Demystifying Virtual Power Plants:
What is a VPP? How are VPPs deployed today? What are the opportunities and challenges for regulators, utilities, and other stakeholders?

Hosted by SEPA with support from NARUC and the DOE’s Office of Electricity and Loan Programs Office

Wednesday, February 15, 2023
1:00 pm - 4:15 pm
Grid-interactive Efficient Buildings: Reinforcing the Grid with DERs

1:20 – 2:00 pm

Moderator:
David Nemtzow, Senior Advisor, Loan Programs Office, US DOE

Featuring:
Lea Márquez Peterson, Commissioner, Arizona Corporation Commission
Lon Huber, SVP of Pricing & Customer Solutions, Duke Energy
Tilak Subrahmanian, VP, Distributed Energy Resources, Eversource
Chris Rauscher, Senior Director, Grid Services Policy, Sunrun
Grid-Interactive Efficient Bldgs. (GEBs)...Resid. too
Groups of GEBs provide added value

- Achieve economies of scale
- Leverage load diversity to smooth demand curves
- Facilitate incorporation of additional DERs
- Achieve greater impact through scale
- Allow for innovative business models
- Can achieve more than the sum of individual buildings

Photo by Haikal Omar from Pexels
Virtual Power Plants

VPPs are connected aggregations of DERs – PV, batteries, responsive loads, EV charging, controls & more – remotely and automatically controlled to deliver affordable power, reliability, decarbonization and clean grid services.

- Aggregations of DERs that are controllable
- Non-co-located assets scaled into a holistic demand-side and/or supply-side resource
- May entitle the VPP participants to compensation for grid services
- VPPs serve essential customer functions, create demand flexibility, fortify grid reliability & resilience
- VPPs support CO₂ reduction, energy equity, and energy bill reduction for households, small businesses, and other end users
- VPPs are utility-scale and utility-grade

➢ Don’t sweat definitions, LPO/DOE is happy to talk about lots of technologies, structures, approaches
Traditional Demand Response Programs

**Load control begins for emergency use only**

**Load control for economic purposes begins, starts with AC control devices**

**Smart thermostats are added for summer reduction**

**Smart thermostats are expanded to include winter reduction**

**Electric heat strip control device option added for winter peaks**

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**Demand Response Evolution**

- **1970s**: Load control begins for emergency use only
- **2000s**: Load control for economic purposes begins, starts with AC control devices
- **Early 2010s**: Smart thermostats are added for summer reduction
- **Late 2010s**: Smart thermostats are expanded to include winter reduction
- **2020s**: Electric heat strip control device option added for winter peaks

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**Duke Energy Progress** (NC & SC)
- Smart Thermostat
- AC Control Device
- Heat Strip Control Device
- Water Heater Control Device
- Smart Thermostat + Water Heater Bundle

**Duke Energy Florida**
- Heating
- Cooling
- Water Heater
- Pool Pump

**Duke Energy Carolinas** (NC & SC)
- Smart Thermostat
- AC Control Device
- Heat Strip Control Device

**Duke Energy Indiana**
- Smart Thermostat
- AC Control Device

**Duke Energy Kentucky**
- AC Control Device

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Both EnergyWise Home and Power Manager pay customers to reduce usage via specific devices when demand response events are called.

**Capacity**

- **3,146 MW Summer Capacity**
- **2,277 MW Winter Capacity**
# Next Generation Demand Response

## Current Proposals

| Smart Saver Solar | • Align net metering tariffs to embedded cost of service* through advanced time varying rates  
|                   | • Filed bundled EE incentives to fairly allocate marginal system benefits + utility-controlled demand response programs  
|                   | • Requires solar customers to enroll in the winter BYOT program  

| Vehicle-to-Grid | • Partnered with Ford to pilot the use of F150 Lightning^ batteries to support the grid  
|                 | • Call up to 24 events per year, lasting no more than four hours  
|                 | • Participating customers compensated approximately via a reduced lease payment  

| My Energy Bill+ | • A subscription-based program that provides bill certainty in exchange for utility control of a smart thermostat during periods of peak demand  
|                | • The option to purchase Renewable Energy Certificates as an easy way to participate in clean energy generation  
|                | • Income qualified customers will be offered a free to heavily discounted smart thermostat to expand accessibility to participate in such programs  

*Updated NEM tariffs have been approved in South Carolina  
^Additional Ford models and vehicles made by other OEMs may be included during the pilot
Sunrun is a leader in Virtual Power Plant solutions

- Sunrun actively participates in more than a dozen VPPs
- VPPs in 10% of Sunrun markets; expect 50% in coming years
- Wholesale participation, state-level programs and contracts with utilities
- Recently approval of Puerto Rico’s first Virtual Power Plant, serving the entire island grid

The Power of Virtual Power Plants

New England
- First Residential VPP Successfully Bid Into Wholesale Market + BYOD

California
- Enabling Participation In Utility Demand Response & CAISO Emergency Load Response Program

Puerto Rico
- Customer-Driven Solution: 7000 Homes in First Large-Scale Residential VPP On The Island
Sunrun's High Performance Home

enabling electrification solutions that address customer goals

1. Solar Panels
2. Batteries
3. EV charger
4. Smart circuits
5. Heat pump heating & cooling
6. Heat pump water heater
7. Smart thermostat
8. Induction cooktop
9. Smart bulbs
10. Smart plugs

We Enable No-Compromise, High Performance Homes For Our Customers

*(that happen to be solar powered & all-electric)*
Millions of Mini Power Plants: What Vehicle-to-Grid Technology Means for Reliability, Resilience, and Affordability on the Grid

2:00 – 2:45 pm

Moderator:
Ann McCabe, Commissioner, Illinois Commerce Commission

Featuring:
Lydia Krefta, Director, Clean Energy Transportation, PG&E
Apoorv Bhargava, CEO & Cofounder, WeaveGrid
Dana Guernsey, Co-Founder and Chief Product Officer, Voltus, Inc.
Rima Kasia Oueid, Senior Commercialization Executive, Office of Technology Transitions, U.S. Department of Energy
Bidirectional Electric Vehicles = V2B+V2H+V2M+V2G = V2X

Electric Vehicles can be both a mobility asset and an energy asset

- International Energy Agency estimates 130 million electric vehicles globally by 2030
- These EVs could contain 10 times the amount of energy storage needed by the grid

Source: Wood Mackenzie Energy Transitions Practice, Inside EVs

$28B cumulative spending on energy storage forecasted 2019-2025E
The Vision for V2X & VPPs

Enable transportation and energy networks to work together as a single symbiotic system capable of delivering transport and energy storage services to the grid (e.g. Virtual Power Plants) and serve as a catalyst to help modernize the grid and evolve to a Smart Grid.

Schematic Representation of V2G Operations
Source: National Renewable Energy Laboratory
Enabling customers & partners to monetize their DERs

"Machines to markets to money": The Voltus platform aggregates DERs into VPPs and sells their services (energy, ancillary services, capacity) to grid operators; Voltus shares a portion of that cash with its partners.
Electric Vehicles Can Improve System Economics for All Customers

As power plants built to serve peak demand retire, we can use EVs to utilize excess capacity, reduce unit prices, and provide power back to the grid in lieu of building replacement fossil fuel power plants.

Source: Internal, not an approved forecast
PG&E Hourly Energy Management System Load Data, 2022
Electric Vehicles Can Improve System Economics for All Customers

By 2040, increasing energy sales requires a **significant build out of new energy supply** and a grid that can accommodate its delivery to customers. A wider range of high and low loads and the emergence of a second peak in the winter also necessitates more flexibility in the supply mix and demand-side optimization.

Source: Internal, not an approved forecast
PG&E Hourly Energy Management System Load Data, 2022
Optimizing EV charging enables us to realize a future where EV charging is inexpensive and carbon free. Without optimization, natural gas peaker plants would need to be maintained to meet unmitigated peak demand, adding cost and emissions.

Source: Internal, not an approved forecast
PG&E Hourly Energy Management System Load Data, 2022
Unlocking the Full Potential of EVs

PG&E’s goal is to accelerate adoption of affordable clean transportation fueled by affordable clean energy, leveraging EVs to decarbonize society at the lowest societal cost.

If properly managed, EVs can provide the triple value stack of emissions, reliability, and resiliency benefits.

- Reliability
  Reduces peak demand on a hot summer day

- Resiliency
  Provides backup for medium-long duration outages

- GHG Reduction
  Significantly reduces California’s largest source of emissions (40%)\(^1\)

\(^1\) CARB GHG Inventory (2021 Edition)
WeaveGrid connects two industries undergoing once-in-a-century transformations
Increased EV adoption creates a need for more sophisticated distribution planning

**OVERLOADING FROM EVs COULD LEAD TO DISTRIBUTION ASSET AGING AND FAILURE**

80% of charging happens at home

Level 2 charger = 2-3 homes' demand

EV adoption is very clustered

Local transformer supports 4-8 homes
Preparing the grid for EVs will require Distribution focused optimization

<table>
<thead>
<tr>
<th>Unmanaged Charging Cost</th>
<th>G&amp;T Focused Optimization</th>
<th>Distribution Integrated Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>$6,680 / EV</td>
<td>$6,220 / EV</td>
<td>$2,470 / EV</td>
</tr>
<tr>
<td>$5,380</td>
<td>$5,380</td>
<td>$1,630</td>
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<tr>
<td>$880</td>
<td>$770</td>
<td>$770</td>
</tr>
<tr>
<td>$420</td>
<td>$70</td>
<td>$70</td>
</tr>
</tbody>
</table>

~7% decrease
~65% decrease
Charging optimization value is maximized by solving across time AND location

On-Peak Charging Load
with no management

On-Peak Charging Load
with Managed Charging
Drafting the Blueprint: What Utilities Need to Know and Need to Build to Begin Taking Advantage of the VPP Opportunity

3:15 – 4:00 pm

Moderator:
Yok Potts, Director, Regulatory and Business innovation, SEPA

Featuring:
Matt Schuerger, Commissioner, Minnesota Public Utilities Commission
Pearl Donohoo-Vallett, Senior Manager, Strategy, Exelon
Kevin Brehm, Manager, Carbon-Free Electricity, RMI
Seth Frader-Thompson, President, EnergyHub
RMI’s Virtual Power Plant Partnership (VP3)

Members

- Ford
- gm
- Nest
- leap
- olivine
- OhmConnect
- SPAN
- SUNPOWER
- SUNRUN
- switchDIn
- Virtual Peaker

VP3 Priorities

- Convening
- Direct Support
- Education

Website: vp3.io
VPPs help advance power system performance across multiple objectives

**VPP BENEFITS**

- RELIABILITY
- AFFORDABILITY
- DECARBONIZATION
- ELECTRIFICATION
- HEALTH AND EQUITY
- CONSUMER EMPOWERMENT
Creating Interactive Distribution Systems

Customer Adoption of Climate Solutions

Communications, Monitoring and Control Infrastructure

Active Platform of Climate Solutions
Elk Neck Virtual Power Plant

VPP Profile
- 110 residential customers
- Behind the meter storage (0.5 MW / 1.5 MWh)

VPP Services
- Ancillary services
- Distribution services
- Customer backup generation
Working with over 60 utilities to manage nearly 1 million DERs (distributed energy resources) of flexible dispatchable capacity.
The US will need 500 GW of flexibility

- 0.5 TW flexibility
- 1.5 TW clean generation

US capacity needed to decarbonize 2 TW
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