Technology trends for managing peak load demand, grid stability, energy storage and demand side management
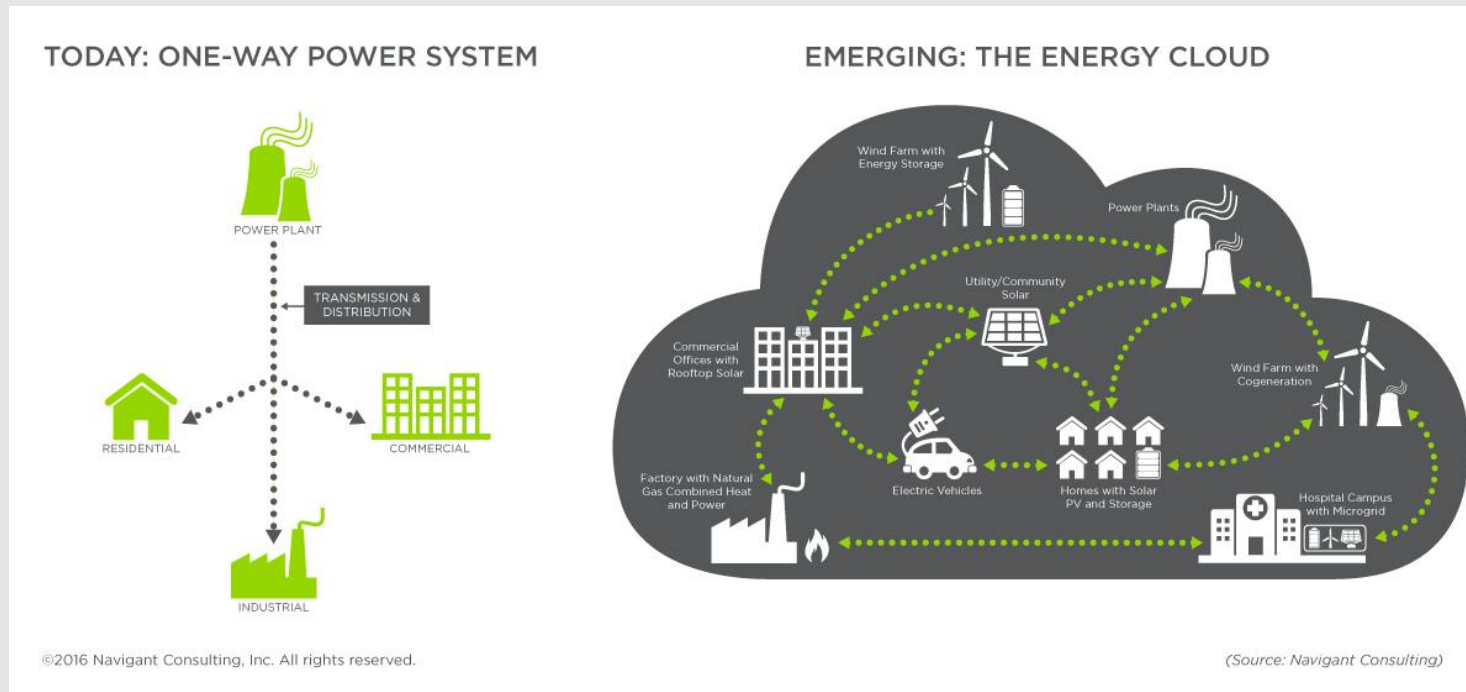
A Platform for Integrating Technology Solutions Across the Grid

TODAY: ONE-WAY POWER SYSTEM

POWER PLANT

TRANSMISSION & DISTRIBUTION

RESIDENTIAL

COMMERCIAL

INDUSTRIAL

EMERGING: THE ENERGY CLOUD

Wind Farm with Energy Storage

Power Plants

Utility/Community Solar

Commercial Offices with Rooftop Solar

Wind Farm with Cogeneration

Factory with Natural Gas Combined Heat and Power

Electric Vehicles

Homes with Solar PV and Storage

Hospital Campus with Microgrid

(Source: Navigant Consulting)

- Large, centrally-located generation facilities
- Designed for one-way energy flow
- Utility controlled
- Technologically inflexible
- Simple market structures and transactions
- Highly regulated (rate base) and pass through

- Distributed energy resources
- Multiple inputs and users, supporting two-way energy flows
- Digitalization of the electro-mechanical infrastructure: smart grid and behind the meter energy management systems
- Flexible, dynamic, and resilient
- Complex market structures and transactions
- Regulation changing rapidly around renewables, distributed generation (solar, microgrid, storage), net metering, etc.

Distributed Energy Resources (DER)

We take a broad view of what encompasses DER.

Distributed Generation

- Solar
- Wind
- Turbines / Micro Turbine
- Fuel Cells

Distributed Storage

- Electrochemical
- Mechanical
- Thermal

Microgrid

- On the Grid
- Customer

Demand Response & Energy Efficiency

- Direct Load Control
- Price Based
- Virtual Power Plants
- Incentive Based

Utility Side Loss Reduction

- conservation voltage reduction (CVR)
- Voltage and VAR optimization (VVO)
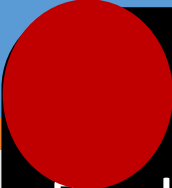- Grid Optimization

Electric Vehicles

- EV Charging
- EV to Grid

Drivers

There are a number of drivers facilitating steady market growth.

Social	Technology
• Climate change mitigation is a major motivating factor • Concerns about reliability and resiliency • Customer confidence in technology	• Falling prices • Efficiency improvements • Improvements in equipment reliability • Greater product availability • Increasing availability of data
Policy	**Financial**
• Renewable energy targets • Regulatory reforms	• Customer saves and/or hedges against electricity rate fluctuations with self-generation • Dedicated businesses create efficiency

The energy cloud represents a wide range of strategic, operational, technological, commercial, environmental, and regulatory changes that are transforming the traditional utility model for energy provision.

Peak Load and Energy Reduction

- **Implement Direct Load Control**
  - Leveraging existing programs and expanded capabilities
- **Implement Rate Programs:**
  - Peak time rebates (PTR)
  - Critical peak pricing (CPP)
  - Time of Use (TOU)
  - Real time pricing (RTP)
- **Volt / VAR Optimization**
  - Conservation Voltage Reduction (CVR)
  - Integrated Volt / VAR Control (VVO)
- **More Detailed Information**
  - Induce conservation for consumers
  - Displaying customers' consumption allows streamlining and targeting DSM program to customers

Grid Reliability and Efficiency

- **Identification of Outage Locations**
  - Locations identified faster and reduced labor time
  - Reduced Truck Rolls for "OK on Arrival"
  - Reduced Nested Outages
  - Reduced / Avoided CAIDI/SAIDI time and penalties

- **Integration of Distributed Energy Resources**
  - Monitor and balance load flow on feeders

- **Load Flow Monitoring**
  - Reduced energy losses from Volt VAR Optimization
  - High impedance detection
  - Reduced restoration costs

- **Fault Location, Isolation and Service Restoration**
  - Utilizing automated switches

Grid Stability, Energy Storage and DMS

- **Storage**
  - Rapidly changing technology deveopment
  - Deployed at residential and utility level

- **Stability**
  - Storage as a means to stabilizing grid
  - Real time control

- **DSM**
  - Smart appliances

Utility Business Models

Model	Description
Traditional	• Vertically integrated utility provides commodity energy to customers. • Utility owns, plans, operates (both physical and market operations), and maintains the distribution system (and possibly also the transmission and generation assets). • Return of and on investment and cost recovery through rates, with oversight by PUC and rate cases. A variety of rate structures (de-coupled, performance based, etc. are possible).
Functionally Unbundled (several variants)	• Distribution utility is functionally separated from generation, which is out of the rate base. • Utility owns, plans, operates (both physical and market operations), and maintains the distribution system. • Investment and cost recovery mechanisms are the same as the Traditional model.
Utility as Distribution System Operator (DSO)	• Utility owns the distribution assets and makes allowable investments based on the DSO planning process. • Utility acts as independent DSO, and conducts market operations (market facilitation of DER and transaction management). • Utility as DSO also conducts physical operations (real and reactive power flow, outage restoration, switching, reliability coordination, and situational awareness).

Value-Added Service Provider*
 	
*Can be combined with any of the above
	• In addition to any of the roles above, the utility is allowed to (and chooses to) provide additional value-added services that may or may not be related to DER, such as:
	  — Behind-the-meter energy services (e.g., home energy management)
	  — Premium (i.e., higher reliability/quality) power supply
	  — Warranties and financing for DER
	  — Ownership/operation of electric vehicle (EV) charging stations
	  — Operations and maintenance of third-party owned DER

Utilities in the Changing Energy Market

- Technology is no longer an issue
- Need to change business approach
- The need for regulatory changes to accelerate RE/EE uptake