TETRA TECH

# *What's your kW? Defining peak demand in Texas*

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- Amy Martin, Frontier Associates, contractor lead for Electric Utility Marketing Managers of Texas (EUMMOT)

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# Texas has a long history of DSM

- First state to establish long-term DSM goals for regulated utilities in 1999
- Set savings targets at 10% of demand growth in 2003
- Increased goals in subsequent years
  - 20% of demand growth in 2010
  - 25% of demand growth in 2012
  - 30% of demand growth in 2013
  - 0.4% of peak demand once trigger is reached
- Cost-effectiveness based on Program Administration Cost Test
  - low-income exception, Savings to Investment Ratio

# Key Players in Texas

Public Utility Commission of Texas

AEP Texas Central

AEP Texas North

CenterPoint Energy

El Paso Electric Co.

Entergy Texas

Oncor

Southwestern Electric Power Company

Texas-New Mexico Power

Xcel Energy

Sharyland

*Other stakeholders including ERCOT, EUMMOT Energy Efficiency Service Providers, implementation contractors, consumer advocates*

# Delivering DSM to Customers

*Utilities recover costs under the Energy Efficiency Cost Recovery Factor Rider*

- **All sectors served**
- Commercial
- Residential
- Low-income – required minimums

- **Through a variety of program types**
- Standard Offer Programs
- Market Transformation Programs
- Self-delivered Programs

- **Mixed administration**
- Contracted implementation firms
- In-house utility administration

# Introduction of EM&V in 2013

Public Utility Commission of Texas, utilities and their contractors and the EM&V team built infrastructure to meet the following goals:

- Verify gross energy and demand savings for over 130 programs across 10 utilities
- Estimate net savings
- Determine program and portfolio cost-effectiveness
- Provide feedback to the PUCT, utilities, and other stakeholders to improve performance
- Prepare and maintain a statewide Technical Reference Manual (TRM)
- Provide ongoing support for M&V plans, savings calculation tools and implementation of EM&V recommendations

# Key Successes: Realized Savings and Improvements

- Cost-effective portfolios
- Overall high realization rates
- Generally high program attribution
- Responsiveness to EM&V recommendations has resulted in improved:
  - Program design and delivery
  - Documentation and tracking system quality
  - Savings estimates and consistency across utilities
    - Energy efficiency measures
    - Load management baseline methodologies
    - Peak demand definitions
  - Transparency of savings calculations and approaches
    - First centralized source of all deemed savings values
    - incorporation of M&V protocols into TRM

# The elusive peak demand reduction

- Peak demand may be based on:
  - the effect of the measure at the time of the utility's expected system peak
  - the average demand reduction of a measure across all or a subset of the peak demand period specified
  - the maximum impact of a measure within peak hours
  - coincidence Factors from other areas of the country

- Time for a consistent approach!
  - Development of the statewide TRM
  - Winter peak demand savings allowed starting in 2013

# Drumroll…….We reached consensus!

- Developed an approach to establish summer and winter peak hours to be used for calculating peak kW reduction or coincidence factors (CF) for measures.
  - Standardized
  - Transparent
  - Accurate

- Peak demand will be updated as measures are updated
  - As determined through TRM prioritization process or as new deemed measures are added

# *So how did we get there?*

# *Props & Disclaimer*

Dr. Jay Zarnikau

Greg Landreth

Lucy Zhu

*Me, goofing off in stats class…*

# In short, we used a lot of Data.

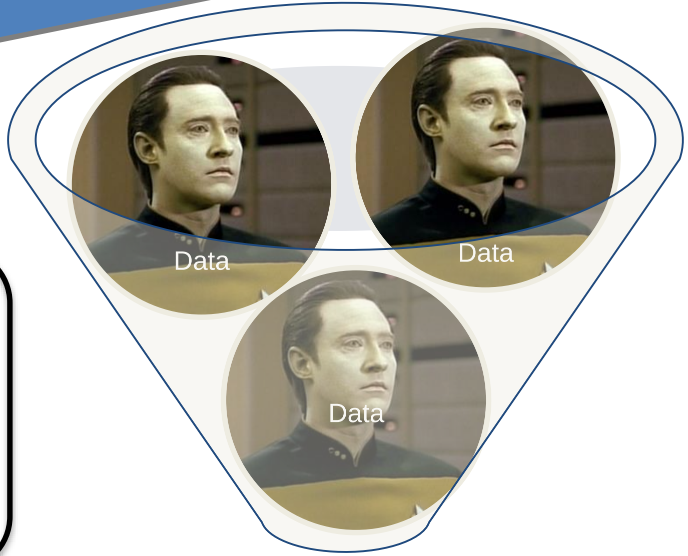
# Quite the Process!

*Peak kW Definition?*

*Per Utility or Weather Zone?*

*What are the Peak Hours?*

*How to calculate savings?*




**Probability-based Method**

*Established a formal probability-based method to estimate the summer and winter peak demand reduction from energy efficiency measures*

# Why does this matter?

- **Texas Goals are primarily based on peak kW**
  - Impacts should be “real” and consistently reported

- **Supporting Energy Efficiency as a Resource**
  - Gives ERCOT planners peace of mind that they can more directly connect the kW reduction produced through the utility EE programs to system-wide peaks and, ultimately, future T&D infrastructure needs.

  - The more we can do to prove EE is worth the investment, the better.

# Which Peak Demand Definition?

## Coincident Peak (CP) Load

- **We seek to estimate the impact of an energy efficiency measure during the hour or interval that the utility system reaches its highest summer or winter demand each year.**
  - Consistent with system planning and rate design peak demand reduction
  - Useful to ISOs and utilities.

- **Rule dictates that there are both winter and summer peaks**
  - Utilities claim savings for whichever peak savings value is greater

# Savings per Utility or Weather Zone?

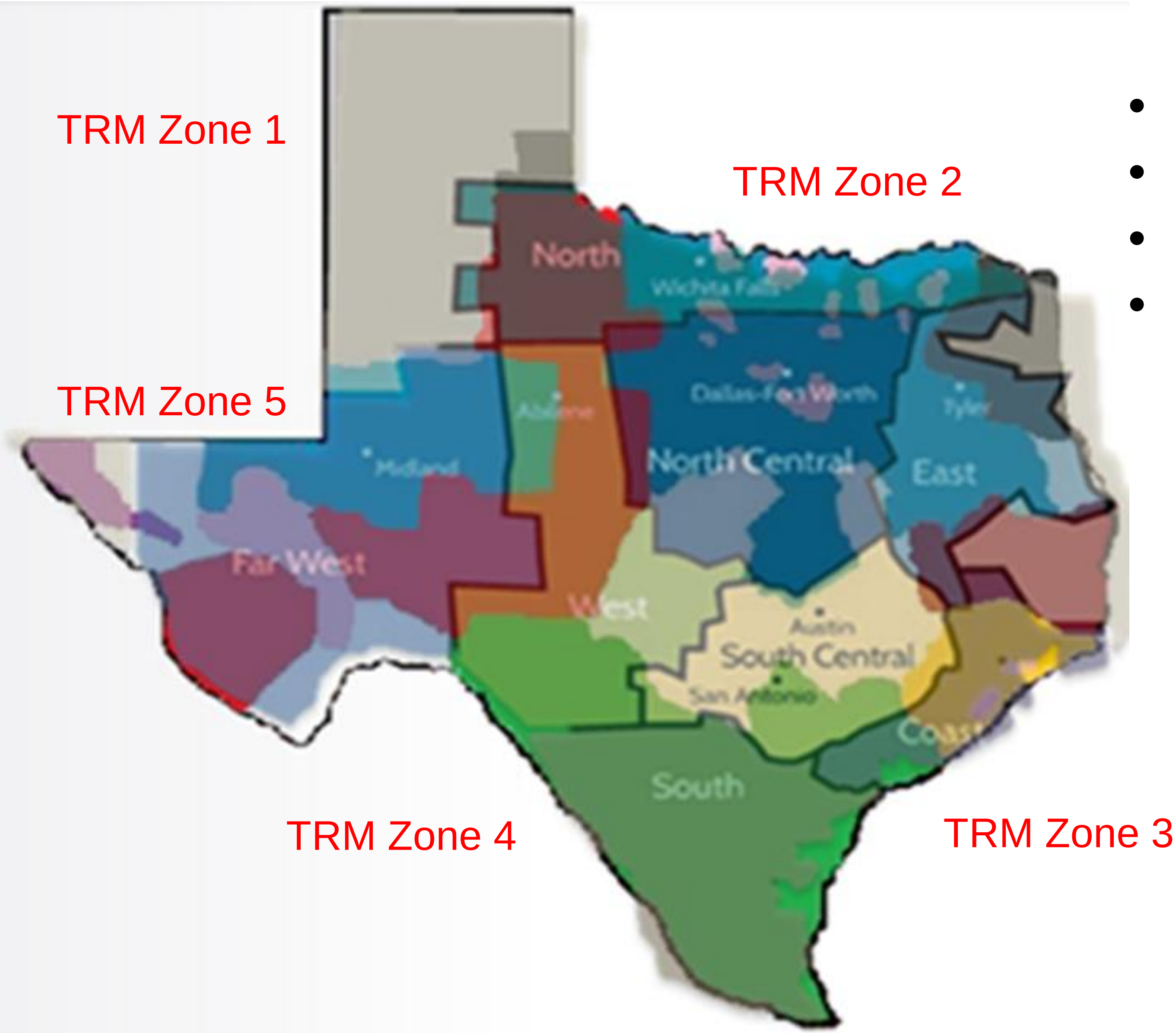
*Energy Efficiency Rule refers to a utility's peak period.*

*Did we really need to change from savings based on weather zones to utility specific savings?*

If we wanted to estimate peak demand reduction *per weather zone* rather than *per utility,* we had to make sure the load data per weather zone used provided *reasonable approximation* to peak demand hours for the utility systems within those zones.

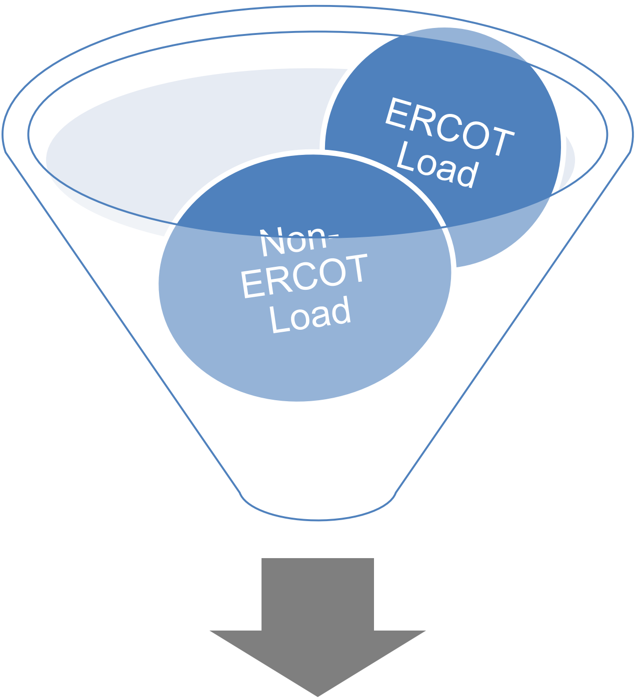
# Complications

- 10 Utilities
- 5 Weather Zones
- 2 Time Zones
- Overlapping!



# Savings per Utility or Weather Zone?

**Goal:** Use ERCOT load data from ERCOT Weather Zones to model peak demand (zones 2-4). Maintain consistency with previous deemed savings.




Savings based on Weather zone

**Data**

- ERCOT load data per weather zone
- Non-ERCOT utility load data

**Process**

- Correlation Analysis
  - Determine how closely load data for weather zones within ERCOT correlate with each other.
- Ranking Analysis
  - Determine if ERCOT-wide load peaks match other areas' load peaks.

**Results**

- Maintain savings per weather zone
  - Peak hours using ERCOT data provides reasonable approximation to peak demand hours for utilities within those zones
  - Ex: MW in Dallas = MW for ERCOT system
- Summer correlations stronger than winter

# What are the Peak Hours?

**How do we select the peak hours for each weather zone?**

*EE Rule details a *range* of peak hours for both summer/winter peak kW*

**<u>Developing Probability Method – Step 1</u>**

Instead of selecting a single peak hour (summer and winter), we wanted to identify the hours in which a peak was most likely to occur. More specifically, we wanted know the probability of every hour within that range being a peak hour.

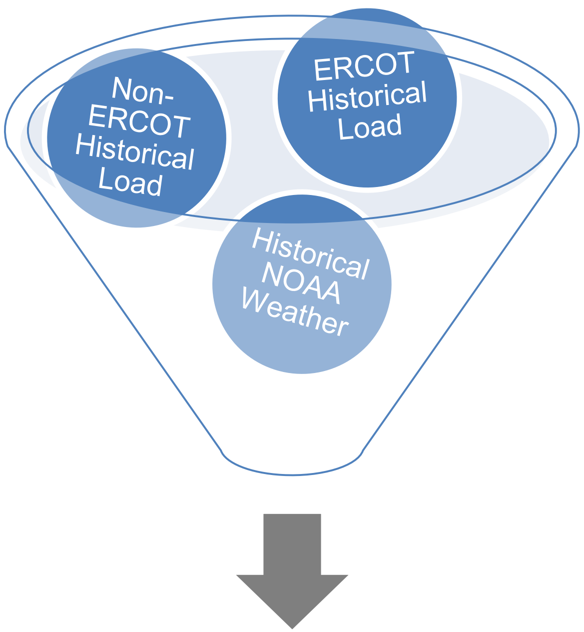
To know this, we had to figure out

*which factors contributed most to a certain hour setting a peak hour.*

# Contributing Factors to Peak Demand

**Logistic Regression Model**

Establish relationship between setting a peak hour and a set of *explanatory variables: Temperature, Month-of-Year, Time-of-Day*




Probabilities

**Data**

- Historical Load Data (2007-14): ERCOT, Xcel, EPE
- Historical NOAA Weather Data

**Process**

- Regression (R) assigns relationships between peak hours and each of the explanatory variables
- Produces coefficient estimates to indicate level of relationship; use relationships to assign marginal probabilities to changes in explanatory variables

**Results**

- Marginal probabilities for explanatory variables
  - How much the temperature, month, and hour impact the chances of an hour being a peak hour

# Jay Z. Says….

The resulting model was thus:

$$\text{Logit}(\text{Peak Hour}) = f(\text{Relative Max Temp, Hour16, Hour17, Hour18, July, August})$$

EUREKA!

**Table 1.** Logistic regression statistical results.

| | Estimate | p-Value |
|---|---|---|
| Intercept | −39.3331 | <0.0001 |
| RelativeMaxTemp | 36.1022 | <0.0001 |
| Hour16 | 1.7570 | 0.000131 |
| Hour17 | 1.9924 | <0.0001 |
| Hour18 | 1.5439 | 0.001012 |
| July | 0.9284 | 0.016848 |
| August | 1.7722 | <0.0001 |

Temperature is key; Peaks most likely in August

# Amy Says…

It's kind of like your online dating profile…

Certain factors impact your chance of being "swiped right" [i.e. picked]

The resulting model was thus:

$$\text{Logit}(\text{Dateability}) = f\,(\text{Living Situation, Attractiveness, Geekiness})$$

| | Living Situation | Attractiveness | Geekiness |
|---|---|---|---|
| Explanatory Variables → |  |  |  |
| Marginal Probabilities → | -50% | +75% | -25% |

# What are the Peak Hours?

## How do we select the peak hours for each weather zone?

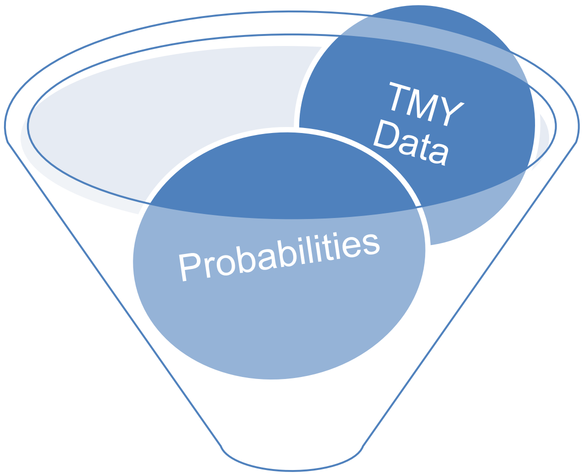
*EE Rule details a *range* of peak hours for both summer/winter peak kW*

**Developing Probability Method – Step 2**

Regression told us which factors contribute most to a certain hour setting a peak hour and the level to which each contributes (marginal probabilities).

Next, we had to align this information with Typical Meteorological Year (TMY) data.

# Applying Regression Results to TMY Data




Top 40 Hours =
Peak Probability Tables
(Texas TRM 3.0 v1)

**Data**

- Marginal Probabilities
- TMY3 Data

**Process**

- (R) software
  - Based on the marginal probabilities of the explanatory variables from the regression, estimated the probability of each hour in the TMY file (within defined peak periods**)** being a peak hour.
  - Provides ranking of TMY hours (highest probability of being a peak hour to lowest)
  - Selected top 40 hours (of which 20 used; account for day of week)

**Results**

- Established set of top 40 hours with highest probability of being the peak hours
  - Meaning, we identified a set of hours presenting the conditions most likely to produce a system peak.

# Peak Hours: Peak Probability Factors

- **Analysis resulted in 10 Peak Probability Tables**
  - 5 Weather Zones
    - Highest Probability Summer Peak
    - Highest Probability Winter Peak

- **Snapshot of TRM Tables**

| Month | Day | Hour Ending (CDT) | Hourly Temperature | Relative Maximum Temperature | Peak Demand Probability Factors |
|---|---|---|---|---|---|
| 7 | 26 | 17 | 98.06 | 0.980208 | 0.894962 |
| 8 | 13 | 17 | 96.08 | 0.960416 | 0.877441 |
| 7 | 26 | 18 | 98.96 | 0.989204 | 0.846795 |
| 7 | 21 | 17 | 96.98 | 0.969412 | 0.806845 |
| 7 | 25 | 17 | 96.98 | 0.969412 | 0.806845 |
| 7 | 27 | 17 | 96.98 | 0.969412 | 0.806845 |
| 7 | 26 | 16 | 98.06 | 0.980208 | 0.806583 |
| 8 | 13 | 18 | 96.08 | 0.960416 | 0.719427 |
| 7 | 25 | 16 | 96.98 | 0.969412 | 0.671536 |
| 8 | 14 | 17 | 93.92 | 0.938824 | 0.632458 |
| 8 | 13 | 16 | 95 | 0.94962 | 0.632068 |
| 7 | 21 | 18 | 96.98 | 0.969412 | 0.59937 |
| 7 | 25 | 18 | 96.98 | 0.969412 | 0.59937 |

# Applying the Probability Method

***How do we use these probabilities to produce an understandable approach for developing future peak kW reduction?***

- **Building Simulation Models**
  - **Step 1:** Run simulation model with TMY3 weather data and assign a calendar year
  - **Step 2:** Calculate the summer and winter peak demand using the probability tables
    - Use the correct Probability table (by weather zone) to identify the top 20 weekday hours from the 8760 output
    - Calculate the probability-adjusted peak demand (Probability * kW) for the 20 hours
    - Sum the 20 probability-adjusted demand values and divide by the sum of the probability factors
    - Single, probability-based peak kW!
    - For CF: peak kW/full connected load

- **Normalized Load Shapes**
  - Similar approach can be applied, but it can get complicated
  - Apply probabilities to energy usage
    - Derive peak ratios acting as a coincidence factors
  - Actual steps vary based on the structure of load profile
  - See TRM Vol 1

# Moving Forward

- Effort to standardize our approach to determining when peaks happen is in parallel to our effort to standardize approaches for all measures and calculator tools
- Will continue to work collaboratively with EM&V team and PUC to refine approach and calculations
- Key Concerns at this point:
  - Models can be tricky – we're only pulling 20 hours
  - Actual impact on claimed savings?
- Still a work in progress!

# Costs and Benefits of Analyzing all the Data

*Our goal was to conduct a thorough, yet reasonable analysis that would yield beneficial results.*

***Team approach:***
*Frontier/Utilities, EM&V, PUC*

# For More Information

- **Open Journal of Energy Efficiency**
  - Zarnikau, J. and Zhu, S.S. (2014) The Identification of Peak Period Impacts When a TMY Weather File Is Used in Building Energy Use Simulation. *Open Journal of Energy Efficiency*, 3, 25-33.

# Thank you for your time today!

## For additional questions:

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