WEATHER, CLIMATE, AND ENERGY

A policy forum developed by the

ATMOSPHERIC POLICY PROGRAM
AMERICAN METEOROLOGICAL SOCIETY

in collaboration with

THE UNIVERSITY OF OKLAHOMA

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Dept. of Commerce (NOAA)
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Panel 4

Implications for Public Policy

POSITION PAPERS

Weather and Climate Effects in Energy Forecasting

W. Calvin Kilgore
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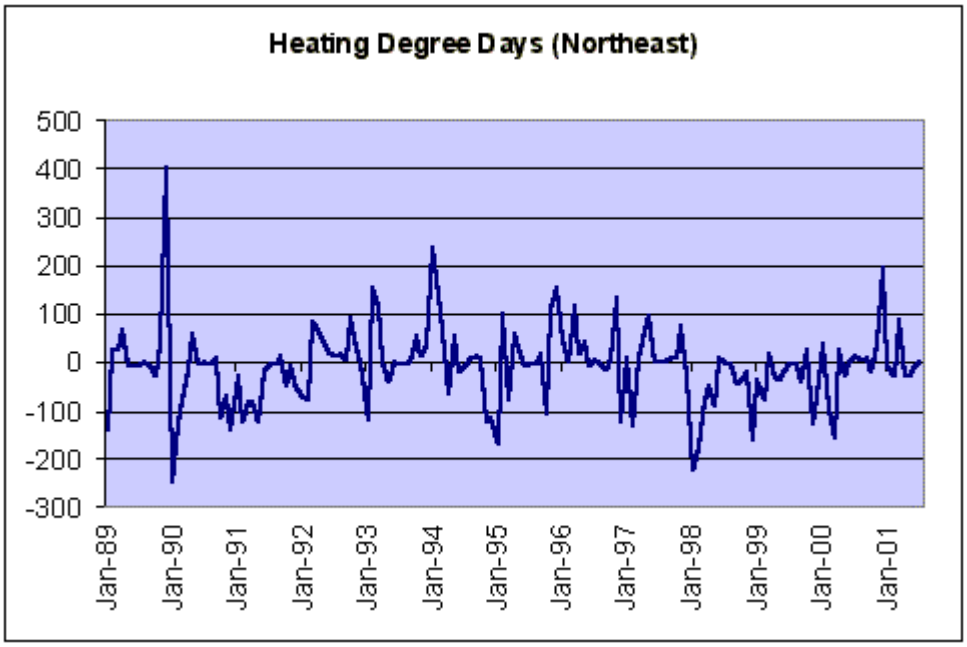
Energy Information Administration

The Energy Information Administration addresses both weather and climate issues in conjunction with its energy forecasts. National and regional temperature changes are important explanatory variables in our short-term forecasting equations for such fuels as heating oil, natural gas, and electricity. With regard to climate change, our long-term models are used by the Administration to project future energy consumption and associated greenhouse gas emissions.

Both weather and climate changes are treated in a rather simplistic way in our energy forecasts. Our long-term forecasts, which provide annual estimates, do not factor either weather or climate change into the projections. In effect, we implicitly assume normal weather in each year and no significant change in the climate over the projection period. Our short-term forecasts, which provide monthly estimates, also assume normal weather in the future in the base case projection. The National Oceanographic and Atmospheric Administration provides the definition of normal weather in the short-term forecasts, which does show a slight warming trend over time.

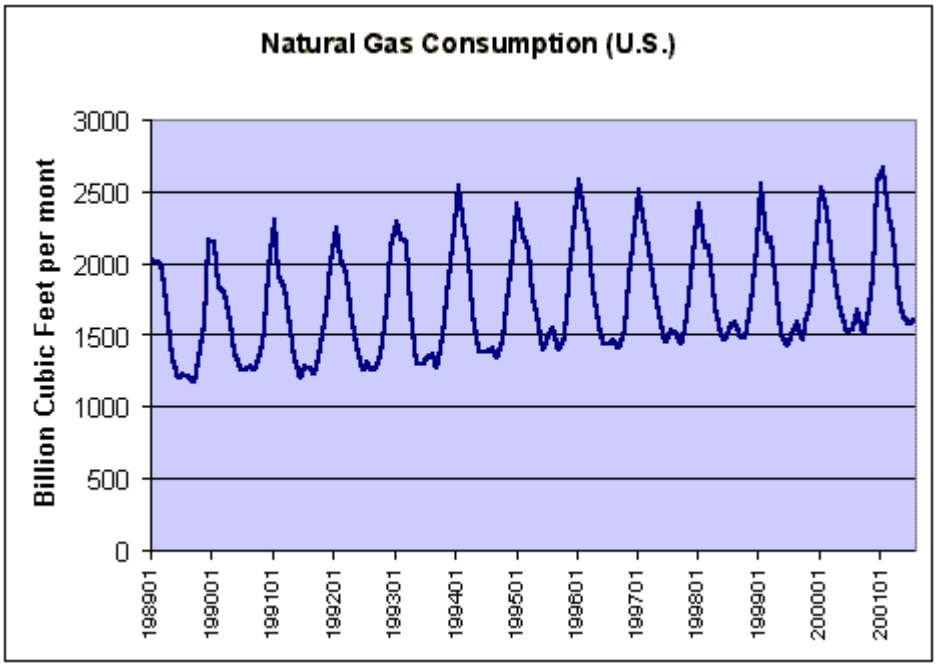
The effects of other than normal weather are a significant part of our short-term forecasting effort. The questions of having adequate heating oil and natural gas for the winter and adequate electricity for the summer have become routine. The answers are almost always yes to these questions if we have normal weather, unless maybe if you live in California. Most variations from normal weather in the winter can be handled well by stocks of heating oil and natural gas. However, an unusually cold winter can and often does overwhelm the stocks on hand and severe economic hardship can result. Our electricity system has held up rather well, again except for California recently, but this remains a concern. A hot summer would probably have been a problem on the west coast this past summer, but luck was with us again and the weather cooperated.

The chart below shows the monthly variations in heating degree-days in the Northeast over the past twelve years. On average this has been a rather warm period. However, you can see that there were periods of very cold weather. Of special note are December 1989 with 400 heating degree-days colder than normal, and both January 1994 and December 2000 with about 200 heating degree-days colder than normal. Our short-term model cannot of course predict these occurrences of very cold weather, so we address these possibilities with cold weather scenarios. We typically look at a case where the number of heating degree-days is ten percent higher than normal for the winter as a whole. This equates to an average of 84 heating degree-days above normal per month during the winter. This might seem too conservative given the cold months noted above, but it is very extreme for the winter as a whole.



To help deal with these extreme cases, the federal government provides money to low-income families to help pay their heating bills. This is the LIHEAP or Low Income Home Energy Assistance Program, which provided over $1.8 billion dollars in FY 2001 to the States in the form of grants. There is also a strategic reserve of heating oil stocks located in the Northeast that holds about 2 million barrels of oil. The Energy Information Administration provides about $300 thousand dollars per year to selected states to gather and report heating oil prices during the winter months.

Another question is just how much does our energy consumption vary when the temperature changes? I will not bore you with the numbers, but the answer is a lot. The best graphic that I could find to show this is one of natural gas consumption in the United States. The chart below shows that natural gas consumption routinely increases by about one trillion cubic feet per month between the warmest and coldest month of the year. This compares with an average monthly consumption of only about two trillion cubic feet. Weather clearly matters when trying to forecast natural gas. The effects on distillate fuel consumption (which includes both heating oil and diesel fuel) and electricity are also significant.



The real question here today is would better weather forecasts enable us to make better energy forecasts. The answer is yes if we have some confidence that the weather is likely to be significantly colder (or warmer) than normal during a specific few months, especially if we could say this for a particular region such as the Northeast. If we had confidence in such forecasts, then stocks could be increased (or decreased) to help deal better with the change. Such a weather forecast could be included as a scenario in our Short-Term Energy Outlook and the energy implications of that scenario could be provided on our web site and made available to the energy industry.

Weather and Climate Forecasts in International Energy Agency Analyses

Klaus Rehaag
Director
International Energy Agency

A number of distinguished speakers who have been invited to participate in this forum will address the impact of weather on the global economy, energy sectors and the energy industry. I will attempt to avoid old ground and will focus my attention on the role that weather, and weather forecasts, play in our analysis of supply-demand balances at the International Energy Agency (IEA) in Paris. In this respect, I hope to share with you my perspective of the role that weather and weather forecasting plays on a global basis.

Like many companies and research institutions in the energy business, the IEA has two separate planning and analysis groups, one that focuses on short-term and medium-term, and another that focuses on long-term, issues. I head up the short-term group for the IEA while Fatih Birol, who many of you know, and is responsible for publishing the "World Energy Outlook" (or WEO), heads the long-term section.

Fatih is interested in long-term weather forecasting from the perspective of global energy models that predict the possible effects of "global warming" due to hydrocarbon usage. He needs better and more detailed data on global emissions and their impact on the environment. More important, he needs better tools and better science. My comments are not meant to cast dispersions on the science of "global warming" but simply to point out that the limitations of long-term weather forecasting are significant. I understand that the focus of this forum is on short-term weather forecasting requirements, and I will restrict my comments to these issues.

The IEA's primary focus is on energy security, data transparency and oil market issues. Although we deal with related electricity, natural gas, coal, nuclear, and biomass energy issues, crude oil constitutes the central component of our analysis. This is important from a weather perspective. Crude and petroleum products can be safely transported and stored for long periods of time. Hence, oil stocks are strategic assets that lessen the exposure of the market to the variability of demand due to externalities, including weather.

Storing vast quantities of electricity, natural gas and biomass energy, and transporting them over long distances, is both inefficient and difficult. With reduced capacity, flexibility and reserves the role of accurate and timely short-term weather forecasting in the electricity, natural gas and utility markets is crucial to lessening volatility and the risk of supply disruptions.

As aforementioned, oil and petroleum product stocks held by producer and consumer interests are ways in which the crude market can minimise and manage its exposure to

the uncertainties of weather-related events. For your information, at a strategic level, IEA countries have agreed to hold oil stocks equivalent to 90 days of net imports. The US is no exception, and its Strategic Petroleum Reserve (SPR) holds in excess of 130 days of net imports.

The oil market distinguishes between government strategic and commercial stocks. Our monthly *Oil Market Report* details opening and closing balances for both strategic and commercial stocks for all OECD countries. These balances are closely monitored and, together with prices, are leading indicators of market conditions.

I do not want to leave the impression that strategic stocks are designed to help the market cope with externalities such as weather. This is clearly not the case. It costs a lot of money to purchase and maintain strategic inventories. IEA countries have agreed to assume these expenses to protect themselves from the possibility of a significant supply disruption. At the same time, governments have responsibilities to their citizens to ensure security of supply. In this respect, the government decided last year to create a strategic heating oil reserve in the US Northeast. The purpose of this reserve was not to displace private interests, but as a last resort if conditions warrant – the "perfect storm".

I want to outline briefly how weather and weather forecasts factor into our work at the IEA. We adjust our global supply-demand balances to reflect a variety of "seasonal" weather patterns. Some examples of the adjustments are as follows:

- Spring: - loss of western Canadian production due to thaw and road restrictions
  - increased Russian exports due to winter ice-break-up
- Summer: - loss of Alaska pipeline throughput due to compressor inefficiencies
  - loss of German product imports due to low water barge levels
- Fall: - loss of USGC production due to hurricanes
  - loss of Russian exports due to Black Sea storms
- Winter: - loss of North Sea production due to winter storms
  - loss of Russian production due to ice restrictions

In addition to "seasonal patterns" we adjust our forecasts due to singular events such as floods, snow-cover, annual average precipitation and water reservoir levels. The latter is an extremely important factor for fuel oil demand, and prices, in several European countries. For example, Spain produces hydroelectricity, but when reservoir levels are low due to reduced precipitation or drought they switch to heavy fuel oil to run their utilities. This creates significant one-off demand that can skew normal supply relationships and prices.

We also attempt to adjust our forecast to reflect what is considered to be "normal" weather patterns. Although it is increasingly more difficult to determine what constitutes normal weather, global temperatures that have been increasing over the past few decades have contributed to a change in product consumption – reduced winter heating oil

requirements and increased summer electricity usage. Although we do not understand the science, we follow your pronouncements about El Nino effects with keen interest, and adjust our forecasts accordingly.

While adjustments for local, seasonal and annual weather events may be small in terms of orders of magnitude, they are nevertheless significant and have a profound impact on the market. That is because they effect the "margin". Supply patterns are designed to meet "average" requirements, and regional arbitrage is required to meet peak loads. It takes time, and costs money to move products between regions. Price and market volatility increases the closer the system approaches capacity.

I would like to make a comment about the current limitations and policy implications of weather forecasting from an international and global perspective.

The IEA aggregates monthly supply-demand balances and projects these out for 18 months. There are a variety of transparent and reliable North American sources of weather data (degree-days, degree-events, precipitation, snow-cover, reservoir levels etc.). This situation gets more tenuous moving into Europe and there is a dearth of timely weather-related information, at all but a macro-level, for many Asian, African and Latin American countries. From a global energy perspective this constitutes a definite challenge.

From a policy perspective, obtaining more accurate, timely and transparent global weather data poses a challenge. There is general agreement and co-operation between States, the Federal Government and the private sector in the US. This situation is different in Europe and across Asia, Africa and Latin America where individual countries are responsible for their weather collection systems. There are no uniform standards, definitions and reporting requirements. In many countries, there is no money and no central agency to collect and disseminate weather data. Furthermore, there is no "global depository" of weather data. The question becomes which agency or government is capable of funding an international venture such as this? Clearly, weather is a global phenomenon, and if we are going to understand it, and the role it plays in regional dimensions, them someone, sometime will have to broach this issue.

Let me conclude my remarks by sharing my pet peeve with you. I mentioned earlier that stocks are an effective way in which the crude oil market copes with externalities such as weather. While the IEA publish stock data for OECD countries, there is limited information available for non-OECD stocks. More important, there are few sources of tertiary stocks – those held at the retail and the consumer level – even for OECD countries. From a policy perspective, this lack of information is alarming. It takes time, money and infrastructure to move product from primary and secondary to tertiary storage. In the case of a weather-related supply disruption, while it may be comforting to know that product is available somewhere in the system, this is of limited consequence to those without heat and power if the regional roads, pipelines and refineries are out of commission. This said, we need more timely, accurate and accessible weather and

tertiary and non-OECD stock data, and we, at the IEA, heartily encourage you in your quest.

AMS Panel on Public Policy

Scott Gudes
Acting Administrator
National Oceanic and Atmospheric Administration, Department of Commerce

1. What public policies are needed to foster development of energy-related weather and climate services?

To foster development of energy-related weather and climate services, policies are needed which support modernized weather observations, especially the cooperative network, effective assimilation of an increasing amount of data into our atmospheric models, advancements in hydrologic prediction systems and across-the-board support for the effective science and technology research like climate modeling and the U.S. Weather Research Program.

1. What public policies are needed to facilitate their use by the energy industry?

To facilitate their use by the energy industry, we need to know how best to serve those who serve the industry, from private meteorologists to technicians to energy grid managers. Whether through provision of more information and data, better quality control of data, more real-time access to products and data, higher resolution of precipitation, temperature and wind forecasts, or better product and information delivery through the best possible avenues, we will work with our new partners in the energy industry to provide the best as efficiently as possible.