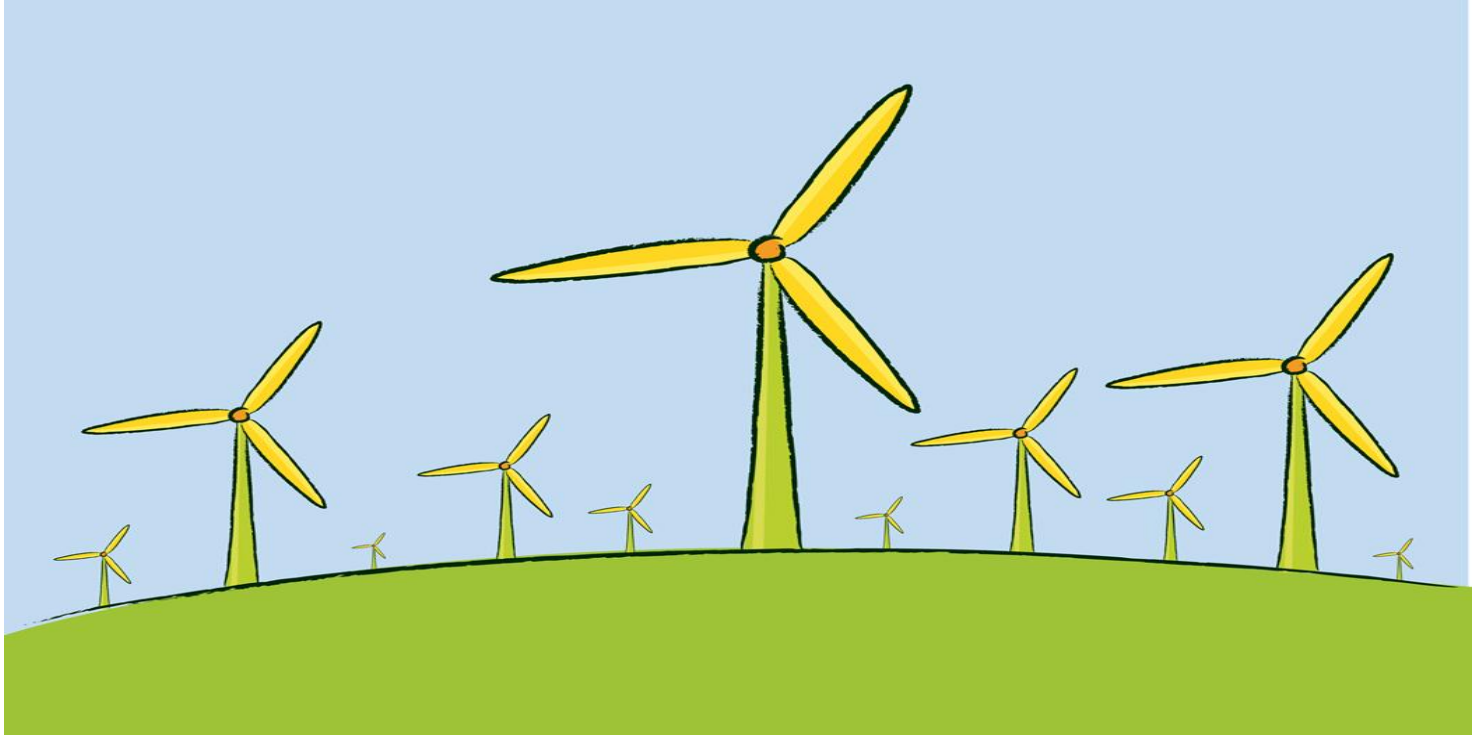
Improving resilience challenges and linkages of the energy industry in changing climate



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- Scene setting and background to Energy structure in UK
- Adaptation Challenges and Climate Change journey
- Key results from the Adaptation Research
- Next Steps/Conclusions

Acknowledgements

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Background to Improving resilience challenges and linkages of the energy industry in changing climate

- Over the next 50 years changes to temperatures, rainfall patterns, sea levels and more extreme weather are expected globally.

- The UK energy industry must prepare its infrastructure for the challenges ahead.
- The Government is investing £200 billion over the next five to ten years to build a low carbon society.
- The challenge lies in using this funding to build a climate resilient infrastructure through national strategic planning.
- This will ensure best value for adaptation and long-term sustainability that supports the transition.
- The UK Energy companies have taken a sector lead, combining existing and new infrastructure assets with long operational lifetimes to increase the sector's resilience to climate change.

Cont (2)

- Energy industry infrastructure is highly interconnected with transport, water, and information and communication technologies (ICT).
- These interdependencies could lead to much greater impacts due to a potential cascade of failures.
- An urgent need to ensure that the interdependencies are fully understood and considered as part of a business risk process, and that planning strategy is at the top of the companies' risk register.
- The UK energy sector is already at an advanced stage in dealing with some of the issues by working in partnership with UK climate scientists.
- Any future resilience planning must be considered in tandem with UK Government policy addressing both mitigation and adaptation to climate change.

UK Climate Change Act

- This Act provides a legal framework for ensuring that the Government both mitigates and adapts to climate change.

- The Act requires that emissions are reduced by at least 80% by 2050, compared to 1990 levels and by at least 34% by 2020.

- The Act also introduces legally binding carbon budgets, which sets a ceiling on the levels of greenhouse gases that can be emitted into the atmosphere to deliver the emissions reductions required to achieve the 2020 and 2050 targets.

The Electricity Industry in the UK

Generators responsible for generating the energy which flows into the National Transmission and regional Distribution networks.

Distributors owners and operators of the network of towers and cables that bring electricity from the National Transmission Network to pass the energy commodity to your property - the suppliers.

Suppliers companies who supply and sell electricity to the consumer. The suppliers are the first point of contact when arranging an electricity supply to domestic, commercial and smaller industrial premises.

How the Energy Industry Operates

Electricity Generation

Electricity Transmission

Electricity Distribution

Electricity Supply

Electricity is generated and gas

High voltage power lines and high pressure gas pipes for bulk long distance trai

Lower voltage wires and lower pressure gas pipes for local distribution to end use

Gas Importation Terminal

Gas Transmission

Gas Distribution

Gas Supply

UK energy landscape is changing

- UK undergoing a period of significant network renewal and expansion in gas and electricity.
- Improvements in metering technologies, renewable and storage.

Climate Change Initiative aims to make Energy Industry **a sustainable, long-term, low-carbon business** whilst maintaining:

- Sustainability - balancing environment, social and economic
- Affordability - minimise cost increases
- Security of supply - providing secure reliable supplies

The Changing Plant Mix

- **25% Plant closures**
  - Coal/oil/nuclear/gas
- **Significant new renewable**
  - >30 GW wind
  - Some tidal, wave, biomass and solar PV
- **Significant new non renewable build**
  - New nuclear/gas/new supercritical coal (some with CCS)
- **Renewable generation share grows from 5% to 35%**

The next 40 years in brief…

2050

- Consumer energy behaviour unrecognisable from today.
- Completing 80% reduction in Co2.

2040

- Carbon capture and storage./Fracking??
- Technology ‘disruptions’ may emerge.

2030

- Distribution network capacity begins massive increase.
- Demand increase driven by electric cars and heat pumps.

2020

- Generation mix ‘overall.’
- Transmission is the focus – investment and operation.

Challenges & Climate Change risk in the Energy Sector

Climate Change risk in Energy Sector (1)

- **Increased temperature/heat waves –** impact on equipment ratings (e.g. switchgear and transformers) at substations, tunnels, underground cable routes, cable bridges, overhead power lines and towers; transformers affected by the urban heat island; increased air conditioning demand.

- **Summer drought -** overhead line structures and underground cable systems affected by summer drought and consequent ground movement.

- **Increased flooding and heavy rainfall/extreme events -** pluvial and fluvial flooding running the risk that due to extreme flooding a site may be lost or unable to function.

- **Sea level rise/tidal surges -** flooding and inundation leading to the risk of sites being unable to function or lost as a result of extreme flooding

- **Increased coastal erosion –** risk to infrastructure, including substations, and underground cable routes.

- **Increased river erosion –** towers, cable bridges and cable routes are at risk of failure if foundations are exposed or weakened, or soil stability is reduced.

Climate Change risk in Energy Sector (2)

- **Vegetation changes -** overhead lines are affected by interference from vegetation, with the risk potentially increasing as a result of a prolonged growing season and changes in the growth of vegetation species sensitive to climate change.

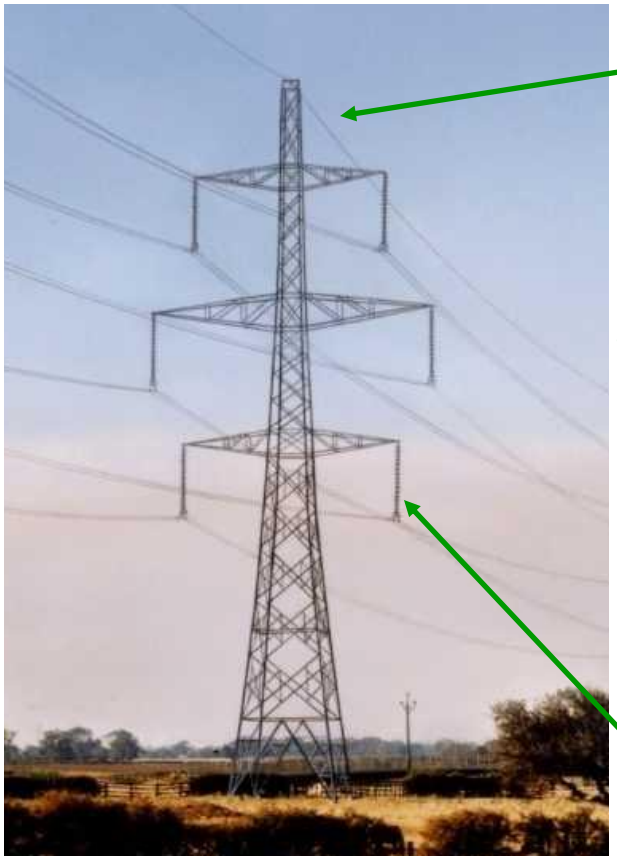
- **Lightning -** overhead lines and transformers are affected by increasing lightning activity.

- **Wind storms -** can result in widespread damage caused by trees and windblown debris

- **Ice storms –** ice accretion potentially causing sag/damage to overhead lines and can cause longer disruption than wind storms.

- **Combined events -** transformers affected by urban heat island and coincident air conditioning demand leading to overloading in summer months

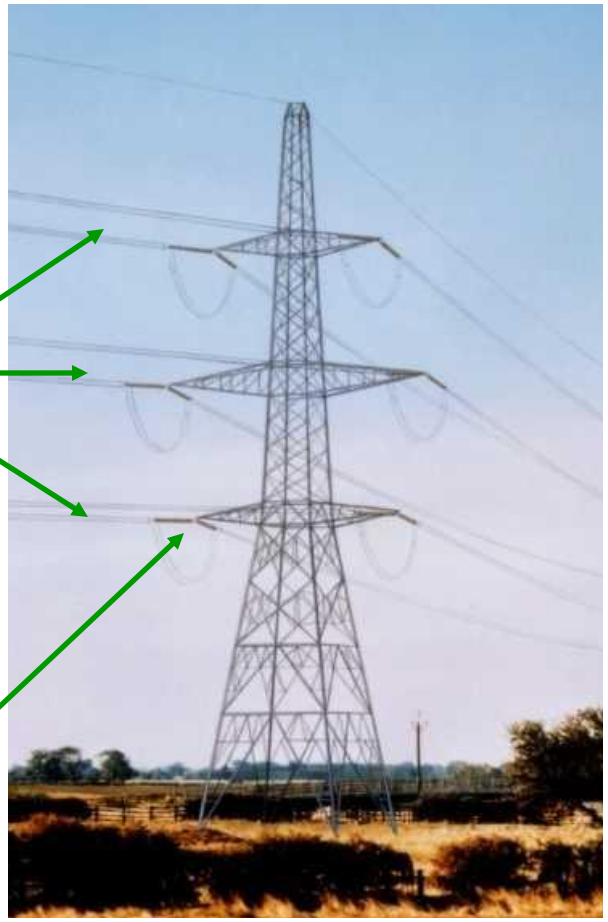
Assets Exposed to Weather conditions: Overhead Lines

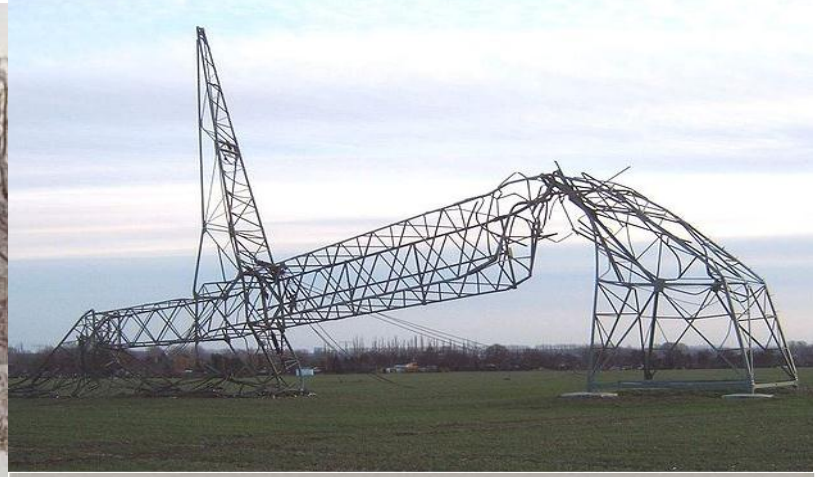


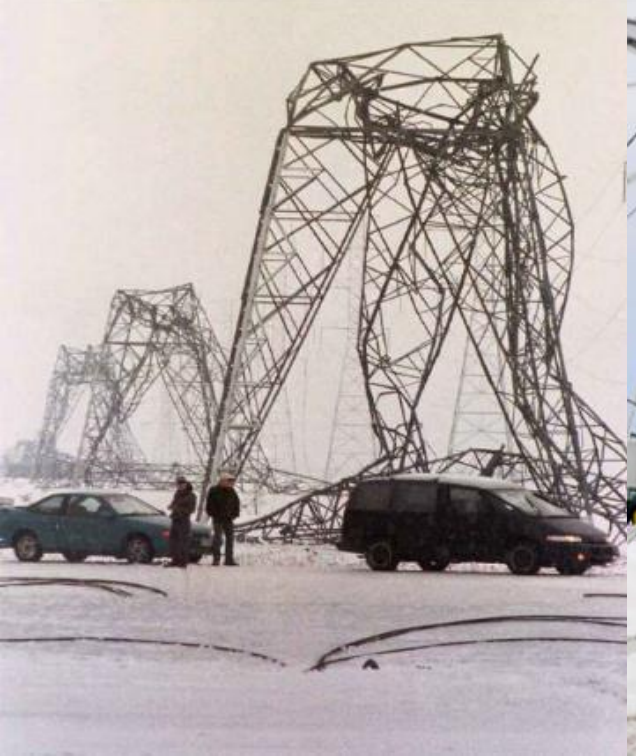
Earth Wire

3 Phase Conductors

Insulators







Climate Change Adaptation and Challenges

Adaptation **will** require:

- More resilient infrastructure
- Broader disaster relief
- Preparedness measures will be the key

What is Energy Industry doing to (…adaptation)

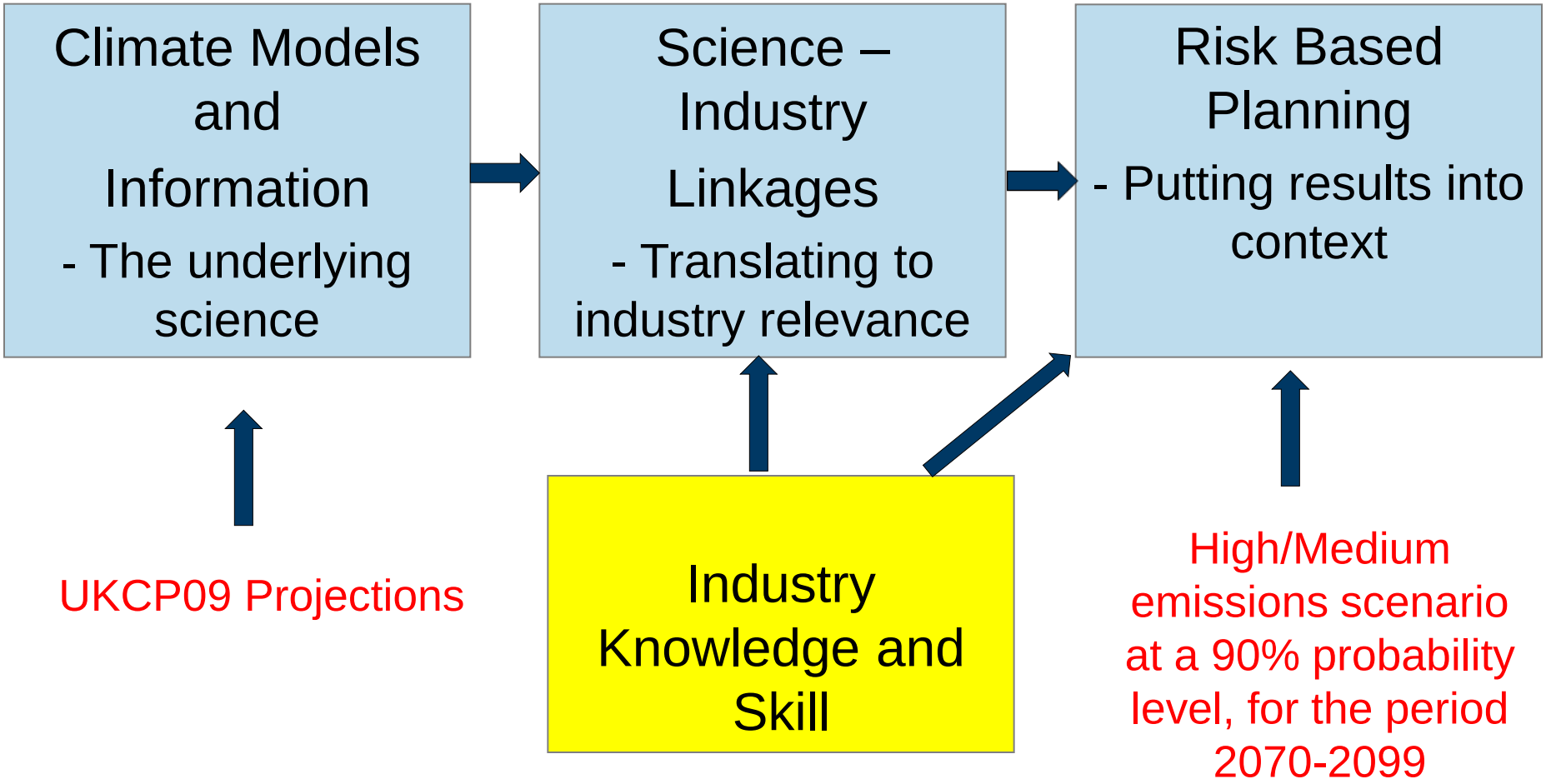
- **Improve** flexibility of energy supplies to cope with incremental climate and sudden extreme weather related demand changes.
- **Increase** electricity network resilience to more frequent storms, extreme high winds, future flooding.
- **Reduce** vulnerability of energy transmission infrastructure to high temperatures and sea-level rise and flooding.
- **Increase** energy production from weather-dependent renewable sources.

How Climate Risk is Managed

The aim must be to prepare for the impacts of climate change and extreme weather by providing a framework that:

- Identifies the main climate impacts.
- Establishes the current risk baseline to understand who and what is at risk today/tomorrow and the in the future.
- Analyses how climate change will change the risk of, for example, flooding, drought and heat waves.
- Uses this analysis for decision making to prioritization of actions to manage the impact and to capitalise on any benefits.

Partnership working UK Energy Partnership
(evolutionary knowledge sharing journey)



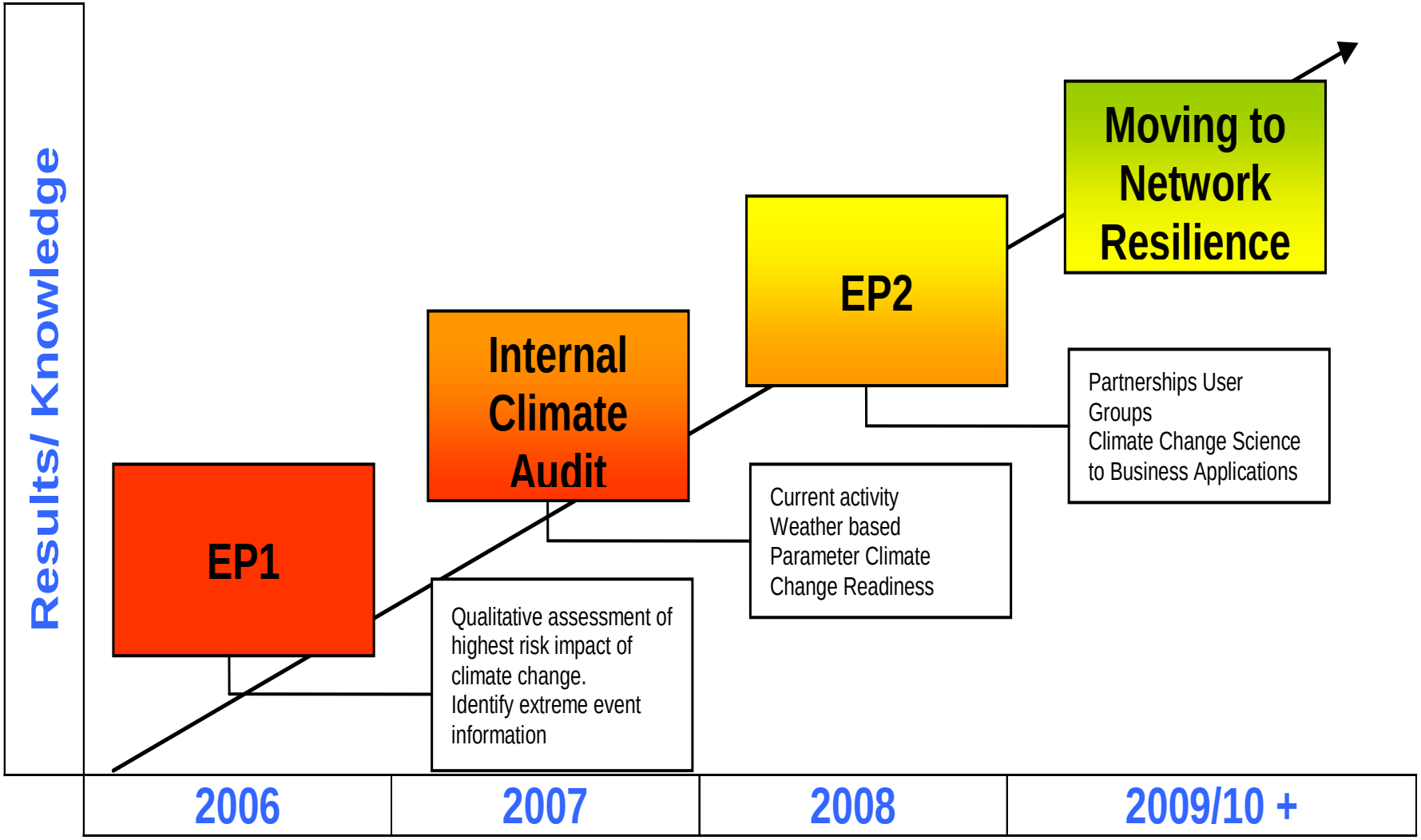
Partnership Approach

- The risk assessment has been undertaken using UK09 projections and also from tailored collaborative research carried out with UK climate scientist.

- Energy companies in the UK have worked alongside climate scientists at the Met Office Hadley Centre.

- This research has lead to better understand and prepare for the wider impacts of climate change on UK electricity and gas assets and business operations.

Climate change impact & journey & engagement



Source: National Grid

Modelling Decision Time line

Long-term modelling. Up to 50 years.

Impact on design and location of new infrastructure.

Long-term modelling. 1 to 15 years ahead

Impact on demand forecasts for planning and severe weather.

Medium-term forecasting. Next winter

Impact on operational planning for next winter

Probability of severe/extreme winter : temperature, wind, precipitation.

Short-term forecasting. 1 day to 4 weeks

Probability of extreme events: temperature, wind, precipitation.

Short-term forecasting. Within-day to 1 week

Forecasts of temperatures and wind speeds.

The project covered the following areas:

- Developed innovative new techniques that apply climate models to energy systems applications so that the industry is better placed to adapt to climate change;

- Investigated future wind resources, enabling the industry to understand the continued uncertainty of future wind power. This has assist risk management and investment decisions;

- Modelled future soil conditions and their impact on cables so that companies can understand the cost and benefits of installing cables for a more resilient future network;

- Deliver a tool to enable the energy industry to assess if rising sea levels should be considered in more detail;

Cont…

- Investigated how the urban heat island effect may change in the future so that networks can develop plans for their infrastructure in cities;

- Produced guidance to help make best use of public domain information on climate change such as the United Kingdom Climate Impacts Programme new scenarios of climate change (UKCP09);

- Delivered new site specific climatologies of temperature, wind speed and solar radiation that account for climate change so that decisions can be based on realistic climate expectations;

Underground Cable Performance

Questions addressed :

- What conditions impact on cable performance ?
- How will climate change affect future soil conditions at 1M and 2M depth ?
- Will cable performance/rating be different under climate change ?
- What cables/soil types are most at risk ?

Research study found that :-

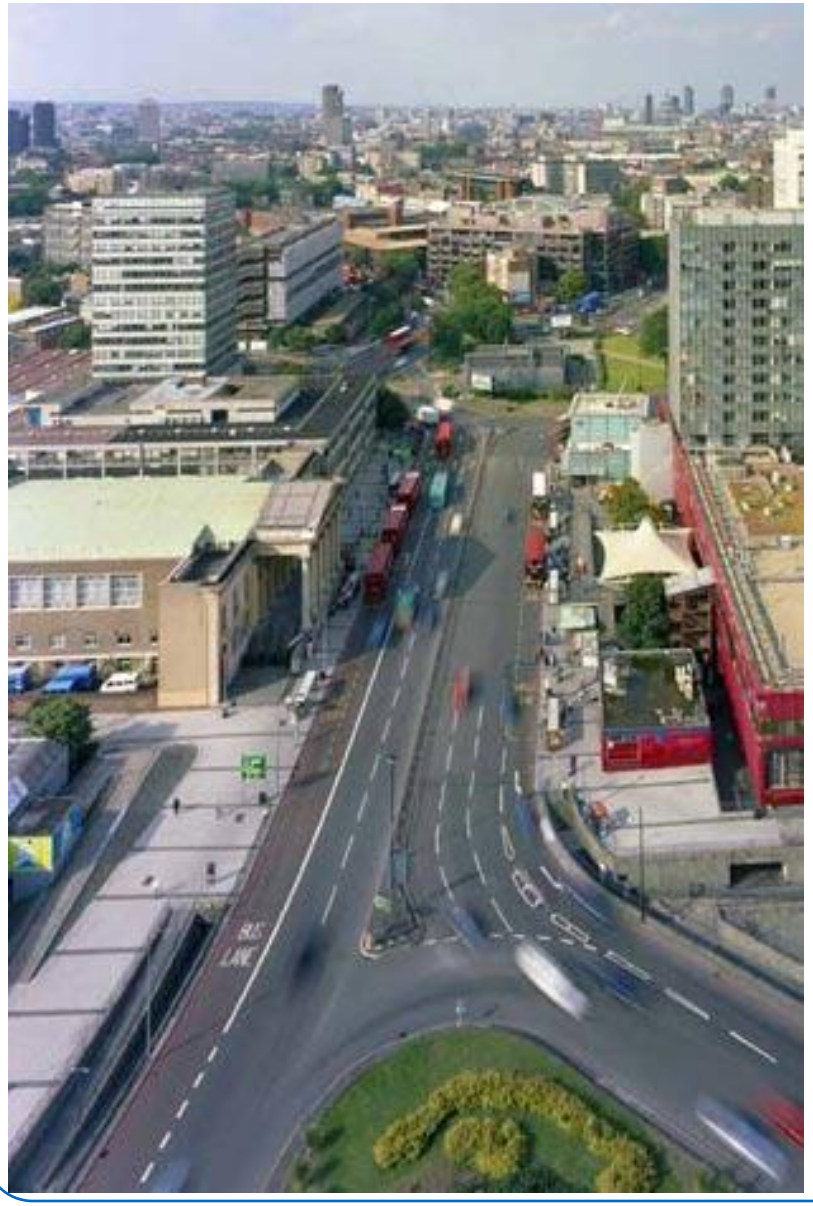
- Recent research suggests that the electricity transmission network is at low risk from weather-related risks because its equipment is more resilient to the weather.
- Faults on the transmission network may be low probability they potentially represent higher impact events.
- The risk profile for transformers will be affected and design thresholds of temperature will be exceeded more often.
- 13 sites that are at risk of flooding and 57 substation sites that are located within areas of coastal erosion.
- Lightning is the dominant cause of weather-related faults (62%).
- Wind and gale, and snow storms/blizzards and ice cause a further 22% and 12% of weather-related faults respectively.
- Cable rating on future soil temperature change of 0.5 degrees C per decade

So what does it mean?

- Plant availability may be affected **as routine maintenance**.
- Fossil fuel plant, particularly gas turbine will operate **less efficiently**.
- Underground cable will require **additional cooling**.
- Energy demand patterns will change – from demand cooling and reduction demand for heating – **more warning in summer than winter**.
- Hotter summer days (increased A/C), impact on infrastructure including underground and overhead cables, **transformers**.
- Storm surges and sea level rises will impact on choice of **coastal sites for generation**.
- Changes to rainfall and wind will impact **water abstraction for cooling**, and where to site wind turbines.

Some examples of results

An example- Urban Infrastructure



The risk profile for transformers will be affected.

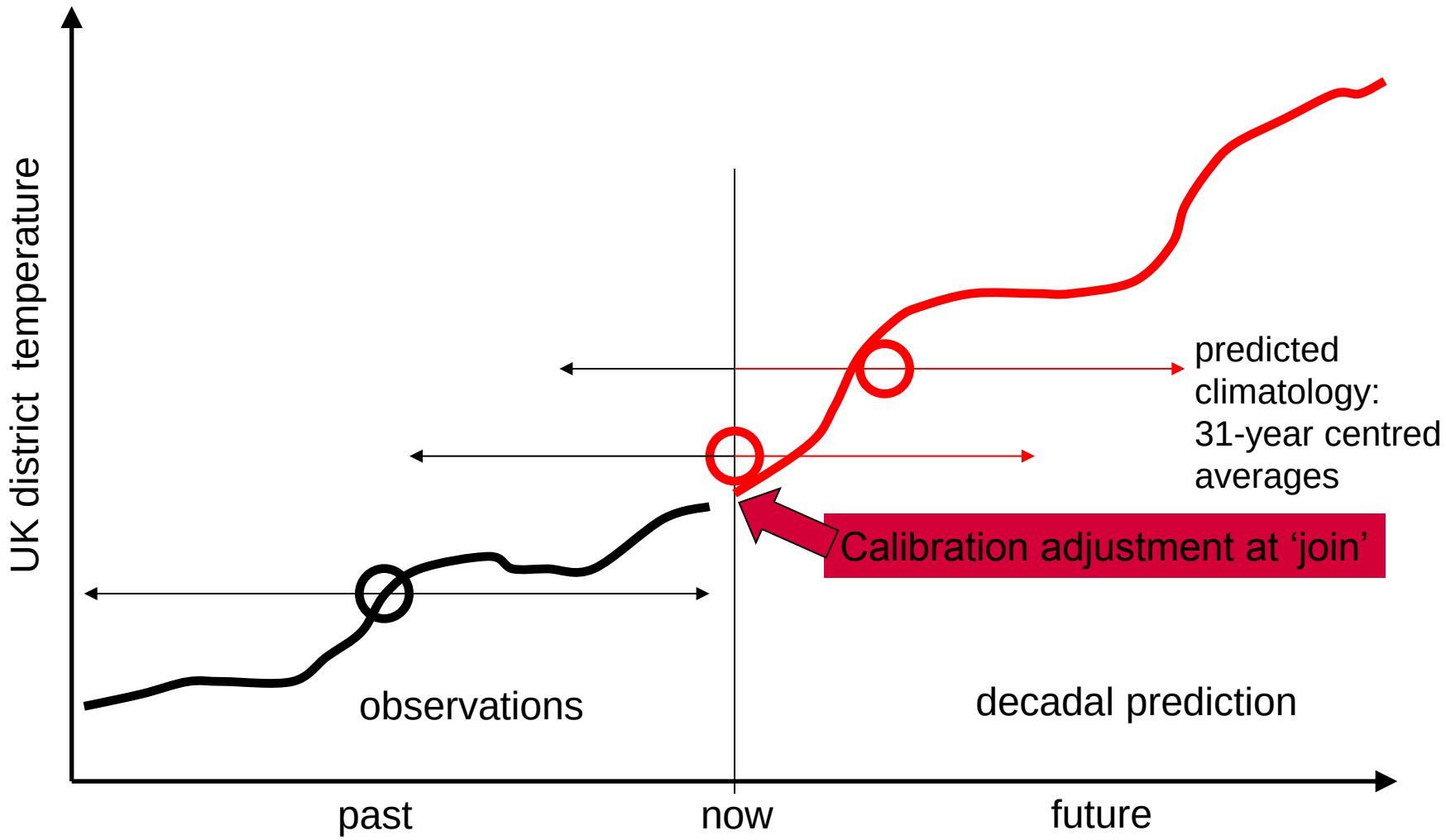
Design thresholds of temperature will be exceeded more often.

More hot nights in cities – 42 days per 90 day summer season.

What can we do about the above:-

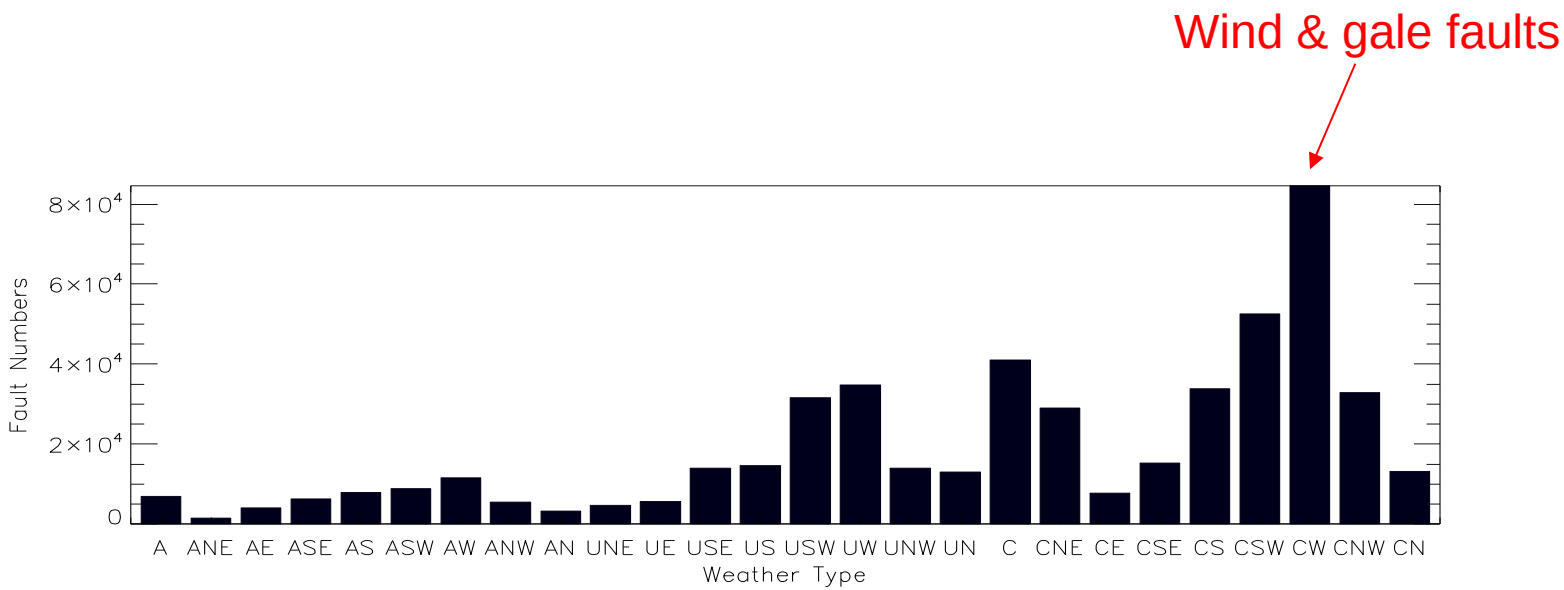
- **More** scenarios studies and advance planning/warning in the areas of hot spots.
- **Correlate** transformer and power line loading with the load demand data in order to understand the **extreme weather risk.**

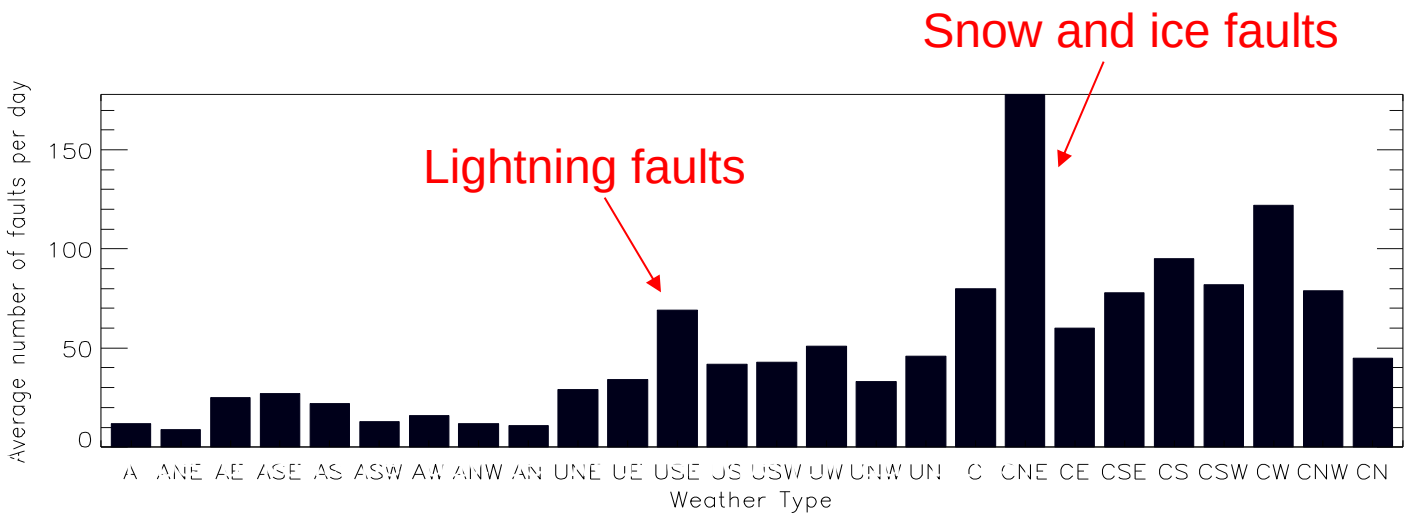
Predicted district climatology: mix of observations and predictions



Source – Hadley Centre

Relationship between Weather Type Network faults(Vulnerability and Risk)





Source: Met Office

Gaps in the Climate science knowledge

Gaps in climate science

Specifically, the following limitations have been identified which the climate community will need to address in the near future:

- There is no information on future changes in frequency and intensity of wind and gales, and of lighting, snow, sleet, blizzard, ice and freezing fog.
- The combined probability of low wind speed (dead calm) events with high ambient temperatures.
- There are probabilistic projections of wind speed, but they are associated with large uncertainty. (Skill ??)

For the energy industry to better manage its business risks, the scientific community will need to fill the knowledge gaps noted above.

Gaps in Climate Science

Lack of detailed information on:

Changes in frequency of intensity of wind/ lightning/snow

Combined probability of low wind speed (dead calm) & events with high ambient temperatures

Regional detail

How to "downscale" climate model output

- Dynamical – e.g. regional climate models
- Statistical – e.g. weather generators

Extreme events

Qualitative information at best – how to plan

Next steps and conclusions

Climate projections for decision making

- Part and parcel of corporate risk appraisal within the electricity transmission sector, managing climate change risks through existing corporate processes.

- The sector level engagement on climate change risk issues, including the commissioning of detailed research studies, is reflected in the analysis of the risk assessments that clearly demonstrate the use of appropriate data, information, knowledge and tools.

- In terms of the methodologies, to make evidence-based decisions on adapting to climate change,

The energy industry acknowledges that climate science is an evolving science and it is envisaged that the flexible approach that has been adopted will allow for risks to be reassessed as further information becomes available

Next steps …….

Knowledge Transfer and filling in knowledge gap

- Clarity
- Consistency
- Co-ordination
- Regular update

- **Physical drivers –** understanding the potential risks such performance, environmental, litigation
- **Regulatory, financial and legal drivers**

Adaptation is therefore essential

Climate Change Risk Management for Business

Focus attention on **business-critical activities**

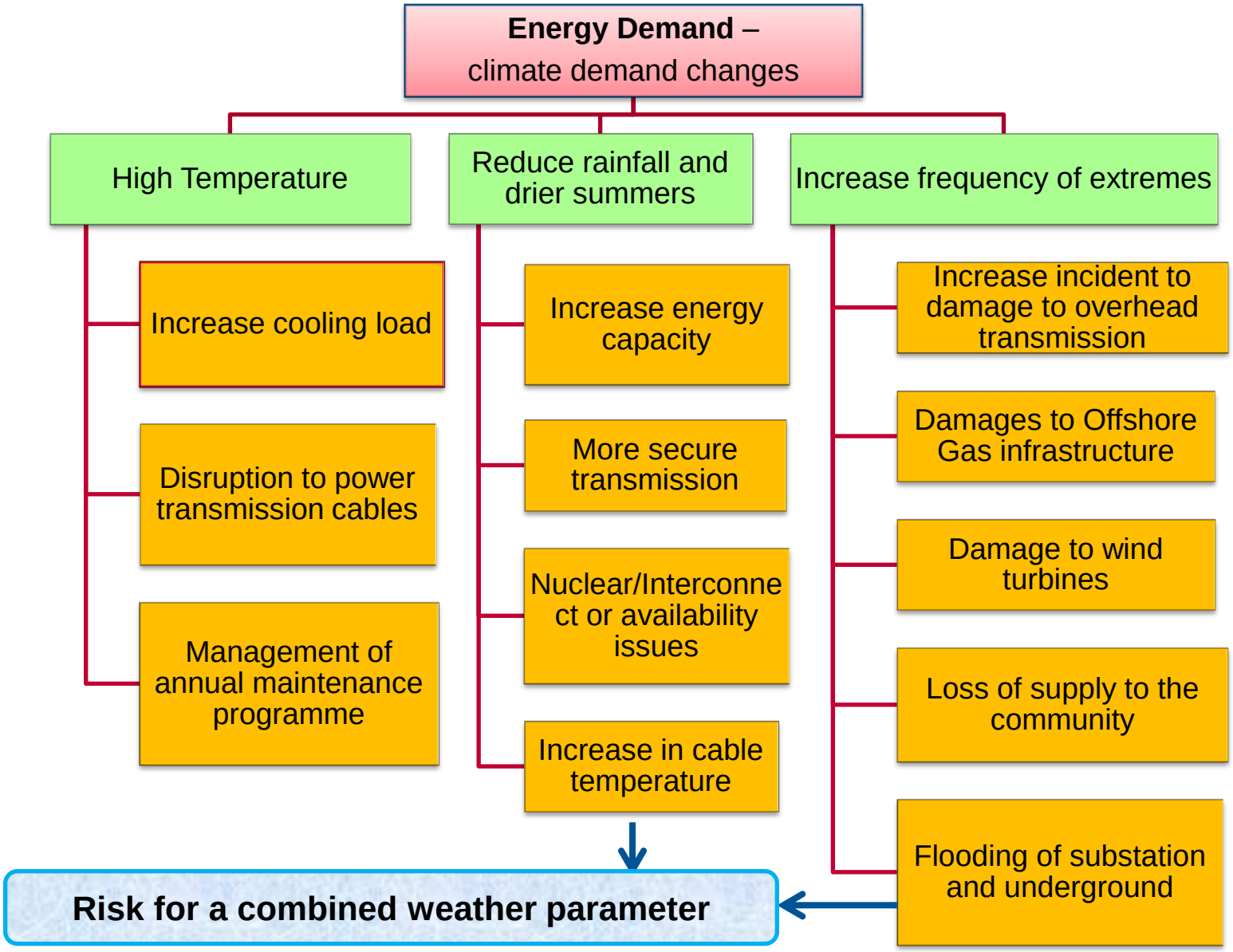
Include climate change risk factors in Annual Reports.

Set out the strategy to respond to:

- common risk, such as **climate change**
- tailor the **guidance** to meet operational and long term requirements

Manage relationship with stakeholders through business risk registers.

Meteorology, Climate and Energy Linkages



In Conclusion

Climate change will have diverse and profound consequences across many areas of society.

The Energy sector is particularly vulnerable and is where many of the impacts will be felt first.

This linkage is vital for both the scientific and engineering community to understand and work together in the future to produce practical solutions to cope with the challenges of a changing future climate.