GENESIS

A Generic Process for Assessing Climate Change Impacts on the Electricity Supply Industry and Utilities

Helping utilities to manage risk within a changing climate.

BKCC

Building Knowledge for a Changing Climate

Project Outcomes

The main aim of GENESIS is to produce a methodology for a utility, such as the Electricity Supply Industry (ESI), to manage levels of risk within its complex and interrelated functions in the context of a future changing climate. A model will be produced to manage risk at various levels, e.g. the generation plant, the transmission network, the distribution network, the consumer demand, etc. This model will allow the related impacts of these different functions to be properly assessed under different climate scenarios. Particular attention will be paid to the impact on the ESI of changing consumer demand patterns driven by both changing climate and socio-economic activity as well as the impact on wind power which is anticipated to provide a significant part of the government's renewable energy target well into the middle of this century. This is to be achieved by the development of a systems model which parameterises the activities of the utility in terms of a number of Key Performance Indicators.

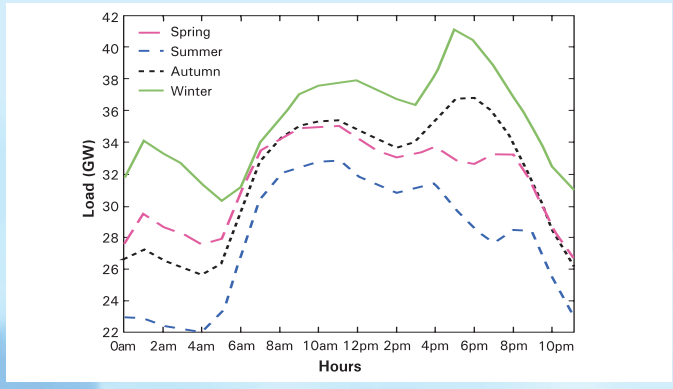

Figure 1: Daily electrical demand patterns for four seasons in 1995 in England and Wales (Source: National Grid Transco).

Stakeholders' Comments

"Future changes in consumption patterns and demand growth are important to our business."
National Grid Transco

"We are now seeing higher building occupation in commercial urban buildings due to economic constraints and lower occupation in domestic housing stock due to demographic changes. This will change future relative demand patterns and affect the demand for air-conditioning."
Building Research Establishment

"Extreme weather events are seen as very important in terms of their impact on the distribution system"
Central Networks

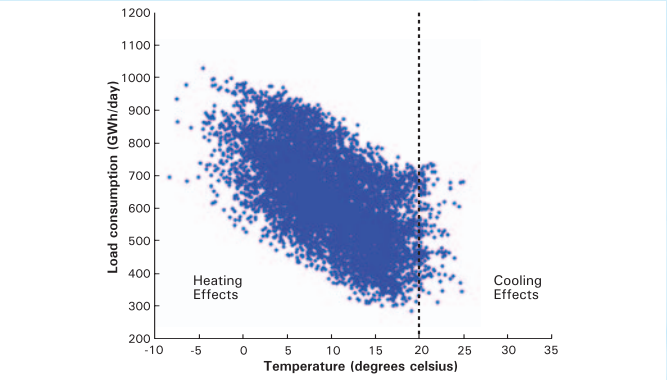

Figure 2: The relationship between temperature and electricity consumption in England and Wales for the period 1970-1995.

Project Description

This project will develop a generally applicable methodology for assessing the impact of climate change on the performance of the electricity supply industry. The generic assessment process will provide the currently missing integrating framework that is essential if the many technical and business risks that climate change may impose on the electricity supply industry are to be properly mediated and managed. The study concentrates on two exemplar aspects, namely: the impact on electricity consumption patterns and the impact on wind power generation. The first of these involves the development of a demand forecasting model on different timescales and for different classes of consumer, i.e. domestic, commercial and industrial. Consumer demand is seen as the key driver to the systems model which will be developed, characterising the response of the ESI in terms of a number of Key Performance Indicators devised following discussions with industry stakeholders.

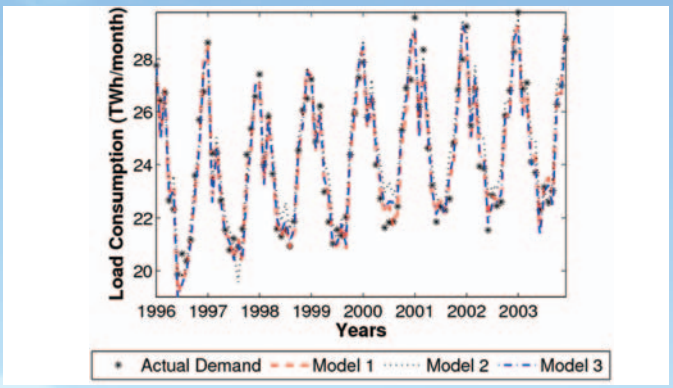

Figure 3: Three monthly forecasting model compared with actual demand data for East and West, 1996-2003.

The research work will focus on demand analysis and its impact on the network at the national (i.e. England and Wales) and regional (i.e. Birmingham and Leicester) level.

A major part of the modelling work will be the impact on the ESI network of changes in demand patterns. The success of a demand forecasting model largely depends on the availability of historical data such as energy data, climate data and socio-economic data. Figure 1 shows the daily electricity demand pattern for the four different seasons for England and Wales in 1995 provided by National Grid Transco. Figure 2 shows the temperature load relationship between 1970-1995. A significant fraction of the electrical demand in UK is for space heating and lighting. Therefore, winter is usually the period that consumes most electricity. However, the trend of summer electricity demand is expected to rise, almost certainly caused by the increasing use of air-conditioning and refrigeration. A value of 20°C is often used as the temperature baseline for cooling effects. There is evidence of a significant rise in the electricity demand during the summer when the temperature is above 25°C. Figure 3 shows an example of different monthly forecasting models comparing their performance with actual England and Wales demand data for the period 1996-2003.

Potential Benefits

1 The forecasted demand will be used as an input to a schematic national transmission system model to predict the inter-and-intra regional power flows. The results from this model can be used to assist a power utility to better plan for future activities on the network, maximise infrastructure utilisation and load management.

2 Assets like transformers and transmission lines are expensive and can be affected by overloading caused by excessive electrical demand. High temperature can also cause overheating and result in failures or shorten the lifetime expectancy. In addition, the thermal ratings for transmission lines are normally calculated by conservative weather conditions and a maximum allowable conductor temperature. Extreme conditions are often ignored. The project will correlate transformer and power line loading with forecasted load demand data in order to assess the impact of possible extreme weather events in the 2020s, 2050s and 2080s.

Sharing the Outcomes

The following journal papers are currently in preparation:

Hor C-L, Watson S J and Majithia S. "Analyzing the Impact of Weather Variables on Monthly Electricity Demand" *IEEE Transactions on Power Systems*, Vol. 20, No.4, November 2005.

Marashi, E., Davis, J.P. "A system-based approach for supporting discourse in the decision-making process", to be issued to *Civil Engineering and Environmental Systems* journal in 2005.

Hor C-L,Watson S J and Majithia S. "Statistical Modelling of the Extreme Events for Load Demand Forecasting" – Currently in preparation and expected to be submitted by January 2005.

Hor C-L,Watson S J and Majithia S. "The Impact of Climate Change on Monthly Electricity Demand: Projection 2020s-2080s" – Currently in preparation and expected to be submitted by November/December 2005.

BKCC Website

An internal distributed report "Analysing the Responses of Monthly Electricity Demand to Changing Climate" is available to download at the BKCC website.

Conferences

Hor C-L,Watson S J and Majithia S. "Assessing Risk in Short Term Daily Load Forecasting using ARIMA-GARCH models". Abstract has been accepted into the 9th *International Conference on Probabilistic Methods Applied to Power Systems (PMAPS)*, 11-15 June, 2006, Royal Institute of Technology – KTH, Stockholm, Sweden. Full paper is currently in preparation.

Marashi, E., Davis, J.P. (2005) 'A Systems Approach to Resolving Complex Issues in a Design Process', *Workshop on Complexity in Design and Engineering*, 10-12 March, 2005, Glasgow, Scotland.

See website for up-to-date details:
http://esi.eerc.bris.ac.uk/

Anticipated project completion date:

October 2006

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UK Climate Impacts Programme

Building Knowledge for a Changing Climate (BKCC) is a portfolio of research projects which look at how changing climate will affect different aspects of the built environment. Most of the projects use case studies in a variety of locations to generate results that can be applied across the UK. This 2005 update part way through the projects is to inform potential users of the research of potential outcomes when the projects are completed in 2006.

EPSRC
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