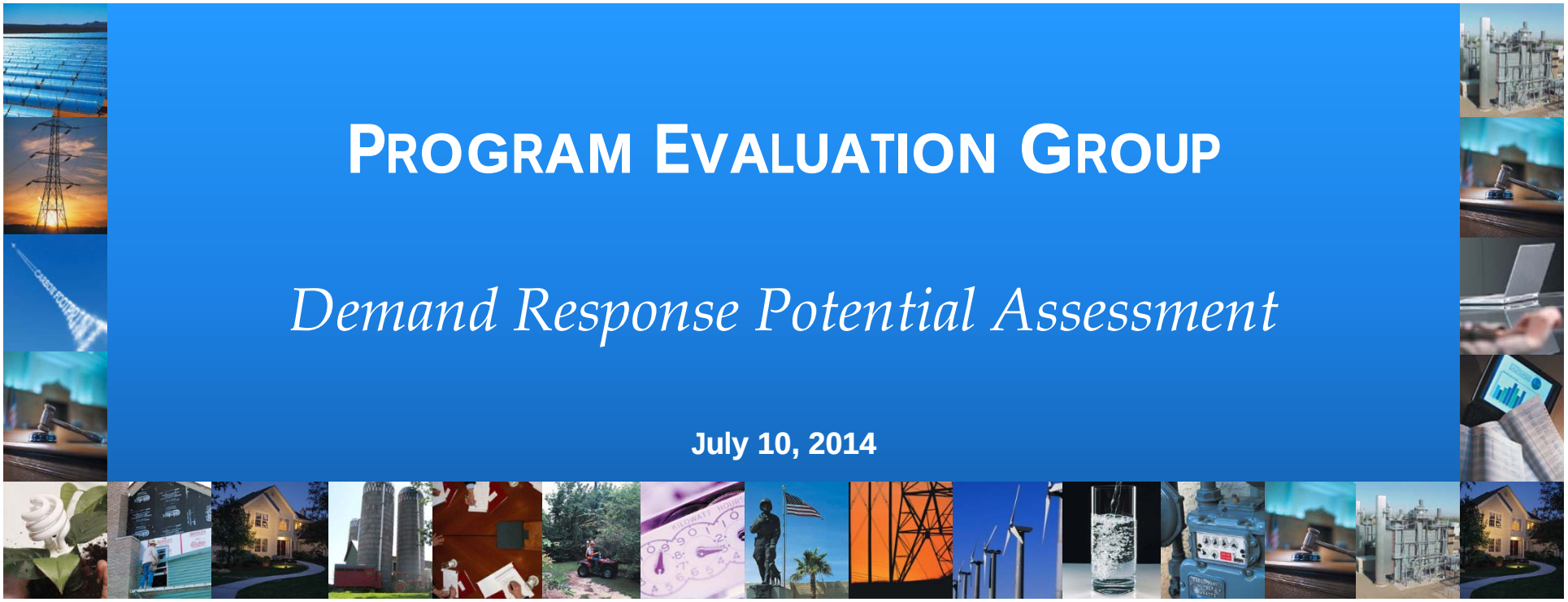


PROGRAM EVALUATION GROUP

Demand Response Potential Assessment

July 10, 2014

Presented by the Statewide Evaluation Team:

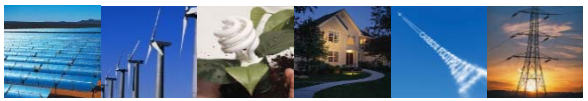
Nexant

GDS Associates, Inc.
Engineers and Consultants

research into action

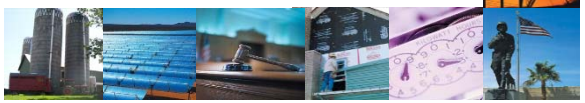
APEX ANALYTICS, LLC

PROGRAM DESIGN



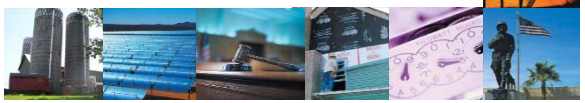
Key Factors in DR Potential

- The amount of demand response potential that can be acquired is influenced by program characteristics
  - Frequency and duration of curtailment events
  - Amount of advance notification
  - Performance risk borne by customers
  - Seasonality of performance period
- In order to assess the magnitude of DR potential in Pennsylvania, assumptions about the structure of a Phase III program are required



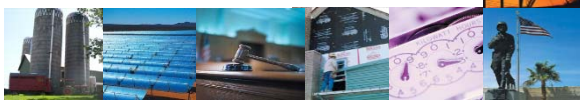
Objectives of an Act 129 DR Program

- Demand response can used to achieve a variety of goals with an electric utility
  - Reduce the need for generation capacity
  - Reduce energy requirements and costs during periods of high load
  - Integration of renewable resources into the system
  - Provide load relief on the transmission and distribution system
  - Avoid or defer T&D upgrades
- DR program design is a function of the objective(s)



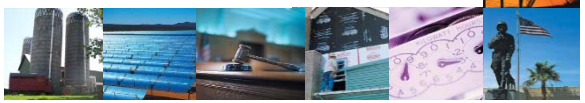
Potential Study Design Assumptions

- Primary objective is to lower the generation capacity obligations of Pennsylvania ratepayers
  - Reductions during the 5CP = lower PLCs
  - Critical to understand feedback loop with PJM
- Secondary Objectives (benefits)
  - Avoided energy. Most will be recovered at lower priced hours, but the LMP difference can be significant
  - Avoided cost of transmission and distribution capacity



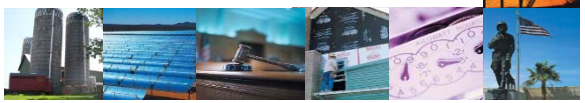
Performance Period

- DR is used as a "nimble" resource in PJM
  - This is difficult for Act 129 because the performance period must be defined years in advance (Implementation Order)
  - 2/20/2014 Commission Order directed the SWE not to assume EDCs would bid programs into the BRA
- How many days/hours need to be curtailed to hit the 5CP?
  - 6-8 events. 3-4 hours each in duration
  - Cap the number of curtailments to prevent the possibility of budgets getting exhausted
- Summer-only program (June-August)

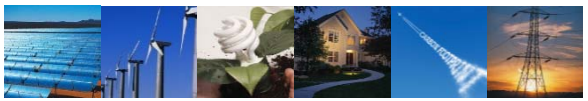


Performance Period

- Use day-ahead forecasts to determine event days
  - EDC vs. PJM forecast?
  - What threshold? 95%, 96%, 97%?
  - Historic comparison of loads is needed to assess expected number of events at different day-ahead thresholds
  - Eliminates the “top 100 hours” forecasting challenges
    - No chance of calling an event that doesn’t count
    - No chance of holding on resources for hot days that don’t materialize
  - Increased potential especially from industrials
  - Allows day-ahead notification for customers, which increases potential



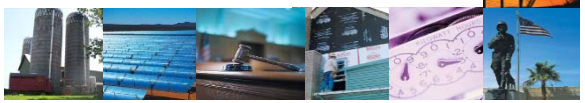
Transmission and Distribution Benefits



Determine T&D Avoided Costs

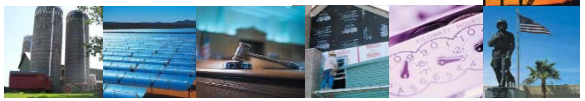
- Collect data on EDC forecasts for T&D capital expenditures
- Work with EDCs to determine portion of capital expenditure forecast is related to load growth
- Develop methodology to calculate T&D avoided costs per kW-year

Nexant research into action APEX ANALYTICS

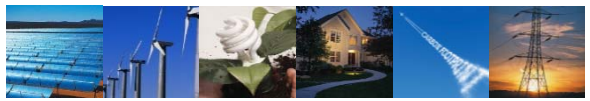


Other T&D Avoided Cost Studies

STATE	TITLE of STUDY	FIRM	DATE of STUDY
California Public Utilities Commission	Methodology and Forecast of Long Term Avoided Costs for the Evaluation of California Energy Efficiency Programs	Energy and Environmental Economics	October, 2004
Manitoba Hydro	Marginal Transmission & Distribution Cost Estimates	Manitoba Hydro	April, 2005
New England	Marginal Transmission & Distribution Cost Estimates	ICF Consulting	December, 2005
New York State Energy Research Development Authority	Deployment of Distributed Generation for Grid Support and Distribution System Infrastructure	Synapse Energy Economics	February, 2011
New England	Avoided Energy Supply Costs in New England	Synapse Energy Economics	July, 2011
New England	Avoided Energy Supply Costs in New England	Synapse Energy Economics	July, 2013
Maryland Energy Administration	Maryland Energy - EmPOWER Planning Avoided Cost Meeting	Maryland Energy Administration	December, 2013



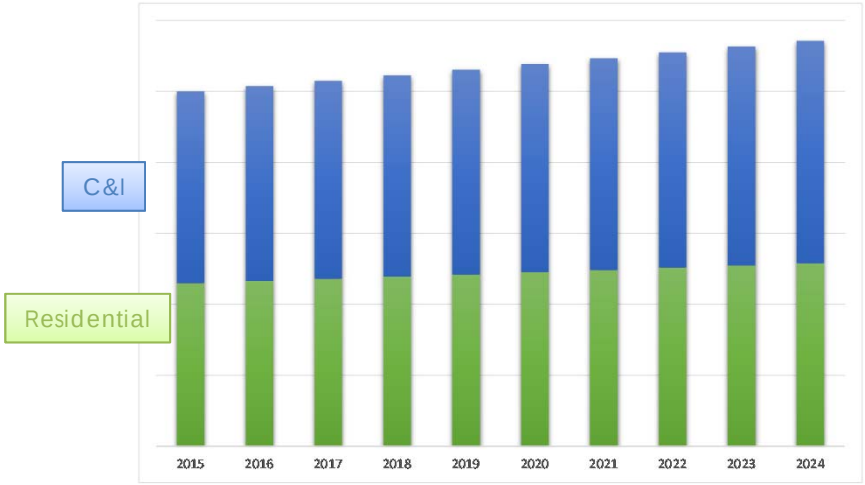
RESIDENTIAL DEMAND RESPONSE



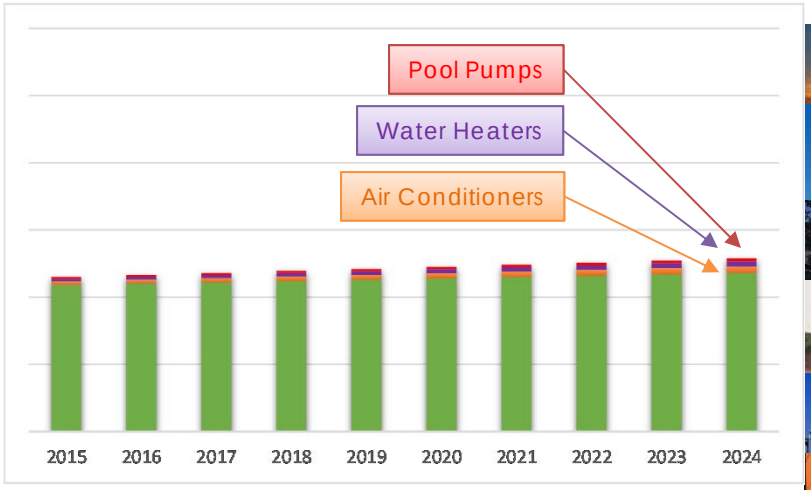
Bottom-Up Approach

- Homogenous loads makes bottom-up approach preferred
- Aggregate measure-level savings to estimate potential

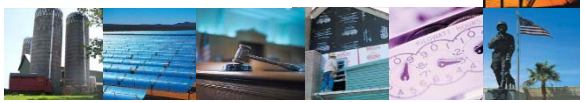
Peak Forecast Disaggregation



Residential DR Potential

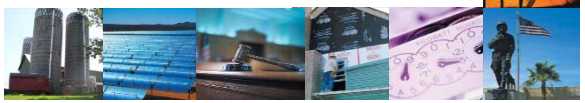


Nexant research into action APEX ANALYTICS



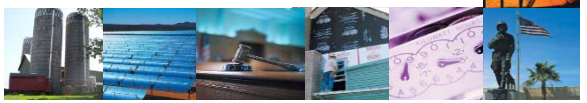
DEMAND RESPONSE TECHNOLOGIES

- Focus is on non-price related technologies
  - Air conditioner control (central and room units)
    - Direct load control switches
    - Communicating thermostats
  - Swimming pool pump control
  - Electric water heater control (bigger benefit in winter, but still some on-peak demand savings in summer)



Residential DR Adoption Rates

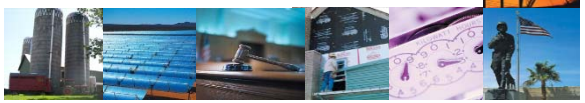
- Data sources
  - Review adoption rate, kW savings and other data from Act 129 Phase I programs in Pennsylvania
  - Review data from October 2013 FERC Survey of Demand Response programs
  - Review data collected by SWE from Phase I review of DR programs in other states
  - Review other recent demand response potential studies
- Program design and incentive assumptions will be critical factors in assumed adoption rates



Residential DR Load Reductions

- Primarily use data collected during Phase I DR study
  - Good data on kW savings for AC programs and correlated temperature information
  - Direct control and thermostat programs were instituted

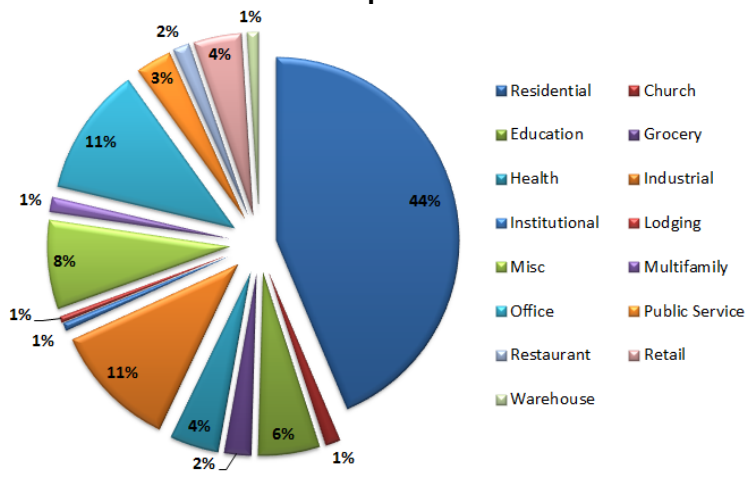
- Review data collected by SWE from Phase I review of DR programs in other states
  - Water heaters - seasonal, but not as temperature sensitive as AC
  - Pool pumps – can use vendor data as well as other secondary data as available

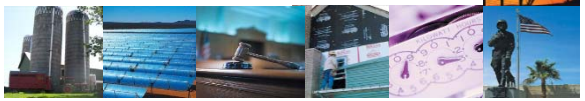


NON-RESIDENTIAL DEMAND RESPONSE

FORECAST DISAGGREGATION

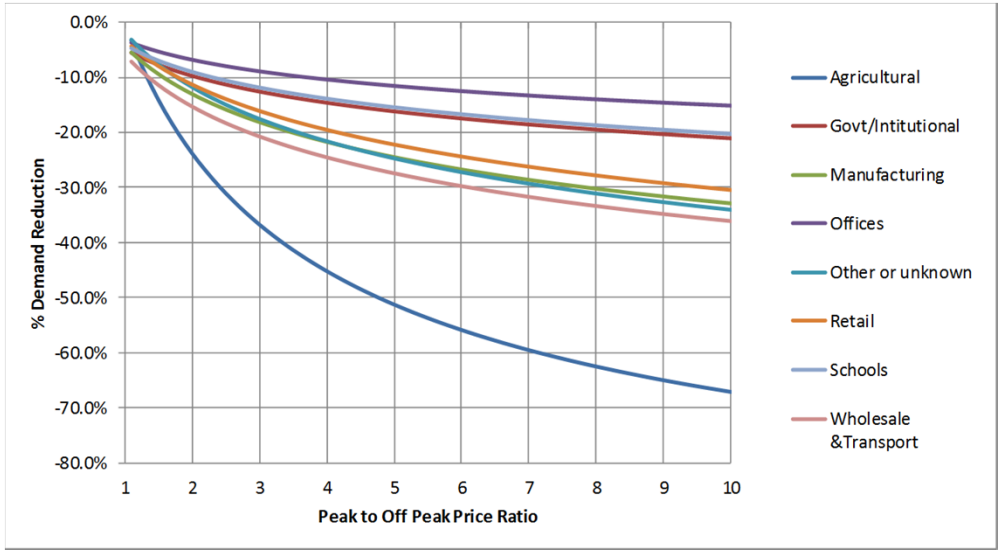
- EDC peak demand forecasts are for all customer classes
- First task is to split residential and non-residential
  - Sum the PLCs of every non-residential account
  - Subtract this total from the forecast to estimate residential
  - Use the customer segmentation developed for the C&I Baseline and EE potential study





FORECAST DISAGGREGATION

- Forecast disaggregation is important because customer loads in certain segments are more responsive than others to pricing signals



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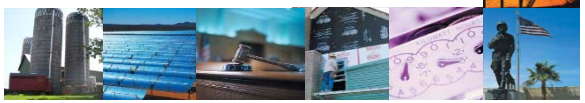
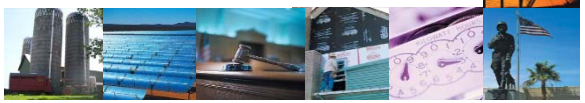
How Do We Know? - California Adoption Rates

- The 2000 California energy crisis led to several specific policies that revealed DR preferences of large customers. At some point nearly all customers were offered DR options and they made a decision about whether or not to participate.
  - 2003 - mandatory TOU rates for all customers > 200 kW.
  - In person outreach by KAMs to all customers above 500 kW in order to offer and explain DR opportunities.
  - Aggregator contractors for additional DR of customers < 500 kW
  - Finally, in 2008-2010, the IOUs implemented default critical peak pricing for customers that had not yet enrolled in DR programs.



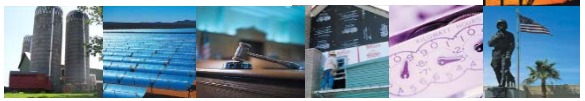
Forecast Disaggregation – End Uses

- Distribution of loads by end-use within a market segment (cooling, lighting, refrigeration, process, water heating)
- Different load shedding potential
- Allows us to better leverage Phase I data. % reduction in building load achieved via various strategies
- Will the energy be recovered during off-peak hours or is it a net savings?



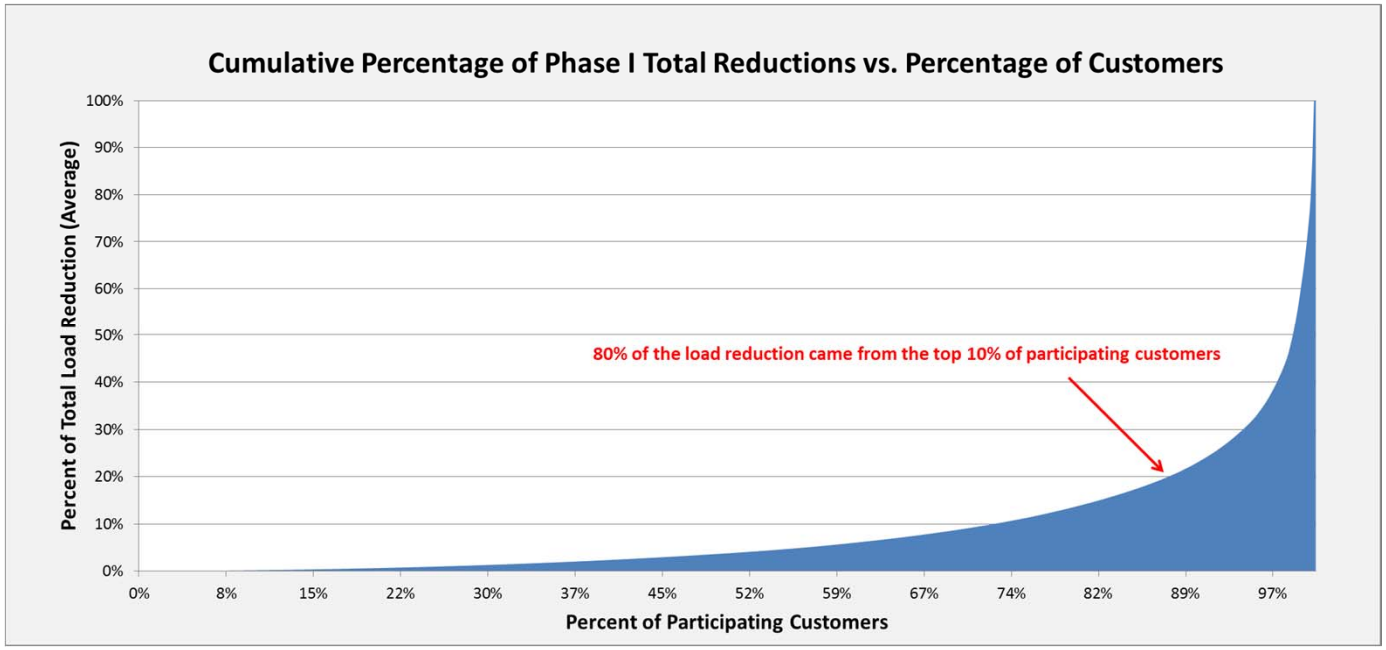
SMALL COMMERCIAL DLC

- Similar to the residential offering
- Will rely on common equipment and installation cost assumptions
- Portion of the segmented forecast attributable to cooling?
  - Interval load data
  - Categorize customers by consumption and weather sensitivity
- Phase I and FERC-731 surveys provide insight into penetration rates



Phase I Participation Data

- Comprehensive records from summer 2012



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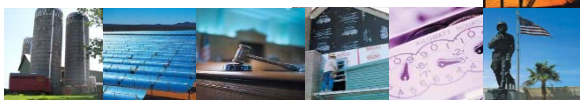
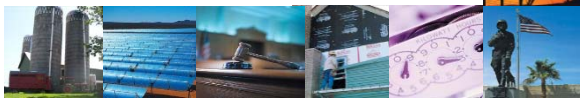
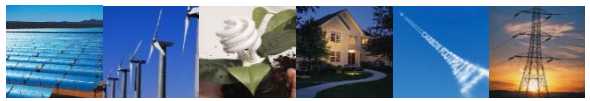


Phase I Participation Data

- Types of businesses that participated
- What end-uses were curtailed at those facilities
- kW reductions achieved and the consistency of those reductions
- At what incentive level
- Number of days/hours of curtailments
- Whether the site was active in the PJM Capacity or Energy DR market

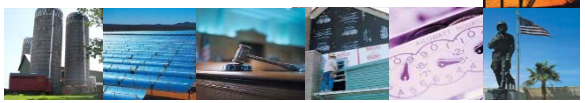


DISTRIBUTED ENERGY RESOURCES STUDY



DER STUDY

- Gap analysis for the EE and DR MPS
- Existing BUGs are part of DR study. The DER analysis will focus on new installations
- Distributed energy resources were excluded from the previous EE potential study but counted for compliance in Phase I and Phase II
  - **West Penn Power** 50 GWh CHP project at Penn State in PY3
  - **PPL** 30 GWh CHP project at Geisinger Medical Center in PY3
  - **PECO** has an entire CHP program in Phase II (Smart On-Site) with a goal of 135 GWh
  - **Met-Ed** had 5 GWh of solar PV in PY4



DER Study

- Technologies considered
  - Solar Photovoltaic
  - Combined Heat and Power
  - Wind
  - Biomass
  - Fuel Cells
  - Microturbines
- Cost-effectiveness considerations
  - 2013 TRC Test Order doesn't consider emission reductions a benefit
  - Upfront cost of solar is dropping rapidly