Item 5: Load Forecasting Review

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Board of Directors
ERCOT Public
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Status of the Load Forecasting Review Process

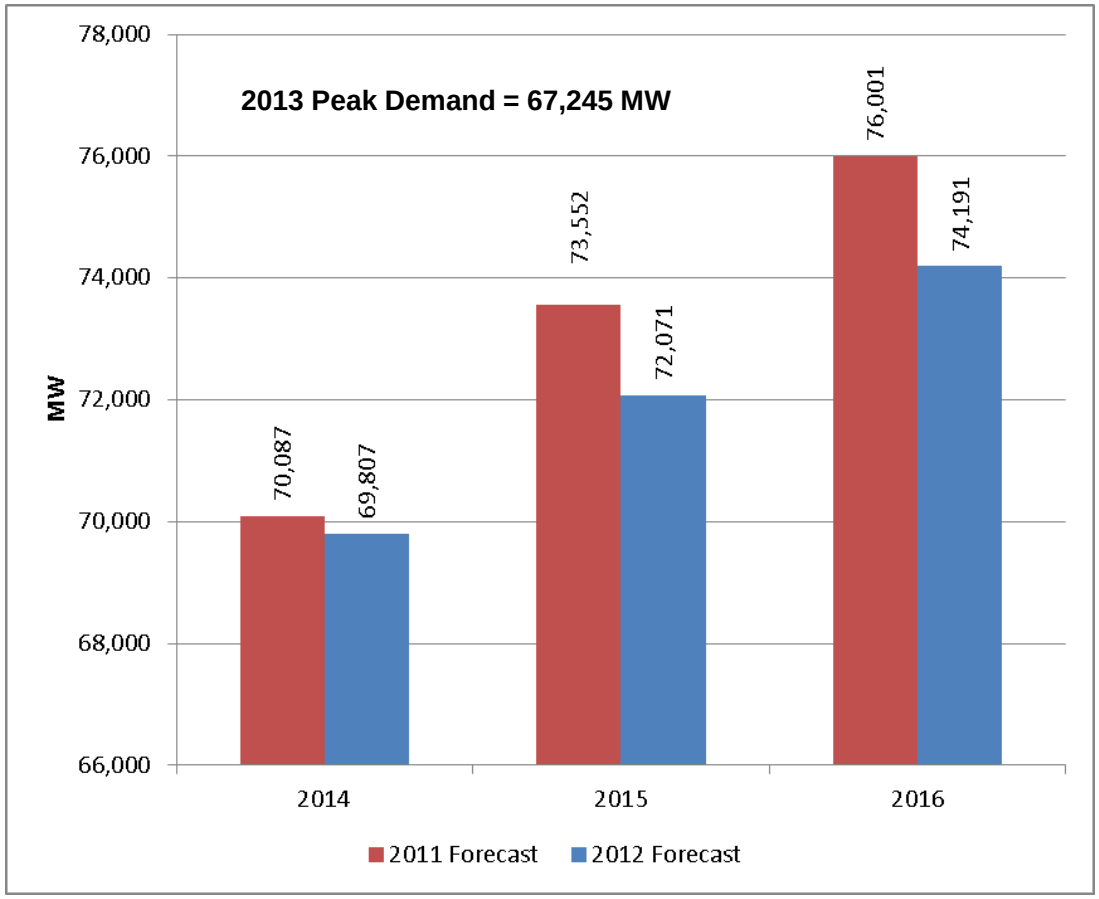
- ERCOT staff has developed a methodology for the load forecast that is different from what has been used in recent years.
- The proposed methodology represents a significant change, and we want to ensure it has been thoroughly reviewed by the Board and stakeholders before it is incorporated into our next CDR Report.
- Stakeholder review will include a workshop held jointly by the Reliability & Operations Subcommittee (ROS) and Wholesale Market Subcommittee (WMS) of the Technical Advisory Committee (TAC).
- ERCOT is also retaining an independent consultant to review the methodology.
- This presentation to the Board details the reasoning behind ERCOT's development of a revised methodology and the specifics of the proposal. ERCOT staff welcomes feedback from the Board on the methodology, as well as on the load forecasting review process.

Outline of Today's Presentation

- **Defining the problem**
- **National and Regional trends**
  - GDP versus energy and demand
  - Energy per customer
- **ERCOT trends**
  - Nonfarm employment historical data
  - Nonfarm employment forecasts
- **Proposed Load Forecast Methodology**
  - Approach
  - Weather normalization changes

Defining the problem – load forecast accuracy

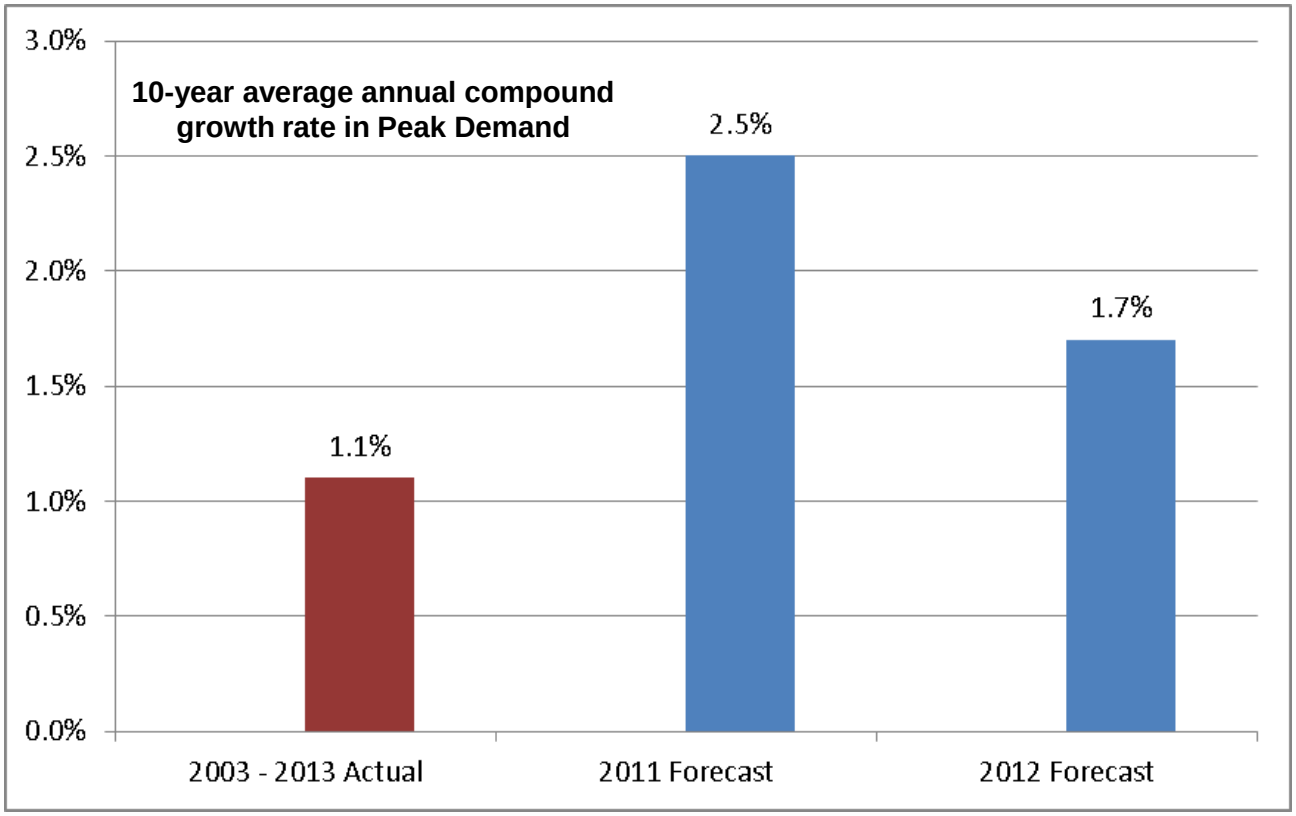
With normal weather, will ERCOT's 2014 peak be 69,807 MW?



2011 forecast based on Moody's base scenario (2012 – 2021)
2012 forecast based on Moody's low scenario (2013 – 2022)

Defining the problem – load forecast accuracy

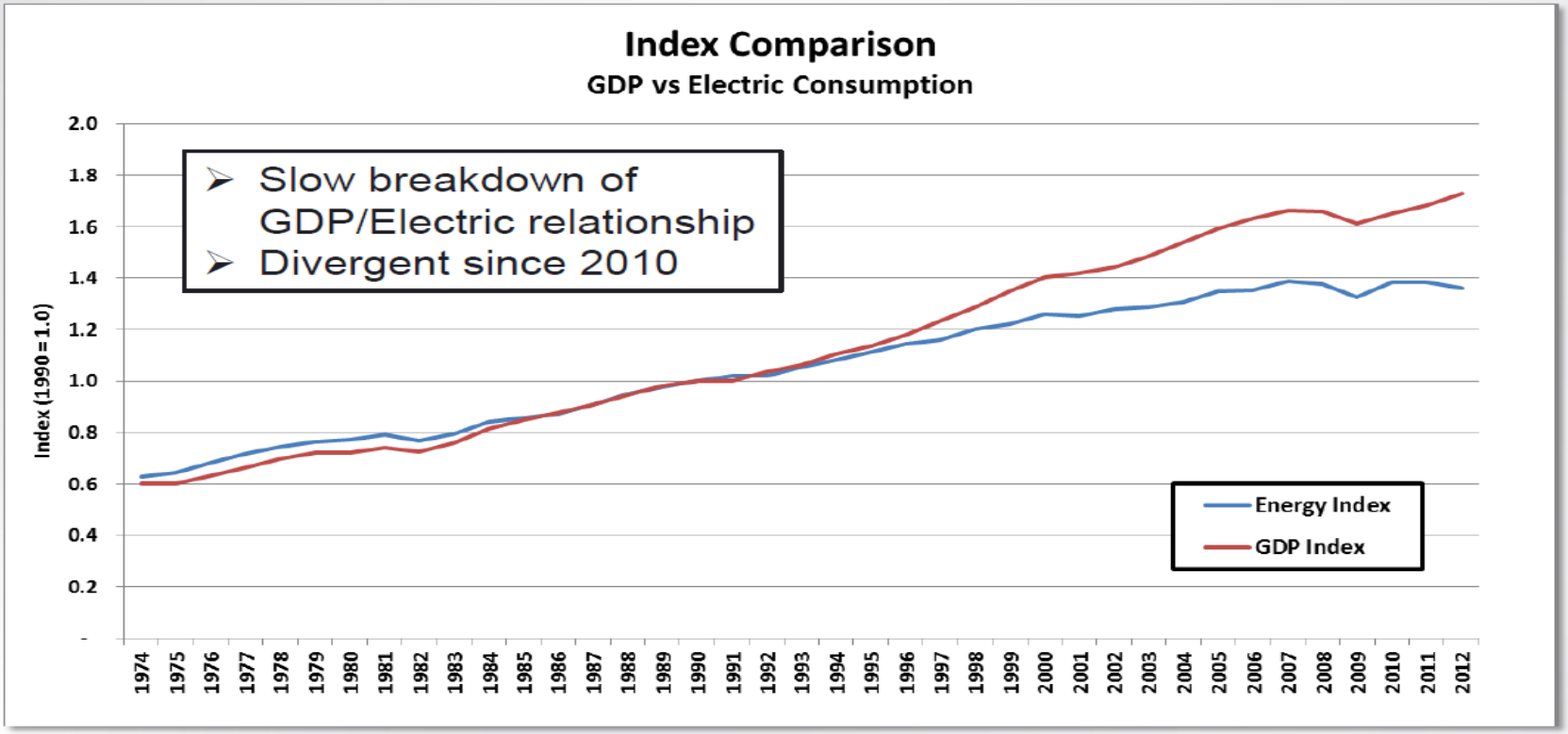
Will Peak Demand grow nearly twice as fast over the next 10 years compared to the prior 10 years?



2011 forecast based on Moody's base scenario (2012 – 2021)
2012 forecast based on Moody's low scenario (2013 – 2022)

National trends

GDP VS. ELECTRIC RELATIONSHIP

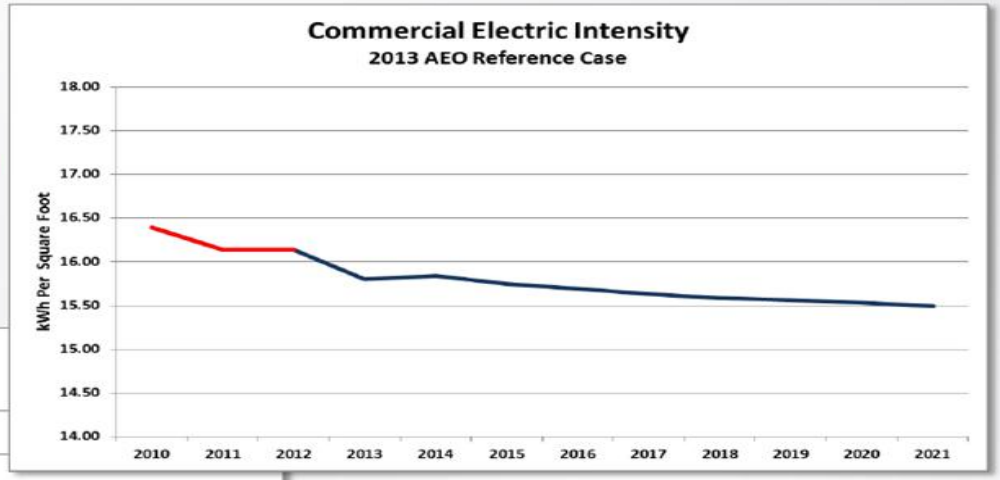


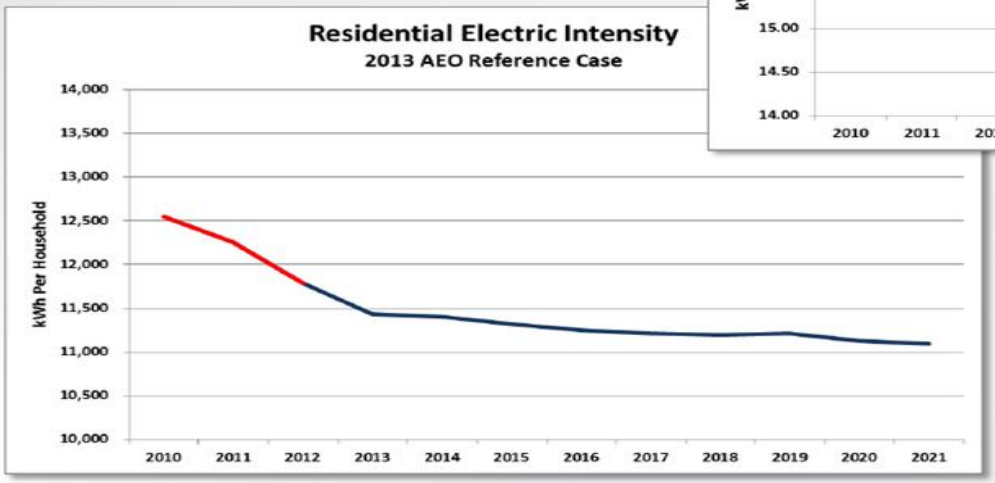
Source: Energy Trends Benchmarking Survey 2013, Mark Quan, November, 2013

National trends

AVERAGE USE IS DECLINING

- Downward trend in average use for the residential and commercial sectors
- Energy efficiency is making an impact





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Source: Energy Trends Benchmarking Survey 2013, Mark Quan, November, 2013

Consumers actively reducing energy consumption

	LED	CFL	Incandescent
Watts Per Bulb	10	14	60
Annual kWh	11	15	65

- Lighting accounts for approximately 20% of annual residential electric use and almost 30% of commercial consumption
- *Source: Customer Value and Utility Mindset, Martin Day, November, 2013*

National and regional trends

SALES GROWTH FORECAST – NEXT TEN YEARS

2013 Survey Result
2013-2023 Growth (%)

Region	Residential	Commercial	Industrial	System	Peak
Canada	0.80	1.04	1.04	0.83	0.70
Midwest	0.44	0.48	0.99	0.64	0.70
Northeast	0.38	0.54	(1.64)	0.41	0.66
South	1.11	1.34	0.97	1.06	0.81
West	0.96	0.87	1.17	1.12	1.14
Total	0.78	0.93	0.91	0.85	0.77

Consistent 1% growth range

2012 Survey Result
2012-2022 Growth (%)

Region	Residential	Commercial	Industrial	System	Peak
Canada	0.70	1.85	1.54	NA	0.60
Midwest	0.37	0.71	0.93	NA	0.69
Northeast	2.70	1.17	1.53	NA	4.89
South	1.03	1.21	0.52	NA	0.88
West	1.37	1.47	0.57	NA	1.18
Total	0.95	1.20	0.84	NA	0.99

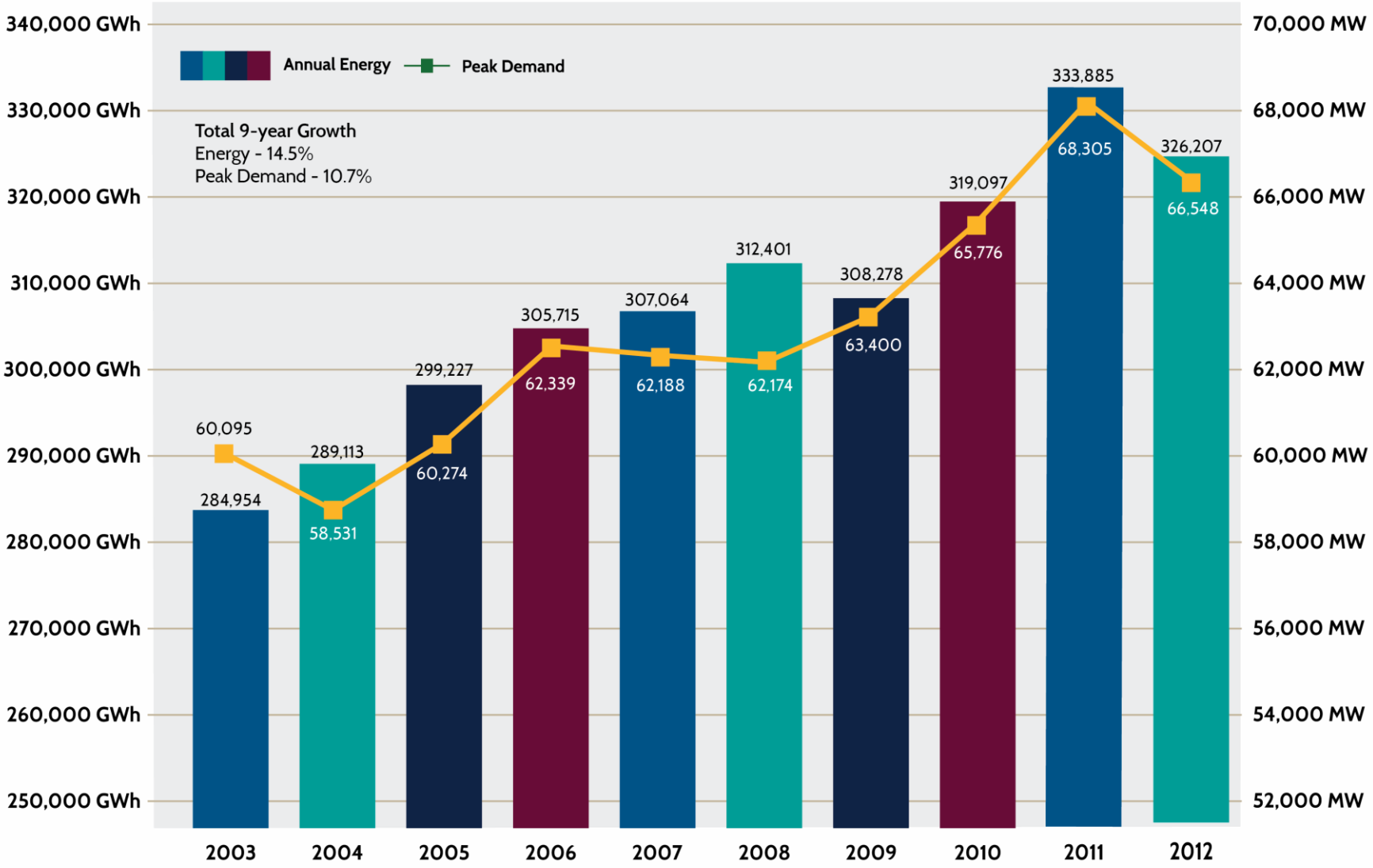
Itron

Source: Energy Trends Benchmarking Survey 2013, Mark Quan, November, 2013

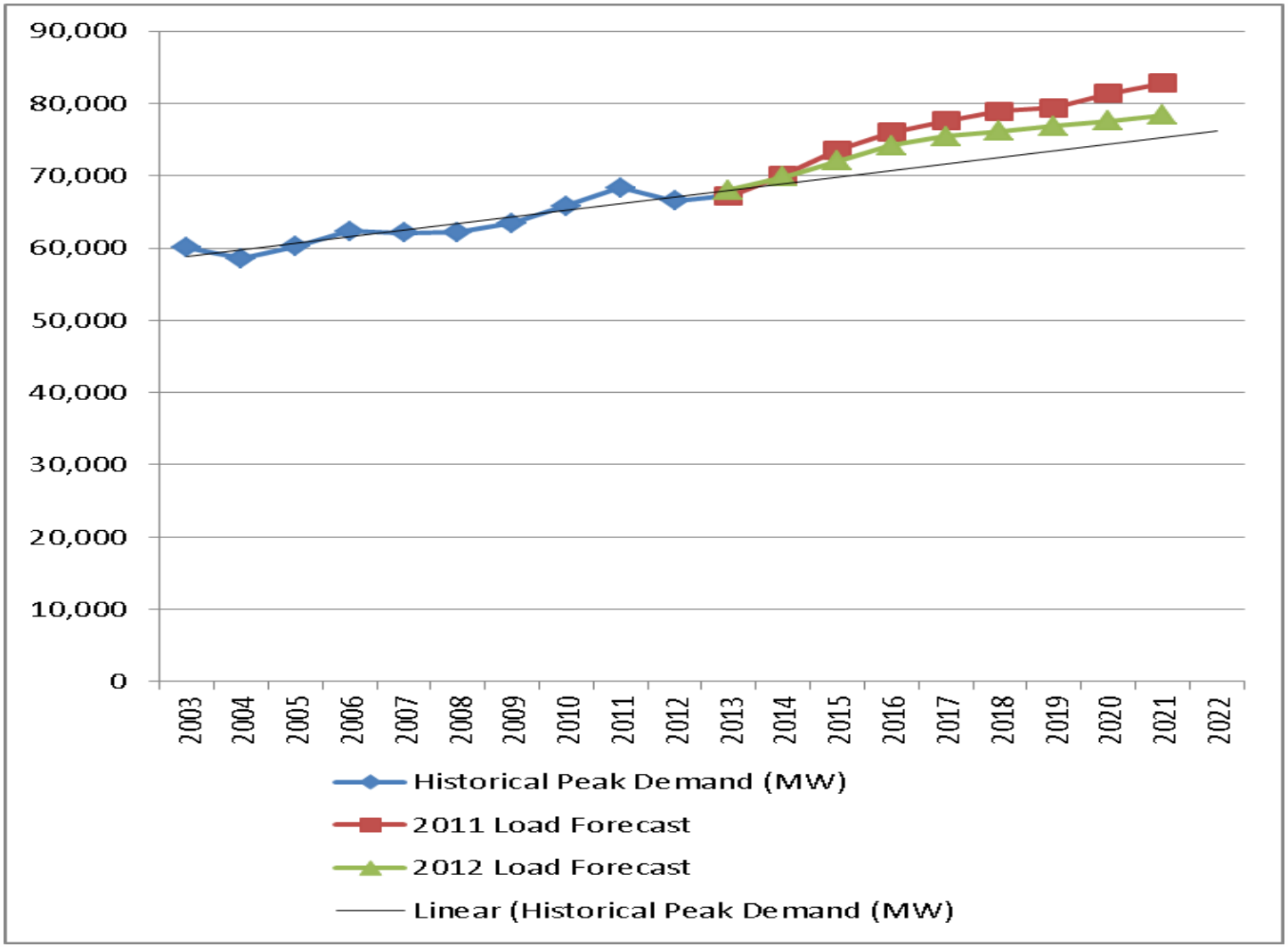
Summary of national trends

- **Changing relationship between GDP and energy use**
  - Declining energy use per customer due to
    - Active energy efficiency
    - Passive energy efficiency
    - Change in behavior
    - Distributed generation
- **Results in lower long-term forecasts**

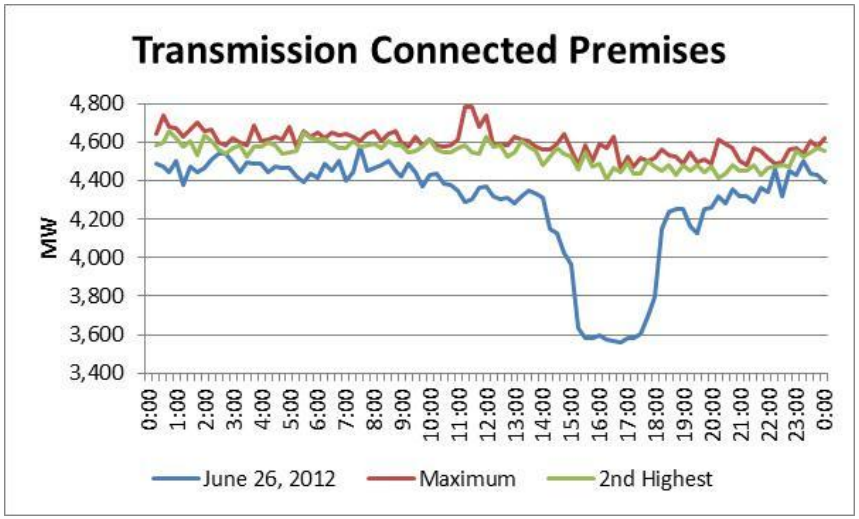
Annual Energy & Peak Demand (2003-2012)



Last two forecasts

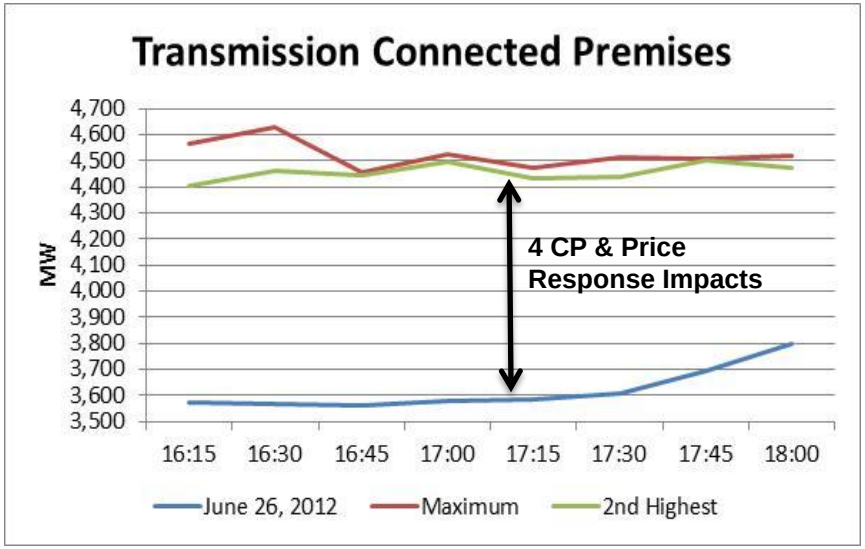


2012 Summer Peak - 4 CP & Price Response Impacts (June 26)



- Impacts shown are based on aggregated transmission load values for ~430 premises
- Not estimated based on an analysis of individual premises

- Difference represents the 4 CP & Price Response impacts of ~ 900 MW on an aggregated basis
- Transmission charges based on 4CP usage apply to Munis, Co-ops, and Loads with >700 kW of peak demand in retail choice areas.
- This data is an example of observed 4CP and price response impacts.



Changing Relation Between Load and Nonfarm Employment

- **Price responsive load**
  - Combination of 2011 scarcity pricing and PUC's decision to increase System-Wide Offer Caps is changing behavior:
    - Commercial & industrial loads with prices indexed to the ERCOT wholesale market are increasing their price response flexibility
    - Load-serving entities (LSE) are investing in demand response as insurance against wholesale market exposure
  - ERCOT Staff, working with LSEs, are attempting to quantify this behavior; starting with summer 2013 data
  - 4 CP impact
- **Energy efficiency upgrades**
  - Energy Star appliances
  - Conversions to CFL and LED lighting

Previous Model – What we've learned

- **Historical revisions impact forecast years**
  - Moody's forecast for Calendar Year (CY) 2013 was increased by 2% in order to align with the revised historical values for CY2012

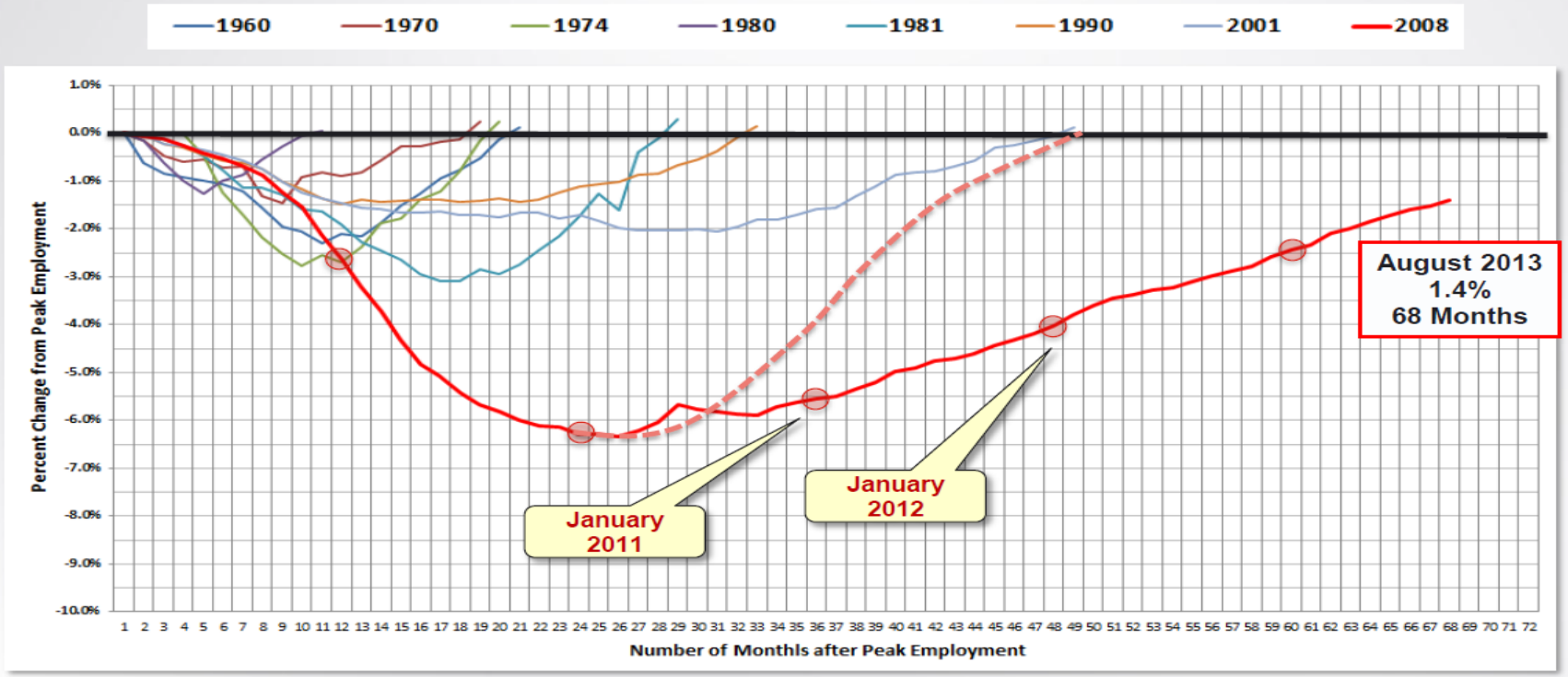
- **Economic forecasts have tended to be too optimistic which has resulted in a tendency for models to over forecast**

- **The relationship between energy usage and non-farm employment is changing.**
  - Some refer to this as the "jobless economic recovery"

Previous Model – What we've learned

Year	Non-Farm Employment (000s)	Annual Growth Rate
2012	9,728	1.8%
2013	9,932	2.1%
2014	10,219	2.9%
2015	10,545	3.2%
2016	10,805	2.5%
2017	10,961	1.4%
2018	11,072	1.0%

Economist view / dilemma



Source: Energy Trends Benchmarking Survey 2013, Mark Quan, November, 2013

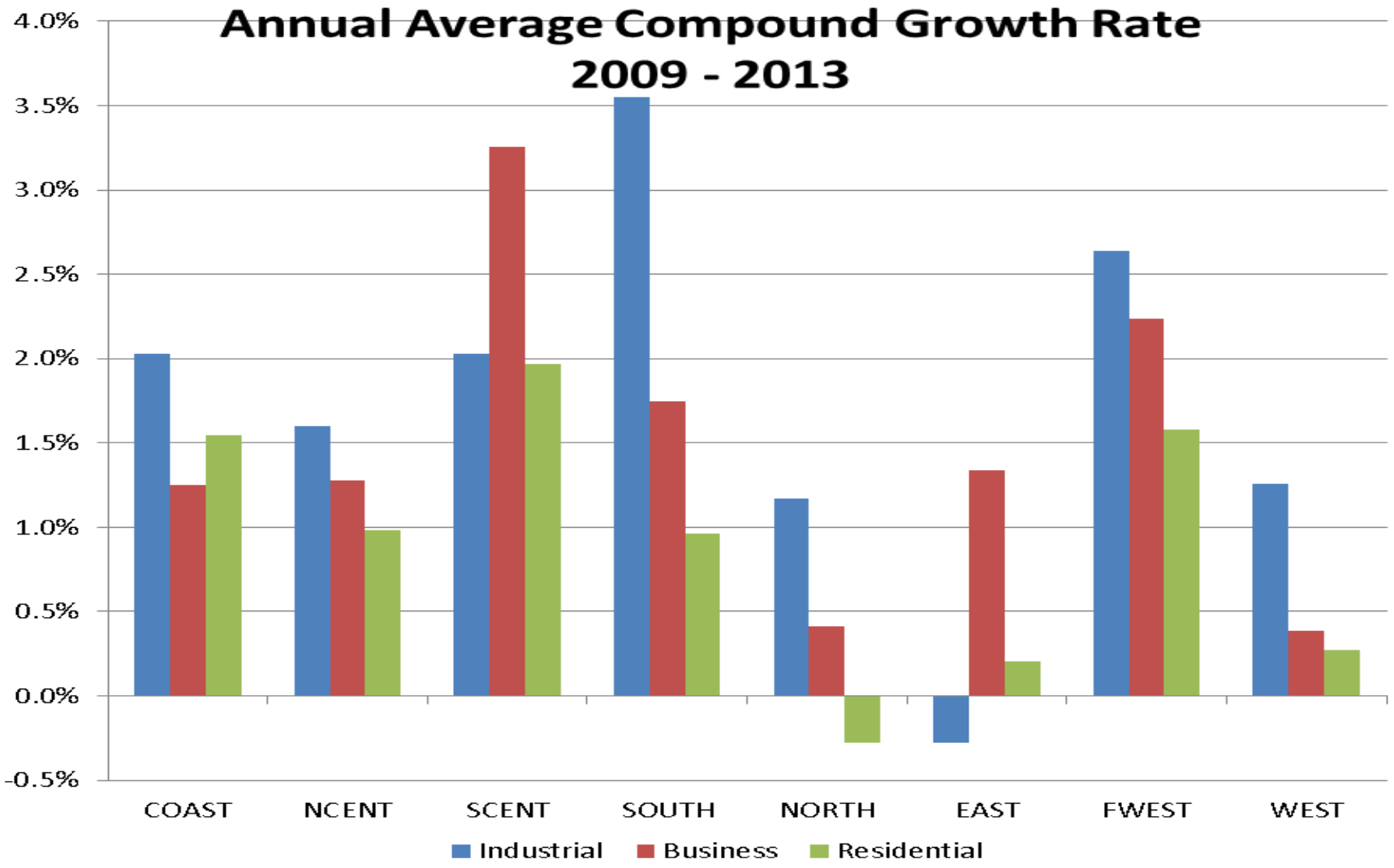
Proposed Load Forecast Methodology

Proposed Model - based on premise level forecasts

- **Energy relationships will now be based on premise counts by customer class (residential, commercial, and industrial)**
  - Historical energy relationships will no longer be based on non-farm employment values
  - Growth rate of premises is smoother than Moody's non-farm employment forecasts
  - Growth rates based on data from 2009 - 2013

- **Benefits**
  - Historical premise accounts will be very stable and not subject to significant changes as were exhibited by non-farm employment revisions

Premise historical growth rates by Weather Zone



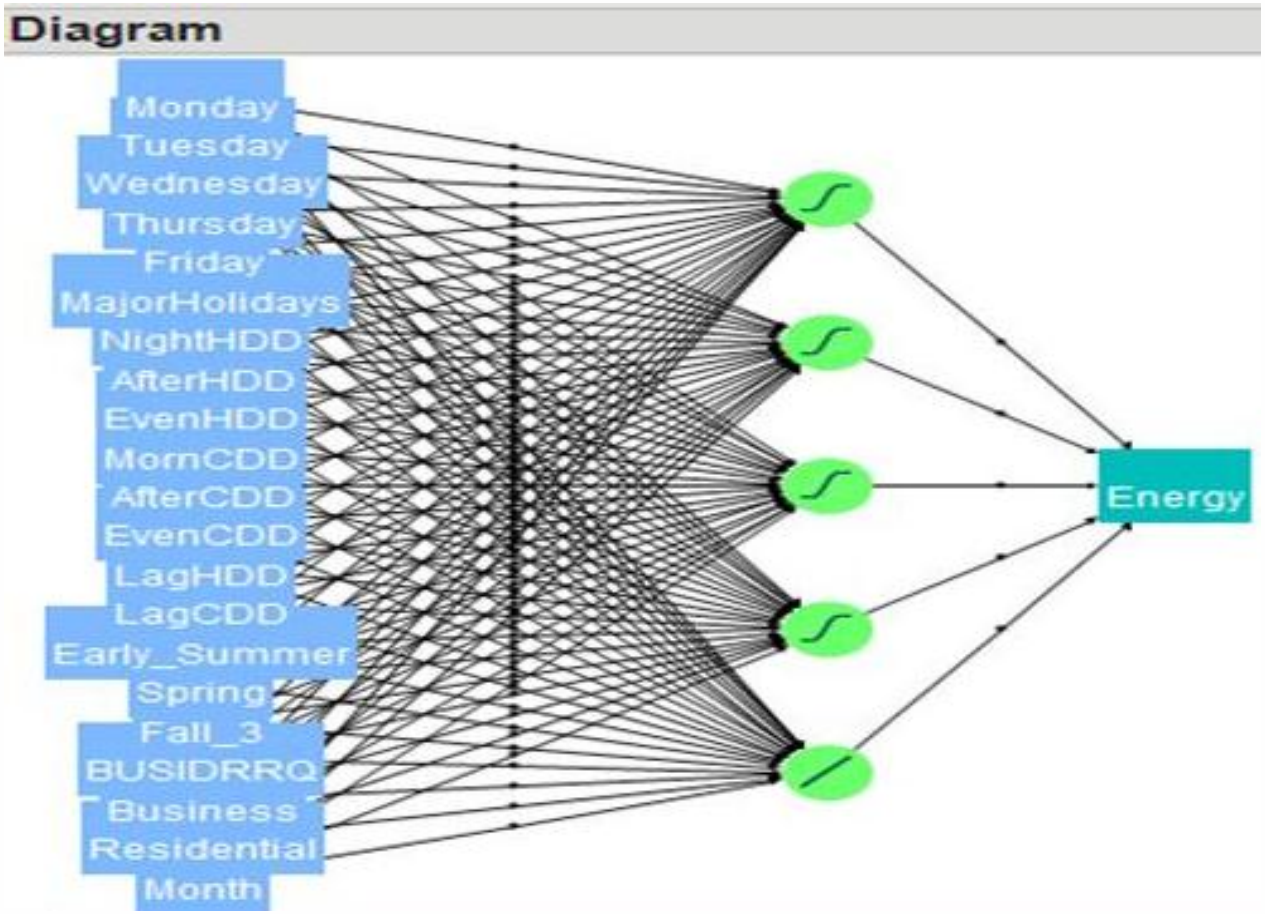
Proposed Model

- **Daily energy forecasted using Neural Network Models**

- **Benefits**
  - Able to determine/account for variable interactions more robustly when compared to linear regression models
  - All predictor variables are used as inputs in each network node
  - More detailed/precise model formulation

- **Challenges using a premise forecast**
  - Premise level forecast is based on previous 5 years of history
  - Model uses the historical relationship of premises in competitive area to total load in a weather zone (which includes competitive and NOIE load)

Neural Network Model Diagram



Proposed forecast based on multiple simulations

- **Forecasts based on multiple model simulations instead of being based on a single model**
  - Neural Network models were developed with 33% of the historical data being withheld from model development
  - The data being withheld was determined randomly
  - Randomly withholding data mitigates over-fitting of the data
  - The model's accuracy was determined based on how well it predicted the sample holdout data
  - Process was repeated thirty times (model convergence)

- **Benefits**
  - In statistics, repeated sampling gives a more accurate estimate than a single sample
  - Improves the robustness of the forecast

Proposed model - normal weather determination

- **The determination of normal weather forecast will now be based on model output using actual load and actual weather data**
  - Data was used from 2002 – 2013 (12 years of historical data).
  - Seeing that 2002 is the oldest historical calendar year for ERCOT's load data, the weather normalization process is based on 12 years of data.
  - Forecasts were created by using each historical weather year in the model. The results were ordered and then averaged (Rank and Average methodology).

- **Benefits**
  - More accurately reflects historical weather patterns
  - More accurately reflects load diversity at time of peak (results in a somewhat lower peak forecast than the previous approach)