

Going the Distance: Off-Grid Lighting Market Dynamics in Papua New Guinea

IN PARTNERSHIP WITH

LIGHTING PACIFIC
Catalyzing markets for modern off-grid energy
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The report has benefitted from inputs and feedback on drafts from several IFC team members. Specifically, the team would like to thank Russell Sturm, Itotia Njagi, Hemant Mandal, John Vivian, Camille Funnell, Salman Zahir, Sue Ahearn and Rwaidda Gharib.

Additionally, the Lighting PNG team would like to thank all external stakeholders for their open and frank inputs which have contributed immensely to the development of this report.

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ABOUT LIGHTING PAPUA NEW GUINEA

IFC's Lighting PNG program works to foster the growth of a sustainable market for modern off-grid energy in Papua New Guinea, with a focus on solar lighting products & appliances, and solar home systems. The program is designed with a series of interventions to remove specific barriers that include market spoilage created by poor products, lack of information on – and access to – distribution channels, lack of financing for companies and consumers, and lack of awareness that quality solar appliances are affordable, viable solutions.

For more information visit: www.lightingglobal.org

COVER PHOTO

Interaction during Lighting PNG's 'Gutpla Solar, Gutpla Life' Consumer Awareness Campaign

Foreword

Access to sustainable and clean energy, even the ability to be able to have a simple light at night to read or study, can have a huge positive impact for those people in need.

For a country like Papua New Guinea, which is undergoing economic and social transformation, the ability of its people and its businesses to access energy has been a challenge.

Papua New Guinea has, in fact, one of the most acute energy access challenges in the world. Only 13 percent of the population of over eight million people are connected to the electricity grid.

Yet, as this report shows, in just five years Papua New Guinea has achieved dramatic growth to become a leader among developing countries in the use of off-grid solar products.

A remarkable 60 percent of Papua New Guinean households are now using off-grid solar technology with off-grid solar lighting products, and battery-based torches and lanterns, now effectively replacing kerosene lamps.

This is an immense change in a diverse challenging country – there are more than 800 different languages spoken among a people divided into more than 10,000 ethnic clans living across 600 islands. Over 80 percent of people live in rural areas, yet with only 18 people per square kilometer, Papua New Guinea is one of the least densely populated countries in the world. Its steep mountains which stretch across the main island, with elevations of over 4000 meters, adds another layer of complexity to infrastructure and business development.

It's in this environment that IFC's Lighting Papua New Guinea program has been able to demonstrate impact by developing a market for quality verified solar products. Market penetration of quality verified

solar products is now at over 17.5 percent up from nearly zero in mid-2013 when the program started implementation.

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 was 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 an ability to charge a phone.

The report's findings reveal a dynamic market, with substantial opportunities for companies willing to invest time and effort in operating in a challenging environment. It's evident in the numbers – the market for lighting solutions in PNG is estimated at \$259 million a year and is expected to grow over the next five years. The report's focus on the demand and supply sides will help companies understand market potential, in-country challenges, and the opportunities for growth.

It's clear Lighting PNG has been able to help catalyze the quality verified off-grid solar market in the country. But there is still tremendous opportunity to build partnerships, deepen reach, and leverage disruption and technological innovation to continue to increase access and support productive uses.

Along with grid electrification efforts being pursued by the Government of Papua New Guinea, we believe off-grid energy will remain a cornerstone of the country's energy supply strategy.

For IFC's part, we look forward to working with both the public and private sectors to help build the market for quality-verified off-grid solar products and increasing the reach of those products into the communities that need them most.



Thomas Jacobs

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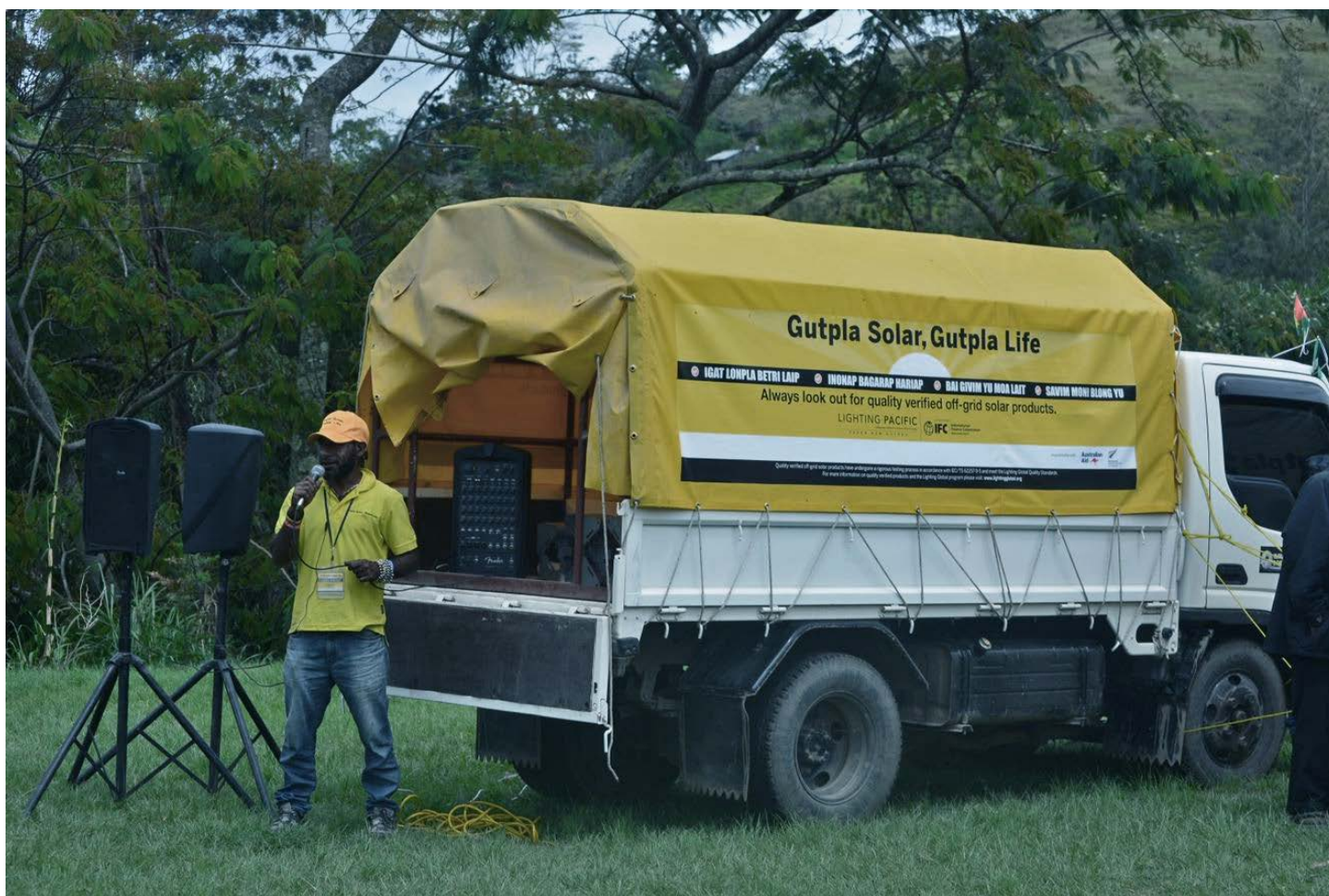


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Key Definitions

Term	Definition
Off-grid population	Population without access to electricity from the national grid.
Tier 1 electrification	Access to 3 to 50W electricity to power basic lights and mobile-phone chargers. These systems provide power to a household for a minimum of four hours a day, of which one hour must be in the evening. ¹
Lighting products	Products used to light a household or a commercial area. Includes: firewood, candles, kerosene lamps, battery-powered flashlights and lamps, and solar photovoltaic-powered lighting products.
Off-grid solar (OGS) products	Solar photovoltaic-powered off-grid energy products including pico solar-lighting products, plug-and-play solar home systems (PnP SHS), and component-based systems.
Quality-verified products	OGS products that have undergone a rigorous testing process in accordance with IEC/TS 62257-9-5 and meet the Lighting Global Quality Standards . ² All products with peak power of 10W or less carry a minimum one-year warranty, while larger products, up to 350W, carry a warranty of at least two years.
Generic products	OGS products that have not been tested in accordance with Lighting Global Quality Standards.
Plug-and-play solar home system (PnP SHS)	OGS products with peak photovoltaic (PV) module power of 10 to 350W, typically powering multiple lights and DC-powered appliances. These products support full Tier 1 electrification or higher electricity access for households. ³
Component-based systems	OGS products for which components like PV panels, batteries, and inverters are bought separately (modular structure).
Pay-as-you-go (PAYGO)	A business model that allows end-customers to pay for an OGS product in installments instead of up front.
Layby	Installment plan used in PNG that typically involves a 10 to 20 percent deposit and the retailer holding the item until a specific portion of the total price has been paid.
Lot shops	A type of shop, with earliest versions housed in shipping containers, selling generic lighting products, hardware items, toys, clothing, and groceries. Products sold in these shops are typically manufactured in China, and very affordable.
Public Mobility Vehicle (PMV)	PMVs are trucks used by villagers to commute to cities and towns for shopping. They usually leave from the village in the morning and bring back the villagers and their purchases in the evening.
Papua New Guinea Kina (PGK)	The Papua New Guinea Kina (PGK) or kina is the official currency. An exchange rate of 3.25 kina to \$1 is used in this report. ⁴

¹ The World Bank, ESMAP, Beyond Connections: Energy Access Redefined, July 2015 ([link](#))

² IFC Lighting Global Quality Standards ([link](#))

³ IFC Lighting Global Quality Standards and Lighting Global, Off-Grid Solar Market Trends Report, 2018 ([link](#))

⁴ Currency conversion dated January 3, 2019 from xe.com ([link](#))

Executive Summary

Off-grid solar (OGS) lighting in Papua New Guinea (PNG) is a success story. Since 2012, sales have grown at an annual average rate of 68 percent, increasing market penetration from 2 to 60 percent of households. PNG today has one of the highest prevalence rates of use of off-grid solar lighting in the world. It is due to several factors. A key issue is the country's persistent low grid electrification rates. Only 13 percent of the population is connected to the grid. The study shows people have enough disposable income to afford the lighting products. Other factors include the spread of a mid-mile distribution network (particularly of "lot shops"), and the introduction of the Lighting Papua New Guinea program in 2014, which helped increase awareness of off-grid lighting solutions and supported an estimated 17.5 percent market share for quality-verified products.⁵

MARKET

The market for lighting solutions in PNG is currently at \$259 million per year and will grow over the next five years. While the Government of Papua New Guinea (GoPNG) plans to invest in grid electrification, off-grid energy will remain a cornerstone of the energy-supply strategy. Households in this lower middle-income country usually have enough disposable income to purchase lighting products, spending on average about \$192 a year. The addressable market encompasses more than 93 percent of PNG's population, or 1.35 million households.⁶

60 percent of PNGs households own off-grid solar lighting, making it the second-most favored off-grid lighting product after battery-powered flashlights. This market penetration is significantly higher than in other off-grid solar lighting markets, such as India, Nigeria, Bangladesh and Myanmar. Between 2014 and 2018, the relative market share of different types of lighting products changed dramatically, with off-grid solar products effectively replacing kerosene lamps.

Between 2012 and 2017, annual off-grid solar sales grew 68 percent from around 30,000 to more than 400,000. In 2017, one in every four PNG households purchased an off-grid solar product. Between 2014 and 2017, 224,000 quality-verified products were sold, generating total revenue of \$13.8 million. PNG's market share of quality-verified products is estimated at 17.5 percent, and the remaining 82.5 comprises generic products.

Total sales revenues for off-grid solar products in 2017 were estimated at \$10.9 million, or around 4 percent of PNG's overall lighting market. 94 percent of off-grid solar products currently in use are pico products. Of those, 40 percent are pico one-light systems and 38 percent are the larger pico products with three or more lights. Plug and play solar home systems (PnP SHS) and component-based systems are only used rarely in PNG, but **hold significant promise for future development.**



⁵ Estimated as at end of 2017

⁶ The World Bank, Papua New Guinea Electrification Project (P159840), Project Information Document/Integrated Safeguards Data Sheet (PID/ISDS), updated: April 10, 2017, Report No: PIDISDSC19714 ([link](#)), Statista, Papua New Guinea: Urbanization from 2007 to 2017", accessed January 4, 2019 ([link](#)) and stakeholder and supplier interviews by TFE Energy. Estimates may not add up to totals due to rounding. The addressable market encompasses households without grid connection as well as households with very unreliable grid power supply

DEMAND

Product satisfaction levels among users of quality-verified products are significantly higher than among users of generic products. 87 percent of users are satisfied with their quality-verified products and 63 percent say they are very satisfied. Among users of generic products, 25 percent are very satisfied. 61 percent of generic-product users find their lights not bright enough, as compared to only 25 percent of quality-verified product users. Generic products are also seen as requiring repairs more than twice as often as quality-verified products.

While all quality-verified products come with a warranty, as many as 62 percent of owners **are not** aware of the warranties. In addition, 39 percent of users think they own a quality-verified product but purchased it through sales channels that only sell generic products. The proliferation of **generic products** appears to have lowered quality (lifetime) expectations of off-grid solar in general.

The price of quality-verified products is, on average, around 30 percent higher, compared to generic products. The largest difference in **price** was observed in the category of pico one-light systems, where **quality**-verified products cost nearly twice as much as generic ones. For larger products, the cost **difference seems to be lower**. At the same time, customers of quality-verified products earn on average about 27 percent more than those who buy generic products. 82 percent of customers purchased their off-grid solar product with cash. 17 percent received it as a gift. Financing schemes through banks and microfinance institutions have not been a strong feature of the market to date and pay-as-you-go (PAYGO) offerings are at very early stages of implementation.

Customers often make purchase decisions in favor of products which are conveniently available to them. This factor might be as important, if not more important, than product price, functionality, and quality, especially for less expensive pico products.

SUPPLY

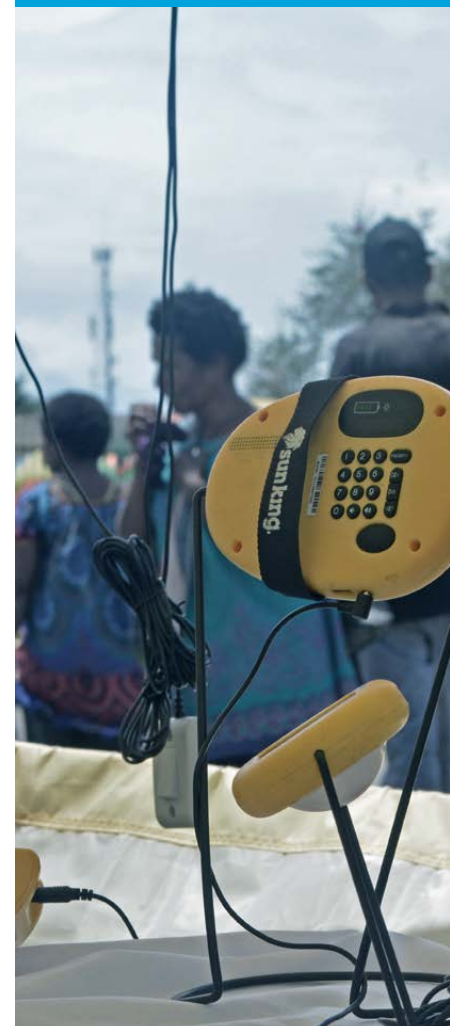
42 percent of off-grid solar products are purchased in large general stores known as lot shops. These are all generic products. Quality-verified ones are not sold in lot shops. Lot shops have grown very rapidly over the past three years and now reach many mid-mile sales points. However, just over half of off-grid solar products, including 82 percent of quality-verified products, are still sold in cities and large towns.

Almost all off-grid solar products, whether quality-verified or generic, are imported from China. While shipping costs to PNG are high, the customs clearance process for the products in the ports of Lae and Port Moresby in PNG is streamlined and fast. There are no applicable duties.

Quality-verified and generic products have entirely different supply routes, and different strategies are deployed to sell them. Quality-verified products are typically shipped to the capital, Port Moresby. Reaching markets beyond the capital is expensive. By contrast, containers with generic products are usually shipped to the more strategically located port at Lae. However, as their reach expands, companies with quality-verified products are starting to take products directly to Lae. Generic products arrive at shorter intervals than quality-verified products and usually carry a mixed cargo of products for off-grid consumers. This, together with a deeper reach into mid-mile markets, gives generic products a clear supply advantage over quality-verified products.

Suggestions for Market Growth

Despite the already high market penetration of off-grid solar in PNG and the comparatively high market share of quality-verified products, there are many options to further increase sales. Starting points include mimicking successful supply-chain practices of generic product suppliers, continuing dedicated marketing efforts to highlight quality differences, strategically timed and directed sales efforts, and developing or supplying products that can break into new markets, such as portable flashlights and - or - plug and pay solar home systems.



Scope, Purpose, and Methodology of the Study

IFC's Lighting Papua New Guinea (Lighting PNG) program focuses on building the market for quality-verified off-grid solar products in PNG. The program activities include market research to help companies make informed business decisions. This report presents a view of current market dynamics and builds on an earlier report on PNG's solar-lighting market published by IFC in 2014.⁷ Since then, the market has seen significant growth and change.

This report analyses both the demand and supply dynamics of the OGS market. From a demand perspective, it looks at current lighting usage by consumers, as well as their willingness to pay, purchasing criteria, and perception of both quality-verified and generic OGS products. From a supply perspective, it evaluates the current state of supply chains, distribution channels, procurement dynamics, and supply bottlenecks.

A survey of 703 households covering nine districts across PNG's four regions was conducted in May and June 2018 to understand market demand. In all, 40 villages were visited, and 3,341 respondents surveyed. Survey locations were chosen to ensure the results were statistically relevant and representative for the entire country.⁸

Table 1: Survey scope for the demand-side analysis⁹

4 Regions	9 Districts	40 Villages	703 Households (hh)	3,341 Participants (ppl)
1 Papua	1 Rigo	6	160hh	702 ppl
	2 Northfly	15	143hh	666 ppl
2 Momase	3 Kaiapit	2	24hh	133 ppl
	4 Markham	8	136hh	672 ppl
3 Highlands	5 Daulo	1	35hh	177 ppl
	6 Goroka	2	48hh	220 ppl
	7 Lufa	1	32hh	154 ppl
	8 Ungai Bena	2	45hh	235 ppl
4 Islands	9 Kavieng	3	80hh	382 ppl

⁷ IFC, Lighting Papua New Guinea, PNG Off-Grid Lighting Market Analysis, 2014 ([link](#))

⁸ The sample size is statistically significant at a 95 percent confidence level, within a confidence interval of 5 for PNG's current population estimated at 7.63 million inhabitants. The respondents were distributed across the 14 survey sites across Papua Region, Momase Region, Highlands Region, and Islands Region.

⁹ Analysis: TFE Energy; Survey data: Anglo Pacific Research

The survey focused on OGS products. It asked if people were aware of and using OGS and, if so, where and at what price they bought them. The survey also asked about people's expectations and purchasing criteria were with respect to functionality, quality, and performance. Responses from owners of other lighting products were also gathered to build a comprehensive picture.

The supply-side analysis is built on primary information from market participants. The authors of the report interacted with a representative number of manufacturers, distributors, importers, government bodies, and international organizations to better understand challenges and opportunities. Site visits were conducted to substantiate and test findings. Stakeholders who contributed to this market research are listed at the end of the report.



SECTION I:

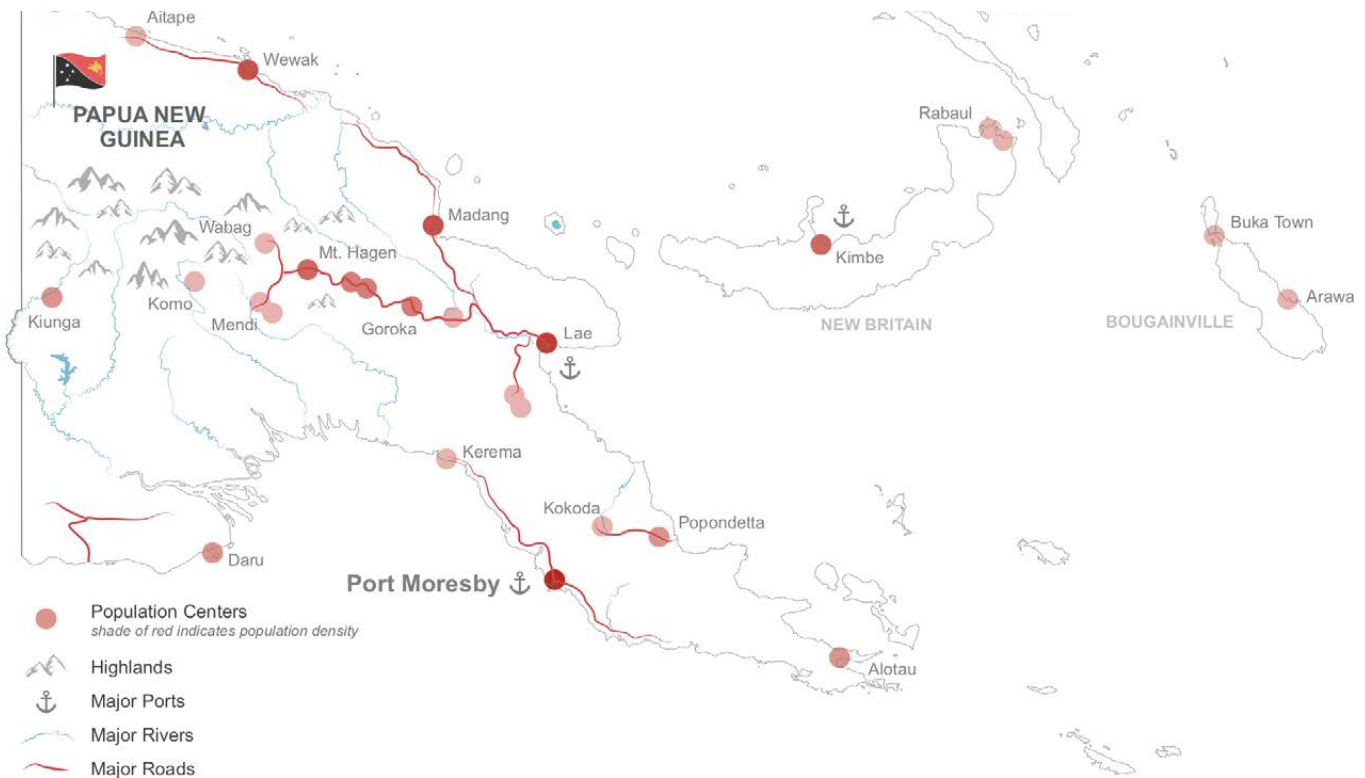
PNG Country Overview



A. Geographic and Political Background

Papua New Guinea, officially the Independent state of Papua New Guinea (PNG) is an Oceanian country in the southwestern Pacific, bordering Indonesia to the west and Pacific Island countries to the east. It has a population of over eight million people and over 800 different spoken languages making it one of the most culturally diverse countries in the world. The capital, Port Moresby, is the country's largest city with around 310,000 inhabitants. The second largest city, Lae, is the main port and an industrial hub with a population of 76,000. With a per capita GDP of \$2,745 in 2015, PNG is considered a lower-middle income country.¹⁰

Figure 1 Geographic features of PNG ¹¹



¹⁰ The World Bank, PNG Economic Update, December 2017 ([link](#))

¹¹ Original image from World Population Review, "Papua New Guinea Population 2018", accessed January 4, 2019 ([link](#))

PNG's challenging geography and demography adds complexity to infrastructure and business development. Steep mountains stretch across the main island of Papua, reaching elevations of over 4,000 meters. In addition, the country encompasses more than 600 smaller islands. Most are not easily accessible. Dense forests and rivers contribute to the isolation of individual populations. About 87 percent of PNG's population lives in rural areas.¹² At only 18 people per km², PNG is one of the least densely populated countries in the world.¹³

PNG has only one major roadway, the Highlands Highway, which connects the Highlands Region with coastal areas. Port Moresby is connected to most of the country only by expensive air routes and by sea. Many rural roads, and even sections of the Highlands Highway, are rugged and require heavy duty vehicles to traverse them, making transit both challenging and expensive. These connectivity challenges throughout the country inhibit the government's ability to provide services such as basic healthcare, education, electricity, and drinking water. As in many other developing countries, the telecommunications sector is the outlier in terms of infrastructure development. In 2016, there were 47 mobile-phone subscriptions for every 100 citizens, up from two only 10 years earlier.¹⁴

The country has a relatively stable democracy with an economy dominated by the extractive sector and agriculture. The extractive industry relies heavily on the country's rich metal ores and hydrocarbon resources and accounts for most of its export earnings. The agricultural sector employs an estimated 80 percent of the population and accounts for 27 percent of GDP.¹⁵ A recent global fall in prices of key commodity products and extractives has sharply reduced GDP growth; it fell from 8 percent in 2015 to between 2 and 2.5 percent from 2016 to 2018.¹⁶ The Economist Intelligence Unit (EIU) describes PNG's economic prospects as "weak", predicting average annual growth of 3.1 percent from 2018 to 2022.¹⁷

The Wantok system

The fundamental building blocks of PNG's society are the extended families. These are centered on the tribal (linguistic) roots of a person, called the "Wantok" ("one talk") system. If one member of a Wantok faces difficulties, other members are obliged to assist in any way they can. In a country with limited social services, where one-third of the population lives below the absolute poverty line of \$1.25 of per day¹⁸, the Wantok system provides a crucial safety net and support network¹⁹. Off-grid solar lighting products (OGS products) are often given to individuals by relatives or by politicians as gifts within the Wantok system.



12 Statista, "Papua New Guinea: Urbanization from 2007 to 2017", accessed January 4, 2019 ([link](#))

13 World Population Review, "Papua New Guinea Population 2018", accessed January 4, 2019 ([link](#))

14 The World Bank, "Mobile cellular subscription (per 100 people)", accessed January 4, 2019 ([link](#))

15 The World Bank, PNG Economic Update, December 2017 ([link](#))

16 Ibid.

17 Economist Intelligence Unit, country report Papua New Guinea ([link](#))

18 World Population Review, "Papua New Guinea Population 2018", accessed January 4, 2019 ([link](#))

19 IFC, Lighting Papua New Guinea, 2014 ([link](#))

B. Electrification Scenario

1. CURRENT ELECTRIFICATION STATUS

PNG’s electrification rates are low. The National Energy Policy for 2018 to 2028 and the World Bank’s 2017 electrification analysis using nighttime satellite imagery **estimate the electrification rate to be 13 percent.**²⁰ This is even lower than the earlier World Bank estimate of 18 percent. By comparison, neighboring Indonesia claims almost total electrification and the Solomon Islands has, in the past two decades, surpassed Papua New Guinea with an electrification rate of almost 50 percent.²¹ In addition, even in areas that are electrified, the quality of supply is inadequate (figure 3).

Figure 2 Grid electrification in select countries (in percentage, 1990 to 2016)²²

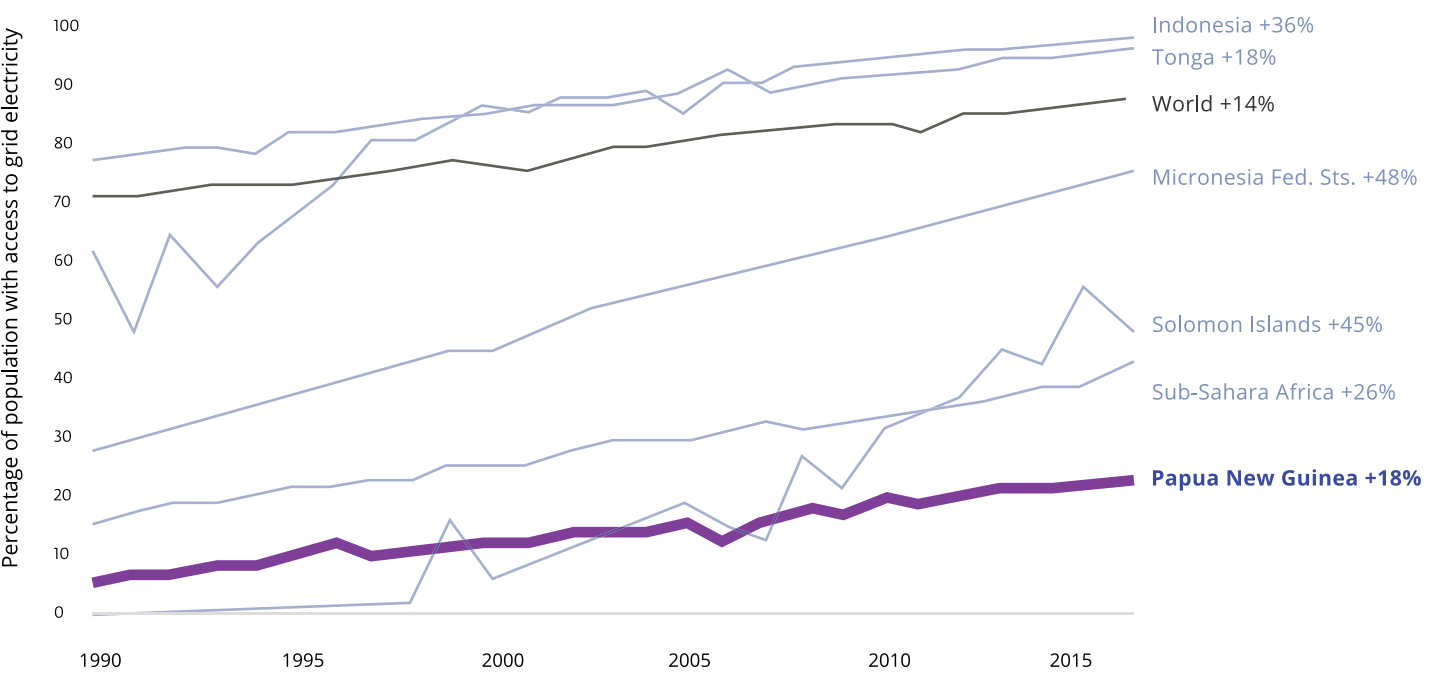
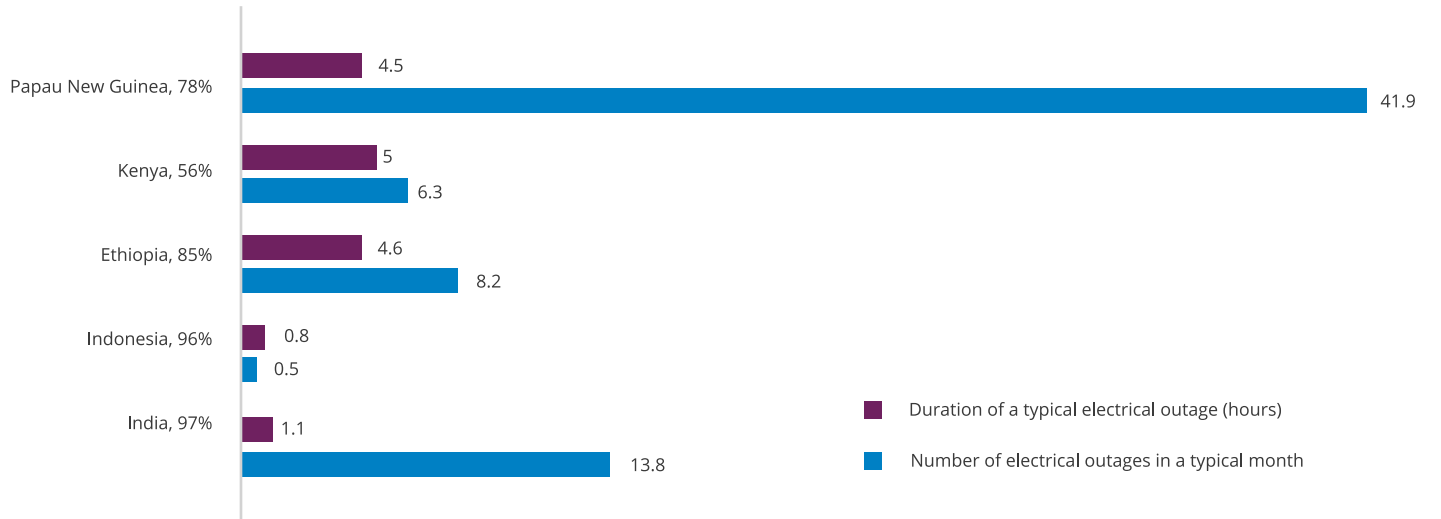


Figure 3 Urban grid reliability in select countries (in percentage, 2013 to 2015)²³



20 PNG National Energy Policy 2018 to 2028

21 The World Bank, “Access to electricity (% of population)”, accessed January 4, 2019 ([link](#))

22 The World Bank, Access to electricity (% of population)”, accessed January 4, 2019 ([link](#)). The electrification rate for PNG (above 20 percent) has been revised by a more recent estimate of 13 percent but is kept here for comparative purposes.

23 Lighting Global, Off-Grid Solar Market Trends Report 2018 ([link](#))



OvSolar products on display at a Lighting PNG consumer awareness activity.

As of 2017, PNG had a total power-generation capacity of 580MW, sourced primarily from hydropower plants (39 percent) and thermal generation—mainly diesel (60 percent).²⁴ In addition to Papua New Guinea Power Limited (PPL), the national utility company, independent power producers (IPPs) comprise a large part of generation capacity with many large mining sites and manufacturers relying on captive power generation. Some IPPs also provide electricity to nearby villages.²⁵

PNG does not have a contiguous national electricity grid. The country has three grid islands, with transmission infrastructure, and 19 smaller grids. PPL's oldest and most stable grid is located in the northeastern island of New Britain, where it supplied power to mining operations for decades. The two other major grids serve the cities of Lae and Port Moresby and their respective peripheries. The 19 smaller grids deliver power to 26 urban areas.²⁶ In total, the

entire transmission and distribution network of the country runs for only 7,000 kilometers.²⁷

2. PAPUA NEW GUINEA'S ELECTRIFICATION STRATEGY

The National Energy Policy for 2018 to 2028²⁸ published by the Department of Public Enterprises and the Department of Petroleum and Energy, aims to support the development of a modern, more renewable-energy based system. It targets 70 percent electrification by 2030. The policy document mentions establishing a designated National Energy Authority, the Energy Regulatory Commission (ENERCOM), the formulation of a Renewable Energy Policy, the unbundling of PNG Power Limited (PPL), and net metering tariffs for electricity generated from renewable-energy sources. Further, the document proposes new energy financing incentives to attract independent power producers. One option discussed is the creation of an Electrification Trust Fund, which would advance sustainable and financially viable power generation in rural areas.

²⁴ PNG National Energy Policy 2018 to 2028

²⁵ PNG National Energy Policy 2018 to 2028 and The World Bank, Papua New Guinea Electrification Project (P159840), Project Information Document/Integrated Safeguards Data Sheet (PID/ISDS), updated: 10-Apr-2017, Report No: PIDISDSC19714 ([link](#))

²⁶ The World Bank, Papua New Guinea Electrification Project (P159840), Project Information Document/Integrated Safeguards Data Sheet (PID/ISDS), updated: April 10, 2017, Report No: PIDISDSC19714 ([link](#))

²⁷ Stakeholder and supplier interviews by TFE Energy

²⁸ PNG National Energy Policy 2018 to 2028

Grid extension requires an estimated investment of \$1.1 to \$1.4 billion, at an average cost of \$1,035 to \$1,274 per household connected.²⁹ Funding will need to be supplemented from donors or investors. The recently concluded Asia-Pacific Economic Cooperation (APEC) 2018 meeting in PNG provided an encouraging start, with Australia, the United States, Japan, and New Zealand offering support.³⁰

In addition to financial constraints, there are other challenges to extending the grid into remote regions of the country. These include: strengthening a grid network that cannot support further loads, high grid losses (of 20 to 30 percent),³¹ and difficulties in recovering payments.

Further, there are economic concerns surrounding the affordability of power. New connections to PPL power are expensive, at a fee of 750 kina to 1,000 kina (\$230 to \$308); and the price can be as high as 1 kina (\$0.30) per kWh for power that is, in many cases, unstable and unreliable.

Despite several market challenges, PPL remains committed to improving grid reliability and providing new connections to households located close to existing power lines and less than a kilometer from a transformer.³² Through this approach, on average,

around 1,600 new households are connected each year,³³ but this will **need to increase to 90,000 new connections to meet the government's electrification goals.**³⁴

A recent National Electrification Roll-Out Plan (NEROP) study assessed least-cost opportunities to help meet PNG's 2030 target of 70 percent electrification. Grid extension is not expected to be least cost for at least 25 percent of all households. **Distributed energy and lighting-product solutions will continue to play an important role in PNG's electrification strategy.**

To accelerate development of this market, the PNG government intends to support off-grid electrification through OGS products.³⁵ Under the National Energy Policy for 2018 to 2028, the Department of Petroleum and Energy plans to regulate solar products entering the market by submitting them to a quality-certification process. In addition, the department intends to set up an agency to look at ways to make off-grid solar products more commercially attractive.³⁶

29 The World Bank, Papua New Guinea Electrification Project (P159840), Project Information Document/Integrated Safeguards Data Sheet (PID/ISDS), updated: April 10, 2017, Report No: PIDISDSC19714 ([link](#))

30 David James, "PM signs Papua New Guinea Electrification Partnership with Australia, U.S., Japan, and New Zealand", Business Advantage PNG, November 21, 2018 ([link](#))

31 Stakeholder and supplier interviews by TFE Energy

32 Stakeholder and supplier interviews by TFE Energy. Geospatial analysis.

33 Stakeholder and supplier interviews by TFE Energy

34 Ibid.

35 Mini-grids, while still in a piloting stage, could be an alternative or additional option. The New Zealand High Commission has explored the possibility of building three mini-grids near Ambunti in North-Western Papua. However, the feasibility study has raised concerns about their economics. Cost estimates came to \$5.5 million to \$6 million for three mini-grids connecting 850 households, or more than \$6,400 per household. The cost of power was estimated at around 5 kina (\$1.52) per kWh. The New Zealand High Commission is now exploring the option of providing solar home systems to the villages instead. (Based on TFE Energy interviews with the New Zealand High Commission and PPL.)

36 Stakeholder and supplier interviews by TFE Energy

SECTION II:

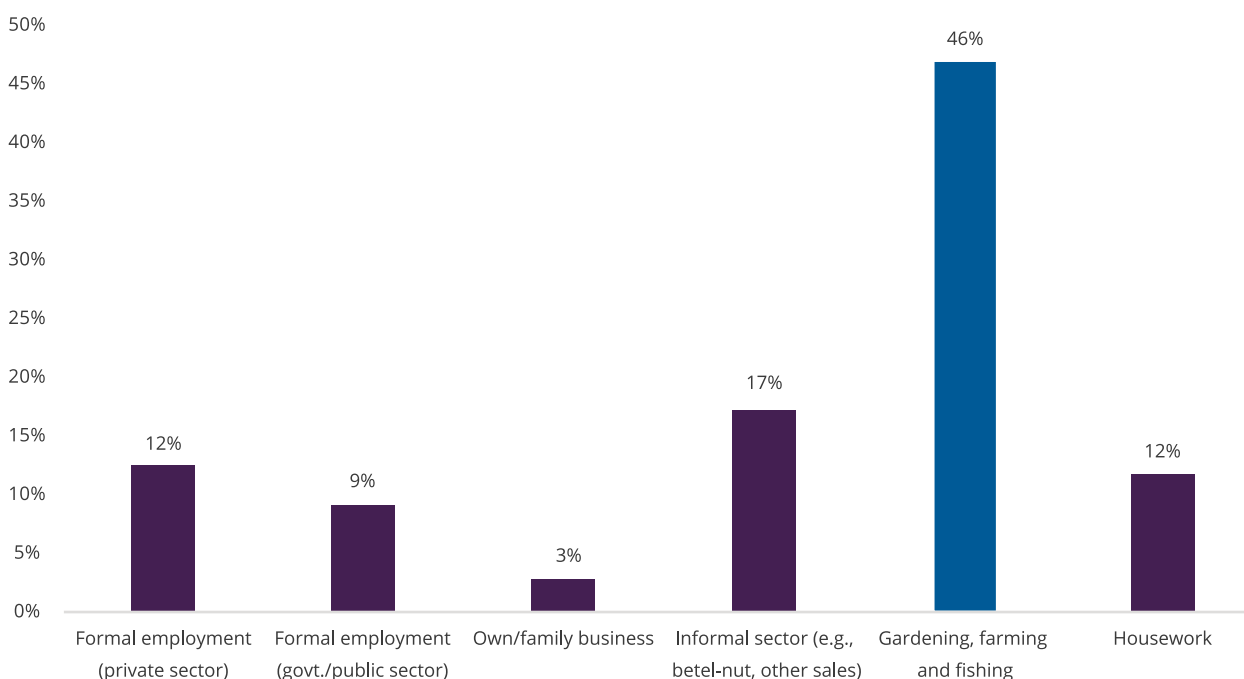
Off-Grid Lighting Market



A. Household Income and Spend on Lighting Products

Agriculture is the main source of livelihood for 80 percent of PNG's population.³⁷ It is dominated by subsistence farming, which generates little disposable income. However, in recent years, the number of households that have started to cultivate cash crops for additional income has risen.³⁸

Figure 4 Main source of employment for men and women in PNG (2018)³⁹



During the market survey, almost half of the respondents cited farming, gardening, or fishing as the primary source of income. This is followed by wages from formal employment in the government or the private sector.⁴⁰ In PNG, wage earners are typically between ages of 18 and 30, who have migrated to cities or urban centers in search of employment. The income they earn is often sent to their rural family households through an established remittance network. Remittances often come in the form of gifts of food, clothing, and electronic gadgets, including OGS products.

³⁷ The World Bank, PNG Economic Update, December 2017 ([link](#))

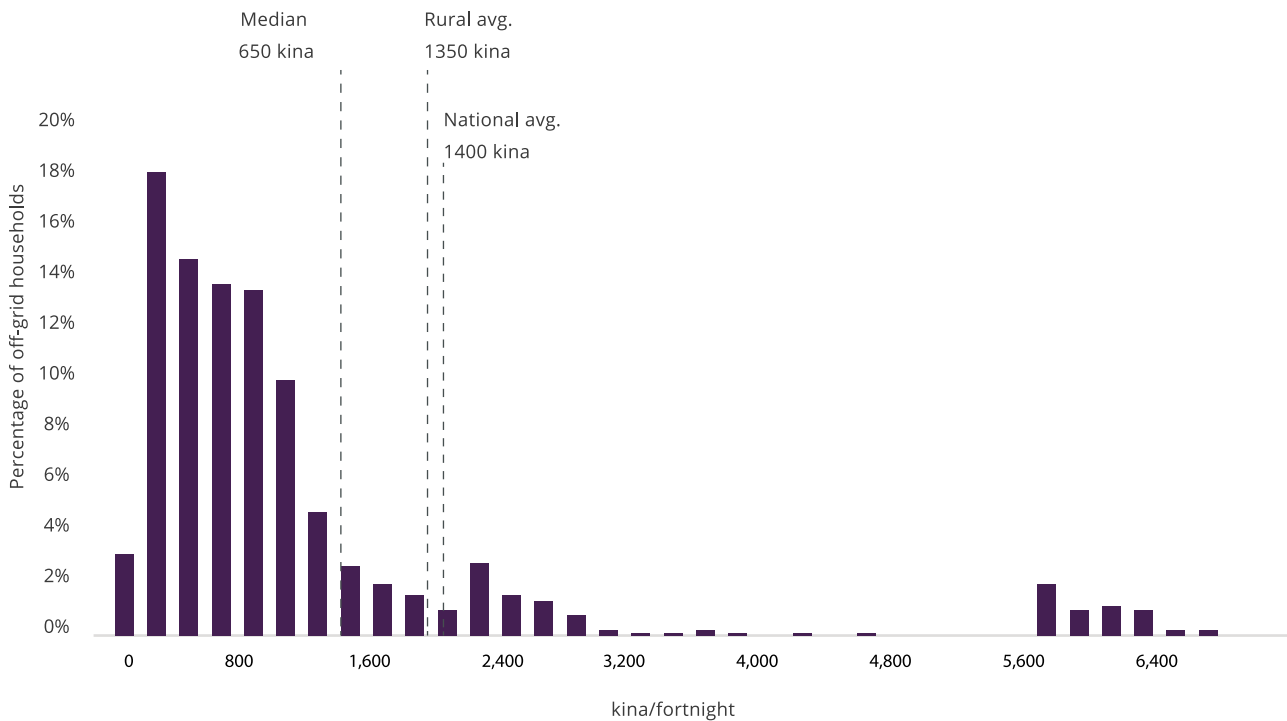
³⁸ World Bank Group, PNG Agriculture Commercialization and Diversification Project (P166222) ([link](#))

³⁹ Analysis: TFE Energy; Survey data: Anglo Pacific Research

⁴⁰ Ibid.

The survey data of rural households shows an average income of 1,350 kina per fortnight (\$830/month).⁴¹ However, since the data shows some extreme outliers on the high-income side, the median value of 650 kina per fortnight (\$400/month) might better reflect the income of potential OGS customers.⁴²

Figure 5 Household income distribution in rural PNG (in kina per fortnight, 2018)⁴³

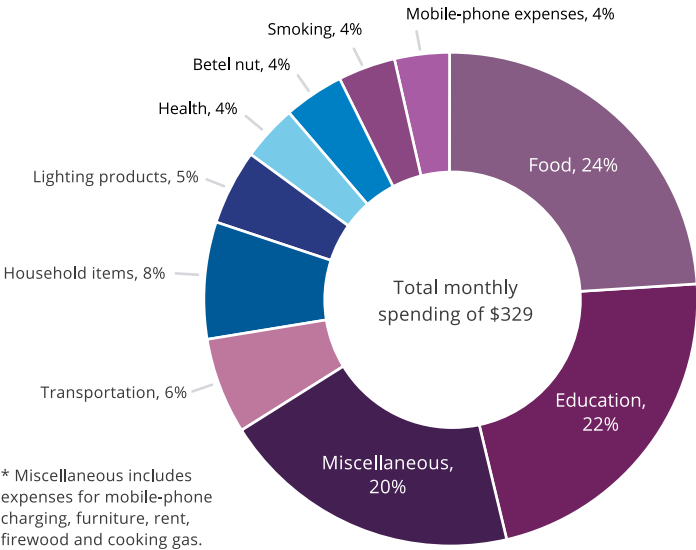


On average, off-grid households spend around 535 kina per fortnight (about \$329 per month) on a surveyed bundle of typical purchases. 4.9 percent of that, equivalent to \$16 per month or about \$192 per year, is spent on lighting products, making them one of the larger expenditure items—much ahead of health or mobile-phone services.⁴⁴ This is comparable to the lighting expenditure of off-grid households in other developing nations.⁴⁵

On average, off-grid households spend around 535 kina per fortnight (about \$329 per month) on a surveyed bundle of typical purchases.

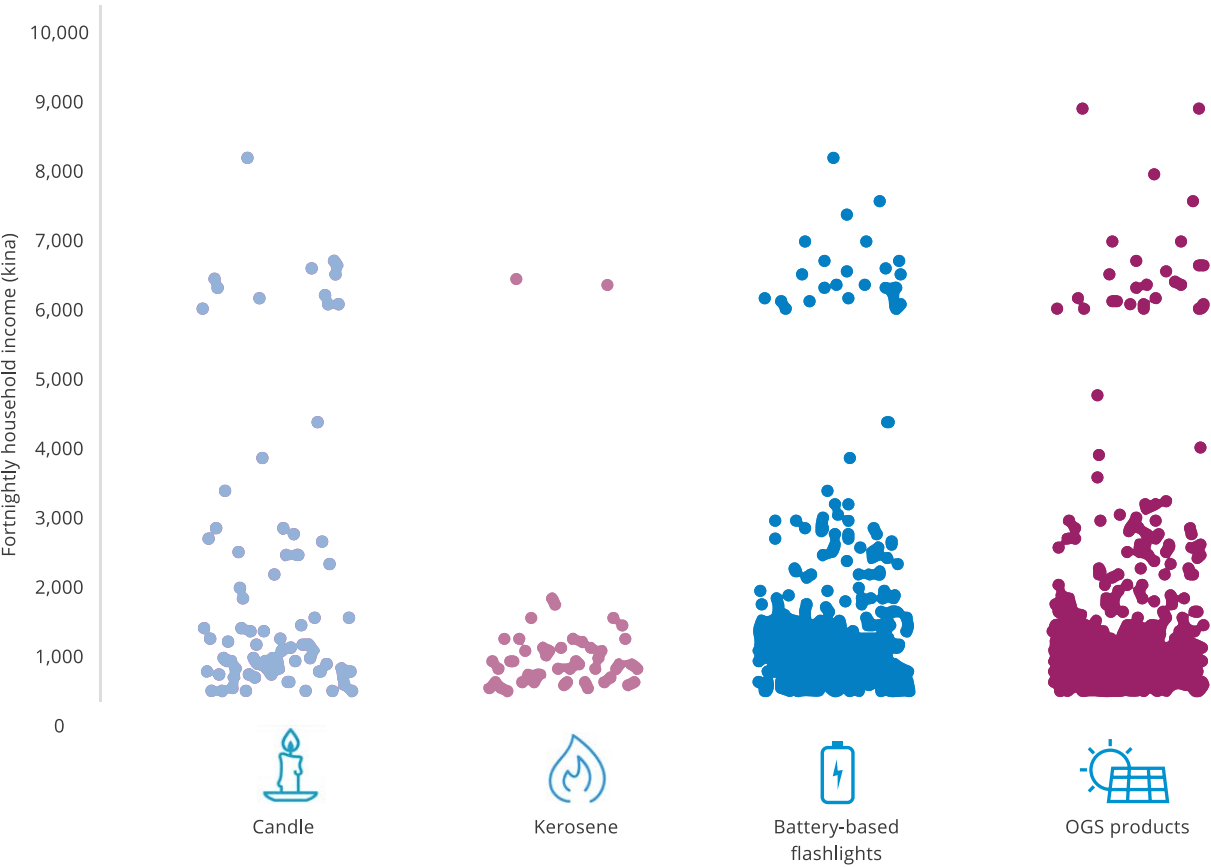
41 Wages are typically paid per fortnight, hence this is the unit of reference in the country.
42 Analysis: TFE Energy; Survey data: Anglo Pacific Research
43 Analysis: TFE Energy; Survey data: Anglo Pacific Research; UNDP, AusAID and World Bank Group
44 There is a significant gap between stated household income and purchase expenditure. This might be because important expenditure items have been missed in the survey or deliberately understated by respondents. A reason for this could be that individual respondents were asked to assess the expenditure of the entire household.
45 Lighting Global, Off-Grid Solar Market Trends Report, January 2018 ([link](#))

Figure 6 Monthly spending of a PNG off-grid household on a typical bundle of purchases (2018)⁴⁶



The survey shows that, in PNG, **household income does not seem to be a barrier to purchasing lighting products**. Nor is it a major factor in determining the type of lighting products used. This is noteworthy, because it shows that even poorer households have enough cash to buy OGS products. They may buy a smaller OGS product and complement it with flashlights, kerosene, or candles. At the same time, it seems there is a slight preference in higher-income households to use battery-based flashlights and OGS products, rather than candles and kerosene. Overall, the correlation between household incomes and types of lighting products used is not very strong.

Figure 7 Household income and off-grid lighting products owned (2018)⁴⁷



46 Analysis: TFE Energy; Survey data: Anglo Pacific Research

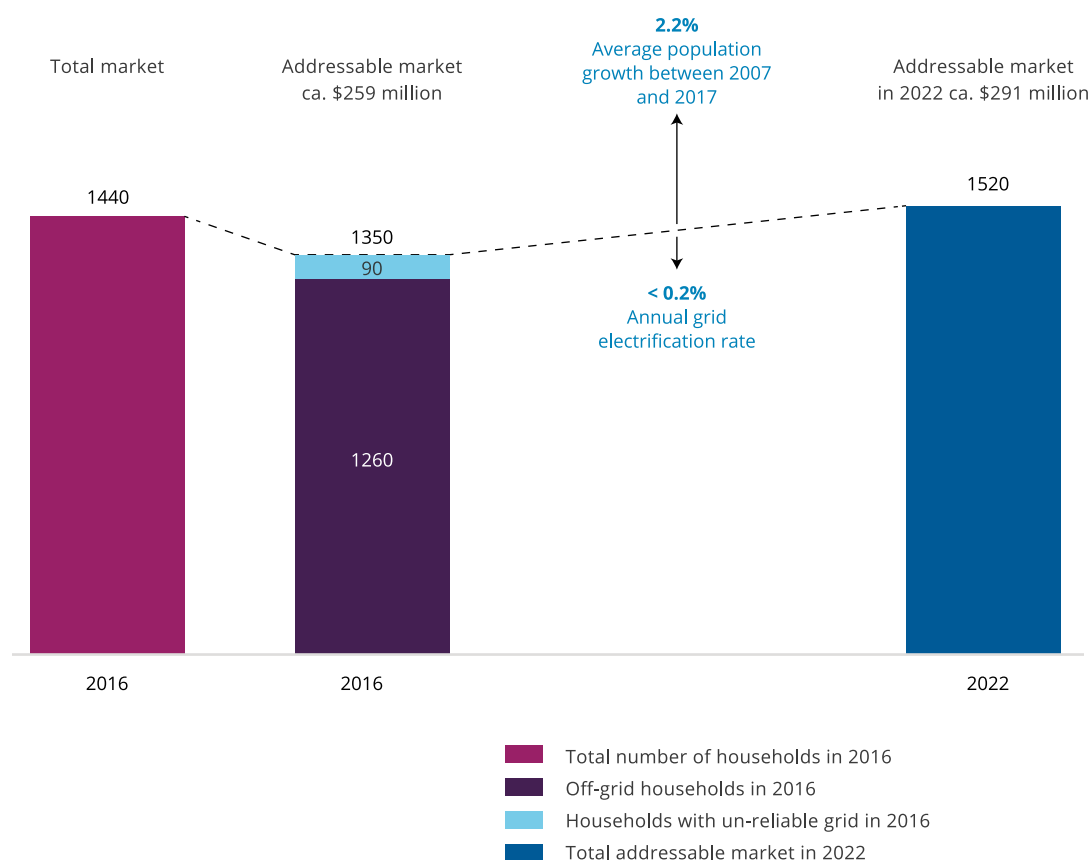
47 Analysis: TFE Energy; Survey data: Anglo Pacific Research. Respondents with income of 10,000 kina per fortnight were considered outliers

B. Market Size and Potential

PNG offers an attractive market for OGS products. Of the country's 1.44 million households, an estimated 1.26 million were not connected to the power grid in 2016.⁴⁸ In addition, more than half the households connected to the grid (approximately 90,000) have unreliable electricity supply. Thus, **there is an addressable market of around 1.35 million households**. At an average spend of \$16 per month on lighting products per household, **the annual market for lighting products in PNG is estimated at \$259 million**.

We expect this market to grow at an annual rate of 2 percent per year as population growth will continue to outpace new grid connections. During this time, availability and reliability of the electricity grid will likely improve. We estimate that it will outpace population growth in the latter half of the 2020s. If and when that happens, the addressable market would likely plateau or decrease.

Figure 8 Potential off-grid lighting market in PNG (by 1,000s of households and market potential in U.S. dollars, 2016 and 2022)⁴⁹

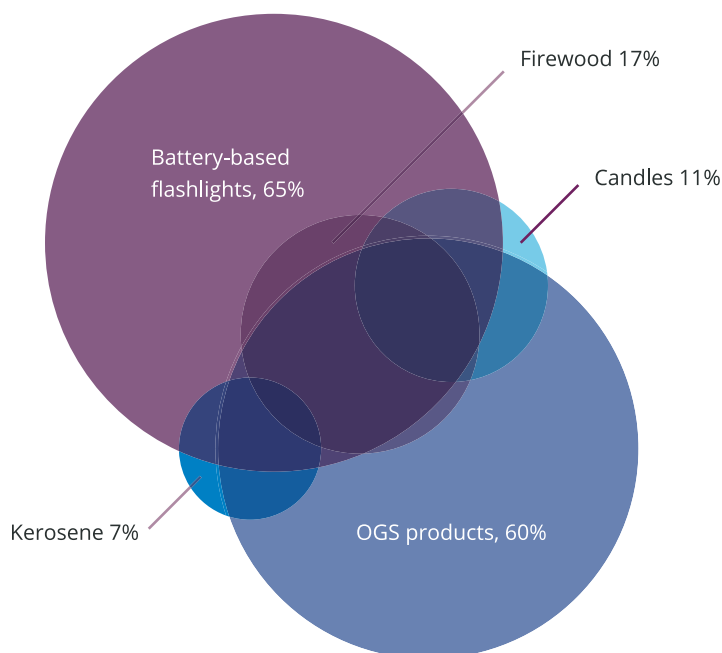


⁴⁸ The World Bank, Papua New Guinea Electrification Project (P159840), Project Information Document/Integrated Safeguards Data Sheet (PID/ISDS), updated: April 10, 2017, Report No: PIDISDSC19714 ([link](#)), Statista, PNG population growth ([link](#)) and TFE Energy interviews with PNG Power Ltd and Department of Petroleum and Energy, Government of Papua New Guinea. Estimates may not add up to totals due to rounding.

⁴⁹ Ibid.

C. Types of Lighting Products Used

Figure 9 Market penetration (ownership) of off-grid lighting products (2018)⁵⁰



Our survey suggests that every household within the addressable market owns at least one lighting product. The most frequently found off-grid lighting products are battery-based flashlights, followed by OGS products. They are used by 65 and 60 percent of households, respectively.⁵¹ Other lighting products such as kerosene lamps, candles, and firewood are also used, but far less widely. They are less luminous than flashlights or OGS products and usually only complement these solutions. Almost half of households (44 percent) own more than one product to meet lighting needs. Flashlights and OGS products are often seen as complementary products: around 30 percent of flashlight owners also own OGS products.⁵²



Sunking and d.light products on display



⁵⁰ Percentages represent total number of households that use a particular product, thus the total does not equal 100 percent. Analysis: TFE Energy; Survey data: Anglo Pacific Research

⁵¹ Analysis: TFE Energy; Survey data: Anglo Pacific Research

⁵² Ibid.

D. Growth of OGS Among Lighting Products

PNG has one of the highest market penetration rates for OGS products in the world. In 2017, 60 percent of households in the addressable market owned one or more OGS product. This is significantly higher than other key global OGS markets, such as India (18 percent), Nigeria (5 percent), Bangladesh (13 percent), and Myanmar (23 percent).^{53, 54}

Between 2014 and 2018, the market shares of lighting products shifted dramatically, with OGS products effectively replacing kerosene lamps. While the market share of OGS products grew from 2 to 60 percent, that of kerosene lamps dropped sharply from 50 to 7 percent.⁵⁵ Candles and battery-based flashlights also grew in sales, but at a much slower pace.

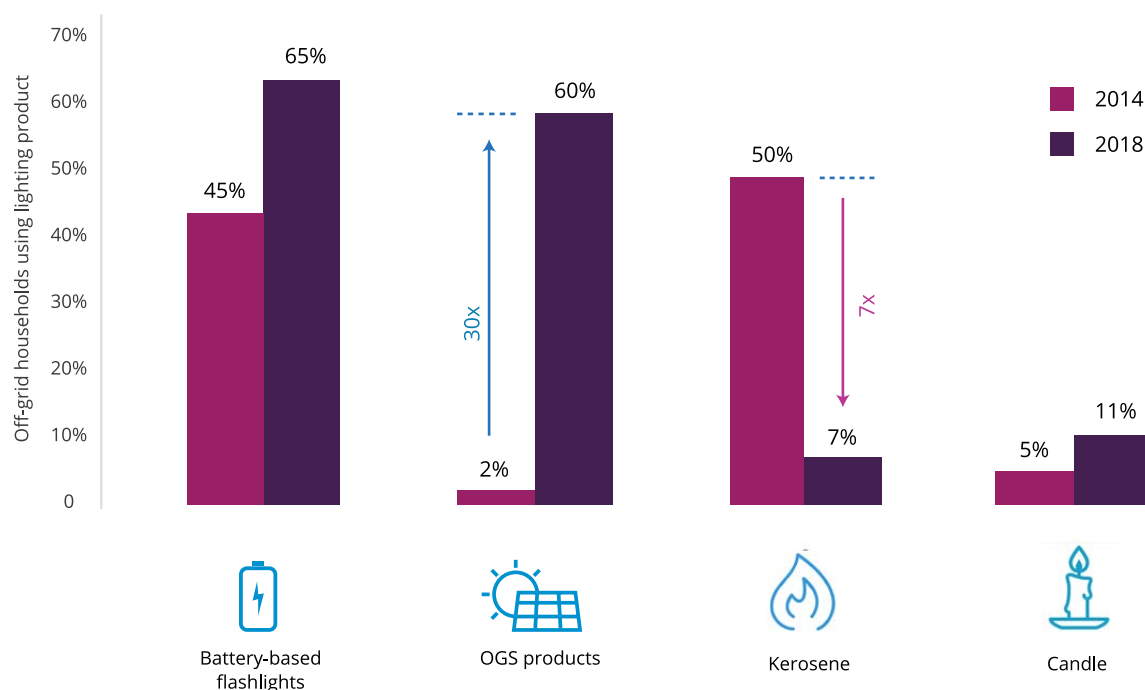


Figure 10 Market segmentation of off-grid lighting products (in 2014 and 2018)⁵⁶

THERE ARE SEVERAL POSSIBLE REASONS FOR THIS DISRUPTIVE CHANGE:

1. **Costs:** Kerosene lamps are relatively expensive to use. The price of kerosene rose by 10 to 40 percent (varying by location) in 2017 alone.⁵⁷ Meanwhile, the cost of OGS continues to fall. In fact, in 2017, a user in PNG could buy a quality-verified pico OGS product for the same amount needed to light a kerosene lamp for seven months.
2. **Sales channels:** Before 2014, OGS products were available in only a few stores in PNG's major cities. However, by 2018, they have become more widely available in larger cities, towns, and in some villages.
3. **Perceived brightness:** The brightness of kerosene lamps is relatively low. One-third of users are not satisfied with the product.⁵⁸ By comparison, OGS products are much brighter.
4. **Features:** OGS products can provide supplementary features, such as radio, mobile-phone charging, an mp3 player and, if large enough, even run appliances.

⁵³ The figure of 60 percent is derived from the household survey and is a percentage of the addressable market, not the entire population.

⁵⁴ Lighting Global, Off-Grid Solar Market Trends Report January 2018 ([link](#))

⁵⁵ IFC, Lighting Papua New Guinea, PNG Off-Grid Lighting Market Analysis 2014 ([link](#))

⁵⁶ Analysis: TFE Energy; Survey data: Anglo Pacific Research

⁵⁷ PNG Independent Consumer & Competition Commission, Indicative retail price notice, accessed November 8, 2018 ([link](#))

⁵⁸ Analysis: TFE Energy; Survey data: Anglo Pacific Research

Flashlights, like kerosene lamps, have comparatively high operating costs. Yet, they have not been replaced by OGS products. This is probably because they provide a different type of lighting solution. Flashlights themselves are inexpensive to buy and can easily be replaced when lost or stolen. Individual members of a household might own a personal flashlight and carry it around. In contrast, even smaller single-light OGS products are relatively expensive. They are usually bought for a household rather than for personal use and kept within the house, even if the design of a particular OGS product permits mobility.



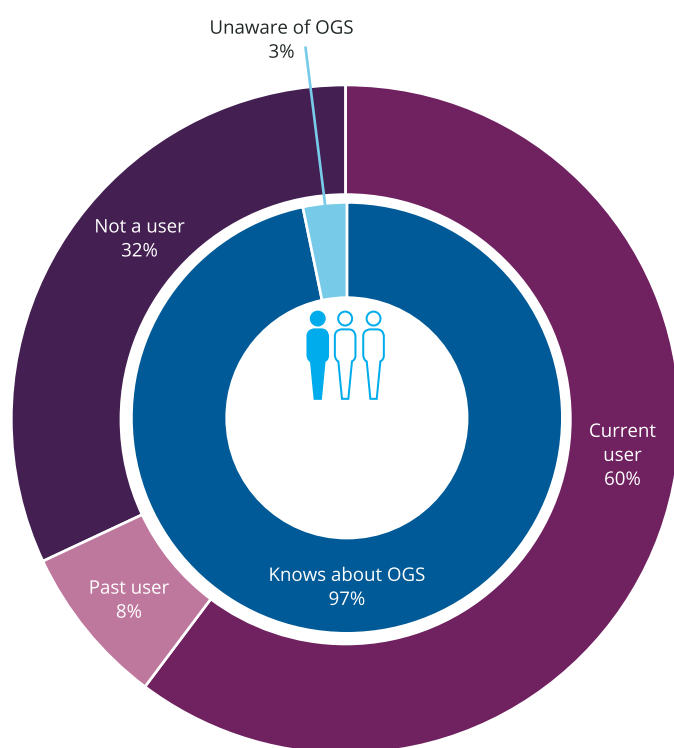
SECTION III: OGS Market



A. Customer Awareness

OGS products are widely available across urban and rural markets in PNG. The customer survey showed that **97 percent of the population in PNG knows about OGS products**. That is encouraging. In part, this is because 60 percent of respondents are current and past users of OGS products. However, even among those respondents living in households where OGS products are not used, awareness is more than 90 percent. In all likelihood, non-users observe and communicate with neighbors who use OGS products.

Figure 11 Awareness of OGS (general and by user, 2018)⁵⁹



B. Sales

Extrapolation of survey data suggests that 864,000 households⁶⁰ in PNG currently own at least one OGS product—and a few own more than one. In total, we estimate **there are over 900,000 OGS products in use in PNG**.⁶¹

This high penetration rate was achieved over five years; annual sales grew at 68 percent per year from 30,000 in 2012 to more than 400,000 in 2017. This means that in 2017, one in every four PNG households purchased an OGS.

We project two boundary scenarios over the next five years. In Scenario 1, market penetration of OGS products will continue to grow at 5 percent per year. The addressable market grows at 2 percent per year. In addition, every year, 10 percent of existing customers buy an additional OGS product, leading to a 17 percent growth in sales per year. In Scenario 2, market penetration of OGS products grows at a slower pace of 2 percent per year. The addressable market also grows at 2 percent per year and, every year, 3 percent of existing customers buy an additional OGS product. This aggregates to a 7 percent growth in sales per year.

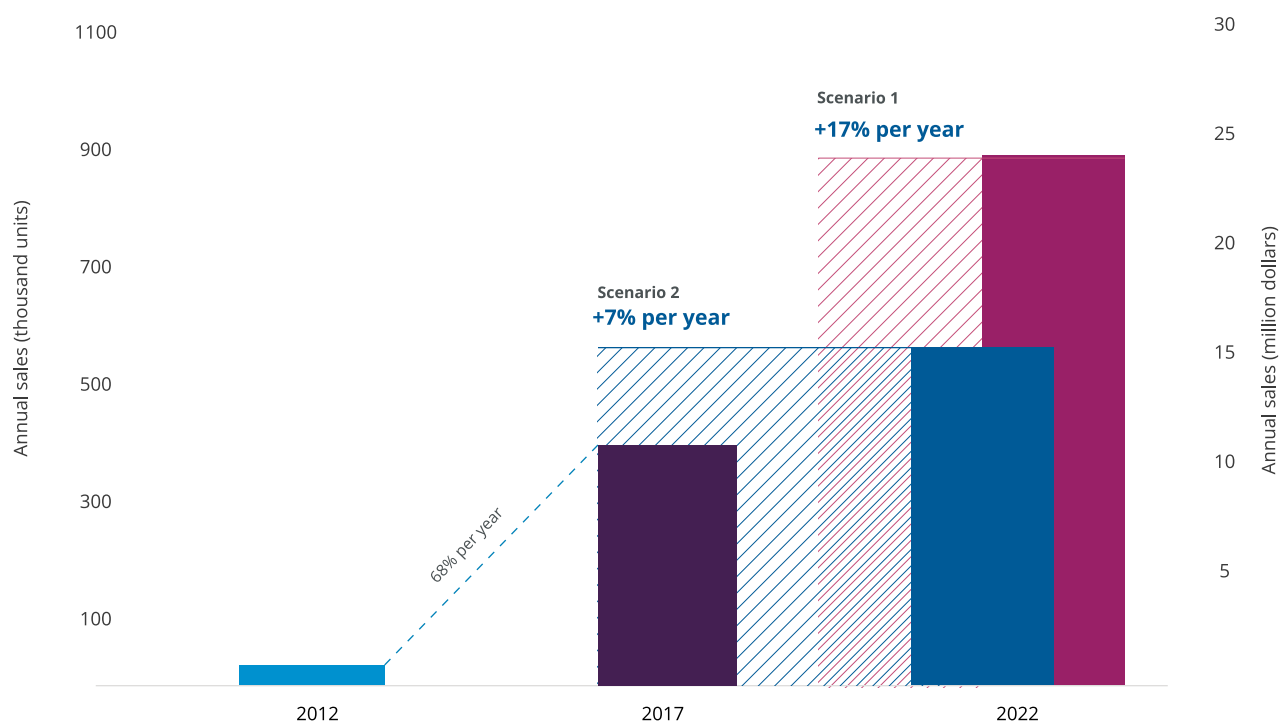
⁵⁹ Analysis: TFE Energy; Survey data: Anglo Pacific Research. Respondents who were gifted OGS products were not considered in this analysis, only those who purchased OGS.

⁶⁰ Equivalent to 60 percent of households that own OGS products within the 1.35 million households in the addressable market.

⁶¹ Equivalent to the total number of OGS products owned (487) as a percentage of the total number of surveyed households (703), multiplied by the 1.35 million households in the addressable market. Sources used are TFE Energy analysis, survey data from Anglo Pacific Research and The World Bank, Papua New Guinea Electrification Project (P159840), Project Information Document 2017 ([link](#))

Boundary scenarios	Market penetration growth	Growth of addressable market	Growth within existing customer base	Upgrading of product	Overall growth in unit sales and dollar value ⁶²
Scenario 1	5 percent per year (85 percent in 2022)	2 percent per year (1.52 million households in 2022)	10 percent per year	Not considered	17 percent per year (883,281 units and \$24.01 million in 2022)
Scenario 2	2 percent per year (70 percent in 2022)	2 percent per year (1.52 million households in 2022)	3 percent per year	Not considered	7 percent per year (565,052 units and \$15.36 million)

Figure 12 Past and projected growth of sales of OGS products (in thousand units and million U.S. dollars, 2012 to 2022)⁶³



⁶² Overall sales CAGR is the aggregated result of growth in market penetration, growth of the addressable market, and the growth among existing customers.

⁶³ Analysis: TFE Energy; Survey data: Anglo Pacific Research; 2012 data from data from IFC, Lighting Papua New Guinea, PNG Off-Grid Lighting Market Analysis, 2014; data for the years 2013 to 2016 is not available ([link](#))

The total sales revenue at the points of sale in the PNG OGS market in 2017 is estimated to be \$10.9 million.⁶⁴ This is equivalent to around 4 percent of the annual lighting market of \$259 million.⁶⁵ Based on our boundary scenarios for 2022, we project sales to grow to \$24.01 million in Scenario 1 and to \$15.26 million in Scenario 2. Here, significant upgrading from pico products to PnP SHS is not considered. If this were to occur, the overall revenues in the market would be much higher than the Scenario 1 projection, because PnP SHS are more expensive than pico products by a factor of 5 to 10.⁶⁶

When these values are placed in an international context, the sales dynamics of the PNG market stands out for its combination of high growth and high market penetration.

Figure 13 Sales and penetration of OGS products in selected markets (2014 to 2017)⁶⁷

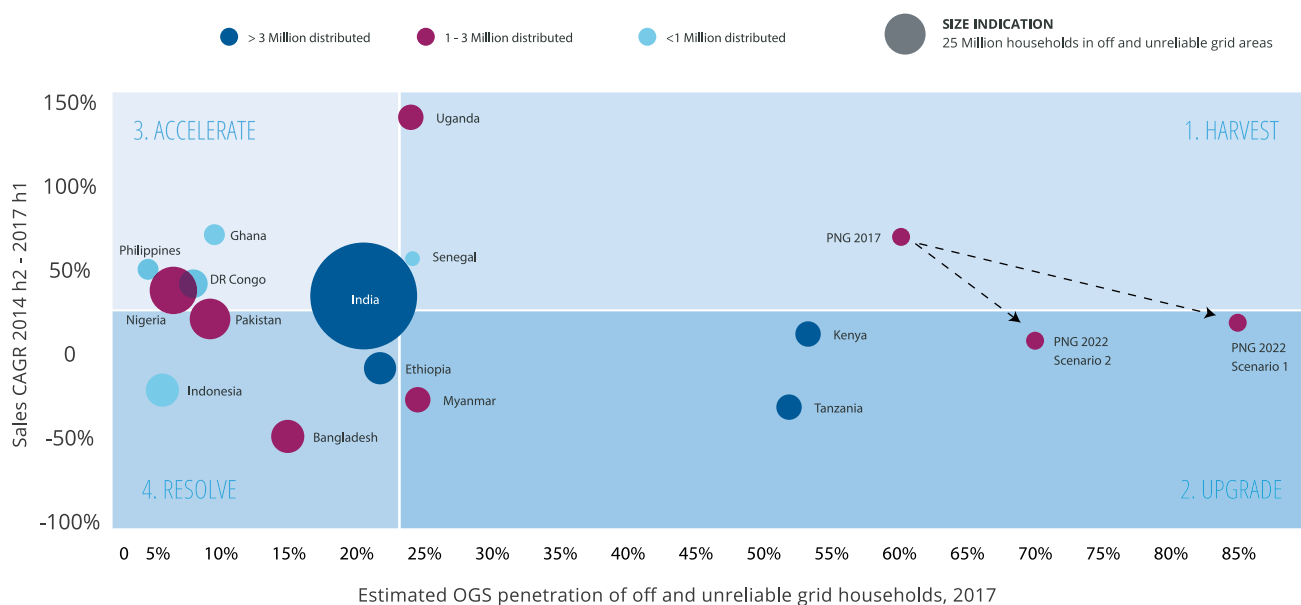


Figure 13 identifies market trajectories based on four quadrants: harvest, upgrade, accelerate, and resolve.

- “Harvest”: Growing sales despite high penetration, suggesting that suppliers can continue to harvest revenues.
- “Upgrade”: Existing high penetration but falling sales rates, suggesting the market is ready for upgrading to larger lighting products.
- “Accelerate”: Up-and-coming markets, where suppliers can continue to scale operations to take advantage of large unpenetrated populations.
- “Resolve”: Under-penetrated markets with falling sales, requiring concentrated supplier investment to resolve context-specific issues.

PNG is an extreme outlier in the “harvest” section. **Given the very high market penetration, it is impossible for PNG to sustain growth rates of the past.** However, since there is no alternative to lighting products in much of the country, the market penetration of OGS might continue to grow. Over time, **PNG can become an ideal “upgrade” market** for distributors. Upgrading can happen along different dimensions: Customers might shift from smaller to larger products. They might also be interested in products with higher quality and better performance.

⁶⁴ TFE Energy estimates. Revenue generated by quality-verified products is provided by Lighting PNG. To calculate total revenue, including of generic products, market shares of quality-verified and generic products were used. For simplicity, the average price point of generic products was considered to be the same as that for quality-verified products.

⁶⁵ Given that 60 percent of the population own OGS products, 4 percent of annual lighting sales seems to be a low value. Possible factors for this are: the spend on lighting might be inflated by a number of respondents who gave very high values (up to 1,200 kina or \$369 per month). The spend on OGS might be understated as in 2017 the average product sold was significantly smaller and cheaper than in 2016. It is likely that spending on battery-powered flashlights is significantly higher than spending on OGS, because of the intensive use of flashlights and the high replacement cost of batteries.

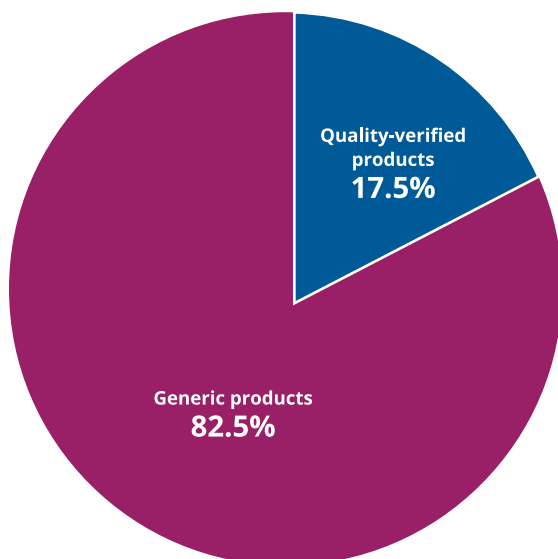
⁶⁶ Based on Lighting PNG data

⁶⁷ Analysis: TFE Energy; Survey data: Anglo Pacific Research; global data from Lighting Global, Off-Grid Solar Market Trends Report, 2018 ([link](#)) and Lighting Global/GOGLA sales data

C. Market Share of Quality-Verified Products

PNG's OGS market has both generic and quality-verified products. 17.5 percent of the approximately 900,000 OGS products currently in use in PNG are quality verified.⁶⁸ The remaining, 82.5 percent are generic products.⁶⁹ The market share of quality-verified products in PNG is lower than the global average of around 29 percent.⁷⁰

Figure 14 Market share of quality-verified OGS products in PNG (by ownership, in 2018)⁷¹



Currently, 30 different quality-verified OGS products are sold in the PNG market.⁷² They are manufactured by brands such as Barefoot, d.light, Greenlight Planet, Niwa, Omnivoltaic, Orb Energy, and OvSolar. The numbers of generic products and brands are not known. There is anecdotal information suggesting that some generic products have no specific brand name and frequently change product names to reduce traceability by dissatisfied customers.

1. VARIATIONS BY PRODUCT CATEGORY

The OGS market has evolved into three main product categories, pico OGS products, plug-and-play (PnP) SHS, and component-based systems. Both quality-verified and generic manufacturers sell pico and plug-and-play SHS products (up to 350W) in PNG. In addition, generic manufacturers offer component-based systems.

94 percent of surveyed households in PNG owning OGS have pico products. Of those, 40 percent use small pico products with only one light. The second-most widely used product category is pico products with three or more lights (38 percent).

⁶⁸ Number refers to OGS products currently in use, not to annual sales.

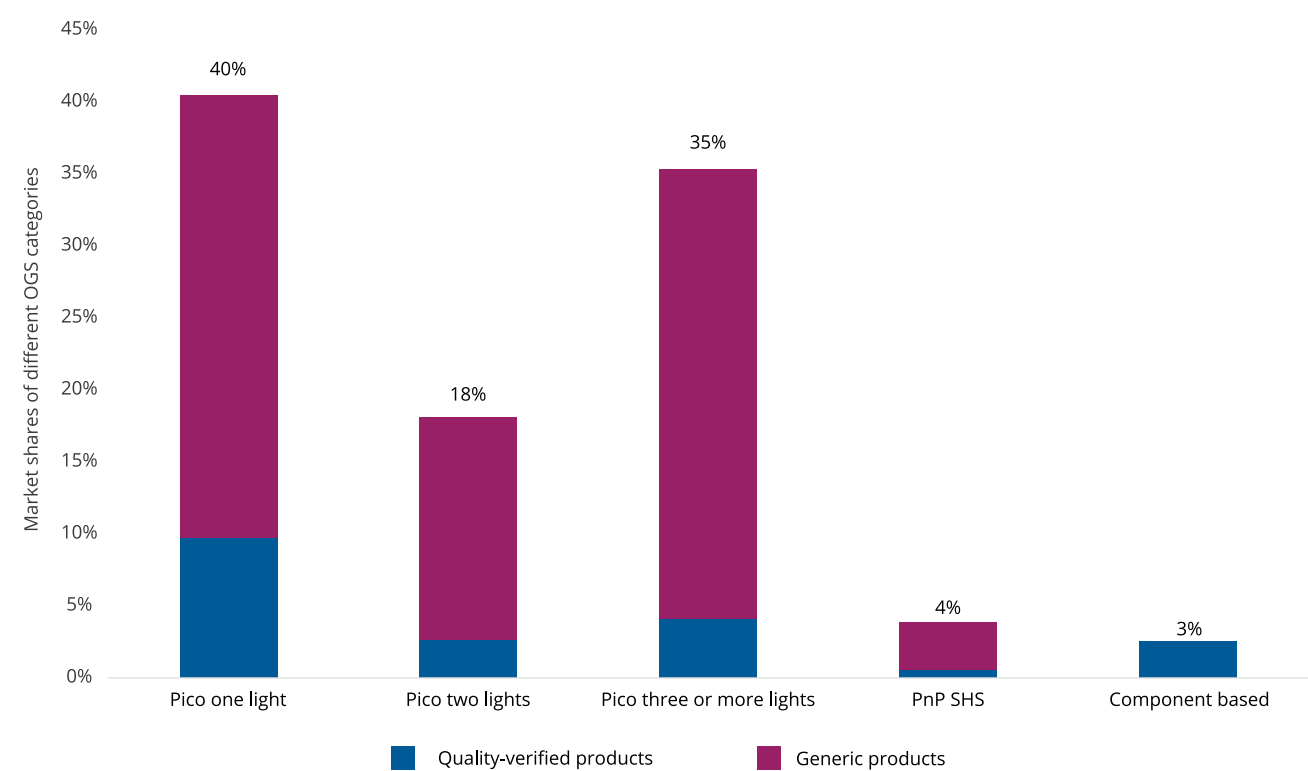
⁶⁹ Analysis: TFE Energy; Survey data: Anglo Pacific Research

⁷⁰ Lighting Global, Off-Grid Solar Market Trends Report January 2018 ([link](#))

⁷¹ Analysis: TFE Energy; Survey data: Anglo Pacific Research. The ownership of quality-verified products of 17.5 percent does not include standalone phone-charging solutions. If those are added, the market share by ownership is estimated to be more than 20 percent (source: IFC Lighting PNG). There is a difference between the number of quality-verified products currently in the market as per the survey (157,500 or 17.5 percent of 900,000) and the number of quality-verified products imported between 2014 and 2017 (224,000). This difference is likely due to the following factors: some households own more than one quality-verified product, some older quality-verified products may no longer be in use, and there may be some unsold stocks.

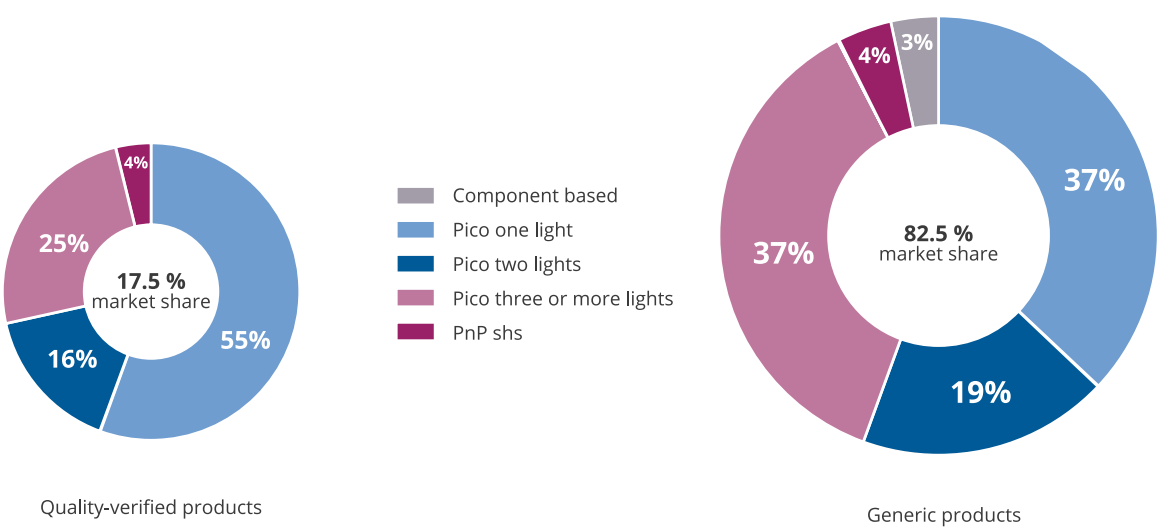
⁷² Lighting PNG data

Figure 15 Market shares of OGS product categories (by ownership, in 2018)⁷³



PnP SHS accounts for only about 4 percent of the market. Since this is a fairly new product category in the PNG market, its share might increase in the coming years. The same is true for component-based products that account for just 3 percent of the market. These products can address new customers, as well as offer “upgrade” options to existing users of pico products.

Figure 16 Variation in market shares of quality-verified and generic products across categories (by ownership, in 2018)⁷⁴



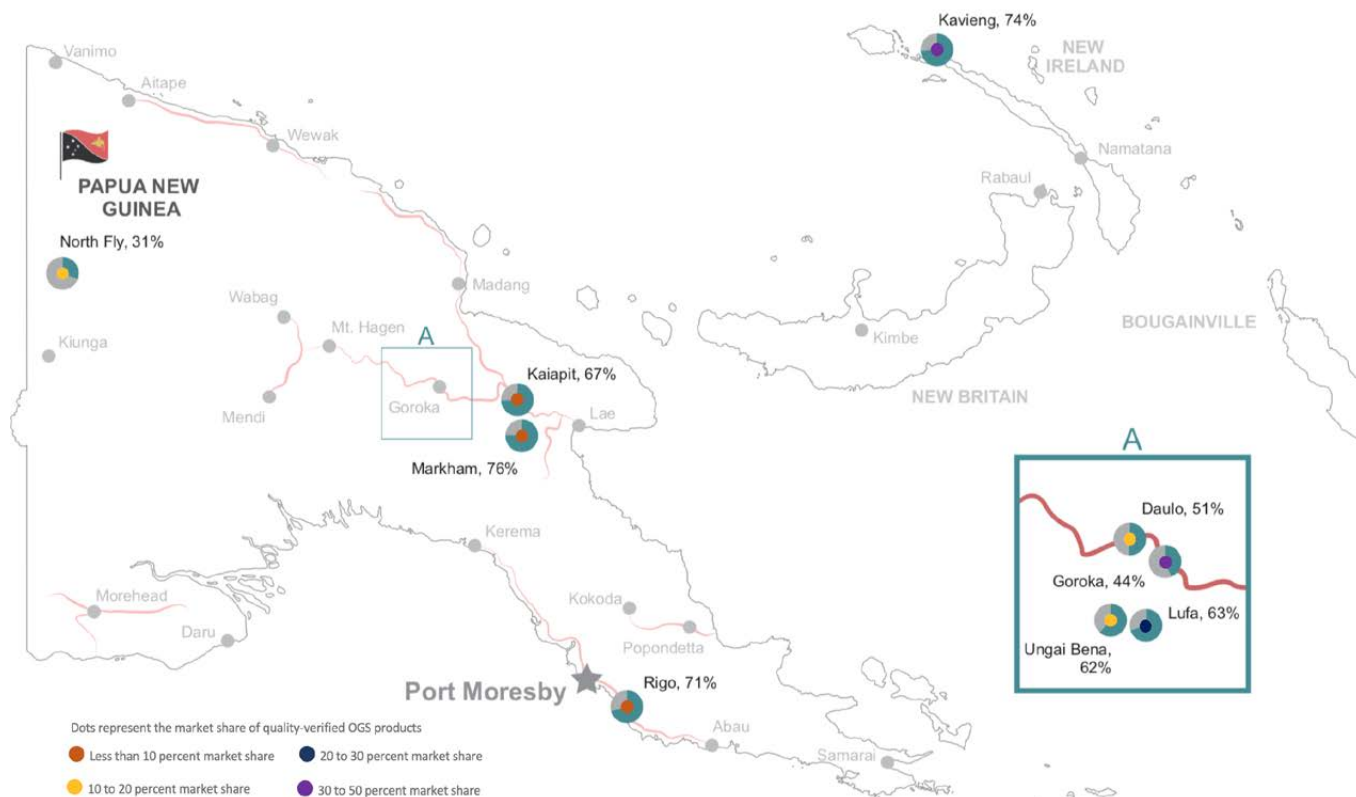
For larger pico products—two-light as well as three or more-light systems—the market share is higher among generic than quality-verified products (at 56 percent, compared to 41 percent). A possible reason for this is that some quality-verified products have a particularly strong light quality and hence a pico one-light system might serve the same need as a generic multi-light system.

73 Analysis: TFE Energy; Survey data: Anglo Pacific Research
74 Ibid.

2. VARIATIONS BY REGION

Market penetration of OGS varies significantly throughout PNG. Villages close to larger port cities, such as those in Kavieng, Rigo, Kaiapit, and Markham, have a higher concentration of OGS. This might be due to stronger supply chains: Products are more easily available and at lower costs. Higher purchasing power in such places could be another reason. OGS are much less frequent in villages that are far from ports. Villages in North Fly, for example, have an OGS market penetration rate of only 31 percent.

Figure 17 Market penetration of OGS products in different regions and market share of quality-verified products (in 2018)⁷⁵



Moreover, there are significant variations in the market share of quality-verified products in the districts surveyed. The share in Kavieng and Goroka districts, for example, is double the national average. These differences are probably driven by availability of quality-verified products with well-known retailers in cities in both districts. This is not the case in certain other districts, such as Rigo, Kalapait, and Markham, where quality-verified products are rarely available, and the market share is no higher than 10 percent.

D. Sales Trends for Quality-Verified Products

The Lighting PNG program started in 2014, leading to a rapid expansion in the sale of quality-verified products. In 2012, of the 30,000 OGS sold, an estimated 5 percent, or 1,500, were quality verified. In 2014, that number jumped to more than 50,000, driven by the opening of new sales channels and bulk orders facilitated through Lighting PNG activities. **In 2017, sales of quality-verified products reached 70,000, representing a CAGR of 11 percent.**⁷⁶ Between 2014 and 2017, 224,000 quality-verified products were sold, resulting in estimated total revenues of \$13.8 million.

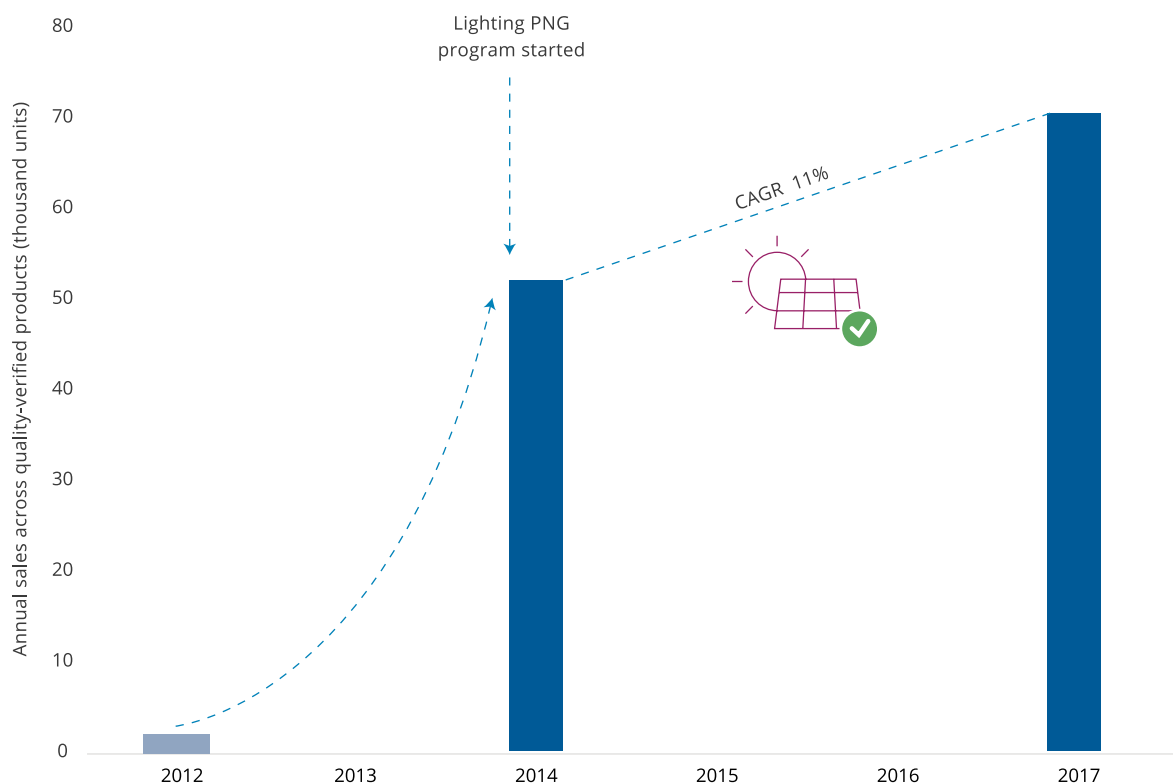
While sales data for generic products in 2014 is not available, it is estimated that market share of generic products started to accelerate in 2015 to 2018 through the growth of city, and mid-mile distribution channels, and particularly through lot shops⁷⁷.

⁷⁵ Ibid.

⁷⁶ Analysis: TFE Energy; Survey data: Anglo Pacific Research; Sales data from Lighting PNG

⁷⁷ The main driver for this could be the rapid expansion of lot shops selling generic products to mid-mile sales points. This is discussed in more detail in the supply section of this report.

Figure 18 Annual sales of quality-verified OGS products (thousands of products, 2012 to 2017)⁷⁸



Although the number of products sold increased between 2016 and 2017, the revenue generated decreased by 3.5 times. This is mostly due to the differences in product mix and associated prices. In 2016, a large number of bigger OGS products (PnP SHS and pico multiple-light with mobile-phone charging and support for appliances) worth \$3.8 million were imported. By contrast, in 2017, imports were dominated by smaller pico one-light systems with mobile-phone charging.⁷⁹ In addition, overall product prices have come down as suppliers become more competitive and input costs have decreased. The dip in revenues in PNG is in sync with global markets, where sales have also dropped from 2016 to 2017.⁸⁰

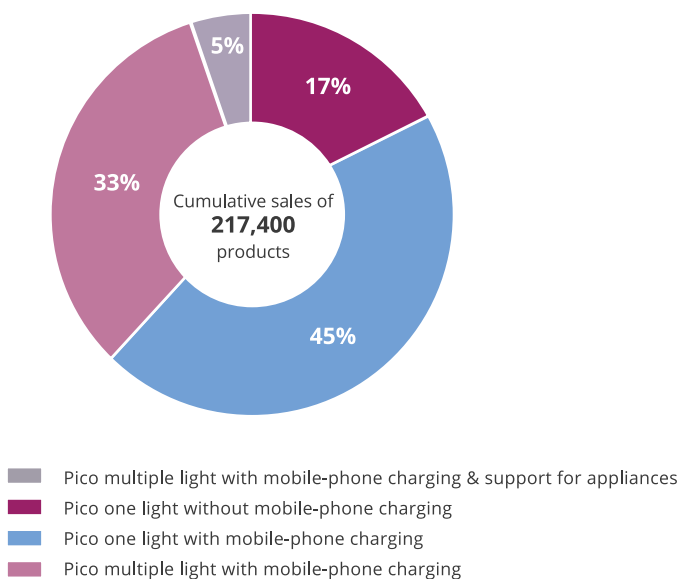
⁷⁸ TFE Energy analysis based on FOB data from Lighting PNG. Data for year 2012 and 2013 is estimated based on the data available in IFC, Lighting Papua New Guinea, PNG Off-Grid Lighting Market Analysis, 2014 report ([link](#)). For year 2012, one-third of total sales were considered to be quality verified; for year 2013, sales were interpolated based on 2012 sales and the CAGR.

⁷⁹ Lighting PNG

⁸⁰ Lighting PNG and global sales data from Lighting Global, Off-Grid Solar Market Trends Report, 2018 ([link](#))

Figure 19

Cumulative sales of quality-verified pico OGS products across categories (2014 to 2017)⁸¹



97 percent of quality-verified products sold between 2014 and 2017 were pico products.⁸² That is a higher market share than the 2017 global average of 86 percent.⁸³ The low cost of pico products makes them an attractive initial choice for customers. Further, they were introduced into the PNG market earlier than PnP SHS, which were only available from 2016.⁸⁴

83 percent of quality-verified pico products include a mobile-phone charger. 45 percent were single-light products with a mobile-phone charger, 33 percent were multiple-light products with a mobile-phone charger, and 5 percent were multiple-light products with a mobile-phone charger and support for appliances. Only 17 percent of pico products were the most basic, single-light kind without mobile-phone charging.

81 Lighting PNG

82 Ibid.

83 Analysis: TFE Energy; Survey data: Anglo Pacific Research; Global sales data from Lighting Global, Off-Grid Solar Market Trends Report, 2018 ([link](#))

84 Lighting PNG



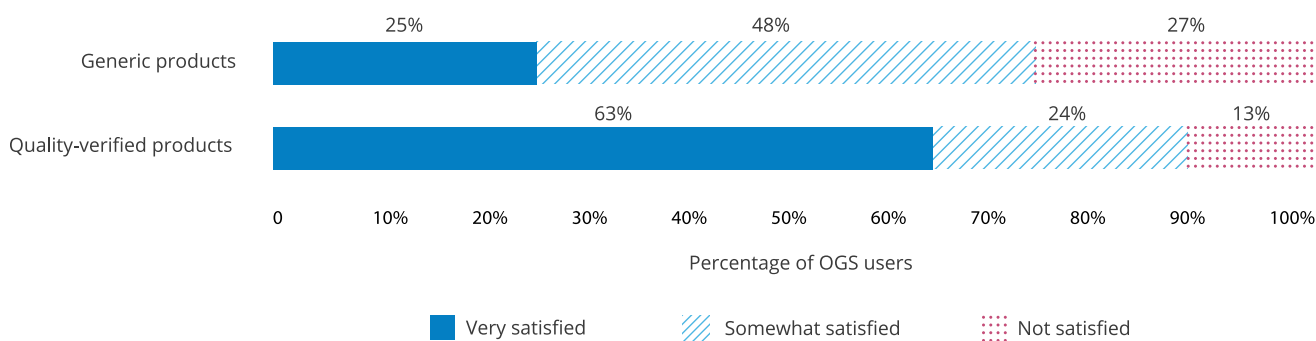
SECTION IV:

Demand-Side Dynamics

A. Product Quality

The survey shows that 27 percent of generic product users are not satisfied with their product. By comparison, only 13 percent of those using quality-verified products are unsatisfied. 63 percent of quality-verified product users are very satisfied with their products—compared to 25 percent of generic product users.⁸⁵

Figure 20 Customer satisfaction levels for quality-verified and generic OGS products in PNG (2018)⁸⁶



The gap in quality perception between generic and quality-verified products can be broken down into different performance parameters.

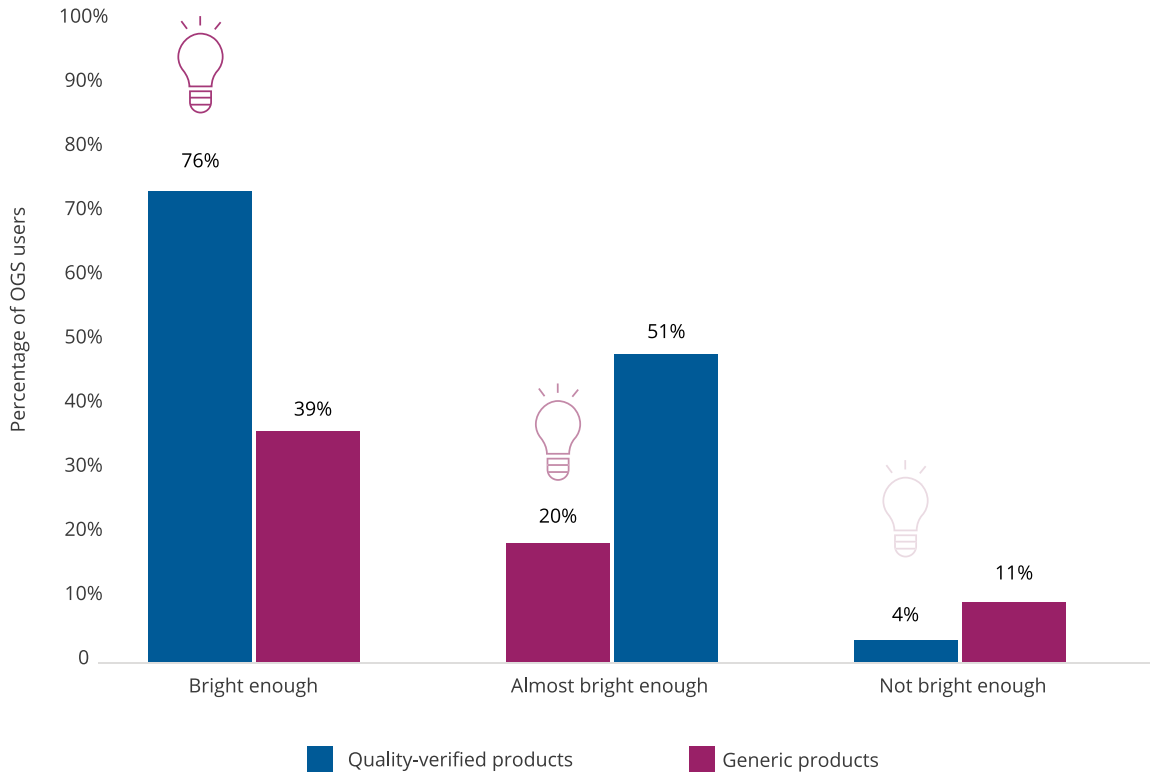
⁸⁵ Analysis: TFE Energy; Survey data: Anglo Pacific Research

⁸⁶ Ibid.

1. BRIGHTNESS

More than two-thirds of the quality-verified product users consider brightness of the light sufficient and only 4 percent are not satisfied. By contrast, 61 percent of generic product users say their lights are not bright enough.

Figure 21 Quality parameter “brightness” (comparison of quality-verified and generic OGS products, 2018)⁸⁷



There is a time dimension to light quality as well. Quality-verified products can maintain brightness of their lights over a longer time than many generic OGS products.⁸⁸

⁸⁷ Ibid.

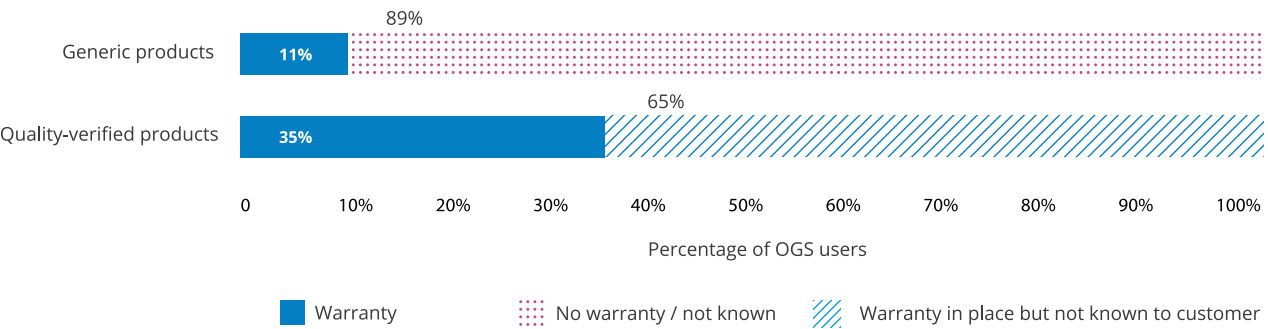
⁸⁸ Lighting PNG

2. WARRANTIES

Warranties for OGS are well known in PNG. 97 percent of customers surveyed were aware of the concept.⁸⁹ What is not known is how much customers trust warranties and make purchase decisions based on them.

Quality-verified product manufacturers provide a warranty for all their products. However, in PNG, warranties are not always passed on to customers. This is reflected in the survey, which shows that 62 percent of customers owning quality-verified products are not aware of their warranties. Most generic products, by contrast, do not have warranties. In the few cases in which warranties are provided, they are likely not honored.⁹⁰

Figure 22 Quality parameter “warranty” (comparison of user perceptions for quality- verified and generic OGS products, 2018)⁹¹



3. REPAIR AND REPLACEMENT

Around 1 to 2 percent of quality-verified products sold globally are returned to manufacturers for repair or replacement within the warranty period.⁹² Replacement rates for generic products that may have warranties are not known.

With respect to repairs, the survey data shows that **generic products require repairs more than twice as often as quality-verified products** over the product lifetime.⁹³ The difference is more pronounced when considering the longer lifetimes of quality-verified products.⁹⁴

Figure 23 Quality parameter “repair and replacement” (comparison of user perceptions for quality-verified and generic OGS products, 2018)⁹⁵



The difference in quality is reflected in design choices. Most generic products are built so that they can be easily opened for repairs by

89 Analysis: TFE Energy; Survey data: Anglo Pacific Research
90 Lighting PNG
91 Analysis: TFE Energy; Survey data: Anglo Pacific Research
92 Quality-verified OGS products manufacturer interviews by TFE Energy. Warranty periods are typically one or two years, depending on product type.
93 Analysis: TFE Energy; Survey data: Anglo Pacific Research
94 Stakeholder and supplier interviews by TFE Energy
95 Analysis: TFE Energy; Survey data: Anglo Pacific Research; Data on replacement of quality-verified product from interviews by TFE Energy.

village electricians, who often mix parts from different products, some of them recycled, to provide a low-cost service.⁹⁶ According to market interviews, battery replacements of generic products are common, because of the use of lead acid batteries, which have lower lifespans than the Li-ion batteries usually used in quality-verified products.⁹⁷ Quality-verified products, on the other hand, are typically difficult to open and parts are designed to be replaced rather than locally repaired. This helps in making them water and dust proof.

The table below provides an overview of the differences in quality parameters between quality-verified and generic products.

Table 2 Overall quality comparison of quality-verified vs. generic OGS products ⁹⁸

	Quality-verified products	Generic products
Overall product satisfaction	High satisfaction	Average to low
Brightness of light	Bright enough	Almost enough or low
Repair and replacement cycle	Low	Medium
Warranty	Always available, but often not known by customer	Rarely available

4. THE IMPACT OF LOW-QUALITY PRODUCTS ON THE PNG MARKET

As lower-quality generic products have gained market share in PNG, **the reputation of OGS products as a whole has been harmed**. Most consumers now expect any product to have a low lifetime and to require regular maintenance. Survey data suggests that about half of OGS users expect their products to last less than one year. There is hardly any difference in expectations with respect to product lifetime between owners of quality-verified and generic products.

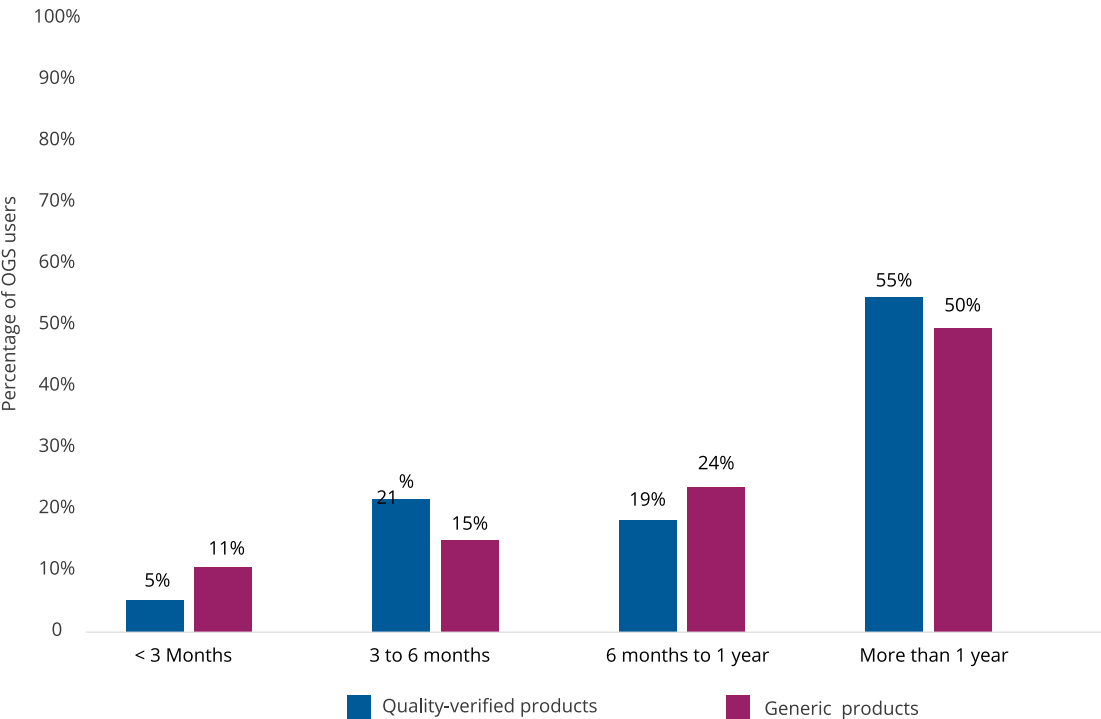
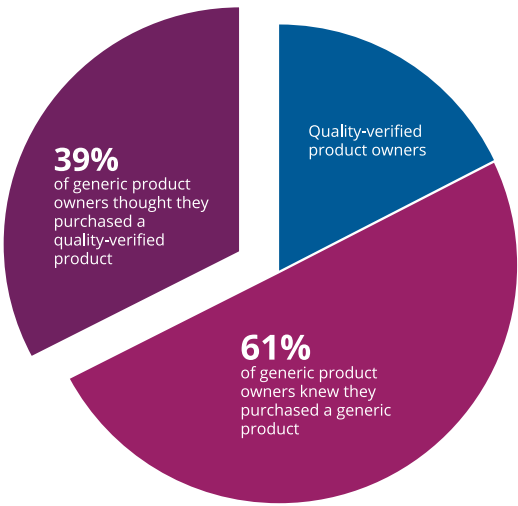


Figure 24
Expected lifetime of OGS products by quality-verified and generic product owners (2018)⁹⁹

96 Stakeholder and supplier interviews by TFE Energy
97 Ibid.
98 Analysis: TFE Energy; Survey data: Anglo Pacific Research
99 Ibid.

Most consumers cannot differentiate between different brands or specific products, not to mention being able to differentiate between quality-verified and generic products.¹⁰⁰ Quality-verified products do not have certificates or labels to identify them as such. In addition, many generic products with similarities to quality-verified products have been in the PNG market for several years.¹⁰¹ As much as **39 percent of owners of generic products thought they had bought a quality-verified product.**¹⁰²

Figure 25 Ownership of quality-verified and generic products, including mistaken attributions (2018)¹⁰³



This finding resonates with a recognized need in the market for ongoing awareness creation about quality-verified products and retail points. The CEO of one of the largest OGS product distributors in PNG noted: “Most people know about OGS products, but they do not know, which one is quality-verified and which one is not. They also do not know where to buy them.”¹⁰⁴

The lack of awareness with respect to quality differences is compounded by sparse knowledge of new battery and solar-cell technology.¹⁰⁵ Quality-verified products typically use smaller Li-ion batteries as well as more efficient solar panels, offering a higher charge capacity and longer operating hours in a smaller design when compared to their generic counterparts. For example, one quality-verified product sold in a hardware shop in PNG advertised that a fully charged battery would run a lamp for about 72 hours. Since customers do not understand the technology well and have had bad experiences with generic OGS products in the past, they believe

that such a product promise is false and might opt for the larger generic product with a bulky battery.¹⁰⁶ The same is true for batteries. Customers often find it hard to believe that batteries used in quality-verified products last for more than a year, given their experience with batteries used in generic products, which typically last much less than a year.

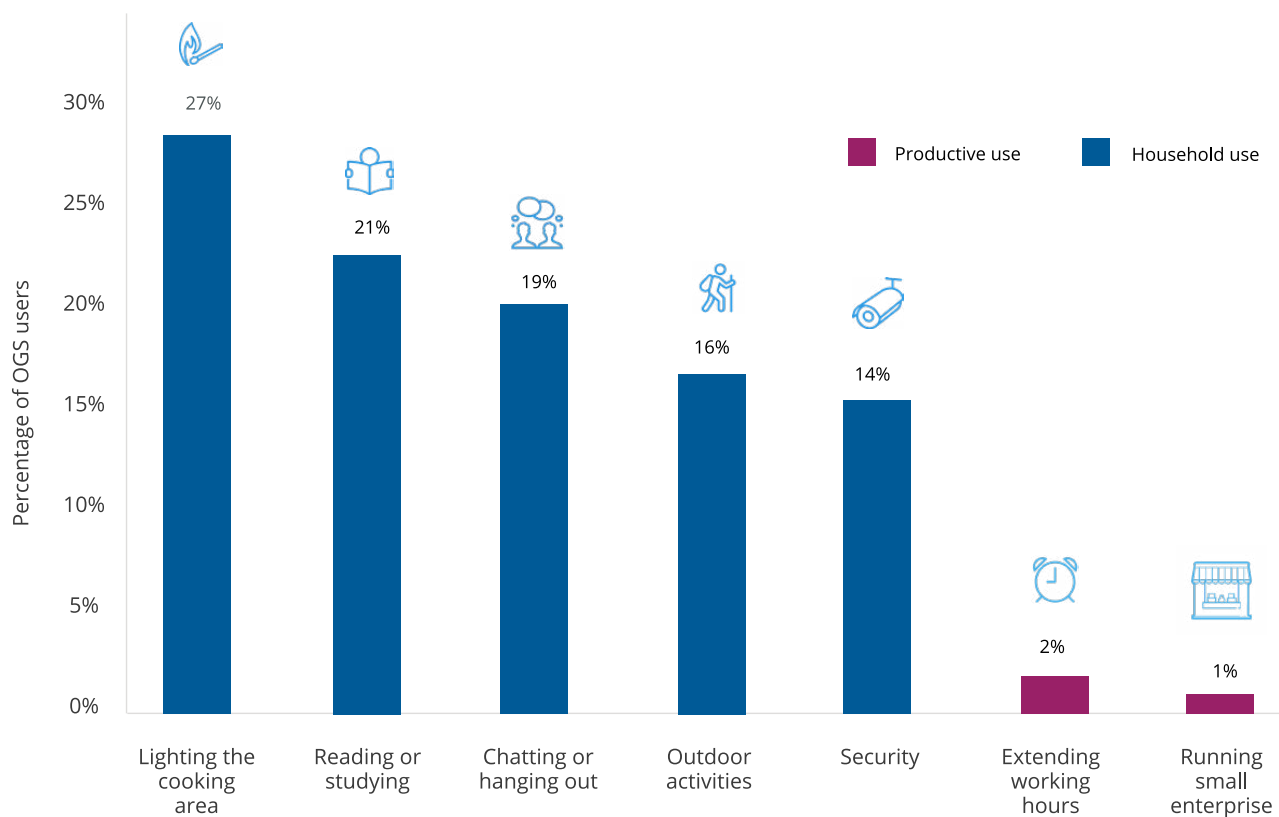
100 Analysis: TFE Energy; Survey data: Anglo Pacific Research; Stakeholder and supplier interviews by TFE Energy
101 Stakeholder and supplier interviews by TFE Energy
102 These are users who stated in the survey that they own a quality-verified product, but have bought it from a store that does not sell quality-verified products (typically lot shops).
103 Analysis: TFE Energy; Survey data: Anglo Pacific Research
104 Stakeholder and supplier interviews by TFE Energy
105 Ibid.
106 Ibid.

B. Product Preferences

1. PURPOSE OF USE

Survey data suggests that most households use lighting to “illuminate cooking areas”, followed by “reading and studying”, and “chatting or hanging out”. Only 16 percent use OGS products for outdoor activities, where flashlights are often considered more useful than solar products.

Figure 26 Primary use of OGS products (2018)¹⁰⁷



Interestingly, **OGS products in PNG only rarely support income-generating activities** (“productive uses”). Only 3 percent of respondents use lights to extend working hours or to run an enterprise—a significantly smaller percentage than in, for example, Myanmar.¹⁰⁸ This might be due to a lack of awareness of how larger OGS can support productive uses. It might also be due to the cost of electrical appliances. For example, a solar-powered DC refrigerator, which could be used for a business selling cold drinks, costs around 4,000 kina (\$1,300).¹⁰⁹

¹⁰⁷ Analysis: TFE Energy; Survey data: Anglo Pacific Research

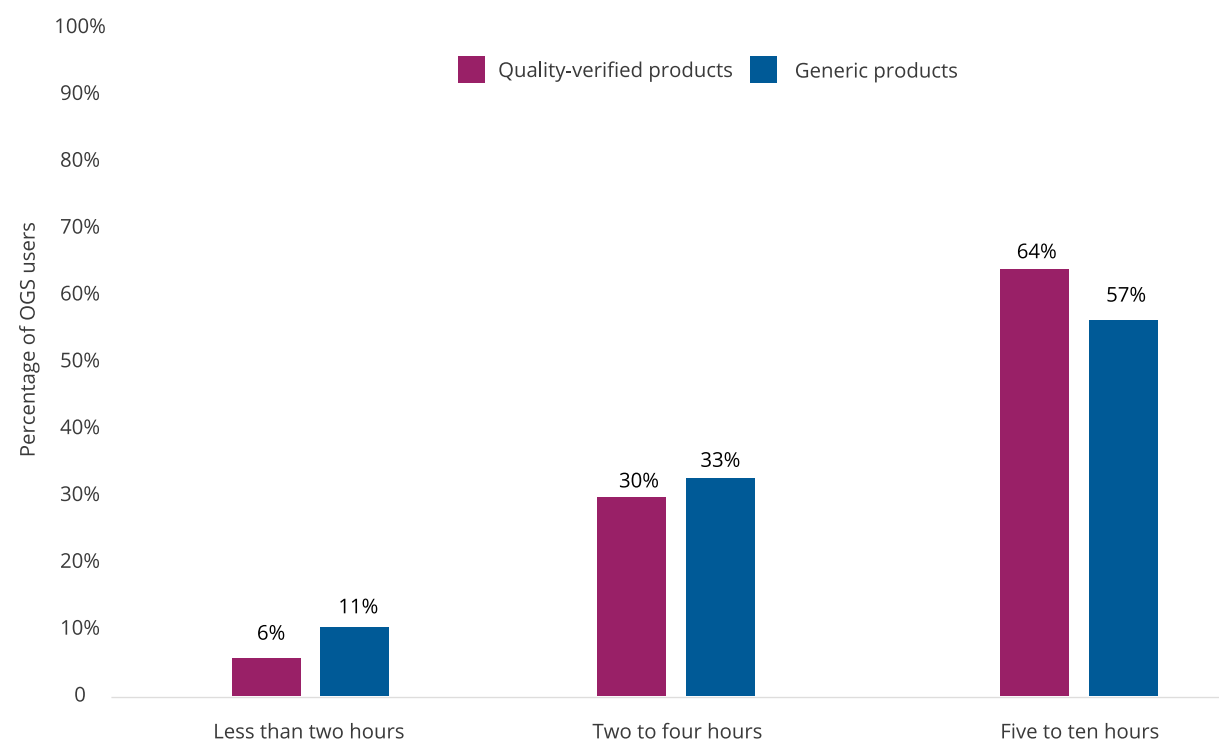
¹⁰⁸ TFE Consulting, “Bridging the Energy Gap: Demand Scenarios for Mini-Grids in Myanmar”, 2018 ([link](#))

¹⁰⁹ Stakeholder and supplier interviews by TFE Energy

2. USAGE TIME

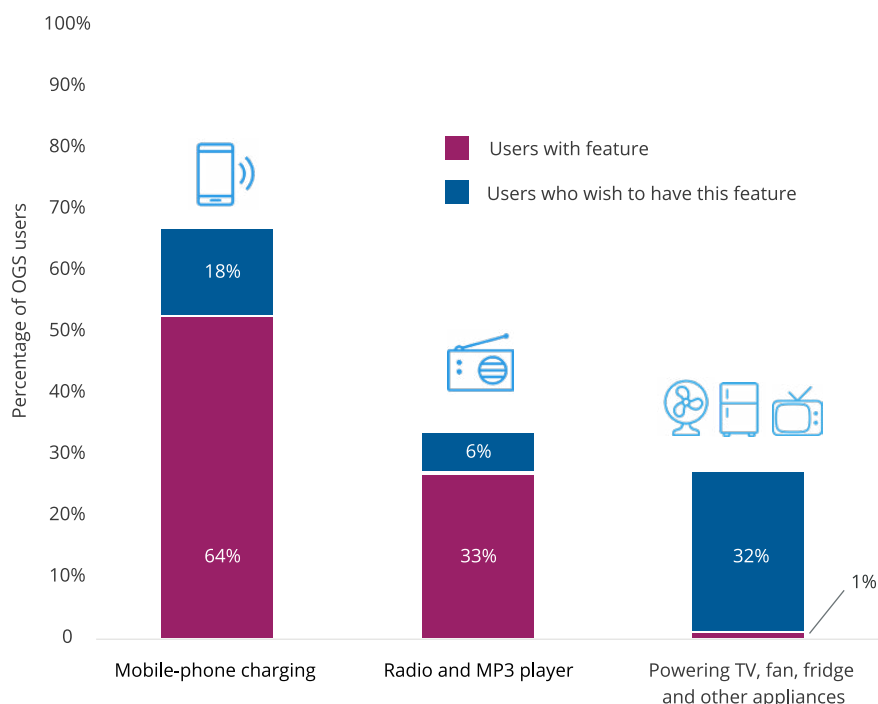
Over half of OGS are used more than five hours a day. Quality-verified products are used slightly more, often for more than five hours, while a higher percentage of generic product users use them for less than five hours a day.

Figure 27 Time spent using OGS products (per day, 2018)¹¹⁰



110 Analysis: TFE Energy; Survey data: Anglo Pacific Research. Graph does not represent the number of hours OGS products can last in a single chart. It shows the number of hours users choose to use their OGS product in a day.

Figure 28 Preferred extra features of OGS products (2018)¹¹¹



3. FEATURES

Survey data suggests that the feature most valued by users is the ability to charge phones. 64 percent of OGS users already have it. 18 percent of those who don't, would like to have it. This customer data corresponds with the earlier mentioned sales data of quality-verified products, which shows pico products with mobile-phone charging as the best sellers. The largest unmet customer demand is with respect to powering appliances such as TVs, fans, refrigerators, and other appliances. These features and appliances are not readily available in the market as yet, but companies are exploring opportunities.¹¹²

Mobile Phone-Charging Kiosks

A household in PNG with no access to electricity or solar power typically spends 20 kina (\$6) per month on charging mobile phones.¹¹³ This is almost the same as they would spend on the actual phone service, around 24 kina (\$7.20) per month.¹¹⁴ If there is no mobile-phone charger available in the household, customers seek out phone-charging kiosks like the one pictured here (Image 1). These are located throughout the country and are usually powered by petrol or diesel generators. A full mobile charge costs 2 to 3 kina (\$0.62 to \$0.92).

One kiosk operator said that customers have now started to charge their phones more than twice a week, because the newer phones, with more data usage (often social media and streaming music), consume more energy.¹¹⁵

Opposite: Mobile phone-charging kiosk¹¹⁶



¹¹¹ Analysis: TFE Energy; Survey data: Anglo Pacific Research

¹¹² Ibid.

¹¹³ Ibid.

¹¹⁴ Ibid.

¹¹⁵ Stakeholder and supplier interviews by TFE Energy

¹¹⁶ Image credit: Nabin Raj Gaihre, TFE Energy

C. Prices and Purchasing Behavior

Collection of data on product purchase costs was **challenging**. Respondents often found it difficult to recollect exact amounts and, in many cases, products were gifted. Further, products were bought at different sales points throughout the country, some close to the villages (in which case transportation and intermediary commissions would add to costs) and some in the cities. When breaking down available data sets by product category or by quality-verified vs. generic, they mostly become too small and vary too much to support reliable analysis. This contrasts with the much more robust data gathered on product preferences.

With the above caveat in mind, there are some observations that can be made. The first is **that the price of quality-verified products is, in general, around 30 percent higher than that of generic products.**¹¹⁷ The largest cost difference was observed in the category of **pico one-light systems. Here, quality-verified products cost nearly twice as much as generic ones.** This observation is supported by data from 144 households.¹¹⁸ The data for other product categories, while less reliable, shows a smaller relative gap between quality-verified and generic products. Data for quality-verified pico two-light products was particularly limited (only nine owners of quality-verified products responded). The costs reported for pico three or more-light systems cannot be fairly compared, because of large variations in product type. Several generic product users paid over 500 kina (\$154) for their product. This is indicative of a system with more than three lights and possibly extra features.

Figure 29 Comparison of purchase costs of quality-verified and generic products by category (2018)¹¹⁹



¹¹⁷ Analysis: TFE Energy; Survey data: Anglo Pacific Research

¹¹⁸ Ibid.

¹¹⁹ Ibid.

The difference in cost between quality-verified and generic products is also reflected in the fact that **people who buy quality-verified products earn about 300 kina (\$100) more every fortnight than those who buy generic products**. However, it is noteworthy that even households with very high incomes buy generic products.

Figure 30 Incomes of customers of quality-verified and generic OGS products (2018)¹²⁰

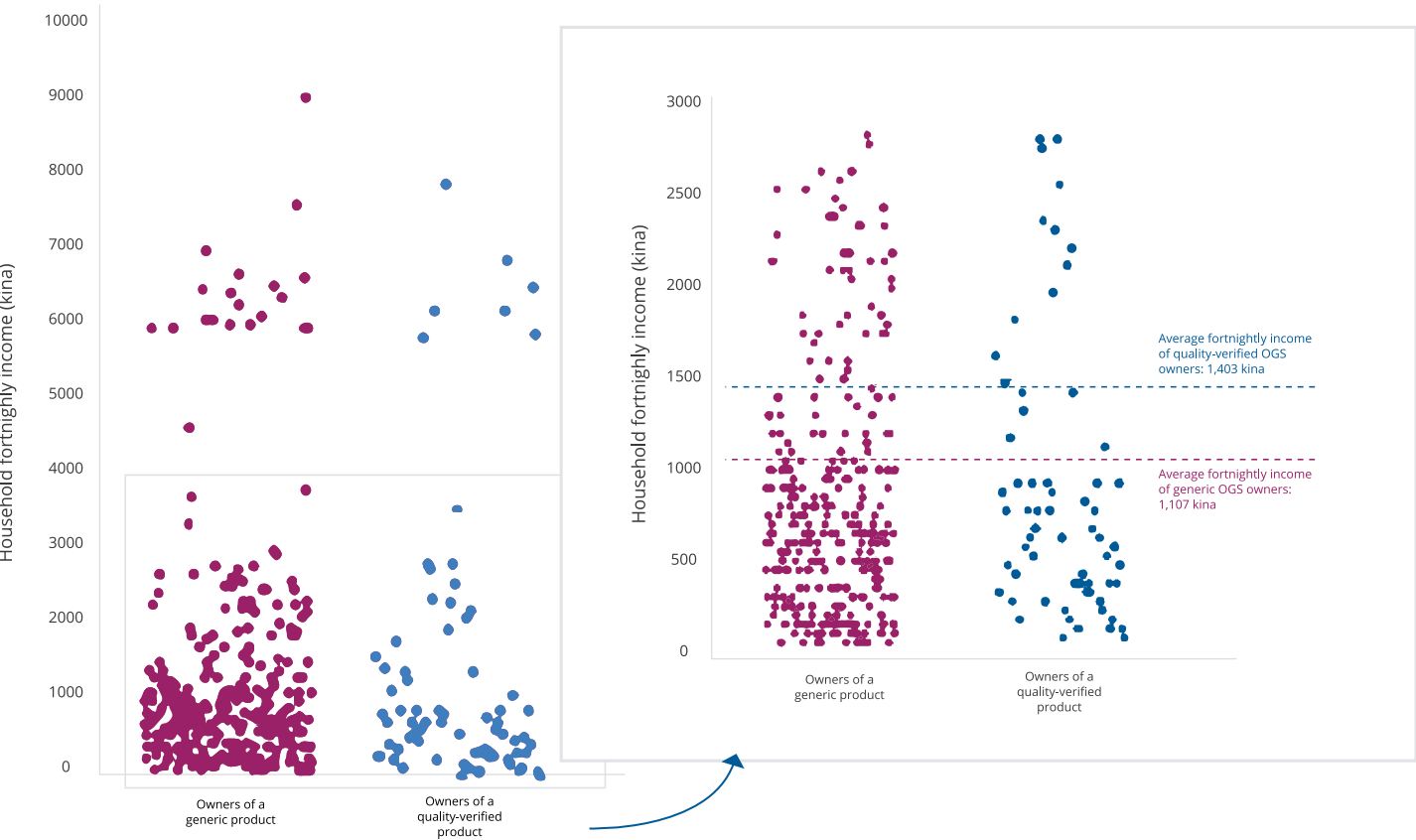
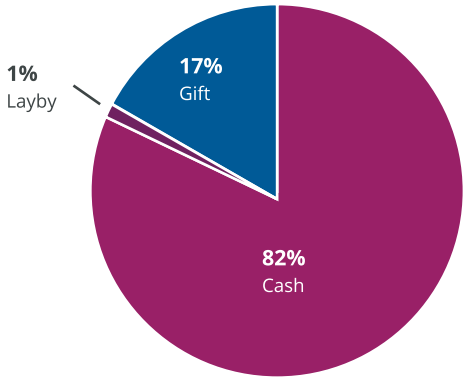


Figure 31
Means of acquisition of OGS products (2018)¹²¹

1. MEANS OF ACQUISITION

82 percent of customers purchased their OGS product with cash. 17 percent received it as gifts. Although there are some Pay-As-You-Go business models emerging, financing schemes for OGS are almost non-existent in PNG. Only 1 percent of OGS product owners claimed to have purchased their product on “layby”. This is an instalment plan used in PNG that typically involves a 10 to 20 percent deposit and the retailer holding the item until a specific portion of the total price has been paid.



Formal loans for OGS products are not prevalent in the market today. This might change in the future, as the reach of banking (especially mobile banking, PAYGO products, and micro loans) in PNG increases. 63 percent of households surveyed have at least one member with a bank account. The overwhelming majority of those are with the Bank South Pacific (BSP). Overall, bank access remains challenging in PNG, particularly in rural areas where 85% of low income population is reported as having no access to formal financial services - with women and rural adults being especially excluded.¹²²

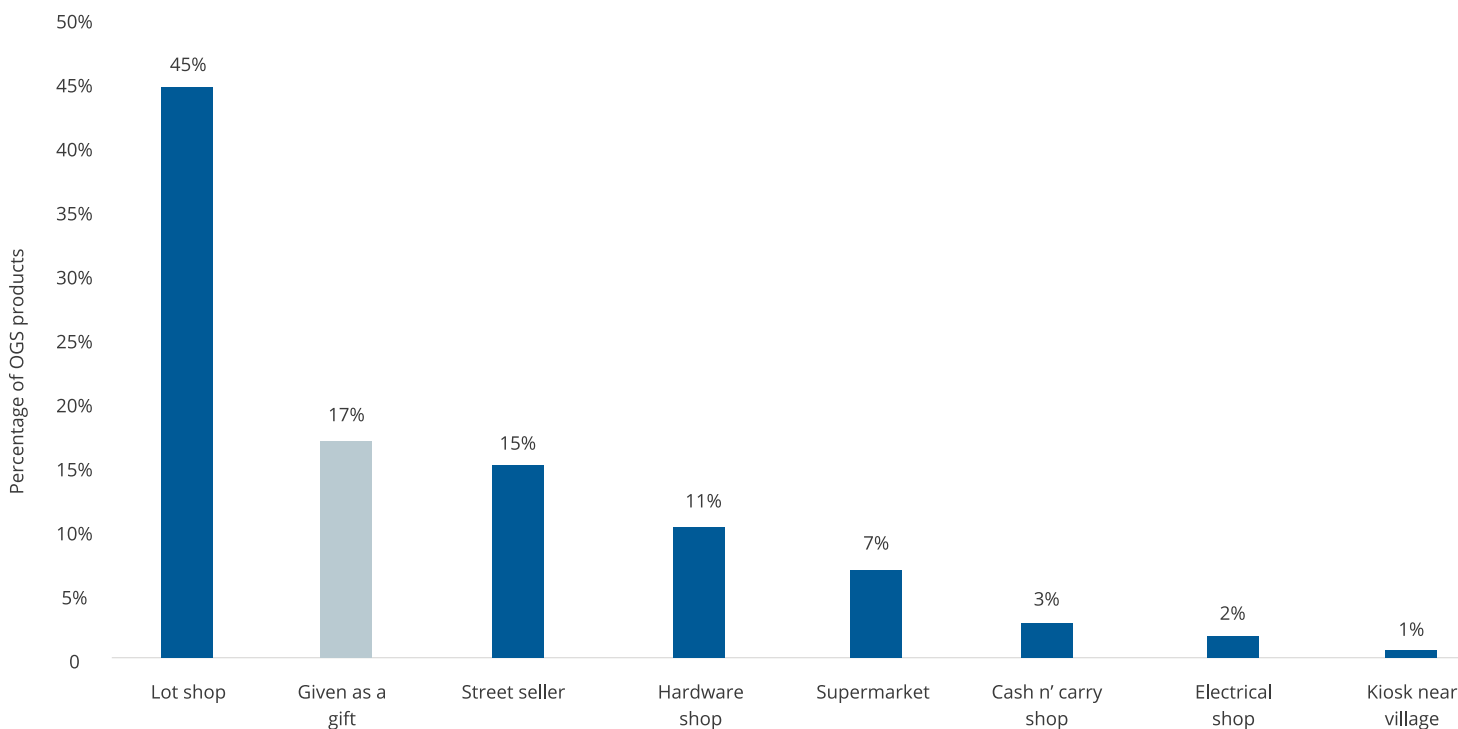
120 Ibid.
121 Ibid.
122 Introduction to financial inclusion ([link](#)); accessed 8 March 2019

2. POINTS OF PURCHASE

45 percent of all OGS products are bought at lot shops. These shops offer a broad range of products for off-grid households, ranging from kitchenware and food to clothing and lighting solutions. **The second most frequent source of acquiring OGS is through gifting.** Such gifts might have been purchased anywhere. Gifts are either given by family members, by local church ministers and donors, and, not least of all, by elected officials. MPs regularly distribute gifts to those who elected them or to an entire village in their voting district. These gifts come in many forms, but lately, OGS products have been a favorite. For example, in the villages of Matairuka and Saroa Keina in the Rigo district, nearly every OGS product had been gifted by an MP.

Channels in the categories “street seller”, “hardware shop”, “supermarket”, “cash ‘n’ carry shop”, and “electrical shop” are typically found in cities or towns and district centers. **Just over half of all OGS products are purchased at shops in cities.** This is particularly the case for quality-verified products. 82 percent of them are purchased in the city, usually at hardware shops, supermarkets, and electrical shops that also offer warranties on the products. 45 percent of generic products are also bought in cities, mostly at lot shops.¹²⁴ The other half of all OGS products are bought in nearby towns and district centers.

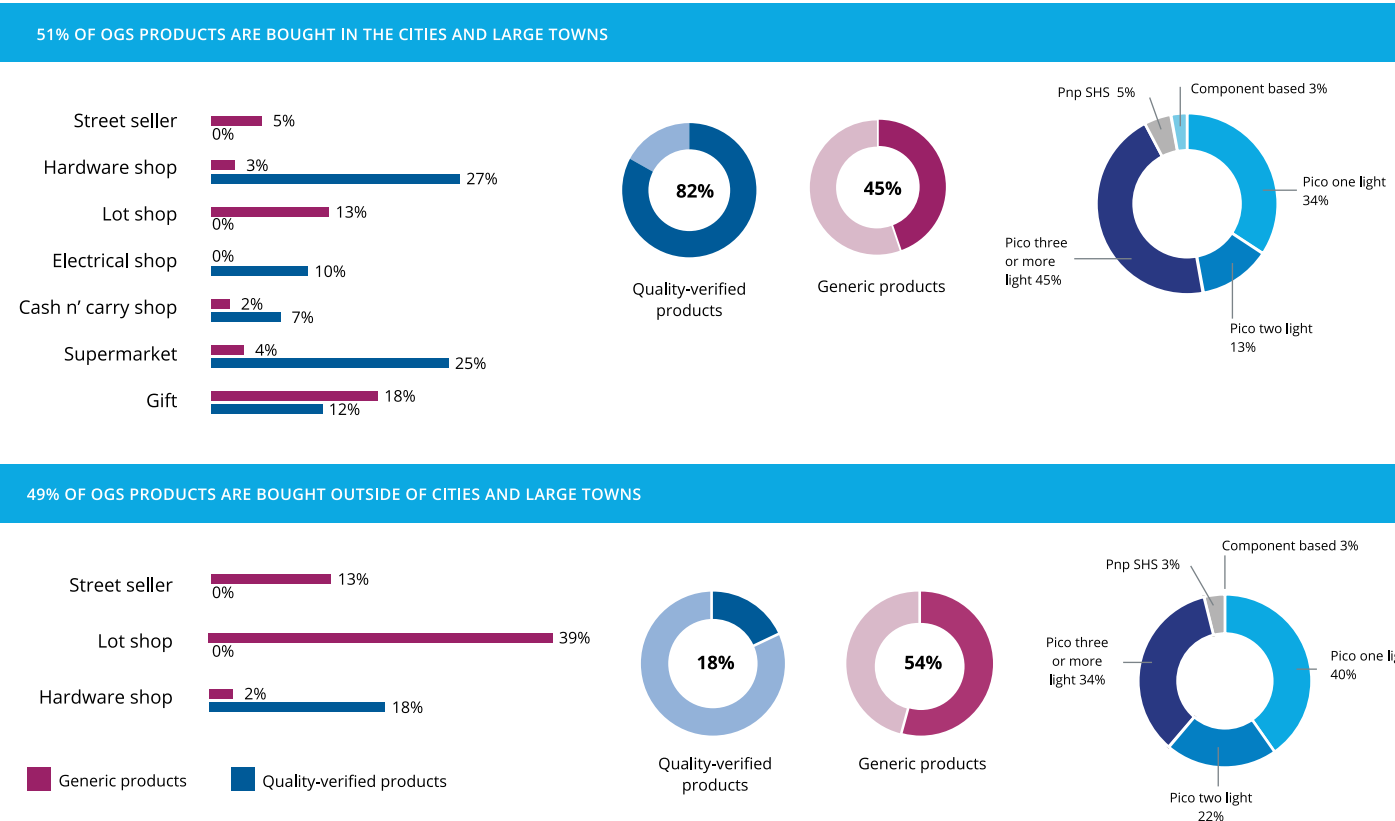
Figure 32 Channels of acquisition of OGS products (2018)¹²³



123 Analysis: TFE Energy; Survey data: Anglo Pacific Research

124 Ibid.

Figure 33 Points of purchase for quality-verified and generic products (2018)¹²⁵



The significant differences between quality-verified and generic products in the points of purchase suggest that **customers often make purchase decisions based on what is conveniently available to them**. This factor might be as important (if not more important) as product price, functionality, and quality, especially for less expensive pico products.

However, the survey suggests that, when it comes to more expensive acquisitions, customers are slightly more prepared to make a longer trip to the city for more purchasing options, warranties, and better service from larger vendors. Details on the supply channels are covered in the following section.

There is a grey zone between the information from the customer survey on where products were purchased and the information from distributors on where they sell, because there is an unknown, but probably significant, number of independent local resellers. This may partly explain the earlier mentioned survey observation that 62 percent of buyers of quality-verified products are not aware that they have a product warranty.

SECTION V:

Supply-Side Dynamics

A. Supply Chains

1. IMPORTING OGS PRODUCTS TO PNG

International shipping costs to PNG are among the highest in the Asia-Pacific region. This is because ships often return from PNG empty or only half-loaded as exports are far lower than imports.¹²⁶

Nearly all OGS products, whether quality-verified or generic, are imported from China. Most quality-verified products are shipped from either Guangzhou or Shenzhen. Ports of origin for generic products are unknown. In PNG, OGS products arrive at Lae or Port Moresby. Lae is a well-connected industrial hub and the largest port in the country, handling around two-thirds of all imports.¹²⁷ From there, goods are transported to the Highlands (via the Highlands Highway) and to the islands (via marine routes). Port Moresby, on the other hand, has no road connectivity to the rest of the country. Goods arriving there are either for consumption in the Port Moresby area itself or are distributed onwards by air or marine routes (often via Lae).

The customs clearance process for OGS products in Lae and Port Moresby is streamlined and fast as there are no applicable duties. Most clearance processes for quality-verified OGS products are handled by professional customs clearing agents. The procedure is initiated with submission of invoices on the customs' web portal before the shipment arrives. If all documents are in order, it typically takes two to three working days to get containers cleared. This is a significant improvement compared to 2014.¹²⁸ But delays in processing can be costly with charges of more than \$500 per day.¹²⁹

2. SUPPLY ROUTES OF QUALITY-VERIFIED OGS PRODUCTS

Previously, quality-verified products typically arrived at Port Moresby. With very few exceptions, the businesses importing them are also based there. They appreciate the size of the city's own market and the proximity to bulk-buying customer groups such as the government, NGOs, international organizations, and embassies. Also, it is easier to serve outlying islands with small quantities through air freight from Port Moresby. Nowadays, with increased coverage and focus from manufacturers, importers of quality-verified products are also bringing stock directly to Lae.

When ordering products from manufacturers, importers of quality-verified OGS products often wait until they have enough purchase orders to fill an entire 20-foot shipping container. Smaller importers order under 'loose cargo loading' and will need to wait for a container to be filled with other orders. Even for a large importer, this usually takes a few months.¹³⁰ They try to mix a variety of solar products—small lights, PnP SHS, or solar products for commercial and industrial customers to fill up a container. Shipping a smaller quantity than a container makes the products very expensive. The downside of waiting for orders to accumulate is that business is lost to faster competitors, who often sell generic products.

To address the larger PNG market, distributors reach beyond the geographically cut-off Port Moresby region, especially to Lae. However, transport there costs as much or more as bringing the product from China to Port Moresby, since the route is serviced by two dominant freight companies with little competition. From Lae, expensive road transportation is used to move products to the hinterland.¹³¹



126 Oxford Business Group ([link](#)) and stakeholder and supplier interviews by TFE Energy

127 Stakeholder and supplier interviews by TFE Energy

128 IFC, Lighting Papua New Guinea, PNG Off-Grid Lighting Market Analysis Report, 2014 ([link](#))

129 Stakeholder and supplier interviews by TFE Energy

130 Ibid.

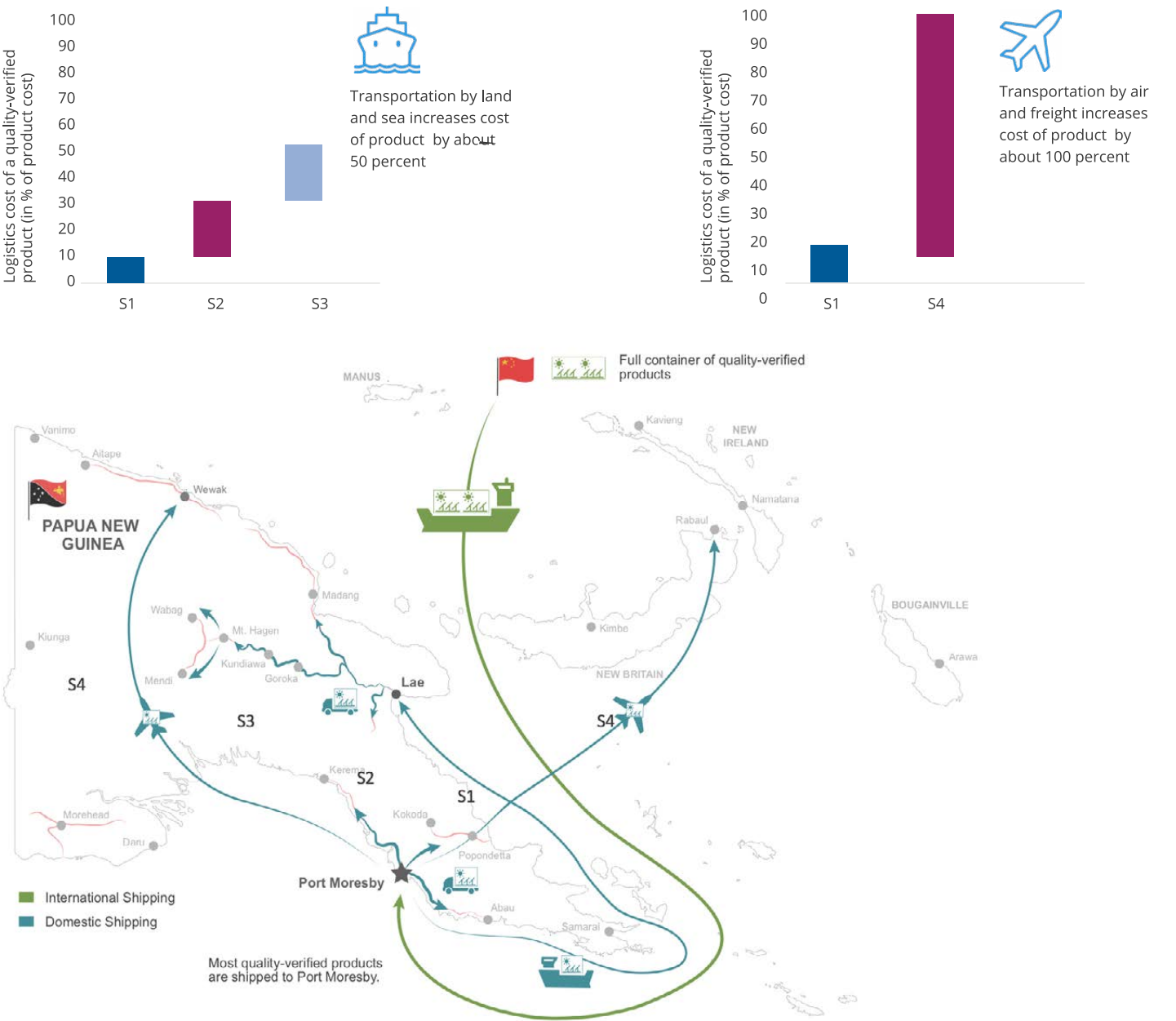
131 Ibid.

To avoid shipping and road transport or to reach disconnected remote areas, some distributors make use of PNG’s well-established air routes.¹³² It is a safe and fast option, but typically only used for small volumes, because of the cost. Transport costs anywhere between 25 kina to 50 kina (\$7.7 to \$15.4) per kilogram, depending on flight distance and type of aircraft used.

Overall, transportation to a remote part of the country can increase the cost of goods by 50 to 100 percent. To give an illustrative example: International shipping from China increases costs by about 10 to 15 percent. Then, domestic shipping from Port Moresby to Lae adds a further 15 to 20 percent. From there, onward road transportation in trucks to the highlands and other parts of the country increases cost by 20 percent. This is assuming that an entire 20-foot container full of products is moved, which is not the norm. If a container is not fully loaded, logistics costs per product increase accordingly.

If domestic air freight is used, costs increase by about 100 percent. The chart below explains how the chosen distribution route affects the cost of products, including the margins taken by different stakeholders in the supply chain.

Figure 34 Supply chain and distribution costs of quality-verified OGS products (2018)¹³³



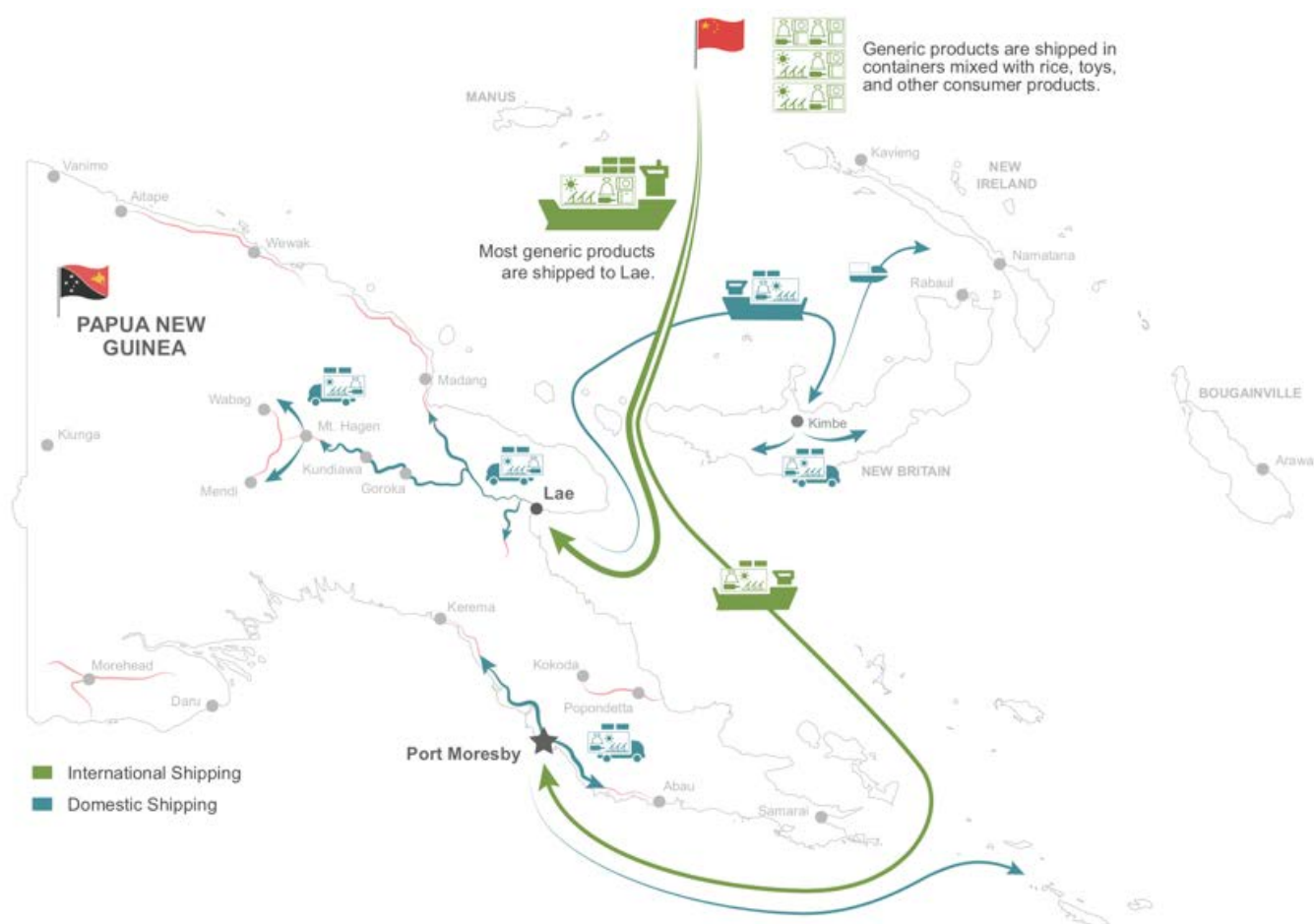
132 Ibid.
133 TFE Energy analysis based on stakeholder and supplier interviews

3. SUPPLY ROUTES OF GENERIC OGS PRODUCTS

Unlike quality-verified products, **generic lighting products are often imported in mixed containers**, which also include a variety of fast-moving goods such as toys, electronics, household utensils, and food.¹³⁴ Individual shipments usually encompass more than 10 containers and arrive at regular intervals.¹³⁵ Unlike quality-verified products, importers of **generic products usually ship to Lae** rather than Port Moresby, avoiding the expensive Port Moresby to Lae marine route. These are clear advantages of scale, speed, and routing for generic over quality-verified products.

Supply chains for generic OGS products are highly integrated. A small group of companies organizes the import of mixed containers that include OGS products, and then manages the onward transport to retail outlets across the country. It is possible that the different stores selling generic products across the country operate as a buyers' group and that many of them are, indeed, owned by a single entity. This could explain the fact that these stores have a very similar product offering. Such a buyers' group might accumulate orders and communicate to a procurement office in China, which sources the entire mix of goods, fills the containers, and ships them to PNG.¹³⁶

Figure 35 Supply chain of generic OGS products (2018)¹³⁷



Using a supply chain that combines lighting products with other fast-moving products targeted at the same customer group ensures a regular supply of generic OGS products and reduced per unit transport costs. However, generic OGS products are typically heavier and larger in size than quality-verified products (for the same electricity or lumen output), which increases the transport cost per unit. Stakeholder interviews indicate that, overall, their transport costs are roughly the same as those of similar quality-verified products.

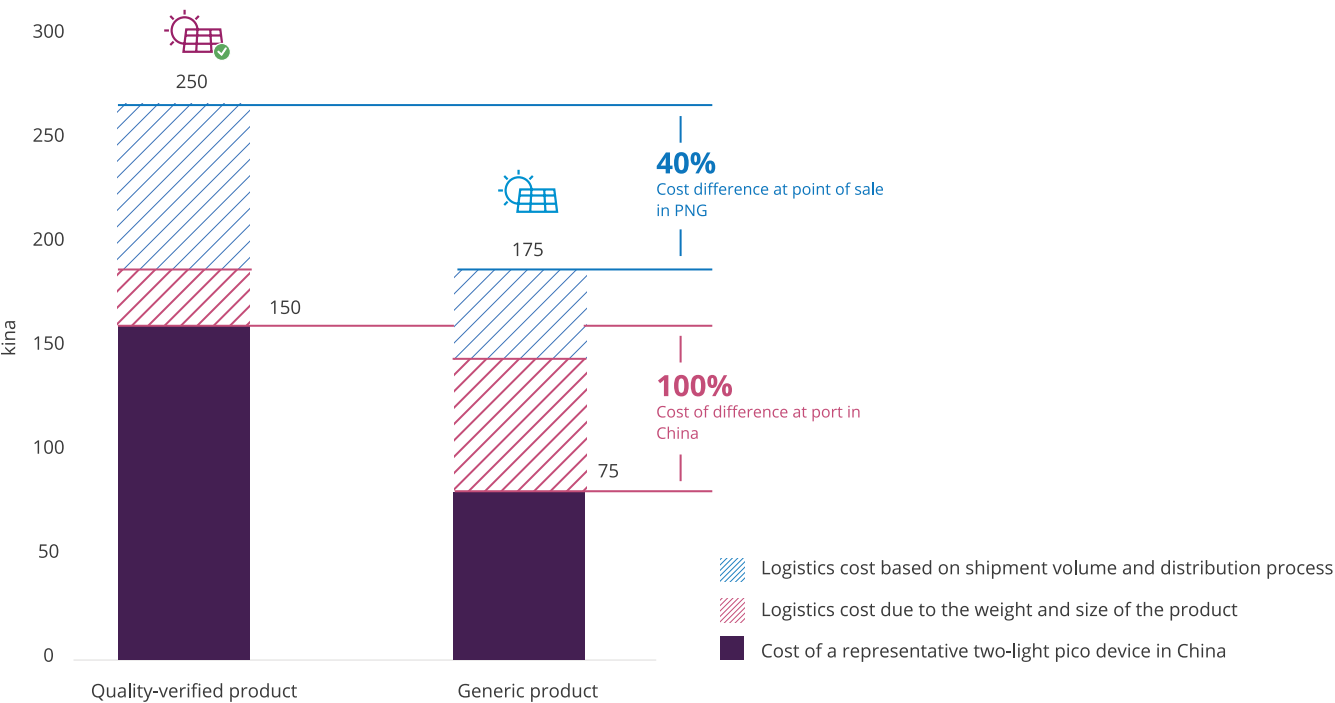
134 Stakeholder and supplier interviews by TFE Energy

135 Ibid.

136 TFE Energy analysis based on stakeholder interviews

137 TFE Energy analysis based on stakeholder and supplier interviews

Figure 36 Estimated logistics costs of quality-verified and generic OGS products (2018)¹³⁸



High transport costs impact both generic and quality-verified OGS products, but reduce the the relative advantage in the manufacturing cost of generic products (Fig.37). This factor could make PNG a more promising market for quality-verified products than other markets in India or Africa with better and cheaper distribution channels. A senior sales head of a large OGS manufacturer expressed optimism about the PNG market for this reason, stating that quality-verified products compete well with generic products in remote parts of the country.¹³⁹

138 TFE Energy analysis based on interviews with quality-verified OGS products manufacturers

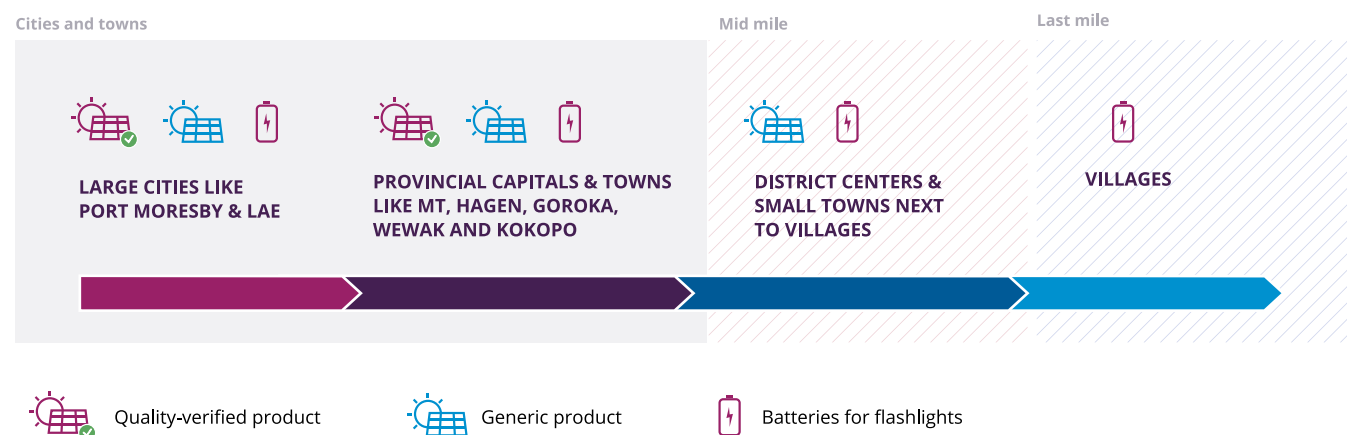
139 TFE Energy interview with quality-verified OGS products manufacturers

B. Sales Channels

Sales channels for OGS products in PNG can be categorized into three segments.

- **Cities and towns:** These are markets in larger urban areas. They include the major port cities of Port Moresby and Lae, and larger provincial capitals like Mount Hagen, Goroka, Kokopo, Madang, and Wewak.
- **Mid mile:** These are markets in smaller district centers and towns across PNG, such as Asaro, Bulolo, Kerema Kupiano, Rabaul, and Ramu, ; and smaller provincial capitals like Alotau, Buka, Kavieng, Kimbe, Kundiawa, Lorengau, Mendi, Vanimo, and Wabag.
- **Last mile:** These are markets in or next to rural settlements.

Figure 37 Sales channels for different product reach



1. SALES CHANNELS OF QUALITY-VERIFIED OGS PRODUCTS

Quality-verified OGS products are currently imported and distributed by at least 20 PNG businesses, including a large solar specialist, electrical shops, hardware shops, department stores, and energy distributors.¹⁴⁰ These businesses are image-conscious and want their brands to be associated with quality. They therefore prefer quality-verified to generic products.

Table 3 Distributors of quality-verified products in PNG (2018)¹⁴¹

Distributor category	Distributor	Sales points	Sales channel type
Solar specialists	Solar Solutions PNG	Port Moresby	Cities and towns
	Titan Distributors	Lae	Cities and towns
	Jedjay Limited	Multiple locations	Mid-mile markets
	Solar Tech Global	Port Moresby	Cities and towns
Electrical shops	Brian Bell	10 stores throughout the country	Cities and towns and a few mid-mile markets
	Niugini Electrical	Lae	Cities and towns
Hardware shops	Badili Hardware	Port Moresby	Cities and towns
	Hardware Haus	Multiple stores in major cities	Cities and towns and a few mid-mile markets
	Tininga Hardware	Mount Hagen	Cities and towns
Department stores	City Pharmacy Ltd. (CPL Group)	Multiple stores in major cities	Cities and towns
	Fair Price (Courts)	Port Moresby and Lae	Cities and towns
	Cool Stuf	Port Moresby and Lae	Cities and towns
	Stop & Shop	Multiple stores in major cities	Cities and towns
Energy distributor	Origin Energy	Port Moresby and through resellers	Cities and towns and a few mid mile
	NGF Limited	Port Moresby and Lae	Cities and towns and a few mid mile
Others	Lae Sport Store	Lae	Cities and towns
	Digicel	Multiple locations across country	Cities and towns, mid-mile and a few last-mile markets
	Sola Paygo	Port Moresby and Lae	Cities and towns, and few mid mile

Due to the organizational setup and business models of distributors of quality-verified products, most sales still depend on customers visiting retail stores, often in the cities. With some exceptions, distributors lack a supply chain to reach customers at mid-mile or last-mile sales points. The survey suggests that **only about 18 percent of quality-verified products were sold in mid and last-mile market segments, usually through resellers.**¹⁴² This happens in a handful of areas that are prosperous because of their geographical proximity to economic activities like mining or high-value, cash-crop agriculture, such as the villages around Ambunti in the Momase region¹⁴³.

141 TFE Energy analysis based on data from IFC PNG

142 Analysis: TFE Energy; Survey data: Anglo Pacific Research

143 Stakeholder and supplier interviews by TFE Energy

Table 4 Examples of distributors of quality-verified OGS products (2018)¹⁴⁴

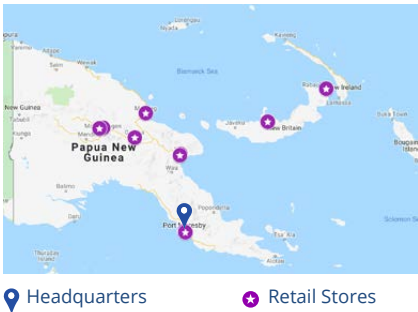
Brian Bell - Port Moresby

TYPE Electrical-appliances chain

OGS PRODUCTS Orb & Niwa

DISTRIBUTION

Mostly to cities and large towns through more than 10 retail shops (shown in map) and 28 resellers.



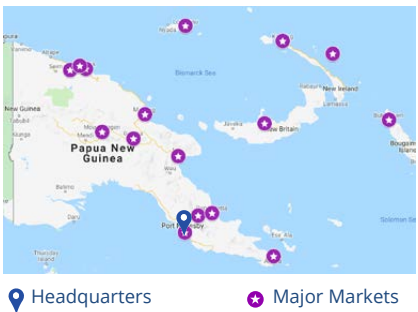
CPL Group - Port Moresby

TYPE Pharmacy and department stores

OGS PRODUCTS d.light

DISTRIBUTION

Mostly to cities and large towns through City Pharmacy, Hardware Haus, and Stop N Shop stores.



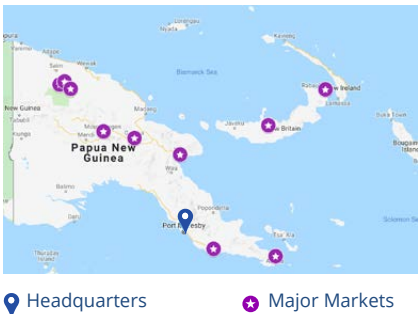
Origin Energy PNG - Port Moresby

TYPE Energy/cooking-gas provider

OGS PRODUCTS ovSolar and Sun King

DISTRIBUTION

In remote areas through a number of resellers, who deliver products door to door, Origin has also piloted PAYGO near Kupiano town. The company now plans to extend this model to other villages.



NGF Limited - Port Moresby

TYPE Large-scale distributor of products used in extractive industries

OGS PRODUCTS ovSolar and Sun King

DISTRIBUTION

NGF Limited is the first warehouse of OGS products in PNG. The company imports to Lae and Port Moresby in bulk and supplies to distributors across PNG.



2. SALES CHANNELS FOR GENERIC OGS PRODUCTS

Generic products are typically sold through lot shops. While there were not many such shops in 2014,¹⁴⁵ they have since expanded rapidly to more than 100 stores throughout the country. Lot shops are found in shopping centers in the cities and along roads and in small towns, at mid-mile market segments. They rely on a village transportation system to attract last-mile customers.

It is common for villagers in PNG to go to nearby towns at least once a month in so-called “public mobility vehicles” or PMVs. These are diesel trucks with flat benches on a sun-shaded cargo area. The trucks usually leave in the morning and return with the villagers and their purchases in the evening. PMVs often stop at lot shops because they offer a good variety of products that villagers need. Further, it is possible that PMV drivers are incentivized by lot shop owners to stop next to their shops.

Store-operators at lot shops outside Lae and Port Moresby were uncooperative when asked questions. This might be due to language barriers. It might also be due to non-transparent business practices or simply a reluctance to share business information. From observations, it seems that 5 to 10 percent of floor space is used for OGS products.¹⁴⁶

Apart from lot shops, generic products are also sold in some large electronics or building materials stores in major cities like Port Moresby.

144 TFE Energy analysis based on data from IFC PNG
145 IFC, Lighting PNG, PNG Off-Grid Lighting Market Analysis Report, 2014 (link)
146 Based on site visits by TFE Energy

Image 2 Public mobility vehicles (PMVs) next to lot shops in Port Moresby¹⁴⁷



Image 3 Generic products sold in a large store in Port Moresby¹⁴⁸



C. Supply Challenges

1. FOREIGN CURRENCY EXCHANGE

A June-2018 PNG business survey ranked foreign currency as the number one constraint to doing business.¹⁴⁹ In part, this is a result of interventions by the central bank to fix the exchange rate of the kina to the U.S. dollar.¹⁵⁰ In part, it is also due to a highly illiquid international market for the kina. The U.S. dollar, the only currency accepted by quality-verified manufacturers, is the hardest to get. The resulting delays lead to lost business opportunities for distributors of quality-verified products.

¹⁴⁷ Image credit: Nabin Raj Gaihre, TFE Energy

¹⁴⁸ Ibid.

¹⁴⁹ “Forex shortage hit”, Post- Courier, accessed July 18, 2018 ([link](#))

¹⁵⁰ Paul Flannagan, “Benefit shortfalls of the PNG LNG Project: a response to Mark McGillivray”, Devpolicyblog, accessed June 12, 2018 ([link](#))

However, the burden is not equally shared. PNG banks give priority to their large customers—to the detriment of smaller businesses. So, while a large supplier of mining accessories can exchange kina for dollars within one or two weeks, a smaller company **may have to** wait for six months to get enough dollars to buy a container-full of quality-verified OGS products.¹⁵¹

Some distributors have asked manufacturers to open kina bank accounts.¹⁵² This will not solve the problem, however, but simply shift it from distributors to manufacturers, as they would then need to find a way to exchange kina for dollars. Given the comparatively small size of the PNG market, it is unlikely that manufacturers will agree to this.

It is not clear how distributors of generic products navigate the foreign exchange problem. There are two likely scenarios. Either the importers buy products from China in Chinese yuan, which is slightly easier to access than U.S. dollars. Or, they get easier access to forex because of the size of their businesses.

2. SECURITY

Security is a concern throughout PNG. According to the U.S. Department of State, the crime rate in Papua New Guinea is among the highest in the world. The major cities (Port Moresby, Lae, Madang, Mount Hagen, Goroka) are riskiest, but crimes can occur anywhere.¹⁵³

The same business survey ranked security incidents and the high cost of security as part of the three major constraints to business (in addition to the shortage of foreign exchange noted above, and the unreliability and high cost of utilities and services).

Businesses suffer losses from theft, kidnapping of staff, armed hold-ups of cargo or other violence. **Goods and people have to be safeguarded; whether at offices, at storage and sales points, or during transport.** Four of five businesses employ security staff.¹⁵⁴ As a result, the private security industry is thriving and has grown into one of the country’s key business sectors.

Securing consignments, warehouses, and stores adds to the overall cost of doing business and thus of the products themselves. Most trucks, whether they carry quality-verified or generic OGS products, have security personnel or even escort vehicles. In many places, the markets that sell solar products are fenced in. These security challenges also create a challenge for companies offering pre-financing solutions for solar products (PAYGO model), as the risk of not being able to collect monthly installments from customers is high.¹⁵⁵

151 Stakeholder and supplier interviews by TFE Energy
152 Ibid.
153 U.S. Department of State, Bureau of Diplomatic Security, “Papua New Guinea 2017 Crime & Safety Report”, June 19, 2017 (link)
154 John Bellinger, “Five things every company needs to know about security in Papua New Guinea”, Business Advantage PNG, June 14, 2016 (link)
155 Stakeholder and supplier interviews by TFE Energy



SECTION VI:

Continuing to Grow the Market for Quality-Verified Off-Grid Solar Products

SUGGESTION 1

CONTINUE TO PROMOTE THE “QUALITY-VERIFIED PRODUCT” MESSAGE—TO ALL STAKEHOLDERS

Many consumers have a broad sense of quality and an interest in buying quality products, if available and affordable.

There is a lack of awareness of the better quality of quality-verified solar products and their associated brands, how they can be identified, and where they can be bought.

Quality-verified products are difficult to distinguish from generic products, particularly as there is no one label to identify a quality-verified product. As a result, marketing should continue to inform customers about benefits of quality-verified products, along with product and brand-specific marketing and where they can be purchased.

Most distributors understand the general need for marketing, but have shied away from the costs, which are particularly high in PNG. As part of Lighting PNG activities, IFC undertook two large consumer awareness campaigns comprising village-level roadshows and a mix of newspaper, radio, and SMS campaigns. The campaign used a slogan ‘Gutpla Solar, Gutpla Life (Good Solar, Good Life)’ to embody the benefits of quality verified solar. Companies active in the market now have an opportunity to leverage the ‘Gutpla Solar, Gutpla Life’ message and build it into their own marketing activities.

Finally, market participants should be encouraged to engage with government stakeholders on relevant platforms to ensure that the features and benefits of quality products are understood. There are agencies willing to take action, if adequately supported. For example, the customs department has started to filter out

counterfeit and hazardous products. This includes a ban on imports of low-quality Christmas lights after PNG Power Limited found that they were a major fire hazard.¹⁵⁶ In principle, the customs department is open to promoting solar products that do not infringe on copyrights or are hazardous, provided it is supported in identifying them.

Image 5 Counterfeit generic product sold in a store in Port Moresby at a similar price to its quality-verified original¹⁵⁷



Copy-cat generic product in a store in Port Moresby



Quality verified d.light S3

Some suppliers of generic OGS products are known to have deflated import duties by showing understated purchase invoices.¹⁵⁸ To counter this practice, PNG customs has started scrutinizing purchase invoices and rejecting clearance requests if products are valued suspiciously low. In such cases, containers are held back at the port until further clarification. The high cost of storing containers in ports (more than \$500 per day)¹⁵⁹ acts as an incentive for importers to avoid causing suspicion. As a result, customs have observed that suppliers of generic products now produce higher, more credible purchase invoices.¹⁶⁰

156 Ibid.

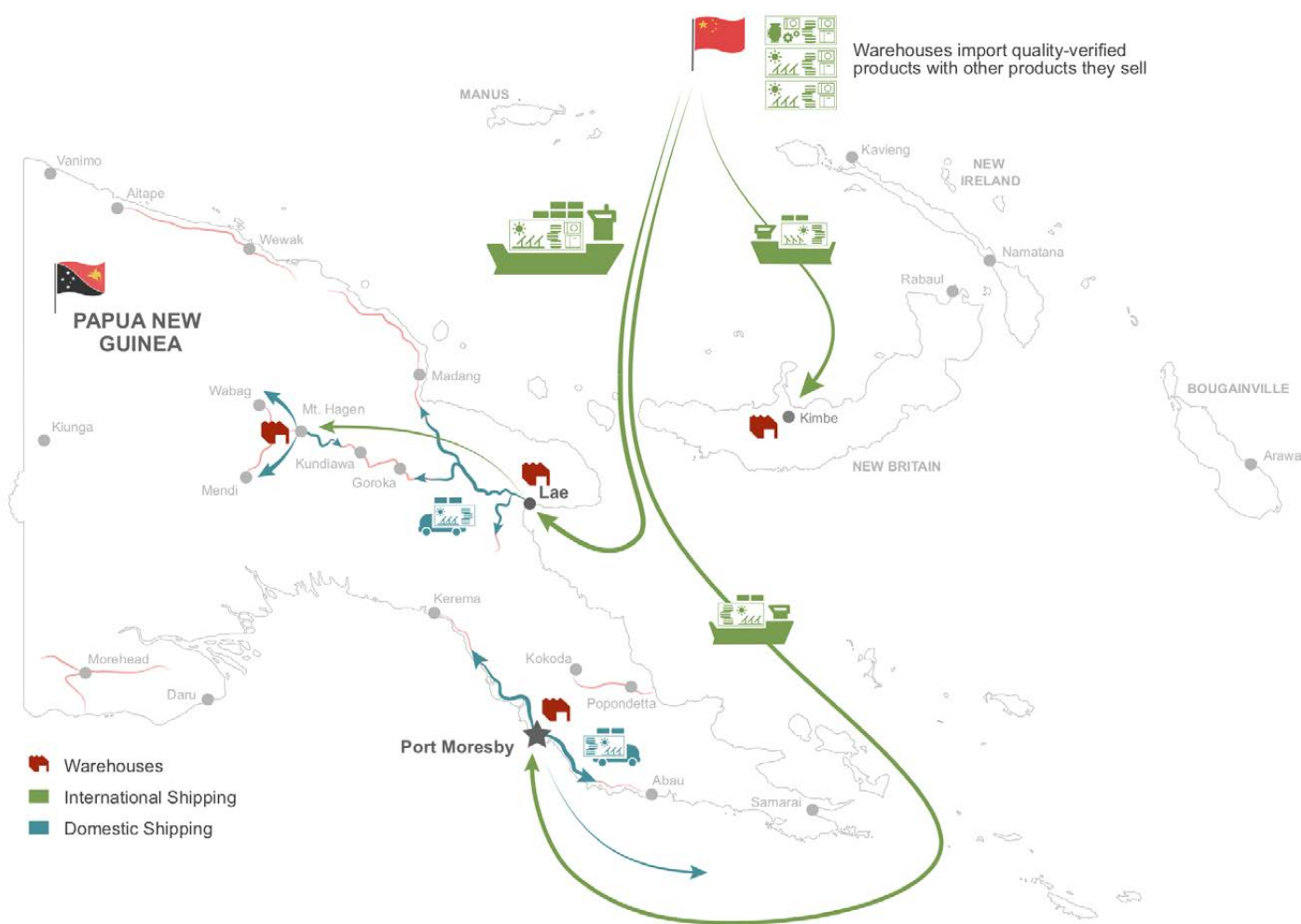
157 Image credit: Nabin Raj Gaihre, TFE Energy

158 Stakeholder and supplier interviews by TFE Energy

159 Ibid.

160 Ibid.

Figure 38 Warehouses can help streamline the distribution of quality-verified products and reduce logistics costs¹⁶¹



SUGGESTION 2

DEEPEN AND BROADEN DISTRIBUTION PARTNERSHIPS, AND EXPLORE WAYS TO INCREASE MID AND LAST-MILE PRESENCE

Given the existing large market beyond concentrated centers, companies must continue to build effective distribution and retail partnerships to increase business efficiency and look at ways they can increase reach to mid and last-mile customers.

Although import processes appear relatively smooth, smaller distributors are often hampered by stocking delays due to the need to collate large orders or wait for containers to fill. Bundling imports and warehousing, as is already done by distributors of generic products, would help distributors of quality-verified products bring products to market more quickly. Such a bundling service could be offered by large PNG businesses with regular import flows and

existing storage facilities. Two brands are already working with one such importer, who takes care of all importing logistics and manages forex challenges.¹⁶²

Mid-mile markets represent a substantive opportunity but have not been extensively tapped. Large distributors of quality-verified products have the means to reach mid-mile sales points, but are often reluctant to do so as they see risk of low revenue on the total portfolio of electrical appliances they sell.¹⁶³ However, the many hardware stores selling at mid mile across PNG typically buy their inventory from larger distributors and could be specifically targeted through them as potential sales channels.

¹⁶¹ TFE Energy analysis based on stakeholder and supplier interviews

¹⁶² Stakeholder and supplier interviews by TFE Energy

¹⁶³ Ibid.

Another approach could be to look for cross-selling opportunities and collaborations with other providers of rural goods or services. Pico-lights with phone chargers, for instance, could be sold together with mobile phones or network connections from mid-mile sales points, or distributors could look to leverage the PMV network.

PMVs stop where rural customers purchase household goods, including generic OGS products, but there is a good chance that PMV drivers and customers don't know of any other stores nearby that might sell quality-verified solar products. Marketing quality-verified sales points aggressively to the PMV network could therefore increase sales. PMV operators and drivers are key to such an approach but operate in a fragmented market. PMVs are typically owned by individual operators, who then hire drivers, making the implementation and scaling of such an approach challenging.

Last-mile shopkeepers are unwilling to stock OGS as the product cost is high and turnaround time is too low, compared to the everyday products they sell, such as rice, soft drinks, beer, matches, or batteries. Villages might be better reached through dedicated, local resellers. Origin Energy, for example, already has a network of resellers, who buy ten or more products and sell them door-to-door. Jedjay Limited has a slightly different approach: the company employs its own sales staff to go to villages, targeting locations based on local knowledge of economic potential.

SUGGESTION 3 PREPARE FOR THE “UPGRADE AND REPLACEMENT” MARKET

The high market penetration of OGS and the prevalence of pico products, suggest strong potential for an “upgrade and replacement” market for distributors. Upgrading can happen along different dimensions: Customers might shift from smaller to larger pico products, and from pico products to PnP SHS, which also have a much higher revenue potential. For replacements, as quality-verified products become more prevalent, consumers may choose these products as like-for-like replacements—if the right solutions are available.

With this in mind, manufacturers should continue to bring innovative products to market that fill gaps and unmet demand. For example, battery-based flashlights are used by 65 percent of households, with 30 percent using them alongside an OGS. Narrow beam, high lumen OGS flashlights, designed to be carried around, could be an attractive alternative to battery-based flashlights.

Refrigerators, TVs, and fans were also identified as desirable products.

Currently, OGS are used predominantly for lighting different living spaces and social activities. They are only rarely used for productive/commercial purposes such as lighting retail spaces and related requirements. Larger pico products and PnP SHS are better suited for such uses, particularly refrigeration and TVs for rural entertainment. Marketing these as sources for income generation might make them more attractive. An OGS multi-phone charger for use in PNG's many phone charging kiosks may be an easy first step, followed by larger products and appliances, which may require finance.

SUGGESTION 4 TARGETING STRATEGIC SALES LOCATIONS, PARTNERS, AND TIMING

High-income villages: High-income villages are characterized either by their production of cash crops like vanilla, coffee, or cocoa or by proximity to mining-extraction industries. Most villagers here are likely to have already used generic products and might want to move to higher-quality OGS.

Communities with grid-access: Many grid-connected households also buy OGS products as back-up. These are mostly in urban and peri-urban areas and within reach of existing distribution channels of quality-verified distributors. Also, many consumers in this market have sufficient purchasing power to buy quality products. This market is low-hanging fruit for quality-verified OGS distributors.

Gift-buying city shoppers: PNG villages have a tradition of buying gifts for relatives. Our survey suggests that 17 percent of quality-verified products were bought as gifts. There could be a dedicated marketing drive in cities to suggest OGS as gifts.

Partner with institutions with rural activities: Government, churches, international missions, NGOs, and CSR teams of extraction businesses already have access to rural communities for their own projects. They could partner with distributors of quality-verified products to better access villages

Harness testimonials: As in many other markets, *seeing is believing* holds true in rural PNG. If one household in the village has a brighter light, or if the light lasts throughout the night, the rest of the village is likely to take notice and might want to buy the same

product.¹⁶⁴ To do this, companies will need to better track and manage customer relationships.

The timing of sales: There is lack of a strongly developed savings culture in PNG. Money is often spent when it becomes available.¹⁶⁵ Since quality-verified products are comparatively expensive, they must be made available when customers have money. This is typically on Fridays, when wages are paid out, or at harvesting and festival times.

Partnerships for finance: Financing solutions will likely play a more important role, the larger and more expensive the OGS products are. Offering financing would require overcoming the strong cash culture, as well as the earlier mentioned security risks. Companies will need to work to build relationships with banks and microfinance institutions to target banked customers, as well as continue to build PAYGO offerings. Two PAYGO models are currently being tested in the market and serve both banked and unbanked customers.

164 Stakeholder and supplier interviews by TFE Energy

165 “People lack saving culture, says Bank Governor Bakani”, Loop, July 22, 2016 ([link](#))

List of Interviewed Stakeholders

THE FOLLOWING WERE THE PARTICIPANTS OF IN-PERSON OR TELEPHONIC INTERVIEWS CONDUCTED BY TFE ENERGY.

Brian Bell Group: Srinivas Ramamoorthy and Peter Del Monte

d.light: Karl Skare

Department of Petroleum and Energy, Government of
Papua New Guinea: Vore Veve

Fair Price (Courts): Christopher Elphick

Greenlight Planet: Sanaullah Fathi, Ishita Kotak and Ismeet Kohli

Jedjay: Mary Handen

New Zealand High Commission, Port Moresby: Davene Vroon

NGF Limited: Phil Ho

Niugini Electrical Company: James Fountain

Origin Energy PNG: Lesieli Taviri

Patricks Transport: Leung Chen

PNG Customs Service, Lae: James Barasuru

PNG Customs Service, Port Moresby: Tom B. Vere
and Wilma Seolo

PNG Power Limited: Bruce Corbet

Solar Solutions PNG: Jon Pittar

Solartech Global: Zha Agabe-Granfar

The World Bank, PNG: Gerrad Fae

University of Papua New Guinea: Manu Rawali