Small is Beautiful:
An analysis of the NGO Alofa Tuvalu's 10 year sustainable development project in Tuvalu in respect of local governance and regional policy.

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Abstract

Tuvalu is a small island developing state (SID) with least developed country (LDC) status. Presently, Tuvalu is close to being a totally oil dependent economy (83% of primary energy), whose energy security is dependent upon foreign aid to ensure its ability to pay international oil companies. The renewable energy component of Alofa Tuvalu's Small is Beautiful (SiB) project is aimed at ensuring provision and access to a matrix of secure, affordable, appropriate & sustainable energy sources throughout Tuvalu by using Tuvalu's own resources (biomass, solar, wind). The overall objective of SiB is to improve access to energy services for the rural poor and thereby improve economic, social and environmental conditions for all isolated communities throughout the 9 atolls of Tuvalu. SiB is a ten year initiative which began in 2005. This paper analyses SiB's objectives and outcomes so far against the backdrop of local governance processes, regional and national policy initiatives and the Tuvaluan Government's commitment to 100% renewable energy – "being carbon neutral" - by 2020.

Keywords: Biodiesel; Bioenergy; Biogas; Biomass; Coconut; Energy Sector; Gasification; Governance; Policy; Renewable Energy; Tuvalu.

1. Introduction and Background Information

For Tuvalu, the lack of access to adequate, affordable, reliable, safe and environmentally benign energy is a severe development constraint. Located 1100km north of Fiji, Tuvalu consists of 9 atolls, with a total landmass of 26 km^2 spread over an EEZ of around 1,000,000km^2. These physical characteristics have enormous consequences for Tuvalu's economy. For example, there is no economy of scale for land-based production and, due to transportation costs, by the time any goods for export reach the international market they are very expensive. In addition, again due to high costs of transportation, any goods which are imported are also expensive. Two inter-island boats service the 8 outer-island settlements. Tuvalu's total population is around 11,000: with around 4,500 on Funafuti – the administrative centre. The population density is high with around 423 people per km^2 across Tuvalu as a whole and 1,610 in Funafuti. (ADB 2006; UNDP 2006). Many NGO's and international organisations have run climate change awareness campaigns in Funafuti and people are generally alert to climate change issues.

The country's main food resource is the ocean, agriculture is in no way self-sufficient and consists primarily of coconut and banana trees. Pig keeping is part of Tuvaluan culture and a food source for many households. Taro (staple root crop), has lost its economic importance over recent years due to climate change related seawater encroachment of Taro pits and disinterest in traditional farming techniques amongst the younger generations.

The remoteness of these islands has four major effects – all of which exacerbate Tuvalu's vulnerability to climate change: 1) Very expensive imported goods due to shipping costs; 2) A lack of exports; 3) A limited potential for tourism development; 4) Supply disruptions of all imported goods – especially food and fuel to outer islands (Woods *et al.* 2006).

In 2008, Tuvaluan imports (totalling Aus$26 million) were 186 times greater than exports. This situation is unsustainable. Foodstuffs represent around 25% of imports and fossil fuels around 19% (Hemstock & Smith, 2012). 76% of households on outer islands are in the bottom fifth of the income scale. The other quarter of the poorest households are on Funafuti and are often worse off in the more monetary economy there with no access to land on which to produce food or access to traditional biomass, cooking using plastic bottles as fuel is not uncommon. In addition, they have less access to water, electricity and other energy sources, sanitation and waste disposal services, and insecure tenure - they are more exposed to poor living standards and the conventional correlates of poverty. The copra market collapsed in 2002 leaving subsistence farming households in outer islands increasingly reliant on remittances from family

members working overseas. Across Tuvalu, mode and average income per day ranges from 1.8A$ to 4.0A$. (Chung 2006; ADB 2006).

Alofa Tuvalu is an international NGO, registered in France and with a counterpart organisation in Tuvalu – with its own constitution, officers and steering committee. Alofa Tuvalu was set up in 2005 by filmmaker Gilliane Le Gallic with the primary objective of assisting Tuvalu to survive as a nation, operating on the basis that Tuvalu is a microcosm of the environmental threats that we all face over the near to long-term future – "We Are All Tuvalu". The overall intention of the NGO's activities is to develop Tuvalu as a replicable model for environmentally benign living. Community consultation is fundamental prerequisite to all activities and the NGO's 10 year "Small is Beautiful" (SiB) scheme, launched in 2005, is aimed at addressing energy and related environmental problems associated with energy provision and resource use.

The 10 year "Small is Beautiful" (SiB) scheme is aimed at addressing energy and related environmental problems associated with energy provision and resource use. It was launched in 2005 via an initial inventory of available natural resources and renewable energy potential (Hemstock 2005; Hemstock and Radanne 2006). Additionally, along with available resource assessment, establishing a community need for energy services was a crucial first step in the planning process - this was achieved via a series of community meetings. Failed community projects throughout the region show that both grassroots community members and local governance structures must be involved in the decision making and project planning process from the outset (Woods *et al*., 2005). In order to ensure the sustainability of any intervention, women were involved at grassroots level as they would be the main users of domestic fuel. Initially community meetings were held with each of the 8 island communities and included participatory assessments and technology sensitisation – mainly focussing on women's groups and subsistence farmers in the outer-islands (for consultation and assessment methodologies see Rosillo-Calle *et al.* 2006). Initially some women were anxious that we were not working through the correct channels, since we had approached them first and not the Kaupule/ Falekaupule (the local council where women were not allowed to speak). However, it was pointed out that the women's input to the project was crucial as they were the end-users and their views would then be represented at Kaupule/ Fale Kaupule level. Promotion of community ownership, awareness (via workshops and radio programmes) and supporting women's groups have all been successful SiB strategies. 2006 saw the first practical RET installation – a biogas digester at the Tuvalu Maritime Training Institute (TMTI). From the community meetings, training on all aspects of RET (renewable energy technology) installation and use was the most requested intervention, so a MoU was drawn up between Alofa Tuvalu and TMTI regarding the use of TMTI facilities as a RET Demonstration and Training Centre.

2. Objectives of SiB

Following a series of community meetings which targeted women's groups and subsistence farmers, SiB's specific objectives were drawn up in response to community identified needs and include:

- Reducing fossil fuel GHG emissions by improving energy efficiency & increasing renewable energy to a minimum 40% of primary energy consumption (4574toe – tonnes of oil equivalent).
- Reducing poverty by improving access to affordable modern energy carriers and increasing household incomes (via production of coconut oil biodiesel and biogas-food initiatives).
- Building capacity for technical and engineering support (ongoing training programmes in isolated outer-island communities on equipment use & maintenance).

3. Enlargement of Tuvalu's Energy Sector

The years chosen for this energy sector analysis indicate energy provision and consumption both prior to (2004) and following (2007) the installation of 3x600kW diesel electricity generators on Funafuti by DiNipon/Mitsubishi as part of a JICA aid project worth around US$9 million. It should also be noted that since the installation of the generators, JICA has continued to subsidies diesel fuel for their operation by up to Aus$2 million per year. This does not engender a "level playing field" for renewable energy development in Tuvalu, nor did the Pacific Island Energy Policy and Plan (PIEPP), which was developed in 2002 to provide a regional energy policy which was supportive of renewable energy sources. Under the auspices of the Secretariat of the Pacific Community (SOPAC) and the Forum Secretariat, the energy policy & strategy development process has continued under various acronyms (Singh et al., 2012). This process

resulted in a national energy policy for Tuvalu, designed to "Promote and implement the use of appropriate, proven, affordable and cost effective renewable energy technologies both for urban and rural applications". During 2006-7 the Government were in the process of formulating and adopting policy strategies and activities, finally publishing them in 2009 (Government of Tuvalu, 2009), as well as considering a commitment to being "100% renewable by 2020".

Table 1 shows that in 2004, the total energy consumption was 4.6 ktoe, with imported oil accounting for 3.8 ktoe (82%) and biomass for 0.8 ktoe (18% of the total primary energy consumption) (Hemstock and Radanne 2006). Annual energy consumption in 2004 was approximately 0.4 toe per capita.

By 2007, the total energy consumption had increased to 5.8 ktoe, with oil accounting for 4.8 ktoe (83%), biomass for 0.8 ktoe (14%) and solar 0.1 ktoe (2%) (Table 1). Annual energy consumption in 2007 was approximately 0.5 toe per capita (Hemstock 2010). However, despite these increases in primary energy, there is relatively little impact for those living on outer-islands, who remain more than 70% biomass energy dependent for their domestic energy needs.

From 2004 to 2007, petrol use decreased by 13% (Table 1). This is mainly due to the impact of increased retail fuel prices which resulted in an increased use of "traditional" fishing canoes, rather than a large reduction in road vehicle use. The use of toddy ethanol to fuel small fishing boats could provide a viable role for toddy production (Hemstock 2013). The increase in kerosene use in 2007 is accounted for by the refuelling of the Air Pacific plane in Funafuti.

Table 1: A comparison of primary energy supply in Tuvalu for 2004 and 2007

Primary Energy Supply: Fuel Type	**2004** **(tonnes of oil equivalent - toe)**	**2007** **(tonnes of oil equivalent - toe)**
Biomass	814	814
Solar Thermal	0.3	0.3
Solar PV	0.6	150
Liquid Petroleum Gas (LPG)	43	43
Petrol	624	543
Diesel	2639	3245
Kerosene	453	1045

Source: Hemstock and Smith 2012; Lifuka 2009; Lotolua 2009.

4. Technology Implementation

From analysis of the national energy budget (above) and the available biomass resource base (Table 2) it is evident that there are opportunities for biomass energy schemes such as biogas, gasification, and biodiesel for electricity generation and biodiesel and bioethanol for transport fuel.

Table 2: Tuvalu's biomass resource base available for use in bioenergy schemes.

Total energy currently available from unused husks & shells*	**Theoretical availability of coconuts for oil production****	**Total amount of manure available annually for use in biogas digester*****
$GJyr^{-1}$	Nuts per year ($x10^6$)	tyr^{-1}
20,232 (482 toe)	**7.5**	**2,106**

*This resource would be available for gasification.

** This refers to sustainable production of coconut available annually, but does not account for collections difficulties – around 15% of these nuts are produced on islets which are difficult to access. Biodiesel from available coconut could sustainably replace 56% of inter-island shipping fuel annually.

***1,578m3 of gas could be produced per day providing cooking gas (and possibly electricity) for 526 homes.
Source: Alofa Tuvalu Survey – 2009 (Hemstock 2008; Hemstock 2010).

Even where land is limited, residues and wastes from existing agricultural and forestry activities could be used as the basis for the provision of sustainable biomass energy resources for modern applications (Table 3). Tuvalu has a considerable biomass resource base and biomass resources will not be a limiting factor.

Table 3: An estimate of the current total number of coconut palms in each vegetation class

Total for Tuvalu **Vegetation Class**	**Total Area** **(ha)**	**Current total number of coconut palms ($x10^3$)**
Coconut woodland		
High density	136	87
Medium density	640	216
Low density	707	123
Coconut & broadleaf woodland	106	9
Coconut replant areas	65	13
Scrub & coconuts	405	21
Settlement area (vegetation)	178	4
WWII Airstrip	22	4
TOTALS	**2260**	**477**

Source: Alofa Tuvalu Survey – 2009 (Hemstock 2010; Hemstock, 2013).

Modernisation of biomass energy use, via biogas, biodiesel and gasification, will involve some social and cultural changes. Political attitudes which emphasise the enforcement of existing policies will be required for successful implementation of the energy initiatives discussed – this may mean saying "no" to the Aus$1-2 million annual fossil fuel subsidy currently supported by JICA.

The development of an RET Demonstration and Training Centre at TMTI was the initial starting point for the SiB initiative. TMTI is now equipped as a training centre for biogas, cookstoves – solar & charcoal, vegetable gardening (using biogas digester slurry), coconut biodiesel production, toddy bioethanol production and gasification. These technologies were chosen on the basis of:
1) Robust and basic technology design - all could be manufactured and repaired in Tuvalu; 2) Biomass is culturally accepted (traditional biomass energy use provides for the majority of domestic energy services); 3) Biomass resources (coconuts and pigs) provide upstream and downstream income; 4) Resource availability – implementing replanting and reforestation as part of the SiB initiatives (Tables 2 & 3) (Hemstock 2010).

TMTI was chosen for the basis for the RET centre since there are skilled marine engineers and classrooms & workshops available. TMTI is not attached to any one island community – it is a national asset. TMTI staff and students crew the inter-island boats so engineering staff and trainees could provide any technical and engineering backup for future RET's in the outer-islands – ensuring technical sustainability on a national basis. Projects have failed in the past because once the "project cycle" ends, installed equipment breaks down and there are no parts or trained technicians to repair it. By partnering with TMTI, the SiB approach avoids these pitfalls. The TMTI RET Demonstration and Training Centre is considered to be the base – a maintenance hub - from which community RET implementation will expand throughout Tuvalu. The training seafarers will also benefit as this will expend their engineering knowledge, skills and future employment prospects.

As a RET training and demonstration centre, TMTI has been successful – training 4 people on the construction of 8m fixed dome digesters; 200 plus people on digester operation and maintenance (fixed and

floating dome); and demonstrating gasification, toddy bioethanol and biodiesel (FuelPod) technologies to more than 500 people.

However, the use of the digester, gasifier and biodiesel Fuelpod to provide energy for TMTI has not been so successful due to issues such as the reluctance of staff to use shared pig pens, vandalised equipment, and the lack of financial incentives for the school to be energy efficient since the Government of Tuvalu pays for TMTI's energy bills. Due to the pioneering nature of this project, some technical issues had to be overcome with regard to preventing rainwater infiltration of the digester and sealing the digester from salt water intrusion as the tide rises – these issues were resolved during construction.

Due to lack of funding or finance opportunities, progress towards renewable technology implementation has been very slow. The first outer-islands biogas digesters were installed on Nanumea in August 2010, they were installed on a household rather than community basis and are still in daily use.

4.1 Implementation and local governance

Using the Nanumea biogas installations as an example, the Nanumea Kaupule (local Nanumea Island Council) and Alofa Tuvalu identified this project at an Island Council meeting in Funafuti in 2008. Nanumea was identified as it has the highest number of pigs per family (30 pigs per family) compared to other islands in Tuvalu (around 12 pigs per family), half the island was used for the rearing of pigs and there had been issues with pig waste, smell and large numbers of flies (thought to be due to the large amount of pig waste).

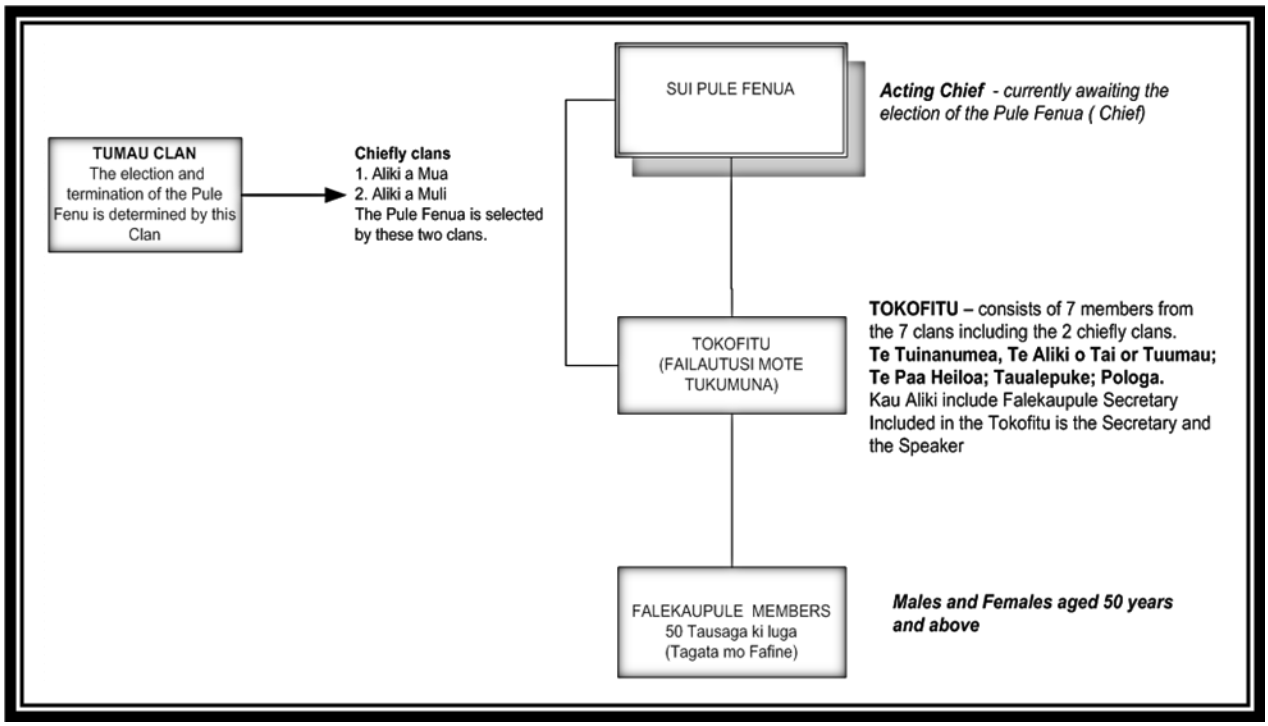
Alofa Tuvalu consulted on project design with the Nanumea Kaupule and the Nanumea community in Funafuti and secured funding from the UNDP Small Grants Scheme for the project. The Alofa Tuvalu consultant then visited Nanumea to discuss with the Kaupule and wider community the installation of biogas units - using lessons learned from the TMTI installation. A series of around 20 meetings were held with different groups within the community over a period of 1 month. Initially, the Kaupule and wider community (including students of Kaumaile Primary School) were introduced to the technology and those community members that had attended the TMTI digester trainings were encouraged to share their experiences. The basic issues discussed at these community and council meetings were as identified by Rosillo-Calle et al, 2006:

- to describe the background of Alofa Tuvalu and the 'Small is Beautiful' project;
- to make clear links between climate change, carbon emissions and energy use using films and radio programmes produced by Alofa Tuvalu in Tuvalu to reinforce these concepts;
- to point out the benefits of family gardens (food security, improved income, reduce waste by compost making, reduced reliance on imported foods, etc.);
- to give instructions on how to set up a family garden (ground preparation, where to buy compost, planting seeds, watering, pollination, collecting and storing seeds, organic fertilizer and composting techniques, etc.) – meetings were held with the Kaupule gardener and vegetable seeds provided to him;
- to supply seeds to the women (tomato, lettuce, basil, melon, marrow, chilli pepper) – via the National Council of Women, the Kaupule Women's Community Representative, and other community leaders;
- to describe biogas technology and types of implementation – using examples of relevant biogas plants – the Kaupule/Falekaupule were the decision makers and selected the design of the biogas units (i.e. plastic digesters), the siting of digesters, and the scale of installation i.e. household scale, rather than community basis..
- specifically providing women with information about the technology as they are the main users of domestic energy.

From consultations with the Nanumea Kaupule it was decided that the Kaupule select four (4) families to participate in this biogas project. This Kaupule decision was then taken to the Falekaupule Nanumea. The Falekaupule takes its name from the traditional meeting hall where all of the elders and head of families in the community, including women and youth, gather for the general meeting with the Kaupule (see Box 1). These "Assemblies" happen on a quarterly basis and it is here where annual budgets and plans are discussed and ratified (see Box 2). During these meetings, the wider community get a chance to voice their views to the Kaupule of how projects are implemented and how they can be improved. One useful output for the project from this local governance structure was the recommendation that training the

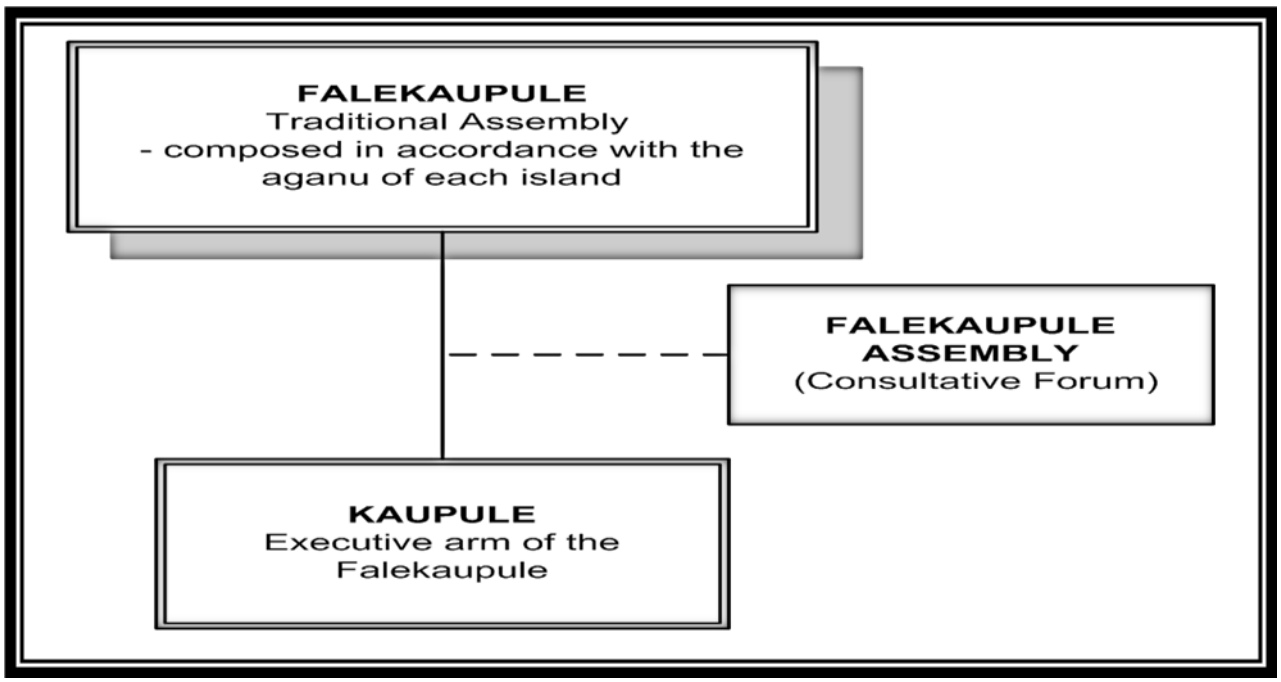
wider community in the construction, set-up, operation and maintenance of biogas digesters should form a cornerstone of the project. It was argued that if a large number of people in the community were trained, if the initial family selected to have a digester lost interest in the project, the digester could easily be moved to a different household (this has happened once since 2010). Recommendations were also made in order to improve sustainability of the project after the Alofa Tuvalu team hand over the infrastructure to the Kaupule. For example, TMTI recent graduates were selected to be on the team who would help the biogas consultant set-up the digesters and train the wider community in operation and maintenance. Additionally, it was decided that the digesters were to be implemented on a household basis as this would reduce the arguments associated with community based schemes – as demonstrated by the TMTI community digester.

Box 1: Traditional Governance Structure for Nanumea



Source: Home Affairs Island Profile for Nanumea 2012, Government of Tuvalu.

Box 2: Governance Structure links Falekaupule and Kaupule



Falekaupule agreed that there should be two families from each of the two villages on the island. The selection of the families was on a voluntary basis - four family heads raised their hands voluntarily to represent their villages in the project.

Materials for the project (digesters, and materials for pig pens and family gardens) were shipped from Fiji to Funafuti, the capital of Tuvalu, and then onto Nanumea on the TMTI operated boat "Nivanga 2". Alofa Tuvalu consulted Kaupule Nanumea as well as the Department of Rural Development within the by Ministry of Home Affairs regarding the materials required for gardens and pig pens and shipping to Nanumea. This ensured national and local governance structures were engaged in the process.

In order to monitor the progress of the project on the outer island, Alofa Tuvalu employed a Project Coordinator stationed on Nanumea to assist the Kaupule in the implementation of the Project and update Alofa Tuvalu on progress.

During 2011 drought took its toll throughout Tuvalu and a state of emergency was declared. The digestion process requires fresh water, but this was not available. However, due to the training received, the families responsible for the digesters used manure and green leaves to maintain some degree of gas production.

Stoves were replaced in December 2011 as the stoves supplied initially were not of good quality and did not survive Tuvalu's corrosive tropical environment.

In September 2012, Kaupule surveyed the four units and found out that all were well used. The feedback from the four families with the units, especially from an elderly couple, was that the unit had changed their lives dramatically in the sense they no longer had to collect firewood and they were cooking "smokeless" inside their house. Refilling of their unit only took two buckets of manure a week which was very easy for them to collect. Other families mentioned that the units had assisted them in cooking inside their main house during bad weather while some mentioned they use their unit when there is a lack of imported gas on the island.

5. Discussion and Conclusions

Due to aid dependency, perverse incentives and fossil fuel subsidies, and lack of funding or finance opportunities for domestic-scale renewables: progress towards renewable technology implementation has been very slow.

However, SiB installed the first outer-islands biogas digesters in August 2010 (on a household rather than community basis), and they are still in daily use. Additionally, Tuvalu's outer island of Nanumaga is going to replicate the Nanumea project as part of the University of the South Pacific European Union Golbal Climate Change Alliance project by installing 7 digester units, pigpens and gardens at a

household level – working through the Nanumaga Kaupule. This, along with the reduced petrol use (Table 1), demonstrates that people are very able and willing to use alternative sources of energy which are local, convenient and renewable.

Although it has little impact on national fossil fuel use, the success of this low-cost project (US$50,000) for the community of Nanumea comes from using existing governance structures to identify a need for energy services and a rationale for implementation. This rationale allowed the participation of the wider community in the project, and promoted a transparent process for the selection of the beneficiary households/families by the wider community. In such manner, the four families were publically committed to the project, knowing that they represent the community as a whole. This selection of the project sites and activities such as training by the wider community actually imposed the ownership of the project.

In this case it would appear that the "ownership" of the project by the wider community, even though the majority of benefits are at an individual household level, is the cornerstone of the projects success. This would not have been possible without the use of Nanumea's traditional governance structures.

SiB's initiatives and findings have been presented to Cabinet (in 2006, 2008, & 2010), and it is apparent that Tuvalu's decision makers are well aware of the value and potential of Tuvalu's indigenous energy resources (biomass, solar and wind); unfortunately they do not currently have the capital or capacity to capitalise on these resources. Despite popular community and political support for SiB initiatives, political decision making is limited to what is "on offer" from the various donors since Tuvalu's energy sector is totally aid dependent (Hemstock & Smith 2012). The majority of recent energy sector infrastructure has been paid for by bilateral and multilateral aid projects. Subsidies which encourage the use of fossil fuels are also currently in place such as the JICA payment to cover the cost of diesel for electricity generation in Funafuti. In addition, multilaterally funded regional efforts to encourage renewables have previously placed much of their emphasis on policy and market development without realising that SIDS do not follow the established rules of "market development" – particularly in their outer-islands. From Table 1 it is apparent that donor efforts re market and policy approaches have failed to reduce fossil fuel usage. Additionally, regional policy development efforts have not resulted in a marked improvement in the coordination and implementation of energy sector aid projects. Efforts now need to be re-aligned to provide practical help and actual installations, such as SiB's biogas, gasification and biodiesel units and the e8's (which comprises ten leading electricity companies from the G8 countries) 40 kW grid-connected solar system in Funafuti (E8 2009). Despite these few practical success stories, aid for the energy sector in Tuvalu is being channelled into "technical assistance" to produce reports such as the "Tuvalu 10 year Renewable Energy and Energy Efficiency Master Plan", which espouses the destruction of highly productive coconut palms and replacing them with totally inappropriate J*atropha curcas* for biodiesel production (Wabnitz 2010). Additionally, the contribution of biomass still goes unrecognised in "official statistics" and reports. For example, the SPC's Tuvalu Country Energy Security Indicator Profile (SPC 2012) makes absolutely no mention of biomass energy – which supplies (securely) 64% of primary energy to Tuvalu's domestic sector (Hemstock & Smith 2012). The fact that biomass is ignored by official statistics is extremely relevant to why energy planning has failed in this region and why, despite government decrees and commitments to being fossil fuel free by 2020, many countries in the region remain fossil fuel dependent. There has been a failure to recognise the role indigenous resources already play, a failure to recognise indigenous resource potential and, these failures have compounded into a critical failure to support concrete and successful small-scale bioenergy initiatives such as biogas, coconut oil biodiesel, gasification, improved stoves, etc… For many governments and CROP agencies "traditional" bioenergy use really is the "elephant in the room" as far as energy planning is concerned. Linkages between food and energy security for climate change adaptation are ignored resulting in an inaccurate picture of how people in isolated Pacific communities live their lives on a daily basis.

SiBs activities have shown that the modernisation of biomass energy use, via biogas, biodiesel and gasification, will involve some social and cultural changes; in addition an unwavering political commitment to only allow donor assistance that is in line with national energy policy is a prerequisite for RET uptake. As can be seen from the increase in fossil fuel use from 2004-2007, *policy is meaningless and has no impact unless it is implemented*. This situation may be likely to continue since the Tuvalu Country Energy Security Indicator Profile (SPC 2012) also states that there is no Government funding available for the activities outlined in the Tuvalu Energy Policy's Strategic Action Plan. However, the success of the SiB initiative in Nanumea indicates that structure exist within communities that are well able to implement simple bioenergy

projects successfully – with training and capacity building, communities can empower themselves to improve their energy services and utilise available indigenous resources.

Findings from Woods et al., (2006) are inherent in the design of the SiB project and account for: capacity building via training and strengthening service provision; community involvement from project inception; appropriate technologies which can be manufactured and maintained without foreign agency "Technical Assistance"; the build-up of a critical mass of similar apparatus throughout Tuvalu, so systems maintenance is cost effective; an integrated multi-disciplinary and multi-sector approach which builds on Tuvalu's existing infrastructure and institutions for service provision. The need to reduce and ultimately eliminate "Technical Assistance" should be a priority for Tuvalu since it accounted for 12% of Tuvalu's US$32 million GDP in 2008 (Government of Tuvalu 2009b; OECD, 2011).

To assess the final outcomes of this approach, a future analysis of the project will be required. However, it is apparent at this stage that there has been no success in increasing the renewable energy contribution to the national energy budget. This situation is in direct conflict to the statement made at the UNFCC Cop16/CMP6 (Bangkok, July 2009), the then Minister for Public Utilities & Industry, the Hon. Kausea Natano, declared "We look forward to the day when our nation offers an example to all - powered entirely by natural resources...," and set a goal of having all Tuvalu's energy from renewable resources by 2020. Clearly, there is political backing of renewable energy technologies - at least intellectually – and there is capacity in terms of community mobilisation and governance for RET implementation and use. In practice, however, the picture appears to be very different and with little funding available for community-scale off-gird energy services the plight of people living in isolated Pacific communities' is unlikely to improve in the short to medium term.

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Table 1: A comparison of primary energy supply in Tuvalu for 2004 and 2007

Primary Energy Supply: Fuel Type	**2004** **(tonnes of oil equivalent - toe)**	**2007** **(tonnes of oil equivalent - toe)**
Biomass	814	814
Solar Thermal	0.3	0.3
Solar PV	0.6	150
Liquid Petroleum Gas (LPG)	43	43
Petrol	624	543
Diesel	2639	3245
Kerosene	453	1045

Source: Hemstock and Smith 2012; Lifuka 2009; Lotolua 2009.

Table 2: Tuvalu's biomass resource base available for use in bioenergy schemes.

Total energy currently available from unused husks & shells*	**Theoretical availability of coconuts for oil production****	**Total amount of manure available annually for use in biogas digester*****
$GJyr^{-1}$	Nuts per year ($x10^6$)	tyr^{-1}
20,232 (482 toe)	**7.5**	**2,106**

*This resource would be available for gasification.
** This refers to sustainable production of coconut available annually, but does not account for collections difficulties – around 15% of these nuts are produced on islets which are difficult to access. Biodiesel from available coconut could sustainably replace 56% of inter-island shipping fuel annually.
***1,578m3 of gas could be produced per day providing cooking gas (and possibly electricity) for 526 homes.
Source: Alofa Tuvalu Survey – 2009 (Hemstock 2008; Hemstock 2010).

Table 3: An estimate of the current total number of coconut palms in each vegetation class

Total for Tuvalu **Vegetation Class**	**Total Area** **(ha)**	**Current total number of coconut palms ($x10^3$)**
Coconut woodland		
High density	136	87
Medium density	640	216
Low density	707	123
Coconut & broadleaf woodland	106	9
Coconut replant areas	65	13
Scrub & coconuts	405	21
Settlement area (vegetation)	178	4
WWII Airstrip	22	4
TOTALS	**2260**	**477**

Source: Alofa Tuvalu Survey – 2009 (Hemstock 2010; Hemstock, 2013).