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Integrated Distribution Planning

A Proactive Approach for Accommodating High Penetrations of Distributed Generation Resources

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12/12/19

U.S. DEPARTMENT OF ENERGY
NNSA National Nuclear Security Administration
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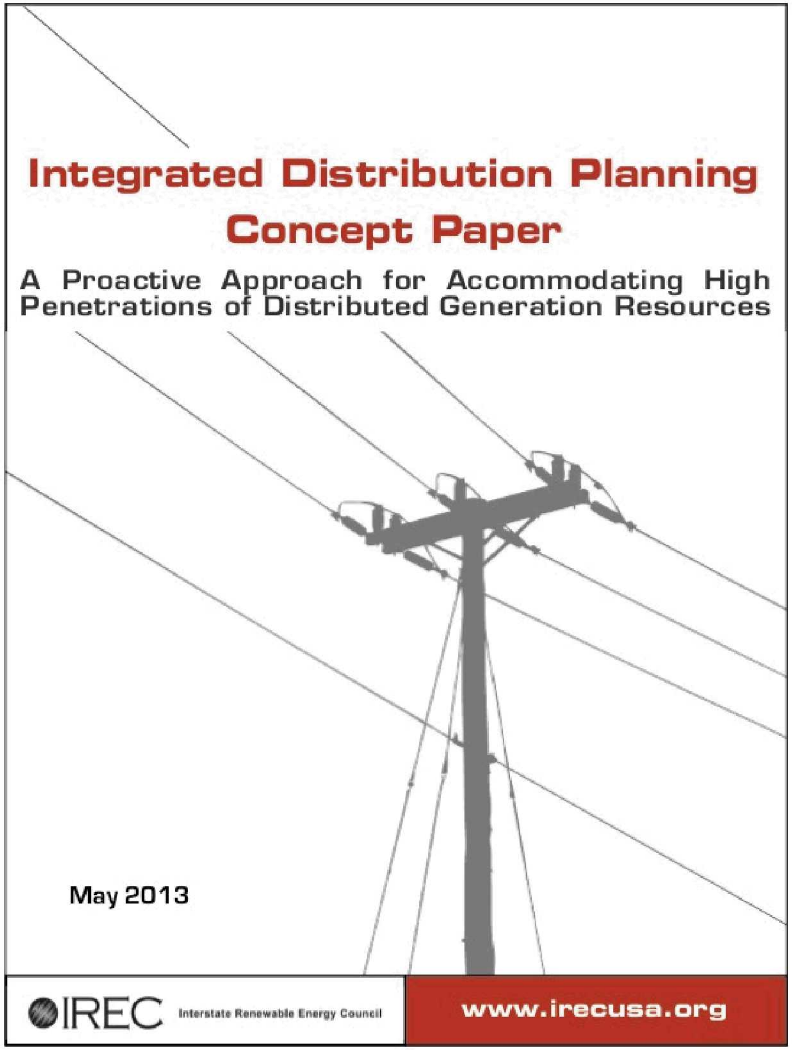
IDP

What is IDP?

- Interstate Renewable Energy Council & Sandia National Laboratories proposed an Integrated Distribution Planning (IDP) approach to proactive planning for DG growth.
- IDP leverages existing tools from distribution system planning to estimate the hosting capacity of distribution circuits in advance of a utility studying a particular interconnection request.
- IDP also analyzes a circuit's ability to accommodate anticipated DG growth and identifies any potential infrastructure upgrades needed to accommodate that growth.



IDP

Sandia National Laboratories

Why do we need IDP?

- The typical utility interconnection process today is still largely reactive, waiting for an application to interconnect a generator before potential impacts to safety, reliability and power quality may be assessed.
- The reactive nature of this approach means that the hosting capacity of a distribution circuit (the ability to accommodate new DG without upgrading the circuit) is determined after an interconnection request is received, if it is determined at all.

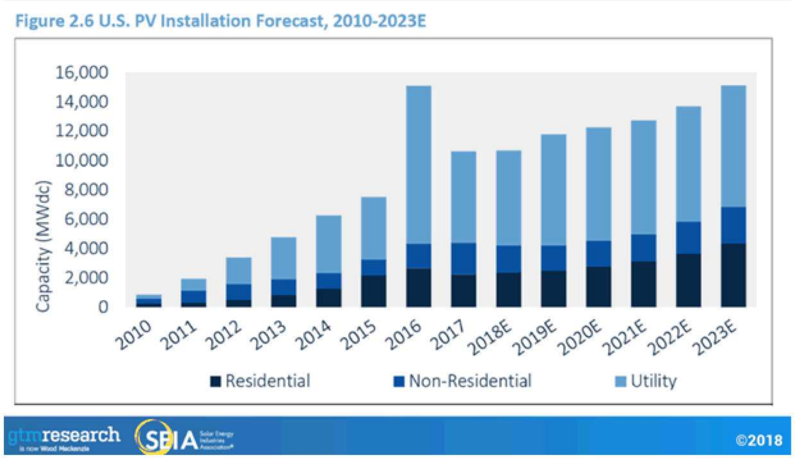


Figure 2.6 U.S. PV Installation Forecast, 2010-2023E

1/3 of Installed capacity in 2019 and beyond will be customer sited PV systems at residential and commercial locations

IDP

IDP 2 stage process

- The first stage leverages existing distribution system planning efforts to anticipate DG growth.
  - Where anticipated growth exceeds a distribution circuit's hosting capacity, the utility can identify additional infrastructure that may be necessary to accommodate the anticipated growth.
- The second stage uses modeling to determine the ability of distribution circuits to host DG.
  - The results of a proactive study inform the processing of subsequent interconnection requests by estimating in advance the level of DG that can be accommodated without impacts.

At higher penetration levels, a utility will have foreknowledge of the upgrades that may be required to ensure maintenance of safety, reliability and power quality standards.

IDP

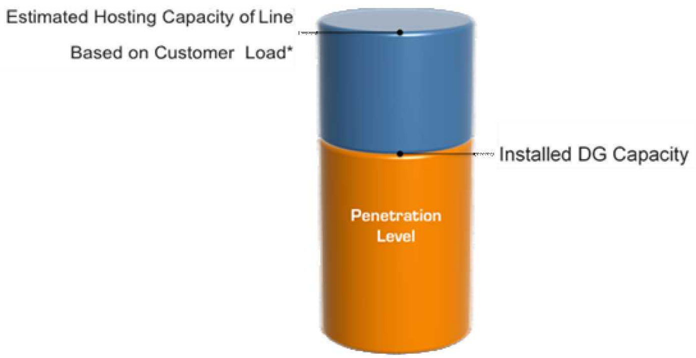
IDP proceeds in the five steps shown below:

1. Forecast DG Growth on the Circuit
2. Establish the Hosting Capacity and Allowable Penetration Level
3. Determine Available Capacity on the Distribution Circuit
4. Plan Upgrades and Expediting Interconnection Procedures Based on IDP
5. Publish the Results

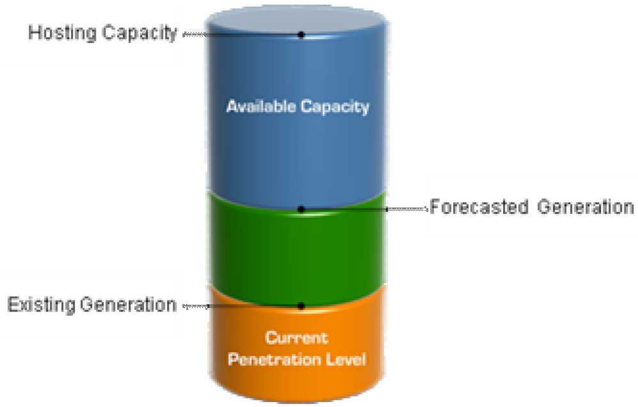
IDP determines the hosting capacity of existing distribution circuits and identifies potential upgrades that may be needed to accommodate anticipated DG growth.

IDP will allow utilities to process interconnection applications more efficiently without any reduction in the utility's ability to maintain safety, reliability and power quality.

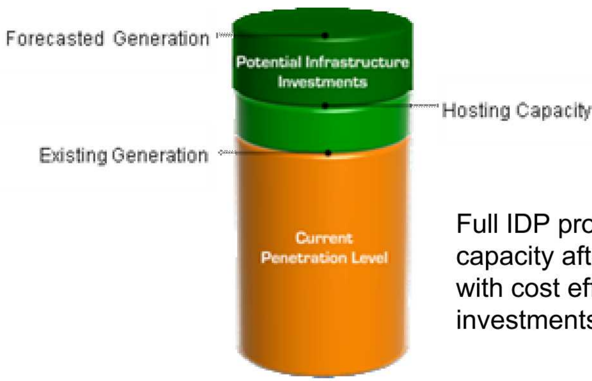
IDP



*The two most common estimates of hosting capacity based on customer load are 15% of peakload and 100% of minimum load.



Locational based hosting capacity based on power flow analysis gives actual hosting capacity by location



Full IDP process determines hosting capacity after potential upgrades on circuit with cost effective infrastructure investments. (usually voltage based)



Integrating Microgrids into the Electric Power System

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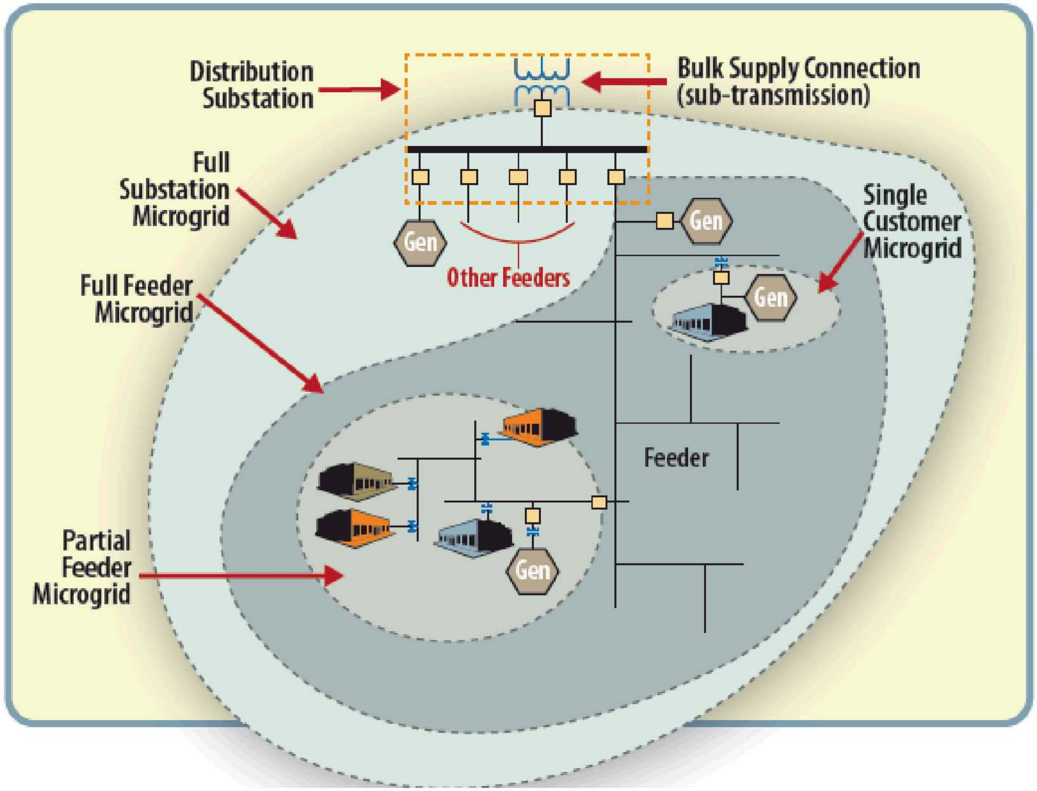
What is a microgrid?



Microgrid Attributes

- Can be sized at full substation, feeder, partial feeder or customer level
- Can operate islanded or grid-tied
- Can integrate distributed and renewable generation, CCHP and manage and control power demand and distributed resource allocation

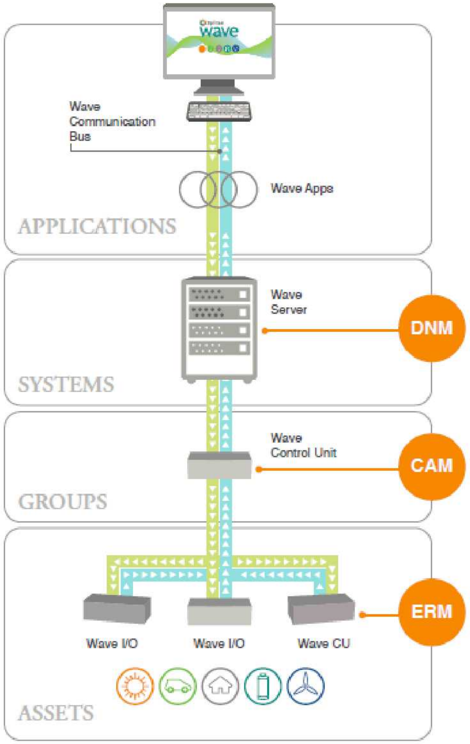
Blue sky benefits depend on how microgrid can provide revenue streams such as by providing on-going PV and energy storage services to the grid, leveraging CCHP, and providing distribution services such as demand response for peak periods, voltage and Var support, arbitrage, black start, etc.

What are MEMS?

The microgrid energy management system (MEMS) includes the control functions that define the microgrid as a system that can manage itself, operate autonomously or grid connected, and seamlessly connect to and disconnect from the main distribution grid for the exchange of power and the supply of ancillary services.

The IEEE Standard for the Specification of Microgrid Controllers (IEEE P2030.7) was approved December 2017. It addresses the functions associated with the proper operation of the MEMS that are common to all microgrids, regardless of topology, configuration, or jurisdiction.

The scope of this standard is to address the technical issues and challenges associated with the proper operation of the MEMS that are common to all microgrids and to present the control approaches required from the distribution system operator and the microgrid operator.



Spirae Wave microgrid controller

What are the challenges[1]?

Establishing a Generation/Load Portfolio— Investing in a balanced and diverse energy portfolio can help support the economic value proposition for microgrids and allow for a permanent grid-parallel DER installation while supporting a wide range of priorities, including risk management, fuel cost hedging, and GHG reduction.

- Technical challenges surround efforts to combine inverter-based systems with dispatchable, synchronous systems.
- Asset response times and ramping characteristics need to be coordinated. Moreover, local load characteristics (e.g. variability, baseload) typically dictate generation and storage technology selection and sizing.

Connection and Protection: Interconnection and protection technology must likewise be evaluated. Transfer switches and reclosers must be installed such that the system may be safely islanded at the point of common coupling (PCC) with the utility. Breakers and reclosers designed to operate with fault currents commensurate with the larger system connection may need to be redesigned for compatibility with a microgrid's islanded mode. In this case, fault currents might be sufficiently lower, and coordination between devices might be needed.

1. EPRI document: Microgrids: Expanding applications, implementations and business structures. December 2016

What are the challenges[1]?

Grid Transitioning—Considerable technical challenges exist when toggling a microgrid between grid-connected and islanded modes. During transition to island mode, phase and frequency drift is highly likely, causing loads and distributed energy resources to trip. Without a finely calibrated synchronization process, grid reconnection could damage generators and loads within the microgrid and in surrounding systems.

System Stability and Control—Balancing generation and load in the microgrid system is among the most difficult challenges for microgrids. Grid operations for microgrids can be very different—especially those built around PV and battery storage—because these microgrids have orders of magnitude less inertia than rotating machines. Consequently, controllable loads and the algorithms in the microgrid controller may need to operate much more quickly in order to preserve energy balance and system stability. Alternatively, energy storage located on the system can provide additional support, but often at a higher cost.

Power Quality—Microgrids may result in higher short-circuit impedance compared to a larger system, total voltage harmonic distortion in microgrids could be significant. Similarly, capacitor-switching and other transients must be managed in order to avoid equipment damage.

1. EPRI document: Microgrids: Expanding applications, implementations and business structures. December 2016

Standard to Address Testing of Microgrid Controllers

IEEE **Standard for the Testing of Microgrid Controllers** (IEEE P2030.8) was approved July 2018

"The scope of this standard is to develop a set of testing procedures allowing the verification, the quantification of the performance, and a comparison of the performance with expected minimum requirements of the different functions of the microgrid controller that are common to the control of all microgrids, regardless of topology, configuration, or jurisdiction.

"It is recognized that microgrid components and operational solutions exist in different configurations with different implementations."

It aims to present metrics for a comparison of the control functions required from both the microgrid operator and the Distribution System Operator (DSO). A set of testing and performance metrics is developed."

Standards used in Consolidated Edison's Interconnection Process:

Reference Number	Title
IEEE 1547-2003	Standard for Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547.4-2011	IEEE Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems
IEEE P2030.7	Standard for the Specification of Microgrid Controllers
IEEE P2030.8	Standard for the Testing of Microgrid Controllers
NYS-SIR	New York State Standardized Interconnection Requirements and Application Process for New Distributed Generators 5 MW or Less Connected in Parallel with Utility Distribution Systems

conEdison

SOURCE: TECHNICAL REQUIREMENTS FOR MICROGRID SYSTEMS INTERCONNECTED- SPECIFICATION EO-2161 REVISION 0