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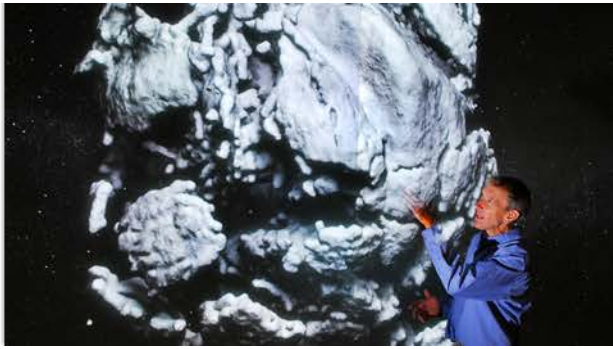

2013 Inverter Reliability Workshop
Breakout Session F: Performance/Reliability/Costs

Moderators: Tom Key, Charlie Hanley

April 30, 2013

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Session Topics – *What is a failure, acceptable rates, repair/replace strategy, allowable output reductions, availability and un-availability planned vs breakdown and risks to bottom line.*

Key Takeaway's and Questions:

1. Review of O&M and system aspects of reliability, from breakout A.
2. Design objectives for PV "availability" showed some high numbers:
   - large plants (100 MW) at 99.7%, residential at 98%, worst 90%
3. What is Availability? Does it consider solar irradiance (fuel availability? Should we measure dc compared to ac?
4. IEEE Standard No. 762 "Definitions for Use in Reporting Electric Generating Unit Reliability, Availability and Productivity."
   - Defines everything, but assumes "dispatchable" generation
   - Availability is one "performance index" and is defined as:

     AF = available hours/period hours x 100
   - Unavailability is also defined as:

     UF = unavailable hours/period hours x 100

5. Everything is defined for “conventional generation,” 15 energy and capacity terms, 21 time designations and dates, 25 performance indices for individual generating units, including availability, capacity, and outage factors (also weighted and un-weighted to consider fleets of plants)
6. Do we have data on PV unavailabilty? What are the main failure modes of inverters….software, AC interface, communication? Is the main concern number of incidences or downtime?
7. Back to PV, a lot of discussion on how much more reliable we are now than we used to be 20-25 years ago, but still there are not “PV industry performance standards.”
8. Concerns about assessing risk and making related decisions. This included decisions about maintenance, about design, one large vs many small, series connected systems, single point failures, etc.
9. Measuring current and predicting future performance…..is more testing and related test standards the answer? Commissioning, HALT and HASS, durability and environmental tests.
10. Review of O&M and system aspects of reliability, from breakout A.

11. Is a 20 year inverter a cost effective approach or can does it make sense to plan a replacement (like relamping)?
12. Several develops spoke up and indicated that they were having to create there own performance measures and tests.
13. Some discussion on users group to get together and create some performance specifications

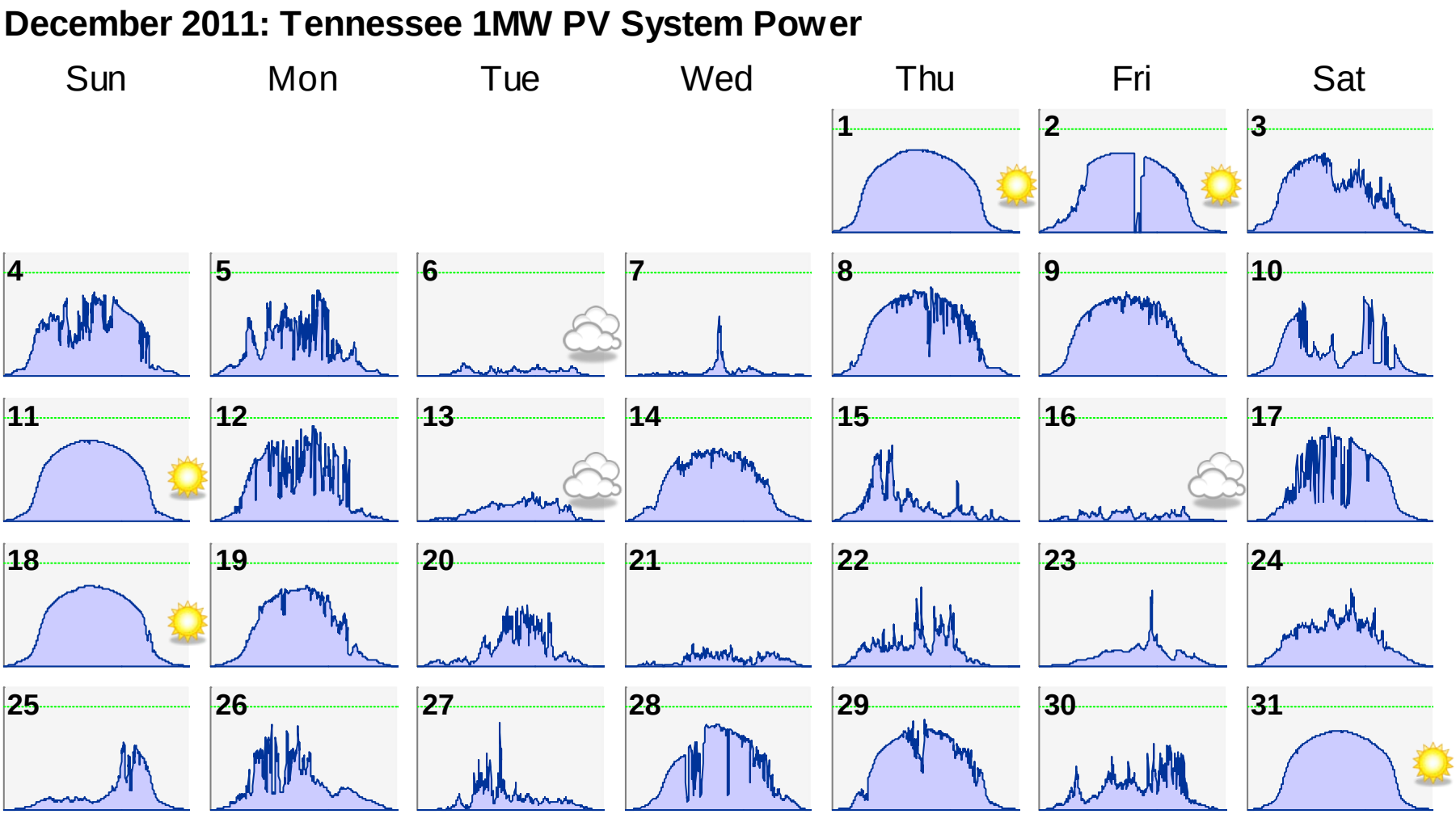
References:

1. IEEE Power and Energy, http://magazine.ieee-pes.org/ Mar/Apr 2013 "*PV Measures Up for Fleet Duty*" by EPRI, Sandia and Southern
2. J. Stein, C. Hanson, and M. Reno, "The variability index: A new and novel metric for quantifying irradiance and PV output variability," presented at ASES Annual Conference, May 2012, Rep. SAN D2012-208.

- NREL , "Performance parameters for grid-connected PV systems," NREL , Golden, CO, Rep. NREL /CP-520-37358, 2005.

Solar Resource Calendar – 1MW$_{AC}$ Output Power

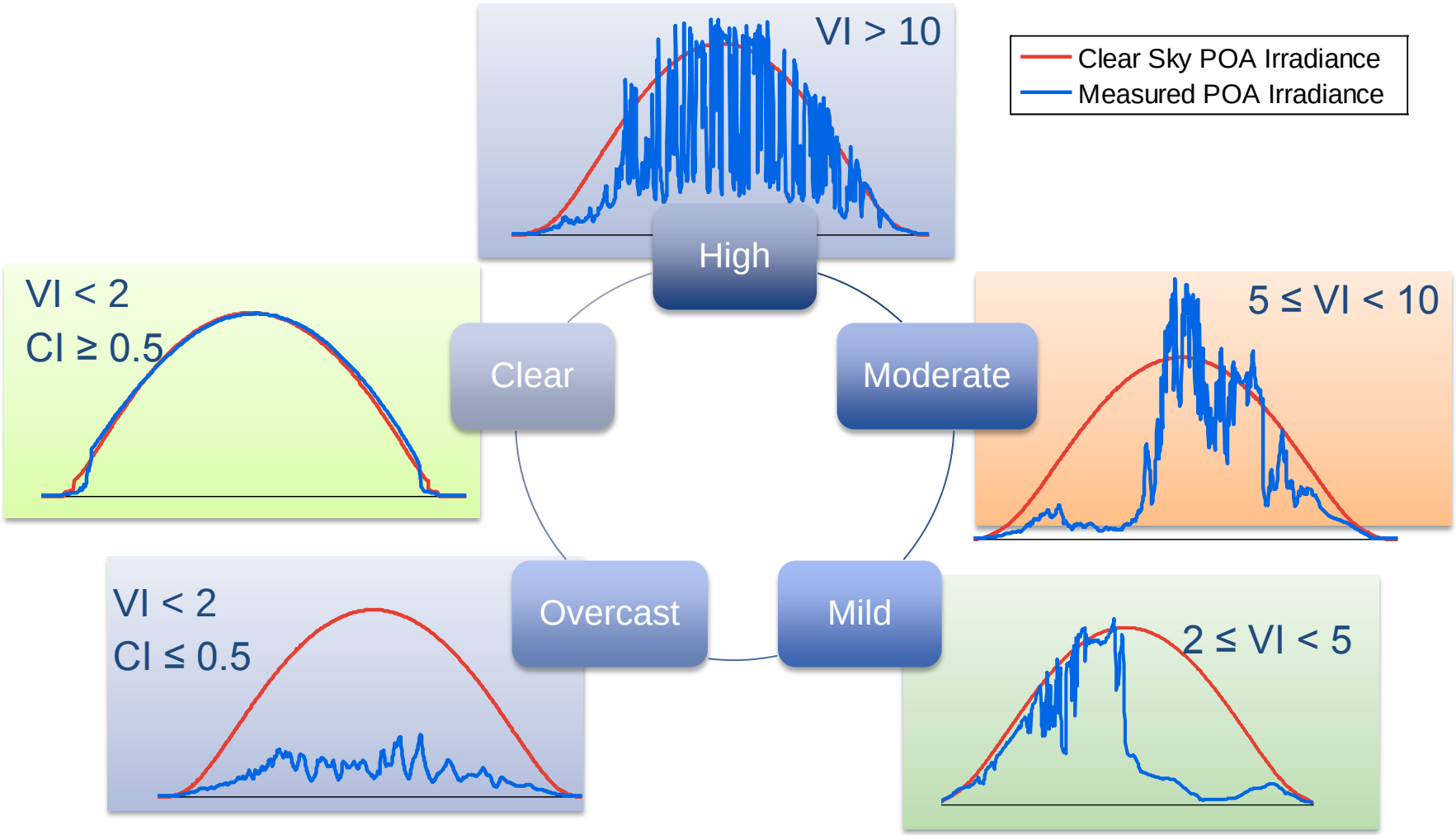
December 2011 at 1MW PV site in Tennessee



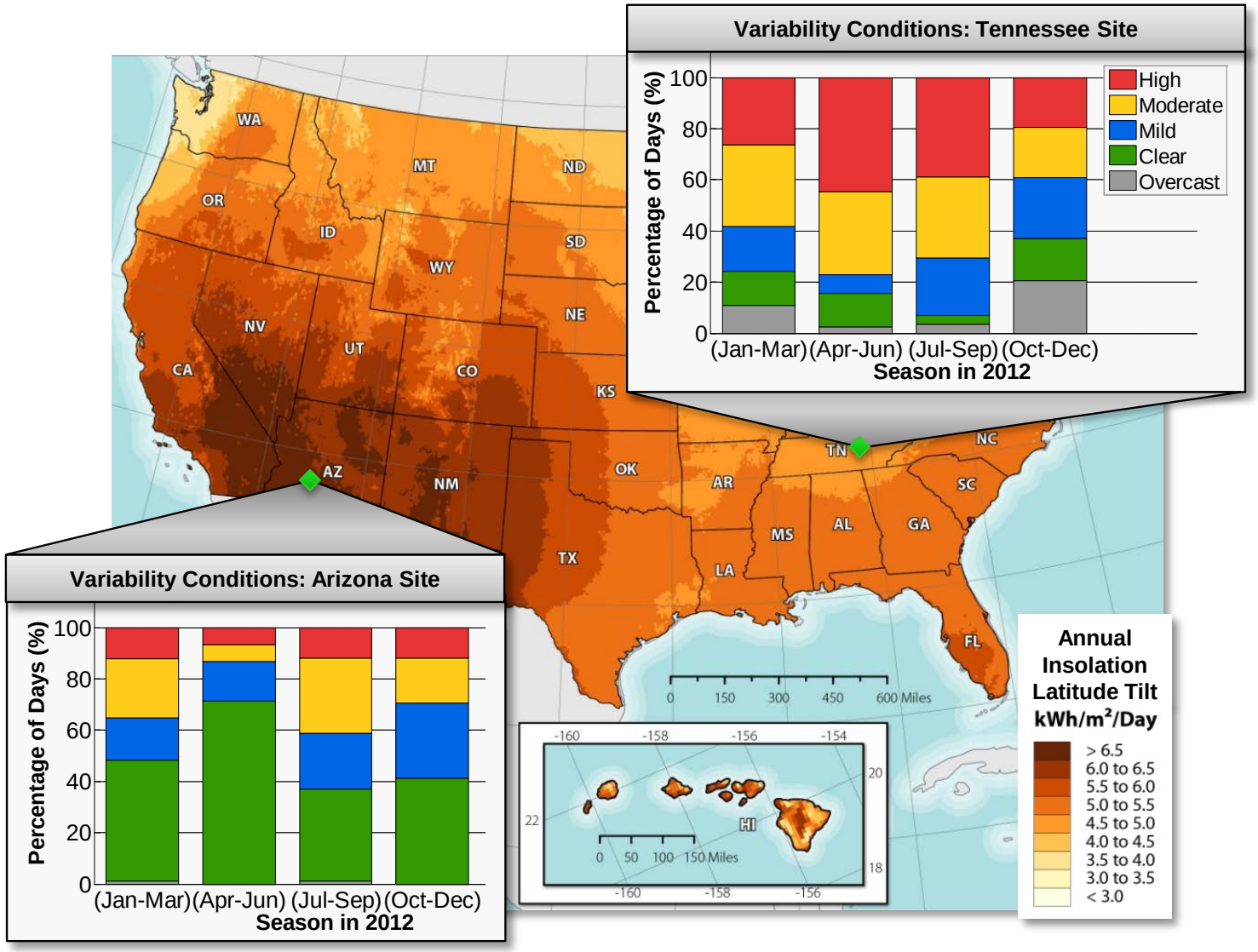
Calendar profiles are 1-minute averages derived from 1-sec data

Defining Solar Resource Variability: Day Types

Using clearness index (CI) and variability index (VI) to classify days

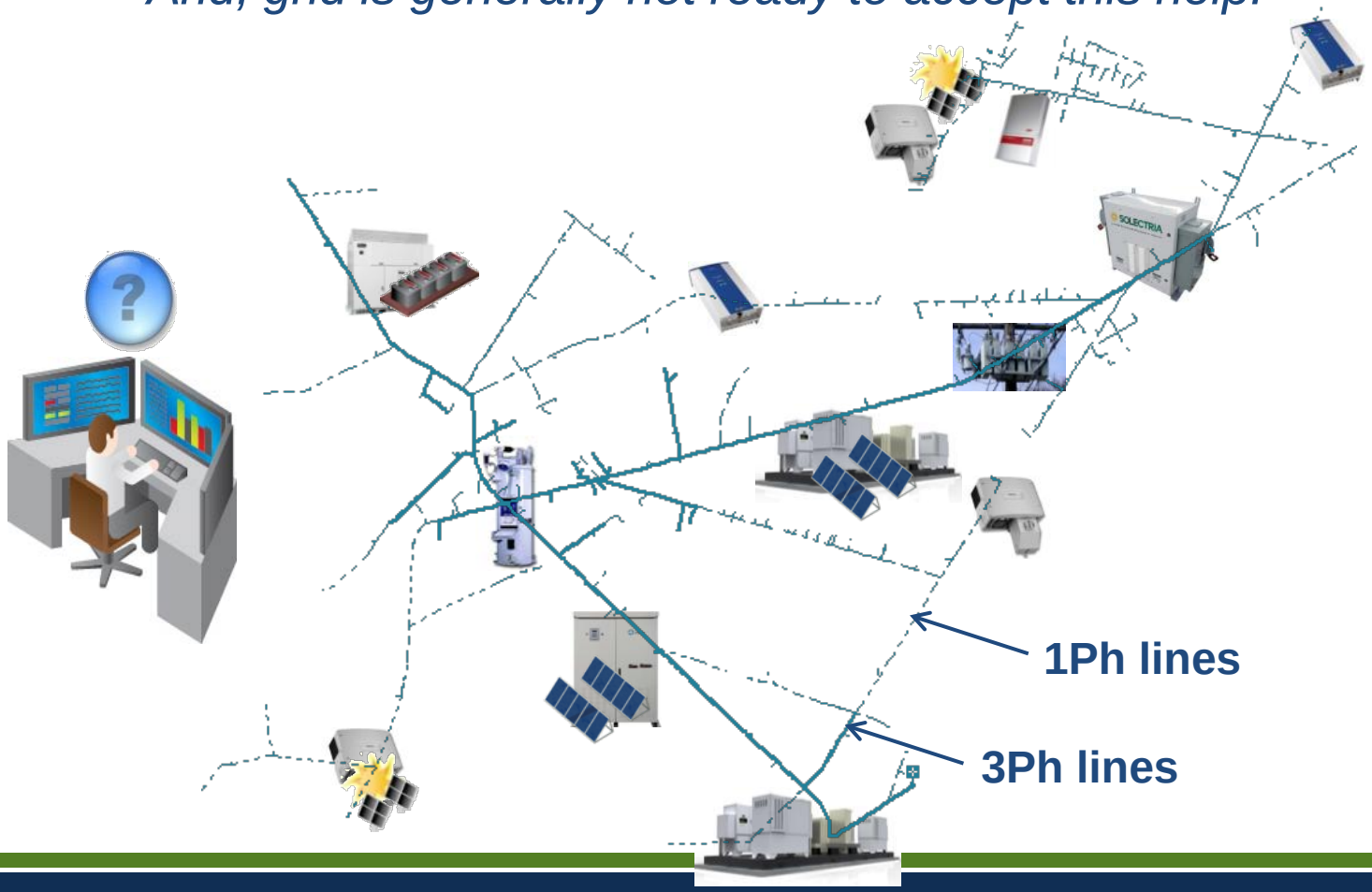


Variability Day-Types: Comparing PV Sites in AZ and TN

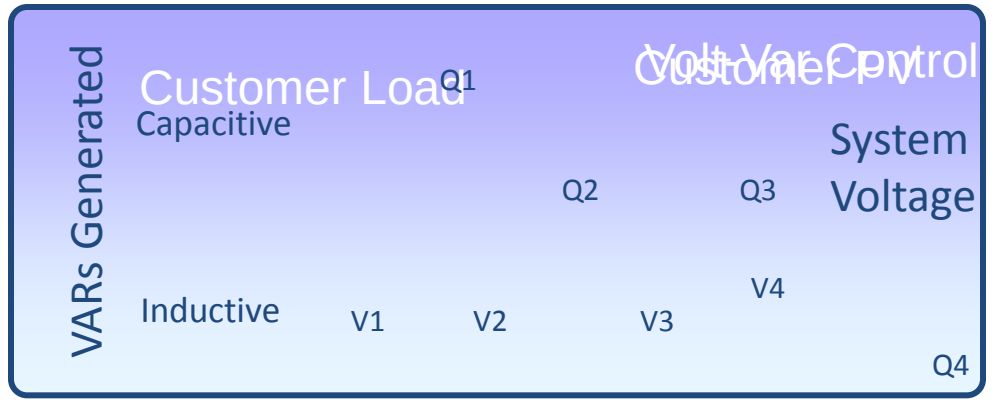


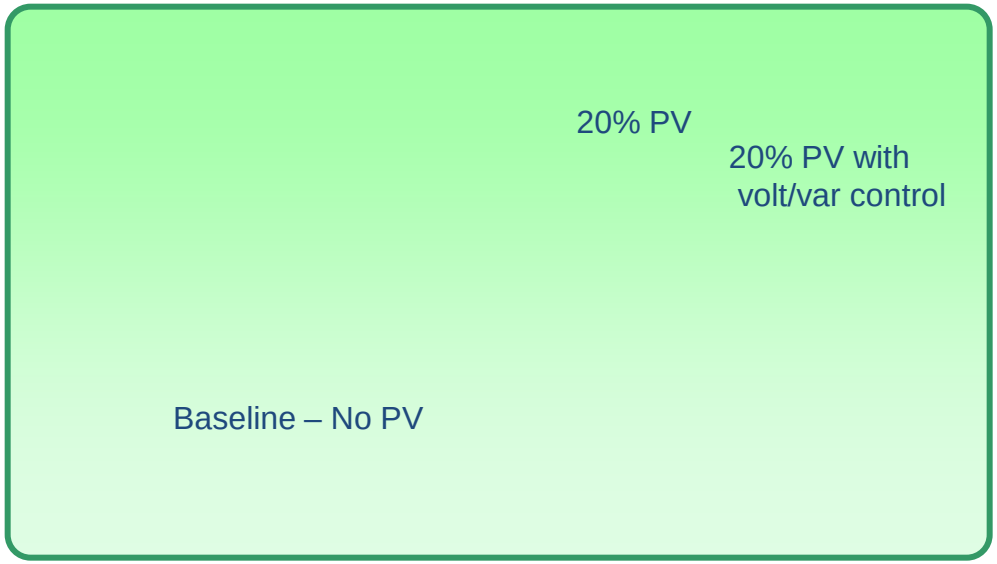
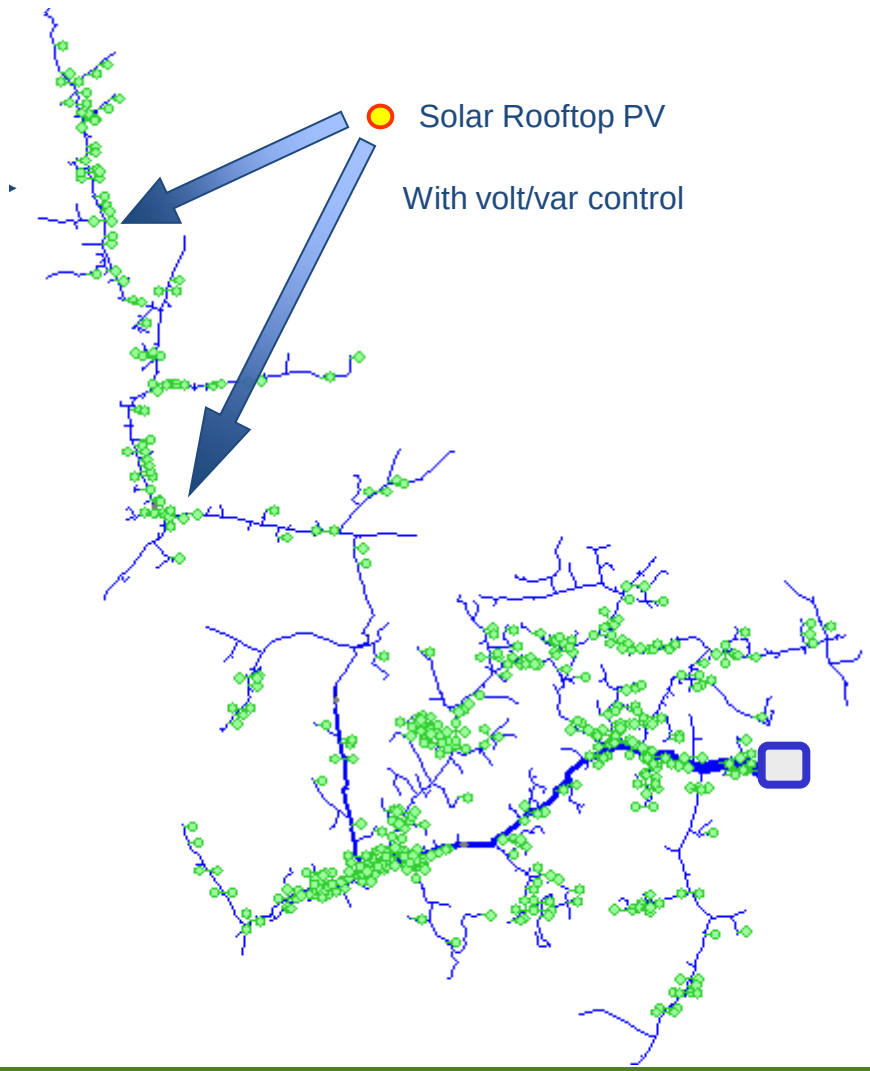
Grid Support from Advanced Inverter Function

- *Inverters are ready for participation in smart grid.*
- *However, too many manufacturer-proprietary protocols.*
- *And, grid is generally not ready to accept this help.*



For Example: Volt-Var at One Connection





24 Hour Simulation