Smart Networks and Demand Response

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Imagination at work.
The traditional electricity sector is being transformed by digitalization, decentralization, and electrification.

3 trends disrupting the traditional power sector:

**Digitalization**
- **What**: explosion in the number of connected devices and smart sensors
- **Impact**: allowing decision making based on dynamic prices

**Decentralization**
- **What**: growing penetration of distributed resources (generation storage, efficient devices)
- **Impact**: end user become an active actor of the power system

**Electrification**
- **What**: electrification of energy uses, transport (EVs) and heating
- **Impact**: growth of electricity demand, and an acceleration of decentralization of the power sector
Renewable integration...at incredible speed

Global Installations
Cumulative (GW)

- 42 (03)
- 80 (06)
- 178 (09)
- 380 (12)
- \(~550\) (Energy storage)
- \(~380\) (Solar PV)
- \(~178\) (Wind)

Source: GWEC, Navigant, REN21, Bloomberg, MAKE

Impact on California

- 2012
- 2014
- 2020

March 31 net load

Source: CalISO

Growing Complexity in Renewable Integration
Growing Scarcity in Grid Flexibility

California 40% RPS, ~200 hrs/yr > 5 GW of curtailment

PJM 50% Renewables, 4600 hours per year with curtailment

$3.3b/year production cost savings with 10% of the loads providing flexible spinning reserves in PJM

New Grid Control Strategies requires once Grid reserves are reached: Eirgrid

Ancillary service market expected to multiple by 5 within 2020 (50 to 250me/y)
Emergence of New Industrial Internet Platforms

Reaching Inflection Point: technology sourced from the consumer internet enabling faster and more secure developments of Industrial IoT apps and fostering new Data Business Models

- Industrial-grade technology
- Agent Deployment on Grid edge
- Optimized for networked asset data models and operational workflows
- Advanced Grid Digital Twins
- Embedding Industrial Big Data, Artificial Intelligence and Machine Learning
- Improved Energy Dispatch decisions
- Modern Development tools and new app store for faster Innovation
- New Business Partnerships
Significant on-going technology prototyping
New Renewable-Grid integration strategies

Improved renewable controllability
- Grid Curtailment
- Integrated Renewable-Storage dispatch
- Volt/VAr dispatch through Smart Inverters
- Advanced Inertial response

New Generation dispatch strategy
- Compound real-time renewable forecasting
- Stochastic Economic Dispatch
- Storage & Demand Response controls
- AI Based Load Forecasting

New Distributed Energy Resources aggregation
- DER Virtual Power Plant participation into Markets & Grid ancillary services
- Optimal Gridedge connectivity through Microgrids

Development of new Smart Digital Grid Connections
Pressing needs to redesign energy markets

**Transmission**

- TSO
- RTO / ISO
- Market
- GENCO
- Marketer

**Distribution**

- Industrial
- Residential
- Commercial
- Aggregator
- DSO
- Marketer
- Retailer
- TSO
- RTO / ISO
- Market
- GENCO
- Marketer

- Mature market structures
- Incremental regulatory changes
- Evolution towards real-time continuous trading, flexibility scarcity & locational grid capacity pricing
- Grow
- Market structures nascent, following transmission
- Uncertain regulatory framework
- Local models – but accuracy usually poor
- What are we trying to solve?
  - Incent introduction of DERs...value streams
  - Solve local energy balance and constraints
  - Incent DER contribution beyond power

All eyes on progressive US states ... NY, CA, TX
The new Digital Energy Value Chain 2.0

RESILIENCY
- Real-time Asset conditions & limits assessment
- Low inertia Grid Stability, Wide Area Defense Plan & Natural Disaster Recovery
- New Regional Security coordination role

EFFICIENCY
- TSO Flow Based markets & DSO Market facilitation
- Digital Substation
- Integrated Grid Edge/OT & IT/cloud architectures
- New Energy Data Play

DER INTEGRATION
- Enable DER (renewable, storage, demand) Virtual Power Plant Aggregation
- Real-time DER integration into Grid Economic Dispatch & reserves
- New Smart Connection planning with renewable & community Microgrids
Virtual Power Plant & Microgrid integration

- 763 MW substation capacity
- 2013 peak, 785 MW (6 years ahead of projection)
- 107 MW sub-transmission overload by 2023

- **Traditional solution**: transfer load, build new substation ($1B CAPEX equal 20ME/y amortisation)

- **Alternative solutions**: Aggregated DER side technology (DG, DR or SD)
  - Capital deferral
  - New regulation driven by UK RIIO & NY REV

Develop alternate to complex Grid reinforcements
Virtual Power Plant architectures

A collection of distributed energy resources (loads, generators, and storage) that are aggregated and coordinated to provide value to stakeholders (Prosumers and electricity Markets)
Typical Deployment
Demand Response Management

- 2.4 million customers
- 45,592 square miles
- 7215 MW of peak demand
- 5815 MW of generating
- 3 different demand response programs
- 5 different load management systems
- 75,000 customers connected
- 120 MW of demand response
- Another 200 MW target

Enable Demand Resource Participation