ERCOT DER Representation in Transmission System Models

Version 2.0

Document Revisions

Date	Version	Description	Author(s)
6/16/2023	1.0	First draft	Eric Meier
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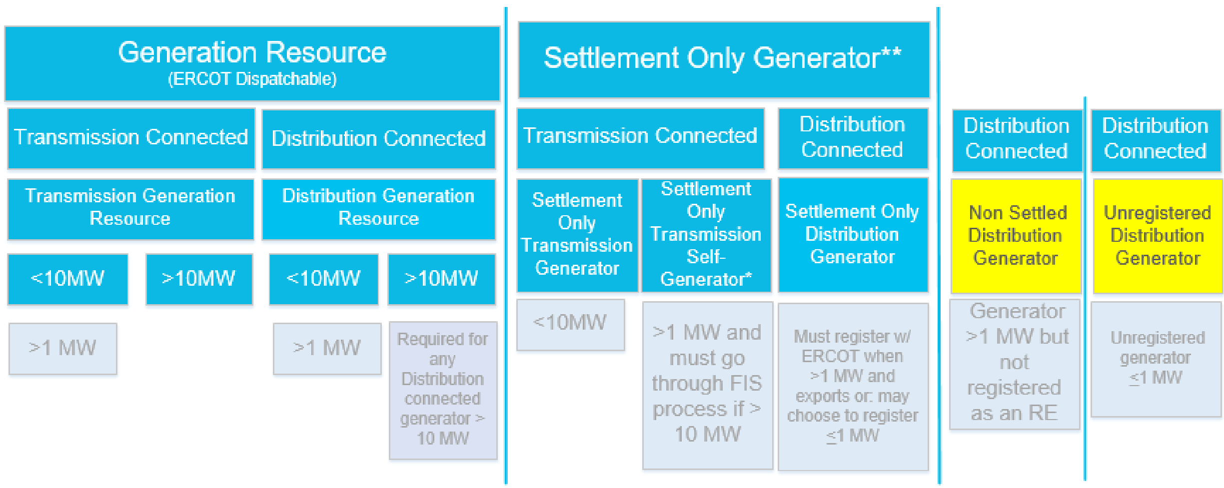
1. Resource Definition Classification

Over the past few years, ERCOT has refined its resource definition framework to better classify resource types. Within this framework, Distributed Energy Resources (DERs) are comprised of generation resources that are classified into Distributed Generation Resources (DGRs), Settlement Only Distributed Generators (SODGs), and Unregistered Distribution Generators (UDGs) classes as shown in Figure 1.



*Transmission Self Generator may occasionally export, but does not generate with the *intent* to sell at wholesale
**Settlement Only Generators can't participate in Ancillary Services Market, RUC, SCED, or make Energy Offers.
*** Non-settled Distribution Generator mapped for reliability purposes only.

Figure 1. ERCOT Generator Resource Definition Framework

While Energy Storage Resources (ESRs) are classified similarly to DERs, ESRs are classified slightly different from generation resources due to their unique characteristics. This framework can be seen in Figure 2.

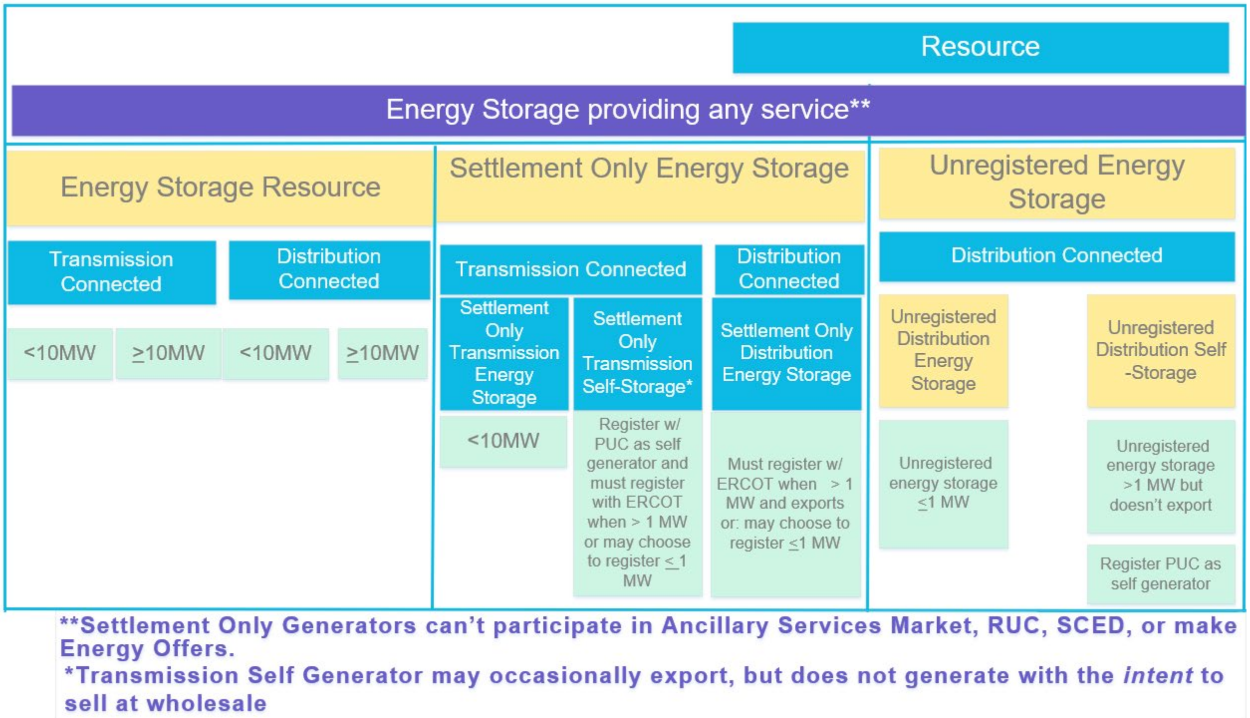


Figure 2. Energy Storage Resource Definition Framework

DGRs/DESRs are fully modeled in ERCOT's operations and planning systems. To be properly modeled, these resources must submit full modeling details in the ERCOT Resource Integration and Ongoing Operations (RIOO) system to be modeled across the operations and planning domains. DGRs/DESRs can fully participate in the energy and ancillary services sections of the ERCOT market.

SODGs and Settlement Only Distribution Energy Storage Systems (SODESSs) may be settled at the load zone level or individual node and only provide energy (although they are not issued explicit base points by ERCOT). These resources are modeled in ERCOT's operations and planning systems but at a lower level of fidelity when compared to DGRs/DESRs. These resources are not qualified to provide ancillary services.

UDGs are comprised of behind the meter generators that are not visible to ERCOT, such as residential rooftop solar units. These units are embedded in the load forecasts in ERCOT's operations and planning systems.

The following table in Figure 3 provides a summary of the different types of DERs on the ERCOT system and their differences.

Type	Required to Register with ERCOT?	Size	SCED Dispatchable	Settlement Level
Distribution Generation Resource (DGR)	Yes	1 MW or more	Yes	Nodal
Settlement Only Distribution Generation (SODG)	Yes, if 1 MW or greater	Any size	No	Zonal
Unregistered Distributed Generator	No	1 MW or less	No	None
Unregistered Distributed Self-Generation	No	>1 MW, no export	No	None

Figure 3. Summary of DER Differences

2. Inclusion in Operations Models

2.1. CIM Modeling of DGR/DESRs

ERCOT models DGRs/DESRs at the transmission level bus where the load is connected to. Initially DGRs/DESRs were modeled in a DGRs/DESRs station that connected to the transmission level bus by an equivalent impedance line as shown in Figure 4. However, this posed several challenges for operations within the Energy Management System (EMS) and Market Management System (MMS). Additional modeling was needed to create alternative flow paths to the transmission grid when there were outages and switching between distribution circuits that lead the rollover of generation between these circuits. The DGRs/DESRs could not participate in the ERCOT market unless there was a path to the transmission system.

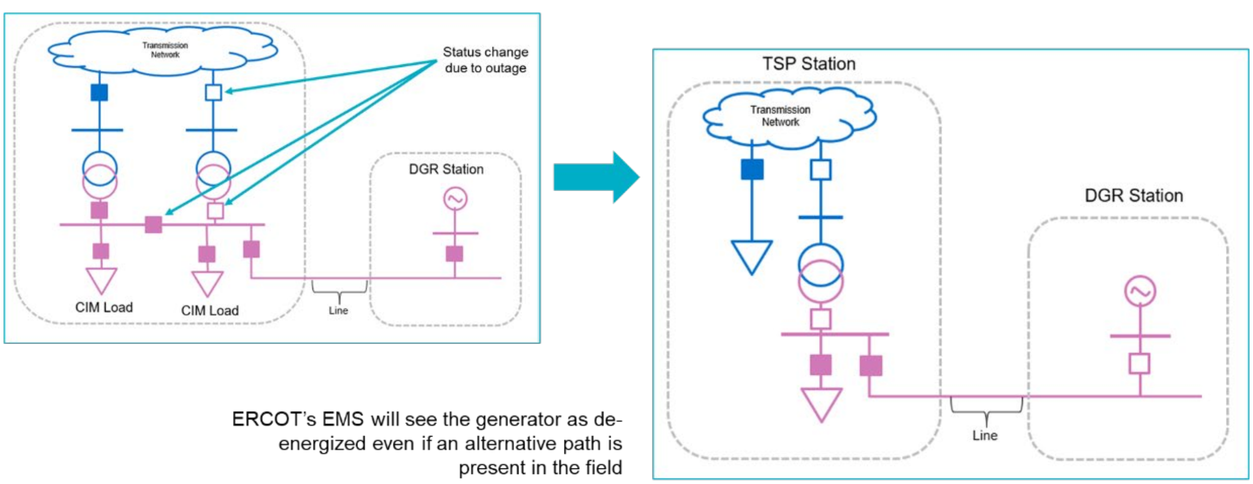


Figure 4. Old Style Modeling of DGR/DESRs

Therefore, ERCOT transitioned the DGRs/DESRs to be modeled directly on the transmission level bus in the operations system as shown in Figure 5. This configuration allows ERCOT's EMS and MMS to see the generator as online even in the event of distribution switching caused by outages or maintenance.

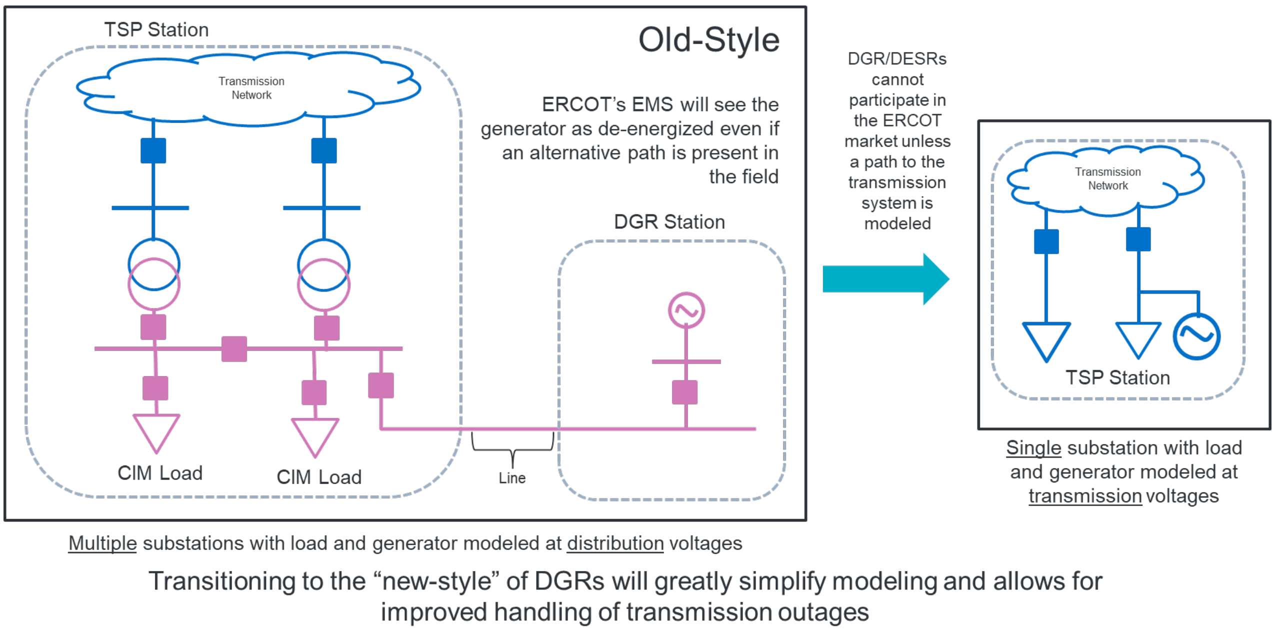


Figure 5. Current Modeling of DGR/DESRs

This new modelling setup allows the alternate path details to be abstracted for EMS/MMS implementation. Without this abstraction, if the transmission equipment connecting a DGR/DESR is opened then the DGR/DESR has no path to the grid as shown in Figure 6 in the MMS even though it has a connection through the distribution system. This would not be visible to ERCOT as the distribution system is not modeled in ERCOT systems. Therefore, the abstraction allows the DGR/DESR to continue participation in the Real-Time Market in the event of a connection to an alternate path.

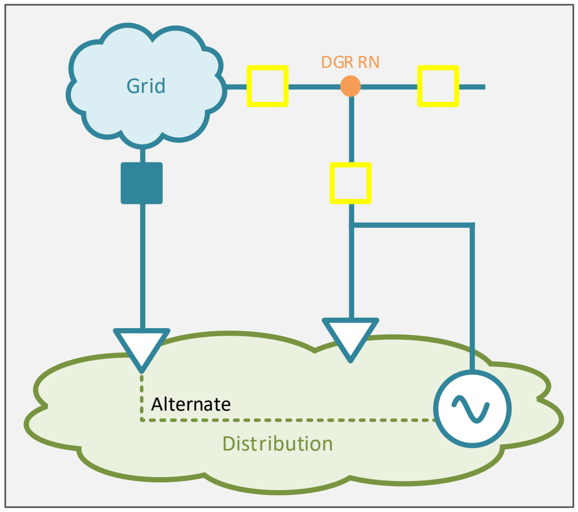


Figure 6. DGR/DESR Alternate Connection Path

In the Network Model Management System (NMMS), DGRs/DESRs are modeled within the Common Information Model (CIM) as a "DistributionResource" object that is linked to a "GeneratingUnit" and "ConsumerLoad." Figure 5 provides a graphical representation of this modeling framework. These units are modeled as full generating units due to their full market participation.

Figure 7. Distribution Resource in NMMS

2.2. CIM Modeling of SODG

In NMMS using CIM, SODGs are modeled as a "DistributionGeneration" object under a "EnergyProducerResourceMeter" under a "CustomerLoad," which is shown in Figure 8. The "EnergyConsumerAltConnections" provides a link to a secondary load point that allows ERCOT to enable the resource to alternate between distribution circuits for outage coordination purposes. The "EnergyProducerResourceMeters" provides identification of the relevant settlement meter for market systems.

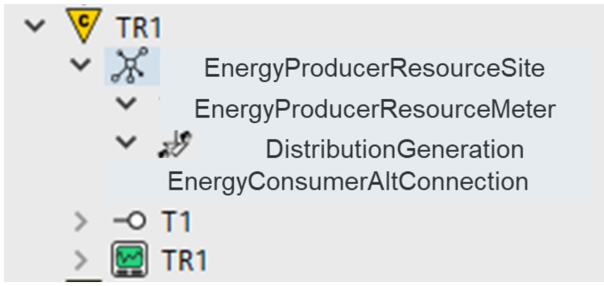


Figure 8. SODG in NMMS

2.3. CIM Modeling of UDG

UDG resources, such as roof-top solar, are not explicitly modeled in NMMS. In real-time operations, the contributions from UDGs appear as a reduction in the load.

3. Inclusion in Transmission Planning Models

As NMMS serves as the basis for ERCOT's steady-state transmission planning models, the modeling of DERs in NMMS has an impact on steady-state models. The steady-state model serves as the basis for dynamic, short circuit, and other transmission planning models. By populating DER information in the steady-state models, ERCOT ensures the base topology flows into downstream models. For the dynamic and short-circuit models, DERs require more data than is in the steady-state model.

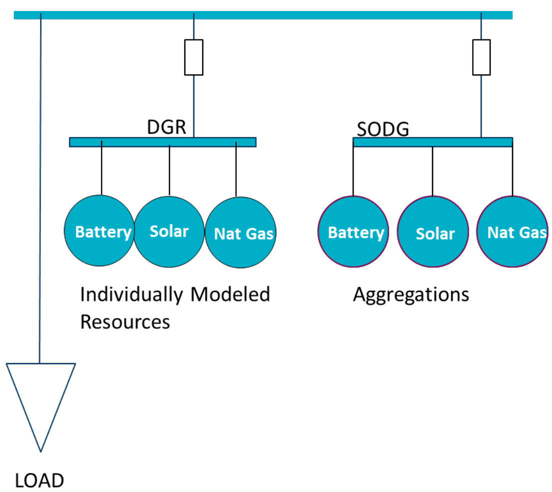


Figure 9.Visualization of DER Models in Planning Models

3.1. Steady-State Models

During the case building process, various DERs are dispatched. DGRs are dispatched according to the same methodology as conventional transmission level generation resources. For SODG, only solar and wind units are dispatched.

3.1.1. DGR/DESR Modeling in Steady State Planning Models

In the steady-state models, ERCOT models DGRs/DESRs as discrete, individual generators. DGRs/DESRs are modeled in NMMS as full generators and come into the steady-state base cases through ERCOT's Topology Processor which converts a node-breaker CIM model into a PSSE node-breaker RAW file. As these units are modeled in the same way as transmission generation resources, they have full machine data in the planning models. While DGRs/DESRs can provide reactive support, they are not required, and only some units provide values for reactive capability.

3.1.2. SODG Modeling in Steady-State Planning Models

SODGs are modeled in NMMS and brought into the steady-state models via a custom script that queries the NMMS database and creates a change file for PSSE and MOD, respectively. The SODG units are aggregated by fuel type at their transmission bus within the 700,000 bus range (700,000 + transmission bus number) and are connected to the transmission bus by a zero-impedance branch. They are assumed to operate at unity power factor.

Each SODG is given a unique PSSE ID to help with their identification in the model.

Types of Generation Unit	Unit ID Prefix	Unit ID	Comment	Explanation
Settlement Only Distributed Generation	J	JB	Battery	SODG unit IDs by resource type
		JS	Solar	
		JN	Natural Gas	
		JD	Diesel	
		JW	Wind	
		JG	Landfill Gas	
		JH	Hydro	
		JI	Other Inverter-Based Resource	
		JO	Other Synchronous Generation	

Figure 10. SODG Generation Unit PSSE ID Prefixes

3.1.3. UDG Modeling in Steady State Planning Models

UDG is currently embedded into the load forecasts by the Transmission Service Providers (TSPs). The values used are provided by their distribution engineers and incorporated into the load forecast. Some entities also use the load DGEN fields to indicate net capability for additional visibility in PSSE and ERCOT is careful to not turn the DGEN fields on and double count the load.

The Steady State Working Group (SSWG) Procedure Manual provides the following guidance for the inclusion of DER into the steady-state planning cases.

DER Type	Should be Embedded in Load Forecasts?	Modeled as Generation by ERCOT?
DGR	No	Yes
DESR	No	Yes

SODG	No	Yes
UDG	Yes	No

The specific guidelines for modeling UDGs involve representing the aggregated total nameplate value for UDGs behind each load point in each load distributed generation field, with the 'Distributed Generation Operator Mode' field disabled. This is to ensure that only the aggregated total nameplate capability for the UDG is reflected in the models. If the 'Distributed Generation Operator Mode' field is enabled, there is a risk of disproportionate representation of the UDG contribution due to the load models currently aggregating UDG contributions.

3.2. Short Circuit Models

In the short circuit models, the base DER information is taken from the steady-state model. DGRs/DESRs are modeled as full generators with impedances provided by the Interconnecting Entity (IE).

SODGs are modeled as generators with the same implementation utilized in the steady-state case, but kept offline. However, due to the lack of impedance information regarding SODGs, they are given an infinite impedance so that they will not contribute fault current if they are turned on.

As loads are not included in the short circuit models, UDGs are not considered in the short circuit model.

3.3 Dynamic Models

3.3.1 DGR/DESR Modeling in Dynamic Planning Models

Resource Entity (RE) provided models will be used to represent inverter-based DGRs and DESRs. If the RE is not required to provide a model and/or an adequate model is not available to the Dynamics Working Group (DWG), the DER_A model will be used. Parameterization will be based on the DWG approved parameters in the ERCOT DWG DG Parameterization Guideline for the DER_A model and will represent capabilities consistent with the DGR/DESR requirements in the ERCOT Nodal Operating Guide.

RE provided models will be used to represent synchronous DGRs. If the RE is not required to provide a model and/or an adequate model is not available to DWG, a generic model with DWG approved parameters in the ERCOT DWG DG Parameterization Guideline will be used with capabilities consistent with the DGR requirements in the ERCOT Nodal Operating Guide.

3.3.2 SODG Modeling in Dynamics Planning Models

RE provided models will be used to represent inverter-based SODGs with nameplate capacity of 5 MW or greater. If the RE is not required to provide a model and/or an adequate model is not available to DWG, the DER_A model with DWG approved parameters in the ERCOT DWG DG Parameterization Guideline will be used.

RE provided models will be used to represent synchronous SODGs with a nameplate capacity of 5 MW or greater. If the RE is not required to provide a model and/or an adequate model is not available to DWG, a generic model with DWG approved parameters in the ERCOT DWG DG Parameterization Guideline will be used.

SODGs less than 5 MW will be represented as negative load (with GNET) in DWG base cases.

3.3.3 UDG Modeling in Dynamics Planning Models

UDG dynamics will not be explicitly represented in DWG base cases. DWG will not modify UDG representation in the SSWG case, and UDG will be embedded or reflected in the load according to current TSP conventions.

4. Aggregated Distributed Energy Resources (ADER)

In 2022, the Public Utility Commission of Texas (Commission) started developing a pilot project to answer "questions related to how ADERs can support reliability, enhance the wholesale market, incentivize investment, potentially reduce transmission and distribution investments, and support better load management during emergencies." ADERs are DERs that are geographically dispersed but participate in the ERCOT market as a single aggregated unit.

The ADERs are currently modeled as a Load Resource (Controllable or non-Controllable) in the ERCOT model. In downstream systems, like the EMS, there is an offset specific to each ADER that ensures that the systems always see the Resource as consuming, even if the aggregation of devices is physically injecting power. When creating the pseudo-Load Resource, we asked that the aggregator aggregate locations that are the same load zone and the same Distributed Service Provider (DSP) territory.

No special enhancements were required for this pilot in downstream network applications in the EMS. If the pilot is successful, further application upgrades will be needed to properly support all the desired functionality ADERs seek to provide, including allowing systems to see both aggregate consumption and injection.

ADER includes aggregated devices such as synchronous generators, stationary batteries, HVAC systems, and more. They can provide energy, non-spin, or ECRS. The ADERs are not used to resolve congestion, as they are settled at a load zone level.