Methods and Tools for Distribution Resources Planning
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Integral Analytics Presentation
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Key Takeaways

- Public Utilities Code Section 769 requires utilities to file distribution resources plans (DRPs) by July 1, 2015.
  - Proper plan development implies a need for geo-spatial forecasts at the local distribution level.
  - Leveraging AMI data to define customer cost of service.
  - Applying optimization analytical processes like LTPP, but at a local level.
Key Takeaways

- **Geo-Spatial Analytics**
  - Proper plan development requires geo-spatial forecasts at the local distribution level.
  - Avoided costs are location specific.
  - DER / DR / Distribution equipment decisions are location specific.

- **Customer Analytics**
  - Leverage AMI data and “big data” to enable customer targeting and define customer cost of service.
  - Build load shapes to cover the expance of planning needs:
    - Distribution planning area
    - Sub-station
    - Circuit
    - Customer
Key Takeaways

- **Optimization analytics**
  - An analytical process that integrates all distribution level options provides the best value proposition.
  - Given CYME type power flows, the choice of options to address power flow issues can be optimized to minimize Distribution Marginal Costs (DMC)
  - DMC are the full set of avoided costs at the distribution location. Focus also on kVA/kVah, not just kW/ kWh
  - DMC values at distribution are like system level LMPs
  - DMCs and Distribution Marginal prices are foundations for transactive energy prices
Key Takeaways

- Cost effectiveness is unchanged but granularity is increased in moving to the DRP process.
  - Only the inputs change (i.e., granularity and specificity for small area loads and avoided costs).
  - Avoided costs become location specific.
  - Analysis must consider location specific load shapes.

- Geospatial customer targeting reduces implementation costs and maximizes value creation.
LTPP Analytics

- Long Term Procurement Plan (LTPP)
  - Load Forecast assuming no DER / DR
How to Square with Avoided Costs?

- Components of avoided costs
  - Generation Avoided Capacity Cost (Statewide average)
  - Generation Avoided Energy Cost (Statewide average)
  - T&D Avoided Capacity Value (Utility System average)
Gaps

- Procurement process ignores value below the generator level, i.e., distribution system avoided costs.

- Cost effectiveness screening of EE programs largely ignores the locational benefits of DER resources.

- Cost effectiveness screening of EE programs also ignores the locational cost specificity of distribution equipment investments.
Gaps

Levelized Cost
$/kVah

Marginal Cost

High Cost
Distribution Options

Clean generation

High cost EE

Renewable resources

Low Cost Distribution Options

Low cost EE

Low DMC

High DMC

kWh
Linkage to DRP

- Process is similar, just operates at a locational level using more granular data.

- Instead of a statewide or system level analysis, DER / DR screening occurs at the appropriate distribution level.
  - Distribution planning level, substation, circuit

- Generation options remain the same, though supplemented with local DG options.
Components of avoided costs revised

- Generation Avoided Capacity Cost, but applied to the locational load shape
- Generation Avoided Energy Cost, but applied to the locational load shape,
- T&D Avoided Capacity Value (Location Specific)
- T&D Avoided kVah Value (Location Specific)

Expand marginal cost curves to include investment in distribution equipment in addition to DER and DR options
Integrated DRP: Roundup Silos

- Process requires geospatial forecasts.
- Local distribution load shapes from AMI data replace the system or statewide load shape.
- Greater number of resource options:
  - DER / DR
  - Distribution equipment
  - Generation
- Cost effectiveness operates the same, now just use localized inputs
- Given CYME type power flows, the choice of options to address power flow issues can be optimized.
Must Create Geo-spatial Forecasts

- Since DERs are at the Grid Edge, need “edge” forecasts
- DER impacts are not in the historical data. Regression modelling will not capture that
- Commonly known among distribution planners that spatial forecasting is needed, but sparsely used in past 30 years. (See Distribution Planning Handbook, Lee Willis)
- Dramatically improves power flow analysis as acre-level forecast gets placed at appropriate circuit section versus proportionally “smearing” load growth and avoided costs over whole circuit
- Allows forecasts of future demand per bank (ISO need) which aids in more detailed price/transmission analysis
Integrated DRP: Customer COS

- **Must Focus on Customer Cost of Service**
  - To identify least cost, locally, need to understand customer cost of service
  - California has very rich AMI data that should be leveraged
  - Enables identification of which customers contribute the most to supply capacity needs. (“Peakier” circuits and customers impose higher reserves vs. average of 17%)
  - Enables identification of which customers cause more peak load risk to the substation banks and circuits which is useful for customer targeting of programs
  - Can quantify the option value, or load at risk during extreme weather and extreme price conditions
  - Allows for more accurate settlement shapes, innovative rate design by customer, and true cost to serve per customer
Smart Grid programs target the Zone of Covariance

Covariance Driven By Key Factors

Hot Weather
Cold Weather
Drought (hydro)
Forced Outage
High Fuel Costs
Market Forces

Increasing Market Prices

Avoided Generation Costs ($$)

High Value Target Zone

More Extreme Weather

$60/MWH
$30/MWH

Its About Cost Management First, and Load Management Second
Integrated DRP: Optimize

Must Optimize

- Just as LTPP optimizes supply costs vs. load forecast, the DRP should identify optimized mix of DERs given local geo-spatial load forecasts. DMC uses power flows vs. LTPP production model.
- System lambda and LMPs are analogous to DMCs.
- Enables optimal identification of location of PV.
- Enables optimal location of smart inverters and storage.
- The marginal “shadow price” (DMC) is the right transactive signal.
- If customers follow the signal, then loads are levelized, voltage improves, costs avoided, and ISO ancillary service costs decrease.
- Optimization done jointly over KVAh, not just kwh. So, we don’t create costs by only focusing on KWH (HVAC ECMs).
Integrated DRP
County Level Land Use Forecast (2011)

Land Growth Classes
2 = Residential - Rural
3 = Residential - Suburban
4 = Residential - Multi/Dense
5 = Residential - High Rise
6 = Retail Commercial (Including Parking Lots)
8 = Business Parks
12 = Light and Medium Industrial
15 = Institutional (Schools, Churches)

Legend - Existing

Legend - Growth
County Level Land Use Forecast (2028)

Legend - Existing
LanduseRaster
Type
- Agriculture
- BusinessPark
- Commercial
- High Suburban Density Residential
- Industrial
- Public Institutional
- Recreational
- Rural Density Residential
- Suburban Density Residential
- Transportation
- Urban Density Residential
- Water
- Woodland

Legend - Growth
- 0
- 2
- 3
- 4
- 5
- 6
- 8
- 12
- 15

Land Growth Classes
2 = Residential - Rural
3 = Residential - Suburban
4 = Residential - Multi/Dense
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Land Use Forecast (2010)
Land Use Forecast (2030)
City Level Reliability Results

Red = Target EE/DR/PV

Green = Load
Building is Least Cost, for EV Charging or New Economic Development

Red = Over Capacity
Green = 50%-75% Loaded
Local load increases get assigned to nearest CYME node for improved power flow analysis.
Simulation of load flows is required to enable full understanding of avoided costs.
Limiting Factors: Power Flow Over the Peak Day

@ Service Transformer
Blue < 116V
Red = Overloaded

Animate by hovering cursor over map, Click Play
DMP Prices (4pm) BASE CASE
Transactive Price Signal from IDROP
(Circuit 11XX, Western US Utility)
4 – 5 PM

$/MWH
- $9.59 - $23.61
- $23.62 - $37.63
- $37.64 - $51.65
- $51.66 - $65.67
- $65.68 - $79.69
- $79.70 - $93.71
- $93.72 - $107.73
- $107.74 - $121.75
- $121.76 - $135.77

1 Mile

Power Flow
Substation
Distributed Marginal Prices (DMP : DMC)

DMP Prices (4pm) WITH DR
Transactive Price Signal from IDROP
(Circuit 11XX, Western US Utility)
4 – 5 PM

$/MWH
- $9.59 - $23.61
- $23.62 - $37.63
- $37.64 - $51.65
- $51.66 - $65.67
- $65.68 - $79.69
- $79.70 - $93.71
- $93.72 - $107.73
- $107.74 - $121.75
- $121.76 - $135.77

1 Mile

Power Flow Substation
DMP Prices (4pm) WITH DR and KVAR
Transactive Price Signal from IDROP
(Circuit 11XX, Western US Utility)
4 – 5 PM

Power Flow Substation

$MWH
- $9.59 - $23.61
- $23.62 - $37.63
- $37.64 - $51.65
- $51.66 - $65.67
- $65.68 - $79.69
- $79.70 - $93.71
- $93.72 - $107.73
- $107.74 - $121.75
- $121.76 - $135.77

1 Mile
Summary / Conclusions

- Geo-Spatial Analytics
  - DRP requires geo-spatial forecasts at circuit level
  - Avoided costs are location specific. DER/Distribution equipment decisions change when location specific

- Customer Analytics
  - Leverage AMI data to define customer cost of service

- Optimization Analytics
  - An analytical process that integrates all distribution level options provides the best value proposition
  - Given CYME type power flows, the choice of options to address power flow issues can be optimized to minimize costs (DMC) – like a local level LTPP
  - DMC (DMP) values provide the foundation for transactive energy price
Summary / Conclusions

- Cost effectiveness assessment remains unchanged in moving from the LTPP process to DRP process
  - Only the inputs change (i.e., granularity and specificity for small area loads and avoided costs).
    - Avoided costs become location specific.
    - Analysis must consider location specific load shapes.

- DMC values at the distribution level are analogous to system level LMPs. DMC/DMP values provide the basis for transactive energy

- Geospatial customer targeting reduces implementation costs and maximizes value creation
Integral Analytics Software

- **LoadSEER**
  - Geo-spatial load forecasting system for electric distribution planning.

- **DSMore**
  - Widely used tool for DER cost-effectiveness – also used to develop 8760 load shapes.

- **SmartSpotter**
  - Intelligent customer targeting to increase cost-effectiveness.

- **IDROP**
  - Integrates distributed resources into an optimal portfolio. Generates DMC’s and DMP’s.