Solar Measurement Webinar

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TEquipment.NET

- Aerospace / Aviation
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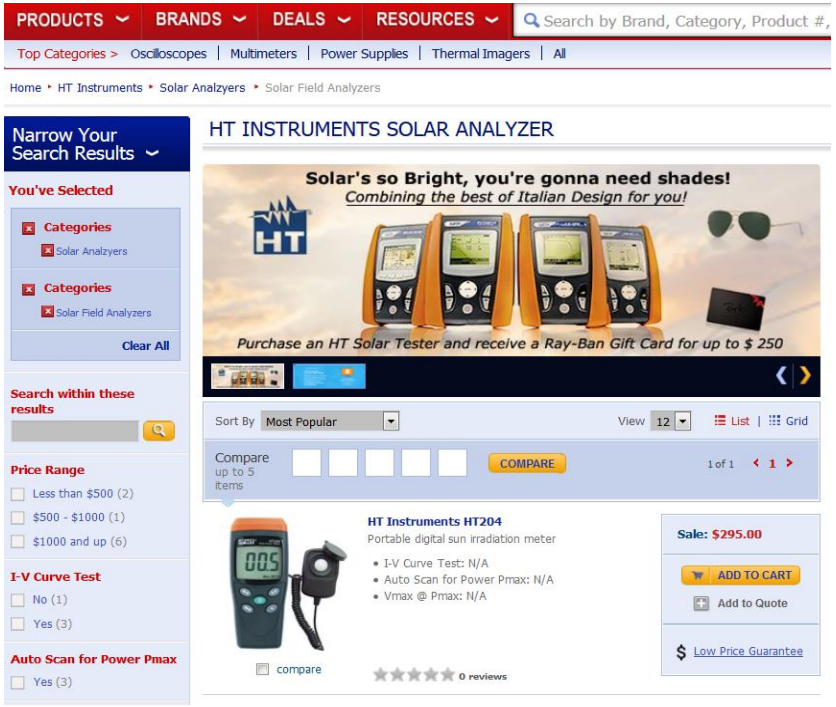
- Manufacturing
- Military
- Petrochemical
- Pharmaceutical
- Power / Utility
- R & D
- Semiconductor
- University

And much more…

- Audio
- Battery
- Boroscopes
- Calibrators
- Combustion Analyzers
- Current
- Data Loggers
- Environmental Meters
- Energy
- Fiber Optic Testing and Certification
- Function Generators
- Gas Analyzers
- Ground Resistance
- Hart Communicators
- Hi Pot Testers / Insulation Testers
- Humidity
- Light
- Multimeters, Analog, Digital, Clamp-On
- Network Testing and Certification
- Oscilloscopes
- Power / Power Quality
- Power Supplies
- Pressure
- Programmers
- Refrigeration
- RF Generators
- Signal Generators
- Solar Analyzers
- Soldering
- Sound Level
- Spectrophotometry
- Spectrum Analyzers
- Tachometers / Stroboscopes
- Thermal Imaging Cameras
- Temperature
- Vibration
- Voltage

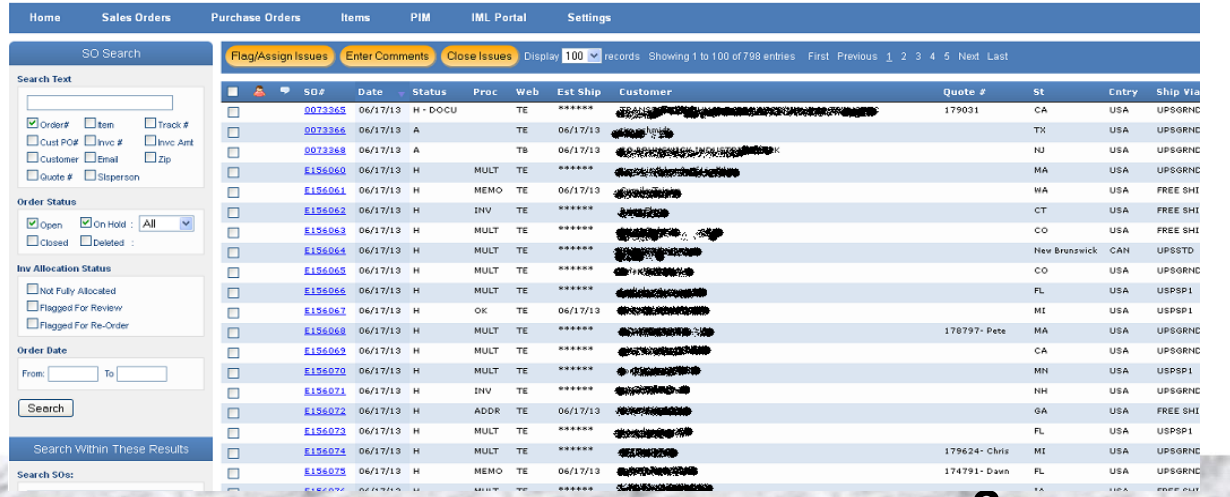
Next Generation Websites

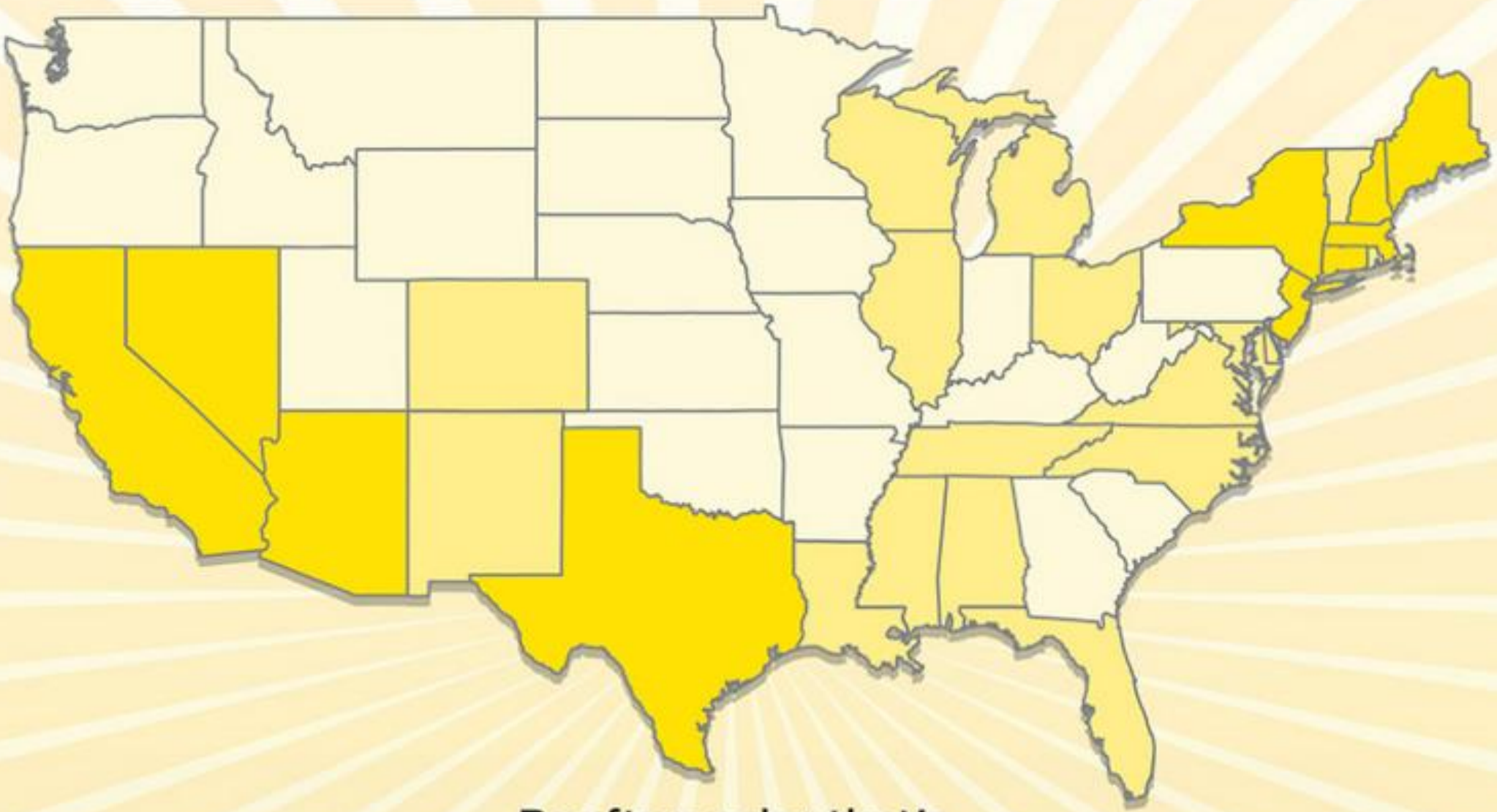
- **First for Test & Measurement retail websites. Q4 2013**



- **Advanced search and filtering**
- **Side by side comparisons**
- **Customer portal for special pricing and preferences**
- **Customer community product reviews**

- Internal Order Portal
  - Customized for our needs
  - Linked to accounting
  - Vendors to update status
  - Faster & more accurate



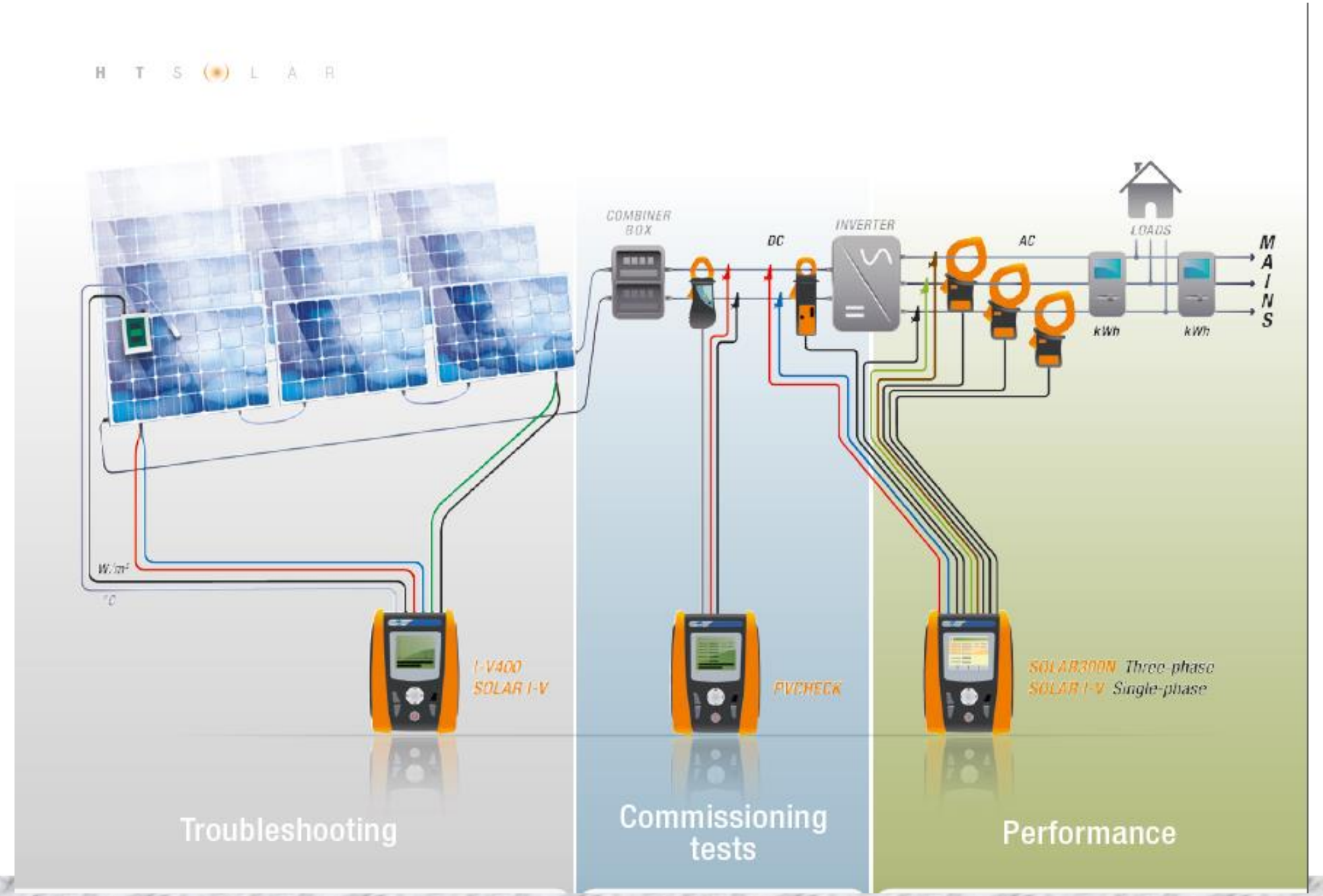

Rooftop solar that's
as cheap as the grid:
NOW
NEAR TERM
1-3 years
LATER
4+ years

PV Market 20,000 ft.

- PV installations growing at >30% CAGR
- Two distinct markets –
  - Commercial – Large with $ to test up to 100 MW
  - Residential – Fast and Cheap. Testing is only beginning in general
- N.E. Hybrid models– Tax benefits
- Farms are largely in the SW (CA, AZ, NV)

Measurements for Solar PV

- Drivers for PV Measurements
  - O&M needs
    - Acceptance Testing – Making sure the system is delivering to specification – There are no manufacturing final tests in most companies. Too expensive
    - Periodic Checks on Safety and performance often part of service agreement.
    - Troubleshooting
  - Differentiation – Many Installers and O&M companies are wanting to show quality and value by testing their work.
- Solar PV Measurement overview:
  - Insulation and Conductivity – Safety and Basic Performance
  - IV Curves – Performance, troubleshooting and ensuring panels are in Spec.
  - Efficiency from sun to DC power to AC power


COMBINER BOX
DC
INVERTER
AC
LOADS
MAINS
kWh
kWh
W/m²
°C
I-V400
SOLAR I-V
PVCHECK
SOLAR300N Three-phase
SOLAR I-V Single-phase
Troubleshooting
Commissioning tests
Performance

Are Solar Measurements Different?

- Some measurements are the same as traditional electrical measurements.
  - DC Power, AC Power, Continuity
- Different
  - IV Curves, I short circuit, V open circuit
- Mixed
  - Insulation resistance has challenges on Panels, strings and fields.
    - Example is doing the standard Insulation testing (Megger)

OPC and STC

- Terms
  - Standard Test Conditions (STC)
    - 1000 W/mm, 25 degrees C, Atmospheric density of 1.5
  - Operating Conditions (OPC)
    - Physical Test Results
- Need – Determine if panel or string is meeting the specifications.
  - Translate OPC measurements to equivalent STC to evaluate.
  - Requires to understand the Irradiance at the time of test.

Installation Testing

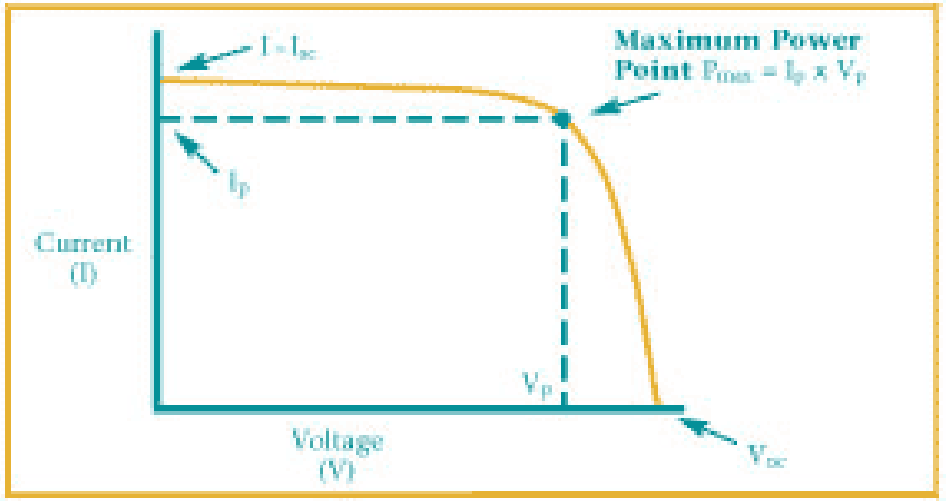
- Standard for Grid Connected systems outlines 4 tests.
  - These are pretty good for making sure the field is running and is safe.
    - Isc, Voc, Insulation of active cables and Continuity of Grounding cables.
    - Standard does not call out checking Isc and Voc to STC.
    - Many professionals are using Reference cells in combination with Testing to determine

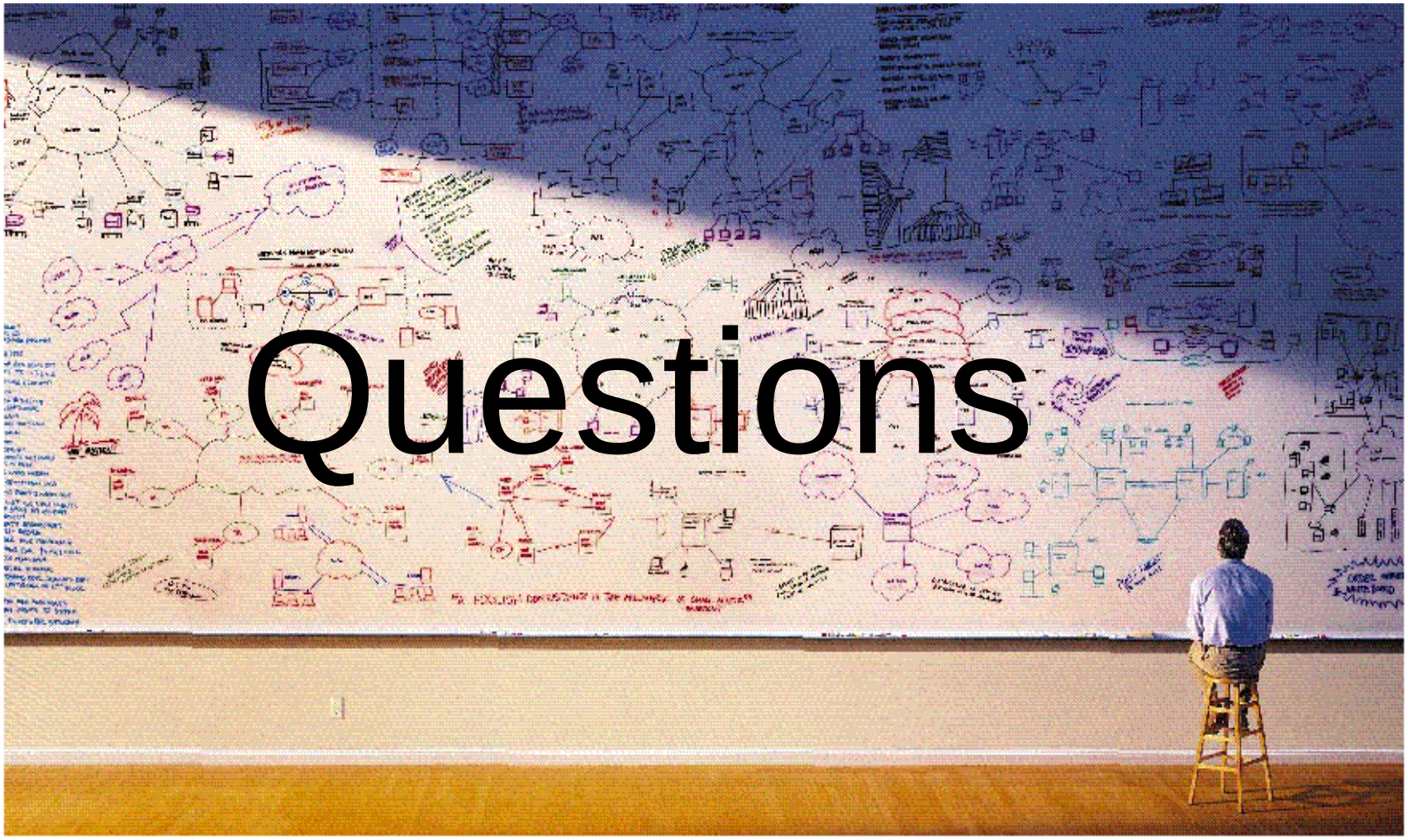
Why can’t a megger Work?

- Quick answer is that the PV Panel or string presents a great deal of noise into the system.
  - While you place a megger onto the PV conductor it is presenting you with up to 1000V DV right back at you, and it varies with sun etc.
  - This creates an uncertain measurements environment and will guarantee a bad reading on Insulation.
- What the answer?
  - Specialized tools Short out the + and – sides of the panels then measure Insulation. It is not recommended that you try this method by yourself in shorting the lines.
  - HT Method of Field tests the entire filed by measuring at the combiner box in one test!

Installation and Troubleshooting

- I-V Curves are the Core Measurements to ensure the Panel is performing to specifications.
- Key Measurements
  - I Short Circuit – Current when output is shorted Today up to ~ 10
  - V Open Circuit – Voltage output with no Load
  - MPP (Max Power Point)= Impp * Vmpp
  - I Max Power Point (MPP) – Current at the high power point.
  - Vmpp Voltage @ MPP
- Other issues:
  - Curve should be smooth as shown.
  - I is fairly linear to the suns output
  - Voltage is fairly stable to the sun




Questions