Application of the Climate Information and Prediction in the Energy Sector: Capabilities

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THE WORLD CLIMATE CONFERENCE-3
Geneva, Switzerland, 31 August–4 September 2009

Introduction

- Energy plays a critical role in socio-economic development of a nation or country.
- However, energy consumption, and in particular the burning of fossil fuels, has been the major source of human-induced greenhouse gas emissions and consequently, climate change.
- The activities in the energy sector such as exploration, extraction, production, refining, distribution, and sale of energy are all impacted upon by climate variability and change.

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- The provision of tailored climate information to the energy sector is therefore crucial for ensuring the most efficient production and consumption of essentially all forms of energy including coal and gas-fired generation, distribution and utilisation of electricity; and especially for design and operation of infrastructure and the exploitation of sustainable environment-friendly energy resources such as wind, solar, hydropower and biomass energy all of which are influenced by climate variability.

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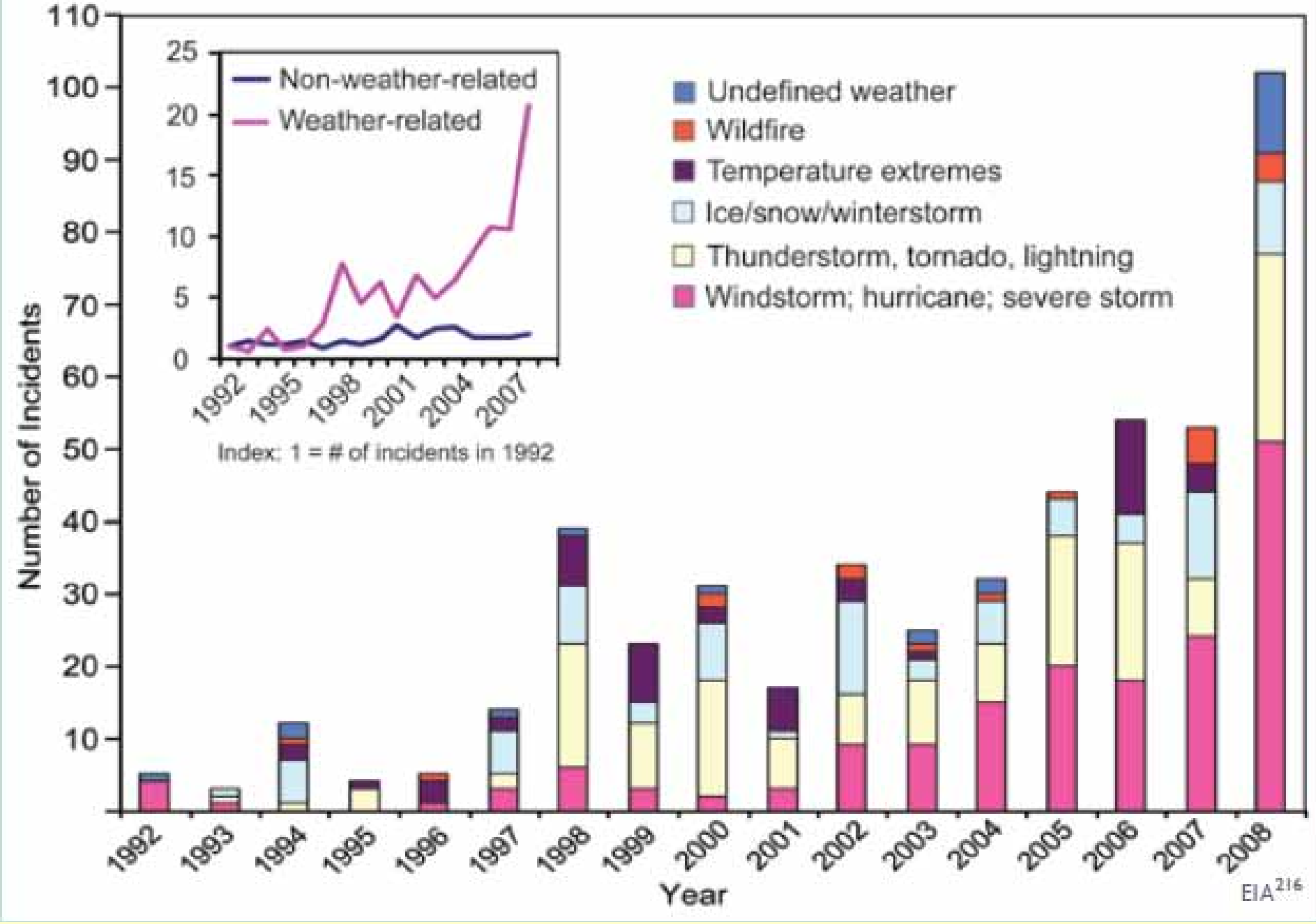
- For purposes of planning for sustainable energy supply into the future, climate information and predictions services need to be integrated into the design, development and management of energy supply systems and also to use the available climate data to explore other potential energy sources and to develop energy-efficient systems.

Uses of weather and climate information in the energy sector

- Climate and weather data and products are increasingly being used within the energy sector in planning, design and operations of various energy related applications.
- Electric power disruptions are sometimes related to weather and climate conditions in that the distribution systems are usually damaged by short duration weather events such as storms.
- Lightning strikes do cause majority of the electrical power disruption in many countries of the world since they may damage some peripheral structures, generation and transmission systems. Strong winds may directly cause damage to power structures, towers and transmission lines, or indirectly by causing trees to fall upon them.

Significant Weather-Related U.S. Electric Grid Disturbances



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- Climate information is being used in a variety of ways some of which include:
- Using global surface hourly data for studies of wind energy potential to drive wind turbines for electricity generation.
- Using solar radiation data to estimate solar energy potential.
- Using temperature information to aid in the assessment of equipment requirements for heavy power line loads during extremely hot weather.
- Using hourly temperature, relative humidity (and/or dew point), cloud cover, precipitation, and wind speed and direction data in electric load forecasting models and scenario analyses, for use by utility and power trading companies.
- Using heating/cooling degree day data. A relatively high number of heating degree days indicates a cold climate, and a high number of cooling degree days indicates a hot climate.

Exploration, Development and Production of Oil and Natural Gas

- In almost every phase of offshore operations, companies engaged in the exploration, development and production of oil and natural gas rely heavily on climate information for enhancing production techniques, preventing damage to equipment and personnel, or limiting negative environmental impacts.
- The weather-related events that effect exploration, development and production of oil and natural gas include tropical weather systems, strong winds and wave heights, and abnormal ocean currents.

Electricity Generation, Transmission and Distribution

- Changes in weather and climate directly affect the demand for electricity through the use of air conditioning, heating, or other essential appliances
- Some power purchase companies require forecasts of temperature, humidity, storm, and precipitation trends from 1 to 12 months ahead, focusing on anomalies that may cause a surge in demand such as unusual heat waves during summer or cold spells during winter.
- Improved demand forecasts rely on the ability to predict weather from several hours out to several weeks in order to determine the best and most cost-efficient generation mix to meet electricity load demands.

Renewable Energy Resources (Wind Energy)

- The distribution of wind energy varies markedly in space and time and knowledge of these distributions is necessary for proper selection and siting of wind energy conversion systems.
- Various types of data sets are considered most appropriate for wind energy systems development and these include among others mean hourly wind velocity distributions, characteristics of local turbulence and gusts, occurrences of extreme winds, and calms, vertical profiles of wind velocity as a function of atmospheric stability, frequency of severe thunderstorms, lightning, hail, icing, tornados, or hurricanes, and presence of salt spray or blowing dust.

Solar Thermal Power and Photovoltaic (PV) Electricity Generation

- Weather-related information such as the amount of sunlight, dust, and cloud cover are required for the selection sites for solar energy application and the type of solar power system to be used.
- Solar utility companies need hourly and daily information regarding insolation, cloud cover, dust conditions, and precipitation to forecast the amount of electricity that will be generated from solar power and how much electricity is to be produce from other sources.

Solar Cont..

- There are a variety of technologies for the conversion of solar energy into useful energy and range from solar collectors on house roofs for space and water heating to solar power plants, with large arrays of mirrors concentrating solar energy to heat water and drive turbines to produce electricity.
- The type of solar energy conversion system installed in an area will greatly depend on the prevailing climate, e.g. solar thermal electric conversion systems based on the `power tower' concept convert only direct solar radiation and these are therefore more suited to the dry desert climate regions, where the proportion of direct radiation is high.

The SWERA Project

- The Solar and Wind Energy Resource Assessment (SWERA) project that involved a total of 13 countries of Cuba, El Salvador, Honduras, Nicaragua, Guatemala, Brazil, Ghana, Ethiopia, Kenya, China, Sri Lanka, Nepal, and Bangladesh has provided easily accessible high resolution database of solar and wind energy resources, global horizontal irradiance, which is mostly used for the planning of photovoltaic systems, and direct normal irradiance, which is needed for solar concentrating systems.
- Partners within SWERA has made it possible to also provide solar irradiance with high temporal resolution of 1 hour and with a spatial resolution of 10km x 10km.

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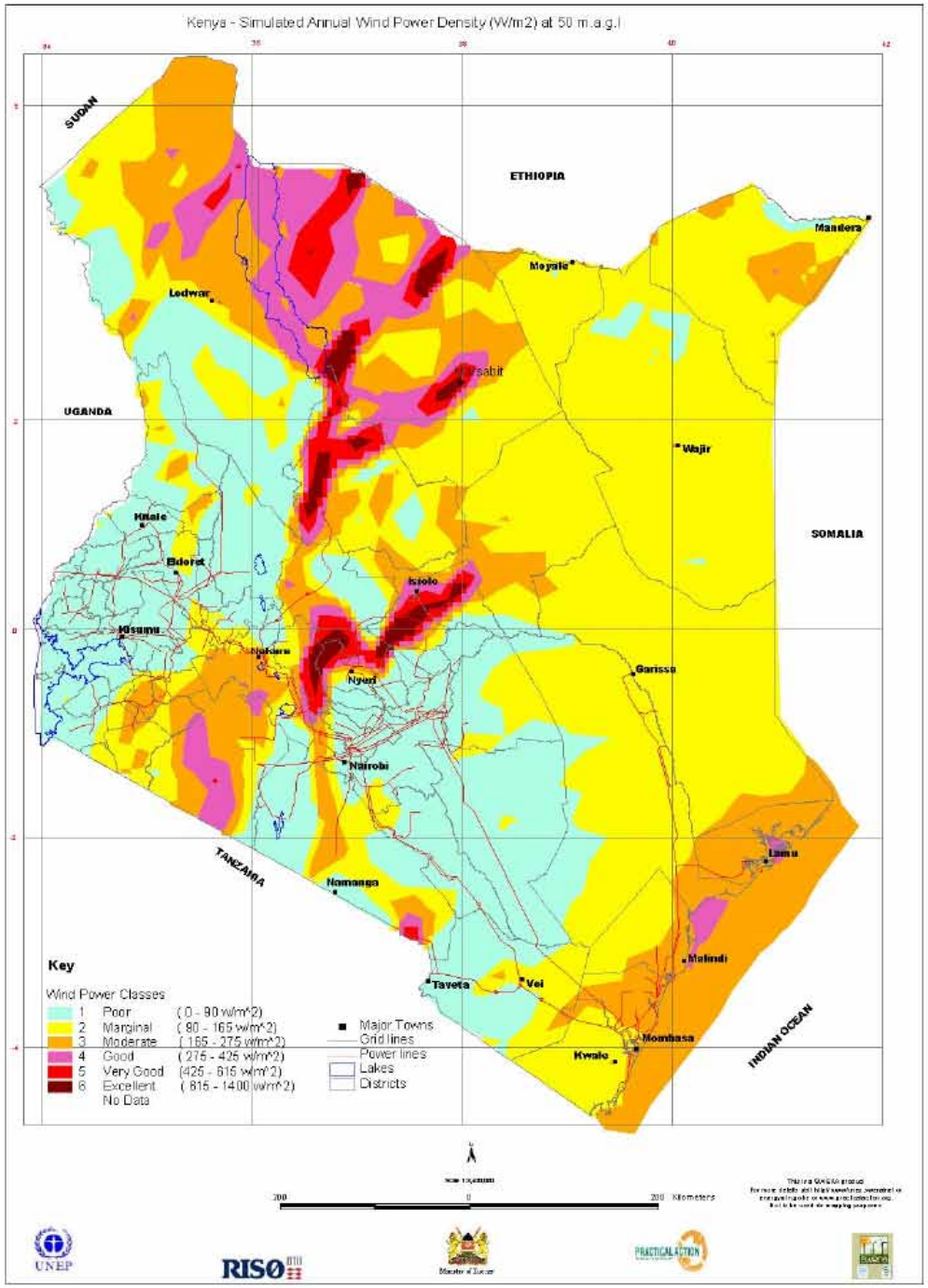
- SWERA was designed to deliver a number of important outputs, including providing:
- Consistent, reliable, verifiable, and accessible global data on solar and wind energy resources for international and in-country investors and other stakeholders
- Better targeting and increased confidence associated with investment and development decisions for solar and wind energy projects
- Increased awareness among key stakeholders and decision makers of the potential to utilize solar and wind energy resources
- Increased local, provincial, national, and regional capacity to plan solar and wind energy projects


Kenya - Simulated Annual Wind Power Density (W/m2) at 50 m.a.g.l
SUDAN
ETHIOPIA
UGANDA
SOMALIA
TANZANIA
INDIAN OCEAN
Mandera
Moyale
Lodwar
Marsabit
Wajir
Kitale
Eldoret
Isiolo
Kisumu
Nakuru
Nyeri
Garissa
Nairobi
Lamu
Namanga
Malindi
Taveta
Voi
Mombasa
Kwale
Key
Wind Power Classes
1 Poor (0 - 80 w/m^2)
2 Marginal (80 - 165 w/m^2)
3 Moderate (165 - 275 w/m^2)
4 Good (275 - 425 w/m^2)
5 Very Good (425 - 615 w/m^2)
6 Excellent (815 - 1400 w/m^2)
No Data
Major Towns
Grid lines
Power lines
Lakes
Districts
200
0
200 Kilometers
UNEP
RISØ
PRACTICAL ACTION

Hydropower Generation

- Water availability varies geographically, and stream flows fluctuate on daily, seasonal, annual and decadal time scales. Run-off depends on climatic processes that to some extent follow regular seasonal patterns.
- To determine the suitability of a specific site for hydroelectric generation, detailed information about the hydrological conditions of the watershed is needed. This includes a historical analysis of precipitation (including seasonal variations), run-off, and the occurrence and impacts of droughts and floods.
- Models for forecasting stream flow are usually modified to incorporate local conditions and require the input of local precipitation, wind, temperature, humidity, and solar radiation data.

Biomass Power Generation

- Biomass cultivation is directly influenced by severe weather events such as droughts, floods, damaging winds and forest fires resulting from extended drought.
- Biomass producers use weather forecasts to determine whether or not they should buy crop insurance. Biomass producers use seasonal and monthly weather forecasts to get a sense of demand during the upcoming heating season and to plan future harvesting and biomass processing strategies.

Challenges

- The challenge faced by the meteorological community is to whether or not they are capable of providing the climate information and prediction services as required by the energy sector at global, regional and local levels

Capability Assessment (Seasonal Climate Forecasts)

- Remarkable achievements have so far been made over the past two decades on the skill of seasonal climate prediction, largely in response to increased understanding of the El Niño/Southern Oscillation (ENSO) phenomenon.
- State-of-the-art statistical models and computer models that link the tropical oceans with the global atmosphere have demonstrated measurable predictive skill on seasonal timescales.
- By exploiting these empirically derived "teleconnections", it is possible to provide useful seasonal probabilistic forecasts of up to three seasons in advance with a level of skill significantly better than statistical forecasts based on persistence.

Mechanisms for stakeholder interaction in decision making

- The Regional Climate Outlook Forums (RCOFs) process is one avenue through which users of climate information can interact with providers of the same to support decision making process within the sensitive sectors of the world in adapting to and mitigating the impacts of climate variability and change energy sector.
- The RCOFs process also provides a forum for regional networking capacity building and user awareness.
- The process brings together national, regional and international climate experts, to produce regional climate outlooks based on input from NMHSs, regional institutions, Regional Climate Centres (RCCs) and Global Producing Centres of long range forecasts (GPCs) and other climate prediction centres.

Mechanisms for stakeholder interaction in decision making

- Through interaction with sectoral users, extension agencies and policy makers, the process normally assess the likely implications of the seasonal outlooks on the most pertinent socio-economic sectors in a given region and explore avenues through which these outlooks implemented.
- RCOFs also review impediments to the use of climate information, experiences and successful lessons regarding applications of the past RCOF products, and enhance sector-specific applications.
- The RCOFs products then lead to national forums who are responsible in developing detailed national-scale (Downscaled) climate outlooks and risk information including warnings for communication to decision-makers and the public at large.

Recommendations

- Need to provide of good quality weather and climate prediction services to the energy sector
- Need to build the capacity of users in the energy sector on the interpretation of climate forecasts
- Need to develop sector specific tailored product for the energy sector
- The producers of climate information should work very closely with the energy sector
- Need to integrate climate information and predictions services into the design, development and management of energy supply systems for sustainable energy supply into the future.

THANK YOU ALL FOR LISTENING