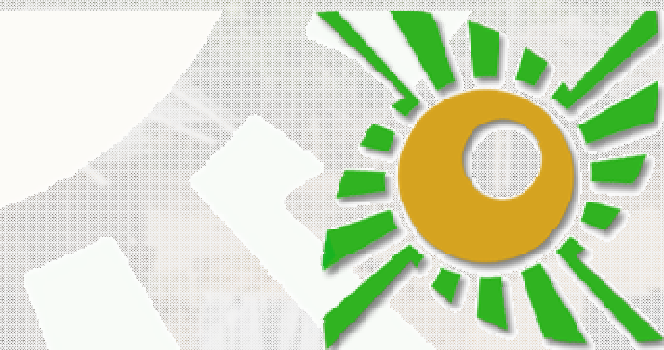


SIDS and Vanuatu Sustainable Energy for All Strategy




Village Infrastructure



Village Infrastructure

Making Energy
Affordable



SURVIVE
THIS
DRIVE

Summary

1. Summary of SIDS-related projects by VIA
2. Detailed project summary for Vanuatu
3. Design philosophies
4. Design tools and innovations
5. Results to date
6. Near term future plans

VIA Introduction

Village Infrastructure Angels is a not for profit company focused on investing in micro-infrastructure projects for villages in developing countries, primarily focused on energy and electricity access

The staff have been working in village energy for over 15 years and have helped over 2 million people in 30 developing countries gain access to modest amounts of electricity.

The wider VIA network includes investors, research institutions, supply chain and manufacturing experts, agro-processing specialists, technology entrepreneurs, capital-raising consultants, fund managers, and others with useful skills.

Summary of SIDS-related Projects

Ghana, 2012 - now

Client: Barefoot Power + G20

200 households of solar charging stations + solar DC minigrids for lighting & phone charging services, 3 year loans

Vanuatu, 2012 - now

Client: internal project supported by IRENA, Rotary, angels

200 households of solar charging stations + solar mills

Indonesia, 2012 - now

Client: Hivos

600 households of solar charging stations + solar mills

Honduras, 2012 - now

Client: internal project supported by Rotary, angels

200 households of solar charging stations

Liberia, upcoming project

Client: Mercy Corp and European Union

3000 households of solar minigrids and solar mills

Other projects:

Pacific SE4All Infrastructure Investment Fund Feasibility Study (ADB), household location mapping (various), mass design of minigrids for Master Planning rural electrification (various), Working Group Chair for Mapping for UN Foundation, Policy Advice for Water Pumping and Kerosene subsidies in India (World Bank), SE4All White papers on financing and development finance (Sierra Club), solar agro-processing mill technology development (IRENA)

Household Georeferencing Tool

Click on map and create marker

MOUSE POSITION x=647,y=556

lonlat => lon=9143821.0473628,lat=3408524.2175915

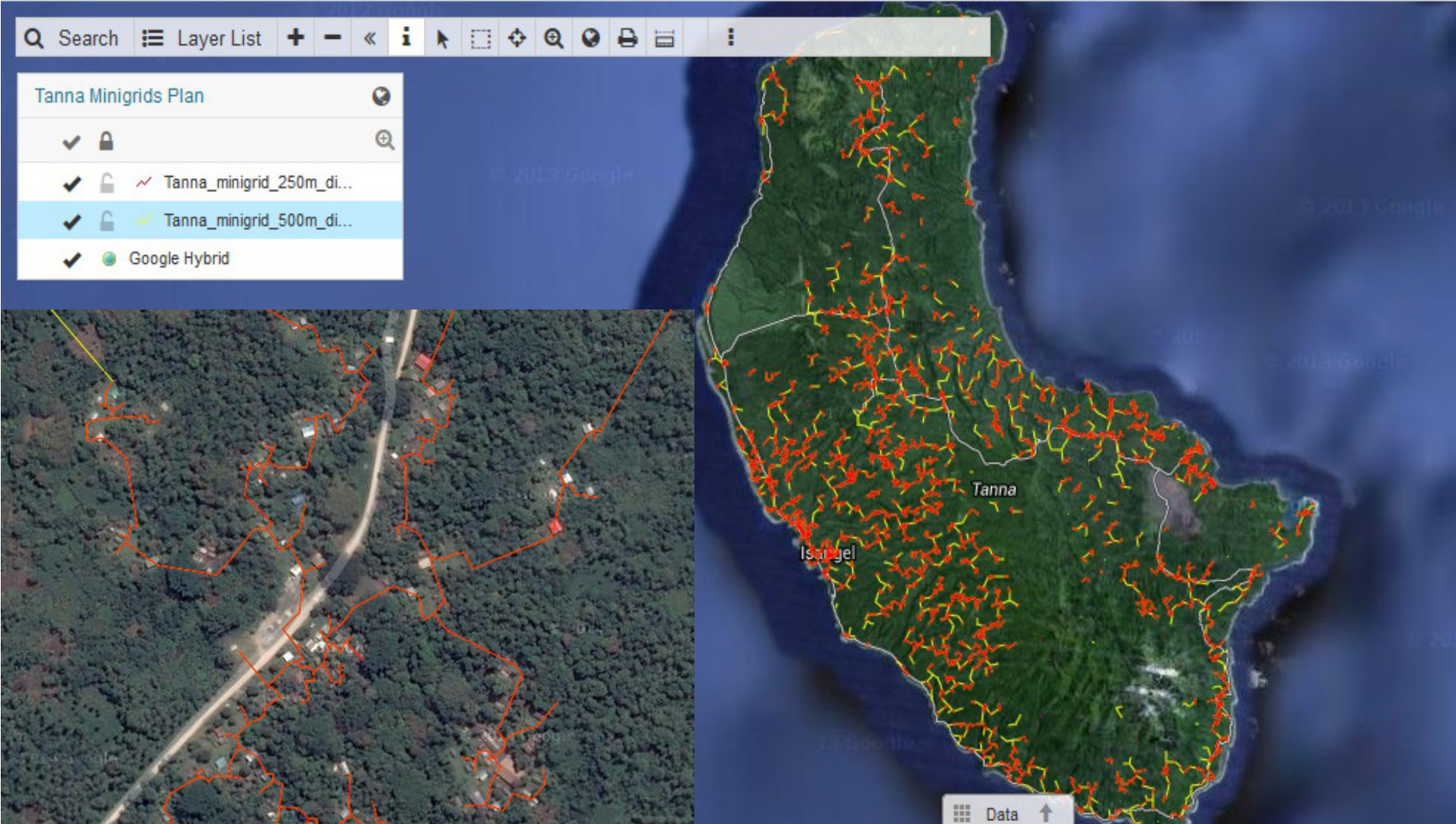
lonlatTransf => lon=82.14034203243176,lat=29.25799531993263

HouseCode	Latitude	Longitude
082137029258_1	29.257648994351364	82.13742915344233
082137029258_2	29.258107641490838	82.13756326389323
082137029258_3	29.258594366817874	82.13787976455568
082137029258_4	29.25905300971785	82.13853422355666
082137029258_5	29.258978129384396	82.13858250331847
082137029258_6	29.258964089316272	82.13874343585935
082137029258_7	29.258964089316272	82.13874343585935
082137029258_8	29.259324450464895	82.14016500663725
082137029258_9	29.259268290369395	82.14006844711272
082137029258_10	29.25942741056041	82.14001480293273
082137029258_11	29.259549090538492	82.1399987096782
082137029258_12	29.259638010431463	82.1396071071619
082137029258_13	29.25979713004644	82.13920477581017
082137029258_14	29.259867329798404	82.1389901990884
082137029258_15	29.260241727659764	82.1382660026549
082137029258_16	29.259661410390247	82.13837865543307
082137029258_17	29.259544410541867	82.13866296958847
082137029258_18	29.259572490517662	82.13841620635941

Vanuatu Lighting Project Location



New Map Map Properties Refresh Duplicate Map Delete Map Add Layer Import CSV or XLS Share or Publish Export Map Bookmarks



Technology Used

1-lamp kit
Sun King Pro



3-lamp kit
from Betta Lights

Agro-processing Project Location





threshing maize



pounding = grinding
corn/cassava or hulling rice



winnowing



grating cassava / yams



grinding flour



grating coconut

Mechanized offgrid agro-processing



Diesel

2-20 kW engines directly driving mills via belts

Consume 1-7 L/hour of fuel, costing \$1-7/hour, serves 200-2000 households at 200 kg/hr

1-4 hours/day operation means \$300-3000/year on fuel

Solar

0.2-2 kW solar systems drive mills directly or via batteries.

Panels \$1-2/watt = \$300-2000

Batteries 0-300Ah = \$0-2000

Controllers, other = \$100-500

Solutions can be delivered for \$500-5000 for 25-250 kg/hour, but may be slower than diesel

2-5 year paybacks on diesel



Project installations

Mills installed (target of 2 mills)

- 3 mills installed in Vanuatu
 - 2 in ACTIV main office at the end of Port Villa
 - coconut grater + flour grinder
 - offgrid villages next door can use to value-add and sell in urban markets
 - real-time energy metering installed on coconut grater, can see performance online
 - 1 in Tanna Island (West Tanna), a cassava grater
- 4 mills installed in Papua New Guinea
 - All at Malahang Industrial Compound, head office of PSS PNG
 - coconut grater + flour and feed grinder + rice mill + herb chopper
 - offgrid staff and industry area workers and nearby offgrid villages can use

Controlled conditions, not remote, for best feedback and visibility by stakeholders

Solar agroprocessing rationale

UN Target: "Access to Energy" for all by 2030

- Lighting + phone charging \neq "access"
Need more than 2-10W solar lamps/kits

Possible "Access to Energy" package:

- Residential, mostly night-time needs:
Lighting, phone charging, radio, fan and/or TV
 - Community/business, mostly day-time needs:
Refrigeration (especially for clinics), communications for market access, productive power for processing crops, carpentry, others?
- = "Tier 2+" service package
= 75-150 kWh/year/house, or 25-50W/house

Tiers of Energy Service

Supply side: Tiers based on attributes of electricity supply

ATTRIBUTES	Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
Peak Available Capacity (Weq)	-	>1	>50	>500	>2000	>2000
Duration (Hrs)	-	≥4	≥4	≥8	≥16	≥22
Evening Supply (Hrs)	-	≥2	≥2	≥2	≥4	≥4
Affordability	-	-	√	√	√	√
Formality (Legality)	-	-	-	√	√	√
Quality (Voltage)	-	-	-	√	√	√
Global Tracking for SE4All	No	Basic	Advanced			

Service side: Tiers based on regular use of appliances

Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
-	Task Lighting AND Phone Charging	General Lighting AND Television AND Fan	Tier-2 AND any low-power appliances	Tier-3 AND any medium-power appliances	Tier-4 AND any high-power appliances

Current view of "access to energy" is still uncertain, and current thinking is based on tiers of services.

However, very focused on consumers / households

- Does not account for**
- clinic needs for health
 - community mills
 - school equipment, comms
 - solar water pumping

and similar.....mostly community-scale needs.

Hence, "Tier 2+" suggested which includes these needs.

Opportunity of Productivity

Saving 1 hour/day for 250 million women globally that lack electricity

= 100 billion hours/year of productivity

= 50 million peoples' worth of 8-hour days

= entire workforce of the UK or France

by reducing energy-related time spent by women processing crops, fetching water and collecting firewood.....needs patient loan finance

Solar agro-processing recently recognized by

[AFD's Challenge-Climat \(http://challenge-climat.com/home/\)](http://challenge-climat.com/home/)

as one of top 12 global leading innovations for agriculture









Lighting Project History

Project History

- **Dec 12: 1st Lighting Loan starts (\$11k guarantee + \$10k work. cap.)**
- Mar 13: Reconnaissance field visit to find field partners
- **Jul 13: \$24k IRENA contract secured for capacity building**
- Sep 13: Field visit to show product samples, collect orders
- Oct 13: Products ordered, all household locations mapped on Tanna Island
- **Nov 13: Balance of investment secured (\$40k total work. cap.)**
- Dec 13 - May 14: Installation of 180-200 lighting kits (45 small + 135-155 large)
- **Apr 14: 2nd IRENA contract secured (\$45k) for solar agro-processing**
- Jun 14: Technical check and default management field visit
- **Aug 14: 2nd Rotary loan secured (\$10k) for solar agro-processing**
- Aug 14: Project audit and default management training
- **Sep 14 - now: preparation for scale-up from 200 to 2000 households**

Next field visit likely in May 2015

Investors include Rotary Melbourne and one angel investor

Lighting Project Financial Model

- \$200 installed cost per house - financed by Construction Investors (10-15%)
- \$3/week/house gross revenue for loan - financed by Lending Investors (0-10%)
- 3 year lending period = \$450/house gross revenue
- Gross profit = \$250 after capital repayment
- Operating costs per house
 - 10% profit to Construction Investors at refinancing \$20
 - 10% cost of making Kiva profiles \$20
 - 10% revenue share for loan collection partners \$45
 - Net project profit over 3 years \$165
- For 1000-2000 houses of loans in Vanuatu, \$165k-330k operating profit over 3 years is sufficient to run a small team costing \$50k-10k/year = breakeven scale

Access 2 Energy Power Stations

LIGHTING + PHONES

- \$150-200 cost per house for 3-lamp solar kit
 - \$2-8/month current expenditure = \$25-50/year
 - 2-8 year payback

**3-5 YEAR LOANS
MINIMUM
REQUIRED**

100 houses x \$175
+ \$2500 per mill
= \$20,000 / village

MILLING

- 3kW diesel
- 120 kg/hour, 200 kg/day
- 1 L/hr for fuel
- 500 hrs/year
- \$500 + 5x\$500 (@ \$1/L)
= \$3000 every 5 years
- 1kW solar
- 50 kg/hour, 200 kg/day (slower)
- no fuel, use long-life (LiFePO₄) batteries
- 1500 hrs/year (= sun-hours)
- \$1500 panels+\$300 mill+\$700 other
= \$2500 for 5-10 year life? longer?

- \$1 per 25-50 kg per family lasts 2-4 weeks, so \$12-25/year
- families need 2-3 kg processed per day, so can serve 70-100 houses
- \$12-25 / year x 70-100 houses = \$1000-2500/year gross revenue
- 4-5 yr payback if solar loan = \$500/year (fuel cos)t = 20-50% of revenue

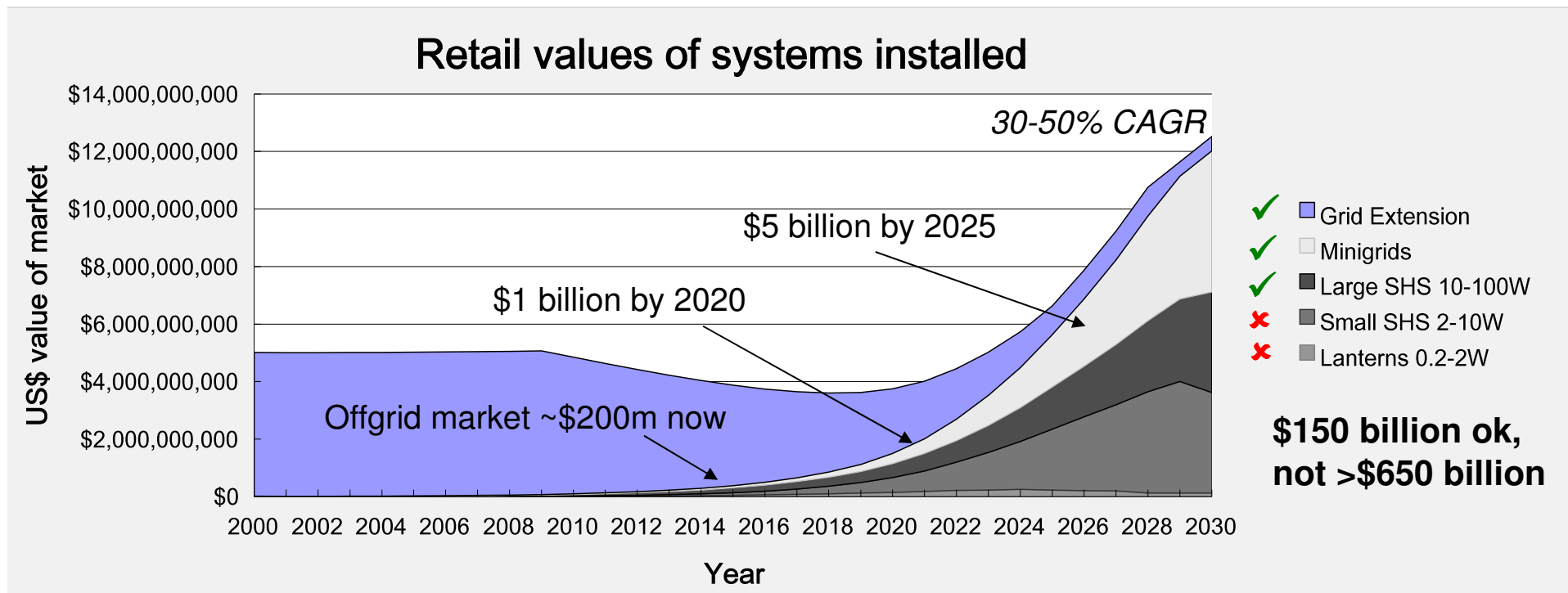
Delivering "access to energy"

as modeled by VIA, Sierra Club and Evan Mills (LBNL)

"Access" ≠ only lights and phone charging

2-4 1W LED lamps + phone + TV/fan (20-30W per house)
+ agro-processing (10-20W per house)
+ clinic refrigeration + comms/internet (2W + 1W per house)

Power = 30-50W / house **Energy = 45-75 kWh/year** vs IEA = 250-500 kWh/year



Capital Mobilization

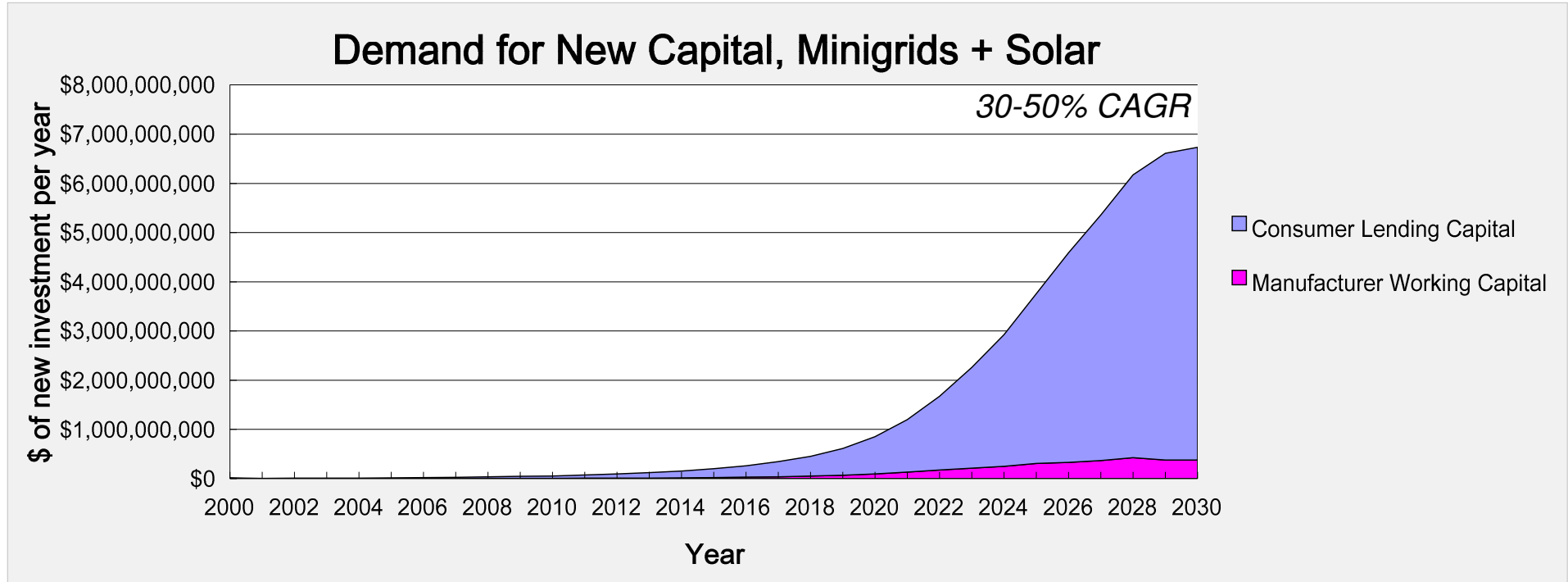
\$200-500 / house x 300 mill households (via 5-10 year loans)

= \$60-150 billion of lending capital to 2030

.....\$500 million required in the next 3-4 years

.....\$1 billion per year by 2020

....mostly debt, not equity....**start lending!!!**



Lighting Project Results

Technical

- No tech problems, products work well. Demand shifts 90% to larger 5-10W kits.

Social

- Charging station design re-arranged to solar home system by villagers due to inconvenience of having to charge every 2 days (ie. panels moved from operator back to households)
- OK for households who are paying promptly, but solar panels being removed from households who are not paying on time, and later, full kit will be removed

Financial

- 85% repayments by Households to Operators to date
 - West Tanna: 72%
 - North Tanna: 94%
- 99% repayment by Operators to West/North Regional Managers
 - West Tanna: 96%
 - North Tanna: 100%
- 58% repayment by Regional Manager to VIA (Target is 70%, 30% covers costs)
 - West Tanna: 77% OK, within target
 - North Tanna: 49% Outside target

**\$10,000
refinanced
on Kiva**

Solution: PAYG technology

Kiva refinancing

- VIA launched on Kiva May 2014
<http://www.kiva.org/partners>
- 0% 3-year loans from >100 investors =
"crowdfunding" at \$20-100 per investor
- Credit level raised from \$20k to \$50k in Sep 2014
- First \$10k of projects put on Kiva in mid 2014
Only took 3-4 hours per project to get financed
- Next \$40k of projects to be put on Kiva Apr-Jun 2015
- Aim is to increase to \$200k-400k in mid-late 2015



About Us

How Kiva Works

About Microfinance

Social Performance

Support Us

Field Partners

How to become a Field Partner

Village Infrastructure Angels

Approved to post Kiva loans from: Vanuatu

Kiva conducts regular, ongoing monitoring of all Field Partners, but only posts status updates here in response to relevant, major changes at the partner.

Partner Description:

Village Infrastructure is a for-profit social enterprise founded in the UK that brings together business angel investors and the poorest communities in developing countries. The organization makes solar energy affordable through energy loans of up to three years.

A unique lending approach:

Village Infrastructure loans on Kiva will be for citizens of the southern pacific island nation of Vanuatu.

FIELD PARTNER

[Learn more](#)



What to know about this partner:

Field Partner: Village Infrastructure Angels

Field Partner Due Diligence Type: Experimental Due Diligence

Field Partner Risk Rating: Non-Rated

Time on Kiva: 4 months

Kiva Borrowers: 46

Total Loans: \$9,250

Interest & Fees are Charged: Yes

Loan Characteristics On Kiva

	This Field Partner	All Kiva Partners
Loans to Women Borrowers	25.00%	74.20%
Average Loan Size	\$201	\$418
Average Individual Loan Size	\$0	\$656
Average Group Loan Size	\$2,313	\$1,828
Average number of borrowers per group	11.5	8
Average GDP per capita (PPP) in local country	\$0	\$3,427
Average Loan Size / GDP per capita (PPP)	0.00%	12.20%
Average Time to Fund a Loan	0.13 days	5.64 days
Average Dollars Raised Per Day Per Loan	\$1,549.47	\$74.19
Average Loan Term	37 months	10.36 months

0% default during 2015 thanks to Rotary guarantee

Average time to raise funds only 3-4 hours!!!!

Credit raised from \$20k to \$50k in Sep '14

RECENT SEARCHES

- ★ Village Infrastructure Angels
- ★ mill

Click ★ to save a search.

COUNTRY [Clear](#)



Ipai Village Group

Vanuatu | Personal Use | [Home Energy](#)

13% repaid

A portion of [Ipai Village Group's](#) \$1,975 loan helped a member to pay for [solar lighting systems](#).

\$0 to go

[Read their story »](#)

Loan amount: \$151.92 (per borrower)
Funding via Village Infrastructure Angels



Namasmitane Group

Vanuatu | Personal Use | Home Energy

13% repaid

A portion of Namasmitane Group's \$3,350 loan helped a member to pay for home solar lighting systems.

\$0 to go

Ipai Village Group

Ipai, Vanuatu | Personal Use | [Home Energy](#)

[LOAN OVERVIEW](#) [REPAYMENT SCHEDULE](#)



In this Group: Henry, Sam, Nakou, Charley, Alex, Natlman, Nancy, Mary, Merry, Claris, Marie, Leah*, Nawlapam* *not pictured

PAYING BACK

This loan has been fully funded!

A portion of Ipai Village Group's \$1,975 loan helped a member to pay for solar lighting systems.

13% repaid

[Find a Loan](#)

Repayment Term: 37 months (more info)
Repayment Schedule: Monthly
First Disbursement: Apr 1, 2014
Listed: Jun 3, 2014
Currency Exchange Loss: Possible

FIELD PARTNER [Learn more](#)



Village Infrastructure Angels administers this loan.

What to know about this partner:

Field Partner: Village Infrastructure Angels
Field Partner Due Diligence Type: Experimental Due Diligence
Field Partner Risk Rating: Non-Rated
Time on Kiva: 4 months

Energy Poverty keeps ~20% of the world's population living in the dark, lighting their homes with dirty, dangerous and expensive fuels like kerosene.

In the small Pacific Island state of Vanuatu, our organization along with our partners, have spent years helping households buy small [solar lights](#). Distributed through cooperatives and women's groups and sold for the same cost as a few months of kerosene, the lights have allowed work to continue beyond sunset. Families can keep businesses running and children can study while the health risks of breathing in kerosene fumes or getting burnt are no longer creating worry. Our field partners have sold [more](#) than 10,000 of these solar lights and have been a part of eradicating kerosene from close to 50% of the entire country.

Ipai Village Group

Ipai, Vanuatu | Personal Use | [Home Energy](#)

[LOAN OVERVIEW](#) [REPAYMENT SCHEDULE](#)

Show Advanced

	Expected Repayments	Actual Repayments	Comments
August 2014	\$164.62	\$164.62	✓ Repayment Received
September 2014	\$50.64	\$50.64	✓ Repayment Received
October 2014	\$50.64	\$50.64	✓ Repayment Received
November 2014	\$83.30	Available Nov 1	
December 2014	\$50.64	Available Dec 1	
January 2015	\$50.64	Available Jan 1	
February 2015	\$83.30	Available Feb 1	
March 2015	\$50.64	Available Mar 1	
April 2015	\$50.64	Available Apr 1	
May 2015	\$83.30	Available May 1	
June 2015	\$50.64	Available Jun 1	
July 2015	\$50.64	Available Jul 1	
August 2015	\$83.30	Available Aug 1	
September 2015	\$50.64	Available Sep 1	
October 2015	\$83.30	Available Oct 1	
November 2015	\$50.64	Available Nov 1	
December 2015	\$50.64	Available Dec 1	
January 2016	\$83.30	Available Jan 1	
February 2016	\$50.64	Available Feb 1	
March 2016	\$50.64	Available Mar 1	
April 2016	\$83.30	Available Apr 1	
May 2016	\$50.64	Available May 1	
June 2016	\$50.64	Available Jun 1	
July 2016	\$83.30	Available Jul 1	

Scale-up details

- \$200,000-400,000 budget for 1000-2000 households
- \$10,000 pre-installation investment to fund low cost project managers (PM) to live on Tanna for 3-4 mths during Jan-Jun 2015
 - prepare the next \$40k of Kiva profiles (photos, profile)
 - completing the "flip" of all pilot-scale investments to the crowd
 - reduce default issues, strengthen local capabilities
- \$100,000-200,000 cost of products from China
- +90-100% additional cost to install into villages
 - 5-15% international shipping (China to Port Vila)
 - 5-10% local clearance taxes, duties
 - 40-50% importer margin at Port Vila (capital of Vanuatu)
 - 10-15% local shipping (Port Vila to Tanna Island)
 - 20-30% local installation costs

Breakeven Analysis

- VIA makes 10% on the build, and 10% per year managing the assets (better than usual fund manager rates of 2-4%)
- Hence, needs \$1.5 million of assets built or managed per year to "breakeven" against \$150k/year of costs per asset manager, to stop needing to do consulting
- \$1.5 million at \$250/house installed
= 6000 households = 60 x 100-house village projects
- Targeting \$5-10 mill assets under management to support a 3-5 person team --> 20,000-40,000 households

Key Weblinks

- **House mapping service (first 1000 households mapped can be free)**
<http://www.developmentmaps.org>
- **Global SE4All Developers Atlas (500 layers, 2 million data points)**
<http://unmapper.developmentmaps.org>
username: UNMAPS password: maps2012
- **Minigrid mapping example, Tanna Island**
<http://editor.giscloud.com/map/309747/tanna-minigrids-plan>
- **Solar agroprocessing video (rough 1st cut draft only)**
<https://www.youtube.com/watch?v=dS60hV7QV0s&feature=youtu.be>
- **VIA / Sierra Club / LBNL paper on financing SE4All by 2030**
<http://content.sierraclub.org/press-releases/2014/06/new-report-reveals-clean-energy-solution-energy-poverty>
- **VIA project reports for IRENA on Vanuatu solar lighting + milling**
https://www.dropbox.com/sh/4z5b4hhc623c45j/AADAZLwOSzo5LbsHd_ojhv1a?dl=0

Further Information

Questions?

Please email
stewart@villageinfrastructure.org

Case Study - Cassava grating

Base Case

Manual cassava and yam graters are used 15-30 mins/day are used across the Pacific, at a rate of around 5 kg/hour. During large festivals, up to 30 women process 200-500 kg over many hours.

Solar solution

A 2/3 hp (500W) electric drill has a grating attachment added, or more sophisticated graters can be purchased, that can process up to 150 kg / hour serving 75-150 households with 1 hour of use per day.

3 x 80W solar panel for 1 hour/day use	= \$250-350
1 x electric grating machine	= \$100-200
1 x 40Ah battery for 1 hour/day use	= \$ 80-150
1 x 2000W Whistler Pro inverter	= \$150-250
Controller, wires, other	= \$ 20-50
TOTAL COST	= \$600-1000

If paid in cash, \$0.05/kg generates \$7-8/hour revenue

If paid in kind, one \$10/house/month local handicraft can be exchanged for supply of the service, and sold

Revenue = \$1000/year, 1-2 year payback possible



Case Study - Coconut Grating

Base Case

In South-East Asia, freshly grated coconut is available in local markets as well as whole coconuts, whereas in the Pacific, only whole coconuts are available. Peri-urban households can grate coconut for time-poor urban housewives or restaurants.

Solar solution

A 1/4 hp (175W) electric coconut grater can process up to 50 nuts per hour (typically 10-20 nut), producing 250g of grated meat per nut or 2.5-10 kg per hour.

1 x 80W solar panel for 1 hour/day use	= \$100-150
1 x 175W coconut grater with DC motor	= \$100-200
1 x 24Ah battery for 1 hour/day use	= \$ 50-100
Controller, wires, other	= \$ 0-50
TOTAL COST	= \$250-500

Whole coconuts sell for \$0.10 each while one 500g of coconut milk (1 nut worth) sells for \$1, so the selling price of grated coconut is set at \$0.25 per nut (250g).

Profit = \$0.15 x 20 nuts/day = \$3/day = \$1000/year
Of this, \$0.05/nut is charged for mill use = \$1/day
Hence, 1-2 year payback possible



Case Study - Coconut Oil

Base Case

Coconut oil can be used to displace fuel in remote islands, or as a cooking oil, or for other uses. It is usually made in centralized mills, and villagers supply dried coconut meat (copra). Small scale oil expelling may also be possible to add local value to this crop.

Solar solution

A 1/4 hp (175W) electric coconut grater can process up to 50 nuts per hour (typically 10-20 nut), and a 150-500W oil expeller can produce 3-5 L/hour.

1 x 150W solar panel for 1 hour/day use	= \$150-250
1 x 175W coconut grater	= \$100-200
1 x 150W electric cold oil press	= \$400-600
1 x 40Ah battery for 1 hour/day use	= \$ 80-150
1 x 2000W Whistler Pro inverter	= \$150-250
Controller, wires, other	= \$ 20-50
TOTAL COST	= \$900-1500

Coconut oil value \$1-5/litre, depending on use.

Production = 4 L/day x 250 days/year = 1000 L/year

Gross revenue \$1000-5000, payback period <2 years

