Road mapping Virtual Power Plants: Finding the Path Forward

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

Wednesday, July 19, 2023
1:00 pm – 5:00 pm

Smart Electric Power Alliance

Road mapping Virtual Power Plants: Finding the Path Forward

Welcome and Introduction

Sheri Givens | President & CEO, SEPA

Smart Electric Power Alliance

Road mapping Virtual Power Plants: Finding the Path Forward

VPP Overview: Key Concepts

Jen Downing | Senior Advisor
Loan Programs Office, US DOE

Smart Electric Power Alliance

Loan Programs Office

Virtual power plants: Key concepts

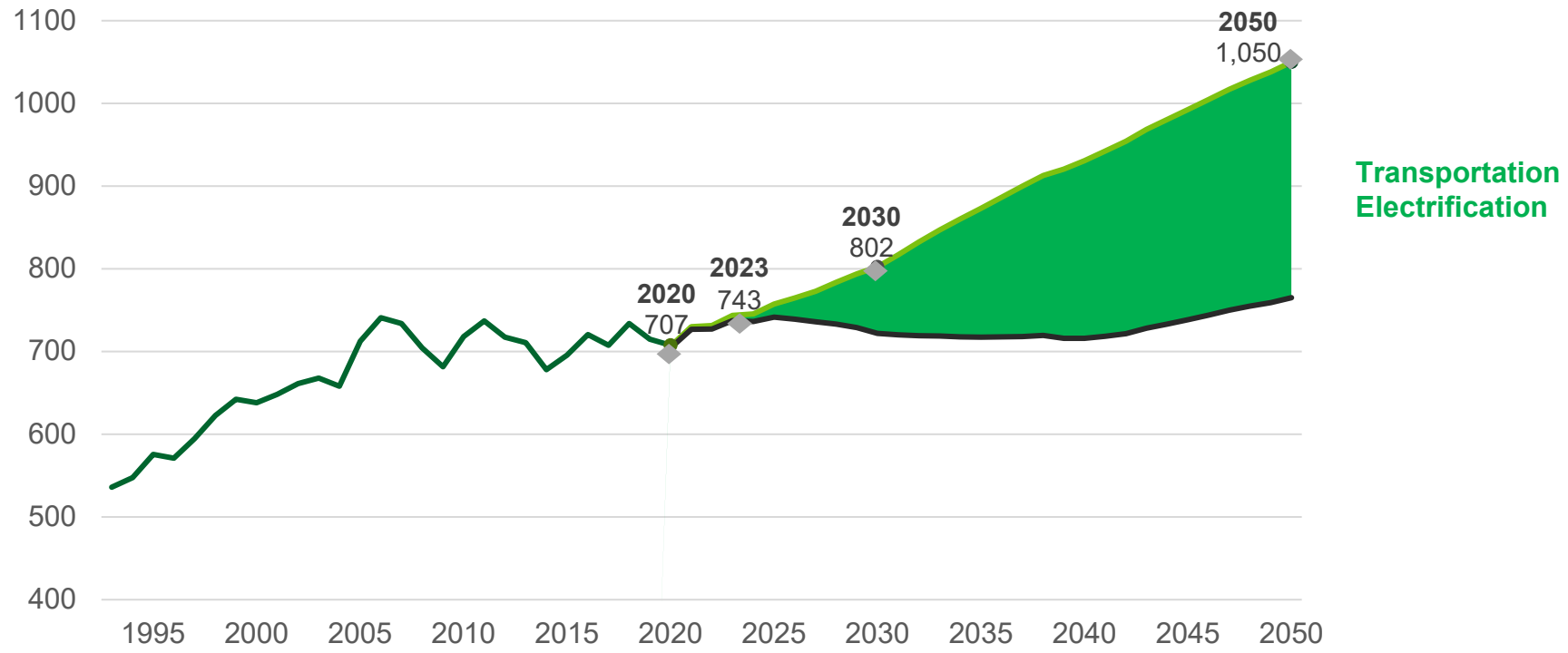
Roadmapping Virtual Power Plants

NARUC Summer Policy Summit

July 2023

US annual peak load is expected to grow for the first time in a decade

US system peak demand, historical and projected, (1995-2050) (GW)



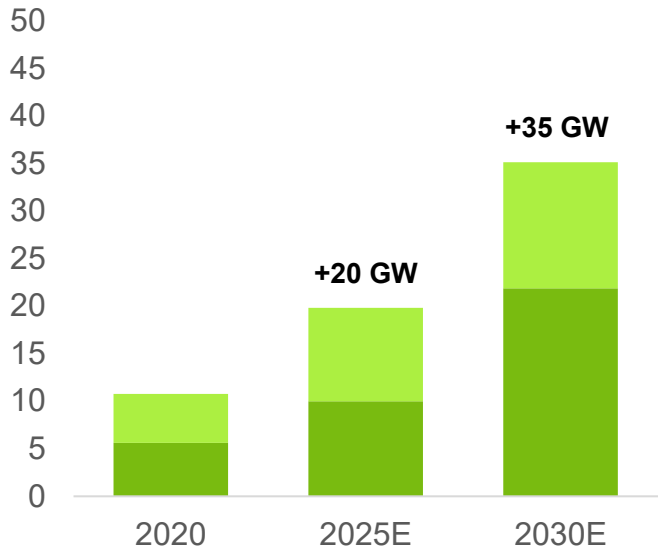
Note: Working draft analysis. National coincident peak based on sum of peaks across FERC regions.; Source: Historical energy demand sourced from AEO. Coincident peak demand (point-in-time peak, not total energy consumption) estimated by The Brattle Group (2023) based on forecasted total energy consumption sourced from OP-NEMS mid-case scenario. This mid-case scenario includes some industrial electrification, but this is not a major contributor to peak due to estimated hourly consumption patterns.

Source: Historical energy demand sourced from AEO; forecasted energy sourced from OP-NEMS mid-case scenario that includes some industrial electrification.

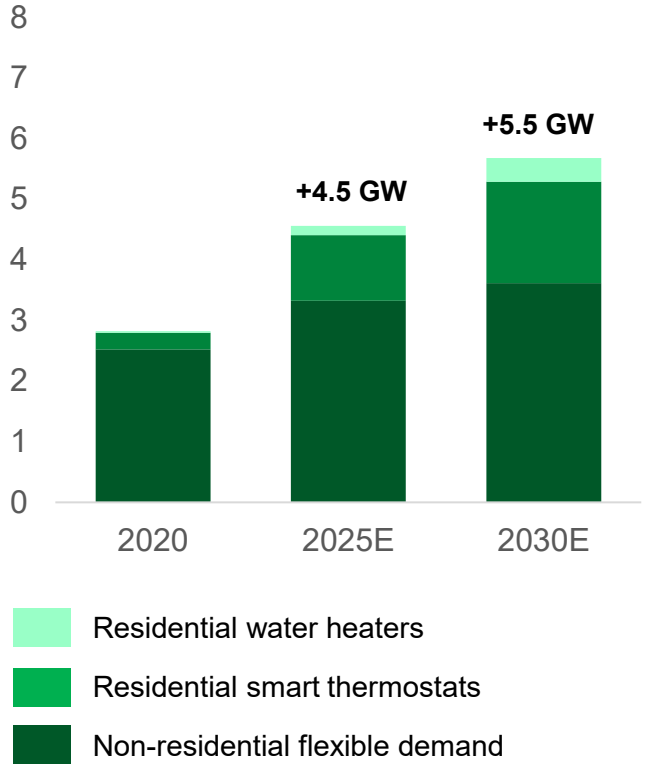
Flexible capacity additions are accelerating across generation, flexible demand, and storage DERs

Annual DER capacity additions - Generation, Flexible demand, Storage (2020-2030E)

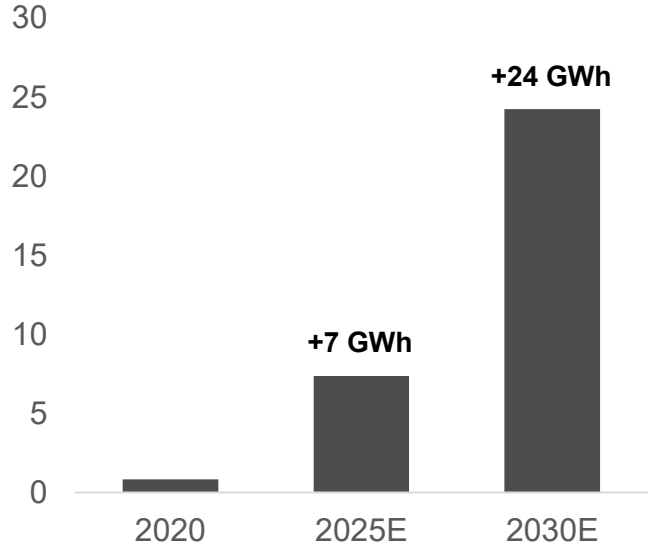
Nameplate generation capacity additions, GW



Flexible demand capacity additions, GW



Nameplate storage capacity additions, GWh

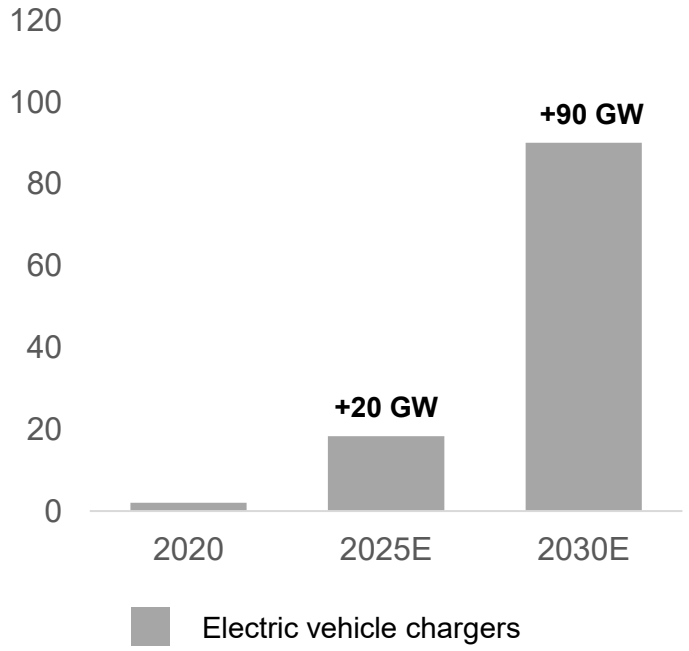


Note: Working draft analysis. Note: Conversion of DER nameplate capacity (generation, demand, or storage) to DER contribution to VPP capacity varies by DER type. Source: WM refers to "Wood Mackenzie Power & Renewables"; Solar: NREL dGen (capacity growth), WM (capacity); "Mid-case, no nascent techs, current policies" scenario used for solar capacity growth projections; Fuel-based generation: OP-NEMS (capacity growth), WM (capacity); Non-resi. flexible demand: WM (capacity); Resi. ST flexible demand: WM (capacity); Resi. WH flexible demand: WM (capacity); BTM battery storage: BNEF (capacity).

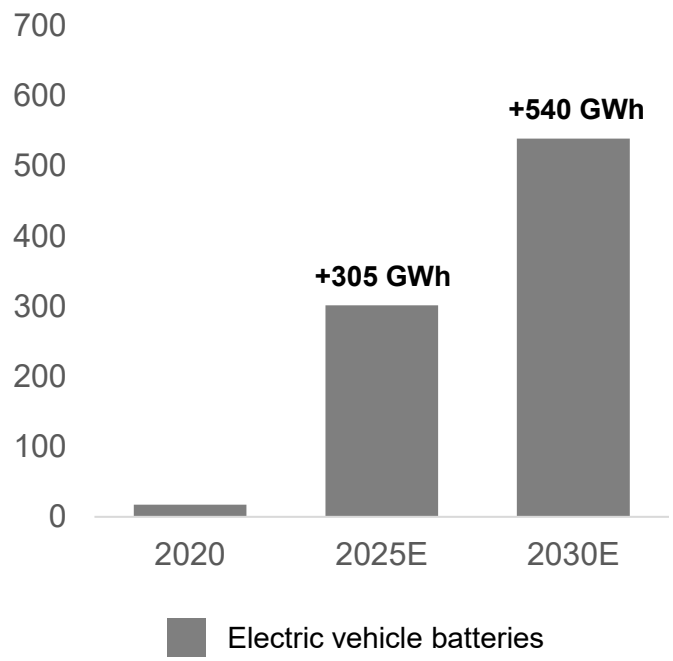
Each year, EV chargers and EV batteries will add 20-90 GW of demand and 305-540 GWh of storage capacity (nameplate)

Annual EV charger and EV battery capacity additions – Demand, Storage (2020-2030E)

Nameplate demand capacity additions, GW

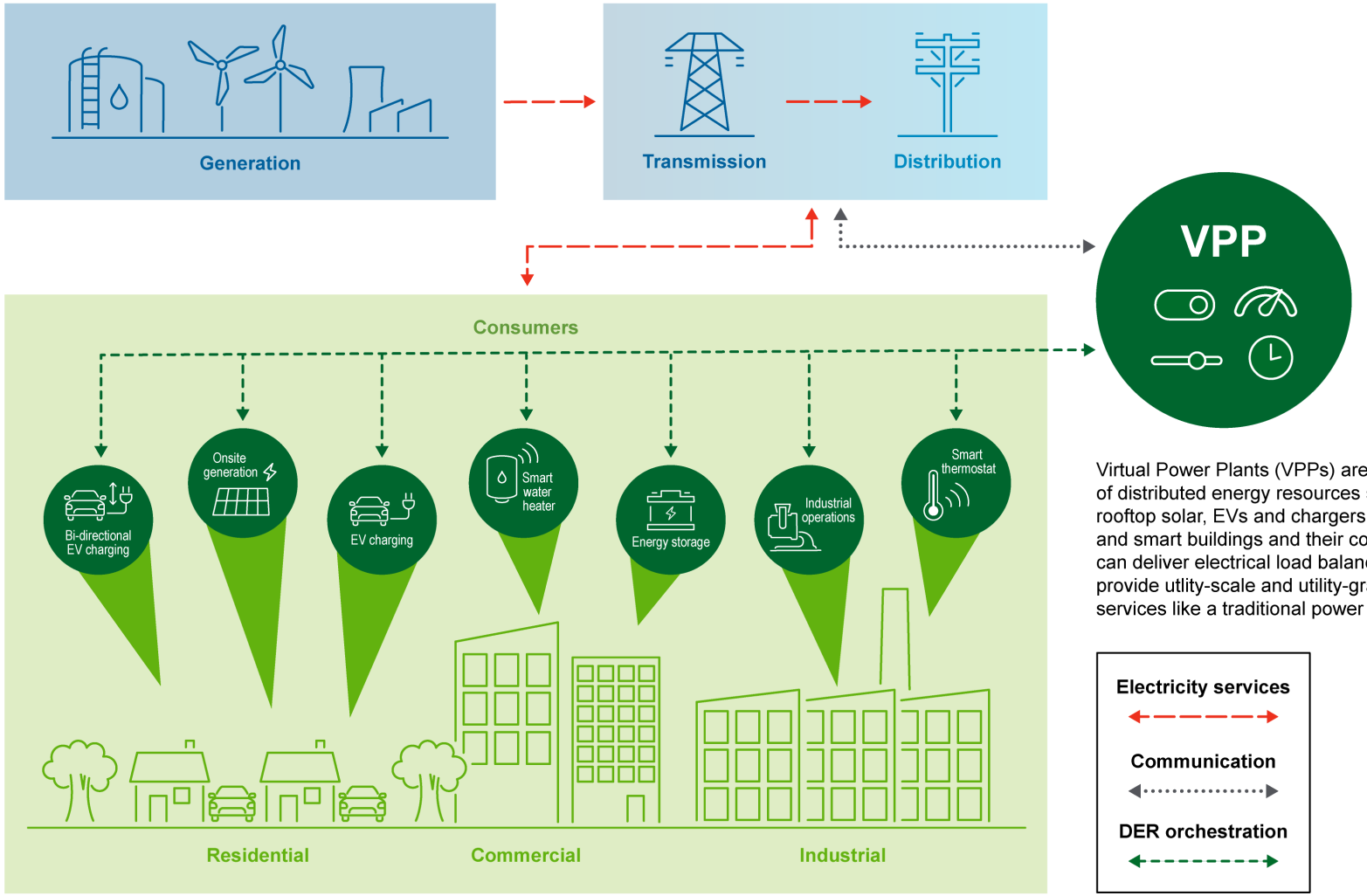


Nameplate storage capacity additions, GWh



Note: Working draft analysis. Note: EV charger estimates based on NREL projections for 2025 and 2030 charging port count, NREL estimates of equipment and installation costs, and DOE AFDC capacity estimates. Source: WM refers to “Wood Mackenzie Power & Renewables”; EV chargers: NREL (Number Ports); DOE AFDC (Capacity per Port); EVs: EERE/NREL/ORNL (non-resi. EV capacity/DER); EIA (2019 LDV EVs); EV-Database (resi. EV capacity/DER); Kelley Blue Book (resi. EV price); OP-NEMS (EV stock); VTO (non-resi. EV price).

What are virtual power plants?



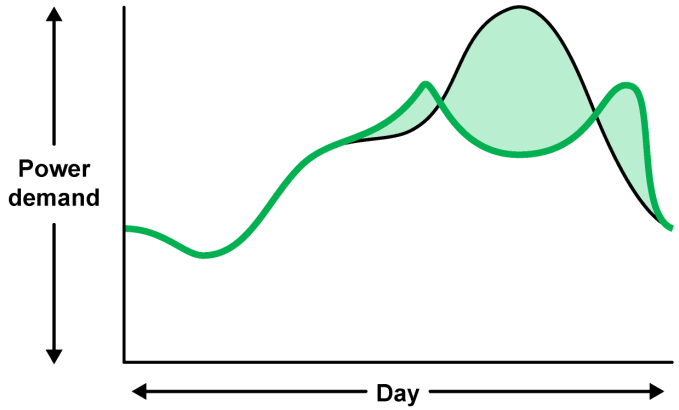
Virtual Power Plants (VPPs) are aggregations of distributed energy resources such as rooftop solar, EVs and chargers, batteries, and smart buildings and their controls that can deliver electrical load balancing and provide utlity-scale and utility-grade grid services like a traditional power plant.

Electricity services

Communication

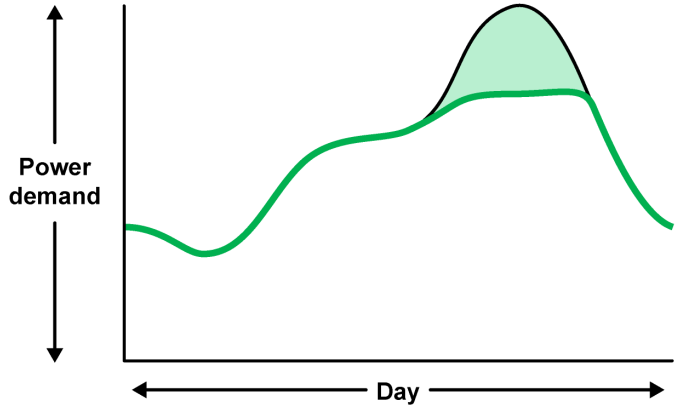
DER orchestration

How VPPs use DERs to provide grid services



SHIFT

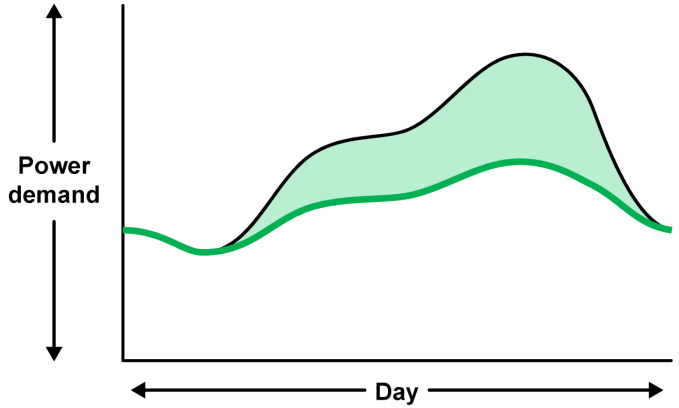
- EV charging
- Smart thermostats
- Smart water heaters
- Storage
- Pool pumps



SHED*

- C&I loads
- Lighting
- Behavioral demand response

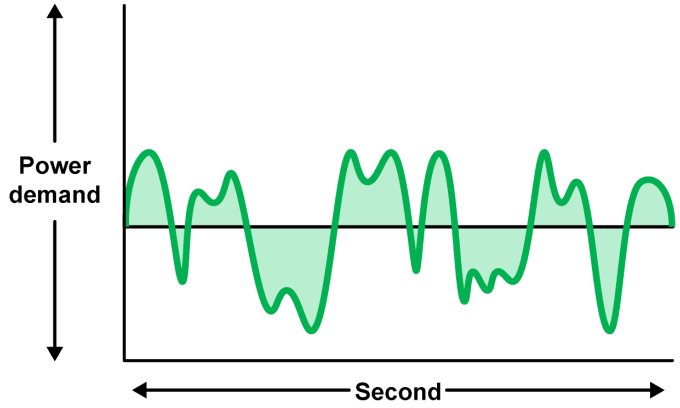
* Load shed for some DERs results in load shifting to later hours as a system (e.g., HVAC) recovers from an event.



SHAPE

- Solar + storage**
- Efficiency (e.g. heat pumps replacing resistance heat)

** Distributed solar + storage reduces demand on the grid; total consumption may not change.



SHIMMY

- Storage (batteries)
- Water heaters

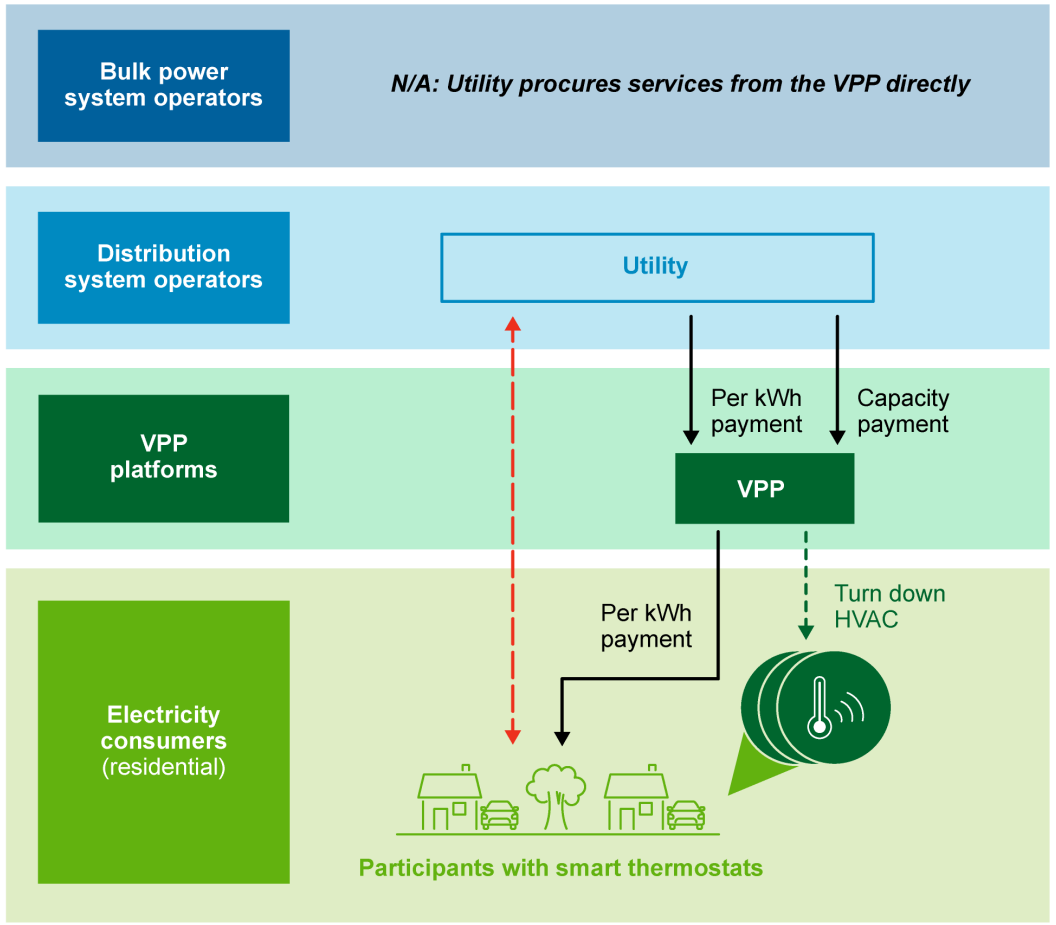
Note: Working draft analysis. Source: Adapted from Lawrence Berkeley National Laboratory and NASEO-NARUC Grid-Interactive Buildings Working Group

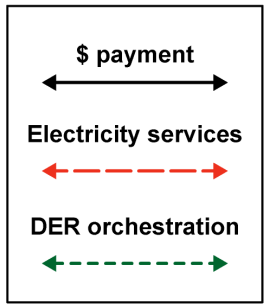
VPP value proposition

Resource adequacy	Affordability	Reliability & resilience	Decarbonization & ambient emissions reduction	T & D infrastructure relief	Consumer choice	Versatility & flexibility
• Integrate distributed generation and storage capacity • Shift demand to follow supply	• Defer grid capex (generation, T & D) • Avoid fuel costs • Compensate consumers and businesses	• Integrate back-up power • Eliminate single-point-of-failure	• Add distributed renewable generation • Reduce curtailment of renewables • Reduce reliance on fossil fuels	• Bypass transmission and/or distribution • Shrink demand peaks	• Empower consumers to optimize between cost, convenience, and source of energy	• Customize design to fit grid needs • Reconfigure as needs evolve

Note: Working draft analysis from LPO.

Example: Smart thermostat demand response VPP



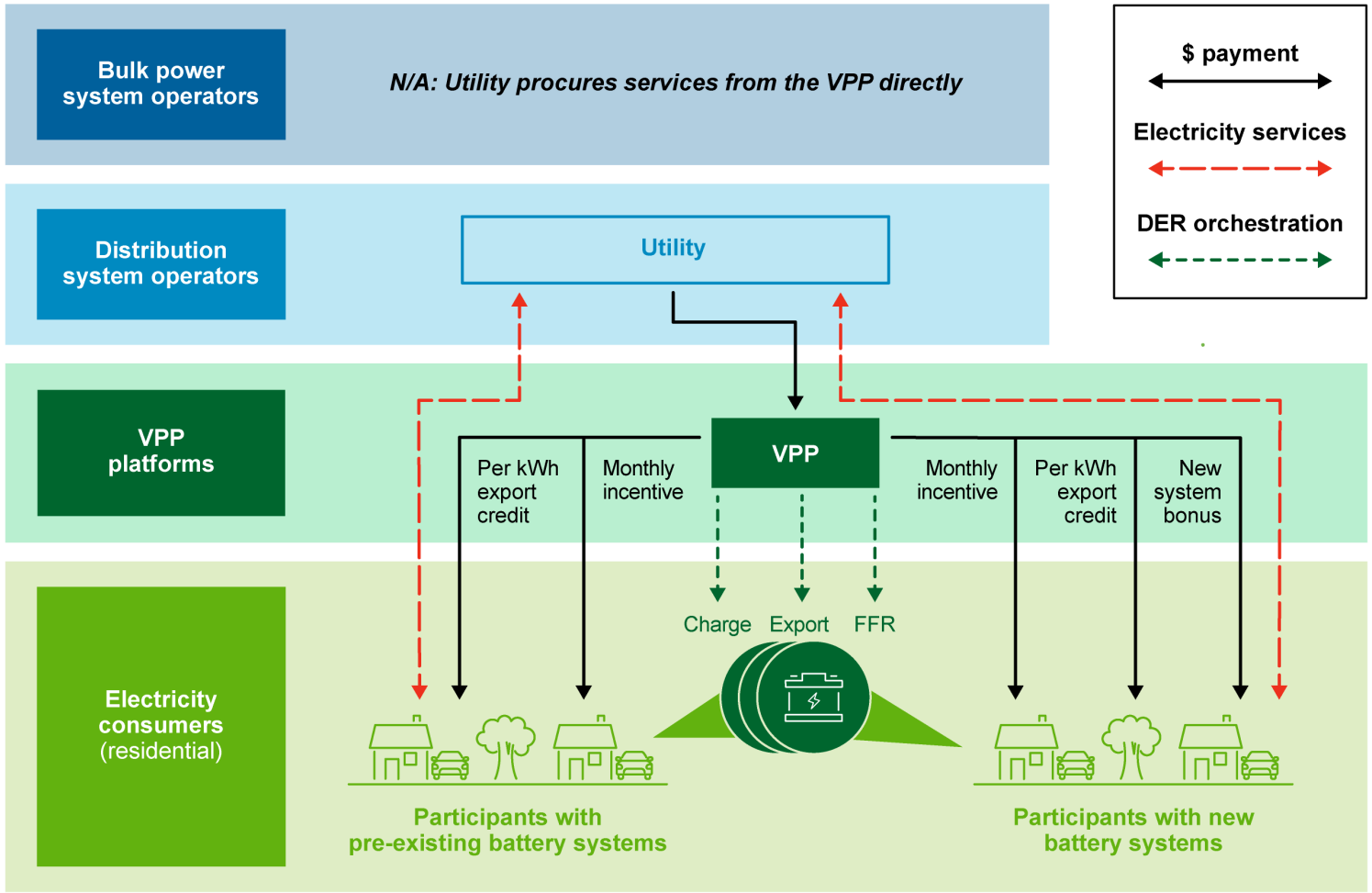


VPP composition: 100,000 smart thermostats (100 MW)

- *Costs:*
  - VPP operator recruits 100K participants and subsidizes ST and installation ($75 per ST)
  - ~$1M one-time start up costs; ~$700K / year (includes IT and admin)
  - VPP pays customers $1.50 per kWh for turning down HVAC for 2h during peak (~20/yr)
- *Revenue:*
  - VPP sells 100 MW of capacity, $80-100 /kW-yr
- *Margin for VPP operator:*
  - Roughly break-even after five years
- *Participant perspective:*
  - Free smart thermostats
  - Receive (or save) $3-6 per event

Note: Working draft analysis from LPO.

Example: Utility-integrated BTM battery VPP



VPP composition: 7,500 batteries (20 MW)

- *Costs*:
  - Administrative and IT costs
  - VPP pays participation incentives:
    - $1000 per kW up-front for NEW battery systems
    - ~$16 monthly flat payments
    - $0.20 credit per KWh exported
- *Revenue:*
  - Utility pays the VPP for three services:
    - Capacity reduction during peak demand (*export*)
    - Capacity build during peak solar supply (*charge*)
    - Fast frequency response
  - Prices for range from $80-375 per kW-yr of capacity
- *Margin for VPP operator:*
  - Highly dependent on the negotiated prices for services
- *Participant perspective:*
  - $9,000-12,000 price per new battery (4 kW flexible capacity) is partially offset by a $4,000 new system bonus, $200+/yr
  - Enough charge remains in the battery to always provide back-up power if needed

Note: Working draft analysis from LPO.

Additional examples

1979 (!): New Hampshire Electric Coop began offering an interruptible water-heating program.

2019: Sunrun bid into ISO-NE in 2019 with 20 MW from home solar and battery systems…

2022: … delivered 1.8 GWh.

2023: Retail electricity provider Octopus Energy offers Texas customers a discounted rate (per kWh) if they allow managed EV charging overnight.

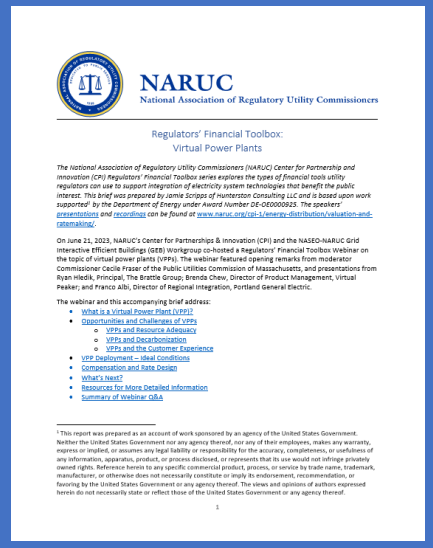
NARUC Resources Related to Virtual Power Plants

Demand Flexibility within a PBR Framework


NARUC
National Association of Regulatory Utility Commissioners

Demand Flexibility within a Performance-Based Regulatory Framework

Financial Toolbox: Virtual Power Plants


NARUC
National Association of Regulatory Utility Commissioners

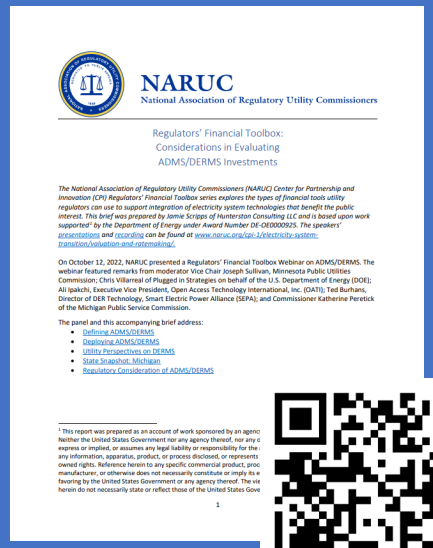
Regulators' Financial Toolbox:
Virtual Power Plants

Digitalizing in Electric Power Systems and Regulation


NARUC
National Association of Regulatory Utility Commissioners

Digitalization in Electric Power Systems and Regulation: A Primer

Financial Toolbox: ADMS/DERMS Investments


NARUC
National Association of Regulatory Utility Commissioners

Regulators' Financial Toolbox:
Considerations in Evaluating
ADMS/DERMS Investments

Smart Grid Interoperability


SMART GRID INTEROPERABILITY:

Prompts for State Regula

National Association of Regulatory

Interoperability Learning Modules in English & Spanish:

www.naruc.org/cpi-1

Identifying the Value of VPPs & Describing Success
1:30-2:00 pm

Break
2:00-2:15 pm

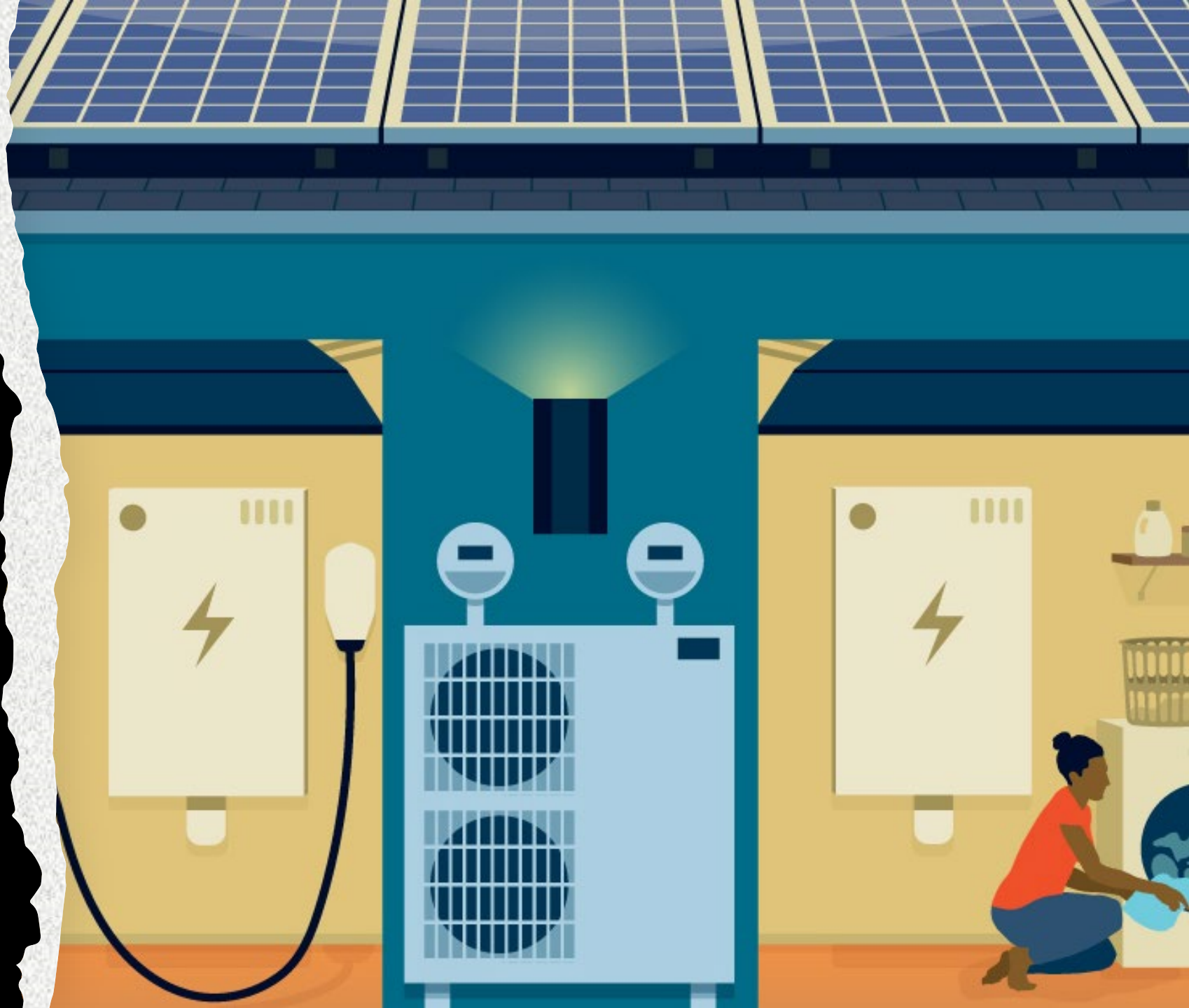
Group Reflection
2:15-2:30 pm

Vision for Success; Articulating Challenges to VPP Deployment at Scale
2:30-2:45 pm

Road Mapping How to Address Barriers
2:45-3:50 pm

Report Out & Commitments
3:50-4:50 pm

Conclusion & Next Steps
4:50-5:00 pm



Identifying the Value of VPPs & Describing Success

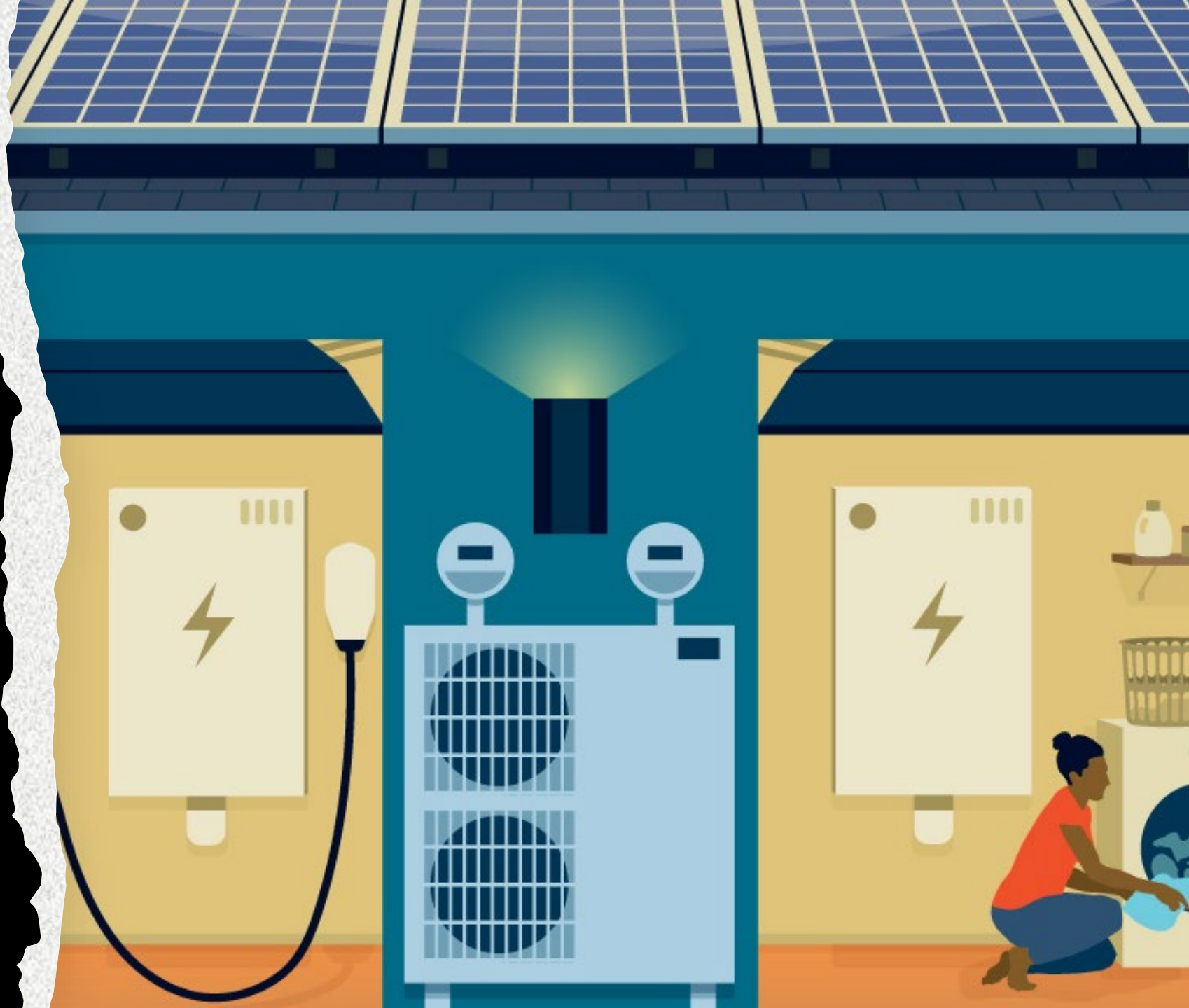
At your table:

1. On sticky notes, write the top three most important (valuable, impactful) grid services that VPPs can provide

10 minutes

2. On the flip chart, write a draft aspirational metric for VPPs that would indicate market maturity or wide-spread deployment of VPPs

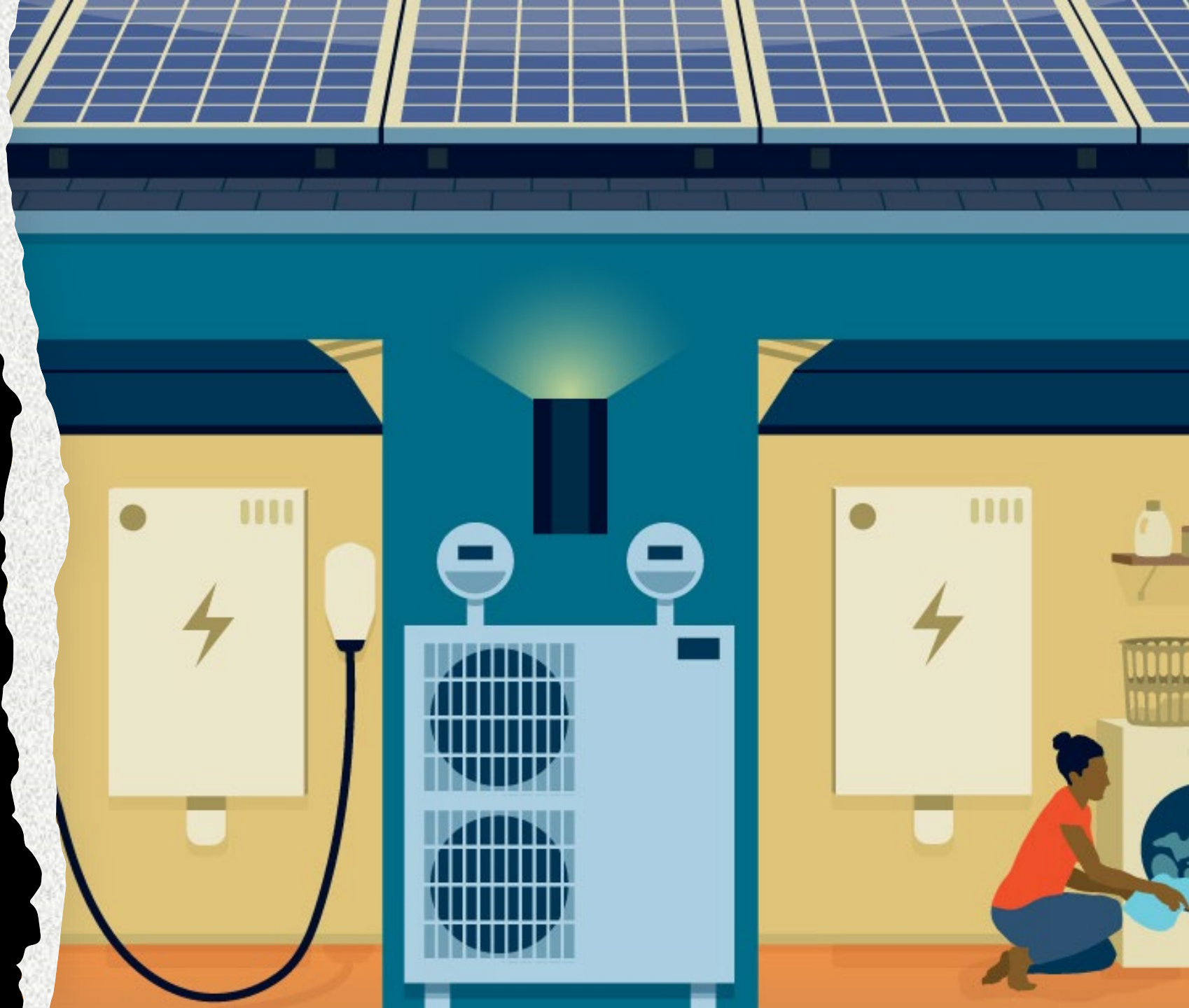
15 minutes



Break

Visit the collage of sticky notes, use your dots to vote for those you most agree with

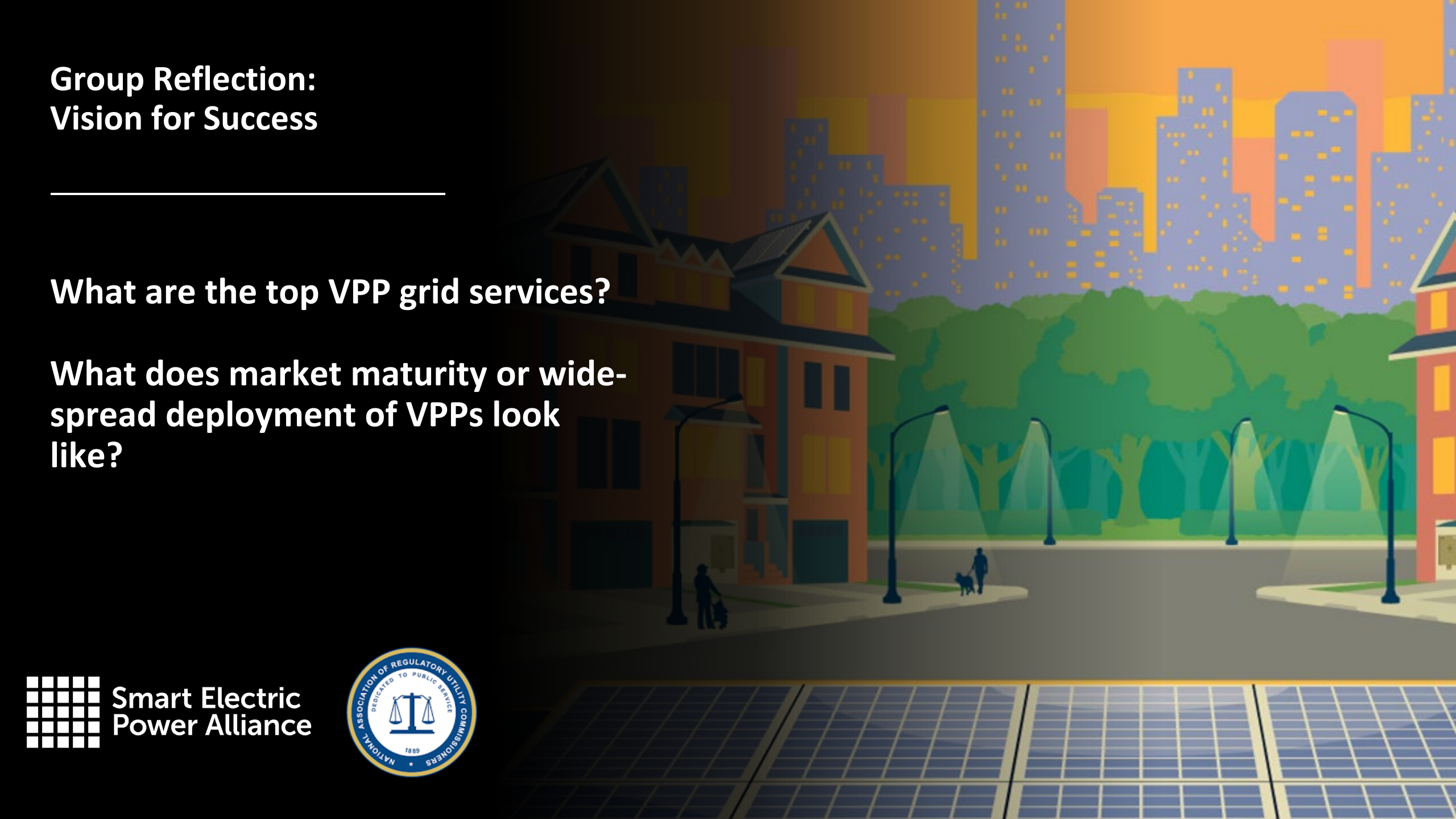
Return by 2:15 pm



Group Reflection:
Vision for Success

What are the top VPP grid services?

What does market maturity or wide-spread deployment of VPPs look like?



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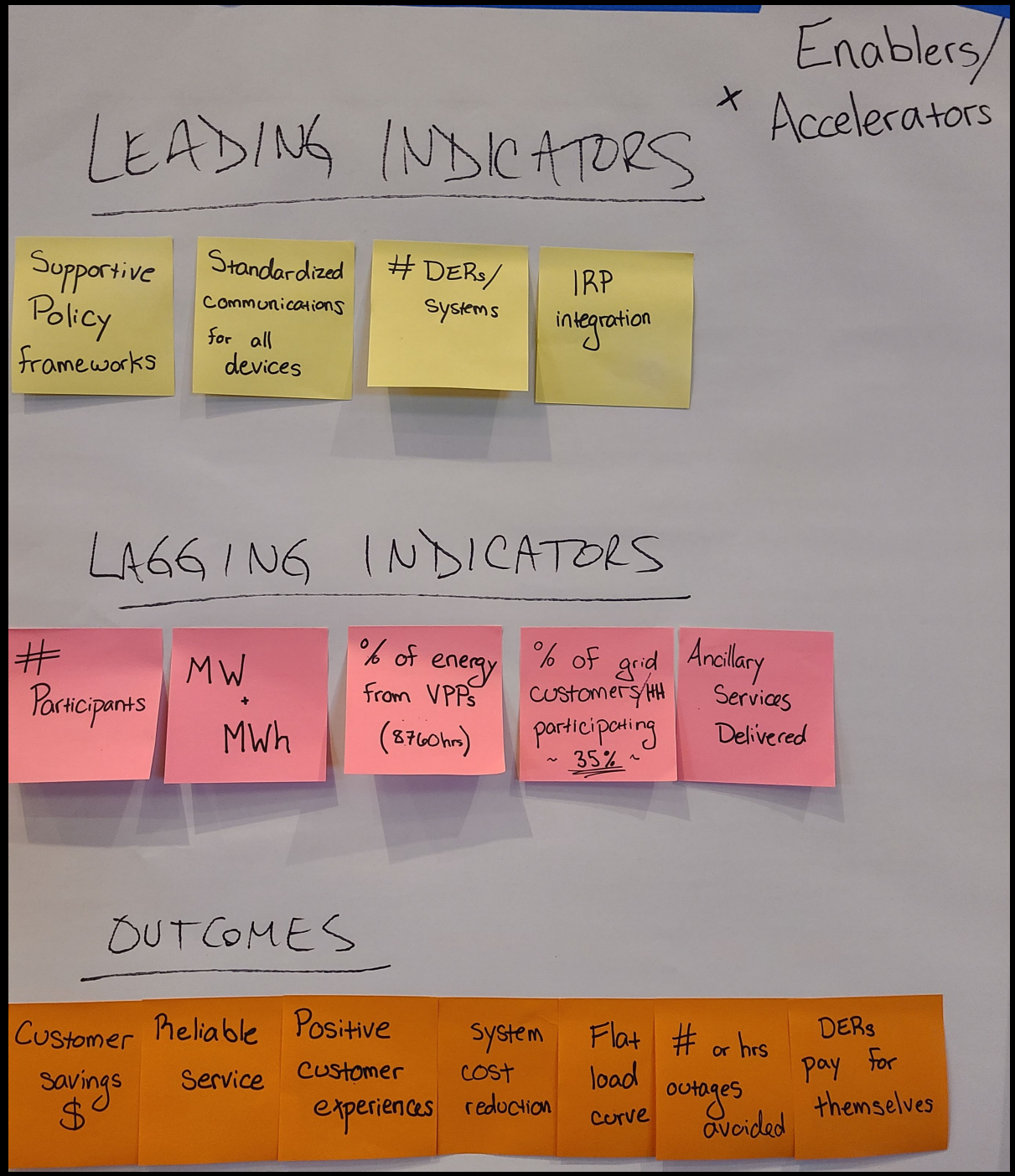
Group Reflections: What are the top VPP grid services?

#1 – Flexibility / operational efficiency
#2 – Resilience
#3 – Peak load relief

Group Reflections: What does market maturity or widespread deployment of VPPs look like?



Presentation & Group Discussion

Articulating Challenges to VPP Deployment at Scale

Jen Downing | Senior Advisor
Loan Programs Office, US DOE

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Scaling VPPs requires solutions in consumer markets and power markets

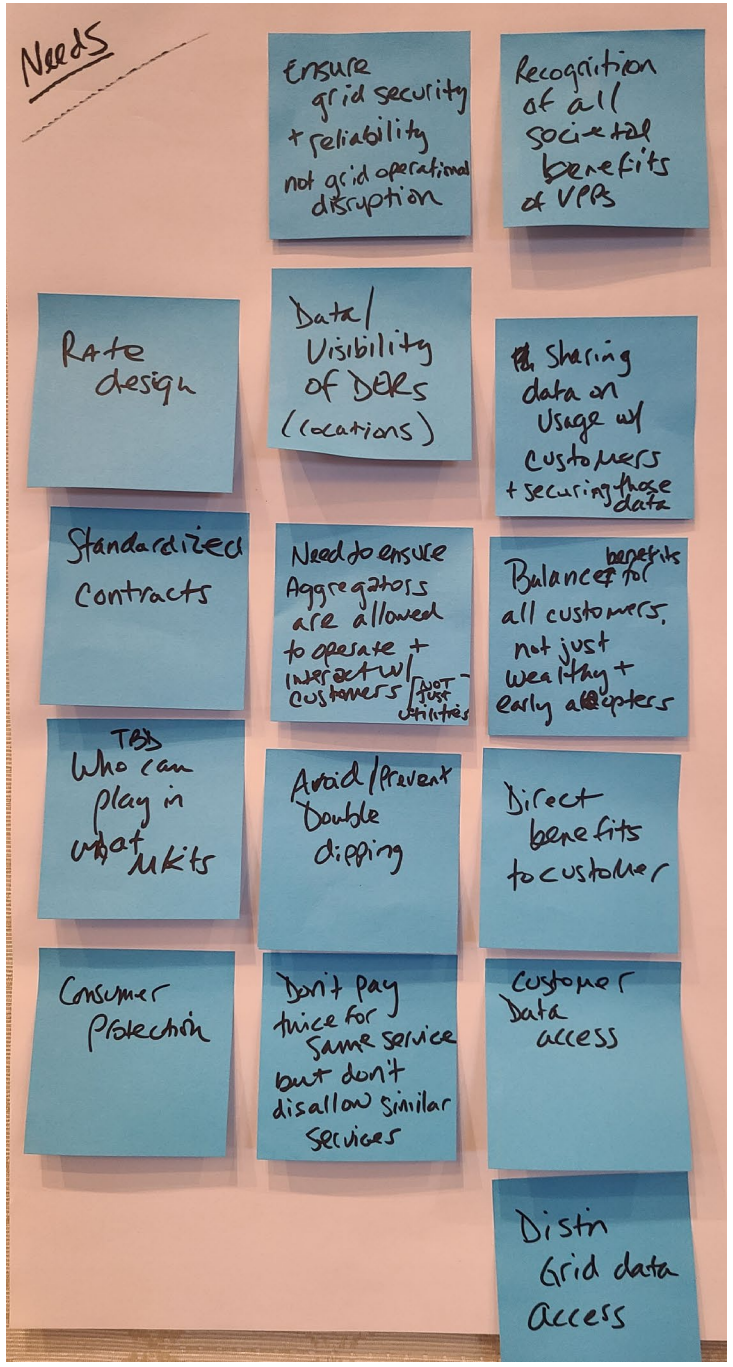
Imperatives for VPP liftoff

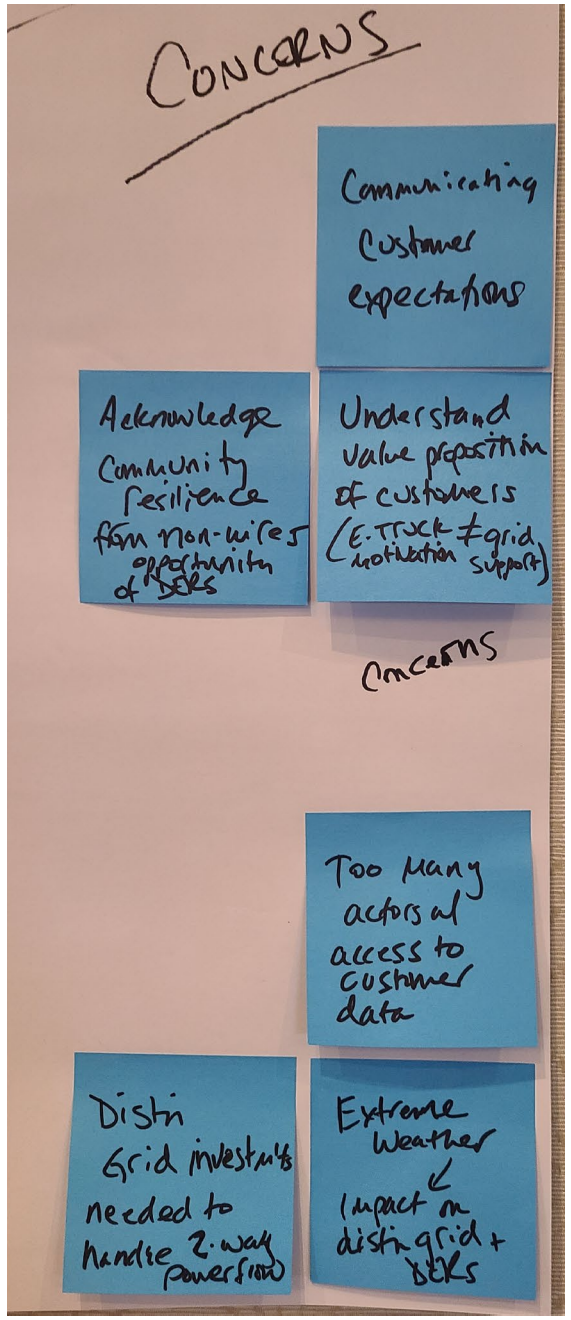
1. Broad and equitable DER adoption & VPP benefits
2. Simplified VPP enrollment
3. Standardized operational models for VPPs
4. Retail market integration
5. Wholesale market integration

Conversation starter: Challenges to scaling up VPPs

To scale up VPPs, we need:	Challenges we face
1 **Broad and equitable DER adoption & VPP benefits**	• DER price tags • Installation hurdles
2 **Simplified VPP enrollment**	• Customer acquisition costs • Under-valued grid benefits → hard to afford customer low participation incentives
3 **Standardized operational approaches for VPPs**	• Fragmentation of VPP forecasting & measurement methods → perception of risk • Wide ranging DER interconnection standards & lack of data standards • Unclear cybersecurity responsibilities • Need for distribution grid protocols for increasing number of actors
4 **Retail market integration**	• Low VPP awareness and understanding • Complexity of revising regulatory frameworks for planning, compensation
5 **Wholesale market integration**	• Timeline and approach to FERC Order 2222 implementation

Group Reflections: Additional Needs & Concerns





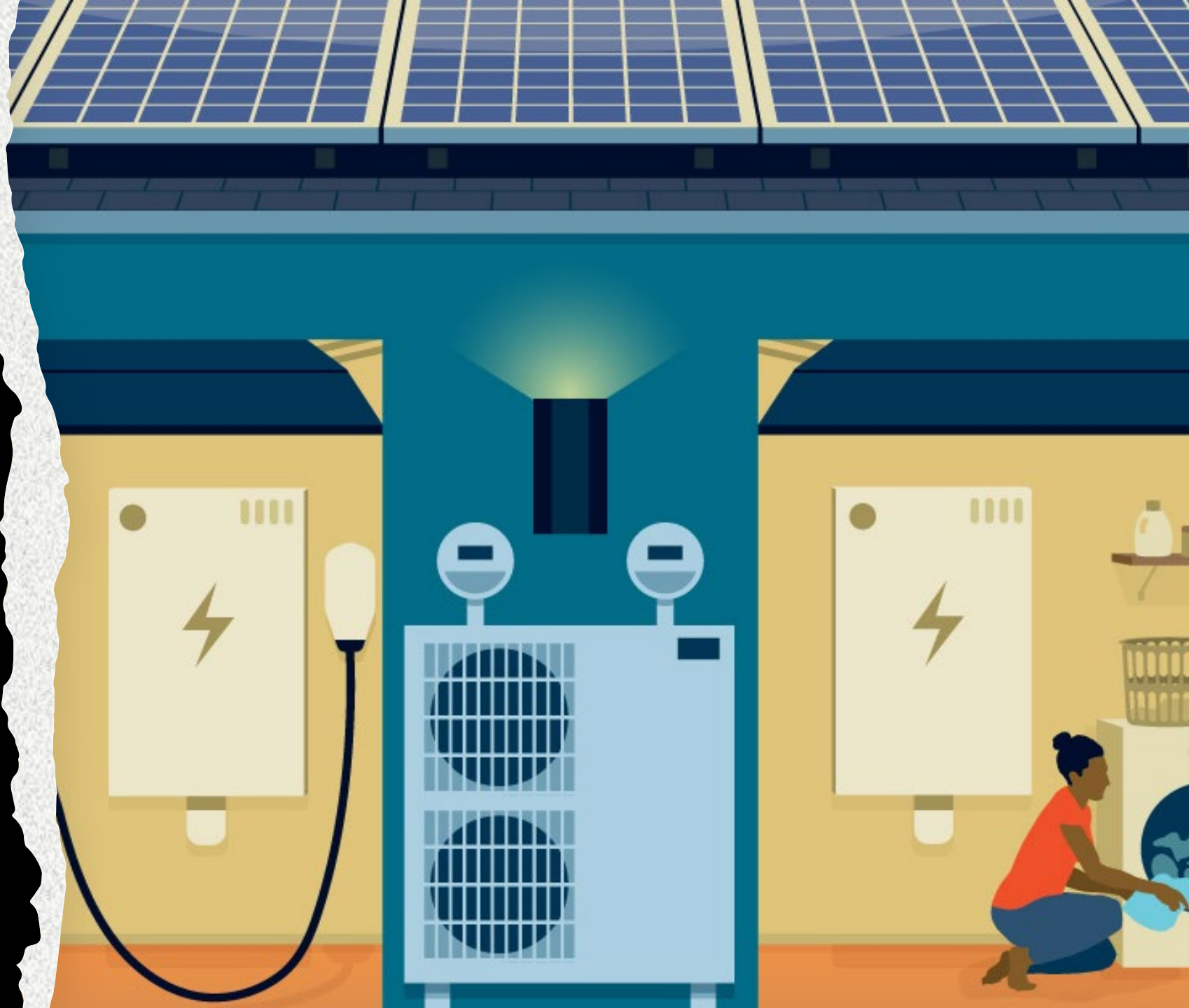
Road Mapping How to Address Barriers

Your table has a been assigned a specific barrier to address

Solo | 5 mins
Reflect on an idea that you think can solve for this barrier

Pair | 15 mins
Pair up with 1 person and decide on an iterated ‘great idea’ for a solution

Table | 40 mins
Discuss, debate, and reach agreement on a great idea to overcome the barrier and draft a SMART solution

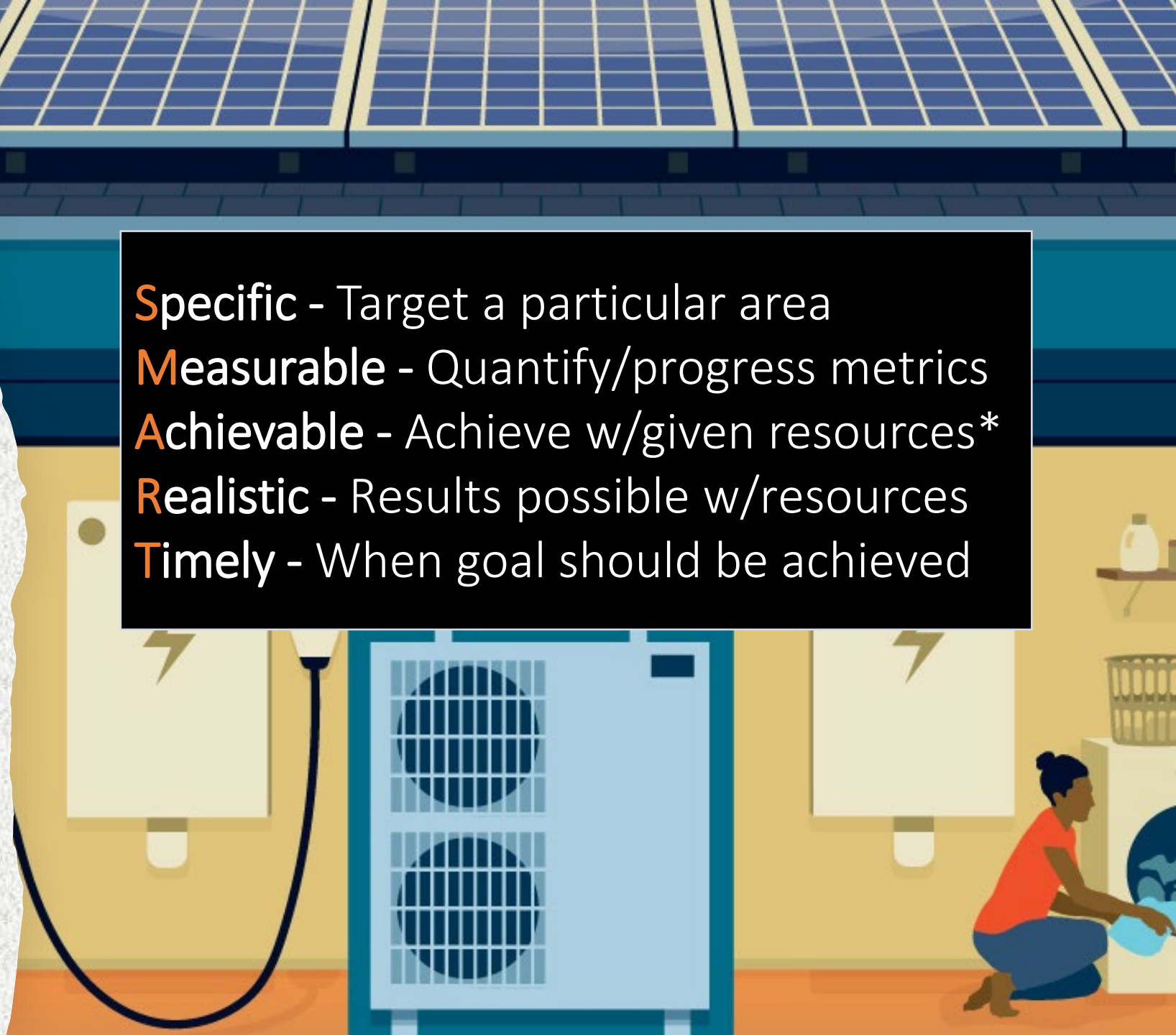


Road Mapping How to Address Barriers

Table | 40 mins

- Discuss, debate, and reach agreement on a great idea to overcome the barrier
- Draft a SMART solution that explains the great idea and puts it in context
- Plan to frame your **SMART** solution with an ‘ask’ to other stakeholders in the room who might be willing to commit to working to achieve your solution and goal

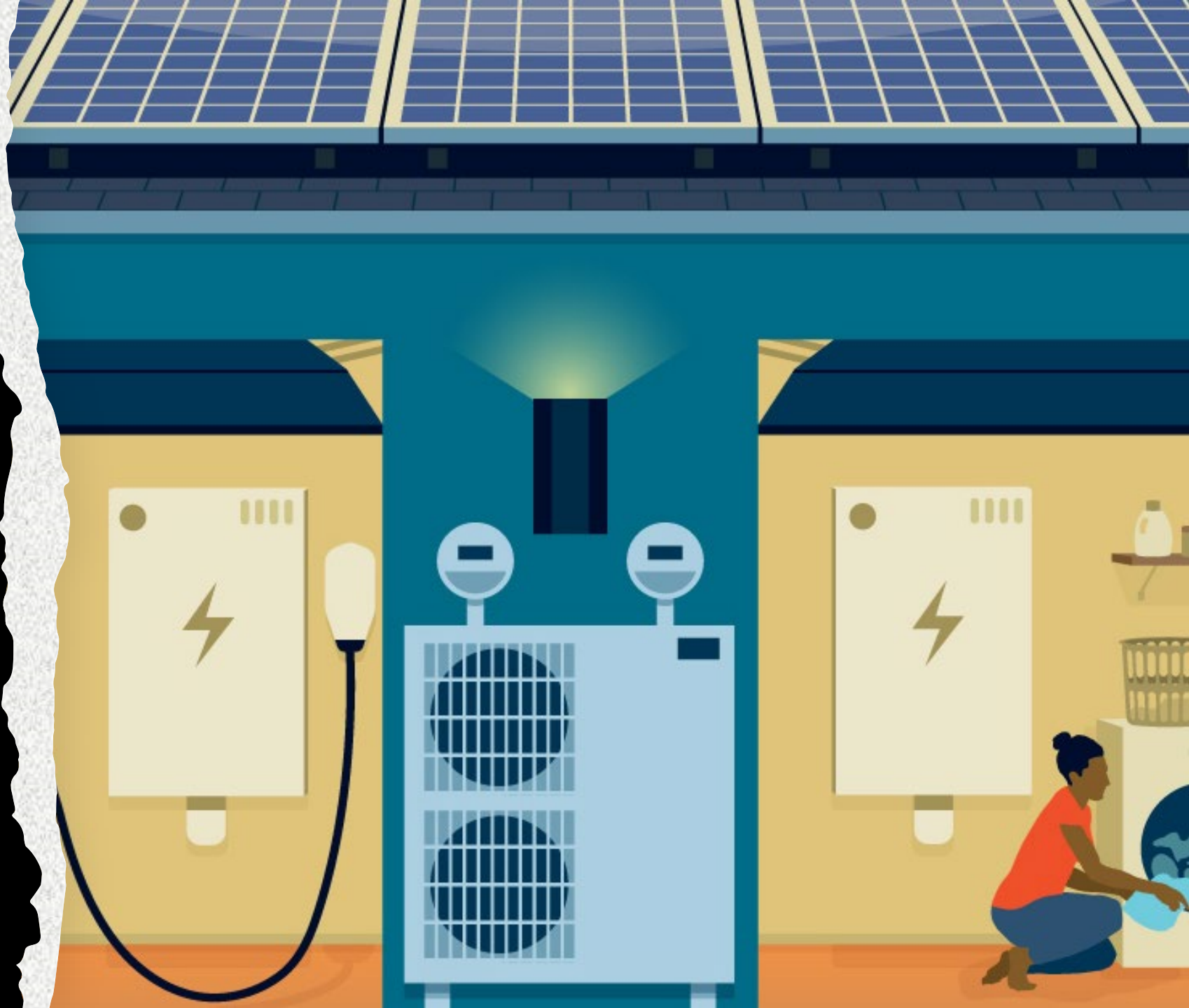
Specific - Target a particular area
Measurable - Quantify/progress metrics
Achievable - Achieve w/given resources*
Realistic - Results possible w/resources
Timely - When goal should be achieved



Report Out & Commitments

What is your SMART solution?

Who is needed to carry this forward?



1) Broad and Equitable Adoption

- Solution: Geographically target enrollment for areas where grid needs are present, especially within disadvantaged communities (DACs). Enroll customers in demand response programs as main avenue => VPP => load reduction
  - S: Give customers BTM devices
  - M: Track enrollment
  - A: Proof point: SDG&E purchased Nest thermostats w/auto enrollment in VPP program
  - R: Program cost will come down with economies of scale (buy many BTW devices at once)
  - T: Existing avenue / can start tomorrow
  - WHO: Use local installers for development/ neighborhood by neighborhood; educate local community incl. schools, PUCs

1) Broad and Equitable Adoption

- Solution: Include VPP packages in weatherization programs; for those ineligible, provide DERs/VPP with on bill financing.
  - S: Address upfront cost challenge to DER adoption for low and middle income residential customers
  - M: Based on uptake
  - A: Leverage funding from EPA Green Bank or DOE grant programs | or ratepayer funds | or tie to revenue from the program (e.g., shared savings)
  - R: Program admins / installers will need bandwidth; could partner w/providers
  - T: TBD
  - WHO: Federal, state, local WAP administrators; utilities; aggregators; installers

2) Simplified VPP Enrollment

- Solution: VPP value stack shown as energy guide label: what are the values being provided to the customer
  - S: Identify, increase, communicate customer value proposition
  - M: Measure the adoption rate over time
  - A: Through federal & industry engagement that's inclusive
  - R: Meet w/DOE, gov't, industry => catalyze for enrollment ("baton race")
  - T: Near-term engagement for 2030 solution
  - WHO: Entities getting federal funding need to be part of the solution now to get this going

3) Standardized Operational Models for VPPs

- Solution: Form an accreditation mechanism to provide trust in VPPs based on a standard, user-friendly process for heterogenous DERs. Will allow VPPs to access multiple markets and programs with lower entry costs, then compete on a level playing field with any other resources
  - S: Lowering barriers to entry across different DERs and different markets
  - M: Look at IRPs to see how VPPs are showing up there; VPP #s increase over time
  - A: Consider track record (performance) of VPP; automate the process, if possible, to streamline accreditation for VPP aggregators
  - R: Need to ensure there is value for the VPP aggregator (e.g., as one builds credit score => get more favorable rates)
  - T: Will take a while (12-18 months?) to get stakeholders to agree & help streamline the process, but then everything else moves faster
  - WHO: Aggregators & others in a stakeholder process who will compromise to achieve the result

3) Standardized Operational Models for VPPs

- Solution: Devise a model ‘open access’ distribution tariff that allows DERs to come into utility service openly to create customer benefits; can be used by states for adoption. Includes standardized, open source M&V requirement
  - Includes: Customer education campaign informed by market research (not utility led) <-> customers educating us about their needs
  - Requires: Open source M&V standard
  - T: Q1 2025 at NARUC Winter Policy Summit

4) Retail Market Integration

- Solution: Playbook for utility commissions to begin putting in place initial programs / recipes for addressing some of the key barriers ----- cost recovery, ratemaking, multi-year ratemaking, initial programs ---- to get things started
  - S: VPPs get a foothold where there's a clear capacity constraint
  - M: It exists or doesn't
  - A: NARUC, DOE, SEPA, federal gov't could support / provide funding
  - R: It's realistic by nature
  - T: By next summer
  - WHO: Led by PUCs and open to all utilities / if required state legislative changes to utility compensation structures/cost recovery; state wide opportunity better than single utility

4) Retail Market Integration

- Solution: Establish rewards for customer-utility partnerships
  - Update rate designs / utility programs to align customers with grid needs
  - Offer rewards upfront / visibility of what could save or earn if they enroll, use tiers with savings / benefits based on performance (e.g., airline miles, gamification)
  - Align utility incentives / rewards for standards of performance / customer-related metrics also

5) Wholesale Market Integration

- Solution: Create Best Practices Framework for complying with FERC Order 2222 for VPPs that include guiding principles. For example:
    - Comprehensive, fast, clear, consistent – staged to allow for incremental improvement (good – better – best)
    - Reliability (with very specific analyses on any reliability requirements)
    - Open access by default
    - Performance standards not technical requirements (e.g., for metering)
    - Shift burden of proof for O2222 plans: RTO should prove why any restriction on DER participation is a concern
  - T: ASASAP – as soon, as simple, as possible
  - Benefits: simplicity, consistency, lower cost for deployment & participation
  - WHO: FERC should initiate a process to devise a staged rule set to allow for incremental DER / VPP growth

Action Items / Commitments from Participants

1. DOE LPO: Finish writing Liftoff report
2. DOE LPO: Continue to prioritize VPPs -- want to finance $100 billion of VPPs
3. DOE SCEP/EERE/others: Need for weatherization; rebates & tax incentives for smart water heaters, heat pumps, vehicles => Deploy more VPPs
4. DOE OE: Grid protocols; integrated distribution system practices
5. SunRun: As part of RMI VP3 advisory group, will communicate and collaborate with other members to put rules / best practices into place ---- taking on the playbook idea
6. NARUC: Will seek DOE support to work on developing the Commission playbook that was described; will engage members & stakeholders in its creation
7. SEPA: Will increase VPP educational offerings for our members - including utilities - that highlights industry case studies/best practices; identify ways to facilitate greater utility involvement in industry conversations
8. RMI: Facilitate VP3 and will incorporate broad & equitable adoption into the initiative
9. Local Solar for All: Socialize that VPPs aren't an alternative to a no-cost path – there are broad benefits with an equitable deployment
10. Recurve: Supporting open source software as an option to accelerate VPPs (openEE meter = EE, DER, EV); seek others to join in fixing & collaborating on software (and then compete on the client side)
11. Advanced Energy United: Continue filing at FERC re: PJM and NYISO O2222 filings re: poison pills (e.g., NY DER Participation Model excludes <10kW systems because of paperwork burden)
12. Autogrid: Will share lessons learned from NY, CA, TX re: retail rate reform and DER compensation
13. Collaborative Utility Solutions: Will continue developing a nationwide DER registry for accreditation & location of DERs to remove a lot of friction/gatekeeping. Software exists; seeking participants.

Conclusion & Next Steps

Danielle Sass Byrnett |Senior Director
Center for Partnerships & Innovation
NARUC

Courtney Galatioto | VP, Strategic Partnerships
SEPA

Jen Downing | Senior Advisor, U.S. DOE Loan Programs Office

Smart Electric Power Alliance

Thank you!