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Session : Virtual Power Plants (VPPs) and Power System Flexibility

Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions

Presented By

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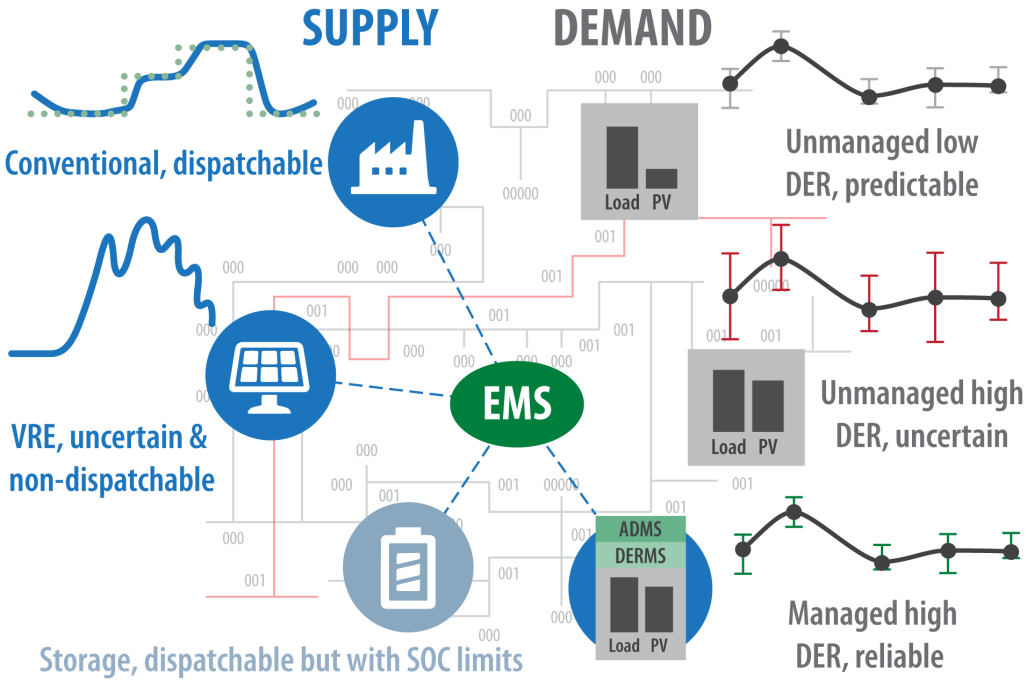
Increased uncertainty in supply and net demand

- There are **fewer conventional, dispatchable generation resources** and more variable renewable energy (VRE) and distributed energy resources (DERs).
- There is **more uncertainty from bulk-level VRE** and net demand from distribution systems with high DER levels.
- NREL's **Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions (FAST-DERMS)** project aims to develop and demonstrate a scalable solution for managing uncertainties in supply and demand at the grid edge.
- We propose that **distribution system operators (DSOs)** provide firm net load forecasts to the bulk system operator's energy management system (EMS).

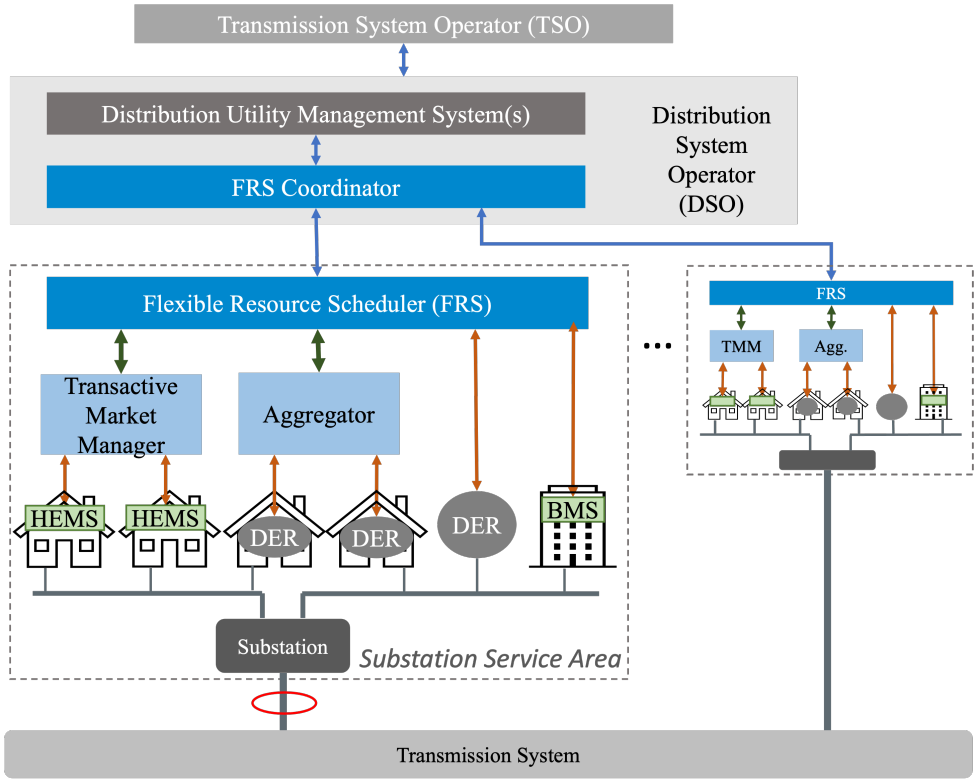


FAST-DERMS

Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions

- Develop a control architecture to manage a broad range of DERs across the grid for bulk system services through transactive, aggregation, and direct control methods.

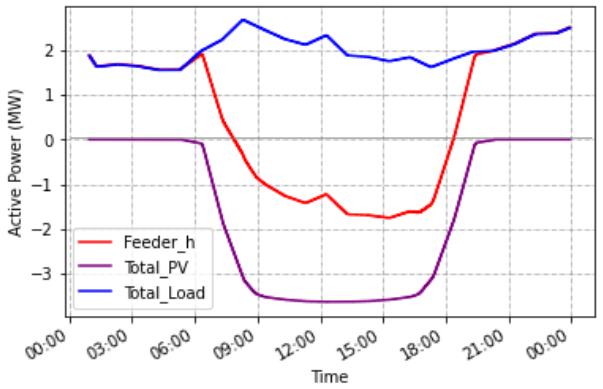
- Key architecture features:
- Total DSO approach
- Network-aware stochastic optimization
- Distributed intelligence at substations
- Manage net power flow at substations.



Implementation and Evaluation

GridAPPS-D Day-Ahead Results

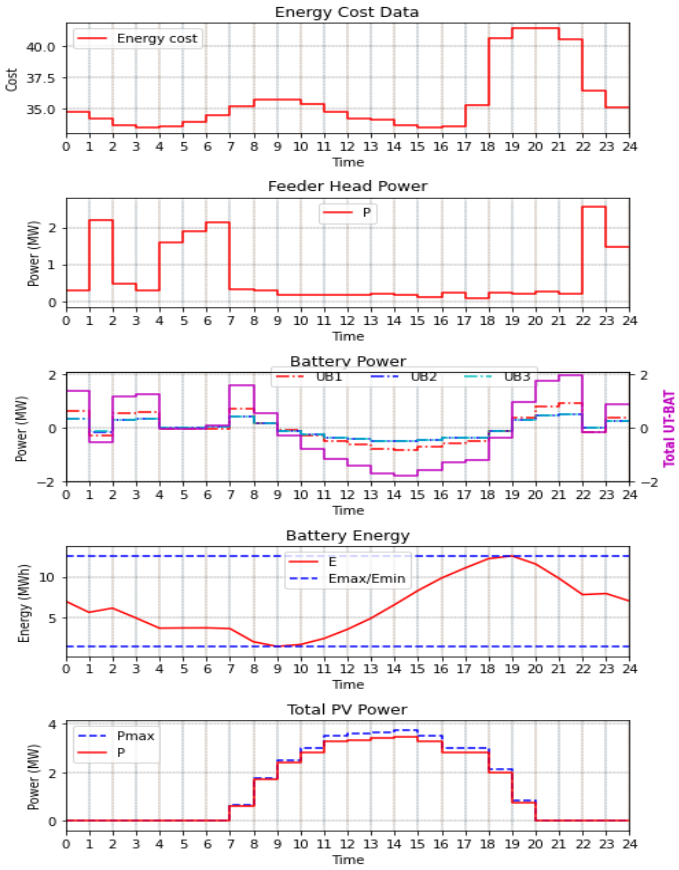
- Southern Company feeder:
light load and high PV day—baseline:



Added utility-scale battery systems to model to address reverse power flow.

Day-ahead FRS stochastic optimization:

- Objective is to minimize cost, subject to network constraints
- No reverse power flow allowed (per use case)
- Performs energy arbitrage using battery
- Limited PV curtailment.



Use Case Applications of VPPs for Energy Justice

Type of VPP Program	Examples
Wholesale VPP	Programs wherein participants can interact directly with and be compensated by wholesale market (e.g., Sunrun in ISO New England and OhmConnect in California)
Retail VPP	• "Bring your own device" models such as Massachusetts Connected Solutions • Utility-led projects such as Avangrid Flexible Interconnection Solutions and PG&E DERMS • Aggregator-utility partnerships such as Swell Energy partnership with Hawaii Electric • Sunrun's 17-MW VPP approved by the Puerto Rico Electric Power Authority (PREPA)

Source: Speetles, Brittany, Eric Lockhart, and Adam Warren. 2023. *Virtual Power Plants and Energy Justice*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A40-86607. https://www.nrel.gov/docs/fy24osti/86607.pdf.

Use Cases	Relevant Tenet of Energy Justice				Monetized
	Recognitional	Distributive	Procedural	Restorative	
Acting as Non-Wires Alternative & Supporting Resource Adequacy		✓			✓
Frequency Response		✓			✓
Market participation		✓			✓
Optimization of DER dispatch		✓			✓
Peak shaving		✓			✓
Voltage regulation		✓			✓
Increasing energy access	✓	✓		✓	
Increasing situational awareness of DER availability	✓	✓	✓		✓
Increasing system resiliency	✓	✓		✓	
Reducing electricity bills		✓	✓		✓
Supporting workforce & economic development	✓	✓	✓	✓	✓
Reducing Noise & Indoor/Outdoor Air Pollution	✓	✓		✓	
Supporting climate goals	✓	✓	✓	✓	✓
Supporting electrification	✓	✓	✓		

Discussion Points

1. Benefits of VPPs – increase grid resiliency, reduce emissions and improve air quality, reduce T&D congestion, and empower communities
2. How VPPs integrate various DERs to improve the overall efficiency and reliability of the power systems?
3. What are the types of resources typically included in a VPP and how they are managed?
4. Role of prosumers in the VPP regime
5. Standardization of technological infrastructure behind VPPs - tools and protocols for VPP planning and operations, real-time monitoring, forecasting, and dispatch of resources; and measurement and valuation necessary for VPP integration with distribution grid and bulk power systems
6. How VPPs enhance grid flexibility, including their role in load balancing, peak shaving, and integrating intermittent renewable energy resources
7. Economic benefits of VPPs and their participation in electricity markets, providing services like frequency regulation, reserve capacity, and demand response
8. Business models for VPPs and incentive mechanisms for DER owners and other participants
9. Policy and regulatory support to facilitate the growth of VPPs, including issues related to market access, pricing, and grid codes
10. Challenges facing the widespread adoption of VPPs, such as technical limitations, regulatory hurdles, and cybersecurity concerns; and how to overcome these barriers

THANK YOU

For discussions/suggestions/queries email: ***isuw@isuw.in***

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- Baggu, Murali, and Pratt, Annabelle. Federated Architecture for Secure and Transactive Distributed Energy Resource Management Solutions, NREL/PR-5D00-88781, Presented at the 2024 Conference on Innovative Smart Grid Technologies North America (ISGT NA), 19-22 February 2024, Washington, D.C.. Web. https://www.nrel.gov/docs/fy24osti/88781.pdf
- Speetles, Brittany, Eric Lockhart, and Adam Warren. 2023. *Virtual Power Plants and Energy Justice*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A40-86607.

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