# RAPS Village Power System -- Technology Description

Presented by

*Douglas R. Danley*

**Orion Energy Corporation**

**Frederick, Maryland USA**

**www.orionenergy.com**

**in cooperation with**

**ILZRO RAPS Peru**

# The Need for Rural Electrification

- Electricity is needed for :
  - Community services -- schools, health posts, etc
  - Telecommunications and Internet access
  - Household uses
  - Commercial uses
  - “Productive” uses such as craftspersons, light manufacturing, refrigeration, boat /vehicle repair
  - Public lighting and community centers

# Technology Choices

- Grid Extension -- expensive or not possible, especially for small loads
- Prime Diesel Generators -- typically5 hrs per day
- Solar Home Systems -- Very limited energy
- RAPS systems -- 24 hr power but more costly and complex than diesels
- Other technologies -- wind, hydro, biomass

# RAPS Technology

- Complete generation system provides utility grade AC power for 24 hours per day
- Battery-based “hybrid” system uses solar, wind and diesel generator
- Diesel generator provides half the energy, but only runs about 12% duty cycle
- Can be expanded to incorporate wind, micro-hydro and advanced technologies such as fuel cells and micro-turbines

# Typical RAPS Sizes

- Apex$^{tm}$ - 6 to 18 kWh per day. Used for core village services or dedicated load. Self-contained in 1.4m x 1.4m x 2.6m shelter
- RAPS-60 -- 60 kWh per day for general electrification. Serves 500-800 people. Fits in single ISO shelter.
- MHPS -- 120 to 600 kWh per day. Serves villages up to 8,000 people. Modular system for easy implementation.

# Apex Mini Hybrid

# RAPS Advantages

- 24 hour power enables productive use and communications (Internet) applications
- Dramatically reduced fuel consumption and maintenance vs. Prime Diesels
- Reduced pollution and greenhouse gas emissions
- Prepayment metering system insures revenue collection
- Remote monitoring is included for efficient maintenance operation

# Peru RAPS Project

- Pilot Project involves installation of RAPS in two villages in Loreto, Peru
- 90 kWp of PV Modules
- Indiana has 5K population and estimated energy use of 600 kWh per day
- Padre Cocha has 2.5K population and estimated energy use of 300 kWh per day
- Installation starting in May/June 2001
- Developing business plan for "Replication Phase"

# Technology Overview

- Flexible Design uses 150 kWh “modules”
- Indiana has four modules,
- Padre Cocha has two modules.
- Basic components are:
  - System battery
  - PV Array
  - Control and power electronics
  - Diesel generator
  - Equipment shelters

# System Battery

- Battery must have deep cycling, low maintenance, and long life
- We have chosen Energel from Battery Energy South Pacific, based on specifications, cost and technical support
- Estimated 8-10 years life with daily PSOC operation and periodic equalizations
- Estimated 48 metric tons of batteries
- Batteries will be recycled after end of life

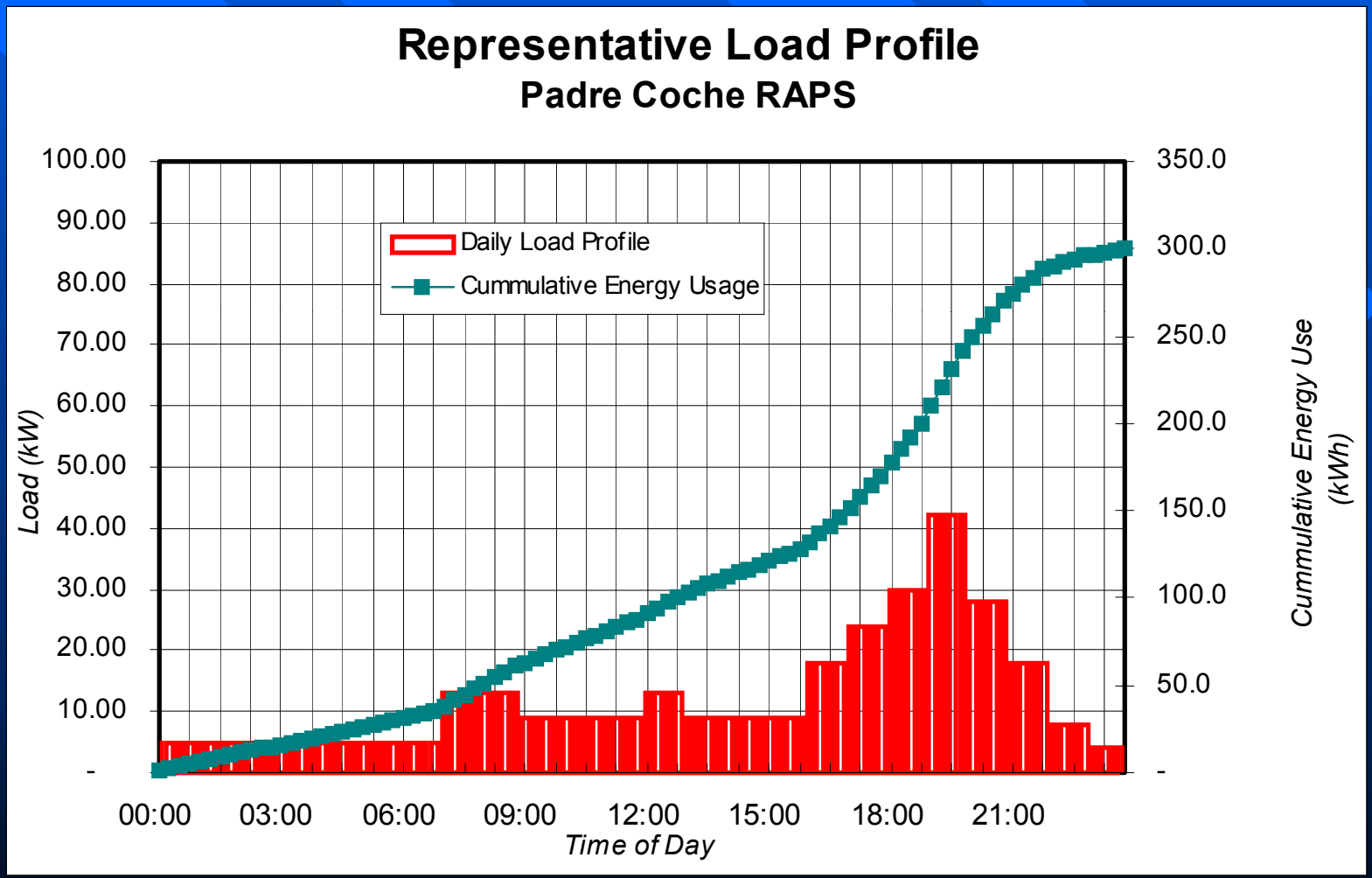
# Control and Power Electronics

- Modular Microprocessor Control System
- Inverters are 50 kVA, with 200% surge
- Inverters use IGBT and have sine wave output
- IGBT battery chargers will implement advanced battery charge algorithms based on work being done under IGP

# PV Array

- Approximately 60 kW of PV at Indiana and 30 kW at Padre Cocha
- Crystalline PV from BP Solar
- Elevated array structures optimized for annual energy capture
- Array also acts as shade for equipment and battery shelters

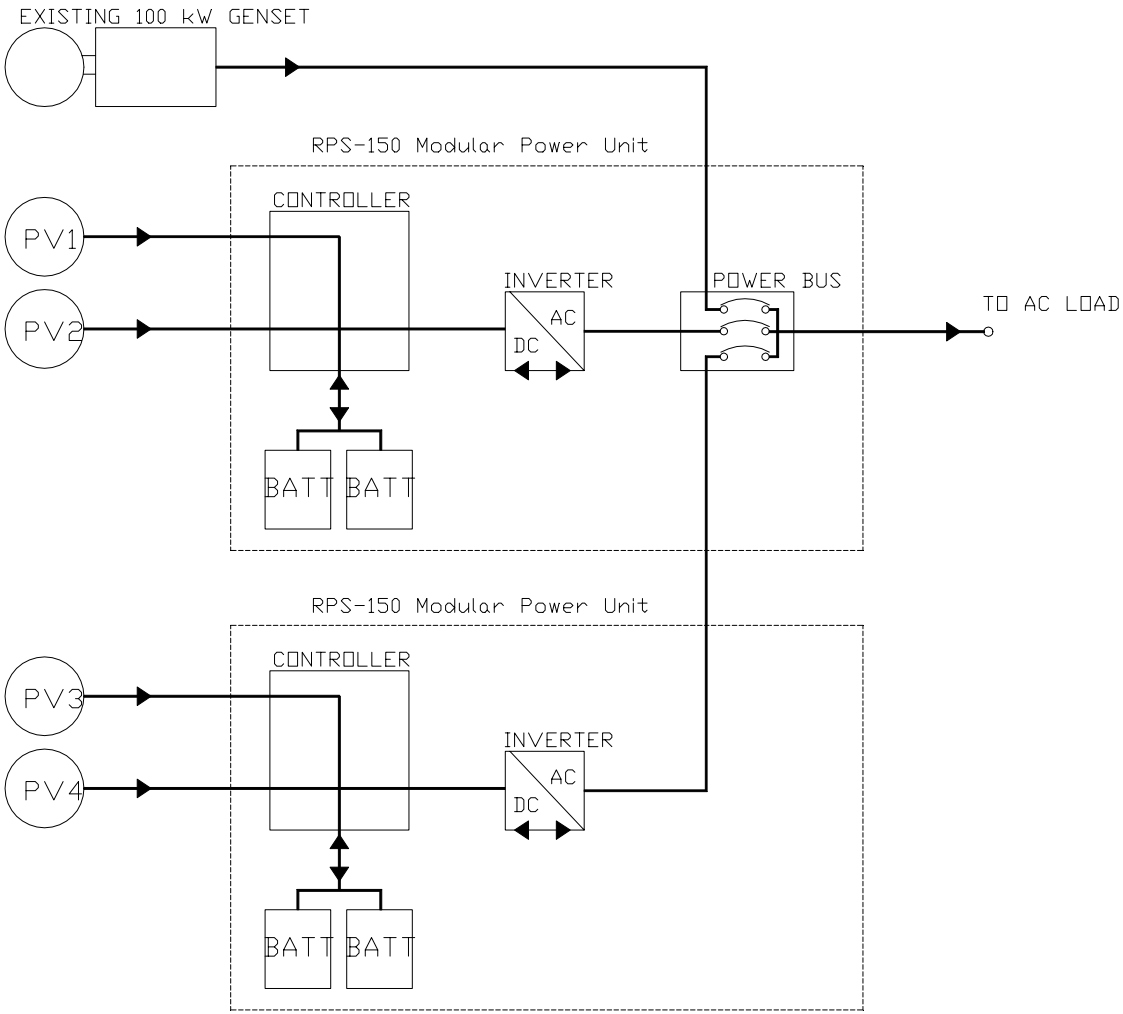
# Typical Load Profile



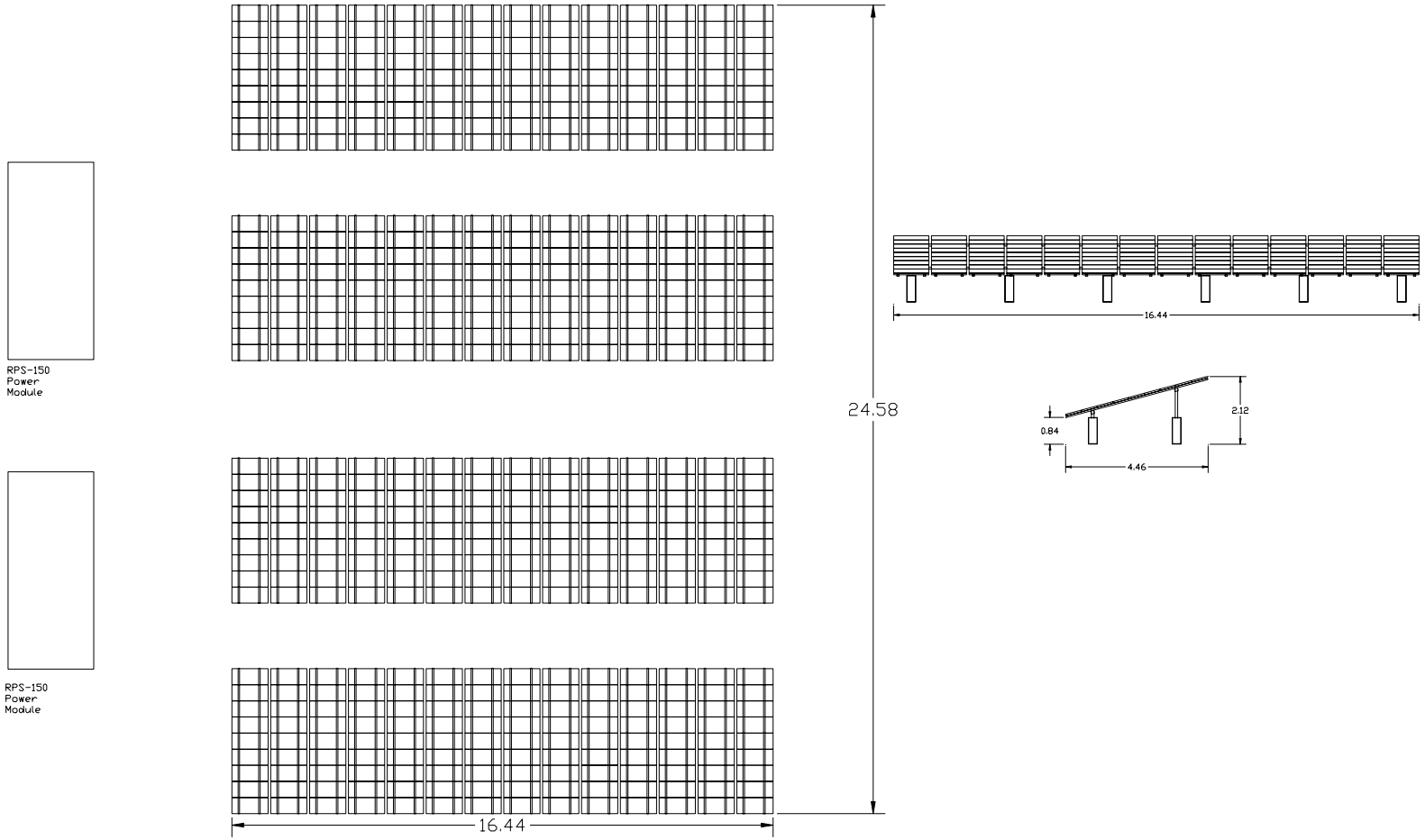
# Estimated Energy Usage

- Residential Loads -- 62%
- Commercial Loads -- 8%
- Productive / Industrial Loads -- 15%
- Institutional Loads -- 15%

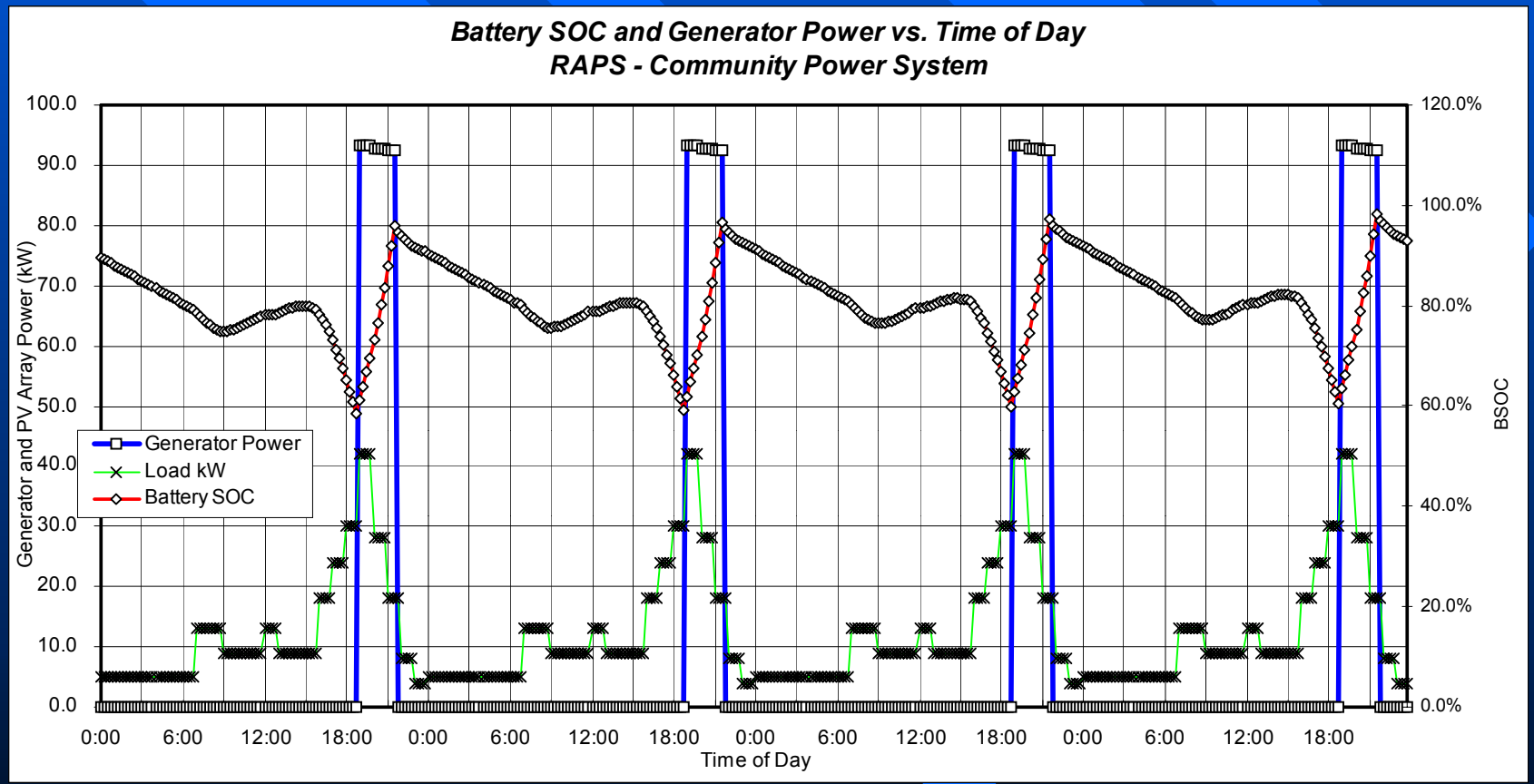
# Typical Hybrid System Configuration - Padre Cocha



# System Layout -- Padre Cocha



# Typical System Operation - Padre Cocha



# Typical Performance - 300 kWh/d System

| ***Hybrid System*** | per day | per year |
|---|---|---|
| *Run Hours* | 2.75 | 1,004 |
| *Fuel Consumption* | 89.8 | 32,784 |
| *Load Ah/d* | 1,326 | - |
| *PV Ah/d* | 458.2 | - |
| *PV % Load* | 35% | - |
| *DEG % Load* | 65% | - |
| | | |
| ***Prime Diesel*** | | |
| *SA Hrs* | 24.0 | 8,760 |
| *SA Fuel Consumpt.* | 369 | 134,515 |

# Manufacturing / Installation Plan

- First unit built in USA
- Subsequent units assembled and tested by Orvisa and SIMAI in Iquitos
- Core units fully tested before shipment to the sites
- Plan to use willage labor to assist with installation tasks
- Installation scheduled for third quarter ‘01

# Maintenance

- Systems are fully automatic
- Primary maintenance is for generator at approximately three month intervals
- System lifetime is 20-25 years, with replacement of batteries at 8-10 year intervals
- Generator operates only 1,000 hours per year, so life is 20 years or more.

# Remote Monitoring

- RAPS Systems include integral remote satellite monitoring for maintenance purposes
- Satellite will be INMARSAT (Mini-M)
- Primary purpose of monitoring is for efficient scheduling of maintenance visits and verification of revenues.
- Will also include intensive monitoring of batteries to validate advanced charging algorithm.

# Customer Metering

- Each customer connection will include a prepayment meter, which will also include energy limiting as necessary.
- Customers pay for “PowerKey”-- a “smart card” that stores pre-payment information, as well as information about energy limits and payment terms. This card can be customized to meets specific energy constraints and tariffs.

# Future of RAPS Technology

- Coordinated development of energy storage, power electronics and control electronics
- High DC voltage systems (750 VDC?) will require smaller (and cheaper) power electronics, which will reduce BOS cost
- More rugged batteries are required so we can "utilize" more of the installed capacity (e.g 20-90% PSOC operation with 15-20 yr life)
- Baseload Generators such as fuel cells or run-of-river hydro may be added to the system

# Summary

- RAPS technology is leading edge of cost effective renewable energy systems for rural electrification.
- Preliminary business plans shows that RAPS systems can provide both general electrical services and communications services at an affordable cost.


# Orion Energy Corporation

4580A Mack Ave

Frederick MD 21703 USA

Tel: ++1.301.662.8000

Fax: ++1.301.668.8084

Web: *www.orionenergy.com*

Email: *drdanley@orionenergy.com*