Load Composition Update

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NERC Default Data

- LBNL, BPA, and SLAC have collaborated to prepare region-specific feeder models for use in transmission planning studies that rely on the composite load model
- NERC footprint divided into 80 climate regions, with representative cities identified by airport codes
- Load composition factors have been generated for these representative cities for feeder/season combinations:
  - Feeders: RES, COM, MIX, RAG
  - Seasons: Summer peak, Winter peak, Spring light load

Composition Updates

- Weather Analysis
- Vancouver Feeder Composition
- Residential Building Model Updates
- Load Composition from AMI Data
- WECC CMLD Comparison

WECC Representative Cities

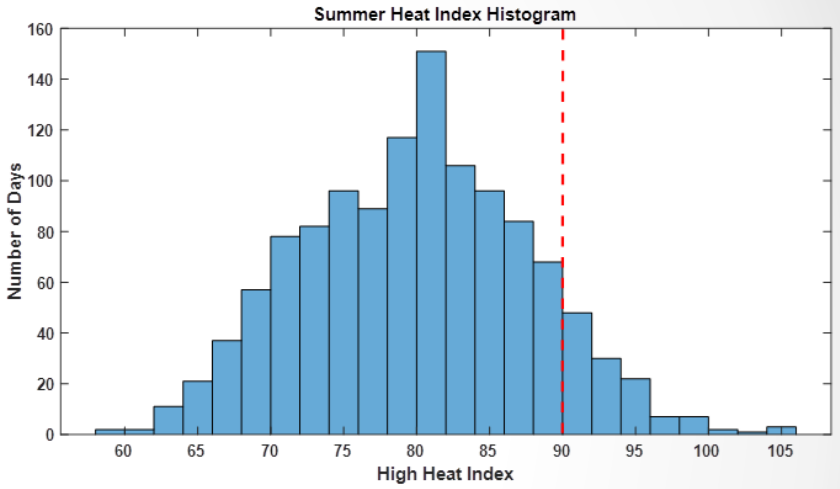
- BFL - Bakersfield, CA
- CYS - Cheyenne, WY
- DEN - Denver, CO
- GEG - Spokane, WA
- LAX - Los Angeles, CA
- ONT - Ontario, CA
- PDX - Portland, OR
- PHX - Phoenix, AZ
- RAL - Riverside, CA
- SAN - San Diego, CA
- SEA - Seattle, WA
- SFO - San Francisco, CA
- SLC - Salt Lake City, UT
- SMF - Sacramento, CA
- YYC - Calgary, AB

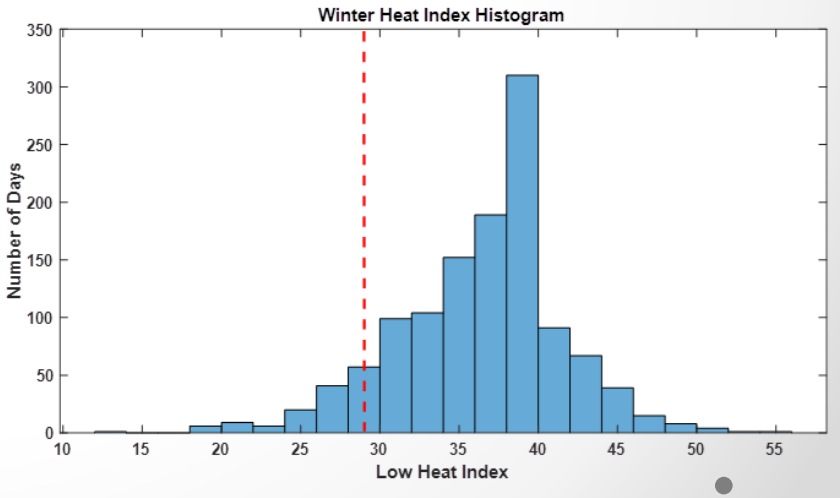
WECC Weather Analysis

- ***Issue 1***: Duplicate cities identified in some legacy climate zones
  - E.g., Salt Lake City, UT and Denver, CO are both "High Desert"
- ***Issue 2***: Representative cities may not accurately capture local weather within a region
- Weather analysis performed to address potential need for additional representative cities

WECC Weather Analysis

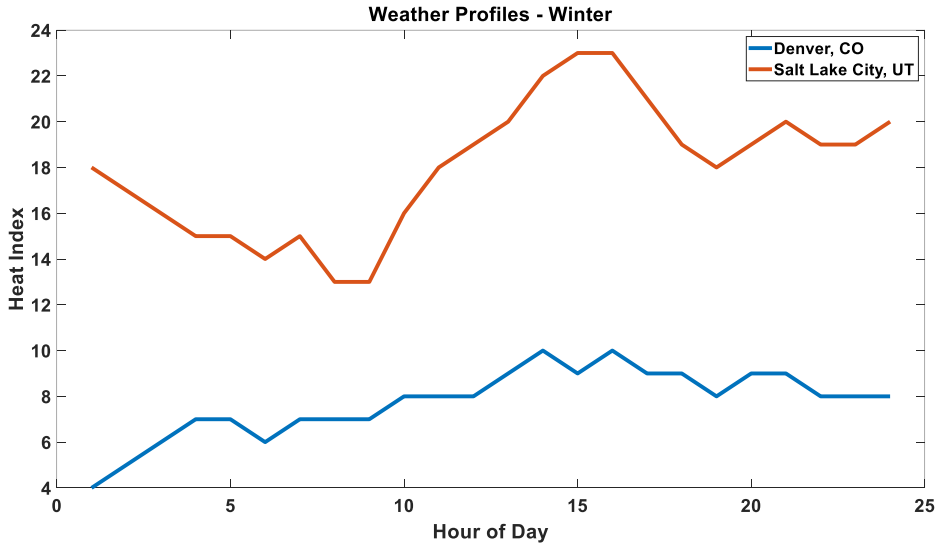
- Initial WECC representative cities: 15
- Additional "potential" cities evaluated: 12
- 20 years of historical weather data collected from NOAA
- Hourly "Heat Index" derived from dry bulb temperature and humidity
- Representative historical peak summer, peak winter, and light spring days selected





WECC Weather Analysis

- Example – Denver, CO and Salt Lake City, UT



Composition Factor	DEN_MIX for Hour 8	SLC_MIX for Hour 8
Motor A	8.6%	8.8%
Motor B	11.0%	11.3%
Motor C	2.6%	2.7%
Motor D	3.6%	3.5%
PE	9.8%	10.0%
Const-R	46.2%	45.0%
Const-I	18.2%	18.7%

Weather Analysis Cities

- ABQ – Albuquerque, NM
- BIL – Billings, MT
- BOI – Boise, ID
- ELP – El Paso, TX*
- FAT – Fresno, CA
- HLN – Helena, MT
- LAS – Las Vegas, NV
- PSC – Tri-Cites, WA
- RNO – Reno, NV
- TIW – Tacoma, WA
- TUS – Tucson, AZ
- YEG – Edmonton, AB
- YVR – Vancouver, BC

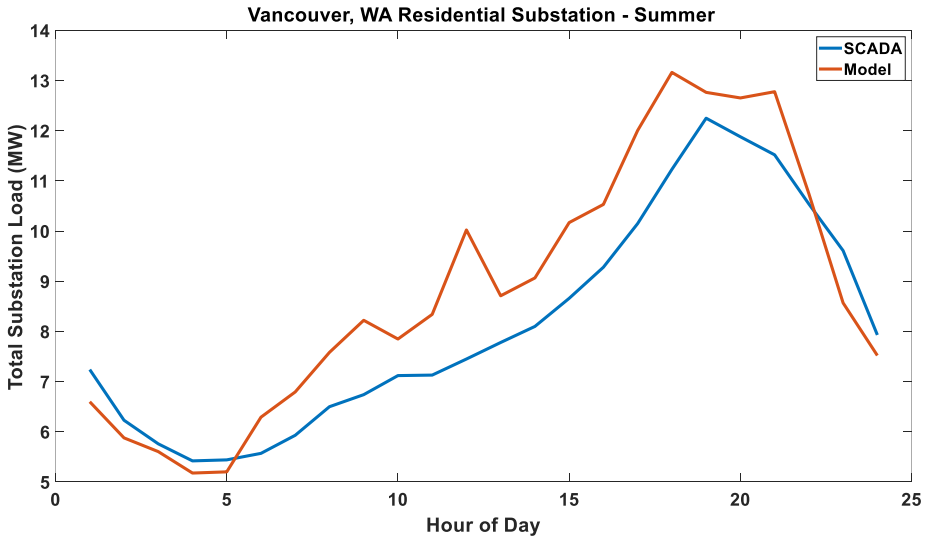
*Will be added to list of representative cities

Vancouver, WA Feeders

- **Goal:** Develop composition of actual feeders to verify and validate building models
- BPA working with Clark PUD to generate models of feeders in Vancouver, WA area
- Datasets:
  - Building square footage and commercial use (retail, restaurant, etc.)
  - Mapping of buildings to specific feeders/substations
  - Estimate of electrification (% cooling, heating, etc.) per substation
- Generate 24 hour load shapes and load compositions for these feeders using NERC process
- Compare load shapes with observed SCADA data
- Tune models and iterate

Sample Initial Results

- Highly residential substation for representative summer day:



- Accuracies show method is reasonable. Differences show need to tune both residential and commercial building models
- More iterations, additional substations to come

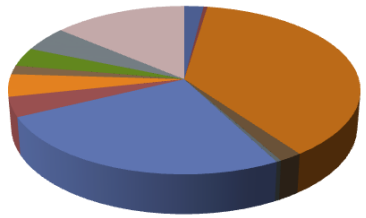
Residential Model

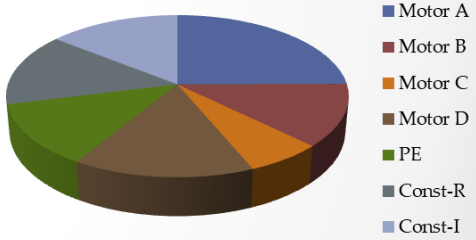
- Vancouver substation analysis informs potential changes in residential model
- Heating and cooling driven by historical data and accurate feeder composition
- Non-temperature sensitive loads currently derived from NEEA RBSA data set
- RBSA replaced by Home Energy Metering Study (HEMS)
  - Publically available, multiple years of residential metering data
  - New model parameters currently under evaluation based on updated datasets

Load Composition Using AMI Data

Feeder composition (load at peak) by NAICS/ SIC → Convert to CEUS building types → Apply end use load distributions from NERC study → Apply rules of association → Generate final load composition

NAICS Code	kW at Peak
111111	100
111112	150
111113	200
Etc…	Etc…





If any feeder composition is available by NAICS or SIC codes, seasonal load shapes and load composition can be generated

Load Composition Using AMI Data

- New effort to obtain AMI data for generating load composition factors in ISO New England
- Data requirements, per feeder:
  - NAICS or SIC codes for all buildings
  - Metered load for each building under summer peak, winter peak, and light spring conditions
  - Estimates of electrification (per building type, if possible)
  - Representative weather city
- Given this metered data, load composition factors will be generated for each feeder
- This process can be replicated for WECC entities, if AMI data is available

CMLD Comparison

- Comparison of WECC CMLD and NERC CMLD fractions

Feeder:	PDX_MIX
Description:	Portland, OR MIX
WECC Region:	NWV_MIX

Feeder with climate region

NERC composition factors

Calculated Load Composition - Summer

Type	Hour1	Hour2	Hour3	Hour4	Hour5	Hour6	Hour7	Hour8	Hour9	Hour10	Hour11	Hour12	Hour13	Hour14	Hour15	Hour16	Hour17	Hour18	Hour19	Hour20	Hour21	Hour22	Hour23	Hour24
Motor A	19.7%	19.5%	19.2%	19.3%	18.8%	19.3%	20.0%	20.8%	21.8%	23.2%	24.1%	24.1%	25.8%	26.3%	26.3%	26.8%	24.9%	22.4%	21.7%	20.1%	18.3%	19.3%	19.3%	18.2%
Motor B	11.7%	11.9%	11.8%	12.2%	12.3%	14.3%	15.8%	15.7%	15.3%	15.6%	15.2%	14.9%	14.8%	14.5%	13.9%	13.3%	12.4%	11.6%	11.4%	10.9%	10.6%	11.0%	11.4%	11.4%
Motor C	5.2%	4.9%	4.8%	4.4%	4.0%	4.0%	3.9%	4.1%	4.4%	4.6%	5.0%	5.1%	5.3%	5.6%	5.8%	6.1%	6.4%	6.6%	6.4%	6.3%	6.3%	6.1%	5.8%	5.6%
Motor D	12.3%	11.0%	10.8%	8.4%	6.8%	5.3%	4.5%	4.8%	4.6%	4.3%	5.1%	5.6%	6.1%	8.4%	9.6%	11.6%	15.0%	18.0%	17.0%	17.6%	17.7%	15.3%	14.0%	15.7%
PWREL	11.0%	10.9%	11.0%	10.9%	10.7%	12.4%	13.6%	14.1%	14.5%	14.8%	14.7%	14.7%	14.8%	14.3%	14.0%	13.5%	12.4%	11.5%	11.3%	10.8%	10.8%	10.9%	11.0%	10.8%
CONST-R	16.7%	17.1%	17.7%	17.7%	18.5%	21.0%	19.7%	18.1%	18.0%	16.8%	16.5%	16.9%	15.2%	14.2%	14.5%	13.7%	14.6%	15.4%	16.0%	16.4%	18.6%	18.1%	17.5%	17.4%
CONST-I	23.3%	24.6%	24.5%	27.1%	28.9%	23.6%	22.3%	22.3%	21.3%	20.6%	19.4%	18.7%	17.9%	16.7%	15.8%	14.9%	14.3%	14.6%	16.2%	17.9%	17.6%	19.3%	21.0%	20.9%

Load Composition From Model - Normal Summer

Type	Hour1	Hour2	Hour3	Hour4	Hour5	Hour6	Hour7	Hour8	Hour9	Hour10	Hour11	Hour12	Hour13	Hour14	Hour15	Hour16	Hour17	Hour18	Hour19	Hour20	Hour21	Hour22	Hour23	Hour24
Motor A	15.3%	15.6%	15.7%	15.6%	15.2%	14.6%	13.1%	12.0%	12.6%	13.1%	13.7%	14.4%	14.9%	15.0%	14.9%	14.2%	13.7%	12.2%	11.0%	10.3%	10.4%	11.0%	12.0%	13.9%
Motor B	14.0%	14.4%	14.5%	14.5%	14.0%	14.6%	13.5%	12.6%	12.3%	12.2%	12.3%	12.6%	13.1%	13.7%	13.9%	14.2%	14.2%	13.9%	13.7%	13.2%	12.9%	12.2%	12.1%	12.8%
Motor C	8.7%	8.8%	8.8%	8.7%	8.4%	8.0%	7.4%	6.9%	6.9%	7.1%	7.0%	6.9%	6.7%	6.5%	6.3%	6.1%	6.0%	5.8%	5.7%	5.8%	6.2%	6.8%	7.5%	8.3%
Motor D	4.0%	4.2%	4.2%	4.1%	3.8%	3.5%	3.0%	2.6%	2.4%	2.4%	4.2%	6.2%	8.9%	11.8%	13.9%	15.7%	16.8%	17.3%	17.9%	16.2%	13.7%	9.9%	6.0%	3.6%
PWREL	19.4%	19.9%	20.2%	20.3%	20.0%	20.4%	19.4%	19.9%	19.9%	19.9%	19.5%	19.2%	18.8%	18.2%	18.1%	17.6%	17.5%	18.0%	17.8%	17.8%	18.2%	18.6%	19.0%	19.8%
CONST-R	17.4%	15.5%	14.6%	14.3%	14.7%	17.0%	20.9%	23.3%	22.9%	23.1%	22.1%	20.3%	18.2%	16.4%	15.2%	15.2%	16.4%	18.4%	19.5%	19.8%	21.6%	24.7%	25.4%	22.0%
CONST-I	21.3%	21.7%	22.0%	22.4%	23.9%	22.0%	22.8%	22.8%	22.9%	22.2%	21.2%	20.4%	19.4%	18.5%	17.8%	17.0%	15.4%	14.4%	14.4%	16.9%	17.0%	16.8%	18.0%	19.5%

WECC composition factors

Load Composition From Model - Hot Summer

Type	Hour1	Hour2	Hour3	Hour4	Hour5	Hour6	Hour7	Hour8	Hour9	Hour10	Hour11	Hour12	Hour13	Hour14	Hour15	Hour16	Hour17	Hour18	Hour19	Hour20	Hour21	Hour22	Hour23	Hour24
Motor A	14.7%	15.2%	15.7%	15.9%	16.0%	15.6%	14.5%	13.7%	14.0%	14.6%	15.5%	16.4%	16.8%	17.0%	17.0%	16.4%	15.9%	14.2%	12.5%	11.4%	11.2%	11.5%	12.1%	13.4%

GEG_RAG | LAX_RES | LAX_COM | LAX_MIX | LAX_RAG | ONT_RES | ONT_COM | ONT_MIX | ONT_RAG | PDX_RES | PDX_COM | PDX_MIX | PDX_RAG

Tables for each city/feeder/season

CMLD Comparison

- Comparison summary spreadsheet is available using NERC default data
- Will be updated and released following updates to residential (and possibly commercial) building models
- Analysis needed:
  - Event response with new composition factors
  - Determine need for additional cities, feeders types, etc.

Next Steps

- Complete weather assessment and finalize WECC representative weather cities
- Update residential building model
  - Use Vancouver, WA feeders as a validation point
  - Revisit commercial building models
- Generate new CMLD fractions with updated building models, compare with existing WECC model
- Address potential need for additional feeder types