

Facilitating Private Sector Participation in the Promotion of Energy Security in Papua New Guinea, Solomon Islands and Vanuatu



Energy Security and Investment Roadmap



SPC
Secretariat
of the Pacific
Community





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ABBREVIATIONS

ADB	Asian Development Bank
bpd	barrels per day
BPNG	Bank of Papua New Guinea
DMO	domestic market obligations
DOE	Department of Energy
DSP	Development Strategic Plan
DSPPAC	Department of Strategic Planning, Policy, and Aid Coordination
EE	energy efficiency
EIP	Electricity Industry Policy
ESCOs	energy service support and management companies
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environment Fund
GPOBA	Global Partnership on Output-Based Aid
GTE	gas-to-electricity
HPS	high-pressure sodium
ICCC	Independent Consumer and Competition Commission
IEA	International Energy Agency
IFIs	International Finance Institutions
ILG	Incorporated Land Group
IPBC	Independent Public Business Corporation
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of Nature
JICA	Japan International cooperation Agency
kWh	kilowatt hour
LED	light emitting diode
LNG	liquid natural gas
LPG	liquid petroleum gas
MLNR	Ministry of Lands and Natural Resources
MTDP	Medium Term Development Plan
MV	mercury vapour
MW	megawatt
MWh	megawatt hours
PICTs	Pacific Island countries and territories
PIES	Public Institution Electrification Scheme
PIFS	Pacific Islands Forum Secretariat
PNG	Papua New Guinea
PNGSEL	PNG Sustainable Energy Ltd
PPI	Private Participation in Infrastructure
PPIAF	Public Private Partnership Advisory Facility
PPL	PNG Power Limited
PPP	Public Private Partnerships
PPP	Purchasing Power Parity
PPPI	Public Private Partnerships in Infrastructure
PSP	Private Sector Participation
REEEP	Renewable Energy & Energy Efficiency Partnership
REP	Rural Electrification Policy
REU	Rural Electrification Unit
SCO	Straight Coconut Oil
SIEA	Solomon Islands Electricity Authority
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
toe	tonnes oil equivalent
UNELCO	Union Electrique du Vanuatu Ltd
UNDP	United Nations Development Programme
WB	World Bank

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EXECUTIVE SUMMARY

2012 was declared the United Nations International Year of Sustainable Energy for all. This message was reinforced at the Rio+20 conference in June, which called for a renewed effort to put energy security and investment at the centre of all development measures and policies. More than USD 513 billion was pledged to build a sustainable future, a move that signalled a major step forward in achieving the future we all want.

The Secretariat of the Pacific Community (SPC) responded quickly throughout the Pacific Community and accelerated an initiative to facilitate private sector investment in sustainable energy and target a 20% contribution of renewables in the Pacific region energy mix by 2030.

Energy in all its forms is now central to nearly every major challenge and opportunity that the world faces today: health, education, communications, jobs, security, climate change, food production and enterprise. Access to energy for all is at the core of the SPC initiative and it is hoped that the proposals in this report help to turn the United Nations message into a reality throughout the Pacific family of nations.

SPC member states recognise that funding of the Micro and Macroeconomic Energy Pathway is critical. It is clear that new Pacific Energy Funds will need to be established to bridge the forward risk investment gap. In this report we will reflect on the findings in the attached Melanesian energy market reports and propose options which may be considered and promoted by the beneficiaries' Agencies and National Authorities. The planning of a 'Pacific Energy and Social Investment' symposium is recommended, so that an economic framework to enable these proposals to become operational actions can be debated and agreed.

The South Western Pacific States of Papua New Guinea (PNG), Solomon Islands and Vanuatu collectively known as Melanesia, present a unique challenge for developing the concept of universal energy provision and energy security for all of its peoples. The task of creating the conditions for attracting private sector investment in support of this goal is equally challenging. A recent study and analysis undertaken in support of this summary report highlights the complex and wide ranging historic factors that have conspired to delay energy expansion and security across the region. In this document we present some strategic proposals and regional recommendations that may be seen as a potential roadmap for projects. These projects may enhance the ability to facilitate and incentivise private sector investment and bridge the deployment gap that currently excludes most of the population from access to energy.

Each Pacific Island nation has a different outlook on energy policy and delivery. Few have sought to integrate or harmonise environmental, energy and economic policies in practical terms. The wider Pacific region can be characterised by its unbalanced distribution of natural resources, commodities and wealth. A variety of approaches are needed when attempting to design and deliver sustainable heat, light and power to all the peoples who inhabit the region.

There seems to be no shortage of reports and papers reflecting on the opportunity to develop bio and renewable energy markets in the Pacific. However converting these aspirations for development and the supply of renewable and bioenergy into a vital and sustainable enterprise culture will require structured action plans and funding methods. Governments need to tackle the historic core issues that have weakened investor confidence in the past, and copy successful examples and measures that reflect true market need. Enterprise support must also be aligned with realistic time lines for deployment: this support should be harmonised with interstate and inter-island policies which, combined, can provide renewed confidence to the international donor and private investment community.

The actions and recommendations prescribed in this consolidated report also require technical consideration by governments, NGOs, and public agencies and should include consultation with regional leaders to enable a socially inclusive approach. Strategic symposiums are proposed, to address these recommendations and bring together industry, government, international donors, and private and public investors, with a view to agreeing a harmonised approach to the funding and deployment of energy security. Private enterprise is willing to invest in well-structured projects, but weaning Pacific nations off their addiction to liquid fossil fuels will also need incentives to stimulate medium term private sector investment.

Expert consensus confirms that 3 to 5 year timelines for policy applications are simply too short to enable forward risk and capital investment to be secured. Energy generators and fuel processors also indicate that 15 to 20 year fiscal and carbon policy horizons are needed to stabilise the conditions for long range capital and asset finance. These provisos have been confirmed by leading investment bankers and private investors in existing green fund markets. Thus the Pacific family of nations and, more specifically Melanesia, should consider developing 'Innovation Capital Zones' to host and incubate micro enterprise solutions. Such solutions should support greater social inclusion for the rural population who are, and could remain, disenfranchised from access to sustainable energy and communications for many years to come. Reports funded by the World Bank, Asian Development Bank and, recently, the European Investment Bank, cited access to electricity as one of the key limiting factors for 'doing business' in Melanesia.

We can go further and say that **'Harmonisation of Water, Sanitation and Energy Production should be seen as the key to unlock the full potential of these island states and facilitate realistic and meaningful opportunities for private and public sector investment'**. Therefore the work of land management, natural resource planners, and finance, energy and agriculture experts, must be consolidated to align projects which can emancipate the collective benefits of any investment. Disparate projects which pilot solutions will produce disparate results and weaken the investment confidence of fund managers.

The majority (80%) of the inhabitants of the Melanesian states can be categorised as a 'rural subsistence' demographic which does not have access to energy to facilitate enterprise, health, education and communication. The relationship between agriculture, health and education can be a powerful driver for selecting a particular renewable energy technology. This can act strengthen the trading relationship between buyers and sellers of resources who have previously disputed resource ownership or access. Previous reports on energy security seem to have ignored these important human needs and relationships, assuming instead that wind, solar or biomass are already the only accepted solutions for renewable energy delivery.

It is now clear that social inclusion and respect for traditions must also play an important part in navigating the path to energy delivery and security in the Pacific region.

Social inclusion can be a powerful driver for measuring the benefits of energy delivery in rural communities, and thus enabling governments and investors to connect directly with the health and wellbeing of people and their livelihoods.

The following proposals are a response to the analysis undertaken on PNG, Solomon Islands and Vanuatu, and provide stimulus for specific recommendations for each state as set out later in this report.

I REPORT OBJECTIVES

- To disseminate the findings of recent research missions which reviewed energy supply markets, and enhance these findings through executive analysis of industrial, social and economic factors to show how these could influence private investment participation in the energy sectors of Melanesia;
- To provide options and mechanisms which may enhance energy security in the target regions;
- To recommend drivers and programmes that may facilitate private sector investment in the energy systems of the target regions; and
- To recommend policy and regulatory enhancements to support and incentivise private sector investment in the energy infrastructure and deployment of renewable energies across the target regions.

II INTRODUCTION

Regional summary

PNG is rich in both natural and carbon resources. Despite the discovery and availability of substantial reserves of liquid natural gas (LNG), however, PNG, like its sister nations of Solomon Islands and Vanuatu in the Melanesian chain, still has a major energy delivery deficit for its rural population.

Some 75% of the population of these three nations still have no grid-based delivery system for electricity across the important last mile to homes and businesses. Many communities and home owners have installed small petrol and diesel generator sets, but these are expensive to operate and cause substantial levels of air pollution. The effect on the health, education, communications and enterprise opportunities for these communities forces them into a subsistence lifestyle which propagates dissent and pushes another generation to be excluded from opportunity.

All three nations still rely heavily on diesel fuel for power generation to the 25% populations living in the capital cities and medium size settlements. While PNG has considerable hydro supply, Solomon Islands and Vanuatu rely almost entirely on diesel generation with limited opportunity to underwrite the cost of the last mile delivery of power. These constraints are exacerbated by the historic monopoly of contractual agreements or state power management which focuses investment within designated concession zones. PNG is also unique in the region in having a reasonably large scale geothermal energy installation to service the Lihir Gold Mine located in New Ireland Province, some 700 km north east of the Capital, Port Moresby. Other renewables, such as wind and solar energy, presently exist on a smaller scale in PNG, Vanuatu and Solomon Islands funded mainly as joint public-private initiatives to support the business expansion needs of companies who have access to capital and energy demand.

Companies such as the commercial agri-business New Britain Palm Oil Company¹ which owns and manages 78,000 hectares of palm, sugar and livestock resources in PNG and Solomon Islands demonstrates what well managed companies with a strong emphasis on social development can do to increase the opportunity for energy and enterprise security for small holders in the rural communities.

Other companies such as Carbon Bridge have pioneered renewable biogas projects in the region and demonstrate the need for governments to establish a focal point for project promoters to incubate, deploy and measure appropriate technologies.

¹ <http://www.nbpol.com.pg> New Britain Palm Oil Ltd

This type of approach should be fostered to enable investment for small and medium-sized enterprises, particularly if mandated by longer range policies that target rural communities.

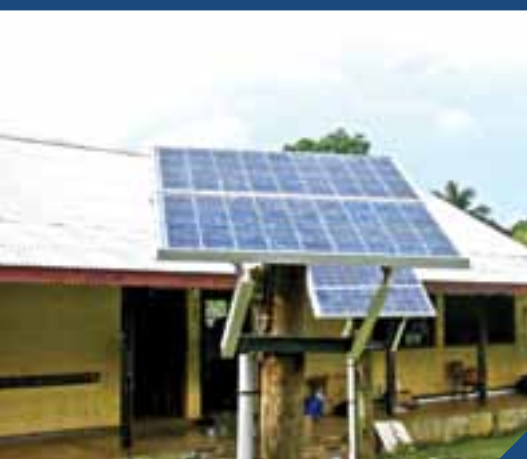
The 'Country Reviews and Proposals' should provide further direction for SPC members and development groups who wish to facilitate and stimulate private sector investment to support energy expansion and security. The regional proposals should be referenced in association with the executive sections of this report. It is anticipated that the contents of this document will trigger strategic actions and help to formulate operational plans to fill the void that exists between urban and rural populations across the Melanesian territories.

Energy investment and development in the region

The executive proposals and recommendations throughout this report have been developed in response to the need to enhance energy security and expansion of rural electrification in the Melanesian states of PNG, Solomon Islands and Vanuatu. The proposals arise from analysis undertaken across these states, which led to specific recommendations for each state, set out later in this report. The Forum of Ministers for the Pacific Island countries and territories (PICTs) has also identified medium term constraints and risks, which were confirmed by the 2012 territory analysis studies.

Summary analysis

- i. Current regional energy frameworks do not give clear enough guidance to the Melanesian countries for the delivery of regional energy services. This process needs to be made more effective by strengthening corresponding policies and strategies at national and state level.
- ii. A lack of appropriate funding mechanisms will reduce the scope and volume of services which can be developed for PICTs. Only 100 new rural residents will gain access to energy in 2012.
- iii. Fossil fuel and renewable projects are being deployed without ensuring that recipients have the capacity or expertise to maintain the solutions, which in turn will limit the sector's power to advance. There is also a weakness in the technical and managerial capacity of the power utilities and the petroleum fuels sector. Insufficient capacity to effectively plan, implement and support energy initiatives will seriously restrict investment confidence.
- iv. The absence of meaningful and succinct baseline data and spatial analysis indicate that a low priority is given to data collection, analysis and research which makes it challenging to ensure that policy development is based on evidence-based data.
- v. The lack of awareness of the links between energy delivery and social mobility and enterprise expansion in some PICTs, and donor development partners, is limiting energy security. The monopoly service and concession agreements in some states are also weakening the free market development.
- vi. No professional technical agency or expert business unit has been established to incubate and develop solutions within Melanesia. A bio and renewable energy incubation hub should be established to emancipate and target funding to promote energy security and social inclusion with community based schemes.
- vii. Few structured private and public sector investment mechanisms are in place to help consolidate projects across existing industries. A regional capital fund should be considered to enable energy services expansion alongside existing agricultural and commodity projects to ensure that rural electrification is integral to the provision of business licensing.



Solar rehabilitation project in Samoa Province of Vanuatu

A market in Solomon Islands

Power grid lines in PNG

C. Proposal to enhance energy security policy and regulatory reform

The recent SPC study and analysis by Melanesian framework support partners confirms that conflict between traditional and national authorities across the region has retarded progress in deploying energy and enterprise opportunities. At the core of these restrictions is the matter of land rights and access, which are, and will remain, fundamental in the planning and deployment of any power grid extensions. While the issue is particularly difficult to resolve in Solomon Islands due to historic ethnic tensions, it is also a region-wide restriction to attracting inbound investment. Offset land issues must be addressed for grid extension to become a reality. Thus a proposal should be made to establish a Land Use and Land Use Planning Forum to agree social inclusion rights for most rural populations in all Pacific States. The proposal should include 'Power Line Permit Ways' agreements to facilitate the routing of grid extensions.

D. Special considerations: land use policy and regulation analysis:

Land access and land zoning issues need to be resolved in order to provide appropriate long range due diligence for rural electrification and grid expansion. A regulatory reform group should be formed to validate and rectify any weakness in the ability to facilitate land designation policies as a precursor to establishing energy development zones and grid extension corridors.

SPC Forum comment & analysis:

The longer-term challenges facing Solomon Islands and other PICTs are significant. It is reported that the root causes of tension from 1998 to 2003 included land ownership and tenure, the clash between traditional and non-traditional authority systems, inadequate government services, lack of economic opportunity (leading to urban drift) and problems with the delivery of law and justice. By 2012 these matters had not been fully addressed and could be a barrier to private sector investment, grid extension and energy security in general. Other long-term challenges include: reconciliation, and sustainability which is closely linked to the focus on capacity development, population growth outstripping economic growth, and governance and leadership opportunities for women.

E. Proposal for the establishment of enterprise incubation and hosting hubs

As a way of leading by example, a proposal should be developed to build enterprise incubation sites throughout the rural and coastal settlements of each state.

These hubs could host an 'anchor tenant' on 'alienated lands' or government land and focus on the development for new industry, or upgrading existing enterprises and adding value to these. There is a crossover with the co-location proposals with the emphasis of hosting Energy Service Providers for maintenance, installation and training of local groups.

These proposed enterprise incubation units may also act as the host location for project managing the blended infrastructure for biogas/biofuel/biomass conversion. The emphasis is on biogas and waste treatment and agri-fertiliser products output as a combined cycle programme. This model has been adopted in other international regions and is gaining support and positive outcomes.

III EXECUTIVE DEVELOPMENT PROPOSALS

The following proposals are designed to respond to the outputs of a wide range of reports and field studies executed over the past five years, specifically as a result of the three country studies undertaken. The proposals should also act as a roadmap for actions that can accelerate the task of bridging the substantial gap between urban and rural access to energy in the Melanesian states of PNG, Solomon Islands and Vanuatu.

A. Power development using scalable off-grid rural biogas units

A proposal should be developed to evaluate the effect of deploying distributed, community-based Renewable and Waste – Energy Service Cooperatives. Although these are settlement based, they may address the triple service deficits for solid, liquid and agri-waste, value-added reprocessing and, as a consequence, deliver sustainable power outputs in the 150 kw–500 kw range to small unit networks. The investment model should also facilitate 'micro finance debt' and 'voucher offset trading' on all inbound waste resource delivered in order to balance the CapEx and OpEx ledger and offset the value of electricity sales. These projects may be scaled and combined with a wide range of waste streams including fish processing and organic cycles, to target inland and coastal locations across Melanesia.

B. Proposal for industrial development/grid extension, with mandated provision for local residents

The potential exists to develop a multiyear agreement between PNG and other Melanesian states to convert existing diesel generated power to the use of LNG. PNG has substantial reserves of LNG and opportunities to increase trade with other Melanesian states. In harmony with these actions, regional governments should implement policies to apply Renewable Conversion Obligations to underwrite a proposed Pan Pacific Green Infrastructure Fund. Such a fund would be dedicated to installing interconnections closing the 'Grid Connection Gap' which currently excludes the majority populations of PNG, SI and Vanuatu from low cost common access to energy.

Having regard to the geographical and topographical restrictions which exist in the island chains, these executive options can be aligned with the current net and future projected energy demand of the territories. The attached territory reports cite examples of successful grid extension programmes (Western Power-PNG)

F. Proposal for accelerating infrastructure investment in hydro & geothermal installations

PICTs have a well documented and well established programme for building Hydro and Geothermal Energy Generating Hubs. PNG is already ahead of many Western countries in this field and Vanuatu and Solomon Islands also indicate good potential. It is therefore proposed that SPC in concert with existing agencies and industry partners propose the establishment of a Hydro and Geothermal Research Unit as an international development and training facility. The project should be aligned with the other executive proposals and capital funding options presented in this report.

G. Proposal to establish micro-finance and trade for energy programmes

Electricity is without doubt the primary enabler for good health, enterprise and communications in society. Because the traditional communities with no access to energy do not always appreciate the values attached to it, new value methodologies may need to be considered. It is proposed that a project is established to evaluate the key deployment modalities for distributed rural bioenergy generation using the triple drivers of waste water treatment, potable water treatment, and biogas to electricity generation. New scalable technologies exist to deliver all three process options and can be deployed with minimal disruption to traditional bylaws.

The programme could be considered as a pilot within the proposed Pacific Energy Incubator Projects and used to anchor the expert technical and funding services of the proposed new Business Unit within each Melanesian State. Project co-location or hosting by existing industry should be considered to encourage private sector investment options.

This proposal should demonstrate that electricity can improve health, give access to communications and education and expand social inclusion in the rural community. The outputs should improve the availability of potable water and provide new income streams through the collection and supply of organic and waste materials in the biogas production channels.

H. Stimulating private sector investment in energy

Private enterprise can play a critical role when enhancing access to energy and, more broadly, in the expansion and transformation of national energy systems to deliver clean, reliable and affordable energy access the broader population. Integrating social programmes with business can also be a key to unlock investment and deliver access to energy, bringing to the table innovative products and services, technologies, management skills and financial resources.

As we move on in this report to examine the conditions and opportunities for specific actions in PNG, Solomon Islands and Vanuatu, it is important to put into context the key areas of opportunity for scaling up the contribution of business in expanding access to energy. We should also put into context the policy frameworks, financing mechanisms and public incentives and how to enable these opportunities in the Pacific Island community.

However, mobilising the required scale of investment also requires political will and well-designed and stable policies to overcome many of the barriers.

It is recommended that policy-makers focus on prioritising energy access in national development planning, improving the investment climate and implementing measures to promote the primary energy access solutions. Meeting universal energy access targets will also require mobilisation of significant additional financial resources.

Public development finance mechanisms should be specifically designed to leverage additional private investment. The broader financing architecture must address the quality of the regulatory and investment climate, which affects risks and returns associated with private investment. We will examine one option to increase fund flow in the sector. However, other options should be explored to consolidate international aid and donor finance to help enable meaningful scale projects, rather than simply event actions that foster ‘talking shops’ for action.

The development of partnerships and cross-sector approaches is essential to make these opportunity areas successful. Effective public-private partnerships will be particularly important drivers for progress towards universal access to energy, especially for most rural communities of the Pacific who may remain severely disadvantaged without access to energy and communications.

I. Developing investment funding mechanisms

Given the highly specialised nature of the bio and renewable energy sector and the need to be able to leverage global technologies and best practice, it is recommended that SPC in concert with national authorities seeks to establish two new business units. These would provide project development planning and technical support and project funding support. The business units would incubate projects and enable both public and private funds to be targeted to underwrite the forward capital and operating costs of energy projects.

A traditional fund management approach is to raise funds from various investors who would commit capital for a range of projects and territories under certain criteria for a return on their investment. The amount committed would depend on, among other things, the ability of a fund manager to generate enough project deal flow to invest the funds in appropriate projects or enterprises that match the primary fund mandate. Typically this is articulated in the fund agreement and fund activity plan approved with the strategic investor or donor.

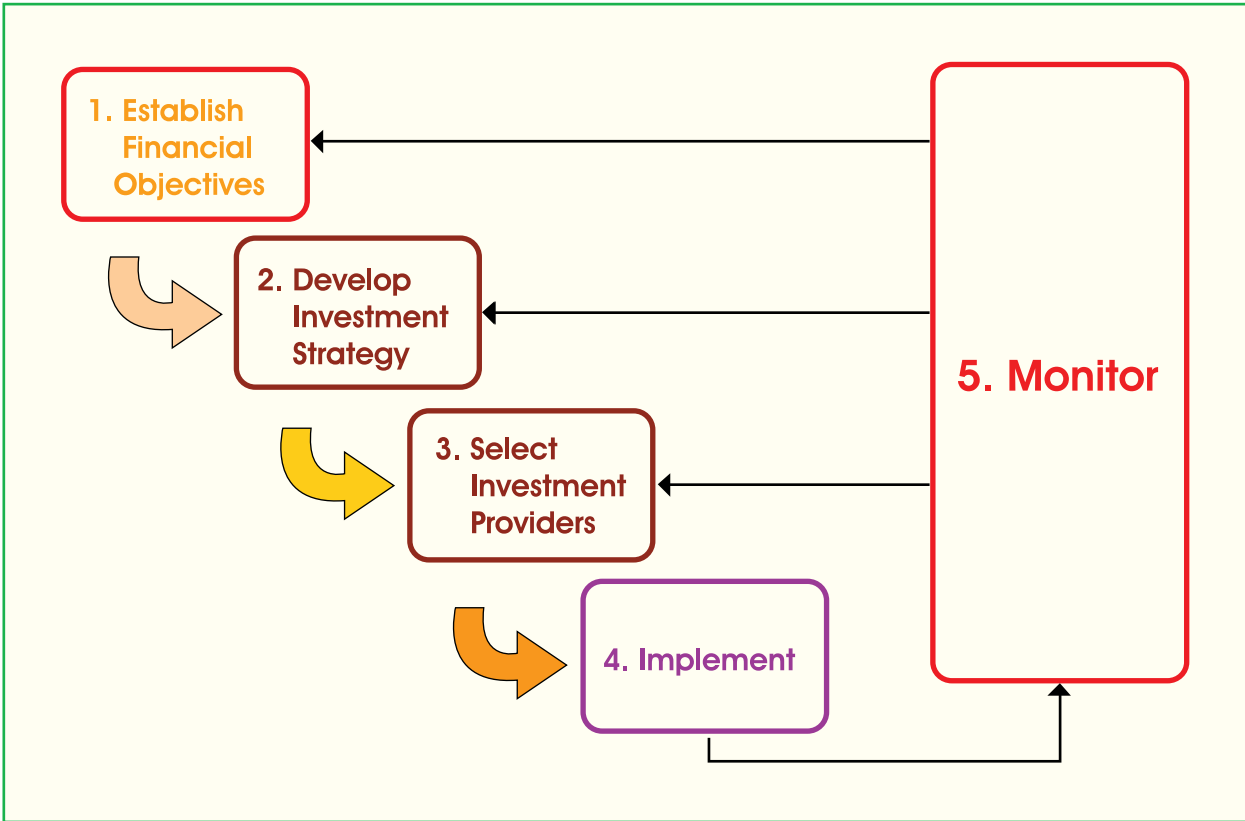


Figure III.1 Traditional fund structure

It is also an option to raise a ‘softer’ pool of non-recourse grant type funding to target research or proof of concept on pre-commercial projects. It is proposed that a larger pool of grant funds should be consolidated to enable a larger range of pilot or test projects to be deployed across Melanesia. A fund of € 30 million would, for example, enable the deployment of 18 medium capacity waste-to-energy biogas projects and deliver some 10 MW of power to 1800 rural homes and businesses. The primary fund may then be syndicated to commercial infrastructure fund managers within 24 months of proven operation.

The original 30 M would in essence be revolved annually thereafter to enable a further 18 annual projects to be deployed. Detailed targets can be calculated as part of the project development process.

Many commercial funds do not mandate any forward support investment, which has become a major limiting factor in the deployment of advanced bio and renewable technologies which need a minimum of two years operation to validate a return on capital.

Venture capital models and international aid funding can support some risk gap projects, but equity conversion and exit mechanisms are much harder to provide in larger scale distributed energy projects. Government backed bonds or carbon bonds could be introduced but these require complex monitoring which can cost more than the project output in energy terms.

The proposed Pacific Infrastructure Fund would act as an impact investor to support growth-orientated energy service support and management companies (ESCOs), and renewable and waste-to-energy service cooperatives, which generate single digit returns for the fund and provide enterprise wealth for communities who support the sustainable supply of waste and biomass to the projects. The fund would also align to recognise the positive socio-economic impact this business can, and should have, on the communities in which they operate.

This would allow the SPC Business Units to report on fund performance to investors on the basis of economic impact, social impact, environmental impact and governance impact in terms of professionalising and formalising small and medium enterprise energy businesses.

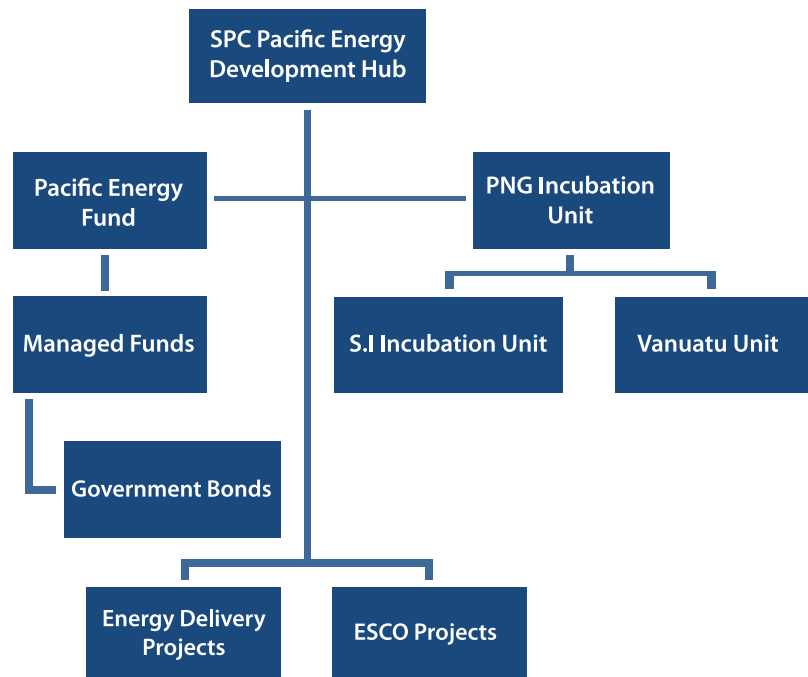


Figure III.2 Proposed SPC fund cycle

It will be important for SPC Business Units to track impact on the ‘base of the pyramid’, for example, education and health care. Given the nature of the proposed fund, it will be essential to measure the social effect of providing electricity to people who previously had no rural employment or access to communications due to the lack of power.

In addition, tracking any environmental benefits, that is, waste recycling, better use of water resources, and carbon footprint will all gain value in the return on investment balance sheet. Existing examples of organisations such as IRIS and GIIRS (Global Impact Investing Rating System) and others are seeking to formalise how impact is measured and described. Cooperation with these groups and World Bank monitors and auditors is to be encouraged.

The key focus is to build a bridge to enable investment in energy supply businesses that will become, or remain, commercially viable and so create a positive, long term, sustainable impact. Impact investing in energy security is about achieving a balance, while being socially inclusive.

The extent to which the proposed Pacific Energy Security Fund wishes or has the capability to bridge the risk gap, will have implications for which existing and new funding institutions and donors can be approached. With the goal of enabling the SPC primary fund to be revolved annually to assist new projects each year, a group of other international and commercial funds will need to be identified to take out the initial risk investments.

These commercial funds will have the ability to identify, manage and mitigate risk on the maturing energy projects in the pacific nation economy. Private equity funds may also be approached as they may wish to develop extended commercial investments in say agriculture, forestry or fisheries. After three years of energy delivery or operation most projects could be matured to gain senior debt funding from conventional banks with the loans or facilities typically secured by the project assets or maturing revenues.

Government may also wish to provide loan guarantees or warranties to ensure that the funding process maintains an annual energy security or grid expansion target.

In summary then, the establishment of a Technical and Business Development Incubator and a separate Managed Fund would, we feel, maintain a healthy tension between incubating energy projects and the financial investment and repayment process.

It should also be possible to incentivise and measure both parties according to their function and deliverables. Other business development and funding options can be explored, but the principle remains the same. This type of radical approach is needed to overcome the huge imbalance in energy delivery in the Pacific economy.

1. Stimulating enterprise through social inclusion projects

Specific assessments of the opportunities for energy development are presented with relevant recommendations in this report. It is clear that distributed micro and community based power generation solutions hold the key to energy security for the majority of rural populations.

Incentivising small and medium scale ESCOs and co-location of new power generation with established industries, who can tool up for the migration to a sustainable low carbon economy will not be easy when fossil fuel prices remain low on weak global recessionary demand and when advanced technologies are difficult to fund. These conditions conspire to create what is now referred to as the risk investment gap.

2. Drivers for energy security

- establish policies to attract investment into rural areas;
- promote agricultural development and diversified revenue streams;
- substitute imported oil with a balanced mix of local resources;
- target reductions in the distorting effects of subsidised agricultural production in developed countries;
- create increased social inclusion programmes for rural communities;
- incubate and develop an energy for enterprise culture;
- agree a framework for enabling common trade policies across PICTs.

Clear government policies, regulations and incentives are a prerequisite for development and investment in the distributed energy industry.

“The development and formation of a Renewable Energy Enterprise Incubator Hub and an associated Investment Fund could be a primary motivator for sustainable developments and a focal point for inbound investment”.

Pacific economies have remained underperforming for much of the last two decades, compared with other similar regions. Developing an enabling environment for private sector participation (PSP) in the promotion of energy security in the Pacific region is seen as an important step towards the realisation of the goal of the Pacific Plan. The objective is to enhance and stimulate economic growth, sustainable development, good governance and security for Pacific countries through regional economic development. At the core of the strategy for the Pacific Plan is the implementation of actions that promote and enable energy security and energy access within the Pacific.

PNG, Solomon Islands and Vanuatu are some of the most disadvantaged Pacific Countries, as electricity is only accessible to about 20% of the population. Indeed, from a regional development perspective, PNG, Solomon Islands and Vanuatu appear to lag behind other island states such as Mauritius. A Human Development Index of 0.541, 0.610, and 0.693, respectively, ranks PNG, Solomon Islands and Vanuatu 148th, 135th, and 126th out of 182 countries. The three will have to adopt accelerated programmes to ensure their people have equal access to enterprise communications, health and education.

Delivering energy in all its forms, across these disparate island states is complicated further by the pressing global call to replace carbon fuels with renewables and so attain the ambitious climate change targets which will reduce harmful emissions into the atmosphere.

However, just because renewable alternatives exist, it does not follow that these are affordable or sustainable in all circumstances. Finding and deploying appropriate solutions needs careful technical and environmental analysis and a clear roadmap with realistic operational and deployment plans. The primary ability of the consumer to pay for services is, and will remain the principal measurement for a sustainable economic energy network and is without doubt the key driver for private and public investment policies. It is established that the majority of rural and coastal peoples living in Pacific communities lack the knowledge and income to support the delivery of sustainable light and power to their settlements, homes and businesses. A succession of reports has been authored in relation to energy development, but few have recognised solutions that leverage water, health and education which rank higher in aspiration for the majority populations. It should follow therefore that energy and enterprise solutions must also embrace the need for social inclusion as a mechanism to leverage economic stability in the delivery of energy.

With the current emphasis on renewable energy and carbon replacement policies, governments need clear guidelines on the dynamic effect of mixing a range of renewable energy solutions. All power generation technologies need to be underwritten by consumer billing, metering and payment.

Operating overheads and management costs for renewable technologies are still a major factor in creating a sustainable power network. Solar, wind and hydro generation are in the main ‘free’ sources but do attract similar support costs to those of fossil fuels.

Nevertheless decreasing the dependency on fossil fuels with long distance supply chains and removing restricted or monopoly contract restrictions are all tools in the process of diversifying and democratising the energy mix.

Industry and consumers in Pacific territories still depend heavily on imported diesel and kerosene fuels for electricity generation. There was a general understanding among Pacific states that existing technology can support the roadmap to power grid extension. The true challenge is to transform this appreciation for the problem by measures that share knowledge and expertise and create social inclusion for the majority of rural consumers who still do not have access to the liberating and enterprise driving value of electricity.

The governments of PNG, SI and Vanuatu recognise that greater cooperation among all stakeholders will be critical to the future ownership and funding of secure energy systems.

With volatile fossil fuel prices, long and costly supply routes, and relatively small energy markets, the typical power supply costs are in the range of USD 0.3–0.6 per kWh, even higher for some remote islands due to high transport costs. Approximately three quarters of the imported oil products are used for the transportation sector, while about a quarter is used for electricity generation. A transition to renewable energy and increased energy efficiency can result in a more sustainable and secure energy future in the Pacific region. Many PICTs have formulated ambitious targets for renewable energy, some aiming for 100% electricity from renewables. Today, renewables contribute only 10% to the average energy mix in global markets.

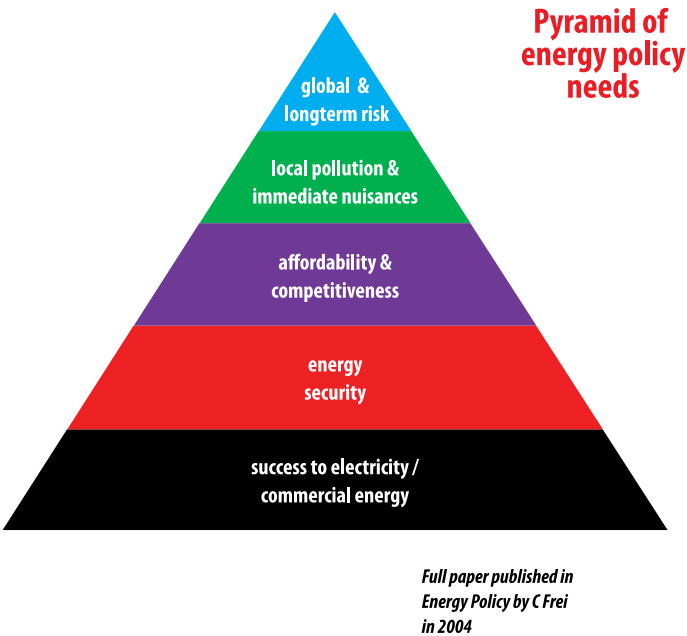
The proposals and action plans in this report should lead to a better understanding of the energy sector of the three countries and the dynamics of the energy supply and demand matrix. The existing policy and regulatory frameworks for the pursuit of renewable and energy efficiency targets and the marketing and promotion of investment opportunities in the region do not fully reflect the practical and on-going support requirements of the renewable technologies. Deployment is only the first step; new technical and business support centres will be required to ensure full life cycle return on investment, a position that has eluded many donor aided projects across the world over the last 20 years.

PICTs must be able to appreciate where they are in terms of their energy security indicators (in terms of access to energy, affordability of energy, efficiency and productivity of energy use and the environmental quality of the generation, distribution and consumption of energy). To formulate the appropriate policies for the private sector to invest and help Pacific nations to adopt renewable energy and energy efficiency goals, much more emphasis should be placed on funding solutions and technical management.

These will require the full backing of the regional governments and so mirror the successful model created in Africa by the Africa Union States when it formed the New Partnership for Africa’s Development as a Leading Technical Agency.

Forum Economic Ministers have recognised that domestic factors are important in understanding and improving the economic performance of Forum Island Countries. The region faces many natural

constraints to growth, but there are also weaknesses in governance, macroeconomic management and public sector efficiency that governments must address if private sector investment confidence is to resurge and deliver an energy dividend.



External conditions also influence regional economic performance, in particular through dampened global demand for products and services and continuing weak export trade growth, as well as increasing food prices, resulting in increasing inflationary pressure. Regional economic growth is expected to moderate in 2012 through 2013, due mainly to slowing growth in the larger resource exporting economies as a result of the completion of a number of significant infrastructure projects. However, improving tourism and export prospects will provide positive growth prospects for some smaller PICTs.

A decade of regional and state analysis has provided many possible solutions and there is no shortage of reports and position papers reflecting on the potential to develop sustainable energy markets in the Pacific region. Converting these aspirations for development and the supply of scalable and expanded power networks into a vital and sustainable enterprise culture will take more than words on paper. Enterprise support must also be aligned with realistic time lines for deployment and be harmonised with regional interstate policies, all of which are pivotal to building investor and industry confidence. These actions also need a mature consideration and joined up thinking by governments, NGOs and public utilities charged with the mandate to effect real change for people of the region.

Private enterprise is always keen to capitalise on public demand, but when it comes to weaning the Pacific states off their addiction to fossil fuels, well structured incentives are needed to stimulate medium term investment by the private sector. These incentives must also be aligned with energy policies that track the pace of development and align with a socially inclusive programme of micro finance drivers that facilitate the future power consumer's ability to pay. This basic concept can be translated into action with accurate spatial analysis of existing natural and waste resources and the public funding of community managed projects that act as a catalyst for private sector emancipation of long term energy security.

Energy policies must transcend any changes in government and, as has been demonstrated in developed economies, 3 to 5 year timelines for renewable energy policy and incentives are simply too short a period to allow capital and operating costs to be recovered.

Current analysis and feedback from large energy generators and fuel processors in Europe and North America, suggest that 15 to 20 year fiscal and carbon policy horizons will be required to

satisfy the conditions for long range harvesting from renewable energy systems. Such conditions are also being indicated by investment bankers, serial investors and Green Fund managers.

In this regard, the Pacific region and more specifically PNG, Solomon Islands and Vanuatu should adopt policies that allow indigenous and inbound investments to flourish alongside the existing natural resources. This process can be greatly enhanced by the integration of energy solutions that will address the provision of sanitation, fresh water, land management and energy security.

Incentivising bio-entrepreneurs and established industry to research and tool up for migration to a sustainable low carbon economy will not be easy. Fossil fuel prices remain low on weak global recessionary demand and advanced technologies are difficult to fund and maintain in remote locations. These conditions conspire to create what is now referred to as the 'risk investment gap' or 'the space that expands between innovation and commercialisation'.

3. Summary of executive proposals and recommendations

Recent assessments have identified a wide variety of potential opportunities for energy development and security in Melanesia. These initiatives are supported by the international community, but seem to be failing to deliver cohesive frameworks which attract private investment funds. These weaknesses are cited in many reports and point to a lack of strategic financial and technical dialogue between key government and agency actors. It is essential that a new forum is created to focus these initiatives so that there is a free exchange of experiences and information, particularly in relation to the funding and deployment of bio and renewable technologies as part of the energy mix.

In order to progress the following recommendations are made:

3.1. Further develop the sustainability framework of the Melanesian states, to help ensure secure power delivery to most rural communities

The risk and lost value of double funding and project crossover in the search and piloting of energy solutions is a constant threat when dealing with multiple international agencies. It is therefore proposed that an SPC-led Melanesian Island Task Force is convened to implement and promote a Framework for Sustainable Energy on a national and regional island level throughout the tri-state region. This framework should be supported by the formation of a Business Unit, which can marshal and work in close consultation with relevant stakeholders from industry and the investment community.

3.2. Develop stronger investment guidelines

Energy security targets expressed by local and international investors must be supported by clear guidelines on how to establish fully sustainable bioenergy and renewable energy projects. Member states should develop and harmonise guidelines reflecting their own particular circumstances and procedures, but invite international experts to audit the operational aspects of the framework. Developing national and regional markets is important to maximise socio-economic benefits from energy delivery. A symposium should be considered to bring together as many of the current project developers and new projects to measure their current needs and issues. This should be seen as a part of the incubation process for energy security and so include regional consultation with community leaders.

3.3. Strengthen national legislative frameworks

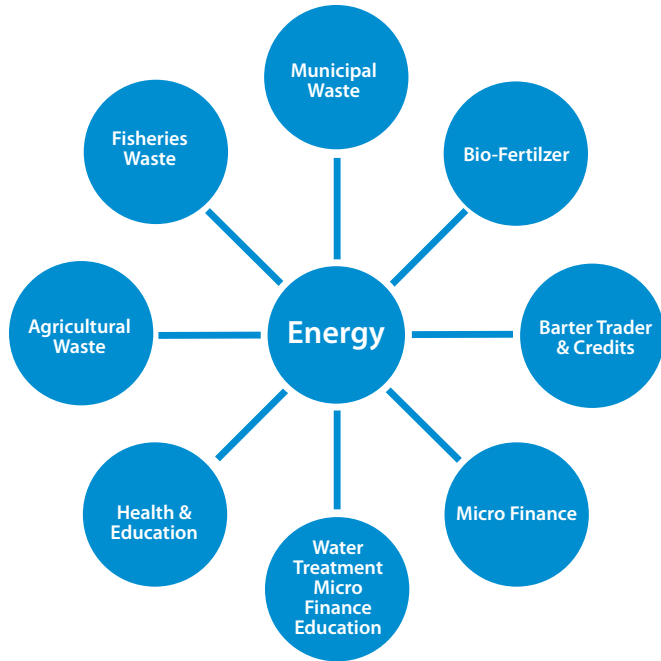
Most member states have no specific legislation to deal with bio and renewable energy production, processing or use. Legislation in the form of an Energy Security Act needs to be reviewed and updated to include biofuel, biogas, hydro and geothermal production. By adopting a harmonised approach to land use planning, licensing and delivery obligations, investors will gain added confidence that

PICTs are adopting long range measures. These are now a prerequisite for private fund investment and management.

3.4. Food fuel: energy and land re-zoning

Internationally acceptable criteria on land evaluation should be considered to identify land for biofuel crops and to define the building criteria for dual waste water treatment and biogas facilities. Agri-ecological land zoning is a critical component of informed decision making in sustainable energy projects. This is even more important in the Pacific with a history of land and title disputes which can retard investment or protract monopoly concession imbalance. Island member states need to develop strategies for the integrated management of land, water and natural resources, thus promoting conservation and sustainable use in an equitable way. Among others, this would include water and soil qualities, and considerations for livelihoods and rural development. Cropland expansion, whether for food or non-food production, should not occur at the expense of high value natural ecosystems and traditional customs. The path to energy security must have a high degree of social inclusion to clear the historic hurdles of objection caused by the ‘imposition’ of policy.

3.5. Social inclusion objects as drivers for energy security and investment



The recommendations in this report are presented to try and align with the Melanesian States Energy Analysis in Section 6.0 PNG, 7.0 for SoLomon Islands and 8.0 Vanuatu, which is a summary of the Field Studies. This final recommendation is an attempt to consolidate the range of proposals and integrate operational plans to deliver a common series of projects that could allow beneficiaries and project authorities to facilitate the dual goals of energy security and private sector motivation. Given the problem of waste treatment, sanitation and clean water provision, it would seem logical to select an energy solution that can consolidate and convert these needs with the delivery of energy and enterprise.

Socially inclusive projects which connect directly with the community and respond to their priorities at the base of the demand pyramid, will always gain better traction than top down mandated policies. The country energy sector reports agree that achieving energy delivery and security, needs all aspects of society’s needs to be accommodated, or at least the priority issues.

With this programme criteria in mind the following proposal should be viewed as having ‘energy’ at its nucleus but ‘impact investment’ feeding its survival.

3.6. Community equity delivering integrated water & energy security

It is accepted that larger Islands in Melanesia have higher than average opportunities to capture and direct the outflow from streams, rivers and mountain run-offs, to drive hydro power and sanitation solutions.

Water and more particularly ‘water sanitation’ presents a particular challenge for most rural Pacific communities. However with the application and development of waste water treatment solutions, the additional prize of Biogas production is now achievable in a common integrated cycle.

Substantial design and technology advances and have been made in recent years in the search for alternate energy solutions, and the well tested process of converting ‘waste’ into methane gas known as biogas and then using the gas to fuel electricity generation is now possible. A wide range of solutions from small scale, home-based systems to large scale community and municipal systems are now deliverable anywhere in the world.

These integrated water treatment – waste processing and energy production solutions would be ideally suited to the disparate environments and settlement variables in Melanesia. Industrial scale solutions for treatment of mine water and reprocessing of agricultural and fisheries waste could take these solutions to the heart of every community and costal enterprise in the Pacific.

While a broad mix of biomass, solar and wind energy solutions are also part of the methodology, we must always be mindful of the capital and operational overheads of these solutions. The ability to earn revenue and pay for energy goes to the heart of due diligence when selecting appropriate solutions.

‘The rights of ownership and return on investment are as important to the subsistence farmer or fisherman as they are to the fund manager or foundation credit committee.’

3.7. Project concept: water-sanitation-energy

This report’s emphasis on social inclusion and impact investment, as already explained, leads us to recommend that SPC design and facilitate a series of projects to deploy a range of scalable integrated water and energy delivery solutions. The projects should be seen as primary to the aim of facilitating private sector investment, in order to promote energy security, health and communication in the rural populations of PNG, Solomon Islands and Vanuatu.

We also propose that the projects will be anchor developments for the Bio and Renewable Energy Incubation Unit or SPC Business Unit. The projects should be leveraged as the opportunity to seek ‘collocation industry partners’ to co-sponsor and co-invest in Waste to Energy Service Cooperatives, which offer the opportunity for ‘community shared equity’ projects, to accelerate the delivery of electricity and clean water for the rural majority.

The initiative should also be seen in the context of refocusing attention on finding ways to establish decentralised local power grids which can be driven towards industrial zones and larger scale projects.

3.8. Facilitating trading inputs and outputs

Historical analysis of experiences in PNG, Solomon Islands and Vanuatu suggests that many projects have been implemented without proper regard for longer term operational costs and maintenance. Even in the protected enclaves of the urban energy concession zones where electricity penetration is demonstrably easier, payment delinquency is on the increase and incidents of diesel fuel and power theft is quite common. Industrial sector managers and agency field experts concur that ownership and ability to pay are hurdles to enable energy investment and power grid extension in Melanesia.

In this context of ability to pay, it is proposed that communities which were elected, or tendered the offer to be recipients of ‘New Energy Solutions’, should first be encouraged to demonstrate commitment, by being asked to measure the volume and variety of waste and biomass and non-traded organic materials that could contribute to the overall ‘base biomass and waste fuel mix’ in their community.



Figure III-4 Biogas cycle

The incentive/driver for the project, arrives when the convertible value of the resources is calculated. ‘Convertible value’ can be defined as the amount of biogas (cubic metres) or thermal value (megajoules per kilo) that can be derived from the materials that are destined to be delivered to the energy project, which can then be processed into electricity or by-products such as residual fertilizer.

3.9. Monetising and value adding the process

The principle of ‘gate fees’ is a well tested practice in mature markets and one that should easily translate to a value model in the proposed energy projects. It is recommended that a working group of the SPC Business Unit should evaluate the proposal and consider ways to align the principle in practice drawing on their superior detailed awareness of local conditions and attitudes.

‘Energy for waste’ should not be a difficult concept to sell and as such the proposal should facilitate the opportunity to enable the basis for an equitable exchange to underwrite the long term funding of the projects and encourage competitive demand.

Companies leading the development of these combined cycle energy and environmental solutions are happy to share the opportunity to develop pilot and commercial test sites and project authorities are encouraged to engage with them to develop their project deployment and investment options.²

IV PAPUA NEW GUINEA REVIEW AND PROPOSALS

1. Executive summary for Papua New Guinea

The Government of PNG, assisted by SPC and the European Community, wishes to develop programmes to enhance the security of energy supply and sustainability. The output from these programmes will provide the strategic context and framework for future development assistance for the technical selection and deployment of energy as part of the National Vision for 2050.

² <http://www.ekogea.com/en/> Ecogea Ltd Biogas- Energy Examples Website.

This articulates the aspiration of spreading the benefits of mineral wealth toward broader growth with employment and improved service delivery for all. This sector report is designed to assess the opportunities for facilitating and incentivising private sector investment in the energy sector, in particular, providing appropriate solutions that aid access to power and maintain security of supply, and making recommendations for action to secure private and public sector investment.

The country is considering the prospect of a trade surplus in fossil fuels, after the discovery of 15.6 trillion cubic feet of proven reserves of natural gas at the end of 2010. These resources could transform the energy sector and provide a positive balance of trade for the national economy, and provide a broader opportunity for energy security in other Melanesian states. It should also support increased government revenue to enable much needed public-private investment initiatives, to convert older diesel and oil powered generating stations as well as facilitate a programme of power grid extensions to major industrial zones and communities in the emerging and expanding mining sector.

PNG also enjoys one of the largest areas of pristine forests in the Southern Pacific. The country also has access to substantial quantities of waste biomass from the bordering nation of Indonesia and near neighbour, Malaysia. In these terms PNG has access to the fourth highest ratio of primary and waste biomass resources in the world.

When combined with existing and expanded hydro and geothermal renewable, PNG can look forward to meeting its balanced carbon goals by 2030.

Energy	Capacity value	Units	Rank	Period	Source
Natural gas reserves	226,500,000,000	Cubic meters (cu m)	44	2010	BP
Oil reserves	170,000,000	Barrels (bbl)	62	2010	Exxon
Coal reserves	Unavailable	Million short tons	N/A	2008	EIA
Solar potential	1,244,136,981	MWh/year	56	2008	NREL
Wind	0	Area (km²) Class 3-7 wind at 50 m	161	1990	NREL

Abbreviations: EIA, Energy Information Administration; NREL, National Renewable Energy Laboratory.

Excluding natural gas and oil, the main economic activity for PNG is focused in two sectors, agriculture and mining, however despite the prospects for the carbon fuels sector, subsistence farming still engages 65% of the working population. PNG agricultural outputs include livestock, fruit and vegetables which are predominantly for domestic consumption; agricultural products for export include copra (coconut flesh), palm oil, coffee, cocoa, and tea. New mining operations have compensated to some extent for the inherently weak rural enterprise culture with gold and silver mines at Ok Tedi in the Star Mountains, on Misima Island, and at Porgera, creating employment. Forestry is also growing as a result of an essential road building programme to allow access to the LNG licence fields. The fishing industry also remains robust and generates considerable waste outputs.

PNG’s electricity demand forecast is projected to increase by 150% by 2020. This figure can in the main be attributed to the provision of electricity to the 82% of the population who do not at present have access to power or grid connection. While there is a desire to make renewable and bio energies a major pillar in satisfying future power demand, the proposed hydro, geothermal, solar and wind energies will need to be deployed within an overall energy mix and should not be viewed as the only selection. This increase in capacity will create many opportunities for private sector development, as summarised in the table above.

1.1 PNG Demographics

When considering energy security and distribution, population density and demand profiling are crucial for the selection of appropriate technology and its management. Human settlements and grid length are essential data for investment planning.

The PNG labour force is estimated at 3.4 million. Agriculture accounts for 85% of the workforce, particularly in small farming communities and isolated villages. The projected population for PNG in 2025 will be 8.2 million. The country is formed into 20 provinces, including the National Capital District. Each province has its own government, headed by a premier. In addition, there are more than 160 locally elected government councils. The population density is 13 per sq km (33 per sq mile), with major concentrations of population in the highlands and eastern coastal areas of the Island of New Guinea.

In 2005, 87% of the population of PNG lived in rural areas and 13% lived in urban areas. Those urban areas were growing at an annual rate of 2.56%. The capital city, Port Moresby, had a population of 275,000 in that year. Other large cities and their estimated populations include Lae, 120,000; Madang, 35,300; Wewak, 25,143; Goroka, 25,000; and Rabaul, on New Britain, 17,855.

The local government system went through a process of reform in 1995, when the then 19 provincial governments were replaced by regional authorities. Bougainville presently exercises significant autonomy in its administrative affairs.

1.2 Transportation sector

Transportation is a major problem in PNG because of the difficult terrain. Major population centres are linked chiefly by air and sea, although road construction has increased to supplement these expensive means of transport. Of some 19,600 km (12,179 miles) of roads in 2002, only 686 km (426 miles) were paved. In 2003, there were 34,468 passenger vehicles and 89,215 commercial vehicles. PNG has no railroads. However, there are 10,940 km (6,798 miles) of waterways. Supply chains need good road and or rail access to support the sustainable movement of goods and services. Where these infrastructure assets do not exist or may be unjustified in relation to final energy demand, distributed energy solutions may be more effective.

1.3 Environmental analysis

PNG's environmental concern includes pollution, the effect of global warming, and the loss of the nation's forests through unplanned deforestation and mining. There is also a concern over the diminishing quality of coastal waters which are becoming polluted with untreated sewage and residuals from unmanaged industrial run off. PNG has an estimated 801 cu km of renewable water resources, of which 49% of the annual withdrawal is used to support farming and 22% for industrial activity. Only 88% of the nation's city dwellers and 32% of the rural population have access to improved water sources. Another significant source of pollution is open-cast mining. Solid waste from the major conurbations is estimated at 140,000 tonnes per annum.

1.4 Fossil energy sector (ExxonMobil (XOM)/Oil Search Projects)

Oil Search is a large corporation with activities in Iraq, Tunisia, Yemen, as well as having a number of gas- and oil-producing fields in the highlands of PNG, where they have been since 1929. They have all of the producing oil and gas fields in PNG: Kutubu, Moran, Gobe, Hides and SE Mananda.

They are presently constructing an LNG facility (they have a 29% stake in the project) with Exxon (33.2%), PNG government (16.8%), Santos (13.5%), Nippon Oil (4.7%) and PNG landholders (2.8%). The project has already been sold out, but Oil Search is on the hunt for the gas resources to underpin a possible third train.

They also have a 20,600 square kilometre exploration portfolio in PNG and are about to embark on some serious exploration (but also appraisal) drilling. On many of these licences, ExxonMobil either has a stake and/or is the operator, and even where it is not, they benefit from finds in that they are the biggest stakeholder in the PNG LNG venture.

LNG gas reserves are believed to be at least five times greater than the original oil reserves so there is considerable potential for future development. It is likely that ExxonMobil's existing LNG project will be expanded before 2020 and other companies have plans for additional LNG plants. The InterOil oil refinery near Port Moresby plays a very important role in relation to PNG's energy security and is the only oil refinery in the South Pacific – a valuable resource opportunity that seems to have escaped the attention of sister nations when negotiating supply contracts.

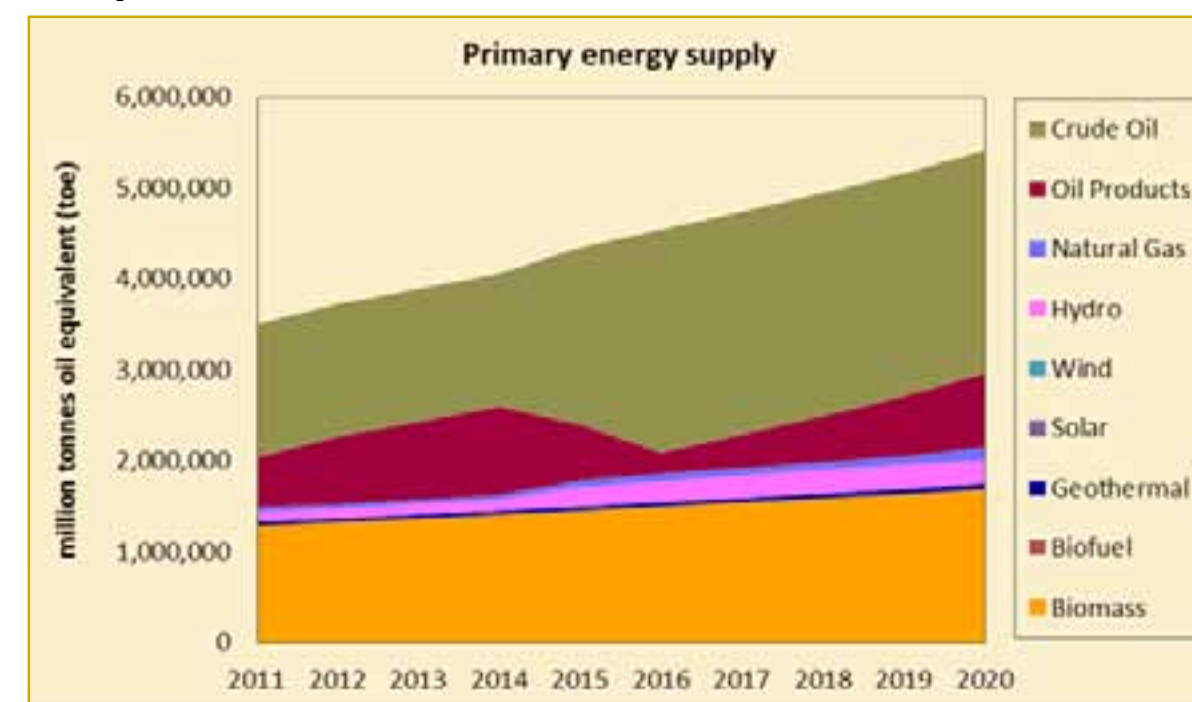
1.5 Energy balance base data

Some key energy balance indicators for reference:

- In 2011 oil products accounted for approximately 57% of total primary energy supply, biomass 36.8% and hydro, gas and geothermal power the remaining 5.8%. In relation to energy total final consumption biomass accounted for approximately 59% of the total, oil 26.1% and electricity 14.8%.
- The share of oil products in the country's energy supply has increased from 49.2% to 57.4% at the expense of biomass, which fell from 43.8% to 36.8% and the other energy sources (hydro, natural gas and geothermal), which also fell from 7% to 5.8%. The of renewables over the same period from 5.8% to 8.6% is most significant and, particularly, generating capacity of electricity from renewable energysources (51% in 2011), is predicted to rise to 70% in 2020.

Forecast energy balances for each year to 2020 are presented in the figure below.

The three main indicators are domestic production, total primary energy supply and total final consumption.



IV.1 Primary energy graph

The oil and gas industry is run by private sector companies such as Oil Search, ExxonMobil and InterOil. However, the electricity industry is dominated by the state-owned PNG Power Limited (PPL), although there is also significant private sector involvement, particularly for the mining projects.

Energy policy in PNG is mainly the responsibility of the Department of Petroleum and Energy which has two divisions: Petroleum, covering oil and gas; and Energy, covering electricity and renewable energy. There is no single, comprehensive energy policy for the country but separate policies for the different energy industries, which are discussed in detail in subsequent sections of the report.

The report highlights the importance of two recent government publications:

- Development Strategic Plan 2010–2030 (DSP);
- Medium Term Development Plan 2011–2015 (MTDP).

These plans set targets for the oil, gas and electricity industries. For example, it is planned that 41% of the population will have access to electricity by 2020 and 70% at least by 2030, compared with the baseline estimate of just 12.4% in 2009. The MTDP is intended to be the first of four rolling plans to implement the longer term DSP.

The table on the following page summarises the key policy, legislative and institutional framework elements that play a role in energy sector development.

Key policy, legislative and institutional framework summary

Key	Information summary	Review
Policy		
Development Strategic Plan 2010–2030	Overarching plan for PNG development that includes some ambitious electricity capacity development targets	Key document underlying electricity sector development
Medium Term Development Strategy 2011–2015	Enabling document for key medium term activities (e.g. Least Cost Development Plan and Electricity Super Corridor Feasibility Study) that will help achieve DSP objectives	Main driving force behind near term electricity sector development
Electricity Industry Policy	Specific policy initiatives for the sector including: establishment of an Electricity Management Committee to plan/procure new electricity infrastructure and strong focus on PSP for development	Rebalance to support rural programmes is necessary.
Rural Electrification Policy	Focuses on establishing mechanisms for the scaling-up of rural electrification principally through renewable energy development	Subsumed into DSP
Legislation		
Electricity Supply Act	Specifies the powers of the Minister for Petroleum and Energy in relation to electricity infrastructure built with government funds	Open market updates are necessary to encourage private sector
Electricity Industry Act	Specifies the functions and powers of PPL	Should be aligned with investment
Independent Consumer and Competition Act	Establishes the Independent Consumer and Competition Commission (ICCC) and associated regulation regime for the electricity and petroleum sectors	Should be audited by 3 rd Party Counsel

Geothermal Act	Will be an important enabler for geothermal capacity development	An early draft in process
Institution		
Department of Petroleum and Energy	Electricity division is responsible for formulating and implementing policy for the sector but provides only limited output and influence	A department expansion to respond to the emerging markets and new discoveries should be applied.
PNG Power Limited	State-owned electricity utility with some monopoly rights	Needs reforming if PSP is to be enabled
Independent Consumer and Competition Commission	Regulator for the electricity sector	Reform would be welcomed and an increase in support staff.

PNG would gain significant potential benefits if some of its gas was used for electricity generation, replacing much more expensive diesel-fired generation. All the gas from the current LNG project will be exported but the Government should be able to ensure in the future that more gas will be consumed in the country, for example through domestic market obligations (DMO) in future gas agreements.

Current electricity installed capacity in PNG is approximately 530 MW but is forecast to increase by approximately 150% to 1328 MW in 2020, as shown in the table below, as a result of the Government’s DSP and MTDP.

1.6 Private sector development programmes

The private sector is already engaged in PNG’s electricity sector in a number of ways:

- electricity generation in support of industrial and large scale commercial activities;
- independent power projects such as the diesel station at Kanudi;
- Public–private initiatives such as Yonki Hydro Ltd. and Origin Energy/PNGSDPL.

Looking ahead, the government’s DSP (as well as the Electricity Industry Policy) provides a strong basis for private sector engagement in the country’s electricity sector especially in relation to renewable energy deployment in both urban and rural areas. Several critical enabling factors need to materialise, however, including:

- construction of (at least part of) the electricity super corridor to which privately financed independent power producers can connect;
- establishment and deployment of the Electricity Management Committee;
- allocation of sufficient government funding for the Electricity Trust Fund and possibly also for other rural energy infrastructure subsidy support;
- development of electricity network access rules and codes as well as a power contracting framework;
- related legislation needs updating or completion of current drafts (National Energy Policy Framework, Electricity Supply Act, Electricity Industry Act, ICCC, and Geothermal Act);
- the electricity regulation capacity of the ICCC needs to be enhanced to enable it to rapidly develop the rules, regulations and policies necessary to facilitate private sector generation investment and its integration into the national energy system;
- government and other major players in the energy industry need to accelerate their efforts to integrate EE as part of their response to the development of the sector;
- the facilitation of renewable energy and EE development through tax breaks, duty exemptions,

subsidies provision or other types of schemes depending on the specific sector should be considered;

- the improvement of access to cost-effective financing and enhancing the local finance infrastructure and/or lowering transaction costs are essential elements of an enabling environment for the private sector;
- increased engagement of the development partners and the private sector in on-going support to the renewable energy sector.

Assuming the enabling factors discussed above come to fruition, the table below summarises the kind of PSP opportunities that are forecast for PNG over the coming years.

PSP opportunity summary – renewable energy development

	Renewable Energy Sector	Other Sectors
PSP Potential	Considerable potential: - Between 200–300 MW new hydro capacity by 2015 and 600 MW by 2020 - Up to 4 MW new solar capacity forecast by 2020 - Up to 6 MW new wind capacity forecast by 2020 - Up to 9 MW of biomass/biogas capacity development forecast by 2020 59 MW of new geothermal development by 2020	Significant potential: - Forecast of up to 60 MW new gas fired capacity development by 2015 and 210 MW by 2020 - Forecast of 30 MW new coal fired capacity development by 2020 - Some (or all) of PPL's generation assets could be subject to partial or outright sale - PPL transmission infrastructure could be subject to some form of PSP arrangement (e.g. concession) - Off-grid distribution and supply
Enabling Factors	- A fully capable and functioning Electricity Management Committee - Construction of all (or part) of the electricity super-corridor - Expanded set of enabling contracting, economic, technical and competition policy regulations - Establishment of a fully resourced Electricity Trust Fund - Unbundling of PPL	

2. Papua New Guinea energy market summary

Population:	6.2 million	Geography: large island. Half of island of Guinea. Mountainous central spine. Heavily forested. Also Islands of New Britain and Bougainville
Capital:	Port Moresby	Surrounded by mountains. Located in the south east.
Labour:	85% of population engaged in agriculture	82% without power
Government:	Parliamentary democracy, 22 administrative regions, Prime Minister + President	
Resources:	Large amounts of oil (reducing latterly), LNG 15 trillion M3	(Exxon) Copper and gold also prevalent. (Oil, copper, gold = 72% of exports)
Energy primary supply 2011	3.5 m toe	
Electricity 2011	620 MW	42% diesel, 38% hydro, 11% gas, 8% geothermal
Electricity provision connection to grid	Public: 12% of population	PPL (Papua New Guinea Power Limited)

Energy management		Department of Petroleum and Energy
Policies	Development Strategic Plan	Medium Term Development Plan
Oil Import	Private	Exxon, Interoil and Oil Search
Land access:	Issues as per Pacific region	3% lands alienated/Government

3. Conclusions and recommendations for Papua New Guinea

3.1. Industry sector proposals for increasing investment potential

Commercial agriculture models

New Britain Palm Oil Ltd provides a good example of a highly respected commercial agriculture company which supports over 15,000 small holders who supply palm fruit, sugar and land management. The company operates on 75,000 hectares of land in PNG and Solomon Islands and demonstrates that environmentally friendly, energy secure solutions are possible with good management and governance.

Biogas plants

There are highly effective examples of biogas plants for biological breakdown of organic matter in the absence of oxygen. In these plants, biogas is gathered by the anaerobic digestion of recyclable material such as biomass, manure, sewage and municipal waste, green waste and energy crops. The biogas produced in these plants is used as low-cost fuel for cooking and to generate mechanical and electrical energy. These technologies can also be customised as per the requirements of the clients. These plants are well-equipped with the latest CMBR technology to offer effective results. We refer to the executive proposals in this report for recommendations and proposals to stimulate this option for rural expansion energy and enterprise.

Major advantages of biogas plants with integrated water treatments:

- biogas can be produced from any type of food waste, animal dung, and sewage;
- low primary power consumption;
- no noise generation;
- safe biogas storage and low maintenance costs;
- smokeless combustion of gas;
- waste water sludge treatment;
- sludge generated provides fertilizer and can be used for soil enhancement.

3.2. Domestic market obligations

There are reportedly some limited DMOs associated with gas development and, specifically, the allocation of some extracted gas for electricity generation purposes. However, all such DMOs are apparently utilised through self-generation activities suggesting that they are very limited. The application (or not) of DMOs is an important government policy decision. There is obviously a trade-off between permitting gas companies to export as much of their production as possible with the government benefiting from royalties and duties applied to such sales, set against requiring these same gas companies to allocate at least some portion of their gas sales for domestic generation. This

allocation could be made available just to PPL or, ideally, to any eligible generator. The gas sales price need not be discounted or subsidised (although this would be another government policy decision) but it would be expected to be less than (or equal to) the export sales price and would be expected to be below the imported diesel price. The fact that such DMOs do not presently exist in any significant form suggests that the government's priority is not to promote energy security but to maximise its income from gas export sales.

3.3. Land ownership

Across much of the region, land ownership and access problems act as a major deterrent to development. To its credit, the PNG Government has proposed ways of trying to deal with the issue. Specifically, it is proposing to 'develop a framework for landowner participation as private equity partners' and also to 'encourage the employment of landowner companies in the development and construction phase by acting as preferred providers of services'. Both appear to be sensible strategies. The question is whether they will be successful particularly as the country attempts to scale up its hydroelectric capacity.

3.4. Energy demand

There is an inherent trade-off between the economic motivation to construct large scale generation facilities in order to benefit from the economies of scale that ensue and the problem, with the exception of a few urban communities, of insufficient demand to warrant such investment. Most commercial and domestic loads are insufficient to warrant major generation investment. The possible exception are hotels and tourist resorts but even here, increasing demand may potentially be offset by reduced demand from energy efficiency initiatives (e.g. installing more efficient air conditioning units). The ideal solution is for larger scale power development to be anchored by an industrial or large commercial enterprise such as a mine, canning facility or marina development. When such businesses are located near to population centres, a potentially opportune mix of a guaranteed minimum off-take from the generation facility is combined with service provision to smaller commercial and residential customers. In many instances (especially mines), however, these potential anchor tenants are located far from other load centres. The only solution under these circumstances is for multiple, small scale, distributed generation facilities to be constructed which is costly and therefore unaffordable for many of the customers who wish to be served. In off-grid rural areas, stand alone household solar systems are probably the best option as each household can manage its own energy supply, there are no land issues to deal with, and benefits in the form of reduced kerosene/wood usage can be enjoyed.

3.5. Key objectives of the proposed PNG Incubator Unit:

- ❑ promote sound macroeconomic and public expenditure management;
- ❑ promote well-governed, sustainable extraction industries offering significant benefits at local and national level;
- ❑ promote the ability of the private sector to provide significant employment and livelihood opportunities;
- ❑ improve livelihoods through policies and investments that promote inclusive, sustainable growth in key agricultural subsectors;
- ❑ support the development of more responsive, accountable local governments that deliver cost-effective public services for community needs;
- ❑ help develop well-managed national and local transport services;

- ❑ expand access to reliable, affordable electricity to support service delivery and rural enterprise development;
- ❑ facilitate provision of reliable, affordable access to telecommunications;

PNG's development path is complicated by the persistence of a dual economy, a narrow formal sector based on minerals extraction and plantations and a broad informal sector consisting of subsistence agriculture, fisheries and small-scale cash crops. The country has one of the lowest rural electrification rates in the world and access to modern fuels by its rural communities is severely constrained by the absence of transport and delivery infrastructure.

Meeting the energy needs of rural facilities delivering critical services to the rural poor is a financial and operational drain on the government providers. There is a very strong reliance on diesel fuel for power production, and to a lesser extent kerosene for lighting, which results in high operating costs, poor reliability, limited hours of operation and poor quality of delivered light and power.

Transportation is a critical limiting factor in the supply of energy resources, as there is no through road across the country and the main mode of transport is either small aircraft or boat. Once at the sites, little infrastructure exists unless a community lives in or near areas of mineral extraction. PNG is a country of contrasts, with very little intra-community cohesion but strong clan networks, little private entrepreneurship but clever hunters and fishermen. Therefore, the location, widespread poverty and diversity of culture provide a number of challenges for delivery of energy services.

Renewable energy technologies must play a key role in providing innovative approaches to provision of rural electricity services in PNG. Intermediate technology consultants with local partners carried out rapid site appraisals of 12 remote locations in PNG to identify possible energy delivery models. The appraisal focused on using participative and consultative methods, where appropriate, to achieve maximum ownership of the resultant options among key stakeholders, at policy level (Government, NGOs and the private sector) and at community level.

The report's conclusions include the view that while there will undoubtedly be a major transformation of the energy sector in PNG over the next few years because of the current LNG project and other possible gas projects, this gas development will have a limited impact on domestic energy supply and consumption because virtually all of the gas will be exported.

There has been important progress in key areas of structural reform in recent years; in particular, opening markets in telecommunications and air transport has produced major welfare gains for the population. To diversify the economy and increase employment, attention is needed to the challenges of maintaining law and order, improving the business climate, commercialising state-owned enterprises, reducing the regulatory and licensing burden and equity of resource access (including land) for development. Developing infrastructure – electricity, telecommunications, road and other transport – continues to be a critical precondition for accelerated private sector-led growth.

Converting strong macroeconomic performance and extraction industry revenues into a broad improvement in living standards remains the key challenge for PNG. Ensuring the integrity of the public financial management for service provision, improving efficiency of sectorial spending, raising the performance of the civil service, and improving transparency and accountability in budget management will be crucial in converting the forthcoming windfall revenue into palpable improvement in service delivery.

The PNG market for all its opportunities, still has not embraced the full task of rural energy delivery. Therefore it is proposed that a special task force is formed with the support of SPC to harmonise the proposals and recommendations in this report and align these proposals with Solomon Islands and Vanuatu to halt the imbalance in energy security for the majority rural populations across all three nations.

4. Summary analysis and recommendations for PNG

The people of PNG like their Pacific neighbours are highly susceptible to the changing shift in global climate patterns. These weather changes punctuate the lives of its people with heavy rains, cyclones, and drought and associated tectonic events such as earthquakes and tsunamis. The entire Melanesian chain of countries which includes PNG, Solomon Islands, Vanuatu and Fiji are especially prone to these shifts in conditions, which affect the fragile economies and well being of these island populations.

PNG is the largest and in many ways least developed of the Melanesian chain and is ranked 139 out of 177 countries in the context of human development. It faces immense social, political and economic problems to rebalance the distribution of its emerging rich carbon and natural resources among the hundreds of tribal groups who are separated by the challenging hurdles of topography, language and communication.

The trend towards greater urbanisation, and the problem of rural migration to urban districts of the capital, Port Moresby, and elsewhere around the coastal regions is placing unsustainable demands on an already weak infrastructure.

The PNG Government aided by International donors such as the European Investment Bank and ACP Business Climate facility (BizClim) are now focused on measures that will deliver improvements to the standards of water, sanitation and health. A key driver for development is of course the availability of electricity and energy support services. Energy in all its forms is now a prerequisite for developing enterprise, improving incomes, and thus helping to provide affordable health and education services.

As with the other countries in the region, the desire of enabling energy security should take a back seat to the goal of the achievement of primary energy delivery and equality across both urban and rural communities of PNG. With 82% of the rural population without any form of sustainable electrical power, and a growing imbalance in wealth from resource exploitation, the cycle of mistrust caused by the fossil fuel sectors could derail genuine attempts to deliver sustainable renewable energy solutions to rural communities.

The expectation of delivering renewable forms of energy to the 80% majority of the population will need to be funded and managed carefully.

In order to put this report's recommendations into context we must look at the three primary factors that make a viable energy market: fuel selection, generation types and power delivery methods, create the criteria for measuring whether energy is and can remain sustainable. Ability to pay or finance the capital and operating costs provides the second set of criteria for the selecting of appropriate technology and the pace of deployment.

Under both sets of criteria, PNG can respond with its own resources to service the energy sector, but this will require the PNG Government to apply realistic changes to the policies that foster the current race to exploit PNG LNG, gas and oil resources.

The full extent of PNG's energy resources is still unknown, but exploration activities underway reflect a feast of options to expand big business opportunities.

Oil Search, an existing licensed exploration company, suggests that recent extra LNG gas discoveries would support an additional 3.3 million tonne supply for its existing PNG LNG project. The company echoes an Exxon statement, which suggests that the find could double PNG's GDP.

Development of PNG's oil fields has been ongoing for almost two decades but according to reports by financial services company UBS, the gas sector could accelerate exploration well beyond the reserves of oil.

There are already a number of commercialised LNG discoveries in PNG. The Hides field is very large and one of the cornerstone fields behind the PNG LNG project, which is expected to come on stream towards the end of 2014. The InterOil Corporation has also confirmed its intention to move forward with an LNG project in PNG.

Royal Dutch Shell has also re-entered PNG and the Government is working with the company to exploit the Elk/Antelope resource, currently licensed to the smaller player, InterOil.

PNG will need a progressive policy of harmonised public and private sector investment across the carbon, mineral and natural and the resources sectors. The experience gained from working with existing PNG exploration investors such as Shell and Exxon can be expanded.

PNG should balance exploration policies with support and incentives for indigenous, small and medium sized enterprises and supply chain companies, to ensure that the support space is not filled by short term imports of services and labour.

Many of the significant LNG finds have been onshore, in remote and challenging regions like the Southern Highlands, while drilling in the Gulf area is showing great promise.

However there is the potential for discourse in PNG about the benefits from major resource extraction with a fear that the supply and extraction margins for these resources will find their way offshore leaving little in the way of economic benefit to the PNG majority rural population.

Major oil, gas and mining companies publish messages about the community benefits from their extraction projects in terms of employment and supply chain spin-offs, but also warn that such benefits may not necessarily eventuate. Most of these investments are for importing drilling and technology equipment, and the headline 'multi-billion dollar project' finishes by delivering much smaller economic impacts to the local economy and its communities.

PNG's civil societies should raise concerns about the growth of the resources extraction sector. The first major recommendation here is designed to ensure that Government and key international agencies focus on 'social impact investments', which can leverage and stream public and private sector funding to socially inclusive and sustainable rural energy projects, and consolidate the dual needs of energy delivery and environmental security. The following measures are proposed to ensure that PNG resources are leveraged to provide macroeconomic measures that warrant international loan securities to the PNG Government. The measures are also proposed as integrated policies in support of the target actions to deliver energy, enterprise and social stability. The proposals can be read in association with the Sector Analysis reports prepared in 2012.

4.1. Facilitating private sector exploration levies to underwrite domestic energy expansion in Papua New Guinea

It is recommended that an Expert Policy and Regulatory team is assembled to review the current Carbon Resource Licensing criteria in order to define and calculate appropriate energy extraction levy's, which can be routed to an Energy for all PNG Treasury Investment Fund.

The proposed fund would be operated under the dual authority of the Ministry of Finance and Ministry of Energy and Natural Resources, with fund management provided by an independent and experienced fund management division of an international bank.

The exploration levies should follow similar standards of application as have been well applied, for example, in Europe (North Sea) and America (Gulf of Mexico).

A task force of the European Investment Bank, Asia Development Bank and World Bank along with energy policy and regulatory experts should be convened to develop the framework process and work efficiently to provide loan funds to secure early deployment of rural energy projects which balance the inevitable disruption that will be caused by increased oil and gas exploration.

4.2. PNG renewable energy projects Review and realignment of the sector to enable greater social impact

There is a strong desire to incorporate and apply renewable energy solutions alongside other technologies and infrastructure projects. Any practical assessment of the geography and social structure of PNG, suggests that large scale interconnection of these proposed systems will require a substantial improvement in the roads and access paths to enable the majority rural communities to gain access to both the opportunities that energy can bring, while maintaining social cohesion. A large-scale roads programmes in support of the oil, gas and mining exploration industry and associated deployment of mobile and fixed telecoms, should provide a 'glide path' for energy and environmental solutions. As such, a formal spatial plan should be agreed with the Government to map and measure the least cost pathways for deployment of complementary renewable energy solutions. This measure should also include a land use management policy to ensure that deforestation occurs with full substitution of high yield biomass crops and or other community revenue schemes.

It is therefore recommended that all current medium and large scale renewable energy development projects are reviewed, to consider economic sustainability and return on investment, in particular, projects with a high dependence on grid extension. Many of the projects under consideration assume that there is sufficient skill and resources to maintain them in the longer term. In the experience of the author of this report, these projects are executed without proper regard for the final beneficiaries' technical and economic ability. Given the changing and extreme weather patterns as documented above, it is proposed that some of the current wind, solar and hydro projects in the planning stage, should be reconsidered in the short term in favour of waste to energy projects that can also incorporate integrated water management and sanitation technologies.

These waste to energy and environmental solutions are easier to deploy and can be constructed and deployed using the same diggers and earth moving equipment as being used in roads projects. Given the recognised and growing problems of poor sanitation and water borne disease, energy systems that can convert waste materials into gas to power generators, and provide heat for cooking and create whole cycle benefits for communities, will be easier for rural communities to engage with, as the final output from biogas units is digestate (sludge) which is also a fertilizer and soil enrichment medium. There are many modular solutions available and these should be included in the proposed Renewable Energy Review process.

4.3. Establishment of a private sector project & business incubation unit

There are many potential or planned projects to deploy energy projects including large scale hydro (300 MW by 2016), LNG gas replacement (60MW by 2015), wind (6 MW by 2014) and biogas (9MW by 2015). While these projects may deliver much needed up scaling of generating capacity, there must be an equal or greater investment in national grid and local grid deployment if the proposed power generation increase is to deliver a real benefit beyond the larger mining and industrial sites along the central highways of PNG.

The capital cost per kilometre of high voltage transmission line is approx € 350,000 for a 130 KV line rising to € 600,000 per km for a 400 KV line. When substations and local distribution to the last km is taken into account, one can quickly see that any investment in larger scale central generating capacity must be matched with an equation for delivery of the power over major distances.

Even in mature European landscapes there can be many land disputes and routing problems. In PNG with its intense and complex terrain, and mountainous landscape the task, while not impossible, would be even more costly.

In this regard it is proposed that distributed and small scale decentralised biomass, biogas and renewable solutions are considered to maximise the equity and equality of deployment over the next five years. This option is recommended to ensure that enterprise and social development can be sustained and converted into local ownership and so promote greater opportunities for the majority rural population. Measures that dissuade rural dwellers from congregating on the fringes of major cities will assist national authorities and energy developers to ensure that power delivery and usage in major towns and cities is commensurate with the ability of users to pay for services and so stabilise the availability of power to commerce and key industries.

4.4. Facilitating private sector investment

The private sector is already engaged in PNG's electricity sector in a number of ways:

- electricity generation in support of industrial and large scale commercial activities;
- independent power projects such as the diesel station at Kanudi;
- public-private initiatives such as Yonki Hydro Ltd. and Origin Energy/PNGSDPL.

Private sector investment in the energy sector will however need to be expanded beyond the current 12% of the population and move the opportunity for growth beyond the current public utility. Many of the existing industries in PNG and new multinational exploration companies have the balance sheet resources and expertise to play a meaningful role in energy security and expansion. Unlocking these resources will need a catalyst to consolidate and focus the collocation and new energy service company opportunities.

In order to support the development of new ESCOs, which can be trained to deploy, manage and operate these proposed decentralised energy enterprises, a Private Sector Project and Business Incubation Unit should be established under the guidance of SPC and supported by national authorities.

The proposed incubation unit can be structured to provide strategic guidance and coordination between departments and ministries of the National Government and act as a platform through which international donors and experts can focus resources, and avoid project contention across all the key planning and development channels. This approach is also recommended to avoid the historic problem of double funding similar projects by multiple agencies. Given the scale of the task in PNG, international agencies must work together and channel donor funding to maximise the consolidated capital outcomes that consolidated budgets can deliver.

The entire Melanesian family of states could also harmonise these measures and establish similar business incubation units which, with guidance, could adopt common fuel and energy projects.

 SOLOMON ISLANDS REVIEW AND PROPOSALS

1. Executive summary for Solomon Islands

Solomon Islands in Melanesia, east of PNG, consist of 999 islands, covering a total land mass of 28,400 square kilometres (10,965 square miles). The capital, Honiara, is located on the island of Guadalcanal. The nation of Solomon Islands is a member of the Commonwealth of Nations.

Solomon Islands Electricity Authority (SIEA) currently uses diesel to generate power, and the country has the highest electricity charges in the Pacific region.

Kerosene is the main source of home lighting while wood is used for cooking. Of the rural households in 2010, 93% used an open fire for cooking and 88% used a kerosene or spirit lamp for lighting. The serviceable capacity of the electric power system of the country totals 22.1 MW as at 2009. Power generation was about 77 GWh in 2009, of which about 80% was in Honiara. Diesel-fuelled power generation accounts for over 98% of the total power generated in Solomon Islands.

1.1. Reliance on fossil fuels

All fuels have to be imported, amounting to 31% of the country’s total imports. The small import quantities, long transportation routes, and frequent transshipments, often result in the high costs of petroleum products in the country.

Throughout Solomon Islands, less than 16% of the population is grid connected. In Honiara, 72% of households have electricity but the number of connections is declining.

SIEA has experienced trading difficulties in connecting new customers. The high energy costs mean that many customers are unable to pay what have become the highest energy costs in the Pacific at USD 0.83 cents to USD 0.89 cents per kWh (Source 2012. SIEA, CBSI). The problem is worst in rural areas, where 85% of the population lives and where less than 10% of total households have access to electricity.

Tariffs for third quarter 2012	Current tariff Price ZAR SI dollars	Expressed as US dollars
Domestic tariff	SBD 5.7435	USD 0.81 cent kWh
Commercial tariff	SBD 6.1859	USD 0.87 cent kWh
Industrial tariff	SBD 6.0205	USD 0.84 cent kWh

These tariffs clearly indicate the challenge for investors in the energy sector and raise questions about the options which should be applied in the longer term.

A sustainable solution with multiple payback options and conversion to LNG from diesel should be examined in the medium term. The proximity to PNG with its large capacity LNG fields should be explored. However rurally distributed solutions in proximity to enterprise would also be required to upscale the broader economic outlook.

Of the households with access to electricity, 69% received power from SIEA. Outside Honiara, only 41% of electrified households had SIEA service, and 28% deployed their own small scale fossil fuel generation source. Sustained outages have forced many business and industrial users to install their own generators, a position that may leverage support for collocation projects and cooperative investments by the private sector. Cost per kWh will be the key driver to support these investment options.

1.2. Renewable solutions analysis and summary

Geothermal

There are indications of exploitable geothermal resources in at least four locations, with an estimated potential of 10 MW. It should be noted that these are not short term options as more research is required and grid expansion will also require investment.

Hydro-power

The final proposal for Solomon Islands’ long-awaited Tina River hydro-power scheme is expected to be ready to go to the Government in early 2013.

Feasibility studies for a dam on the Tina River began in 2009 but the final proposal was delayed because of unexpected problems with the geology of the river. It is hoped that if the Tina River project is deployed, it could provide a long term and cheaper source of power, although it could be 2015 before construction starts, with first power expected in 2018.

It is unlikely that the project will help resolve the medium term problem of grid extension, and therefore high impact decentralised solutions still need to be applied in the short term to lift the economic capability of the majority rural and distributed population.

There is substantial small scale hydropower potential. However, dams and storage reservoirs would be technically difficult and expensive, limiting most sites to run-of-river schemes. The Government developed a database of over 100 sites for possible small hydro development, of which 62 have an estimated overall capacity of 11 MW. The private sector needs to demonstrate a qualified feed-in tariff agreement and secure customers with the ability to pay to warrant the cost of capital.

The total cost of the project, which will include the building of a dam and small storage reservoir, is likely to exceed USD 100 million. The cost per MW over a 20 year cycle has little prospect of achieving a return on the capital, but it could stabilise 30% of the existing network. Distributed systems could create a higher impact for this level of investment and gain traction within the short term if the recommended regional options in this report are adopted. SPC should seek to host a meeting of Melanesian Finance and Energy Ministers to look at other short term options and establish common energy support agreement to strengthen the investment options for the private sector.

Solar developments

The Solomon Islands are situated close to the equator, so that the opportunity for a considerable increase in solar energy gain with isolation values of 5 kWh/m²/day are in the highest range across the Pacific region. The cost of capital and the footprint for PV is problematic on island locations and investors are now seeking minimum output thresholds of 30–40 MW to qualify for asset and debt funding. Solar energy, like all forms of technology, needs a stable maintenance programme and grid connection in addition to battery storage to be effective. Care is needed to ensure that the ongoing costs do not exceed the input savings of the solar gain.

Wind

There are no data on Solomon Islands' wind energy potential. Nonetheless, wind would be a costly option, because of the variable wind regime together with the need to design equipment for typhoon conditions. Small scale, demountable, 10–20 KVA towers could be applied but, as with solar, need battery storage and extended grid connections to be applied. The weather profile and accessibility of towers must be a factor in the total cost of operation analysis.

Biomass and waste biomass streams

The Islands are heavily forested. Palm oil and copra are major agricultural commodities. Palm oil plantation extension may be possible. Copra output exceeds 40,000 tonnes, enough to produce an equivalent of 28 million litres of distillate, sufficient to displace about half of current diesel fuel imports. High yield perennial energy crops like miscanthus could be farmed and provide twice the output of wood by area, but supply chains and transport links limit the economic model considerably. Waste biomass and the trading of coconut shells and palm kernels from neighbouring countries such as PNG and MY could enable co-firing potential and small scale syngas deployment as part of the renewable energy mix. A study of the appropriate energy mix should be undertaken with a focus on energy output. The waste to energy channels also need biomass and this could form the basis for a revaluation of the biomass and organic waste streams across each of the islands in the chain of Solomon Islands.

Energy efficiency priorities

While energy efficiency is an important refinement for early reduction in energy use, many of the controls for energy efficiency and products need a stable supply base to be effective. This is NOT the case in Solomon Islands and one should be suspicious about the priority of EE in this context while so many people are without access to stable energy.

Lighting, refrigeration and air conditioning are major energy consumers in buildings and there is potential for making energy savings and reducing CO₂ emissions by replacing inefficient lamps and refrigerators with high efficiency alternatives or by proper maintenance and introducing more efficient air conditioners and controls, 'where practical'.

1.3. Ownership and management of energy generation

Solomon Islands Electricity Authority (SIEA) is a government-owned statutory body, which is responsible for power supply and distribution to all urban and provincial centres. It was established in January 1969 by an Act of Parliament as a 'body corporate', as the sole manager and operator of electricity generation, transmission and distribution installations transferred to it by the Government.

The provision of energy services to other parts of Solomon Islands apart from the areas serviced by SIEA has attracted the interest of the private sector and civil society groups. A number of NGOs in Solomon Islands are actively participating in developing rural electrification projects. While SIEA has recently started cooperation with some independent power producers, this new policy to encourage public-private partnerships in energy generation and retail should be seen as a prospect for a much greater opportunity to rebalance the generation load from urban to rural centres.

SIEA is vertically integrated, combining generation, transmission and distribution, like many of the energy and electricity utilities in the Pacific. This organisation has created a complacent environment that will make nationally sourced private investment difficult to sell.

A consolidation of funds from the existing donors, international institutions and foundations through a new managed fund, could create an environment where the rebalancing of rural and urban generation plans can deliver integrated projects which would stabilise the security of supply in the short term. These options should be reviewed at a strategic level with existing aid and government finance leaders. If privatization is to improve the quality of SIEA power services and the overall performance of the company over the longer term, it needs to be supported with policies that promote competition and effective regulation of the industry.

1.4. Energy policy framework

Roughly since 2006, there has been a National Energy Policy in place, implemented through the Pacific Islands Energy Policy and Strategic Action Planning (PIEPSAP) Project. However, the official status of this policy is unclear. The World Bank started a Sustainable Energy Finance Project five years ago (2007) aiming to significantly increase the adoption and use of renewable energy technologies in participating Pacific Island states (including Solomon Islands) through a package of incentives to encourage local financial institutions to participate in sustainable energy finance in support of equipment purchase. The Japanese, Australian and EU programmes appear to mirror or duplicate these World Bank measures. These collective budgets should have delivered far more traction and supply within the last five years. The SPC Technical Group should review these programmes in the context of the proposals in this report and align the Melanesian Fund with a more effective range of 'targeted energy deliverables'. This should include a trade agreement for longer term purchase of LNG to replace volatile diesel supplies.

This proposal also reflects the wishes of the governments of the Pacific Islands and the donor community who wish to seriously reduce the burden of fossil fuel imports on the respective national budgets while also tackling the impacts of climate change.

1.5. Strengthening the role of government

The Energy Division of the Ministry of Mines, Energy and Rural Electrification currently bears the responsibility for legal and regulatory development along with institutional strengthening but has been inadequately staffed and resourced to perform its required functions fully.

There is no national energy committee or other mechanism to coordinate energy sector issues. A climate change committee at the time of writing reportedly seldom meets. This situation should be examined by the SPC Regional Energy Group so that the role of government in all Melanesian states can be examined and enhanced, and private sector investment options can be targeted. Where there are weaknesses on policy, incentives or deployment paths, these can be fast tracked by an interregional taskforce.

Energy regulation in Solomon Islands

There is no independent energy regulator at present. SIEA is developer, supplier, generator and distributor of energy and is a quasi self-regulating entity. SIEA is 100% state-owned and managed and is directly accountable to the Minister for Mines and Energy, who appoints the directors, and reports to the Minister via the Permanent Secretary who is a civil servant. These types of semi-state self-regulatory structures are not conducive to enabling effective private sector engagement. The continuing weakness in energy security is a testament to the need for an independent or third party executive. The Government should provide capital investment to replace its ageing generators, transmissions, and standby generators for Lungga power station and provide the opportunity to look at a conversion to LNG. This would assist Solomon Islands in developing trade with PNG and to secure price agreements that break the volatile cycle of high oil costs.

1.6. Regulatory framework change management

Private sector involvement in sustainable energy is not fully institutionalised yet in Solomon Islands. There are some signs that SIEA is willing to move towards more public–private arrangements. In order to establish an efficient regulatory framework a wide range of structural changes within the various institutions in the energy sector must still be made and brought about urgently to enable the ‘competitive argument for private sector investment in the Solomon Islands’ to be made. A shared regional regulation function could be considered so that ‘the broader sustainable resource capability of the Melanesian Island chain can be linked together to drive the engine of energy security, trade and employment for its people’ (Maxwell 2012).

1.7. Improving revenue management

Revenue streams are recognised from two derivatives: kilowatts billed to customers and collections on customers’ accounts.

With only 11,000 customers in Honiara and other urban centres in Solomon Islands the challenge of being tasked with service delivery across seven main islands maintaining and achieving a reliable and effective supply chains would be difficult for any modern company.

Broadening the customer base and establishing new partnerships with industry should now be a priority for SIEA. Therefore an early engagement with the SPC on these issues is recommended.

It would seem that SIEA has a primary billing weakness of 17.5% of the electricity it generates. This is due to meter readings not being accounted for in the current billing system as a result of potential faulty meters or ‘consumer tampering’ with pay-as-you-go meters.

A further matter is electricity redirection by means of an ‘unapproved consumer connection’ to the power lines, in order to by-pass the electric meter. These and other billing failures need to be corrected. However with such high costs for energy and poor diligence the only way to rectify the problem is by lowering the cost of energy and changing the pattern of consumers.

2. Solomon Islands energy market summary

Key	Information	Review
Solomon Islands Population	530,000 people	
Capital:	Honiara, island of Guadalcanal	Total of 1000 islands in 17 groups in Solomon Islands chain
Geography:	(17 Island groups)	No gas, No oil, Clean rivers and streams
Labour:	75% of population engaged in fishing and subsistence agriculture.	80% rural population
Government:	Potential for administrative change and weakness in policy due to changes in programmes	
Electricity production:	State Owned SIEA ** Highest tariff in Pacific	Energy gross demand 54.6 MW
Policies:	No specific regulatory body/(Ministry of Mines, Energy and Rural Electrification)	National Energy Policy Framework (2007) – very little headway made
Resources:	Small deposits of gold, copra, timber, tuna processing	Waste biomass analysis needed as part of a New Energy Mix Study
Energy consumption 2011:	190 K toe Private: Markwarth Oil and South Pacific Oil	(53% oil, 43% biomass, 4% electricity) Electricity: 54.6 MW – 99% diesel generation (20 K toe used)
Electricity provision:	Connection to grid: 16% of population	Small scale home generators provide 15% of rural light and power
Water & sanitation management:	50%–70% of rural population has access to piped or improved water supply while coverage in urban areas is about 80%–90%	Water and waste cycle could be a strong driver for bioenergy solutions which offer biogas at low cost
Land access:	Land Acts allow compulsory land purchase	Land apportionment: 13% alienated lands (boundaries and survey), 87% customary land with traditional ownership rights

3. Conclusions and recommendations for Solomon Islands

3.1. The national Solomon Islands energy development options

There is no doubt a canvas awaits for a mix from a range of renewable energy colours on the Solomon Islands map. Electricity production from hydro and geothermal is possible but not necessarily appropriate in all cases.

The Solomon Islands country report suggests a potential rebalance from 99% diesel generated electricity by 2020 to a mix of 41% hydro, 39% geo, and 17% fossil. Short distances from source to end user are beneficial for achieving this rebalance, which is not possible in this sprawling archipelago. These targets will be meaningful only with a further detailed analysis of the essential energy mix and total cost per MW potential for both urban and rural populations. The reseeded energy from rural and semi urban regions should be examined to rebalance the investment programme and to review the distributed biogas and waste stream reuse. These tasks would include the adoption of some of the other recommendations and proposals in the executive section of this report. SPC should again consider a Melanesian Incubator Fund to refocus investment options away from the current 'consumer cashflow' weakness that is encountered by the current state energy provider.

3.2. Solomon Islands renewable sector summary and analysis

Many previous renewable energy schemes (principally hydro and solar) were operated in rural areas. Unfortunately many have failed due in part to the lack of adequate capital and operational funds to support essential maintenance and refurbishment. The lesson here is powerful – no project should be authorised without community support and a warrant from the developer in relation to 'reserve funds', to support operations beyond the first three years of life. These sorts of measures would lend some confidence to investors and donors. Above all the Solomon Islands need to rebuild confidence with its energy consumers, businesses and developers in the private sector.

A 300 MW market potential for hydro is suggested, based on several recent reports; of this market, 73% would be in the regions of Guadalcanal with a further 15 MW at Tina Hydro. The European Investment Bank and the International Finance Corporation are still funding feasibility studies and it is suggested that the Gold Ridge Mine could be an anchor off-taker of power. Other 'renewable solutions' may provide the answer for mine waste water and methane gas recycling. Most of these alternatives could be more competitive in the short term, which highlights the dilemma for Solomon Islands in the context of its lack of policy and regulatory precedents. A strong framework setting out a programme to 'energise' the economy and refocus on enterprise and energy security would encourage investment.

Other bioenergy feedstocks are biofuel oils/copra distillate, and coconut oil, which offer opportunities for replacing diesel fuel. The country reports look at this area of renewable substitution for diesel in some detail. What seems on the surface to be the least line of resistance for an alternative fuel, could mask some unrealistic supply chain costs along with subsidy management overheads which may derail the business case argument. A realistic whole chain analysis is required, to ensure that all actors have a margin and equity. The risk here is that projects will breach investor confidence in the medium term. Co fire and fuel blending could revive the business case but let us not forget that these base commodities can find higher values in other markets, and this risk could create stranded assets overnight. Although important advances have been made with coconut oil deliverables, when the risks of weather and subsidies are considered, the competition with LNG or biogas may be questionable.

Electricity, for many Solomon Islands families, is considered lower in the priority list than health and education. Although the benefits of electrification are welcomed, a social inclusion model is required to ensure that communities can see quality of life benefits as well as equity in heat and light. In low GDP regions, private investors need to know that investments are stable and supportable by consumers.

The strongest platforms for facilitating forestry/mining (inland) and fishing (coastal) are obvious key industries for the targeting of projects and the development of disparate grids.

3.3. Industry opportunities for private sector investment:

Agri-business: Copra production increased by a massive +40% to a record 36,565 tons in 2011, palm oil by +10% to 31,952 tons and coffee by +21% to a record 6495 tons. The Central Bank attributes these large rises in production to explain the export prices for the commodities.

Fisheries: Fishing is a key activity which is often missed or barely mentioned in energy reports or barely mentioned. The fishing sector and fish processing supply chain has huge biogas potential which is heavily exploited in European countries such as Denmark. Fisheries waste is a major catalyst for biogas production but requires to be blended with a buffering feedstock such as cow or pig manure or other biomass to create the ideal mix. The fish processing industry has a need to tidy up its act on waste run-off. Thus a marriage of business need and private sector investment could transform the revenue streams of the fishing sector.

Soltuna/Soltai recently expanded its fish processing facilities at Noro, where it employs about 1000 people, and is clearly one of the largest employers in the country. National Fisheries Development is another fishery. Both are owned by Trimarine. Noro is situated on New Georgia Island, 96.5 kilometres from Guadalcanal. The following reference examples are recommended as an introduction to the opportunities www.lemvigbiogas.com.

Forestry/logging is the country's most valuable export industry and accounted for about 16.5% of annual GDP in 2011. It is not a large consumer of oil or electricity, but it is understood that most of the logging companies import their oil products themselves (on the returning log barges) rather than through Markwarth Oil or South Pacific Oil.

3.4. The way forward for energy security in Solomon Islands

Solomon Islands has a unique opportunity from a very low baseline to develop a strong, renewable energy future, and free the country from the cost burden of oil. Realistically, the country will require new funding mechanisms to securitize the deployment of renewables to do this well, and crafted incentives and priorities need to be written into a technical and operational framework.

It is proposed that in addition to the recommendations in this report, project authorities and SPC should obtain a detailed expert and economic analysis across the board for SIEA as the main generator:

- ❑ revise the Electricity Act Cap 128, to allow competition and enable the provinces including the capital state of Honiara to facilitate the development of private generation companies (actions in addition to current plans).
- ❑ a consolidated multiyear investment plan should be agreed, to enable conversion and upgrading of the existing generation plant to LNG. SIEA will, in our opinion, find it difficult to continue to sustain its operation in the long term, subsidizing as it does the outstations with revenue from Honiara.
- ❑ SPC may consider approaching the SI government along with donors such as ADB, World Bank, European Investment Bank, GIF, and AusAid to consolidate timely funding and support to help SIEA meet the proposed operational and expansion needs, especially replacing existing generators with new advanced dual cycle gas generators. In addition a programme of rurally decentralised projects in semi-urban boundaries to main towns should be proposed. These should be focused on waste treatment and biogas processes. The final energy mix should also be designed within a spatial plan so that all participants including new industrial and private sector investors can buy in to the process. A high level symposium would assist this message.

These measures should be aligned with the other technical and funding recommendations in this report. In order to facilitate private sector investment, Solomon Islands will need to present a strong, competitive opportunity to the outside world and its neighbours. Sectors of growth in the economy such as agriculture, tourism and fisheries services should be engaged in the process to maximise the opportunity for investment.

VI VANUATU REVIEW AND PROPOSALS

1. Executive summary for Vanuatu

With 63 inhabited islands out of a total of 83, Vanuatu's population stands around 250,000. It has an estimated growth rate of 3.5% in urban areas and 1.9% in rural areas – a growth rate more than twice that of Europe. Its GDP per capita is approximately USD 5500, which the United Nations defines as a Small Island Development State. Vanuatu has retained greater stability in recent years and in July 2010 was voted the happiest place on earth. This island archipelago is a popular tourist destination and the increased frequency of flights from Australia, New Zealand and Asia along with anchoring cruise ships has refocused the priority to strengthen the electricity supply sector and energy security by increasing the adoption of renewable fuels and expanding the use of biofuels in transport and power generation.



In 2011, the Government of Vanuatu launched its 'Energy Roadmap' to encourage the development and expansion of the energy market. Electricity generation is moderately stable in urban and semi-urban areas, but coverage and stability in rural areas is very weak. This position and the fact that 65% of the Main Island's settlements are directly involved in agriculture weaken the ability to deliver health and education and communications to the majority of people.

The body that regulates the sector is the Utility Regulatory Authority, set up under Utilities Regulatory Authority Act No. 11 of 2007 to ensure safe, reliable and affordable water and electricity. The Authority sets prices (tariffs) under the rules of the existing contracts, and it manages consumer facing matters and is the main advisor to the Government.

The key energy generation and water supply concession contracts for the main centres of Port Vila (capital), Luganville, Tanna and Malekula are leased to Union Electrique du Vanuatu Ltd (UNELCO). To understand the nature of the energy security issues and restructuring needs in Vanuatu, one needs to understand the conditions in which the near monopoly energy generator works. It is also important to measure what changes are necessary before the establishment of private sector investment programmes in the energy sector can be considered.

1.1. Energy sector: concessionaire profile

Union Electrique de Vanuatu Limited (UNELCO), is a division of the French multinational energy group, GDF Suez, and has enjoyed a unique market position in Vanuatu for over 60 years. The position has been diluted a little with the granting of a new concession to Vanuatu Utilities and Infrastructure (VUI), which has a single new distribution zone. While UNELCO has been involved with the deployment of a number of renewable energy projects, which include a coconut oil project and a windmill farm to generate electricity, further investment approvals by the company may be reduced as it seeks additional tenure security warrants and a tariff flexibility for the roll out of payment meters to overcome a growing problem of delinquent consumer receivables.

Any new private sector or collocated industrial investment in the energy sector in Vanuatu will be difficult to align with the contractual feed-in and interconnect terms set by UNELCO. Rural energy markets are not within the current UNELCO concessions and grid extensions would seem to be retarded by the business case set by this dominant generator. A change in the energy landscape will be possible only after an overhaul of the current regulator and licensing framework. How this framework is developed will depend on the policies and payments that can be guaranteed to new investors regarding feed-in tariffs.

In the meantime, the electricity tariff for small domestic customers (<60 kWh a month) has been pegged at VATU 55.76 per kWh. UNELCO services 77,000 urban and city consumers of the 250,000 total population, equating to a delivery share of 20% of the population. UNELCO announced an increase of 20.25% in the production of renewable energy in August of 2012, but this increase could be viewed as supporting rather than adding to current capacity.

The level (of 20.25%) was achieved by using wind power with 623 MWh (13.4%), coconut oil with 311 MWh (6.7%) and solar power with 10 MWh (0.2%) (a substitution policy).

The UNELCO target is to reach 23% renewable energy by 2014 and the company would like to have more partnerships with farmers in the islands by buying copra direct from the islands of Malekula, Epi and South East Ambrym. Currently 6.7% of energy produced from coconut oil represents VUV million and is paid directly to copra farmers in the islands.

One thousand subsistence farmers from Lamap, Tisman Bay, Akhamb or South East Ambrym have been selling their copra for use in the generators at UNELCO's Tagabe power station. To date this equates to a total purchase of VUV 45 million which has gone directly to the copra farmers in the islands. However, because the margin and price data are not currently disclosed, measuring the sustainability of these markets and contracts is not possible.

UNELCO has donated two hybrid generators using solar and diesel power to support the dispensaries of White Sands in Tanna and Melsisi situated in Pentecost in 2011.

The company is also contributing VUV 120 million (130k USD) to the funding of a 1 MW solar farm in Efate in conjunction with the European Commission. The Vanuatu Government; UNELCO is also working with Kuth Energy on the complex geothermal project proposal at Takara. Other projects for electricity production should be developed to enable individual clients to gain a buy-back price for the electricity generated.

Tourism

Tourism's contribution to GDP has grown from 15% in 2006 to almost 50% by 2011. This is another key driver for improving energy security and access, to open up the rural area to development and enterprise.

Expanded resorts and support industries along with agriculture processing capacity has created a forward energy demand expectation that will necessitate an additional generation capacity of 40 MW by 2020. This will not be achieved by the adoption of a business-as-usual approach.

Tourism and construction are two sectors where much of the investment in Vanuatu is directed, accounting for almost 57% of all investment between them (47% and 10% respectively). By contrast, education and health share just 10%. Primary education is not free and is cited to be the main reason for the country's poor performance in early childhood education.

Agriculture

Agricultural exports of coconut oil, kava, copra and beef, contribute approximately 20% of annual exports and there are again strong drivers here for expanding the traditional economy. Vanuatu has several coconut oil processing units which provide biofuel oil to replace petroleum products in power generation as well as in vehicles. UNELCO is blending approx 30,000 litres of this new coconut biofuel in generating electricity. This rate may not be sustainable as the commodity gains a higher competitive value in the cosmetics sector and in transport fuels. The government programme to convert its vehicles to use biofuels is also a pressure point for energy use.

Investment

The country is pursuing new avenues and the Vanuatu Investment Promotion Authority provides a one-stop-shop for potential inbound companies and investors and also assists with the interface to the directorates for trade, finance, customs, lands, labour and immigration, now consolidated under one roof in Port Vila. This organisation should assist projects, particularly SPC energy projects, to facilitate streamlined access for newly incubated bio and renewable promoters and developers. The country still lags behind in several critical indices of the Millennium Development Goals. Notably primary education and healthcare therefore investment continue to be poor in both sectors. Many still cannot afford to send their children to school, although thanks to widespread reliance on a subsistence economy few, if any, go hungry in the archipelago. However, the pressures of a monetary based economy are growing particularly in urban centres like Port Vila.

1.2. Energy policies

Vanuatu has no single, comprehensive energy policy, but separate policies for different sectors, notably electricity.

Overall responsibility for formulating and implementing energy policy resides with the Department of Energy Mines, Minerals in the Ministry of Lands and Natural Resources (MLNR). The Department’s responsibilities include implementing energy policies, coordinating rural electrification programmes, and reviewing the existing concession agreements.

A National Energy Policy Framework was developed in 2007 but does not appear to have been translated into much tangible action.

As part of the MLNR’s vision to ‘establish an appropriate framework to promote the sustainable development of the nation’s natural resources for the social, environmental and economic well-being of the people of Vanuatu’³ the (then) Energy Unit’s key objectives included:

- promoting the use of local energy resources;
- ensuring that adequate, reliable and affordable energy supplies are available at a reasonable cost;
- enhancing the supply of electrification into rural areas through funded projects.

3 National Energy Policy Framework, 2007.

More specifically, in 2009⁴ the MLNR made a commitment that Vanuatu would, ‘reduce our use of diesel generation below 80% of the total by 2020’. To help achieve this target the Electricity Act was to be amended to remove existing restrictions on new electricity generators,⁵

The Act was indeed amended in 2011 but there remains no formal government electrification policy for either urban or rural areas in Vanuatu.

A document entitled the Vanuatu Energy Road Map (VERM), now renamed the NERM, is presently being drafted and will be an important policy initiative for the sector. Also being drafted is the Vanuatu Infrastructure Strategic Investment Plan (VISIP) that to some extent incorporates the electricity sector.

2. Vanuatu energy market summary

Key	Information	Review
Population:	245,000	
Capital:	Port Vila,	Located on island of Efate.
Geography:	Archipelago of 82 islands; 65 inhabited of which 13 large, the rest small.	
Labour:	65% of population engaged in agriculture + fishing.	GDP Per Capita USD 5500
Government:	Parliamentary democracy, 6 main councils, Prime Minister + President	
Resources:	No gas, no oil Limited minerals Kava, copra, cattle, pigs, fishing	Indigenous 99% Services: tourism, financial Waste streams estimates 100 K tonnes per annum
Energy consumption 2011:	32,000 toe	
Electricity production 2011:	81% diesel, 14% hydro, 4% coconut oil, 1% wind. Private.	
Electricity provision: UNELCO VUI	2 Concessionaires 3 Zones UNELCO 1 Zone VUI	UNELCO/Monopoly
Energy management:	Department of Energy Mines, Minerals	
Regulation Policy Department:	Utility Regulatory Authority	
Connection to grid:	27% of population	83% off grid – average for Melanesia
Oil import:	Private: Pacific Petroleum, Origin Energy	
Land access:	Lands Acts – issues	Investment zones possible

A document entitled the Vanuatu National Energy Roadmap (NERM), is presently being drafted and will be an important policy initiative for the sector. The Roadmap was started in 2011 and a draft set of policy proposals has been issued for consultation in support of the Roadmap aspirations.

4 Speech made by the Minister for Lands, Energy, Environment, Geology, Mines & Water Resources (the Hon. Paul Telukluk).
5 This amendment merely removed the legal obstacle for others to install renewable generation (or any generation for that matter) within the concession zone and then supply that power back to the concessionaire. It did little to encourage renewable energy as constraints still remain within the concession contracts between the Government and UNELCO, regarding the monopoly right of UNELCO to develop generation capacity. Note that this generation development issue does not exist in the proposed new concession between the Government and VUI (or whoever operates the Luganville concession).

Most of Vanuatu's energy needs (in gigajoule terms) are currently met by wood and other biomass fuels. It is estimated that out of the total energy consumption in 2011, biomass accounted for approximately 66%, oil products 25% and electricity 9.0%. About 73% of the population has no access to electricity. Domestic energy production accounted for an estimated 51.3% of the energy supply in 2011, imported oil products accounted for the other 48.7%. Of the former, biomass (principally for cooking purposes) accounted for 50.0% and other renewable energy sources – specifically wind, hydro and biofuel – just 1.2%.

It is forecast that Vanuatu's energy consumption will increase by +39.3% over the decade to 2020, with average annual growth of about +3.5%. Domestic energy production is expected to account for about 70% of energy supply in 2020, compared with just over 50% in 2011. Most of that will continue to be from biomass in the rural areas but its share is predicted to fall from 96.6% in 2011 to 87.3% in 2020 while the share of renewable energy should increase to 12.7%.

From an energy security point of view, the main potential⁶ lies in replacing existing diesel-powered electricity generation with local renewable energy. There are some opportunities for additional hydro generation in Vanuatu although only limited potential for larger scale facilities. In total, some 4.4 MW of realistic hydro development potential is estimated to exist. Other renewable energy capacity development potential includes approximately 1.5 MW each of biofuel and solar capacity development and 8 MW of geothermal capacity.

Presently, almost 100% of Vanuatu's commercial energy needs are met by the private sector in contrast with the situations in PNG and Solomon Islands. Biomass is obviously supplied by the local population, primarily in the rural areas; oil products are imported by Pacific Petroleum and to a much smaller extent by Origin Energy; electricity is supplied by UNELCO and VUI.

Thus the scope for further PSP in Vanuatu's energy sector is limited in the sense that the two principal urban areas and several remote communities are already covered by long term contracts. However, two major opportunities for PSP in Vanuatu's electricity sector do exist: first, the development of renewable energy. Independent power projects that will sell power to the existing concessionaires⁷ under long term power purchase agreements and, second, the development of multiple, small scale rural (or very small urban) renewable energy schemes to provide electricity service to communities currently unconnected.

To facilitate this PSP engagement, the Government needs to:

- ❑ provide tangible support for larger scale (grid connected) renewable energy infrastructure development such as by offering financial assistance and/or financial guarantees to underwrite investment, helping to deal with landowner issues and offering subsidies to utilities to defray grid extension/connection costs;
- ❑ facilitate off-grid renewable energy capacity development (principally solar) to support isolated households/and communities. The Government can assist with this process, for example by fully supporting the VERD programme, making solar systems more affordable by reducing import duties on batteries, and subsidising solar system costs;

⁶ It should be noted, however, that transport accounts for twice as much petroleum fuel use than electricity. Ten years ago there was a thriving biofuel industry for transport in Port Vila with many commercial and private vehicles using a diesel-coconut oil blend and a few vehicles burned highly filtered crude coconut oil (close to 100%) successfully. The industry flourished because of government taxation policies which eroded margins but also changes in the value of copra as an export product. A second generation bioenergy project should be considered.

⁷ In fact as VUI has yet to sign a concession contract because of issues before the courts, the company presently operates under the terms of an O&M contract.

- ❑ undertake initiatives targeted directly at supporting renewable energy development. For example, it could mandate that a specific proportion of coconut oil (or some other form of renewable energy) be used for generation purposes which, in turn, may well require government action in terms of helping to secure a supply of coconut oil or copra.

EE has, to date, not featured significantly in Vanuatu's energy development plans despite the potential shown by one of two pilot projects and very high electricity tariff levels. An ADB regional project entitled Promoting Energy Efficiency in the Pacific proposed six EE focus areas. The total potential savings that were forecasted to be attainable from adopting these energy conservation measures amounted to some 9.9% of total energy consumption per annum (5400 MWh per year). The measures were also forecast to deliver USD 2.1 million annually in cost savings and emission reductions of 3100 tons of CO₂. Promoting Energy Efficiency in the Pacific 2 (2012–2014) is currently reassessing priorities and goals for Vanuatu and may focus on reducing the growth rate of petroleum imports, rather than an actual reduction.

1. Conclusions and recommendations for Vanuatu

The National Energy Road Map (NERM) Draft form for Stakeholders Q3/Q4 2012, previously the National Energy Policy Framework 2007, is very slow and needs a joined up approach with some stimulus in terms of strategic thinking and operational direction. The proposals in the report for the overall region should be considered and discussed with the Vanuatu and SPC stakeholders.

The existing private sector nature of electricity business reduces the possible role for other private entities, unless independent power producers, selling into the private sector grids, can have some mandate to strengthen their business case. Access to capital and in particular risk capital for solar projects and wind projects under 40 MW are hard to finance. Distributed solutions under 5 MW are an option if they can gain risk funds support or warrants from government and donors.

The Government should mandate greater use of copra for both industrial and fuel use in renewable energy power generation. Mostly biomass (wood) used for fires and heating is wasted by the use of open fires. Biogas could replace larger proportions of this form of heat if used for cooking.

There is a greater scope now for solar installations for hot water and PV energy. Seven existing small scale installers are working on the islands and have formed an association, however larger scale solutions may be required to create an incentive for investment but then larger footprints of land will be needed to host the solutions.

Biofuel – Coconut oil was tested quite extensively in a 40 kW scheme providing power to 260 houses. Again, maintaining the systems is a problem. The high price of copra/balance compared to diesel pricing and fluctuations affect sustainability.

Agriculture. Each family is estimated to have five pigs and 12 chickens, and also raise livestock. A study of waste streams should be considered, and small-scale household biogas pilots established. A series of options for projects are set out in this report:

- ❑ fundamentally with such high levels of cow/pig agriculture, the distributed processing of materials both for power, and to add value, is recommended;
- ❑ 30 large commercial farms including large scale pig production on Tanna Island;
- ❑ 75% of agriculture is for export with kava and copra as the largest cash crops;
- ❑ there is considerable scope for high yield biomass (lignocellulosic stocks);
- ❑ water security and supply requires the opportunity for waste recycling and filtration;
- ❑ combined cycle of waste to energy should be considered.

The Islands have more than sufficient waste streams and agri and organic waste to support small, medium and large community scale biogas installations. Community installations could be the best way to expand the generation capacity at homes, schools, clinics, settlements and co-located industries.

Geothermal has good potential, although seismic surveys and thermal mass analysis research will need to be consolidated in order to encourage investment.

- Efate 4MW project proposed by Australian (KuTH Energy);
- stalled at regulatory phase with no power interconnect agreements between concessionaire companies at present;
- independent Power Production agreements need mandated regulatory reform to open the investment options and accelerate deployment;
- land access with locals still has to be agreed;
- project requires a 5–10 km grid extension investment.

3.1. Private sector project opportunities

As discussed above, Vanuatu is unusual in the context of the Pacific Region in already having its electricity sector dominated by a private concessionaire. Looking ahead, the incumbent concessionaire (UNELCO) along with possibly the new concessionaire (VUI) will continue to control much of the country's urban electricity sector as a result of their long term contracting arrangements and committed capital exposure. As such, the potential for other private engagement is largely limited to small urban and rural areas that presently fall outside the concession zones. The following assessments present a more detailed discussion of where there may be scope for other private sector involvement, subject to access and regulatory reform.

To date, contract requirements in Vanuatu have done little to facilitate either electrification (for example there are no connection targets set for the concessionaire UNELCO) or private engagement. Again for example under the existing UNELCO contracts, private generation is not permitted within the concession zone. Further significant development outside the concession zone will depend on the concessionaire offering viable interconnection options and feed-in terms for electricity and or competitive fuel off-take terms for biomass and biofuel suppliers and farmers.

Looking ahead, there are principally two major opportunities for new private sector engagement/investments in Vanuatu's energy sector:

- (renewable energy) independent power producers could sell power to the existing concessionaires under long term power purchase agreements.
- for reasons of economic viability, such independent power producers will likely need to have a capacity of at least 5 MW–20 MW, which means large scale solar or wind projects (as well as geothermal).
- best of all, perhaps, would be a large scale hydro investment located reasonably close to an urban centre but with the potential to serve multiple virgin rural communities. A critical enabling factor, of course, is for the developer and concessionaire to agree power purchasing terms that will also satisfy the regulator.
- large scale waste to energy schemes with independent mixed collocated industrial or agri-business off takers could be a more viable option and a study of these options should be undertaken.
- development of multiple, small scale rural (or very small urban) renewable energy schemes to

provide electricity service to un-served communities. By definition, however, the small scale nature of such investment and the difficulties associated with rural electricity provision (low energy demand, inability or unwillingness to pay, access difficulties, etc) means that any potential investor will have to either expect minimal (if any) reward or receive significant government/donor assistance to help finance the investment and, potentially, to provide ongoing support.

- impact investment through the establishment of an Incubation Fund should be considered to bridge the risk investment gap and encourage microfinance options for rural communities. There are limited numbers of significant population centres outside the current concession zones. Port Olry and Torba are the largest with approximately 2800 and 1200 inhabitants respectively. This means there is limited potential for the private sector to (profitably) gain returns from any single project, however cooperative waste to energy and biomass clusters could create scale and engage in electricity supply with a range of other value added social inclusion service deliveries. We recommend Project Authorities to examine the 'Methods and Options' as proposed in section 2 of this report for further consideration and adoption.

4. Final review recommendations: Vanuatu

Facilitating private sector investment in Vanuatu and more specifically in the pursuit of Energy Expansion and Energy Security will not be easy. Projects will need to be aligned with the appropriate scale of demand for energy and the creation of ways to monetise both capital and operational repayments within a structured business plan.

Decades of well documented 'donor dependency' has created a cycle of 'project fatigue' that seems to have diluted private sector aspiration.

Notwithstanding the key observations in relation to the apparent dependence on the current monopoly of the Electricity Generation Concessionaire who provides power and energy services within main conurbations, there are major opportunities to enable energy expansion to the majority rural community and these should be driven by the existing productive sector industries. These industries have an open opportunity to expand and take ownership of the longer term energy deployment capacity in Vanuatu.

In common with the recommendations for Papua New Guinea, and with emphasis on the incubation of projects and business expansion, the following proposals should be seen as a recommended approach to facilitating private sector investment in the energy sector. These proposals should not be seen as yet another opportunity to formulate one off projects with donor support, but rather as a 'Stakeholder Equity Policy' to enable shared ownership of key assets. Assets that will be the building blocks of private enterprise expansion throughout the Vanuatu chain of Islands. Vanuatu enjoys comparatively strong growth in several productive sectors, a position that these sectors have successfully developed and exploited for over 40 years.

4.1 The agriculture sector private energy development initiative:

Vanuatu has a strong agri-business sector with the following strong indicators:

- a substantial land mass with documented high standards for animal husbandry, land use productivity and market values;
- a relatively favourable climate for agriculture, supporting year-round pasture and crop production;
- potential for high yield biomass including forestry and cane crops;
- pre-existing commercial agricultural investments and processing infrastructure;
- comparatively low incidence of agricultural pests and disease, naturally quarantined from the neighbouring countries. w

The opportunity to establish clustered & cooperative energy projects with public/private equity and facilitate regional Green Energy Service Companies

It is proposed that a Sector Programme is developed to Incubate and cluster agri stakeholders to incorporate and develop rural energy service cooperatives with the assistants of Government. This model has been developed with great success in other regions, but would need the support and guidance that a Bioenergy Incubator Enterprise Unit could offer.

A project should be developed by SPC to invite agri stakeholders to review the options for development, which can be facilitated by investment from the European Union and other primary supporters of the sector programmes.

The proposed mandate should be to enable private ownership of projects that deliver agri-fuelled Biomass and biogas projects along side solar and low voltage wind technologies.

4.2 The fisheries sector private energy development Initiative

Vanuatu has a strong sea fish–business sector with reasonably strong indicators:

- ❑ well managed sea ports and infrastructure;
- ❑ sustainable fishing practices;
- ❑ a maritime environment with useful (if limited) fish stocks;
- ❑ existing processing capable of expansion;
- ❑ underutilised waste streams.

The opportunity to establish clustered and cooperative energy projects with public–private equity and facilitate regional Maritime Energy Service Companies (MESCOs)

It is proposed that a Sector Programme is developed to incubate and cluster maritime stakeholders to incorporate and develop rural energy service cooperatives with the assistants of Government. This model will be derived from the proposal for the agri sector but apply variant modalities for technology deployment.

The projects would initially need the support and guidance that a Bioenergy Incubator Enterprise Unit could provide. A project should be developed by SPC to invite fisheries industry stakeholders to review the options for development, which can be facilitated by seed investment from the European Union and other primary supporters of these sector programmes. The mandate should be driven by the need to enable private ownership of projects that leverage the strength of a common desire to reduce operating costs by providing lower cost and more sustainable forms of energy.

These proposals can be extended to include the hotels and tourism sector, with a variant on scale according to the number of properties in a cluster and the location of the target host venues for the energy projects. These measures should be viewed as an opportunity to substantially increase the numbers of ‘green tourists’ and create new investment opportunities to expand the volume of visitors.

These proposals can be recommended to the Governments of the Solomon Islands, Fiji and Vanuatu and it is recommended that a symposium to develop the opportunity is proposed by SPC in 2013.

These development proposals should be developed alongside the strengthening of the other energy policy and regulatory measures recommended in this report, and be independent of the existing concessionaire agreements.



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