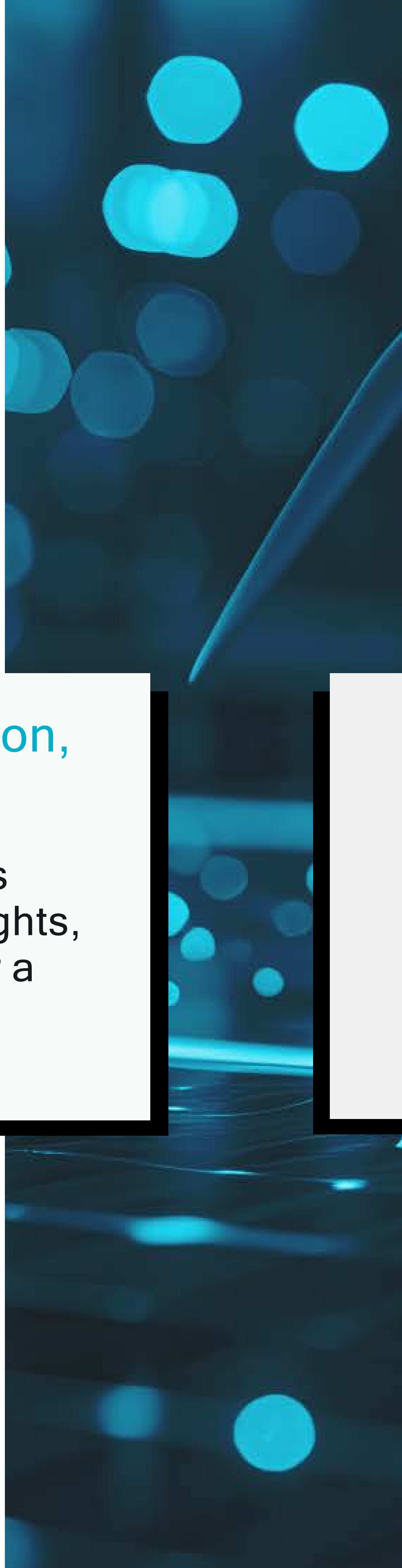

Grid Research, Innovation, and Transformation

Distributed Energy Resources Operational Data: Value, Insights, and Technology Pathways for a Reliable Grid

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Contents

Executive Summary

Historically, the proliferation of Distributed Energy Resources (DERs) in the Electric Reliability Council of Texas (ERCOT) region was insignificant. Today, there are many more kinds of DERs and many more reasons to install DERs than there were a decade ago. DERs may be installed for resiliency, to offset consumption, and to reduce reliance on other grid sources.

DER penetration in the ERCOT region continues to trend upward. There are already about 6,050 MW of DERs, including those located in the competitive choice areas and in the Non-Opt-In Entity territories on the Texas grid as of December 31, 2024.

DERs have great potential in the ERCOT region and can help ERCOT with many grid reliability services. They could improve load forecasting, provide ancillary services, provide voltage and frequency support, incentivize demand response, and help with black start and emergency services. But not receiving functional model and operational data from DERs can lead to many challenges for ERCOT.

This white paper discusses the need for modern technology solutions to more easily communicate with DERs, without modelling or managing sub-transmission networks while still receiving operational data from them into the control room for situational awareness.

1. Energy Resources/ Generation Definition

According to IEEE Std. 1574-2018, a DER is a source of electric power that is not directly connected to a Bulk Power System (BPS). Federal Energy Regulatory Commission Order No. 2222, defines DERs as small-scale power generation or storage technologies (typically from 1 kW to 10,000 kW) that can provide an alternative to or an enhancement of the traditional electric power system [1]. These can be located on an electric utility's distribution system, a subsystem of the utility's distribution system, or behind a customer meter. They may include electric storage, intermittent generation, generation, demand response, energy efficiency, thermal storage, or electric vehicles and their charging equipment.

ERCOT uses the term Generation (DG) to refer to an electrical generating facility located at a customer's point of delivery (point of common coupling) 10 megawatts (MW) or less and connected at a voltage less than or equal to 60 kilovolts (kV) which may be connected in parallel operation to the utility system [2]. DG and DERs are referring to the same resources and, for the sake of consistency with the industry standards, we will use the term DERs throughout this white paper.

DERs can include a variety of resources, such as, but not limited to:

- Solar photovoltaic systems
- Energy storage systems
- Micro turbines
- Small wind turbines
- Internal combustion engines
- Biogas systems
- Small hydro turbines

2. DER Growth in ERCOT Region

DERs have been growing at a rapid pace in the ERCOT region [3]. Looking at Figure 1, the total DERs capacity grew from 650 MW in 2015 to 6050 MW in 2024. The resource type that is driving the growth of DERs is rooftop solar. The estimated total rooftop solar capacity in 2024 is approximately 3,110 MW. The projected growth of rooftop solar ranges between 4000 MW and 7000 MW for 2030.

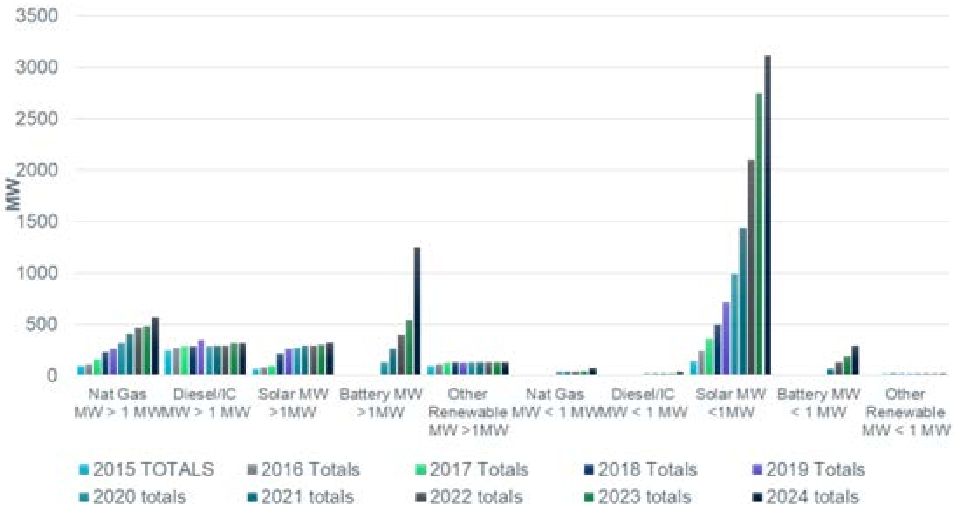

Figure 1. ERCOT Estimated Total DG Growth 2015-2024 (MW)

3. The Challenge for ERCOT

DERs are increasingly becoming more relevant to operating the transmission grid as more and more individual battery, renewable, and standby generation is being connected on the distribution grid. The impacts of DERs are clearly going to be more important than they have been historically. As the penetration of DERs increases in the system, they could be potentially used for several planning and essential reliability functions.

The growth of DERs at ERCOT has reached a stage where DERs–individually and in aggregations–are increasingly used as load-modifying resources for both distribution Non-Wires Alternatives (NWAs) and wholesale capacity and ancillary services.

At higher penetration levels, DERs have the potential to affect grid operations in multiple ways [4], including:

- Increased error in Load forecasting, which could result in excessive reliance on Regulation Service and other Ancillary Services to mitigate the potential frequency excursions caused by the output of both variable and self-dispatched DERs
- Less accurate inputs to the State Estimator and Load Adaptation; these ERCOT functions are critical for managing transmission-level line loading and maintaining single contingency ("N-1") reliability
- Load Distribution Factors, which are among the key inputs to numerous studies conducted in both the ERCOT Energy Management System (EMS) and Market Management System (MMS), and which can be affected by DERs
- Reactive power, voltage control, and dynamic response to faults
- Transmission-level congestion management
- Uncoordinated system restoration, potentially involving large voltage or frequency swings, in the event of a load shed event.

ERCOT wrote white papers in the past addressing this situation [4]. Many of the concerns associated with DERs could be alleviated if ERCOT were to acquire real-time visibility of the DERs and their operational data. Enabling real-time observability is essential for operational use of DERs for use in Ancillary Services and voltage and frequency support. Also, when the penetration grows, they could be used as tools for accounting for stability, Black Start, and system restoration plans.

ERCOT has some information on where the DERs are mapped to in the CIM model and some real-time telemetry of DERs. DERs that are greater than 1 MW have the biggest impact on the grid and, therefore, having functional model and receiving real-time information for these DERs will be more impactful and beneficial to have. ERCOT has some tracking of DERs via annual reports and some telemetry for DERs and Distributed Energy Storage Resources as well as some mapping [3]. The information is not complete and is lacking.

The lack of operational data is also inhibiting ERCOT from coming up with solutions that could effectively leverage DER and demand response information to potentially alleviate Interconnection Reliability Operating Limit situations.

As behind-the-meter DERs continue to proliferate, they introduce challenges to grid reliability and operational transparency. One key issue arises from netting generation and load, particularly on feeders with high DER penetration. This phenomenon, often referred to as load masking, occurs when grid operators can no longer accurately assess the system's real-time load because they cannot "see" the generation downstream of switching devices. This makes the system susceptible to incorrect assessments of feeder load, potentially leading to voltage imbalances, thermal overloads, and failures when switching or reconfiguring circuits during emergency situations. If grid operators can gain real-time visibility into downstream activities, it will help mitigate load masking issues. This, in turn, will improve decision-making and reduce risks when managing feeder loads or reconfiguring circuits under abnormal grid conditions.

4. Value of Receiving Operational Data from DERs

Based on the latest distribution system evolution reports from the U.S. Department of Energy, DER is increasingly becoming more relevant to operating the transmission grid [5]. Figure 2 below illustrates the range of operational benefits that DERs can provide across different timeframes.

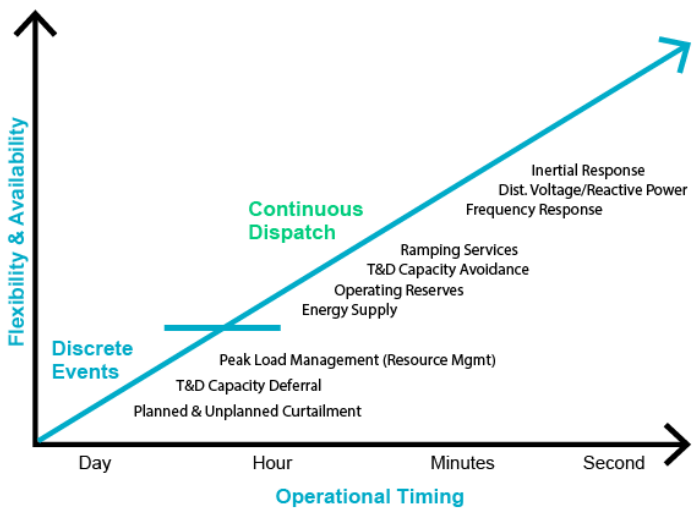

Figure 2. Potential Flexible DER Applications

Some key areas where ERCOT can benefit from the visibility provided by operational data from DERs include:

- **Peak shaving during energy shortages and other emergencies:** Peak shaving plays a critical role in grid management by reducing peak electricity demand during emergencies or energy shortages. This is essential for preventing blackouts, managing energy shortages, and saving utilities from using expensive peaking plants. By utilizing DERs like battery storage, local generation, and demand response programs, utilities can reduce the demand on the grid, minimizing the need to activate expensive peaker plants or buy high-cost energy.
- **Provide ancillary services (frequency regulation, voltage support)**: Ancillary Services help maintain grid stability and ensure reliable

operation. DERs provide essential grid services like frequency regulation (keeping the grid frequency stable), voltage support (maintaining voltage levels), and spinning reserve (quickly available backup generation). These services ensure overall grid reliability during peak times or unexpected disruptions.

- **Resiliency during extreme weather conditions**: DERs significantly boost grid resilience, especially during natural disasters or extreme weather events (e.g., hurricanes, wildfires, ice storms). Localized generation, like solar panels or wind turbines, combined with energy storage systems, ensures that communities or critical infrastructure can maintain power during extreme weather events. DERs enhance system resilience against weather-related disruptions, offering localized generation and backup power.
- **Lower transmission and distribution cost**: Optimizing the use of DERs can reduce the need for large-scale grid infrastructure investments and operational costs. The use of DERs potentially reduces the need for extensive transmission and distribution infrastructure investments because energy is generated closer to where it's consumed, cutting down on both energy losses and the cost of transmitting power over long distances. Moreover, avoiding peak demand pricing through energy storage and peak shaving can reduce operational costs for utilities, which can pass on savings to consumers.
- **Demand Response**: DERs can significantly enhance demand response programs by providing localized, flexible energy resources that support grid stability. During demand response events, when the grid is stressed or demand is high, these local DER units can generate power for local use, reducing the overall demand on the central grid. During a demand response event, instead of solely relying on consumers to reduce or shift their electricity usage, DG can supply power locally, mitigating the need for consumers to curtail their load. This alleviates the need for significant load reductions, ensuring that essential operations can continue running while still contributing to overall grid stability.
- **Virtual Power Plants (VPP) or Aggregated DERs (ADERs)**: A VPP or ADER aggregates many DERs (e.g., solar panels, batteries, EVs, and demand response resources) and coordinates their operation as if they were a single power plant. VPPs provide:

    - **Grid services** – Aggregated DERs can collectively provide grid services like frequency regulation, voltage support, and demand response.
    - **Market participation** – Small-scale distribution generators and energy storage systems can be pooled together in VPPs to participate in energy markets, allowing them to sell power or provide ancillary services.
    - **Flexible, scalable energy resources** – VPPs can help the grid respond more flexibly to demand fluctuations, renewable energy variability, or unexpected grid disturbances.
- **Management of net load ramping**: DERs help balance the grid by addressing the intermittency of renewable energy sources. As renewable generation fluctuates due to changes in weather or sunsets, grid operators must balance these rapid changes in power supply. This can be managed using battery storage systems, which can quickly discharge stored energy to fill gaps during solar ramp-downs, or by activating demand response programs that reduce load when solar generation decreases.

5. Technology to Receive Operational Data from DERs

DERs can improve reliability, efficiency, and overall performance of the ERCOT system, and having the technology to receive operational data from DERs will help ERCOT to run the grid reliably and efficiently. ERCOT currently has means to receive real-time telemetry from market participants using Inter-Control Center Communication Protocol (ICCP) through the ERCOT Wide Area Network (WAN). DERs typically communicate with Distributed Energy Resource Management Systems (DERMS) using protocols such as OpenADR, IEEE 2030.5, or custom APIs based on REST or gRPC. Some can communicate using traditional Supervisory Control and Data Acquisition protocols such as DNP3 or Modbus. ERCOT believes that the communications between DER aggregator systems can leverage newer architecture patterns to receive DER information.

ERCOT released a Request for Proposals in February 2025 for a new technology platform called the ERCOT Distribution Awareness Platform (EDAP) that will become an enabler to receive operational data from DERs [6]. At a conceptual level, as shown in Figure 3, ERCOT expects to interface with the Transmission and Distribution Service Providers (TDSP) Energy Management System (EMS), Advanced Distribution Management System (ADMS), DERMS, and Aggregator DERMS or Demand Response Management System (DRMS) or similar platforms in order to receive DER and demand response information.

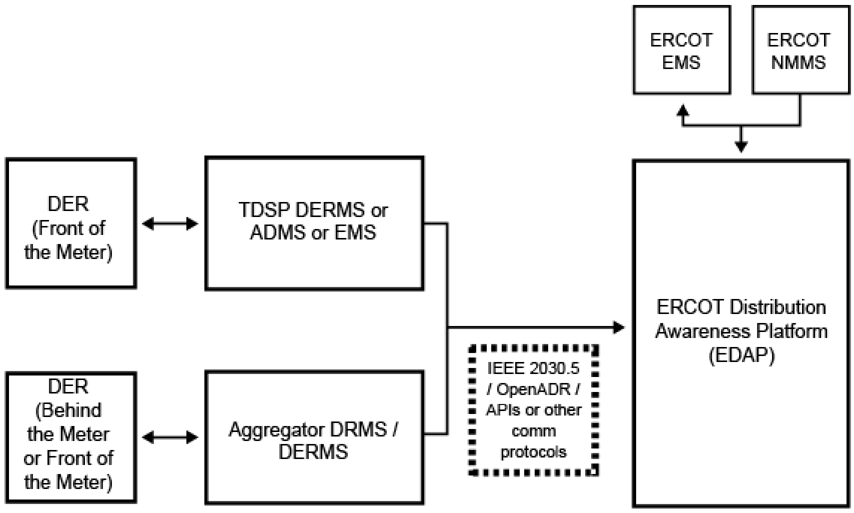

Figure 3. ERCOT EDAP Architecture

6. Conclusion

Due to the growing quantity of DERs within the ERCOT region, ERCOT believes that there is value in receiving functional model and operational data from DERs. Receiving this information will help ERCOT to overcome the challenges around keeping the grid reliable as DERs start providing several reliability services. ERCOT is investigating a range of technical approaches to bring the operational data from DERs into ERCOT systems.

7. References

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