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Weather, Water & Climate Services

VANCOUVER, BC, CANADA

TODD DAVIS AND MARY ALTALO
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
ENERGY SOLUTIONS GROUP

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The Economic Value of Improved Weather Forecasting Accuracy: Key Issues, Opportunities And Real Money

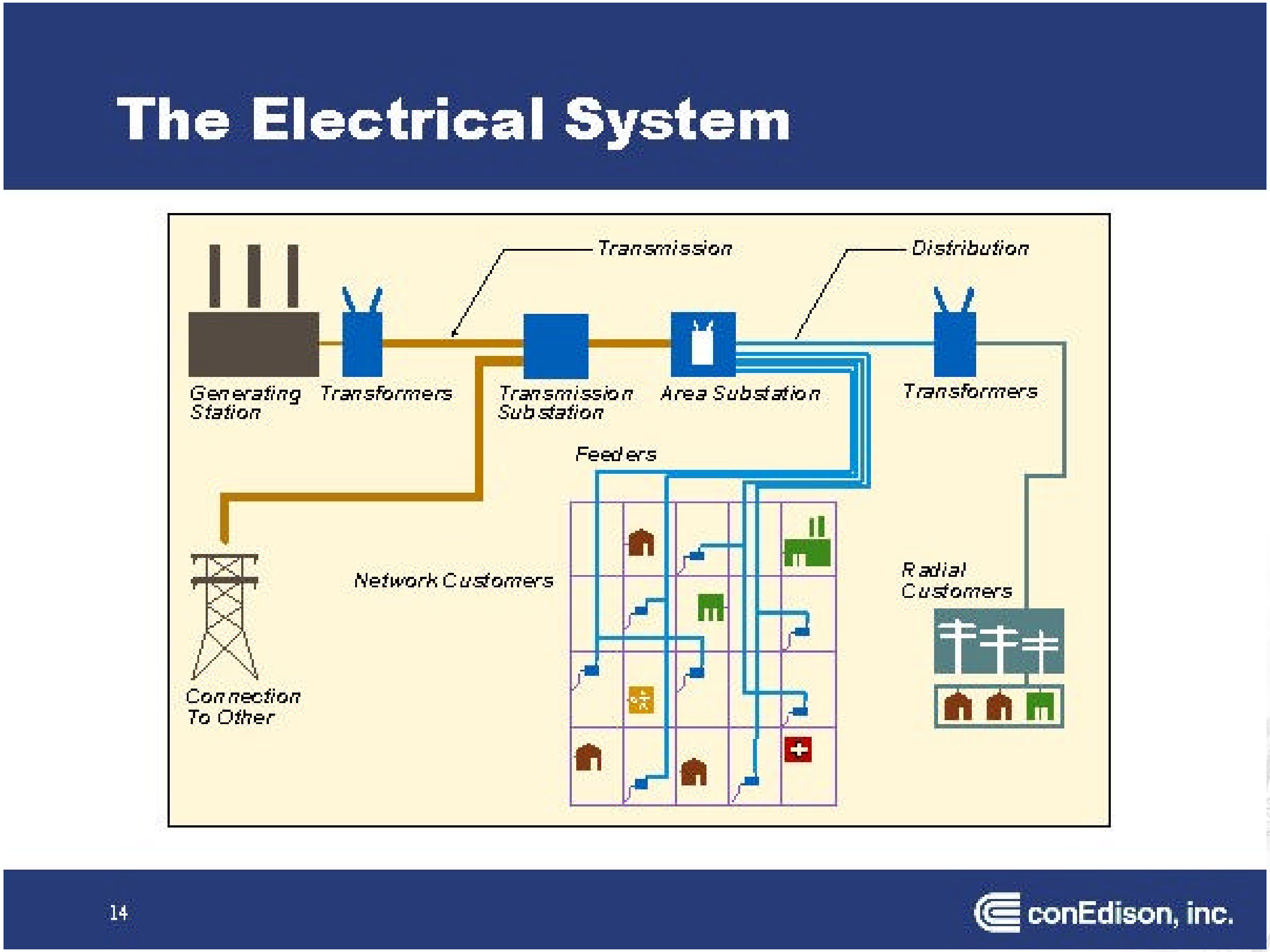
IMPACT ASSESSMENT FOR INDUSTRIAL DEVELOPMENT

Topics

- **Background**
  - Energy Systems Under Stress in the World
  - Weather is the "Tipping Point" or Catalyst of Problems
- **Base Case Situation: Three Case Studies**
  - Cal ISO
  - Con Edison
  - New England ISO
- **Method Used To Investigate How To Improve Forecasts**
- **The Economic Value of Improving Forecast Accuracy**
- **Conclusions**

> - **All members of the supply chain subject to risks**
> - **Forecasting art and practice has real costs and benefits**
> - **Accuracy critical because weather can be a real option if potential to act exits.**

The Electricity Value Chain



Background

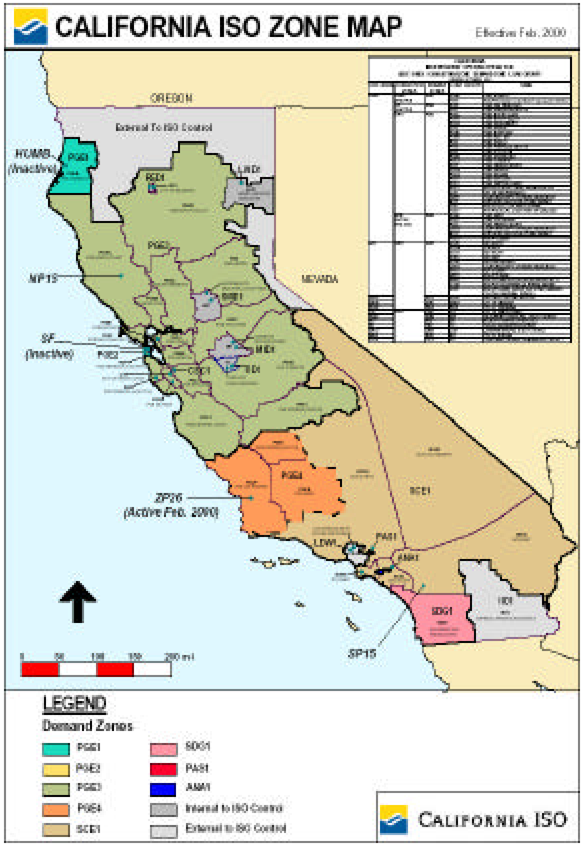
NOAA Sanctioned Three Projects To Evaluate Climate and Weather Impacts on Utilities

- Northeast Energy Network Performance Analysis Project
  - ISO New England
  - Con Edison
  - State University of New York
- The Economic Benefit of Incorporating Weather and Climate Forecasts into Western Energy Production Management
- Evaluation of 20-30 Year Climate Forecasts To Improve Regional Long Range Energy Master Plans For Southern California

CALIFORNIA ISO

- Average forecast errors are 1-2% of projected day ahead hourly loads
- Extreme events occur that may dramatically increase forecast error
- When error occurs – it can be costly
- A 1% error may be 300-500 MW of peak load.

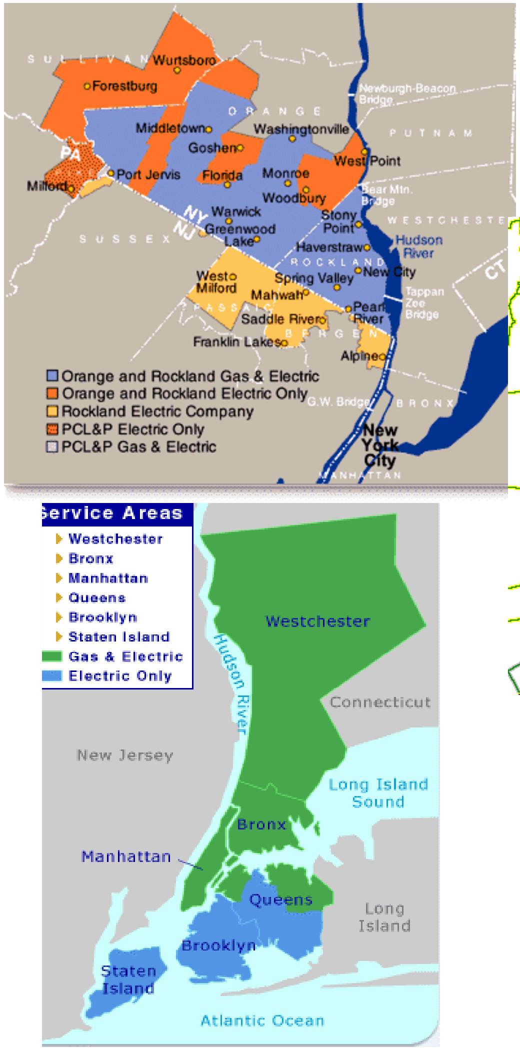
The Case Studies



44,000MW

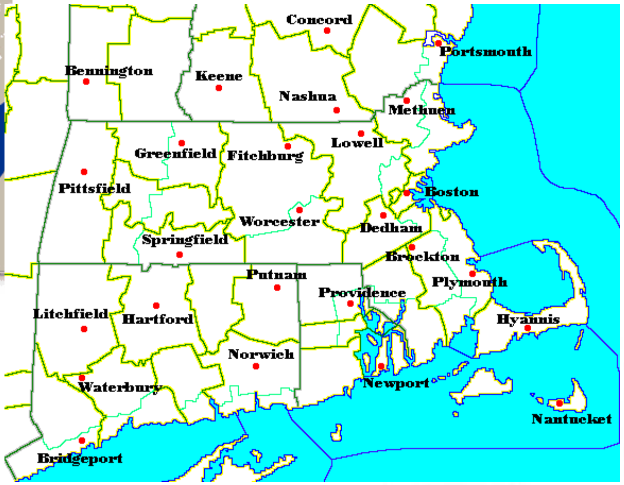
1 MW = 100-150 Homes

Con Edison



13,000 MW

ISO New England



24,000 MW

Base Case Situation: Three Case Studies

Summary of Case Study Electric Delivery Organizations

Delivery Agent	Characteristics	Forecast Issue
Cal ISO	– 44,000MW – Reliability – Load Balancing – Scheduling Generation	– Delta Breeze Forecast Improvement – Reduce Day Ahead Hourly Error
New England ISO	– 25,000MW – Reliability – Load Balancing – Scheduling Generation – Market monitoring	– Reduce Forecast Error of Extreme Events – Validate Choice of Weather Stations – Evaluate Representativeness of Boston Logan Airport
Con Edison Company	– 13,000 MW of Peak – Very high Cost of Power Supply – Limited T&D expansion	– Delay or Avoid Costly Substation Investments – Forecast Sea Breeze – Review Day ahead hourly forecast error

What To Look For To Improve Forecast Accuracy

- **Weather monitoring station bias and reporting error**
- **Weather forecast model bias**
- **Load Forecast Error**
- **Typical errors reported in the case stu**
  - **Con Ed: 40/60**
  - **NE ISO: 60/40**
  - **Cal ISO: 70/30**

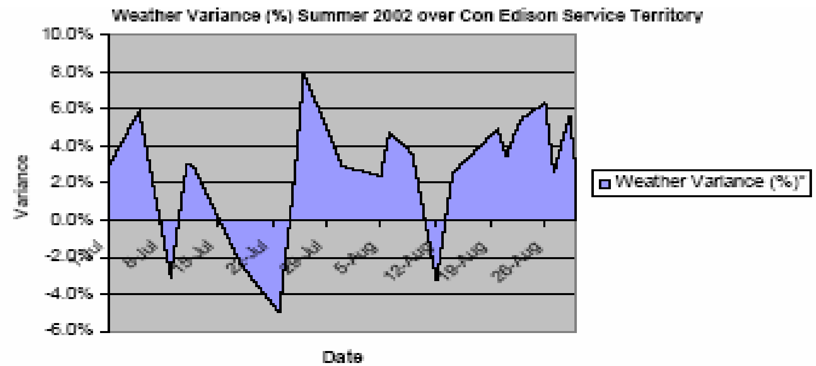


Figure 2-4. Percent Forecast Error by Day

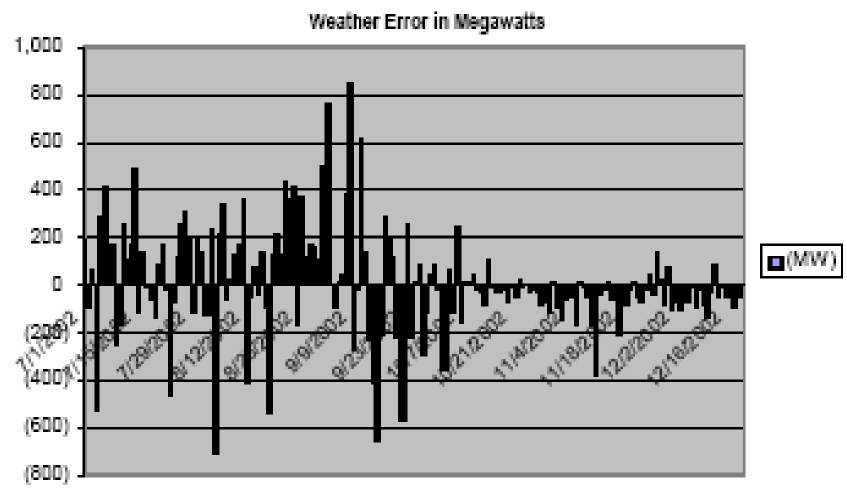
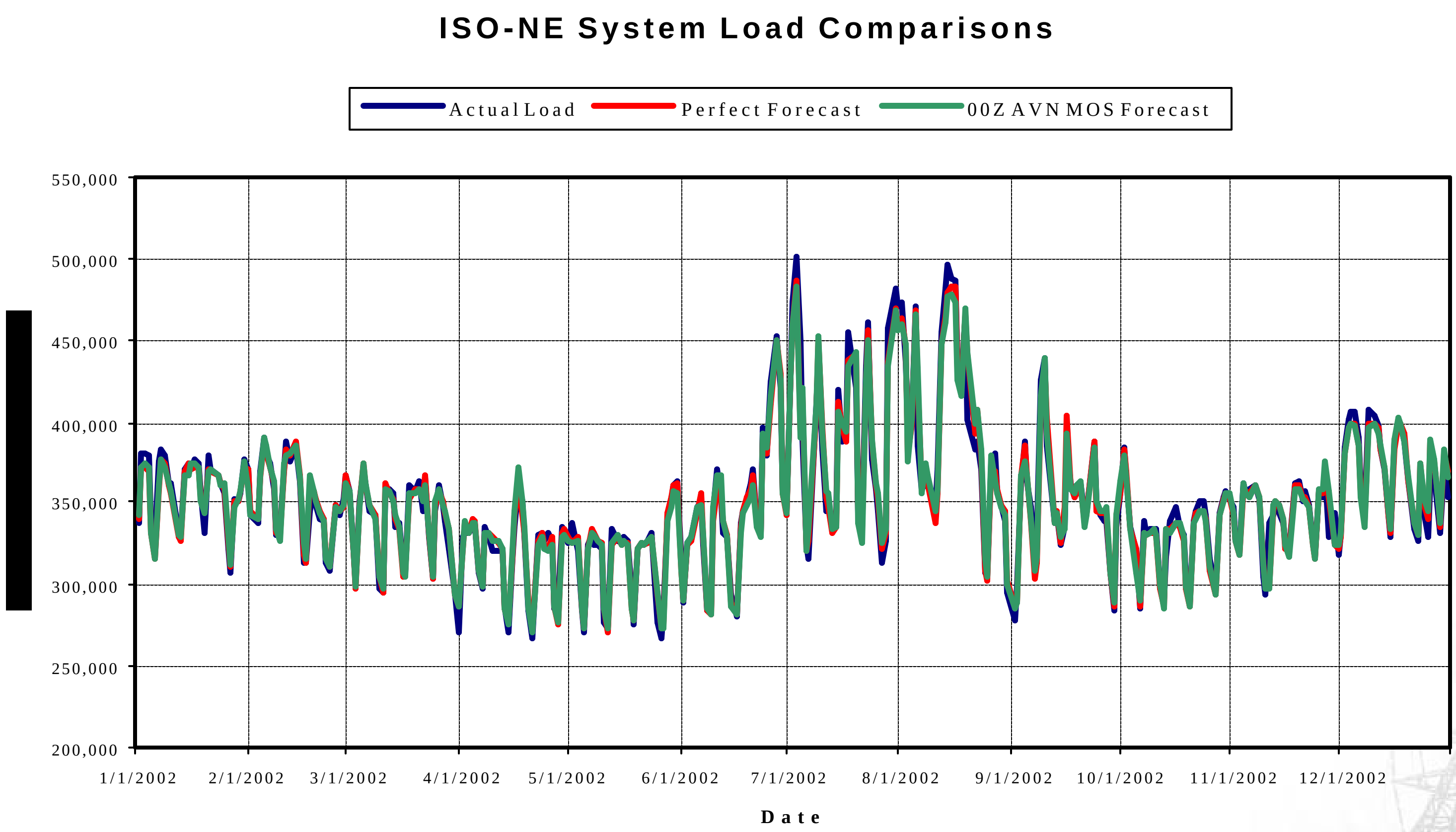
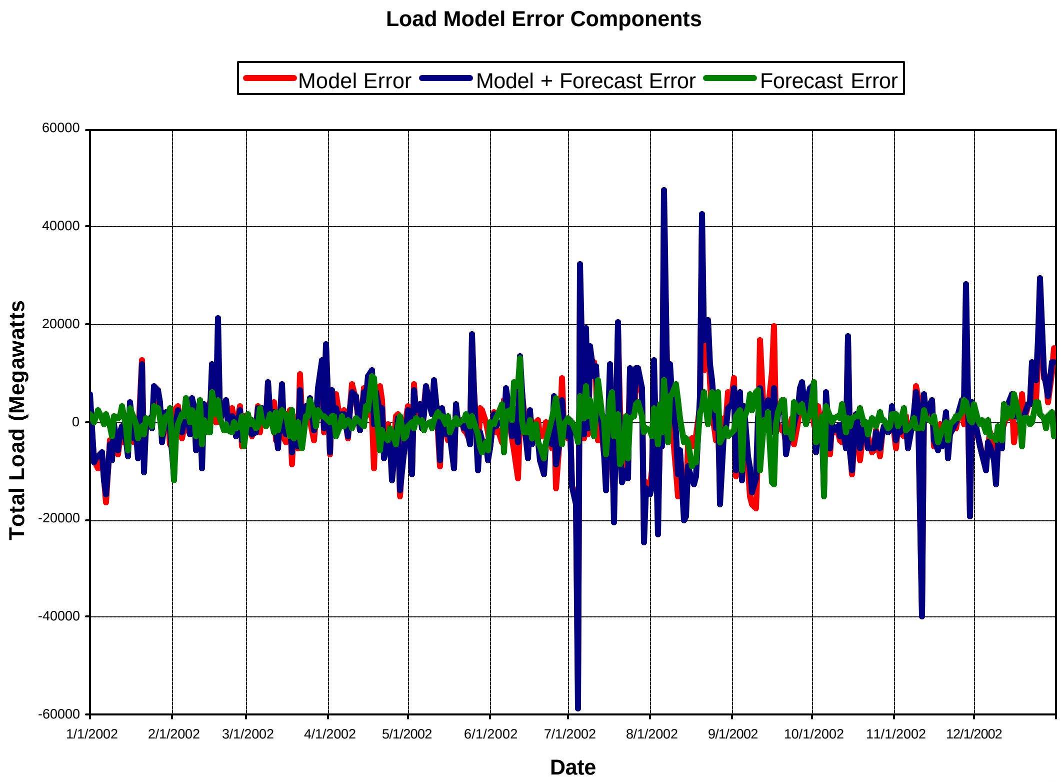


Figure 2-3. MW Error by Day

What To Look For To Improve Forecast Accuracy (Continued)



ISO New England Predicted vs Actual



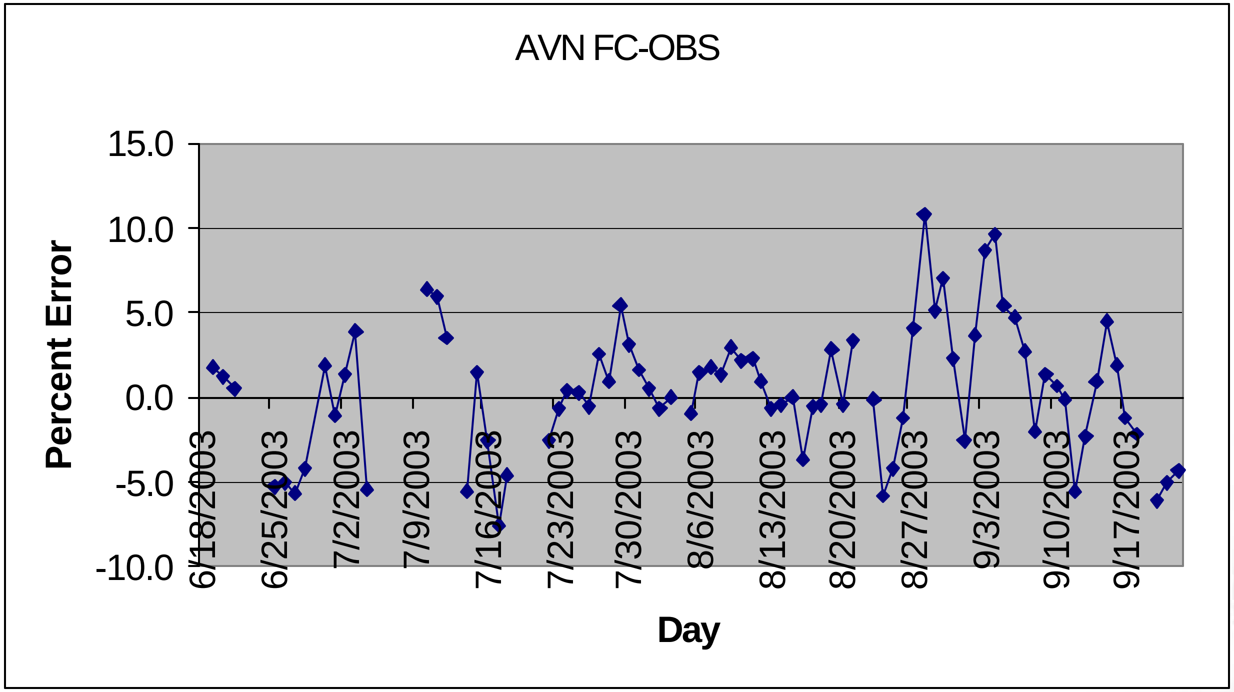
What To Look For To Improve Forecast Accuracy (Continued)

Table 6 shows the incidence of average and extreme forecasts errors in the summer period from May-August 2002. Of the 325 total hours during the peak periods of 1-5, close to one third of the forecast error exceeded 3 %. Some forecast errors were as high as 15% during critical peak days.

Incidence of Forecast Error (May-August 2002)					
Error Band	May	June	July	August	Total
0-1%	24	12	13	6	55
-1.01to -2%	11	8	7	13	39
-2.01 to -3	9	8	1	10	28
>-3	6	10	4	2	22
0-1%	8	4	8	7	27
1.01-2.0%	12	11	3	7	33
2.01-3.0%	13	7	6	10	36
>3%	7	16	30	32	85
Peak Forec Hours	90	76	72	87	325

Table 6. Incidence of Weather Forecast Error, By Error Band and Incidence Level (Hours in Error During the 1-5 PM time period from May-August, 2002).

Cal ISO Forecast Errors



CLIMATE CHANGE IMPACTS ON ELECTRIC UTILITY ASSET OPERATIONS AND COSTS

IMPACT ASSESSMENT FOR INDUSTRIAL DEVELOPMENT

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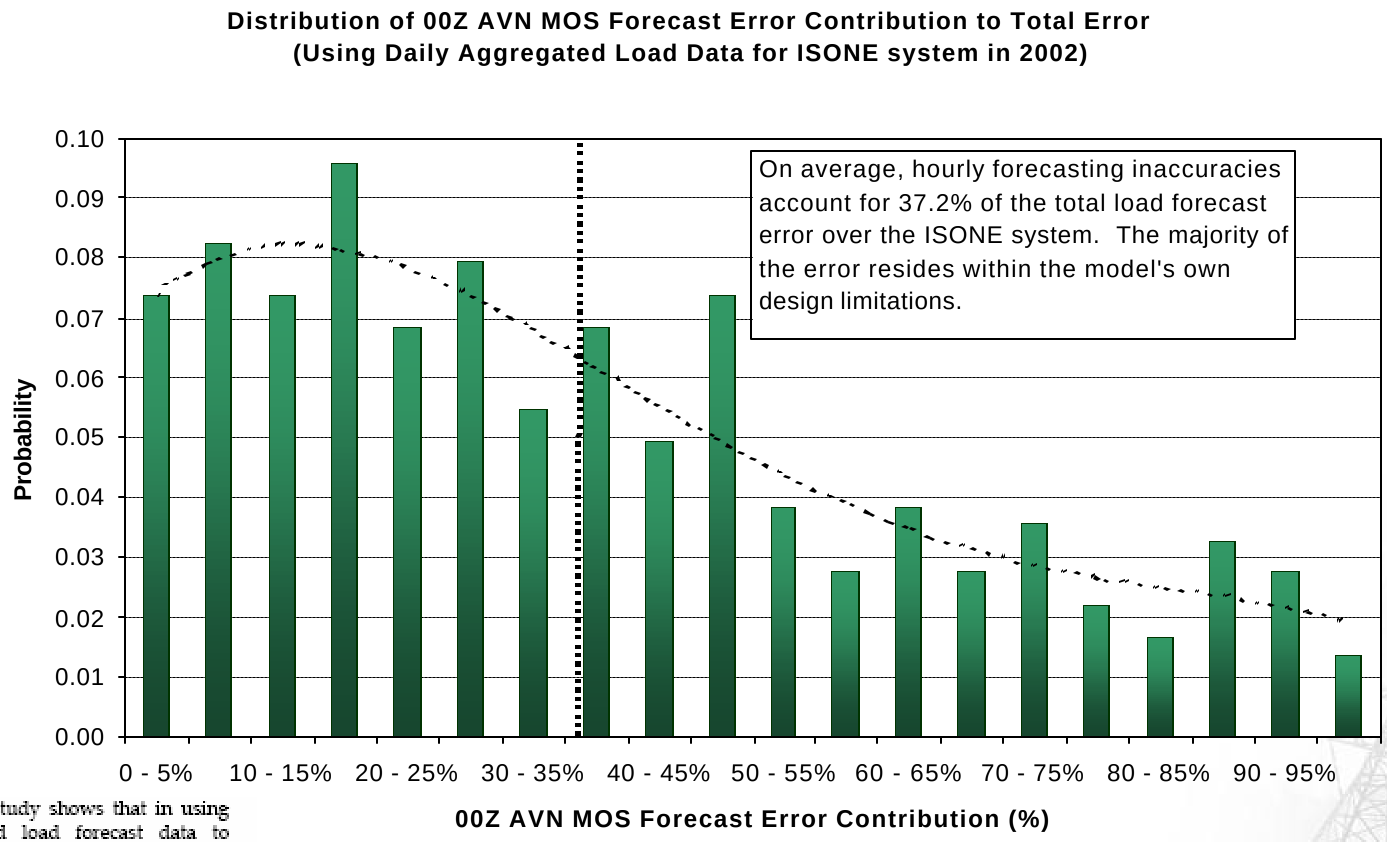
Discovering How To Improve Forecast Accuracy

The study team developed a weather diagnostic approach that involved the following:

- **Evaluate weather station bias and data integrity by comparing historical forecast to actual temperature and load forecasts**
- **Calculate Mean Absolute Error values**
- **Calculate Root Mean Error**
- **Calculate forecast error histograms**
- **Estimate the cost of forecast error during critical peak and off team time periods. Sum up these errors into an annualized error estimate. A combination of bottom up and top-down estimates were calculated.**
- **Extreme or exceptional event analysis was also completed**
- **Weather station correlation analysis and principal components analysis was applied to determine clusters of weather stations and to determine if new weather stations might add more discrimination of data points to identify improved forecast capability**
- **New weather forecast stations and predictive values were added and used in load forecasting models to see what the forecast improvement was. .**

Results applied to an economic valuation methodology.

New England ISO Diagnostics



The first case study shows that in using the weather and load forecast data to improve load forecast accuracy the following results are reported:

- A 1° F error in load forecast results in a 0.25-0.5% load error
- Current peak load averages about 22,000 MW.

The Economic Value of Improving Forecast Accuracy

- Very interesting methodological issues in evaluating the economic value of improving weather and load forecast accuracy for electric utilities
  - **Different approaches exist – good to try multiple approaches**
  - **Can you isolate weather factor? OR are other factors at play?**
  - **Requires consensus view**
  - **Often hard to achieve given fragmented use of weather forecasts**
  - **Forecast error is sensitive issue (internal and external)**

The Economic Value of Improving Forecast Accuracy (Continued)

- The Approaches
  - The Marginal Cost of Generation Method
  - The Statistical Method
  - The Market Price/Value Method
- The Results

Hourly Costs To Run A Coal and Natural

Gas Plant	Cost/Hr	Cost/Day
Cost Cost	$7250	$174,000
Gas Cost	13,600	325,400

Forecast Error Cost Benchmarks

1. **Cal ISO = $100,000/Incident**
   - **Range is $100k-800K/Incident**
   - **For every degree F error = 530 MW**
   - **Cost of all days of error = $9.9 million – $14 Million/yr**
2. **Duke Power Estimate $8 million/Yr.**
3. **Con Edison – (Weather Total)**
   EPS impacts $-.05 to $.15/share total, equates to -$11 Million to +$36 million/ year. Weather forecast error is about $4.4 million/year.

Forecast Error Causes

Events	Error Impact/# Events	
•Frontal Boundaries	H or L	10
•Marine Flow	H	6
•Strong W Winds	Too Low	6
•PM Showers	Too High	5
•Other	High/Low	3

ISO New England Experience

Conclusions

- Weather and load forecast error from many sources
- Sources are discoverable – but not necessarily easy
- Error and bias represents real cost
- Need more exploratory and hands on investigations
- Need to watch out for “push button” forecasts
- Need to sweat details of weather and modeling value chain
- Need for more functional specialization of weather, load and asset valuation studies
- Recognize that weather is a real option that can be leveraged in times of stress – if you can adequately predict it
- Need to keep score card of performance.

The Score Card

Indicators	MAE (MW)	Improvement (%)
All Days		
•Baseline	•6,089.2	--
•Perfect	•5,365.4	11.89
•Station Swap	•6,082.9	.12
•+1 degree-F	•5,699	6.61
Top 30 Error Days		
•Baseline	•10,043	--
•Perfect	•7,492	2.54
•Station Swap	•9,915	1.71
•+1 degree-F	•8,481	15.76