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IAIA ANNUAL CONFERENCE

Incorporating Weather and Climate Forecasts into Energy Production Management: Economic Benefit, Risk Reduction and Power Industry Applications

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THE IMPACT OF ENHANCED WEATHER DATA AND ASSESSMENT ON THE RISK PROFILE OF THE ENGERGY INDUSTRY

Outline of Presentation

- Identifying risks
- Assessing vulnerability to risk
- Benchmarking risk
- Risk management and mitigation options
- Conclusions

Types of Risk Faced by Businesses

Five general risk types affect all businesses:

1. Market risk or price risk (unexpected changes in interest rates, exchange rates, stock prices, or commodity prices)
2. Credit/default risk
3. Operational risk (equipment failure, fraud)
4. Liquidity risk (inability to buy or sell commodities at quoted prices)
5. Political risk (new regulations, expropriation)

In addition:

- Environmental risk
- Risks to reputation
- Regulatory risk
- Risks to energy security

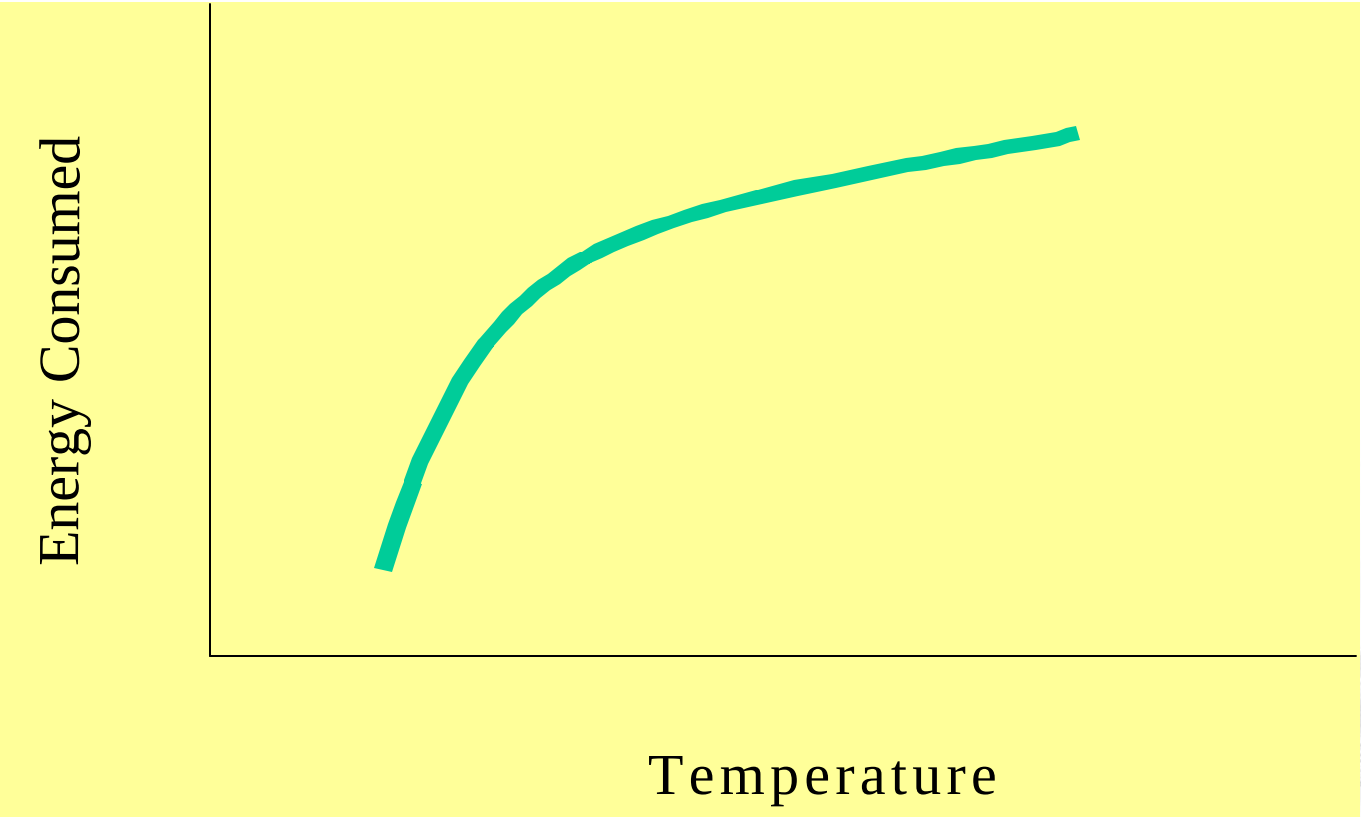
- Risk to an organization arise from a combination of factors specific to the sector and the organization

Weather Risk (risk FROM the environment)

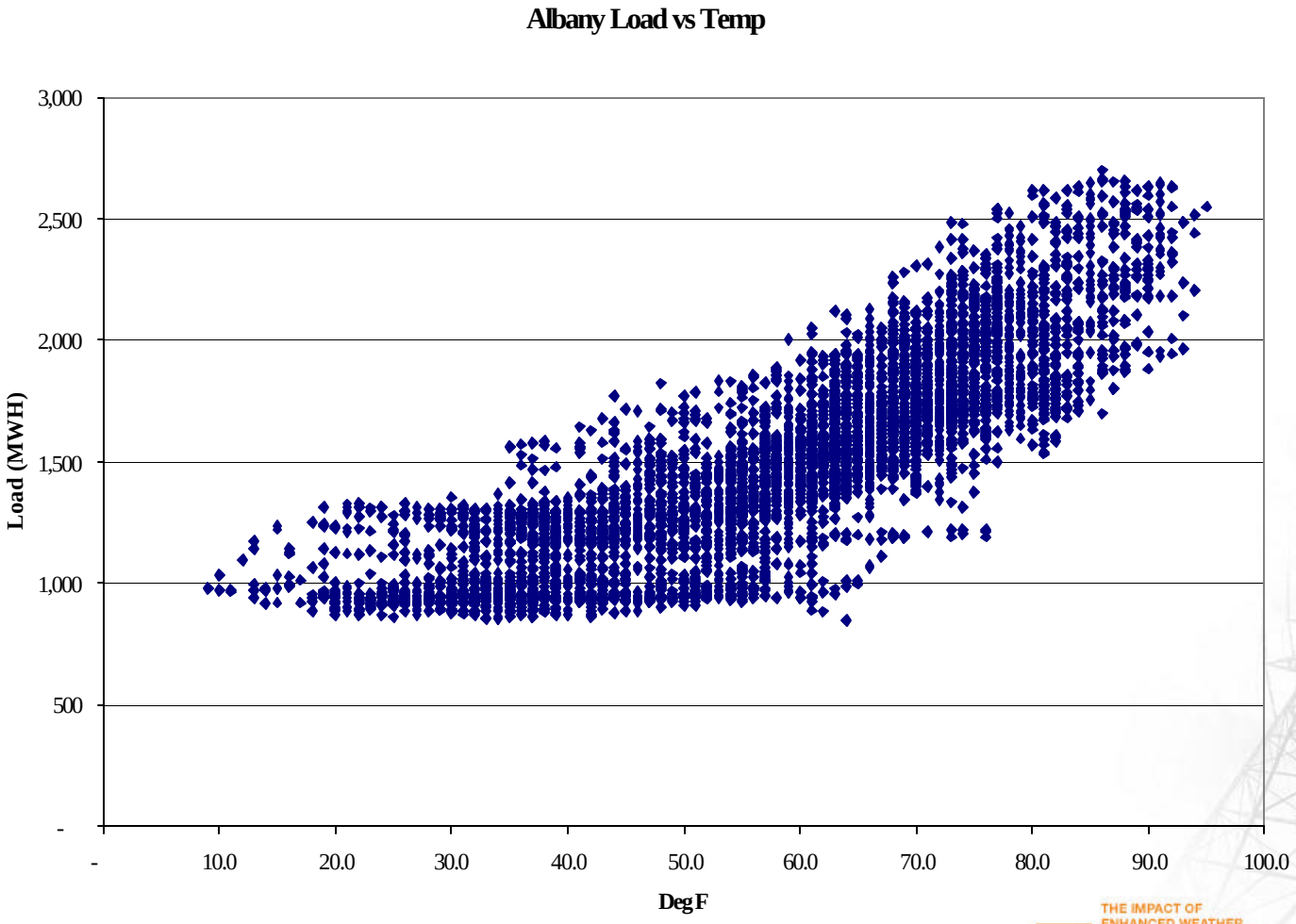
"An estimated 70% of all businesses are impacted by some form of weather risk – earnings volatility" (*AON, 2001)*

- Weather risk is the uncertainty in cash flow and earnings caused by weather volatility
- The weather is energy companies largest source of financial uncertainty
- Adverse economic impact of 'deviation's' from usual weather conditions on trading results of corporations due to:
  - Increases in costs
  - Reductions in revenues

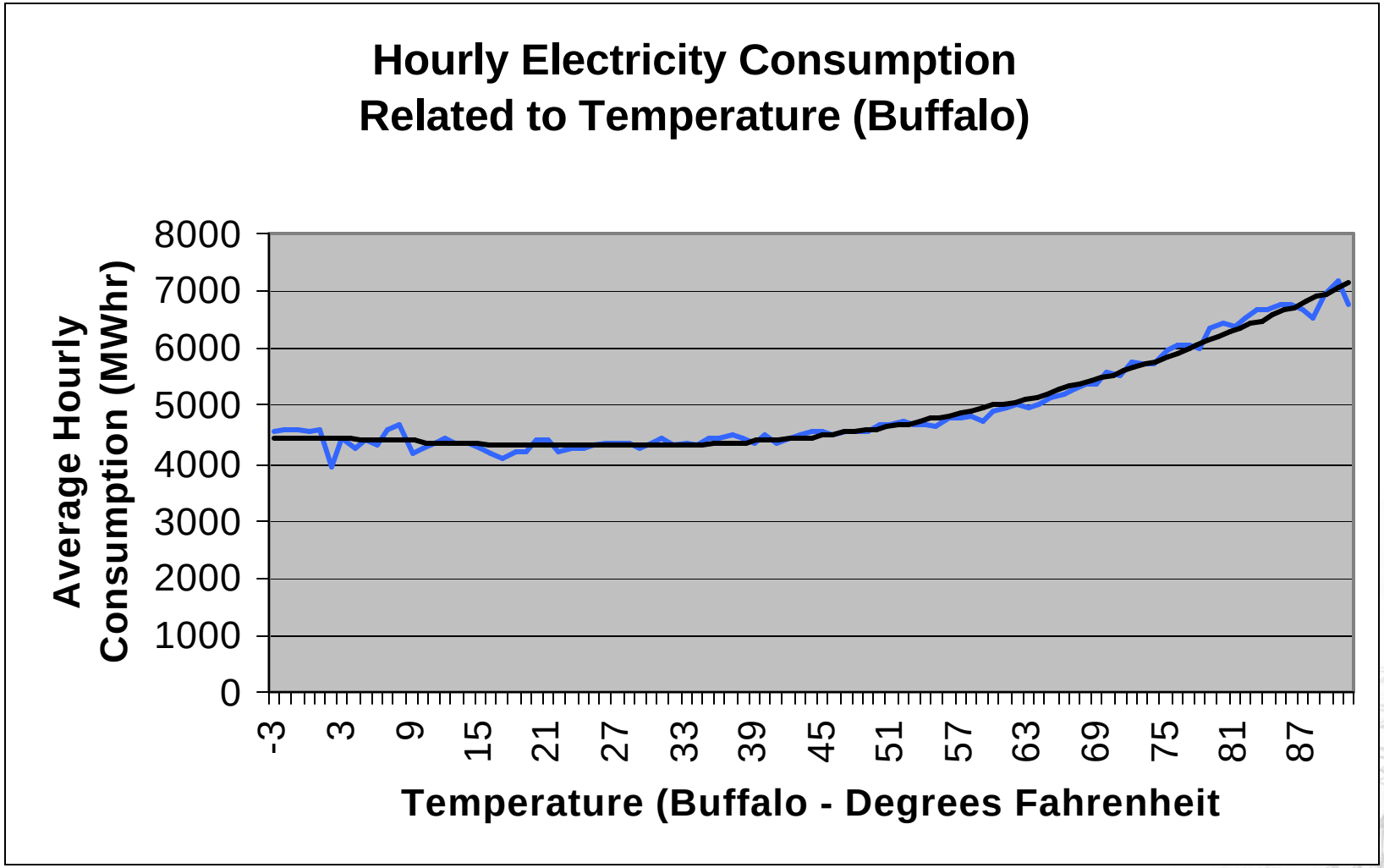
Correlation Between Temperature & Energy Demand



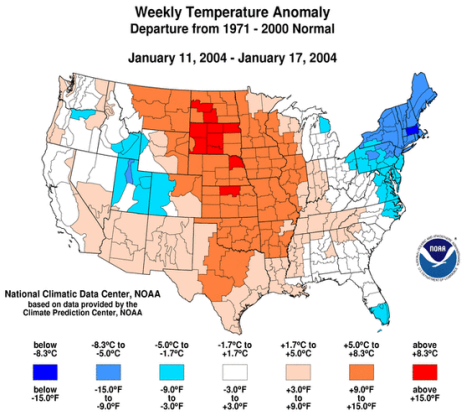
Demand As A Function of Temperature



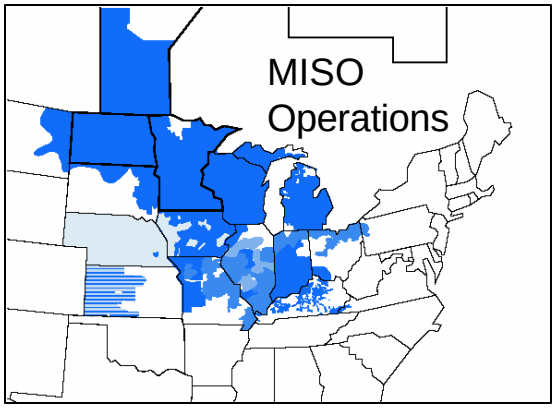
Temperature and Energy Consumption

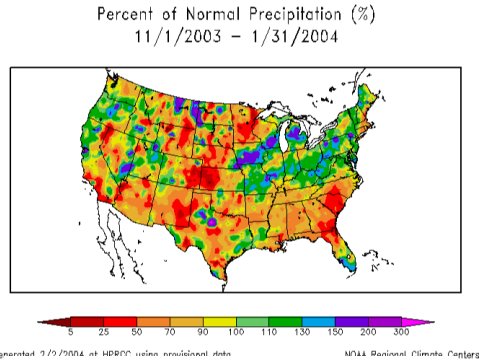


MISO's Exposure to Weather Risk

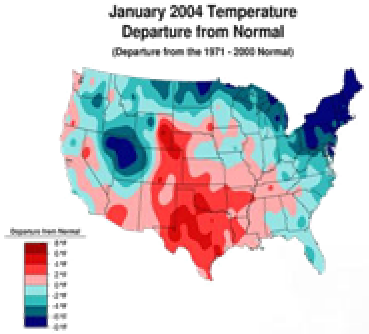


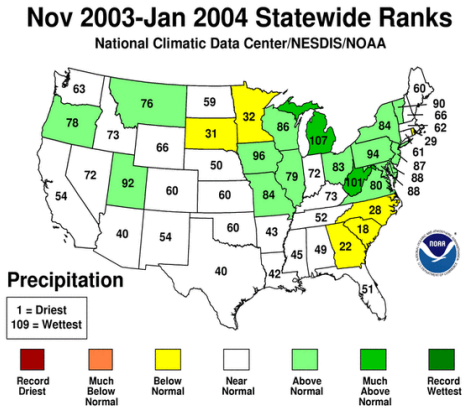
Poorly forecast anomalies
Dynamic Atmospheric Gradients



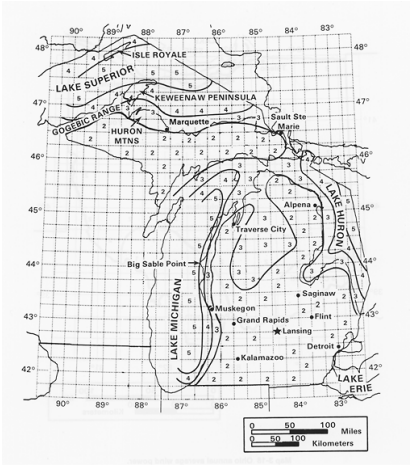


High Zonal PPT & T Gradient

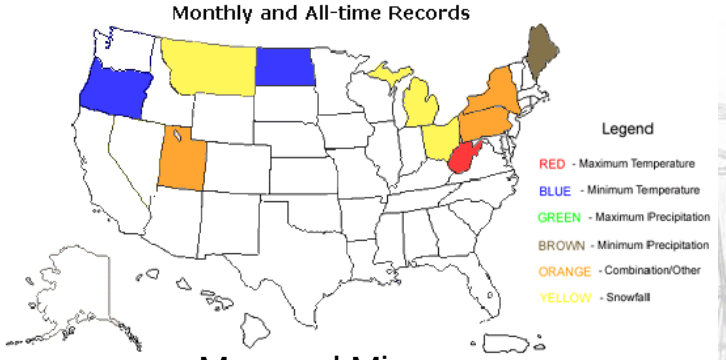




High Zonal PPT Variability



Uncaptured Lake Events-
T and PPT Impact



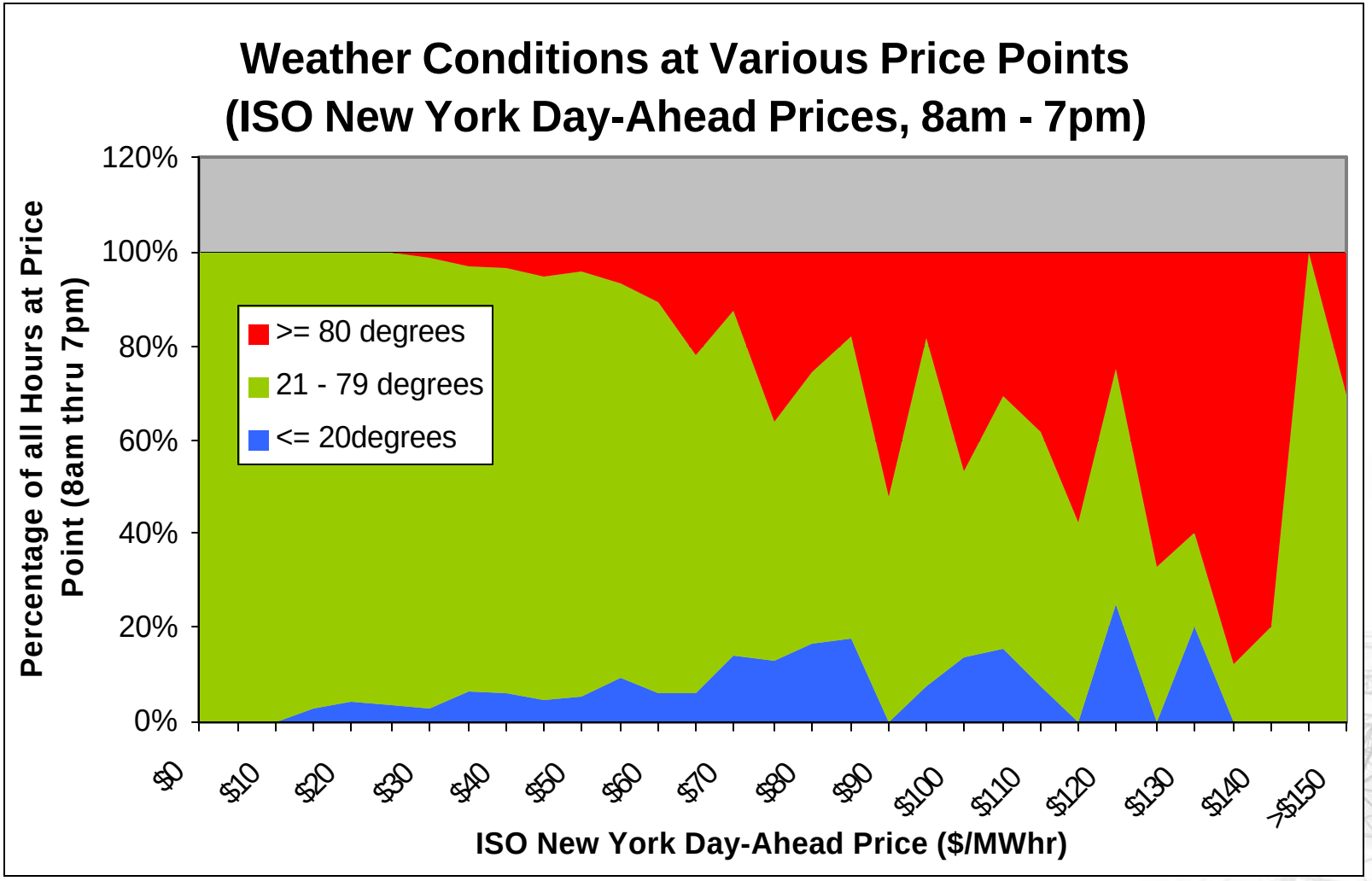
Max and Mins

Price Risk

- **Demand shifts quickly in response to weather conditions**
  - electricity cannot be moved to areas where there are unexpected increases in demand,
  - cheap local storage is limited for electricity
  - 'surge production' is limited and expensive
- **Price risk: energy sector is very susceptible to market risk due to extreme volatility of energy commodity prices**
- **Wide swings in accounts receivable and inventories result from temperature extremes**
- **Price risk management: relatively new to the energy sector as, until recently, it has been regulated**
- **Price volatility due to shifts in the supply and demand**
- **With falling energy prices, equity values of producing companies fall, cash becomes scarce, and likely that contract obligations for energy sales or purchases may not be honored**

Impacts of price variation & volatility

- Lower return on equity reduces interest coverage
- Threaten corporate financial plans and household budgets
- Makes investments in energy conservation and production risky
- Difficult for investors (individuals or corporations) to judge whether current prices indicate long-term values or transient events may result in cash losses
- More extreme weather conditions automatically raises debt proportions at the peak of the finance cycle due to inventory/receivable peaks and troughs
- Energy trading: has been transformed from a risk management function performed out of necessity to a speculative enterprise to generate profits


Weather Conditions at Various Price Points
(ISO New York Day-Ahead Prices, 8am - 7pm)
Percentage of all Hours at Price Point (8am thru 7pm)
120%
100%
80%
60%
40%
20%
0%
>= 80 degrees
21 - 79 degrees
<= 20degrees
$0
$10
$20
$30
$40
$50
$60
$70
$80
$90
$100
$110
$120
$130
$140
>$150
ISO New York Day-Ahead Price ($/MWhr)

Reputational Risk

- When an organization has doubts raised about its products or services are being unsafe or unreliable, or key staff are incompetent, or corrupt, reputation will be damaged (e.g. Arthur Andersen, Enron)
- Increasingly CSR and sustainability parameters are being used to 'judge' companies by investors, shareholders, financial institutions & the public
- Reputation is intangible but key questions in understanding reputation are:
  - Identify the stakeholders
  - Avoid unrealistic expectations
  - Understand what is expected by the organizations' constituency

Regulatory Risk

- Changes in regulation impact market risk (particularly where changes in regulation affecting the energy sector are designed to change risk exposure)
- Environmental regulations (e.g. emissions controls) are accompanied by financial penalties for non-compliance
- Actions of the regulator can lead to utility bankruptcy, e.g. PG&E
- Public policy efforts can reduce energy price volatility by:
  - increasing reserve production capacity
  - increasing transmission and transportation capability
  - making real-time prices more visible to users

Risks to Energy Security

- Strong linkages between energy and the environment:
  - rapid changes in energy prices can destabilize fragile financial structures
  - resolution of territorial disputes can be linked to concessions in energy or other trade
- Few analytic methods to evaluate the degree energy security: difficult to make cost-benefit tradeoffs between financial, technical & policy measures intended to improve energy security, or to evaluate energy security measures in a larger policy context

Environmental Risk (risk TO the environment)

- Environmental risk: the likelihood & severity of a potential event that would have an adverse impact on the environment
- Environmental liability risk: the financial risk of incurred costs associated with causing an adverse impact on the environment
- Environmental risk is ‘credit risk, compliance risk, political risk, operational risk, asset impairment risk, technology risk, etc., depending on the context in which it is considered’ (UNEP)

Measuring Risks and Assessing Vulnerability

Risk Performance Measures in Management:

- Cost/benefit analysis
- Financial analysis
- Customer satisfaction
- Risk identification
- Value-at-Risk (VaR)
- Return on Investment
- Business experience
- Risk-adjusted return on capital
- Shareholder value
- Risk exposure analysis

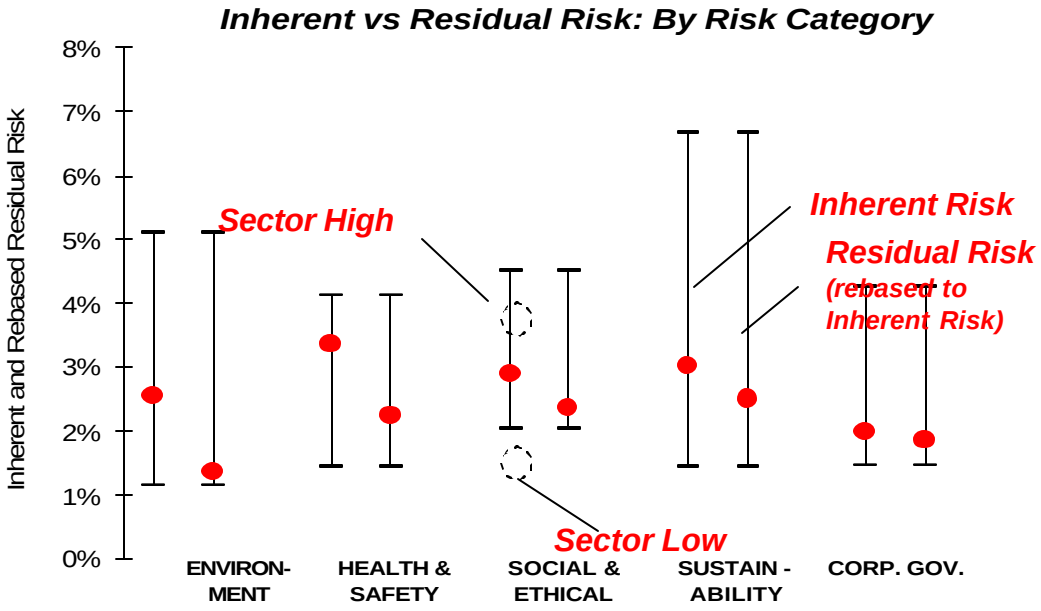
Assessing Risk

- Adequate risk identification and assessment depends on -
- Data:
  - Availability of reliable measurements
  - Position of weather stations
  - Data consistency, cleaning, enhancement
- Modeling:
  - Weather forecasting techniques (statistical vs. probability forecasts)
  - Understanding the relationship between climatic conditions and a company's costs & revenues and share price
- Performing vulnerability assessment of the 'weather sensitivities' of energy operations

Risk Rating

- **Company Performance vs. Sector Average**
- **Company Detail**
  - Environmental Risk
  - Health and Safety Risk
  - Social and Ethical Risk
- **Inherent Risk:** function of the sector, company size, its longevity and its volatility
- **Management of Organizational Risk:** the extent to which a company is managing down its Inherent Risks
- **Residual Risk:** The result of the Risk Management Factor applied to the Inherent Risk - a quantification of a company's overall risk levels, given its Inherent Risk and management efforts
- An algorithm to allow the risks to be measured and comparisons to be drawn between companies and sectors
- The Regulatory environment is an important component of rating

Benchmarking Risk



(a) ***Benchmarks the relative importance of different risk categories in a given sector or pre-selected portfolio***

(b) ***Benchmarks the spread of risk management within each sector / portfolio***

(c) ***Identifies the risk categories in which a company is outperforming or underperforming its sector / portfolio.***

- The Company dot positions the company with in the range of the sector / portfolio.
- If the Company dot moves downwards between Inherent and Residual Risk, it means it is outperforming the sector / portfolio average risk reduction.

Managing and Mitigating Risks

- The Aim of any weather transaction is to maintain income at levels concurrent with typical weather conditions
- A weather instrument will hedge and reduce risk rather than be a gamble on certain weather conditions occurring
- Instruments may be 'tailored' to match specific needs (e.g. for temperature, precipitation, snowfall, or wind speed)
- Transferring risk, e.g. products such as "pluvius insurance"
- Non-insurance weather market: weather derivatives
- Public policy
- Company sustainability policies
- Better use of environmental information

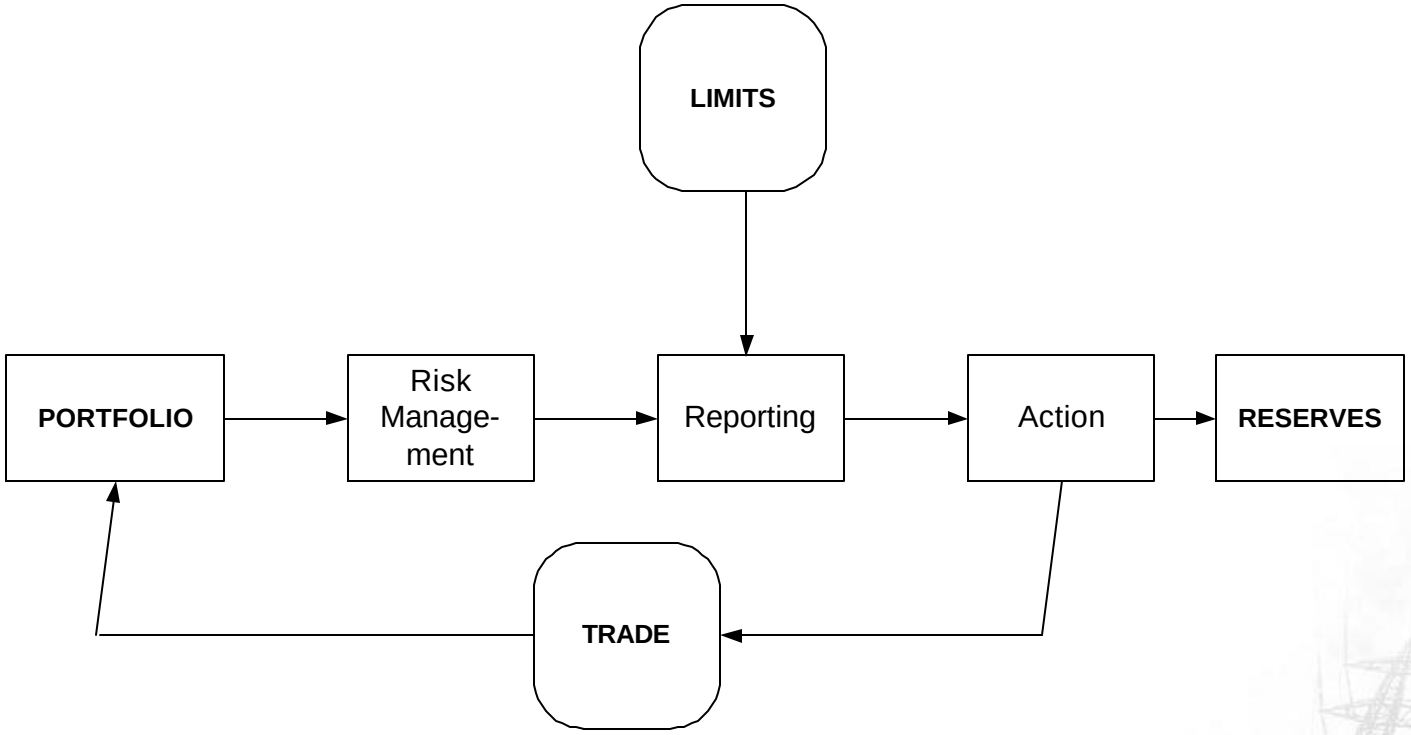
Tools to Manage Price Risk

- Traditional tools for managing risks:
  - diversification
  - long-term contracts
  - inventory maintenance
  - insurance
- These do not work well for managing energy price risk
- Derivatives used to manage risks arising from high volatility of energy prices by energy firms, investors & customers

Weather Derivatives

- Derivative contracts transfer risk, especially price risk, to those who are able and willing to bear it
- Weather derivative ‘value’ is calculated from estimates of future outcomes based on the probability of future meteorological events
- Started in 1997 when Enron embedded a weather derivative in a power product to isolate financial risk & as a ‘hedge’ to reduce exposure to risk
- Subsequently expanded by Enron, Acquila & Koch
- In 2000 the U.S. market undertook 4,000 deals with approx. $8-10 billion notional outstanding

Market Risk Management Process



Conclusion: Using Environmental Information to Hedge Risk

- **As an alternative or as part of an overall risk management strategy**
- **Determining minimum requirements for weather information in the operations management, planning activities and decisions (temporal/spatial resolution, lead time, precision, & format)**
  - Parameters (temp, ppt, wind)
  - Reliability
  - Historic, Real-time, Forecast
  - Forecast period (24 hours; 2-4 days; 7-10 days seasonal, etc.)
  - Adequacy of weather station coverage
  - Statistical vs. probability forecasts
  - Data manipulation
- Load forecast model considerations
  - Reliability
  - Data stream

Energy Operations Aided by Reductions in Environmental Forecast Uncertainty