Council of Industrial Boiler Owners
38th Annual Meeting / October 19-21, 2016
The Woodstock Inn, Woodstock, Vermont

Electricity Interconnection, Availability and Reliability

Will Environmental/Energy Policies Drive a New Manufacturing Business Model?

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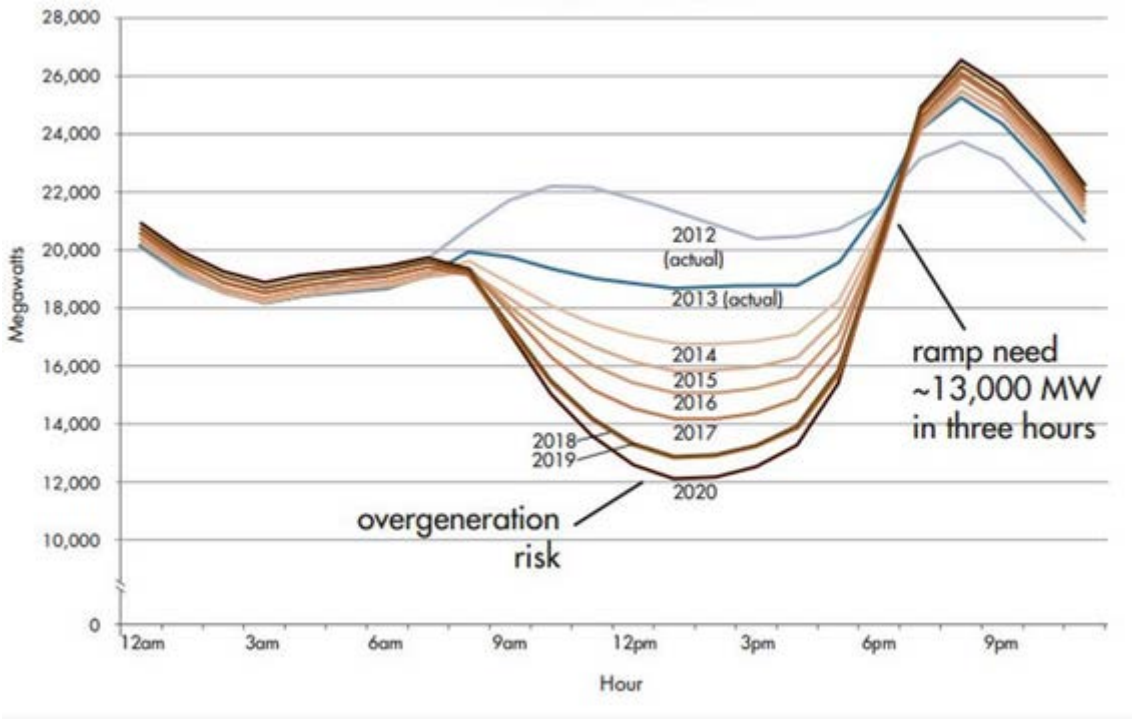
Another Electric Industry Transition is Underway: Grid Modernization

- The energy and environmental policies of several important States and the Federal government are promoting very radical changes to the structure of the electric industry.
- The changes are an extension of the concept variously called “Smart Grid” or “Grid Modernization.”
- Most of the changes are now targeted at the distribution level.
- Think of it as Smart Grid Meets EPA’s Clean Power Plan.

How Will Large Manufacturers Fit into the New Paradigm?

- Assume EPA's CPP is affirmed by the SCOTUS and EPA successfully tightens the requirements to achieve GHG emissions reductions of 80% below 1990 levels by the year 2050 ('80 by 50').
- How are large manufacturers expected to operate?
- Assume no constraints on costs, including the availability of energy storage.

The Infamous Duck Curve



Shows Steep Ramping Needs and Over-generation Risk Resulting from High Penetration of Wind, Solar & DER

Key Components of Grid Modernization: The Tools

- Advance Metering Infrastructure
- Asset/System optimization
- Cyber and Physical security systems
- Demand Response (DR)
- Distributed Control Systems
- Distribution Automation
- Distributed Energy Resources (DER)
- Electric Vehicles
- Energy Management and SCADA
- Energy Storage
- Intelligent Electronic Devices
- Microgrids
- Network Equipment/Servers
- Transmission enhancement applications (TA)

Microgrids, Energy Storage & DER:
Distinguishing Characteristics

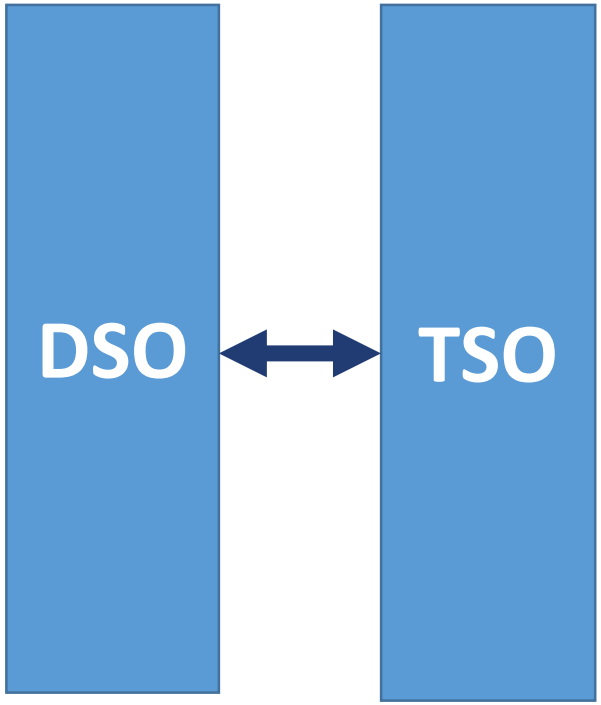
- Two-way communications and two-way power flows between the Bulk Electric System and the distribution system.
- A much bigger role for third-parties under contracts and a reduced role for traditional utilities.
- Every end user will interact with the grid and assume the risks of their own actions.
- More generation at the distribution level assisted by energy storage and the ability to disconnect from the Bulk Electric System by using microgrids to manage contingencies.

DSOs & TSOs

Distribution System Operators & Transmission System Operators

Distribution System

- Traditional Loads
- DER & CHP
- Energy Storage
- Dynamic Pricing
- Demand Response
- EV Charging
- Microgrid
- Energy Efficiency
- EMS



Bulk Electric System

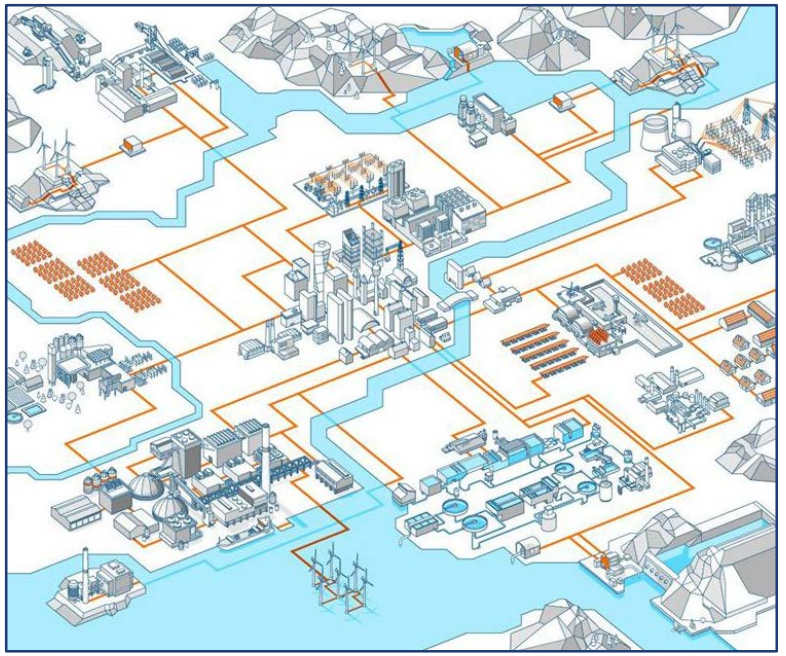
- Wind Farms
- Utility-scale Solar
- Energy Storage
- Geothermal
- CHP
- NGCC
- Combustion Turbines
- IGCC
- Nuclear

Microgrids

- A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and that connects and disconnects from such grid to enable it to operate in both grid-connected or “island” mode.
- The reason customers may need to build a microgrid is resiliency, i.e., to retain service to facilities during electric system events.
- End-use customers will share the burden of providing reliability. Microgrids are a hedge against the intermittent nature of wind and solar resources and extreme events such as hurricanes.

Industrial Microgrids

- Converting a large industrial complex into a microgrid might have some intriguing benefits.
- The microgrid might include multiple facilities of a single company or multiple companies.
- Add CHP or other on-site generation to provide backup and maintenance power, voltage support and other Essential Reliability Services and the occupants of the microgrid could be independent of utilities (including ISOs/RTOs) and independent of utility regulators.

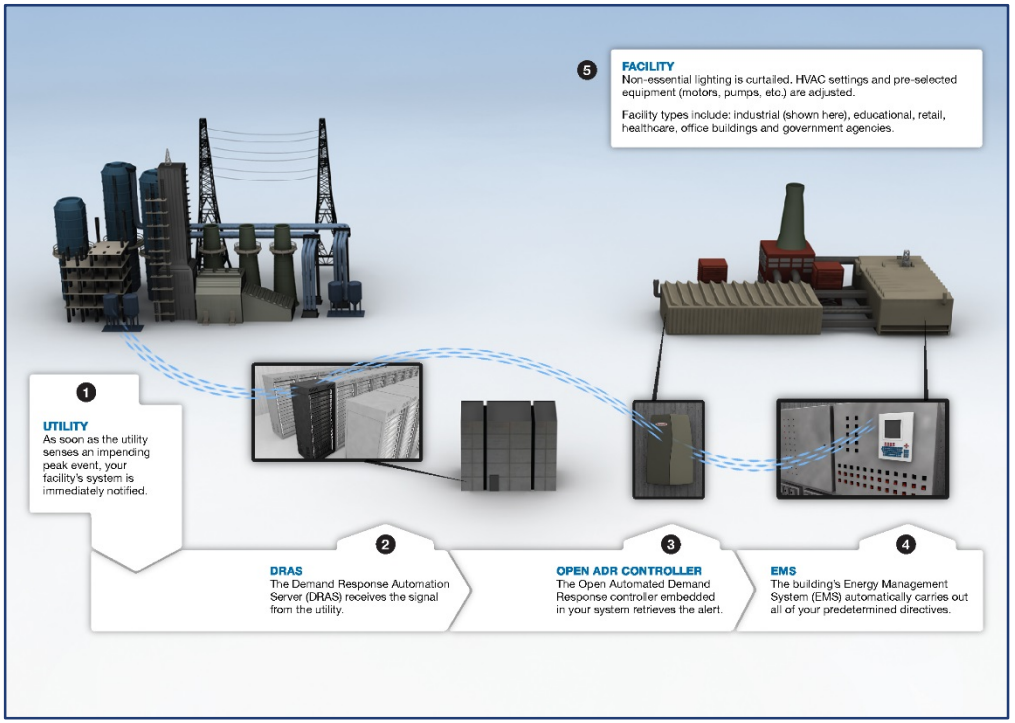


Energy Storage

- Energy storage is an essential component of Grid Modernization. And the whole thing won't work without it.
- It is assigned a role at all voltage levels.
- The expectation for large manufacturers is that they will buy and store power during overgeneration periods, or store their own surplus distributed generation, and use it during high cost periods or sell it as a high-value ramping product.

Demand Response

- With a grid resource mix rich in intermittent generators, it would seem to be a no brainer that demand response would need to play an important role.
- There is a theoretical battle taking place that would replace demand response with dynamic pricing.
- An original promise of Smart Grid technologies was Advanced Metering Infrastructure that would enable dynamic pricing.

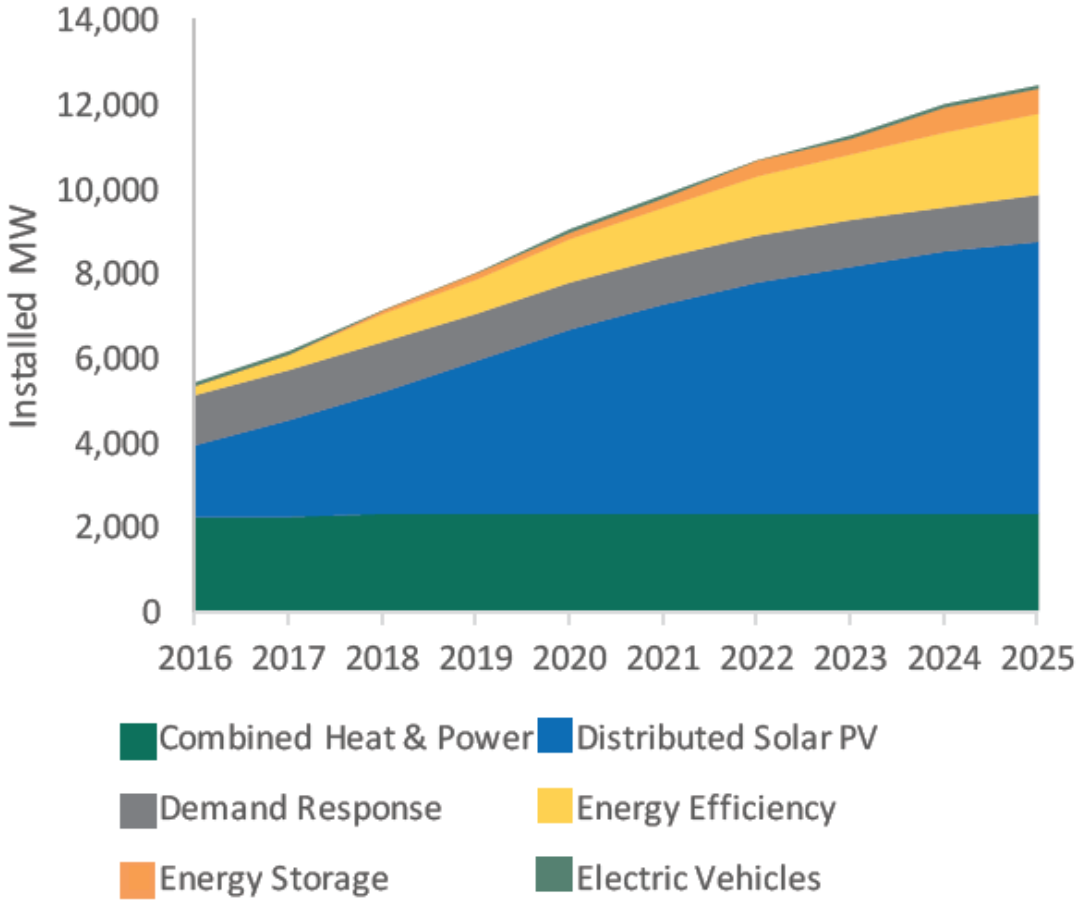


But What About Thermal Processes?

- Steam and other thermal processes that currently depend on fossil-fuels face a particularly tough dilemma – how to survive in a decarbonized economy.
- Unless enough engineering ingenuity is applied to the development of electric-only processes, the only choice seems to be the purchase or generation of carbon offsets.

Putting It All Together

DER Forecast in Southern California Edison Service Territory



Smart Manufacturing Leadership Coalition (SMLC)

- Smart manufacturing is a new way to design and operate industrial processes.
- Pervasive use of real-time, data-driven intelligent systems throughout manufacturing processes and supply chains.
- SMLC's CEO is Denise Swink, formerly with DOE and EPA.
- Supported by EPRI and DOE.
- Developing a Smart Manufacturing Application and Data Platform ("SM Platform")
- Membership includes: Alcoa, Corning, General Dynamics, General Electric, General Mills, General Motors, Owens-Corning, Pfizer Inc., and Praxair

S. 2012, the Energy Policy Modernization Act of 2016

Subtitle D—Electricity and Energy Storage

- Sec. 2301. Grid storage program.
- Sec. 2302. Electric system grid architecture, scenario development, and modeling.
- Sec. 2303. Technology demonstration on the distribution system.
- Sec. 2304. Hybrid micro-grid systems for isolated and resilient communities.
- Sec. 2305. Voluntary model pathways.
- Sec. 2306. Performance metrics for electricity infrastructure providers.
- Sec. 2307. State and regional electricity distribution planning.
- Sec. 2308. Authorization of appropriations.
- Sec. 2309. Electric transmission infrastructure permitting.
- Sec. 2310. Report by transmission organizations on distributed energy resources and micro-grid systems.
- Sec. 2311. Net metering study guidance.

2016 FERC Actions

- FERC To Convene a Technical Conference on Electric Storage Resources as Transmission Assets (AD16-25-000)
- FERC Directs Development of Standards for Supply Chain Cyber Controls (RM15-14-002 & RM16-18-000)
- FERC Moves to Implement FAST Act Provisions on Critical Infrastructure Information (RM16-1-000)
- National Labs Panel on Grid Modernization (AD16-19-000)
- Electric Storage Participation in Regions with Organized Wholesale Electric Markets (AD16-20-000)
- FERC Staff to Convene a Workshop on Reactive Supply Compensation in Markets Operated by RTO/ISOs (AD16-17-000)
- FERC Proposes Changes Requiring Small Generators to 'Ride Through' System Disturbances (RM16-8-000)

NERC

- In January 2016, NERC established the Distributed Energy Resources Task Force (DERTF).
- NERC acknowledges that the North American power system is transforming to a resource mix that relies less on coal and nuclear while integrating more natural gas, wind, solar, distributed generation, and demand response resources.
- The task force will focus specifically on operational and planning impacts of DER and will examine potential reliability implications.
- Utility-scale behind-the-meter generation has been added to the definition of DER.
- NERC is currently struggling with the fact that it has no jurisdiction over distribution and nor does FERC.

Final Thoughts

- What would be the outcome if costs are considered?
- Can energy storage be affordable? Does it matter?
- The emphasis on the distribution level means that risk is being shifted from traditional suppliers to end users. Do we want that?
- How do TSOs and DSOs coexist?
- The emphasis on the distribution level also means that policy makers are giving a higher priority to maintaining grid reliability (so wind and solar get compensated) than serving the needs of customers.
- Missing from the debate is the need by manufacturers to stay in business because they manufacture many of the materials used to reduce energy consumption and decarbonize the economy. Can't have it both ways.