



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

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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

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

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

- **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...*



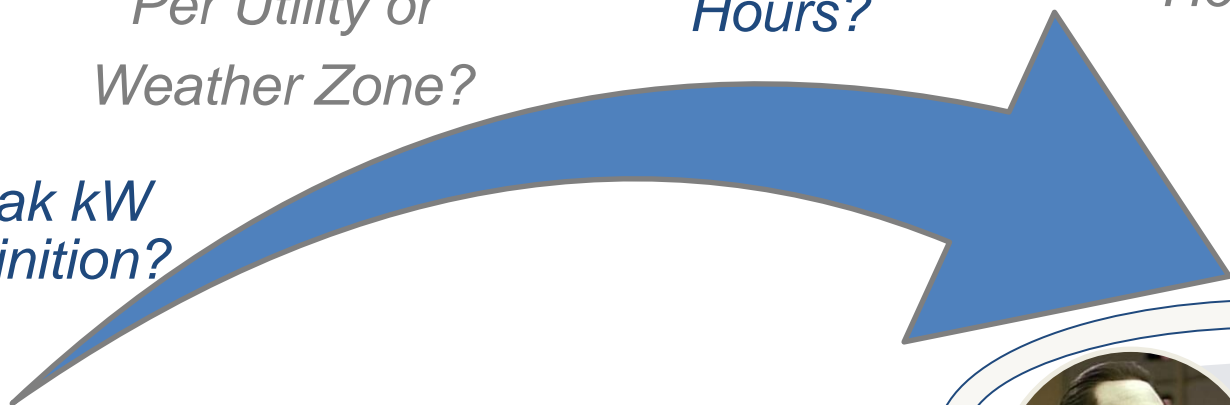
In short, we used a lot of Data.



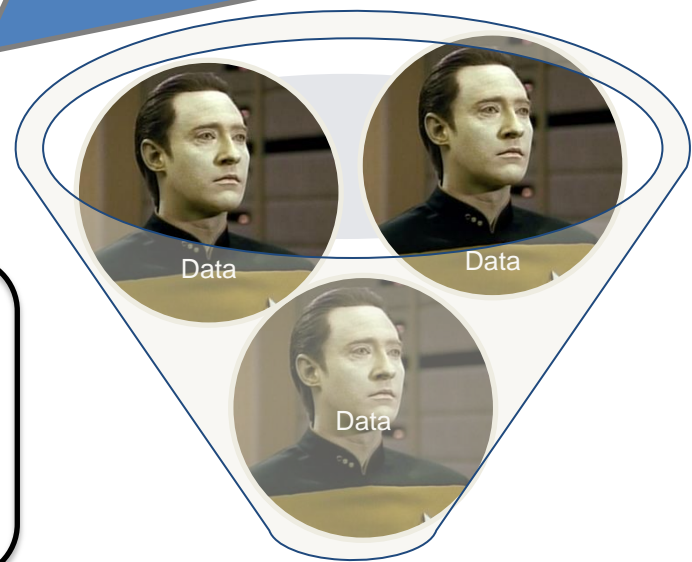
# Quite the Process!

*Per Utility or Weather Zone?*      *What are the Peak Hours?*      *How to calculate savings?*

*Peak kW Definition?*



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



**Probability-based Method**

# 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?

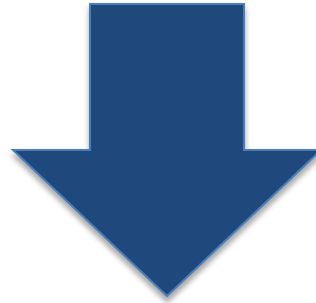
## Coincident Peak (CP) Load

- **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?*



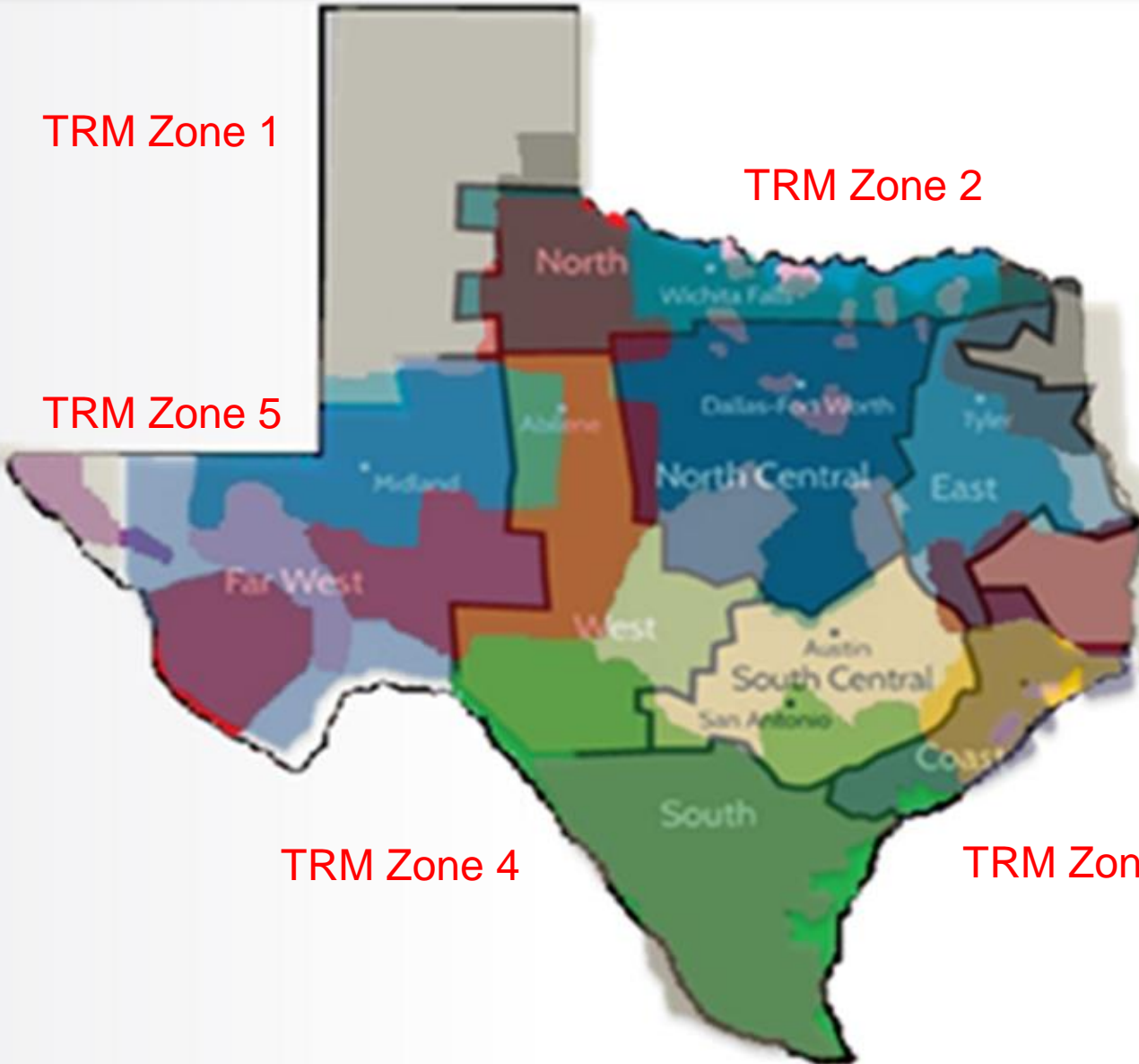
If we wanted to estimate peak demand reduction *per weather zone* rather than *per utility*, we had to make sure the load data per weather zone used provided *reasonable approximation* to peak demand hours for the utility systems within those zones.

# Complications

TRM Zone 1

TRM Zone 2

TRM Zone 5

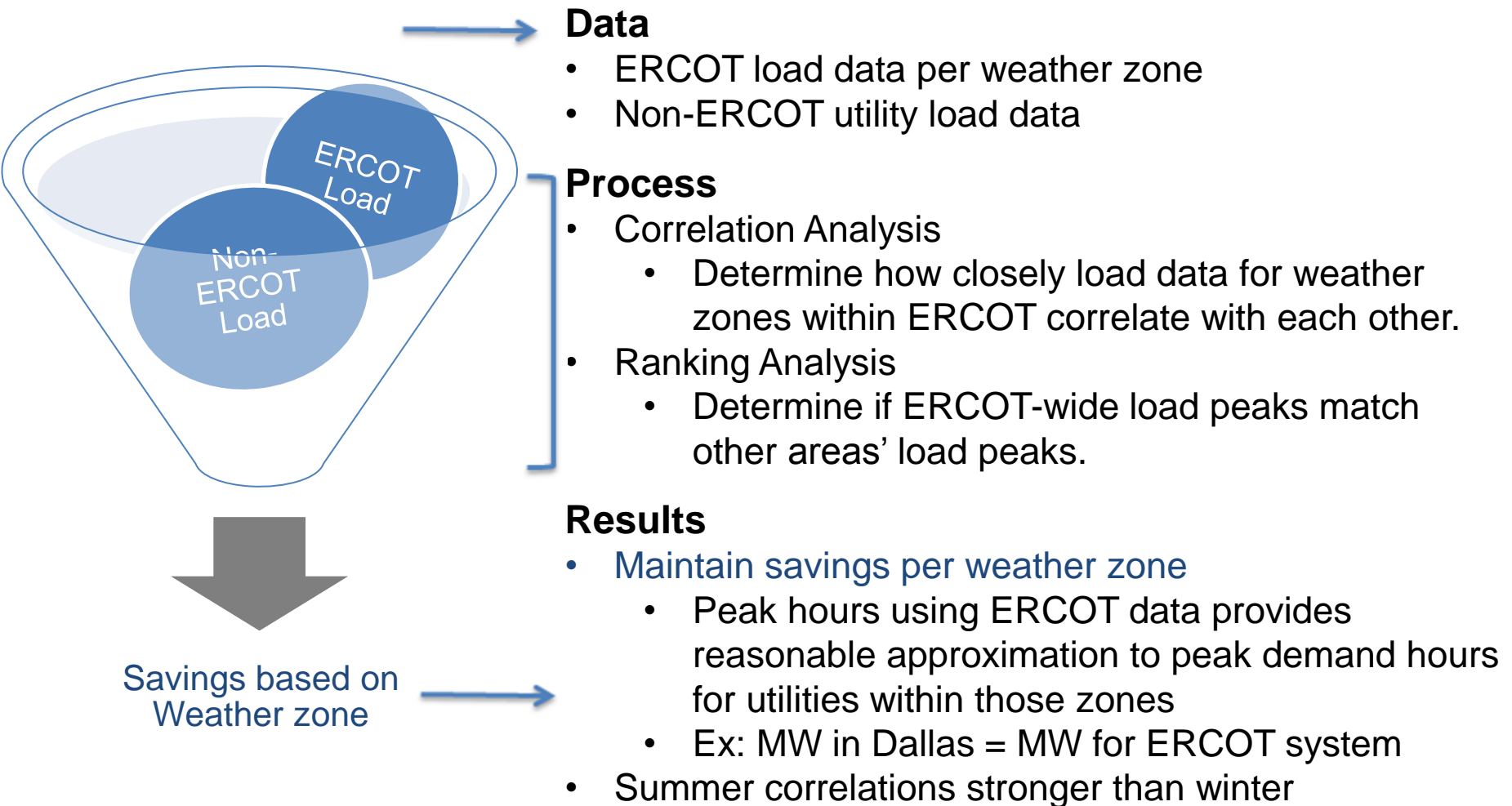


- 10 Utilities
- 5 Weather Zones
- 2 Time Zones
- Overlapping!



# 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.



# 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 1

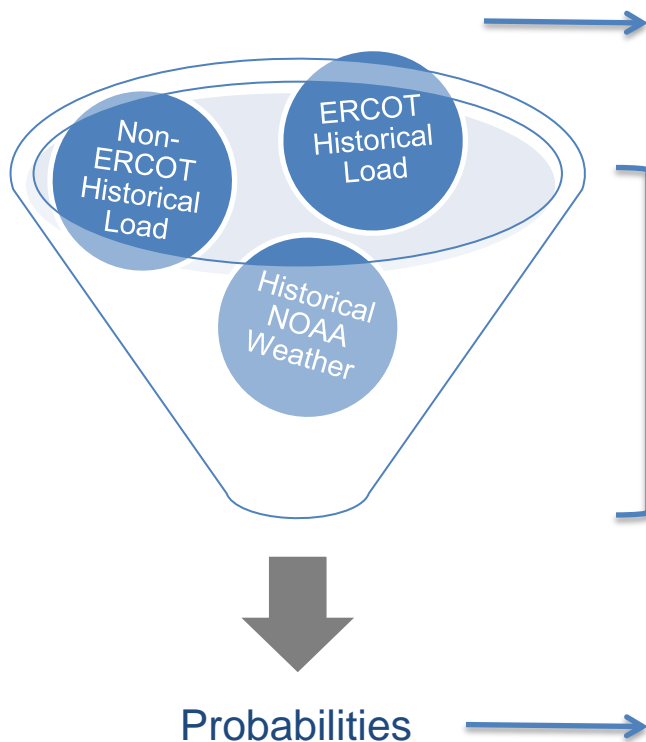
Instead of selecting a single peak hour (summer and winter), we wanted to identify the hours in which a peak was most likely to occur. More specifically, we wanted know the probability of every hour within that range being a peak hour.

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*



### 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:

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

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\*

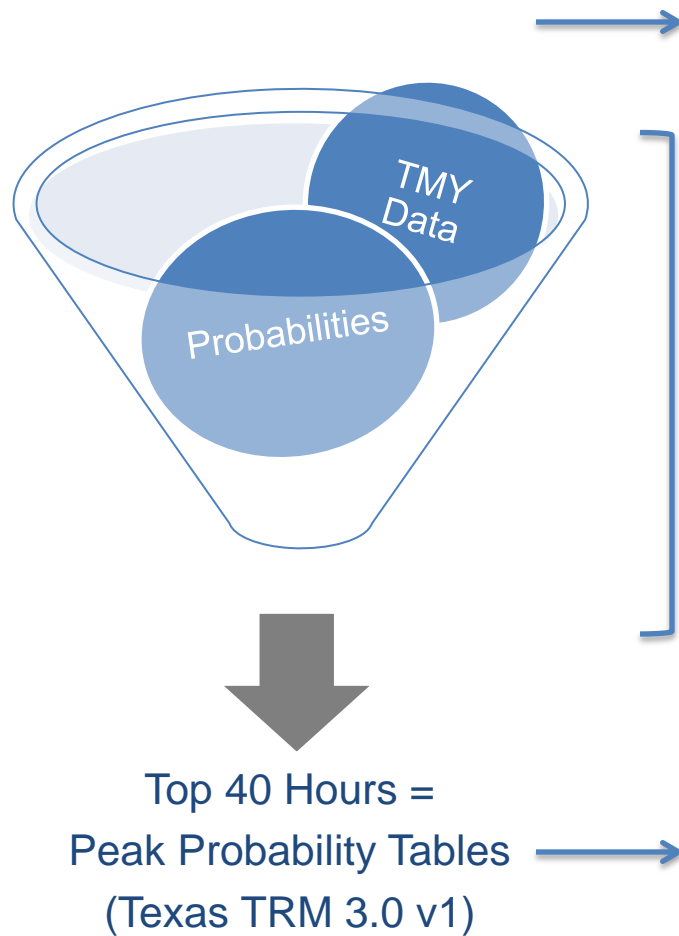


### Developing Probability Method – Step 2

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



## 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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