MADRI Working Group Meeting

Pepco Holdings, Inc

Utility Plans for Infrastructure Improvements

Presented by: William M. Gausman, Sr. VP, Strategic Initiatives

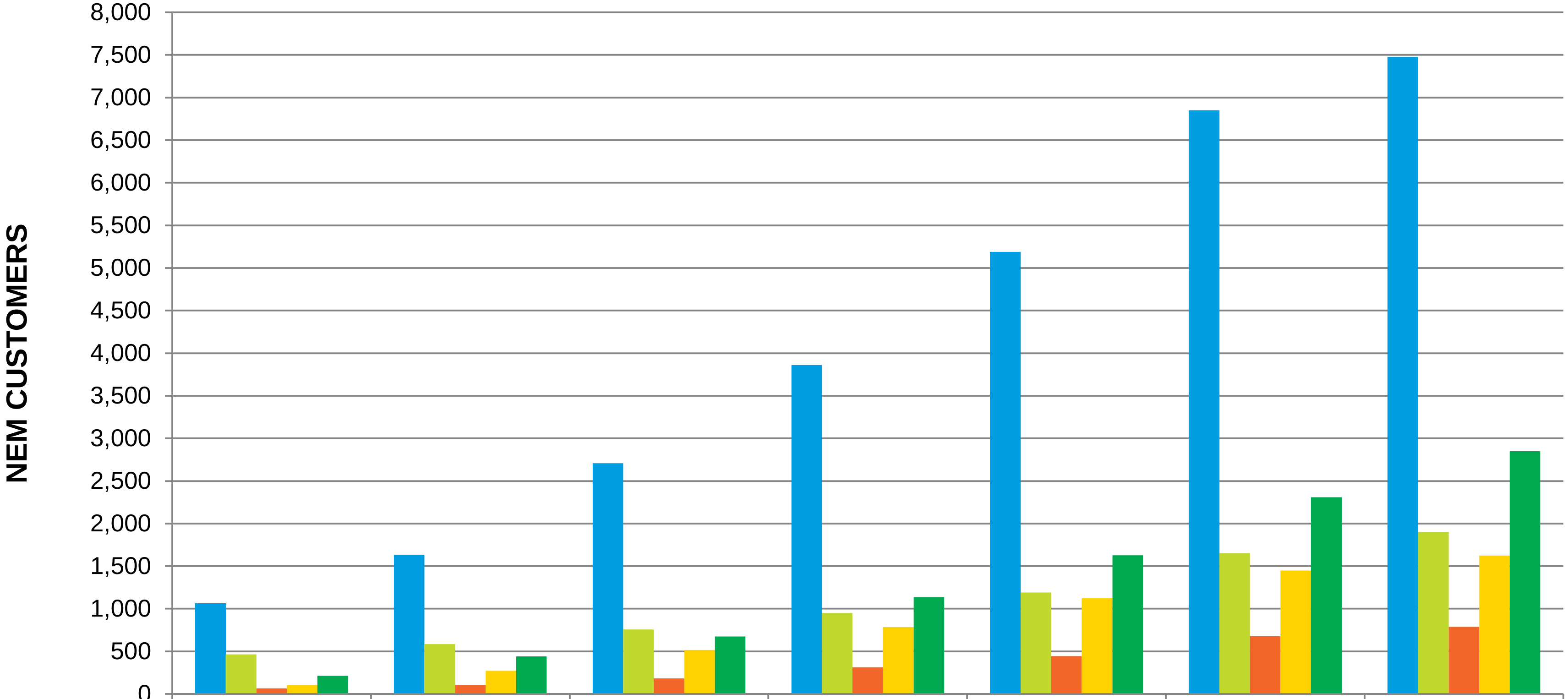
May 14, 2015

Objectives

- Provide an overview of the current state of Distributed Generation (DG) at PHI
- Discuss the challenges that we are facing with DG and the activities we have underway to meet those challenges
- Show a residential DG customer's bill and their actual use of the grid
- Discuss the next form of solar development, Community Net Metering, and the activities needed to process the payments for community solar

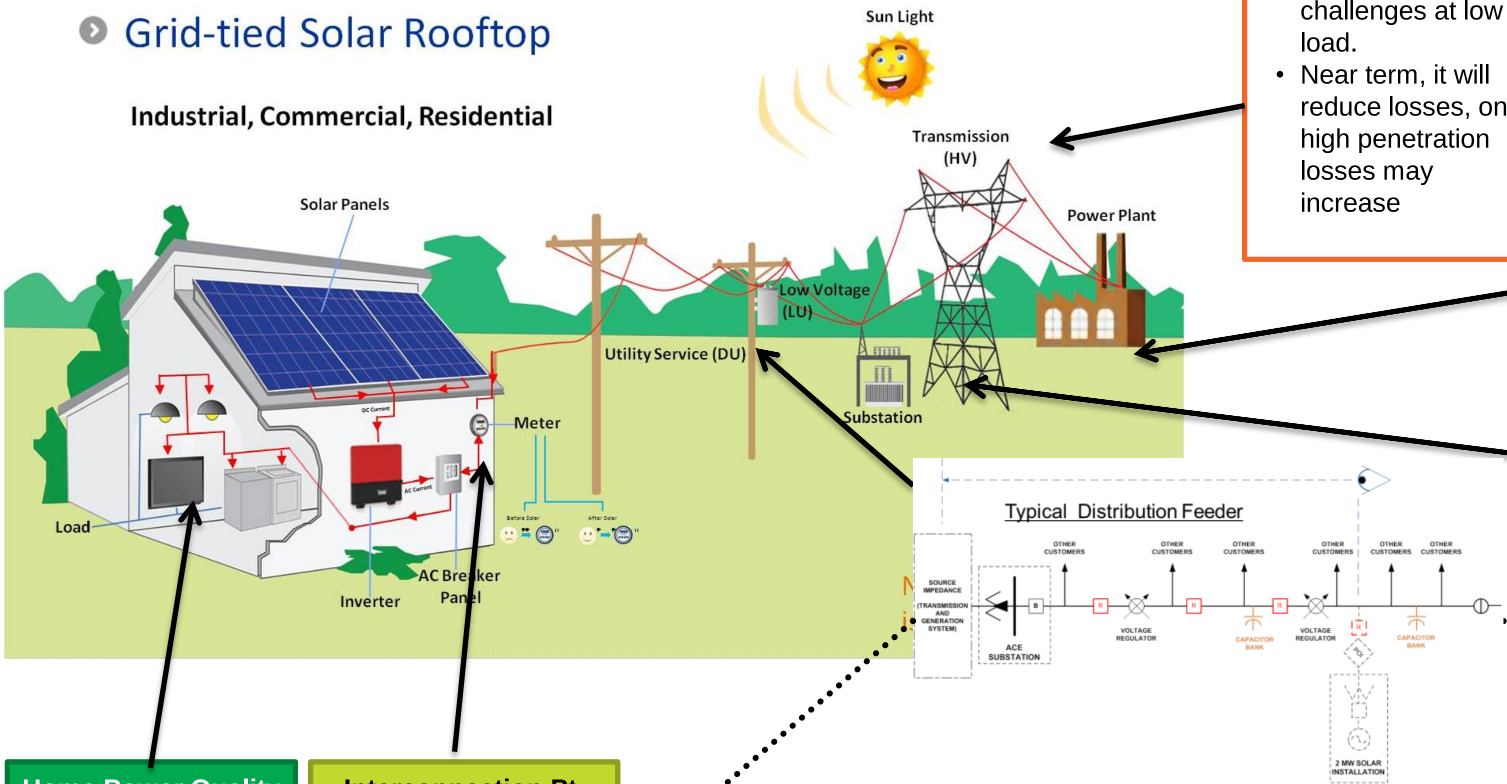
Current Status of NEM Customers – 14,644 Customers & 252 MW's

PHI NEM CUSTOMER COUNT



	2009	2010	2011	2012	2013	2014	2015
ACE	1,063	1,636	2,708	3,860	5,189	6,850	7,478
DPL DE	465	585	758	949	1,191	1,653	1,903
DPL MD	67	104	181	313	445	679	789
PEPCO DC	103	271	517	784	1,124	1,450	1,625
PEPCO MD	215	441	676	1,134	1,626	2,310	2,849

DER Affects the Entire Electric System



Transmission

- Voltage challenges at low load.
- Near term, it will reduce losses, on high penetration losses may increase

Generation

- Scheduling changes required to meet volatile load.
- May increase need for ancillary services.
- Steep ramp rate when sun goes down affects capacity needs

Fdr & Substation

- Increase phase unbalance for three phase circuits.
- Capacity spikes may overload equipment.

Home Power Quality

- Higher voltage caused by generation reduces efficiency of appliances and HVAC,
- Can stress appliances or motors.

Interconnection Pt.

- Inverters trip or cloud shear can create volatility
- Must maintain voltage within mandated bands.
- Net metering masks true load demand.

POI

- Every POI requires study to determine impacts to the system and other customers
- The customer is required to pay for the upgrades

Dist. Automation

- DER can prevent DA schemes from locating fault
- True load to be transferred not easy to calculate

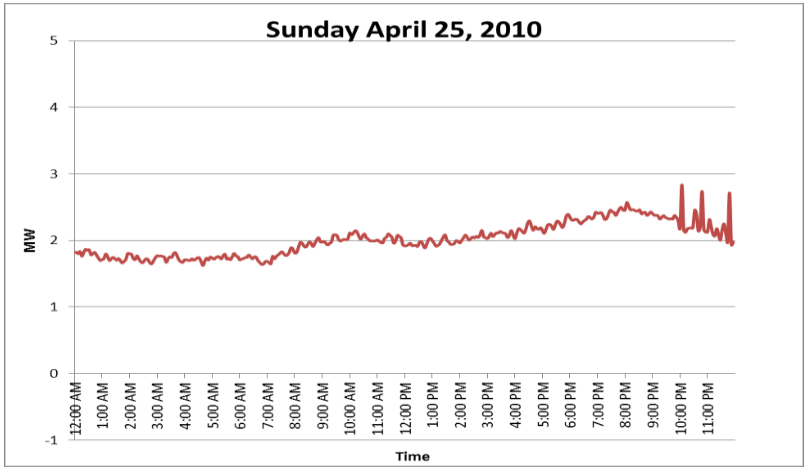
Voltage

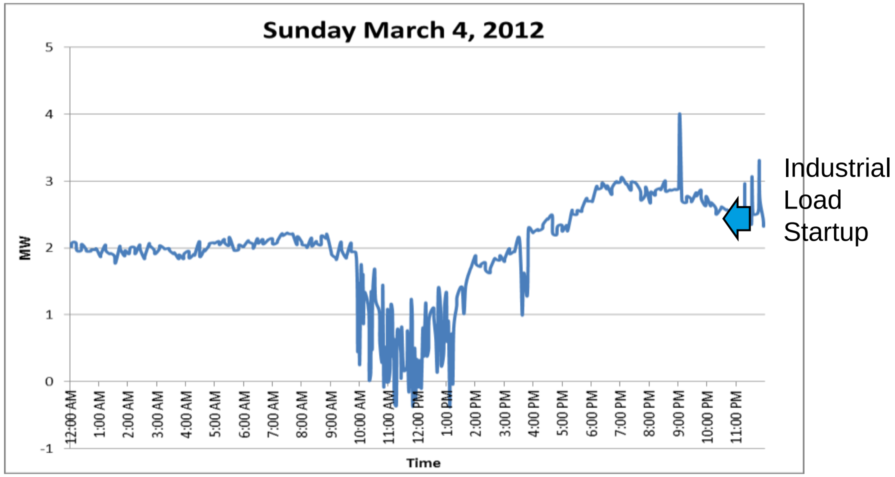
- High or low voltage can result in mis-operation, damage, or reduced equipment life – both on the grid or at premises

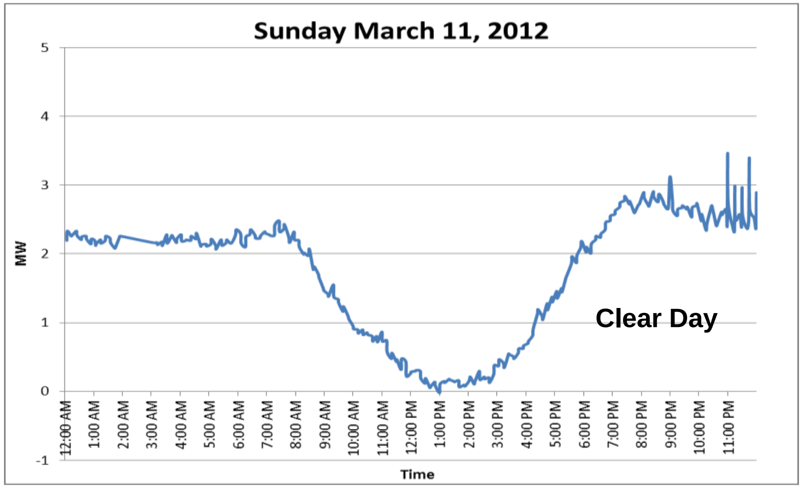
Safety

- Can increase fault current level
- Trip of breaker or recloser may result in inverter out of synchronization
- Reduction of protective reach

Feeder Load Profile – Before & After PV



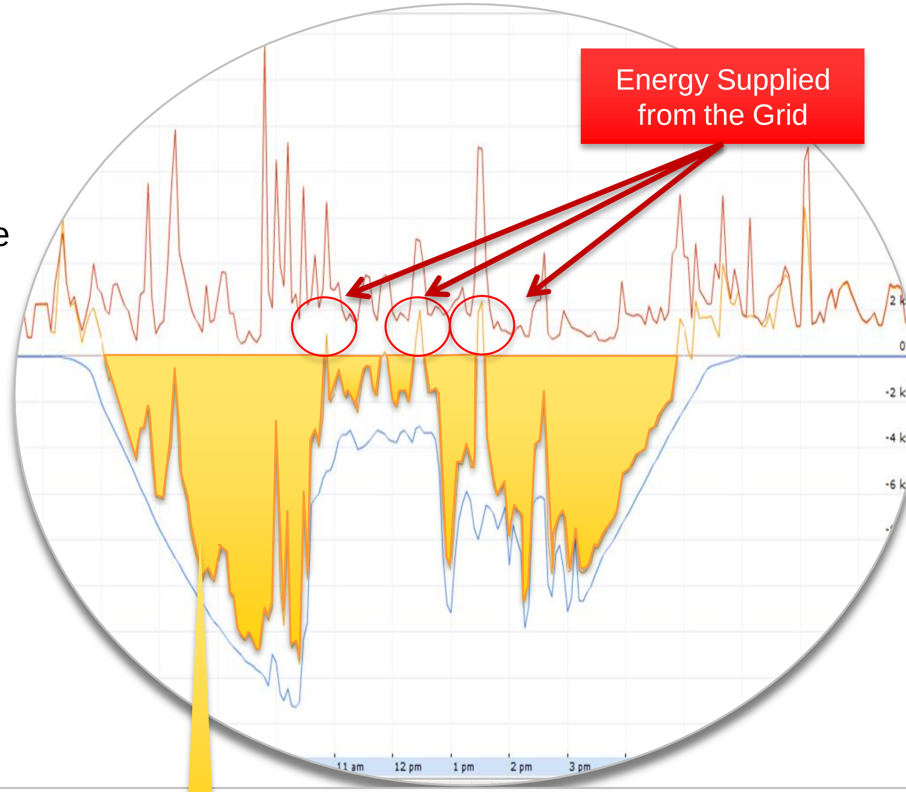




- Data for Distribution feeder with 1.9 MW of solar
- Comparison before and after for clear and cloudy days
- For cloudy day, customers on the feeder are likely to see noticeable voltage variations

… But Higher Resolution Data Tells a Different Story

- 1 Second Data provides a clearer picture of the transactional nature of DG
- This is for a 19 KW residential System
- While this larger residential PV system produces more than the load much of the time when the sun is out, there are a number of times during the day: morning and evening, during cloud shear, or during high premise loading that still require power being supplied by the grid
- For average sized systems (~5KW) this situation would be higher in both frequency and magnitude



[redacted]

Your electric and gas bill for the period
November 4, 2013 to December 5, 2013

Details of your Electric Charges
Residential Service – service number [redacted]
Electricity you used this period

Meter Number Energy Type	Current Reading	Previous Reading	Difference	Multiplier	Total Use
NKA076656866 Usage (kWh)	Dec 5 987635 (actual)	Nov 4 987515 (actual)	120	1	120

Your next meter reading is scheduled for January 6, 2014

Delivery Charges: These charges reflect the cost of bringing electricity to you. Current charges for 31 days, **winter rates in effect.**

Type of charge	How we calculate this charge	Amount($)
Customer Charge		10.89
Total Electric Delivery Charges		10.89

Supply Charges: These charges reflect the cost of producing electricity for you. You can compare this part of your bill to offers from competitive suppliers. The class average annual price to compare is 10.35 cents per kWh.

Total Electric Charges - Residential Service	10.89

Excess Generation Summary

Credit kWh Balance from Your Last Bill	-553
Adjustment to Prior Month	0
Current Month KWH	120
Total kWh Balance	-433
Credit kWh Expired on Anniversary	0
Current Net kWh Balance	-433

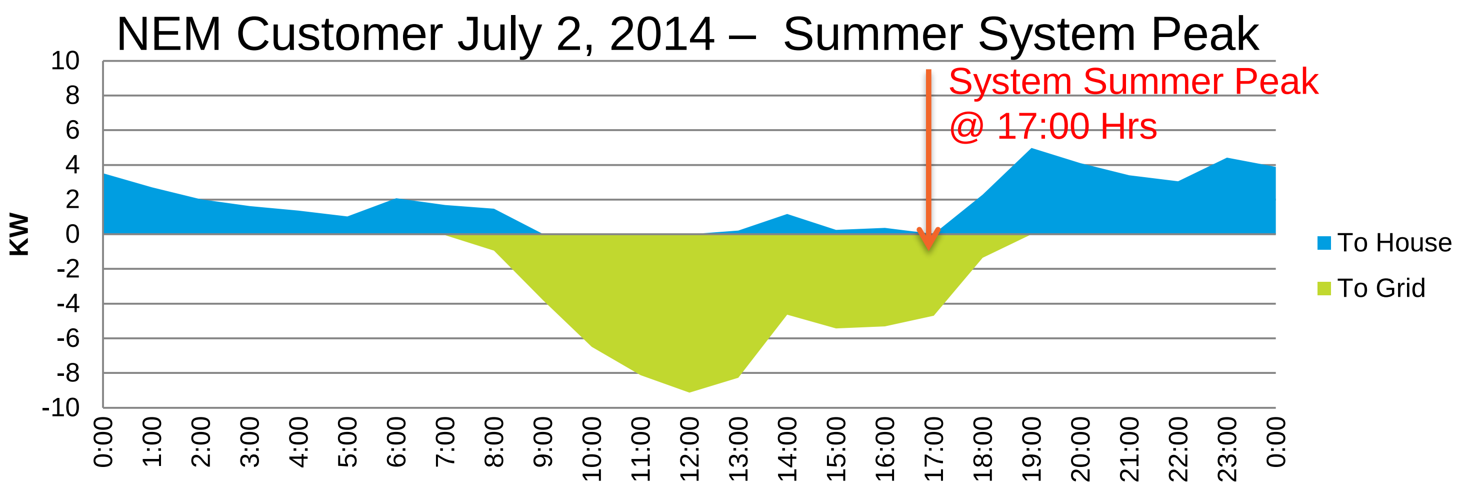
Electric Summary

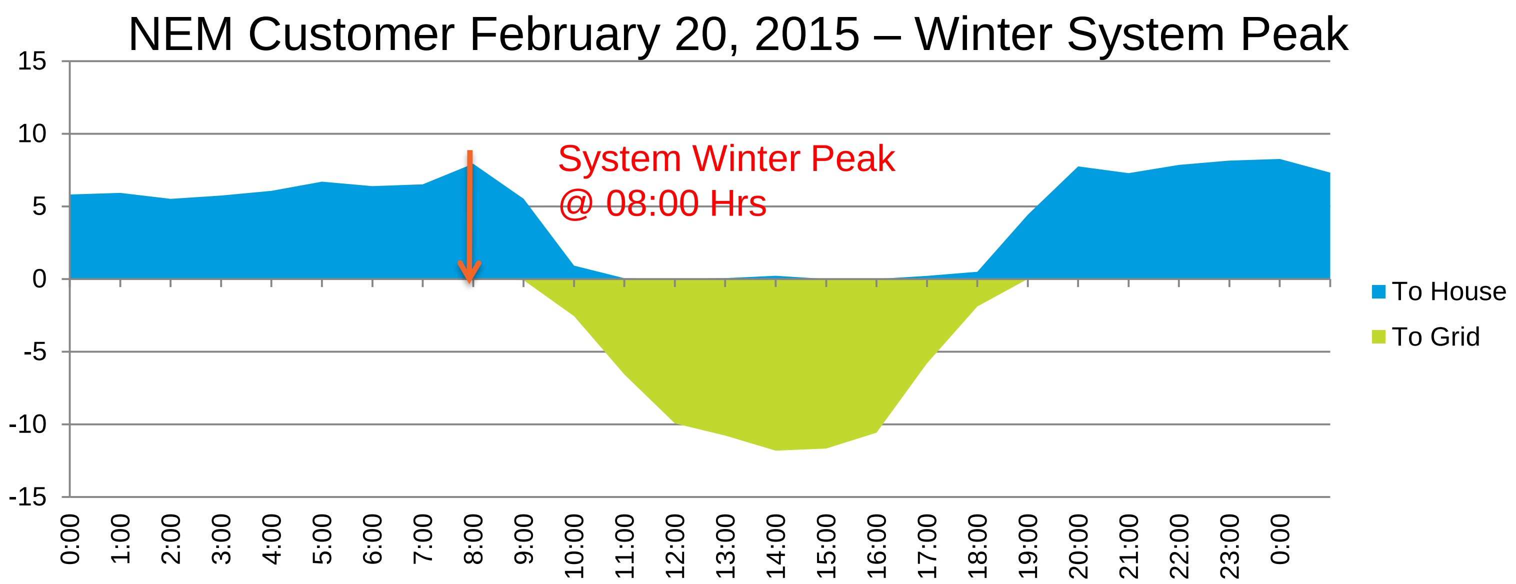
Balance from your last bill	$563.98-
Transferred Balance	$75.57
Changes to electric balance	$75.57
Payment Nov 13	$13.18-
Total Payments	$13.18-
Electric Charges (Residential Service)	$10.89
New electric charges	$10.89
Total Credit Amount	$490.70-

Transferred Balance: Refers to revenue transferred to or from your account(s).

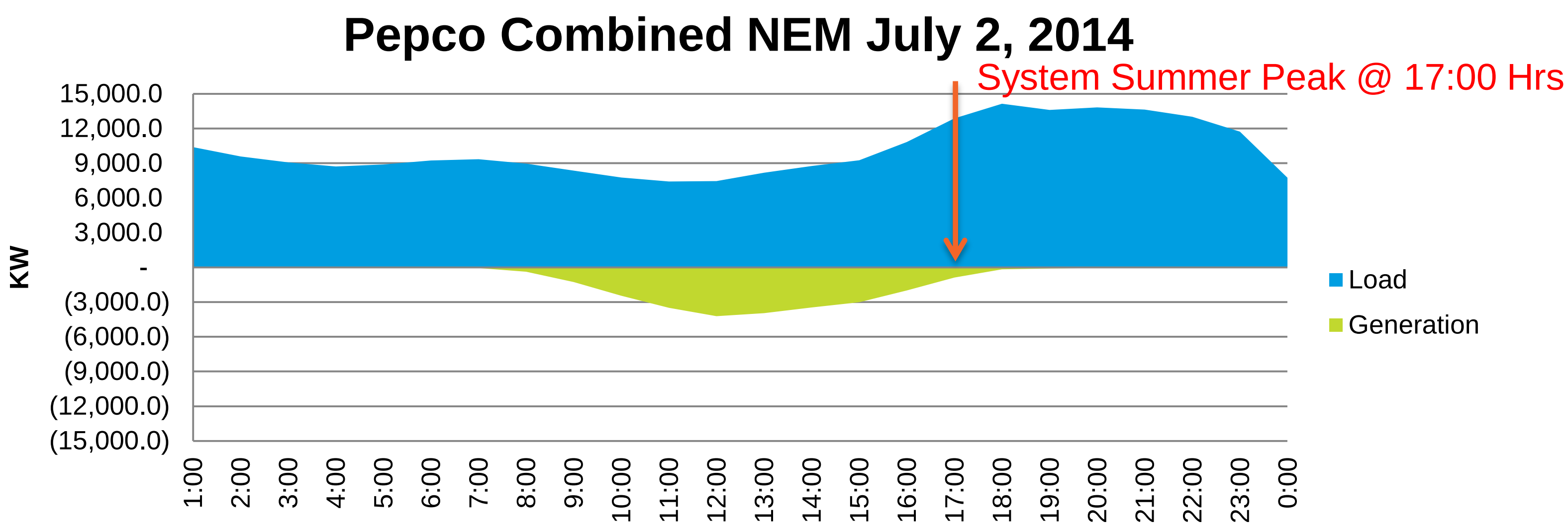
Total System Size :19KW **(Average System Size 5 KW)**

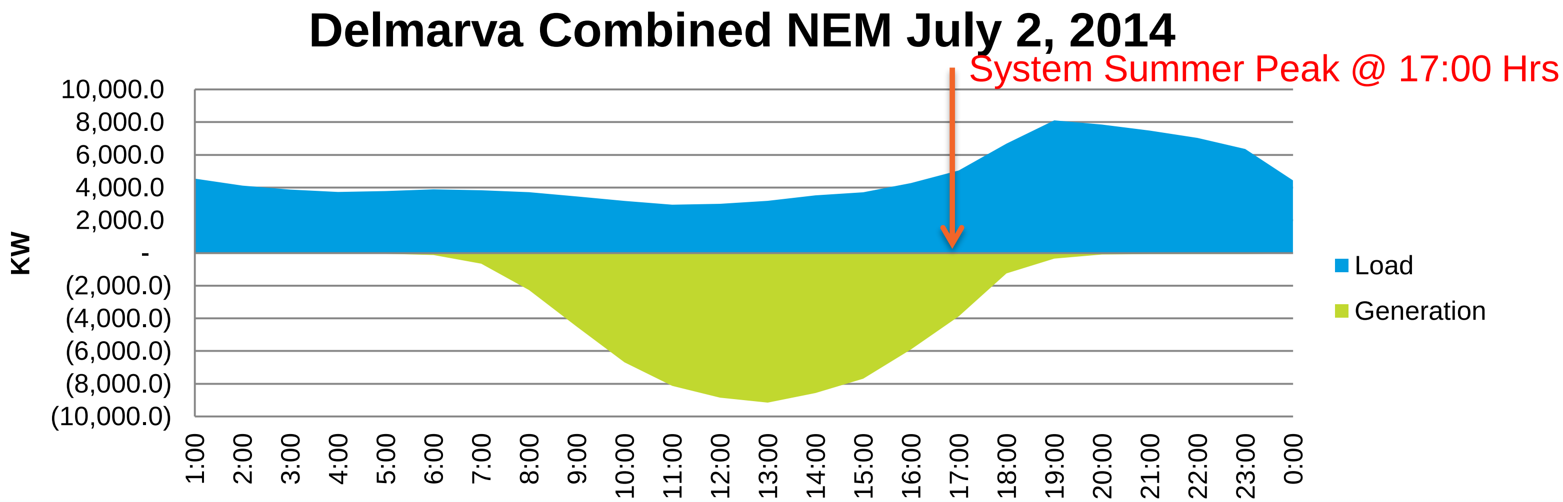
Solar Peak and System Peak are not Coincidental – Single NEM Customer With 19 KW Solar System



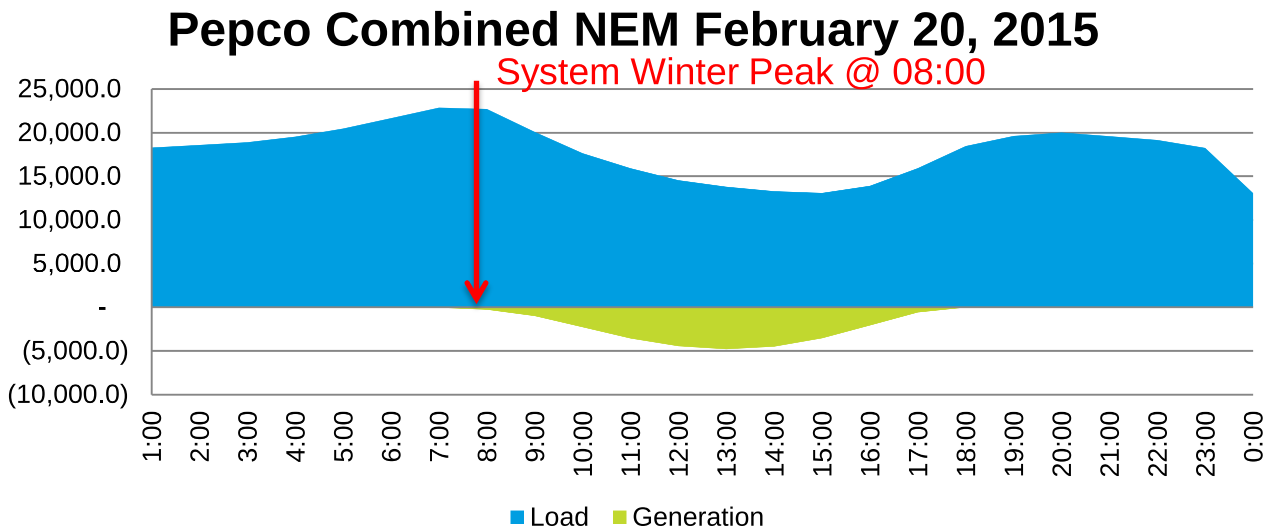


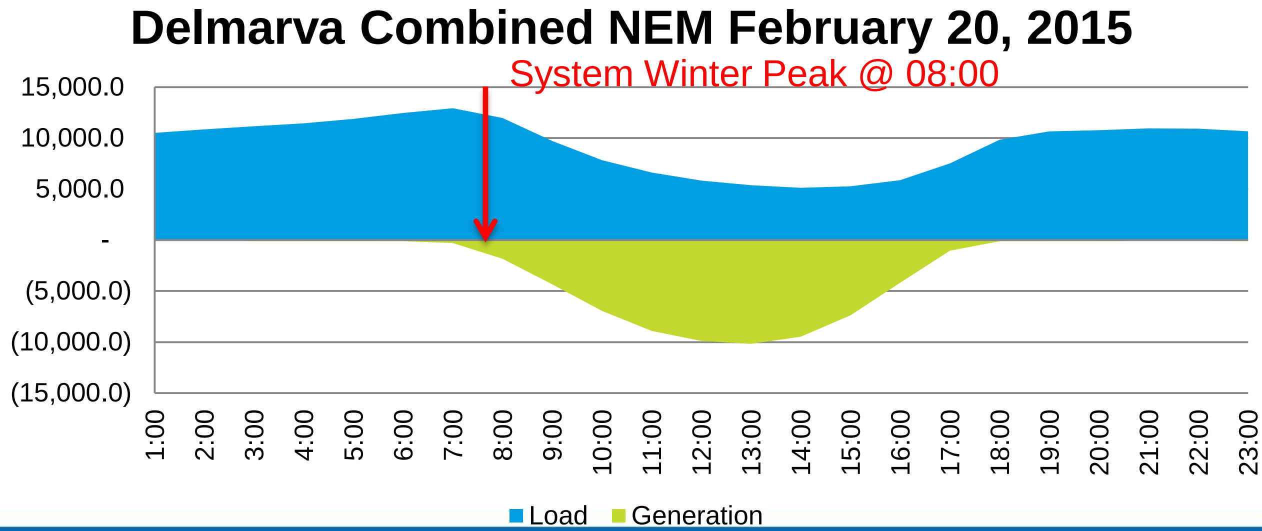
Aggregated View for Summer Peak Load – All NEM Customers Combined





Aggregated View for Winter Peak Load – All NEM Customers Combined





NEM Bill Characteristics

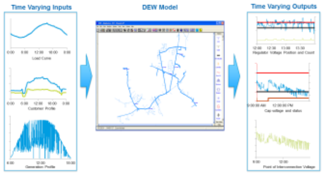
	NJ	DE	MD	DC
Max size	100%	110%	200%	100%
Excess generation treatment on bill	Monthly kWh credit with an annual payout	Monthly kWh credit with an annual payout	Monthly kWh credit with an annual payout	Monthly credit
What the credit covers	Anything on the customer bill	Anything on the customer bill, including Gas	Only kwh based charges	Anything on the customer bill
Kwh Credit price base	Average LMP or TPS retail rate for energy[1]	Average SOS or TPS retail rate for energy[1]	Average SOS or TPS retail rate for energy[1]	Average SOS or TPS retail rate for energy[1]

Note: For MD Customers on TOU rates, the credits are based on the TOU rate.
[1]We request the actual rate from the TPS, who is not obligated to tell us that information, frequently we are paying the average SOS rate even if it's higher.

Activities Underway to Help Accommodate Increased DER

Engaging Regulators and Public Officials: Engaging FERC, State public officials, DOE and other industry groups to better understand the issues and work collaboratively on solutions

Modelling & Analytics: Advanced load flow being implemented, Distributed Energy Resources Planning and Analytics department formed, technical and financial analysis of Micro grids



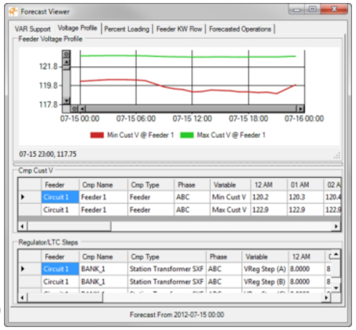
Collaborative R & D: Inverter technology, advanced voltage regulation control, penetration studies with a variety of different partners.

- Hosting Tests based on modeling Advanced Volt/VAR Control, smart inverters and
- AMI to monitor and provide control for small size inverters
- Implementing Cellular telemetry for systems over 2 MWs
- Integrating PV output data into Distribution Automation schemes
- Reviewing feasibility of online application and approval process

DOE Sunrise Project

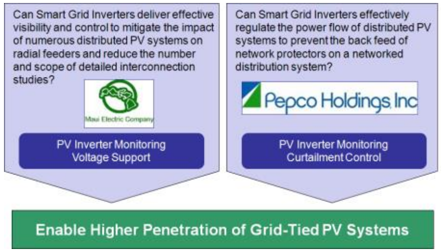
- Model-Based Analysis to simulate the impact solar has on the grid.
- This project is testing advanced voltage regulation strategies to find the most cost effective way to use existing and new equipment as penetration rates of DERs increases.
- It will model both autonomous and central controlled approaches.
- PHI is partnering with:
  - Electrical Distribution Design (DEW software development/technical)
  - Clean Power Research (solar Irradiance data)
  - Rutgers University (economic analysis)

Control can be run against simulator or real system through connection to SCADA



Office of Naval Research Smart Grid Inverter (SGI) Project

- Pilot using AMI data and an algorithm from Silver Spring to dynamically set the power factor and overall watts for inverters.



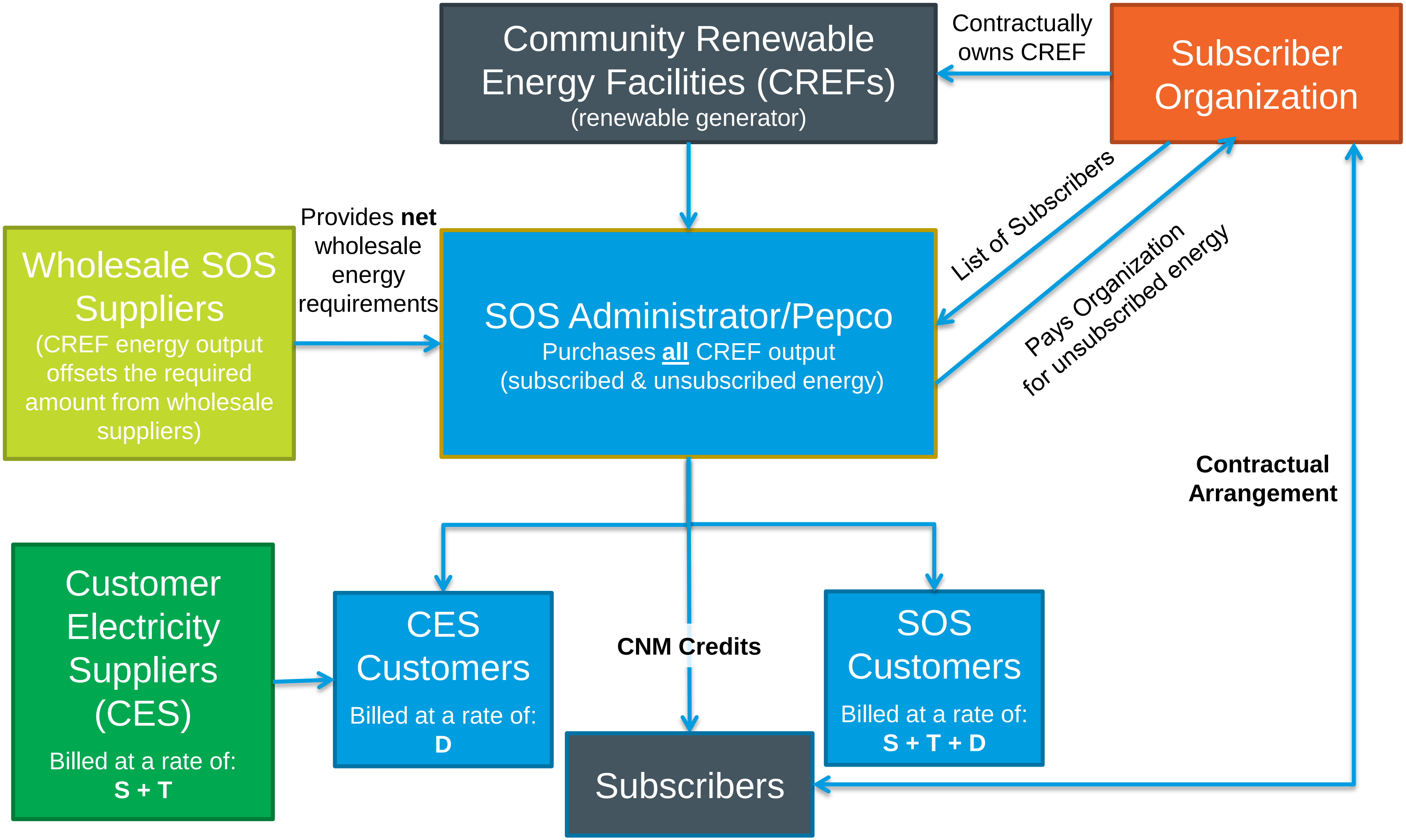
HNEI	Project Lead
Maui Electric Company	Co-Utility Lead
Pepco Holdings Inc	Co-Utility Lead
Hawaiian Electric Company	Co-Utility Lead
Silver Spring Networks	Technology Lead
OG&E	Inverter Testing Lead
Standard Solar	Co-Services Lead
RisingSun Solar+Electric	Co-Services Lead
Fronius	Inverter Technology Lead
Hitachi	Inverter Technology Provider

Community Net Metering Is An Example For Change Within the District of Columbia

- Three primary entities involved in Community Net Metering (CNM):
  1. Subscriber Organizations:
     - Develop Community Renewable Energy Facilities (CREFs) up to 5 MW
     - Contract with Subscribers who will receive a monetary CNM credit on their bill
  2. Subscribers:
     - Must be Pepco distribution customers within the District
     - Can be supplied by any energy supplier including the SOS
     - Will receive a CNM Credit* each month on their Pepco bill based on their percentage participation
  3. Pepco:
     - Will use energy from CREF to offset SOS purchase requirements
     - Will pay the Subscriber Organization for the unsubscribed portion of the CREFs output (at LMP adjusted for ancillary services)

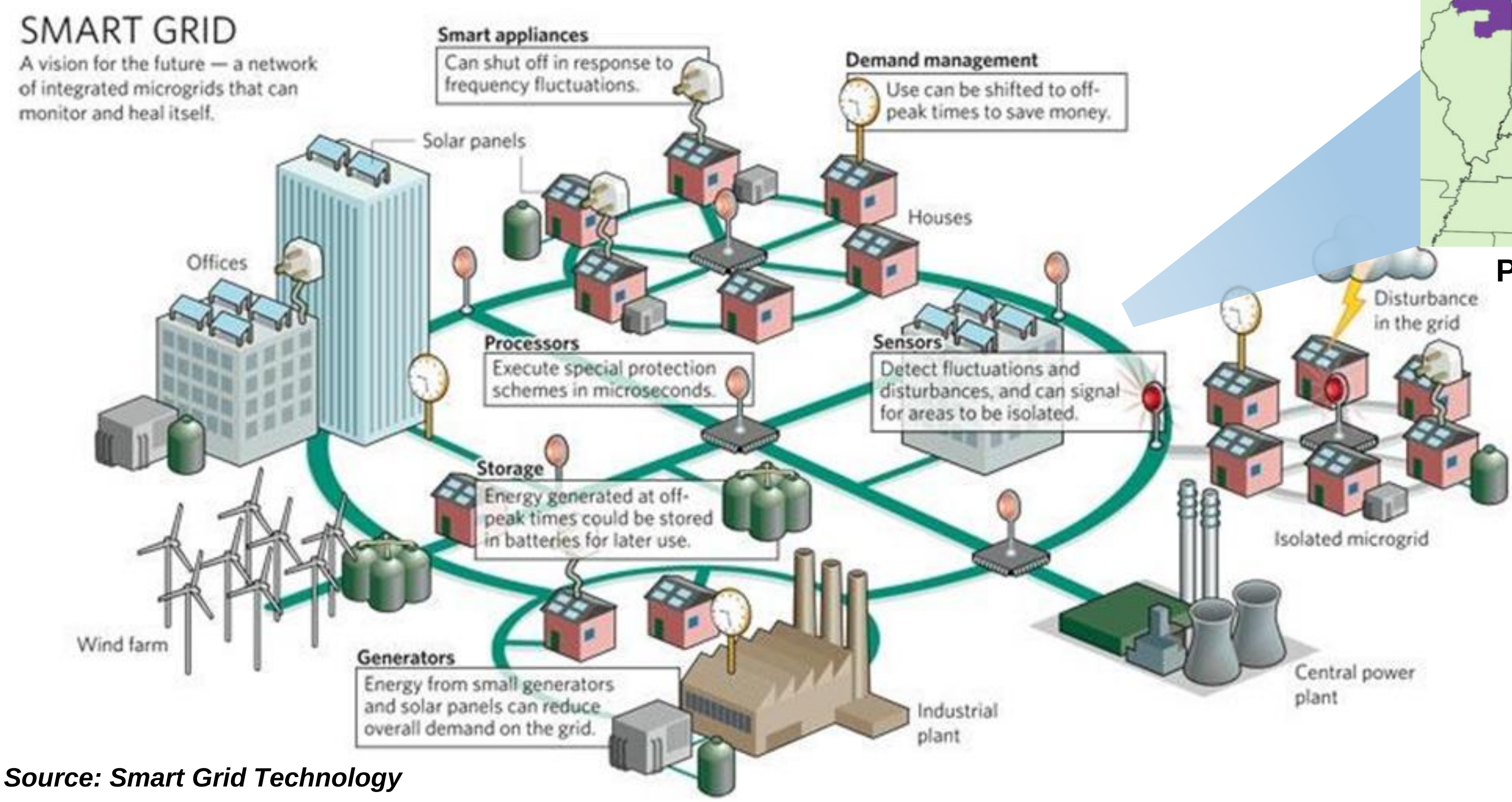
* CNM Credits will be equal to the amount of CREF generation * the Subscriber's percentage * the GS LV ND SOS tariff rate (which kwh-based components to be included still to be settled).

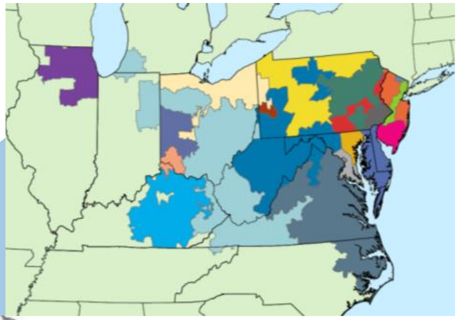
Community Net Metering Overview & Structure



Distribution System of the Future

- With the increase of distributed and community-scale generation, energy storage, and potential new capacity loads (i.e., electric vehicle), existing distribution systems will need to change in order to manage a load that is less predicable than in the past. Distribution systems of the future will not only require internal investment in controls, but also will need to integrate with smaller networks across the larger grid and be able to monitor and dispatch small scale distributed generation.





PJM Interconnection

Source: Smart Grid Technology

Points to Consider…

- Planning and Operating the future Distribution Grid will become more complicated
  - Higher penetrations of DER
  - Deployment of storage
  - Microgrids
  - Electric Vehicles / Vehicle to Grid
  - Advanced Demand Response
- Distribution System Operators will need to manage the Distribution System, much in the same way PJM manages Transmission and Generation today
  - Control, Measure, Dispatch, Protect, Control, Optimize
- Based on system conditions, some DER or Microgrids may need to be temporarily curtailed, or dispatched for system need
  - New polices will need to be developed to facilitate these future transactions