Grid Modernization Activities in Delaware

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Topics

- GEAC mission and working groups (WG)
- Grid Mod WG recommendations
  - General Categories
  - Ex: few specific recommendations
- My personal favorites for Grid Mod actions to increase PV hosting capacity

Caveat

- I am representing the efforts of the DE GEAC Grid Mod WG
- I don’t speak for or represent University of Delaware or DE Natural Resources and Environmental Conservation (DNREC)

Governor’s Energy Advisory Council (GEAC)

- Established and briefly activitated ~ 2010 then dormant
- Reactivated 2023
- Council, Chair and Staff (DNREC)
- ~50 Members and their delegates
  - State officials: PSC, PA, DNREC, legislator (Senator Hansen)
  - Utilities: PJM, DPL (regulated), DEC (Coop), DEMEC (Corp of 9 Munis)
  - Industry groups: PV installer (DESC), NG and liquid fuel distributors
  - Academics: me, Willett Kempton (EV and wind)
  - Advocates: Sierra Club, Public Health, LMI workforce, CRI, Energize DE
- 20-30 members of public attend in person or virtually

GEAC Responsibilities

- Providing recommendations to the State Energy Office on updates to the Delaware Energy Plan and Climate Action Plan every 5 years from date of enactment. The updating process shall include a process for public input and measures for progress in attaining goals.
  - DNREC converts rec's to policy, regulation, programs, etc
- Monitoring federal, state and regional energy issues, identifying the impacts on Delaware and recommending actions and policies.
- Details including recommendations from all 4 working groups
  - https://dnrec.delaware.gov/climate-coastal-energy/energy-office/advisory-council/

Working Groups and Chairs

- ***Renewable Energy and Clean Technologies***
    - Dale Davis, CMI Solar, Director of DE Solar Energy Coalition
- ***Energy Efficiency and Electrification***
    - Bahareh van Boekhold, EE consultant, Board Green Buildings
- ***Grid Modernization***
    - Dr. Steve Hegedus, University Delaware
- ***Environmental Justice and Energy Equity***
    - Cassandra Marshall, Small Business Environmental/Construction Consulting and Proposal Prep

Grid Modernization WG Recommendations: Broad Categories (#)

- Infrastructure (6)
- Reliability (2)
- Cybersecurity (2)
- Costs/Incentives (4)
- EVs (1)
- Microgrids (3)
- Transmission/Distribution (5)
- Battery/storage (1)
- Electric Rate Design and TOU (4)
- Forecasting climate impact (1)
- Workforce Development (1)

Ex: Infrastructure

Further study and evaluate the state’s distribution grid to identify opportunities (i.e., battery storage, microgrids, etc.) and establish a baseline of current conditions to help guide and plan future infrastructure investment.

Ex: Infrastructure (merging of 2 recs)

Study benefits and barriers, including cost, to implement DER Management System (DERMS) to accelerate the integration of more PV on the distribution grid. Work with one or more utilities to implement DERMS. Identify resources to incentivize the development and deployment of pilot scale DERMS on feeder or substation having high DER penetration.

Ex: Costs/incentives

Since accumulated growth of PV systems eventually restricts circuits for future PV installations because the mitigation cost is too high for the next system, study alternate methodologies of handling the cost.

Ex: Microgrids (merging of 2 recs)

Define microgrids, identify barriers, and <u>develop goals, incentives, and selection process</u> for the installation and operation of several Microgrid pilot projects serving different load customers. <u>Encourage 'value stacking' </u>of multiple financial and operational benefits (resilience, reliability, deferred distribution upgrade, demand charge reduction, PJM arbitrage, and frequency stabilization services)

Ex: Storage (merging of 2 separate recs)

Study Delaware's electrical energy storage needs and set incremental goals to achieve both stand-alone and PV-attached storage goals. Encourage pilot deployments of different battery technology and scale (residential, commercial, utility) including expected lifetime and safety issues.

Challenges identified (impact all WGs)

- DE only has one regulated utility DPL (68% load)
  - One third of DE load is from unregulated utilities
  - Smaller muni's and Coop varying levels of technical personnel and resources (some have ~ no AMI)
- Public Advocate (PA) mandate is
  - "To advocate ***the lowest reasonable rates*** for consumers consistent with the maintenance of adequate utility service and consistent with an equitable distribution of rates among all classes of consumers"
  - Makes it difficult to rate base Grid Mod or new technology pilot projects
- Limited workforce to accomplish goals

My views of critical topics or pathways to enhance Grid Mod

- Value stacking to incentivize Batteries and Microgrids
- Implementing Smart Inverter Grid Voltage Control to enable higher PV penetration
- DER Coordinated Control

Portland Gas Electric 5 MW/1.25 MWh battery value (for PNNL grid service study not back-up, 2015)

https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26858.pdf

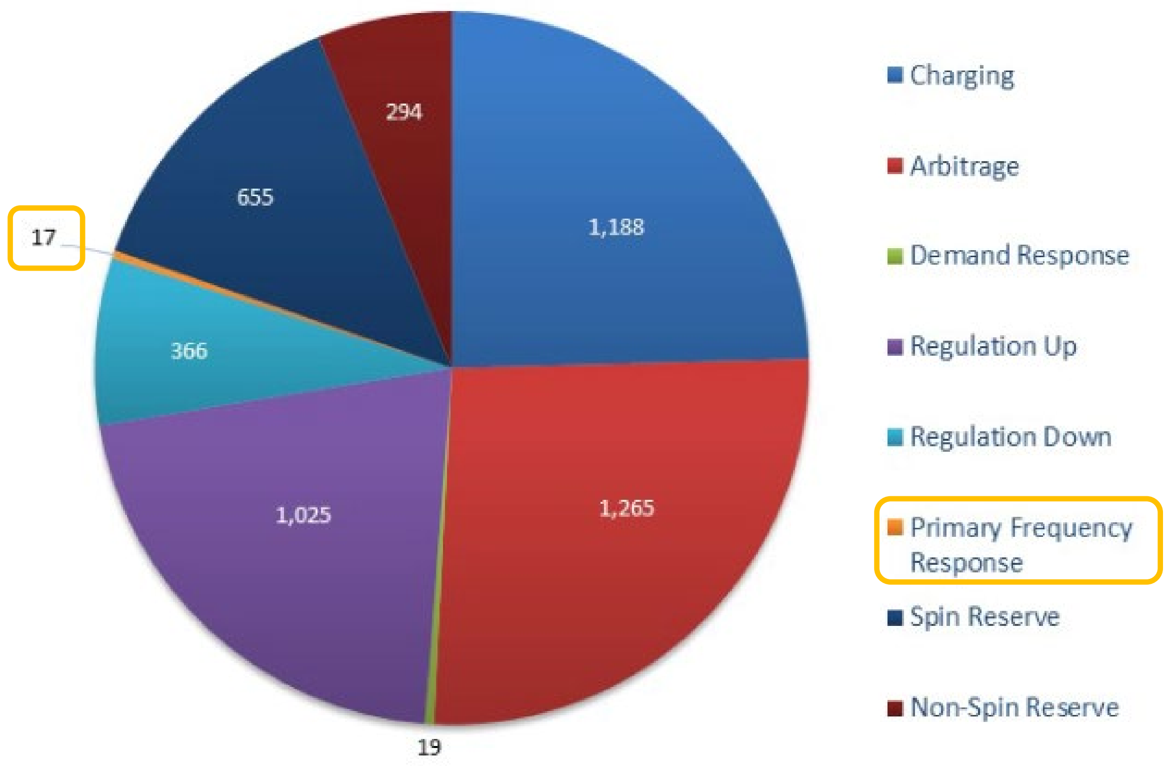


Figure 5.5. Annual Application Hours of the Energy Storage System under Base Case

<u>Compare hrs vs $ value of Arbitrage and Freq Response</u>

Arbitrage: 1200 hrs, 12% of value ($0.7M)
Freq Response: 17 hrs, 56% of value ($3.5M)

Value Stack for Renewable Based BTM Microgrid

MG Life cycle cost

Diesel Generator Cost for occasional back-up

Avoiding $ losses during grid outage*

Reduced kWh $

Reduced Peak kW demand $$

Green Incentives, CO2 reduction

Avoid generator fuel, maint.,

Selling Ancillary Services to Grid**

*Avoided $$ losses may be difficult to quantify: factory production, lives, food, comfort, convenience, lost customers?

**Ancillary grid services: Voltage or frequency stability (power factor), arbitrage (buy low, store, sell high), ramping control

Smart Inverter Grid Support Controls

- IEEE 1547-2018/2020 and Sunspec Smart Inverter communications required for inverters since 2018/2020
  - Preset autonomous Volt-VAR, Volt-Watt, PF, Freq-Watt controls
  - Or remotely set using standard comms (Modbus, DNP3, IEEE)
  - Help maintain V or f within accepted local standards with increased PV power flow or variability
- Key tool ***to increase Hosting Capacity*** already available for free in existing inverters yet rarely ever deployed!
  - Challenges with different brands having different comms and control protocols, interoperability

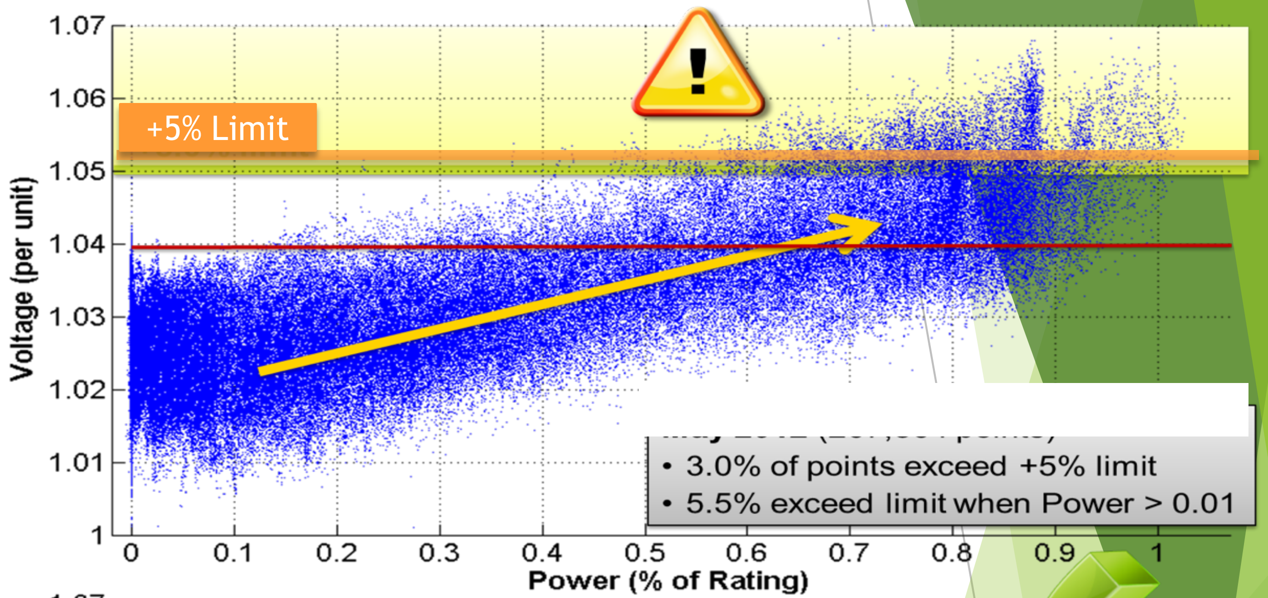
Inverter PF Settings Mitigate High Voltage (PHI, NJ)

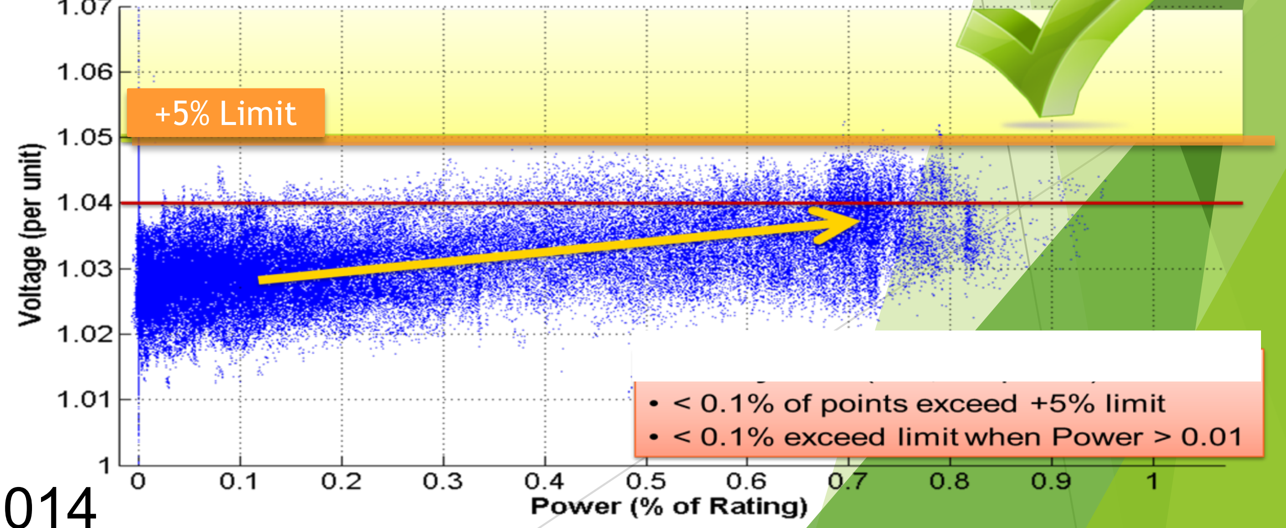
PV customer had 1.9 MW PV system 5 miles from substation

Significant high voltage events when inverter was near maximum output

- Reducing PF (=0.96) on the inverter significantly reduced frequency of overvoltages
- Lowest cost option of mitigating problem compared to battery storage or 'reconductoring'

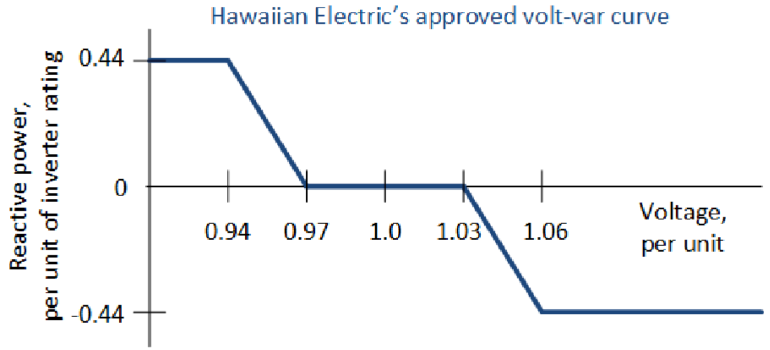
This example is from a 1.9 MW customer in NJ

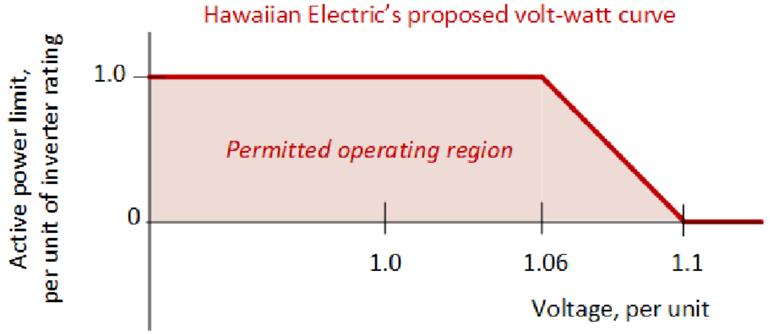




Steve Steffel, Pepco Holding, March 2014

Volt-Watt and Volt-VAR control curves enable smart inverter to support the grid -become part of the solution not the problem!





NREL and HECO performed quasi-static time-series analysis of two HECO feeders to evaluate 0.95 PF, Volt-VAR, Volt-Watt control

- Volt-VAR had fewer voltage violations, fewer tap-changes, reduced losses than PF=0.95
- PV energy curtailment due to Volt-VAR and Volt-Watt was near zero
- HECO requires Volt-VAR for all new DERs as of 2020

https://www.nrel.gov/docs/fy17osti/68681.pdf
https://www.nrel.gov/docs/fy19osti/72298.pdf

Yet even in 2023 very few states require adopting IEEE 1547-2018

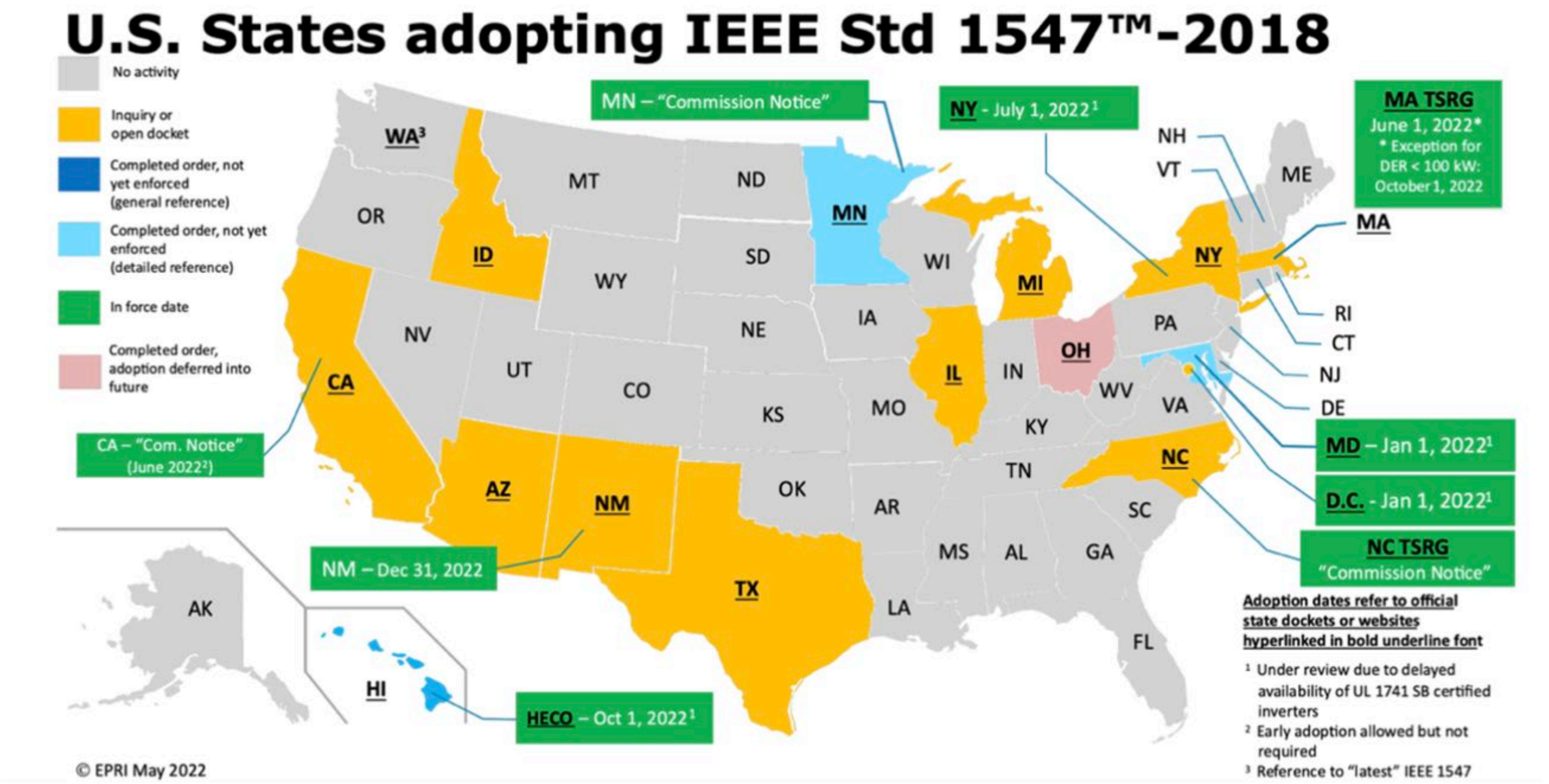


Figure 1: Map of IEEE 1547-2018 adoption by state. Source: IEEE

Coordinated Voltage Control (CVC) of Feeder

- Four year study (EDD, PHI, UD, others)* funded by DOE to enhance hosting capacity on distribution circuit eastern MD with summer peak load 13 MW and PV fraction 17%, or 2.3 MW
- Simulation using graph-trace-analysis (GTA) based, time-series optimization algorithm
- Apply CVC of existing utility components (1-substation LTC, 1-Volt Reg, 3-switched capacitor banks)
- CVC similar to DERMS (controls vs generators)

Data on next page

- DOE DE-0008768 ‘Faster-than-real-time Simulation with Demonstration for Resilient DER Integration’
- Team leader Robert Broadwater, Energy Distribution and Design/NISC

Coordinated Voltage Control Results

- Solar PV penetration is increased until overvoltage violation occurs. This process is done three times: default (no CVC), CVC (PF=1) and CVC (PF=0.95)

	Existing	Default Controls	CVC (PF=1)	CVC (PF=0.95)
Scale ALL existing PV	17% (2.3 MW)	55% (7.3 MW)	200% (27 MW)	250%* (33 MW)

- CVC of existing utility control hardware enables huge increase in PV Hosting Capacity! And smart inverter control increases even more!

Thank You!