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Unlocking Cost-Effective Grid Flexibility in Thailand: VPPs and the New Role of Regulators

RAP and RETA webinar

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Unlocking Cost-Effective Grid Flexibility in Thailand: Virtual Power Plants and the Role of Regulators

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Introducing the Regulatory Energy Transition Accelerator

Accelerating »
the energy transition.

November 20, 2025

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Content

01

VPP Concepts,
Benefits &
Examples

02

Business
Models and
Regulatory
Topics

03

Business
Models in
Action: Hawaii
and Australia

04

Application to
Thailand



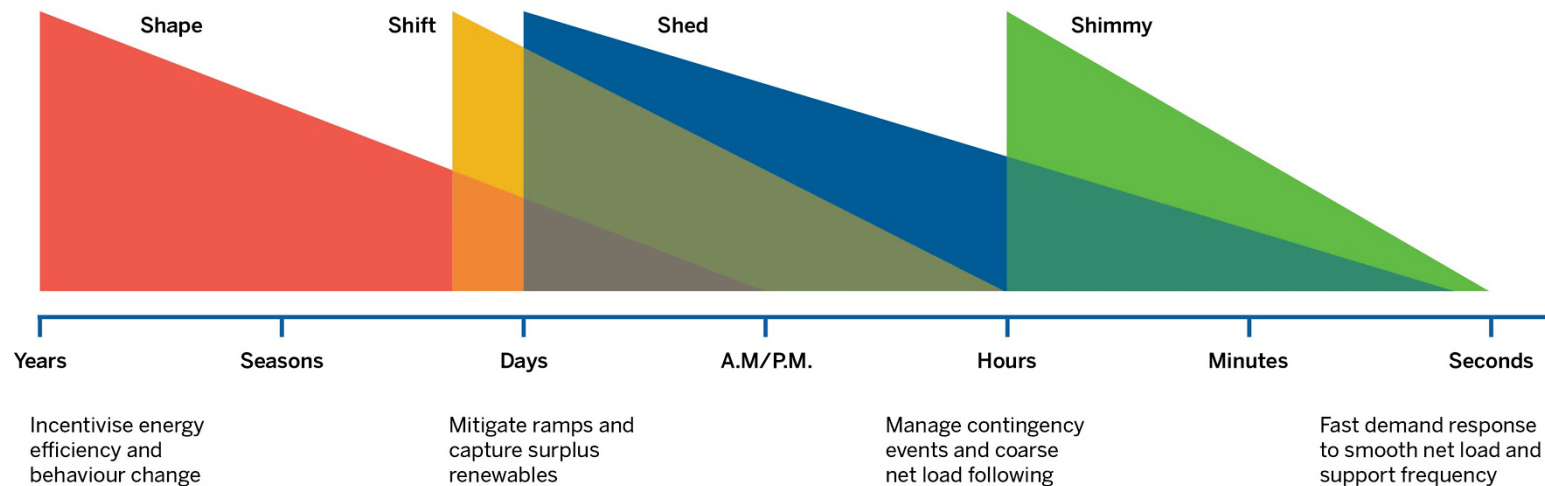
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Flexibility & VPPs: Concepts, Benefits & Examples

What is Grid Flexibility?

“...the ability of end-use customers to temporarily reduce their electricity consumption from the grid during periods of system stress by using on-site generators, shifting workload to other facilities, or reducing operations.”

Demand Response Service Types over Different Timescales



Source: LBNL, <https://eta-publications.lbl.gov/sites/default/files/lbnl-2001113.pdf>

Two Components of a Virtual Power Plant

1. Aggregations of behind-the-meter Distributed Energy Resources (DERs).



BTM Batteries

Source: SEPA (2025).



Rooftop Solar Panels



Smart Thermostats



Electric Vehicles



Water Heaters

2. Enabling software that that allows DERS to be controlled and networked.



Distributed Energy Resource Management System (DERMS)

Source: Garth et. al. (2025). Decoding DERMS: Options for the future of DER management

Comparison of VPPs & Demand Response

Similarities

Location

- Both VPPs and DR assets are typically behind the retail meter.

Grid Services

- Both VPP's and DR assets can provide energy, capacity, and other ancillary services (load shedding, load shifting, etc.)

Technologies

- Both may include demand-side and supply-side devices or processes.

Other Similarities

- There is no single definition of VPPs and DR assets, and there can be considerable overlap.

Differences

Customer Class

- VPP's typically come from the residential class.
- DR assets typically come from the C&I class.

Size

- VPP's are typically made up of <10kW *devices*.
- DR assets are made up of larger (often >100 kW) *processes*.

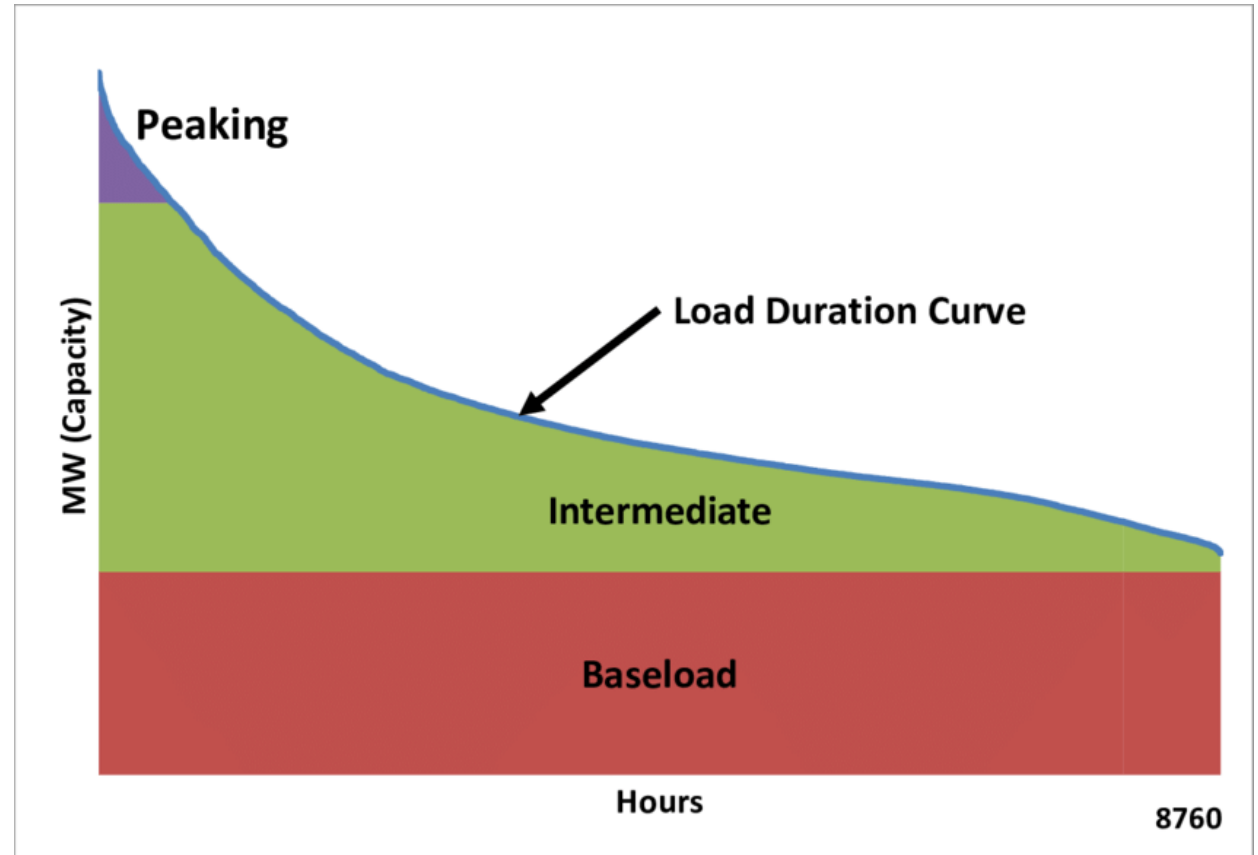
Aggregation

- VPP's are aggregations of small scale DERs.
- DR assets are not always aggregated.

Why VPPs? To Increase System Utilization

- To get more out of the grid we have.
- By decreasing peak loads and increasing system utilization.

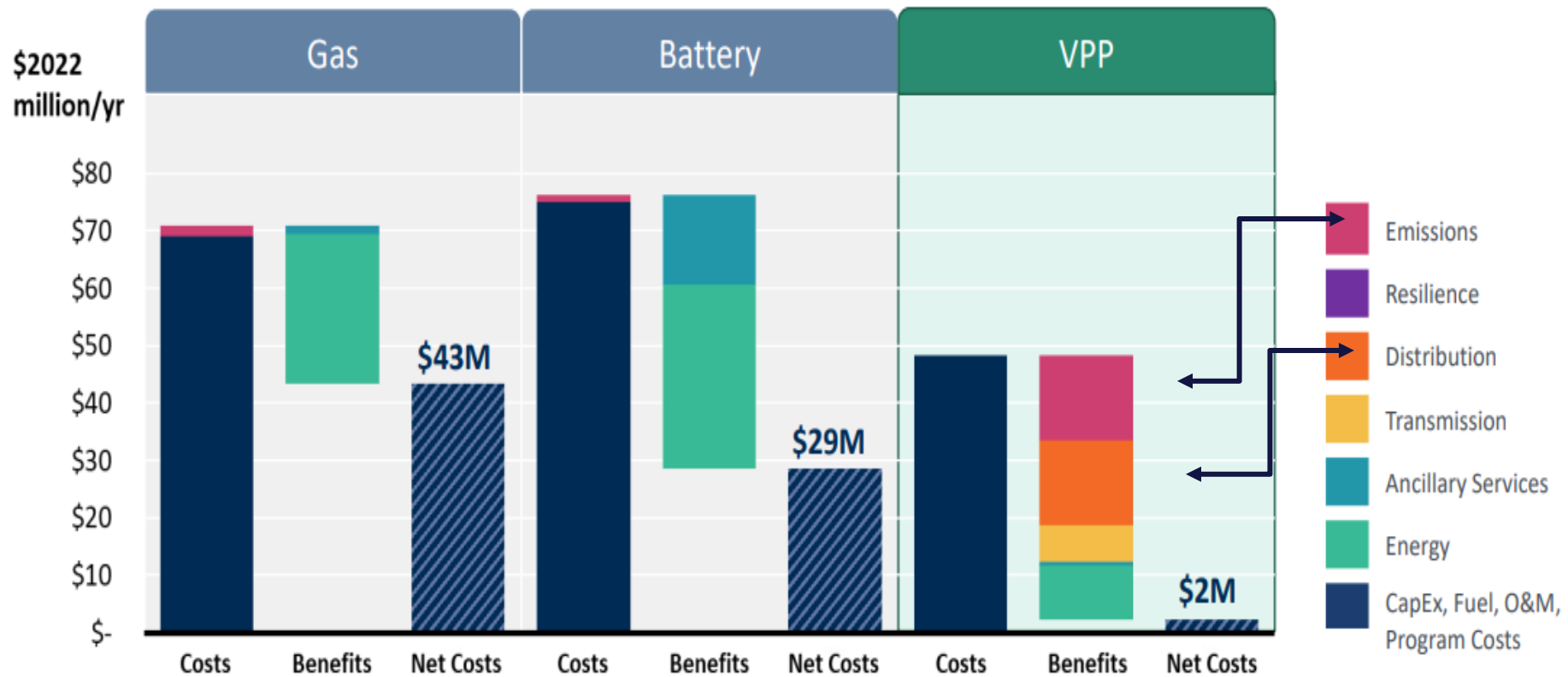
Illustrative Load Duration Curve



Graphic Source: NREL, Treatment of Solar Generation in Utility Resource Planning (2013)

Why VPPs? To Lower Costs

Annualized Net Cost of 400 MW Resource Adequacy



Source: Hledik, R., & Peters, K. (2023). *Real Reliability: The Value of Virtual Power*.

Why VPPs? To Speed Deployment

- California, United States

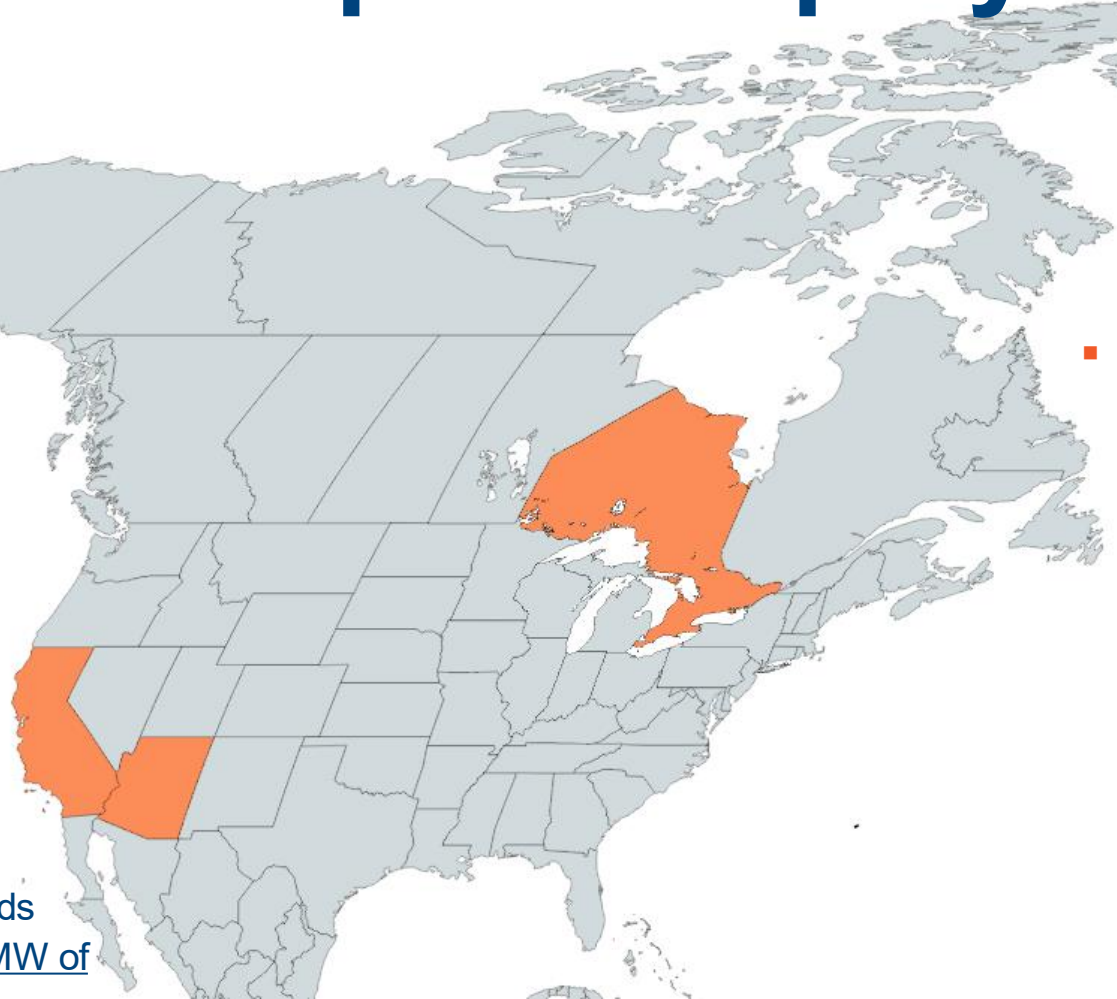
The Demand-Side Grid Support Program has enrolled over 750 megawatts (MW) of customer-sited storage — a 500 MW increase from January to October 2025.

- Arizona, United States

Arizona Public Service's Cool Rewards thermostat program adds nearly 40 MW of capacity each year.

- Ontario, Canada

The Peak Perks smart thermostat program enrolled 100,000 homes (90 MW) in six months.

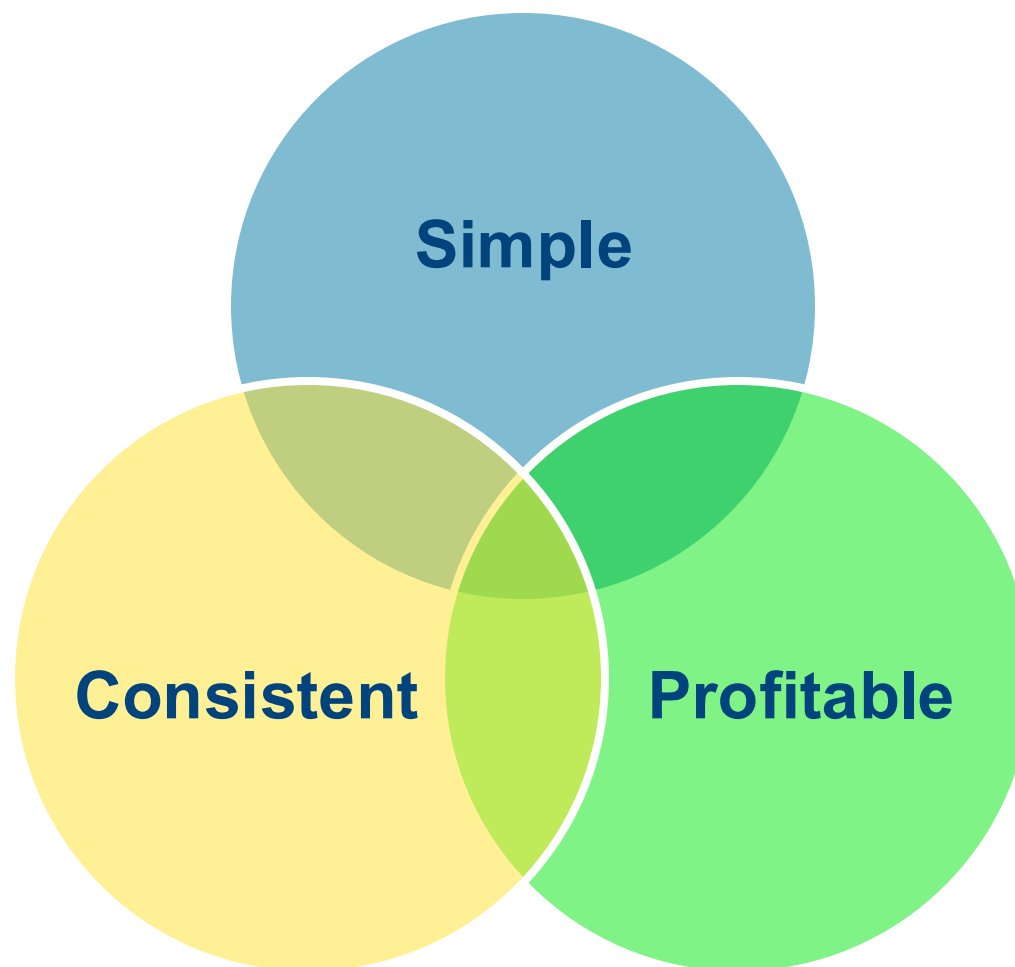


Created with mapchart.net

VPP Programs are Proliferating

Distributed Energy Resource (DER)	Aggregator-led	Utility-led
BTM Battery	PG&E / Tesla — Demand Side Grid Management VPP (USA)	Rocky Mountain Power — WattSmart Battery Program (USA)
Solar + BTM Battery	Tesla — South Australia Virtual Power Plant (AU)	PacifiCorp — WattSmart Program (USA)
Smart Thermostat	EnergyHub & IESO — Peak Perks Program (CA)	Arizona Public Service — Cool Rewards Program (USA)
Electric Vehicles	Octopus Energy — Intelligent Octopus Go for EVs (UK)	Green Mountain Power — In-Home Level 2 EV Charger (USA)
Water Heaters	Hawaiian Electric — Shifted Energy Water Heater VPP (USA)	Portland General Electric — Connected Water Heaters (USA)
Multiple DERs	Tiko Energy — HEMS (smart thermostat, solar, EV charger) (EU)	Roanoke Cooperative — Smart Energy Savings Program (water heaters, thermostat, EE) (USA)

Objectives for Successful VPP Programs



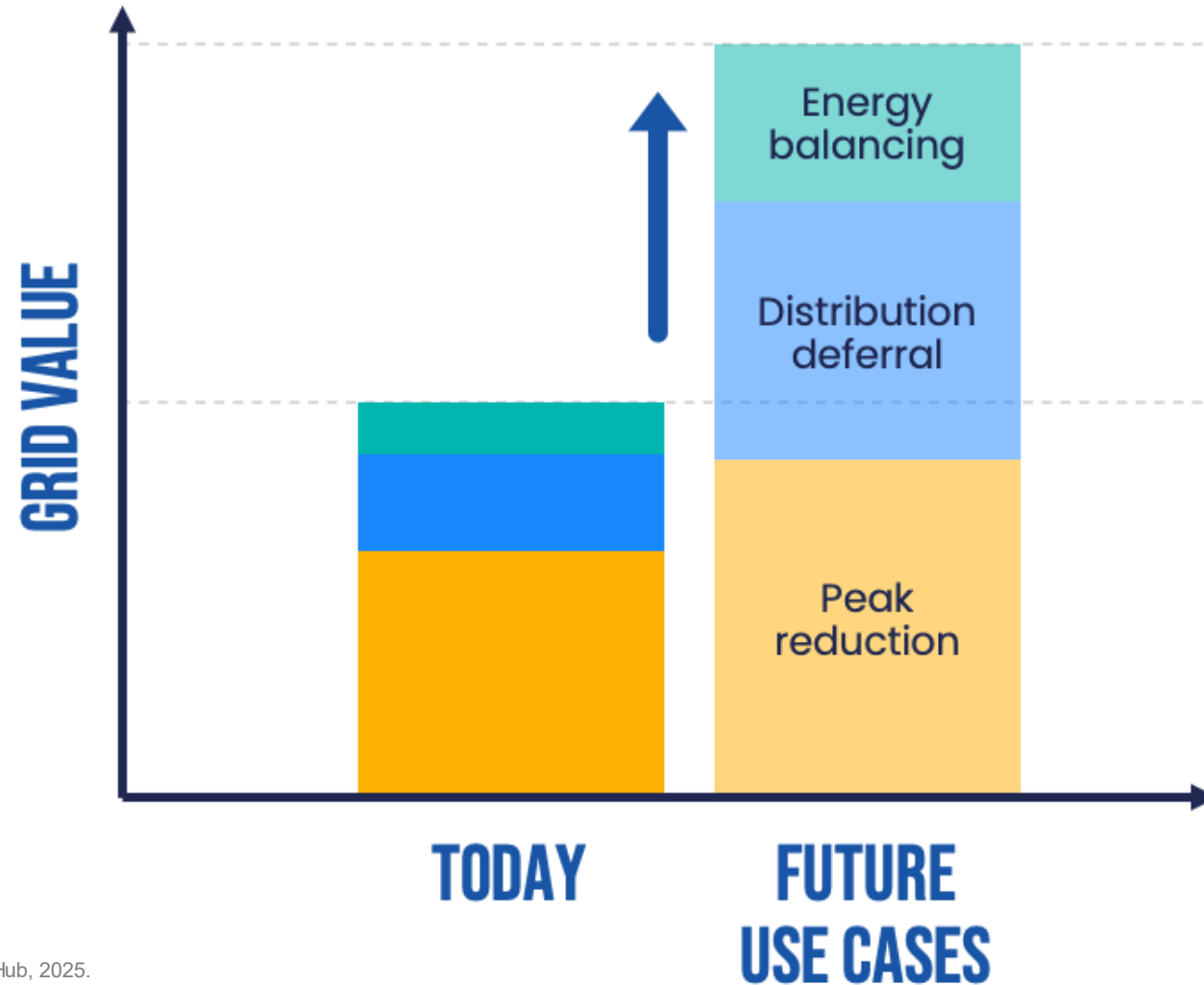
Credit (concept): Doug Middleton, Tesla

An aerial photograph of a large-scale solar farm. The image shows numerous rectangular photovoltaic panels arranged in neat, parallel rows across a landscape. The panels have a blue-tinted surface with visible grid lines. The background between the rows of panels shows green vegetation and some trees, particularly on the right side. The overall scene is captured from a high angle, looking down at the solar array.

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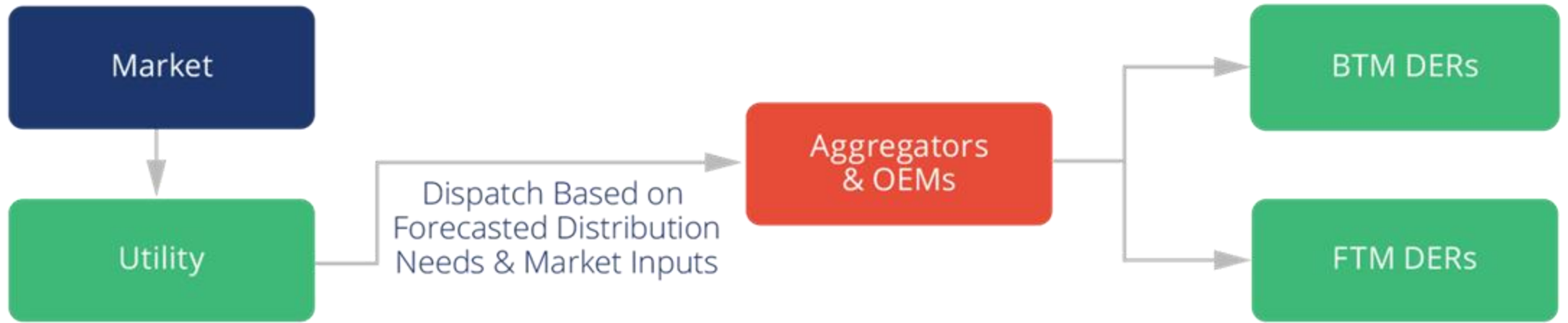
Business Models & Regulatory Topics

Delivering More Value with VPPs



Source: Figure used with permission from Energy Hub, 2025.

DER Participation: Utility-Led Model



Source: EnergyHub (2025). Recreated by SEPA.

Advantages

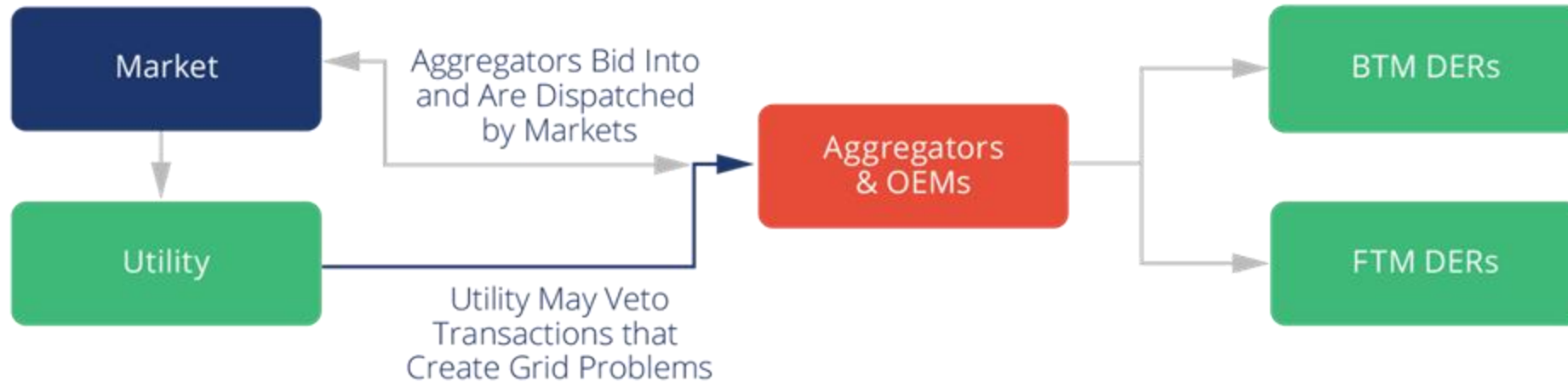
- Streamlined customer experience and program messaging
- Completed distribution management
- System-wide optimization of conflicting objectives

Disadvantages

- Limits customer to single program offering
- Limits competition from aggregators

Source: Garth et. al. (2025). Decoding DERMS: Options for the future of DER management

DER Participation: Aggregator-Led Model



Source: EnergyHub (2025). Recreated by SEPA.

Advantages

- Expanded choice through competitive offerings
- Diversified performance risk
- Agility in program iteration

Disadvantages

- Customer confusion from competing offerings
- Inconsistent messaging
- Limited utility visibility and control over distribution system impacts
- Challenges in capturing distribution system benefits
- Limited regulatory oversight of aggregators

DER Participation: Hybrid Models

- A **hybrid approach** to DER program management **could** combine elements of the **utility-led** and the **aggregator-led** direct participation models.
 - Hybrid models **could** maximize the benefits captured across the generation, transmission, and distribution value chain.
 - **Conceptually aligned with FERC Order 2222's** market participation objectives.
 - Although programs like ConnectedSolutions incorporate some hybrid elements, a fully integrated model **remains largely theoretical** (in the U.S.).

Advantages

- Balanced utility control with competitive market participation.
- Potential for optimized value capture across multiple value streams.

Disadvantages

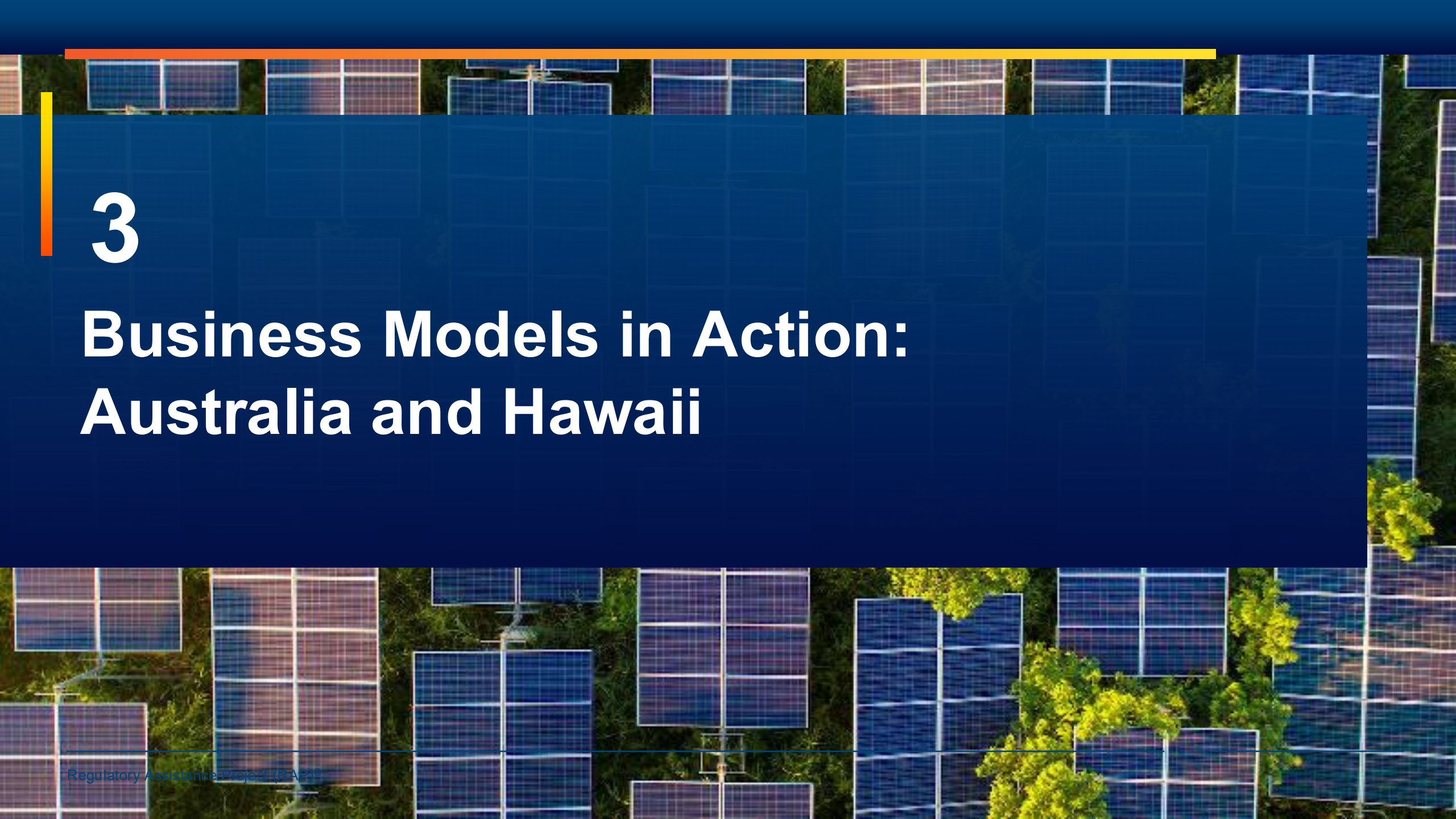
- Potential for double-counting resource commitments and conflicting dispatch signals.
- Requires careful coordination and clear rules to prevent conflicts.

Regulatory Topics

Topic	Key Questions
Grid Services and Utility Planning	▪ What grid services are needed? ▪ Which utility planning processes should analyze VPPs?
Technical Requirements: Connection and Cybersecurity	▪ What are the technical requirements for DERs to provide the various grid services? ▪ What are the technical requirements for cybersecurity? ▪ What are the terms and conditions for connection?
Cost-Benefit Analysis	▪ What costs and benefits are to be considered? ▪ What cost-effectiveness test(s) should be used?
Business Model	▪ Who is leading the development of the VPP? ▪ Is a utility-led or a market-led (system operator) model preferred?
Procurement Approach	▪ Is a volume-based goal (megawatt, megawatt hour) or a price-based offer (\$/megawatt hour, \$/kilowatt) preferred? ▪ Is a volume-based goal with a price cap or a price-based offer with a volume cap appropriate?

Regulatory Topics

Topic	Key Questions
Program Design and Compensation	- What kind of programs will be offered? For example, point-of-sale, tariff-based, upstream. - What level of compensation is appropriate?
Rate Design	What kind of electric rates can increase DER adoption? Consider, for example, time-of-use, critical peak pricing, peak-time rebate, variable peak pricing or real-time rates.
Cost Recovery	How will the program be funded and its costs recovered? (e.g. through rate cases, wholesale markets, or a system benefit charge?)
Customer and Aggregator Enrollment	- What customer classes are eligible and how are they enrolled? - What are the terms and conditions for aggregators?
Data Access and Privacy	- How is data shared between the utility and the aggregators? - What privacy protections are required?
Evaluation, Measurement and Verification	- How much funding is dedicated to evaluation, measurement and verification (EM&V)? - Is an independent EM&V contractor required?

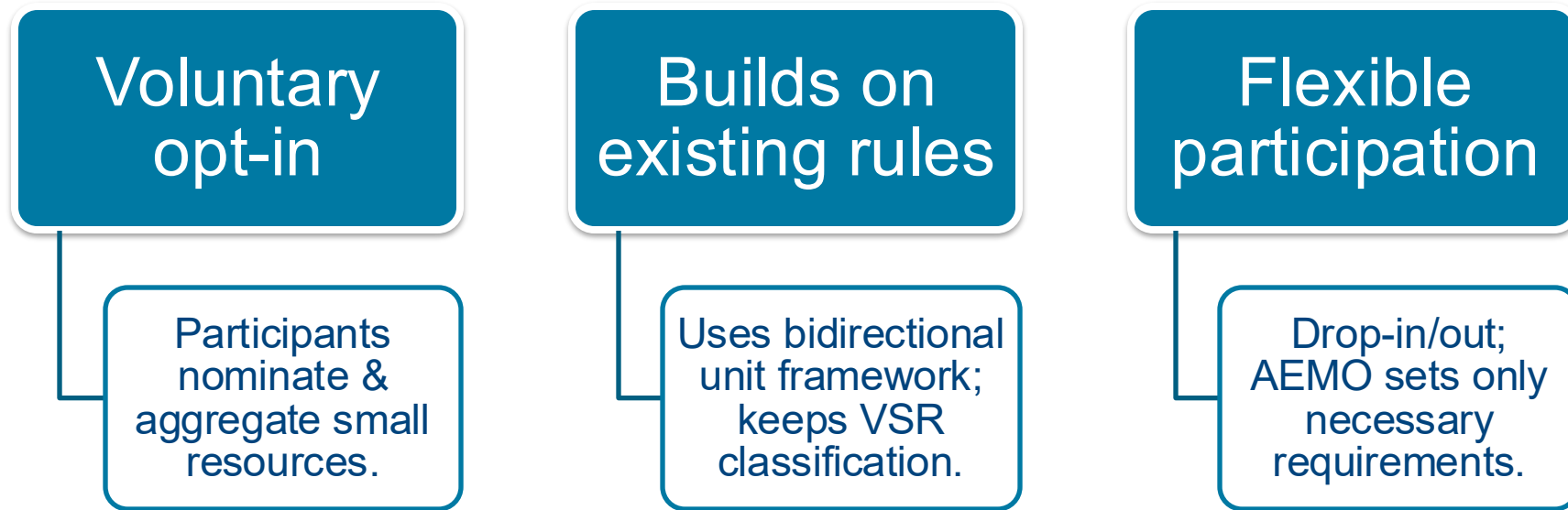
An aerial photograph of a large-scale solar farm. The image shows numerous rectangular photovoltaic panels arranged in neat, parallel rows across a landscape. The panels have a blue-tinted surface with visible grid lines. The background shows some greenery and trees, suggesting a rural or semi-rural setting. The overall perspective is from directly above, looking down on the solar array.

3

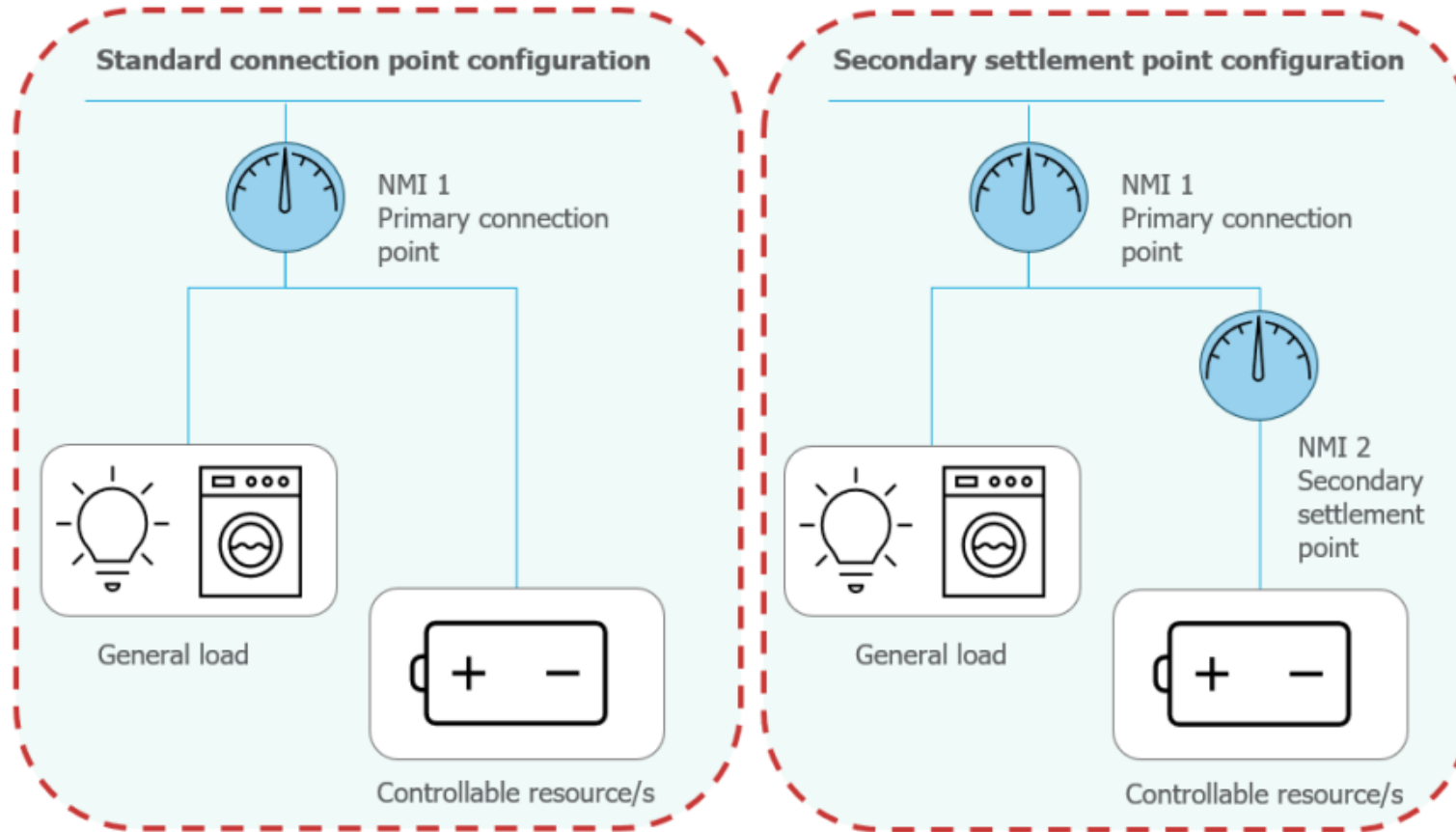
Business Models in Action: Australia and Hawaii

Market-led Model in Australia

Key Features of the Dispatch Mode Rule



Comparison of Settlement Point Configuration



Source: AEMC. (2024a). Rule Determination: National Electricity Amendment (Integrating Price-Responsive Resources into the NEM)

Regulatory Topics: Australia

Topic	Key Questions
Market scheduling and price formation	▪ How can price-responsive resources be integrated into central dispatch to improve price formation and market efficiency?
System and cybersecurity	▪ How can the Australian Energy Market Operator gain better visibility and control over distributed resources that materially impact grid reliability? ▪ What are the technical requirements for cybersecurity?
Technology and competitive neutrality	▪ How can the rules ensure a level playing field between scheduled and unscheduled participants?
Voluntary participation and participant flexibility	▪ Can a new dispatch framework be introduced that is optional and scalable for different types of market participants?
Compliance and enforcement	▪ What obligations and penalties should apply to voluntarily scheduled participants to ensure fairness and system integrity?

Regulatory Topics: Australia

Topic	Key Questions
Demand forecast accuracy	▪ How can demand forecasts be improved by accounting for previously invisible, price-responsive behavior?
Access to ancillary services markets	▪ Should aggregated DERs be eligible to provide frequency and system services?
Settlement and cost allocation impacts	▪ What procedures can ensure that aggregated DERs are settled accurately and fairly?
Consumer protections and aggregator responsibilities	▪ How should consumers participating via aggregators be protected, and what standards should aggregators follow?
Implementation complexity and transitional support	▪ How can the rule avoid being overly complex? ▪ How can the rule be implemented smoothly and affordably across the market?

Regulatory Questions: Hawaii

Question

1. What types of new DER programs should be examined and developed?
2. What advanced rate designs will be offered to customers?
3. How should existing DER programs and tariffs be addressed (maintained, phased out, grandfathered)?
4. What improvements can be made to the connection process and technical standards to better facilitate the integration of DER into the companies' systems?
5. Should legacy equipment be updated or retrofitted to current equipment settings?

Hawaii's Regulatory Topics

Grid Services & Utility Planning:

- The Commission evaluated how customer-owned DER devices could reliably provide grid services through programs like the BYOD tariff.
- The Commission addressed the integration of DERs into utility planning and operations.

Program Design & Compensation

- The Commission examined how to structure export-based DER programs that are sustainable, fair, and responsive to system value.
- This included determining appropriate compensation for exported energy and ensuring cost-effectiveness for non-participating customers.

Rate Design:

- Through the Advanced Rate Design track, the Commission explored how TOU rates, non-export options, and customer incentives could better align behavior with grid needs, while supporting equitable participation across income groups.

Technical Requirements and Connection:

- The Commission addressed technical issues such as advanced metering infrastructure, telemetry requirements, and inverter standards.

Cost Recovery:

- The Commission considered how utilities should recover costs for DER programs, including customer incentives and grid service payments, and how to allocate those costs fairly across ratepayers.

Transition Plan

- A major focus was managing the transition from legacy DER programs (e.g., NEM, CGS) to new tariffs, with policies to ensure stability in the clean energy market and avoid disruptions for installers and customers

Hawaii's Smart DER Tariff

- The **Non-Export Rider** allows customers to self-consume all the energy their systems produce without sending any excess back to the grid. This is intended to simplify connection and reduce grid integration challenges.
- The **Export Rider**, in contrast, enables customers to export energy to the grid and be compensated at time-varying export rates, designed to reflect the value of energy to the system at different times of day.

Hawaii's Smart DER Tariff – Export Rates

Island	Overnight (9pm-9am)	Daytime (9am-5pm)	Evening Peak (5pm-9pm)
Oahu	\$0.189	\$0.135	\$0.329
Hawaii Island	\$0.148	\$0.106	\$0.231
Maui	\$0.131	\$0.066	\$0.182
Lanai	\$0.259	\$0.267	\$0.408
Molokai	\$0.174	\$0.179	\$0.272

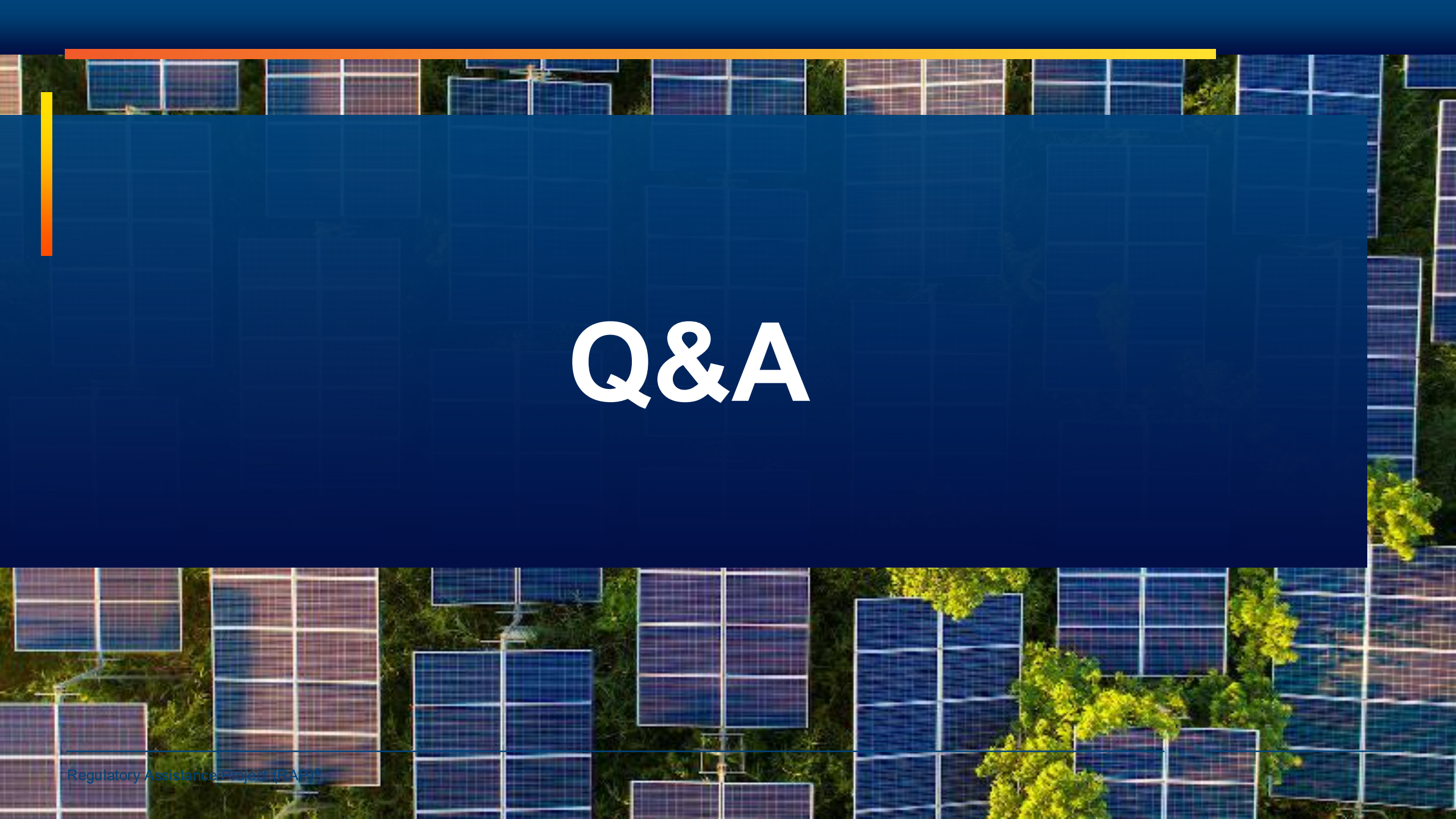
Hawaii's Bring Your Own Device Tariff

Term	Level 1: Flexible User Dispatch	Level 2: Utility Dispatch	Level 3: System Grid Services
Description	Daily scheduled capacity load reduction for two hours, typically during evening peak	Capacity load reduction for one hour in response to utility events	Capacity load reduction or load build for up to two hours in response to utility events
Upfront Incentive	\$100 per kW, up to \$500 LMI Adder: additional \$100 per kW, up to \$500 (may also be applied to monthly incentives)		
Monthly Capacity Performance Incentive	\$5/kW	\$5/kW	\$10/kW
Credit for Controlled Energy Exports	Smart DER Tariff Export Rider's evening peak export rate		

- **Level 1 Rider (Flexible User Dispatch):** Requires customers to schedule their Battery Energy Storage System (BESS) device to discharge a promised amount of power for two consecutive hours each day.
- **Level 2 Rider (Utility Dispatch):** Requires customers to respond to utility-determined events by providing a promised amount of power for one hour; and
- **Level 3 Rider (System Grid Services):** Requires customers to respond to utility-determined events by charging (load build) or discharging (load reduction) their battery from up to two consecutive hours.

Comparison of Australia & Hawaii Cases

Element of the Process	Australia (Market-led Model)	Hawaii (Utility-led Model)
Market Structure	Competitive wholesale and retail market. Unbundled, competitive wholesale market.	Vertically integrated jurisdiction.
Leading Entity / Buyer	The market (wholesale market operator, AEMO).	The utility/distribution company (Hawaiian Electric).
Central Mechanism	Aggregators offer (bid) the VPP's capabilities directly to the market. The AEMC finalized a rule for "dispatch mode" allowing aggregated resources to actively participate in the national electricity market.	The utility forecasts customer loads and distribution system grid service needs. The utility uses specific tariffs (such as the Smart DER Tariff or the BYOD Tariff) to contract and incentivize participation.
Dispatch Process	The market determines the dispatch order. Distributed assets are scheduled like large generators, submitting bids and receiving dispatch instructions.	The utility sends a dispatch signal to the aggregator, who then dispatches their VPPs accordingly. Customers respond to utility-determined events (e.g., in BYOD Levels 2 and 3).
Revenue Source (Aggregator)	The aggregator collects market revenues for the grid services provided by their VPP.	The utility pays aggregators a percentage of their avoided costs for the grid services the VPP provides.
Customer Compensation	Compensation is offered by the retailer (aggregator). This can include fixed/variable prices, discounts, sign-up bonuses, and performance-based rebates (e.g., AU\$1/kWh for exporting energy during grid events).	Payments are typically performance-based, often including both a capacity payment (kW/month) and an energy payment (kWh). Payments reflect the avoided cost of electricity delivered to the grid, not the full retail price.
Key Regulatory Focus	Integration of VPPs into the wholesale market. Focus on price formation, competitive neutrality, and participant flexibility.	Integration of VPPs into utility planning, operations, retail rate structures, and cost recovery processes. The focus is on avoided cost studies.



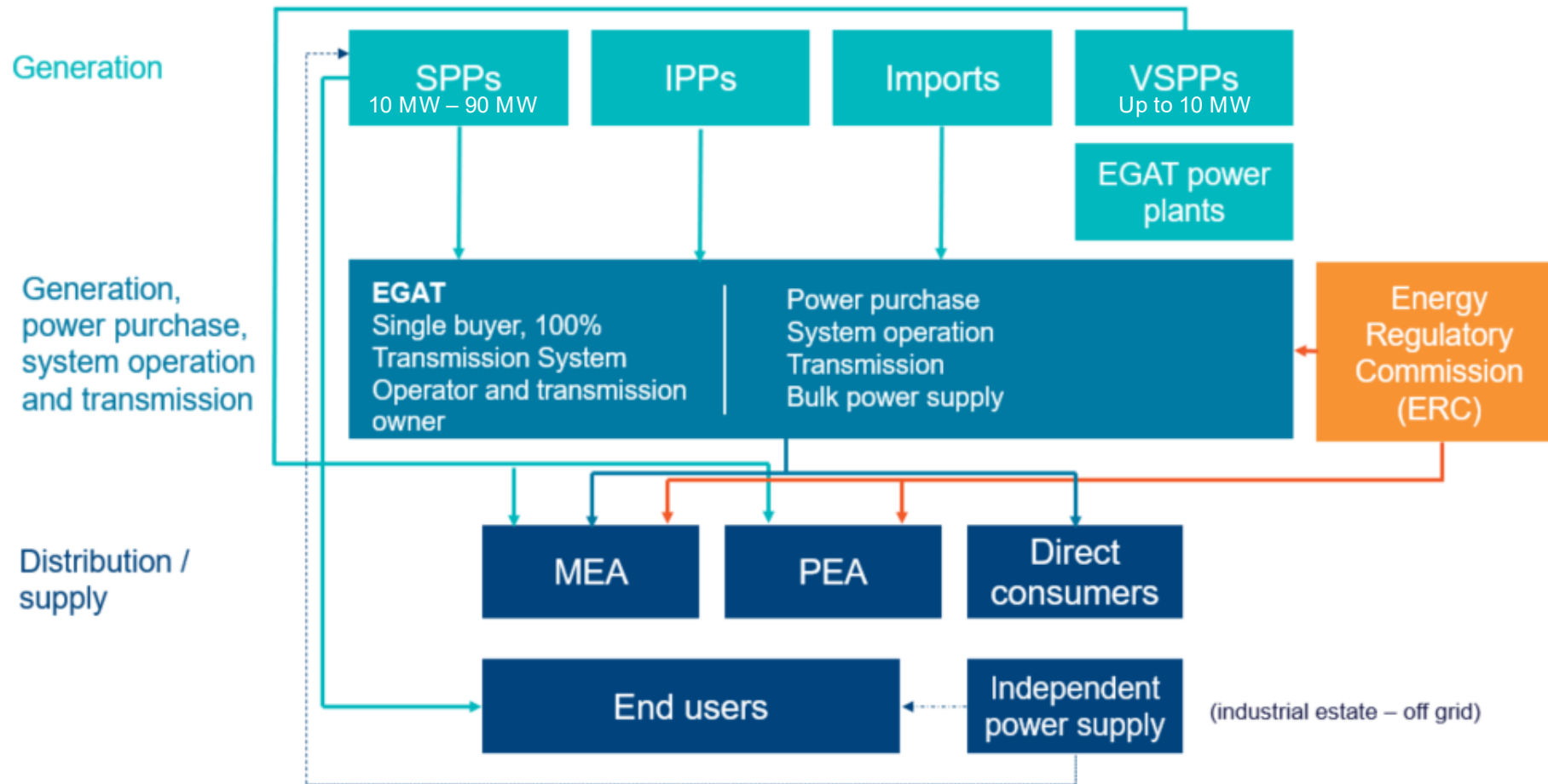
Q&A



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Application to Thailand

The Enhanced Single Buyer Model in Thailand



Source: Guyon, J. et al. (2018). Thailand's Clean Electricity Transition

Observations from Past DR Pilots

- More than 10 years of experience due to gas supply crises.
- Participants:
 - Earlier pilots industrial and residential customers
 - Firm Response Program/Capacity Bidding Program, 2022-2023: medium to large-sized businesses.
- Demonstrated feasibility, but low responsiveness relative to targets
- The design of incentives has changed since the first pilots.

Recommendations from School of Renewable Energy and Smart Grid Technology and PEA (2023)

Policy

Clear DR policy
Integrated in long-term plans

Data

Shared access
Privacy safeguards

Market

Reform ESB rules
Standard DR procedures

Incentives

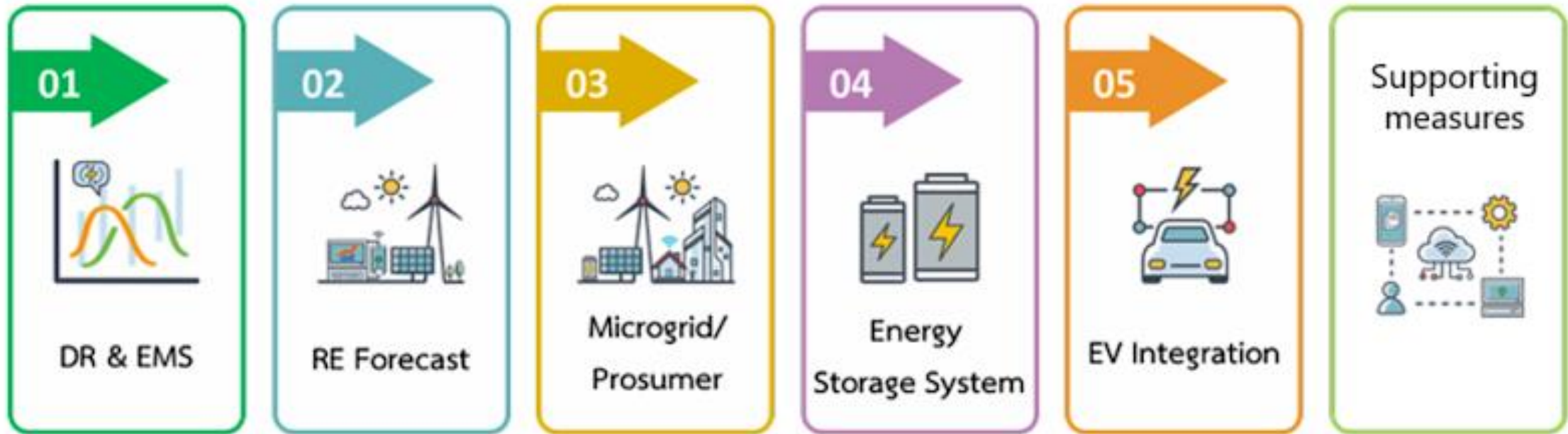
Attractive returns
Early participation

Collaboration

Fair sharing
Strong partnerships

Outcome: Thriving & Inclusive DR Ecosystem

5 Pillars of the Smart Grid Implementation Action Plan



Medium-Term Implementation Plan (2022–2031)



VPP Deployment under the Smart Grid Action Plan

First phase
2022-2023

Foundational Readiness

- **Pillar 1 (DR & EMS):** Semi-auto DR launched for large C&I customers
- **Market structure:** State utility agencies stand up **load aggregators**.
- **MEA pilot:** VPP-format Hybrid Energy Management Systems in buildings (semi/auto DR).
- **Outcome:** Aggregation + tech. integration **piloted** → groundwork for next-stage VPP deployment

Mid-term
2024-2026

Integrate Private Market Actors

- **Pilots:** Aggregator/VPP business models (Microgrid & Prosumer)
- **Rules:** Start microgrid-connection regs for aggregator/VPP models
- **DR:** Private L2 aggregators → reach smaller customers
- **Policy/regulations:** Study VPP+storage; draft VPP & P2P trading rules

Long-term
2027-2031

Full Commercialization

- **Microgrid pillar:** formal market pilots; VPPs deliver core services.
- **Deployments:** PEA projects with VPP systems + grid analytics
- **DR pillar:** Full-scale auto DR for multiple grid services
- **ESS pillar:** Scale BTM storage; begin grid service integration
- **Regulation:** Draft rules authorizing VPP & peer-to-peer trading

Recommendations for Thailand



Conduct a potential study for flexibility on the distribution grid

Key Question

- What grid services can be cost effectively provided by VPPs?



Consider the utility-led business model

Key Question

- What roles and responsibilities does each market actor hold within the business model?



Consider using competitive, distributed capacity procurement

Key Question

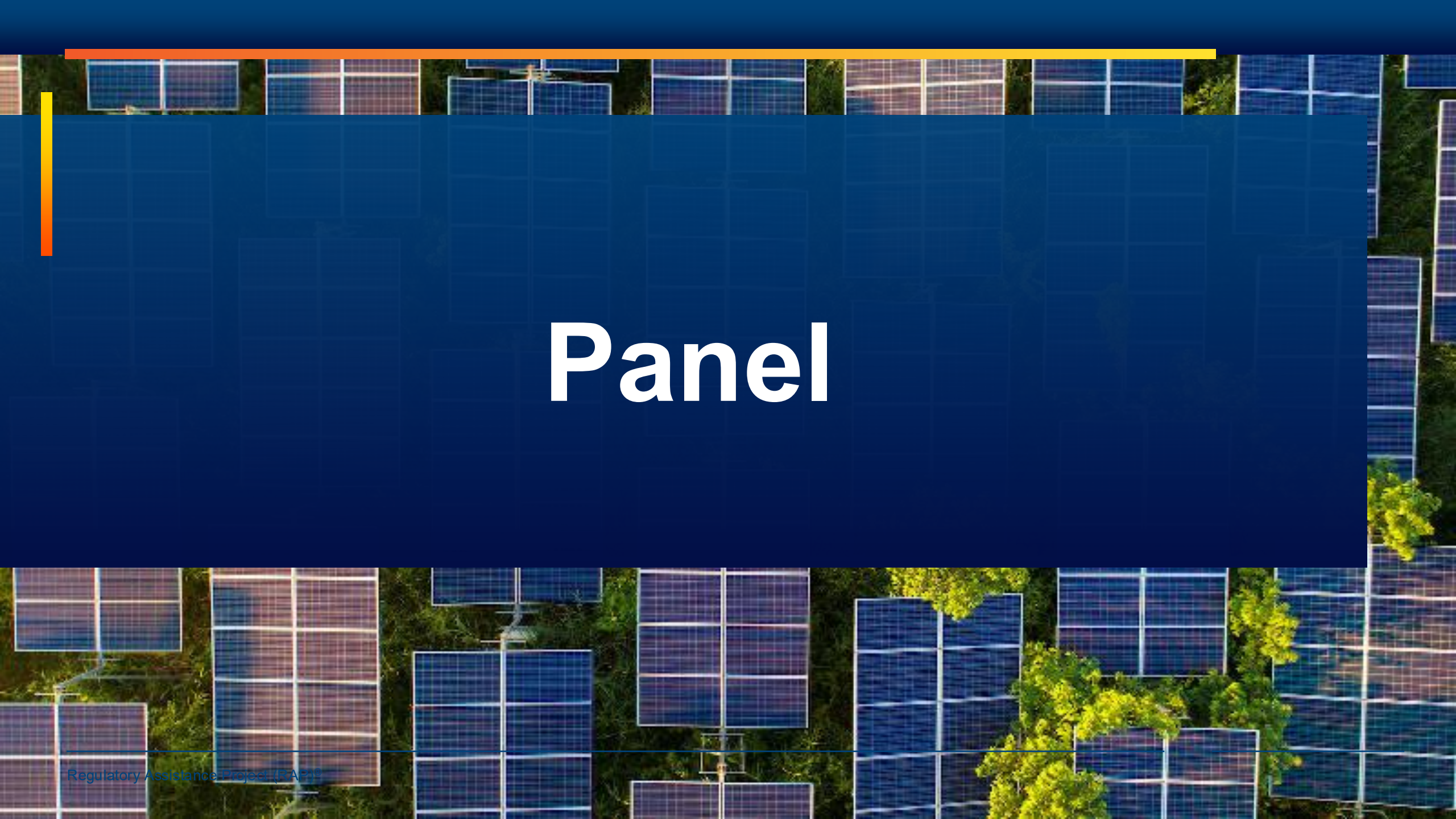
- What planning and procurement process do the stakeholders want to create?



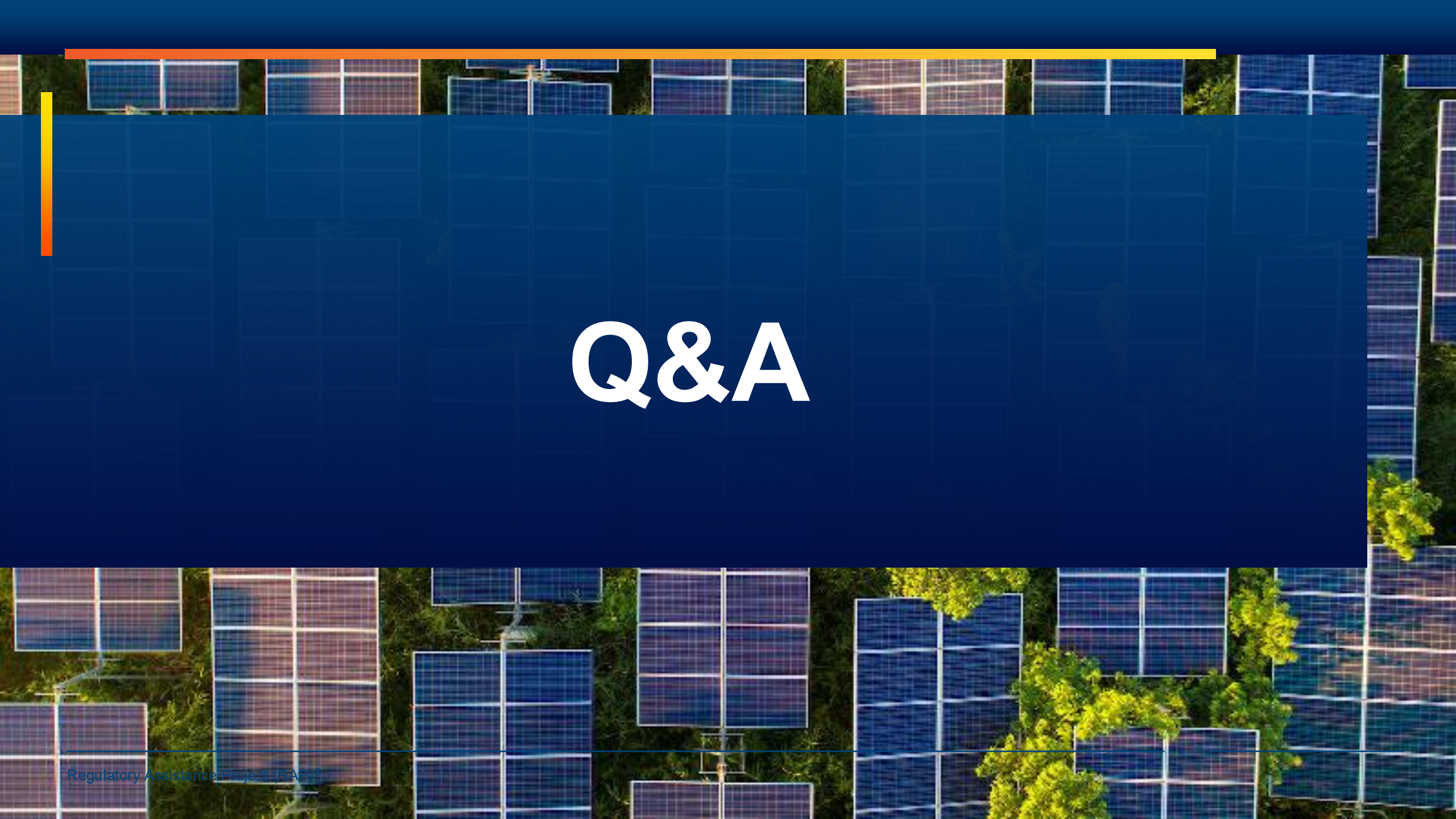
Establishing working groups

Key Question

- What method(s) of stakeholder engagement is likely to create a shared and transparent understanding of the topics?



Panel



Q&A