VIRTUAL POWER PLANT

FLIPBOOK

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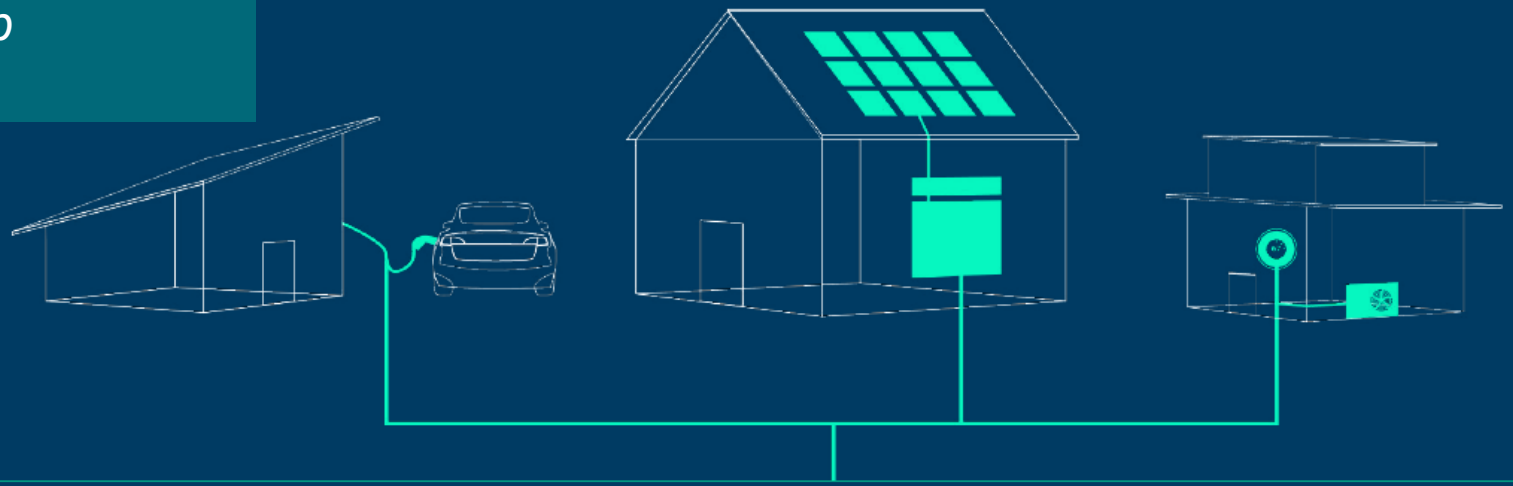
Presentation to NASEO-NARUC GEBs Working Group
September 4, 2024



How utilities and their customers are already benefitting from VPPs and insights for future implementation

All images are from the VPP Flipbook unless otherwise stated.

Agenda

Objectives

1. **Provide an overview of RMI, VP3, and the VPP Flipbook**
2. **Showcase a variety of VPP approaches, and the roles of utilities, third-parties, and customers within them**
3. **Discuss takeaways for VPP implementation**

Agenda

- **Introduction to RMI and VP3**
- **Key Insights from the VPP Flipbook**
  - **VPPs and Their Benefits**
    - *Why are utilities advancing VPPs?*
    - *What's the potential impact at scale?*
    - *What is the utility's role in a VPP?*
    - *How are customer engaged?*
  - **Takeaways for VPP Implementation**
    - *Effective program design*
    - *Reimagined utility practices*

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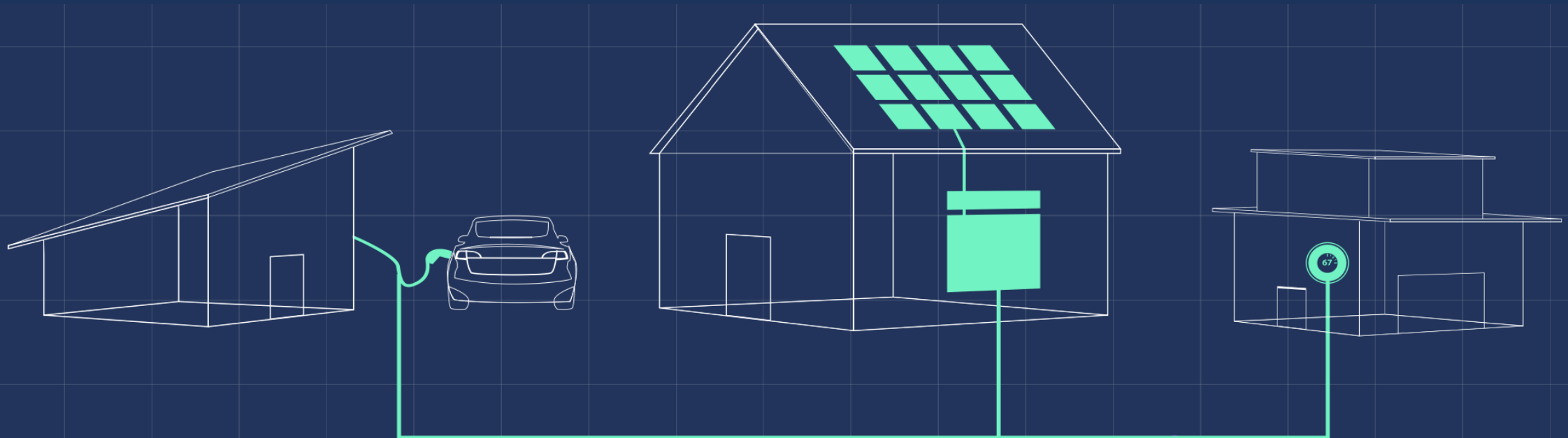
Introduction to RMI and VP3



About RMI

The VP3 team is powered by RMI resources and expertise.

Decarbonizing Key Sectors

- Electricity
- Buildings
- Transportation
- Industry

Using Powerful Market Catalysts

- Policy
- Technology
- Finance
- Data & Transparency
- Education & Workforce Training
- Strategic Communications

To Drive Energy Transitions Around the World

VP3 is an initiative housed within RMI and funded by VPP technology and service providers

To advance our mission…

To catalyze industry and change the necessary policies, regulations, and market rules for VPPs to scale in ways that benefit communities and society

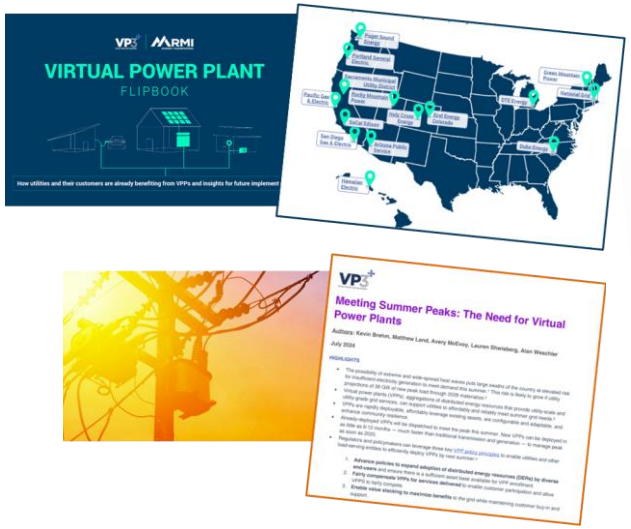
VP3 advances three priorities…

- **Create and compile research and resources**
- **Convene VPP industry and its supporters**
- **Engage policymakers and utilities**

…across four focus areas.

- **Working with Utilities**
- **Regulatory/Policy**
- **Communicating the VPP Story**
- **Data, Communications, and Interoperability**

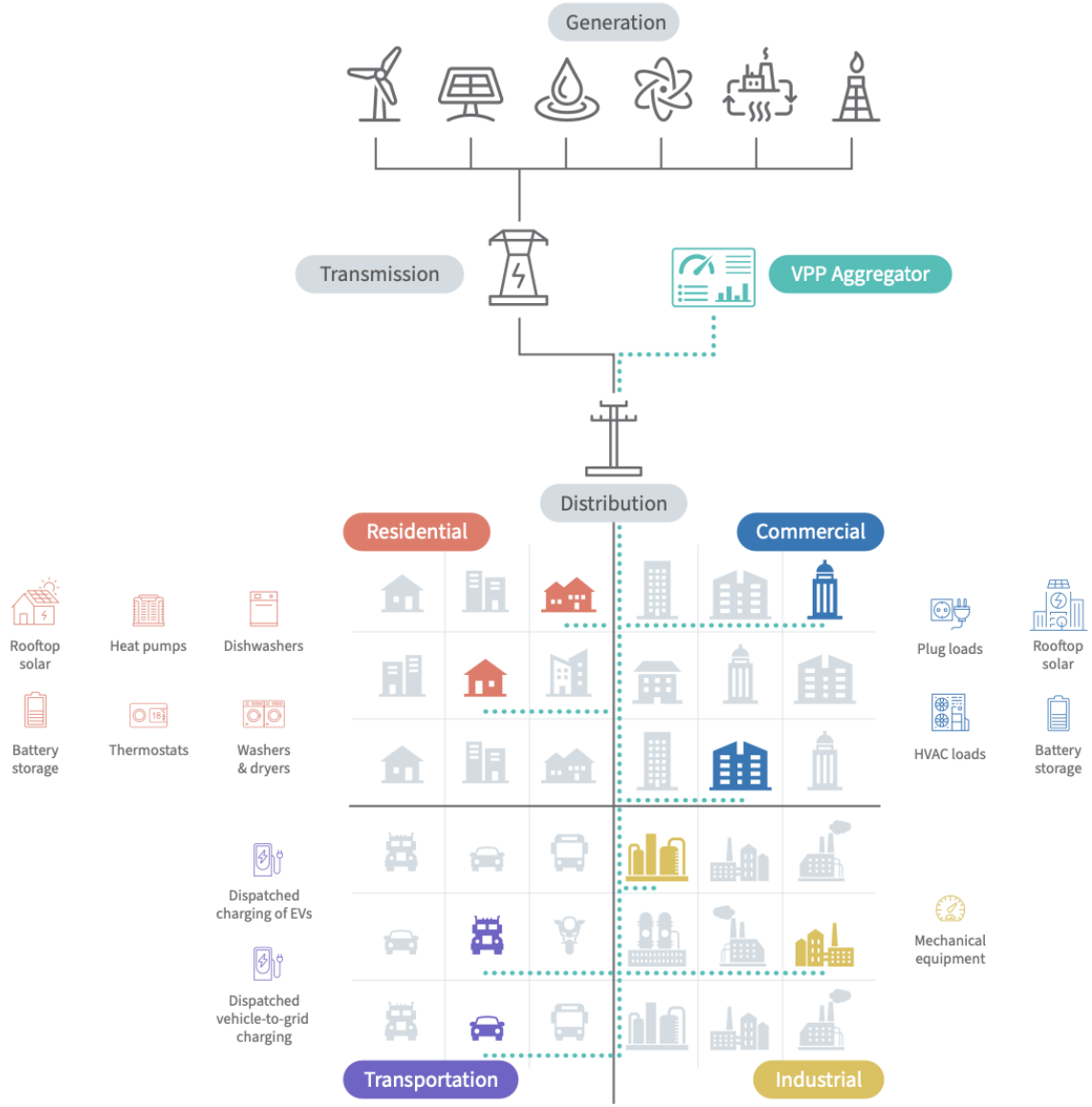
Recent Publications



What is a virtual power plant?

A virtual power plant (VPP) is an aggregation of grid-integrated, distributed energy resources* (DERs) that can balance electrical loads & provide utility-scale & utility-grade grid services.

*** Distributed energy resources (DERs)** include equipment located on or near the site of end-use that can provide electricity demand flexibility, electricity generation, storage, or other energy services at a small scale (sub-utility scale) and are typically connected to the lower-voltage distribution grid.



Sources: Definitions: Adapted from the DOE *Pathways to Commercial Liftoff: Virtual Power Plants*, 2023
Infographic: RMI *Virtual Power Plants, Real Benefits*, 2023

VPPs are integrated solutions that provide multiple benefits including T&D infrastructure relief

Resource Adequacy

Integrate distributed generation and storage capacity

Shift demand to follow supply

T&D Infrastructure Relief

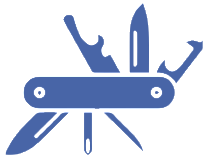
Increase efficiency by smoothing peaks

Alleviate congestion with local dispatch

Reliability & Resilience

Integrate back-up power

Eliminate single-point-of-failure



Versatility & Flexibility

Customize design to fit grid needs

Reconfigure as needs evolve

Affordability

Defer grid capex (generation, T&D)

Avoid fuel costs

Compensate consumers and businesses

Community Empowerment

Enable consumers to optimize energy costs, use, and source

Retain and create good jobs

Decarbonization & Air Pollution Reduction

Add distributed renewable generation

Reduce curtailment of renewables

Reduce reliance on fossil fuels

Benefits (from DOE) are ranked left to right from most to least compelling based on interviews with 8 utilities.

Source: DOE, *Pathways to Commercial Liftoff: Virtual Power Plants*, 2023
Antenna Group interviews conducted on behalf of VP3

VP3 has released new VP3 resources this summer

New VP3 Publications

VPP Features Flipbook

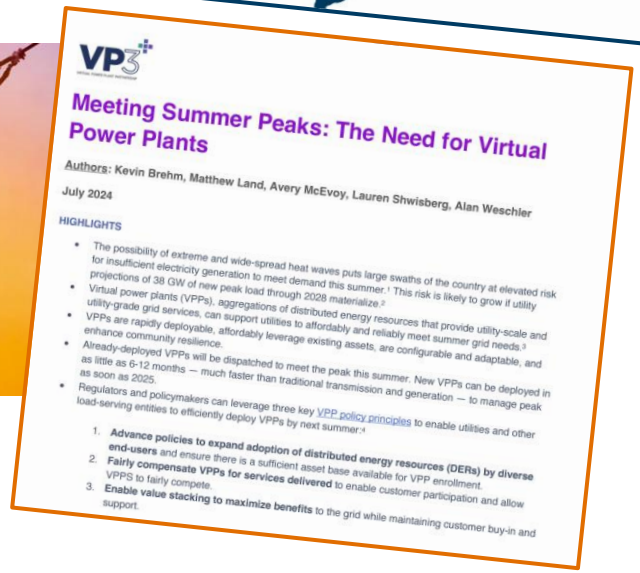
A collection of 14 VPP utility case studies highlighting key program design elements and implementation takeaways.

Download Here

Summer Reliability Brief

Nine-page brief describing how operating VPPs are being used to support grid reliability and affordability, with examples.

Download Here



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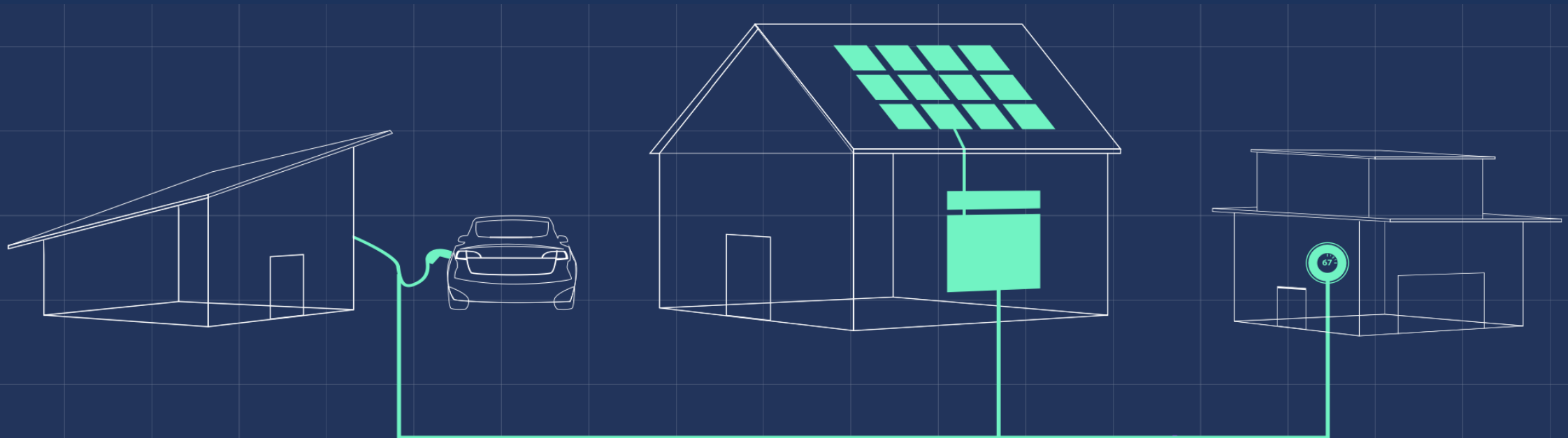
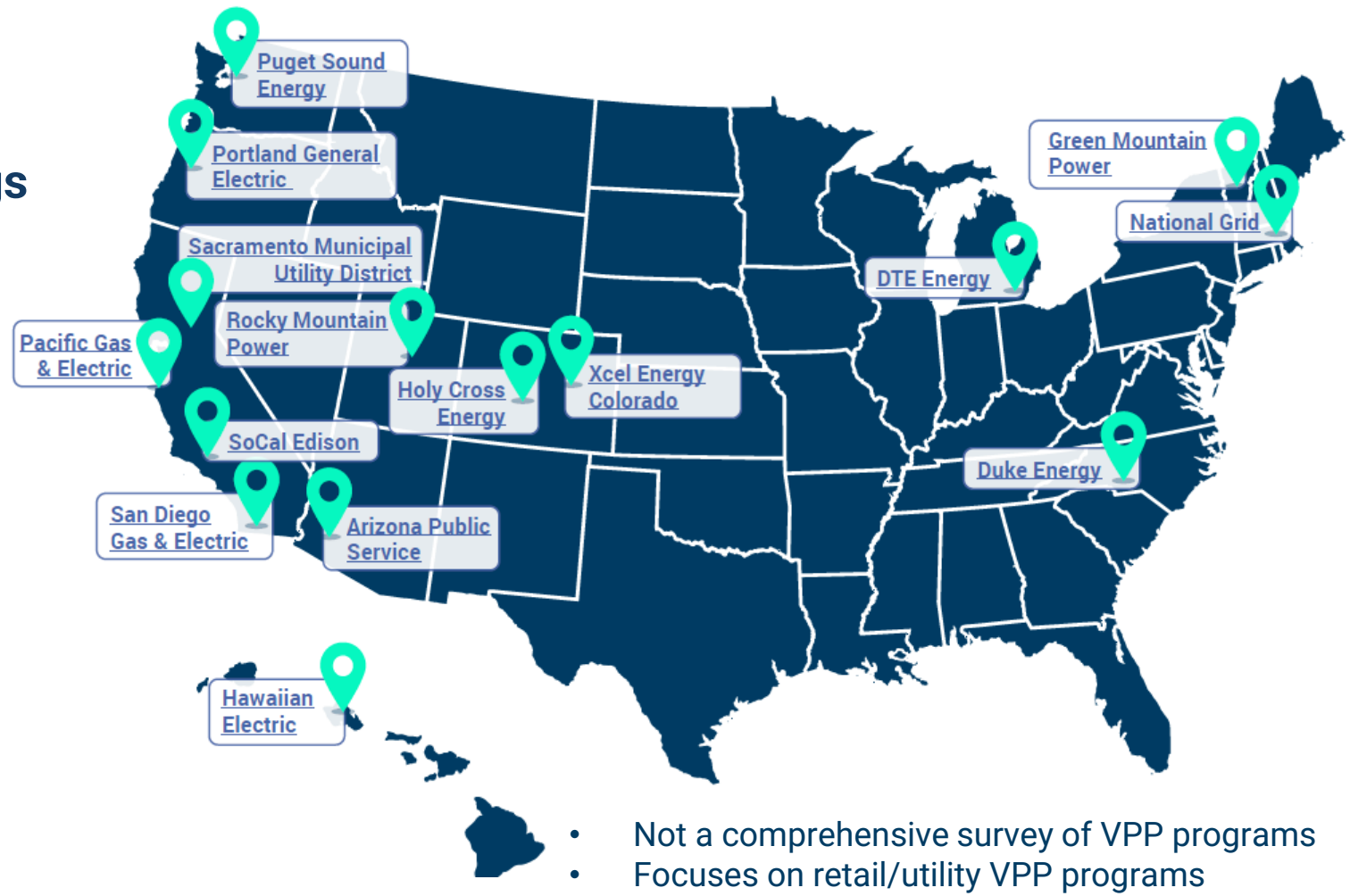
Key Insights from the Flipbook



VPPs are no longer just a concept

VPPs today are providing critical grid services to utilities and delivering savings to customers across the country.



The VPP Flipbook is a collection of 14 VPP utility case studies and their takeaways to help utilities implement efficient and impactful VPP programs.

- Not a comprehensive survey of VPP programs
- Focuses on retail/utility VPP programs

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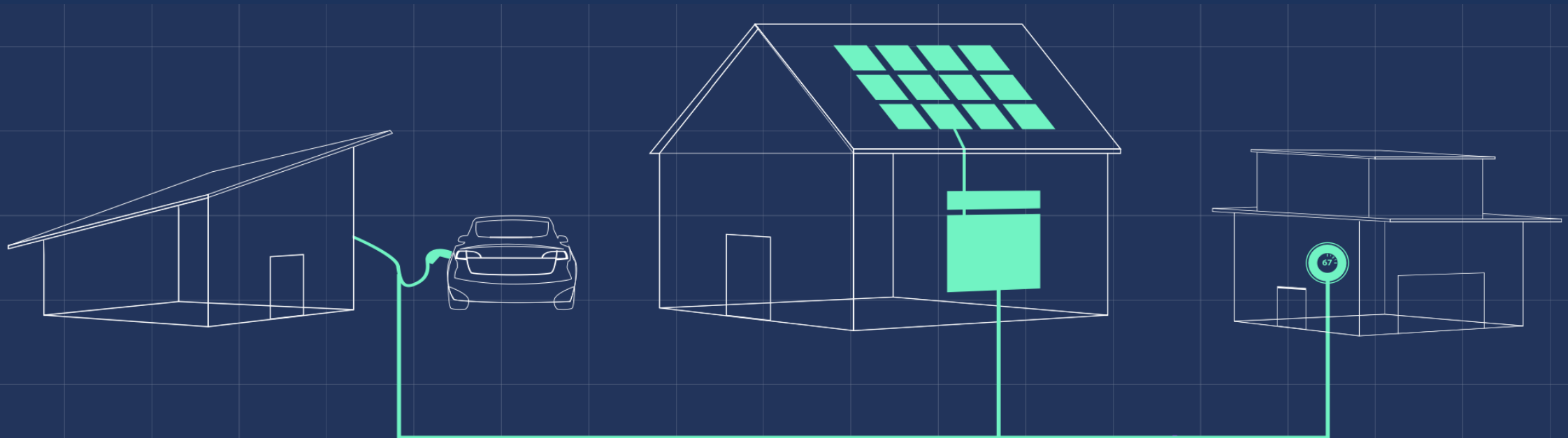
VPPs and Their Benefits



Why are utilities advancing VPPs?

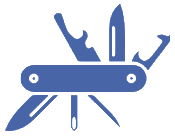
VPPs generate diverse benefits and can provide multiple grid services to meet utility needs

Primary Drivers

Resource Adequacy

T&D Infrastructure Relief

Reliability & Resiliency



Versatility & Flexibility

Affordability

Community Empowerment

Decarbonization & Air Pollution Reduction

Grid Services

Ancillary Services

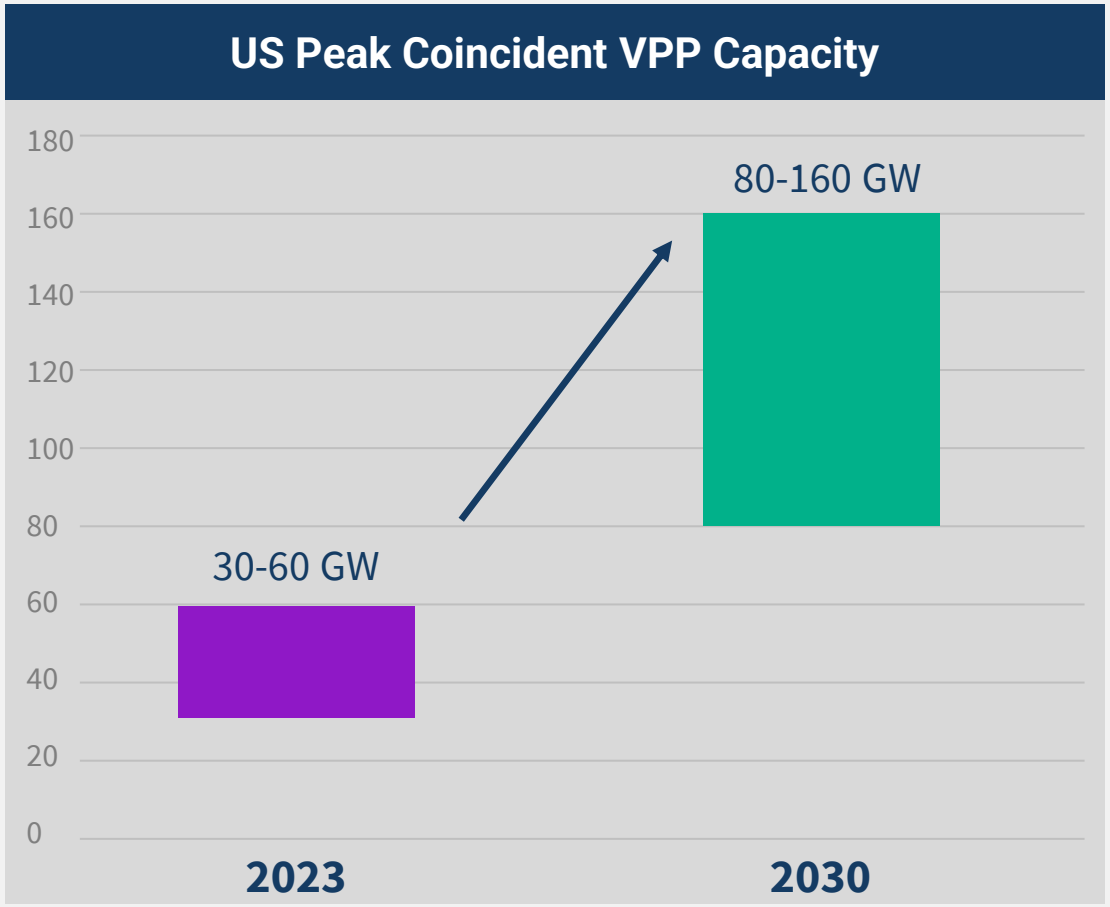
Energy

Capacity

Resilience

What is the potential impact of VPPs at scale?

VPP capacity could grow to 80-160 GW by 2030

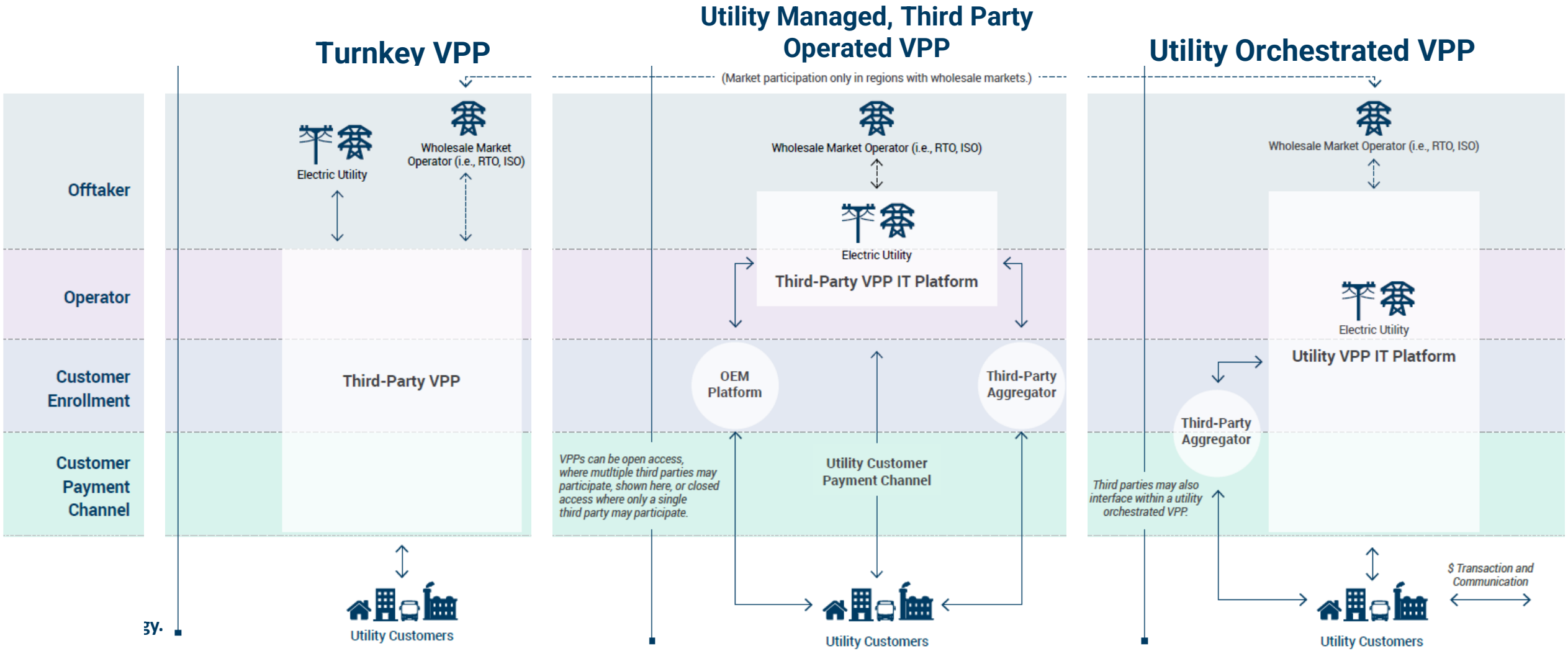


According to DOE, tripling VPP scale by 2030 could address 10-20% of peak load while saving ~US$10 billion per year.

Source: DOE, *Pathways to Commercial Liftoff: Virtual Power Plants*, 2023

What is the utility's role in a VPP?

Utilities play a variety of roles within a VPP. Example utility VPP participation models:



How are customers engaged in a VPP?

There are various ways with different levels of involvement to engage customers in VPP decisions:

Who owns the device?

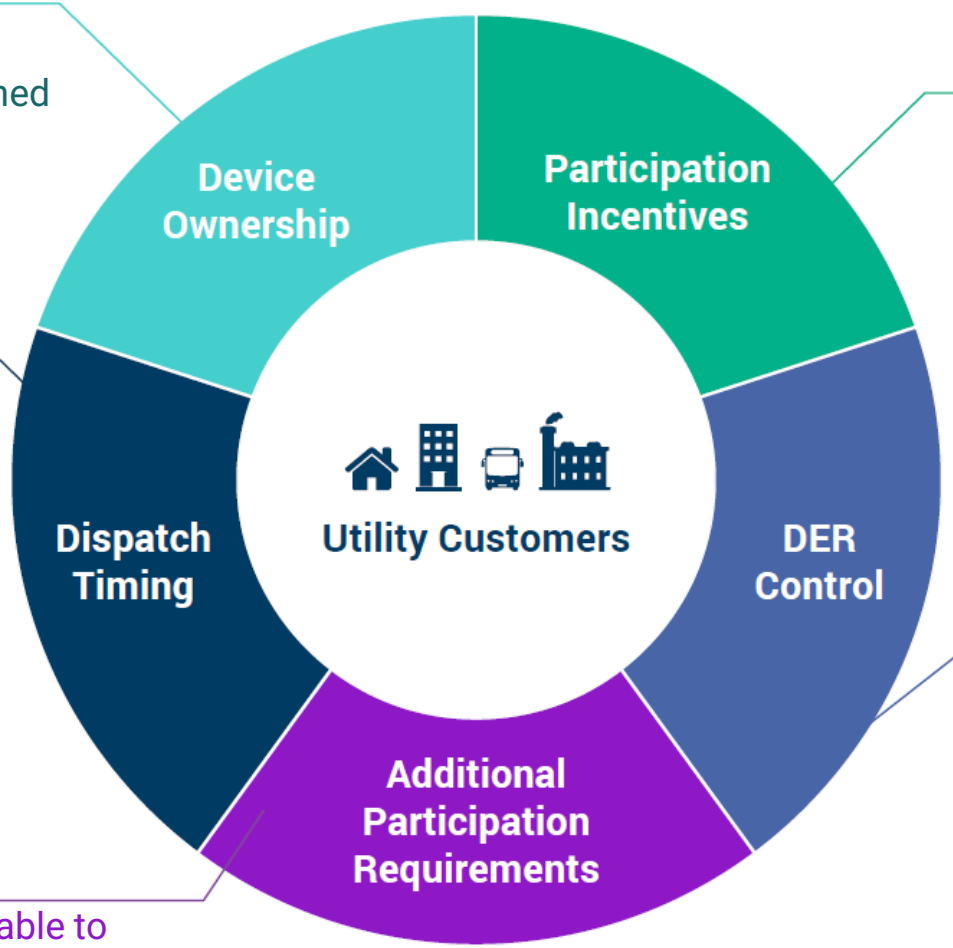
- Customer
- Customer sited, financed or owned by a third party or utility

How often and for how long is the device dispatched?

- **Frequency**: daily, seasonally, solely for emergencies
- **Duration:** range from five minutes to several hours
- **Scheduling:** Dynamically scheduled (day-of or day-ahead) or statically scheduled based on historic patterns

Who can participate and under what terms?

- Potential contract lengths or unable to participate in a conflicting program



How are customers incentivized?

- Up-front and/or completion payments
- Performance payments
- Monthly or annual bill credits/payments
- Bill reductions if customer is on TOU rates and shifts use during peak pricing
- DER rebates to reduce up-front costs

Who controls DER dispatch?

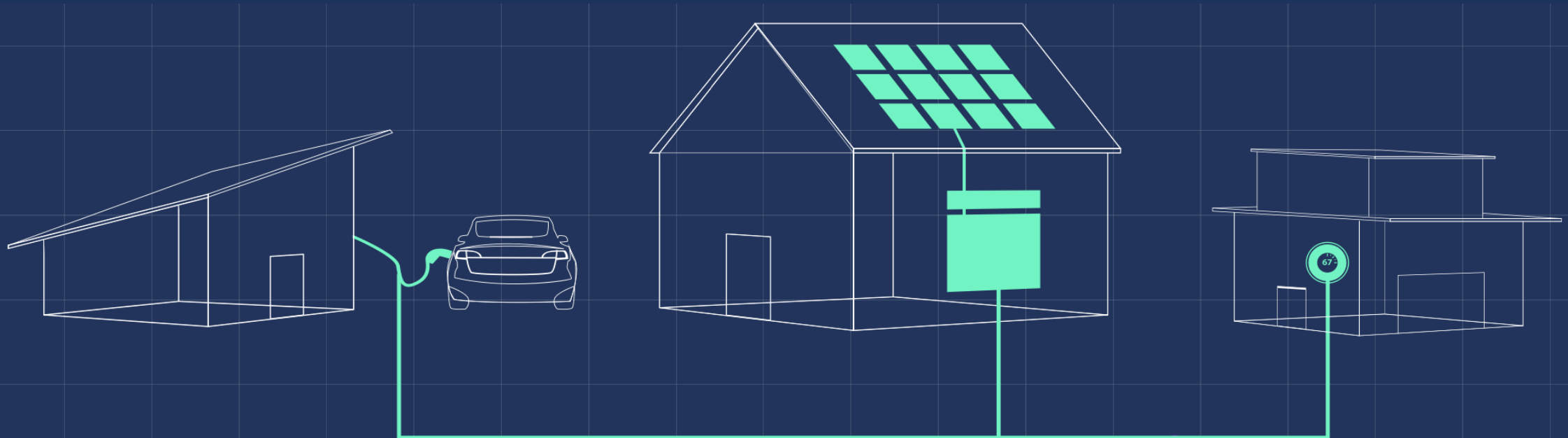
- **Auto VPP-controlled without customer override**
- **Auto VPP-initiated with customer override**
- **Customer-controlled**

Each feature has a program design table with metrics from the first flipbook section to enable comparison across VPPs:

	Metric	Definition	Category Options and Definitions
Overview	Primary Drivers	Primary motivations for establishing the VPP	Resource adequacy, reliability & resilience, T&D infrastructure relief, affordability, decarbonization, costumer empowerment, versatility & flexibility
	Grid Services	Primary grid services provided by the VPP	Ancillary services, energy, resilience, capacity
	Resource Type	VPP resource type(s) included	DER: Batteries, solar + batteries, EVs, smart thermostat, heat pumps DR: Interruptible load and behavioral load shaping
	Customer Market Segment	Participating customer segments in the VPP	Residential, commercial, and/or industrial
	Participating OEMs	OEMs who may participate in the VPP	Could be multiple OEMs or a single OEM depending on the program
	MW Enrolled	How many MW enrolled in the VPP	Numerical value (MW)
	Customers Enrolled	How many customers enrolled in the VPP	Numerical value (customers)
VPP Roles and Responsibilities	Resource Offtaker	Party responsible for determining the operating conditions (i.e., calling the events) and settling the energy resources.	**Utility** – Utility is calling the events and settling the resources, **Market Integrated** – resources are bid into the market, **Market Aware** –resources are dispatched by market operators
	Program Operator	Party responsible for coordinating devices and aggregations to perform when called upon by the resource offtaker.	Utility or a third-party service provider
	Customer Enrollment	Responsible for enrolling and aggregating DERs	Utility, third-party aggregators, installers, and/or OEMs
	Customer Payment Channel	Party responsible for delivering customer payments	Utility, third-party aggregators, and/or OEMs. Can be the same or different as the party responsible for customer enrollment.
Customer Experience	Device Owner	Owner of the enrolled DER device	Customers may own their enrolled DER, or DER could be customer-sited but financed or owned through a utility or third party
	Participation Incentives	Payment structure and value for participating customers	Numerical value and compensation structure (up-front, completion, pay-for-performance, monthly or annual flat-rate bill-credits, DER rebates, etc.)
	Participation Requirements	Any additional requirements for customer participation	Potential requirements could include contract lengths, not participating in a conflicting program, and/or minimum connected capacity
	DER Control	The level of DER control the VPP and customer has during the program	Autonomously VPP-initiated with customer override: device responds autonomously but customers can opt out of an event Autonomously VPP-controlled without customer override: device responds autonomously and customers can't opt out of an event, Customer-controlled: customers control their devices in response to an event notification
	Dispatch Timing	Description of VPP dispatch events	Frequency: DERs may be dispatched daily, seasonally, or solely for emergencies. Some VPPs may have a set minimum or maximum events per month or year. Duration: Dispatch events may range from 5 minutes to up to 4+ hours Scheduling: Events may be dynamically scheduled the day-of, day-ahead, or statically scheduled further in advance based on historic electricity patterns

Takeaways for VPP Implementation

Successful VPP implementation requires not only effective program design, but also reimagined utility practices



What are leading utility VPP design practices?

Effective VPP design addresses common barriers to VPP deployment

Common Challenge	Leading Practice: VPP Design
Tech-specific programs lead to fragmented customer experience and increased management burden	1.1 Open access in a VPP to integrate multiple technologies, vendors and programs
Limited staff capacity or experience with VPPs	1.2 Develop partnerships that leverage third-party capacity and complementary capabilities
Complicated customer experience limits enrollment or participation	1.3 Streamline customer experience during enrollment and participation
Unclear payback for customers and aggregators limits interest	1.4 Execute long-term programs (5+ years) with enrollment and operating terms to improve cost-effectiveness
Up-front cost barriers to DER adoption prevent equitable adoption	1.5 Incentivize DERs to enable additional customer participation

What are leading utility VPP processes to support VPP deployment?

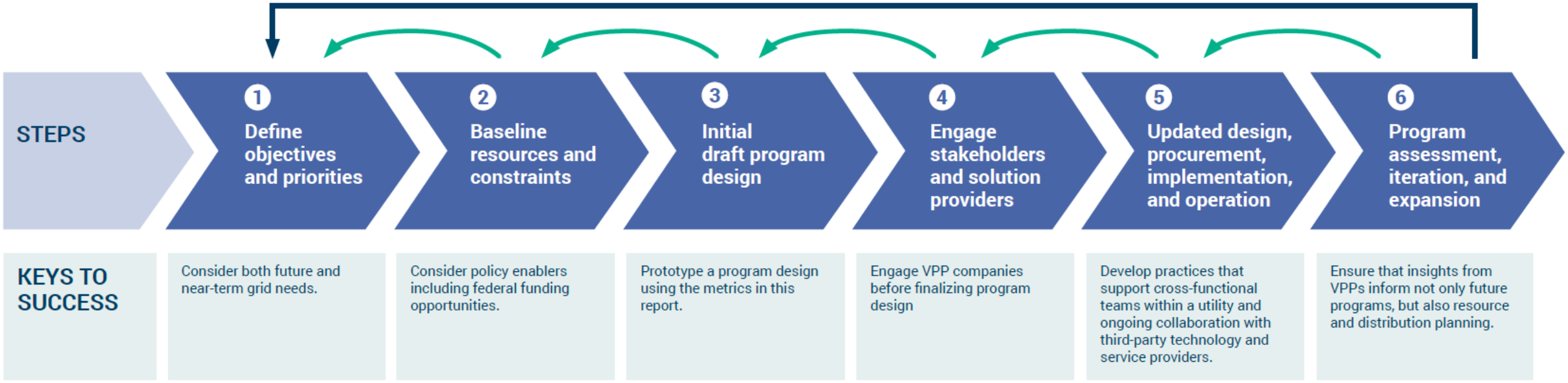
Reimagined utility practices use a set of common approaches to deploy VPPs

Leading Practice: Utility Processes	
2.1 Incorporate DERs into generation and distribution planning	Iteratively integrate DERs into planning processes
	Evaluate VPPs transparently in planning with defined metrics
2.2 Proactively engage regulators and policymakers around effective VPP policy	Work with regulators to structure VPPs as an opportunity to test new regulations, such as via a regulatory sandbox
2.3 Transform business practices	Implement cross-functional teams
	Automate VPP administrative and operational processes

What Are the Steps to Developing a VPP?

A VPP begins with understanding current needs and resources. From there, a program can be continuously iterated upon over time to incorporate learnings and meet evolving grid needs.

VPP design and initial implementation involves six main steps for utilities*



* The six steps are not strictly linear. Insights will be iteratively incorporated to refine design and inform implementation
** VPPs may be developed in response to a policy mandate, planning need, or proactively to test and develop new capabilities. In all instances, the same six general steps will apply.

VPPs today are providing critical grid services to utilities and delivering savings to customers across the country.

Key Takeaways

1. **VPPs are real and tangible.** They are not science fiction, they are providing real benefits, and there's no need to reinvent the wheel!

2. **VPP approaches are diverse.** This is both a source of innovation and an obstacle to market scaling.

3. Throughout the VPP process, **successful implementation is supported by effective program design and reimagined utility practices.**

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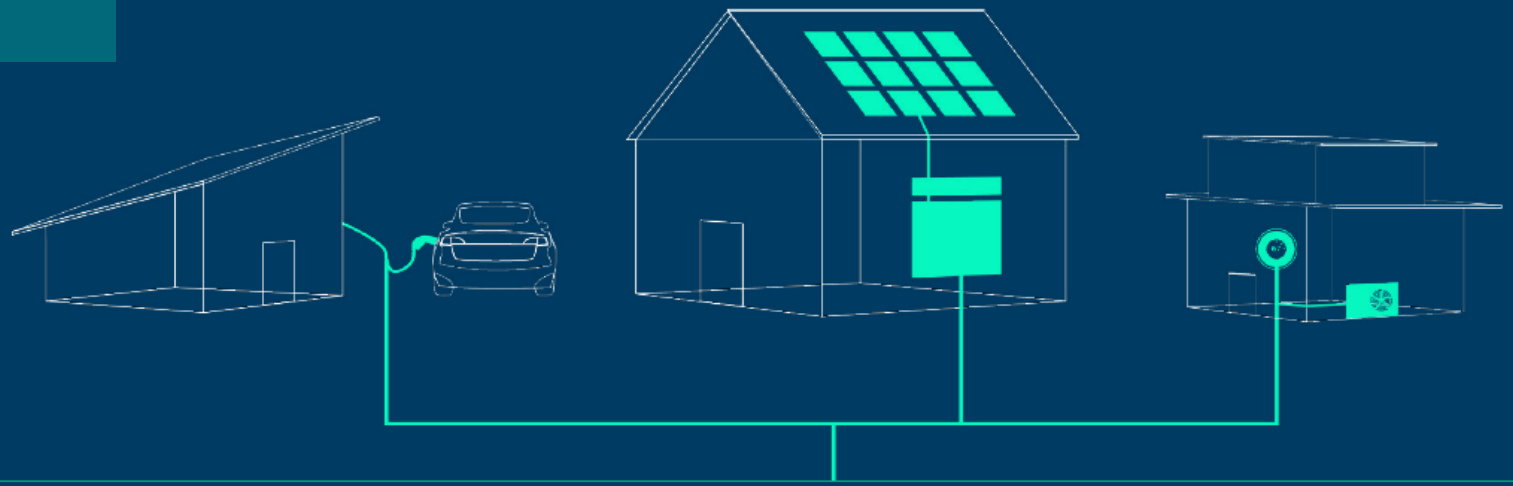

How utilities and their customers are already benefitting from VPPs and insights for future implementation

Thank You!