existing fuels. The projects in this ‘economic zone’ would need to justify the upfront investments in infrastructure, whereupon secondary markets could be developed over time. This could include LNG and CNG for transport and industrial/commercial uses, which generally require much smaller volumes per individual application.

The most relevant PICTs with sufficient fuel demand (either individually or in aggregate) are Fiji, French Polynesia, Guam and New Caledonia. PICTs with smaller demands could conceivably seek to leverage off any use of LNG in the larger economies, though this would also require comprehensive analysis ahead of any infrastructure investments that would be needed.

In the situation where market conditions make cost-effective supply of LNG possible in a PICT, the following actions could be considered:

- an individual power station, IPP, government, gas importer, or consortium could enter into a long-term contract for LNG supply, and/or
- PICT governments could consider facilitating LNG use in transport or industry once LNG infrastructure is established on the back of an ‘anchor demand’ in power generation.

PNG and Timor-Leste are special cases: they have indigenous supplies of natural gas and could investigate local use of LNG or piped natural gas.

Recommendations

Although further commercial, technical, policy and environmental factors need to align for a significant fuel transition to occur, a number of recommendations, requiring a relatively low investment of time and resources, can be made:

Expansions of LPG

1. The transition to LPG from biomass and kerosene for cooking be accelerated, given that it has positive health and environmental benefits. This could include assessing the need in some PICTs to reduce the import duty and tax for LPG relative to household kerosene (given it is subsidised in some PICTs), supporting subsidised cylinder exchange/ deposit schemes, microfinance initiatives or other initiatives designed to reduce health risks (particularly for women), environmental impacts and overall costs for individual domestic customers and some commercial enterprise as well.

2. PICT governments consider approaches for developing small piped LPG networks in urban areas to supply LPG for cooking and other purposes. This approach would help improve economies of scale and create centres of demand.

3. PICT governments consider developing LPG options for the transport sector. In addition to providing a cleaner burning fuel, the increased demand may improve economics for LPG across the region.

4. PICT governments consider introducing appropriate incentives for private sector and other stakeholders to increase their LPG import and storage capacities to facilitate increased LPG usage.

Potential Introduction of Natural Gas

5. Relevant end-users with an aggregate power-generation capacity of more than 40 Megawatts (MW) assess the economic viability of importing bulk LNG, including using floating storage units (FSUs) or a floating storage and regasification unit (FSRU).

6. Governments develop policy frameworks for LNG import and use in those countries where there is realistic potential for LNG substitution.

For both LPG and Natural Gas

7. Power-generating utilities and Independent Power Producers (IPPs) consider investing in multi-fuel and gaseous fuel injection capability (LNG/natural gas, diesel, HFO, LPG) when buying new generators in relevant countries. This offers maximum flexibility in future fuel choices with a relatively small incremental cost.

Fuel pricing

8. Secretariat of the Pacific Community (SPC) and Pacific Power Association (PPA) develop an ongoing ‘watching brief’ on the world’s bulk LPG and LNG markets to identify potential oversupply conditions and price anomalies and keep Governments and private sector groups informed of emerging opportunities.

**LPG and Natural Gas as Alternative Energy Sources for the Pacific**

This research study was commissioned by the Pacific Region Infrastructure Facility (PRIF) and undertaken in collaboration with the Pacific Power Association (PPA), a member of the Council of Regional Organisations in the Pacific (CROP), which represents 25 electric power utilities in the Pacific, and the Secretariat of the Pacific Community (SPC), which participates through its Economic Development Division in Suva, Fiji.

The report summarises the research and outcomes of several workshops with industry experts, development agencies and government officials. The views, conclusions and recommendations expressed in the report are those of the authors and do not necessarily reflect the views and policies of the PRIF Members or partner agencies or the governments, companies or institutions they represent.

**Background**

The Pacific Island Countries and Territories (PICTs) face particular energy supply challenges in regard to their small, remote island economies, limited natural resources, and long distances to major markets. Most PICTs are highly dependent on imported petroleum products to meet their energy needs. This dependence means they are heavily impacted by high or volatile global oil prices. In addition, these countries are among the most vulnerable in terms of climate change and natural disasters.

Historically, limited options have been available to displace liquid petroleum fuels such as kerosene, gasoline and diesel. However, recent market developments have changed this situation: liquefied petroleum gas (LPG) and natural gas, including compressed natural gas (CNG) and liquefied natural gas (LNG), are increasingly offering more economical, low-emission interim solutions in the transition from liquid petroleum fuels towards renewable energy.

This study assesses the potential and economic feasibility of LPG, LNG or CNG to meet medium term energy needs in the PICTs. It considers the end-use applications of

### Pacific Region Infrastructure Facility (PRIF)


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Liquefied Petroleum Gas, or ‘LPG’, refers to a family of light gases called propane and butane, derived from the processing of natural gas liquids and the refining of crude oil. LPG is gaseous at normal temperature and pressure, and becomes liquid when subjected to modest pressure or cooling. LPG is used mainly in cylinders for portable applications, cooking, heating, lighting, refrigeration and transport fuels.

Natural gas is composed primarily of methane (usually over 85% by volume), but it may also contain ethane and propane with small amounts of heavier hydrocarbons (and some impurities which are removed before liquefaction). Liquefied Natural Gas, or ‘LNG’, is natural gas which has been processed to liquid form for ease of storage or transport, by cooling it to approximately −161°C depending on its exact composition, at which point it becomes a liquid, reducing the volume of the gas by a factor of more than 600 times as it goes from its gaseous state to liquid.
LPG

Potential to expand use of Liquefied Petroleum Gas

All PICTs already use LPG, mainly for household cooking and this study finds significant opportunity for expansion. If use of LPG was expanded to displace all cooking kerosene and biomass in the Pacific region, the current demand could double. The argument for making this change is for health reasons, environmental sustainability and for cost-saving for individual householders. However, the increase in demand could be expected to achieve better economies of scale to different degrees across PICTs. Increased volume could drive some PICTs to move to bulk delivery which could have a significant impact on the delivered price. The addition of LPG use in transport or small piped gas networks would further increase volumes and might be expected to achieve better bulk import economics. Based on commercial technology already available in Australia, experimental work is currently being conducted in Fiji on the use of LPG in heavy vehicles and blending of LPG with other fuels in electricity generation.

There are also other ways to stimulate demand for LPG, both in domestic and commercial settings, including:

- providing grants or microfinance initiatives for early market uptake of LPG
- organising information campaigns on LPG use for both domestic and commercial applications
- introducing subsidised cylinder exchange/deposit schemes
- adopting LPG in schools, hospitals, hotels and via other business customers
- developing a niche use for LPG in commercial air conditioning systems
- supporting or providing training of installers, contractors and building managers to operate LPG appliances.

This would not only directly stimulate use of LPG, but it would also grow the capacity of suppliers, agents and depots and expand the secondary market through reduced overall costs for individual domestic customers.

LNG

Potential for Liquefied Natural Gas

LNG can be shipped long distances cost-effectively in bulk ships in capacities as small as 10,000m³. However, a major drawback is that in most PICTs unloading facilities and storage systems would need to be built. These storage systems could be fixed land-based facilities, floating storage units with land-based regasification, or floating storage and regasification units.

To cost-effectively supply LNG to PICTs, two pre-conditions are required. First, there must be individual or collective points of demand that are large enough to justify bulk LNG shipping and local unloading, storage and regasification facilities. This applies possible in meeting some/all of the power generation demand in Fiji, French Polynesia, Guam and New Caledonia. Second, the market conditions and supply arrangements must be such that the delivered cost of LNG is less than that of diesel or HFO (depending on which fuel is being replaced) on a dollar/MMBTU basis over the life of the contract, which would typically be 15+ years. Clearly, each country would have to undertake its own economic cost-benefit analysis. However, once LNG is established in a country on the back of an ‘anchor demand’, it could also be expanded to transport, commercial, industrial or pipeline applications. There is also some potential for nearby PICTs to benefit from the existence of storage units and supply, but each case would require careful analysis of the risks, costs and benefits.

PNG is a unique case. Pipeline supply of natural gas to major centres might be feasible in the short term if supply for local needs can be made available from the well-head or via a branch line from the existing pipeline to the LNG plant in Port Moresby.

CNG

Potential for Compressed Natural Gas

CNG cannot be shipped cost-effectively over large distances due to its relatively low energy density. It can, however, be produced if LNG shipments are put through a pressurised vapourisation process within the country – the so-called Liquefied CNG (LCNG) process. However, this technology is very expensive, so it is likely to be less attractive to the PICTs.

Fuel price forecasts

Relative future fuel costs are critical to investment decisions on fuel conversion. There is considerable volatility in the global market. End-users should understand the long-term price trends for various fuels, as well as future fuel supply and demand scenarios, and make investment decisions on this basis rather than on present-day cost and demand.

Conclusions

Expanding the use of LPG

This study shows that there is significant opportunity in a broad range of PICTs to increase LPG utilisation. It is a cleaner burning fuel than biomass and kerosene, therefore providing both health and environmental benefits and increased uptake may improve economies of scale in supply chains. In some cases, the capacity of existing port and storage infrastructure is sufficient but, in others, it would require investment and expansion.

Fiji has demonstrated that the adoption of LPG for land transport can result in developing economies of scale and increased competition to deliver lower prices for household LPG. In other PICTs, there are also opportunities for increased uptake of LPG in transport and other applications in both domestic and commercial settings. These warrant further consideration.

Possible introduction of LNG

Under current market conditions, LNG might possibly prove to be a viable investment for a few of the PICTs. Any shift to the introduction of LNG requires considerable new capital investment in ports, storage facilities, in-country distribution networks, and equipment conversion. It also requires the development of new skills and regulations, as well as extensive marketing to ensure adequate demand. Whether such investments and reforms are appropriate will depend on the size of the market, the relative cost of alternative energy sources, and the degree to which costs can be amortised over the life of the assets with a reasonable rate of return.

If LNG is introduced to a new market in the Pacific, a possible use could be for a limited number of stationary power applications that are geographically concentrated in a few areas around sites and/or major ports. Other possibilities also discussed in workshops in this study include providing energy via a new gas pipeline network for an economic zone where LNG could be used to displace...