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CPUC/CSI Initiative Research, Demo, and Deployment Program, *Grant Solicitation #3*

Screening Distribution Feeders: Alternatives to the 15% Rule

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Project Objective

Develop new methods for quickly and accurately determining the PV "hosting capacity" of individual feeders

- use available data….
  - PV size/location, settings
  - feeder characteristics and loading
- consider impact on….
  - voltage (overvoltage, voltage fluctuations)
  - protection, thermal loading/reverse power
  - power quality and reliability

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Why Consider Alternatives to Existing Screening?

- a simpler, peak-load based % rule won't be very accurate
- informed intuition doesn't always work, see comparison in table for "similar" circuits
- feeders have **specific and known characteristics** that can be used to classify/screen (load level and voltage class)
- a unique "hosting capacity" limit can be determined with relatively high confidence

Feeder Characteristics	Feeder A	Feeder B
Voltage (kV)	13.2	12.47
Peak Load	5 MW	6 MW
Minimum Load	0.8 MW	0.7 MW
Minimum Daytime Load	1.1 MW	0.7 MW
Existing PV (MW)	1.0	1.7
Feeder Regulation	Only @ Substation	Yes, highly regulated
Total Circuit Miles	28	58
Feeder "Footprint"	7 mi^2	35 mi^2
Minimum Hosting Capacity		
Due to Voltage Impacts	**>3500 kW**	**250 kW**
Due to Protection Limit	**777 kW**	**390kW**

70% of Peak Load

4% of Peak Load

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Overall Approach

- Work with utilities to document the landscape (what is the baseline? What's being done now? What works? What doesn't?)
- Determine the *range* of feeder topologies in CA
- Obtain high-resolution PV production and feeder/load data for model development and screening validation
- Perform detailed, PV deployment scenario analysis on select feeders
- Develop and validate screening methods based on findings
- Test drive with utility partners and share findings with community

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Project Partners

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San Onofre Nuclear Generating Station

Pacific Gas and Electric Company®

SDGE
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Sandia National Laboratories

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Task Breakdown

- Task 1: Project Management (EPRI Lead)
- Task 2: Document Current Screening Practices (NREL Lead)
- Task 3: Define Feeder Configurations in CA (Sandia Lead)
- Task 4: Collect High-Resolution Solar Data (EPRI Lead)
- Task 5: Detailed Modeling of Test Feeders (EPRI Lead)
- Task 6: High-Pen PV Analysis (EPRI Lead)
- Task 7: Develop Screening Methodology (EPRI Lead)
- Task 8: Validate Screening Methodology (NREL Lead)

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Task 2: Current Screening Practices

- Task Purpose
  - Investigate and document current practices for screening PV interconnection requests among California utilities and from other sources outside California.
- Approach
  - Consideration for federal, state, and local interconnection procedures pertaining to CA (Rule 21, WDAT, SGIP)
  - Consideration for non-CA and European utility screening practices as well

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Task 3: Define Feeder Configurations in CA

- Purpose of task
  - Determine the range of feeder configurations and characteristics for CA utilities
  - Identify a selection of feeders to be used in developing and validating the proposed screening methodology
- Approach
  - Develop database of feeder characteristics for statistical processing
  - Identify 20 feeders representative of range of Dx feeders in CA
    - 15 Test Feeders for methodology development
    - 5 Control Feeders for methodology validation
  - Will require each utility to provide feeder-characteristics data on Dx feeders throughout their service territory

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Task 4: Collect High-Resolution Solar Data

- Purpose of Task
  - Collect high-resolution, time-series solar data that can be used for
    - Model validation
    - defining PV output for modeling of high-penetration PV scenarios
    - Validation of screening approach
- Approach
  - From selecting feeders ID'd in Task 3, obtain high-resolution (1-sec) PV production data via new monitors and/or existing monitoring systems
  - Will require each utility member to install pole-mount and existing PV facility monitoring equipment (provided by EPRI)

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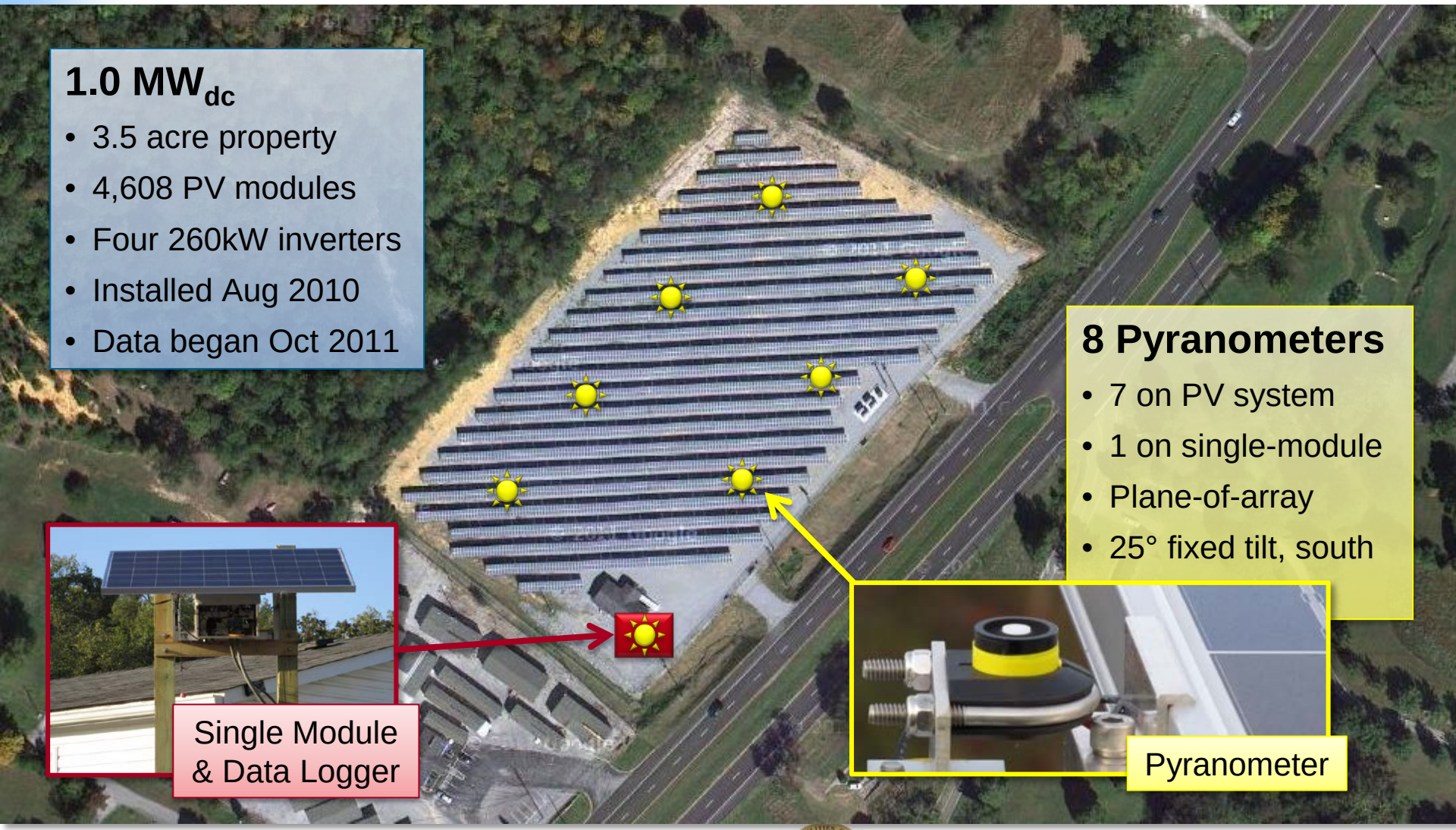
1MW PV System in Tennessee

Solar resource and AC output recorded at 1-sec resolution



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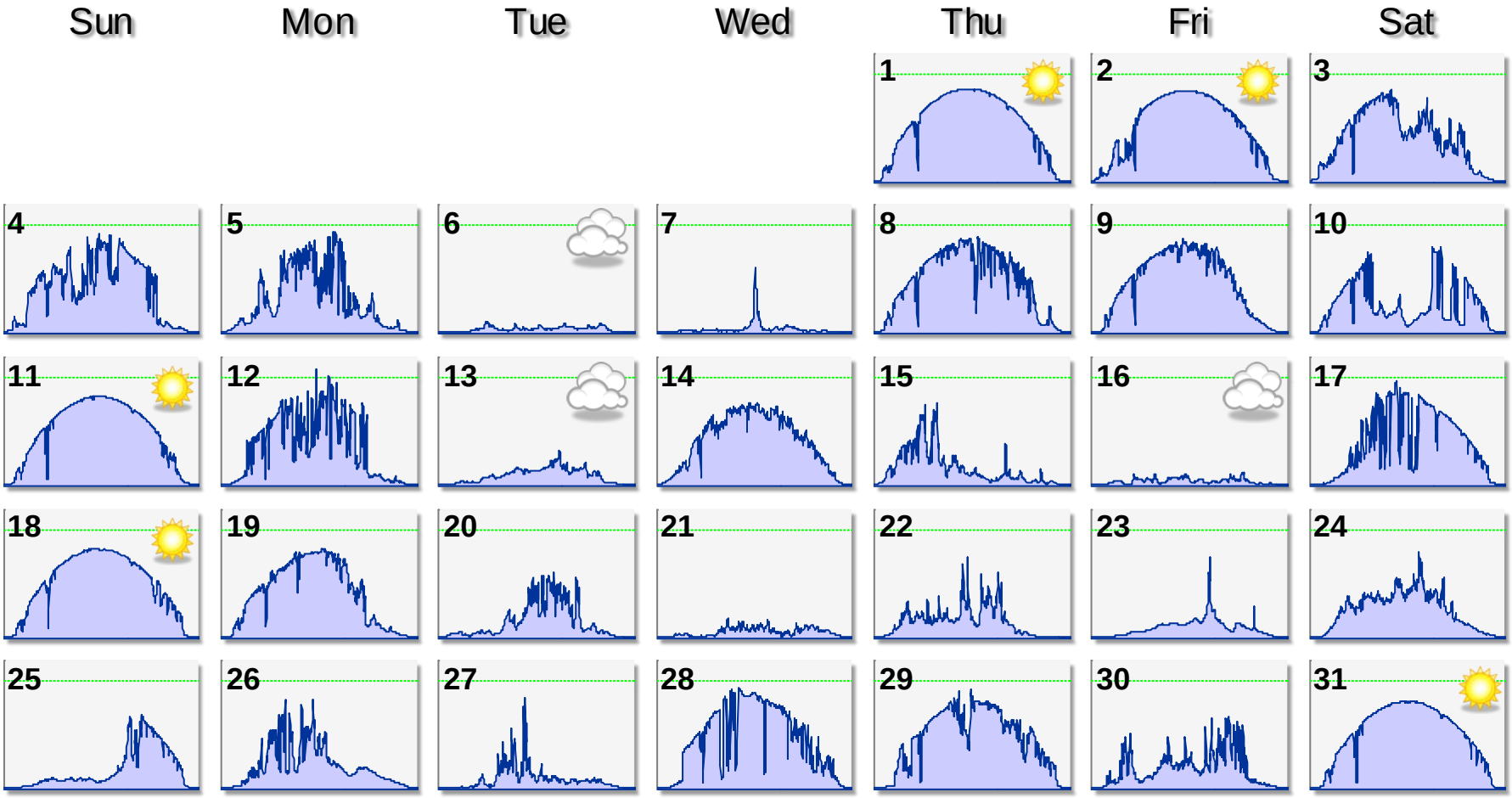
Solar Resource Calendar – Single Pyranometer

December 2011 at 1MW PV site in Tennessee

December 2011: Tennessee Plane-of-Array Irradiance



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

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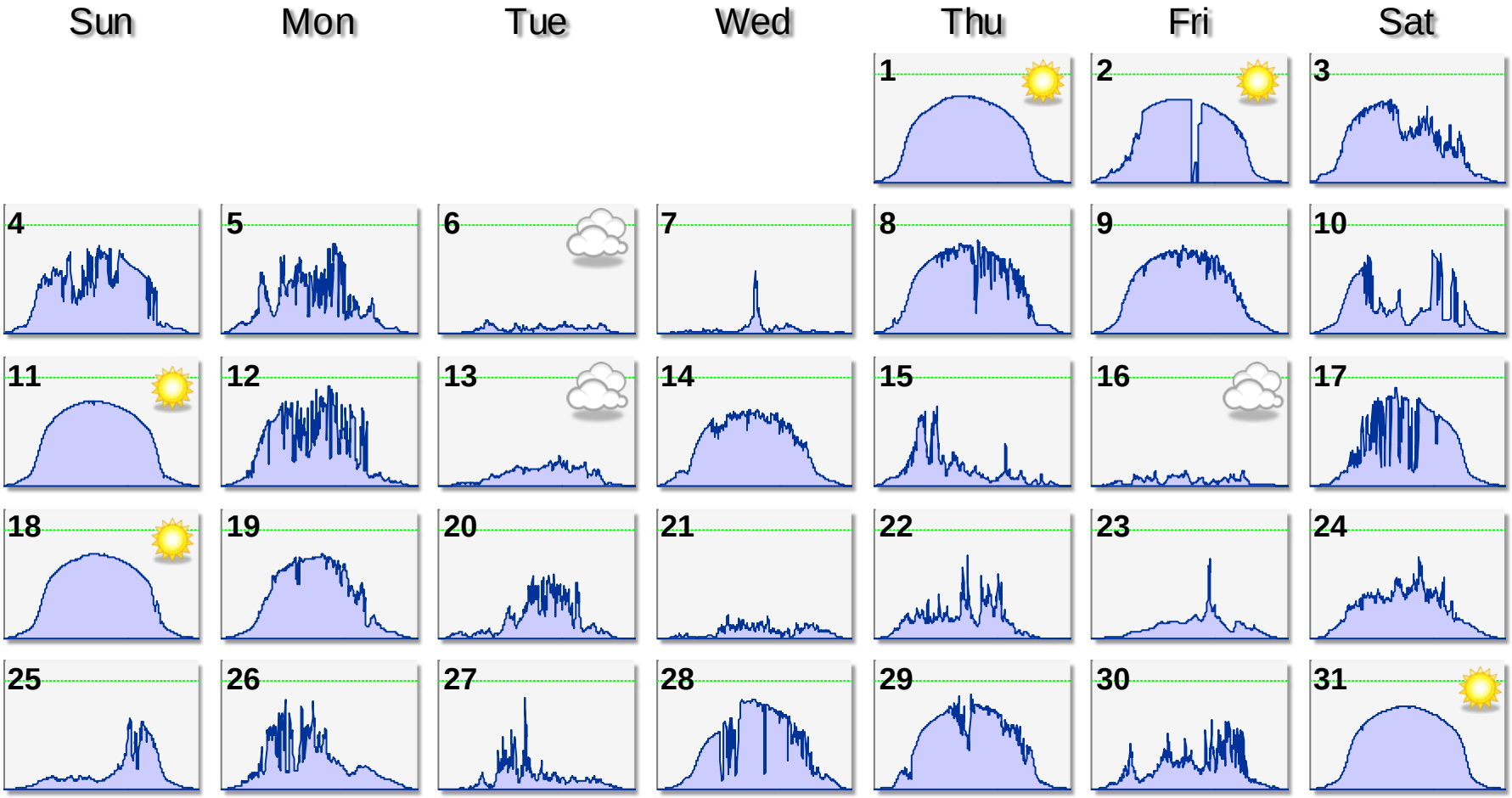
Solar Resource Calendar – AC Output Power

December 2011 at 1MW PV site in Tennessee

December 2011: Tennessee 1MW PV System Power



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

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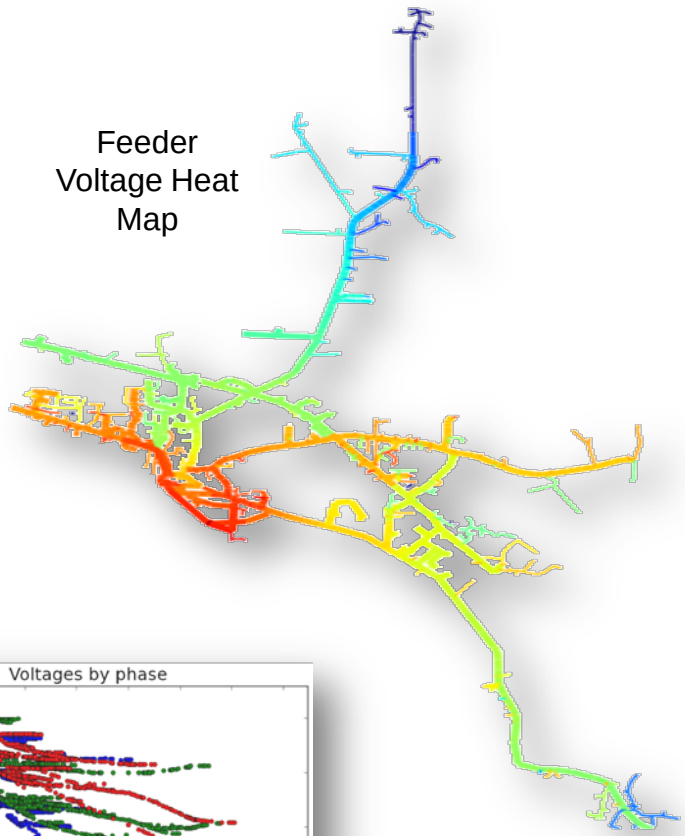
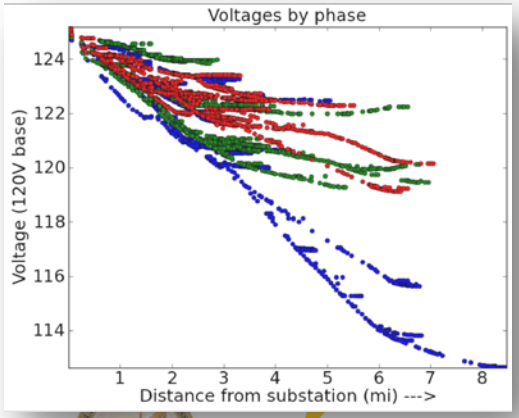
Task 5: Detailed Modeling of Test Feeders

- Purpose of Task
  - develop detailed distribution feeder models for the test group and control group of feeders
- Approach
  - Work with participating utility to obtain feeder data (incl. underlying model and auxiliary data)
  - Convert model to OpenDSS
  - Validate/verify model w/ measurement data





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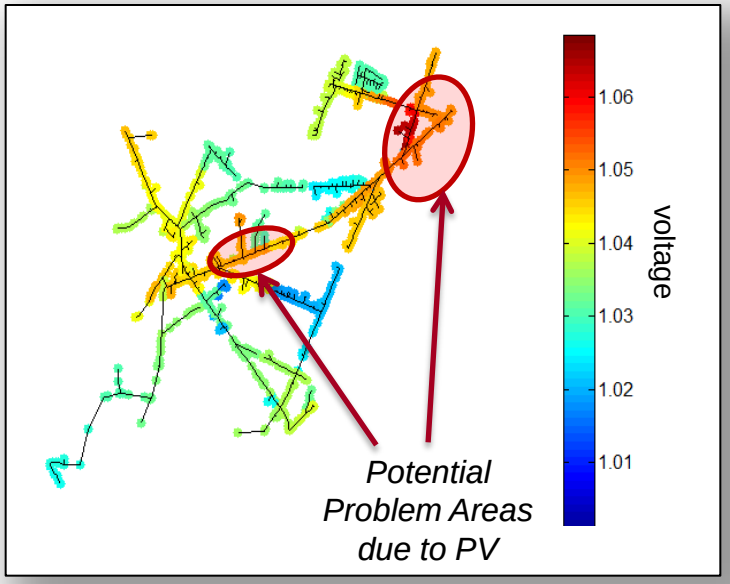
Task 6: High-Pen PV Analysis

- Purpose of Task
  - perform high-penetration assessment of the test feeders to determine each specific feeder's hosting capacity for solar PV
- Approach
  - Utilize EPRI's Distributed PV (DPV) Feeder Analysis Approach for determining feeder impacts and hosting capacity
  - Simulate a wide range of PV deployment scenarios and penetration levels on each feeder and present to utility
  - Aggregate results from test set of feeders



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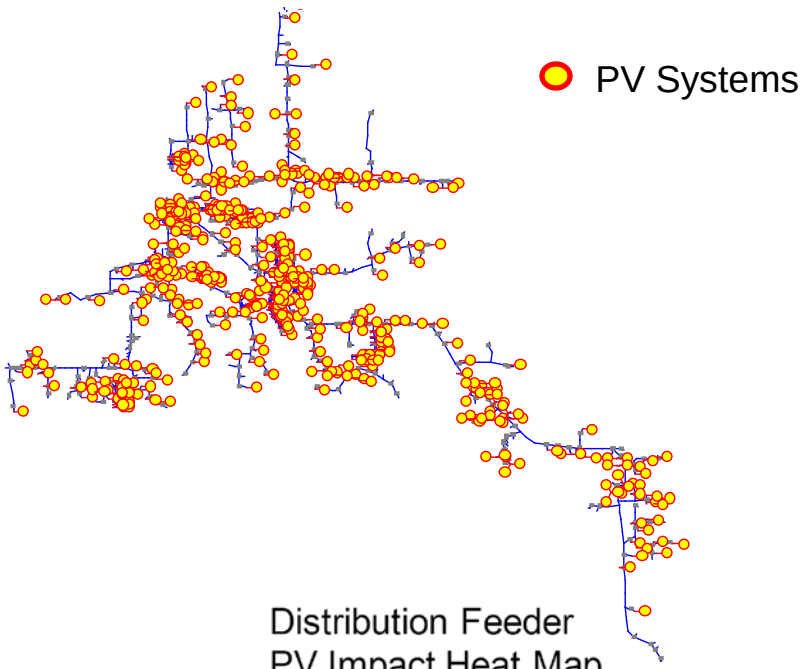
High-Level View of DPV Feeder Analysis Approach

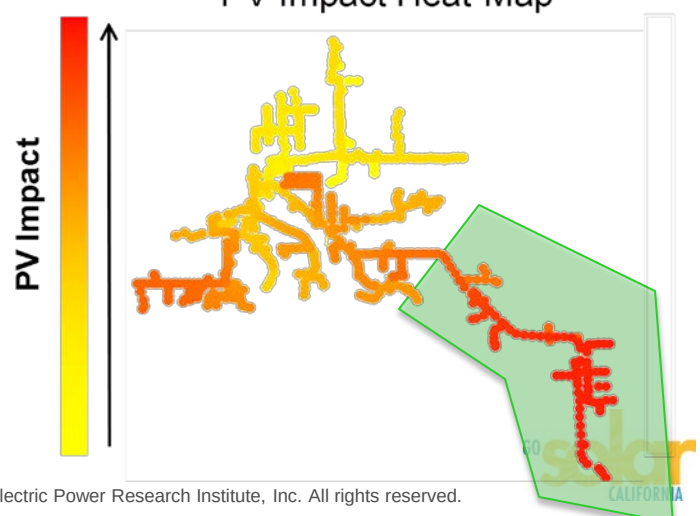
Stochastic: Multiple Scenarios and Penetration Levels



- Baseline – No PV
- PV Penetration 1
- PV Penetration 2
- PV Penetration 3
- Beyond…

Process is repeated 100's of times to capture many possible scenarios

Distribution Feeder
PV Impact Heat Map



Increase Penetration Levels Until Violations Occur

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Task 7/8: Develop and Validate Screening Methodology

- Purpose of Tasks
  - Develop and validate a practical screening criterion for evaluating new interconnection requests
- Approach
  - Using results from Task 6, analyze key factors that result in maximum and minimum hosting capacity for PV
  - Develop screening methodology/approach
  - Validate approach using control group of feeders and corresponding modeling and measurement data

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Schedule

Project Approach and Scope of Work		Year 1												Year 2											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Task 1	Project management, reporting, technology transfer, and outreach	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Task 2	Document current utility screening practices and available tools	■	■	■	■	■	■																		
Task 3	Define distribution feeder characteristics in California	■	■	■	■	■	■																		
Task 4	Collect high-resolution PV output data for use in feeder impact simulations	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■									
Task 5	Complete detailed modeling for selected feeders with particating CA utilities					■	■	■	■	■	■	■	■	■	■	■	■	■							
Task 6	Run full range of high penetration PV scenarios on selected feeders									■	■	■	■	■	■	■	■	■	■	■					
Task 7	Develop practical screening method for handling new interconnection requests															■	■	■	■	■	■	■	■		
Task 8	Validate screening method using site measurement and specific feeder data																				■	■	■	■	■

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