Real Reliability
The Value of Virtual Power

PREPARED BY
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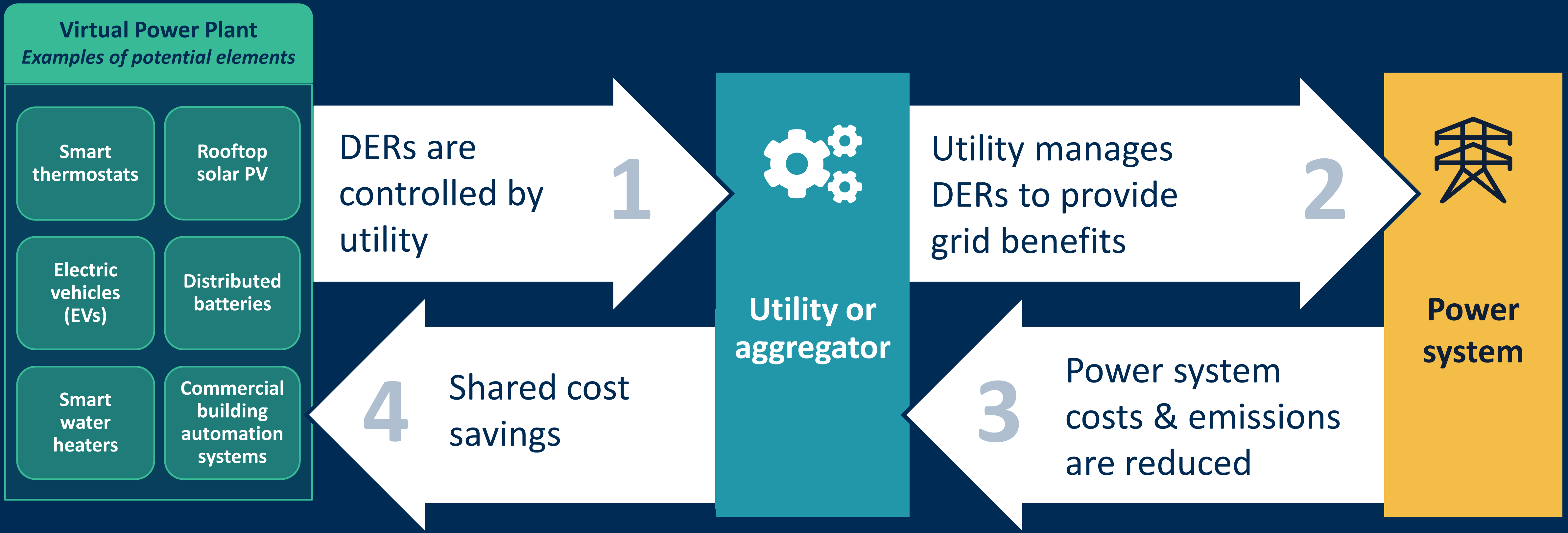
NARUC-NASEO VPP FINANCIAL TOOLBOX WEBINAR

JUNE 21, 2023

Brattle

What Is a VPP?

A VPP is portfolio of distributed energy resources (DERs) that are actively controlled to provide benefits to the power system, consumers, and the environment.



VPPs are at a deployment inflection point

Drivers

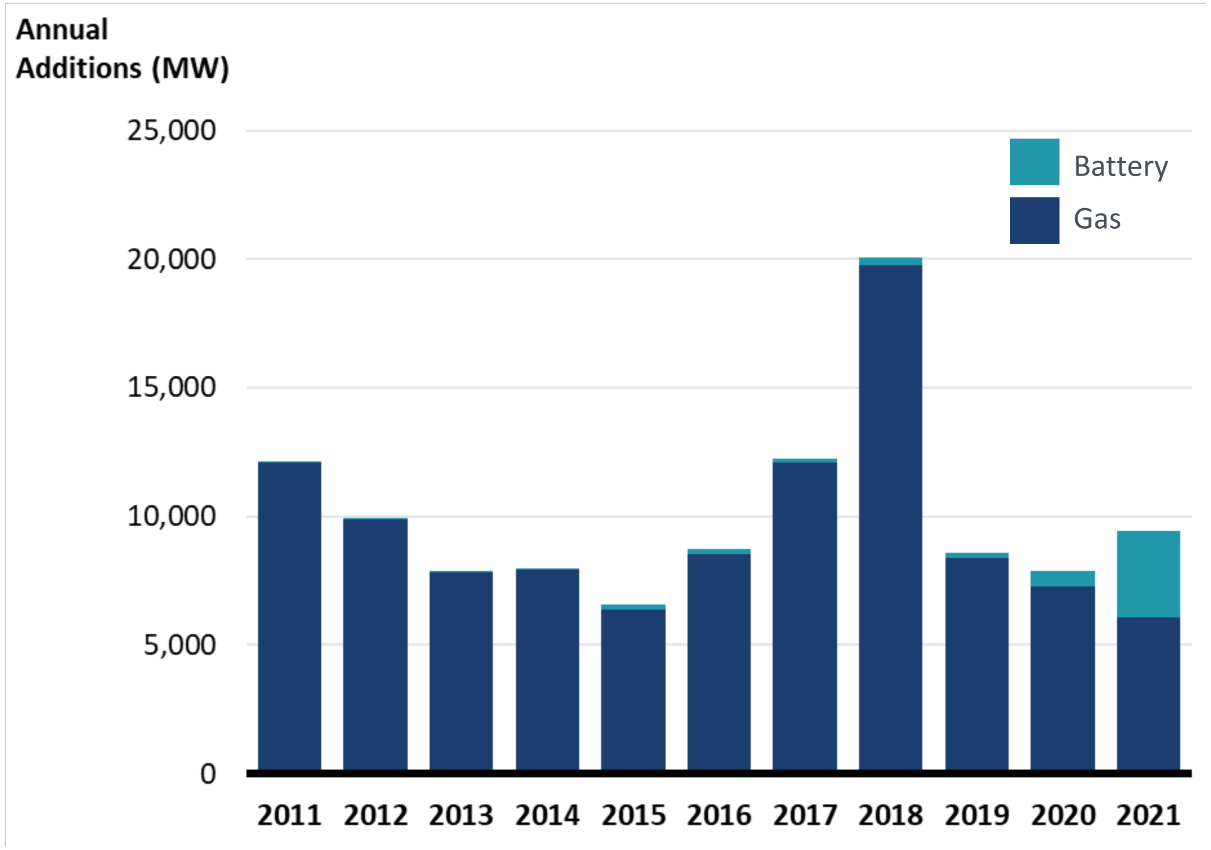
- Declining DER costs
- Technological advancement
- Inflation Reduction Act
- FERC Order 2222
- Growing model availability
- The decarbonization imperative

	PRESENT	2030
Homes with Smart Thermostats	10%	34%
Homes with Electric Water Heating	49%	50%
Residential Rooftop Solar	27 GW	83 GW
Behind-the-Meter (BTM) Batteries	2 GW	27 GW
Light-Duty Electric Vehicles	3 mil.	26 mil.

Resource adequacy needs persist in the US

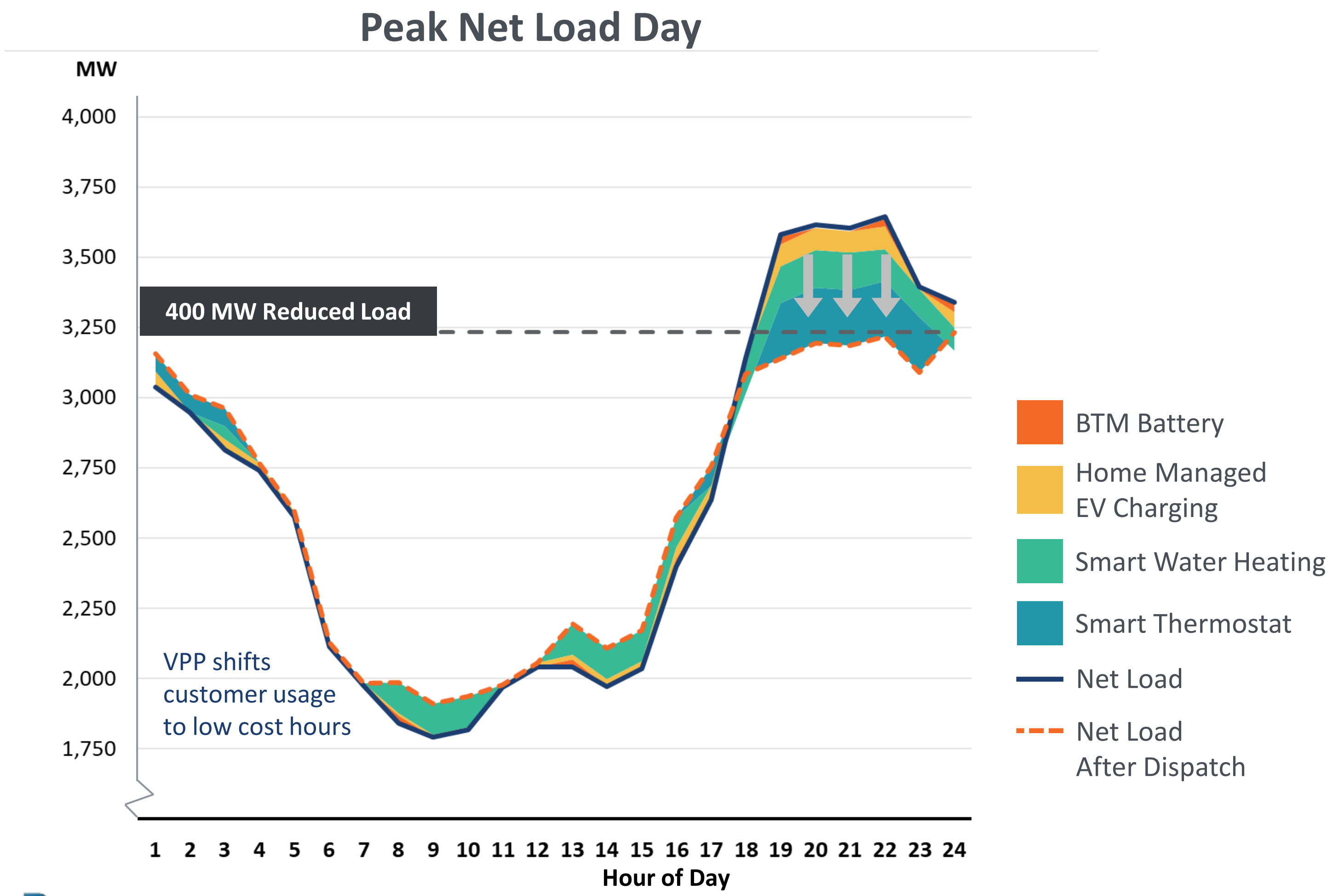
- $120 billion of investment in past decade
- Driven by electrification, coal retirements, and growing renewables dependence
- Our study:
  - Can VPPs reliably serve this resource adequacy need?
  - And can they compete economically with gas peakers and batteries?

Historical U.S. Capacity Additions for Resource Adequacy
~110 GW, 2012-2021



The modeled VPP can fully provide 400 MW of resource adequacy for a moderately-sized utility

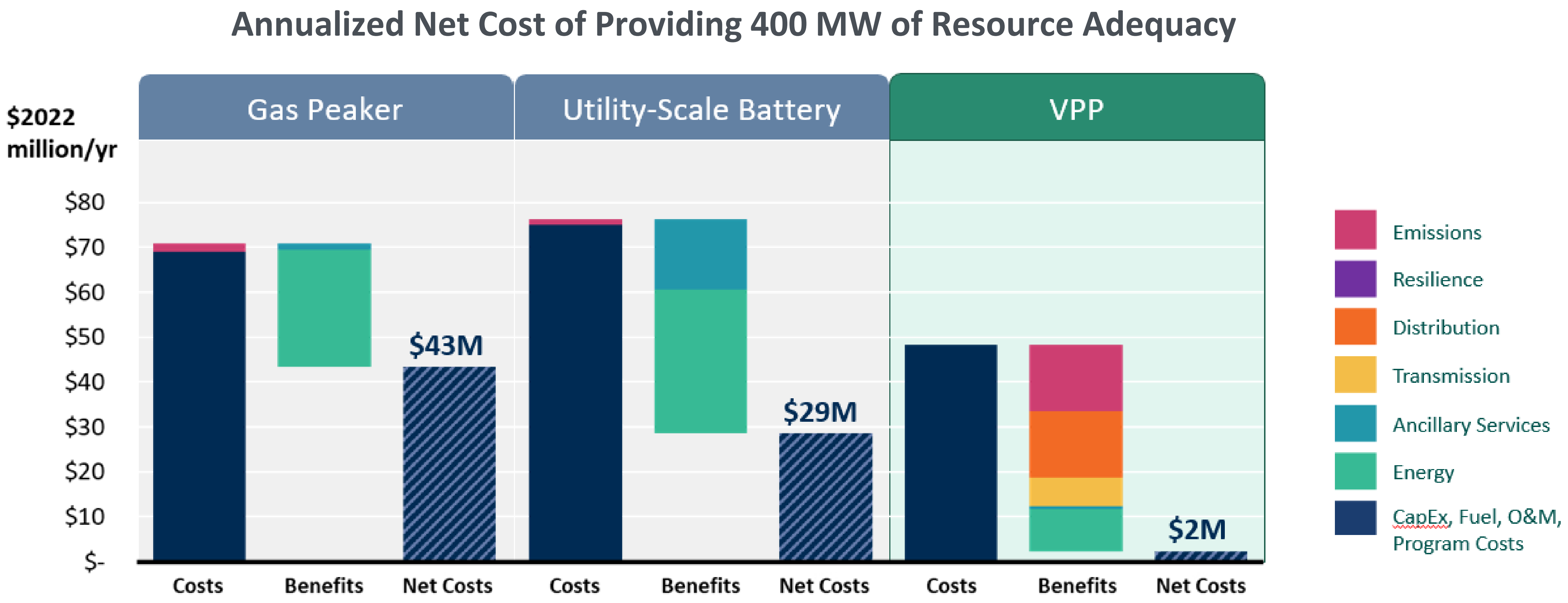
We modeled four commercially available residential demand flexibility technologies for an illustrative utility composed of 1.7 million customers



The VPP reduces load in:

- Summer and winter
- 7 months
- 63 hours of the year
- 7 consecutive hours

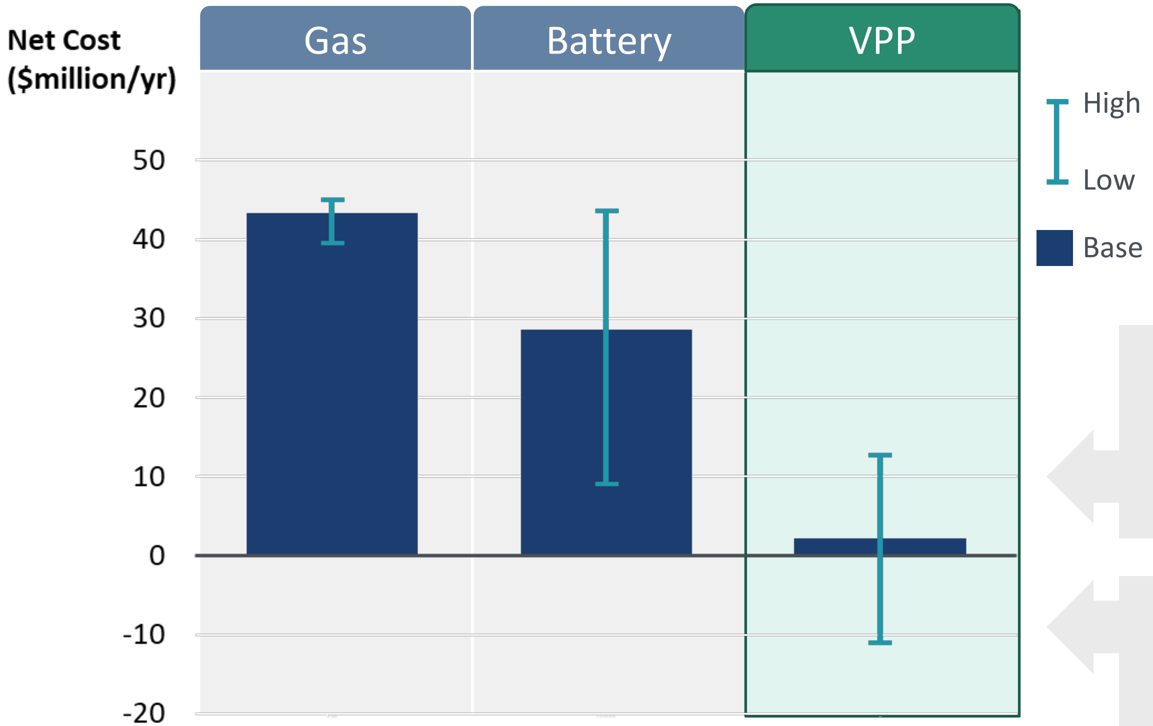
Resource Adequacy… For Cheap



RMI estimated that 60 GW of VPPs could be deployed nationally by 2030. At that scale, VPPs would save $15 to $35 billion in resource costs relative to the alternatives over 10 years … plus $20 billion in societal benefits

The VPP could provide resource adequacy at a *negative* net cost to society

Net Cost of Providing 400 MW of Resource Adequacy
(Range observed across all sensitivity cases)



Economic competitiveness of battery storage and VPPs varies across markets, depends trajectory of future cost declines.

In markets with higher T&D costs or higher GHG emissions costs, the additional (i.e., non-resource adequacy) value of a VPP can outweigh its costs

VPPs can provide several additional major benefits not modeled in this study

Increased renewables deployment

Flexible scaling

Better power system integration of electrification

Enhanced customer satisfaction

Faster grid connection

Improved behind-the-meter grid intelligence

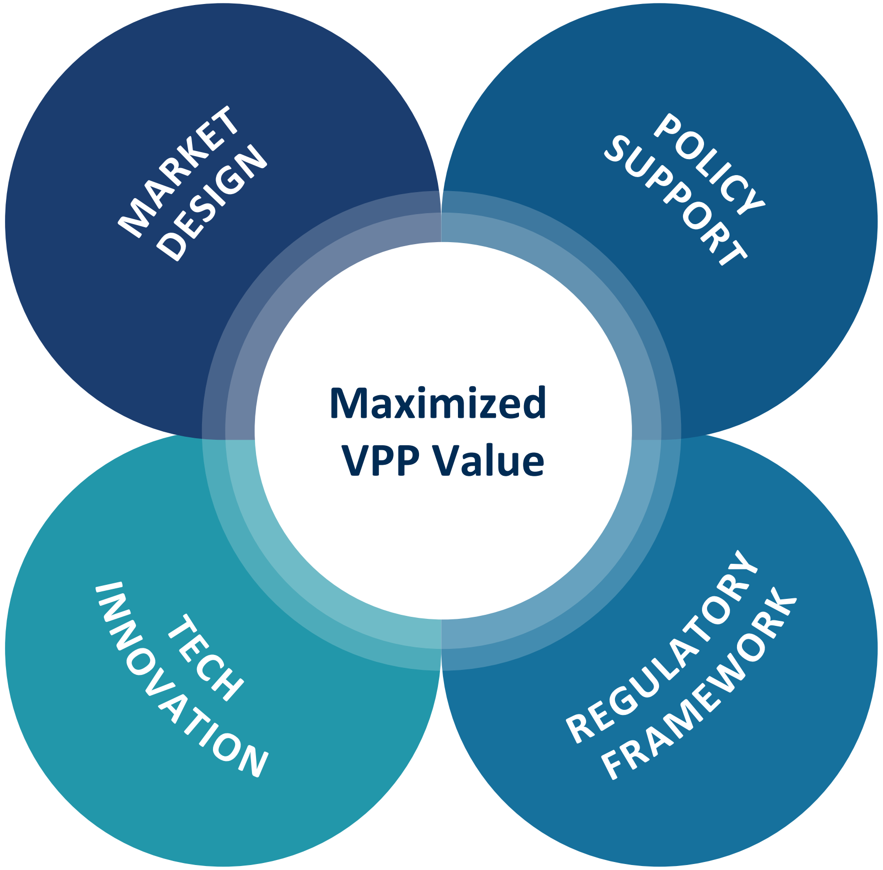
The ideal conditions for VPP deployment

MARKET DESIGN

- Wholesale markets provide a level playing field for demand-side resources.
- Retail rates and programs incentivize participation in innovative, customer-centric ways.

TECHNOLOGY INNOVATION

- DERs are widely available and affordable. DERs can communicate with each other and the system operator.
- Algorithms effectively optimize DER use while maintaining customer comfort and convenience.



POLICY SUPPORT

- Codes and standards promote deployment of flexible end-uses.
- R&D funding supports removal of key technical barriers.

REGULATORY FRAMEWORK

- Utility business model incentivizes deployment of VPPs wherever cost-effective.
- Utility resource planning and evaluation accounts for the full value of VPPs.

Three low-risk actions utilities and regulators can take now

1. Conduct a jurisdiction-specific VPP market potential study. Then establish VPP procurement targets.

2. Establish a VPP pilot. Test innovative utility financial incentive mechanisms.

3. Review and update existing policies to comprehensively account for VPP value.

For more information:

https://www.brattle.com/real-reliability/

Clarity in the face of complexity

Brattle

Virtual Peaker

Virtual Power Plants - Financial Toolbox Webinar

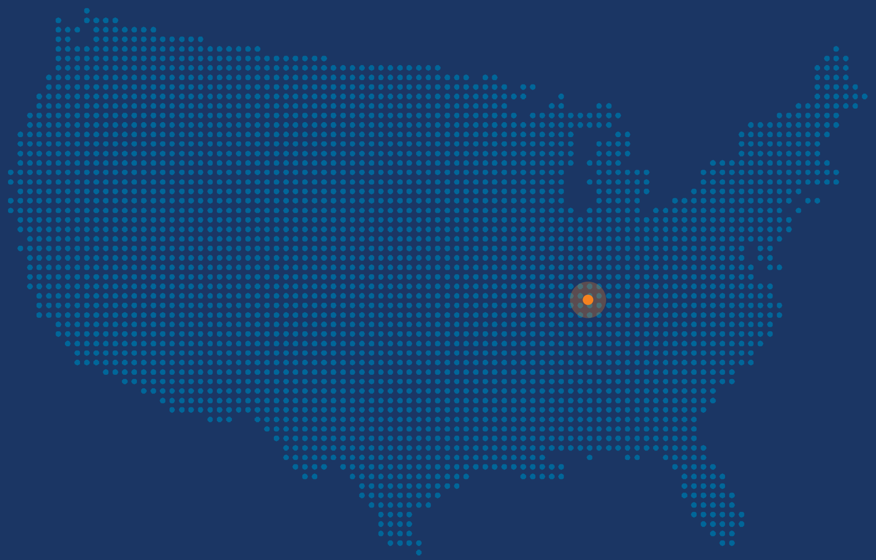
Brenda Chew
Director of Product Management

PREPARED FOR:

NARUC – NASEO 2023

ABOUT US

Virtual Peaker helps utilities digitize, decarbonize and decentralize.



- Year Established
  2014
- Headquarters
  Louisville, KY
- Business Model
  SaaS

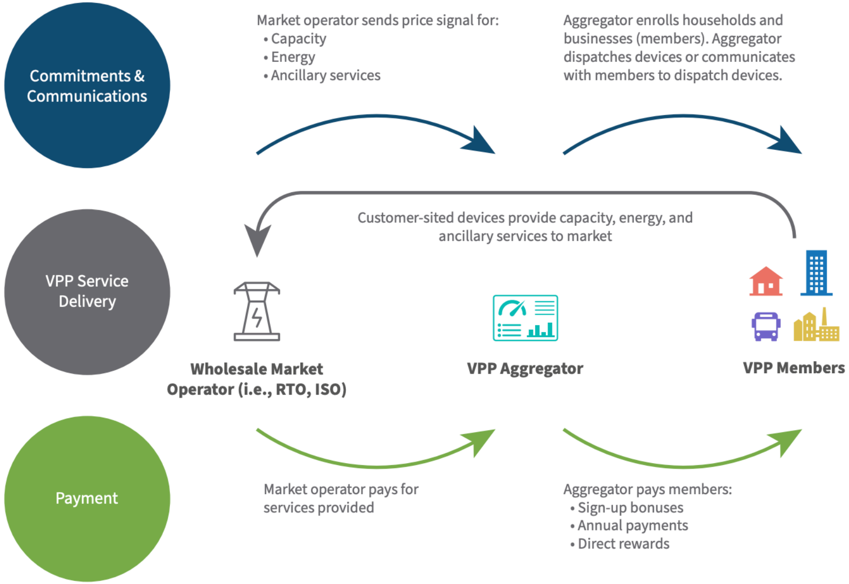
Virtual Power Plants Business Models

▸ **Market Participation VPP**

Third party brand

Provides benefits directly to market

e.g. OhmConnect



Source: RMI, VP3, 2023.

Defining VPPs

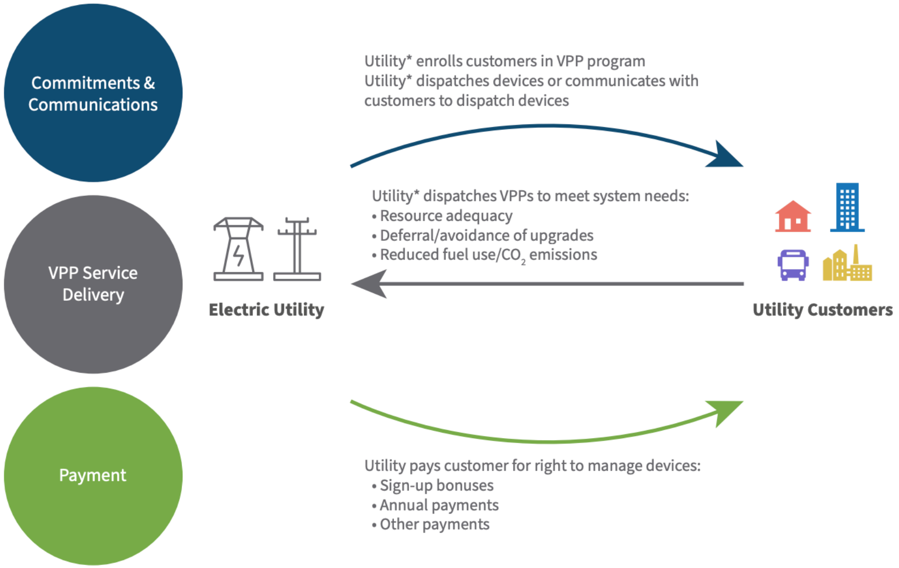
Virtual Power Plants Business Models

- **Retail VPP**

  Utility brand

  Provides benefits to the utility (could include market benefits)

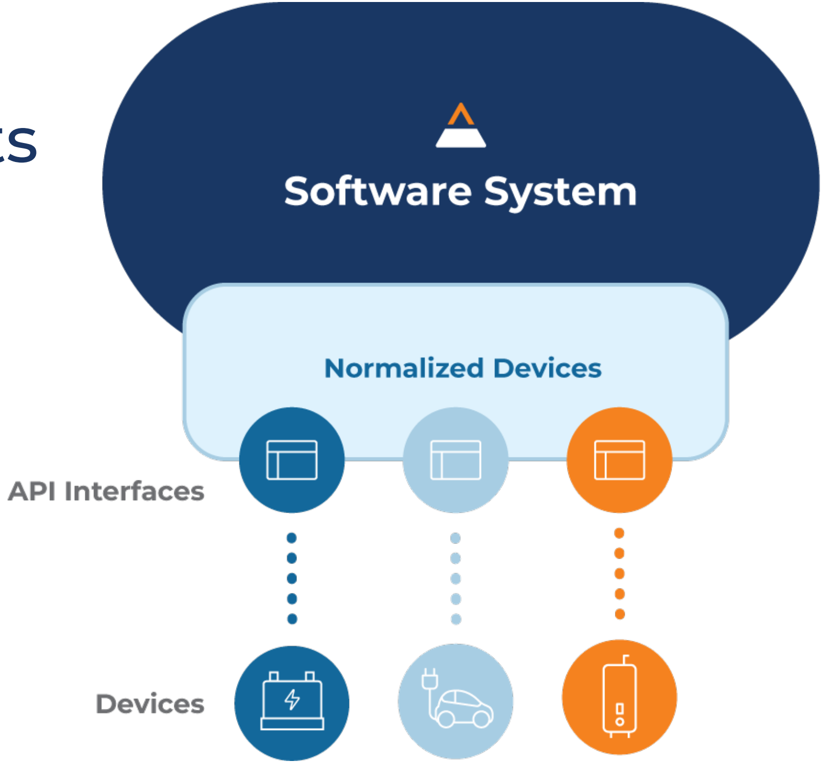
  e.g. PGE



Source: RMI, VP3, 2023.

Technical Virtual Power Plants

- **Knit together heterogenous assets,**
  All device types, e.g. batteries, thermostats, EVs
  Address ALL OEMS, e.g. Nest, Generac, Tesla
- **Make demand behave like generation**
  e.g. at 5pm provide 40MW reduction,
  at 6pm provide 35MW of reduction, etc.
- **Understand future possible reduction**
- **Consider the "fuel" constraints**
  Not important consideration for current power plants



Customer Focus

- **How to consider incentives**
  Marginal cost of VPP resources
- **How to engage the customer**
  Know when they are participating
- **How to minimize impact on customer**
  Program constraints
  Personal constraints/preferences

Looking Forward

The Next Generation of VPPs: Opportunities & Challenges

- **Bridging the Gap Between Customer Programs & Operations/Planning**
- **Ensuring an Equitable Transition for All**
- **Unlocking More Quantifiable Value**
- **Enabling a Culture of Innovation in our Industry**

Thank You!

Brenda Chew, Director of Product Management
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Virtual Peaker

Virtual Power Plant (VPP)

NARUC Financial Toolbox Webinar

Franco Albi, Director of Regional Integration
Portland General Electric
June 21, 2023

Portland General Electric at a glance

Serving all customers in our territory

- Vertically integrated electric utility encompassing generation, transmission and distribution
- Approximately 926,000 retail customers within a service area of approximately 1.9 million residents
- Roughly half of Oregon's population lives within PGE service area, encompassing 51 incorporated cities entirely within the State of Oregon
- Roughly two-thirds of Oregon's commercial and industrial activity occurs in PGE service area

Leading the way to a clean energy future for Oregon

- Our goals align with the 100% clean energy by 2040. The targets to reduce baseline greenhouse gas emissions from power served to Oregon retail customers are:
  - 80% reduction in greenhouse gas emissions by 2030
  - 90% reduction in greenhouse gas emissions by 2035
  - 100% reduction in greenhouse gas emissions by 2040

3,300+ MWs of Generation

2022 Portland General Electric Emissions

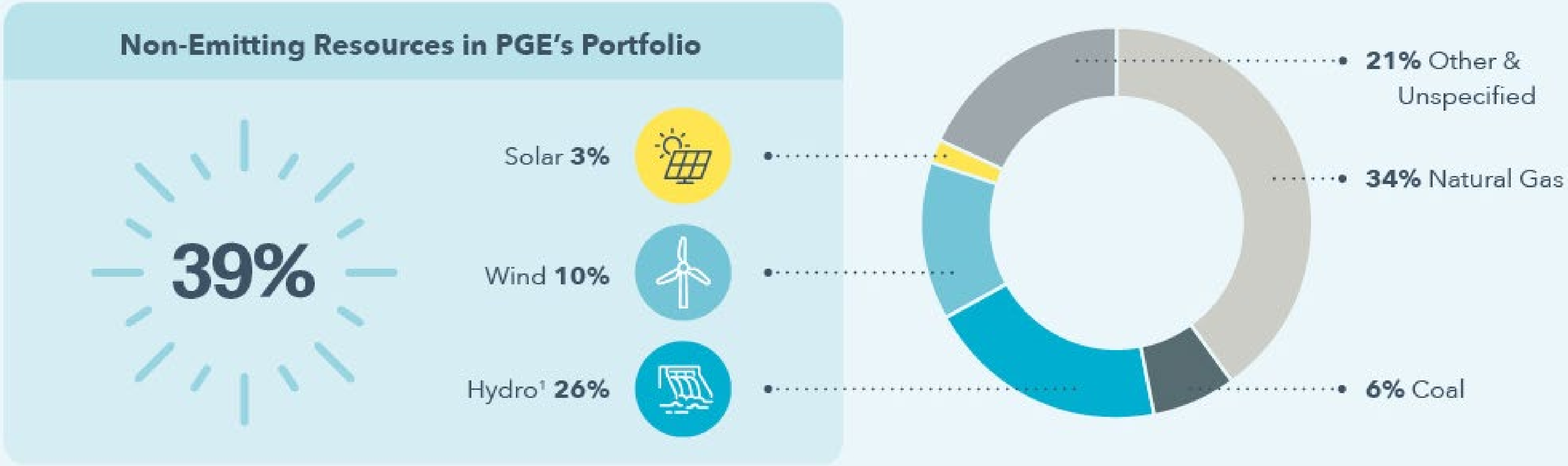
Emissions are already 25% below target baseline level*

GHG Emissions from Power Served to Oregon Customers

GHG Intensity for Power Served to Oregon Customers

0.30 metric tons of CO2e per MWh

Resource Mix for Power Served to Oregon Customers



Emissions goals

80% by 2030

90% by 2035

100% by 2040

* Baseline = 8.1 MMTCO2e as established by Oregon DEQ based on average of 2010-2012 PGE reported emissions.

Based on energy served to retail customers within the State of Oregon, as required by Oregon DEQ.

Some or all the renewable energy attributes associated with PGE's Basic Service Mix may be sold, claimed, or not acquired.

All 2022 emissions data is subject to change as internal review procedures are performed.

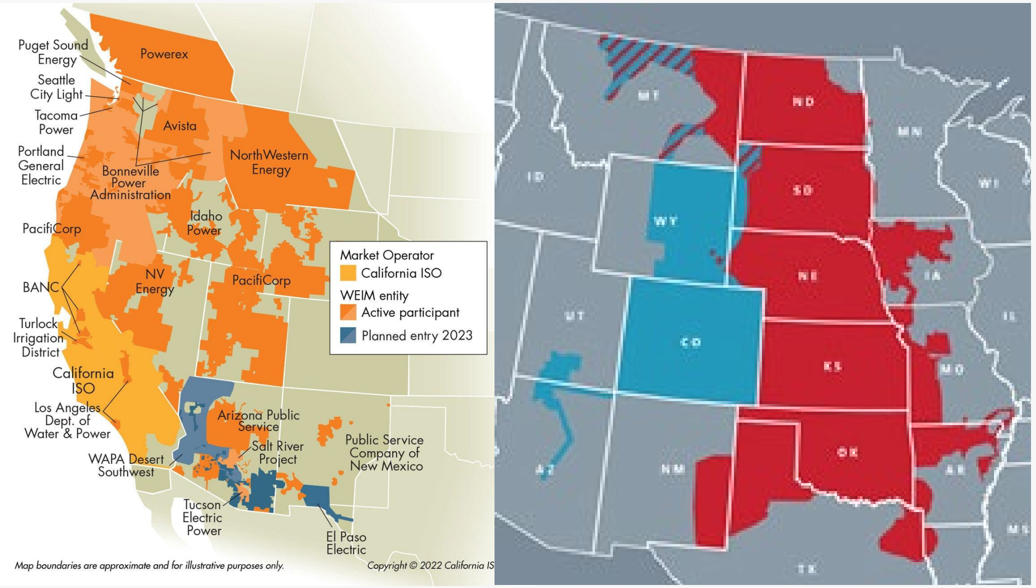
Certain emissions information is subject to review and approval by the Oregon DEQ and Environmental Protection Agency.

1. Includes hydro power purchased from Bonneville Power Administration

Regional resource adequacy

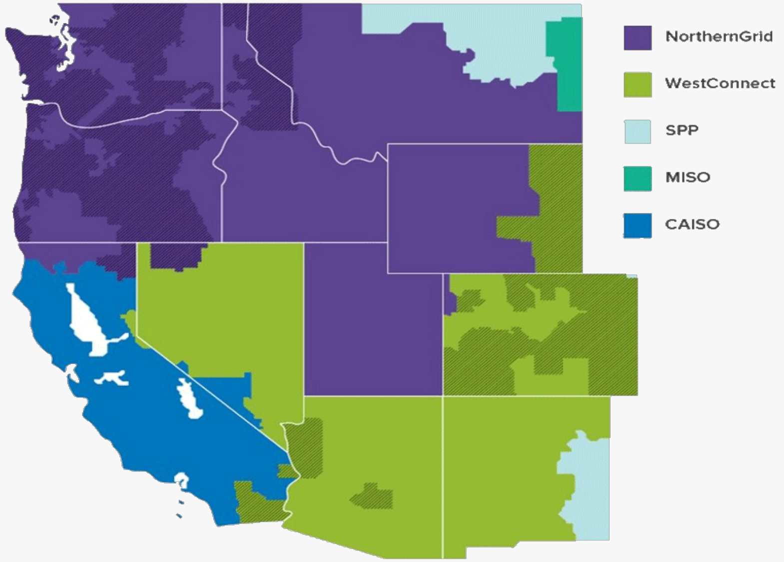
Complex market dynamics and challenges in connecting clean energy resources to customers increases the importance of virtual power plants

Western Market Evolution

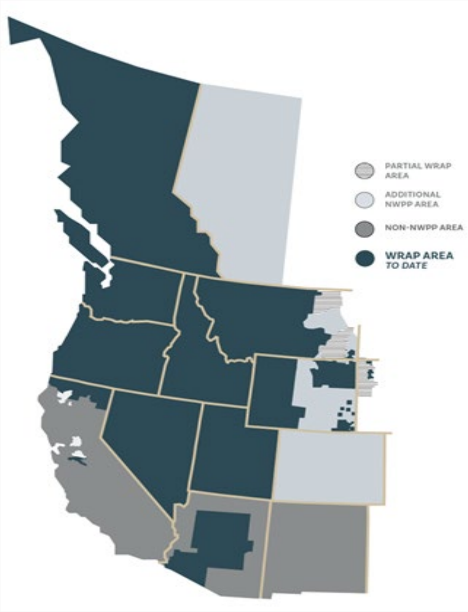


The California ISO and Southwest Power Pool are seeking to expand their respective roles in extended day-ahead markets

Transmission Planning



Western Resource Adequacy Program

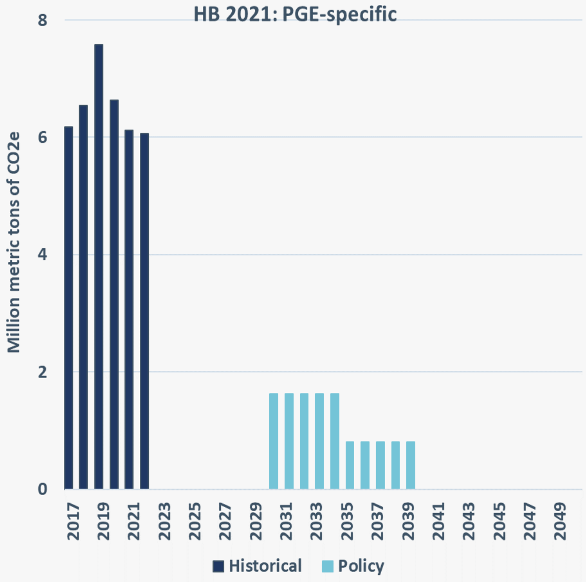


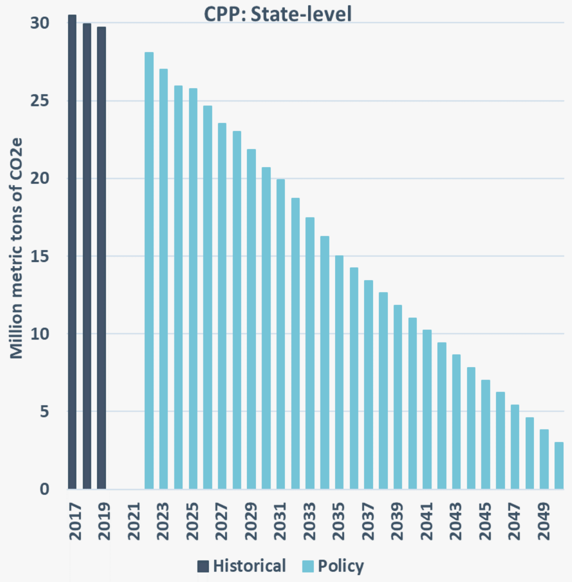
Decarbonizing during highly dynamic period of change

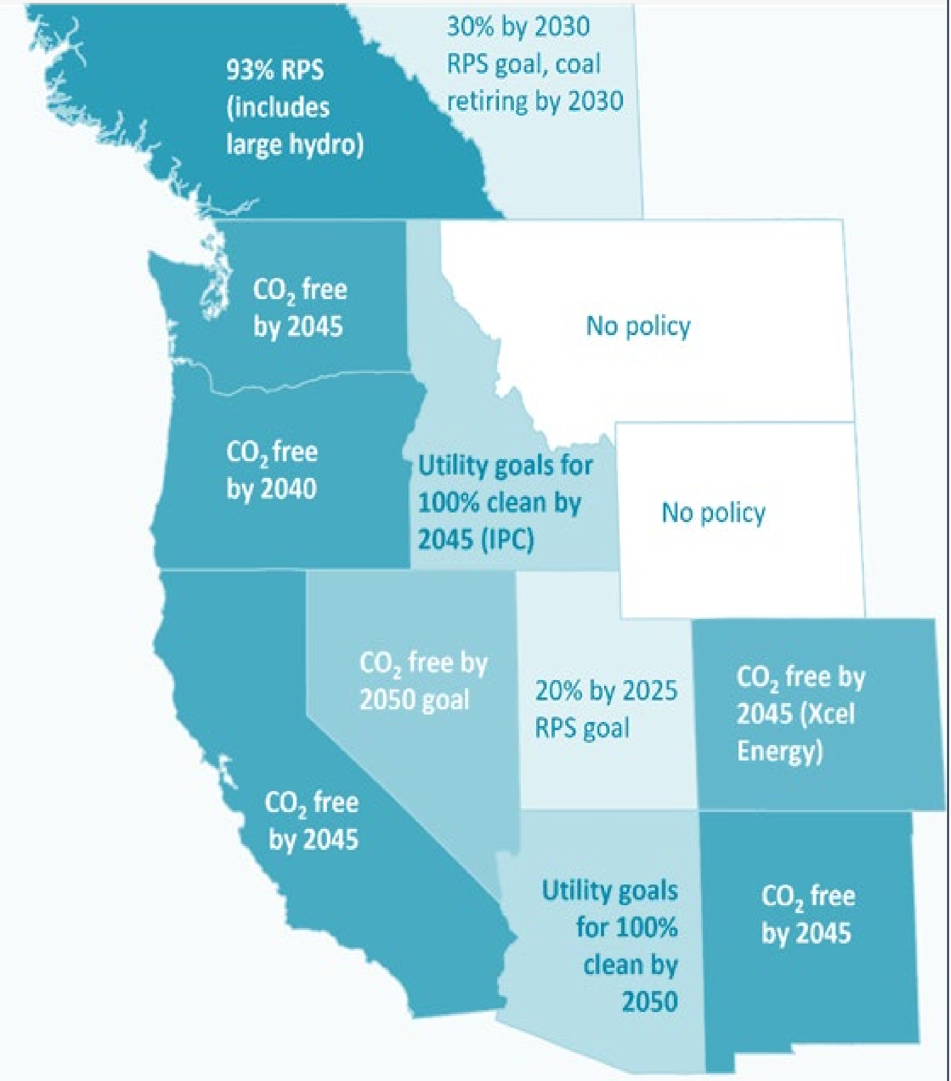
Increased collaboration across state and traditional market boundaries is needed

Federal, state, and regional decarbonization efforts pose significant challenges:

- Forecasting load
- Resource competition
- Supply chain and labor market dynamics
- Transmission constraints
- Resource adequacy
- Forecasting technology development and costs
- Market constraints







An integrated system for the 24/7 clean energy future

Increasing customer choice and control requires a bidirectional, automation-enhanced grid

Traditional Generation Plants

- Wind
- Solar
- Hydro
- Nuclear
- Battery Storage

Regional Transmission Grid

Integrated Operations Center

- Grid Operations
- Power Operations
- VPP Operations

Two-way Distribution Grid

Virtual Power Plant

- Transportation
- Heating Systems
- Industrial Processes
- Solar
- Battery Storage
- Smart Devices

Decarbonize

Electrify

Perform

Virtual Power Plant

PGE is scaling our VPP to meet 25% of peak load and provide grid services 24/7/365.

Virtual Power Plant

The orchestration of
Distributed Energy Resources and Flexible Load,
through technology platforms,
to provide grid and power operations services.

Customer Programs	Distributed Solar	Distributed Thermal(1)	Distributed Storage	Utility Storage
• Energy Partner • Peak Time Rebate • Residential T-Stat • Multi-Family Wtr Htr	• Residential • Community • Qualifying Facility	• Customer Back-up Generation	• Storage (<50MW)	• Storage (>50MW)

Technology Platforms

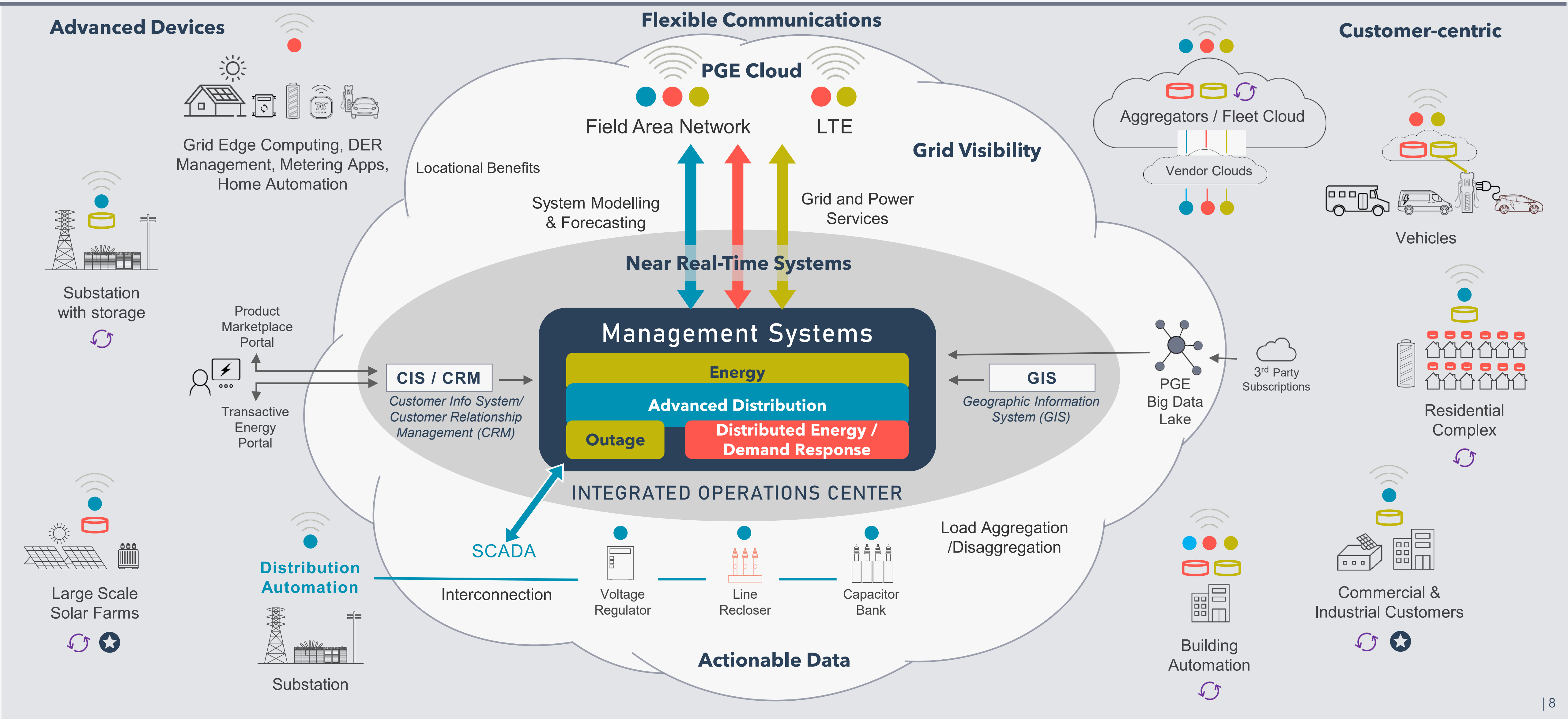
Distributed Energy Resource and Demand Response Management Systems	Energy Management System

Policy and Regulation

(1) Distributed Thermal represents the customer back-up engines in the Dispatchable Standby Generation (DSG) program

On the inside

PGE manages the complexity of technology and infrastructure to provide reliable operation and deliver exceptional customer experience



KEY: Potential µGrid / Microgrid; Potential Qualified Facility; Demand Response Mgmt System (DRMS); Distributed Energy Resource Mgmt System (DERMS); Node communicating with system; 1-way or 2-way communication through Vendor, Aggregator, or direct to PGE

On the outside

Customer expectations for increasingly clean energy, without compromising reliability and keeping costs as low as possible, require increased integration of Distributed Energy Resources and Flexible Loads

RESIDENTIAL

(SINGLE-, MULTI-FAMILY)

- Rooftop Solar
- Distributed Batteries
- Smart Devices
- Vehicle charging
- Heat pumps
- Thermostats
- Hot water

IOC

(INTEGRATED OPERATIONS CENTER)

- Uniform standards
- Open-source API
- Plug-and-play connectivity

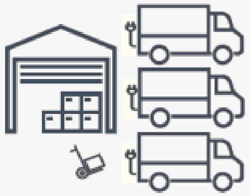
COMMERCIAL & INDUSTRIAL

- Heating Systems
- Building Management Systems
- Industrial Processes
- Warehouse automation
- Chillers
- Data Center
- Back up batteries & generation

MUNICIPALITY, SCHOOL, UNIVERSITY, HOSPITAL

- Community-based renewables
- Microgrids
- School bus V2G
- Advanced Heating/Cooling

As Virtual Power Plant capabilities increase, customers have more choice and control of the energy that powers their home, work, life and community.



TRANSPORTATION ELECTRIFICATION

- Transit & Freight
- Fleet charging
- Public charging
- Rental Properties
- OEM V2G and V2X

Let's meet the future together.

Contact:
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