

Carbon Disclosure Project Report Global Electric Utilities Building business resilience to inevitable climate change

The Adaptation Challenge



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IBM Viewpoint



IBM believes the electricity industry is central to addressing world concerns about both energy and climate. Reducing greenhouse gas emissions, adapting to the climate change already underway and planning for a secure energy future must be addressed in concert. And action is required now.

History shows the need to invest for the future

Throughout history major problems have been the catalyst for major change. The growing demands and constraints on the electricity industry suggest we are rapidly approaching such a critical moment. So, a look back to the lessons from previous large scale infrastructural changes might be timely.

The problems of overcrowding and unhygienic living conditions in Victorian London endangered not only people's health but also the political and commercial well-being of the city. The result was major expenditure on a new infrastructure, the sewerage system. The difficulty in transporting people and goods over large distances in 19th century USA, was a major inhibitor to growth removed by massive investment in the rail network.

Key to both examples is that a completely fresh approach was taken and the investment made for the future rather than repairing existing infrastructure.

A crisis of energy demand and supply

We now face a series of major problems relating to the generation, transmission and consumption of energy, all of which are essential to the commercial world, the way we live and the development aspirations of the majority of humankind.

The world is demanding more and more energy. The projected growth of worldwide energy demand by 2030 is 36.8% according to the International

Energy Agency¹. This is due not only to population growth, urbanisation and improvement in living standards, but also to new requirements such as electric vehicles and the substitution of electricity for hydrocarbon-based fuels as an 'energy carrier'. We can expect further growth in energy demands as individuals, communities and organisations strive to adapt to changing climatic conditions.

The industry faces major challenges in meeting this growing demand, not least because of inhibitors such as: regulation and legislation; inadequate investment returns and out-dated economic incentives that are now unhelpful; and the supply of natural resources. **Climate change concerns both constrain and direct the way in which these challenges can be overcome.**

Taking just one example, electricity companies face major financing challenges. With an urgent demand for more capacity, the industry must raise capital for these projects. This is particularly difficult because of the size of the investment (in the UK, the industry requires an estimated £233.5 bn investment² over the next 15 years which equates to a cost of approximately £9000.00 per household), the desire from investors for a short return on investment and the general lack of funding available due to the current global financial situation. The situation is made more complex by the relative immaturity and lack of commercial scale of some of the technologies central to these projects.

Any growth in energy supply must be achieved in a low carbon way. Power generation creates 25% of the world's CO₂ emissions, the largest man-made source, according to The Climate Group and McKinsey & Co³. Sadly, too much of the generated energy is currently wasted. According to a recent Ontario Smart Price Pilot report⁴, 170 billion kilowatt-hours of electricity are wasted each year by consumers due to insufficient power usage information.

So, the industry is both a major greenhouse gas emitter and one of the solutions to reducing emissions. For example, electric vehicles are promoted by many as the best option to reduce vehicle emissions, but there is little point in doing this if the generation, transmission and distribution of electricity is no 'cleaner' than it is today.

Climate change will exacerbate some existing industry challenges and give rise to new ones.

Climate change problems and solutions are intertwined

The two core focus areas in addressing climate change come together for the electricity industry more acutely than in many areas of society:

- **Mitigation:** reducing greenhouse gas emissions to limit the impact of climate change in coming decades will require changes in consumption behaviour and new supply side technologies
- **Adaptation:** addressing the risks and opportunities resulting from the inevitable climate change – occurring now due to previous emissions of greenhouse gases – which are changing demand patterns and placing operational and resource constraints on supply.

Mitigation has been the main focus of the industry so far. There are many good examples of the work underway here, with investment to reduce emissions from existing infrastructure, the development of new technologies such as wind and solar, and the deployment of smart grids and smart meters. But there is much still to do and it is vital that these efforts intensify without delay.

Adaptation, according to the analysis in this report, has not had the same focus and we ignore this at our peril. We need to understand the effects that inevitable climate change will have on the electricity industry over the next few years – and what steps the industry should be taking.

¹ International Energy Outlook 2008.

² Times article, quoting Ernst & Young Study, 25 May 2009.

³ The Climate Group and McKinsey & Co., "Smart 2020 Report".

⁴ Ontario Smart Price Pilot report: <http://www.oeb.gov.on.ca/OEB/Industry+Relations/OEB+Key+Initiatives/Regulated+Price+Plan/Regulated+Price+Plan+-+Ontario+Smart+Price+Pilot>

Scientists inform us that climate change is underway and the direct effects of increasing global temperatures, changes in precipitation and rising sea levels are becoming more evident. The indirect impacts on social, environmental and economic systems are also beginning to come into view. For the electricity industry, these effects are likely to bring increasing pressures, for example:

- **Significant changes in the demand for electricity.** Increasing urbanisation will be driven in part by climate change with people migrating to find water, food and work, etc. Energy infrastructure will be placed under increasing pressure. For many urban areas the capacity to meet growing demands will be inadequate or non-existent
- **Significant changes to the supply chain.** Access to and transportation of raw materials, commodities and goods will be affected by changes in climate creating disruptions to supply chains. We are already seeing conflicts between users for water with competing demands to grow crops, provide drinking water and cool power plants. In addition, as urban centres change and expand, it is likely that food and water will have to be transported over longer distances requiring ever greater energy inputs
- **Significant shifts in the availability of natural resources.** Climate change will alter the productivity, economics and operational feasibility of renewable and non-renewable power generation in different areas of the world.

There is a confluence of conflicting pressures: a variety of restrictions to generating additional supplies of electricity; a growing demand for more energy; a changing geographic demand for energy; changing climate and environmental conditions on a geographic basis; and a need to reduce greenhouse gas emissions.

Consumers must help with the supply side and utilities with demand

Electricity is a complex system-of-systems and it requires an integrated approach to fundamentally redesign the way the industry works if it is to meet the challenges of a changing climate. Optimising this system-of-

systems means more dynamic control of the flows of power, information and money; new sources of 'supply' and 'demand'; and changed relationships between the two.

Many opportunities exist to optimise and grow existing capabilities and accelerate emerging technologies to commercial scale.

IBM sees the need for three areas of action to happen consecutively, not sequentially.

- **Optimise:** Apply smart solutions to optimise and extend existing capabilities, making the most efficient use of the assets that already exist to buy time and take appropriate adaptation action. Examples could include: asset life extension and optimisation programmes, and new, cleaner fossil-fuel plants.
- **Grow:** Rapidly grow existing commercialised capability through smarter design and operation providing 'low-regret' solutions with potentially large benefits, for example: factoring changing climatic conditions into the design stage for new cooling systems; developing transmission systems to cope with increased temperatures and provide greater access to remote renewable energy assets; new-build nuclear programmes; automated and intelligent smart grids; smart metering and demand management technologies; and new regulatory incentives.
- **Accelerate:** Nurture and accelerate new capabilities to commercial scale, whilst at the same time maintaining options that allow further adaptation actions in the future. Examples could include: carbon capture and storage, deep-water wind, tidal and wave power, micro-combined heat and power (CHP), more efficient home wind and solar, distributed on-shore wind, waste and bio; various forms of storage; electric vehicle infrastructure; and intelligent home devices. Other industries will need to transform the energy efficiency and demands of the products and processes both to ease pressure on the electricity industry and reduce their risks to increasingly stressed supply.

To achieve this, we need the consumer to become part of the electricity management and efficiency story. Examples of this type of engagement include:

- **Encouraging people to use less energy, differently.** This can help to lower energy usage directly and lower and spread peak usage. A smart way of achieving this would be to implement smart grids (which could help to lower emissions by 14% by 2020⁵), smart meters, remote operation and automated operation of electrical appliances and goods
- **Encouraging people to collaborate with utilities in generation –** expansion of micro generation, for example CHP, photovoltaic, solar heating, etc., has the potential to provide an almost infinitely controllable electricity generation capability able to meet demand more closely than the current centralised approach.

Change is needed now to enable prosperity in a much different future

Successful electricity companies over the next 10 years will be those that act now upon the clear signals that climate change is underway.

They will have recognised the risks and opportunities arising from a changing climate and will have created business models that understand the changing nature of supply, demand and control in the electricity sector.

They will have a fully integrated approach to the challenges of the energy revolution, reducing emissions and adapting to climate change. They will use the lessons gained from the present financial crisis and from history to avoid the even greater and entirely 'predictable surprise' created by climate change.

The industry must behave differently to address pro-actively the immediate and longer term impacts of inevitable climate change while continuing to deal with today's immediate pressures.

Senior executives in the sector must take the lead and drive their companies towards this transformation.

Executive Summary



Electricity companies must assess the risks and opportunities arising from inevitable climate change as well as taking essential action to reduce emissions. The focus so far, as evidenced by responses to the Carbon Disclosure Project, has been primarily on electricity companies reducing emissions and secondarily on understanding the risks posed by climate change. Companies should recognise the need for action in the near term to build business resilience to manage the risks and capitalise on the opportunities that inevitable climate change brings.

This century will see unprecedented urbanisation and intense competition for scarce resources, driven by population growth and economic development. A revolution in energy generation, supply and demand is needed with companies taking an integrated approach to the challenges through:

- The optimisation of existing infrastructure assets, systems and information
- Growth of existing capabilities
- Acceleration of emerging technologies to a commercial scale.

There is scientific consensus that the world's climate is changing due to human activity and that whatever steps we take to limit GHG emissions we are now faced with several decades of increasing global temperatures and a far longer period of rising sea levels. We are already seeing the impacts of these and other climatic changes on social, economic and environmental systems. The impacts will become more severe over time creating, for example:

- Reductions in agricultural and fisheries yields
- Increasing stress and competition for water resources
- Enhanced migration to urban areas
- Changing disease patterns
- Geo-political risks.

These impacts add up to significant changes in the demand for electricity against a backdrop of supply challenges, ageing assets, new technology, prescriptive regulation and impacts on asset performance and efficiency.

Although there is uncertainty in the knowledge we have about the extent and rate of future climate change, there is sufficient information to assess impacts on business models and enable robust decisions to be taken as a result. The successful electricity company of the future is taking climate risks into account today, and is developing adaptive strategies and actions to manage the uncertainties. The existence of uncertainties regarding the business risks arising from climate change, should by itself act as a catalyst for companies to quantify the risks, monitor the impacts as they arise and be prepared for changes to their business models.

Consumer preferences and needs will change; markets will open up in new locations and for new products and services. Those businesses that do not respond will lose out to their competitors, whilst those that recognise the opportunities will become electricity sector leaders.

The present financial crisis is driving many companies to take stock and revisit their business models. This provides the ideal opportunity for companies to look at the strategic and operational issues they will need to address if they are to become climate resilient.

The successful electricity companies of the future will be those that act now upon the clear signals that climate change is underway. They will have a fully integrated approach to the challenges of the energy revolution, reducing emissions and adapting to climatic change. They will use the lessons gained from the present financial crisis to avoid the even greater and entirely 'predictable surprise'⁶ created by climate change. Acclimatise and IBM have jointly prepared a set of Prepare-Adapt questions to help electricity companies take the right steps towards building corporate resilience to inevitable climate change.

⁶ A predictable surprise describes a situation or circumstance in which major issues are marginalised to satisfy short-term expediency. Predictable surprises can be defined as issues that:

- at least some people are aware of,
 - are getting worse over time, and
 - are likely to create a crisis,
 - but are not priorities for decision makers or have not elicited a response fast enough to prevent severe damage.
- See M. Bazerman and M. Watkins (2004) 'Predictable Surprises: The Disasters You Should Have Seen Coming, and How to Prevent Them'.

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1 Introduction



In this report we explore the issues that electricity companies are beginning to face in response to a changing climate and the actions being taken.

The report draws upon an analysis of the responses from global electricity companies to the 2008 Carbon Disclosure Project (CDP). Examples of actions and issues taken from the responses are provided.

As the most carbon intensive industry in the world, the electricity sector is simultaneously a significant contributor to and victim of climate change. Reducing the greenhouse gas (GHG) emissions of the sector is central to achieving a low-carbon economy⁷ and requires “nothing short of an energy revolution.”⁸ Ensuring the resilience of the generation, transmission and distribution network and shifting the focus to renewable sources of energy, low carbon generation and more dynamic balancing of supply and demand will require levels of investment that will transform the industry.

Many of the climate changes that we will see over the next 30 to 40 years are already built into the climate system due to GHG emissions. Mitigation efforts to reduce emissions are vital if we are to keep climate change from surpassing a dangerous and rapidly approaching threshold. This has been called avoiding the unmanageable. However the effects of climate change are already upon us and are growing rapidly. A significant reduction in emissions is essential, but, we must also prepare for and respond to the impacts – we must adapt to manage the unavoidable.

Those companies focussing their climate change activities exclusively on reducing GHG emissions (and many companies have yet to understand the urgency for action in this area) are only considering half the picture. By failing to build resilience they will miss significant business opportunities created by the energy revolution.

The report includes a series of Prepare-Adapt questions prepared by Acclimatise and IBM to help senior electricity company executives identify the steps they need to take towards building corporate resilience to inevitable climate change.

The Carbon Disclosure Project

CDP is an independent not-for-profit organisation which holds the largest database of corporate climate change information in the world. The data is obtained from responses to CDP’s annual Information Requests, issued on behalf of 475 institutional investors, to more than 3,700 corporations across the globe. Since its formation in 2000, CDP has become the gold standard for carbon disclosure methodology and process, providing primary climate change data to the global market place. CDP plays a vital role in encouraging companies to measure, manage and reduce emissions and climate change impacts.

The CDP Information Requests include a series of questions seeking disclosure on the physical impacts of climate change on existing and future company performance and the management responses. (A copy of the questions is available on the CDP website: www.cdproject.net together with a list of the investors).

The Information Request was sent to the world’s largest 218 electric utilities globally (based on market capitalisation). Acclimatise has analysed the responses to assess the business resilience of companies to a changing climate. A separate technical appendix is available online at www.acclimatise.uk.com with the results from the analysis.

Acclimatisation Index

The analysis of the responses to the CDP Information Request has been undertaken using our **Acclimatisation Index** methodology. This enables a semi-quantitative analysis of the responses recognising the scope of the questions. The Index can take into account information from other sources to provide a more comprehensive analysis.

The **Acclimatisation Index** has been used to analyse the resilience of global electricity companies to climate change in response to questions contained within sections 1 and 4⁹ of the CDP questionnaire.

⁷ <http://www.eurelectric.org/CEO/CEODeclaration.asp>

⁸ IEA, 2008.

⁹ Excluding question b ‘Individual Performance’ of section 4 which focused on performance towards GHG targets.

2 Climate change is underway



“Even with drastic cuts in emissions in the next 10 years, our results project that there will only be around a 50% chance of keeping global temperature rises below 2°C. If the world fails to make the required reductions, it will be faced with adapting not just to a 2°C rise in temperature but to 4°C or more by the end of the century.” A 2°C increase in global temperatures will create severe stress in many parts of the world.”

**Dr Vicky Pope,
Head of Climate Change Advice
at the UK Met Office**

“Climate change is increasingly recognised as a key strategic issue for the electricity generation sector...”

The opportunities and compulsion for carbon reduction and adaptation strategies for this sector are therefore considerable and warrant particular attention from investors.”

**Global Climate Disclosure
Framework for Electric Utilities,
Institutional Investors Group
for Climate Change**

There is scientific consensus that the world’s climate is changing due to human activity and that whatever steps we take to limit GHG emissions we are now faced with several decades of increasing global temperatures and a far longer period of rising sea levels.

In 2007, the Intergovernmental Panel on Climate Change (IPCC) – the most authoritative scientific body on climate change – confirmed the scientific evidence that climate change is already under way¹⁰:

- “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.” (see Figure 1)
- “At continental, regional, and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones.”

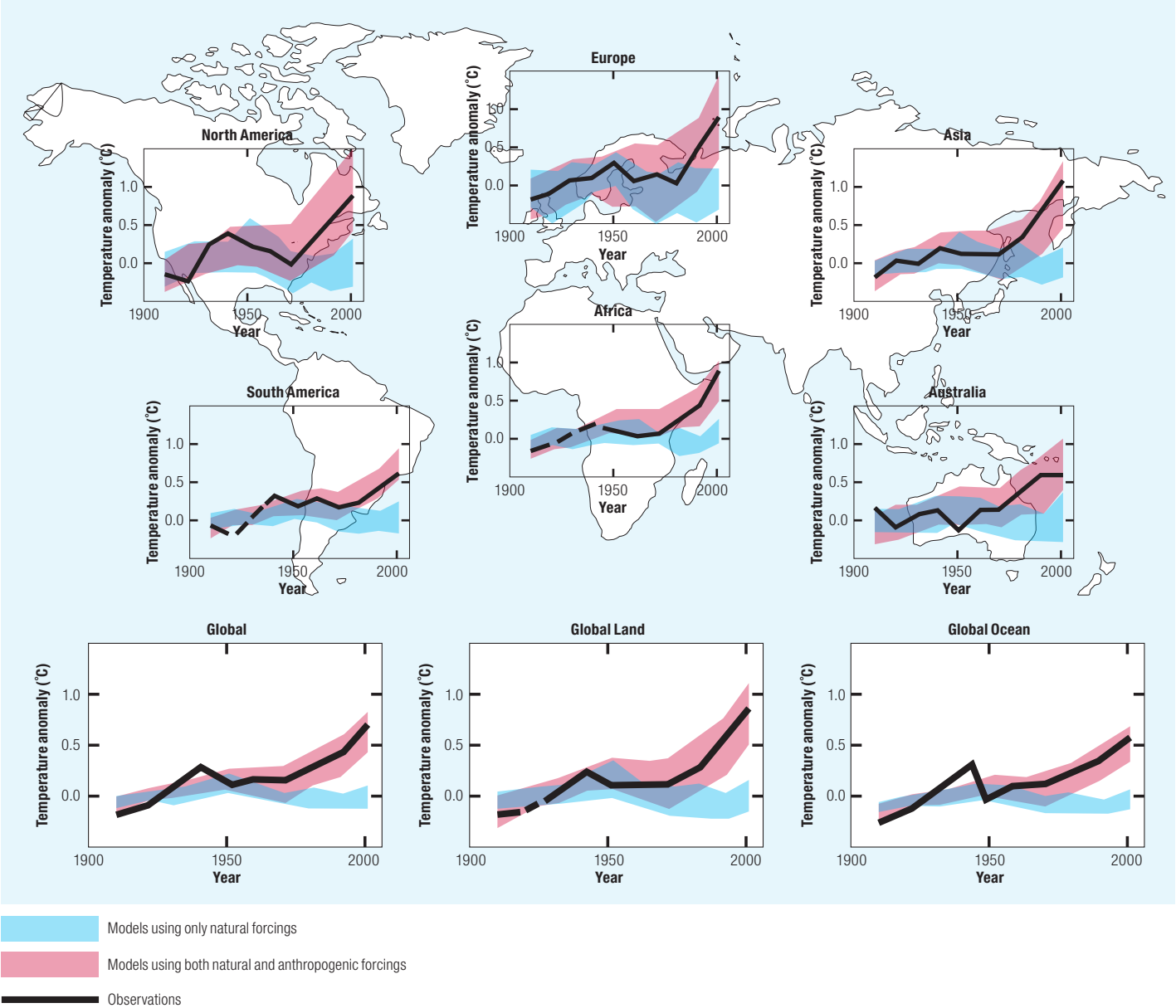
The IPCC has recommended that urgent action is required to limit the concentration of GHG’s in the atmosphere and prevent global average temperatures rising above 2°C. A temperature rise above 2°C will be difficult for contemporary societies to cope with, and will cause major social, economic and environmental disruptions through the rest of the century and beyond. There are also concerns that increases above 2°C significantly increase the risk of large scale, irreversible system disruption.¹¹

Limiting temperature rise to 2°C is looking increasingly challenging and if we fail we are faced with further rises in temperature and an even greater adaptation challenge.

¹⁰ IPCC ‘Climate change 2007: synthesis report’.

¹¹ *Scientific Symposium on Stabilisation of Greenhouse Gases – Avoiding Dangerous Climate Change Exeter February 2005.* Executive Summary of the Conference Report.

Figure 1: Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings¹²



¹² IPCC 'Climate change 2007: synthesis report'.

3 The energy revolution



It is important that any consideration of the impacts of climate change be set against the context of the other challenges already faced by the global electricity sector.

Whereas the eighteenth century may have been characterised by the industrial revolution and the twentieth century by globalisation, this century will see unprecedented urbanisation, shortages of food and water and intense competition for scarce resources, driven by population growth and economic development. Climate change is being driven by the use of fossil fuel based energy sources to meet these challenges.

The responses to these challenges will require a revolution in energy generation, supply and demand. The challenges and how they will be affected by a changing climate are considered in the following section.

Challenges

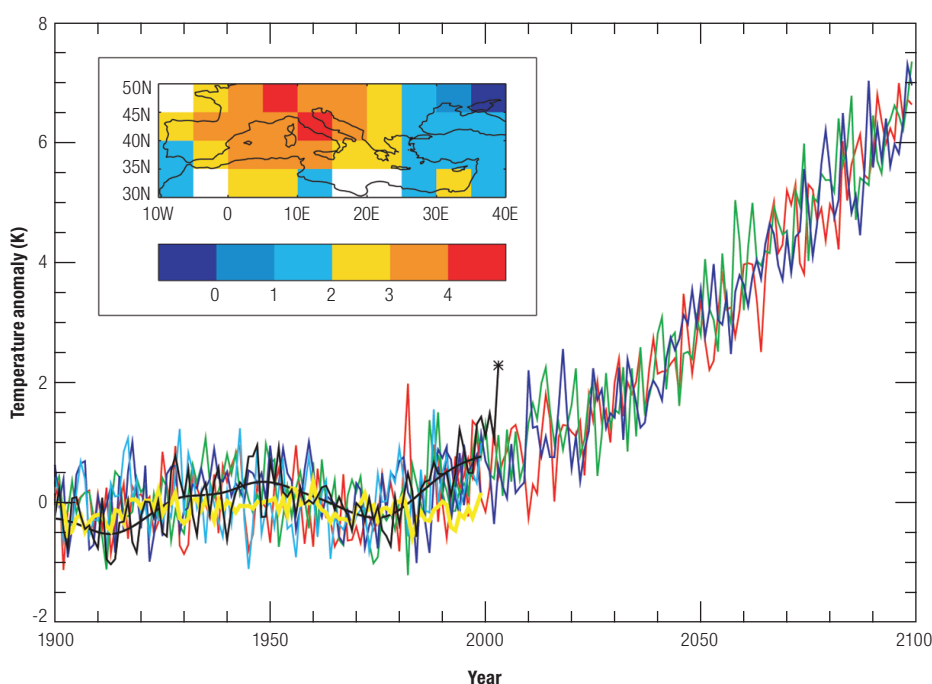
National energy security concerns.

Secure long-term access to fuel and energy supplies is a key element of energy policies for most developed countries and increasingly for the emerging economies.

Supply reliability. Failure in the security of supplies to customers, interruptions and longer term outages cause major financial losses not to mention adverse social impacts and constraints on economic prosperity and growth. In the USA it has been estimated that the annual cost to the economy arising from power interruptions is \$80 billion. A large proportion of these costs are attributable to the combined effect of asset age and the impacts of weather events.

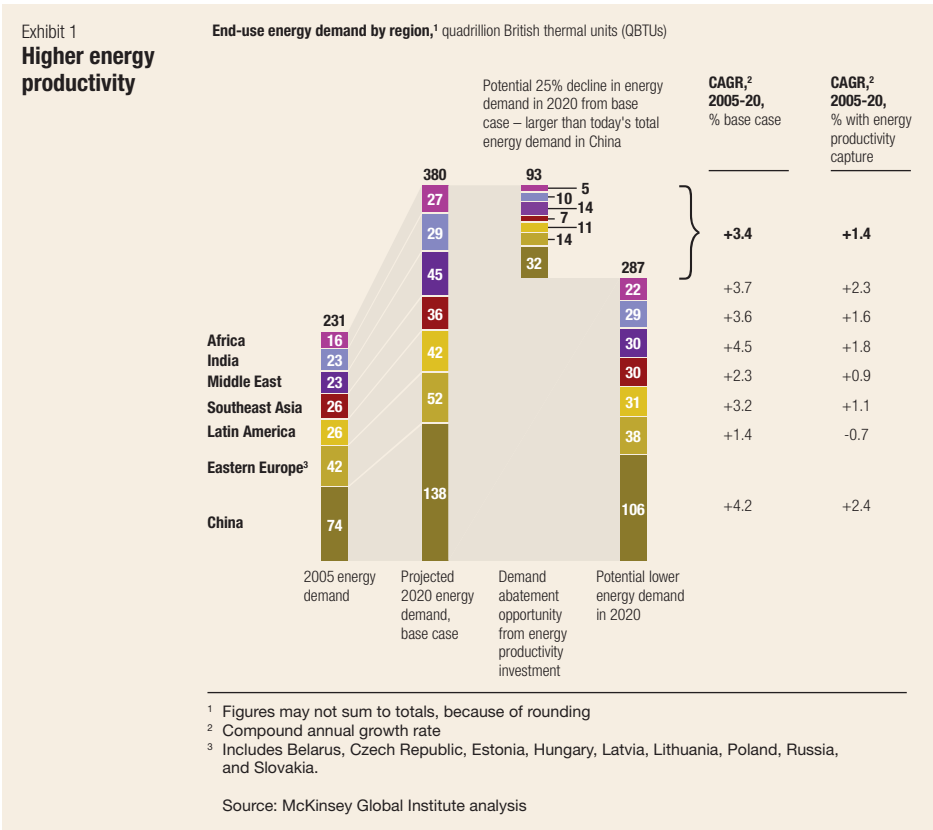
Increasing temperatures will increase the demand for energy and place great pressure on existing assets. Companies will be faced with more difficult supply reliability issues. Figure 2 shows averaged European summer temperatures as observed (black line), and simulated by the Hadley Centre Model (red line) from 1900 to 2100. The observed average European summer temperature for 2003 is marked with a black star. The return period for the 2003 heatwave under climate change increases from a 1 in 500 year event in 2003 to a 1 in 2 year event by 2040. 2003 will be a normal summer in the 2040s and a relatively cool summer by the 2060s.

Figure 2: Observed and modelled changes in temperature in Europe¹³



¹³ Stott, P.A., Stone, D. A. and Allen, M. R. (2004) Human contribution to the European heatwave of 2003. Nature, Vol 432, pp 610-614.

Figure 3: Increasing energy demands from emerging economies¹⁶



“Besides the efforts of reducing greenhouse gas emissions from its operations to limit climate change E.ON acknowledges and plans for both the effects of gradual warming, as well as an increased frequency of extreme weather events. We expect that these seasonal and weather-related fluctuations in revenues and demand will continue. As a response we will improve our grid management and optimize the usage of our power stations. We have also undertaken operational and infrastructure improvements to increase the resiliency of our generating assets and transmission and distribution networks to these extraordinary conditions. E.ON has made these mitigation and adaptation efforts a part of its Business Continuity Management processes.”

Matthias Hansch,
VP Climate Protection
and Environment,
E.ON AG

Increase in global demand for energy. Energy demand is expected to grow by 1.6% per year on average between 2006 and 2030, an increase of 45%¹⁴. Although the current financial crisis has affected energy demand, the underlying growth in demand is expected to continue over the medium-long term. Between 2007 and 2030, around 13.2 trillion US\$ of cumulative investments are forecasted to be required in the power sector to maintain supply and respond to the increased demand for electricity¹⁵. The increasing energy demands from emerging economies and developing countries, relevant to that from the OECD countries, is a key challenge (see Figure 3).

The direct and indirect impacts of climate change (see Figure 4) will increase the demand for electricity and affect the resilience of assets to meet the changing demands. The impacts will also increase the competition for water resources between the electricity sector and other users (for example, agriculture, fisheries, drinking water, industry, and natural habitats).

Energy underpins our social and economic systems. Access to reliable and increased supplies of low-carbon electricity are essential to meet the adaptation needs arising from, for example, increasing urbanisation, agriculture (to improve yields and manage drought), transportation, the built environment (to cool buildings), potable water supplies, drainage and waste water treatment.

It is not clear from the scenarios developed by organisations such as the International Energy Agency if these additional energy needs driven by climate change impacts and adaptation responses have been included in demand estimates.

The IPCC Synthesis Report provides examples of the impacts associated with global average temperature change (see Figure 4). The black lines link impacts; broken-line arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of text indicates the approximate level of warming that is associated with the onset of a given impact.

“People really need to understand that the average global surface temperature is like the temperature of your body – and if you have a fever of 40.5°C, even though that’s only three and a half degrees above normal, it’s potentially fatal. Everything that is expected to result from global climate change driven by greenhouse gases is not only happening, but it’s happening faster than anybody expected.”

Dr. John Holdren,
Chief Scientific Adviser
to President Obama,
6 February 2008

¹⁴ International Energy Agency World Energy Outlook 2008. Paris.

¹⁵ CDP, 2008.

¹⁶ Farrell D. And Remes. J (2009) Promoting energy efficiency in the developing world. McKinsey Global Institute.

“Climate change is a significant global challenge and its solution will have a profound effect on how we produce, distribute and consume energy in the future. But the challenge before us is not solely about greenhouse gas emissions. Physical risks from changes in climate such as potential water scarcity that impedes our ability to produce electricity and changing temperatures that increase our summer peak demand for electricity could significantly affect our business. We are addressing these issues by studying our water needs to ensure we are using this precious resource most efficiently. And we are seizing the opportunity to advance technologies that improve our own use of energy and help our customers to manage theirs. As the largest coal consuming electric utility in the western hemisphere, we have a responsibility to lead on this issue.”

Dennis E. Welch,
Executive Vice President,
Environment, Safety &
Health and Facilities,
American Electric Power

High rate of asset retirement. In developed countries with ageing generation, transmission and distribution assets, many assets are nearing their design life and investment is required now to maintain supplies. Many existing nuclear and fossil fuel power stations are due for retirement creating a supply demand gap. Asset retirement is also driven by pollution legislation, for example in the European Community by the Combustion Directive¹⁷. Asset retirement rates are high in many developed countries (including the U.S., UK and Germany). In the UK alone, a generation shortfall of 20% is predicted by 2015.¹⁸

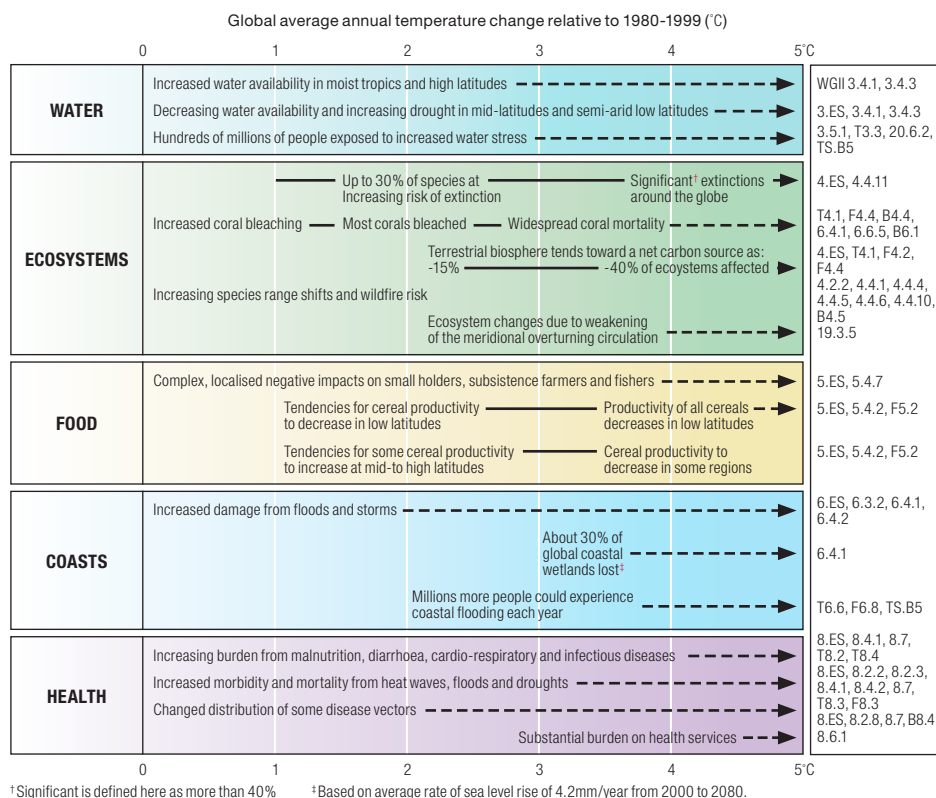
Development of new assets with new technologies (including a growing renewable energy sector). Significant investment is required in new assets to meet the growing energy demands from the developing and transition countries, replace ageing assets in the OECD countries and meet emissions targets. \$250 billion was invested globally in 2008 constructing 157GW of power generation from all sources,

of which 40% (65GW at a cost of \$155 billion) was in renewables (excluding large hydro).¹⁹

Lead time for new assets. The appraisal, design and construction of major assets can take many years. Securing regulatory consents is becoming increasingly difficult in many areas of the world as environmental and sustainability concerns become major political issues. Building new power stations can be difficult in countries with high environmental standards, active NGOs, and complex regulatory and consenting processes. Political issues regarding the building of new nuclear and fossil fuel power stations, and the right financial conditions for the development of alternative renewable energy sources create further delays.

Reducing GHG emissions. Current actions to reduce emissions are insufficient to limit average global temperature increase due to anthropogenic climate change to 2°C.

Figure 4: Examples of impacts associated with global average temperature change



¹⁷ EC Directive 2001/80/EC.

¹⁸ Hewer, 2006.

¹⁹ Global Trends in Sustainable Energy Investment 2009, UN Environment Programme's (UNEP) Sustainable Energy Finance Initiative.

Reducing the GHG emissions of the electricity sector is central to achieving a low-carbon economy and restricting global average temperature increases. Electricity companies are faced with implementing new generation technologies, energy efficiency and demand management measures to meet emissions targets. Investments are needed in new assets, retrofit technologies to clean legacy assets, transmission and distribution strengthening for resilience and distributed generation, and control technologies (smart grid, smart metering, distributed/micro generation, virtual power plants, demand management).

Increasing urbanisation. More than half of the world's population now lives in cities. According to the 2008 Revision of the official United Nations population estimates and projections, the world population is projected to reach 7 billion early in 2012, up from the current 6.8 billion, and surpass 9 billion people by 2050²⁰. The population living in urban areas is projected to gain 3.1 billion, passing from 3.3 billion in 2007 to 6.4 billion 2050. The urban areas of the world are expected to absorb all the population growth expected over the next four decades while at the same time drawing in some of the rural population.

Furthermore, most of the population growth expected in urban areas will be concentrated in the cities and towns of the less developed regions. Asia, in particular, is projected to see its urban population increase by 1.8 billion, Africa by 0.9 billion, and Latin America and the Caribbean by 0.2 billion. Population growth is

therefore becoming largely an urban phenomenon concentrated in the developing world.

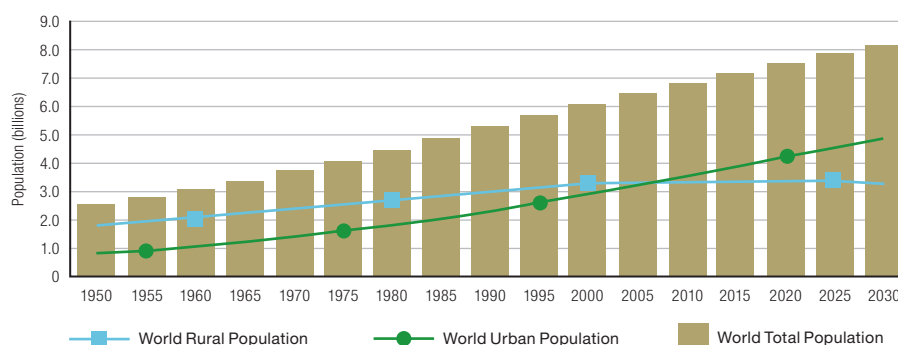
The trend for increasing urbanisation is expected to be accelerated as people move from failing rural areas under increasing pressure from climate change to cities. Urban areas already face power shortages in many areas of the world. Electricity companies will face major challenges in providing new generation capacity and supply reliability within urban areas to meet the increased demands from domestic customers, essential urban utilities (for example water and sewerage), and the technological changes in transportation (for example the increased use of electric vehicles). Ability to pay by an increasing proportion of urban populations who are poorer and disadvantaged will become a significant issue for electricity companies, particularly in emerging economies.

Water resources. Global fresh water resources are under increasing stress. Less water, declining water quality, and growing water demand are creating immense challenges to the electricity sector which is a major user of water (see Figure 6). The sector has historically taken clean, reliable and inexpensive water for granted. These trends are creating operational issues, restrictions on abstractions, more stringent water quality regulations, pressure to move towards full-cost water pricing, and increased public scrutiny of corporate water practices.²¹ The electricity sector requires a consistent supply of water – in the USA it accounts for 39% of total freshwater abstractions.²²

“Cemig has developed strategies and undertaken projects to minimize impacts on its business related to extreme climate events caused by global warming. About 97.0% of Cemig's electric energy generation system is composed of hydroelectric plants. Therefore, extreme droughts or heavy rains may result in alterations in the generation, transmission and distribution of energy and impact the company. With this issue in mind, Cemig has been working to improve its initiatives in respect to both monitoring and communicating hydrometeorological events and atmospheric discharges and has been studying and simulating raised-flow events in order to guarantee the security of its generation system and of the surrounding communities.”

Djalma Bastos de Moraes,
CEO, Cemig, Brazil

Figure 5: Population change and urbanisation



²⁰ United Nations (2008) Department of Economic and Social Affairs. Population Division. *World Urbanization Prospects: The 2008 Revision*. United Nations 2008.

²¹ Ceres, Pacific Institute 'Water scarcity and climate change: growing risks for businesses and investors' 2009.

²² Energy Demands on Water Resources: Report to Congress on the Interdependence of Energy and Water," U.S. Department of Energy, December 2006.

Figure 6: Water consumption by type of energy generation²³

Energy type	Total water consumed per megawatt hour (m ³ /MWh)	Water consumption required for U.S. daily energy production (millions of m ³)
Solar	0.0001	0.011
Wind	0.0001	0.011
Gas	1	11
Coal	2	22
Nuclear	2.5	27.5
Oil	4	44
Hydropower	68	748
Biofuel (1st generation)	178	1958

A particular area of concern for the electricity sector is the impact of climate change on water resources. The IPCC Synthesis Report released in 2007 states²⁴:

“Climate change is expected to exacerbate current stresses on water resources from population growth and economic and land-use change, including urbanisation. On a regional scale, mountain snow pack, glaciers and small ice caps play a crucial role in freshwater availability. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by meltwater from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes), where more than one-sixth of the world population currently lives.”

“Changes in precipitation and temperature lead to changes in runoff and water availability. Runoff is projected with high confidence to increase by 10 to 40% by mid-century at higher latitudes and in some wet tropical areas, including populous areas in East and South-East Asia, and decrease by 10 to 30% over some dry regions at mid-latitudes and dry tropics, due to decreases in rainfall and higher rates of evapotranspiration. There is also high confidence that many semi-arid areas (e.g. the Mediterranean Basin, western United States, southern Africa and north-eastern Brazil) will suffer a decrease in water resources due to climate change. Drought-affected areas are projected to increase in extent.”

Delivering and treating clean drinking water together with safe sewerage and waste water treatment systems to an increasing global urban population will create significant increases in the demand for electricity.

Current global financial situation. The International Energy Agency estimates that global electricity consumption could drop by as much as 3.5% in 2009 – the first annual contraction since the end of the Second World War.²⁵ There is a risk of complacency creeping in as the recession decreases demand, obscures the greater challenges from the energy revolution and climate change and delays action. Investment is needed to invest in assets now during the downturn to prepare for the future. A prolonged depressed financial situation will delay investment and create further pressures for electricity companies and for societies and economies.

Financing the energy revolution.

Power-sector investment in the short-term is expected to be severely affected by the current financing difficulties. In the longer term the scale of the investment required to meet the energy challenge is significant. A recent study by Ernst & Young²⁶ concludes that £234 billion of new investment is now required to meet the UK's energy goals. These additional investments will double the value of the UK's total energy supply asset base (after taking into account depreciation) by 2025.

Clear national government policy.

In addition to the technological challenges, the electricity sector is faced with an uncertain regulatory landscape and in many cases a vacuum in national government policy. Governments are slow to agree and implement the policies needed to create the certainty required by the companies and their investors. The timelines do not match that required to close the growing supply – demand gap.

New regulatory landscapes. Although new regulatory provisions are being developed in many countries in response to these challenges, there remains a great deal of uncertainty regarding the scope, content and format of future legislation. Greater certainty about the future regulatory landscape is required to encourage companies to invest. New regulatory pricing structures will be required in some countries to encourage greater energy efficiency and demand management measures.

²³ Linking Water, Energy & Climate Change: A proposed water and energy policy initiative for the UN Climate Change Conference, COP15, in Copenhagen 2009, DHI, Draft Concept Note, January 2008.

²⁴ IPCC 'Climate change 2007: synthesis report'.

²⁵ OECD and IEA The impact of the economic and financial crisis on global energy investment May 2009.

²⁶ Ernst & Young (2009) Securing the UK's energy future – meeting the financing challenge. London.

4 What are the impacts for the electricity sector?



Successful electricity companies already cope with climate risks, ranging from day-to-day and seasonal changeability in weather and extreme events. Assets have been designed to operate within thresholds and margins to:

- Meet the climatic differences across the various regions in which they operate
- Maintain environmental and health and safety regulatory requirements
- Deliver against financial performance standards
- Meet operational performance and customer service delivery standards.

Most companies have practical strategies in place to manage climate uncertainty and minimise disruption, including taking out insurance, maintaining updated contingency plans, and hedging wholesale electricity and fuel supplies.

These strategies continue to be important in coping with natural climatic variability. However, the baseline climate is changing, and business decisions and practices will need to evolve as a result. Electricity assets have been designed on the basis of historic climate data and a period of relatively stable weather.²⁷ These design assumptions together with those thresholds and margins set for regulatory, operational and financial performance requirements will constrain the future effectiveness of assets to deliver under climate change.

Two main types of climatic changes will affect the electricity value chain²⁸:

- More frequent and intense extreme or 'acute' weather
- Incremental or 'chronic' climatic changes.

Companies should recognise that climate change will have both direct and indirect impacts. It is vital that companies do not limit their risk assessments to the direct physical impacts of climate change. The compound impacts are likely to reverberate through a company's business model – creating a 'pinball machine effect' as the impacts in one area rebound and have consequential impacts elsewhere in a company's business systems for example affecting:

- Natural resources and raw materials
- Procurement supply chains and logistics
- Asset design and construction
- Asset operation, performance and maintenance
- Markets and customers
- Products and services
- Workforce
- Local communities and the environment.

"As climate change takes hold, few businesses will be able to escape the impact of greater competition for resources. As nations become more protective of their assets, and markets become more volatile, it can no longer be business as usual. Business strategy and operations will be increasingly impacted and it is critical that companies and their insurers work to understand these interdependencies now, and begin to reflect them in their business plans and approach to risk management."

Dr Richard Ward,
Chief Executive Officer,
Lloyd's

²⁷ Power Systems Engineering Research Center (2007) The Electric Power Industry and Climate Change: Power Systems Research Possibilities. Illinois, USA.

²⁸ An overview of the components of the electricity sector value chain is provided in Appendix 1.

“CLP’s facilities were affected by three extreme weather conditions in the past 12 months. Heavy rain and flooding in Paguthan, India in late June/early July of 2007 caused loss of life and heavy damage in the township near our GPEC power plant...the plant was shut down for 3 days due to a decline in the electricity demand.

“[In addition]...severe snowstorms in China in late January/early February of 2008 resulted in widespread electricity outages and hardship. We shut down our Anshun II power station for several weeks because the grid was unable to take the power, although the plant was capable of running.”

CLP Holdings

“Demand for electricity in Australia is heavily dependent on economic growth and temperature. As the economy grows so does demand for energy, and as temperatures rise, so too does the demand for electricity... because of higher utilisation of air conditioning. As demand can change quite rapidly due to higher temperatures, prices at peak demand times can often increase by several thousand percent.”

AGL Energy Limited

Extreme events and incremental change

Both ‘acute’ and ‘chronic’ climate change effects will impact the bottom lines of electric utilities by influencing:

- Operational performance as a result of degraded site conditions, damages to assets, decreased efficiencies of operations, reduced availability and quality of raw materials and natural resources, effects on workforce health and safety
- Social performance because of increased competition with local communities for access to climate-sensitive natural resources and changes in socio-economic conditions
- Environmental performance through changes in habitats, flora and fauna, impacts of discharges and use of natural resources.

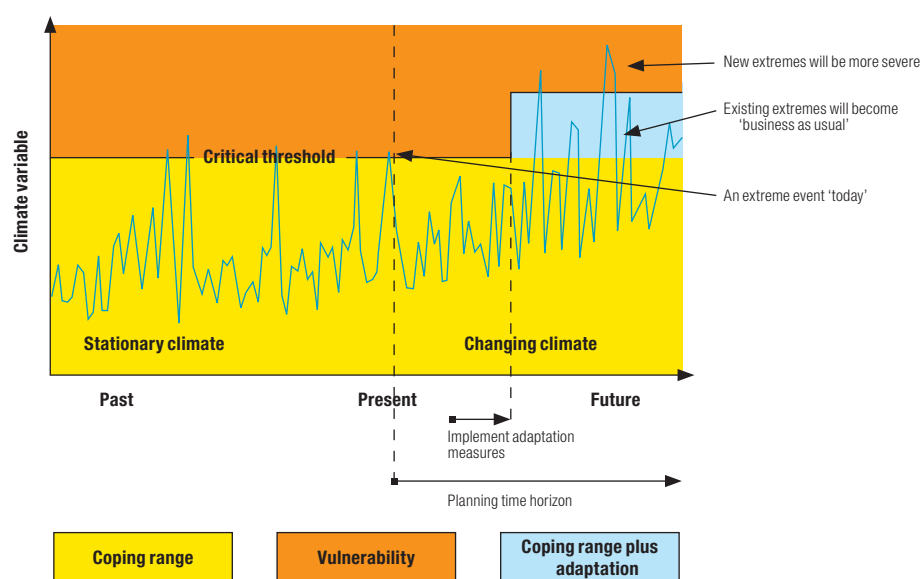
Disruptions to energy supplies and the increase in energy prices driven by recent extreme events (for example, the 2003 European heat wave and drought in Australia and the USA in 2008) serve to illustrate the vulnerability of assets to events greater than the industry’s current asset design, engineering and operational standards.

These events, combined with the availability of increasingly sophisticated climate change models, have generated greater interest in planning for more severe and frequent climatic events. In contrast the ‘creeping’ average changes are much harder to recognise and are more likely to be overlooked.

Figure 7 illustrates the importance of identifying climatic sensitivities and critical thresholds for assets and business systems. These provide the boundaries between tolerable and intolerable levels of risk. Information and data on current and future climate conditions can then be assessed against the asset thresholds, to evaluate the likelihood of their being exceeded.

Acute (extreme) events. Setting the critical thresholds for asset design and operation is essential, but there is always an event (for example an extreme event or a change in demand during a heatwave) greater than that for which protection has been provided. Climate change (as indicated by Figure 7) is predicted to increase the risk of extreme events exceeding critical thresholds. Companies should assess their risks and develop strategic plans to expand the ‘coping range’ of their assets through adaptation measures.

Figure 7: Impact of extreme events and incremental change on critical asset (or business system) thresholds²⁹



²⁹ Willows, R.I. and Connell, R.K. (Eds). (2003). *Climate adaptation: Risk, uncertainty and decision-making*. UKCIP Technical Report. UKCIP. Oxford.

Business continuity and crisis-management responses are appropriate to manage the impacts of extreme events but have little relevance to incremental change. The latter requires companies to carry out fundamental reviews of their business models and check that processes are 'fit for purpose' and climate-proof under new operating conditions.

Chronic (incremental) changes. These changes to our climate are more subtle and their impacts on business models and assets may pass undetected until critical thresholds are breached. The responses may result in 'step-changes' for a company, increasing operational costs beyond forecasts, falling revenues, unplanned capital investment and additional balance sheet financing to manage the consequences.

Assets and operational processes designed without any allowance for incremental change may fail to meet design criteria, operational performance targets, key performance indicators (KPIs) and future regulatory standards. Understanding the incremental changes in the climate and a company's current thresholds, sensitivities and vulnerabilities are significant issues to be considered in any analysis of a company's future financial performance. They should feature in corporate assessments of strategic, operational and project risks. This is a particularly important area for companies to focus on when undertaking asset and capability optimisation actions.

Examples of observed and potential impacts of climate change across the electricity value chain have been provided in Appendix 2.

Change drivers for corporate action

Inevitable climate change will have impacts for all companies, but electricity companies are particularly vulnerable.

The key drivers for adaption will be experienced through regulatory and legal liabilities, changes in cost profiles, market transformations, stakeholder interest and governance (Figure 8).

Figure 8: Change drivers for corporate action³⁰



Some examples of how these drivers are beginning to affect electricity companies, and how they are anticipated to change over the next few years are given in the following paragraphs.

Regulatory and legal drivers

As the impacts of climate change become more direct we are likely to see governments resort to prescriptive regulation and statutory controls to ensure that electricity companies providing essential infrastructure take appropriate action on adaptation. Early indications of action by governments are already evident. In the United Kingdom the Climate Change Act 2008 gives the government the power to require electricity companies to assess and disclose the impacts climate change might have on their business.

Prescriptive action is also inevitable with regard to other key resources used by the electricity sector. For example, the increasing stress placed on fresh water resources from competing demands driven in part by climate change will change the way in which water is priced and regulated. It is inevitable that water will become a highly regulated and state controlled resource, with electricity companies having to understand the future regulatory and cost implications within their business models.

The wider geo-political risks arising from access to scarce water resources should be considered for those companies operating in sensitive areas.

The wealth of information on the impacts of climate change from the scientific community, academia, research institutions, government, trade associations, and NGOs is so great that no company or director, senior manager or professional advisor could claim ignorance in a legal challenge. As the financial impacts of climate change are further recognised, we are likely to see litigation used to recover costs incurred from changing climatic conditions.

There are examples of lawsuits against power companies aimed at securing compensation for damages resulting from extreme events (and which are projected to become more frequent under climate change).³¹ The legal costs and reputational damage associated with defending such climate-induced legal actions could be significant.

New regulatory approaches are required that maintain competition whilst allowing more collaboration. Regulation is also required to provide incentives and funding to support research and implementation of technologies.

³⁰ Adapted from the "Energy & Efficiency Framework," IBM Climate Change Centre of Excellence.

³¹ For example, a power company responsible for maintaining the transmission lines in Victoria (Australia) is being sued in a class action suit introduced by victims of a wildfire allegedly caused by a fallen power line. The claim is made "on the basis of negligent management of power lines and infrastructure".

"As an electric utility we are highly dependent on weather, both concerning demand and production, and therefore also on climate. Lower demand for heating but higher for cooling, more precipitation in the north and increasing frequency of severe weather situations are likely scenarios. Planning under uncertainty requires preparing for risks as well as openness to harvest possible benefits. Vattenfall is reinforcing hydro power dams and substituting exposed overhead power lines with underground cables as well as developing businesses to meet new challenges on the industry and our customers."

Agneta Rising, Vice President, Environment, Vattenfall AB

"Verbund's experts are currently analysing historic trends in precipitation and possible impacts on generation and profitability using Monte Carlo simulation models. First results show positive effects on profitability due to a shift of generation from summer to winter. Further calculations will include inputs from downscaled climate models."

Verbund

Cost drivers

All of the impacts identified in the business impacts tables have a potential cost implication. For example, operational costs will increase in response to changes in equipment efficiency and resilience under higher temperatures, lower air pressure and modified humidity. Changes in security and quality of water supplies used for cooling will have significant cost implications for water-intensive thermoelectric generating facilities.³²

Electricity prices can be expected to become more volatile as the impacts of climate change affect asset performance, the cost of raw fuel sources, and water abstraction. The cost of maintaining system reliability to meet growing customer expectations will increase particularly during extreme events and peak demand periods.

Emerging technologies have a low investment viability currently exacerbated by limited global finance. Assistance from national governments through regulation and incentives is required to enable electricity companies and others to bring to market low carbon technology. Incentives are also required to both electricity companies and consumers to conserve energy.

Stakeholders

Stakeholders – including investors, lenders, insurers, market and financial analysts, governments and regulatory agencies, consumers, local communities and NGOs – are already starting to place greater pressure on electricity companies to address climate risks and opportunities.

Corporate operations are increasingly scrutinised in the context of climate change, for example:

- The impacts of climate change on the economic, social and environmental performance of hydropower schemes is increasingly being questioned
- Securing land-use planning and other environmental costs is becoming more challenging. In the USA companies have been refused consents due to increasing competition for water resources.³³

Pressure for disclosure is increasing. In the USA, Xcel Energy and Dynegy agreed in 2008 to disclose all climate risks, including physical climate change impacts, in their Securities and Exchange Commission (SEC) filings.

Market drivers

Electricity companies will need to review their current strategies for generating, transmitting and distributing energy to meet the changing expectations and demands from their customers. Increasing urbanisation driven in part by climate change will change the demand profiles for electricity.

Peak demands will increase in summer months in response to increasing temperatures and the need for energy for cooling. Changes in electricity consumption for space heating, transportation and other climate-sensitive processes such as pumping water for agricultural irrigation and other industrial and domestic uses will also occur in the near-future under a changing climate.

Governance

The impacts of inevitable climate change and the drivers for change will place increasing pressure on companies to demonstrate that their system of governance is adequately assessing and managing the risks and capable of taking advantage of the opportunities.

Investor groups are challenging companies, through initiatives such as:

- Carbon Disclosure Project (CDP), Global Framework for Climate Risk Disclosure and the Global Reporting Initiative (GRI)
- The Investor Network on Climate Risks (INCR) and Ceres in the USA.
- The Institutional Investors Group on Climate Change (IIGCC) in Europe.
- The Investor Group on Climate Change (IGCC) in Australia and New Zealand.
- The Association for Sustainable and Responsible Investment in Asia (ASRIA).

³² Each kWh of electricity generated via the steam cycle requires approximately 25 US gallons (about 95 litres) of water (Wilbanks et al, 2008).

³³ Wilbanks et al., 2008.

Ceres, IGCC, IIGCC and GRI have all issued reports aimed at the electricity sector. The disclosure requirements in these reports cover issues such as:

- Climate change strategy and processes for managing climate change risks and opportunities
- Impact of regulation
- Quantitative data (both historical and projected) related to their exposure to climate change (for example generation mix and electricity production).

In each of these reports the importance of communications and disclosure in financial reports, sustainability reports, analyst briefings and mandatory reports to securities regulators such as the U.S. Securities Exchange Commission is emphasised. The use of shareholder resolutions to encourage companies to address climate change risks has increased dramatically. Ceres noted that a record high of 57 climate-related resolutions were filed with U.S. companies during the 2008 proxy season. Of that figure, almost half were withdrawn because the businesses positively addressed the issues involved in the resolutions.

The external challenge for greater disclosure should act as a catalyst for internal action by companies to assess, manage, integrate and engage on the consequences of climate change. If investors believe there are

questions to be answered then clearly senior executives should be ensuring that the correct questions are being asked within their own companies.

How are companies responding?

Companies are beginning to identify risks

Respondents most often identify both 'acute' and 'chronic' climate risks to assets and natural resources. Companies operating renewable energy assets such as hydroelectric and wind power installations highlight risks to natural resource availability.

Impacts of climate change on transmission and distribution assets are also reported. For example, Duke Energy noted that "its local electric distribution systems are vulnerable to damage from extreme weather events such as ice storms, tornados and severe thunderstorms – the types of weather events that could potentially be impacted by climate change".

Companies also report changes to markets, demand and price. These include increased energy price volatility, episodes of higher peak demand and overall seasonal demand changes. Consolidated Edison wrote that it is at risk from these impacts, noting that "increases in temperature, in particular, the frequency and severity of heat waves, would result in increased electric and steam demand."

The impacts of climate change on operational performance are rarely reported. Companies did however recognise that the climate impacts on the availability and quality of water was a risk. ATCO Ltd. reported that "reduced cooling water availability may require the addition of air cooling, which would be an additional cost," while Dominion Resources noted that "droughts can result in reduced water levels that could adversely affect operations at some of the company's power stations."

Changing stakeholder perceptions and expectations regarding supply reliability, price and the economic, social and environmental sustainability of new assets are rarely reported. For example, water availability for cooling processes has effects not only on generation processes but also on community relations and social licences to operate. In several American states concerns about water supplies have led to permits not being granted for new thermoelectric power plants.³⁴

Companies are reporting direct climate impacts and particularly those created by extreme events. There is less coverage of the indirect impacts or of risks created by incremental climatic changes.

Actions to manage risks

Companies report investing in more climate-resilient materials and designs, such as coastal sea defences, sustainable drainage systems, dam reservoir overflow management or "disaster-resistant configurations such as power system networking and the multiplexing of power facilities" (Chubu Electric Power, Japan). Verbund in Austria has revisited the level of security of its hydropower dams: "dam security was re-calculated for flood levels of HQ 5000 (a level reached every 5000 years)."

Actions are being taken by some companies to respond by optimising their existing assets, for example by generation companies improving their cooling water processes.

Table 1: The most frequently mentioned risks identified by companies and those that they are being addressed (Source: CDP Information Requests 2008)

Top 10 risks identified	Top 10 risks managed
1. Distribution grids negatively affected by extreme events	1. Distribution grids negatively affected by extreme events
2. Changing levels of precipitation leading to variable river levels for hydro	2. Assets compromised by extreme weather events
3. Assets compromised by extreme weather events	3. Changing levels of precipitation leading to variable river levels for hydro
4. Increased energy demand for air conditioning and refrigeration in summer	4. Disruptions to offsite utilities (e.g. communications, water, waste treatment, etc.)
5. Reduced river flows and efficiency of cooling processes	5. Rising temperatures will increase energy demand for air conditioning and refrigeration in summer
6. Wholesale and retail energy prices will remain volatile	6. Wholesale and retail energy prices will remain volatile
7. Milder winters will result in less demand	7. Customer expectations of secure energy provision will place increasing pressure on companies
8. Disruptions to offsite utilities (e.g. communications, water, waste treatment, etc.)	8a. Increased interruptions to transport systems 8b. Restrictions on water abstraction and efficiency of cooling
9. Changes in sea level and flooding will compromise assets	9a. Changes in sea level and flooding compromising assets
10. Changes in wind pattern that could affect the wind energy production	9b. Increase of wholesale and retail energy prices because of restrictions in supply 9c. Litigation becomes more significant

³⁴ Wilbanks et al., 2008.

There is however less evidence that companies are assessing the wider operational impacts of climate change on generation, transmission and distribution performance and taking action to manage the risks. Some companies report having diversified plant locations, purchased additional or more comprehensive insurance, or made arrangements with other companies to purchase electricity in case of supply disruptions. Chugoku Electric Power Co., Inc. in Japan, for example, is "...involved in exchanging of summer temperature change risks (weather derivatives)."

Opportunities remain to be exploited
Table 2 presents the opportunities that companies most frequently recognise and address through assessment and management actions. Companies report fewer opportunities in comparison to the number of risks reported. This is consistent with other business sectors and reflects the early stages of adaptation to climate change where the focus is on risk.

The two most recognised opportunities were highlighted by 25% of respondents.

10% of companies identified the business opportunities from renewable energy generation. Endesa for example, plans to take advantage of potential changes in water resources and precipitation patterns in South America to develop new hydropower generation plants.

A number of companies have identified optimisation responses and refer to the implementation of demand-side controls that automatically load-shed non-priority customers on peak demand days. Actions such as these minimise the risk of system failures and assist with supply reliability.

Energy East Corporation "is investing in major transmission initiatives that will...address reliability issues." Similarly, Dominion Resources wrote that its "...retail business unit offers customers products that can be utilised in the face of severe weather. Some of the products offered include a variety of home generators (permanent, portable, etc.) and surge protection products."

Climate change adaptation remains to be mainstreamed into corporate governance and management
Almost all electric utilities report assigning responsibility for climate change to an executive body (91%). It is not clear however, if companies are integrating adaptation into risk management processes and decision making.

Regarding policy engagement, more than half of the companies responding noted that they lobby lawmakers and/or participate in trade associations or cooperate with their competitors regarding climate change policy, without providing any specific information on the issue of adaptation and climate change resilience.

Table 2: The most frequently mentioned opportunities identified by companies and those being addressed (Source: CDP Information Requests 2008)

Top opportunities identified	Top opportunities managed
1. Increased demand for electricity because of hotter summers	1. Increased potential for renewable electricity generation
2. Increased potential for renewable electricity generation	2. Increased demand for electricity because of hotter summers
3a. Higher peaks in extreme weather conditions	3a. Increased market for water efficient generation and cooling technologies
3b. Consultation services for plant operation in changing weather conditions	3b. Market for new transmission technology
3c. District cooling expertise	3c. Bring power to vulnerable communities
3d. Sales in times of extreme weather events (e.g. short-term power stations)	3d. Improve species mitigation and adaptation by reviewing site strategies and project locations
	3e. Reduce capex in future extreme events by improving reliability of transmission grid

"Exelon has long had to deal with and prepare for the effects of extreme weather conditions. These conditions have a direct impact on electric and gas usage and hence peak demand. Thus, we need to address weather as a component of both short-term and long-term planning..."

"In the short term, on a daily basis we need to ensure energy is available to meet customer demand on a real-time basis. We also have to project those needs into the daily, weekly and monthly scheduling of resources. Over the long term, we have to engage in resource planning that will meet the projected future demand of our customers. In addition, weather events can impact our operations due to the potential for damage to our capital assets."

Exelon Corporation

"In Nordic conditions [the potential implications of climate change and adaptation needs to physical risks] include...a changing annual production pattern of hydro power and decreased need for heating energy. As many of our power plants are situated on the coastal area the sea level rise may impose risk for the operation of the plants and there is need to reconsider gradually the dimensioning of the location (from sea level) of plants and plan flood protection and cooling water pumping. There is also need to consider more frequent and stronger storms in the distribution operations."

Fortum

5 What actions should companies take?



A business will only flourish if its leaders are adept at weighing risks and making robust decisions in the face of uncertainty. The successful business of the future is taking climate risks into account today, and is developing adaptive strategies and actions to manage the uncertainties. Although there is uncertainty in the knowledge we have about the extent and rate of future climate change, there is sufficient information to enable robust decision-making to take into account the possible impacts on business models. The existence of uncertainties regarding the business risks arising from climate change, should by itself act as a catalyst for companies to quantify the risks, monitor the impacts as they arise and be prepared for changes to their business models.

There is scientific consensus that the world's climate is changing due to human activity and that whatever steps we take to limit GHG emissions we are now faced with several decades of increasing global temperatures and a far longer period of rising sea levels. We are already seeing the impacts of these and other climatic changes on social, economic and environmental systems. The impacts will become more severe over time creating, for example:

- Reductions in agricultural and fisheries yields
- Increasing stress and competition for water resources
- Enhanced migration to urban areas
- Changing disease patterns
- Geo-political risks.

These impacts add up to significant changes in the demand for electricity against a backdrop of supply challenges, ageing assets, new technology, prescriptive regulation and impacts on asset performance and efficiency.

If businesses are to become climate resilient and meet the challenges of the energy revolution then they need to draw on the experience of the current financial crisis. In our report exploring the FTSE350³⁵ we set out some of the key challenges for senior executives. These challenges apply equally to companies operating in the global electricity sector:

- **The relevance of climate change to fiduciary responsibilities –** Senior executives need to act in accordance with their wider fiduciary responsibilities to create sustainable business growth and return over a longer time scale. Senior executives, who focus on the response to immediate challenges at the expense of a balanced position on the risks facing their business arising, are not acting in the best interests of their shareholders, nor of those of their employees, customers and the communities in which they are located.
- **Governance meeting the challenge –** The scientific evidence that climate change is underway, that further climate change is inevitable and that impacts are already occurring in social, environmental and economic systems, is overwhelming. It is incumbent upon all senior executives to ensure that potential risks to their business models and value chains have been identified and assessed to understand the consequences of decisions and the factors affecting their company's future.
- **Risk disclosure –** In most countries the regulation of companies under statute requires some form of disclosure of future risks, for example:
 - In the USA Item 303 in the Securities Exchange Commission Act of 1933 requires U.S. publicly traded companies to disclose *"where a trend, demand, commitment, event or uncertainty is both presently known to management or reasonably likely to have material effects"* on the financial condition of the company.

"A fundamental question confronting those of us in the electric power business is what kind of world we want to leave to our children. Will it be a world given over to rising seas, stronger storms, widespread drought and exorbitant energy prices? Or will it be a world where we harness the power of markets to tame carbon emissions, preserve our environment, and strengthen our energy security?"

FPL Energy

³⁵ Acclimatise (2009) 'Building business resilience to inevitable climate change' FTSE350.

“In the context of a sustainable business, the ability to adapt to a constantly changing world is a necessity. Now that much of the international scientific community has advised governments of the inevitability of climate change, businesses should prepare for the new future that is predicted. Those that see not only the risks, but also the opportunities may be ahead of many. However it is those that have already started acting on the identified risks and opportunities that will be in a better position to weather the storm. At CLP, we began acquainting our staff with the concept of adapting to climate change through an adaptation brainstorming workshop whereby staff from across different functional units were provided climate change scenarios to which they developed adaptation solutions relevant to their functions.”

Andrew Brandler,
CEO, CLP Holdings Limited

- In the United Kingdom the Companies Act 2006 requires that Directors of listed companies understand the likely consequences of any decision in the long term, and disclose the main trends and factors likely to affect the future development, performance or position of the company’s business.

Developing an integrated approach

Adapting to the impacts of a changing climate requires electricity companies to take an integrated approach to their response to the energy revolution. New sources of electricity supply, together with technological change in transmission and distribution systems are required. Customers need to be provided with an ability to make informed decisions about their use of energy to meet changing demands. The relationship between supply and demand also needs to change with new control systems reflecting, for example, that future customers can also be suppliers with their own micro and distributed generation capabilities.

Three complementary adaptation actions are available to electricity companies³⁶:

Optimisation of existing infrastructure assets, systems and information. This will involve applying smart solutions to optimise existing capabilities, for example, through:

- Asset life extension programmes
- New asset maintenance procedures
- Consumption and price information and tariff incentives to influence demand.

Optimisation is essential over the next 5 to 10 years as the only available adaptation response using existing assets. Driving improved efficiencies and performance from existing assets and incentivising demand management and customer behaviour changes are essential. The development of new assets through growth and acceleration will take time and requires action by national governments to both regulate and incentivise.

Growth of existing capabilities.

Electricity companies have opportunities to rapidly grow their existing capabilities using the technology and information on climate change that is now available through:

- Smarter design and operation
- The introduction of automated and intelligent grids
- Smart metering
- Regulatory incentives (with the support of governments)
- Existing new build programmes (designing against a future climate).

Acceleration of emerging technologies to a commercial scale.

The energy revolution and the response to climate change provide companies with an opportunity to take a ‘step-change’ in the vision for their business. Those companies that nurture and accelerate new capabilities to market at a commercial scale will be the sector leaders of the future. Opportunities exist in:

- New renewable energy technologies, for example, deep-water wind and tidal/wave power
- Integrated smart homes, buildings and cities
- Products and added value services that will help commercial and domestic customers predict, monitor, and adapt to the impacts of climate change.

It should however be noted that there may be financial and commercial risks for those companies that are first to market with new technologies, products and services. National governments have a major role to both incentivise companies and underwrite the risks involved as part of their own strategic adaptation responses to climate change.

³⁶ A key challenge facing the electricity sector in meeting the energy challenge is the capacity of the manufacturing sector to meet the potential demand for the construction and supply of new assets.

During 2009 there will be many opportunities for companies to talk to governments, politicians, scientists, trade associations, and NGOs in the run up to the United Nations Framework Convention on Climate Change (UNFCCC) fifteenth Conference of the Parties in Copenhagen. Although the main emphasis of the conference will be on reaching a global GHG emissions agreement, electricity companies must become fully engaged in the discussions on adaptation.

This report has concentrated on the issues for listed companies in the electricity sector. The impacts are however not limited to these companies alone. They apply equally to those countries where the state manages generating, transmission and distribution assets. The impacts are also of relevance to the world's urban areas dependant upon the availability of resilient energy systems in order to function effectively.

The successful electricity companies of the future will be those that act now upon the clear signals that climate change is underway. They will have a fully integrated approach to the challenges of the energy revolution, reducing emissions and adapting to climatic change.

Prepare-Adapt: 10 questions for senior executives in the electricity sector

Acclimatise and IBM have jointly prepared their Prepare-Adapt set of questions to help electricity companies take the right steps towards building corporate resilience to inevitable climate change. A simplified version drawing on a more comprehensive set of questions is provided below.³⁷

Your risks

- 1 What are the operational impacts on your company of climate change?

- What are the implications for the operating performance and efficiency of your existing assets under changing climatic conditions?
- How will the impacts of climate change on the other operators in the electricity value chain affect your business?
- How will changes in water resources and water quality together with increased competition from other users affect your operational capacity?

- 2 Are your current and planned major operating assets located in areas vulnerable to climate change impacts and what are the implications?

- What steps are you taking to design new assets against future climate impacts, what costs would be involved to relocate (where appropriate) and undertake remedial works to provide resilience to existing assets?
- What are the implications of depreciating, abandoning or writing-off assets or of extending asset life through optimisation actions?
- How will the operational performance of your asset portfolio change over time?

- 3 How sensitive is demand for your products and services to climate change impacts?

- How will customer needs, buying behaviour and ability to pay change and over what timescale?
- What are the implications of increasing urbanisation and changing energy demand profiles?
- What are the implications arising from changes in the demographics of the countries in which you operate?

- 4 How could current and future climate change regulations and industry standards affect your organisation and its reputation?

- What is your level of regulatory and financial exposure to the introduction of prescriptive legislation on adaptation, together with further legislation on urgent mitigation action, as the reality of climate change becomes more pressing?
- How effective and auditable is your process for reporting regulatory and policy compliance?
- Which areas of your business are sensitive to media, NGO and local community concerns?

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³⁷ Please contact Acclimatise or IBM if you would like to know more about the 'Prepare-Adapt' questions.

Your opportunities

5 What new and enhanced existing products and services can you offer your customers?

- What steps are you taking to develop new or enhanced business opportunities that will provide competitive leadership?
- How will you develop brand stretch to take advantage of changes in customer behaviours and develop climate related markets?
- Can you provide products and services that that will help commercial and domestic customers predict, monitor, and adapt to the impacts of climate change as well as enhance their efforts to reduce their emissions footprint?

6 What benefits could you realise from better managing your response to climate change?

- How can you improve the attractiveness of your company to investors, banks, credit rating agencies, employees and potential recruits?
- How will you use the current economic crisis as an opportunity and an incentive to revisit your business model and respond to the growing social, environmental and economic challenges?
- What are the cost advantages if you can secure more favourable insurance cover by demonstrating strong operational risk management processes limiting potential consequential loss claims?

Your response

7 How clear and effective are your internal management responsibilities for climate change and your engagement with stakeholders?

- To what extent are your internal climate change leadership and management roles clearly defined, supported and empowered to meet fiduciary responsibilities?
- How are you sharing information with and influencing governments, regulatory bodies, NGOs, consumer groups and the media to manage and forecast exposure?
- What actions are you taking to ensure that the investment community, your bankers and insurers understand and support the steps you are taking regarding climate risk?

8 How well structured is your approach for managing climate change?

- How effective is your process for exploring longer term scenarios and identifying risks and opportunity signals as they emerge to plan and act accordingly?
- How are you assessing the vulnerability of your raw materials and resources, suppliers, assets, operations, workforce and markets to changing risks?
- What steps are you taking to ensure that climate change driven business risks and opportunities are integrated into your decision making through optimisation, growth of existing capabilities, and acceleration of new commercial technologies?

9 How can you ensure that your approach is based on robust information and assumptions?

- How have you integrated the latest available climate science and climate change scenarios to inform your business planning and decisions?
- Are your management information systems for raw materials and resources, assets, supply chains, operations, markets and customers reporting on and monitoring climate change KPIs using realtime, interconnected and intelligent data?
- Can your information systems provide an early warning of climate change driven signals of changes in operational performance and demand profiles?

10 How can you demonstrate that your climate business resilience plans are realistic and financially viable?

- What actions have you taken to understand and manage future liquidity and ensure sufficient contingency funding in preparation for more intense and frequent extreme climatic events?
- How do your business continuity and crisis management plans reflect the changing risk profiles due to climate change and are they well-rehearsed?
- What steps are you taking to involve your employees, develop new skills and expertise to grow your internal capability and accelerate the commercialisation of new technologies?

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Appendix 1



The future electricity sector value chain

In this report we explore the impacts of inevitable climate change and the business resilience of companies operating in the electricity sector. The 88 companies who responded³⁸ to the 2008 CDP Information Request include companies with fully integrated operations across the value chain, and those concentrating on a particular part, for example generation.

The sector value chain is in a period of transition and development in response to some of the challenges identified in the previous section. Energy storage and local, distributed power systems are becoming increasingly important features of the value chain in the twenty-first century. Figure 9 provides a simplified overview of the electricity sector.

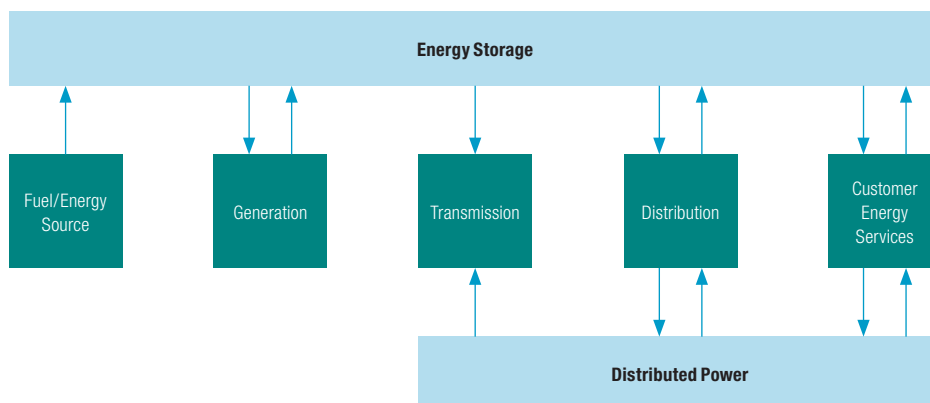
Fuel/energy sources. A variety of sources are used: fossil fuels (coal, oil, natural gas), nuclear, biomass, water, solar, tidal, wave, wind and geothermal. New generation technologies linked to the development of commercially viable fuels (e.g. hydrogen, second generation biofuels, algal derived fuels) will become increasingly important.

Access to and developing each of these fuel sources will need to recognise the effect of changing climatic conditions and indirect impacts on asset performance, supply chains and logistics, interruptions due to extreme events, environmental regulations and local communities.

Generation. Electricity is most often generated at a power station by electromechanical generators, primarily driven by heat engines fueled by chemical combustion or nuclear fission but also by other means such as the kinetic energy of flowing water and wind. There are many other technologies that can be and are used to generate electricity such as solar photovoltaics and geothermal power.

The large fixed assets used in the generation of electricity with comparatively long asset lives are vulnerable to a changing climate. Existing assets will have been designed to operate against historic climate data and demand criteria that are no longer robust as a basis for decision making. New assets must be designed to operate against a range of possible climate scenarios, rather than absolute values.

Figure 9 – The electricity sector value chain



³⁸ 88 companies out of a total 218 electricity companies invited to participate in the 2008 Information Request provide complete responses to the questions covering disclosure on the physical impacts of climate change on existing and future company performance and management responses.

“Origin creates and protects value by managing a range of risk exposures. For a company exposed to changes in the weather, and that sells products that rely on the availability of water, wind and the sun, the risk of long term changes to our climate is an important one to manage. Measures that position us well for a changing climate already form an important part of our portfolio of risk management activities. For example, one of the most significant adaptation challenges for the Australian energy sector is restricted water availability. Origin’s Darling Downs gas fired power station, planned for commissioning in late 2009, will not only emit about half the greenhouse gas emissions of conventional coal-fired power stations – it will also use less than 3 per cent of the water.”

**Carl McCamish,
Executive General Manager,
Policy and Sustainability
Origin Energy Ltd**

Transmission. The bulk transfer of electrical power to demand centres. A power transmission network typically connects power plants to multiple substations near a populated area. Electricity is transmitted at high voltages to reduce the energy lost in transmission. Power is usually transmitted as alternating current through overhead power lines. Underground power transmission is used only in densely populated areas because of its higher cost of installation and maintenance when compared with overhead wires, and the difficulty of voltage control on long cables.

The operational performance and asset integrity of the transmission system are areas where there are major risks arising from climate change. Changes in demand peak and seasonal demand profiles will place pressure on grid systems. The integrity of assets will be compromised by changes in the frequency and intensity of extreme events. Increasing temperatures will reduce the efficiency of transmission grids, increasing the need for compensatory generation capacity.

Distribution. The final stage in the delivery of electricity to consumers. A distribution system’s network carries electricity from the transmission system and delivers it to consumers. Typically, the network would include medium-voltage (less than 50 kV) power lines, electrical substations and pole-mounted transformers, low-voltage (less than 1000 V).

Changes in demand profile, operational performance and asset integrity together with the use of historic climate data as a basis of design and operation will also affect the distribution system. Increasing urbanisation driven in part by climate change will require distribution systems to be reviewed and rebuilt.

Customer energy services. The retail element of the value chain providing the customer focus and main contact with users on metering, billing, new development services, demand management and added values services.

Understanding how climate change will affect markets and consumers is vital. The demands from commercial and domestic customers will change. The range of services they may require to help them manage and adapt to the effects of climate change provide significant business opportunities.

In the future we will need to reconsider the traditional value chain model for the electricity sector. Developing a model based on new supply and demand systems where consumers can also be suppliers, managed by a central control system to balance and regulate will be more appropriate. Adaptation responses should be considered within the context of the changes to the value chain.

Appendix 2



Examples of the impacts of inevitable climate change for the electricity sector

In the following tables a high level overview using examples of observed and potential impacts of climate change across the electricity value chain is provided. The tables are split between the key elements of the electricity sector value chain.

Generation

Resource impacts due to climate change

Hydro power

There will be early gains associated with hydropower on rivers that are reliant on glacial melt. In the long term, however, these gains will be counterbalanced by a significant decrease in flows as glaciers disappear.

Studies indicate that declining river flows in some areas as a result of climate change will lead to declining hydropower production. The IPCC's Fourth Assessment Report points to a 25% decrease in hydropower capacity at existing stations in Spain by the 2070s.

Droughts in Australia have meant that there have been reductions in output for many hydropower dams, for example the largest dam in Australia, the 180 MW Dartmouth Dam – stopped generating electricity in 2007 and is unlikely to restart before 2011.

Biomass

Feed material yields can be affected by higher temperatures, changing patterns of rainfall and soil-moisture deficits.

Indirect impacts on pests and diseases and competition for land for food production will have implications for 'fuel' crops. Crops that remain viable may be of reduced quality.

Companies may be faced with potential reputational and branding issues if large areas of land are taken out of food production in developing countries.

Climate change may induce farmers to grow other crops with a shorter rotation period, including biomass crops.

Solar

Output is affected by cloud cover, which in turn is dependent on wind shear, humidity, temperature and precipitation. Climate change induced changes in these variables could affect the performance of solar panels and seasonal output of solar energy generation.

A study of the output efficiency of photovoltaic solar panels in Scandinavia under climate change revealed that, taking into account increased average temperature and reduced ground reflection, a decrease of solar radiation of 2% would reduce the electricity output of solar cells by about 2%.

Wind

Changes in wind climate characteristics during asset life times may have significant impact on the generation profiles from turbines. There are indications that in some areas (for example Northern Europe) wind speed will increase.

Wind speeds in the eastern Mediterranean exhibit a general increase over land and a decrease over the sea, with the exception of a noticeable increase over the Aegean Sea.

Fossil

During Hurricane Katrina in 2005, 109 oil and gas platforms in the Gulf of Mexico were destroyed or damaged, causing oil prices in the U.S. to rise. Three months after the event, 47% of U.S. distillates were still not functioning.

Up to half of Russia's natural gas reserves are at risk because of permafrost thaw. This will mean that the security of supply for electric utilities reliant on gas from Russia is endangered.

In Queensland, Australia 2008, two major coal mining companies had to declare 'Force majeure' as a result of extreme precipitation causing flooding. Events such as this will severely impact the supply of coal to power stations.

Nuclear

During the European heat wave of 2003 17 nuclear reactors in France had to reduce output or were shut down due to water abstraction and discharge restrictions.

Asset impacts due to climate change

Generic

Asset locations adjacent to rivers or the coast will be at risk from flooding. Sea level rise, increased precipitation and river flows can increase flood and coastal erosion risks. This can lead to asset damage, disruption to operations, and downtime during clean-up operations.

Asset design and operation maintenance procedures will need to take into account changing climatic conditions and potential disruptions.

Turbine performance is affected by increasing ambient air temperature with reductions in thermal efficiency and power output. There is a linear relationship between air temperature and turbine efficiency: a 10 degree Fahrenheit (5.56 degree Celsius) increase in ambient temperature would produce as much as a 3 to 4% reduction in power output.

Although the impacts might appear 'small' in percentage of lost efficiency, they could mean significant losses of supply. On a global scale, a net reduction in fossil-fuel based electricity generation of 1% due to increased ambient temperature would represent a drop in supply of electricity of 25 billion kWh.

The accounting rules for decommissioning assets under IFRS (IAS 37) require a company to recognise a liability as soon as the decommissioning obligation is created, which is normally at the time facility is constructed.

Decommissioning provisions represent a significant financial risk because the majority of cash flows occur at the end of a project's life. Companies will need to assess and report the impacts of changing climatic conditions on the decommissioning costs for their existing and planned assets.

Hydro power

Silting of hydropower dams may accelerate due to increased erosion and sediment load as a result of precipitation and temperature changes.

Climate change will alter river flow levels and velocities. Dams will face changes in flood extremes and return periods.

Increased sediment load may cause abrasion of turbine blades requiring increased maintenance, loss of generating efficiency and increased costs.

Biomass

Energy generation using biomass requires significant amounts of water.

Solar

Solar energy assets located in arid regions may sustain greater damage as a result of abrasion with increasing wind speeds and more intense storms.

Wave and tidal

More intense tropical and extra-tropical cyclonic events will need to be considered in the design and operation of wave and tidal energy assets. Storm surge heights are expected to increase.

Wind

Increasing wind speeds may require turbine design changes.

Nuclear

Sea level rise, increased precipitation and river flows can increase flood and coastal erosion risks. This is of particular concern as many nuclear power stations are

located near the coast for cooling water purposes. It can lead to asset damage, disruptions to supplies and downtime during clean-up operations.

Decommissioning nuclear assets will need to take into account climate change over many centuries. This will become a major issue for coastal assets affected by rising sea levels. Existing decommissioning schemes will need to be reviewed against the latest information on sea level rise.

Regulatory impacts due to climate change

Generic

Increasing competition between stakeholders for water will place pressure on governments to introduce regulatory controls and water pricing.

Early indications of action by governments are evident: In the UK, the Climate Change Act 2008 gives government the power to require electricity companies to assess and disclose the impacts climate change might have on their business.

All sectors of the electricity value chain can expect to see regulations used by Governments to provide greater consumer protection.

Biomass

Increasing competition between stakeholders over access to agricultural land may result in regulatory controls to protect food production.

Nuclear

Nuclear power stations require higher levels of water to operate compared to fossil fuelled electricity generation (between 20 to 83 % more than for other power stations). Water abstraction limits by nuclear power stations may become more regulated as resources are placed under stress by changes in flow and temperature. Increasing competition for water resources from other users in response to climate change will also place pressure on Governments to regulate abstractions and discharges.

Consumer and market impacts due to climate change

Generic

The market impact of hotter, drier summers is already reflected in energy demand trends. Across Europe, new demand profiles are being seen in summer and winter. Summer peak demand will be amplified in cities through the Urban Heat Island effect.

Customer expectations of secure energy provision will place increasing pressure on companies. Companies can be expected to be the subject of adverse media and customer comment.

Successive extreme events leading to outages (heat wave, flood, drought) may create a loss of consumer (and investor) confidence.

Electricity companies will face major challenges in providing new generation capacity and supply reliability within urban areas to meet the increased demands from domestic customers, essential urban utilities (for example water and sewerage), and the technological changes in transportation (for example the increased use of electric vehicles).

Biomass

There is a developing international trade in biomass fuels – which is generally expected to increase and stabilise over the next ten years. Some estimates indicate that a realistic potential for biomass energy generation could be between 35 and 1130 EJ/y worldwide, with a large proportion of this resource being found in the C.I.S and Baltic states, South and North America and the Far East.

Fossil

Restrictions in gas supply due to extreme event disruption are likely to increase wholesale and retail energy prices.

Transmission

Asset impacts due to climate change

Changes in the intensity and frequency of extreme events will create major issues for assets designed to cope with historic climate conditions. Changes in wind speed, icing, temperature and flooding, together with ground movement following subsidence and heave events and permafrost thaw will increase the risks of asset failure. In Melbourne, Australia during early 2009 explosions caused by extreme heat damaged two major 500 KV transmission lines causing blackout for 500,000 residents.

In many countries transmission assets are nearing the end of their design life. These assets may no longer be performing to their original design criteria and the original design standards may no longer be sufficient to meet the impacts of a changing climate.

The efficiency of transmission systems will be affected by increases in average temperatures and heatwaves. Changes in the frequency and intensity of extreme events will increase the risk of transmission failures. Changes in wind speed and ice formation increase the risk of transmission line failures.

Regulatory impacts due to climate change

Early indications of action by governments are evident: In the UK, the Climate Change Act 2008 gives government the power to require electricity companies to assess and disclose the impacts climate change might have on their business. In Australia the National Government is undertaking risks assessments for critical electricity infrastructure.

As a result of lawsuits filed regarding the efficiency of transmissions assets (e.g. March 2009 People of California v. U.S. Dept. of Energy) tighter regulations may be introduced.

All sectors of the electricity value chain can expect to see regulations used by Governments to provide greater consumer protection.

Consumer and market impacts due to climate change

The market impact of hotter, drier summers is already reflected in energy demand trends. Across Europe, new demand profiles are being seen in summer and winter. Summer peak demand will be amplified in cities through the Urban Heat Island effect.

A study commissioned by electricity companies in the UK identified system overload in the summer during the 2020s, taking account of climate change. Overloads and power cuts have already occurred in central London. The number of cooling degree days in London increased by an additional 30-34 days over the period 1961-2006. Further increases can be expected.

Electricity companies will face major challenges in providing new generation capacity and supply reliability within urban areas to meet the increased demands from domestic customers, essential urban utilities (for example water and sewerage), and the technological changes in transportation (for example the increased use of electric vehicles).

Customer expectations of secure energy provision will place increasing pressure on transmission companies. Companies can be expected to be the subject of adverse media and customer comment.

Successive extreme events leading to outages (heat wave, flood, drought) may create a loss of consumer (and investor) confidence.

The UK grid operator issued a supply shortfall warning in 2003 and 2006, when the south-east and parts of Central London were hit by blackouts due to the impact of higher temperatures and increased demand for energy for cooling.

Distribution

Asset impacts due to climate change

In many countries distribution assets are nearing the end of their design life. These assets may no longer be performing to their original design criteria and the original design standards may no longer be sufficient to meet the impacts of a changing climate.

The efficiency of distribution systems will be affected by increases in average temperatures and heatwaves. Changes in the frequency and intensity of extreme events will increase the risk of distribution failures.

The significant increases in demand with increasing urbanisation due in part to climate change (particularly in developing countries) will place major strains on assets, leading to overloads and outages.

Regulatory impacts due to climate change

Early indications of action by governments are evident: In the UK, the Climate Change Act 2008 gives government the power to require electricity companies to assess and disclose the impacts climate change might have on their business. In Australia the National Government is undertaking risks assessments for critical electricity infrastructure.

Regulation may become more focussed on ensuring that distribution systems are secure and climate resilient.

All sectors of the electricity value chain can expect to see regulations used by Governments to provide greater consumer protection.

Consumer and market impacts due to climate change

The combination of summer peakloads, plus losses in generation (due to increasing temperatures and cooling water restrictions) and losses in transmission and distribution (due to increasing temperatures), will add to the growing supply/demand gap. The market impact of hotter, drier summers is already reflected in energy demand trends. Across Europe, new demand profiles are being seen in summer and winter. Summer peak demand will be amplified in cities through the Urban Heat Island effect.

Electricity companies will face major challenges in providing new generation capacity and supply reliability within urban areas to meet the increased demands from domestic customers, essential urban utilities (for example water and sewerage), and the technological changes in transportation (for example the increased use of electric vehicles).

Customer expectations of secure energy provision will place increasing pressure on distribution companies. Companies can be expected to be the subject of adverse media and customer comment.

Successive extreme events leading to outages (e.g. heat wave, flood, and drought) may create a loss of consumer (and investor) confidence.

Customer services

Asset impacts due to climate change

SMART meters are seen as a valuable first step to creating a 'SMART grid', which would enable energy suppliers to be much more efficient in their use of power.

Regulatory impacts due to climate change

Regulation to promote energy efficiency measures and incentivise action by consumers and electricity companies.

All sectors of the electricity value chain can expect to see regulations used by Governments to provide greater consumer protection.

Consumer and market impacts due to climate change

Extreme weather events, for example extreme precipitation or flooding, may result in delayed or cancelled routine maintenance or other services. This could lead to reputational issues.

Electricity companies will face major challenges in providing new generation capacity and supply reliability within urban areas to meet the increased demands from domestic customers, essential urban utilities (for example water and sewerage), and the technological changes in transportation (for example the increased use of electric vehicles).

Increased demands to meet air-conditioning and cooling needs.

The market impact of hotter, drier summers is already reflected in energy demand trends. Across Europe, new demand profiles are being seen in summer and winter. Summer peak demand will be amplified in cities through the Urban Heat Island effect.

Customer expectations of secure energy provision will place increasing pressure on companies. Companies can be expected to be the subject of adverse media and customer comment.

Successive extreme events leading to outages (heat wave, flood, drought) may create a loss of consumer (and investor) confidence.

The UK grid operator issued a supply shortfall warning in 2003 and 2006, when the south-east and parts of Central London were hit by blackouts due to the impact of higher temperatures and increased demand for energy for cooling. Consumers will become more vociferous in their demand for security of supplies.

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Acclimatise specialises in climate change risk management. We have a portfolio of tools that enable businesses and governments to adapt to inevitable climate change. We bridge the gap between the scientific community and the corporate world, reviewing the latest science, providing clear guidance on the business and financial threats and the opportunities arising from inevitable changing climate. We provide strategic and project-specific climate change advice to the private and public sectors.

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