Load Allocation using Spatial Forecasting

Presented by:
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Agenda

• Load Forecasting Methods
• Case Study Description
• Data Challenges
• Special (Spatial) Load Allocation
• Lessons Learned
• Next Steps
• Questions
## Load Forecasting

<table>
<thead>
<tr>
<th>Method</th>
<th>Benefits</th>
<th>Drawbacks</th>
</tr>
</thead>
</table>
| Historical Trending | • Minimal data requirements  
                  |     • Simple, quick and inexpensive  
                  |     • Several available techniques/algorithms                              | • Assumptions are generally poorly documented  |
|                 |                                                                           | • Inaccurate forecast during implementation of demand reduction programs  |
|                 |                                                                           | • No technique for measuring the impact of demand changes                   |
|                 |                                                                           | • Method accuracy dependent on utility knowledge of future developments     |
## Load Forecasting

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<tr>
<th>Method</th>
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<tbody>
<tr>
<td>End Use Analysis</td>
<td>• Assumptions are very well documented</td>
<td>• Extensive data requirements</td>
</tr>
<tr>
<td></td>
<td>• Identifies by customer class usage by demand source</td>
<td>• Method assumes constant relationship between electricity and end-use (electricity per</td>
</tr>
<tr>
<td></td>
<td>• Method provides utility the opportunity to determine</td>
<td>appliance or electricity used per dollar)</td>
</tr>
<tr>
<td></td>
<td>how conservation measure impact demand</td>
<td>• Changes including energy saving technologies or energy prices</td>
</tr>
<tr>
<td></td>
<td>• Method is considered accurate (until data inputs change)</td>
<td>• Method is only accurate for short term forecasting</td>
</tr>
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<tr>
<td>Econometric</td>
<td>• Assumptions are very well documented</td>
<td>• Extensive data requirements</td>
</tr>
<tr>
<td></td>
<td>• Provides detailed information on future demand, why demand changes,</td>
<td>• Accuracy is dependent on projections of electricity, natural gas, or oil</td>
</tr>
<tr>
<td></td>
<td>and how demand is impacted by various factors</td>
<td>prices</td>
</tr>
<tr>
<td></td>
<td>• Can provide customer class based forecast</td>
<td>• Method works best for forecasting at regional or system level – NOT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>feeder level for distribution planning</td>
</tr>
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### Load Forecasting

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<tr>
<td>Spatial / Small Area</td>
<td>• Assumptions are very well documented&lt;br&gt;• Credible and defensible&lt;br&gt;• Method better answers <em>where</em> new or upgraded equipment will be required&lt;br&gt;• Better than trending alone, provides deeper than feeder level understanding</td>
<td>• Extensive data requirements&lt;br&gt;• Requires more advanced algorithms and computing tools and techniques&lt;br&gt;• Expensive&lt;br&gt;• May introduce new methods amongst, older more mature and trusted methods</td>
</tr>
</tbody>
</table>
Case Study: Background

- High Growth Municipal Utility 60K+ customers
- Denser, urban underground system
- Mature WindMil model
- Custom GIS on MS Access / Autodesk
- Several hot new growth areas and annexation areas
- Small area forecast requested to validate electric system expansion
- Provide more detail and longer range forecast to existing feeder-level forecast
- Mainly a data assembly project in initial phase
Case Study: Process

- Top-down load forecast, with small-area/spatial element
- Hybrid approach with trending and small area forecast
- Harmonized with the City Plan and land use projections
- Determined annexations for future 20 years
- Developed load density assumptions and spatial model of load for the current and future system
- Reconciled to the accepted, (20 year) long-range system-level load forecast
- Used small areas to allocate load to WindMil
- Followed-up with capital projects planning study
<table>
<thead>
<tr>
<th>Case Study: Spatial Forecast Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Land parcels with acreages</td>
</tr>
<tr>
<td>• Map Grid by section and ¼ section</td>
</tr>
<tr>
<td>• Current and Future land-use / zoning areas</td>
</tr>
<tr>
<td>• Load Density by acre and load assumptions</td>
</tr>
<tr>
<td>• Special load density study areas</td>
</tr>
<tr>
<td>• Future load under contract / spot loads</td>
</tr>
<tr>
<td>• System-level load forecast</td>
</tr>
<tr>
<td>• City limits / Annexation areas</td>
</tr>
<tr>
<td>• Growth Management Area, regional planning data</td>
</tr>
<tr>
<td>• WindMil model extract from GIS</td>
</tr>
<tr>
<td>• SCADA Feeder Peak Loads</td>
</tr>
</tbody>
</table>
Case Study: Didn’t Have

- “Detailed” model with secondary and customers
  - Could not relate customers to parcels
- AMI data wasn’t ready for primetime not available yet
- Customer load studies correlated to land use
- Weather studies
- DER / Renewables potential
Case Study: Land-Use Types

- Urban Estate
- Mixed Use
- Res. (Low Density)
- Res. (High Density)
- Commercial
- Downtown
- Industrial
- Rural Land
Case Study: Land-Use
Case Study: Special Load Areas

• Red and orange parcels given special treatment for load density as higher load typical to land-use that parcels were zoned for

• Heavier commercial lots estimated to 200 kVA/Acre instead of 100 kVA/Acre for the zoning designation
Case Study: System Load Forecast

![Graph showing historical and forecasted FCU system loads with trend lines for different growth rates.](image-url)
Case Study: Load Density

Legend
- Substation
- Current City Limits
- Current 1-5 kVA
- 1-25 kVA
- 25-50 kVA
- 50-100 kVA
- 100-200 kVA
- 200-500 kVA
- 500-1000 kVA
- 1000-5000 kVA
- 5000-10000 kVA
- Lake/Pond
- Urban/Unincorporated

Current and Future 2035 System Loads from Load Density Study
Data Challenges

• Model and City GIS were not on same geographic base
• “Cleansing” parcel and land-use data
• Determining when for annexations within 20-yr horizon
• Linking model elements to GIS parcels
• Correlating WindMil, SCADA and small areas
• Working spatial methods into traditional planning techniques: system-level forecast, feeder growth forecasts, WindMil model load allocation
• Calibrating initial load density assumptions to reality of current system
Special (Spatial) Load Allocation

- Established data link between model line sections and land parcels
- Used our feeder level load forecast model modified and linked to individual parcels to build-up to feeder level
- Evaluated loads from load density assumptions to model / SCADA current feeder loads to calibrate and change assumptions
- Used future land use for load growth combined with trended growth for established areas
- Used land use within calibration limits for annexation / undeveloped areas
Spatial Load Allocation: WindMil

- Create load bearing elements
  - Node
  - Consumer
  - Overhead/Underground Line
- Connecting load bearing elements
- Applying load to each load bearing element
Spatial Load Allocation: Initializing

• Allocate existing system model
  – Transformer kVA, kWh, or Demands

• Apply load density assumptions to existing zoning

• Identify and correct discrepancies from existing load
Spatial Load Allocation: Calibration

Reconcile

• Forecasted System Coincident Peak
• Forecasted System Non-Coincident Peak
• Feeder Growth Projections
• Projected Zoning
• Projected load densities
Spatial Load Allocation: Forecast

- Apply Load projections to the existing system configuration
- Identify and correct inconsistencies and allow for largest / spot loads
Lessons Learned

• Data is expensive to create and assemble
• Data is key and data can lie sometimes
• Requires collaboration across departments and data “Siloes of Excellence”
• More data and sophisticated techniques needed for simulation rather than trending Small area methods provide focus on specific areas and extents of feeders and deep understanding of makeup
• Even for the hybrid we used, more advanced tools are needed to deal with assembling data – Excel has limitations
• Small area techniques work great on greenfield/annex areas, already developed areas are tricky, requires calibration
• Traditional planning rule-of-thumb load density can work ok, but small area analysis showed where it would not be accurate
Next Steps

- Updating and tracking load forecast and growth
- Integrating AMI data, correlating small area loads
- Studying customer class load profiles
- Refining coincidence and diversity assumptions
- Applying spatial trending techniques, simulation
- Forecasting DER potential for small areas
- Weather normalization
- Predictive analysis
- LUA scripting, creating/using advanced tools and techniques to automate data handling and enhance modeling
Questions?

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