

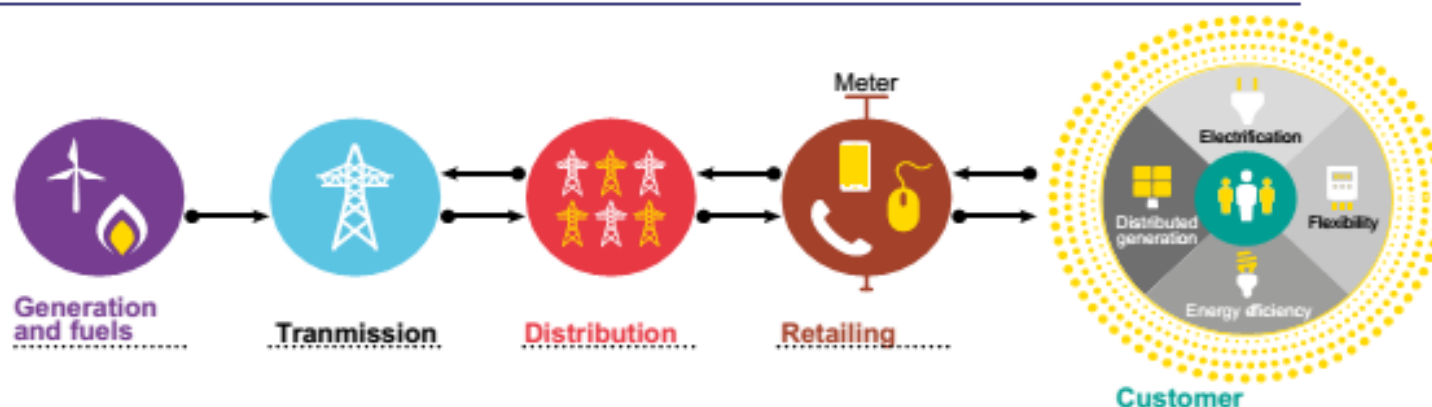


Smart Networks and Demand Response

GE Grid Solutions / Global Smart Grid Strategy Leader
Laurent Schmitt

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

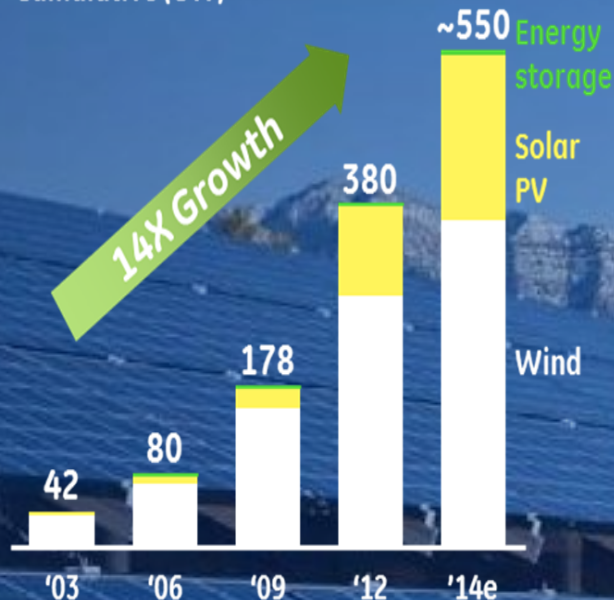
Impact: growth of electricity demand, and an acceleration of decentralization of the power sector

Renewable integration...at incredible speed



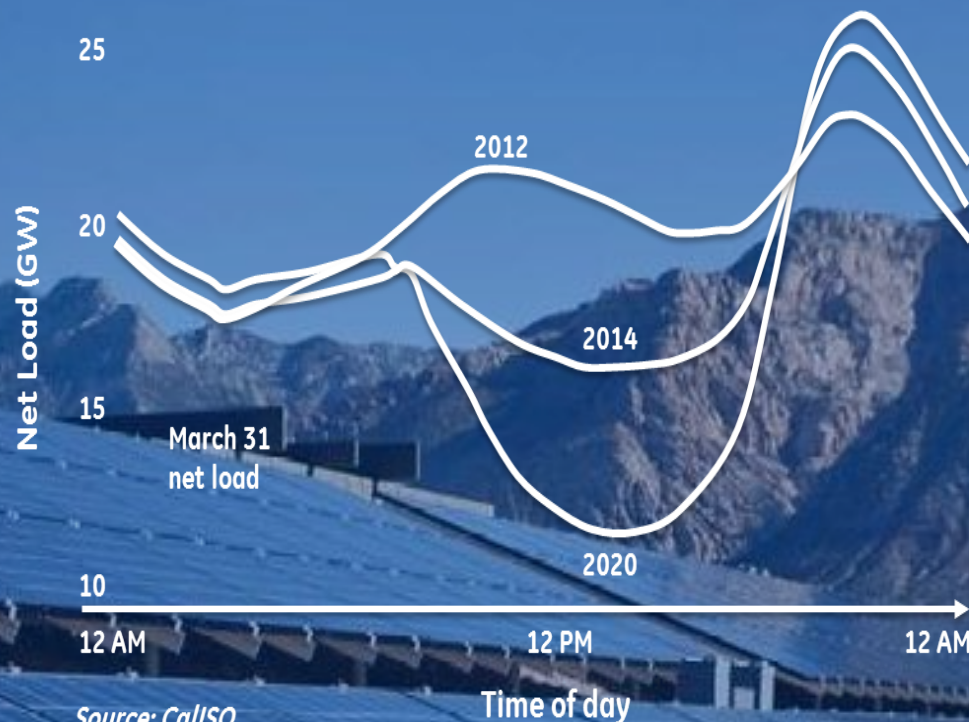
Global Installations

Cumulative (GW)



Source: GWEC, Navigant, REN21, Bloomberg, MAKE

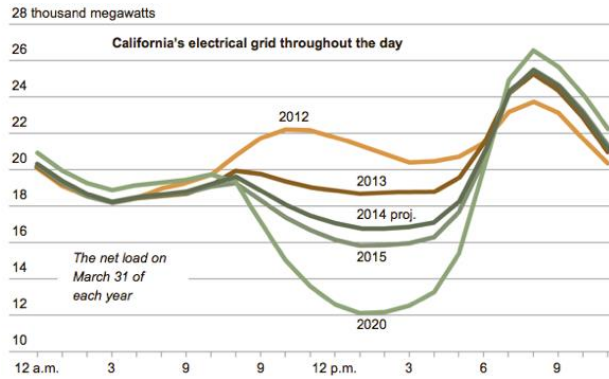
Impact on California



Source: CalISO

Growing Complexity in Renewable Integration

Growing Scarcity in Grid Flexibility



Source: CalISO

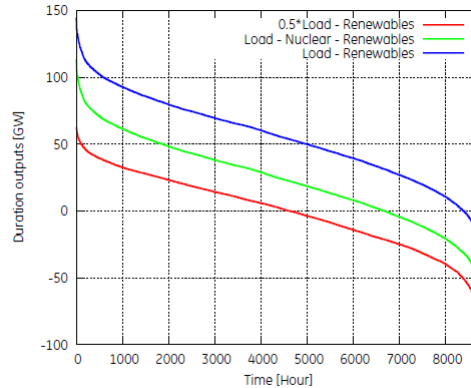
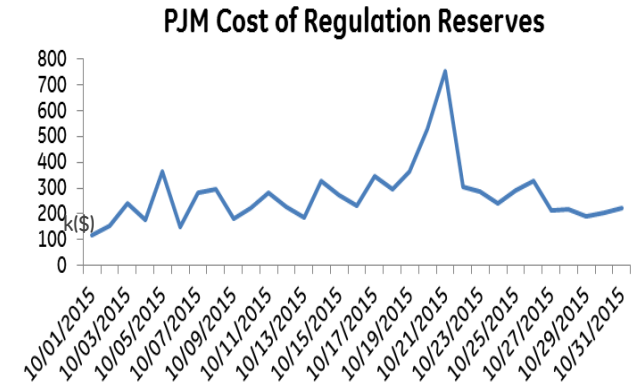


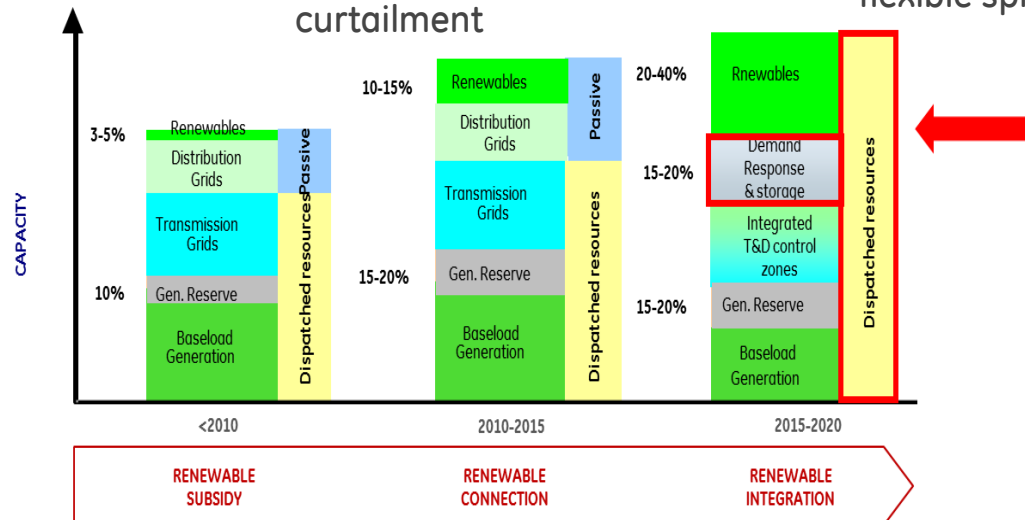
Figure 2.1: Load duration curves for PJM Interconnection



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

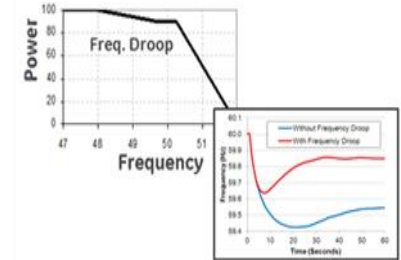
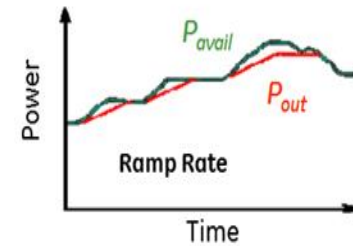


New Renewable-Grid integration strategies



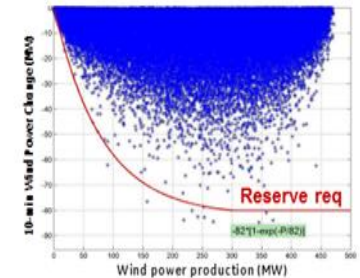
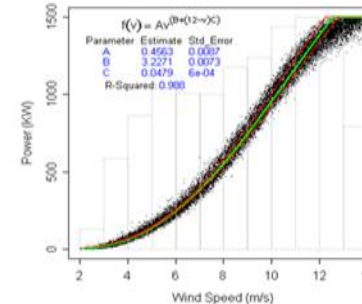
Improved renewable controllability

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



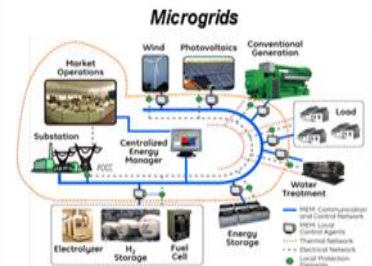
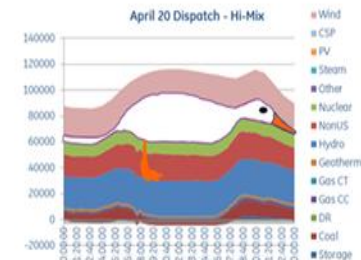
New Generation dispatch strategy

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



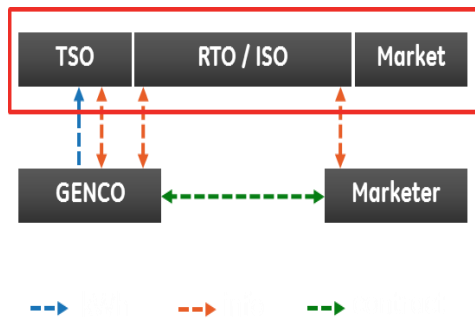
New Distributed Energy Resources aggregation

- DER Virtual Power Plant participation into Markets & Grid ancillary services
- Optimal Gridedge connectivity through Microgrids

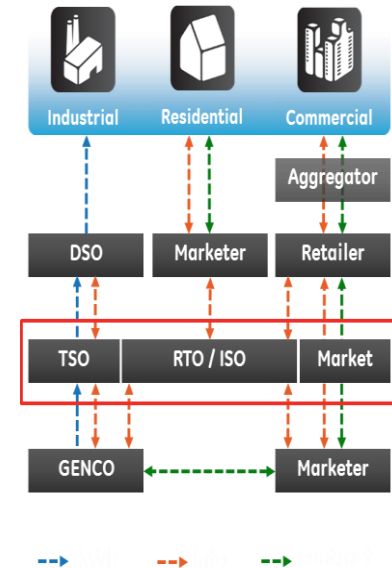


Pressing needs to redesign energy markets

Transmission



Distribution



- 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

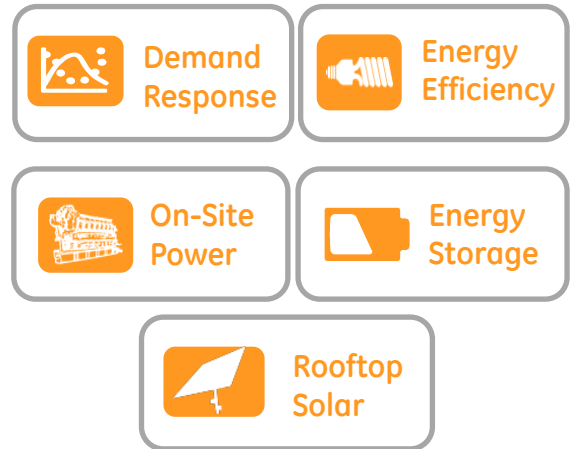
Brooklyn and Queens Zone Map



- 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)



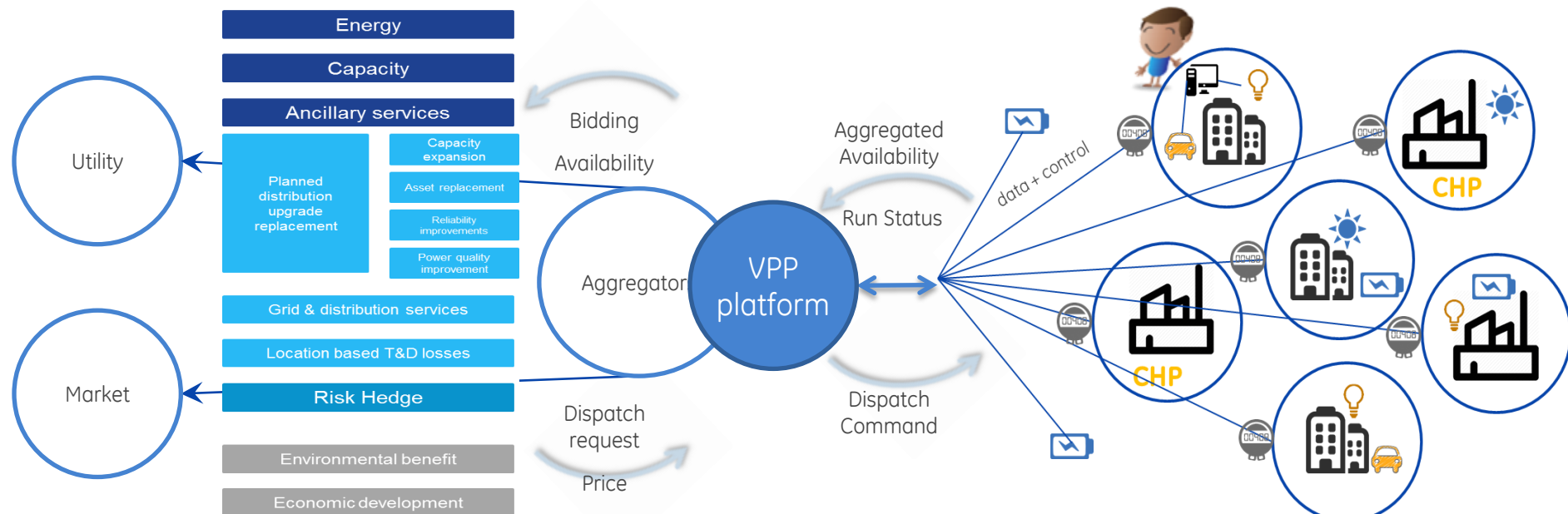
- **Alternative solutions:** Aggregated DER side technology (DG, DR or SD)
- Capital deferral
- New regulation driven by UK RIIO & NY REV



Develop alternate to complex Grid reinforcements

Virtual Power Plant architectures

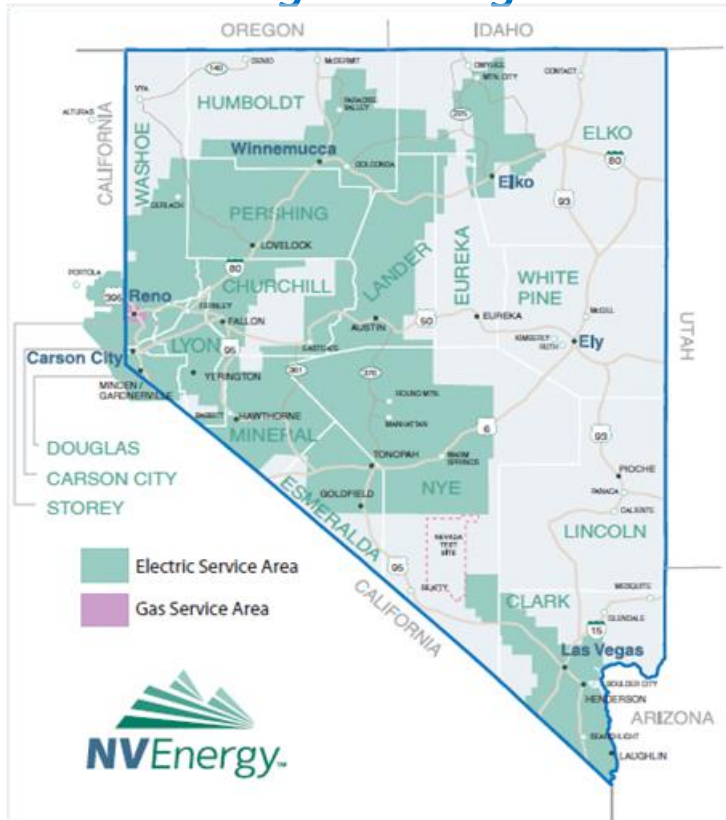
A collection of distributed energy resources (loads, generators, and storage) that are aggregated and coordinated to provide value to stakeholders (Prosumers and electricity Markets)



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



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