ADVANCED INTEGRATED PLANNING
THE DER DRIVEN TRANSFORMATION IMPERATIVE
SEPA
GRID EVOLUTION SUMMIT
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OUR VIEW ON THE INDUSTRY TRANSFORMATION
THE ENERGY CLOUD

TODAY: TRADITIONAL POWER GRID
Central, One-Way Power System

EMERGING: THE ENERGY CLOUD
Distributed, Two-Way Power Flows

1 Navigating the Energy Transformation: Building a Competitive Advantage for Energy Cloud 2.0 (white paper)
Survey of 400+ key industry professionals – July, 2017

“Which one of the following trends is the most disruptive to traditional utility business models over the next decade?”

- Nearly half of the respondents cite increased penetration of DER as the most disruptive threat to traditional utility business models over the coming decade.
- The effects of DER are industry-wide and will have a deep impact on the existing market.
- DER was by far the dominant trend cited among respondents, with all other trends receiving only a small fraction of votes.
DISTRIBUTED ENERGY RESOURCES (DER): WHAT’S INCLUDED?

Resources can be utility, customer, or 3rd party owned on the grid in front of the meter or customer owned behind the meter.
DER IN THE UNITED STATES
WE FORECAST STRONG DER PENETRATION GROWTH OVER THE NEXT DECADE

Observations
• DER deployments will reach ~30 GW this year in the US, versus new central station generation (19.7GW)
• On a 5-year basis (2015-2019), DER in the US is growing almost 3 times faster than central generation (168 GW vs. 57 GW).

(Source: Navigant Research)
EXAMPLE CHALLENGE: LOAD FORECASTING TRADITIONAL TECHNIQUES SHOWING SIGNS OF AGE

• “Past performance is no guarantee of future results”
  - DERs are less predictable (both in installed capacity, and daily performance)
  - Weather patterns seem to be breaking from long term trends
  - Customer behavior (in some cases) is evolving
  - New types of load not predicted or well understood yet (e.g., EVs, grow-ops)

• Geo-special granularity now required

• Recent system-wide forecasting misses—a few examples:
  - Large Eastern utility misses spring/winter forecast: points to unusual weather
  - Southern utility misses annual forecast significantly: reasons under review
  - Mid-sized Northern IOU misses peak forecast on high-side for several years running: weather?
  - Mid-Atlantic utility load forecast used to justify construction of large generating station: actual loads falling far short (economic downturn played a clear role here, and no-one predicted it, to be fair)

• Implications:
  - Under- or over- investment
  - Investment/upgrades in wrong or too many locations
  - revenue shortfalls

• And there are challenges beyond forecasting…

Note: the availability of advanced modeling techniques and cost-effective big data computing power are no longer impediments to conducting advanced analytics & load forecasting with these data
PLANNING MUST BE MORE AUTOMATED AS WELL AS INTEGRATED = ADVANCED INTEGRATED PLANNING

**Traditional Planning:**
- Largely internal to utility
- Some coordination between planning functions
- Stakeholder process engaged at the end of the cycle

**Advanced Integrated Planning:**
- Integrated internal functions, as well as stakeholder process
- “Optimization” of investment across customer, distribution, transmission, generation
- Uncertainty and risk analysis fundamentally integrated

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2-3 year planning cycle

Sub-year iterations

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ADVANCED INTEGRATED PLANNING: HIGH LEVEL ANALYTICAL FRAMEWORK

External Market: Evolving technology and vendor landscape, new service providers, etc.

Internal Operations: People and processes within utility planning functions

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**Internal Systems Context:** OT/IT production systems

1. Advanced Load and DER Forecasting (with integrated customer program / resource scenarios)

Add: Load profile management (daily, hourly); geo-special granularity

2. Distribution Planning & Analysis

Add: dynamic analysis (transient impacts)

3. Transmission Planning & Analysis

Add: system stability analysis: voltage oscillation risk

4. Integrated Resource Planning (IRP)

Add: Load/DER

Add: Cross Team and cross analysis coordination

5. Coordination, Analysis and Integration (coordinated data flows with integrated benefit-cost and reliability analysis)

Add: Criteria—Reliability, Economic, Environmental, Risk/Uncertainty

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**Visualization and Planning Management Layer**

Dynamic, standardized data exchange

Aggregation Load/DER

Geo-special scenario data

Impact of DER Installations

Analysis coordination, automation and data flow control

Wholesale Values of Capacity/Energy

Add: system stability analysis: voltage oscillation risk

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ADVANCED INTEGRATED PLANNING: CAN START WITH EXISTING TOOL SETS

Visualization and Planning Management Layer

- Python (Pandas, Django, d3.js, crossfilter.js, dc.js, leaflet.js)
- HTML5

5. Coordination, Analysis and Integration

- CYMDist (steady state & dynamic)
- Synergi
- Milsoft
- DEW
- GridLabD
- PSSE: Network models needed to assess advanced concepts (e.g. networked systems)

4. Integrated Resource Planning (IRP)

- Siemens PTI - PSSE, Python, MUST
- Power world
- GE - PLSF
- Power Gem - TARA
- Matlab
- EMTP
- PSCAD
- Gridview

1. Advanced Load and DER Forecasting

- Excel
- R
- dB/SQL
- SAS
- Analytica
- TROVE
- IA
- Energia
- Others evolving

2. Distribution Planning & Analysis

3. Transmission Planning & Analysis

Broad array of commercial tools in use today
ANALYSIS OF CIRCUIT UPGRADE COSTS TO MEET DER PENETRATION LEVELS

**High-Level approach:**
- Analyze dynamic performance of distribution feeder for high penetration DER

**Objectives:**
- Apply predictive modeling on representative distribution feeders to assess PQ impacts from variable renewable output
- Assess the capability of advanced inverter functionality to mitigate PQ impacts
The net present value of deployed distribution grid capabilities is $3.2B

- **Net present value of investments (2016 $B)**
  - $3.2B
  - $1.5B

- **Uncertainty analysis for net present value (2016 $B)**
  - Scenario | Best | Expected | Worst
  - NPV ($B) | 5.0  | 3.2     | 1.0  
  - Approximately 3% chance of negative NPV

- **Annual benefits and costs of investments (nominal $B)**

- **Distribution of costs and benefits across the value chain (2016 $B)**
  - Generation
  - Transmission
  - Distribution
  - Customers

The best and worst case represent the 95th and 5th percentile outcomes, respectively.
TO MEET THE IMPERATIVE…

• Convene a cross-functional team charged with planning in a high-DER environment:
  - examine how existing planning tool sets are used, and whether they can meet the more
dynamic needs of high DER planning
  - understand the gaps, and what external tools are available and appropriate
  - Develop internal tools to coordinate across external planning tools processes
• Develop DER adoption scenarios that will impact the business
  - Develop corresponding load forecasts using newer, advanced techniques (bottom-up,
data rich)
• Perform planning analyses for relevant parts of value chain (e.g.
customer programs, distribution, transmission)
• Optimize across potential investment and program areas
• Iterate quickly, as situation on the ground and external market forces evolve