Data Logging of Renewable Electrical Energy

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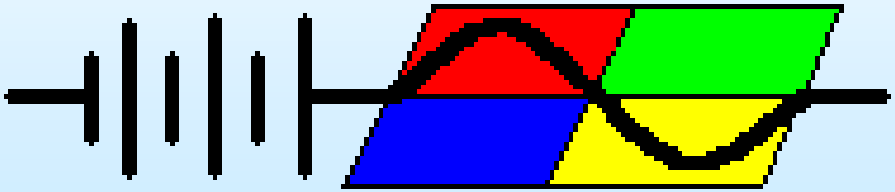


Objective

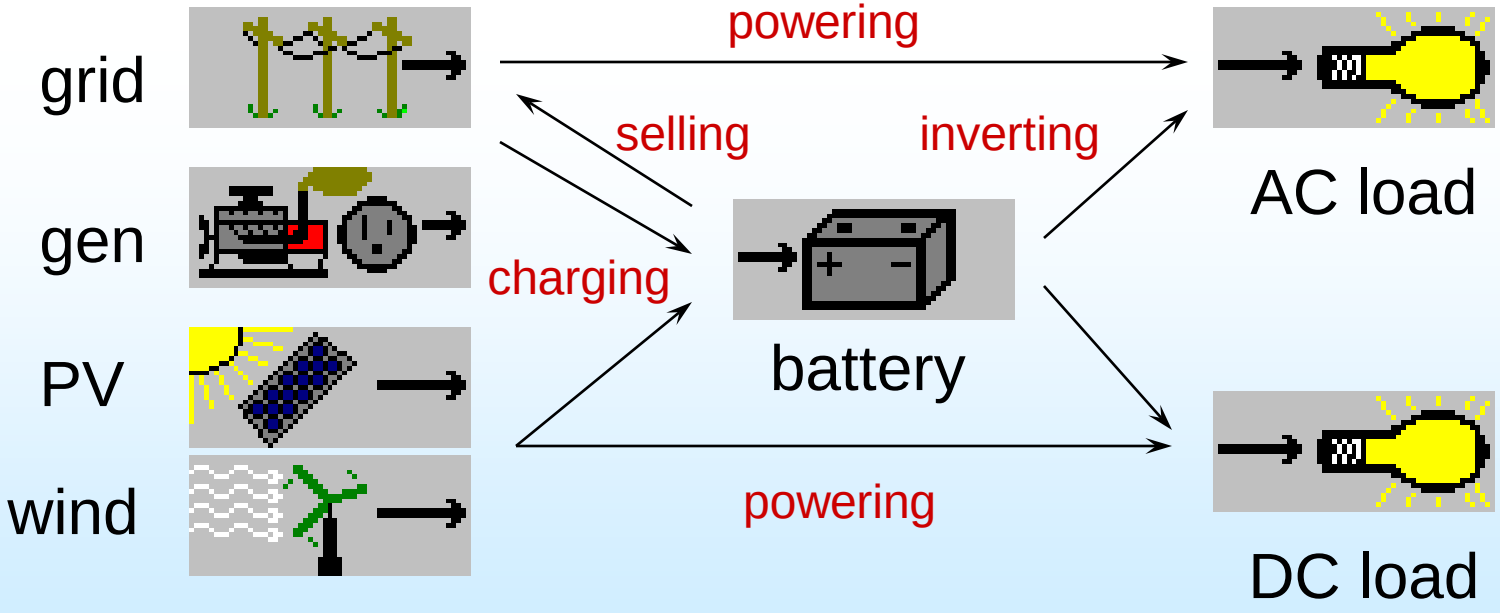
- Explore options for monitoring and logging of residential Renewable Electrical Energy systems.

Overview

- What is data logging?
- Why do data logging?
- What should I log?
- How does logging work?
- A typical logger for power.
- Types of data logging methods & equipment.
- Logging design considerations.
- Summary.
- Questions...

What is Data Logging in a Renewable Energy context?

- Recording the energy transfer between systems



Why do Data Logging?

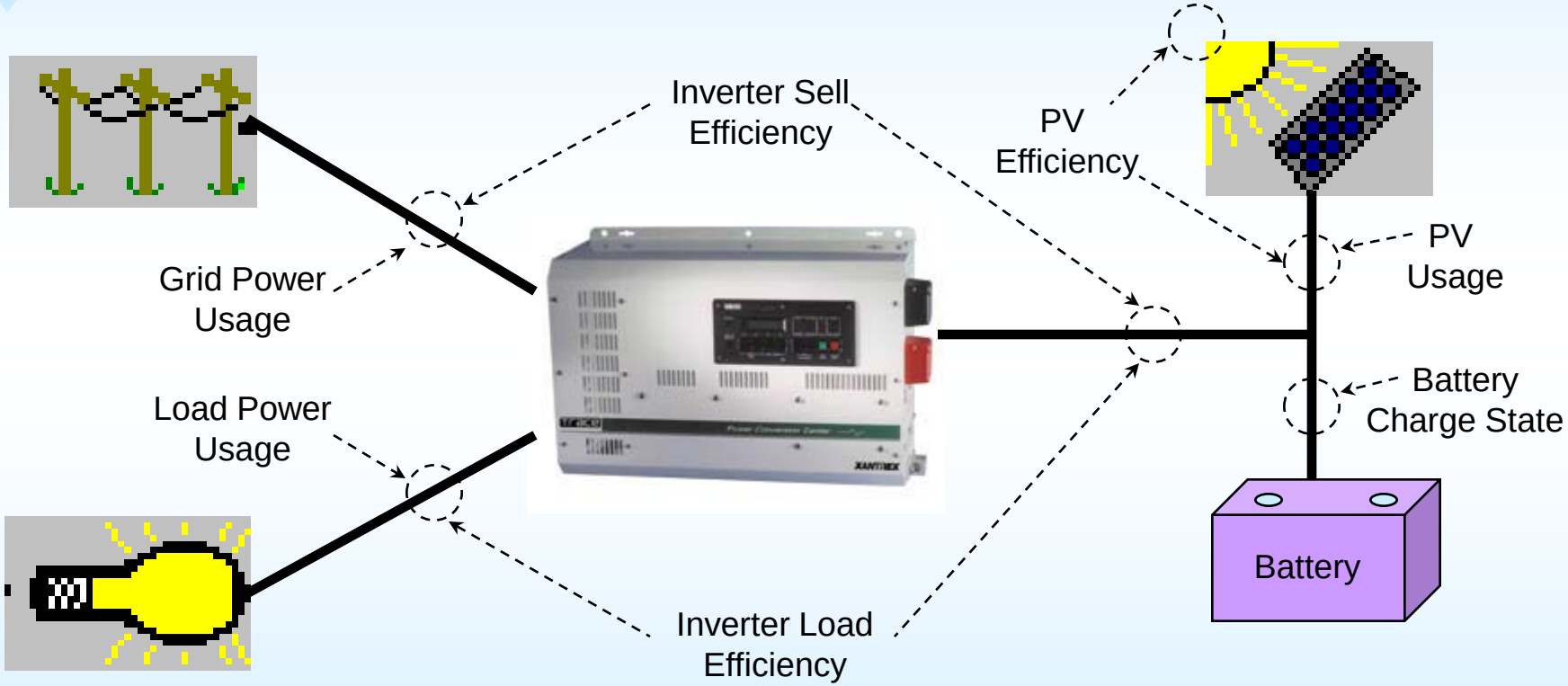
- Why do people want to know how many miles per gallon their car gets?
- Know when something in your system is wrong (loose connection, aging batteries, poor system design, etc).
- Verify the effectiveness of conservation efforts.
- Double check accuracy of power bill.

What Should I Log?

(what do you want to know?)

- Efficiency:
  - Inverter (charging, selling, load power). Is it working up to par?
  - Battery - Is it time to replace the bank?
  - RE Sources - Is the charge controller working right? Are the PV panels or wind gen getting old?
- Power Usage:
  - Grid. How much power bought & sold?
  - Battery. What is my state of charge?
  - RE Sources.

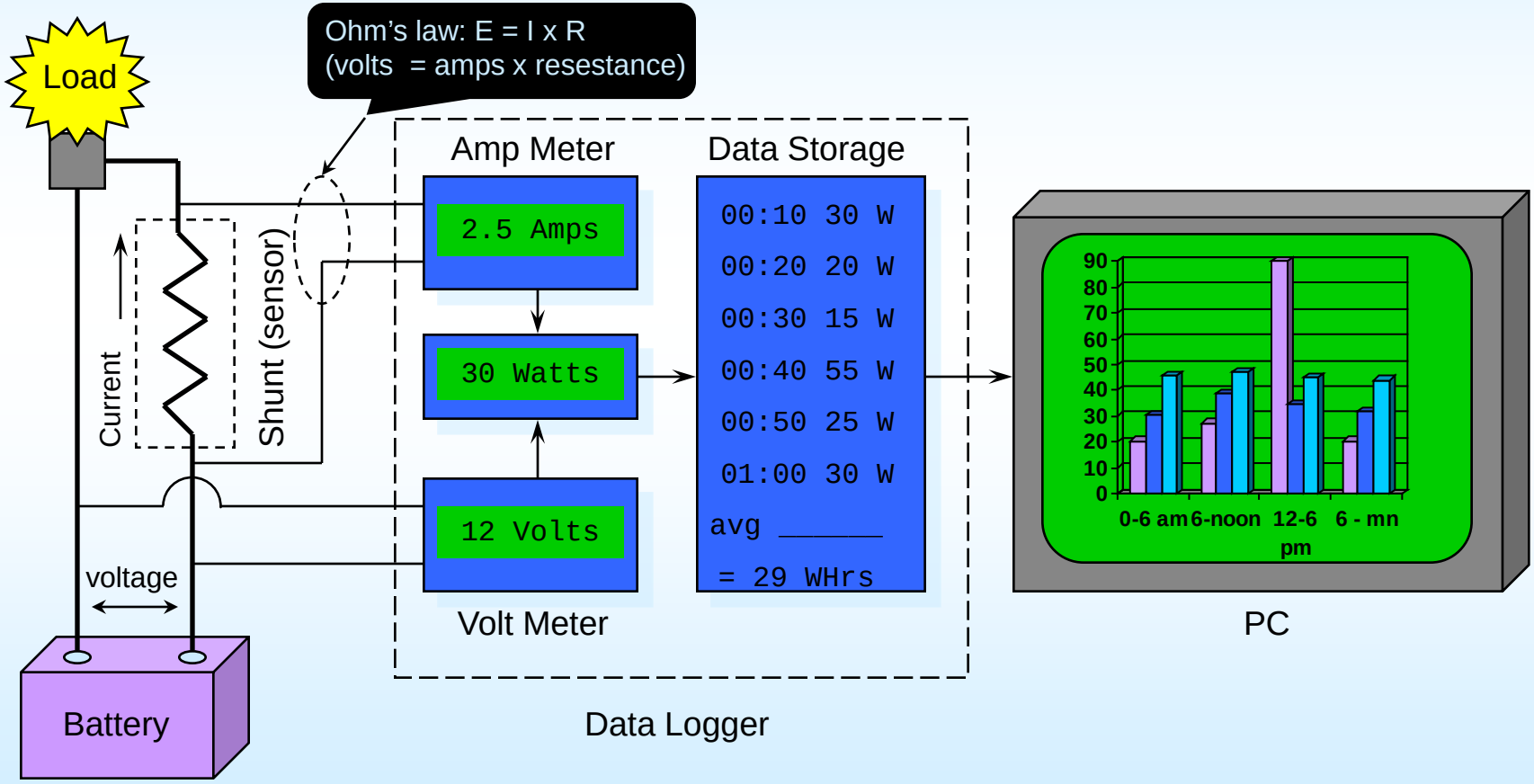
Where Should I Log?



How Does Data Logging Work?

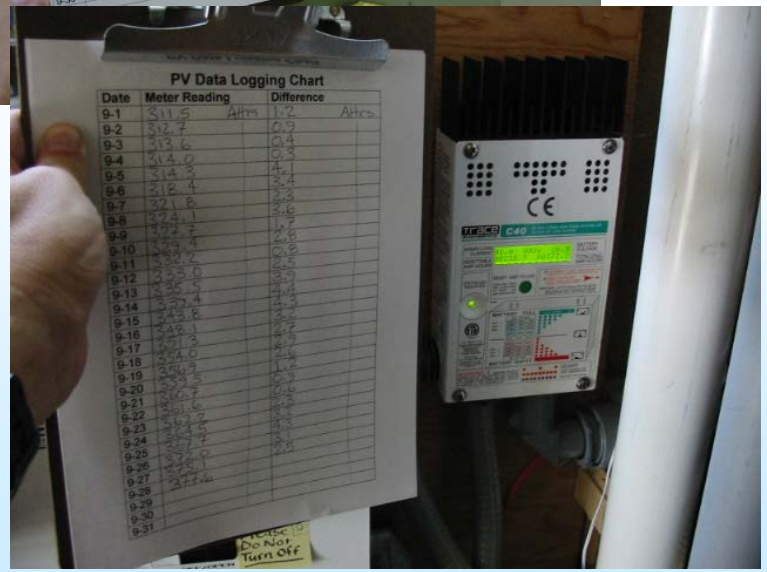
- Power = Amps x Volts (Watts).
- Power used = Amps x Volts x Time (Watt-hours).
- Meters measure volts.
- Sensors convert amps to volts.
- Loggers store meter readings at timed intervals. Can calculate power used.
- Spread sheets graph logged data.

A Typical Data Logger for Power



Manual Data Logging

- Advantages:
  - Least expensive form of data logging.
  - Uses same data as power utility.
- Disadvantages:
  - Requires manual reading at desired intervals.
  - Direct entry into data file may be an extra step.
  - Charts are an extra step.



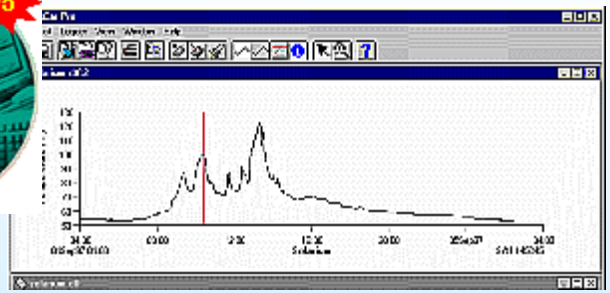
Portable Data Logging

- Advantages:
  - Low cost ($100-$250)
  - Multiple channels/sensors
  - measures AC current
  - Data downloadable to PC
  - Optional graphing utility
- Disadvantages:
  - Doesn't provide real-time meter reading.
  - Must be removed & connected to PC for download.
  - DC monitoring can be hard to install.

4-channel Data Logger

Clamp-on AC current sensor

Solar radiation sensor



Onset Hobo H8 w/ Boxcar software

www.onsetcomp.com

See HomePower Issue 76

Appliance Data Logging

- Advantages:
  - Low to Medium cost ($50 - $350).
  - Very simple installation
  - Most provide AC RMS WHr and power factor readouts.
- Disadvantages:
  - Single purpose device (no DC or Grid data).
  - Requires manual reading (except high-end Brand model).

Xantrex Line Logger. $370.
www.xantrex.com

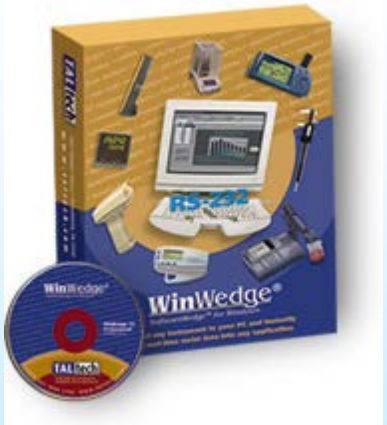
P3 Kill-a-Watt. $50.
www.ccrane.com
See HomePower Issue 90

Brand Power Meter. $150-$350
www.brandelectronics.com
See HomePower Issue 67

Battery Bank Data Logging

- Advantages:
  - Very complete information on battery “State-of-Charge” & efficiency.
  - Automatically outputs data to a logging computer once a second.
  - Can use Windows HyperTerminal for logging, Excel for charting.
- Disadvantages:
  - Medium cost ($375-$875)
  - Must be electrcially & mecanically adept for installation.
  - Must be PC savvy to do logging.

Xantrex Link-10 (E-Meter)
“Choice”. $375
See HomePower Issue 52



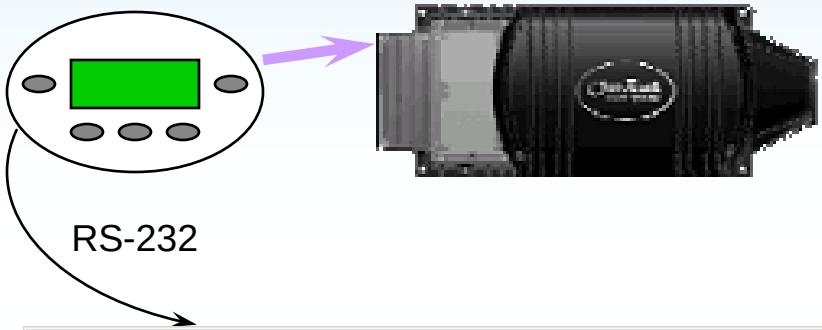
WinWedge RS-232 Data Logging software. $260/$500
www.taltech.com

Inverter-Integrated Data Logging

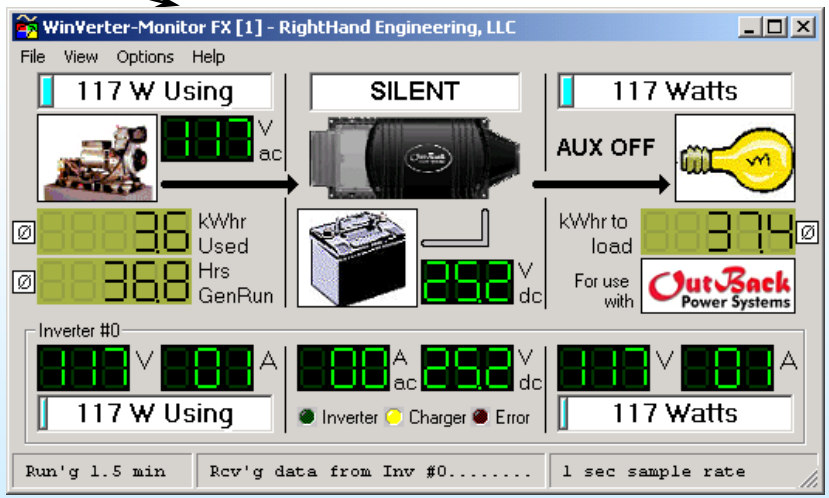
- **Advantages:**
  - Relatively low cost ($170 to $275) as an add-on.
  - Uses inverter's built-in metering.
  - Provides Grid buy/sell data.
  - An easy-to-install post-installation add-on to your inverter.
- **Disadvantages:**
  - PC must be running for logging to take place.
  - Available only for Windows PCs.
  - No RE DC charge information provided.
  - Only high-end inverters support this.

OutBack Mate

OutBack FX Series Inverter
www.OutBackPower.com



Software on Windows PC



RightHand Engineering
WinVerter-Monitor FX. $50
www.RightHandEng.com

Inverter-Integrated Data Logging

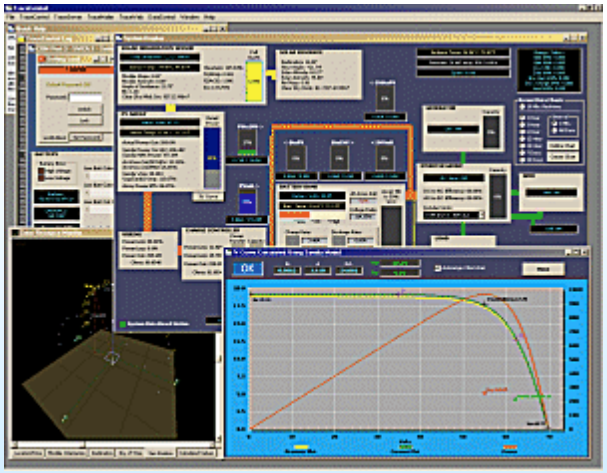
Another alternative.

Xantrex SWCA
Comm Adapter. $175

Xantrex SW Series Inverter
www.xantrex.com

RS-232

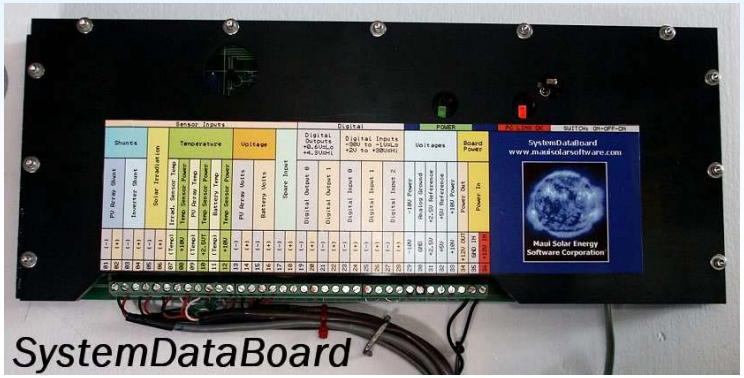
Software on Windows PC



Maui Solar Software
“Trace Tools”. $99.
www.mauisolarsoftware.com

Pro/Scientific System Logging

- Advantages:
  - Provide total system data.
- Disadvantages:
  - Expensive ($1500 - $4500)
  - Usually requires expert installation.
  - Usually PC must be running for logging to take place.
  - Usually available only for Windows PCs.



Maui Solar Software
"SystemDataBoard". $995+.
www.mauisolarsoftware.com

And Many Others...

Logging design considerations

CURRENT SENSORS

- **Shunts (low value resistors)**
  - Good for AC or DC.
  - Relaltively low cost ($20 - $50).
  - Direct conversion to voltage (no extra stuff required).
  - Must be spliced in series with the circuit.
  - No electrical isolation.

Deltec Shunts
www.deltecco.com

- **Hall Effect (m-field) sensors**
  - Good for AC or DC.
  - Relatively low cost ($12 to $72).
  - Requires regulated power for the sensor.
  - Must be threaded over a disconnected wire but no splice is needed.
  - Provides electrical isolation.

Amploc Hall Effect Sensors
amploc.com
See HP85

- **Current Transformer**
  - Good for AC only.
  - Relatively low cost ($15 to $75).
  - Clamps over the wire. Usually no disconnection or splicing required.
  - Provides electrical isolation.

Onset
Clamp-on
current
transformer
onsetcomp.com

Logging design considerations

Power Measurements

- Power = Volts x Amps
  - To measure power you will need to measure both volts and amps.
  - You may be able to take a short-cut for AC or Grid power by assuming the voltage is nearly constant. A variation of a few volts during the day will have little effect on household power measurements. In this case Power = Amps x 117 volts.
  - The exception is if you are running from a generator, or if you are far from the power distribution station, or if loads on your branch from the station vary considerably. Temporary logging can help determine the stability of your voltage.

Logging design considerations

AC Power Measurements

- AC RMS readings
  - Check that your AC measuring equipment does RMS measurements. Complex waveforms from inverters need this.
  - Use only isolated sensors when measuring AC. Shock hazard!
  - Some types of voltage measuring equipment can only accept a DC voltage.
- Bi-directional AC Power readings
  - If you are selling to the Grid, be sure that your Grid power measurement equipment can tell the difference between buying power from the grid, vs selling power to the grid.
  - Very few devices can do this.

Logging design considerations

DC Power Measurements

- Where to put DC shunts?
  - Most DC metering equipment found in the RE industry want the shunt on the NEGATIVE side.

Summary: How to choose the right setup

- How much can I afford to spend?
- Do I want real-time read-out of power? This determines if the equipment must have a built-in display.
- Can I leave a PC running continually? This determines where the data is to be logged.
- Do I need to log AC, DC or both types of power? This determines the type of sensors needed.
- What is the range of power I need to measure at each point? This determines the size of sensors needed.
- Do I need to measure power bought and sold on the grid? This effects the choice of measurement equipment.

Questions?

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