# RESPAR

## Renewable Energy Systems for Peruvian Amazon Region

Presented by
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**FY2001 Energy Storage Systems Peer Review**

# Project Justification

- The project was initiated by ILZRO with the goal of developing applications for lead acid batteries in Remote Area Power Systems (RAPS)
- The project is supported by the US Solar Energy Industries Association (SEIA), the US Department of Energy, and by the Projects Division of the Ministry of Energy and Mines (MEM) in Peru.

International Lead Zinc Research Organization, Inc.

SEIA

energy.gov
U.S. DEPARTMENT OF ENERGY

Peru Government DEP-MEM

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# Project History

- Initial visit by ILZRO and SEIA in June 97 yielded Memorandum of Understanding
- Feasibility Study delivered in Jan 98
- Project Implementation Plan in June 98
- Initial Contract signed in February 2001
- Installation / Commissioning planned completion by end of January 2002

# RESPAR Summary

- Hybrid power systems will upgrade standard/existing diesel generator systems
- Pilot project for two communities located along Amazon River and tributaries in Loreto Province
- Pilot systems for Indiana (600 kWh per day) and Padre Cocha (300 kWh/day)
- Modular System design encompasses 100-900 kWh/day
- Replication phase -- hundreds of potential sites

# RESPAR Participants

- ILZRO
- SEIA
- ILZRO RAPS Peru
- UNDP / GEF
- Common Fund for Commodities
- Peru DEP-MEM
- CTAR Loreto (Regional Government)
- US Department of Energy
- Sandia Nat. Labs
- Orion Energy Corp.
- Ferreyros / Orvisa
- BP Solar
- Battery Energy Power Solutions
- Advanced Energy Associates
- Energia Total
- CSIRO
- Switch Technologies

# Loreto - Peru

- Peru
  - 70,000 Rural Communities
- Loreto
  - 3,000 Rural Communities
  - >130 Communities with Small Diesel Gensets


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# Site Locations -- Loreto, Peru


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# Indiana

- Located along Amazon River near Iquitos
  - 500 Households
  - Est. 600 kWh/day
  - Existing 200 kW generator runs 4-5 hrs/day

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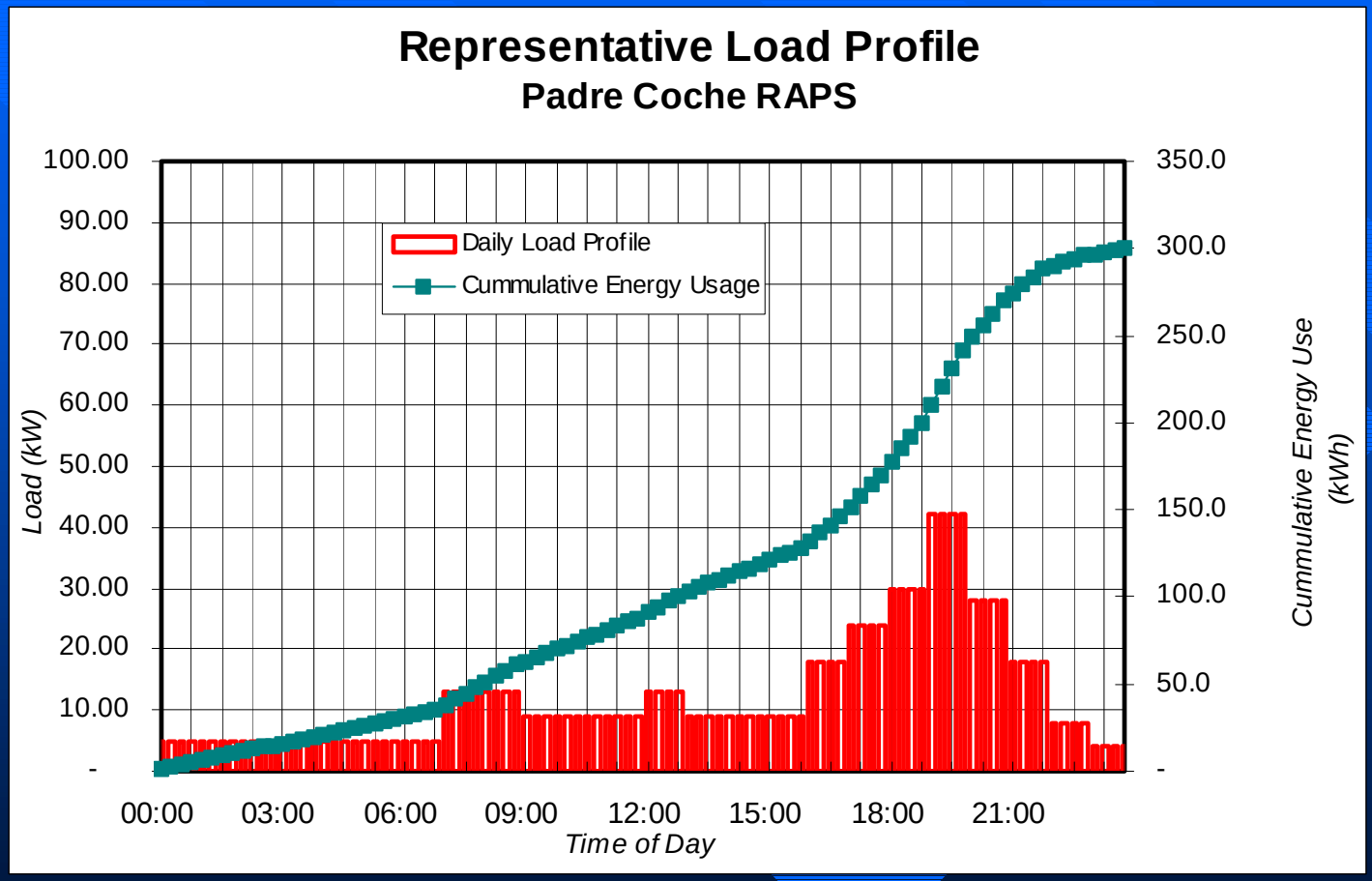
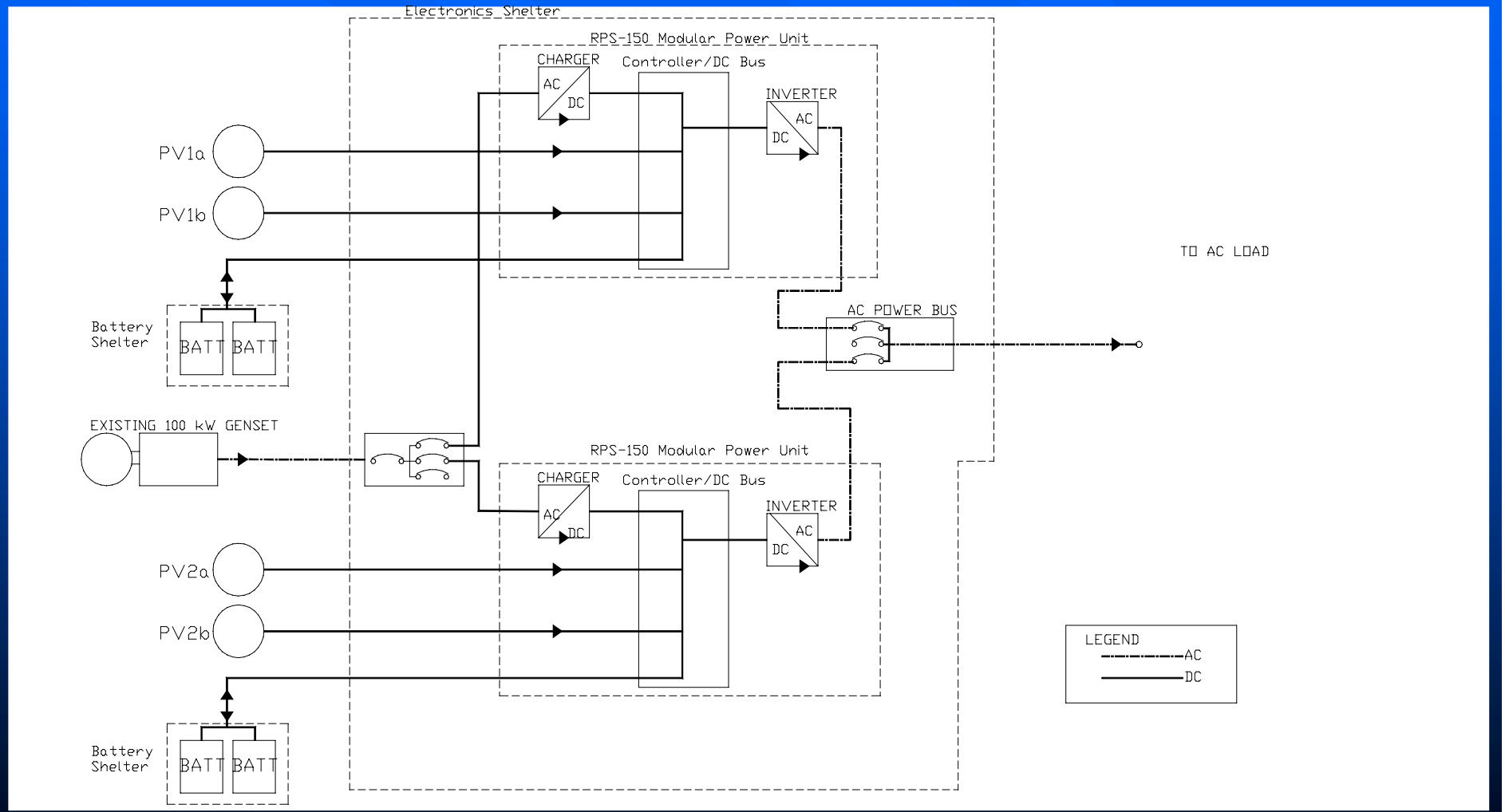
# Padre Cocha

- Located along Amazon Tributary near Iquitos
  - 240 Households
  - Est. 300 kWh/day
  - Planned 100 kW generator
  - Extensive craft industry

# Typical Load Profile



# Hybrid System Configuration - Padre Cocha

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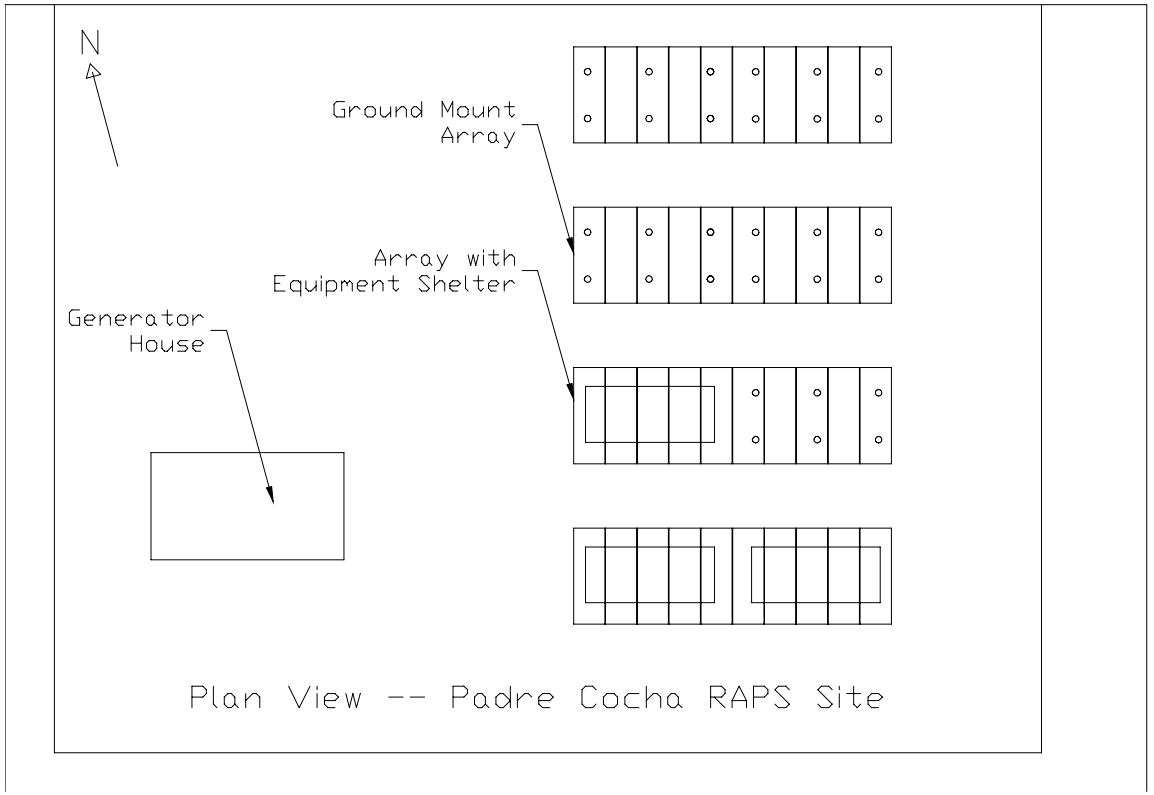
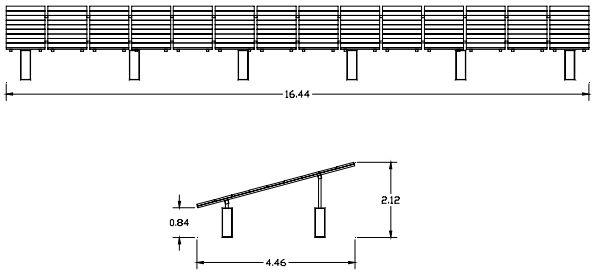
# System Layout -- Padre Cocha

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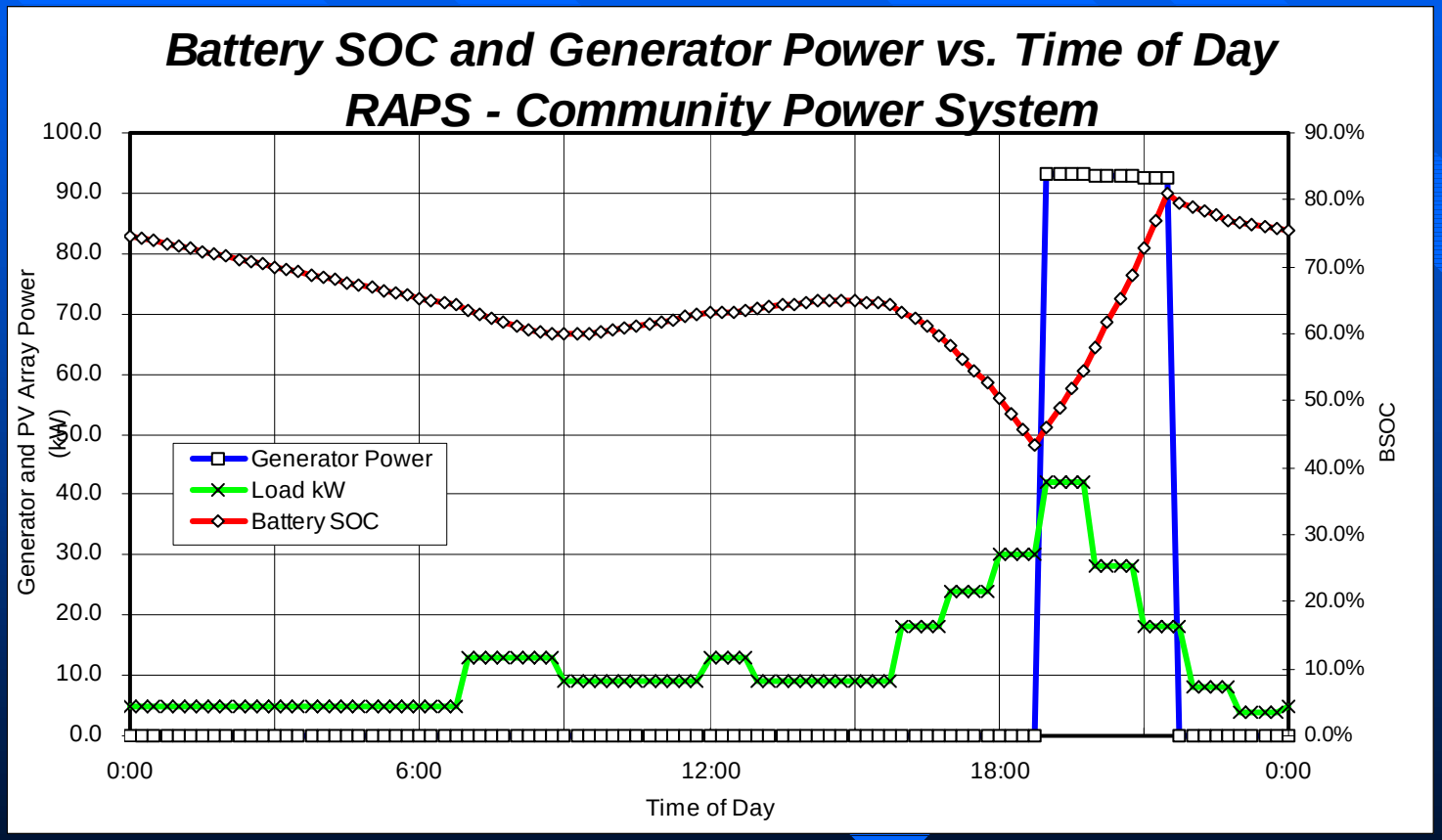
# Typical System Operation - Padre Cocha

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# RAPS Batteries -- Requirements and Constraints

- Modular Design specifies 750 Ah at 240VDC
  -- two strings for reliability
- Heavy cycling, with variable charging
  -- looking for 8-10 years life
- Low maintenance due to remote area and lack of skilled personnel
- Hot (but not excessive) environment
- Ultra-rapid charging and weight are not issues
- Recycling is a MAJOR issue and specific plans have been make for recycling at the end of battery life.

# System Batteries

- RESPAR will use Gel-Type VRLA batteries from Battery Energy South Pacific
  - Batteries were developed by CSIRO in cooperation with TELSTRA
  - Rated cycle life of 2,500 cycles to 50% SOC
  - Testing indicates potentially longer life with PSOC Operation -- goal is 10 year life with daily cycling
  - Total of 1,440 cells (1.1 MWh DC) for first two villages


BATTERY ENERGY

# RAPS Battery Charging

- PSOC (Partial State of Charge) operation -- typically between 40 and 80% SOC
- Periodic rapid equalizations
- Charging via controlled battery charger
- Max charge rate is approximately C/5
- Details of Charge Protocol are being worked out with CSIRO and Orion Energy via actual testing using simulated system operation

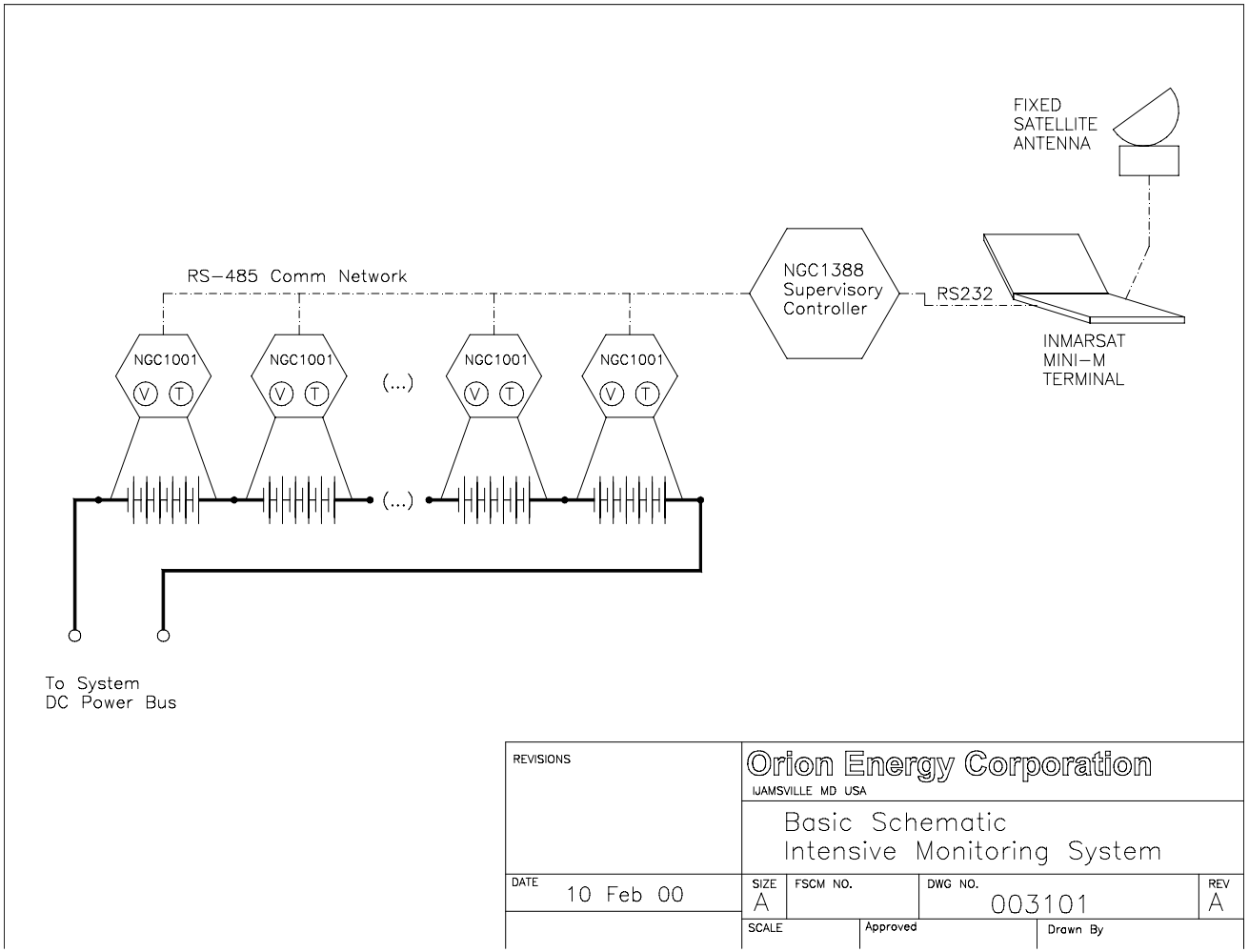
# Intensive Monitoring Tasks

- US Department of Energy is funding intensive monitoring of batteries, administered via Sandia National Laboratories. The task is through ALABC.
- Initial funding of approximately $50K for battery monitors and satellite terminals has been completed, additional $20K for database work for analyzing data once systems are operational.
- This task also includes funding for energy efficiency and conservation work related to successful system operation.

# Remote Monitoring

- Monitoring incorporates voltage and temperature of 12V blocks of batteries.
- Each 240V string thus has 20 monitors, each RAPS "module" up to 60 monitors.
- Monitor is opto-isolated and operates off 12V block of batteries. Measures voltage and temperature at approximately one second intervals.
- RESPAR Systems will include integral remote satellite monitoring for maintenance purposes
- Satellite terminal is INMARSAT Mini-M.

# Battery Monitoring Configuration

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# Other Components

- PV Array
  - BP Solar SX80 - 80Wp
  - 1,134 Modules
  - Indiana - 60 kWp
  - Padre Cocha - 30 kWp
  - PV provides 35% of energy
  - 100% Expansion Capability
- Power Electronics
  - 40 kW 3-Ph inverters
  - Hi Freq PWM IGBT
  - 95% efficiency
  - 40 kW Battery Charger
  - 6 pulse SCR w/ filter
  - Controlled setpoints for optimum charging

# Other Components (cont)

- Controls
  - Microprocessor control system
  - Supervisory controller with dedicated subsystem controllers
  - Access to all modules at single panel
  - Remote access via satellite comms
- Equipment Shelters
  - 20-ft ISO shipping containers are refitted as equipment shelters
  - Each system has one electronics shelter plus 2-4 battery shelters
  - Shelters are treated with ZRC corrosion resistant paint, and mounted under arrays

# RAPS Equipment in Progress

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# Project Status

- Formal work started in February.
- Assembly of shelters and equipment in Peru started in August.
- Site work started in October, complete by end of December.
- All equipment in Peru by end of December.
- Batteries have been manufactured and are on their way to Peru.
- Power and control electronics being manufactured in US by Orion Energy.
- Installation in January, commissioning by end of the month.

# 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 may be added to the system

# Summary

- RESPAR project is leading edge of battery based renewable energy systems for rural electrification.
- Project focuses many different technologies and project considerations
- Replication phase includes large market for batteries.


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