

Overview of Remote Energy Systems for Telecom Towers



Apollo Solar, Inc.

23 F. J. Clarke Circle Bethel, Connecticut 06801 USA +1 (203) 790-6400 www.ApolloSolar.com



Purpose and Disclaimer

- 1. This presentation is an introduction and overview of the training series for the Apollo Solar Remote Energy Systems for Mobile Phone Towers.
- 2. There is a series of presentations to complete the training.
- 3. An Apollo Cabinet may be available for hands-on experience.
- 4. Because the participants may range in experience and talents, we will cover a large range of material.
- 5. Some topics may be over-simplified to save time.
- 6. Other topics may be a technical challenge for novices.
- 7. Some points may be obvious to the most experienced.
- 8. And some slides will be repeated in different sections as they apply.
- 9. Please ask questions during the presentation.



Apollo Remote Telecom Sites



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Many people in African countries now have mobile phone service thanks to the Apollo powered BTS and backhaul microwave repeaters.

These are 2 of the 105 sites in Madagascar using Apollo Solar PVT Systems.

Overview of the Training Presentations

- 1. This Overview.
- 2. Essential Engineering Laws Understanding Power, Energy, their Sources and Batteries for storage.
- 3. System Design Basics Pure Solar and Hybrid Solar/DG.
- 4. MPPT vs PWM Charge Controllers.
- 5. The Apollo Solar T80HV Charge Controller Core of the systems.
- 6. Installing and Wiring the Apollo Solar Cabinets.
- 7. Commissioning the Energy System.
- 8. The GSM Modem Setting up and Connecting to Tower.
- 9. Using the Remote Monitoring for diagnosis and long term support.
- 10. Options Available Enhanced Surge Protection
- 11. Extra Facts Analysis of Harmatten Winds affects on PV

Components of a Complete Installation





PV Structures



PV Modules – made by others



ΡV



- Solene installs the complete Energy Systems so the customer has a single source and single maintenance contract.
- Apollo Solar supplies the unique PV or Hybrid electronic cabinets including Charge Controllers, switchgear and Remote Monitoring providing the best reliability and features available.
- Solene provides the commodity items including the PV Array, Batteries, mounting, battery enclosure and generator if required.
- Together, Solene and Apollo Solar deliver the ultimate in equipment and service for reliable remote energy. 5

Apollo Solar = <u>Reliable Continuous Energy</u>

- 10 YEARS OF FIELD EXERIENCE The Apollo Solar T80HV MPPT Charge Controller, the heart of the Energy System, has been manufactured since 2006. There are many thousands running throughout the World with great reliability.
- > **PROVEN 100% UP TIME** The Apollo Solar systems have proven UP-TIME at 100%.
- PROVEN TRACK RECORD IN AFRICA The climates and logistics in Africa are challenging for remote electronic systems. The Apollo Solar Telecom Energy Systems are tested and proven in several countries in Africa.
- EXPERIENCE AND FEEDBACK Apollo watches the performance of our installations using our Remote Monitoring software. We have the feedback of the performance over years on hundreds of sites so we can be certain about Battery and PV Array sizing.



The Apollo Solar Energy System

Step1

Start with enough Solar and Battery to keep the Tower running for 3 days.



Step 2 – If the space limits the PV Array, add a small (8kW) DC Generator for back up to fill in the difference.



Deep Cycle Batteries provide continuous DC power.

The losses in the battery are not critical because the Solar energy is essentially free.

Apollo Solar - Energy System Cabinet



- The Apollo Gen 4 PVT Systems include all of the electronics in a single cabinet for easy installation.
- The cabinets are powder coated steel and sealed to meet IP66 and are intended to be outdoors, typically in the shade, under the PV array.
- The cabinet is 1000mm wide x 300mm deep x 1200mm tall. It is shown here with 450mm legs. They can also be hung from the ground-mounted PV support system.
- All of the cables exit from the bottom using waterproof glands. The cables can be covered in optional rodent-proof metallic braded shields.
- Multiple cabinets can be installed side by side, or back to back as shown here.



Apollo is the Leader in Pure Solar Installations

Over 900 Apollo Solar Remote Energy Systems are installed in Africa.

Our Pure Solar systems are designed to be ultra-reliable since there is no generator for back up. Many sites are in desert or jungle climates. The maps show some of our locations in Mali, Egypt, Madagascar and Morocco.



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T80HV MPPT Charge Controllers Significant Advantages Over Competitors

- Input Voltage (PV Open Circuit) 180V allowing use of 300+ watt, 72 cell PV modules to charge 48 volt batteries
- Accurate battery voltage sensing for charging to max capacity and long life
- Delivers 80 Amps into batteries at up to 45°C ambient temperature
- Internal Battery State-of-Charge meter
- * Efficiency: 98% to 99%
- Synchronous Parallel units to 1280A
- Isolated Circuitry for Positive Ground or Negative Ground installations

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How the Apollo Hybrid Solar/DG System works

This chart shows when the battery is charged. The BTS load is always on.



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Total Cost of Ownership



The TCO chart shows a real 1kW load system. The costs for each system depend on local parameters including the cost of diesel fuel and the solar irradiance available.



Apollo Solar Hybrid Power System Block Diagram

The Apollo system provides all the elements to provide reliable energy for the tower.

Options allow our system to provide all possible features cost effectively.

The input can be Solar, Generator, or Utility Grid.



Benefits to the Tower Company & MNO

Apollo Solar provides important benefits for hybrid/solar power:

- Lowest diesel consumption Generator run time in minimized
- Our Pure Solar system is field proven at over 700 sites in Africa
- The core is the world's best MPPT Charge Controller The T80HV
- Cost-effective packaging No redundant rack & panel sheet metal
- Options for Indoor or Outdoor installation Shelter not required
- Sizes for 48 volt DC loads from 500 watts to 10kW, or more
- Multiple tenants optional energy metering and control
- Easy Upgrades Add modules as more power is needed
- Integrated Remote Monitoring System to support maximum reliability
- One source for your complete system and Service Level Agreement

Apollo Solar PVT – Real Time Remote Monitoring

- Monitor all your sites simultaneously from any PC
- We can integrate with your existing system and NOC using SNMP
- The color of the pin indicates preset Warning Priority (Red is most important)
- Clicking on the pin brings up the proper Site Status page





Real Time Remote Monitoring

A complete set of new data is pushed out of each site to the server every minute.



Data recorded from each site includes:

- Irradiance Received and Potential Solar Energy Available
- PV Array Voltage, Current and Energy Received
- Battery State of Charge, Voltage, and Energy Flow
- Notification of Circuit Breaker and Contactor changes
- Database of all components, specs and serial numbers
- Temperatures of Charge Controllers and Battery
- Load profile
- Warnings and Alarms with alerts via emails or SMS text
- Log of all Warnings and Alarms

Apollo Solar PVT – Real Time Remote Monitoring

Over a dozen different Charts are provided showing all critical parameters on every site. 3 different charts can be displayed at one time. The user can select which charts to show.



Apollo Solar - CO2 avoided

- The AC Diesel Generators used at remote towers are not efficient.
- Replacing one with an Apollo Pure Solar system avoids 30 metric tons of CO₂ every year.
- With 900 systems currently running, we are avoiding over 30,000 metric tons of CO₂ every year.
- This is equivalent to removing about 6,000 cars from the road.



Apollo Solar Began with Work for NASA





NASA letter commending the work done by Apollo Solar



Apollo Solar CEO John Pfeifer, left, with NASA rocket-borne application engineers



NASA contracted Apollo to design and build a PV Battery Charger to go where reliability was mission critical. National Aaronautos aud Space Administration Lampiny Research Center Hampion, VA. 23681-0001



November 1, 2002

John Pfeifur Electronic Design Lab 23 F.J. Clarke Circle Bothel, CT 06801

Dear Mr. Pfeiffer,

The GPSREX Town and I approving your contributions to the GPS Surface Reflection Experiment and the Radiation Experiment (GPSREX) package for the Mightglow Belloon Mission.

Your contributions in the development and fabrication of the Power Distribution Board and the Charge Controller Boards were critical for the successful completion of the GPSREX flight package.

You were adaptable, worked well as a team player, showed initiative, possessed encodient technical skills, demonstrated follow through, and were resourceful and creative in your work. Your attention to detail was both tredees and critical to the success of this mission.

If was a grant pleasure to work with you and we are delighted to praise you on your commendable contribution to this project. Were it not for your dedicated efforts, we would not have reached this actived millertone at this time.

Condially



Richard A. Walker NIGHTGLOW-GPSREX Project NASA Langley Research Center

Single Source - Single Point of Responsibility

Total Power Electronics Solution from one source

- Our products are Made in the USA
- Apollo created the hardware and software
- Apollo proprietary Control and Monitoring Software
- We provide training for Installation and Commissioning
- Monitoring of all Key Performance Indicators and Alarms
- Warranty 5 years standard, Extensions available



