BIOGAS TOOLKIT

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BIOGAS TOOLKIT

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EU-GIZ ACSE

ADAPTING TO CLIMATE CHANGE AND SUSTAINABLE ENERGY

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It is a pleasure to acknowledge the people who have contributed to the production of this handbook that will assist those interested in installing family biogas units for energy and food security for their families in order to increase their resilience to the impacts of climate change and improve livelihoods.

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Foremost to the European Union and GIZ for providing funds to enable our households in Tuvalu to benefit from this project which has reduced expenditure on LPG and kerosene stoves for domestic use and has improved their food security.

The experiences of all those mentioned, and many others, in installing and using biogas systems on a family basis have contributed to the information contained in this booklet. The aim of this work is to enable other families to share the benefits of using local resources for securing their energy and food sources to build their resilience to the impacts of climate change.

Last but not the least special thanks goes to Titilia Rabuatoka at SPC for assisting with the editing work and Eseta Lauti for the translation work into Tuvaluan.

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CONTENTS

Section 1: How to purchase a biogas system

1.1: INTRODUCTION

This handbook is meant for households who are interested in lowering high costs of energy sources for cooking purposes for their families. High costs of using kerosene and gas stoves for cooking will not build family resilience to the impacts of climate change. Likewise, on the consumption of imported foods, which are increasingly expensive. Having a biogas stove for cooking at home has been proven in Tuvalu to reduce household expenses for cooking using kerosene and gas stoves by 82% and 92% respectively *(Binney, 2015)*. Other benefits of using biogas are also shown on pages 7 and 9 through success stories from households with biogas stoves.

The biogas system described in this handbook is designed to be used at household level and consists of:

i. A biogas digester of a floating dome design, made from Rotamould water tanks – typically one 6m^3 tank (external and unit base), and a smaller tank (inside the 6 m^3 tank).
ii. A pig pen with concrete floor, fencing and a tin-sheet roof with plastic guttering. Roof provides shade and protection for the pigs and acts as a catchment for fresh water.
iii. A water tank for collecting water from the pig-pen roof.
iv. Materials to construct a family garden (fencing and tools).
v. A cooking stove to use with the digester and all tools required to run the Biogas System.

Figure 1: Biogas digesters on Nanumea Island

(Photo: Dr Sarah Hemstock, 2010)

Figure 2: Pig pens for the biogas project in Funafuti

(Photo: Kaio Taula, 2018)

Figure 3: A family food garden on Nanumaga Island

(Photo: Teuleala Morris, 2016)

The most relevant benefits of biogas generation for households in Tuvalu are:

- improvements in household income (from savings on costs of cooking fuels such as kerosene and LPG; saving time in collecting fuelwood);
- food security (breeding of pigs and by using the digestate[1] to fertilise family gardens);
- sanitary housing for pigs (concrete floor pig-pens provided as part of the Biogas System can be easily kept clean using fresh water from the water tank that is also supplied as part of the system); and
- water security – The water tank and pig-pen roof collection area provide an alternative fresh water collection and storage facility.

The aim of this handbook is to:

- encourage households to use renewable energy alternatives for cooking purposes by using local resources which are readily available on the islands;
- provide information to future projects and stakeholders who are interested in installing biogas units as a renewable energy source to secure food and energy sources for building the resilience of their communities to the impacts of climate change; and
- promote biogas as one of the best methods to build resilience to impacts of climate change by securing the basic needs of any household and that is, food and energy sources.

1 The digestate is the liquid that is left after the biogas has been produced. This can be used as a fertilizer as it has a high nitrogen content and plenty of phosphorous and potassium to encourage plants to grow well. If you wash your fish in fresh water (NOT SALT WATER) the dirty water from the bowl where you have cleaned and gutted your fish can be added to the digestate to make an excellent fertilizer for your plants.

1.2: LIST OF MATERIALS AND COSTS

These are the materials required for the installation of one unit of the biogas system used by households in Tuvalu that are part of the EU-GIZ-SPC-Tuvalu Government ACSE project. The costs are in Fijian dollars since most of the materials were ordered from Fiji. Quotes used here were sourced in 2016 from Kasabias Ltd, one of the suppliers in Fiji.

Table 1: Cost of materials required for a single biogas system

No.	Name of Item	Specification	Quantity	Unit	Price Unit (FJ$)	Total Cost (FJ$)
1	Tengy Cement	50kg	8	bags	14.00	112.00
2	Timber Pine Post	3 x100 H4	8	each	35.94	287.52
3	Zincalume Corrugated Roof Iron	12' 0.42mm BMT	6	sheet		
4	Plain roofing nails	2 ½ inch x 3.75mm 1kg	2	kg	5.60	11.20
5	Handy Pack Black Rubber Washer	100gram Packet	1	pkt	2.30	2.30
6	Timber Pine	100 x 50 rough 4/3.6	14.4	mtr	5.25	76.60
7	Timber Pine	75 x 50 rough 4/3.6	14.4	mtr	3.94	56.74
8	Timber Pine	150 x25 rough 2/3.6	7.20	mtr	4.31	31.03
9	Goat Fencing Wire	900mm x50m (3')	2.00	coil	152.00	304.00
10	Jolt Head Galvanised Nails	3 inches x3.75mm x 1kg	3.00	kg	4.30	12.90
11	Jolt Head Galvanised Nails	4 inches x 4.5mm x 1kg	3.00	kg	4.30	12.90
12	Galvanised U Nails	1 ¼ inch x 1kg	2.00	kg	4.95	9.90
13	Galaxy Steel Wire Brush	4 rows 11-14 (240pcs/ctn)	1	each	1.00	1.00
14	Pegler Ball Valve	Large handle ½ inch PB100	2.00	each	11.85	23.30
15	Pegler Brass Bib Tap	15mm 701	1.00	each	12.75	12.75
16	Top Plus PVC Glue	100g	1.00	can	3.20	3.20
17	Steel Welded Mesh	20 x 8 x 668g	1.00	sheet	68.00	68.00
18	Galaxy Yellow Gas Hose	10mm 30mtr coil 157.09	10	mtr	2.80	28.00
19	Ingco Hose clip	13-19mm HMACO81319	4.00	each	0.50	2.00
20	Biogas Stove		1.00	each	75.00	75.00
21	Digester		2.00	tanks	700	1,400
21	VAT					163.83
21	Total Cost					2,730.94

1.3: LIST OF SUPPLIERS

The following suppliers (Table 2) were utilised for installing biogas systems in Tuvalu under the Alofa Tuvalu Biogas Project on Nanumea (2010), the USP-EU GCCA Project on Nanumaga (2013) and the EU-GIZ-SPC-Tuvalu Government Biogas Project (2018).

These suppliers are based in Fiji and have also supplied materials for the construction of biogas systems in the outer-islands of Fiji by the Fiji Government. One can also utilise Google for suppliers of ready-made biogas digesters which are available in other countries. It is important that one has to select the type of biogas that is applicable to one's environment, affordable and use accessible raw materials for the digester to produce methane gas for domestic use.

Table 2: Contacts of suppliers for biogas systems

Supplier name:	Address:	Contacts:	Comments and findings from our project work
Kasabias Ltd	75 Suva St., P.O Box 167 Suva, FIJI	Phone: +679 3315 622	This supplier can also do digester fittings. We found that construction materials from this supplier were generally cheaper than Vinod Patel.
Gurbachan Singh's Steel Mills Limited	Jasveer Singh	Phone: +679 3345241 Email: jasveer@gurbachansm.com	This supplier can supply the biogas digester with fittings at affordable costs.
Vinod Patel	GPO Box 14416, Suva, FIJI	Phone: +679 3393111 Email: enquiry@vinodpatel.com.fj	Can provide construction materials for the pig pen. Service for delivering is reliable.
RC Manubhai & Co Ltd	PO Box 5332, Raiwaqa, FIJI	Phone: +679 3384316 Email: exportmgr@rcmanubhai.com	Construction materials for pig pens can be purchased and a lot cheaper than Vinod Patel and Kasabias. However, their service in delivering is not as reliable as Vinod Patel and Kasabias.
Marco Polo		Phone: +679 3275036 Email: keven@marcopolo.com.fj	This supplier can provide biogas stoves

Note: The above comments are based upon experiences in ordering and delivering materials from Fiji to Tuvalu. It is very important that one has to be in Fiji to order materials and to ensure that all are loaded onto the boat to transport to the destination. This is the backlog of implementation of projects in Tuvalu due to distance and long periods to await materials.

1.4 AFFORDABILITY

The European Union funded Adapting to Climate Change and Sustainable Energy (ACSE) project hired an Economist to analyse the affordability of the biogas used on Nanumaga Island in 2015. It was reported that a household could save up to $495 Australian dollars on an annual basis. The use of biogas by households for cooking had reduced the use of LPG by four bottles and the use of kerosene by 125 litres per year (Binney, 2015).

The cost benefit analysis (Binney, 2015; pg 5) concluded that "Energy for cooking is a major cost imposed on households in Tuvalu". Biogas provides a potential means to provide sustainable, affordable and reliable energy sources for domestic cooking needs. A major trial is about to commence to install, monitor and evaluate the use of household-scale biogas digesters in 40 households across Tuvalu. This report summarises the findings from a preliminary cost-benefit analysis (CBA) of the use of biogas.

In detail the CBA report found benefits to households included:

- "Reduced fossil fuel energy expenditure of up to $495-500 per annum;
- Avoided time to collect and prepare firewood worth up to $500 per annum (based on the marginal returns to labour from home production and sales of agricultural output);
- When output from the digester is used as a substitute for liquid fertiliser benefits in the form of lower fertiliser costs and increased garden yields are worth around $50-75 per annum;
- When the costs to households are included in the analysis (cost of time, cost of water), households could be better off by around $870-940 per annum (assuming similar energy substitution to previous trials); and
- Other benefits include a reduction in the health burden associated with indoor cooking using wood and marginal reductions in CO2 emissions"(Binney, 2015).

Section 2: Installation

STEP 1: PREPARATION OF THE DIGESTER

(Note: These units can be bought pre-prepared, these instructions however, relate to building your own digester from two tanks.)

- Obtain two Rotamould tanks – the outside tank should be of a larger size than the inside tank – e.g. 6 cubic meters for the outside tank and 5 cubic meters for the inside tank.
- Cut the top off the Outside Tank and cut the bottom off the Inside Tank.
- At the bottom of the Outside Tank, put an inlet and install a pipe to it. This pipe should be higher than the Outside Tank and is for pouring manure into the tank.
- Also make an outlet of about 20 cm from the top of the Outside Tank. This will allow the liquid fertilizer to flow out from the digester.
- Put a pipe and plug about 20 cm from the bottom of the Outside Tank – this allows the digester to be emptied in the event that it stops producing gas.
- In the middle of the top of the Inside Tank will be a valve to hold the gas hose from the digester to the stove inside the house.

Figure 4: A completed Outside Tank with fittings on Nanumaga Island

(Photo: Teuleala Morris, 2016)

Figure 5: Fitting the hose-lock and pipe in center of Inside Tank, Nanumea Island

(Photo: Dr Sarah Hemstock, 2009)

STEP 2: INSTALLING THE DIGESTER

- Put the Outside Tank on the base and put the open end of the Inside Tank first with its bottom and valve on top, into the Outside Tank.
- Lead the hose from the digester to the knob in the stove and tighten.

Figure 6: Digester in place2 with hose leading to biogas stove inside the house, Vaitupu Island

(Photo: Kaio Taula, 2018)

STEP 3: MAKING METHANE GAS

- Put half of any size of the bucket with pig manure and the other half with water.
- Mix manure and water to have good mixture and pour through the funnel attached to the Outside Tank. About 20 buckets of this mixture to provide enough methane gas to lighten the stove *(see picture below)*.
- Once the methane gas is accumulated in the digester the top tank started to rise. Therefore, it is best to put bags of sand or bricks on top of the top tank as shown in the picture shown in step 2.

Figure 7: Beneficiary pouring animal manure into digester, Niutao Island

(Photo: Kaio Taula, 2018)

STEP 4: USING THE DIGESTER

- Liquid can be collected from the digester and used as liquid fertilizer for home food gardens like banana, sweet potatoes, vegetables, sugarcane, cassava etc.
- The dried manure in the digester can be used as fertilizer for the home gardens. The dried manure should not be used directly on the plants as it can burn the plant. It should be mixed with soil or added to the compost to quicken the breakdown of the compost.

2 A brick is used to hold methane gas down in the digester.

Section 3: Safety

3.1 SAFETY TIPS FOR THE USE OF THE UNIT

- The use of the stove is just like any other gas stove.
- This is safer to use, as when there is an outlet of gas, the explosion will not be fatal as only manure in the digester will be the outflow.

Section 4: Best Practices

4.1 LESSONS LEARNT

- This model of a biogas digester system only works for a one-burner stove.
- The base for the digester should be on top of the ground and not be dug down. This will ease maintenance.
- When the Inside Tank moves as methane gas is accumulated in the digester, it is advisable to put bags of sand on top of the Inside Tank. Also, it is best to use some measures to steady the Inside Tank when it tips to the sides e.g. wire fencing around the digester etc.

Figure 8: Boiling water using a biogas stove, Vaitupu Island

(Photo: Kaio Taula, 2018)

4.2 SUCCESS STORIES ON BIOGAS IN TUVALU

Biogas at the household level, had been practised in Tuvalu since 2009, and were installed, on the island of Nanumea with four units. This project was implemented and funded by Alofa Tuvalu which was a Non-Government Organisation (NGO).

Four years later in 2013, seven biogas units were installed on the neighbouring island of Nanumaga. The biogas units on Nanumaga were installed under the University of the South Pacific - European Union Global Climate Change Alliance Project (USP-EU GCCA). This was funded by the

European Union (EU) and implemented by the USP Pacific Centre for Environment and Sustainable Development (PACE-SD).

Here are some success stories on the use of the biogas units in Nanumea and Nanumaga islands in Tuvalu.

"No more smoke and I am cooking inside", says Lumepa, an elderly woman on Nanumea Island

One of the three households with biogas units on Nanumea were elderly people and they were so enthusiastic that they were cooking inside the house for the first time and do not have to collect firewood. Also, there was no smoke and easy to keep and more so they were using pig manure which was readily available on the island.

"I did not spend any money for cooking", says Setema on the island of Nanumaga

In March 2015 Cyclone Pam hit Tuvalu and most of the outer islands including Nanumaga were badly affected. Storm surges destroyed crops, trees and homes.

Two households with biogas units were interviewed by Radio Tuvalu several months after the cyclone.

Setema Alielu who was in his mid-sixties had this to say about the day after Cyclone Pam hit the island of Nanumaga, ***"Whilst my neighbours were looking for dried firewood for cooking breakfast, my family had already had breakfast as we cooked our breakfast from the biogas".*** He also added that during his son's 21st birthday he was cooking all the food from the biogas. He enthusiastically mentioned that he was using the biogas stove for cooking but it was different this time because according to him, ***"I did not spend any money for cooking"*** *(2014 Annual Report USP EU GCCA Project:p17).*

Figure 9: Seti Failauga, a beneficiary of the biogas system (Nanumaga Island)

(Photo: Teuleala Morris, 2016)

- Seti Failauga *(pictured above)* on Nanumaga island, who was in his mid-forties encouraged all households to go for biogas as it is easy to use and manure is a readily available resource which had done amazingly to his family. He added that he had been using the liquid fertilizer from the digester and had regular supply of beautiful pawpaw for his family.

Figure 10: Monitoring and evaluation activity, Nanumaga Island

(Photo: Teuleala Morris, 2016)

Foini Lafai *(pictured above in bluish dress)* who was in her early fifties and a neighbour to one of the recipients of the biogas units under the USP EU GCCA Project was interviewed by the Project In-Country Coordinator (ICC) *(pictured in a red top)* as part of the monitoring and evaluation of the project. Ms. Lafai said after seeing the cooking benefits from her neighbour, ***"I want a biogas unit as well for myself"***. She witnessed that her neighbour no longer spent long hours outside cooking toddy.

Ms. Lafai also added that before the biogas units were installed most people in the community on Nanumaga were sceptical about the project. However, after the project installed the biogas units and the community started seeing the benefits to those households with the biogas units, everyone on the island wanted one for themselves.

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