IEEE PES General Meeting Supersession

Distributed Energy Resources and Energy Storage Are Paving the Way to Grid Modernization

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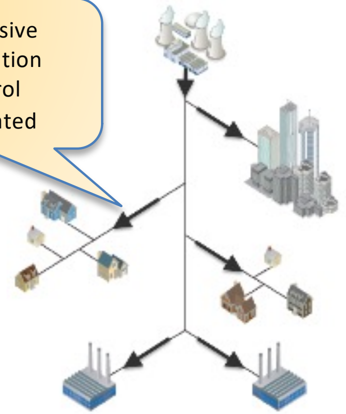
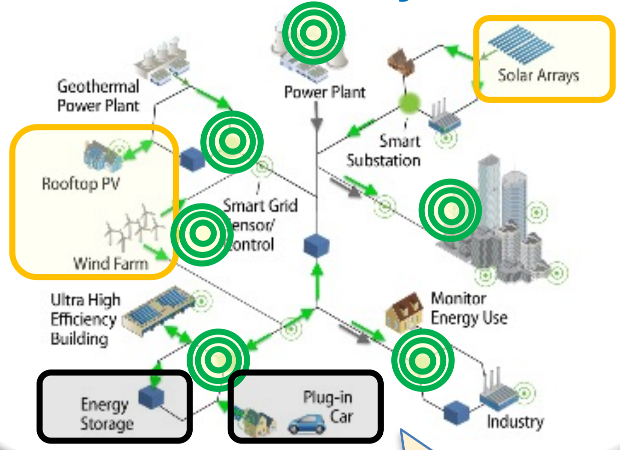
Evolution of the Grid

Current Power System

- Carbon Intensive
- Large Generation
- Central Control
- Highly Regulated



Future Power Systems



DRIVERS

- Increased variable gen
- More bi-directional flow at distribution level
- Increased number of smart/active devices
- Evolving institutional environment

New Challenges in a Modern Grid

- New energy technologies and services
- Increasing penetration of variable renewables in grid
- New communications and controls (e.g. Smart Grids)
- Electrification of transportation
- Integrating distributed energy storage
- A modern grid needs increased system flexibility
- updated standards – e.g. IEEE 1547-2018 (DER as grid assets)

Slide courtesy of Dr. Ben Kroposki, NREL

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Renewable Generation is Driving New Flexibility Needs

- Impact on the transmission system, i. e. line overloads
- Distribution feeder overloads
- Impact on system protection
- Need for voltage and frequency regulation in addition to the PV capabilities
- PV ramp rate reduction



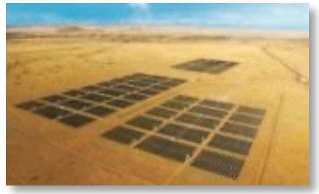
Energy Storage through Different Lenses

- **Capacity Resource**: Peaker replacement or non-wires alternative

- **Flexibility Resource**: System ramping, renewable variability and uncertainty

- **Reliability / Resiliency Resource:** Electricity inventory for reserves

- **Voltage / Power Quality Resource:** Power conditioning system capabilities



Drivers for Energy Storage

- Change in generation resources
- Decrease in energy storage technology costs
- Utility needs
- Policy

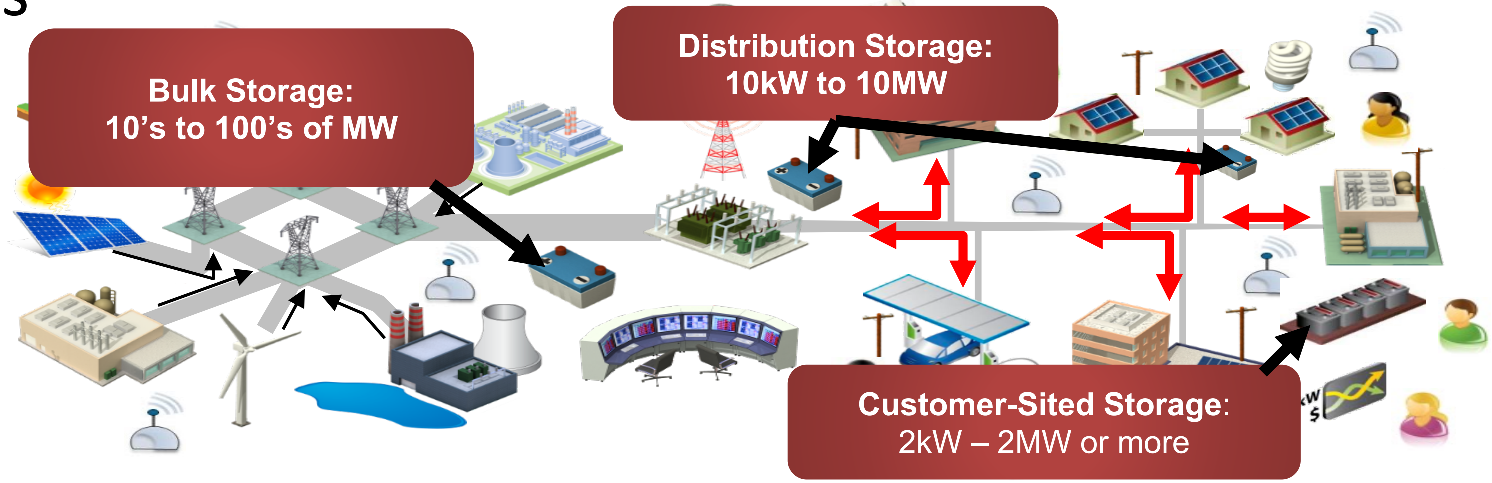
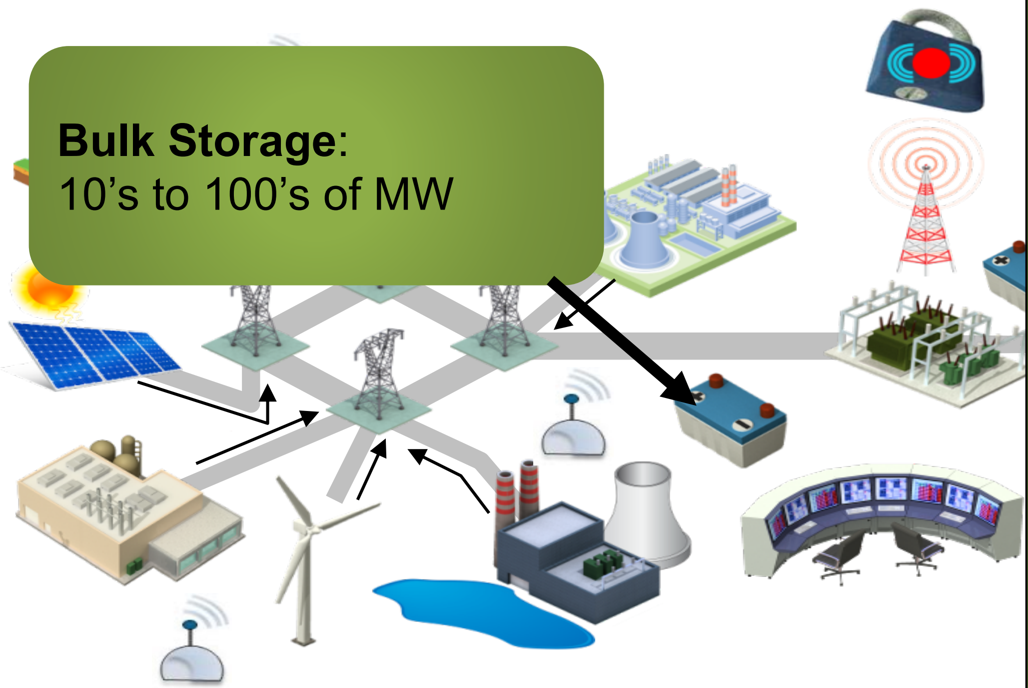


Figure Source: EPRI

Generation and Transmission-Sited / Bulk Energy Storage



Transmission-Level Grid Services

- Long-term planning / resource adequacy
- Transmission upgrade deferral
- Day-ahead/real-time energy shifting
- Frequency regulation
- Frequency response
- Contingency reserve (spin/non-spin)
- Ramping reserve

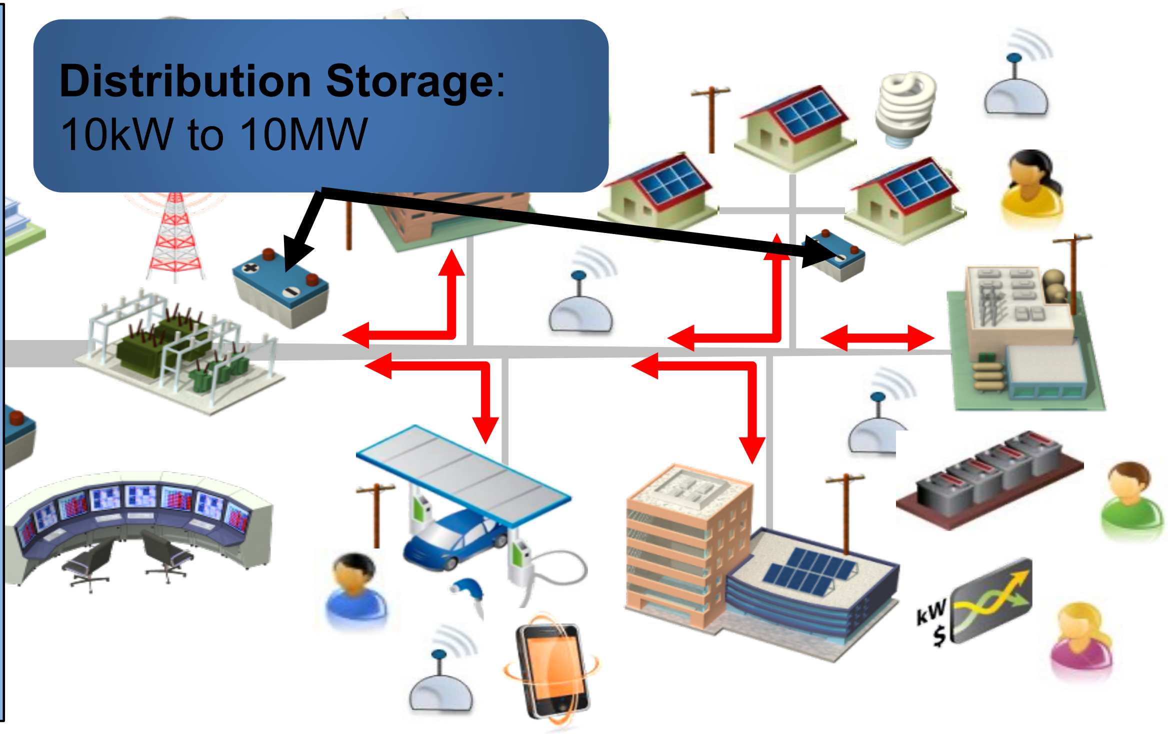
Bulk storage may serve as alternative for generators or transmission assets

Figure Source: EPRI

Distribution-Sited Storage

Distribution-Level Grid Services

- Peak shaving / Distribution upgrade deferral
- PQ/ voltage control
- Phase balancing
- Backup/ Microgrid



May be able to stack distribution and upstream transmission services

Figure Source: EPRI

Customer-sited Storage

Customer-Level Services

- Demand charge reduction
- Time-of-use tariff energy time-shift
- Backup power
- Renewable self-consumption
- Policy incentives – federal ITC, state

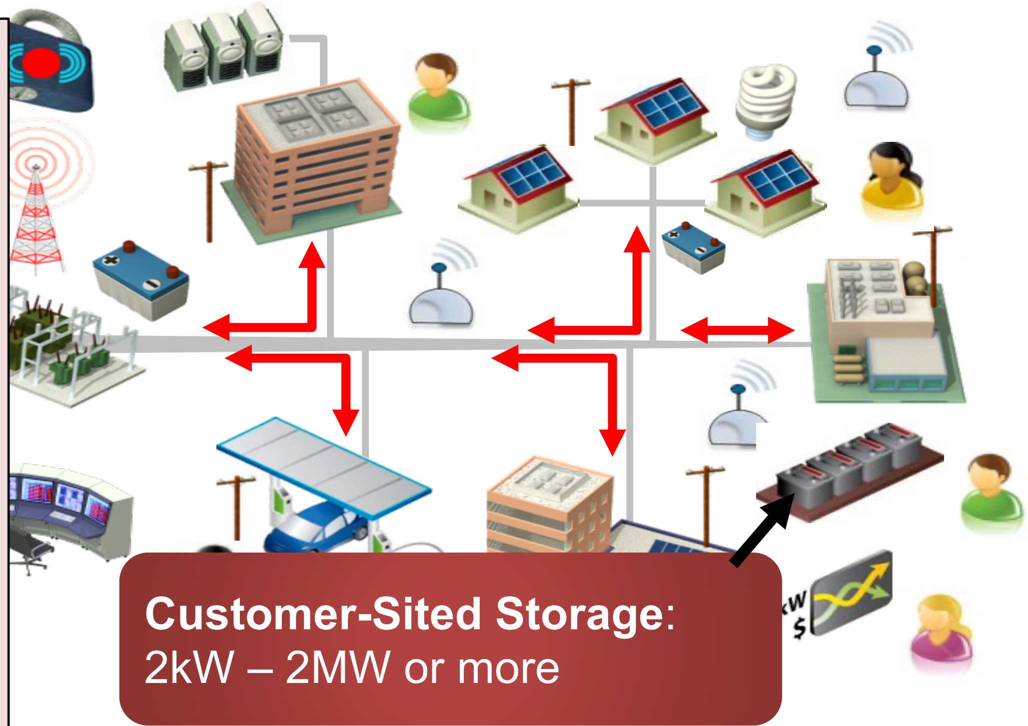
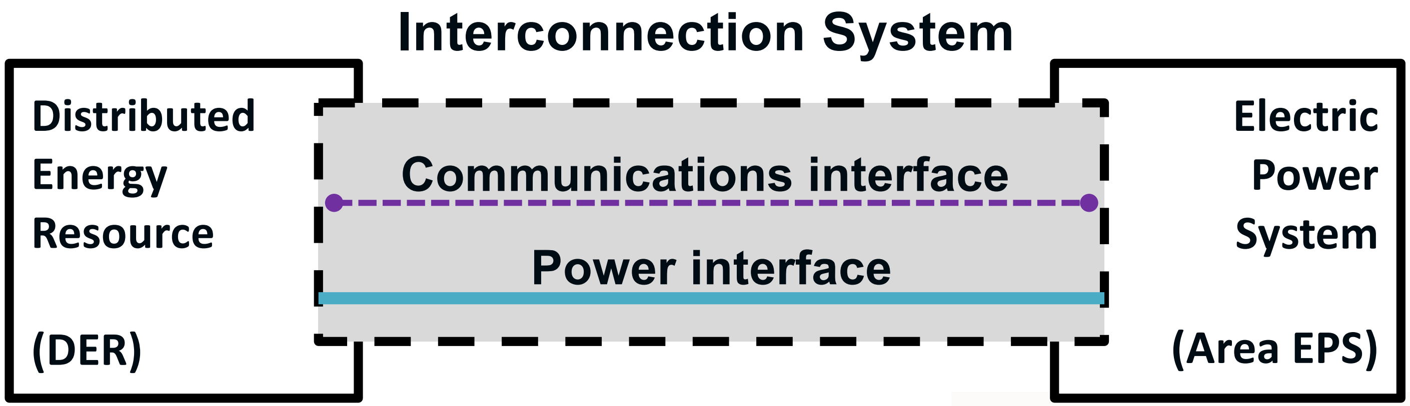


Figure Source: EPRI

IEEE 1547 Scope and Purpose

Title: *Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*

Scope: *This standard establishes criteria and requirements for interconnection of distributed energy resources (DER) with electric power systems (EPS), and associated interfaces.*



Purpose*: This document provides a uniform standard for the interconnection and interoperability of distributed energy resources (DER) with electric power systems (EPS). It provides requirements relevant to the interconnection and interoperability performance, operation, and testing, and, safety, maintenance and security considerations.*

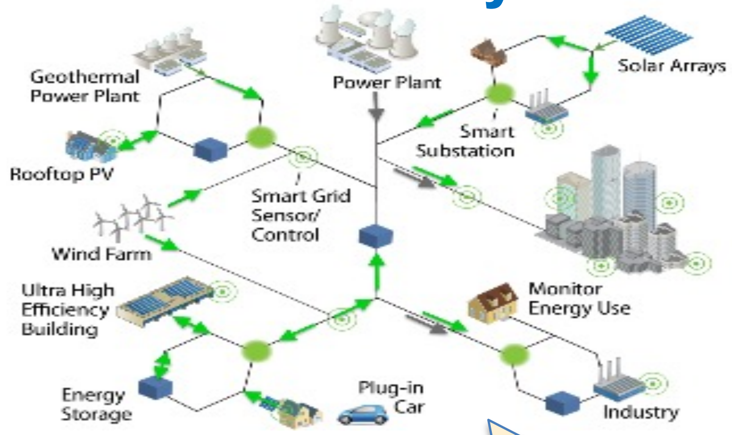
Interconnection system: The collection of all interconnection equipment and functions, taken as a group, used to interconnect DERs to an area EPS. Note: In addition to the power interface, DERs should have a communications interface.

Interface: A logical interconnection from one entity to another that supports one or more data flows implemented with one or more data links.

IEEE 1547 Enables Smart Inverters

- Voltage regulation
- Frequency regulation
- Ride through
- Interoperability
- Islanding
- ………

Future Power Systems



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Clean Energy Transition in New England and New York

New England and New York states are advancing a clean energy transition providing an opportunity for transmission to deliver renewables

Drivers of Transmission Need

- **Demand-side drivers:** Electrification of transportation and heat both in New York and New England could increase load 2-3x current peak (current peak: NE 25 GW, and NY 32 GW).
- **Supply-side drivers**: Clean energy transition will significantly increase installed generation capacity due to intermittency of renewables (4-5x nameplate capacity needed to satisfy load requirements).

Implications for Transmission Opportunities

Additional transmission capacity will be needed to meet increased demand and to bring renewables closer to load centers both in New York (downstate) and New England (MA and CT).

New York:

- Opportunity to build new bulk and local transmission within existing RoW to unbottle renewables in upstate NY
- Use our networks to deploy Energy Storage and Ultrafast EV Charging

Competitive Advantage: Couple asset condition work with clean energy investments to reduce the cost to customers.

New England

- Upgrade existing RoWs due to high cost to build in greenfield
- Lack of offshore wind landing points could require a need for offshore transmission networks
- Retrofit Phase I/II HVDC with new VSC technology to participate in ancillary markets (black start, fast ramping, reactive) that will be needed as thermal generation disappears
- Use our networks to deploy Energy storage and Ultrafast EV Charging
- New HVDC Interconnectors could be beneficial once there is significant OSW/Renewables to balance "spillage" from variable generation

Competitive Advantage: Couple asset condition work with clean energy investments to reduce the cost to customers.

Enablers of Tx. Opportunities

Policy Changes:

- New structures for markets will be needed. In the current market framework, renewables have a zero or negative marginal costs. Under this construct, market incentives and clear directives for investments disappears.

Technology Improvements:

- As most of the generation is variable, new tools such as investments in the Intelligent Transmission Networks will be needed to ensure reliability amidst uncertainty.
- Energy storage and HVDC interconnectors will play a key role in "spillage" of excess generation above load requirements once renewables reach load breaking point.

National Grid can provide leadership and policy direction to help shape the energy future.

National Grid is leading the charge in the deployment of grid enhancing technologies

Building capabilities within our networks will help enable the clean energy transition and advance smarter asset management.

The **Intelligent Transmission Network** is key to deploying innovations that will enable National Grid to manage its network smarter utilizing real-time data to make better decisions and lower the cost to serve. Deploying new technologies is also essential to enabling the clean energy future. Such technologies as power flow control devices, energy storage, and digital substations will allow us to operate networks and change settings that optimize the flow of variable renewable generation, while intelligent smart design will enable us to build quicker and realize capex efficiencies.

Technologies we are currently deploying:

Real-time Intelligence

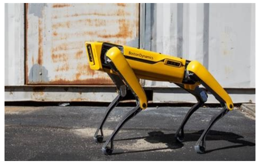

Digital Substations


Online Monitoring

- As we address asset condition issues and build new substations, we are deploying those stations to be Digital Substations with Online Monitoring.
- These stations will allow for ***quicker deployment*** and provide ***insight*** into our assets to make ***better asset decisions.***
- ***Flow power more efficiently*** despite sudden changes due to variable generation and dynamic loads.
- We have deployed dynamic line and transformer rating technologies to demonstrate the utilization of greater line and transformer capacity.

New Tools

Asset Health Tech (AI/ML/UAS/Robotics)




Intelligent Design

- We are testing new innovations in Machine Learning and Robotics. Every year, ***we must inspect thousands of circuit miles to look for defects.*** We walk and fly our lines looking for these faults.
- We are testing robots that will crawl the line conductor evaluating the integrity of the conductor, while also testing Machine Learning to scan through millions of helicopter and ***unmanned aerial vehicles*** images to look for faults. Over time, the data will give us ***predictive data to forecast*** asset conditions.
- Using our new asset management systems **(VOLT Enablement)** this data will be utilize ***to better forecast O&M spend and reliability risks***.
- Intelligent Design will allow us to ***speed and reduce the time to engineer*** our network utilizing 3D and 4D deign capabilities.

Renewable Integration


Energy Storage


Power Flow Control

- Our networks will need to deliver ***much higher amounts of variable generation*** in the future.
- We are deploying technologies such as energy storage and Power Flow Control devices. These technologies allow to i***ncrease the capacity of our networks*** and ***deferring the need for new lines.***
- Essentially ***mitigating the need to obtain new rights of way***, and enabling connection of renewables to the network at a ***lower cost to interconnect.***

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