2012 BPA RATE CASE
Customer Workshop

Weather Normalization

May 11, 2010

Agenda

- Purpose of Work
- Summary of Results
- Weather Data
  - Actual Process
  - Normal Process
- Working through the TRM process
- Next Steps

Purpose of This Work

- Tiered Rate Methodology required that weather-normalized loads would be used in the calculation of the Contract High Water Mark.
- Provision adjustments required that the average of weather-normalized 2007 and 2008 will be the foundation for path 2 adjustments.
- This is the start of that work according to the steps established during workshops in the Tiered Rate Methodology process.

Objectives to Achieve

- Valid statistically accurate results
- Method that is equitable, verifiable, and transparent
- System-wide application of the same method
- Cost-effective method

Where We Have Come From

- TRM established a methodology to weather-normalize loads. Allowed for a series of workshops to discuss specifics with customers.
- Workshops were held with interested parties during August and September 2009.
- Steps were established in workshops with customers that BPA would follow when doing the weather normalization

Normalization General Steps

1. Gather and review 5 years of historical daily loads and average temperature. *(Jan-Mar 2010)*

2. Gather necessary monthly and annual irrigation data from customers. *(Dec 2009-Mar 2010)*

3. Deliver data for customer review*. (Feb-Apr 2010)*

4. Model the load-temperature relationship for each customer separately. *(Apr-May 2010)*

5. Calculate adjusted values. *(Apr-May 2010)*

Normalization Equations

- General non-irrigation load adjustments:
  - Heating adjustment
    - (Normal HDD - Actual HDD) * HDD coefficient
  - Cooling adjustment
    - (Normal CDD - Actual CDD) * CDD coefficient
  - Total adjustment = Heating + cooling adjustments:
    - Adjustments increase or decrease loads to normal conditions.
      - Colder winter results in reduction to loads
      - Warmer winter results in addition to loads
      - Hotter summer results in reduction to loads
      - Cooler summer results in addition to loads
- Irrigation adjustment:
  - Remove actual irrigation load
  - Add in normalized irrigation load

General Summary of Current Normalization Results

- For 2007, the average adjustment lowered loads by 0.9%:
  - Winter months were slightly cooler, with cold months at the beginning of the season offset by warmer months at the end of the season, resulting in a downward adjustment.
  - Summer months were very near normal for the year.
- For 2008, the average adjustment lowered loads by 2.1%:
  - Winter months were much cooler for the season, resulting in a downward adjustment.
  - Summer months were warmer than normal, resulting in a downward adjustment for space conditioning and irrigation loads.

Weather Data
Actual and Normal

Actual Average Temperature

- Actual data is obtained from a satellite feed from NOAA to BPA for the weather stations every hour.
- Hourly reads are the temperature at a set time during the hour (i.e., approximately 5 minutes past the hour).
- Will not likely match with the NOAA-reported daily maximum or minimum temperature:
  - Maximum and minimum are likely within an hour.
- Arithmetic averages of hourly points are used when sufficient observations are available.

Actual Degree Days

- Calculated the several HDD (heating degree day) and CDD (cooling degree day) base values using the arithmetic daily average temperature:
  - HDD = base temperature - actual
  - CDD = actual - base temperature
- If there were fewer than 6 actual observations to calculate the daily average, we replaced the daily average with the daily normal value so as not to distort the comparison.
- Summed to monthly values for the calculations.

Normal Average Temperature

- Based on the 1970-2004 temperature data.
- Each year's values were ranked by season, from highest value to lowest value within each season:
  - Averages of ranked values were obtained, producing average highest values, 2nd highest values, etc.
- Average values were then assigned to representative year, after representative year was ranked by season:
  - 2005 selected as the representative year
  - Same representative year was used for all weather stations, producing a region-wide weather pattern.
- Representative year was then applied to each subsequent year based on calendar pattern of each year:
  - First Monday of the representative year assigned to first Monday of each year, etc.

Normal HDD and CDD Data

- Calculated the several HDD and CDD base values using the daily normal temperature.
- Monthly values are computed as the sum of the daily DD values for each month.
- Each month normal value becomes dependent on the calendar for each year.
- Monthly values for calendar years 2007 – 2012 and 2014 were averaged to single monthly quantities:
  - These calendar years represented the possible different values that calendar years could create.
- Single monthly normal values were used in the normalization process.

Working Through the TRM Process

Making the Process Transparent

- To meet the objectives of the process all data and results are stored in a very large Excel file by customer:
  - All files formatted similarly, such as
    - WN_(customer identifier).xls
  - Spreadsheet can seem quite complicated but is not, when you understand the layout.
  - Current at the start of the process, numbers are not final and still subject to change.

- Trying to meet the following objectives:
  - Use a software that is available to customers (SAS & Excel).
  - Store the data and results for future reference.
  - Model and normalize data within the same application.
  - Provide clear application of the steps and results within the tool.

Finding Steps One and Two in the Spreadsheet

- Gather 5 years of historical daily loads and average temperature:
  - Historical data that will match meter configuration used to produce the customer's bill with losses included. *(Data review worksheet)*
    - Updates to meter readings will be included, so data may not match bill exactly.
    - Loss calculation methods result in differences between data and bills.
    - FYs 2005-2009. *(Metered configuration used & Metered Values worksheets)*
  - Historical temperature data will be average of daily hourly values:
    - Round values to 1 decimal place. *(Temperature worksheet)*
  - Gather necessary monthly and annual irrigation data from customers. *(Irrigation data and Irrigation adj worksheets)*

Finding Step Four in the Spreadsheet

- Model the load-temperature relationship for each customer separately:
  - Use typical statistical package (SAS selected). *(SAS code worksheet)*
    - Each utility's total retail load was the dependent variable.
    - Initial independent variables start with HDD, CDD, month of the year indicator variables, day of week indicator variables, year indicator variables. *(Variables defined near rows 1850-1900 in SAS code worksheet)*
      - Additional indicator variables may have been added as circumstances required.
      - Statistically insignificant variables were removed from models.

Finding Step Four in the Spreadsheet (Continued)

- Model steps. *(Results of iterative process on SAS results worksheet)*
  - **Step 1)** Analyze the data to find starting HDD base.
  - **Step 2)** Include all indicator variables and starting weather variable. Run model.
  - **Step 3)** Remove all insignificant variables.
  - **Step 4)** Rerun model- record Model Root MSE, T-stat of coefficients for starting model.
  - **Step 5)** Increment weather variable base looking for model improvement.
  - **Step 6)** Repeat Step 5 until full improvement is reached based on model Root MSE.

Finding Step Five in the Spreadsheet

- Calculate adjusted values: *(Calcs worksheet)*
  - Key adjusted load values; provisional average and future FY 2010 *(Column D rows 2 & 3)*
  - Specific year calculations *(Rows 7 thru 9)*
  - Temperature values
    - Monthly actual and normal HDD and CDD values . *(Columns G & H starting at row 19)* Annual summary for quick review *(Row 12 & 13)*
  - Normalizing coefficients *(Row 17)*
  - Monthly weather adjustments *(Column E starting at row 19)*
  - Actual base data *(Column D starting at row 19)*

Review Criteria Used by BPA

- Valid statistically accurate results:
  - Reviewed model r-square, root mean square error, AIC, VIF
- Verify model acceptability through residual analysis:
  - Graphic analysis done in SAS package
- Models' r-square (measure of variability explained by model) ranges between .28 and .98:
  - Of the models currently completed
    - 66% greater than .9, 25% between .9 and .8, 9% less than .8
  - Low r-square caused by several factors

Steps Taken to Improve Models

- Lower fit often found with customers that have sizeable industrial load:
  - Industrial load variable with drivers other than temperature.
  - Influential industrial load that could be isolated was included explicitly in the model, explaining variability.
- Lower fit associated with irrigation usage patterns:
  - Removal of irrigation loads resulted in a more variable load than that of non-irrigating utilities.
  - Non-weather sensitive months with highly variable irrigation loads were removed from the model.
- Lower fit was associated with step changes in customer loads:
  - Additional indicator variables were added to capture the step changes.
- Some lower fitting models could not be improved.

Review Criteria Used by BPA

- Reviewed percent change of adjustments:
  - Similar values often found
    - Some differences due to irrigation adjustments
    - Some differences due to micro-climate behaviors
- Compared coefficients across geography looking for pattern and consistency:
  - Coefficients compare to total load so number of customers matters, amount of industrial load, mix of residential and commercial customers, size of commercial customer base-removing direct comparability.
  - Not as comparable as hoped; more comparable if on a residential use per customer basis only.
- Compared base heating and cooling temperatures across customers:
  - Typical HDD base value between 52 and 60 degrees with 55 as the mode.
  - Typical CDD base value between 61 and 72 degrees with 65 as the mode.

Next Steps

- Complete models for all customers:
  - Review of actual is ongoing for some customers and BPA.
- Change the HDD and CDD values:
  - Code that calculates the actual and normal HDD and CDD rounds to even values, not single units.
- Address specific customer questions:
  - If they care to, customers have opportunity to review BPA work further.
- Review first 6 months of FY 2010 data:
  - Add data for the first 6 months of 2010 and have customers review if they would like to.

Other Questions?