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# Weather and Climate Risk Management in the Energy Sector

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| TITLE: | NATO Advanced Research Workshop |
| WHAT: | Twenty-eight participants including weather and climate scientists, engineers, economists, and other specialists in the use of energy formulated recommendations aimed at improving the collaborative use of information by climate scientists and the energy industry. |
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# 1. Introduction

Weather and climate considerations within the context of both climate change adaptation and mitigation are becoming important elements in policy and strategic planning for the energy sector. Corporate energy markets and operations are progressively factoring impacts of climate change into their management and planning, recognizing that climate is a significant component of risk management.

Information from weather forecasts is routinely employed in the energy sector (by producers, traders, and regulators) to assist in decision-making. Such information is used for several purposes, from the direct pricing of energy to the trading of energy and financial contracts. The energy decision process is now turning to other climate information, such as seasonal, decadal, and climate change forecasts. The need for more and better weather/climate information will grow as decision makers address an array of issues, from extreme events to emerging climate change regulations. In addition, weather and climate information is a key element in the development and use of renewable energy resources such as wind and solar power as well as hydropower.

An improved understanding of what climate information can and cannot provide, how it might be used in context, and how communication can be made more effective, will certainly help the interaction between climate scientists and energy experts. The NATO Advanced Research Workshop created an opportunity to bring together experts in these fields to address the outstanding issues not only with the use of weather and climate information by the energy industry but also with communication between the two sectors.

About 20 presentations covering fundamentals, practices, needs, and impediments in the use of weather/climate information in the energy sector and policies for information transfer between the weather/climate and energy sectors preceded the discussions of three groups within the context of the meeting. The experts, comprising weather/climate scientists, engineers, economists, and other specialists in the use of energy, were specifically selected to ensure diversity in the discussions. This summary article focuses on the recommendations made by these experts to accomplish the five objectives set forth with this workshop:

- Identify vulnerabilities of the energy sector to extreme weather events;
- Identify impediments to the use of weather and climate information for the energy sector;
- Suggest ways to improve and facilitate the transfer of knowledge between weather/climate scientists and energy experts to optimize climate risk management;
- Outline proposals to improve the way weather/climate information is used for modeling demand as well as providing warnings for potential disruptions in energy operations and infrastructure;
- Discuss possible contributions of weather/climate scientists and energy experts to climate change adaptation policies for energy security.

## Vulnerability to extreme weather

It was observed that present vulnerabilities of the energy sector to extreme weather events should be examined as a prelude to understanding longer-term risk. Such vulnerabilities include unexpected demand, access, and/or physical damage to generation and transmission facilities, and the inability to meet environmental requirements owing to unexpected conditions. They should be considered throughout the life cycle of energy generation and use, including exploration, extraction and production, transportation, refining, generation, transmission and delivery, and disposal, for all energy sources, both mined and renewable. A significantly vulnerable component of the energy life cycle to climate variability and change is likely to be either transportation or transmission because of regional changes in demand or environmental conditions more severe than anticipated. Noting that current funding for adaptation is about a tenth of the lowest current cost estimate for the energy sector (World Bank, 2008), there is a definite need for a funding increase. Perhaps climate change adaptation in the energy sector could be linked to existing financial instruments in the global carbon market, especially since adaptation strategies overlap with mitigation action in energy efficiency and demand management. Because adaptation is a global challenge and central to economic stability, engaging sufficient financing is worthy of international attention. Investments to support climate and energy collaborations could come from government departments or international organizations not necessarily linked to the energy and/or climate sectors (e.g. this NATO Workshop).

**Impediments to using weather and climate information**

The effective use of weather and climate information in the energy industry requires that the industry identify sensitivities and vulnerabilities with weather and climate components, identify, locate, and make available the atmospheric climatology or forecasts that would be needed, and develop and verify the processes necessary to transform the atmospheric information into decision aids. The development of regional, site-specific models for various forms of energy, studying the extent to which atmospheric information can be used, and discovering the extent to which such data are actually used in practice, will lead to a better understanding of these impediments and assist in developing strategies for creating and storing data.

Methods for converting traditional weather and climate charts or data presentations into forms that depict the opportunity and risk for all aspects of the life cycle for individual components of the energy industry would also be effective and would provide educational resources. Formulating guidelines for using weather and climate information in energy projects—through their life cycles and covering project structure and design, data requirements, science issues, funding issues, and management requirements—would be beneficial and could be illustrated with case studies. The workshop group proposed the concept of “energy teams” that would have mixed representation to enable broad discussion of important needs (e.g., biomass projects in developing and dry countries, although the concept is readily extendable).

**Improving climate risk management**

There is a significant need to develop stronger partnerships between the components of the climate and energy communities. As indicated earlier, it is essential to develop a better understanding of the needs of the energy sector and how atmospheric information can be transformed to meet them. The traditional sources of weather and climate information could then provide critical and valuable information that would be of evident value to the energy industry. Hence, it is recommended that energy advocacy groups be created that could communicate on behalf of the industry its specific weather and climate data and information needs to the meteorological and climate research community. Sessions on weather and climate information and services at appropriate energy sector meetings are recommended to foster such exchanges.

A survey to discover best industry practices in using atmospheric information to reduce risk and improve profitability could provide examples that lead to a more thorough quantitative understanding. As these best practices are identified, they should be analyzed for their potential for wide propagation to industry. However, an effort to identify and disseminate examples of best practices would require some seed funding for website maintenance, organization of the survey, and meeting expenses; potential funding opportunities are being identified. Also suggested for raising awareness are concise workshop summaries in industry magazines and the popular science press (one such article, Bruce, 2008, has already appeared). These outreach activities may reveal an unrecognized demand for information among energy companies and public organizations, which could lead to better energy system management.

**Modeling demand and warnings for disruptions**

The energy industry depends critically on predicting demand on both short and long time horizons so that adequate but not excessive energy generation or conversion is available when needed. Thus, there is a range of requirements for modeling and meeting the demand for energy by the energy sector, with different data required for routine efficient operation and for emergencies. They are:

*A need for observations* – There is a continuing need for observations that can be assimilated into weather forecast models, to supplement high-resolution models, and to validate the weather and climate output for the energy sector. Observing System Simulation Experiments should be performed to optimize the observing system for the energy sector and to generate estimates of the reliability of forecasts.

*Consistency of data* – For use in energy demand and production models, predicted and historical (analyses, re-analyses) data must be consistent; small errors could unacceptably amplify in transfer models. Post-processed forecasts consistent with "observations" would be desirable. For longer time scales, the consistency of datasets should be ensured, and re-analyses continued to the present in (near) real time.

*Access to data* – Reliable access to the data and forecasts of various weather services should be implemented using readily accessible servers and grid computing technology. The lack of such access is a real hindrance, especially for smaller energy sector companies. The problem is threefold. First, although datasets exist, they are not publicly available. Second, owing to the lack of observations, even basic meteorological and climatological data are not available in many developing countries. Third, distributed energy generation systems now being introduced, especially with renewable energy, often do not record data usable for national or supranational strategic energy management and planning. Hence, it is clear that climate and energy monitoring systems should be extended when distributed energy generation systems are installed; that the energy and climatological data from observations and models should be readily available; and that the exchange of energy data (even aggregated) between energy companies and the regulatory and scientific communities should be enhanced to facilitate new ways of using the observations and model products.

Extreme weather events that put energy as well as lives and property at risk are generally predicted adequately by national forecast centers. But even when devastating events such as severe ice storms, large complexes of thunderstorms, or tropical cyclones are predicted accurately, the consequences for the energy industry often cannot be estimated in advance. Thus a better understanding is needed of the relationship between causes and consequences in severe and possibly catastrophic atmospheric events such that warnings for these disruptions can be enhanced.

**Fostering energy security**

The reliability of national or regional energy to maintain the diverse processes of society can be disrupted by political instability, competitive processes, warlike activity, accidents, and environmental events. Energy security is therefore a high priority for most nations, not least in terms of acquiring the supplies necessary to build economies and to maintain the wellbeing of populations. Thus, it would be useful to develop environmental energy security profiles and scenarios for individual countries to serve as models for study and for other countries.  Such models would assist in structuring the forecast process and in anticipating emergency management requirements.

Furthermore, energy projects should be examined for weather and climate sensitivities and such sensitivities should be accommodated within project designs, management, and outcomes and in terms of both mitigation and adaptation. To ensure weather and climate sensitivities are adequately recognized and addressed in the interests of energy security the following research priorities were identified: applied climatology, including case studies of transfer to action; metrics and indicators related to weather, climate, and energy to simplify the study of interactions; identifying notable gaps in information and actions required to ensure energy resilience; needs for weather and climate information in formulating policy, building codes, and other regulations; and finally, optimal training and education processes. Realizing these priorities would help to reduce the vulnerability of the energy industry and the societies they serve to several atmospheric and other environmental events.

**Concluding Remarks**

National and international institutional frameworks are frequently not advantageous in the context of energy and management of weather and climate risk. Reasons include inadequately drawn terms of reference, duplication and competition, and limited constructive interaction between specialized organizations. Weather, climate, and energy are inextricably linked and success in serving the growing global needs for energy and in limiting any adverse effects of climate change will require focused, effective, and wise collaboration between climate science and the energy industry within frameworks designed to serve all nations of the world.

The book of proceedings and recommendations of the Workshop will be published by Springer in 2009 (Troccoli, 2009). Presentations and further information about the Workshop are online at http://www.climate-development.org/atroccoli/nato_arw/.

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