Review of Preliminary Load Forecast

Calvin Opheim Manager, Load Forecasting & Analysis
Mark Quan Principal Forecast Consultant, Itron

January 27, 2014

Outline

- **Summary**
- **Review of Itron's recommendations**
  - **Premise forecast**
  - **Growth index**
  - **Neural Network (NN) model**
- **Review of Model Output (including implementation of all recommendations)**

Summary

- Itron has completed their review of ERCOT's premise forecast and the use of multiple neural network models.
- Itron generally supports ERCOT's proposed forecasting methodology.
- Itron is finalizing work on the Growth Index.
- ERCOT has implemented all of Itron's recommendations and has developed a preliminary forecast.

Itron evaluated three issues

1. **Premise Forecast**

   Underlying ERCOT's Growth Index is a forecast of premise counts. Itron's evaluation examines potential economic drivers to forecast the premise counts relative to ERCOT's initial proposal of using a historic five-year average growth rate.

2. **Growth Index**

   The key growth driver in the NN model is a growth index created as a weighted average of ERCOT's residential, business, and industrial class premise forecast. Itron's evaluation examines the weighting scheme and identifies issues and potential improvements.

3. **Multiple Neural Network Models**

   ERCOT's framework uses a NN model which is used to obtain multiple sets of parameters based on different historical time periods. The estimated parameters are applied to multiple historic weather scenarios to create a distribution of forecast. Itron's evaluation discusses the NN model, multiple sets of parameters, and the historic scenarios.

PREMISE FORECAST

RESIDENTIAL INDEX

Driver Consideration:

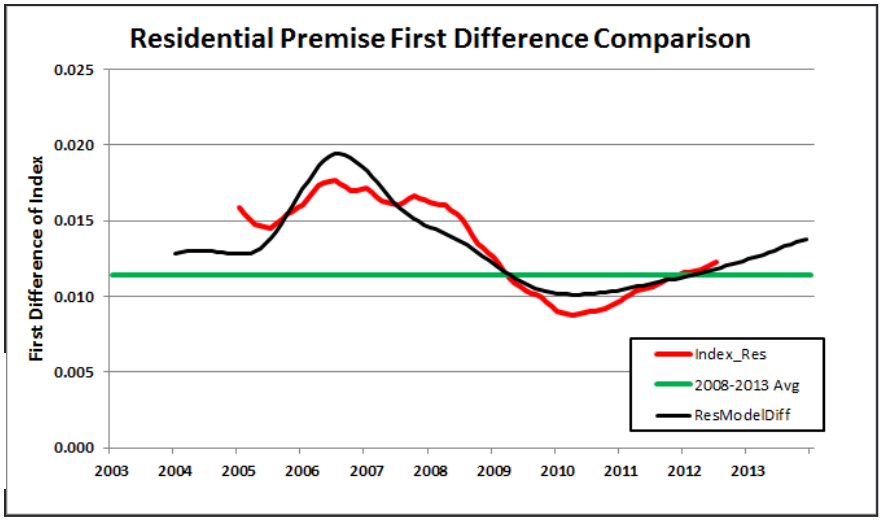
- Average
- Population
- Housing Stock
- Households

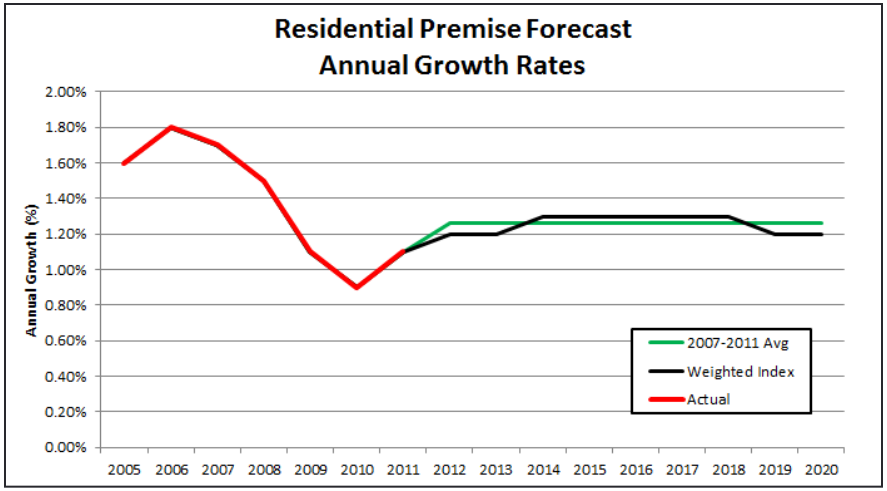
$ResIndexy,m=$

$$(HStocky,m/HStockbase\ )\uparrow 0.5 \times (Popy,m/PopBasebase\ )\uparrow 0.5$$

ERCOT Residential MAPE Comparison					
Model		03-'13	09-'13	F '09-'13	Avg
Res_Pop		0.29%	0.06%	1.16%	0.50%
Res_HH		0.32%	0.03%	1.15%	0.50%
Res_Hstock		0.29%	0.02%	0.88%	0.40%
Res_Trend		0.35%	0.06%	1.36%	0.59%
Res_Wgt		0.07%	0.03%	0.08%	0.06%

Elasticity					
Model		03-'13	03-'08	09-'13	CV
Res_Pop		0.647	0.749	0.520	0.18
Res_HH		0.641	0.746	0.449	0.25
Res_Hstock		0.718	0.631	0.930	0.20
Res_Trend		0.073	0.060	0.080	0.14
Res_Wgt		0.687	0.686	0.674	0.01



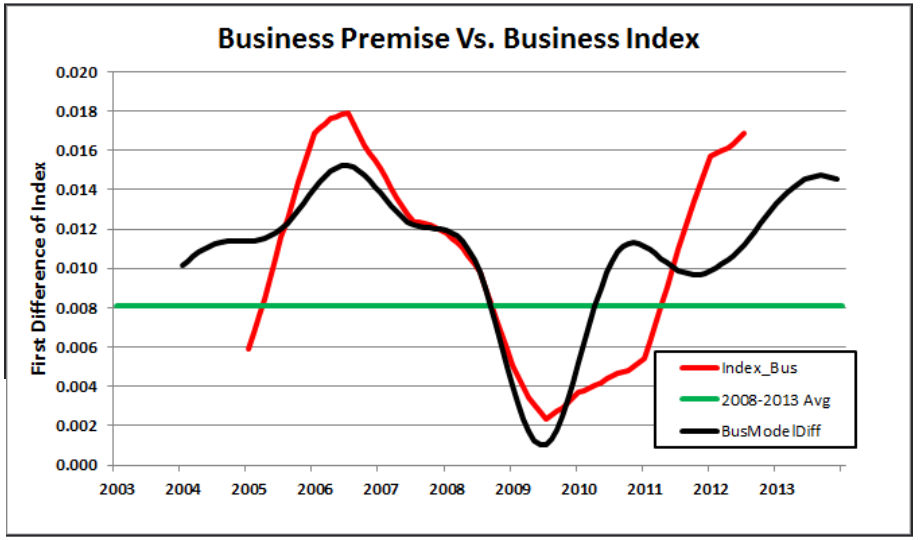


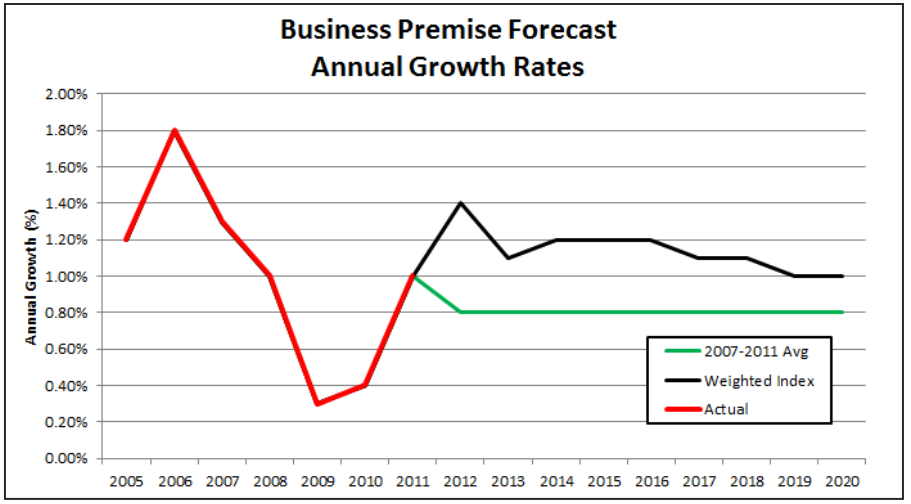
BUSINESS INDEX

Driver Consideration:

- Average
- Employment (Non-Farm)
- GDP
- Labor Force
- Population
- Housing Stock

$$BusIndex_{y,m} = (Popy,m/Popbase)^{0.33} \times (HStocky,m/HStockbase)^{0.33} \times (EmpNF,m/EmpNFbase)^{0.33}$$





ERCOT Business MAPE Comparison

Model		03-'13	09-'13	F '09-'13	Avg
Bus_Pop		0.41%	0.26%	1.68%	0.78%
Bus_GDP		0.47%	0.21%	1.13%	0.60%
Bus_Emp		0.41%	0.26%	0.98%	0.55%
Bus_Labor		0.73%	0.40%	4.19%	1.77%
Bus_Hstock		0.21%	0.18%	0.37%	0.25%
Bus_Trend		0.45%	0.26%	1.82%	0.84%
Bus_Wgt		0.12%	0.12%	0.20%	0.15%

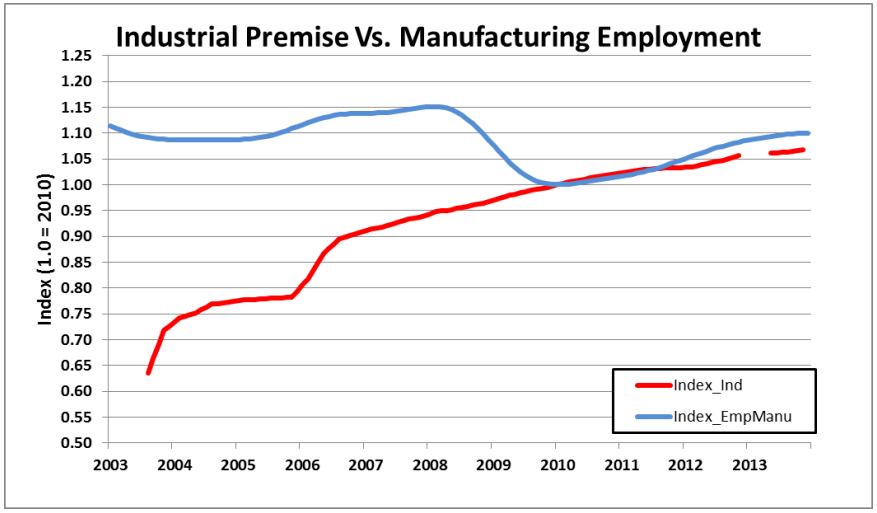
Elasticity

Model		03-'13	03-'08	09-'13	CV
Bus_Pop		0.47	0.60	0.48	0.15
Bus_GDP		0.30	0.35	0.18	0.32
Bus_Emp		0.67	0.79	0.43	0.29
Bus_Labor		0.51	0.95	0.43	0.45
Bus_Hstock		0.52	0.51	0.86	0.32
Bus_Trend		0.05	0.05	0.07	0.22
Bus_Wgt		0.55	0.52	0.58	0.05

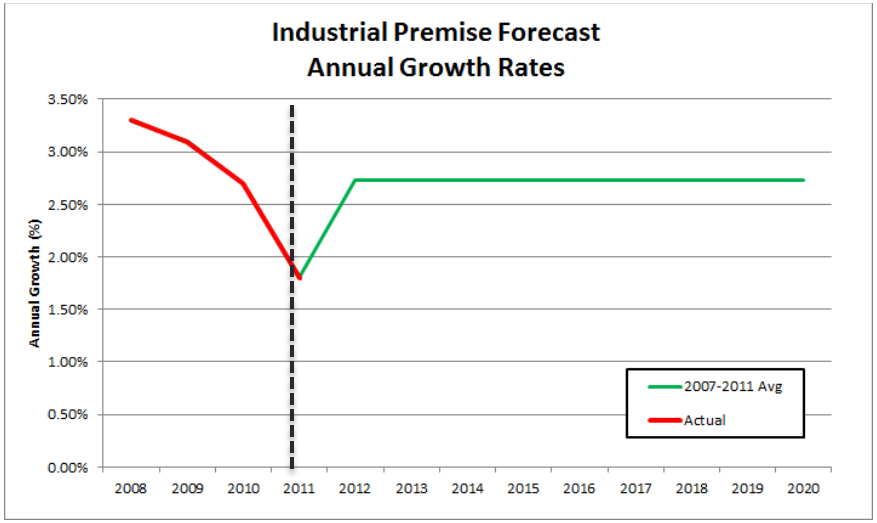
INDUSTRIAL GROWTH

Driver Consideration:

- Average
- Manufacturing Employment
- GDP
- Labor Force
- Population
- Housing Stock



ERCOT Industrial MAPE Comparison					
Model		04-'12	07-'12	F '11-'12	Avg
Ind_Pop		2.23%	0.43%	1.45%	1.37%
Ind_GDP		3.15%	2.04%	4.17%	3.12%
Ind_ManEmp		8.30%	2.02%	4.57%	4.96%
Ind_Labor		3.69%	0.36%	0.68%	1.58%
Ind_Hstock		0.86%	0.52%	0.69%	0.69%
Ind_Trend		2.45%	0.45%	1.53%	1.48%
Ind_Wgt		2.01%	0.24%	0.75%	1.00%



PREMISE RECOMMENDATIONS

Residential Premise Recommendations

- Use Residential Economic Index.
- For West and North zones, use the five year growth rate method.

Business Premise Recommendations

- Use Business Economic Index.
- For Far West zone, use the five year average for this zone.

Industrial Premise Recommendations

- Use the five year average method to forecast industrial premises.
- Revisit the industrial class when more data are available.

Residential Premise Forecast Recommendations

- Itron recommends that ERCOT implement a weighted index approach as the base approach to Residential Premise forecast. The index should be comprised of Housing Stock and Population and use equal weights.

- Itron recommends that ERCOT continue to use the five-year growth rate method for the low growth zones (North and West).

- ERCOT is adopting the recommendations.

- ERCOT has incorporated these weights in the forecast model.

Business Premise Forecast Recommendations

- Itron recommends that ERCOT implement a weighted index approach as the base approach to Business Premise forecast. The index should be comprised of Non-Farm Employment, Housing Stock and Population and use equal weights.

- Itron recommends that ERCOT continue to use the five-year average for this zone (Far West).

- ERCOT is adopting the recommendations.

- ERCOT has incorporated these weights in the forecast model.

Industrial Premise Forecast Recommendations

- Itron recommends that ERCOT continue to use the five-year average method to forecast industrial premises.
- Itron recommends that ERCOT revisit the industrial class and consider the weighted index method in two or three years when more data are available.
- ERCOT is adopting the recommendations.
- ERCOT has incorporated these weights in the forecast model. ERCOT will also consider using a weighted index when more data is available.

Growth Index Recommendations

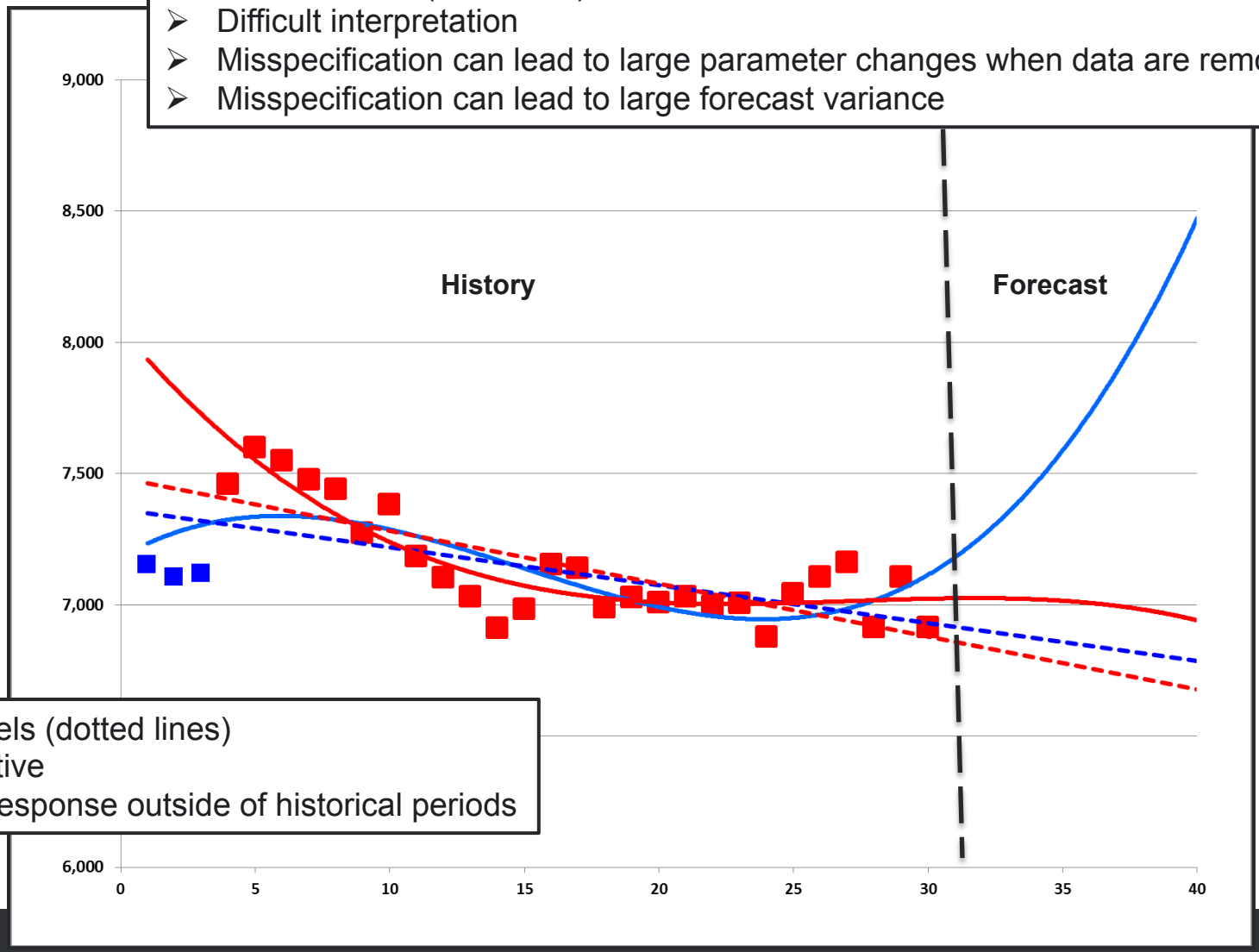
- Itron is still working on its growth index recommendations. ERCOT expects delivery by mid-February.

- A growth index is based on weather normalized premise weights.

NEURAL NETWORK MODEL

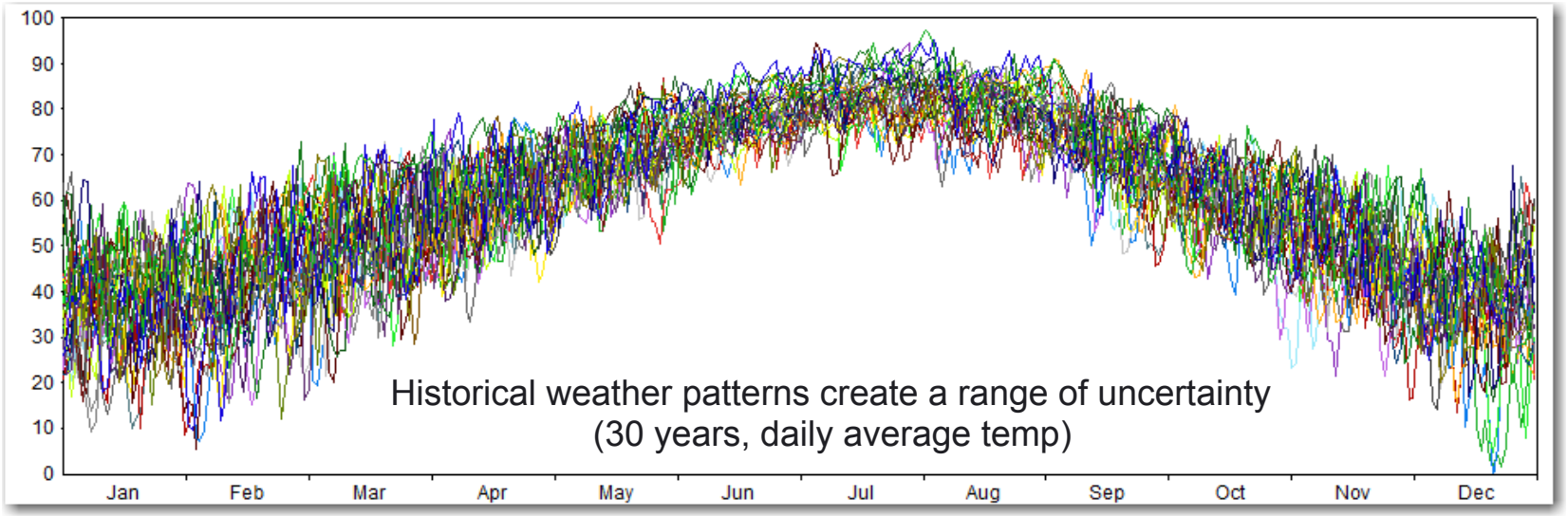
PARAMETER UNCERTAINTY

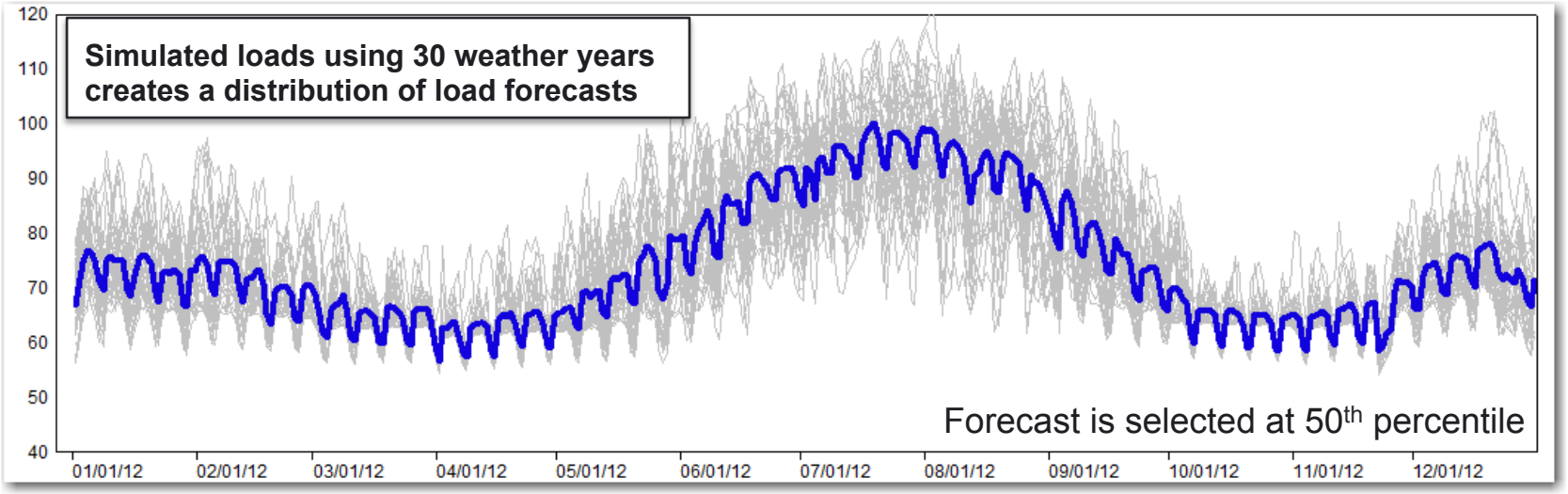
Nonlinear Models (solid lines)
- Difficult interpretation
- Misspecification can lead to large parameter changes when data are removed
- Misspecification can lead to large forecast variance



Linear Models (dotted lines)
- Descriptive
- Stable response outside of historical periods

WEATHER UNCERTAINTY





MODEL RECOMMENDATIONS

Re-specify the NN Model.

- Re-specify the NN model to isolate the growth index and obtain a stable model.

Regression Model.

- Explore using a regression model to validate any advantage of a NN model over a traditional approach.

Weather Simulation.

- Use the historic weather simulations to capture weather uncertainty.

Itron's Neural Network (NN) Model Recommendations

- **Re-specify the NN Model**. Itron recommends that ERCOT re-specify the NN model to isolate the growth index and obtain a stable model.

- ERCOT is adopting the recommendation.

- ERCOT has simplified the neural network model from 5 nodes to a single linear node. This has isolated the premise growth index and improved the stability (variability) of the model.

Itron's Neural Network (NN) Model Recommendations

- **Regression Model.** Itron recommends that ERCOT explore using a regression model to validate any advantage of a NN model over a traditional approach.

- ERCOT is adopting the recommendation.

- ERCOT will continue to maintain a linear regression model and will track its performance versus the NN model.

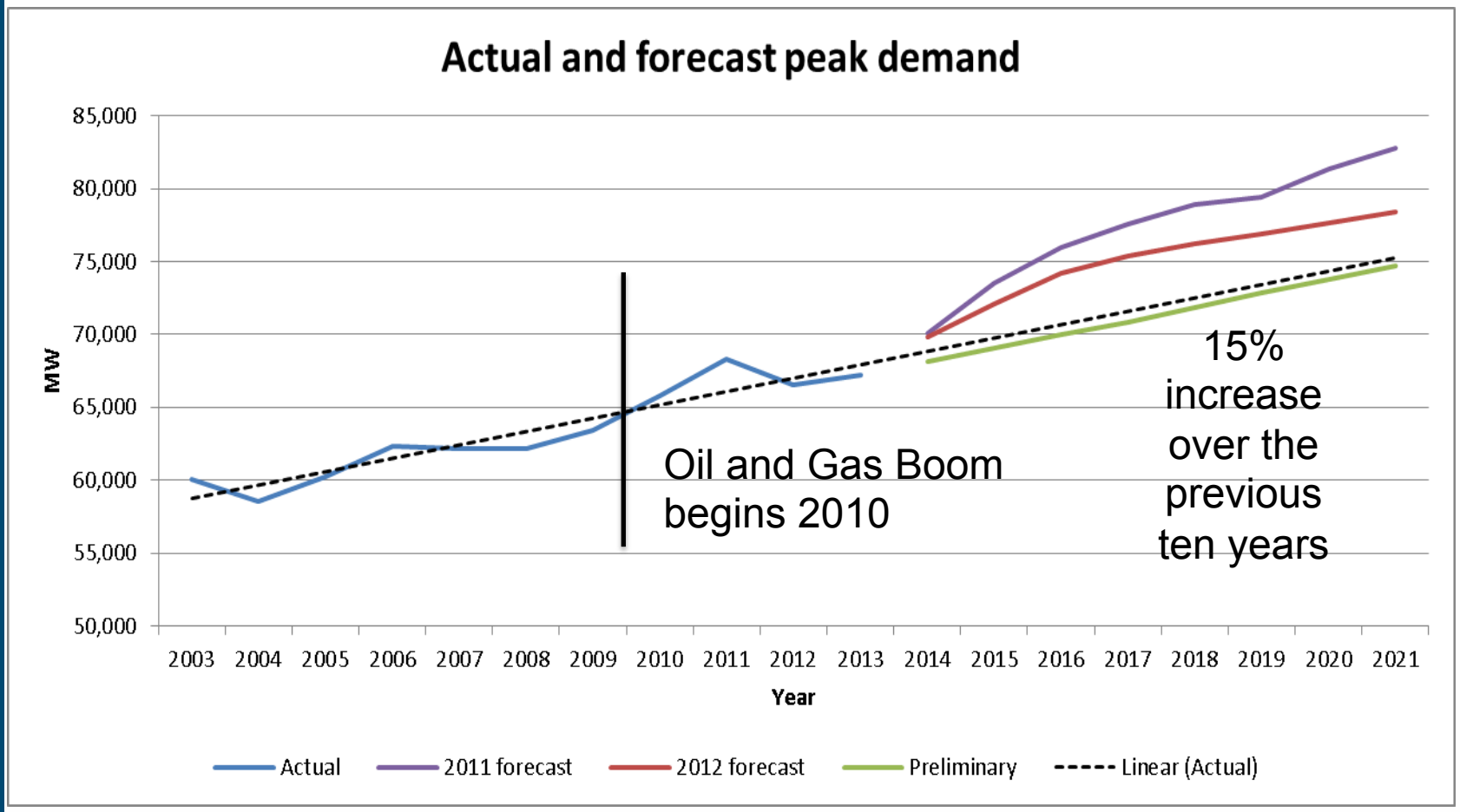
Itron's Neural Network (NN) Model Recommendations

- **Weather Simulation.** Itron recommends that ERCOT continue to use the historic weather simulations to capture weather uncertainty.

- ERCOT supports the recommendation.

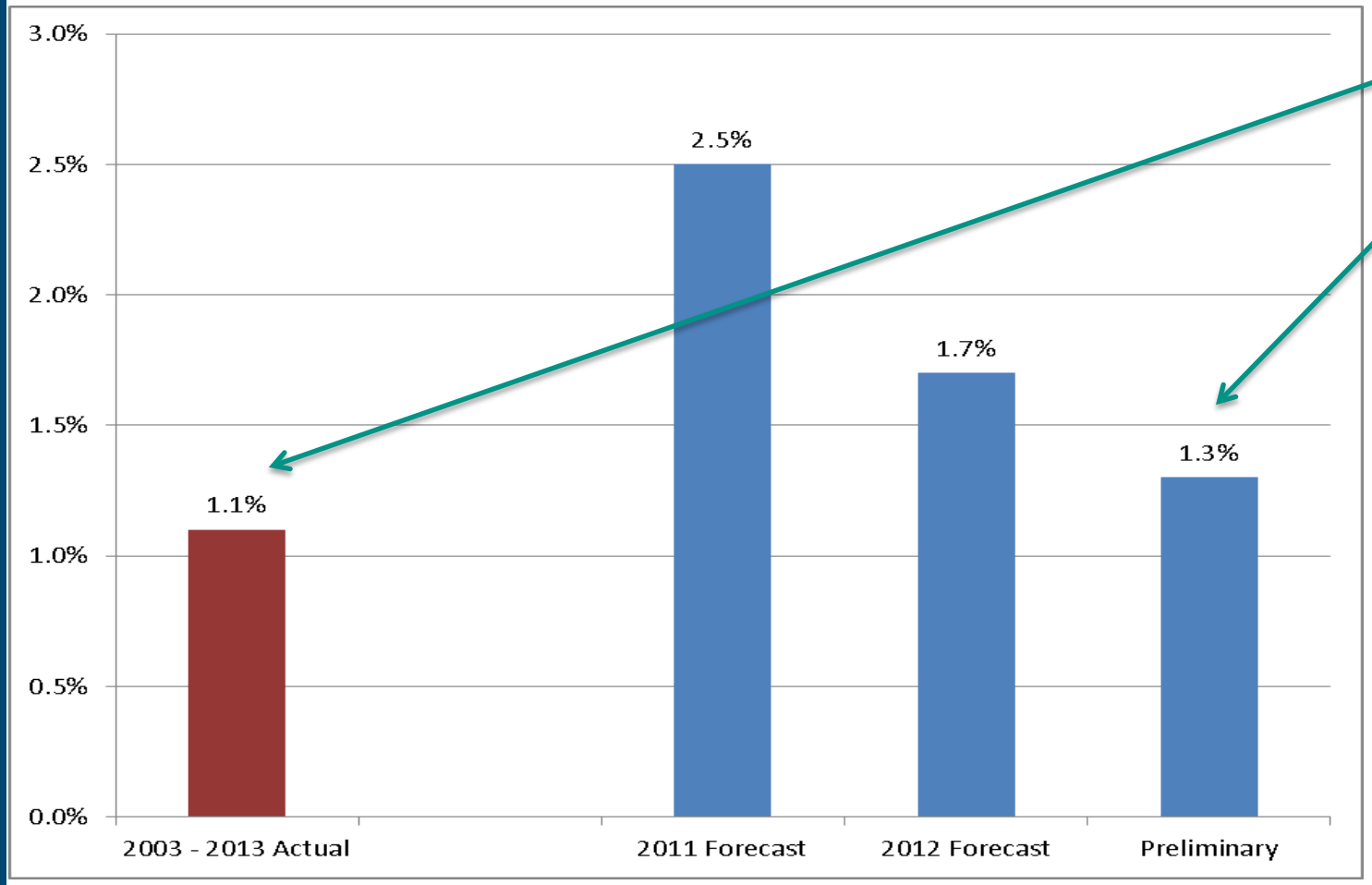
- This recommendation is consistent with ERCOT's proposed changes in determining a weather normalized load forecast.

Comparison of historical peak demand forecasts



2011 forecast based on Moody's base scenario
2012 forecast based on Moody's low scenario

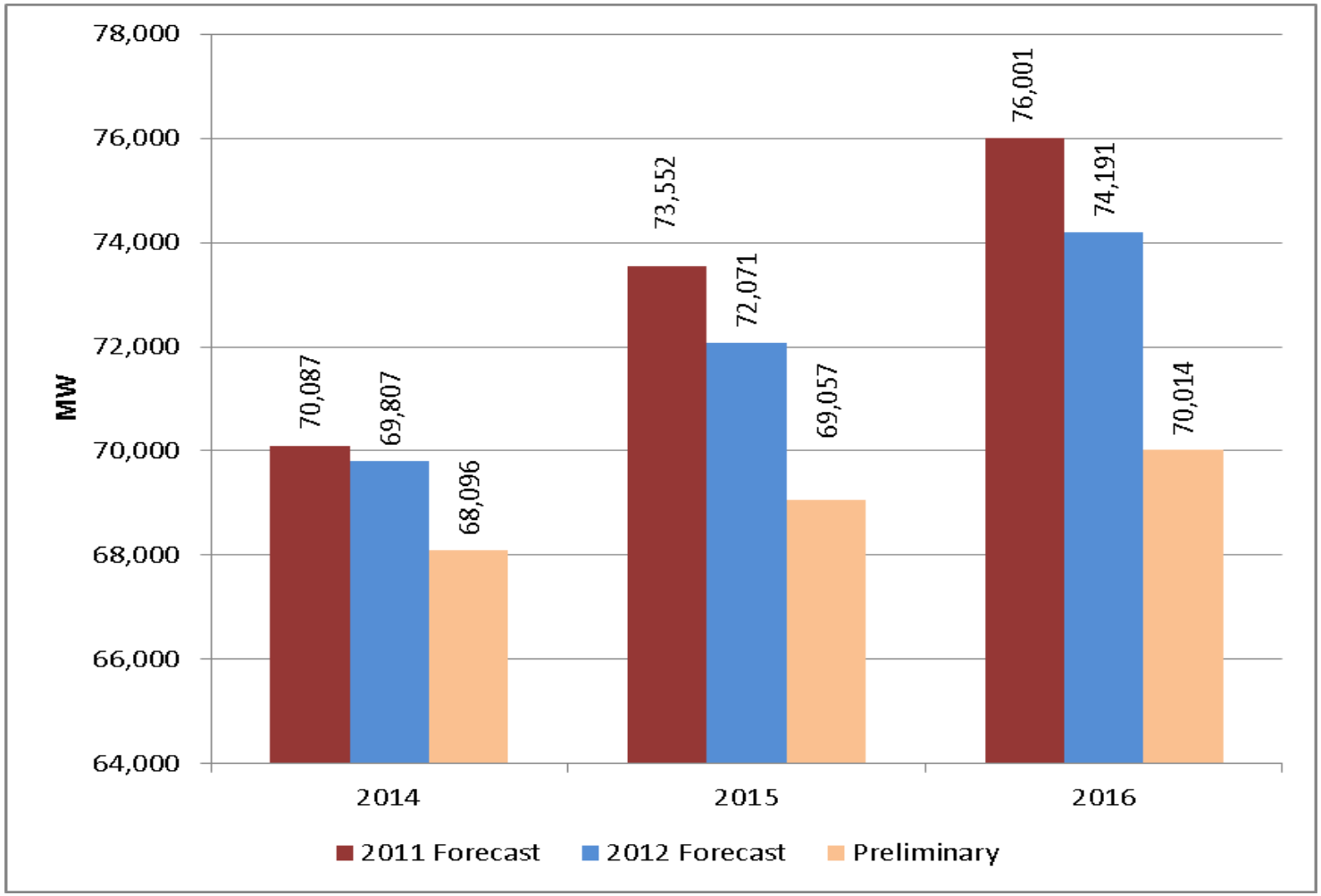
10-year average annual growth rate – peak demand



15% increase over the previous ten years

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

Comparison of historical peak demand forecasts



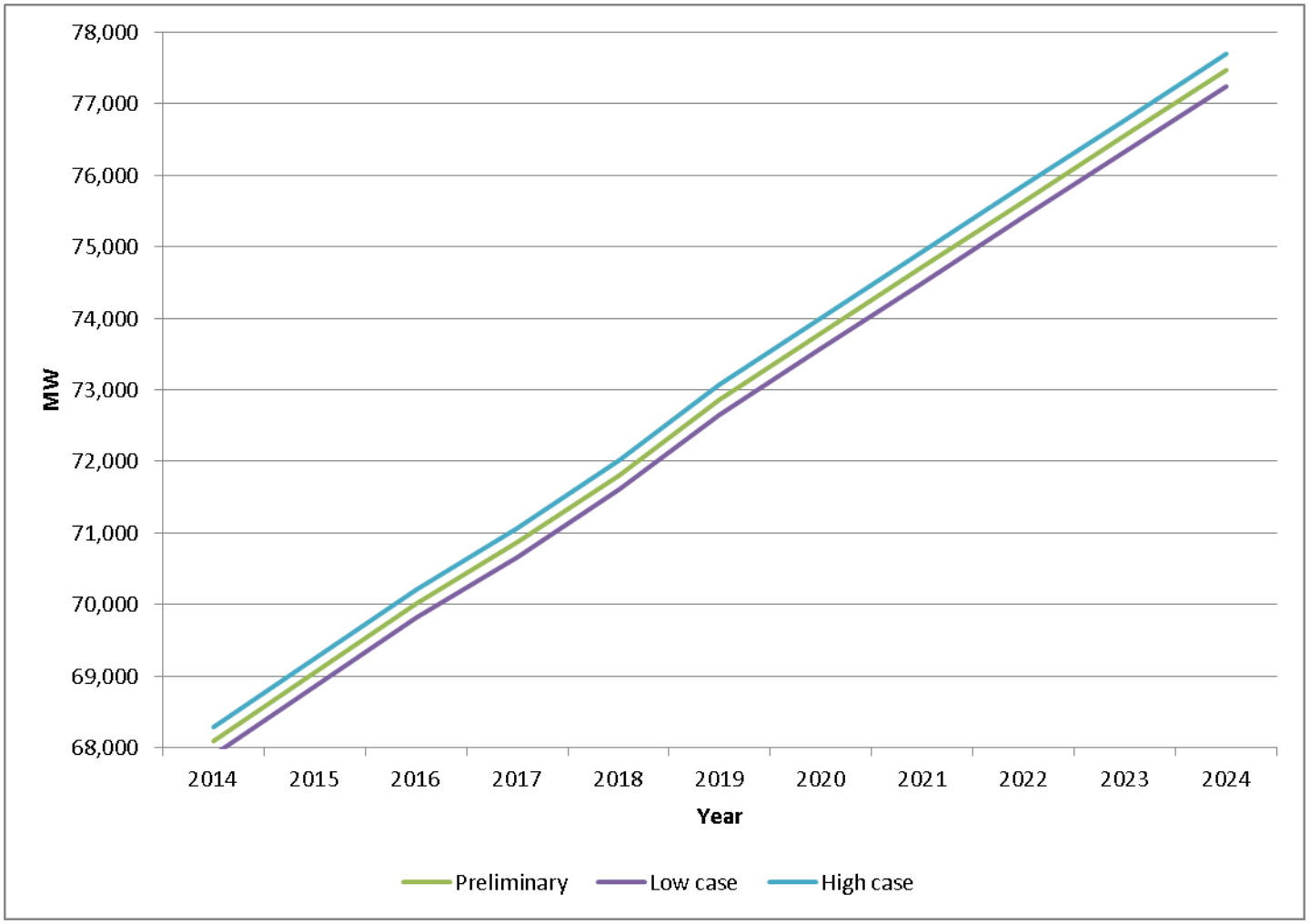
2011 forecast based on Moody's base scenario
2012 forecast based on Moody's low scenario

Sensitivities

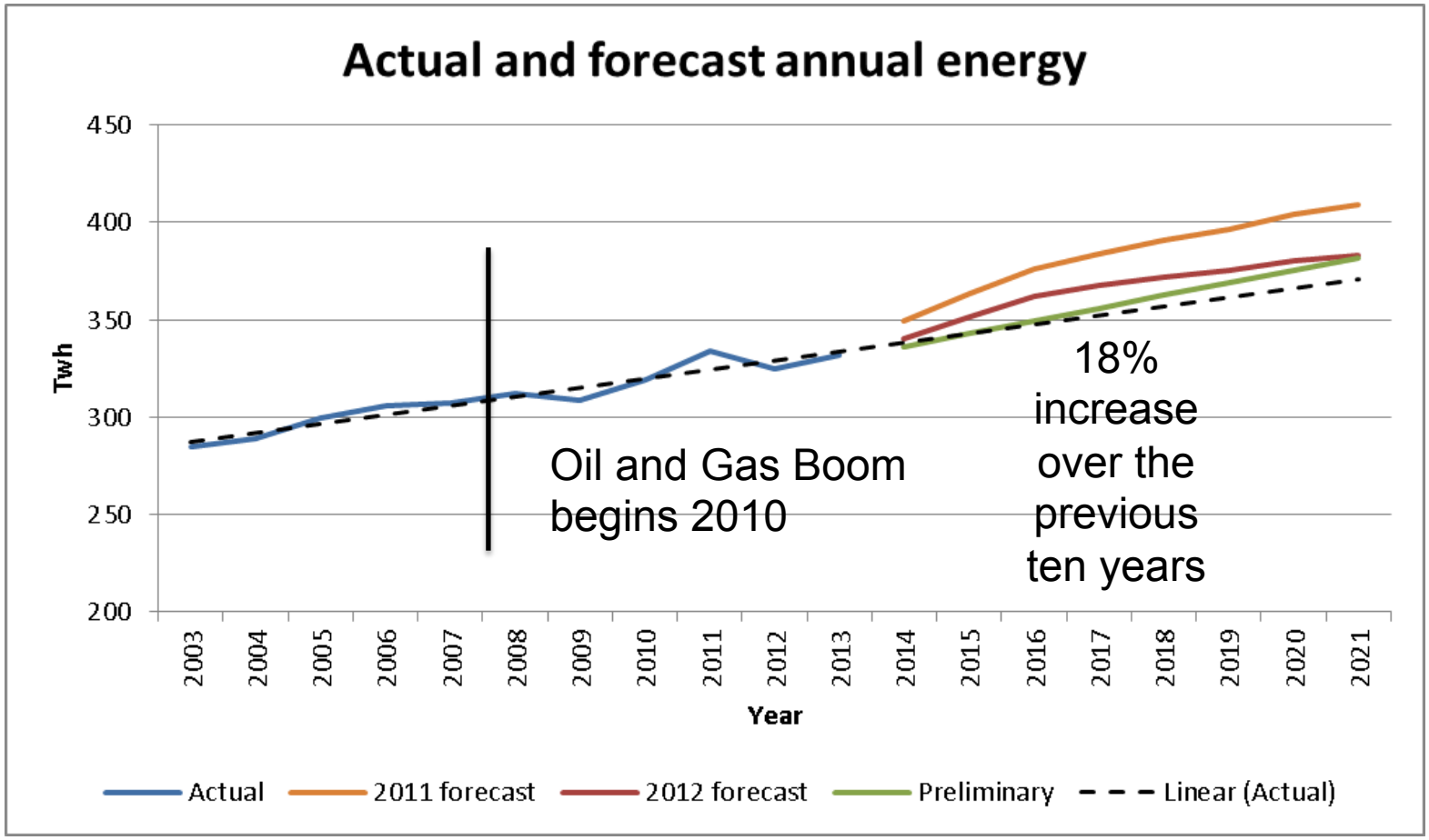
- Two examples were developed to demonstrate model sensitivity to premise forecasts.
  - Increasing the base case premise forecasts by 0.5%
  - Reducing the base case premise forecasts by 0.5%

- These percentage changes were consistent with previous Moody's percentage changes in non-farm employment for their low and high scenarios when calculated on a 10-year average annual growth rate basis.

Summer peak demand forecast sensitivities

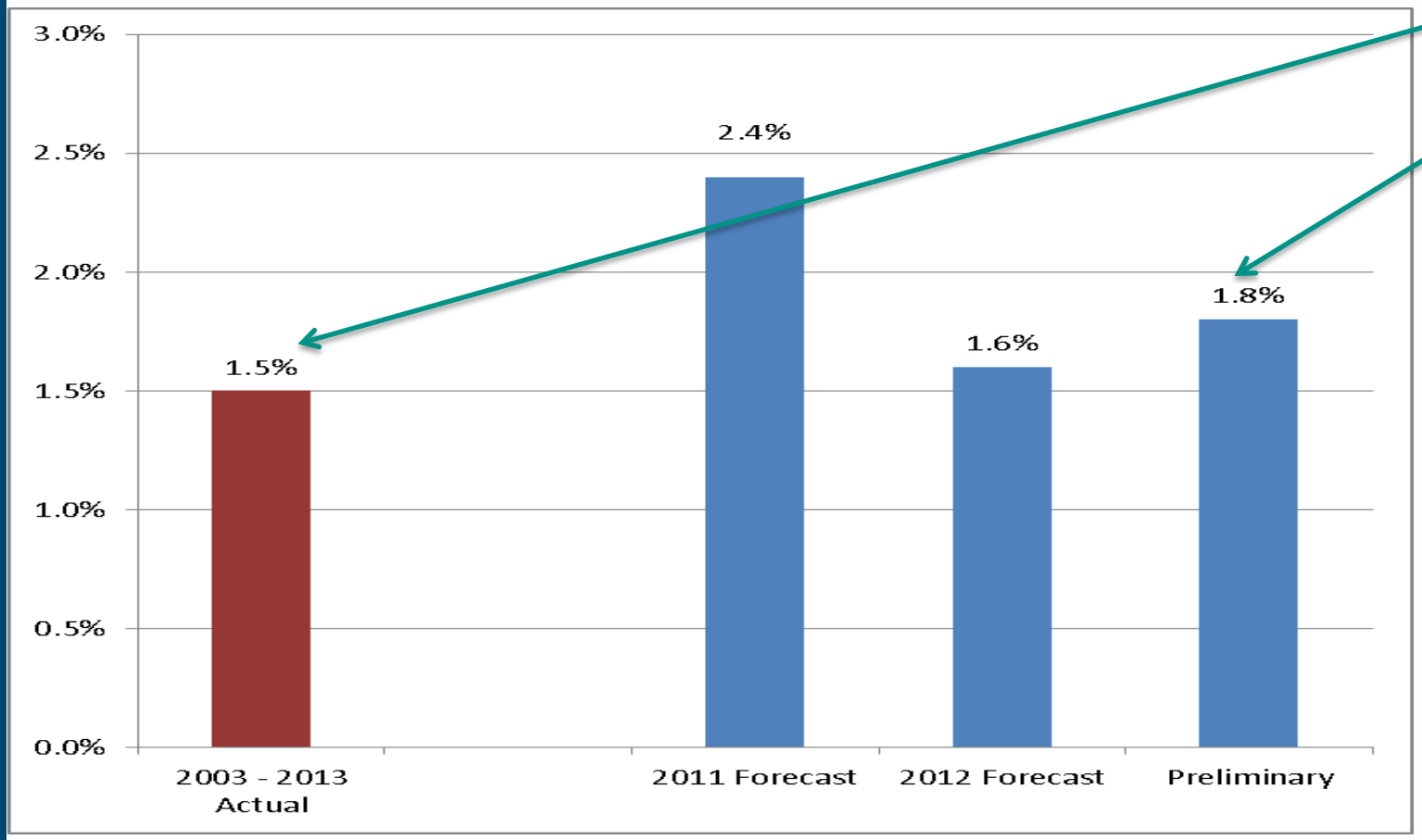


Comparison of historical energy forecasts



2011 forecast based on Moody's base scenario
2012 forecast based on Moody's low scenario

10-year average annual growth rate – energy



18% increase over the previous ten years

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

Benefits of proposed forecasting methodology

- The neural network model decouples the growth in demand and energy.
- Multiple neural network models allow the calculation of forecast sensitivities.
- Historical premise counts are not subject to revision as exhibited by non-farm employment.
- Able to determine/account for variable interactions more robustly when compared to linear regression models.
- More detailed/precise model formulation.
- Improvements in weather normalization to better reflect geographical weather diversity.

Questions