Community Power Corporation

Energy Systems for Sustainable Development

Lessons Learned About Sustainable Rural Energy Services Using Renewable Energy

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President
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James Wolfensohn, president of the World Bank recently explained what the Bank has learned about what poor people in developing countries want:

"In the Voices of the Poor study, where we interviewed 60,000 people in 60 countries, we asked them what was the number one thing they wanted. They said technology and information, they didn't say food, they didn't say charity. Poor people know as well as anybody else that what keeps them poor is lack of competitiveness and lack of knowledge."

The primary key to access to technology and information is: **Electricity**

Community Power Corporation
Capability & Experience

Product Development

Modern Facilities

Experienced Staff

New Products

BioPower Systems

Pre-payment Meters

Rural Development

Rural Electrification

Feasibility Studies *Energy Services Companies*

Rural Enterprises

Product Engineering *Manufacturing Processes*

Community Power Corporation Mission & Focus

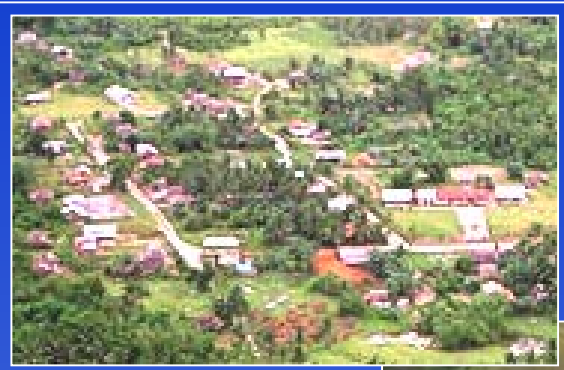
- CPC develops and provides advanced, renewable energy-based power systems to support sustainable rural development throughout the world.

- CPC is a leader in the development of small modular biopower systems for Distributed Generation applications

CPC Experience

Australia, Papua New Guinea, Mexico, Indonesia, Philippines, Mozambique, Brazil, India, USA

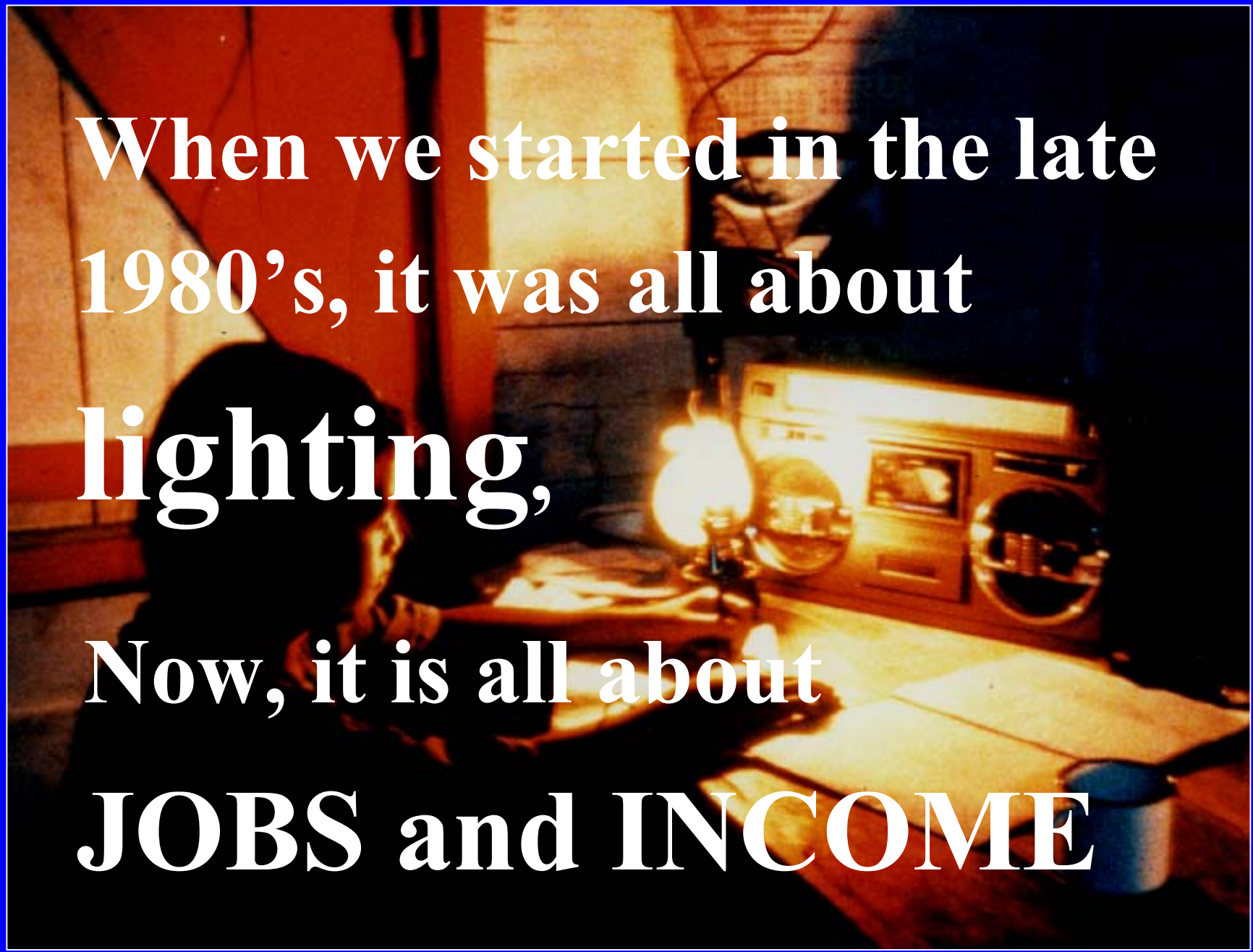
CPC's Field Surveys
Establish Basis for Design of Village Power Projects



India & Mozambique

Philippines & Indonesia

Papua New Guinea & Mexico


When we started in the late 1980's, it was all about
lighting,
Now, it is all about
JOBS and INCOME

Primary Electrification Options

Battery Charging

Small Genset

CPC Solar Home Systems

(Indonesia)

CPC Solar Home Systems
(Indonesia)

A Few of CPC's Pioneering Rural Electrification Projects

PV-Diesel Hybrid
Maria Magdalena-Mexico

Biopower System (Coconut Shells)
Alaminos - Philippines

UtiliMeter – Alaminos
Philippines

PV-Wind Diesel Hybrid
Nusa Penida - Indonesia

PV-LPG Hybrid
Alaminos - Philippines

PV-Solar Home Systems
Lampisi - Indonesia

Rural Enterprise – World
Bank - Philippines

Biomass Residues:
Typically A Wasted Opportunity For Power

Agricultural Residues: A Powerful Source of Energy In Developing Countries

Residue Coconut Husks & Shells in the Philippines

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Energy Systems for Sustainable Development

CPC's Product Development Facility

Littleton, Colorado USA

Small Biomass Power Is Ideal For Rural Enterprises

- Provides “utility-grade” power
- Power for manufacturing and communities
- Locally owned and sourced residue fuels
- Much lower cost and more reliable than PV or wind

Small BioPower Can Support Productive Loads

Thermal

- dryers
- cold rooms
- freezers
- boilers
- purifiers
- distillers
- cookers

Mechanical

- grinders
- saws
- mills
- lathes
- pumps
- fans
- generators

Electrical

- motors
- compressors
- pumps
- heaters
- air conditioners
- computers
- phones

CPC's Team to Develop the BioMax

NREL (DOE)

Shell Renewables & Foundation

US FOREST SERVICE

California Energy Commission

BioMax - Small Modular Biopower System

An Alternative to Diesel Generators

- 5 to 100 kW Power
- 45 lbs/hr wood @ 15kW
- Fully Automatic
- Environmentally Friendly
- Combined heat & power

First, fully automated, modular biopower system to use forest and agriculture residues to produce electricity and heat for rural enterprises and communities. No liquid effluents or toxic wastes.

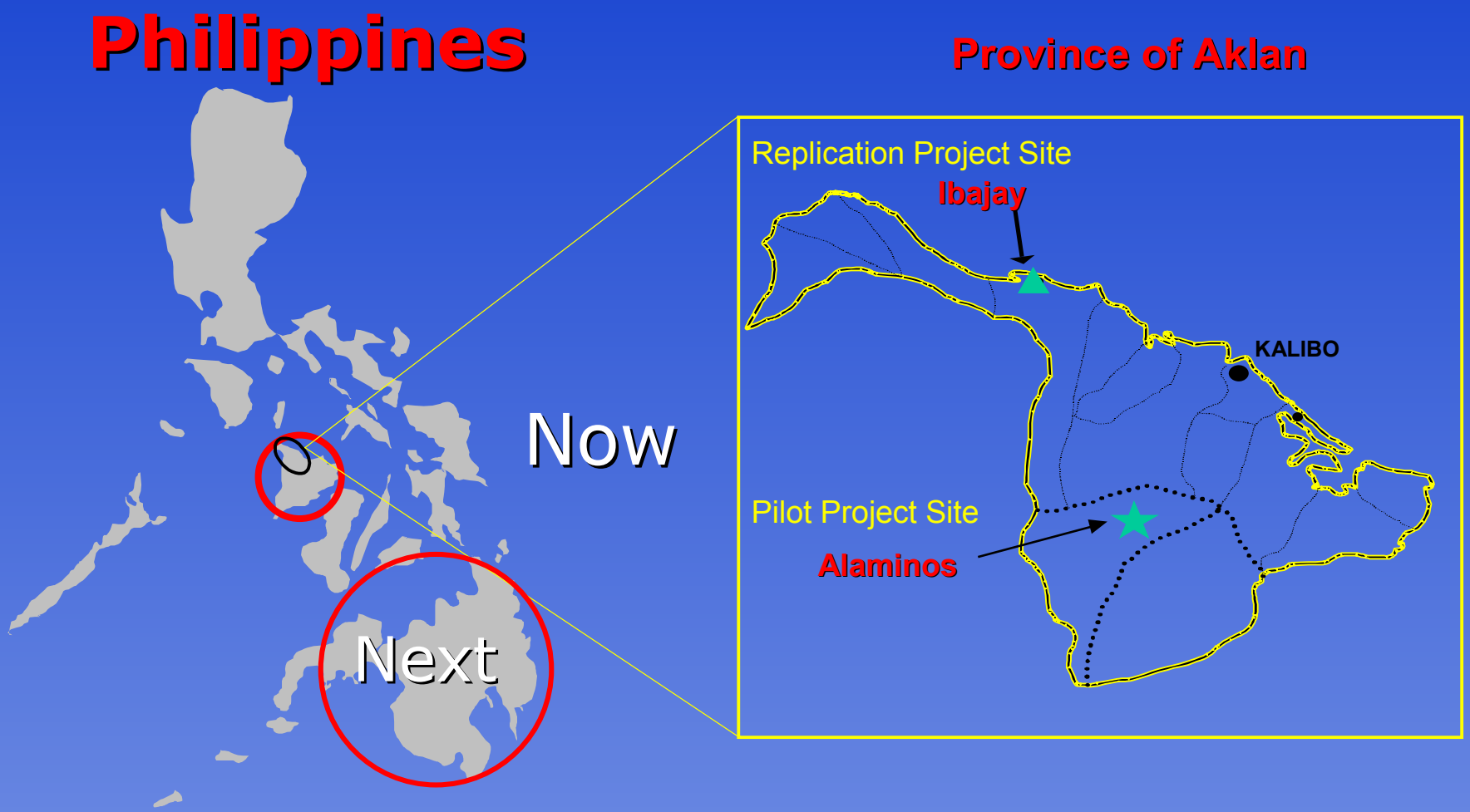
CPC's BioMax System: A Versatile Bioenergy Platform for Different Prime Movers

BioMax Bioenergy Platform

Converts forest/ag residues to a gas capable of operating a variety of power generation technologies

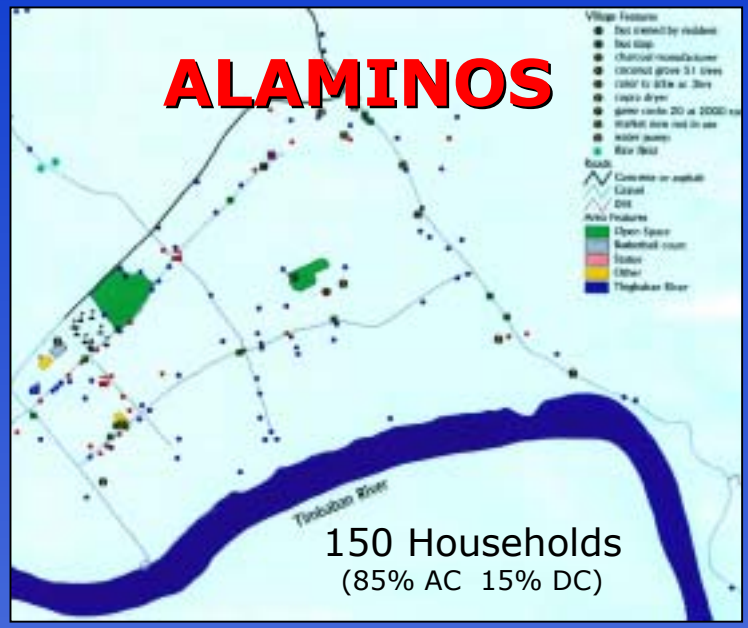
- IC Engines ✓
- Stirling Engines ✓
- Fuel Cells ✓
- Microturbines — New Project Using Capstone Microturbine

CPC Projects in the Philippines



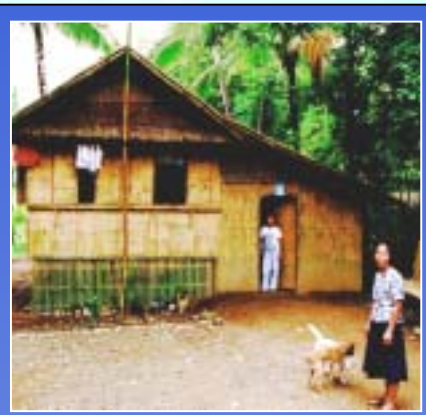
World's First Integrated Rural Energy Services Community
A Pioneering Project by CPC and Shell Renewables

Main Street Alaminos



Alaminos Family

BioMax Power System



Typical House

Vast Resource of Unused Coconut Shells

PV Hybrid Power System Alaminos

220 V AC 24 Hour Power Clean & Green

CPC'S Prototype BioMax-15 Installed in Alaminos, Philippines

Small Modular Biopower for Village Power and Productive Uses

- 15 kWe
- 3 Phase, 220 VAC
- Fuel: coconut shells
- Fully automated
- Powered 80 homes
- Powered 10 hp motor at small coconut mill
- Used engine heat to dry copra
- Generated 1 MWh during 10 day endurance run

SN #1 - Alaminos, Philippines

CPC's New UtiliMeter™ Dispenses Electricity Service and Ensures Collection of Customer Payments

- Customer pre-pays for electricity service with "electronic power key"
- Makes commercial sale of renewable energy feasible for rural electrification applications (market driven, fee-for-service)
- Simple technology solution to socio-political and practical barriers to sustainable R. E. projects (cost recovery)
- Encourages increased investment in R. E. projects by securing revenue
- Reduces cost of R. E. power system

CPC's UtiliMeter™

Customer with Fan and UtiliMeter

Customer Entering Electricity Credits

CPC Established a Community-Scale, SMB Powered, Coconut Products Enterprise in the Community of Alaminos, Philippines*

*Funding provided by Shell Foundation

Power From the Small Modular Biopower System Supports New Rural Enterprises in Alaminos


the
ASIAN
INNOVATION
AWARDS
2001
BIOMAX
SILVER
WINNER
Art Lilley
Robb Walt
Community Power Corp.
FAR EASTERN ECONOMIC
REVIEW
In association with
Brain Power.
ABB
DOWJONES

CPC's World Bank Development Marketplace Project

(Aklan, Philippines)

- Establish Center for Productive Uses of Renewable Energy (C-PURE)
- Develop applications for renewable energy that make a direct positive impact on the local economy.
- Provide technical assistance to rural enterprises to increase their economic performance by using renewable energy.

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Energy Systems for Sustainable Development

Lessons Learned About Sustainable Rural Energy Services Using Renewable Energy

From CPC's experience in the following countries:
Australia, Papua New Guinea, Mexico, Indonesia, Philippines, Mozambique, Brazil, India, USA

Project: Coconut Island

Country: Australia

Type: Government Agency
Free Service

Technology: PV/Diesel Hybrid

Size: 50 Homes

Key Lessons Learned:

- **Free electricity caused rapid and excessive load growth**
- **Without demand side management, a few customers use most power**
- **Lack of load management caused system to be 100% diesel in one year**
- **Politically motivated project not sustainable – no motivated ownership**

Conclusion: Customers must pay reasonable price for electricity and customers' peak loads must be managed.

Project: Maria Magdalena

Country: Mexico

Type: Government Utility
Regulated Tariff

Technology: PV/Diesel Hybrid

Size: 53 Homes

Key Lessons Learned:

- **In- factory, modular assembly makes on-site installation simple**
- **Very low subsidized cost of electricity caused rapid in crease in loads**
- **Lack of load management caused system to be 100% diesel in one year**
- **Utility ownership created fatal barrier to commercial sustainability**

Conclusion: Without commercial drivers, or realistic fees for service and load management, PV hybrids are not economically sustainable

Project: Nusa Penida

Country: Indonesia

Type: Government Utility Regulated Tariff

Technology: PV/Wind/Diesel Hybrid

Size: 96 Homes

Key Lessons Learned:

- **Technology demonstration objective and government ownership created huge barriers to economic sustainability**
- **Site-built buildings caused delays and high cost**
- **Very low subsidized cost of electricity caused rapid increase in loads**

Conclusion: Without commercial drivers, or realistic fees for service and load management, PV/wind/hybrids are not economically sustainable

Project: Alaminos

Country: Philippines

Type: ESCO, Fee-For-Service

Technology: PV/LPG Hybrid & Small Modular Biopower

Daily Fixed Energy Level & Pre-payment meters

Size: 93 Homes

Key Lessons Learned:

- **Consumers will pay far more than regulated tariffs**
- **First 300 watt-hours of service is most highly valued in households**
- **To increase "business density", provide different types of service for each type of customer**
- **Pre-payment and demand side management is critical for success**

<u>Conclusion</u>: ESCO model provides best chance for long-term success and sustainability

Project: Lampisi

Country: Indonesia

Type: ESCO,
Fee-For-Service

Technology: PV-SHS

Size: 40 Homes

Key Lessons Learned:

- **Business model based on imported PV modules is very risky**
- **12 V DC power does not meet consumer demand**
- **Consumers will pay far more than regulated tariffs**
- **ESCO model did provide necessary O&M to meet customer needs**

Conclusion: PV-SHS projects are extremely risky due to high forex cost and inability to meet customer demand for increased power .

Conclusions: Lampisi Final Report

1. PV-Solar Home Systems operated under a RESCO model with local service capability produces a high level of customer satisfaction - initially.

2. The RESCO model using a cooperative to collect revenues has worked very well in Lampisi.

3. Customers paid on time.

4. If adequately informed, most customers appreciate the need for energy conservation and take pride in doing so.

5. The SHS must give the customer accurate information as to the status of the system - especially regarding the amount of daily energy provided and used.

Conclusions: Lampisi Final Report

6. Low voltage disconnects during evening hours (7-10pm) cause significant dissatisfaction. An early warning system is required.

7. The hiring and training of persons from the community to be the Customer Service Representatives (CSR) worked very well.

8. Word of mouth in a community is very strong - whether the message is good or bad.

10. The PV-Solar Home System, operated under a RESCO model is an appropriate technology for large-scale electrification of remote households - providing the customers' requirements for daily energy are in the 100-300 Wh/day and there is no requirement for AC power.

Probability for Sustainability*
Renewable Energy-based Rural Electrification Projects

Reason For Doing Project	Probability for Sustainability ?	Probability for Economic Success ?
Technology Demonstration	Low	Very Low
Utility Expansion	Good	Very Low
Community Owned	Low	Low
Government Agency Project	Low	Low
Private Individual	Medium	Possible
Commercial ESCO	High	High

* Based on CPC's experience in Australia, Mexico, Indonesia, Papua New Guinea, India and the Philippines

Key Factors for Sustainability*

#1: Project is designed and managed to achieve economic payback

#2: Power system capacity matches consumer demand

#3: Fees for energy service are market driven

#4: All potential customers are provided service

*** Based on CPC's experience in Australia, Mexico, Indonesia, Papua New Guinea, India and the Philippines**

Key Factors for Sustainability*

#5: Consumers must purchase electricity service in advance

#6: Owner is commercially driven Energy Services Company

#7: Power system delivers utility-grade power

#8: Demand Side Management technology is used to allow flexible fees based on classes of service

*** Based on CPC's experience in Australia, Mexico, Indonesia, Papua New Guinea, India and the Philippines**

Major Pitfalls To Sustainability*

(Rural Electrification Projects Using Renewable Energy)

#1: Project is technology-driven, not service driven

#2: Regulated, highly subsidized tariffs, not market driven

#3: Owner/operator of power system is not commercially driven

#4: Customers' needs and ability to pay for power is not met

*** Based on CPC's experience in Australia, Mexico, Indonesia, Papua New Guinea, India and the Philippines**

Major Pitfalls To Sustainability*

(Rural Electrification Projects Using Renewable Energy)

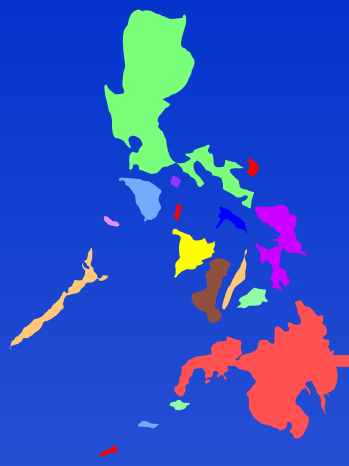
#5: Power system capacity does not match demand for power

#6: Power is not useable for income generating purposes

#7: Conventional billing and collections system is used

#8: Large number of potential customers not served

*** Based on CPC's experience in Australia, Mexico, Indonesia, Papua New Guinea, India and the Philippines**



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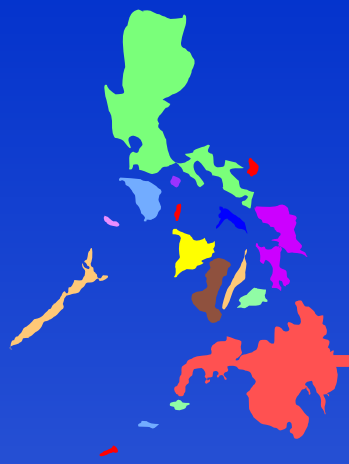
Energy Systems for Sustainable Development

30 Lessons Learned: Village Power Projects

1. Financial sustainability and income generation must drive design
2. The priority needs of paying customers must be the focus/basis for design
3. Any requirement that regulated tariffs must be used is a non-starter
4. Determine and serve customers' high value uses of electricity
5. Base fees for electricity on customers' willingness and ability to pay and commercial sustainability.
6. Any subsidy must be one time and up front
7. Productive (day or nighttime) use of power must be given high priority – income generation is critical to success.



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Energy Systems for Sustainable Development

30 Lessons Learned: Village Power Projects

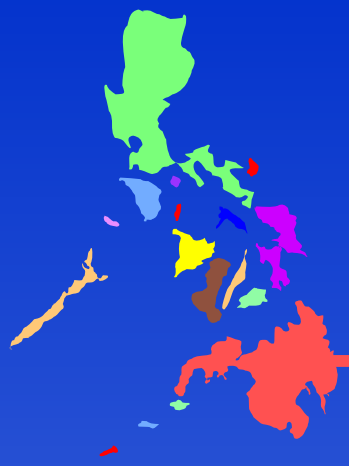
8. Use a private RESCO model for ownership, operation and maintenance. Community or local government ownership most always fails.

9. Do not depend on villagers for maintenance – use RESCO personnel.

10. Match power systems capacity with initial need for power. Load growth is slow.

11. Use power system technologies that best meet customers' needs for power and energy.

12. Use most abundant and economical, locally available energy resources. (Be wary of "technology pushes".)



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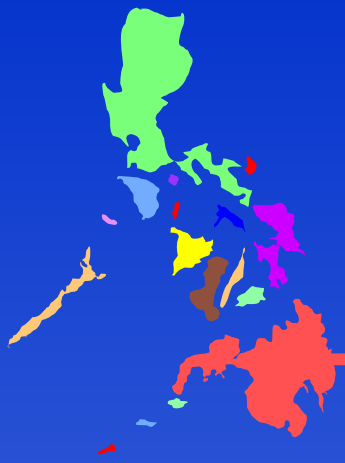
30 Lessons Learned: Village Power Projects

13. For compact communities use a central power system with a low voltage (no-transformer) distribution system.

14. For central AC electricity, most economical power is micro-hydro, then small modular biomass, then PV/LPG hybrids, then PV. Only in very rare cases would a wind/hybrid system be viable. Resource availability, needs, and ability to pay for peak power and energy drive this hierarchy

15. Use multiple R.E. technologies to lower costs and increase customer base and revenues



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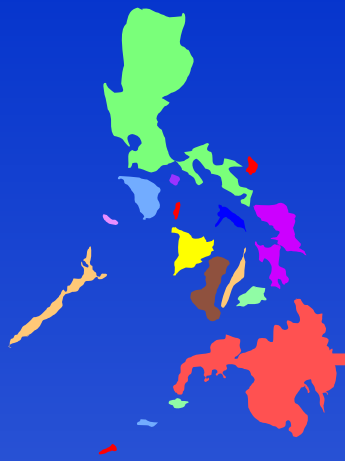
30 Lessons Learned: Village Power Projects

16. For scattered and individual homes use PV solar home systems
17. The "RESCO" must have a commercial incentive to operate and maintain the power systems.
18. All levels of government must support and encourage private investments in RESCOs
19. Use a pre-payment meter to ensure effective, low cost, receipt of customer payments
20. Local market forces must be allowed to work



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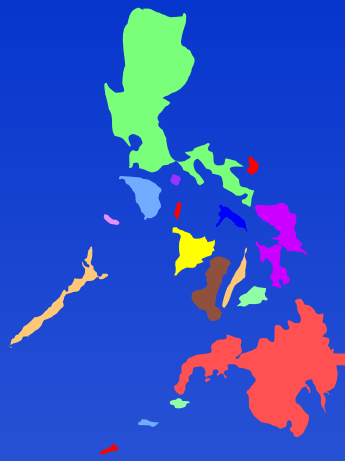
30 Lessons Learned: Village Power Projects

21. RESCOs require patient capital, a stable environment
22. Do not use barriers, such as high connection fees, to hinder customer connections Village leaders must be strong supporters of the project
23. Customers should pay for their own wiring and fixtures
24. Any customer that tampers with the payment meter must be immediately disconnected --- high penalty fee to reconnect
25. The conventional utility paradigm of "build & grow" does not work



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30 Lessons Learned: Village Power Projects

26. Distribution systems must be locally owned

27. Grant aid projects ruin commercial markets and drive away investment

28. Economies of scale must be possible

29. Encourage and support productive uses of electricity

30. Think and act big