



Briefing report for Henderson Global
Investors, Insight Investment, Railpen
Investments and Universities
Superannuation Scheme

UK energy generation

Understanding the investment implications of adapting to climate change

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Report for

Henderson Global Investors,
Insight Investment,
Railpen Investments
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Acclimatise (2009). *'Understanding the investment implications of adapting to climate change – UK energy generation'*. Oxford.

Other reports in this series are:

- Acclimatise (2009). *'Understanding the investment implications of adapting to climate change - oil and gas'*. Oxford.
- Acclimatise (2009). *'Understanding the investment implications of adapting to climate change – UK water sector'*. Oxford
- Acclimatise (2009). *'Understanding the investment implications of adapting to climate change – UK commercial property'*. Oxford

Companion reports have been prepared::

- Henderson Global Investors, Insight Investment, Railpen Investments and the Universities Superannuation Scheme (2008) *'Managing the unavoidable: understanding the investment implications of adapting to climate change'*.
- Henderson Global Investors, Insight Investment, Railpen Investments and the Universities Superannuation Scheme (2009) *'Managing the unavoidable: investment implications of a changing climate'*

All of these reports are available for download from

www.acclimatise.uk.com/resources/investors

This briefing report was prepared by Acclimatise, the trading name of Climate Risk Management Limited, for Henderson Global Investors, Insight Investment, Railpen Investments and the Universities Superannuation Scheme.

It is intended to support the development of an informed dialogue between institutional investors, companies and policy-makers about the direct and indirect impacts of a changing climate on key business sectors. Comments are invited from all those interested in the investment implications arising from a changing climate.

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Understanding the investment implications of adapting to climate change

The UK energy generation sector

Introduction

In January 2008 Henderson Global Investors, Insight Investment, Railpen Investments, and the Universities Superannuation Scheme issued a report *'Managing the unavoidable: understanding the investment implications of adapting to climate change'*. The report highlighted a number of issues on behalf of the investment industry regarding the implications of inevitable climate change for business. These issues included:

- The lack of attention on the now unavoidable impacts of physical climate change that may have significant long-term implications for companies and their investors.
- Tools need to be developed to aid companies and investors in understanding the risks and opportunities associated with climate change.
- Investors need to engage with companies to ensure they have appropriate climate change adaptation systems in place.
- Investors also need to engage with policy makers to ensure the views of long-term investors are taken into account in policy formation in this area.

Henderson Global Investors, Insight Investment, Railpen Investments, and the Universities Superannuation Scheme commissioned Acclimatise to prepare four sector reports (oil & gas, energy generation, water and commercial property) each with a UK company focus to:

- Provide a high-level review for investors and analysts of the risks and opportunities for businesses created by inevitable climate change.
- Identify the specific investment drivers at risk.
- Provide guidance on the questions investors and analysts should ask of companies to encourage further disclosure.

This report explores these issues for the UK energy generation sector and in particular those companies whose core business is in conventional electricity generation from fossil fuels and nuclear power.

Governments, regulators, companies and investors have so far concentrated their climate change interests in this sector on mitigation policies and actions: emissions reductions, carbon trading, new and emerging technologies, and the development of non-fossil fuels. This report concentrates on the impact of unavoidable climate change and the adaptation issues facing those companies involved in energy generation. Transmission and distribution assets are outside the scope of this report.

An overview of these four reports and the research findings following subsequent discussions with companies is provided in a further report by Henderson Global Investors, Insight Investment, Railpen Investments, and the Universities Superannuation Scheme published in November 2009: *'Managing the unavoidable: investment implications of a changing climate'*¹

¹ Available from www.acclimatise.uk.com/resources/investors

The UK energy generation sector: the adaptation challenge

The UK energy generation sector is faced with significant challenges in meeting future energy demands in a low carbon world. In addition companies in this sector with large fixed assets and long asset life times, requiring significant capital investment with high operational costs, are vulnerable to the effects of climatic change.

Five key areas should be taken into consideration when looking at the impacts of a changing climate on a company operating in this sector:

- Business strategies of the company.
- Direct impacts of incremental climatic change and extreme events.
- Indirect and compound impacts of climate change on business models.
- Existing and future asset base and asset maturity.
- Wider external stakeholder positions.

Business strategies

A company's business strategies, its future objectives and plans are the starting point for any risk assessment of the impact of climate change. Although there is uncertainty in the knowledge we have about future climate change, there is sufficient information to enable robust decision making to take into account the possible impacts. Investors should challenge companies that are unable to demonstrate how they have integrated climate change into their strategic planning.

Our review of publicly available documents has failed to provide evidence that either buy-side or sell-side analysts have considered the potential impact of climate change on future asset values. The physical impacts of climate change are now being felt across the world. Within the life of many existing generating assets (and particularly those in the early stages of development) these impacts are predicted to become more severe, potentially leading to increasing operational costs and unplanned capital investment.

Direct impacts: extreme (acute) and incremental (chronic) change²

Disruptions to energy supplies driven by recent extreme events (for example, the 2003 European heat wave and the severe flooding in the UK during the summer of 2007) 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.

Diagram 1 illustrates the importance of identifying climatic sensitivities and critical thresholds. These provide the boundaries between tolerable and intolerable levels of risk.

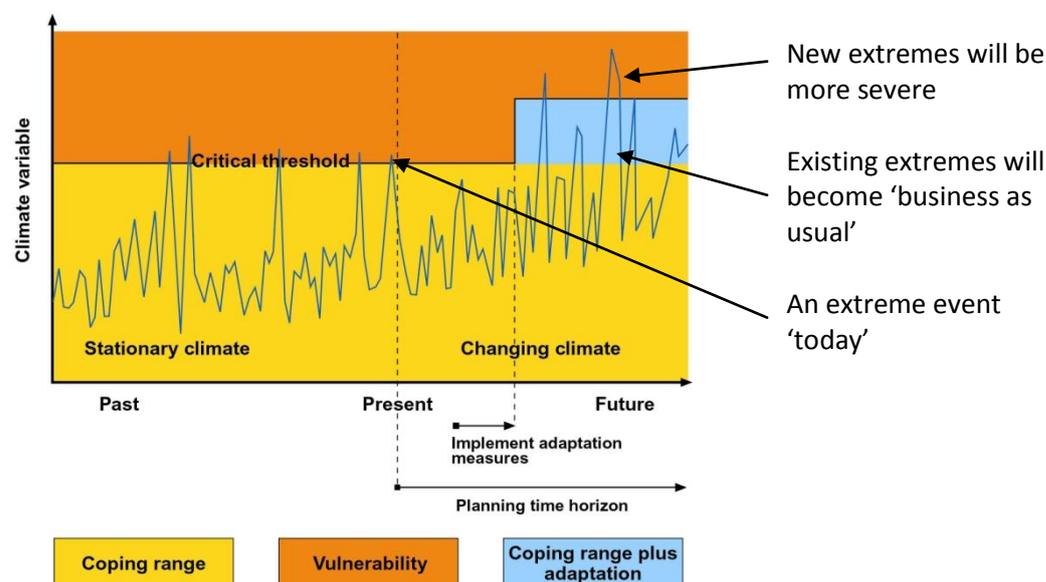
² The UK Climate Projections (UKCP09) provide the latest information on how emissions of greenhouse gases may change the UK's climate over 21st century. UKCP09 comprises a package of information including, publications, key findings, user support and customisable output. This is primarily available on-line. For access to the main technical information about UKCP09, and the full range of information and support, go to <http://ukclimateprojections.defra.gov.uk>.

Information and data on current and future climate conditions can then be assessed against the thresholds, to evaluate the likelihood of their being exceeded.

Setting the critical thresholds for asset design and operation is essential, but there is always an event greater than that for which protection has been provided. The effect of climate change (as shown by Diagram 1) 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.

It is important that the investors take into account the extent to which individual companies are climate-proofing their business models and their individual assets rather than dealing with extreme events through business continuity and crisis management planning.

Diagram 1: Impact of extreme (acute) events and incremental (chronic) change on critical thresholds³



The risk of increasing severity and frequency of extreme events due to climate change has grabbed the media headlines and been the focus of most interaction between companies and analysts. In contrast the 'creeping' average changes are much harder to recognise and are more likely to be overlooked.

Incremental (chronic) 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.

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.

³ Willows, R.I. and Connell, R.K. (Eds). (2003). *Climate adaptation: Risk, uncertainty and decision-making*. UKCIP Technical Report. UKCIP. Oxford.

Sea level rise



Incremental changes in sea level together with extreme events (e.g. storm surges) are increasing the risk of flooding for coastal generating assets (nuclear, fossil fuel and renewables). Recent research reported at the Copenhagen conference⁴ indicates that sea level rise will be greater than that identified in the IPCC Fourth Assessment Report.

Existing flood defences will be compromised and the standard of protection provided will be reduced over time. Remedial work will be required to defences if the design return periods are to be maintained.

Sea level impacts on nuclear power station sites need to be assessed over centuries to ensure that decommissioning liabilities are correctly assessed.

The risks extend beyond the boundary of the generating asset. The impacts on transportation, access routes, utilities, and communications are all relevant issues to be considered.

Assets and operational processes designed without any allowance for incremental change are likely to regularly fail to meet future design criteria, operational performance targets, KPIs and regulatory standards. Understanding incremental changes to 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.

Indirect and compound impacts on business models

In addition to the direct physical effects of climatic change that are predicted, it is important to recognise the indirect and compound impacts operating through a company's business systems. These will be felt by every business irrespective of size, sector, location, markets, products and services, and may affect the following business systems:

- Natural resources and raw materials.
- Supply chains, transport and logistics.
- Fixed asset design and construction.
- Asset operation, performance and maintenance.
- Products and services.
- Markets and customers.
- Workforces.
- Local communities and the environment

For example, the increasing stress on water resources in the UK (particularly in South-east England) due to changes in precipitation, temperature, ecology and water chemistry creates

⁴ 'Climate Change: Global Risks, Challenges and Decisions' International Scientific Congress. University of Copenhagen 10-12 March 2009

further problems for the operation and performance of generating assets, leading to potential implications for production, workforce health and safety, and conflict with local communities and other interests competing for the same water resources.

Analysis for investment purposes needs to consider not only the direct physical impacts and costs of climate change that are likely to arise (such as a major flood) but also these indirect costs. The relative thresholds and sensitivities for the various business systems within each company together with a company's risk attitude need to be assessed and understood.

Nuclear power facilities shutting down in the 2003 heat wave



During the European heat wave of 2003, 17 reactors in France had to reduce output or were shut down. In Germany, the Obrigheim nuclear power plant was shut down, and two other reactors were decreased to 80% capacity.

Shut-down and output reductions were enforced through environmental regulations to protect water resources and water quality.

During heat waves, which are becoming more frequent and intense due to climate change, generating plants may be forced to reduce output or even shut down. At the same time, energy demand during heat waves increases due to meet cooling needs.

This combination of generating plant outages and increased electricity demand can result in higher energy prices.

In France, during the 2003 heat wave, EDF used the open market to secure electricity from other countries to meet its generating shortfall. The cost of electricity rose substantially compared to \$128/MWh in normal summer months. EDF was not allowed to pass along the increases to consumers, which cost the company \$300 million.

The supply restrictions in France had a knock-on effect in the UK and elsewhere, creating significant price fluctuations.

Existing and future asset base

Every company has a unique asset profile based on asset technology, remaining asset life, generating capacity, cost profiles, margins, location, plant and equipment age and efficiency. Each of the assets has unique operating thresholds and sensitivities.

The consequence of changes in climate, the impacts on business systems, stakeholder positions and regulatory change is likely to be different for each company because of its unique asset profile. Each company's risk management options (and operating and investment costs) will be partly determined by the characteristics of its existing asset base.

In the UK the generating fleet is relatively old and nearing its end of life. These assets may be placed under increasing stress and no longer be performing to their original design criteria. The combined effect of asset age and a changing climate should be considered. Asset maintenance and monitoring regimes should be reviewed against the climate change

information provided in this report. The impacts of a changing climate may require changes in maintenance and monitoring procedures (for example, generating companies traditionally use the summer months to carry out routine maintenance, however an increasing need for energy to help cool buildings will require an increase in generating capacity).

Stakeholder positions

When assessing a company for investment purposes, it is important to understand the positions taken by external stakeholders in addition to considering the risks and opportunities arising from climate change. Key stakeholders to consider are:

- Governments
- Regulatory agencies
- NGOs
- Consumer groups
- Suppliers
- Retail and commercial customers
- Investment banks
- Credit rating agencies
- Insurers
- Other institutional investors
- Business organisations
- Customers (commercial and domestic)

The policies and adaptation actions adopted by these stakeholders based on their own climate change risk assessments and perceptions can have significant implications for individual companies. Conflicting and converging objectives set by stakeholders may add to confusion and uncertainty. Policy initiatives (in particular changes to regulatory provisions and codes of practice) are likely to have implications for a company's plans for adaptation to climate change.

One example of government policy initiatives having future direct implications on energy generation sector is the introduction of the Climate Change Act 2008. A statutory power is now available to the Government to direct public sector organisations and statutory undertakers, such as utility companies, to produce a report on how their organisation is assessing and acting on the risks and opportunities of a changing climate. The Government can also ask for a group of organisations to report together on climate change adaptation considerations related to a specific location or a particular sector. It will be interesting to compare risk disclosures by energy companies under the Act with their disclosures in financial reports and business reviews.

It is also important that investors question and challenge the analyses and underlying assumptions made by stakeholders. For example, in October 2009 Ofgem produced a series of scenarios for consultation setting out its view of the critical decisions facing the sector⁵. The four scenarios were developed to assess the energy security risks over the next 10-15 years and reveal a range of potential risks to supplies. However, the scenarios and the consultation paper's conclusions do not take into account the impacts of climate change on:

- Future fuel supplies.
- UK generating fleet asset performance under changing climatic conditions.
- UK transmission and distribution asset performance under changing climatic conditions.
- Impact of extreme events driven by climate change, for example heatwaves.
- Extreme event disruption to critical assets and other infrastructure.
- Changes in peak and seasonal demands, particularly during summer months.

⁵ Ofgem (2009). *Project Discovery Energy Market Scenarios. Consultation Document 122/09*. London

Ofgem’s position is surprising given that in its response to the Climate Change Act 2008 Adaptation Reporting powers it recognised “that the energy sector is particularly susceptible to climate change”.

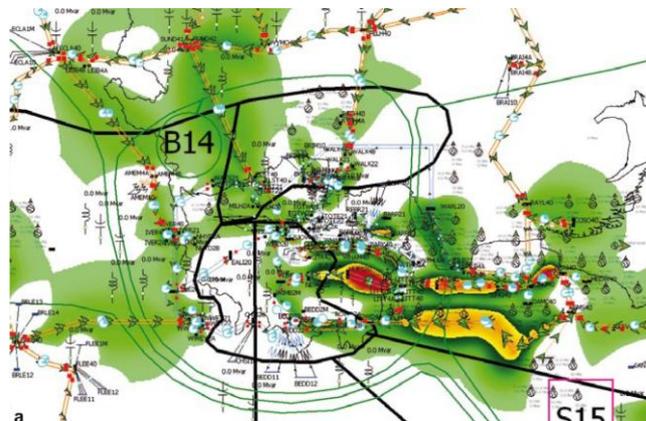
Impacts and consequences

Investors are concerned with securing a sustainable return on investment over a given timescale. They wish to understand the consequences of climate change impacts on the value of individual businesses. Decisions to invest or withdraw investment in a company will be based on each investor’s value drivers.

In discussions with Henderson Global Investors, Insight Investment, Railpen Investments and the Universities Superannuation Scheme the following value drivers of greatest significance to investors relative to the energy sector were identified:

- Efficiency of assets.
- Availability of assets.

Increase in demand during summer months



The map⁶ shows areas of the electricity grid in London overloaded between 12.00 and 15.00 in the summer during the 2020s, taking account of climate change. Red areas are most badly overloaded, with green indicating marginal overloading. Electricity demands are increasing in the summer.

In cities increasing temperatures exacerbated by the urban heat island effect are creating a need for air conditioning and mechanical cooling. Overloads and power cuts have already occurred in central London.

The number of cooling degree days⁷ in London increased by an additional 30-34 days over the period 1961-2006⁸. Further increases can be expected.

During high temperatures supply challenges may also arise. Turbine efficiency decreases in response to changes in ambient air temperature, humidity and atmospheric pressure. Losses also occur in transmission and distribution systems with increased temperatures.

It is standard practice to close down some generating stations during summer months for routine maintenance. This can create additional supply problems to meet changes in demands during higher temperatures.

Additional generating capacity and changes in maintenance programmes are likely to be required to meet the additional demands.

⁶ Watson, S, J (2006) “Report on EPSRC Project GR/18915/01: A Generic Process for Assessing Climate Change Impacts on the Electricity Supply Industry and Utilities (GENESIS)”

⁷ Cooling degree day (CDD) is a quantitative index designed to reflect the demand for energy needed to cool a home or business

⁸ Jenkins, G.J., Perry, M.C., and Prior, M.J.O (2007). The climate of the United Kingdom and recent trends. Met Office Hadley Centre, Exeter, UK.

Most reports on climate change impacts focus on direct climate hazards and environmental effects due to extreme events. They concentrate on analysing a one-to-one mapping of hazard to impact, for example, flood risk for property. This oversimplifies the complex cause and effect relationships that exist as the climate hazards and environmental effects manifest themselves within a company's business systems. It also ignores the effect of incremental climate change and under-estimates the potential costs of the impacts and the adaptation responses by the company and by its stakeholders.

Diagram 2: Relationships between climate hazards, environmental effects, business systems and investment value drivers

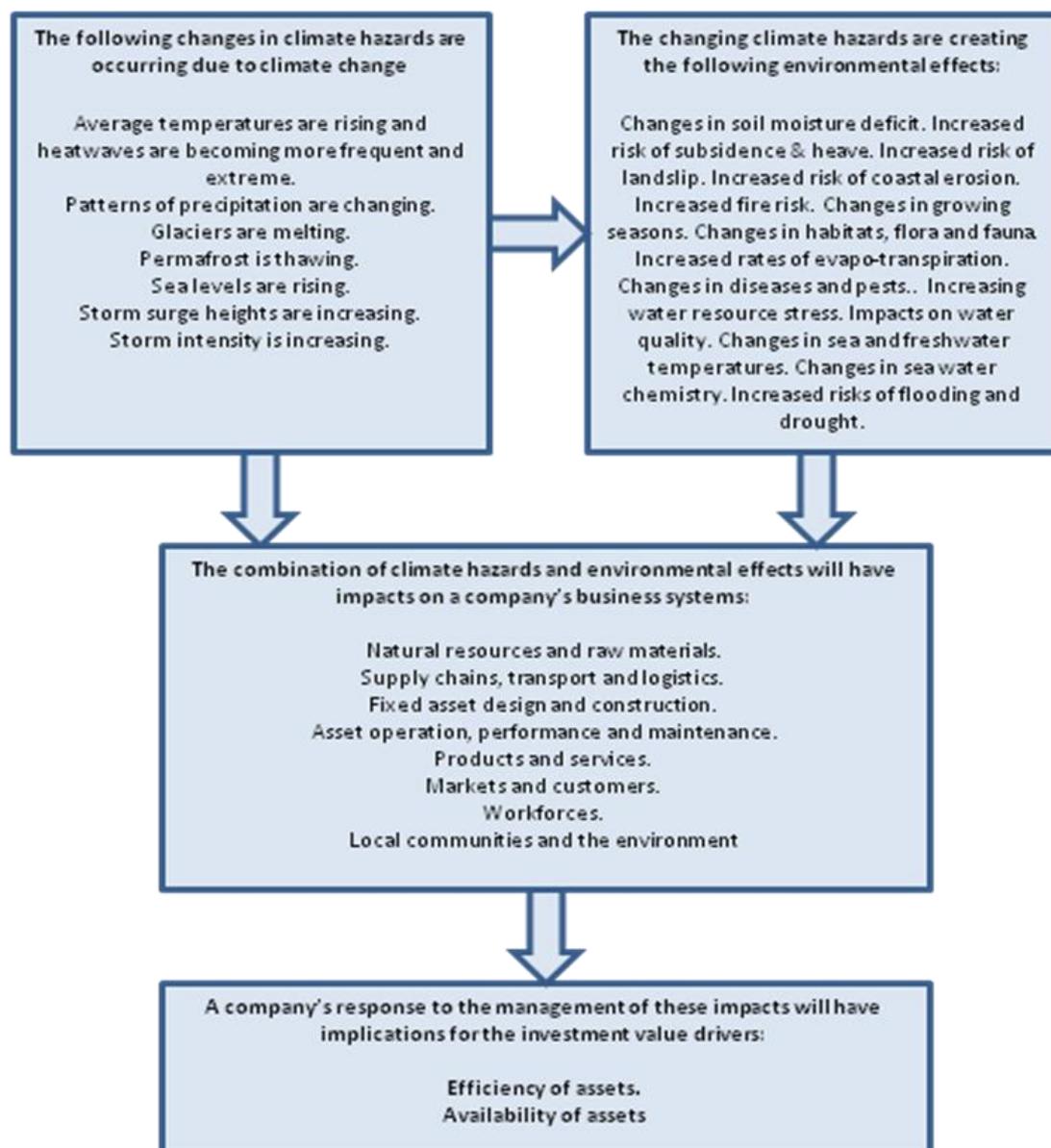


Diagram 2 sets out the relationships between climate hazards, environmental effects, business systems and investment value drivers. Changes in climate hazards in other regions may have an impact on UK energy generation e.g. permafrost thaw (gas supply disruptions caused by the structural stability of pipelines), or increasing intensity of tropical storms (disruptions to gas supplies causing additional problems for the UK with its limited gas storage facilities forcing companies to purchase gas on the open market at higher prices).

Table 1 provides a high-level qualitative review of significant impacts and consequences of climate change, the key business systems affected in the energy sector and appropriate risk management options. It provides an illustration of the range of direct and indirect impacts that can be expected, rather than a comprehensive review of all potential impacts. The impacts and the risk management options are given as examples. The likelihood and consequences of any impact, and the most appropriate options, can only be determined by a detailed risk assessment unique to each company.

Table 1: Investment value drivers: asset efficiency and availability

Business model system	Potential impacts and consequences	Risk management options
Supply chains, transport and logistics	<ul style="list-style-type: none"> The supply chains for major companies may involve a number of suppliers across the world. Just-in-time manufacture, supply and distribution are already vulnerable to climate-related disruptions. Manufacture, storage and distribution of equipment and supplies are likely to become more vulnerable. Assets and transportation routes (together with associated essential utilities provided by third parties) located in coastal areas and on river floodplains are predicted to be at a greater risk. The fossil fuel sector is heavily reliant on marine transport and port facilities. The following list provides an indication of the climate issues likely to be significant in relation to ports and shipping facilities: <ul style="list-style-type: none"> Changes in sea levels, Storm tracks and storm surges, Ambient temperatures (which affect carrying capacity) and extremes of high temperature, Sea water temperatures, acidity and salinity, Impacts on port and harbour assets Unless steps are taken to adapt new and existing port developments, operators face increased risk of supply disruptions, flooding and storm damage to assets and infrastructure, damage to electrical equipment, service disruption, and increased operating costs. Dredging operations may be affected by changes in sedimentation patterns and currents, while equipment operating thresholds may be exceeded during extremes of high temperature or winds. 	<ul style="list-style-type: none"> Diversify supplier base. Provide additional storage capacity for products and raw materials in case of disruption to supply. Insurance policies covering flood damage, business continuity and disruption.
Asset design	<ul style="list-style-type: none"> Flood management and drainage systems may be compromised by sea level rise, storm surges, coastal erosion, changes in precipitation, and greater intensity and frequency of flooding events. This may lead to asset damage, disruptions to off-site utilities (energy, communications, water and waste treatment), disrupted transportation links, more downtime. Proposed sites for new nuclear power stations may not have taken into account more recent information on sea level rise. De-commissioned nuclear sites and nuclear waste management sites will have to take into account climate change over many centuries. A precautionary approach might suggest that the sites should be designed to cope with the worst case high-level emissions scenarios and the consequential changes in climate. NGO groups may be active on this issue. 	<ul style="list-style-type: none"> Recent heat waves highlight the need to consider climate risks in the planning of any new power stations. Careful siting of new facilities taking account of climate change. Third party utility operators and transportation authorities to demonstrate the resilience of their facilities to increased flood risk. Providing own utilities to remove dependence on third parties. Install additional cooling plant. Consider relative merits of air-cooled and water cooled systems. Regulators must acknowledge the impact of climate change on capital investment and operational business plans.

	<ul style="list-style-type: none"> • Assets and transportation routes (together with associated essential utilities provided by third parties) located in coastal areas and on river floodplains are likely to be at a greater risk. Designing a climate resilient generating asset must include climate resilient supply and transportation links. • New assets will have to take into account the increase in demand patterns driven by the impact of climate change on customers. • The impact of rising ambient air temperatures and changes in humidity will have implications for the design of turbines. 	
<p>Asset operation and performance</p>	<ul style="list-style-type: none"> • Increased capex and opex may be required. • ‘Demand surge’ effect following extreme events is likely to increase costs of remedial actions to repair damaged assets. • Maintaining asset performance is likely to require changes to maintenance programmes and greater operating costs. • Turbine performance is affected by increasing ambient air temperature with reductions in thermal efficiency and power output. • The efficiency of cooling systems may be adversely affected in periods of extremely high temperatures. • Existing flood management and drainage systems may be compromised. • Rising temperatures will affect the efficiency and performance of plant and equipment such as compressors, pumps, generators, reducing generating output. • Consequences include increasing energy consumption, increasing emissions, additional maintenance requirements, reduction in asset performance and asset life, higher depreciation costs, earlier asset write off. • Hot, dry summers with reduced river flows leading to restrictions on water abstractions, with consequences for cooling processes when the need for cooling is greatest. This will reduce operational efficiency, increase interruptions to generating output and create potential brand and reputation and regulatory issues if electricity supplies cannot be maintained. • Many of the UK’s coal-fired and gas-fired power stations are river-water cooled. In a future hot dry summer, if the volume of water in a river that supplies cooling water was markedly reduced, it is possible that a power station would have to reduce output to maintain Integrated Pollution Control Licence limits. • As understanding and knowledge of climate change improves, the greater our ability to foresee the impacts will become. Failing to take into account available information and act accordingly may be seen as a failure in the company’s internal risk management and its corporate governance. This may have serious repercussions on company reputation and may create a litigation exposure. 	<ul style="list-style-type: none"> • Review asset maintenance programmes. • Increased generating capacity may be required to compensate for the transmission losses. • Explore technical modification to power generation plant to improve efficiency during warmer average temperatures and higher extremes of hot weather. • Flood and coastal erosion management strategies for existing facilities. • Flood defence measures including: upgrading hard flood defences, creating 'set-back' flood defences, purchasing removable temporary flood barriers and managed retreat (allowing areas to flood) in coastal areas. • Improving drainage systems to increase capacity to cope with greater rainfall intensity and installing Sustainable Drainage Systems (SuDS) which allow water to soak into ground, reducing rapid runoff. • Raising floor levels and using flood-resilient materials. • Business continuity programmes. • Reduced heating for LNG at re-gasification stage may reduce costs. • The impact of climate change on asset life, operational performance, maintenance and capital investment expenditure should be assessed • Current and future climate risks should be incorporated into standard risk management procedures and into the regulatory price determination process • Ensure that sufficient natural resources (especially water) are available over the lifetime of new power generation or distribution investments, taking account of: <ul style="list-style-type: none"> ○ Likely increases in demand for resources from local communities and natural environments. ○ Regulatory risks that may arise during low river flow conditions • All companies should include inevitable climate change on corporate risk registers and assess the implications across business models. • Companies should disclose the assessment results to existing and potential investors and to wider stakeholder groups.

<p>Markets and customers</p>	<ul style="list-style-type: none"> • The market impact of hotter, drier summers is already reflected in energy demand trends. Across Europe, demand peaks are increasingly aligned with summer, rather than winter, temperatures. Summer peak demand will be amplified in cities through the Urban Heat Island effect. • Rising temperatures will increase energy demand for cooling and refrigeration. • Restrictions in gas supply due to extreme event disruption are likely to increase wholesale and retail energy prices. • Fluctuations in global gas prices and the limited UK gas storage facilities create potential generating problems when energy demands increase as a consequence of extreme events (heat wave, cold). • Wholesale and retail energy price volatility to extreme events and seasonal changes. • Energy generating companies can be expected to be the subject of adverse media and customer comment. Customer expectations of secure energy provision will place increasing pressure on companies. • Successive extreme events (heat wave, flood, drought) creating potential energy demand and supply issues and loss of customer confidence. • Failure to identify and take appropriate action to manage and minimise impacts of extreme events on assets and production capacity are likely to become increasingly difficult to explain. 	<ul style="list-style-type: none"> • The industry regulator’s economic models need to reflect that climate change will have an impact on energy demands and supply capacity. • Maintaining generating output during hot summers is likely to require changes in maintenance programmes and the provision of additional generating capacity. • Additional UK based gas storage capability.
<p>Workforce</p>	<ul style="list-style-type: none"> • The impact of climate change on operational processes (increasing temperatures for example) may have additional health and safety implications. • Assets and operational processes designed according to past climate data will be used under different climatic conditions and safety margins may be compromised. • Reputational and litigation implications are significant. • Employer and public liability insurance cover may be compromised if companies fail to take climate change into account during health and safety risk assessments. 	<ul style="list-style-type: none"> • Health and safety policies and risk assessments should ensure that the implications arising from changing climatic conditions on assets and operational processes are assessed. New assets and processes should include revised safety thresholds.

Risk disclosure by major companies

A review of five companies in the energy generation sector (E.ON, British Energy, Centrica, Drax Group plc and Scottish and Southern Energy) was undertaken to identify:

- Current good practice on the assessment, management and disclosure of risks and opportunities driven by climate change.
- Evidence of climatic change affecting the financial value drivers.
- Evidence of action by individual companies to assess emerging climatic risks.
- Evidence of action on specific adaptation measures.
- Evidence of disclosure and reporting to the investment community.

The information was obtained using the company public reports (e.g. annual reports, CSR reports, environmental reports, operating and financial reviews) together with responses to the Carbon Disclosure Project.

Examples of climate change signals and company responses taken from these reports are provided below:

- **British Energy**
 - British Energy recognises that all of its nuclear power stations are situated close to the coast and are therefore at risk from the physical risks of climate change.
 - The company has identified that a growing awareness of climate change and its impacts will lead to changes in customer expectations.
 - In 2006 a study into the possible effects of climate change at their nuclear sites under IPCC worst case scenarios was carried out by the UK Met Office.
 - British Energy has undertaken a safety assessment for each of its power stations against extreme weather events and has taken steps to provide additional protection where necessary. For example, British Energy routinely monitors flood risk and undertakes remedial works to sea defences when necessary.
- **Centrica**
 - Centrica recognises that the effects of climate change will have a number of operational and commercial challenges and that these present both risks and opportunities for their business.
 - The Chief Executive Officer of Centrica has Board level responsibility for environmental matters. The company's Corporate Environmental Committee has responsibility for Centrica's response to climate change.
 - In 2006 Centrica established a climate change advisory committee to guide the company in establishing its position on climate change both in terms of adaptive and mitigation strategies and programmes.
 - Centrica states that it has undertaken work in order to develop a coordinated and effective response to climate change. This work underpins its climate change strategy and determines how Centrica can adapt to and mitigate against the effects of climate change on the Company and on society as a whole.
- **Drax Group**
 - The Drax Group refers to rising to the carbon challenge and addressing the threat of climate change as an objective at the heart of its strategy.
 - The Board of the Drax Group Board has overall responsibility for climate change. It is not clear whether adaptation is included within this responsibility.

- E.ON
 - E.ON recognises that its operations could be negatively affected by changes in precipitation and by a summer with higher than average temperatures leading to reduced hydro-electric generation. The company also recognises that climatic changes will have implications for cooling water discharges.
 - E.ON expects seasonal and weather-related fluctuations in revenues to continue and will take steps to improve its optimization of power station outputs.

- Scottish and Southern Energy
 - Scottish and Southern Energy refers to the implications of climate change as “being here and now.”
 - The CEO has lead responsibility for environmental issues. It is not clear if this includes climate change.
 - In 2006 the company referred to the work it was undertaking to analyse the potential impacts of climate change and the adaptation responses that would be required across the business.

The UK energy industry has been undertaking collaborative research. The National Grid, EDF Energy and E.ON UK commissioned the Met Office to undertake a scoping study⁹ to qualitatively assess the scale of climate change impacts in the UK. The report, published in 2006, identified a number of potential impact areas (which are included in table 1) based on desk-top reviews of available literature and interviews with industry personnel. The report concluded that the industry should continue a collaborative research programme and explore:

- The development of new methods to project impacts dependent on succession and combinations of weather parameters.
- Application of the new methods to probabilistic climate projections for risk management, and extreme event information to be released through the UKCP09 climate change scenarios.
- Further understanding the socio-economic context and future adaptive capacity of the UK.
- Evaluation of the costs (and savings) of the impacts of climate change, and the costs and net benefits of adaptation.

A second research project has been completed (‘Impact of climate change on the UK energy industry – exploring risks, reducing exposure, increasing resilience’) funded by a consortium including E.ON, Centrica and Scottish and Southern Energy. The results from this second study have not been published.

Conclusions

Although companies are highlighting potential risk areas primarily linked to extreme event hazards, there is limited information provided on incremental climate change and indirect impacts working through their business models. The disclosures are qualitative in nature with no disclosure of information on the specific OPEX and CAPEX financial implications or on the longer term implications for returns, asset values and their asset base.

⁹ Met Office (2006) Climate change and energy management

This may be due to a number of factors, including:

- Internal company operating and performance metrics are not designed to capture information relative to changing climatic conditions. Impacts and costs may be assigned to other risk factors.
- Impacts and costs are not recorded or tagged with a climate change label. The early warning signals of climatic change are not picked up by company risk 'radar screens'.
- Less awareness of the impacts on business models and assets arising from indirect impacts and incremental climatic change effects.

Questions for investors

A series of questions has been developed to assist investors to promote discussion and create a basis for further engagement with companies. These are based on:

- Key risks and adaptation issues identified in Table 1.
- Analysis of company public reports together with the responses to the Carbon Disclosure Project.
- The report authors' own insight based on their understanding of the potential risks and impacts inevitable climate change will create.

The questions cover the two key investment value drivers together with a set of questions aimed at understanding issues under the broad heading of 'Governance'. Supplementary follow-up questions are suggested.

These questions should be considered as providing a framework for discussion and engagement. It is not intended that each and every question should be asked, or that there is an implied 'correct' answer. The questions can be modified to suit an investor's particular interest and concerns, and be made specific to a particular company. It should also be noted that the unique asset and financial risk profiles for each company operating in this sector will create different responses. Comparisons between companies may be difficult.

Governance

Are you taking any steps to assess the vulnerability of existing and future assets to changing climatic risks?

- Are there any specific knowledge gaps where further information is required?
- Have you commissioned any external research?

What steps will you be taking any steps in the next 12 months to review both your strategies and your major projects to assess the risks and opportunities posed by climatic change?

Are there any climate adaptation strategies in place within your company? How are these integrated within existing risk management strategies?

- How have you embedded steps to adapt to climate change across your business?
- Is there a process for ensuring climate risks are built into your investment decision making process?

Have you taken any steps to develop internal capacity, awareness and understanding regarding the business impacts arising from inevitable climatic change?

- Have you appointed a Director to take specific responsibility for assessing the impacts of inevitable climate change on the company?
- What are the results of engagement with external stakeholders?

Are you engaged in any discussions with your regulators, suppliers and customers on the impacts of inevitable climate change?

- Are you sharing information and understanding on the business impacts of climate change with your regulators, suppliers and customers?
- What steps have you taken with your suppliers to ensure they are aware of and responsive to the need to adapt to climate change?

Are there any implications for industry economic models arising from changes in seasonal demand?

- Are the long term economic analyses for the industry affected by climate change impacts on wholesale and retail prices and OPEX and CAPEX?

Investment value drivers: asset efficiency and availability

What impacts will changing climatic conditions have on your generating capacity?

- What steps are you taking to monitor current performance relative to changes in climate?
- Have you identified impacts on energy generation in recent summers due to increased in demand?

Rising temperatures will affect the efficiency and performance of plant and equipment such as compressors, pumps, generators, reducing generating output. Are there any implications for: energy consumption, emissions and maintenance requirements?

Have you assessed the operational costs and investment requirements arising from inevitable climate change?

- Do you foresee any impacts on future cash flows?

How will changes in water quality and water resource availability due to climate change affect your operational processes?

- What are the consequences for operational expenditure?
- Are there any specific risks regarding cooling water abstractions and discharges and regulatory consent compliance during warm summers?

How are changes in extreme weather conditions, increasing variability and incremental climatic changes considered in project analysis?

- How are you factoring climate change into your asset design and operational performance forecasts?

If you are not undertaking specific adaptation measures during current project design stages, what steps are you taking to adapt your assets at a later date?

With the increasing energy demands in summer due to higher temperatures, do you foresee any implications for traditional maintenance programmes for major generating plant?

- What are the impacts on required generating capacity as a consequence of rising energy demands in summer?

Will fluctuations in global gas prices and the limited UK gas storage facilities create potential generating problems when energy demands increase as a consequence of extreme events (heat wave, prolonged cold periods)?

What steps are you taking to ensure that proposed sites for new nuclear power stations (and other coastal generating sites) have taken into account more recent information on sea level rise?

- Have you assessed the implications for access routes to sites and the provision of essential utility services?

What are the financial and operational implications arising from taking into account possible climate change over many centuries (e.g. sea level rise) into the de-commissioning of nuclear sites and nuclear waste management sites?

What are the impacts on asset life and depreciation after factoring in climate change?

- What are the implications for asset write-off and future profits?

Have you assessed how climate change will affect your future decommissioning provisions for both existing and planned assets?

- Has a precautionary approach been adopted with regard to the use of the highest emissions scenarios in assessing sea level rise implications for decommissioned nuclear power station and nuclear waste management sites?
- What are the implications for future debt burden?

What actions are you taking to ensure the company is fully compliant with the accounting provisions of IFRS (IAS 37) with regard to future decommissioning liabilities?

Revenue and cost impacts

What are the implications for future cash flows arising from changes in wholesale gas prices and in seasonal energy demands driven by climatic change?

Are there any steps that you can take to exploit the opportunities from changing markets and changes in seasonal energy demands?

Are your company's revenue forecasts at risk as a consequence of an increase in extreme events?

Will there be any impacts on your future revenue projections due to seasonal changes in energy demands (e.g. increase in summer and decrease in winter)?

Legal and consenting impacts

Are you taking any actions to assess the implications of future changes in regulations, legislation and codes of practices on your operations in response to inevitable climate change?

- What steps are you taking to monitor such changes and to engage with regulatory agencies in policy development?
- How will the provisions of the Climate Change Act 2008 affect your company?
- How will these changes affect operational costs and revenue?

Are there any emerging regulatory compliance or litigation exposures?

- What actions are you taking to manage your exposure?

What steps is your company taking to ensure it complies with the Companies Act 2006 with regard to disclosure of risks due to inevitable climate change?

What actions do you believe the industry should take to manage customer and media concerns if generating output is affected by drought conditions and summer energy demand spikes?

- Have you taken any specific actions as a consequence of the European heat wave of 2003?

Are you engaged in any discussions with regulatory agencies on the impacts of climate change for regulatory compliance?

- Do you foresee any issues with regard to compliance with water abstraction licences and discharge consents?

Are there reputational issues for the industry in dealing with fluctuations in global gas prices and volatile wholesale and retail energy prices?

Acclimatise

Acclimatise specialises in climate change risk management operating at both strategic and project levels. 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 corporate and financial risks and the opportunities arising from climatic change.



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