Load Model Improvements – a Case Study

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Data Management

• Complexity of load modeling
  – Each load has a different composition
  – Load magnitude and composition changes over a day, over a year, and over the years.

• Had to find ways to simplify data management processes

• Other entities will also need to find ways to simplify data management, may wish to consider some of WECC’s methods
Load model addition to a new base case

- Developed a process we use to build composite load models for a given base case.
- Don’t need to worry about all the details for each case.
CLZONE – “Climate Zone”

Developed by WECC LMTF to categorize similar load patterns and types

WECC has approximately 60 climate zones, formed from combinations of climate areas, feeder types, and industrial load types.
LID Regions

NWC – Northwest coast
NWV – Northwest valley
NWI – Northwest inland
RMN – Rocky mountain
NCC – N. Calif. coast
NCV – N. Calif. valley
HID – High desert
SCC – S. Calif. coast
SCV – S. Calif. valley
DSW – Desert southwest
### WECC Climate Areas

<table>
<thead>
<tr>
<th>ID</th>
<th>Climate Zone</th>
<th>Representative City</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWC</td>
<td>Northwest Coast</td>
<td>Seattle, Vancouver BC</td>
</tr>
<tr>
<td>NWWV</td>
<td>Northwest Valley</td>
<td>Portland OR</td>
</tr>
<tr>
<td>NWI</td>
<td>Northwest Inland</td>
<td>Boise, Tri-Cities, Spokane</td>
</tr>
<tr>
<td>RMN</td>
<td>Rocky Mountain North</td>
<td>Calgary, Montana, Wyoming</td>
</tr>
<tr>
<td>NCC</td>
<td>Northern California Coast</td>
<td>Bay Area</td>
</tr>
<tr>
<td>NCV</td>
<td>Northern California Valley</td>
<td>Sacramento</td>
</tr>
<tr>
<td>NCI</td>
<td>Northern California Inland</td>
<td>Fresno</td>
</tr>
<tr>
<td>SCC</td>
<td>Southern California Coast</td>
<td>LA, San Diego</td>
</tr>
<tr>
<td>SCV</td>
<td>Southern California Valley</td>
<td>LA, San Diego</td>
</tr>
<tr>
<td>SCI</td>
<td>Southern California Inland</td>
<td>LA, San Diego</td>
</tr>
<tr>
<td>DSW</td>
<td>Desert Southwest</td>
<td>Phoenix, Riverside, Las Vegas</td>
</tr>
<tr>
<td>HID</td>
<td>High Desert</td>
<td>Salt Lake City, Albuquerque, Denver, Reno</td>
</tr>
</tbody>
</table>
### Feeder Type

<table>
<thead>
<tr>
<th>ID</th>
<th>Feeder Type</th>
<th>Residential</th>
<th>Commercial</th>
<th>Industrial</th>
<th>Agricultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>RES</td>
<td>Residential</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>COM</td>
<td>Commercial</td>
<td>20%</td>
<td>80%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>MIX</td>
<td>Mixed</td>
<td>40%</td>
<td>40%</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>RAG</td>
<td>Rural Agricultural</td>
<td>40%</td>
<td>40%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

LID code is `<3-character climate zone>_<3-character load class>`
Or `<7-character industrial load ID>`

LID is a field located in the load table.

For example:
Commercial load downtown Phoenix with high concentration of commercial loads would be identified as "DSW_COM"
Rural agricultural load in Moses Lake, WA would be identified as "NWI_RAG"
## CLZONE – Industrial Loads

<table>
<thead>
<tr>
<th>ID</th>
<th>Feeder Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>IND_PCH</td>
<td>Petro-Chemical Plant</td>
</tr>
<tr>
<td>IND_PML</td>
<td>Paper Mill</td>
</tr>
<tr>
<td>IND_ASM</td>
<td>Aluminum Smelter</td>
</tr>
<tr>
<td>IND_SML</td>
<td>Steel Mill</td>
</tr>
<tr>
<td>IND_SCD</td>
<td>Semiconductor Plant</td>
</tr>
<tr>
<td>IND_SRF</td>
<td>Server Farm</td>
</tr>
<tr>
<td>IND_OTH</td>
<td>Industrial – Other</td>
</tr>
<tr>
<td>PPA</td>
<td>Power Plant Auxiliary</td>
</tr>
</tbody>
</table>
Daily Load Shape Example

Load Profile

- Static P Current
- Static P Resistive
- Power
- Electronic
- Motor D
- Motor C
- Motor B
- Motor A
Daily Load Shape Example

Load Model Fractions

Motor A
Motor B
Motor C
Motor D
Power Electronic
Static P Resistive
Static P Current

Western Electricity Coordinating Council
Routine Process to add Load model to each base case

1) Transmission Planner (or whoever prepares load data) populates a “Climate Zone” field for each load in their power flow data submittal. They typically do this once, use for all future cases.

2) WECC runs a spreadsheet tool to look up the climate zone definitions for a given power flow case based upon the hour of day and season represented. Spreadsheet dumps a calculated sheet with feeder information, proportion of various motor types in each climate zone to a csv file.
Significant effort went into the data in the spreadsheet tool, but that was preparatory. That work does not have to be redone for each case, or by each utility.

The tool computes how much of each motor type, etc. for each climate zone based upon hour of day and type of day.
3) WECC uses an epcl program (WECC uses PSLF to build cases) that reads the completed power flow case to dump a csv file with needed information including load magnitude, voltage and climate zone for each load bus.

4) WECC runs a tool from PNNL to create the composite load model part of the dynamics data file. The tool reads three files:
   • CSV from spreadsheet tool (step 2)
   • CSV output from epcl (step 3)
   • CSV with predefined motor definitions

The tool can output cmpld model data for PSLF or PSS/E dynamics files
Implementation Process

• Several rounds of implementation, then trial, then refinement
  – 2 years of studies by individual utility volunteers with the composite load model
  – Additional adjustments were required, especially to the protection model
  – Finally approved for initial inclusion in base cases with a phased approach
    • The new model provides a better match to system events
Implementation Process

• Phased implementation
  – Currently disabled AC stalling – Phase 1
  – Work continues to better understand AC stalling
  – Hope to continue improving the model – Phase 2