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Integrated Distribution Resource Planning for Electric Cooperatives

Key Points:

- Distribution systems continue to evolve rapidly due the technological improvements, incentives, and integrating more distributed energy resources (DER).
- As the paradigm is transforming to an *integrated grid*, there may be a need to develop an integrated distribution resource planning (IDRP) process to recognize and capture the value of these changes on the distribution grid.
- Public Utility Commissions (PUCs) in an increasing number of states are requiring utilities to create resource plans that include the impact of modernizing the distribution system, integrating new technologies, and determining the value of increasing DER penetration. Also, co-ops might realize benefits from creating their own IDRP.
- Creating resource plans that reflect the impact of the DERs and the evolving distribution grid presents an opportunity for the distribution co-ops and generation and transmission co-ops (G&Ts) to work closer together in the early stages of planning.

What has changed?

In the last two decades, there have been rapid changes in the distribution system due the technological improvements, incentives, and the increased integration of DER. As these technological developments become more significant, they impact both the distribution and the wholesale power systems, creating more interdependencies between the two systems, and transforming the paradigm into an *integrated grid*. As the penetration of DERs and other technologies increase, creating a resource plan that represents an integrated view of the generation, transmission, distribution, and consumption of electricity becomes increasingly necessary for determining optimal infrastructure investments and to plan for reliable grid operations. Developing an IDRP enables co-ops to explore the following:

- How will changes anticipated on the grid impact distribution co-ops and G&Ts?
- How to determine the optimal set of capital investments for the future?
- What is the set of "no-regrets" investment decisions in the grid that will be cost-effective while preparing the grid to accommodate future changes?

This topic of IDRP is also garnering attention at the National Association of Regulatory Utility Commissioners (NARUC) and the National Association of State Energy Officials (NASEO) as a necessary component in the vision of a future electric grid, with regulators in an increasing number of states which have or are considering requiring regulated utilities to develop resource plans that include the impact of

changes on the distribution grid and DER[1]. To date, state IDRP activities vary depending on the underlying issues that integrated planning may resolve, such as cost-effectiveness, reliability, and resilience. While inclusion of changes on the distribution grid including DERs into the integrated resource planning process in a more explicit manner will likely bring benefits to both the distribution co-op and the bulk power supply provider (G&Ts for approximately two-thirds of distribution co-ops), there is no "one-size fits all" approach for creating an IDRP. Indeed, the scope of an IDRP, methodology for creating one, and the benefits it will likely bring, will be different based on regional and local characteristics of the power system and other factors that may be unique to each co-op.

Integrated Distribution Resource Planning (IDRP)

IDRP is a pathway for co-ops to plan and operate the distribution system of the future. It evaluates the current distribution system for a set of posited future scenarios that include variations in power supply, DER penetration, load growth, and other changes, and forecasts their impact on the performance of the distribution grid. It is important to note that DER includes both distributed generation (DG) and demand management. These future scenarios are developed by considering various uncertainties in traditional planning parameters, such as load growth, grid infrastructure changes, and power generation, in addition to considering newer parameters, such as levels of DER penetration. Creating these scenarios and analyzing their impact on the grid is not only important to evaluate the risk (i.e., variation) associated with planned investments into the grid, but also the risk of meeting grid performance requirements (i.e., DER dispatch with time).

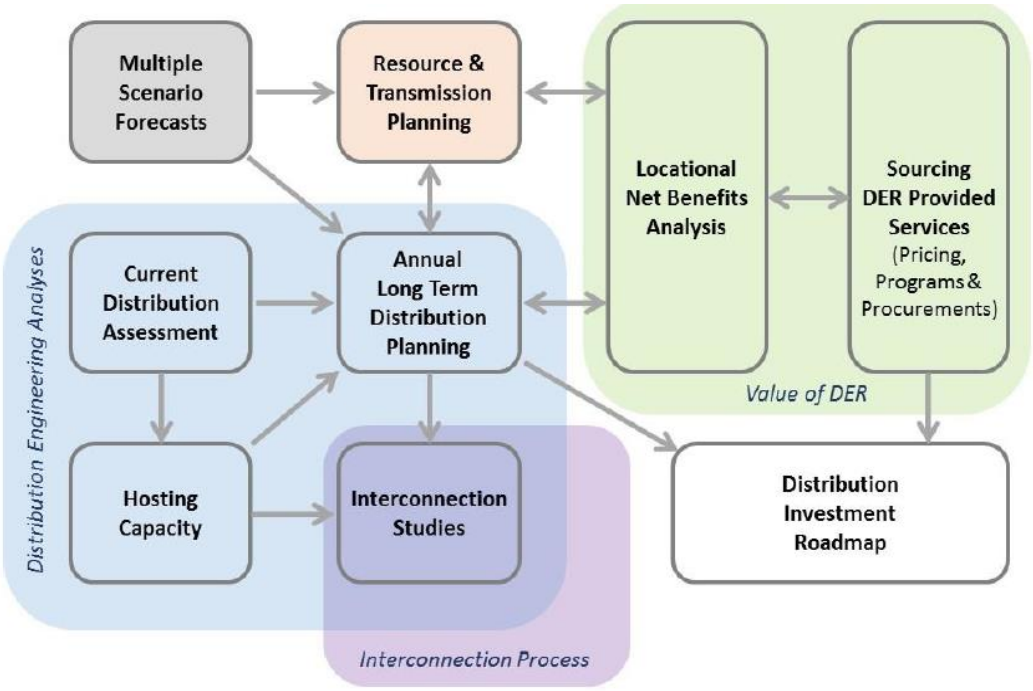

Figure 1: Integrated Distribution Resource Planning Components[2]

[1] NARUC-NASEO: https://pubs.naruc.org/pub/AB647E83-C633-8395-52A3-2F0A95955D91

[2] Taken directly: ICF, for Minnesota PUC: https://www.energy.gov/sites/prod/files/2016/09/f33/DOE%20MPUC%20Integrated%20Distribution%20Planning%208312016.pdf

The steps for creating an IDRP begins with forecasting the growth of load and DER, and includes determining grid infrastructure needed to interconnect and integrate DER into the grid in a manner that ensures continuing reliability of the grid and power supply, identifying and quantifying the locational benefits of DER, and addressing other aspects of grid operations, such as safety, security, infrastructure, and protocols for data gathering and analytics.

A unique aspect of IDRP that differentiates it from the traditional resource planning process is the need to consider the entire grid holistically – i.e., including the impact of DERs and consumer-member activities in load management explicitly on the planning of transmission infrastructure expansion and on bulk power supply, and reflecting the impact of changes in wholesale power infrastructure onto the distribution grid. These two-way (upstream and downstream) interactions in IDRP are shown schematically in **Figure 1** on the previous page. In addition, the role of emerging technologies, such as sensors and anomaly detection, along with the availability of data science and analytics tools in making grid planning and operational decisions, are also included in the IDRP.

What is the impact on cooperatives?

Among distribution co-ops, there is a continuous increase in deploying emerging technologies and DER adoption[3]. These technologies include, but are not limited to, DG assets (e.g., solar energy, energy storage) and demand management assets (e.g., electric water heater, smart thermostats, direct load control, and others). Among industry stakeholders, there is a progressive and important need from technical, investment, and regulatory perspectives to have a better understanding and estimate of future investments and operational risks of the distribution system and the impact of these changes on consumer-members, distribution cooperatives, and generation and transmission cooperatives (G&Ts). Using IDRP may enable cooperatives to fulfill this need through a process that can handle multiple uncertainties and create a plan that will be robust, flexible and sustainable. Regulated cooperatives in Minnesota and South Carolina are required to consider DER impact in the planning stages and, therefore, are using an IDRP process to fulfill this mandate. While the exact steps to create an IDRP and its impact on co-ops will vary based on regional and regulatory differences and specific planning objectives, there is a general interest among the electric utilities in developing a more holistic planning process that considers the entire upstream and downstream electric grid.

What do cooperatives need to know?

There are potential benefits of the technological advancements for co-ops, especially DER integration. However, achieving these benefits needs a detailed planning, comprehensive estimation of costs and benefits, and analyzing the impact of deployment both upstream and downstream of the distribution grid. Some of the benefits include avoiding/deferring capital investment in the distribution and transmission systems, operating the system more efficiently, and supporting wholesale and distribution system operations. These benefits are locational, as they provide a value at consumer-members, distribution system (e.g., substations, feeders), and/or wholesale (e.g., transmission line, energy price). Other benefits could include using DER as a grid asset to manage and optimize operations, enhancing reliability and resiliency, and deploying the latest sensing and other technologies for increasing flexibility and detecting grid anomalies. One example impact of considering DER may be developing a base case assuming

[3] NRECA: https://www.cooperative.com/topics/operations/Pages/IEEE-Standard-1547.aspx

current DER projects and developing future scenarios with different DER penetration levels, and determining the needed investment (e.g., substation capacity upgrade) at a certain year. The IDRP process can also estimate the benefits of using new tools, such as data science and analytics, along with new technologies, such as grid-edge sensors and computing for more optimal decision making, justifying the investments.

From a co-op perspective, embarking on the exercise of developing an IDRP presents a strong potential opportunity for collaboration between distribution co-ops and their wholesale power or transmission suppliers that may lead to maximizing these benefits and optimizing the investments. Although the detailed development process will vary based on regional, regulatory, and respective objectives, below are general steps for cooperatives to create an IDRP:

1) **Employing multi-scenario load and DER forecasts:** Short-term and long-term net-load forecasting models with historical data are needed to project the net-load considering uncertainties. This is an essential first step and needs to use relevant datasets to provide better prediction of net-load. Advanced tools to consider include the use of statistical time series, machine learning, or artificial intelligence techniques.

2) **Evaluating capacity and DER penetration level**: Some of the developments in the distribution system may impact the distribution system components upgrade/deferral (e.g., feeders, substations). For example, performing dynamic hosting capacity studies through time-series power flow analyses can quantify the impact of DERs for the planning horizon (e.g., 10 years), considering the short-term and long-term forecasts for load and DER.

3) **G&T resource planning:** There is a need to evaluate the impact of expected distribution system changes on the supply and transmission resources from the bulk power system. Incorporating this impact into the estimation of future distribution grid investments will enable optimizing these investments, leading to a more cost-effective and flexible electric grid for the future.

4) **Gathering and exchanging data between G&Ts and distribution co-ops:** Predicting and measuring the impact of DER and load growth depend on the interconnection data and the system information gathered and shared between G&Ts and distribution co-ops. Current interconnection, metering and data acquisition requirements may need to be revised from current practices and should be coordinated between the G&T and distribution co-ops to provide the maximum value to all. This step becomes more important when dispatching resources at both the transmission and the distribution levels under high DER penetration scenarios.

Additional Resources

- Lisa Schwartz, Lawrence Berkeley National Laboratory, March 2018: Overview of Integrated Distribution Planning Concepts and State Activity
- 2017 Integrated Resource Plan: Washington Electric Cooperative, Inc.

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