Virtual Power Plants in PJM

A review of the ERCOT journey and potential applications within the PJM Footprint

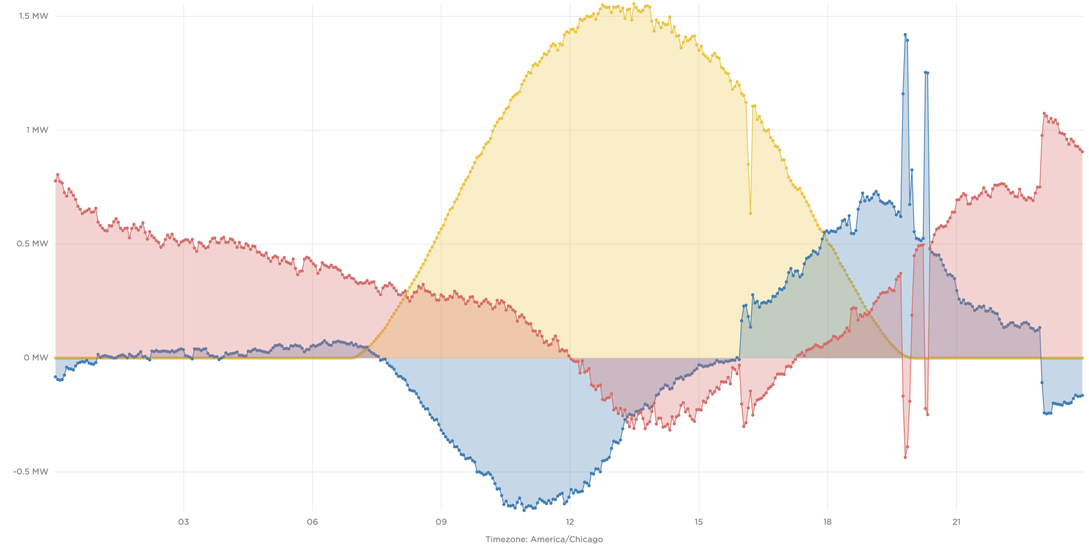
Background: ERCOT

Two Tesla-managed (and supplied) Virtual Power Plants* participate in ERCOT's energy and ancillary service markets

- Assets:
  - Approximately 400 residential battery electric storage systems (Powerwalls) are dispatched by ERCOT for energy and ancillary services
  - Participants in each asset must have the same Transmission/distribution provider and must be within the same Load Zone.
  - Geographically, these aggregations are in Dallas and Houston
  - Electrically, these premises are served by Centerpoint in the Houston Load Zone and Oncor in the North Load Zone

- Telemetry:
  - ERCOT requires that all assets communicate with the ISO by way of their Qualified Scheduling Entity (QSE)

  - All individual assets communicate with Tesla, Tesla aggregates asset availability and response data streams with their QSE



The above graphic depicts the aggregation behavior, including premise load, on site solar, battery charge / discharge in response to ISO instructions.

*VPPs in ERCOT's Pilot Program are known as Aggregated Distributed Energy Resources, Abbreviated as ADER

ADER Pilot Journey

To create, register, and qualify a new type of resource, ERCOT, TDSPs, Tesla, and others had to create new pathways.

New Coordination and Enrollment Pathways

- New Processes Established for Coordination with TDSPs, Enrollment Screening, Interconnection Review
- Updating ERCOT's registration portal (RIOO) and completing new ERCOT and PUC Documentation

Technical Challenges related to Telemetry and Dispatch

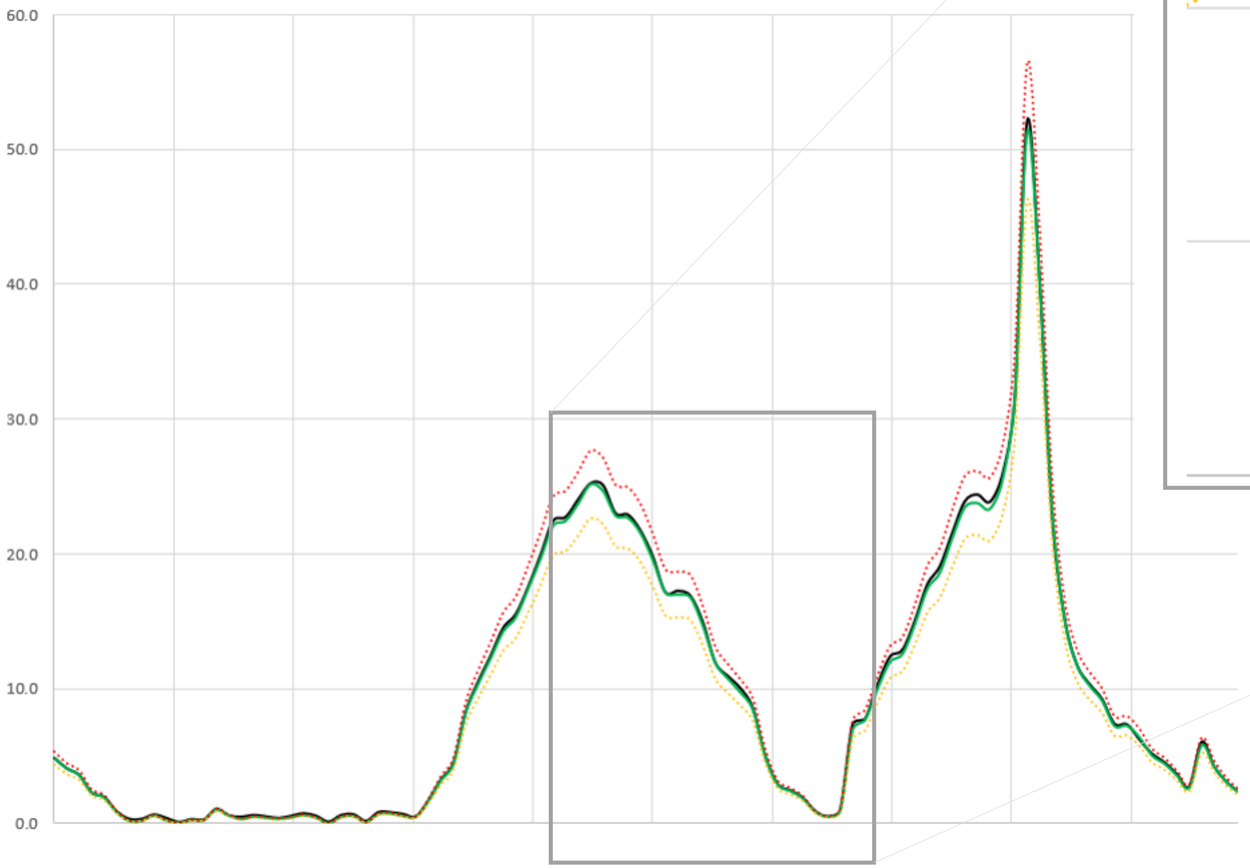
- Communicating with individual devices and creating pathways for aggregating and delivering the information
- Creating dynamic information about availability of the resource to accommodate customer's use
- Developing measurement and verification with the ERCOT ISO (Device-telemetry and real-time SOC)
- Refining dispatch control systems to perform with traditional resource accuracy (or better)
- Building toward a standard for 3rd party participation

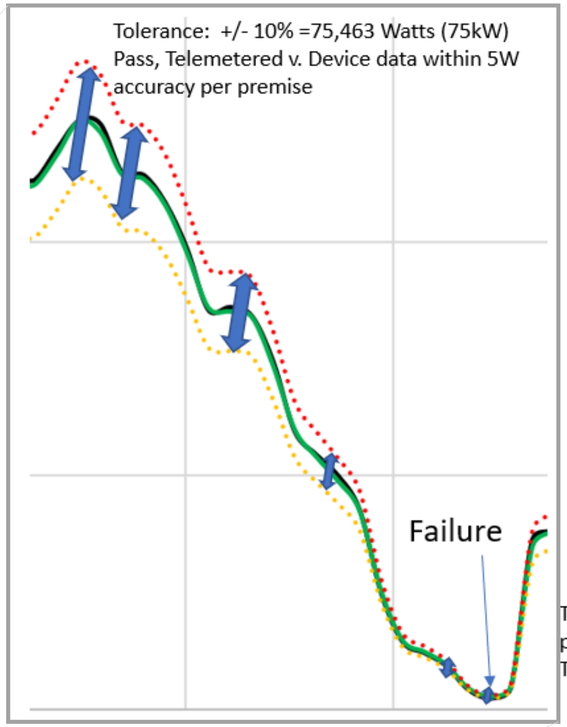
Development of customer offers and experiences

- Customer engagement, marketing and value proposition. Including enabling customer control.
- Creating and implementing customer incentives and compensation

Lessons Learned – Unexpected Challenges

Pilot has been successful at identifying technical changes that will make qualifying smoother for future aggregations





Tolerance: +/- 10% = 17 Watts per premise; 1.3 Watts out of Tolerance per premise

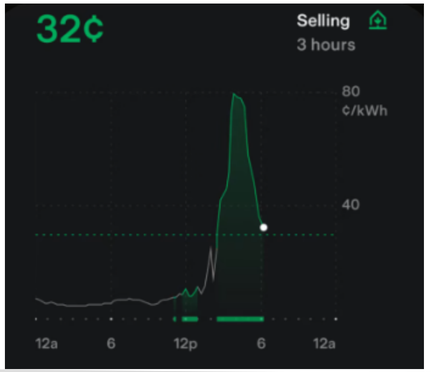
ADER is the top of the Grid Service stack for Distributed Energy Resources

There are different levels of service from a VPP. Market integrated VPPs will unlock highest grid value

3) Market Integration to Expand Services and Increase Grid Value

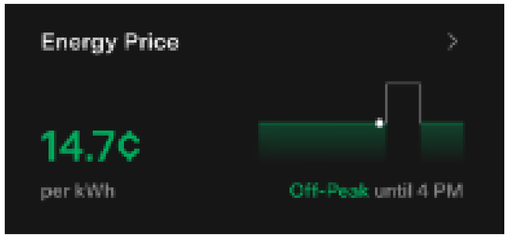
- Market Integrated VPPs (like ADERs) communicate their behavior and intentions to the market operator
- This unlocks additional services and value but more importantly makes the VPP more useful and reliable in grid operations

2) Response to Scarcity Signals from the Grid Operator



- Aggregated DERs provide additional support by exporting more during grid needs
- Motivates the DERs to provide additional capacity when most valuable
- Examples include peak energy prices or 4CP

1) Permanent Load Shift From Static information In Rates

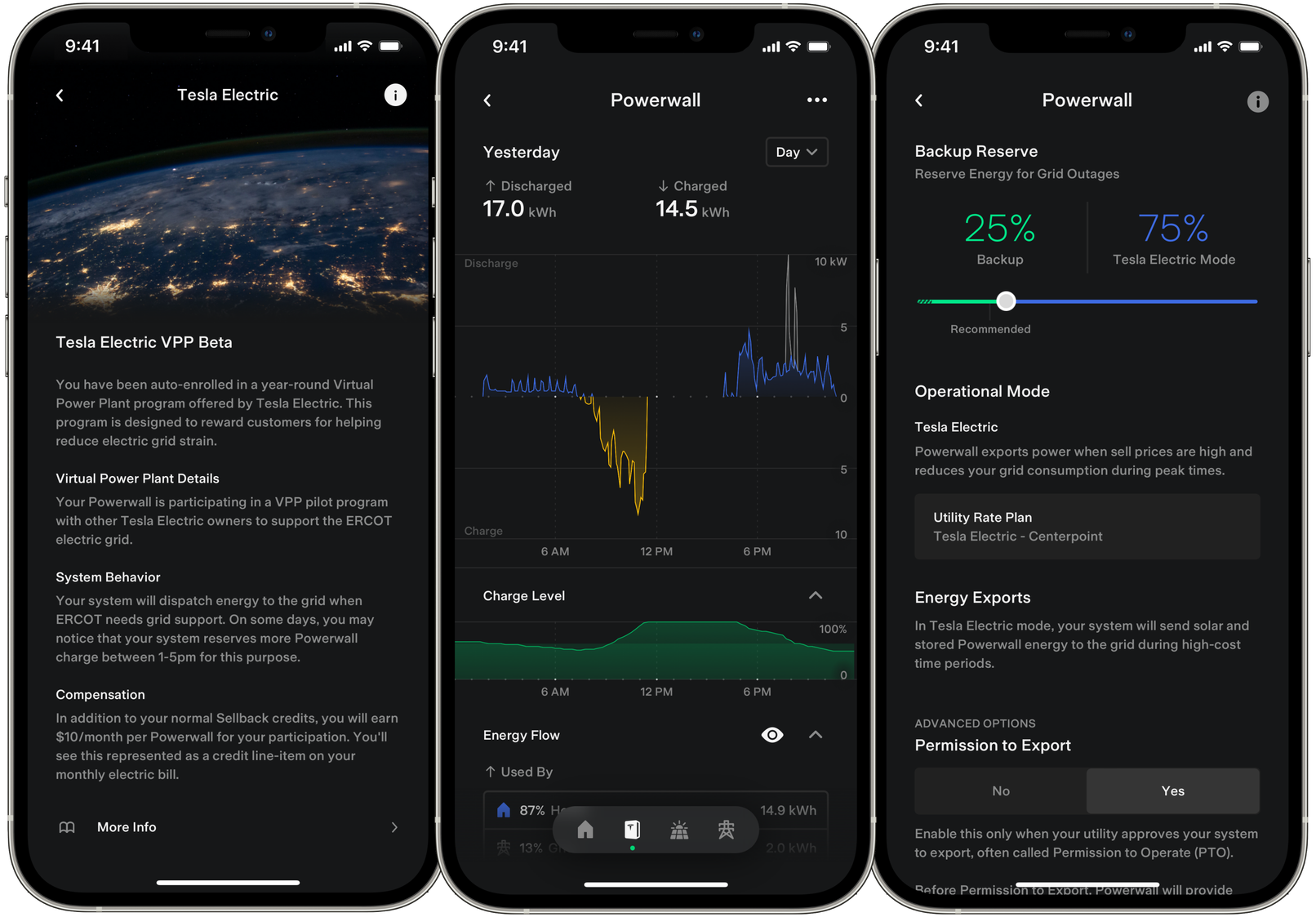


- The most basic grid support from DERs comes from responding to time varying rates
- This modifies the sites consumption profile every day to reduce impact during peak times

Customer Experience of ADER

Focus on Transparency and Control

- Event participation is visible
- Provide customers with the information they need to understand
- Customer control through configuring settings like Backup Reserve
- Offers that integrate ADER will continue to evolve and improve



Considerations for the PJM Region

Tesla filed comments to propose a glide path to enhanced VPP Participation

Under PJM's Proposal:

1. Customers on Net-energy Metering (NEM) with on-premise solar and storage are allowed to participate in aggregations / provide ancillary services

2. Duplicative metering to enable aggregated participation are prohibitively expensive and unnecessary

3. Nodal Settlement, to incentivize and support a more perfect security constrained economic dispatch is unnecessary until participation is at an extraordinary scale

4. Participation in ancillary services should not be considered as double counting

Tesla's Powerwall device has premise, solar, and device level metering with ANSI C12 accuracy