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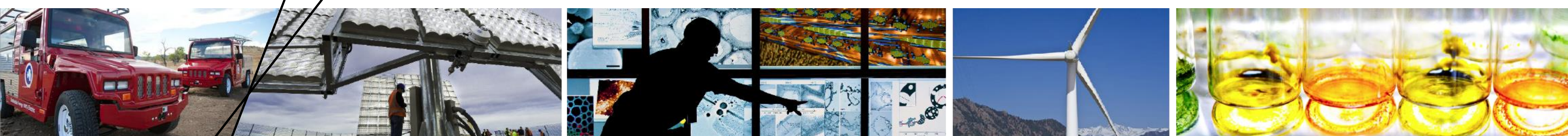
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Western Area Power Administration

Distributed Generation Interconnection Collaborative (DGIC)



"Alternate Strategies for Pre-Application Reporting and Fast Track Analysis"

Steve Steffel and Alex Dinkel, PEPCO Holdings Inc.

February 20, 2013; 11:30-1:00 MST/1:30-3:00 EST

Speakers

Steve Steffel
Manager - DER and Analytics
in Asset Strategy
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Alex Dinkel
System Planner
PEPCO Holdings Inc.

Kristen Ardani
Solar Analyst,
(today's moderator)
NREL

Pepco Holdings, Inc

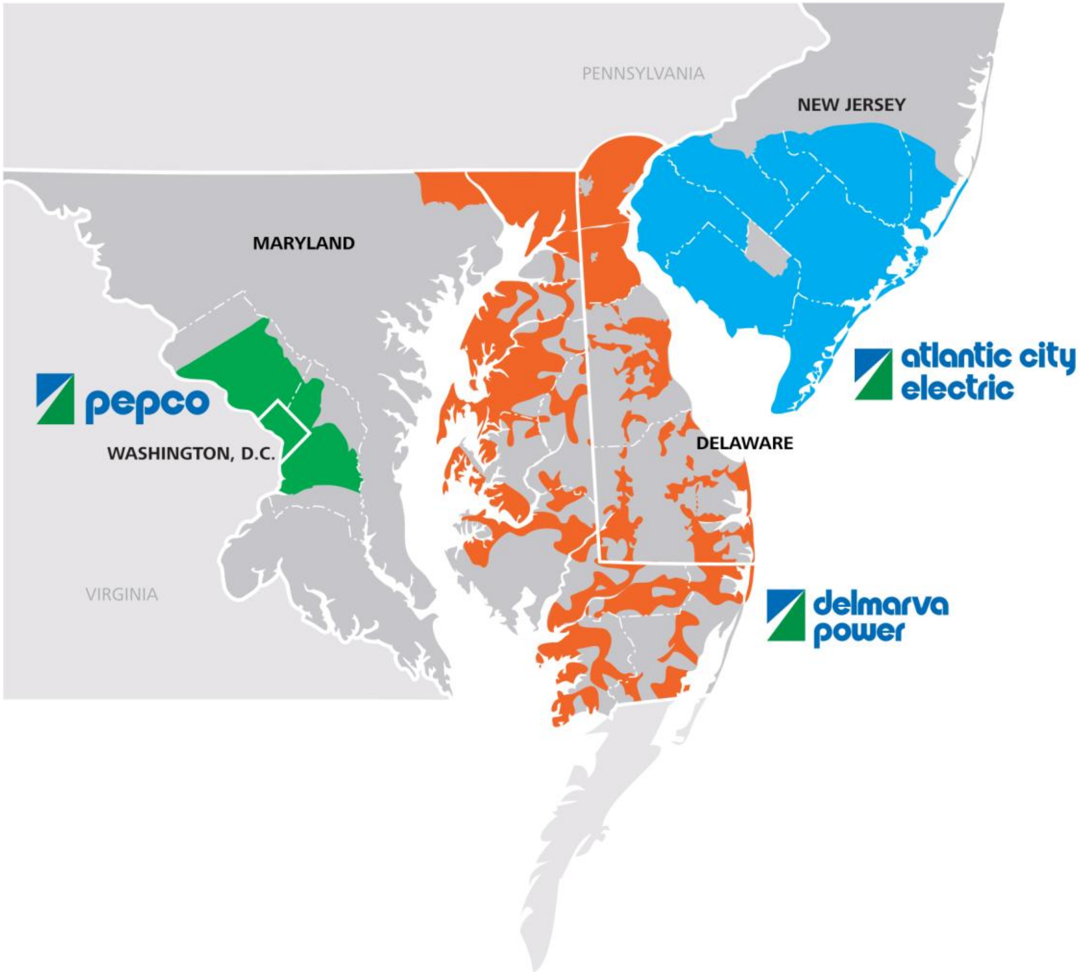
NREL DGIC Webinar: Alternate Strategies for doing the Pre-Application and Fast Track Analysis

Presented by: Steve Steffel and Alex Dinkel

February 20, 2014

Pepco Holdings, Inc. Quick Facts

- Incorporated in 2002
- Service territory: 8,340 square miles
- Customers served
  - Atlantic City Electric:
    - 545,000 – electric
  - Delmarva Power:
    - 503,000 – electric
    - 125,000 – natural gas
  - Pepco:
    - 793,000 – electric
- Total population served: 5.6 million

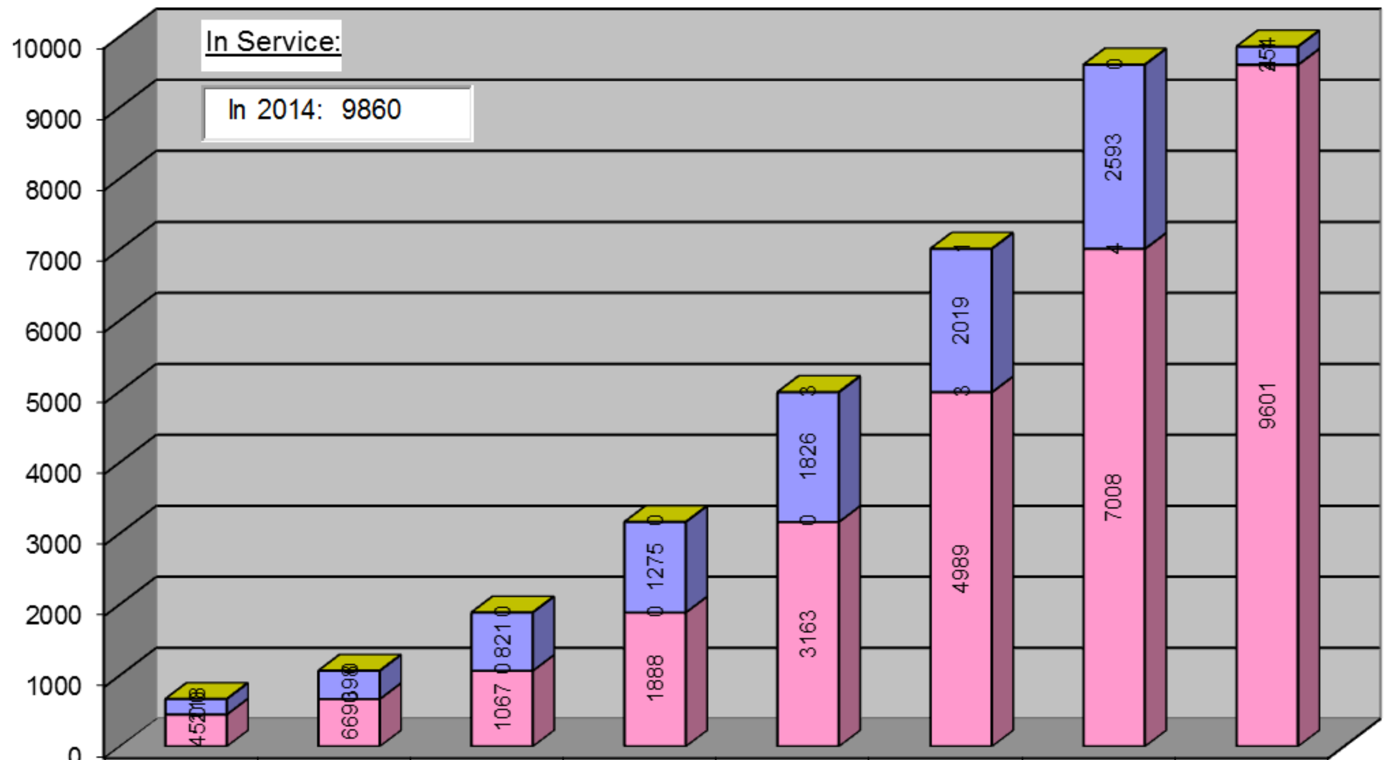


Topics

- PV Activity in Pepco Holdings, Inc. (PHI)
- Advances in Technology
- PHI's Power Flow Screening Procedure
  - Technical explanation of screens
- Why Pursue Advanced Modeling
  - Semi-automated analysis procedure in Distributed Engineering Workstation (DEW)
- Screening results and reports
  - Example Pre-App Report (alternative)
  - Example Fast Track Report (alternative)
- Reasons for the Alternate approach
- Case Study: 100 kW PV system on agricultural site
- Case Study: Reverse power flow through voltage regulator
- Case Study: 1.7 MW PV system in NJ
- Case Study: High Voltage on the Secondaries
- Collaborative R&D Efforts

PHI: NEM &PJM Projects In Service (Cumulative By IS Year)

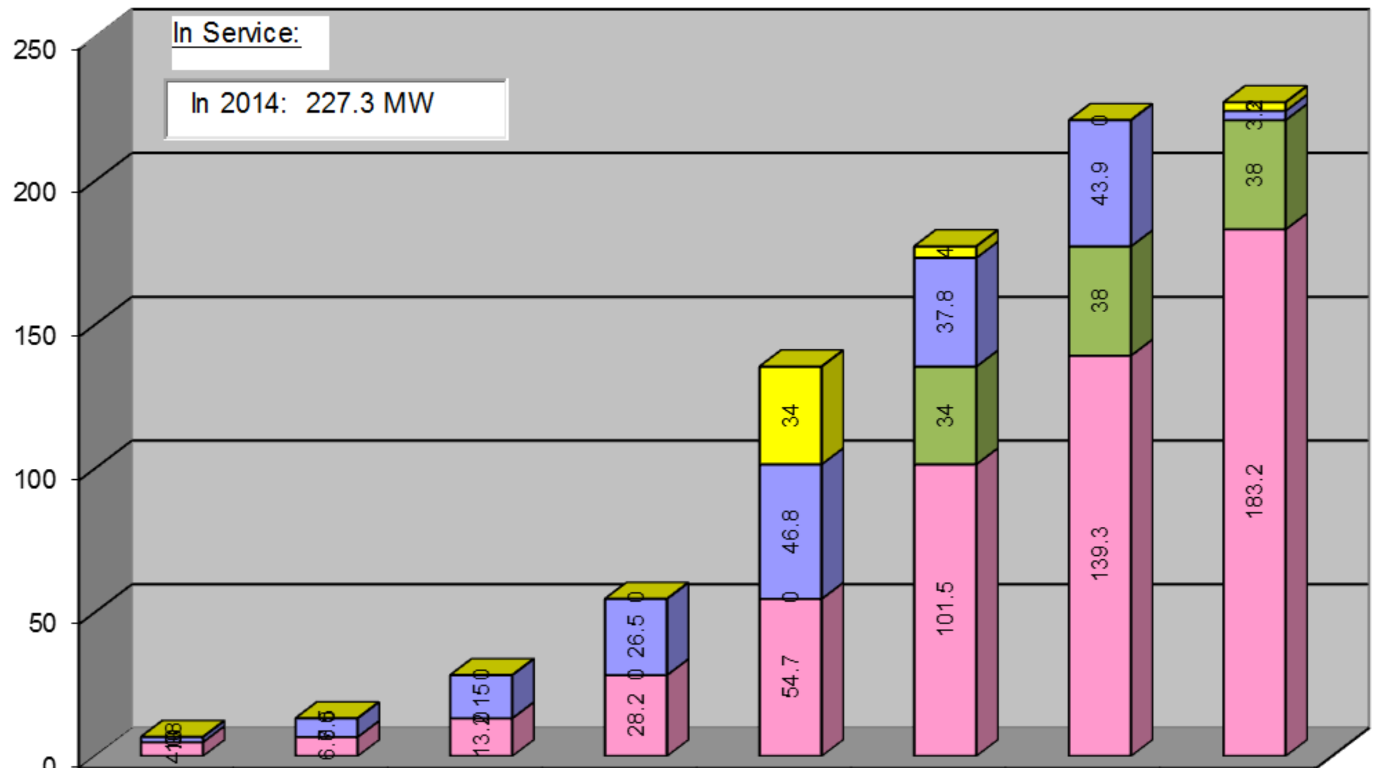
As Of: 2/4/2014



	2007	2008	2009	2010	2011	2012	2013	2014
PV-New (PJM)	0	0	0	0	3	1	0	1
PV-New (NEM)	218	398	821	1275	1826	2019	2593	254
PV-Existing (PJM)	0	0	0	0	0	3	4	4
PV-Existing (NEM)	451	669	1067	1888	3163	4989	7008	9601

PHI: NEM &PJM MW In Service (Cumulative By IS Year)

As Of: 2/4/2014



	2007	2008	2009	2010	2011	2012	2013	2014
PV-New (PJM)	0	0	0	0	34	4	0	3
PV-New (NEM)	1.8	6.5	15	26.5	46.8	37.8	43.9	3.2
PV-Existing (PJM)	0	0	0	0	0	34	38	38
PV-Existing (NEM)	4.9	6.7	13.2	28.2	54.7	101.5	139.3	183.2

Smart Energy

SMART GRID

- ISO (Independent Sys.Operator)
  - Bulk Generation
  - Bulk Transmission
    - Synchrophasors
  - Bulk Load Control
- LDC (Local Distribution Co.)
  - Transmission
  - Substation
    - Power Transformers
  - Distribution
    - Improved Comms
    - Distributed Automation
    - PMU Sensors
    - Microprocessor control
    - DMS
  - DSM, DR
- AMI
  - Outage Mgmt
  - Real Time Pricing
  - Load Profile Info
  - HAN (Home Area Network)
    - Price and other comm.

SMART INVERTER

- LV & Freq. Dev. Ride Thru
- Voltage & Ramp Control
- Autonomous & Centralized Control
  - -- VAR/PF Control
    - Fixed/Dynamic
    - Algorithm based
  - Curtailment
  - Remote Trip
- BATTERY (integrated or separate)
  - Premium Power
  - Voltage Control
  - Frequency Regulation
  - Spinning Reserve
  - Arbitrage (TOU or Real Time Pricing)
  - Demand Side Mgmt.
  - Peak Demand Mgmt.

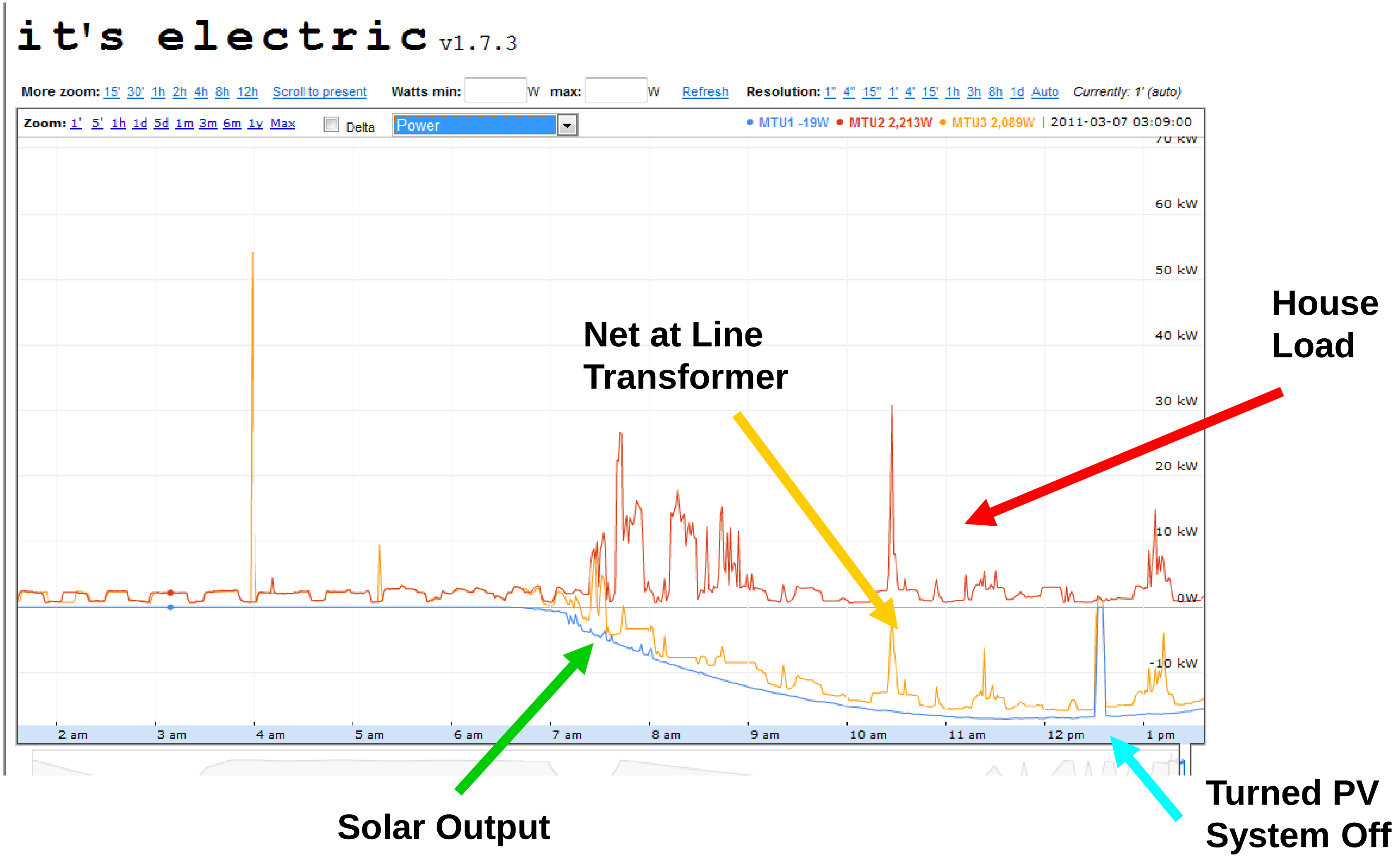
SMART PREMISE

- HEMS (Home Energy Mgmt System)
  - Pricing Signal Response
  - Peak Load Control
- DER (Distributed Energy Resource)
- Renewables, CHP, etc.
- Smart Thermostat
- Smart Appliances
- Smart HVAC
  - Thermal Storage
- EV
  - Controllable Charging, V2G
- Remote Access and Control
- Energy Efficiency & Controls
  - Turn off Phantom Loads
  - Vacant space mgmt.
- Direct Use of DC

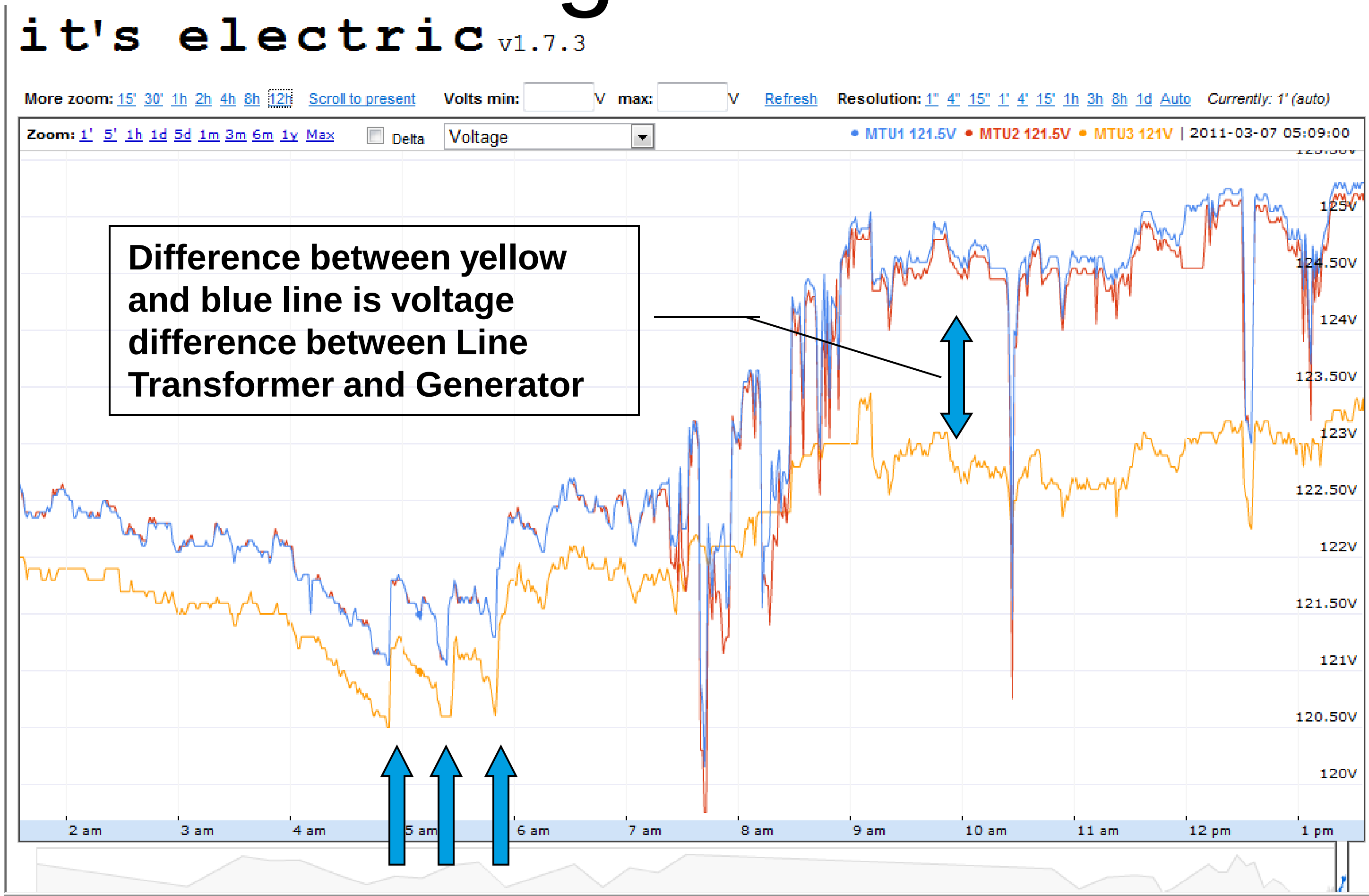
Voltage Regulation Issue

- Voltage Requirements at the Customer Meter
  - At Peak Load
  - At Low Load
  - NEW – While Exporting Power
- ANSI and State Requirements
- Paradigm Change Requires New Measures
  - Provide “Voltage Headroom” for DER customers
  - Other customers not generating must receive adequate voltage

Power vs. Time



Voltage vs. Time



Substation transformer adjusting voltage

Pre-Screens, Screens, Study Requirements

- Size range and requirements for a Pre-Screen (or very high level review): 50-250 kW
  - Insures systems at the end of rural feeders won't cause a problem (ie 100kW farm system on single phase lateral was identified as potentially adverse)
- Size range and requirements for a Screen (or static level load flow review): over 250kW
  - Determines if a larger system will have an impact requiring a more detailed study

- NOTE: Doing the load flows with all active and pending PV mapped onto the circuit and occasional aggregate analysis will catch areas that may become a voltage problem due to concentrations of small units.

Sample Power Flow Criteria (May vary by utility)

Criteria			Limit
Voltage	Overvoltage		1.04 – 1.05 pu
	Voltage Fluctuation	At Regulator	½ of bandwidth
		At Capacitor	½ of deadband*
		At POI	2%
Protection	Fault Contribution		10%
	Sympathetic Trip		150 A
	Reduction of Reach		10%
	Fuse Saving		100 A

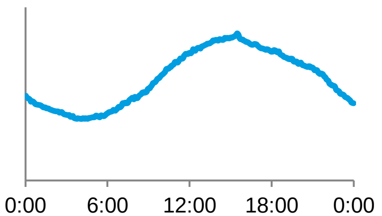
- Cap Deadband is defined as (OFF Voltage – ON Voltage) - Cap Switch Voltage Rise
  (not all caps use voltage for primary control – may use VARs, Temp, Current, Time, etc.)

Why Pursue Advanced Modeling

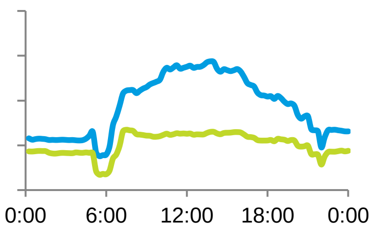
- Significant increase in DERs - aggregate impact must be assessed
- Masking/uncertainty of feeder peak load, need PV forecast
- Requires an automated mapping of DERs into the load flow model
- Many detailed studies require time series analysis
- Impacts on load tap changers, voltage regulators and switched cap banks must be checked
- Many applications - need for semi-automated impact assessment
- Impacts on protection must be checked
- Makes planning and operation of automatic sectionalizing and restoration schemes much more complex
- Some DER output reduces losses, some increase losses
- Must evaluate transmission on distribution impact and vice versa
- Need to simulate the secondary to model voltage at the meter

Where Do the Criteria Come From?

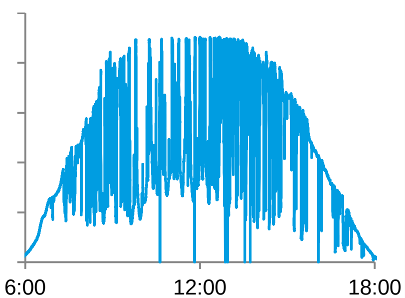
Time Varying Inputs



Load Curve

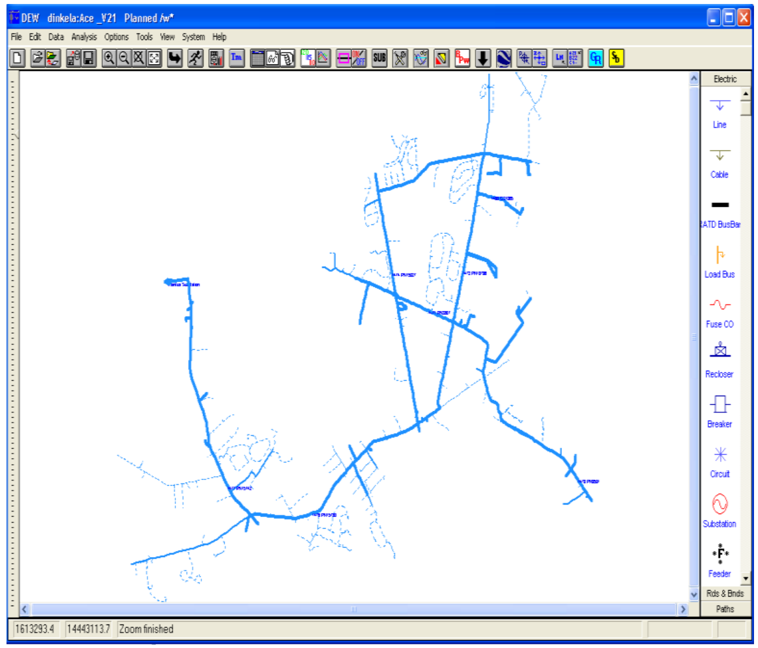


Customer Profile

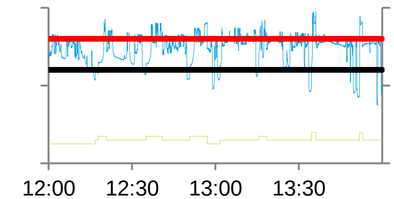


Generation Profile

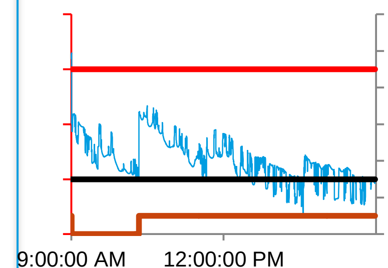
DEW Model



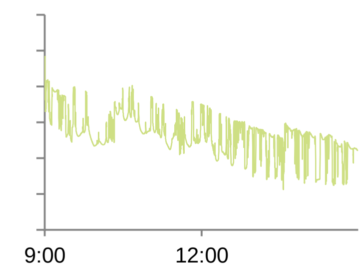
Time Varying Outputs



Regulator Voltage Position and Count



Cap voltage and status



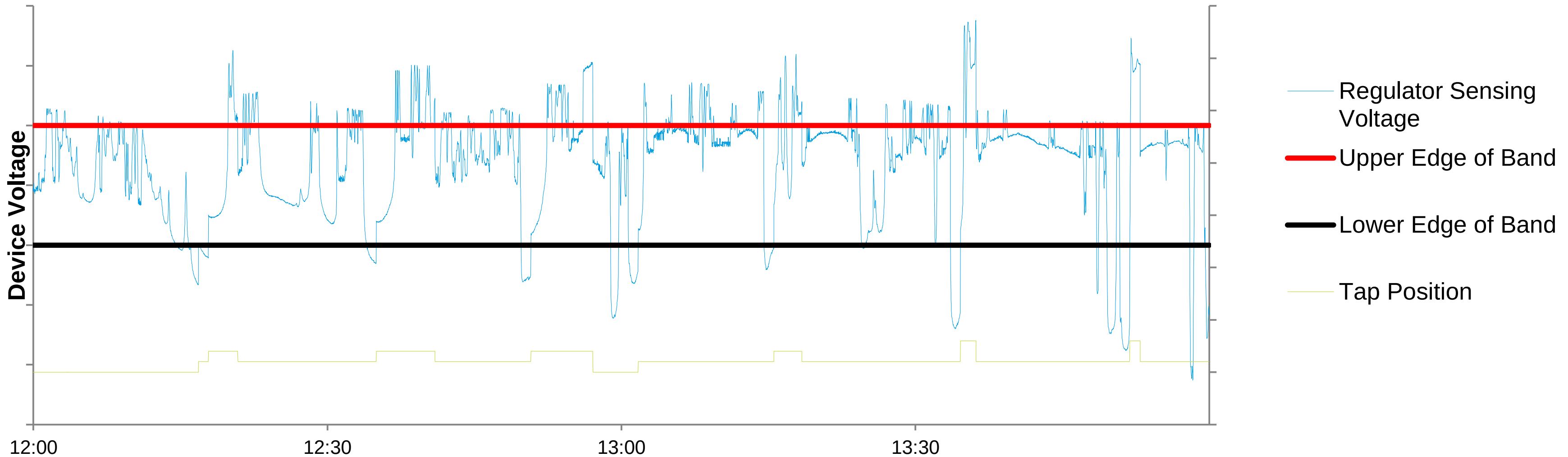
Point of Interconnection Voltage

Simulate 1 second intermittent generation profiles interacting with 30 – 90 second voltage regulation time delays

Where Do the Criteria Come From?

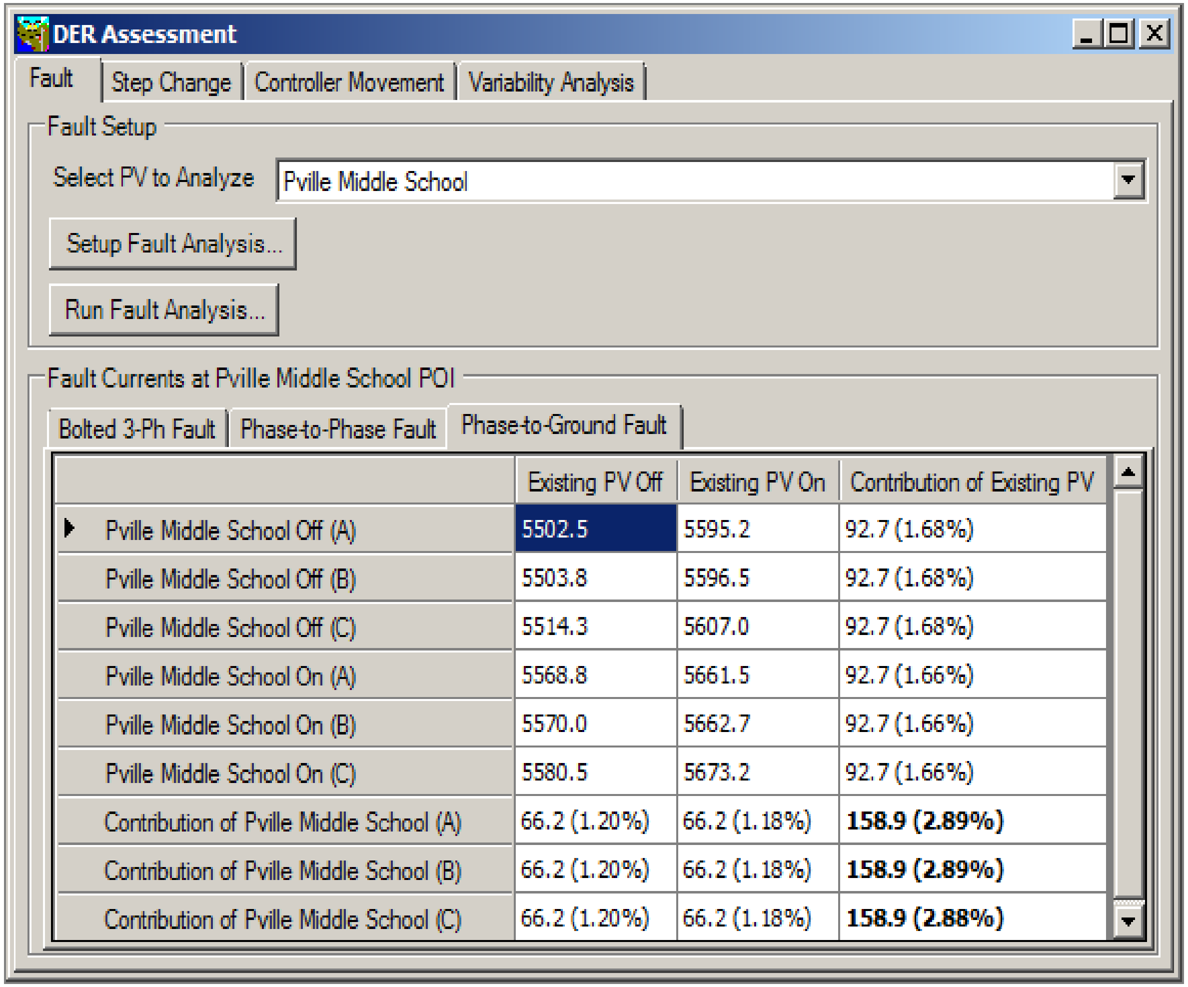
- Use Time Series simulations to analyze and understand how variable resources such as solar, wind, and battery storage impact a distribution feeder
- Simulate interaction between LTC, Capacitors, and regulators in 1 second intervals
- Create a timeline of which device operates in what order and understand how the devices coordinate and interact with each other
- Simulate regulator behavior using the logic programmed into the controller [below.] The voltage regulator is set to operate its tap changer to correct voltage after a 60 delay. View duration and severity of voltage deviations before the regulator has time to react and the tap position of the regulator and its cumulative number of operations (not shown.)

Voltage Regulator Operation from the perspective of the CL6



Using DEW to Evaluate Power Flow Criteria

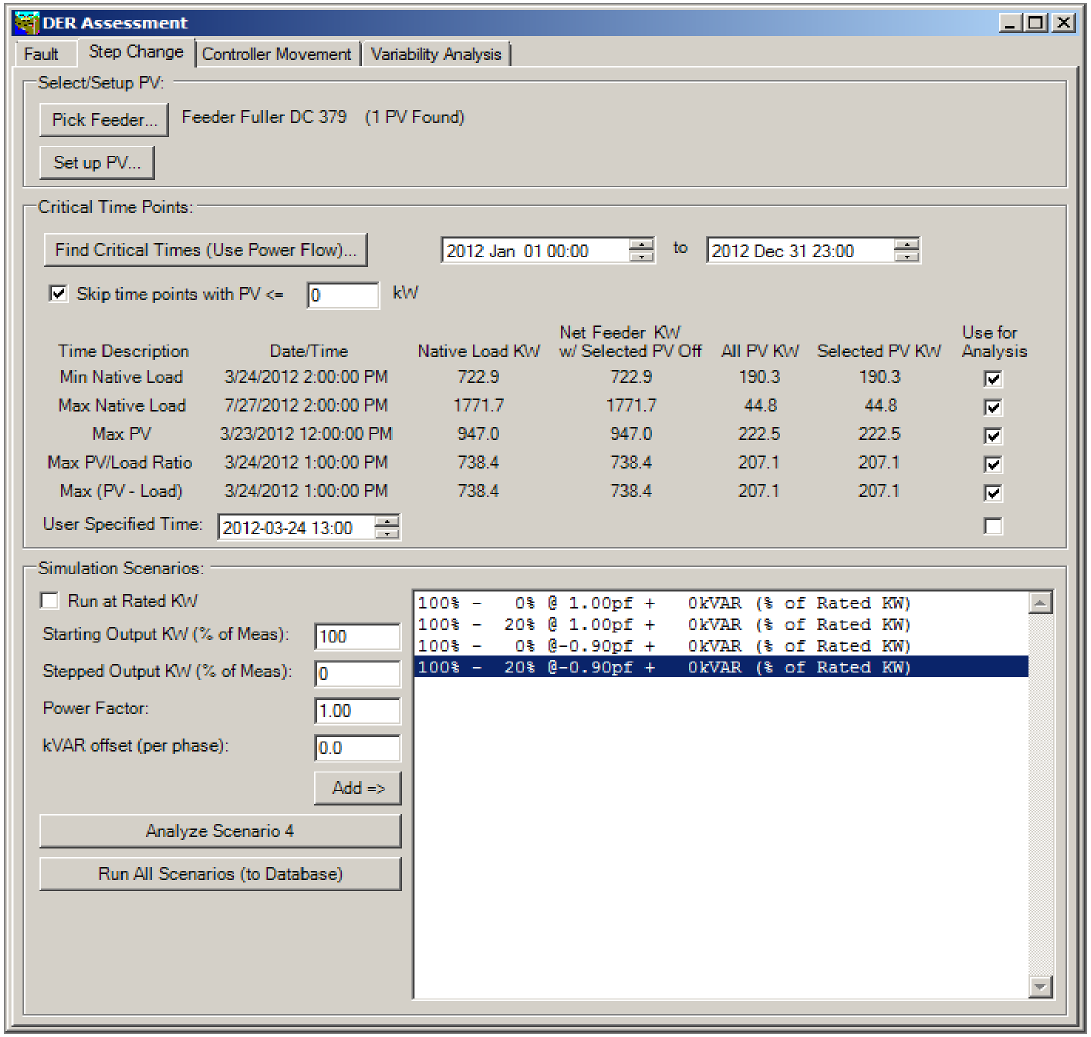
- Calculate Fault current on primary side of interconnection transformer with and without generator



	Existing PV Off	Existing PV On	Contribution of Existing PV
Pville Middle School Off (A)	5502.5	5595.2	92.7 (1.68%)
Pville Middle School Off (B)	5503.8	5596.5	92.7 (1.68%)
Pville Middle School Off (C)	5514.3	5607.0	92.7 (1.68%)
Pville Middle School On (A)	5568.8	5661.5	92.7 (1.66%)
Pville Middle School On (B)	5570.0	5662.7	92.7 (1.66%)
Pville Middle School On (C)	5580.5	5673.2	92.7 (1.66%)
Contribution of Pville Middle School (A)	66.2 (1.20%)	66.2 (1.18%)	**158.9 (2.89%)**
Contribution of Pville Middle School (B)	66.2 (1.20%)	66.2 (1.18%)	**158.9 (2.89%)**
Contribution of Pville Middle School (C)	66.2 (1.20%)	66.2 (1.18%)	**158.9 (2.88%)**

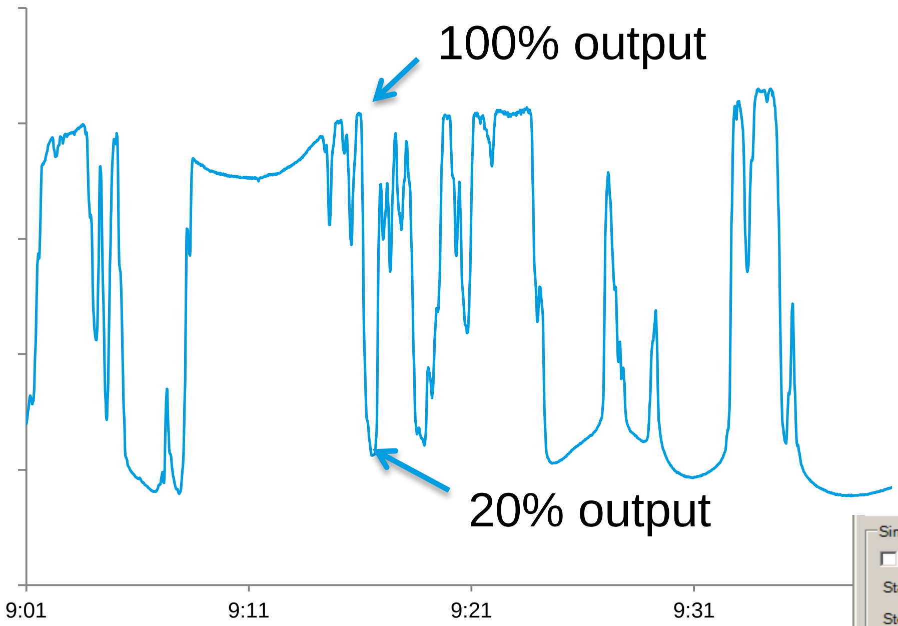
DEW

- Quasi Static power flows determine voltage fluctuation

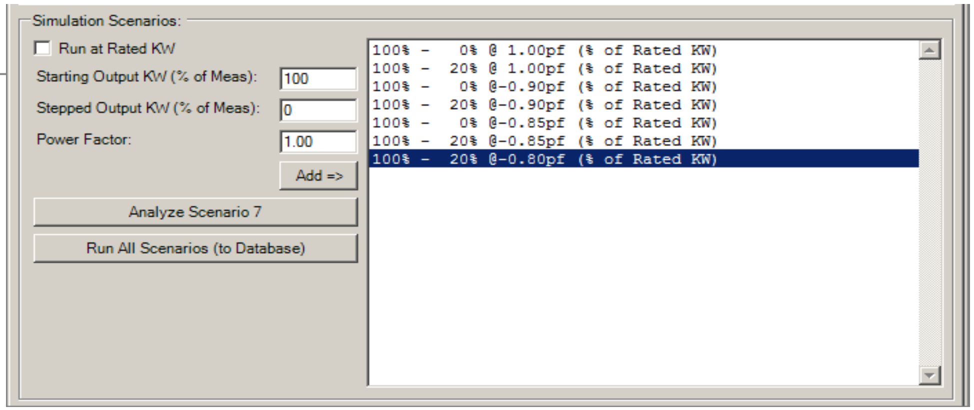


DER Assessment – Step Change

Select depth of fluctuation, then simulate only the points before and after the fluctuation to see impact quickly and easily



- DEW automatically locks caps and regs while the PV system output changes allowing the user to view just the PV system's affect on voltage



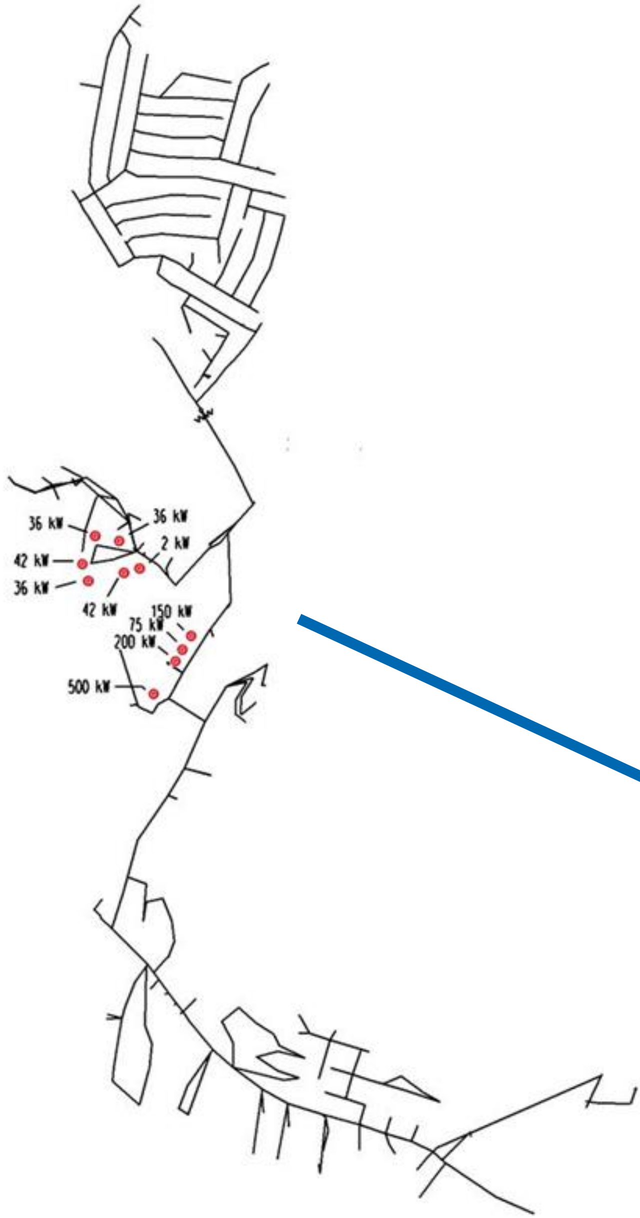
DER Assessment – Step Change

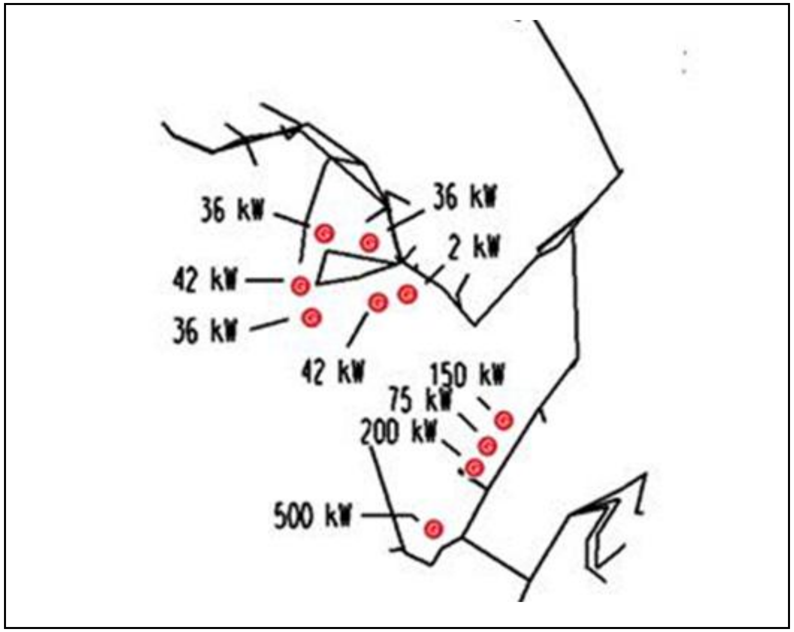
- Run multiple power flows automatically and view results quickly in one report
- Run multiple absorbing generator power factors with one mouse click and visually select the least restrictive value that meets PHI criteria
- Example: select a power factor where voltage fluctuation does not exceed the 2% (2.4V on 120V base) criteria:
  - PF Voltage Fluct
  - 1.00 5.5 V Exceeds Criteria
  - 0.99 3.8 V Exceeds Criteria
  - **0.98** **2.1 V** Passes
  - 0.97 0.6 V Passes (may be reqd in future w/more close by PV)
  - 0.96 - 1.2 V Exceeds Criteria

	Feeder	Component Name	Component UID	Component Type	Phase	1.0 PF lossFrzVchg (A)	1.0 PF lossFrzVchg (B)	1.0 PF lossFrzVchg (C)	isPVstepped	.99 lossFrzVchg (A)	.99 lossFrzVchg (B)	.99 lossFrzVchg (C)	.98 lossFrzVchg (A)
▶	Mantua T...		UID_0_1_15_123	Transmission Trans...	ABC	-0.17	-0.16	-0.16	N/A	-0.09	-0.08	-0.09	-0.05
	f_NJ2041	1474 PN15327	1474_Cap	Switched Shunt Ca...	ABC	-3.08	-2.30	-1.88	N/A	-2.19	-1.48	-0.99	-1.81
	f_NJ2041	Regulator	Regulator	Voltage Regulator	ABC	-3.66	-2.73	-2.20	N/A	-2.58	-1.74	-1.12	-2.11
	f_NJ2041	Gloucester City Coll	PV1	Inverter Type DR	ABC	-4.66	-3.68	-3.08	Yes	-2.98	-2.09	-1.42	-2.26
	f_NJ2041	Gloucester Vo Tech	UID_0_1_2468_65	Inverter Type DR	ABC	-5.48	-4.50	-3.84	Yes	-3.13	-2.24	-1.50	-2.11
	f_NJ2041	Gloucester Vo Tech	UID_0_1_2469_65	Inverter Type DR	ABC	-5.48	-4.50	-3.84	Yes	-3.13	-2.24	-1.50	-2.11
	f_NJ2041	1468 G21065	1468_Cap	Switched Shunt Ca...	ABC	-4.61	-3.56	-2.93	N/A	-3.37	-2.42	-1.70	-2.83
	f_NJ2041	1472 PN10736	1472_Cap	Switched Shunt Ca...	ABC	-3.99	-3.01	-2.44	N/A	-2.84	-1.96	-1.30	-2.35
	f_NJ2041	1471 PN2807	1471_Cap	Switched Shunt Ca...	ABC	-3.59	-2.67	-2.14	N/A	-2.52	-1.69	-1.08	-2.06
	f_NJ2041	1470 PN3591	1470_Cap	Switched Shunt Ca...	ABC	-3.60	-2.68	-2.15	N/A	-2.53	-1.69	-1.08	-2.07
	f_NJ2041	1476 PN15780	1476_Cap	Switched Shunt Ca...	ABC	-2.26	-1.71	-1.44	N/A	-1.63	-1.13	-0.81	-1.35
	f_NJ2041	1477 PN15742	1477_Cap	Switched Shunt Ca...	ABC	-1.61	-1.24	-1.06	N/A	-1.17	-0.82	-0.61	-0.97

Concentrations

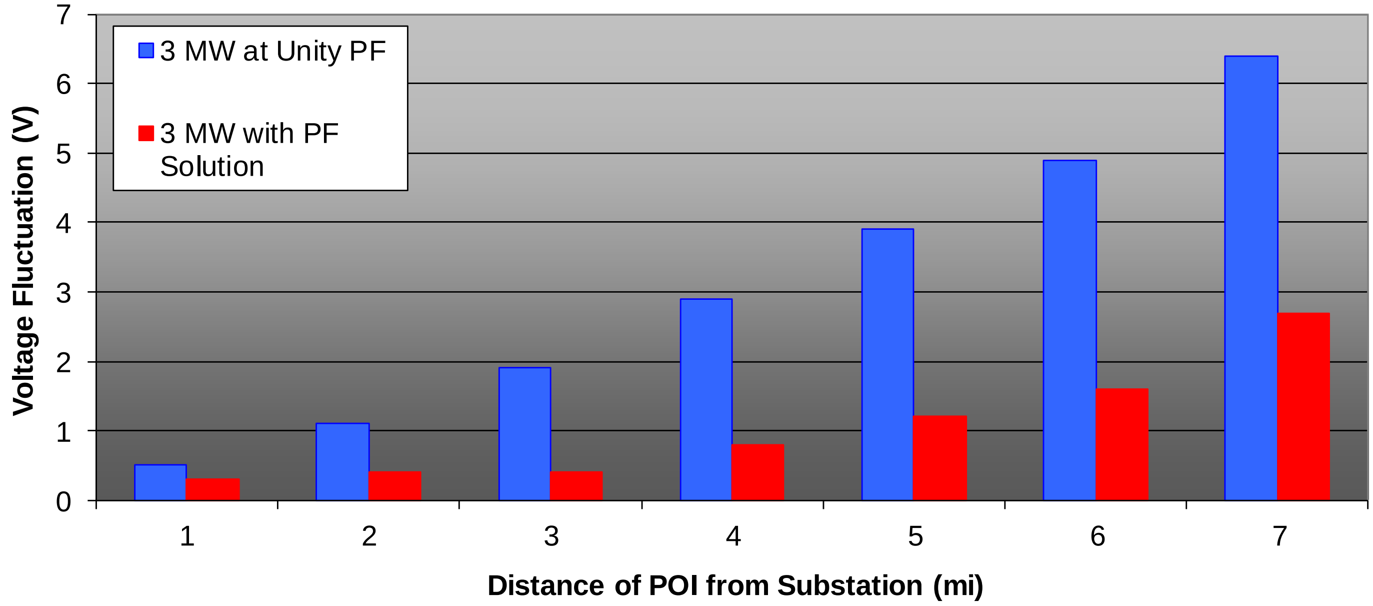
- Concentrations of smaller systems can have the same effect as larger systems.





Fixed Power Factor

Absorbing Power Factor Solution For PV Inverters
3 MW System: Voltage Fluctuation at Point of Interconnection (POI) vs. Miles from Substation
Power Factor Limited to +/- 0.95 by Criteria



Power Factor Selected	**0.99**	**0.98**	**0.97**	**0.95**	**0.95**	**0.95**	**0.95**

Sample Pre-application Report

The results of the pre-application report are non-binding. Information provided below is subject to change. It is informative in nature only and does not hold a position in the interconnection queue.

Voltage Level at POI: .480 kV
Feeder Voltage Level: 12.47 kV
Number of Phases: 3
Availability of Circuit: Open/Restricted/Closed
Circuit Type: Radial/Area Network
If three phase service is not available but requested, distance to nearest three phase circuit: N/A

The following criteria were evaluated to determine the largest AC size of a distributed generator that shall be permitted to interconnect at the POI specified by the customer without any system modifications. Power factor mitigation has been incorporated when it would allow for a larger system size. A power factor of 0.95 was used for this calculation.

Available Circuit Capacity per Criteria			1500	kW
Circuit Injection Limit	3000	kW		
Installed Generation	1000	kW		
Pending Generation	500	kW		
Voltage Fluctuation			500	kW
Steady State High Voltage			800	kW
Reverse Power Flow			1200	kW
Final Result			**500**	**kW**

Power Flow Screening Results Provided to Applicant (Alternative to Fast Track Screen)

Transparency

The following criteria were evaluated in response to the customer's interconnection request (violations in red.) **A power factor of 0.97 is required** to mitigate voltage impact.

	Before Generator	With Generator	Screening Criteria
Voltage Fluctuation			
At POI	n/a	0.17%	2.0%
At nearest voltage regulation device	n/a	0.08%	1.0%
Steady State High Voltage at Low Load*			
Highest Voltage Simulated at POI	102.50%	102.67%	105.00%
Highest Voltage Simulated on Feeder	103.42%	103.50%	105.00%
Reverse Power Flow			
Generator Rating Divided by Minimum Load by Device			
Voltage Regulator	22%	115%	80%
Feeder Terminal	15%	37%	80%
Substation Transformer	8%	14%	80%

*Low Load values are used from 9am - 3pm for PV when available

Customer Options

1. In order for the application to be approved at this size, Regulator P1234 must have settings changed to "co-generation" mode. The customer will be responsible for the cost of this upgrade.
2. The customer may revise the interconnection application to 600 kW and proceed without system upgrades.

Explanation of Screens Provided to Applicant

- Voltage Fluctuation – This metric is used to assess the DER's impact on distribution feeder voltage. It quantifies the difference in feeder voltage between when the system is running at full output and directly after the generation has been suddenly lost. Larger systems and systems connected further from a substation tend to have a higher voltage fluctuation value. An absorbing power factor can be used by the generator to avoid violations of this criterion or to increase the amount of generation which will pass the criterion at a particular location. If this criterion is violated an impact study will be required to ensure that voltage can be maintained within applicable standards.

- Steady State Overvoltage – A simulation is performed which predicts how high the voltage will rise at the worst case hour of the year. For solar generators, daytime minimum load is used in this simulation. The system is simulated in steady state. In some cases, steady state high voltage can be mitigated by changing settings on voltage regulation equipment, which may be considered a minor system modification if the setting change has a minimal impact on the operation of the circuit.

- Reverse Power Flow – Some devices may require setting changes, a re-evaluation of their control scheme, or replacement if reverse power flow is possible. This is determined using minimum load or daytime minimum load depending on the type of generation. When a reverse power flow related voltage, power quality, or reliability concern has been identified, a conservative method will used to estimate when reverse power flow will occur. For example, if a voltage regulator will mis-operate if it experiences reverse power flow, PHI will only allow generation up to 80% of daytime minimum load estimated downstream of the voltage regulator.

Criteria Supplied to Applicant

1. Single Phase Limit
The largest capacity single phase generator or DER (battery) operating in parallel with the gird is 100kW. Above that size, a balanced 3 phase system is required.

2. Voltage Limits
DERs are permitted to cause up to 2% voltage fluctuation at the Point of Interconnection and ½ the band width of any voltage regulator or ½ the net dead band of a capacitor bank. DERs in maximum output, are permitted to raise feeder voltage to the ANSI or state limit whichever is more conservative.

3. Existing Distribution Circuit Capacity Limits
The aggregate limit of large (250 kW and over) generators running in parallel with a single, existing distribution circuit is 0.5 MWs on the 4kV, 3MWs on the 12 kV, 6 MWs on the 25 kV, and 10 MWs on the 34 kV.

4. Express Circuit Capacity Limits
Distributed generation installations which exceed the limit for an existing circuit require an express circuit.

The maximum generator size for express circuits shall be:

- 4 kV 0.5 MW
- 12 – 13.8 kV 10 MWs
- 23 – 25 kV 10 MWs
- 33.26 – 34.5 kV 15 MWs

Criteria Supplied to Applicant

5. Distribution Power Transformer Limit

The aggregate limit of large (250 kW and over) generator injection to a single distribution transformer of 22.5 MVA nameplate or larger is 10 MWs. Transformers with nameplate ratings lower than 22.5 MVA will be given lower ratings on an individual basis. If the transformer rating is significantly greater than 40 MVA it may be possible to consider a greater generation capacity.

Adding a new transformer will be considered if there is no availability on any of the existing transformers and space is available in an existing substation. Any proposed transformers would be PHI's standard distribution transformer (37 MVA nameplate rating.)

6. Express Circuit Length Limit

If there is no more injection capacity or space for an additional transformer at the closest substation, the next closest substation will be considered. The length of an express circuit is limited to 5 miles, or for the sake of the feasibility study, 3.8 straight line miles to the substation. This simplification is used because the feasibility study phase does not allow for the time and resources to examine routes in detail (including existing pole lines, easements, ROW, and environmental issues etc.)

7. When a New Substation is Required

If a distribution express circuit can't be built from an existing substation for a project, it will be necessary to construct a new distribution substation with a standard ring bus design. It will be supplied by extending existing transmission lines. In NJ, it is the developer's responsibility to verify eligibility of this configuration for solar renewable energy certificates with New Jersey's Clean Energy Program if desired.

All limits, given above in MWs, are subject to more detailed study to ensure feasibility.

“Hosting Capacity” as an Alternative to the SGIP

- It is more accurate. Although the SGIP screens are pretty good, they do not catch every problem.
- It is what the developer wants – actionable results
- As utilities collect and harness data better, it will be just as quick
- Saves time on any final studies needed
- Use utility criteria to study applications and meets FERC reqts.
- Incorporate advanced features including PF settings
- Giving out distribution system data *(next slide)* as required by the SGIP can lead to:
  - Security issues
  - Speculation by those receiving the info
  - The need to insure stale data is not used
  - A push by State or other authorities to have 3rd party firms use the data to do the calculations utilities should be responsible for.

Distribution System Data – SGIP Pre-application Report

- Total capacity and available capacity of the facilities that serve the Point of Interconnection
- Peak and minimum load data
- Circuit distance between the proposed Point of Interconnection and the substation likely to serve the Point of Interconnection
- Number and rating of protective devices and number and type of voltage regulation devices between the proposed Point of Interconnection and the Substation
- Limiting conductor ratings from the proposed Point of Interconnection to the Substation

Challenges

- Availability of Data (GIS, voltage regulation settings, load data)
- Availability of Analysis Tools (Power flow program with capabilities, power flow model)
- Power flow model must be created in advance for power flow screening of distributed generation to meet time and financial constraints

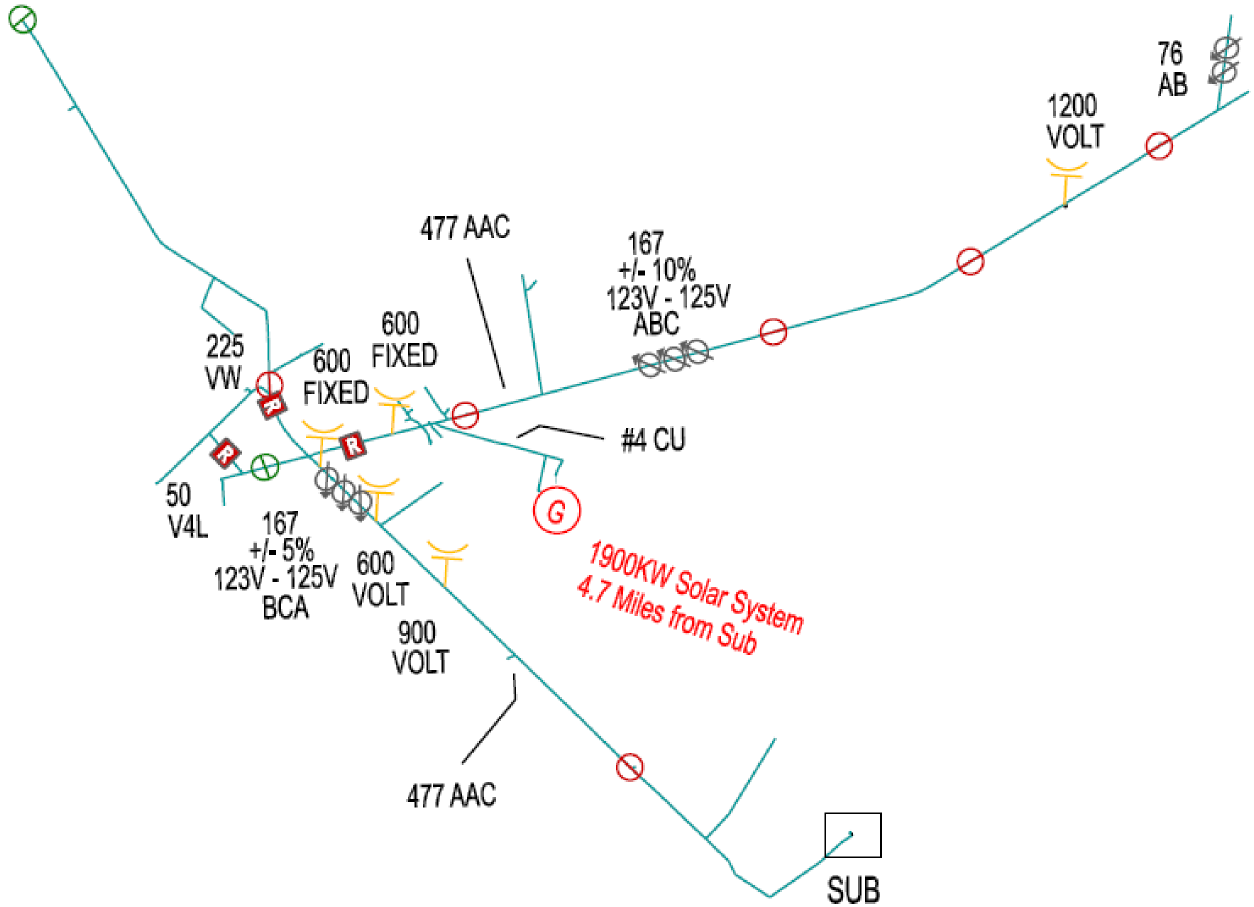
Case Study: Small Agricultural Site

- Applied for:
  - 117 kW
- Challenges:
  - 15,000 ft. of single phase
  - Cost of $800,000 to add phases (100kW limit for single phase installations)
  - Many single phase inverters can't adjust PF
- Solution:
  - Contractor decided to reduce size to 100 kW
  - Contractor found micro-inverter able to operate at a selectable fixed power factor

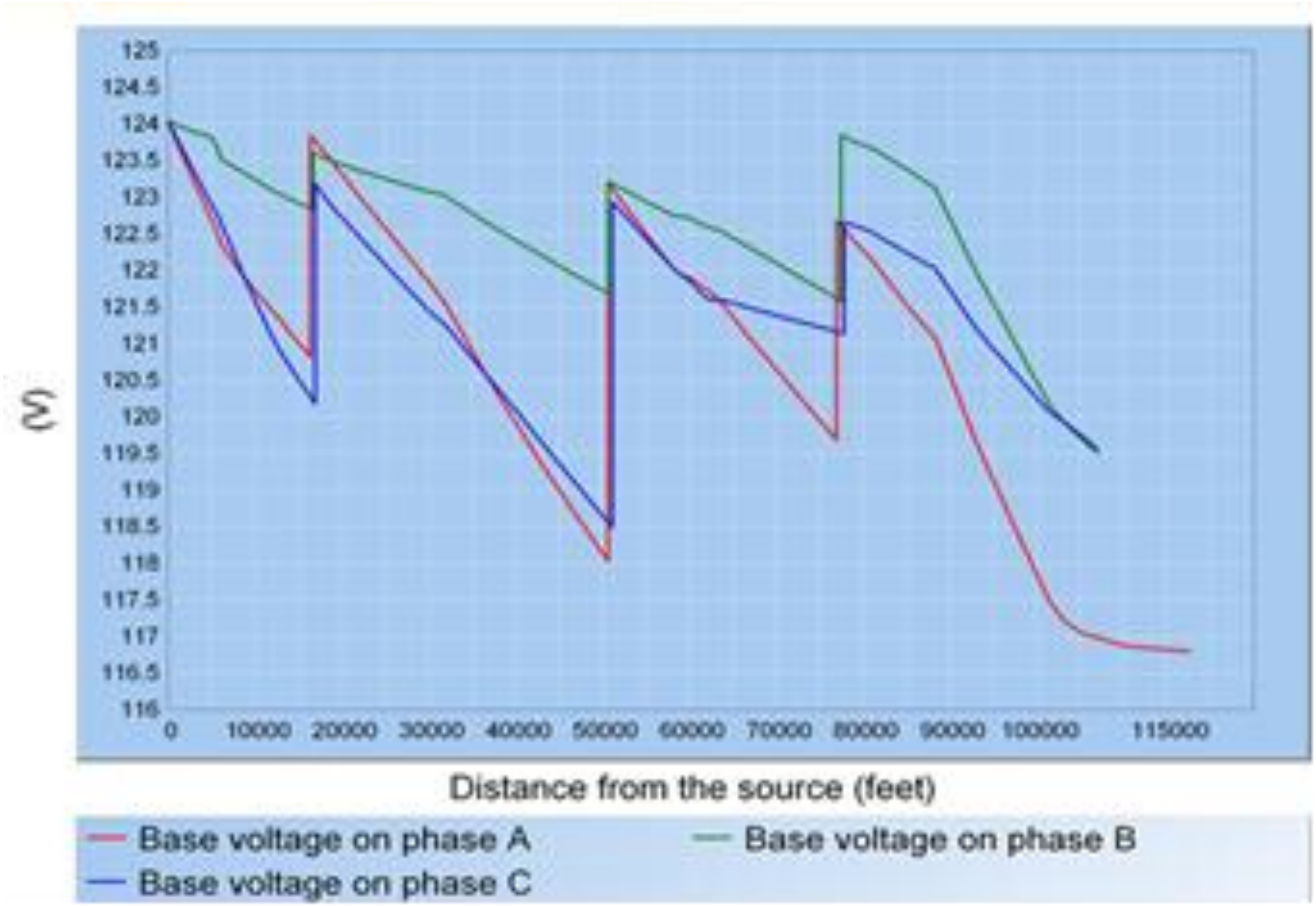
Case Study: 1.3 MW Solar Farm Reverse Power Flow Issue

- The circuit experienced reverse flow on several spring weekends. Further review showed low daytime load on the weekend to be very close to 15% of peak.
- The reverse flow caused substation regulator(s) with non-reversible controls, to operate to max raise on the line side. This occurred on one or two phases several times.
- This resulted in high voltage on the circuit and damage to some customer equipment.
- The reverse flow on the substation power transformer caused an unacceptable condition from a system protection standpoint
- After studying situation, feeder position was swapped with feeder on transformer with heavier load than original

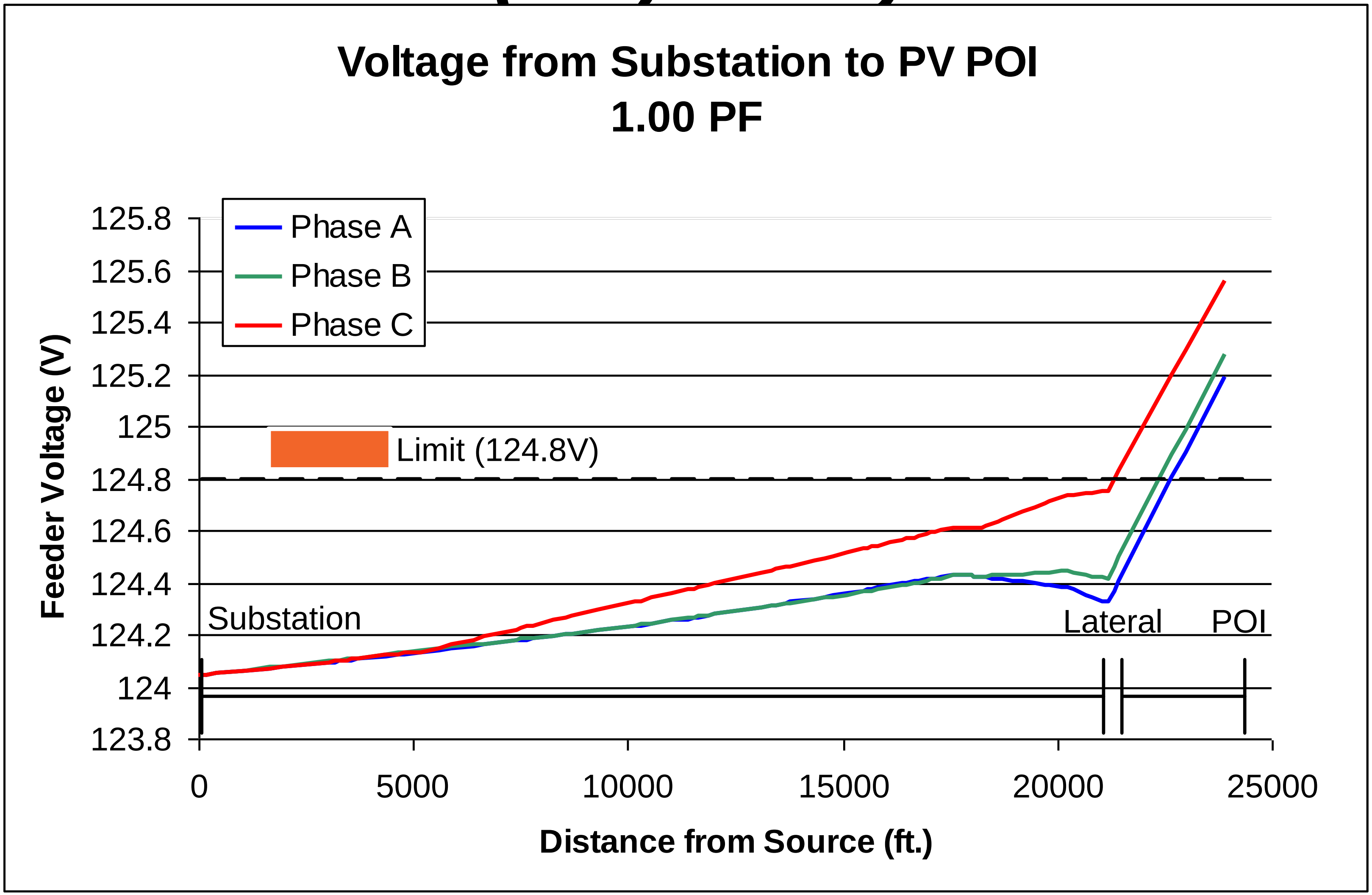
Case Study: 1.9 MW PV System
(Feeder Nominal Voltage: 12,470V)



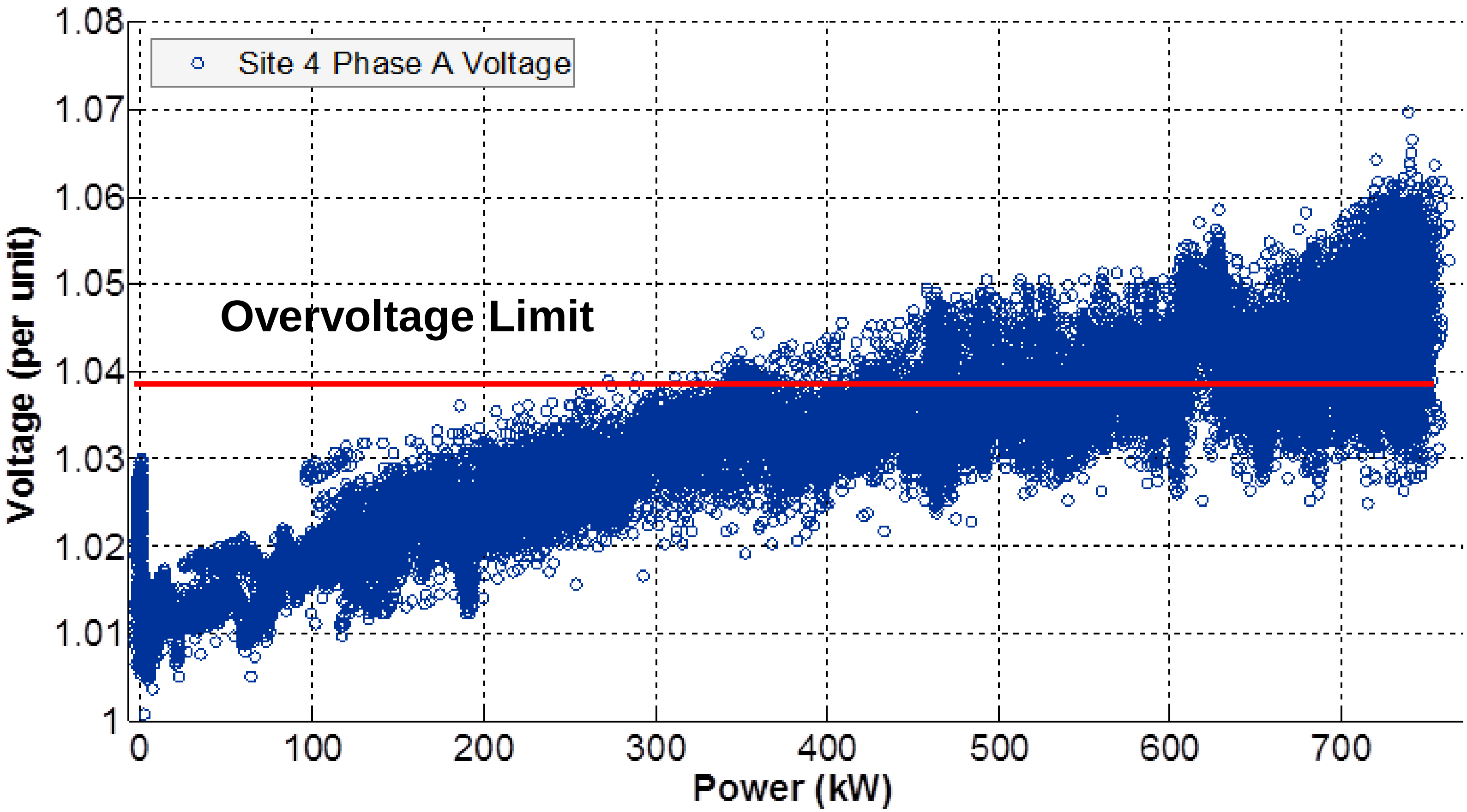
Plot of Feeder Voltage over Distance



1.7 MW (AC) PV System



Overvoltage at a Group of Inverters



Source: EPRI Monitoring

1.7 MW (AC) PV System

3 Options to Mitigate Voltage Issues

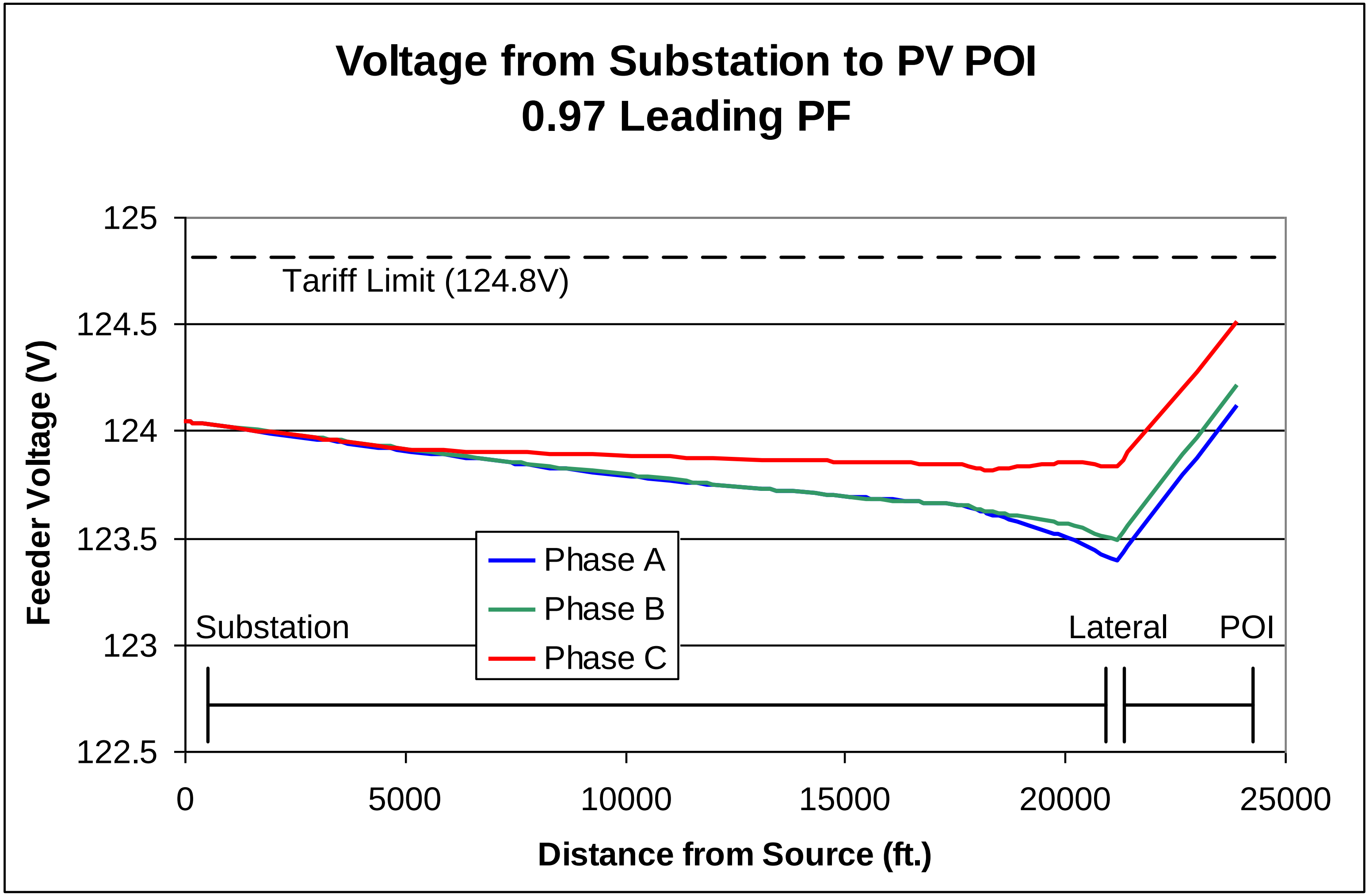
Summary Table				
	*Maximum Steady State Voltage(V)	Maximum Voltage Fluctuation at the PV site(V)	Maximum Voltage Fluctuation at the Upstream Regulator(V)	Cost
Without Mitigation	125.3	2.3	1.0	$0
Absorbing Power Factor Solution**	124.0	1.2	0.2	$2,200
500KVA/1500kWh Battery Solution	125.0	0.5	0.1	$1,115,014
750KVA/3000kWh Battery Solution	124.7	0.0	0.0	$2,189,390
477 AAC Reconductor	124.9	1.3	1.1	$266,000

*All Maximum Steady State Voltages occurred during low load,

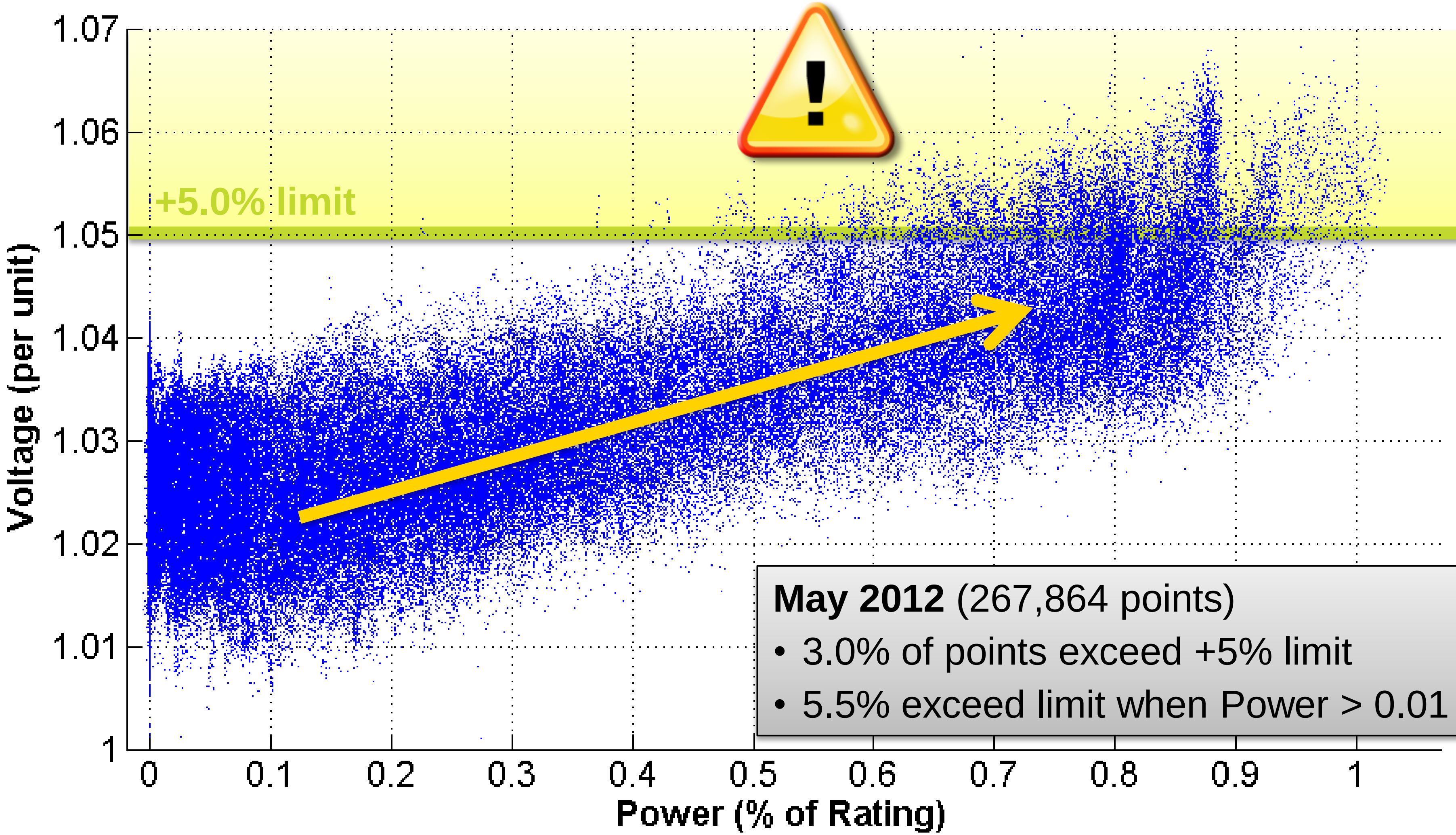
**Absorbing Power Factor of .97 was used for this study

***The battery storage solution is unlike the other solutions and may have other operating value streams but also may have maintenance and/or replacement costs over the life of the solar system. These have not been investigated and included in this comparison.

1.7 MW (AC)PV System

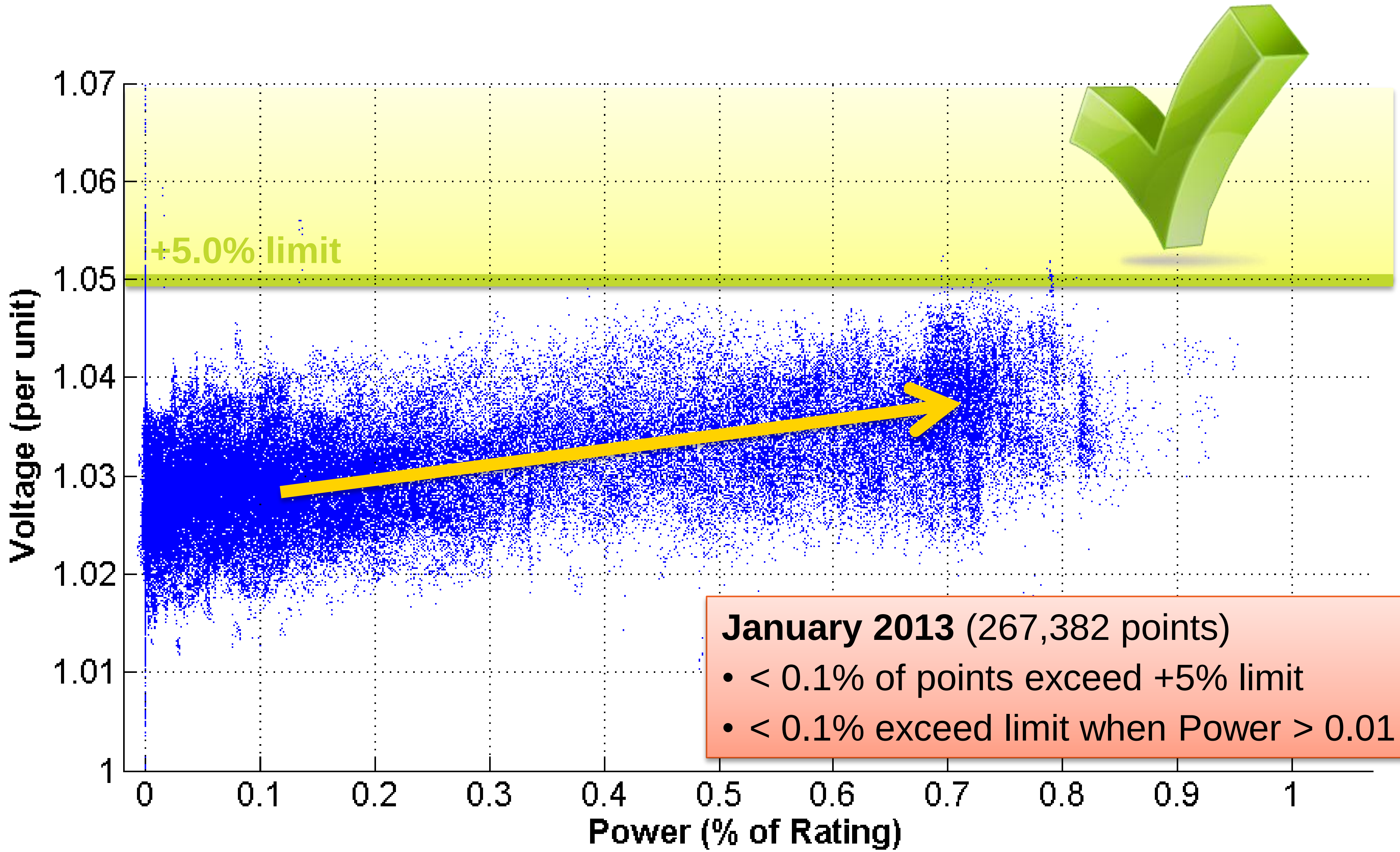


Power Factor Set Incorrectly



May 2012 (267,864 points)
- 3.0% of points exceed +5% limit
- 5.5% exceed limit when Power > 0.01

Much Better: Power Factor Readjusted



January 2013 (267,382 points)
- < 0.1% of points exceed +5% limit
- < 0.1% exceed limit when Power > 0.01

Secondary and Services

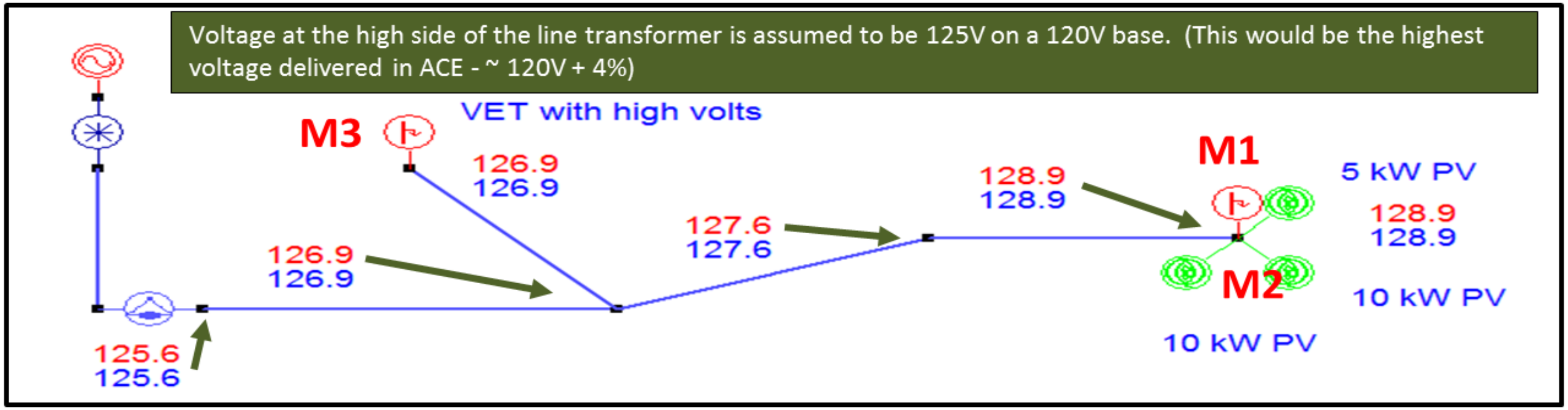
Benefits of Modeling

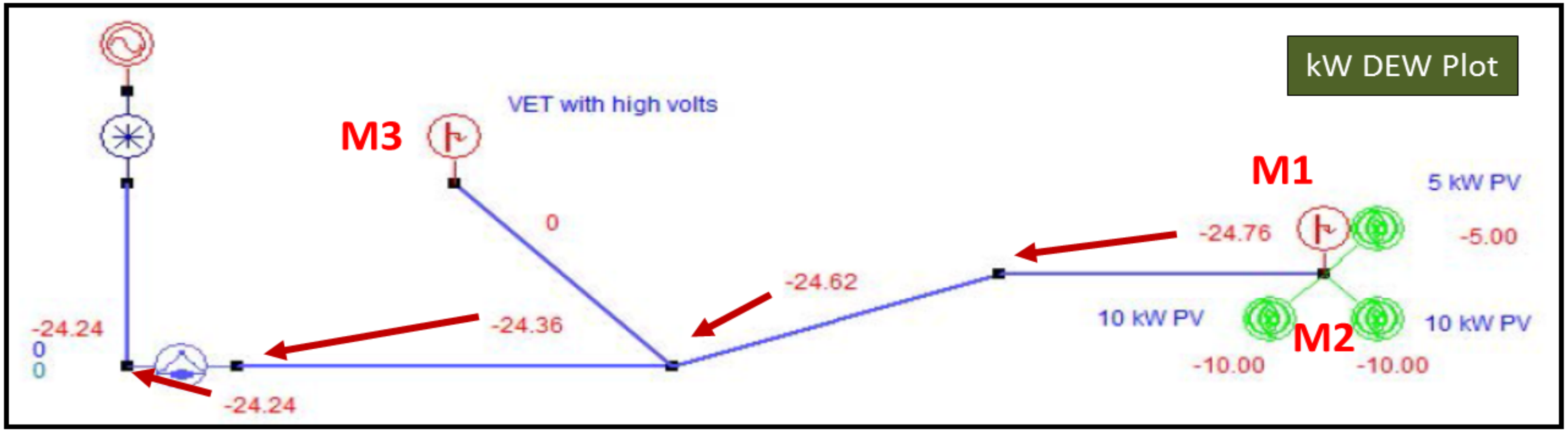
Most models use customers aggregated load at the low voltage side of distribution transformers

Modeling secondary/services can provide additional benefits especially where distributed resources are present.

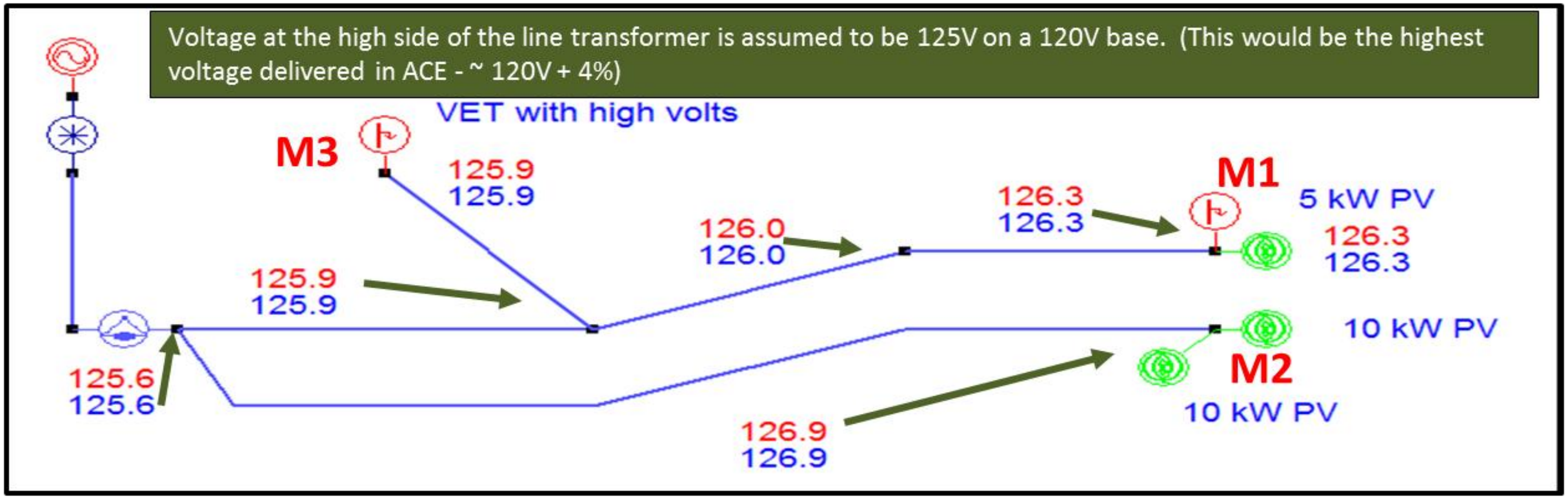
- Power flow results (amps, volts, kW, kVAR, percent loading, etc.) are available down to the customer meter
- Control strategies for PV including watt-VAR and volt-VAR can be determined for each installation allowing higher adoption percentages
- Secondary voltage and loading issues resulting from added PV installations can be identified and mitigated

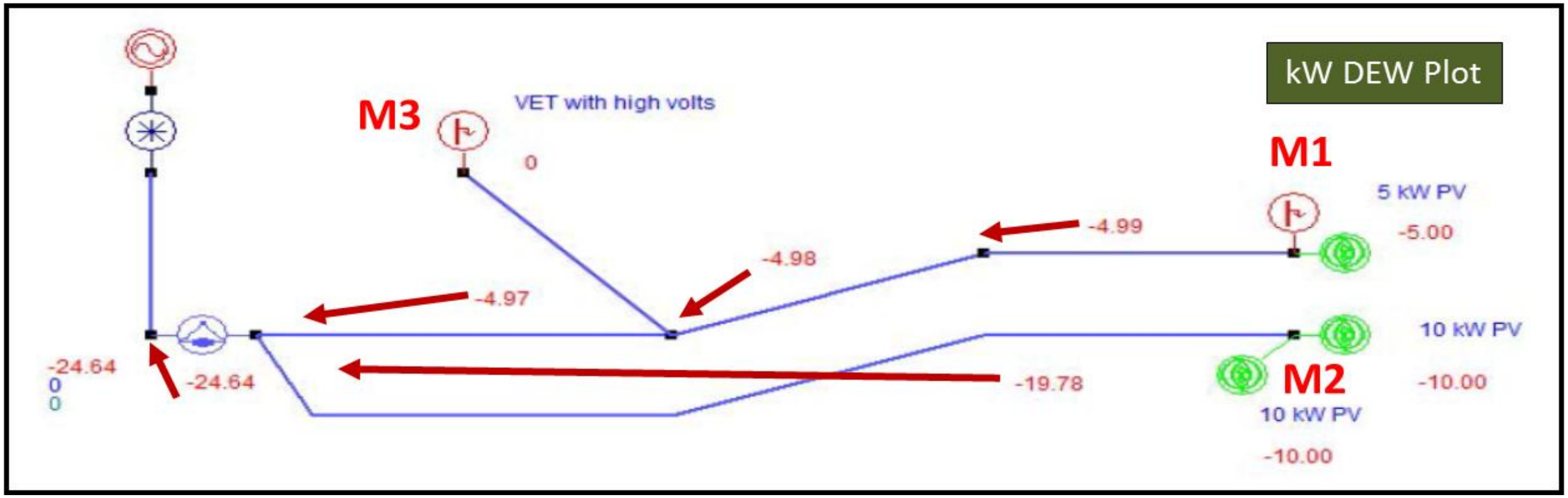
Before -- (modeled in DEW)





After -- (modeled in DEW)





Sharpened Tools and Collaborative Research:

Utility Collaborative Efforts to Develop Advanced Solutions

New electric system model of both the T & D system that will run time series analysis with all renewables and other generation represented as well as load – will provide aggregate impact, large system impact studies and higher penetration studies

Collaborative R & D on new anti-islanding scheme

Collaborative R & D on dynamic var control, centrally controlled vars

Hosting Tests of Advanced Volt/VAR Control

Utility Collaborative Efforts (cont.)

Collaborative effort on collecting 1 second data from multiple points on a feeder and large PV system output to better understand impact on automatic line equipment and model penetration limit

Collaborative effort to verify the accuracy of atmospheric data, both historical and predicted

Effort to utilize AMI to monitor and possibly provide control signals to small size inverters

Develop Wireless Secure Telemetry for large size systems

Utility Collaborative Efforts (cont.)

Integrating PV output data into Distribution Automation schemes

Reviewing feasibility of a completely online and automated way for applying and approving PV systems, reprogramming the meter, then transmitting output data automatically -- for very small/low impact systems in areas with AMI.

Selected for a DOE Grant to Study advanced voltage regulation strategies and central control fo system operators. Most of the work will be done in the Advanced Load Flow with some field installations.

Outside Demo at ACE Training Yard with smart switch, incorporating load, and battery system.

(Work done with DOE SEGIS Grant to Petra Solar)

Outdoor Demo of Micro-grid mode – can operate off PV and battery, then resync with grid

(Work done with DOE SEGIS Grant to Petra Solar)

Contact Us

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