National Research Institute (NRI) must diligently and proactively conduct cutting-

edge researches and offer courses in Energy Efficiency, Rural Electrification, Solar Systems, Wind and Tidal Energy. Their research should also focus on novel Energy Storage Systems, Biomass, Technology Transfer, Renewable Energy, Patents, and Innovations and how an Entrepreneurial Hub for PNG could be established and sustained.

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