NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Transmission and Distribution Coordination Strategies

SPIDERWG White Paper
October 2023

Statement of Purpose

As many of the System Planning Impacts of Distributed Energy Resources Working Group (SPIDERWG) documents mention that coordination of multiple transmission entities and distribution entities are necessary, this document serves to identify specific available coordination strategies.[1] Work in industry has been ongoing in this area since SPIDERWG's inception in 2019.[2] These efforts have culminated in various methods[3] to allow distribution entities to collaborate with transmission entities to make reliability focused decisions for distributed energy resources (DERs). This document serves to highlight available strategies reviewed by the NERC SPIDERWG and key aspects for Bulk Power System (BPS) perspectives.

Applicable Entities

The NERC SPIDERWG anticipates that the Registered Entity types of Transmission Planners (TPs), Planning Coordinators (PCs), Balancing Authorities (BAs), Reliability Coordinators (RCs), Transmission Operators (TOPs), and Distribution Providers (DPs) may find this whitepaper useful. Further, the SPIDERWG anticipates that state, federal, or provincial regulators may also find these strategies informative when addressing data sharing in their territories.

Collaboration in the Planning Horizon

Planning engineers require an accurate depiction of their system so that they can accomplish their reliability objectives. Thus, they readily dictate the data granularity and frequency of sharing updates to the data set to ensure they have the most accurate representation of electrical equipment in their footprint. This includes the transmission to distribution interface (T-D Interface), the equivalent distribution system, aggregate load, and aggregate DERs. The SPIDERWG identified in past materials[4] that the DER information for this representation is generally as follows:

- DER Model Information (steady-state and dynamic representation)
  - Capacity
  - Electrical Location
  - Operational Characteristics and applicable distribution practices affecting ride-through

[1] Other DER guidance and materials has been performed by NERC and the technical stakeholder committees (e..g, RSTC and SPIDERWG). The NERC DER Quick Reference Guide is available here: https://www.nerc.com/pa/Documents/DER_Quick%20Reference%20Guide.pdf
[2] One such effort is EPRI's work on collaboration and coordination. Available here: https://www.epri.com/research/products/000000003002021985
[3] EPRI has some methods for coordination and collaboration among distribution and transmission entities documented in their report available here: https://www.epri.com/research/products/000000003002016712
[4] See SPIDERWG reliability guidelines available here: https://www.nerc.com/comm/Pages/Reliability-and-Security-Guidelines.aspx

- Underfrequency Load Shedding[5] and Undervoltage Load Shedding[6] coordination with DERs notification
- Distribution system information
  - Voltage relay settings
  - Voltage Regulator and LTC positions for the T-D transformer
  - Equivalent impedance of aggregate model
  - Available fault current at high-side bus

While the above information is generally assumed to flow from distribution entities to transmission entities, some of the above can be used in distribution planning focuses. The NERC SPIDERWG did not identify any uses of equivalent distribution system modeling for distribution planning, but rather found that distribution utilities may have a use for available fault current and the voltage stability of the high-side transmission bus in planning for distribution system refinements.

Frequency of Sharing

Generally, planning information is updated based on the latest project's in-service date for individual projects, or on an annual or quarterly basis for aggregate information. These requests are generally sent by Interconnection-wide case builders to appropriate PCs and TPs such that the Interconnection-wide planning case is built; however, individual transmission entities may update their models on a more frequent basis. One such example is the Western Electric Coordinating Councils' (WECC) Master Dynamics File (MDF). The WECC MDF is updated whenever a more up to date transient model is available for the equipment, typically a generator. This is then pushed to every new case build that includes that equipment. Thus, while frequency of data sharing for planning cases may span between the frequent and infrequent, it is a necessary decision to specify to deploy a transmission and distribution coordination strategy.

Collaboration in the Operations Horizon

Data sharing in the transmission operations time horizon is impacted by solely the TOP, RC, and BA ability to maintain situational awareness and reliably operate the BPS. Each of these entities play a role in ensuring the BPS remains reliable and have various methods identified in the NERC Reliability Standards[7] to obtain their needed data. In the operations horizon, data flow is straightforward with the authority to specify data needs for the TOP, RC, and BA to those entities in order to operate the system. The NERC SPIDERWG did not identify a need for a broader collaboration of data sharing improvements to operations horizon outside of ensuring the T-D Interface is monitored for their appropriate flow conditions and representations of the load and generation at the T-D Interface.

[5] SPIDERWG's reliability on UFLS program design is available here: https://www.nerc.com/comm/RSTC_Reliability_Guidelines/Recommended_Approaches_for_UFLS_Program_Design_with_Increasing_Penetrations_of_DERs.pdf

[6] SPIDERWG's white paper on UVLS programs is available here: https://www.nerc.com/comm/RSTC_Reliability_Guidelines/White_Paper-DER_UVLS_Impact.pdf

[7] Particularly TOP-003, available here: https://www.nerc.com/pa/Stand/Reliability%20Standards/TOP-003-3.pdf

FERC Order 2222 Impacts to Operational Collaboration

That while DERs can operate independently or as part of a DER Aggregator in markets,[8] there exists another entity that can alter the electrical impact of the DERs at their T-D Interface. In areas where DER Aggregators exist, there is a need to ensure that the DER Aggregator impacts are monitored by the TOP, RC, or BA in their real-time activities. This will differ between markets in the exact procedure of coordination, but the SPIDERWG has identified in their previous white paper[9] that clear situational awareness, facilitated by data exchange between DER Aggregators, distribution utilities, and transmission entities, is necessary to ensure reliable BPS operation.

Available Information Sharing Strategies

With the ongoing grid transformation, there is a direct benefit to ensure transmission and distribution entities are collaborating to address potential risk to the BPS. As seen in Figure 1 below, there are various stages and needs to obtain valuable information for distribution and transmission entities.

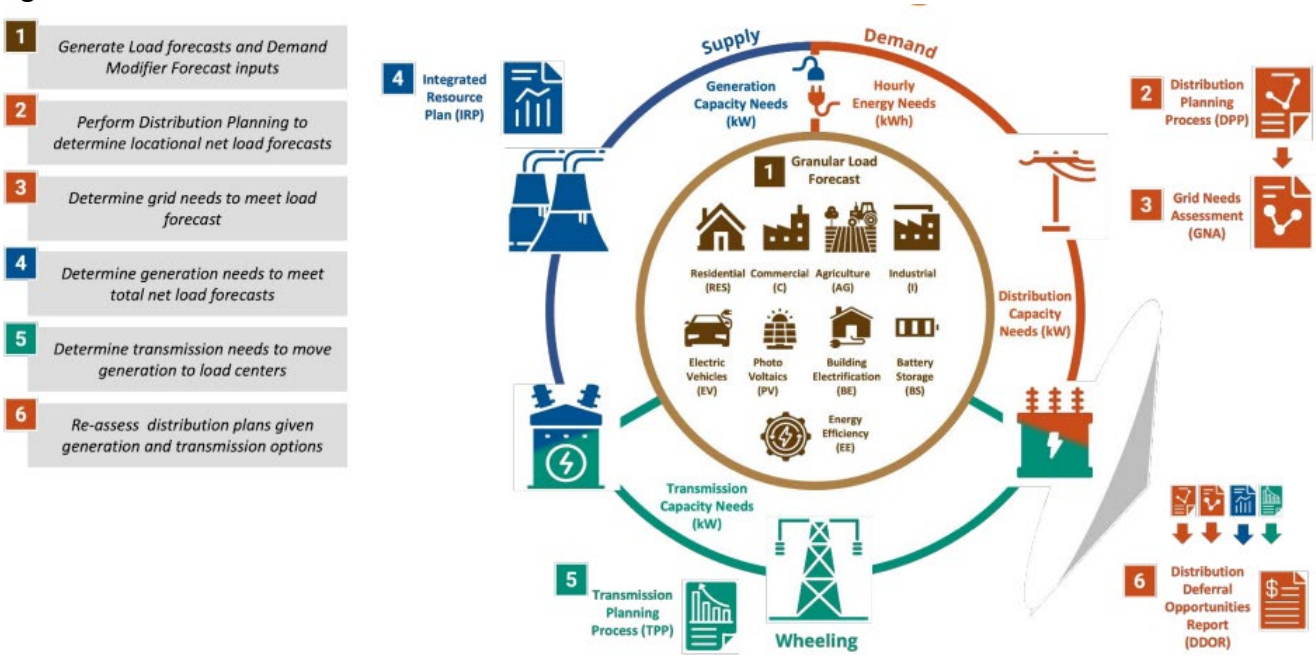

Figure 1: Potential Transmission and Distribution Benefits from Collaboration [Source: Kevala[10]]

Posting of Technical Interconnection and Interoperability Requirements (TIIR)

Some entities have found success in implementing transmission-focused postings of technical interconnection and interoperability requirements (TIIRs) to their stakeholders. While heavily influenced by the needs of the transmission system, this a pathway to sharing distribution information necessary to ensure the representation of the distribution system in transmission studies is accurate. However, due to the processes necessary to enforce forms that reference TIIRs, there can be some delay between the

[8] Market structure is not the focus here, but rather the need of another entity, the DER Aggregator, is part of the information sharing and monitoring of the impacts of DERs to the T-D Interface and the BPS.
[9] See *BPS Perspectives on DER Aggregators*, available here: https://www.nerc.com/comm/RSTC_Reliability_Guidelines/SPIDERWG_White_Paper_-_BPS_Persepectives_on_DER_Aggregator_docx.pdf
[10] Taken from: https://www.nerc.com/comm/RSTC/SPIDERWG/SPIDERWG_Presentations_May2023.pdf

identified need for specific information and the procurement of that information to fill out the model. These lags can also be affected by sharing restrictions on model libraries; however, the sharing of specific parameter settings for DERs has found more success than a full model of the DER equipment. As such, there are joint needs addressed in posting of TIIRs. One such standard form comes from EPRI,[11] and is used by a few entities to convey the transmission system needs to entities responsible for DERs in their area. Outside of voluntary collaboration and sharing, there are some entities seeking tariff revisions or contractual updates to include specific items of a TIIR form. Thus, this method can be found in many different entity structures.

Statistically Representative Representations

Another method of sharing information comes from the statistical models that represent DER behavior. These models are representative of historic output of DERs using advanced metering infrastructure readings, system control and data acquisition (SCADA) information, or other information system outputs to drive a predictive model of DER behavior. As such, the core information is found in the distribution utilities and DER owners who supply their equipment performance, ratings, and data from their end. Further, some entities have found use in aligning this "bottom-up" method[12] with "top-down" methods generally used by transmission entities to plan load and DER[13] growth. As such, these statistical models interface between projected growth from the transmission side of load and DERs and the equipment performance expected from the "bottom-up" approaches. Further work in this area is needed to inform on expected performance changes not represented by historical behavior as well as the different transmission needs to model between long-term and short-term projections. Still, this is one strategy that can be used to coordinate between distribution system needs and transmission system needs for DERs.

DER Registry

At its core, a registry is a database that can describe the registered components in detail such that end-users of the data can readily poll the registry record for their uses. DER registries take this into account by ensuring that appliable fields are well articulated and electrically based so that policy and alterations in terms are not affecting the physical interconnecting qualities. One such registry effort underway is proposed by Collaborative Utility Solutions,[14] that take a Common Infrastructure Model (CIM) so that the registry can be used by utilities regardless of their chosen modeling software or practice. While originally developed by EPRI, the CIM models are now maintained under the International Electrotechnical Commission (IEC) and can be identified by the five-digit number assigned to that common model. Using CIMs as the basis of the DER registry, entities can ensure that no additional data translation is necessary to interface between entities if they can accommodate that common model. Controls on the data are available to the managing entity of the DER registry, and specific end-users can obtain only the information necessary to accomplish their task. The NERC SPIDERWG sees this registry having strong applications in the planning collaboration discussions; however, CIM models in the operations timeframe are also a possibility.

[11] The EPRI information can be found here: https://www.epri.com/research/products/000000003002022563
[12] Due to the fact that it aggregates known equipment performance to a higher level. Hence the term, "bottom-up".
[13] Not all entities project their own DER growth. The concept still applies for the entity that performs system level projections rather than the "bottom-up" approaches.
[14] See presentation to the SPIDERWG, available here: https://www.nerc.com/comm/RSTC/SPIDERWG/SPIDERWG_Presentations_May2023.pdf

Recommendations

The NERC SPIDERWG reiterates its recommendation in its reliability guidelines that BAs, RCs, TOPs, TPs, PCs, TPs, and DPs begin collaborative efforts to facilitate data sharing and necessary changes to mitigate identified risks aggregate DER have on their footprint. Each of the listed efforts are aids that can be used to obtain and post information that facilitates the collaboration. The NERC SPIDERWG recommends entities begin proactive, good faith collaboration so that both transmission and distribution needs are met.