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Integrating Renewables with the Distribution System

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Shay Bahramirad, PhD
Director of Distribution Planning, Smart Grid and Innovation

Outline

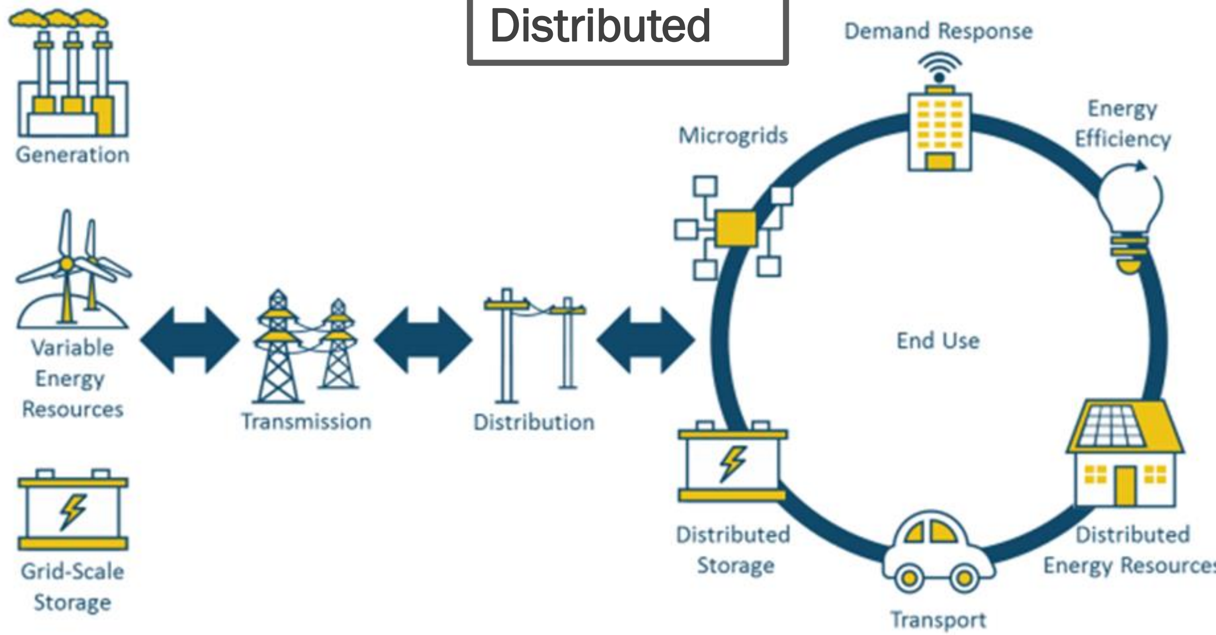
- Transformation of Distribution System
- Challenges from Renewables Integration
- Smart Inverters
- Battery Energy Storage
- Hosting Capacity
- Bronzeville Community Microgrid
- Distribution System Operator

Transformation of Distribution System

One-Way Flow
Centralized Generation

Two-Way Flow
Distributed

New components:
- Renewables
- Storage
- Communications
- Electric Vehicles
- Demand Response
- Microgrids
- Digitalization



Source: energy.gov

Challenges from Renewables Integration

There are a **number of challenges** that can result from the intermittency and limited controllability of renewable resources:

- The network has predominantly been designed for one-way power flow
- Up to a threshold, the network can accommodate distributed generation without requiring upgrades
- Every feeder is unique and can reach that threshold at a different moment.

Potential Distribution System Issues from Renewable Generation	
Voltage	Overvoltage
	Voltage regulation
	Phase imbalance
Loading	Equipment overload
Protection	Loss of co-ordination
	Loss of reach
	Anti-islanding
Harmonics	Total harmonic distortion

Smart Inverters

Inverters convert the **direct current (DC)** electricity from solar PV modules or battery energy storage systems into **alternating current (AC)** electricity used in the grid.

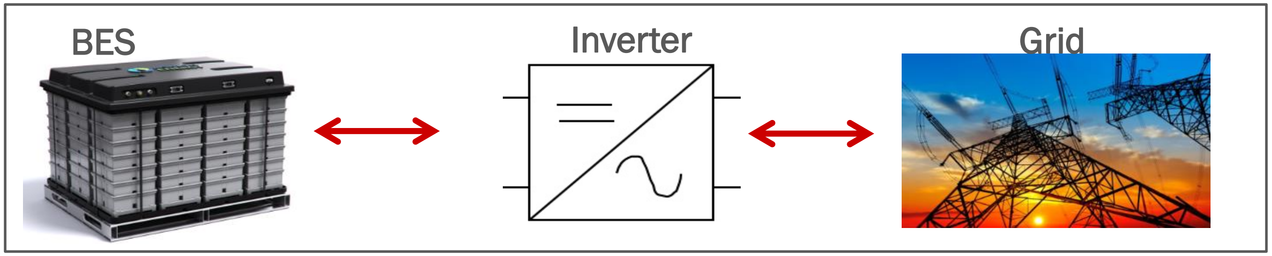
Smart Inverters :

- Allow for two-way communication between the inverter and the electrical utility
- Can help balance supply and demand either automatically or via remote communication with utility operators.
- Allow utilities to have insight into (and possible control of) supply and demand, allowing them to ensure grid stability and reduce the likelihood of power outages.
- Provide control over intermittent resources, improving power quality, frequency regulation and voltage control.

Source: Energy.gov

Battery Energy Storage

- **Battery Energy Storage** (BES) is a type of electrochemical energy storage, that can be found in many different shapes and sizes.



Inverters act as the interface between BES and the grid

Benefits for Energy Storage Deployment:

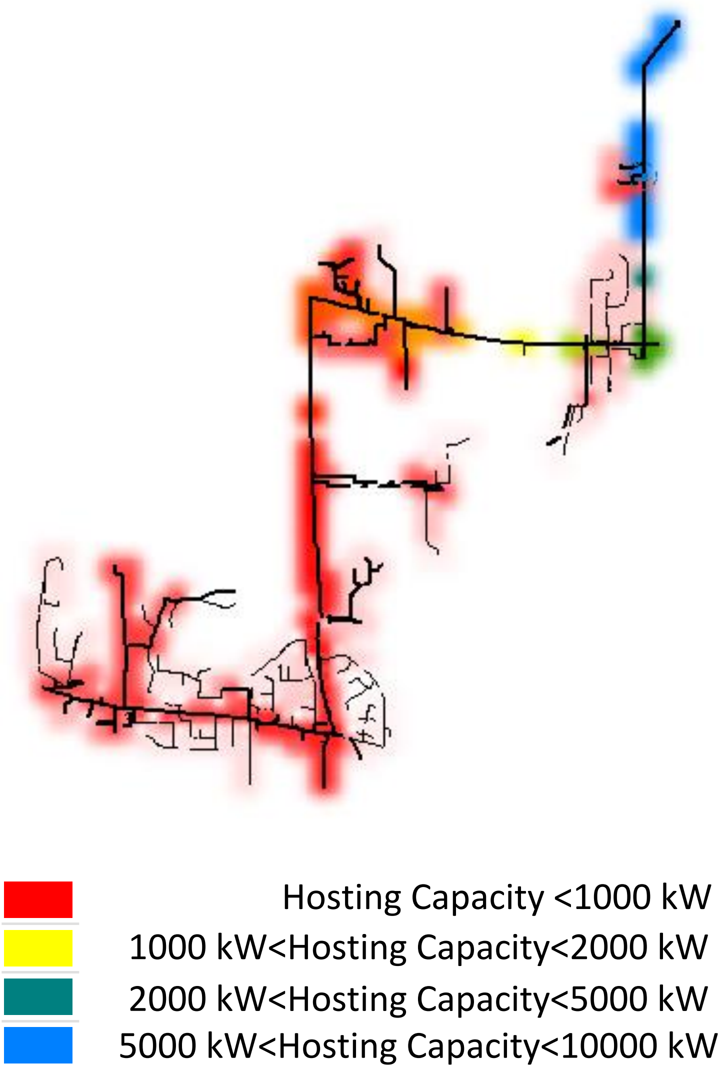
- **Improved value of renewable energy generation**
- **Cost reductions** through capacity and transmission payment deferral
- **Improved power quality** and the reliable delivery of electricity to customers
- **Improved stability and reliability** of transmission and distribution systems
- **Increased lifetime of** existing **equipment**, by deferring or eliminating costly upgrades
- Improved availability and **increased market value of distributed generation sources**

Hosting Capacity

Hosting Capacity is defined as the maximum amount of distributed generation that can be accommodated on a distribution feeder without negatively impacting system operation, power quality and reliability under existing control and infrastructure configurations.

Hosting capacity methods present an analytical approach so as **to decide if additional distributed generation interconnection could potentially cause adverse effects anywhere in the system.**

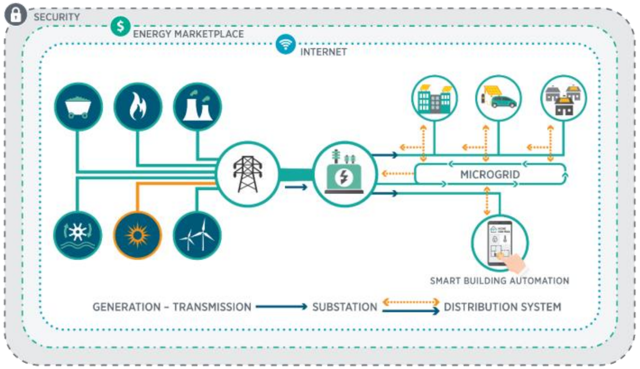
Hosting capacity can be estimated by means of heuristic screening techniques (faster/less accurate) or detailed engineering studies (slower/more accurate). **ComEd has been developing techniques that provide a more reasonable trade-off between accuracy and efficiency.**

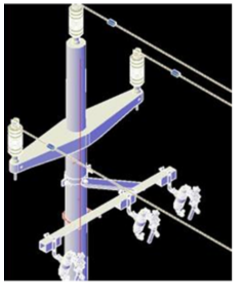


Bronzeville Community Microgrid

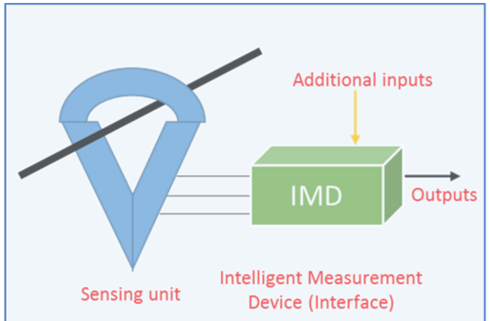
Teaching and Learning with DOE-funded Technology

- $4M DOE project awarded to ComEd under the SHINES initiative. The objectives of the project include demonstrating the capabilities of the proposed Microgrid Integrated Solar/Storage Technology (MISST) to accommodate high levels of solar PV generation through the following:
  - Smart Inverters
  - Efficient Battery Storage
  - Microgrid Control
- The MISST project will deploy solar PV and battery storage and leverage the DOE-funded microgrid master controller and the DOE-funded IIT microgrid
- The DOE granted $1.5 million to ComEd to develop and test a platform for sensors that can provide the highly granular and accurate data needed to control the voltage all across the system in the presence of distributed generation.





Distribution Feeder

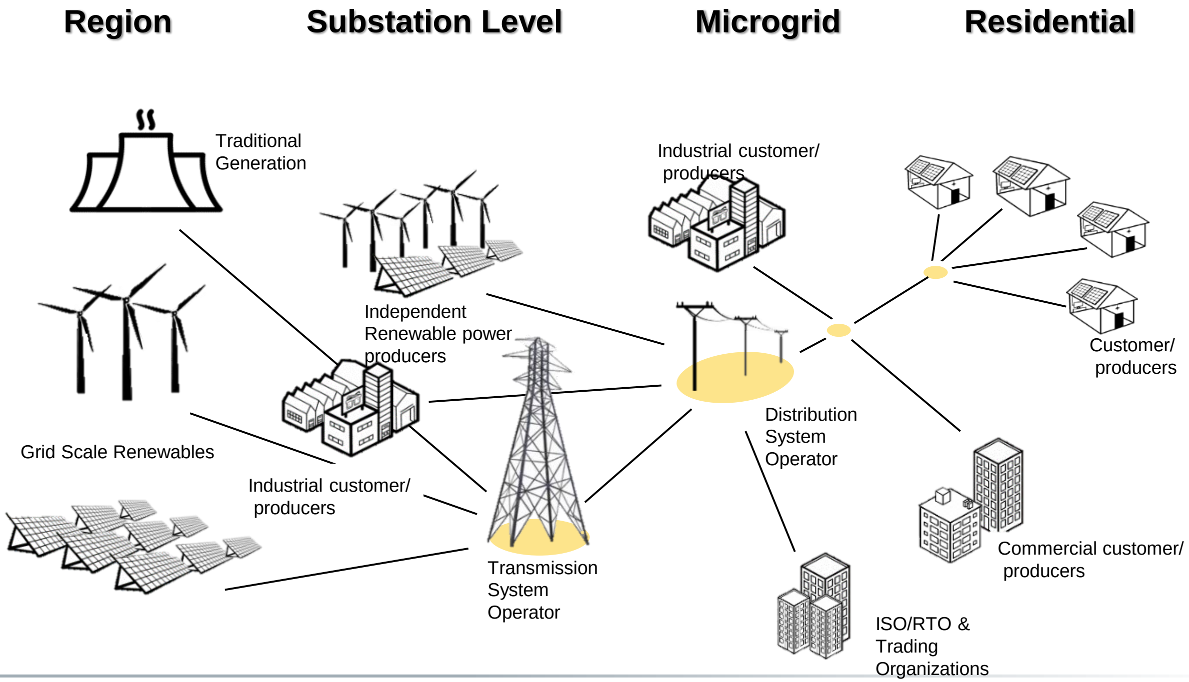


SIMPLE (platform)

Distribution System Operator

Motivated by the evolving roles and functions of the distribution grid, the Distribution System Operator (DSO) model calls for the transformation of the electric utility business from a service provider (kWh sales) to a grid and market operator.

- Main goals :
  - Establishing a strategy for integrating significant levels of DERs
  - Enabling proper electricity market and system management
  - Developing clear regulatory directions and market rules



Preparing for the Future

- In developing the vision for their future, utilities should consider integration of renewable resources and system, customer and business model impacts and opportunities
- Other states and other countries are already seeing the impact of high penetrations of distributed and renewable sources on their network. As this continues to increase we need means for easily understanding and limiting adverse impact
- Developments to policy, regulation and screening techniques will undoubtedly assist in promoting the safest way to implement these technologies in the system
- If renewable sources are installed in a targeted manner they have the potential of providing benefits to the network, but utilities have little control over the deployment and location can be disadvantageous. Quantification of potential benefits is difficult
- Utilities need to be subject matter experts, to provide required guidance to customers and developers, and this can be achieved by investing in research and pilot projects.