

Climate Change



Sustainability Research

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ADAPTATION

Utilities: profits reined in by less rain?

With UN climate talks at a standstill, the world will have to contend with a few degrees more. In a series of reports, we assess the vulnerability and adaptation needs of companies in climate-sensitive sectors, starting with utilities. 2011 was generally warmer and drier in Europe, mostly penalising Verbund (a EUR165m hit). Fortum comes out as the least exposed to the multi-billion euro climate adaptation costs estimated for the sector.

■ The warm-up: adaptation a rising theme

The standstill at the UN climate talks in Durban underlines the idea that the +2°C scenario is out of reach as countries fall short of carbon reduction prescriptions. A few degrees more is enough to significantly increase vulnerabilities and adaptation needs.

■ Uncertain climate, uncertain results

Climate-sensitive sectors represent not less than one-third of US GDP, while more than 50% of European companies in the Telecom, Utilities, Food & Beverage and Insurance sectors see climate change as a significant risk to their businesses. Global warming comes on top of natural climate variability and is likely to bring new extremes (e.g. record high temperatures, water scarcity hotspots, extreme events) that will test the resilience of companies' results. The quantification by companies of climate impacts on their results remains relatively poor, in our view. We aim to fill this gap and start a series of "climate impact" sector reports, beginning with utilities.

■ Utilities: 2011 warmer and drier. Who will bounce back?

Utilities' top lines are significantly driven by temperatures, while major changes in the availability of hydro and wind resources, along with potential storm damage, frequently affect their profits. As guidance is based on normal climate conditions, we provide monitoring tools to better anticipate companies' operational and financial results and to avoid climate-related profit warnings. Most companies reported adverse weather effects in 2011. We estimate that Verbund (+EUR165m), EDF (+EUR450m), and GDF Suez (+650m) would gain the most if normal conditions resume in 2012.

■ Fortum the least exposed to long-term adaptation costs

Climate change carries significant risks for T&D assets and hydro capacities in Europe. A report ordered by the European Commission's DG Energy estimates adaptation costs of EUR15bn-19bn for the power sector. We assess the vulnerability of T&D assets to storm damage and show that EDP is the most negatively exposed to the forecast regional shift in precipitation, while Fortum stands out with the most climate-proof power generation portfolio.

Erwan Créhalet

Climate Change Analyst
ecrehalet@cheuvreux.com
(33) 01 41 89 75 18

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■ CHEUVREUX'S ESG TEAM

Stéphane Voisin (coord.) France (33) 1 41 89 74 69 (direct) svoisin@cheuvreux.com

Erwan Crehalet France (33) 1 41 89 75 18 (direct) ecrehalet@cheuvreux.com

Sudip Hazra France (33) 1 41 89 75 34 (direct) shazra@cheuvreux.com

Samuel Mary UK (44) 207 6215190 (switchboard) smary@cheuvreux.com

Catharina Saponar UK (44) 207 621 52 66 (direct) csaponar@cheuvreux.com

Robert Walker UK (44) 207 621 51 86 (direct) rwalker@cheuvreux.com

In collaboration with Marine Mellado et Alexandre Castelnau

Written in collaboration with CLIMPACT

Founded in 2003 by climate experts, CLIMPACT is the European leader on the Climate Business Intelligence market. CLIMPACT's clients come from weather-sensitive sectors such as the consumer goods industry, food and beverage, retail, agriculture, transportation, insurance, services, energy, tourism, health, etc. By understanding, measuring and anticipating the impact of weather and climate on their businesses through CLIMPACT's Climate and Weather Competitiveness Services, companies can now turn weather and climate fluctuations into competitive advantages for all of their products or services. More on www.climpact.com.

Climategate ultimately did not affect the robustness of the IPCC's climate science...

I – The warm-up

Two years after the “Climategate” scandal, the IPCC’s climate change science has regained its credibility and continues to drive the international political consensus on the need to act against rising carbon emissions.

However, international talks on climate change remain at a standstill notably due to the lack of leadership of the US, and dissension as to what the nature of a post-Kyoto framework should be.

The emissions reduction targets agreed to by countries under the Copenhagen Agreement clearly fall short of the “+2°C only” scenario. With CO₂-free nuclear power generation technology being called into question following the Fukushima incident, the climate change equation looks even more impossible to solve.

■ What science tells us

Back to basics

In 2007, the fourth assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) concluded with an increased level of certainty that:

- Warming in the climate system is unequivocal;
- Most of the observed increase in global average temperatures is very likely (i.e. >90% probability) due to an increase in GHG concentrations;
- Continued GHG emissions would induce many changes that would very probably be larger than those observed. Among these changes, it was estimated as virtually certain that most land areas would experience warmer and fewer cold days and nights, and warmer and more frequent hot days and nights, while an increase in the frequency of heat waves and heavy precipitation events was deemed very likely.

This call by the scientific community has been heard by global leaders, who have been endeavouring to ramp up efforts for further commitments to cut carbon emissions within the UN Framework on Climate Change, anticipating the end of the Kyoto Protocol at end 2012, and to move towards a low-carbon society.

What has changed a year and a half after Climategate?

Confidence in the conclusions of the IPCC was shaken in November 2009, just a few days before the start of the Copenhagen UN meeting on climate change, which gathered most global leaders. Hacked e-mail exchanges from the Climatic Research Unit of the University of East Anglia (a unit contributing to the IPCC) sparked allegations of scientific malpractice in climate sceptics’ blogs. In addition, some mistakes were discovered in the IPCC’s fourth assessment report in the following months, further fuelling the debate over the quality of the climate science proposed by the IPCC.

The IPCC’s scientific findings are robust

Since then, official inquiries have concluded that the allegations of a lack of integrity among scientists were unfounded and that despite the few “typos” in the report, the IPCC’s scientific findings were robust.

The debate is not over yet, but no scientific research has come out to invalidate the IPCC’s consensus so far. The conclusions reached by the IPCC are based on a consensus forged on the results of climate modelling, integrating many different scientific disciplines that deal with aspects of the Earth’s climate. The consensus reflects the current state of scientific knowledge, and it is important to follow up any new research that could cause the current consensus to evolve.

Some scientists have contested the conclusions of the IPCC, notably arguing that the level of certainty (>90%) that human-made carbon emissions are the major cause of

**...but it severely
eroded public support
for climate action,
especially in the US**

global warming is too high given the remaining gaps in scientific knowledge on factors that might be underestimated (or even unaccounted for) in current climate models contributing to the IPCC. These factors include the role of solar activity and clouds.

A research paper published in 2010 by the NASA Goddard Institute for Space Studies (GISS) reaffirmed the role of atmospheric CO₂ as “the principal control knob governing earth temperature”. Moreover, it concludes that “ample physical evidence shows that CO₂ is the single most important climate-relevant greenhouse gas in Earth's atmosphere (over water vapour and clouds)”, and states that “Of the climate control knobs relevant to current climate, those on the solar side of the energy balance ledger show only negligible impact. Several decades of solar irradiance monitoring have not detected any long-term trends in solar irradiance beyond the 11-year oscillation associated with the solar sunspot cycle” (Lacis *et al.*, 2010).

Conversely, recent research papers suggest that the influence of solar spectral variations on radioactive forcing of the climate may have led to temporary warming (Haigh *et al.*, 2010) and could influence temperature conditions on a continental scale over Europe or the US without any substantial influence on the global average temperatures (Ineson *et al.*, 2011).

Overall, at this stage, we consider that the scientific and political consensus over the IPCC's scientific findings remains solid.

The shadow of Climategate is still affecting the US

However, Climategate has been widely publicised and has cast doubt on climate science among citizens of the world. The results of a Gallup poll show a clear loss in confidence among citizens of developed countries (which have better access to information) that human activities (through carbon emissions) are responsible for climate change.

In the United States, less than half of respondents now fully or partly attribute climate change to human activities. This figure stood at 60% before the Climategate scandal.

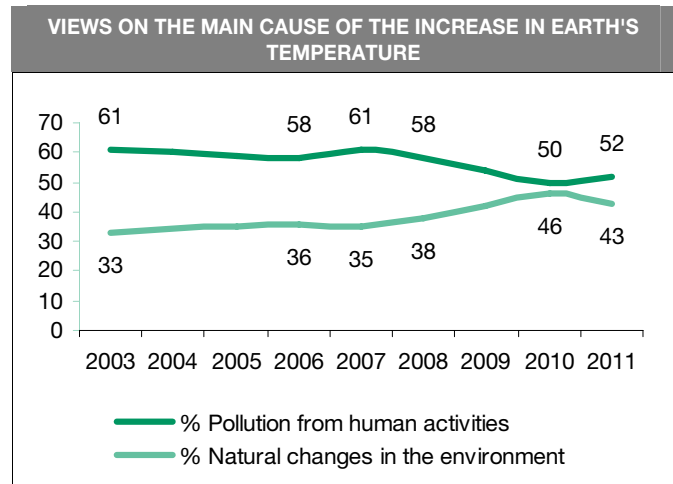
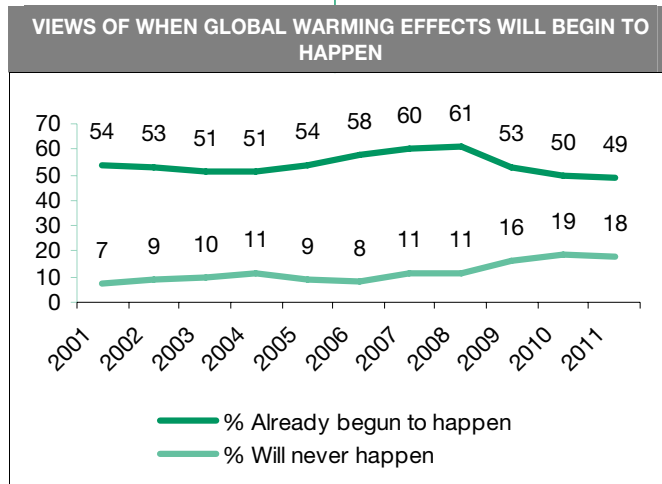
PUBLIC PERCEPTION OF HUMAN CONTRIBUTION TO GLOBAL WARMING WORLDWIDE

2007-2008 vs. 2010

	A result of human activities + both in 2007-2008	A result of human activities + both in 2010	Difference (percentage points)
World	43%	48%	+5
Canada	72%	72%	0
Developed Asia	88%	83%	-5
Western Europe	76%	69%	-7
Eastern and Southern Europe	74%	68%	-6
Latin America	59%	65%	+6
Commonwealth of Independent States	51%	51%	0
United States	60%	48%	-12
Developing Asia	34%	39%	+5
Middle East and North Africa	40%	37%	-3
Sub-Saharan Africa	24%	32%	+8

Source: Gallup

We believe that Climategate had direct consequences on the results of the Congressional elections held in 2010. Given the clear partisan split on the climate change issue in the US, Climategate probably helped Republicans regain control of the House of Representatives, making it even more difficult for the Obama administration to pass a federal climate bill and to take a firm commitment at international negotiations on climate change. A few Democratic Representatives were said to have been voted out due to their support of the US Climate Bill reviewed by Congress in 2009.



The fact that the second largest contributor to global carbon emissions has failed to pass a domestic climate policy directly hampers any progress on international climate change talks.

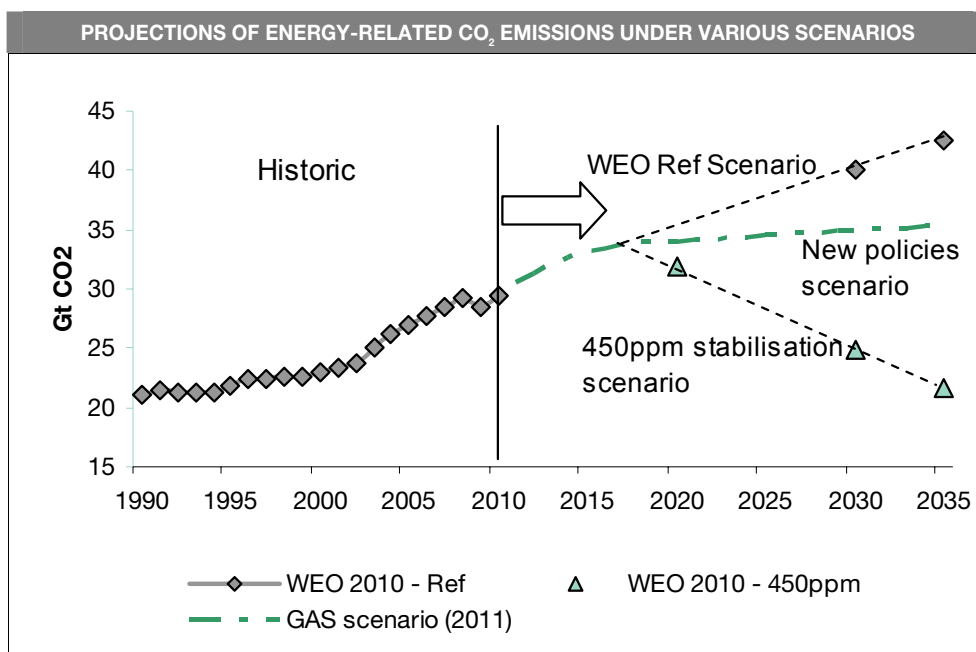
■ Climate change policies fall short of GHG mitigation prescriptions

In June 2011, the International Energy Agency (IEA) released a new long-term energy scenario, boosting the role of natural gas in the global energy mix by 2035 on the back of: 1) a more ambitious policy for gas use in China's five-year plan; 2) lower growth of nuclear power; and 3) greater production of unconventional gas and lower gas prices.

In the new GAS Scenario, **global CO₂ emissions in 2035E fall only slightly below the base-case scenario** of the World Energy Outlook 2010 (WEO 2010), as emissions increases due to higher energy demand, reduced nuclear and renewable energy offset most of the gains due to a substitution of gas for coal and oil.

This scenario puts emissions on a long-term trajectory consistent with stabilising CO₂ concentration at 650ppm, **suggesting a temperature rise of 3.5°C.**

The benchmark energy scenario points to a +3.5°C global warming scenario...



Source: IEA's WEO 2010 and GAS Scenario 2011, CA Cheuvreux

...and carbon
reduction pledges give
little downside

Emissions reduction targets set by countries fall short of the +2°C pathway

As a whole, the emissions reduction commitments made by the developed (Annex I) countries fall significantly short of the climate stabilisation target (450ppm / +2°C), since even the higher proposals (which are subject to conditions) would mean a level of GHG emissions for these countries only 18% below 1990 levels, whereas scientists of the IPCC state that a 25% to 40% decline would be required for this group of countries.

EMISSIONS REDUCTION COMMITMENTS MADE BY DEVELOPED COUNTRIES UNDER THE COPENHAGEN ACCORD

	Emissions 2008 (mtCO ₂ e)	% of total	lower proposal (%)	higher proposal (%)	Base year	Target 2020 (mt)	Target 2020 (mt)	Lower % reduction vs. 1990	Higher % reduction vs. 1990
Australia	550	3%	-15%	-25%	2000	422	372	1%	-11%
Canada	735	4%	-17%	-17%	2005	607	607	3%	3%
EU 27	4 940	28%	-20%	-30%	1990	4 454	3 897	-20%	-30%
Japan	1 282	7%	-25%	-25%	1990	952	952	-25%	-25%
Russia	2 240	13%	-15%	-25%	1990	2 831	2 498	-15%	-25%
Ukraine	428	2%	-20%	-20%	1990	743	743	-20%	-20%
Belarus	91	1%	-5%	-10%	1990	133	126	-5%	-10%
U.S.	6 925	40%	-17%	-17%	2005	5 897	5 897	-4%	-4%
Norway	54	0%	-30%	-40%	1990	35	30	-30%	-40%
Switzerland	53	0%	-20%	-30%	1990	43	37	-20%	-30%
N. Zealand	75	0%	-10%	-20%	1990	55	49	-10%	-20%
Croatia	31	0%	-5%	-5%	1990	30	30	-5%	-5%
Total	17 403	100%				16 200	15 237	-13%	-18%
Cut required according to IPCC scientists								-25%	-40%

Source: UNFCCC, CA Cheuvreux

Nuclear shutdowns further deteriorate the emissions pathway

And individually, at the country level, of the six countries responsible for 96% of the emissions of the group, three (Australia, Canada and the US) and are still far from even implementing national policies to achieve these targets, which are nonetheless challenging from current emissions levels (the upper Australian target implies a 32% cut in emissions in 2020 compared to 2008 levels).

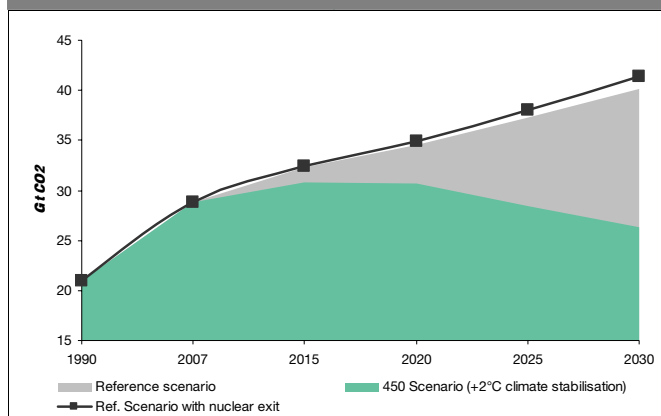
The Fukushima incident further complicates the equation

The challenging target proposed by Japan is clearly called into question and under review since the country has to redesign its energy policy considering a potential total phase-out of nuclear capacities as a result of the Fukushima incident. The environment ministry has estimated that Japan's GHG emissions could rise 10% above 1990 levels by 2020 if the nuclear reactors damaged by, and halted after, the earthquake/tsunami are not restarted and if plans are cancelled to build up to nine new reactors.

More generally, nuclear is one of the existing technologies that can help achieve climate stabilisation targets. A worldwide phase-out of nuclear capacities would further put the +2°C climate stabilisation target out of reach, in our view, by increasing emissions by 1.2 to 2.8bn tonnes of CO₂ by 2030, implying a further +3-7% increase compared to a business-as-usual scenario.

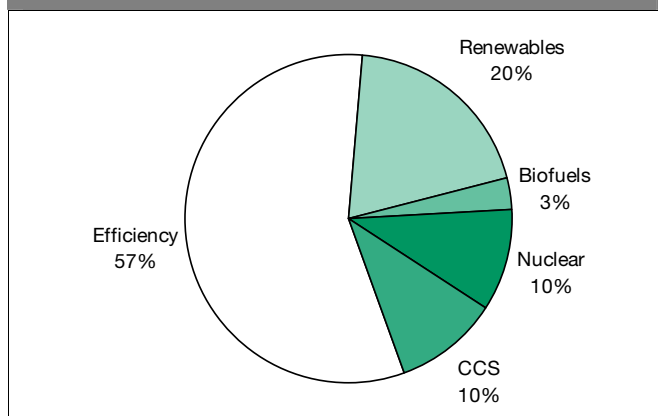
The Reference scenario (i.e. base case) set by the IEA in the World Energy Outlook 2009 forecasts a fairly steady increase (ca. +0.6bn tCO₂e p.a.) in energy-related CO₂ emissions out to 2030, when carbon emissions are expected to reach 40bn tonnes of CO₂. Assuming a gradual shutdown of existing nuclear capacities by 2030, replaced by different sets of technologies, this scenario would add from 0.96bn to 2.16bn tCO₂ of annual emissions by 2030 to the Reference scenario. In addition, additional nuclear capacity forecast in the Reference scenario out to 2030 (+104GW net) would have to be replaced with other power generation technologies, thus adding between 0.27bn and 0.6bn tCO₂ by 2030.

CARBON EMISSIONS TRENDS UNDER VARIOUS SCENARIOS



Source: IEA WEO 2009, CA Cheuvreux

BREAKDOWN BY TECHNOLOGY OF THE ADDITIONAL EMISSIONS REDUCTION EFFORT REQUIRED TO PUT THE WORLD ON THE PATH TO A +2°C CLIMATE STABILISATION



Source: IEA WEO 2009, CA Cheuvreux

In addition, in setting an alternative scenario that would put the world on track to cut carbon emissions by ca. 14bn tCO₂ compared to a reference scenario, the IEA had placed 10% of the CO₂ reduction burden on nuclear.

A few degrees more...

We estimate that the current emission reduction targets, if met, point more to a minimum +3°C global warming scenario.

**Only 1°C degree
more...**

Given the fact that:

- Developed countries are falling short of the targeted 25-40% reduction recommended by the scientific community to match a +2°C global warming mitigation scenario, and
- Proposals from developed and developing countries overlap to a certain extent, due to double accounting of actions generating international offsets,

We estimate that these emission reduction targets as a whole are not sufficient to comply with the scenario defined by the IPCC to limit the concentration of GHG in the atmosphere to 450ppm CO₂-eq.

DIFFERENT STABILISATION PATHWAYS PROPOSED BY THE IPCC

Climate scenario	Parties	2020	2030
+2°C (450 ppm CO ₂ -eq)	Developed countries	-25% to -40%	-80% to -95%
	Emerging countries	Substantial deviation from the baseline	Substantial deviation from the baseline
+3°C (550 ppm CO ₂ -eq)	Developed countries	-10% to -30%	-40% to -90%
	Emerging countries	Deviation from the baseline	Deviation from the baseline, especially in LatAm and the Middle East
+4°C (650 ppm CO ₂ -eq)	Developed countries	0% to -25%	-30% to -80%
	Emerging countries	Baseline	Deviation from the baseline in LatAm, the Middle East and East Asia

Source: IPCC

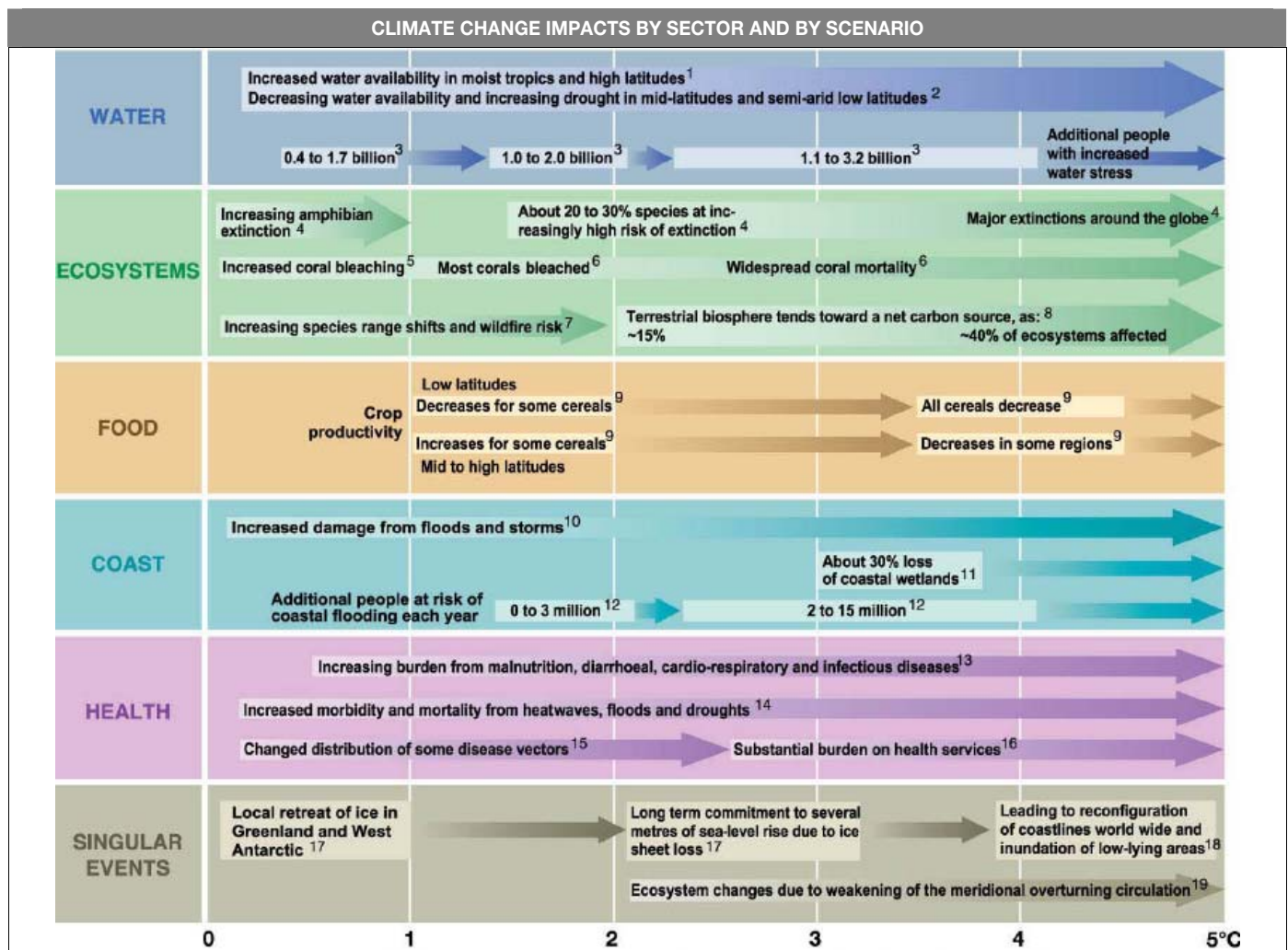
**...triggers new above-
threshold
vulnerabilities...**

...will increase vulnerability and trigger the need for climate change adaptation

The concept of adaptation was introduced at the Copenhagen climate conference in 2009, and since then, it has gained an important place in political debate and the climate change agenda. For a long time, this subject was not pushed forward, as the community in favour of climate change mitigation was afraid that some countries could use adaptation as an excuse for not taking measures to reduce GHG emissions. Now, regardless of the emissions scenario for the next few decades, preparations must be made for future changes in the climate.

The IPCC has defined “adaptation”, in the context of climate change, as the “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderates harm or exploits beneficial opportunities”.

The concept of adaptation to changes in the climate is not new. Throughout history, human societies have had to adapt to changing environments and to make the most of it. However, historical records from direct observations and past climate data show unprecedented changes in the climate system not only in magnitude, but also in a rate never before encountered over many thousands of years. The more substantial and more rapid the climate changes, the more difficult and thus more expensive it will be to adapt.



...and more climate change adaptation investments

Investments needed to contend with expected climate changes are sizeable. According to an estimate made by the World Bank in 2007, the necessary adaptation investments would amount to between USD44bn and USD166bn p.a. (Agrawala and Fankhauser, 2007), of which EUR1bn-6bn for France. A more recent report gave dramatically higher estimates of between USD422bn and USD475bn p.a. (Parry M. *et al.*, 2009).

UN climate talks at Cancun notably created the Cancun Adaptation Framework in an attempt to develop financing capabilities for fast-start investments in adaptation projects identified by Least Developed Countries: a necessary task since, until then, the capacity of the UN Adaptation Fund, fed with 2% of the proceeds of Kyoto carbon credits issued (i.e. only some 23 millions credits with a market value of EUR115m) by the end of 2012, was too limited.

Climate-sensitive sectors already affected by natural climate variability

II – Uncertain climate, uncertain results

Climate change projections presented by the IPCC in 2007 are for 2030: i.e. outside the time horizon of most investors. What is more important to consider, in our view, is that we are entering a period of increased uncertainty over weather patterns, as climate change trends call into question the validity of historical references for determining temperature and precipitation highs and lows, along with the frequency of extreme weather events.

As one-third of the US economy is weather-sensitive (Dutton 2002), economic and business resilience is at stake as climate change is likely to further enhance the volatility of natural climate variability, and to lead to new climate extremes.

■ Weathering natural climate variability

Globally, weather is notably influenced by climate oscillations which occur on different timescales (e.g. inter-seasonal, inter-annual, decadal, multi-decadal). Each of these oscillations are linked to different weather patterns across the globe.

When considering the impact of climate on companies, we believe it is more important to understand the behaviour and the impact of climate oscillations which better match the frequency of financial reporting by corporate entities: the North Atlantic Oscillation (NAO) and the El Niño Southern Oscillation (ENSO) which show inter-seasonal to inter-annual fluctuations.

In the table below, we describe the main features of these two climate oscillations which have a significant influence on the weather in the Atlantic and Pacific Basins.

BRIEF DESCRIPTION OF MAIN CLIMATE OSCILLATIONS NAO AND ENSO

	What it is	Scope of influence	Periodicity	Impact	Current phase	Predictability
ENSO	Variations of ocean surface temperature in the equatorial Pacific	Global, with greatest fingerprint in the tropical Pacific	3-7 years with episodes lasting 6-18 months	Extreme weather in many regions of the world, especially countries bordering the Pacific Ocean	La Niña	Quite high: "For the October-December season currently in progress, there is an approximately 78% probability of the La Niña conditions continuing, a 22% probability of a return to neutral conditions, and virtually no chance of the development of El Niño conditions. Weak to moderate La Niña conditions are the most likely scenario for the remainder of 2011, into the first couple of months of 2012". (IRI Enso prediction – October 2011)
NAO	Variations of atmospheric pressure over the north Atlantic Ocean between Iceland and the Azores	North America and Europe	Highly variable with fluctuations ranging from days to decades, with no strong periodicity	Particularly dominant in Winter. A wet northern Europe and a dry Mediterranean Europe during a high NAO winter (the opposite during a low NAO winter)	Low NAO in September 2011	Weak: "The NAO is a noisy mid-latitude phenomenon and even the best predictions to date have not been able to capture more than 10% of its year-to-year variance" (CRU)

Source: CA Cheuvreux based on information available on NOAA, IRI, CRU, Climate Impacts Group's websites

The cold 2009-10 winter was attributed to the exceptionally negative NAO index

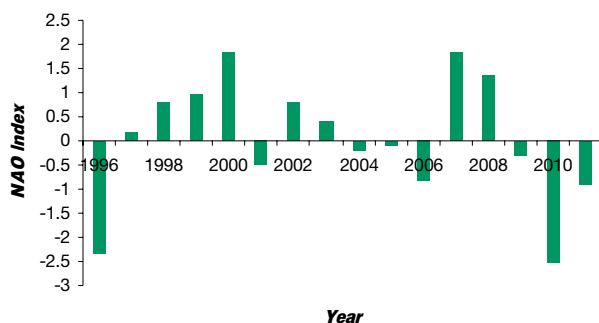
The North Atlantic Oscillation: a key driver of the European winter climate

The North Atlantic oscillation (NAO) is a pattern of Atlantic climate variability which affects the climate of Europe. The phenomenon is measured by monitoring the difference in air pressure between Reykjavik, Iceland and Lisbon, Portugal for example. The NAO index reflects the variations from the mean.

The NAO is responsible for much of the changeability in weather especially during the winter months, (incl. temperature, precipitation and wind) in the North Atlantic region, including Europe. Scientists are attempting to understand the potential link between climate change and the NAO.

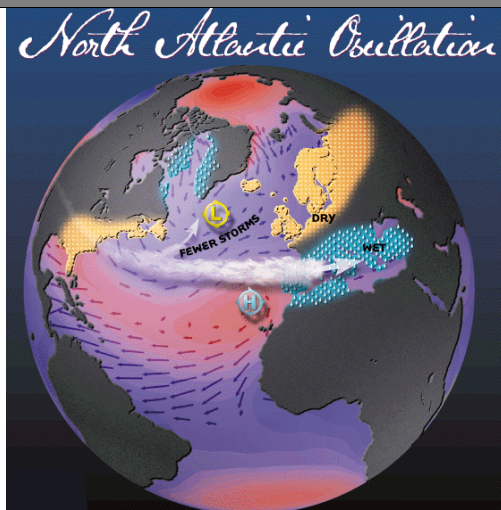
As illustrated in the chart below, for Europe, a negative index corresponds to weak if not reversed westerlies, deep freezes, reduced rainfall in northern Europe counterbalanced by increased rainfall and storm activity in southern Europe. For instance, the unusually cold and snowy conditions over north-western Europe in winter 2009-10 were attributed to the exceptionally negative NAO index observed over the period. Conversely, a positive NAO index is associated with strong westerlies, mild winters, frequent rain and enhanced cyclonic activity.

WINTER NAO INDEX UPDATED FOR WINTER 2010-11



Source: CRU data, CA Cheuvreux

ILLUSTRATION OF TYPICAL CLIMATE PATTERNS DURING NEGATIVE NAO PHASES

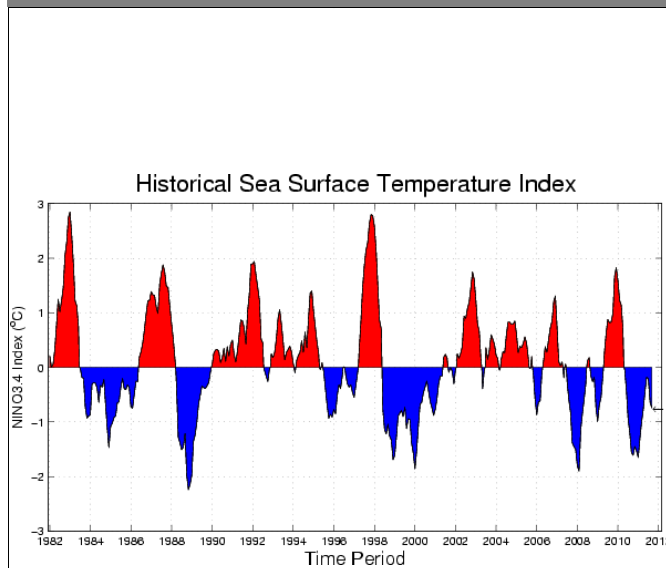


Source: Martin Visbeck and Heidi Cullen, Lamont Doherty Earth Observatory, NOAA

The ENSO also drives the weather in the tropical Pacific region...

The El Niño / La Niña Oscillations have greater repercussions in the tropical Pacific region. We have been through two years of La Niña, with a notably strong cold phase experienced in 2010. The typical climate effects of the La Niña phases are depicted in the right-hand chart below.

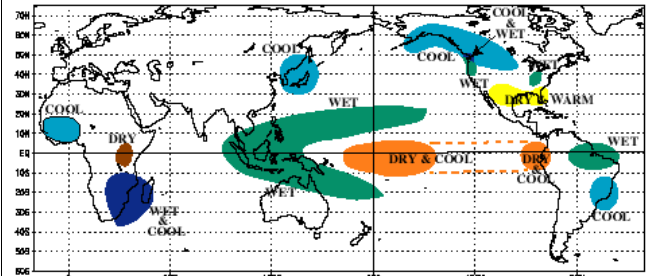
ENSO EL NIÑO / LA NIÑA SEA SURFACE TEMPERATURE INDEX



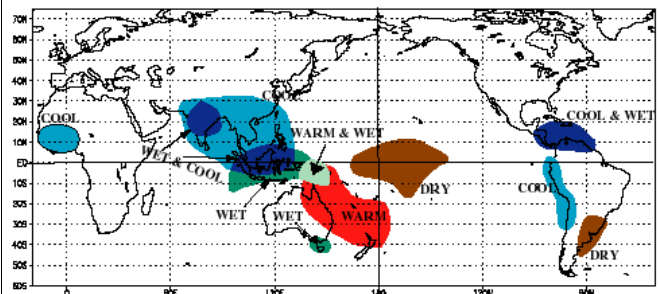
Source: NOAA

ILLUSTRATIVE IMPACT OF A MODERATE LA NIÑA EVENT OVER WINTER AND SUMMER *

COLD EPISODE RELATIONSHIPS DECEMBER - FEBRUARY



COLD EPISODE RELATIONSHIPS JUNE - AUGUST



*Opposite patterns during El Niño events

Source: NOAA

...and the cold phase in 2010 was a cause of the floods in Australia

ENSO events more predictable than NAO phases

Multi-decadal oscillations such as the Atlantic Multidecadal Oscillation (AMO) and the Pacific Decadal Oscillation (PDO) can interfere with NAO/ENSO oscillations and sometimes enhance their climate effects on specific areas.

For instance, the 2010 floods in Australia were characteristic of a severe La Niña episode reinforced by a negative Pacific decadal oscillation pattern.

Overall climate forecasts remain uncertain

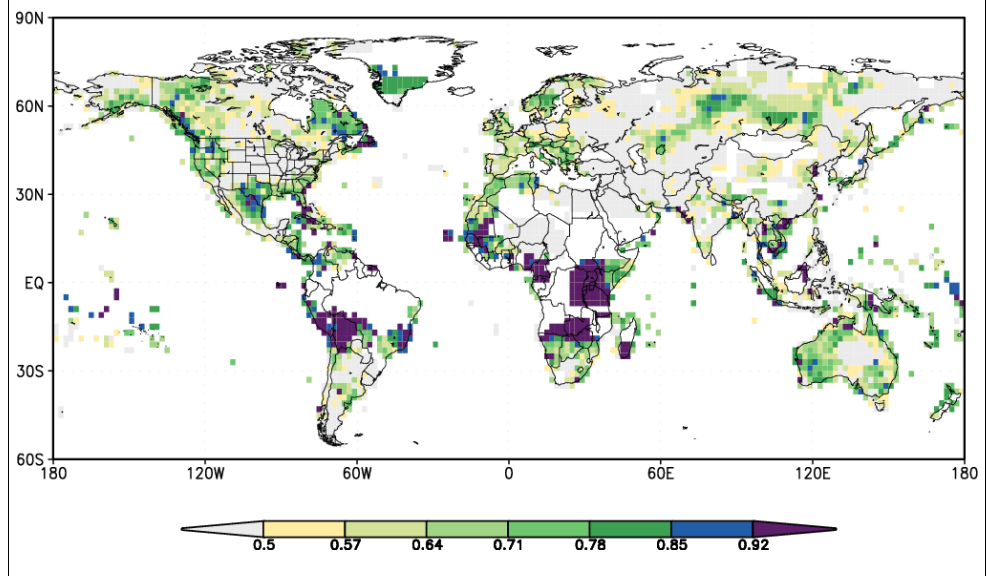
Because of the physical processes involved, ENSO events are more predictable than the NAO phases. For the latter, decent correlations between forecast and actual values are obtained only seven to 10 days ahead (NOAA, GFS forecasts).

The NAO is expected to remain positive for the rest of the year (NOAA), while "weak to moderate La Niña conditions are the most likely scenario into the first couple of months of 2012.

While recurrent weather patterns generally correspond to these oscillations, weather predictions for a given area are nonetheless hardly reliable more than a few days in advance.

The performance of seasonal forecasts varies significantly by region (less reliable for western Europe than for the Pacific Rim for instance), season (summer/winter), and the meteorological parameter observed (temperature/rainfall).

VERIFICATION OF IRI'S SEASONAL CLIMATE FORECAST – TEMPERATURE FORECAST SKILL



* Grey indicates no (or negative) skill, while Purple indicates highest skill
Winter season, with a 0.5-month lead

Source: IRI:

■ Human-induced climate change: normal climate a benchmark of the past

Whatever the emission scenario, **surface warming** is expected to continue during the 21st century and could reach 1.1 to 6.2 °C by the year 2100.

The range of uncertainty of surface warming depends on both the emission scenarios (i.e. the pathway of future emissions) and the discrepancy between climate models simulations (1.1°C to 2.9°C for scenario B1 and 2.1°C to 6.2°C for scenario A2.). Whatever the scenario, surface warming is stronger over the continents than over the oceans. Locally, average surface warming can be several °C stronger than the global average.

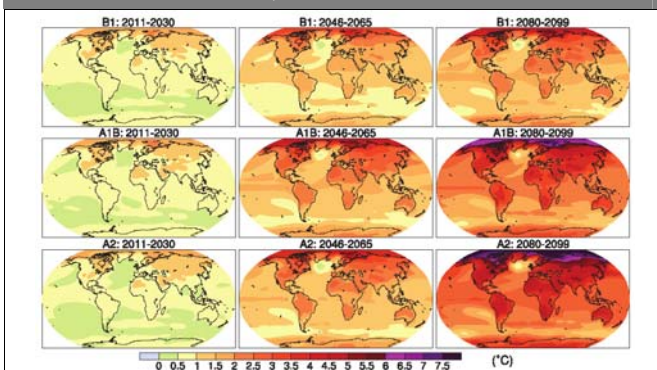
Changes in precipitation are more difficult to estimate than temperature changes and results can differ significantly depending on the climate model. However, although the frontier between zones of increased and decreased average precipitation is unclear, some general patterns do emerge.

Increasing change in rainfall patterns in the coming decades (see right-hand map below) implies a potential significant reduction in run-off water affecting several large areas of arable land in particular in Europe, the United States, part of Brazil, southern Africa and southern Australia. It puts at stake water availability to meet irrigation and manufacturing needs for beverage and food supply purposes. While, northern latitudes and tropics would be increasingly exposed to flooding raising crop failure risks.

Climate change likely
to exacerbate climate
stress...

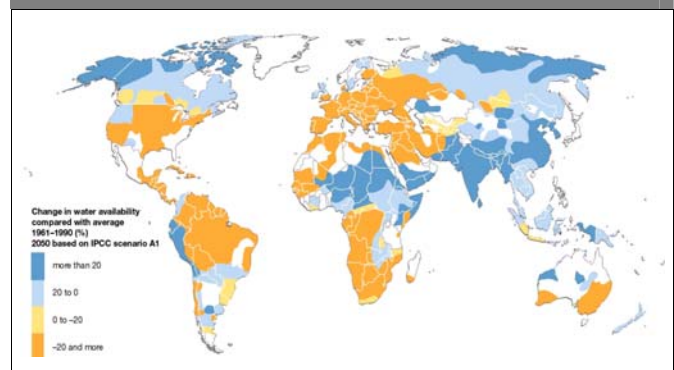
...with new hot spots
for water stress

GLOBAL SURFACE WARMING UNDER THE MAIN IPCC SCENARIOS, RELATIVE TO 1980-1999



Source: IPCC AR4 2007

THE CONTRIBUTION OF CLIMATE CHANGE TO DECLINING WATER AVAILABILITY

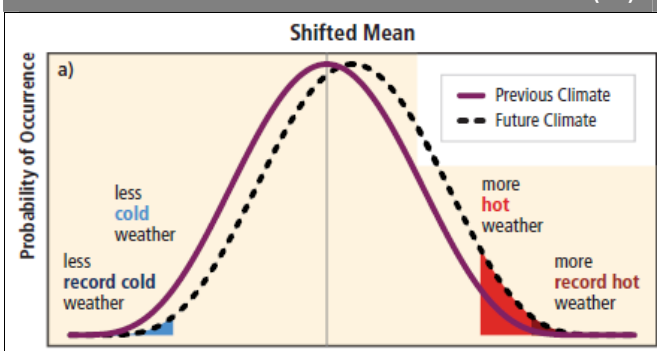
Source: UNEP, Philippe Rekacewicz (*Le Monde Diplomatique*), Arnell

...and new temperature extremes

Climate change is often thought of as a gradual and progressive shift towards a new climate with higher temperatures. The path is likely to be more chaotic with new extremes surging (see charts below).

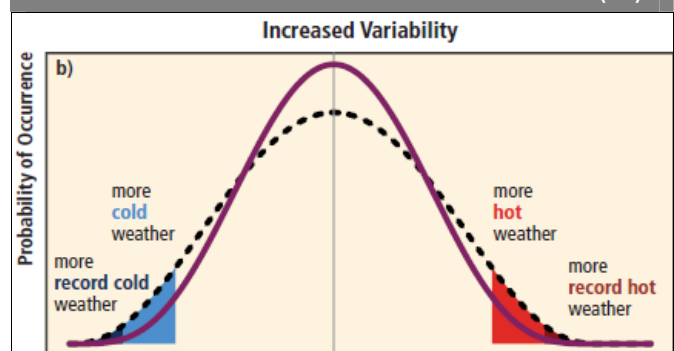
In a recent report to decision makers, the IPCC highlights more evidence that climate change has contributed to the weather hazards experienced over recent years.

EXAMPLE OF CLIMATE CHANGE IMPACT ON NORMALS (1/2)



Source: IPCC SREX Summary for Policymakers

EXAMPLE OF CLIMATE CHANGE IMPACT ON NORMALS (2/2)



Source: IPCC SREX Summary for Policymakers

A sea level rise is already a reality...

Sea level rise: a risk revised upward since 2007

Thermal expansion and the melting of land-based ice are driving sea levels upwards. Ocean warming and increased water inflows from melting glaciers and ice sheets are the primary contributors to rising sea levels. Over the past 15 years, thermal expansion, glacier melting and ice sheet mass loss have each contributed about one-third of the observed sea-level rise.

According to the fourth IPCC assessment report, the global average sea level rose at an average rate of 1.8 [1.3 to 2.3]mm p.a. from 1961 to 2003. The rate was faster from 1993 to 2003 at about 3.1 [2.4 to 3.8]mm p.a. Whether the faster rate for 1993 to 2003 reflects natural variability or an increase in the longer-term trend is unclear. The IPCC is very confident that the observed sea-level rise rate increased from the 19th to the 20th century. The overall rise in the 20th century is estimated to have been 0.17 [0.12 to 0.22]m.

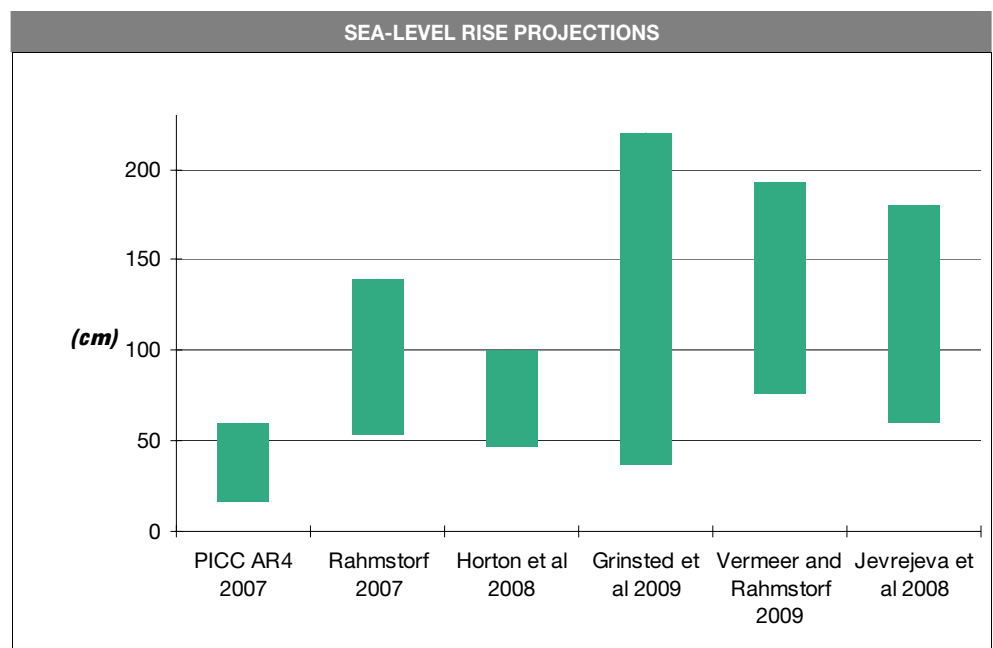
...and most recent forecasts are 2x to 4x worse than in the IPCC's 2007 assessments

New estimates for past sea-level changes have become available since the latest IPCC report. For 1993 to 2008, the sea-level rise was continual (3.5 [3. to 3.]mm p.a. and consistent with earlier estimates. Moreover, other studies have revised the sea-level budget for the past four decades and have shown that the ocean contribution had been underestimated, leading to a better match between the observed rise in the sea level and climate contributions.

As future trends, the IPCC climate model-based projections of the rise in the global average sea level at the end of the 21st century (2090–2099) range from 0.18m to 0.59m for all scenarios. Note that human-induced warming and sea level increase would continue for centuries due to the time scales associated with climate processes and feedback, even if greenhouse gas concentrations were to be stabilised. Ice sheet melting is projected to continue irreversibly on human timescales and will be the primary contributor to the rise in the sea level far into the future, well beyond this century.

Recent new estimates show that the ice sheets in Greenland and Antarctica are melting into the ocean faster than expected. Melt rates are sensitive to climate and are accelerating as both land and ocean temperatures rise. For example, an additional 0.1–0.2m associated with rapid dynamical changes in ice flow of the ice sheets (source: Meehl et al., 2007) have been found. Since then, the IPCC's figures have been challenged with new estimates of a 0.5–1.4m (Rahmstorf, 2007), 0.75–1.90m (Vermeer and Rahmstorf, 2010), 0.8–2.0m (Pfeffer et al., 2008), 0.8–1.3 m (Grinsted et al., 2010) and 0.6–1.6m (Jevrejeva et al., 2010) sea-level rise by 2100.

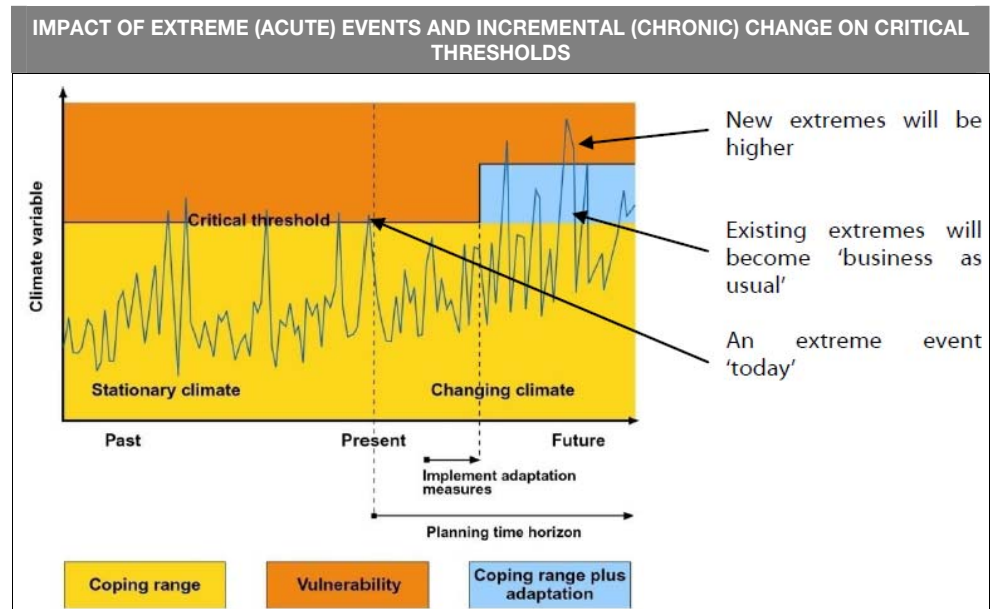
Here we consider the current state of the art for projecting sea level rise for the 21st century. Beginning with the global sea level, we underline that there are now a number of ways of providing information on future changes. Taking the global 21st century sea-level rise estimates from recent studies gives a range of around 20cm to 2m by the end of the century when both emissions and model uncertainties are considered. A key aspect of the next IPCC assessment could be to discuss whether the different approaches taken to give the various ranges of the projected sea-level rise are all valid, and then attempt to narrow this range.



Source: Adapted from Nature

■ Climate and businesses: where is the link?

In addition to natural variability, climate change may add volatility to the climate variable. New extremes would test the vulnerability and profit resilience of climate-sensitive sectors.



Overall, we retain that climate/weather can impact companies in three main different ways:

Three main types of climate change: extremes, anomalies, and "new" climate

- Climate anomalies: year-on-year change in climate conditions, for instance a significant change from above to below normal hydro conditions or temperatures.
- Climate extreme events: risk of major climate hazards such as exceptionally intense storms, or droughts.
- Persistent new climate patterns: a long-lasting change in climate conditions, which may require adaptation measures (e.g. the rise in sea level and lower hydro resources).

CLIMATE RISKS MATRIX

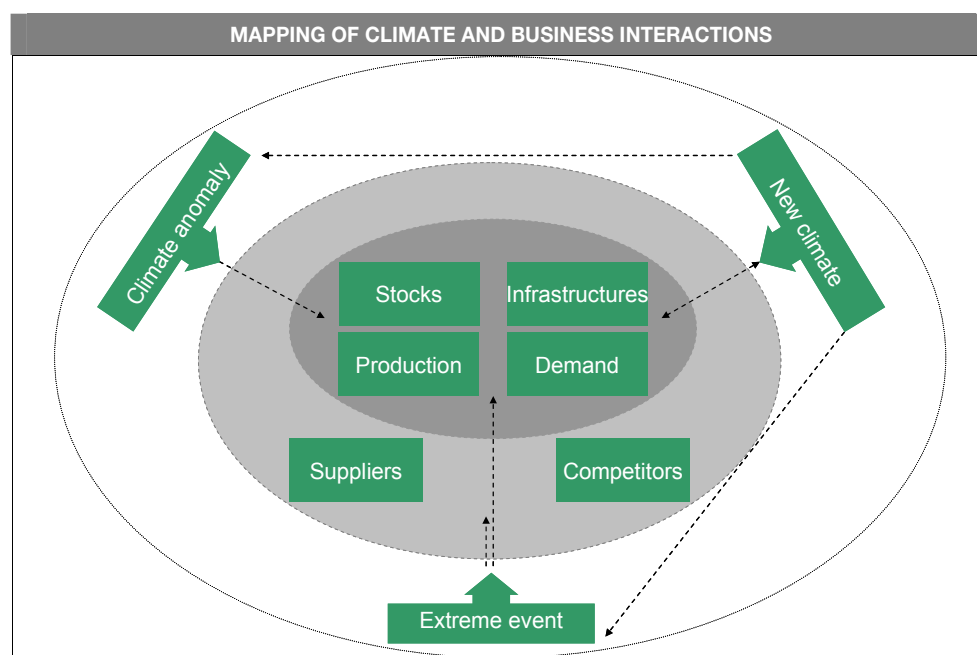
	Climate extreme	Climate volatility	Persistent trend
Temperature	- Heat wave	- Temperatures a few degrees above/below historical average	- Milder winter seasons
Precipitation	- Water shortage due to extreme drought	- New historical high/low in hydro reservoir volumes	- Systematic lower water resource availability
Wind	- Destructive storms	- Change in wind speed	- Evolution of wind corridors
Sea level	-	-	- Loss of land, sea water intrusion

Source: CA Cheuvreux

The demand for products or services, the supply chain or infrastructures of a company can be affected by climate anomalies and weather extremes

The business of a company can be directly impacted by climate at different levels:

- **Production:** for instance, droughts can reduce the availability of power generation capacities (hydro), severe droughts can also create production disruptions for water-intensive industries, cold snaps in winter hamper the construction activity as they have to comply with regulatory standards, etc.
- **Demand:** the demand for climate-sensitive products and services such as water bottles; clothes, electricity for cooling/heating, etc. (see full list in appendix) may vary.
- **Supply risk:** climate hazards can hamper the sourcing of key input for the production process, with potential impact ranging from higher procurement costs in the event of tensions on agrocommodities due to crop failures, to potential disruptions in the supply chain in the case of concentration of the production of key raw materials/components in a single area.
- **Infrastructures/Fixed assets and stocks:** destruction or damage due to extreme weather events / climate hazards (e.g. T&D assets of utilities, telecom equipments, real estate, carmaker inventories)
- **Other:** positive volume or price effects in the event a competitor is struck by an extreme event.



Source: CA Cheuvreux

Climate risks for corporates

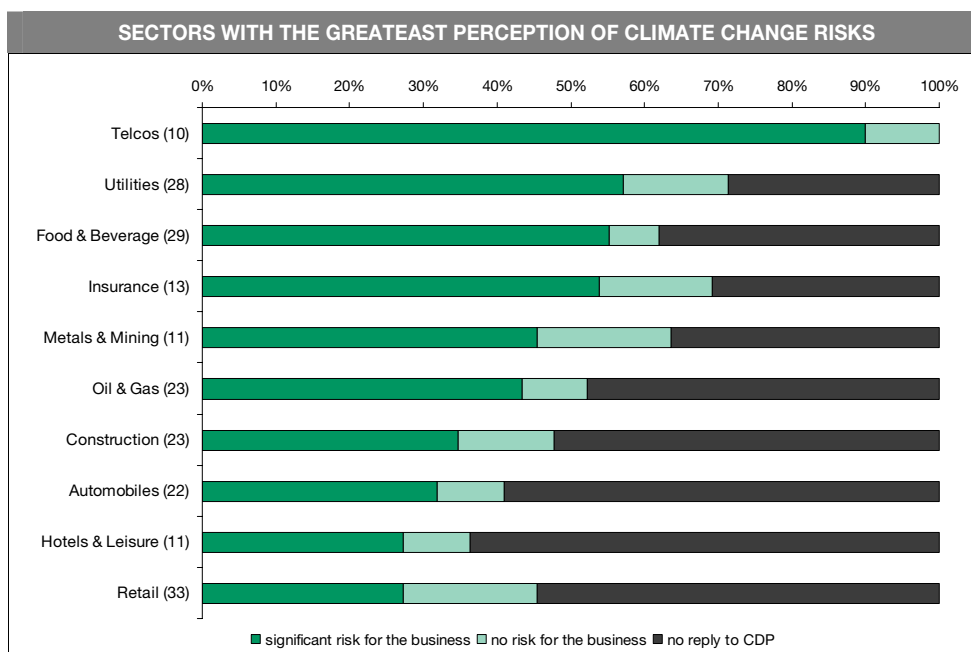
Sectors with the highest perception of climate change risks

More than 50% of European Telecom, Utilities, Food & Beverage and Insurance companies...

The Carbon Disclosure Project annual questionnaire asks listed companies whether they consider their business to be exposed to the physical risks associated with climate change.

In the following table, we analyse the answers of more than 200 European companies within our European research coverage. More than 50% of European companies in the Telecom, Utilities, Food & Beverage and Insurance sectors see climate change as a significant risk to their businesses.

**...consider climate
change to be a risk for
their businesses**



Source: Bloomberg CDP data, CA Cheuvreux

MAIN CLIMATE CHANGE RISKS AND CHALLENGES IDENTIFIED BY SECTOR

	Weather volatility (y-o-y)	Extreme events (weather peaks)	Long-term "new" climate patterns
Automobiles		- Floods, storms, hail risks on buildings, equipment and stocks. Risk of business discontinuity if supply chain is affected	
Metals & Mining		- Production disruption/outage at mines due to extreme weather events (droughts, floods) - Risk for tailing ponds, hampering land rehabilitation efforts	- Increased water costs where water availability become scarcer: southern Africa, south Australia, Central America, the Mediterranean, Middle East, for aluminium, steel, and mining activities - Access to ports due to sea level rise - Supply chain disruption due to thawing of winter ice roads
Hotels & Leisure	- Snow cover at mountain resorts	- Deterioration of assets due to rise in extreme events	- Water scarcity - Deterioration of fragile environment (e.g. coral reef) - Sea level rise endangering resorts - Rise in the number of epidemics - Potential extension of the peak season
Food & Beverage	- Demand for weather sensitive (refreshing) products: bottled water, beer, ice-cream, etc. - Crop yields	- Disruption or price inflation in the agricultural supply chain due to extreme events impacting procurement costs	- Physical availability and quality of water resources (e.g. for bottling operations) - Shift in the location of most adequate production areas. Producers shifting to more drought resistant crops. - Distribution of diseases or pests
Insurance		- Increased losses could raise the cost of capital - Insurers may face annual payouts some US\$ 30-40 billion higher than at present	- Assets may become uninsurable against extreme events
Oil & Gas	- Demand for heating oil and natural gas	- GoM seen as the most sensitive area with regards to risks of increased frequency/intensity of storms in E&P areas - Risk of damages in coastal facilities (refineries, LNG terminals)	- Sea level rise and wave height an important parameter for offshore platforms - Number of icebergs and permafrost melting in arctic regions
Telcos		- Storm and flooding risk for TLC structures, reparation costs - Extremely hot summers a challenge for cooling exchanges (energy and water requirements)	
Construction & Infrastructure	- Construction activity discontinued due to: a) temperatures above/below regulatory standards in developed countries; b) rainy season in tropical countries	- Damage to infrastructures and access to insurance coverage and/or insurance price increase	- Climate migrations could create shifts in construction market - Demand for concrete rather likely to increase as the result of climate change
Utilities	- Electricity and gas demand for cooling (at summer) & heating (at winter) - Hydroelectric and wind production	- Severe droughts hamper hydro and thermal technologies (incl. nuclear) - Damage of storms on networks - Floods damage in Central and Medit. Europe	- Higher temperatures induce efficiency losses in distribution networks - Smoothed peak demand (milder winters, hotter summers) - Lower hydro resources in SE, higher in Nordics - Seal level rise and wave height for wind offshore
Retailing	- Clothing sales affected by weather conditions	- Logistical challenges if disruption in production countries	

Source: Companies, Bloomberg CDP, CA Cheuvreux

Interestingly, we note that water-related risks are seen as the most short-term, whereas others are considered to be more on a medium- to long-term timescale.

Heating needs driven by temperatures

300 more Heating Degree Days than normal in the UK at end Oct. 2011

III – Effect of climate swings on utilities' results

■ Temperatures: a strong driver for the top line

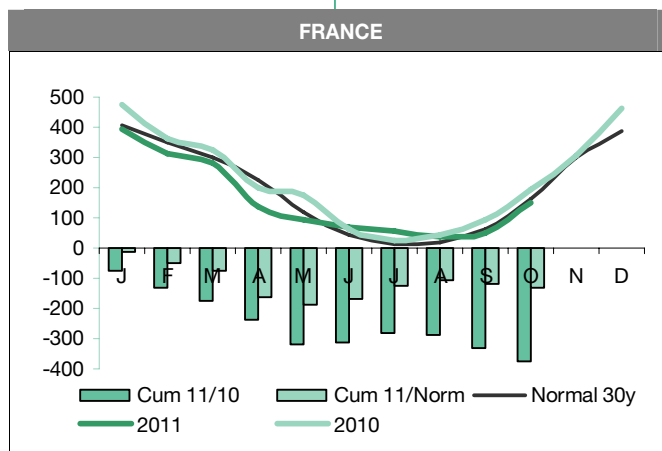
Buildings consume ~ 40% of energy within the EU, mostly natural gas and electricity for heating and cooling use. Temperature anomalies therefore significantly affect demand for electricity and gas.

Energy consumption is the lowest at comfort temperatures (15-20°C), and energy consumption generally grows when temperature rises above these levels because of demand for heating or cooling. European countries show different patterns, however, in terms of sensitivity of gas and electricity demand to temperatures.

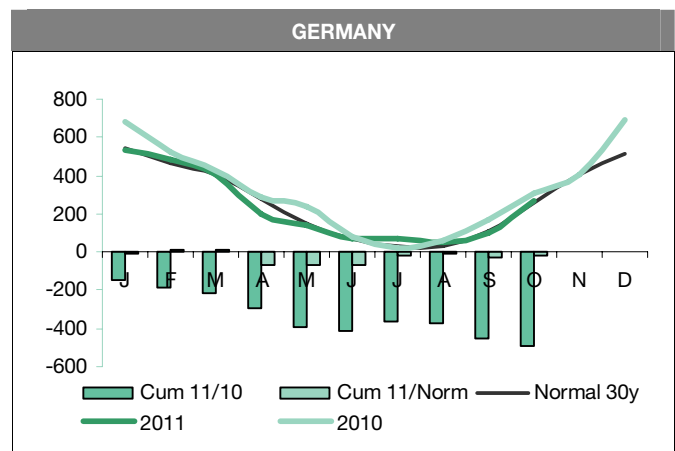
2011: a warm year, especially in France and the UK

2010 was marked by exceptionally cold temperatures across Europe, notably in January and December. 2011 showed opposite patterns, with milder-than-normal temperatures experienced year to date.

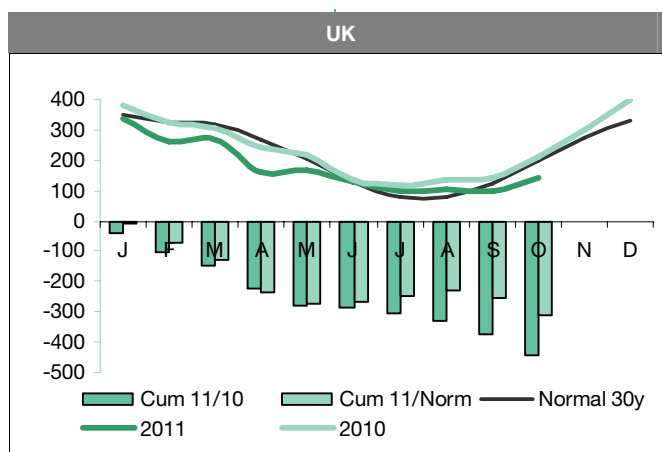
It is possible to track the year-on-year change in heating needs by analysing the evolution of Heating Degree Days (data available on Bloomberg). Based on this indicator, heating needs in Germany, Sweden, the UK, and France have been 12% to 20% lower year-to-date compared to 2010 (see charts below).



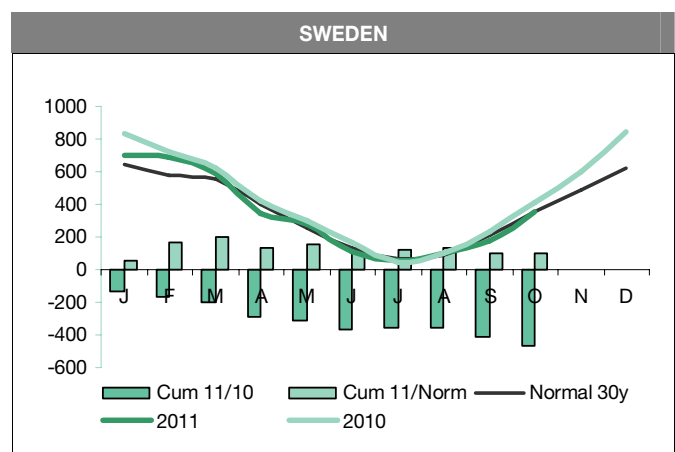
Source: Bloomberg, CA Cheuvreux



Source: Bloomberg, CA Cheuvreux



Source: Bloomberg, CA Cheuvreux



Source: Bloomberg, CA Cheuvreux

Significant impact on UK and France energy consumption

Electricity consumption in France is particularly sensitive to lower temperatures in the winter

→ Demand for heating in the UK and to a lesser extent in France was hit both in comparison with 2010 and below "normal" levels. A normalisation of temperatures would therefore positively impact the results in retail energy sales for EDF, GDF-Suez and Centrica.

From degrees to energy sales

Sensitivity of electricity consumption to temperatures

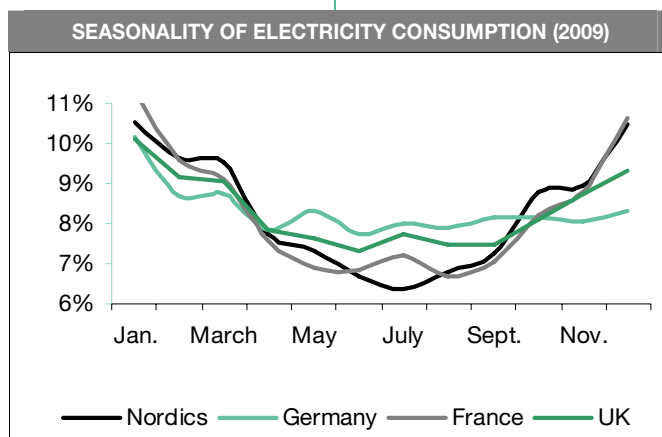
A sensitivity analysis comparing temperatures and electricity consumption in five of the main energy markets in Europe shows France as the country with the highest sensitivity of internal electricity consumption to lower temperatures in the winter (see the sensitivity table below). This specificity is due to the high rate of electrification of heating systems. The other consequence is high seasonality in electricity consumption. In addition, the development of heat pumps is likely to increase demand sensitivity to cold temperatures according to RTE.

Spain and Italy share relatively similar patterns, as incremental electricity needs for cooling requirements are visible for temperatures above 20°C. These markets show low seasonality in electricity consumption, and consumption in summer months can even be higher than in winter.

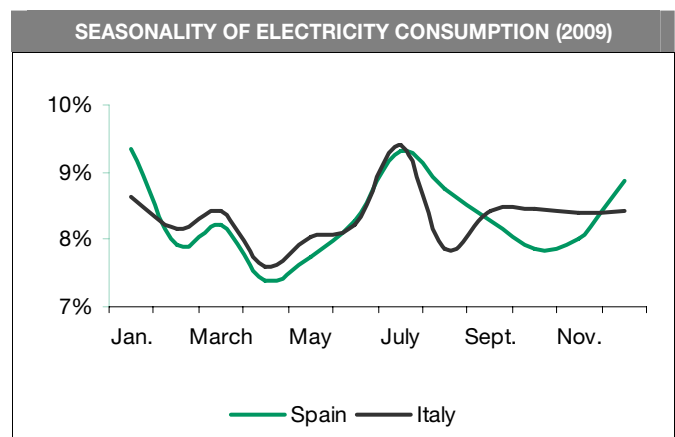
SENSITIVITY OF ELECTRICITY CONSUMPTION TO +1°C MONTHLY MEAN TEMPERATURES

	January	August
France	-2%	0.5%
Spain	-1.25%	2.0%
Italy	-0.5%	2.0%
UK	-1%	0.25%
Germany	0%	0.0%

Source: CLIMPACT based on ENTSOE data of hourly load from Jan 2006 to November 2011 except UK from January 2009 to November 2011



Source: CA Cheuvreux

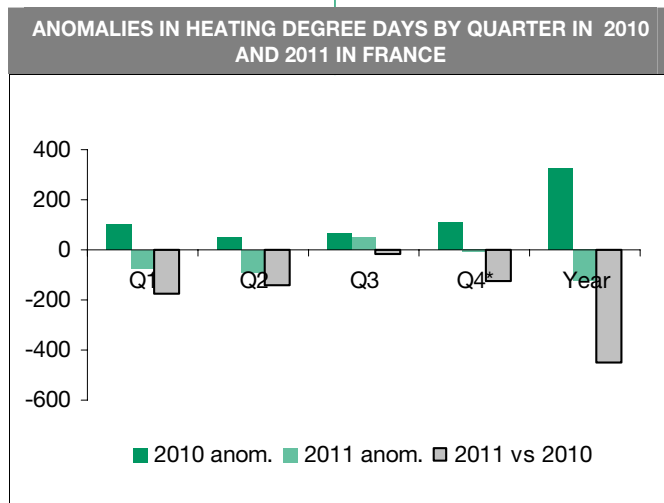


Source: CA Cheuvreux

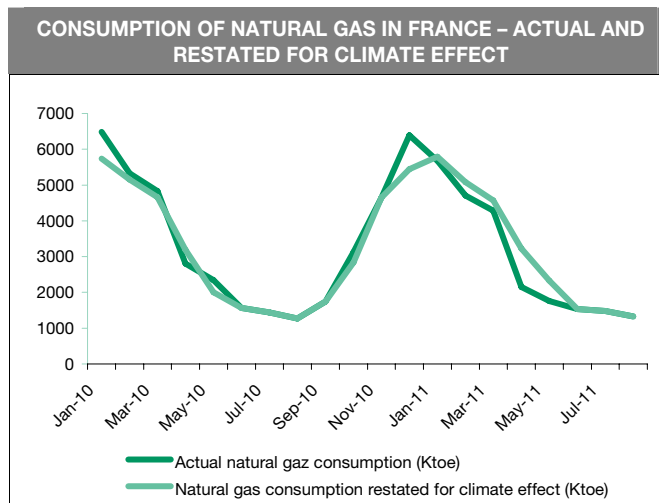
Based on the RTE (transmission network operator) monthly bulletin estimating the monthly electricity consumption restated for the climate effect, we find that a **+1°C deviation to normal tends to lead to -/+ 1.4TWh** over one month on average (except summer months)

Sensitivity of gas consumption to temperatures

By comparing HDD anomalies with natural gas consumption figures provided by the French energy minister and restated for the climate effect, we find that one additional 100 HDD (approximately equivalent to 1°C warmer temperatures over three months) results in additional consumption of ca. 13TWh of natural gas in France.



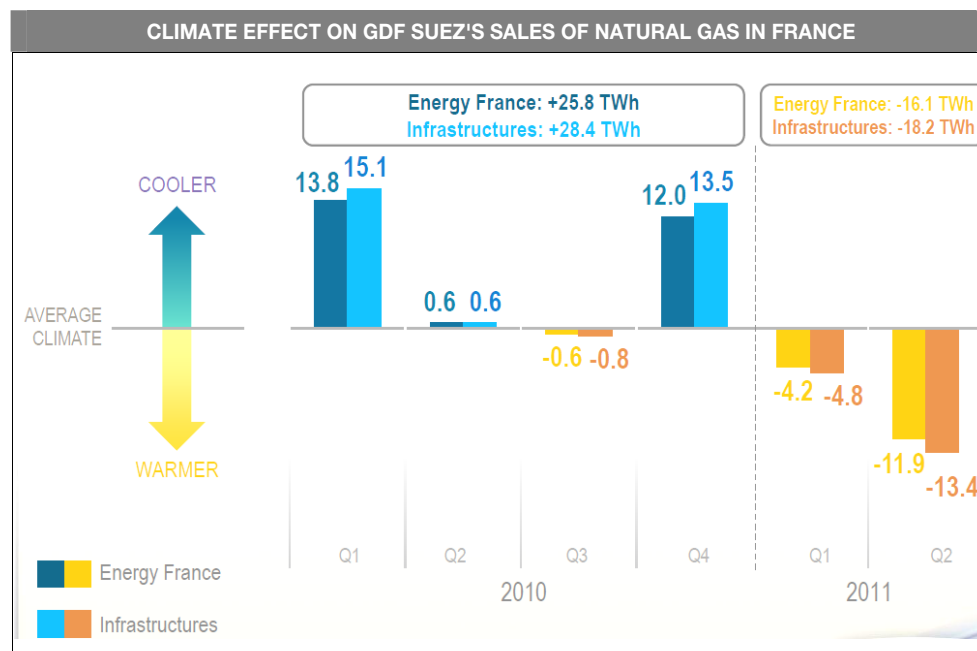
Source: Bloomberg, CA Cheuvreux



Source: Pegase database

+100 Heating Degree Days translates into +12-13TWh of gas consumption

These figures match relatively well with the analysis provided by GDF Suez on the impact of climatic conditions on their sales of gas in France.



Source: GDF Suez

For the UK, we estimate that the additional domestic gas consumption per 100 HDD, could be around +12TWh on average, or a 3.5% increase on annual retail gas sales.

**At the EBITDA level:
sensitivity estimated
at +EUR15m/TWh for
French players**

**Verbund, EGP, Fortum
and EDP rely the most
on hydro power**

We have estimated this figure by comparing the year-on-year change in HDD in the UK with the change in domestic gas consumption in H1 2011, and assuming an underlying 3% reduction due to energy efficiency improvements.

From energy sales to EBITDA

The effect on EBITDA is the most difficult to estimate. GDF Suez provides the following sensitivity: for a +1/-1TWh change versus average climatic conditions, EBITDA changes by +15/-15m.

EDF does not provide a clear sensitivity figure but reported in 2010 a EUR215m positive impact on EBITDA for 13.7TWh in additional sales due to the colder weather. This suggests a sensitivity quite close to that reported by GDF Suez (+EUR15.7m of EBITDA per TWh sold).

Therefore, we estimate that EDF might report a negative impact of EUR235m due to climate in 2011. However, assuming a normalisation of temperatures in 2012, the potential upside for 2012 EBITDA is much more limited, in our view.

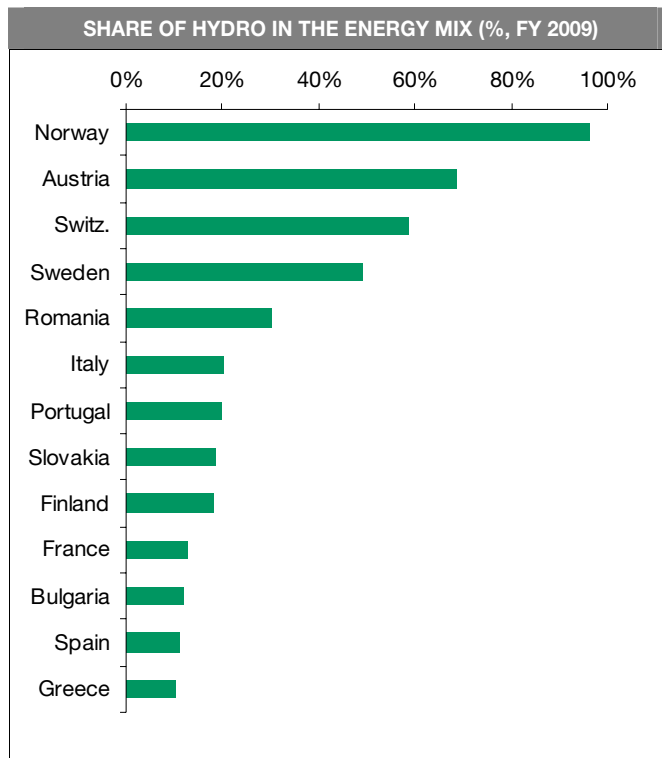
■ From hydro conditions to profits: a complex relationship

In the EU-27, 12-13% of power generation comes from inexpensive hydroelectric energy, with wide disparities by country (from 0% in the Netherlands up to 96% in Norway).

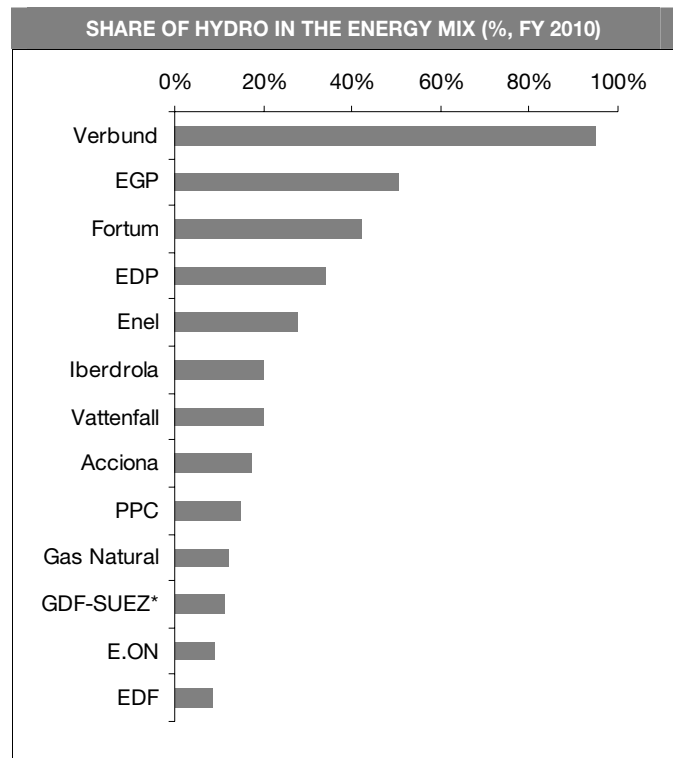
Among companies, Verbund is by far the most dependent on hydro resources, as hydro represents 95% of its energy mix. Enel Green Power (51%), Fortum (42%) and EDP (34%) come after, with more than a third of their electricity production coming from hydroelectricity (see right-hand chart below).

The availability of hydro resources is relatively volatile and greatly depends on precipitation levels, but also temperatures that drive snow and glacier melting.

The EBITDA of these companies is therefore sensitive to hydro availability. For electricity distributors (e.g. Verbund), lower hydroelectric production forces distributors to source expensive energy from the grid to serve their clients (with potential net losses), while for pure power generators (e.g. EGP, serving the grid), this represents (only) a revenue shortfall.



Source: Eurostat, CA Cheuvreux



* CA Cheuvreux estimate

Source: Companies, CA Cheuvreux

But beware of indirect effects through electricity prices

Wider effects due to the impact on electricity prices

In liberalised electricity markets, where power plants producing the marginal MWh set the price, lower hydro generation tends to push electricity spot prices higher. Therefore, the level of hydroelectricity production impacts all the operators selling electricity at market prices.

Thus, in addition to the share of hydro in the energy mix, the key criteria to look at in order to properly assess the net impact of changing hydro conditions are:

- Are power prices influenced by changing hydro conditions? Does the utility cover its electricity sales with its own power generation portfolio?
- What percentage of the power generation portfolio is directly exposed to a change in electricity spot prices? What is the usual percentage of hedging of normal output?

In the Nordic countries (Norway, Sweden and Finland) and Iberia (Spain and Portugal), hydro conditions are an important factor influencing electricity spot prices. Despite a high reliance on hydro-based power generation, Austrian prices are linked to German prices due to interconnections between the two electricity markets, and they are therefore mainly driven by coal and CO₂ prices.

Hydro coefficient 12% below normal levels offers +EUR165m of upside potential for Verbund in 2012

Record low water resources in Austria and France hit Verbund, EDF and GDF Suez

Verbund – nearing a trough

Verbund generates 86% of electricity from large hydro reservoirs and run-of-river plants, most of which are located in Austria and Germany. The company reports on a hydro coefficient calculated as the coefficient of annual hydro power generation relative to average generation potential of the plants (based on historical water supply).

This indicator dived from 1.06 in 2009 to 0.99 in 2010 and further deteriorated in 2011 with 0.88 reported for the first nine months of the year. The hydro resource therefore is nearing a trough for Verbund, as the record low level since 1955 is 0.84.

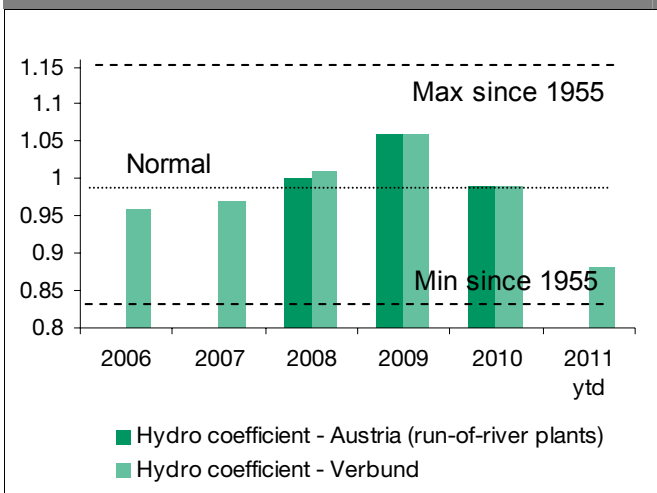
Verbund's results are highly sensitive to: 1) wholesale electricity prices; and 2) the availability of its hydropower capacities.

■ Due to strong interconnections with the German electricity market, Austrian electricity prices are linked to German prices and are not significantly driven by hydro conditions. There is no significant price effect to expect for Verbund due to a change in the water supply.

■ The group estimates that a 1% change in hydropower generation volumes would have a EUR11.9m effect on its operating result for 2011 – all else being equal. Based on the historical trend in Verbund's hydro coefficient over 2006-2010, we estimate that the variation in the water supply added some EUR120m to the group's EBIT over 2007-2009, followed by a significant correction in 2010 and 2011.

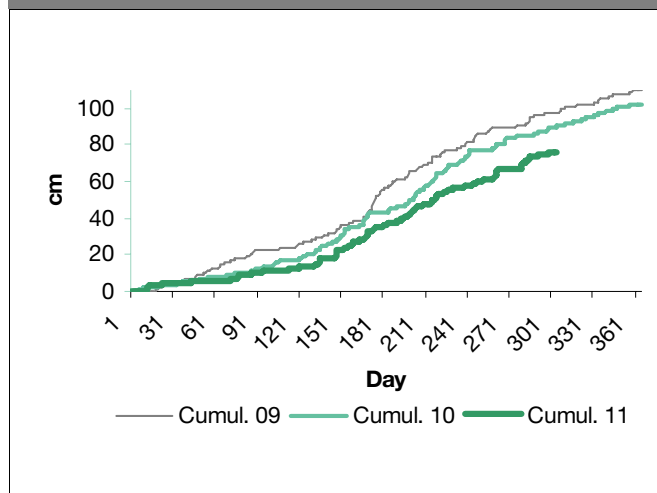
Assuming normalised hydro conditions in 2012, we estimate that Verbund's EBIT can recover by +EUR165m.

HYDRO COEFFICIENT IN AUSTRIA AND AT VERBUND



Source: E-Control, Verbund, CA Cheuvreux

CUMULATED PRECIPITATION IN AUSTRIA OVER 2009-2011



Source: Bloomberg, CA Cheuvreux

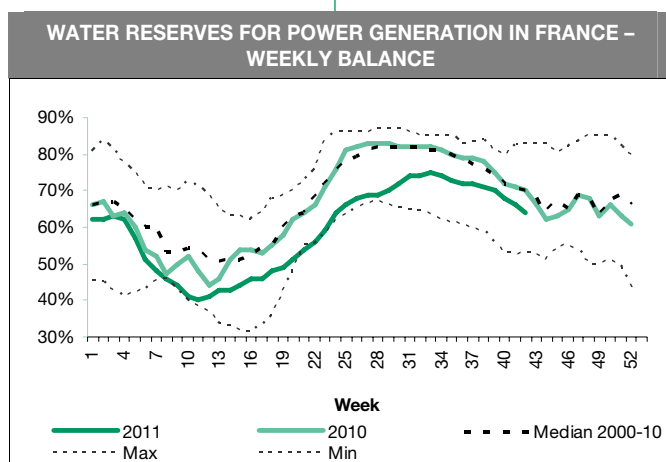
Hydro production volumes 13% below 10-year trough for GDF Suez in H1 2011

EDF and GDF Suez hit by dry conditions

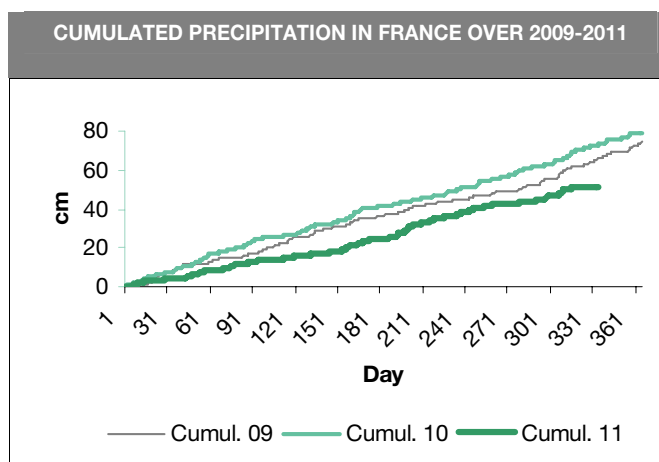
In France, EDF and GDF Suez were hit by dry conditions in 2011 both in comparison with 2010 and versus normal.

Precipitation and water reserve levels were significantly below both 2010 and normal levels (see charts below). At end 9M 2011, EDF hydroelectricity production was 9TWh below 2010 levels. At end H1 2011, GDF Suez estimated that it had produced 3.2TWh less than in H1 2010, with production volumes 13% below the 10-year trough.

It can be estimated that +/-1TWh of hydroelectricity generation translates into +/-EUR45m-50m at the EBITDA level.



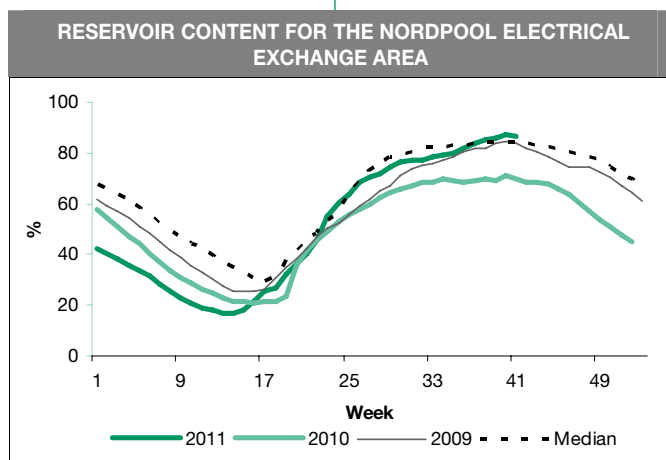
Source: RTE, CA Cheuvreux



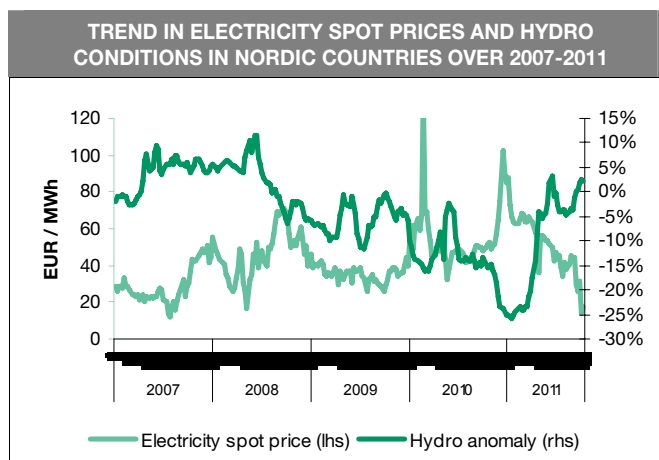
Source: Bloomberg, CA Cheuvreux

Nordics: poor hydro conditions over 2009/mid-2011 returning to normal and putting downward pressure on electricity spot prices

The Nordic power systems have come out of a period of below-average reservoir content (since mid-2008). 2010 was an exceptionally dry year for Nordic hydro reservoirs, whose content plunged 26% below median levels (1990-2006) in Q1 2011. The situation then rapidly normalised to reach above-average levels in October 2011.



Source: Nasdaq OMX, CA Cheuvreux

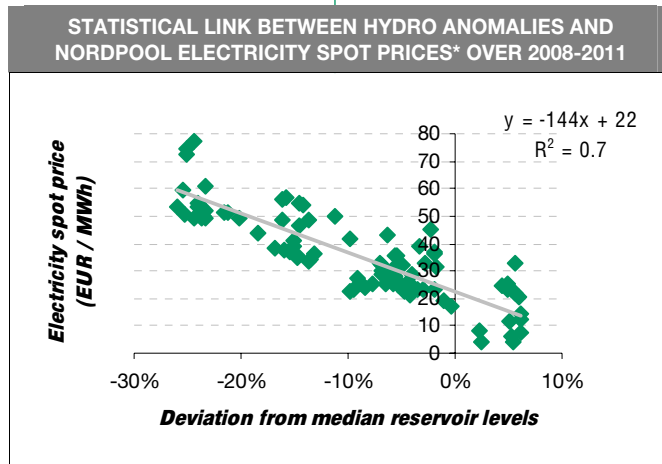


Source: Nasdaq OMX, CA Cheuvreux

Electricity spot prices pushed down by the recovery of hydro reservoirs in Nordic countries

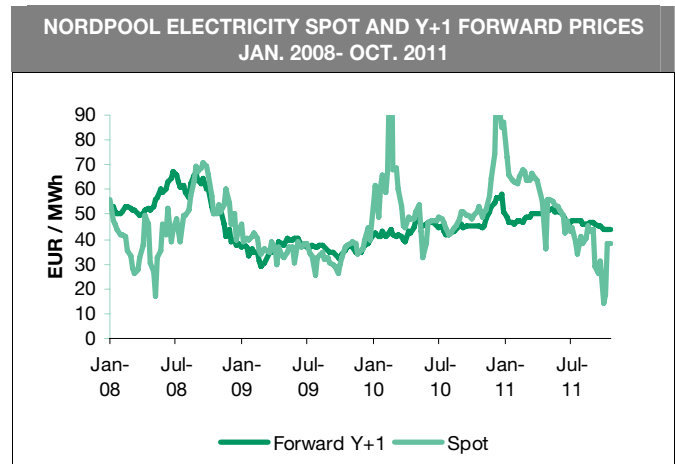
As the main drivers for Nordpool electricity spot prices are said to be CO₂ prices and hydro conditions, we have carried out statistical regression analyses between electricity spot prices (restated for the CO₂ price) and hydro anomalies (deviation from median reservoir levels).

We find that a +/-1% change in the level of the hydro anomaly leads to a +/-EUR1.44 per MWh change in the spot price.



* Restated for CO₂ prices

Source: CA Cheuvreux, Nasdaq OMX, Bloomberg



Source: Bloomberg, CA Cheuvreux

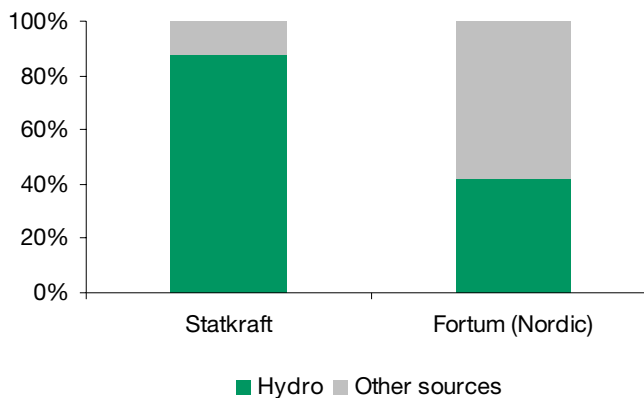
Change in hydro conditions has a rather neutral effect on Fortum

Fortum and Statkraft

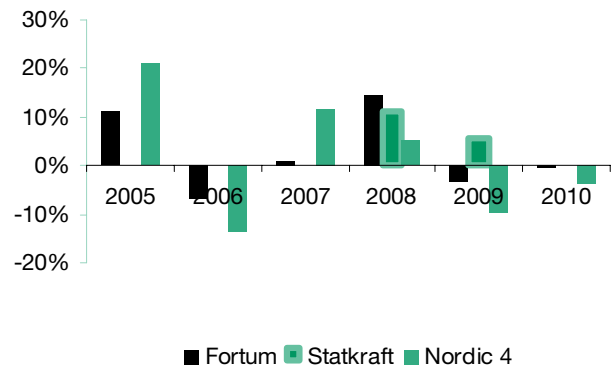
In 2010, Fortum and Statkraft produced almost 37% of total Nordic hydro power generation. Although hydro power decreased in the area both in volumes (-13%) and in contribution (-5 percentage points) over 2008-2010, production volumes were more upbeat for these two companies (Fortum: -3.9%; Statkraft: +5.7%).

The financial sensitivity due to hydro conditions for a company like Fortum is twofold:

- **Price effect:** A change of EUR1 in the achieved power price for Fortum equals ca. EUR50m million in comparable operating profit. Fortum's hedging strategy reduces the exposure to electricity spot prices, which are more driven by hydro conditions than forward electricity prices, which tend also to be influenced by coal prices.
- **Volume effect:** Assuming an electricity price of EUR50/MWh, a 1% variation in hydroelectric generation equals ~EUR22m in comparable operating profit. Overall, over 2004-2010, power generation from hydroelectric plants has been less volatile at Statkraft and Fortum than in the four Nordic countries as a whole (see right-hand chart below). In our view, this suggests that either reservoir levels are better managed or capacities are located in areas where precipitation levels are less volatile.
- **Hedging ratio:** Fortum hedges ca. 70% of its power generation with Y+1 forward sales. Overall, and based on the above-mentioned sensitivity, the hydro impact on Fortum appears relatively neutral.

SHARE OF HYDRO POWER GENERATION IN THE NORDIC AREA


Source: Company data, CA Cheuvreux

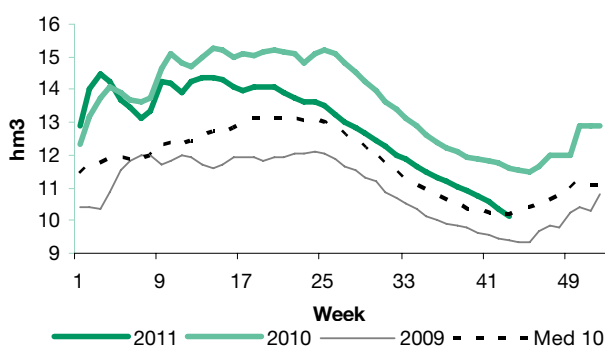
TREND IN HYDRO POWER GENERATION Y-O-Y


Source: Company data, CA Cheuvreux

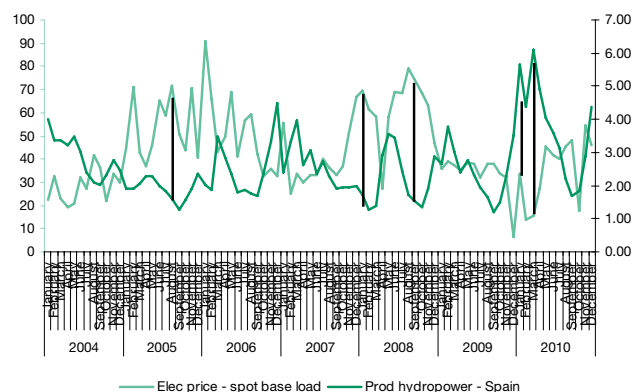
Iberia: normalisation from 2010 ten-year record-high levels

After five years of relatively low reservoir levels, high precipitation in 2010 sent reservoir levels back to historical high and allowed more than 5TWh of hydro power generation to feed the grid for three consecutive months in 2010. Since the end of Q1 2011, the level of reservoirs has generally tended to return to normal in Spain (see chart below, left-hand scale).

Although the availability of hydro power is only one of the factors influencing electricity prices in Spain (along with gas prices, and CO₂), the influence of hydro conditions remains determinant on spot electricity prices (see chart, right-hand scale). Due to interconnections, wholesale electricity prices in Portugal are linked to Spanish prices.

LEVEL OF HYDROELECTRIC RESERVOIRS IN SPAIN


Source: MARM, CA Cheuvreux

HYDROPOWER GENERATION AND ELECTRICITY SPOT PRICES IN SPAIN SINCE 2004


Source: MMA, Reuters, CA Cheuvreux

Iberdrola, Acciona and EDP show less sensitive profiles, in our view

In the table below, we present the main factors influencing the level of sensitivity of Iberian companies' results to changes in hydro conditions.

Counter-intuitive sensitivities in Spain...

...as Iberdrola has a relatively good standing in a context of lower hydro power generation

The first two factors determine the sensitivity of the cost base (procurement costs or unit production costs). For instance, a gap in hydro generation forces companies which produce less electricity than they sell retail (such as Endesa or Iberdrola) to source expensive electricity from the grid.

However, such an adverse impact can be more than offset by the (positive) effect of lower hydro generation on electricity spot prices. The other two factors (share of zero-cash cost capacities in the power generation portfolio; percentage of generation hedged forward) indicate how much a company may benefit from higher electricity spot prices. Acciona and Iberdrola are well positioned to capture the benefit of higher pool prices.

Hence the positive top-line effect more than offset the adverse effect of procurement costs for Iberdrola in 9M 2011 in an environment of deteriorating hydro conditions.

In a context of deteriorating hydro conditions, profiles such as Acciona and Iberdrola tend to be positively impacted, despite the higher share of hydroelectricity in their mixes, while a company such as Endesa tends to suffer.

EDP is a specific case. Although the company's power generation portfolio largely relies on hydroelectricity, the group's financial sensitivity to changing hydro conditions is largely muted by the specific remuneration framework in Portugal (CMEC).

KEY FACTORS OF HYDRO SENSITIVITY AT IBERIAN ELECTRICITY UTILITIES, AS OF 9M 2011

Company	Long/short (% of energy purchase)	Share of hydro	Share of non-variable production costs	Hedging	Comments
Endesa (Portugal & Spain)	-36%	9%	42%	70-75%	Lower liberalised margin due to lower hydro (-2.3TWh) and nuclear production (-1.8TWh). Negative impact on EBITDA (-10% y-o-y, or ~EUR480m)
Iberdrola (Spain)	-34%	23%	78%	~80% (40TWh sold for 2012)	Basic margin slightly lower (-40bp) but up in volume as higher prices more than offset higher procurement costs
Acciona	N/A	14%	96%		Conventional hydro production down 34% but EBITDA margin up thanks to higher pool prices
Gas Natural (Electricity Spain)	5.3%	9%	26%	N/A	Hydro production down 30%; partly explains the negative trend with gross margin down 440bps and EBITDA down EUR148m y-o-y
EDP (Liberalised Iberia)	-68%	12%	19%		Average sourcing cost up 29% (both due to higher procurement cost and fuel costs) versus avg. selling price up 16%
EDP (PPA/CMEC)	N/A	56%	56%	eq. 100%	CMEC plants do not benefit from windfall profits in case of power price increases. Higher/lower than normal hydro conditions are paid back/recovered. 9M 2011: EUR38m to be paid back due to higher than anticipated hydro production
EDPR	N/A	0%	ca. 100%	See comment	Leverage on capacities under transitory regime only (before 2008). Ca. 92% of RD661/2007 capacity was under the fixed tariff option as of Sep-11

Source: Companies, CA Cheuvreux

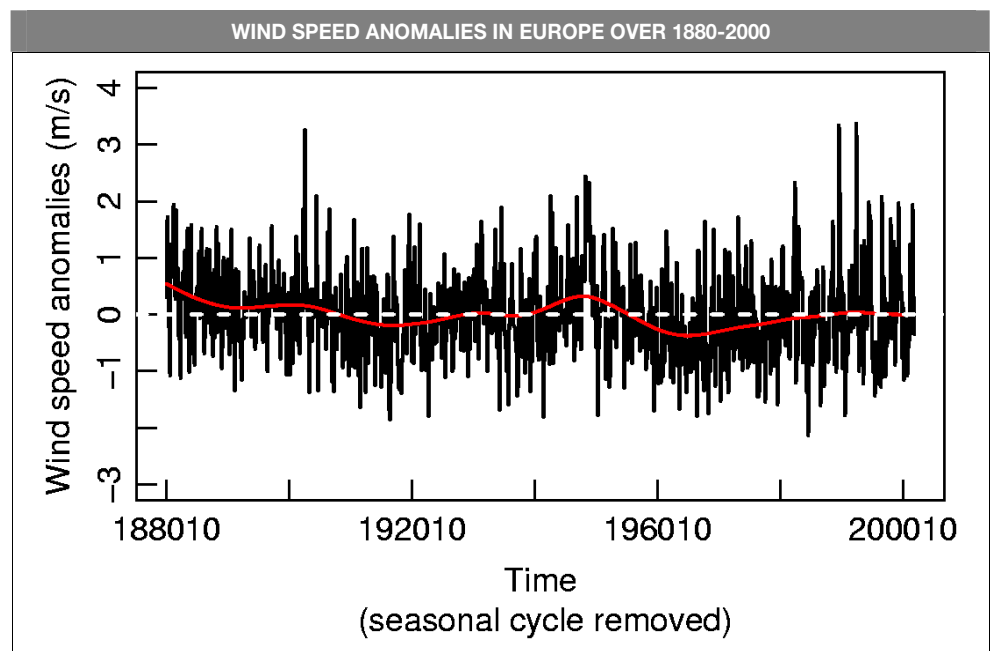
ENEL: Adjusted for one-off items, ENEL's Q2 results were quite weak (organic EBITDA down 6%) and affected by poor hydro conditions in Italy and Spain and the severe drought in LatAm (combined estimated impact of ~EUR200m). Assuming normalised hydro conditions and excluding the tax, EBITDA would have been roughly in line with last year.

■ Wind resource variability means earnings volatility for wind companies

The operations of wind developers are highly dependant on the availability of wind resources, which, at a given location, show significant inter-annual, seasonal and intra-day variability.

Wind speeds are influenced by:

- Large-scale patterns, e.g. the general circulation of the atmosphere, driven by large-scale atmospheric circulation patterns (such as the North Atlantic Oscillation);
- Local thermal contrasts and topography.

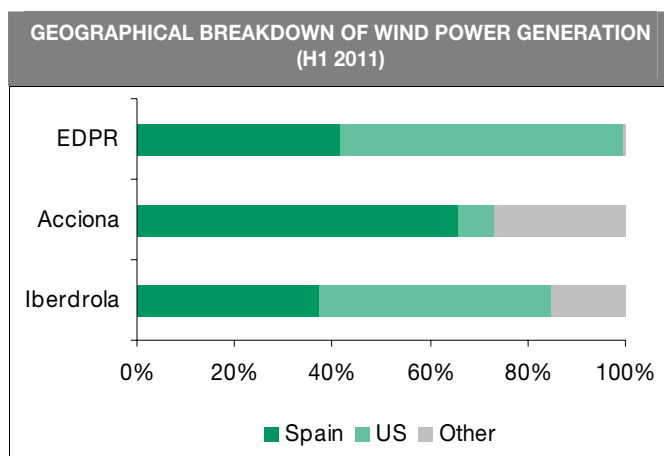


Source: Ansell *et al.* (2006)

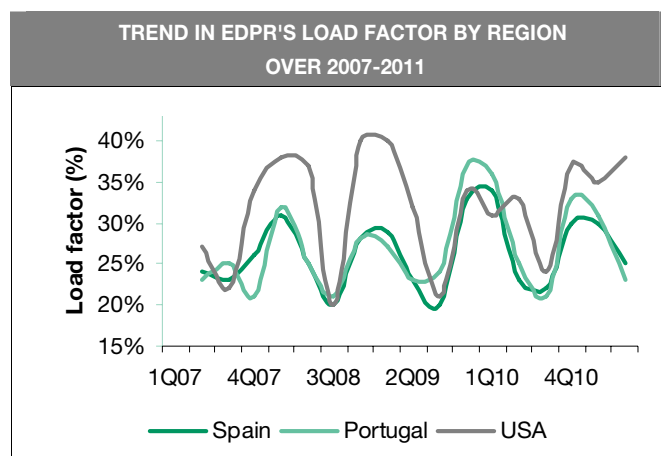
**Wind speeds drive
load factors of wind
assets...**

Over the longer term, climate change is likely to have an influence on wind patterns, but research in this area is limited.

The short-term variability of wind resources directly impacts load factors of wind farms and consequently production and earnings figures reported by companies such as EDPR, Acciona, Enel Green Power and Iberdrola.



Source: Company data, CA Cheuvreux



Source: EDP, CA Cheuvreux

...and EBITDAs of wind farm developers

Companies limit the sensitivity of their results to local wind resource availability by diversifying their geographical mixes. For instance, Iberdrola Renovables' H1 2011 load factor came out fairly stable y-o-y, as the 320bp drop in the load factor in Spain was more than offset by rises of 300bp and 760bp, respectively, in the load factors in the US and the UK.

Hence, at a company level, apart from exceptional events, it is sensible in our view to assume that y-o-y swings in annual load factors are limited within a +/-100bp variation.

EDPR is the most sensitive stock in our universe

The table below shows how sensitive companies' results are to a +/-100bp variation in their annual load factor. EDP Renovaveis appears to be the most sensitive, with potential upward or downward swings in operating results of +/-7.6%.

ESTIMATED IMPACT OF A 100BP RISE IN THE LOAD FACTOR ON ANNUAL RESULTS

	Capacity at H1 2011 (MW)	Incremental production for a 100bp increase in the load factor (GWh)	Average price / MWh (H1-11)	EBITDA margin (%)	Incremental EBIT due to a +100bp rise in the load factor (est.)	As a % of EBIT 2011E	EBIT 2011E
EDPR	6887	585	56	75%	25	6.4%	392
Acciona	5747	488	70*	72%	25	3.9%	637
Iberdrola	12792	1087	64.5	70%*	49	1.0%	4989

* Assumptions. Availability factor of wind turbines is assumed at 97%

Source: CA Cheuvreux, company data

Storms with wind velocity above 25 m/s weigh negatively on load factors

The remaining question is: can we anticipate such swings in load factors in order to refine earnings forecasts and avoid surprises from quarterly publications?

Tracking wind speeds to enhancing wind power production forecasts

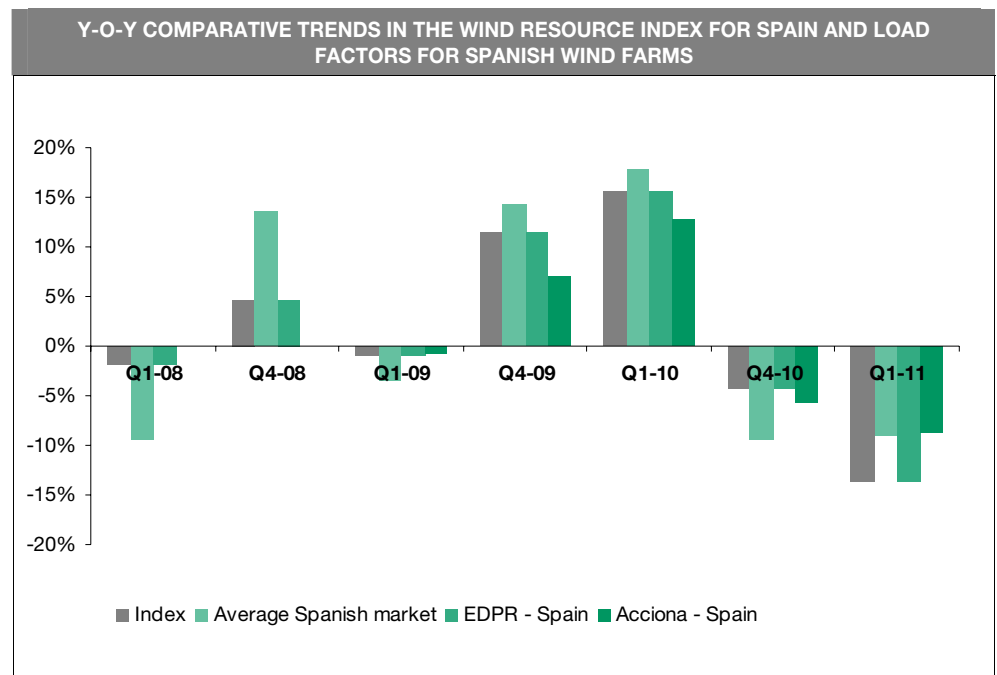
Being able to track wind data can help to enhance and refine forecasts of operational performances, and hence the operating results of wind developers.

For a real-time follow-up, we have built an index aimed at being representative of the availability of wind resources for wind power generation in Spain. The index is a wind-power-capacity weighted average of regional daily wind speeds, with data sourced from the Bloomberg weather platform. To take into account the fact that a typical wind turbine reaches its maximum power output at a wind speed between 12 and 14 m/s, all the data points above 14 m/s have been restated at 14 m/s.

**Our tool to track
significant changes in
the wind resource in
Spain**

Importantly, wind speed values above 27 m/s are restated at 0 to reflect the fact that wind turbines normally stop when they face winds with velocity higher than ~25 m/s (or 90 km/h). The Klaus windstorm, which hit Spain in January 2009, can notably explain the historically low load factors reported for Spain in Q1 2009, as we estimated it led to two days of outage of wind turbines.

A comparison of the trend in this index with quarterly trends in Spanish wind farm load factors shows a decent correlation for winter and autumn periods. These quarters experience the highest load factors but are also the most volatile from one year to the next.



Source: CA Cheuvreux, Bloomberg weather data, company data, AEE

IV – 2011: drier and warmer, but not a trough for everyone

In the table below, we summarise the weather effects reported by companies for 2011, along with our estimates of the effect on companies' results in 2012 of a potential normalisation of climate conditions.

■ Highest climate upside for Verbund, GDF Suez and EDF

Verbund would benefit the most from a normalisation in the availability of hydro resources in 2012, as this scenario would push EBITDA up EUR165m from 2011E levels (+13%).

CLIMATE EFFECTS REPORTED IN 2011 AND OUTLOOK ASSUMING NORMALISATION

	Temperature	Hydro	Wind	Estimated effect of climate normalisation	
ELECTRICITY UTILITIES					
EDF	FR: Negative sales impact EUR953m (-5%). At EBITDA level, -EUR180m in regulated activities; +EUR100m in supply activities (wholesale). Negative volume impact in gas activities in the UK. -14TWh sold in France due to milder weather conditions	-EUR380m in H1 2011; -9TWh in hydro production at end Sept. 2011 (-7.6TWh at end June 2011) so we can estimate a EUR450m adverse impact due to poor hydro conditions at end Sept. 2011 (versus 2010)		+ EUR450m in case of normalisation of hydro generation	+3% of EBITDA 2011E
ENEL	No information	Estimated EUR200m adverse impact from poor hydro conditions in Italy and Spain and severe drought in Latin America			Positive
Fortum	Warmer weather main reason for 2% decrease in electricity consumption in Nordic countries	Record low water inflow during Q1 2011. Positive effect from increased hydro volumes in Q3 2011		Q1 2012: +EUR20m	-
Iberdrola	Scottish Power in the UK; gas retail sales down 15%	Lower hydro in Spain (-27%) but reserves still +15% above historical level at end Sept. 2011	Lower wind resource negative (20.9% vs. 22.6% load factor). Seen improving in Q4		Positive
RWE	Temperatures in Germany, the UK, the Netherlands and central Eastern Europe, were higher than the long-term seasonal average. RWE's estimates for gas markets in Central Europe all have volumes dropping by about 9%. A decrease of 14% was calculated for the UK.	Below 2010 as rainfall in the spring was unusually low	Wind conditions lower than long-term seasonal average but higher than 2010 in Germany and the UK		-
E.ON	Gas sales volumes down 11.5% in customer segments (customer losses, weather effects, energy efficiency effect quoted)	Lower volumes: -EUR59m in Germany, Sweden and Italy			-
Verbund	No information	Hydro coefficient 0.88 vs. 0.97 in 2011. Hydro power -7.9%. Higher procurement costs		+EUR165m on EBITDA	13% of group EBITDA 2011E

GAS UTILITIES					
GDF Suez	Energy France: -42TWh adverse effect vs. 2010; -16.1TWh vs. normal. +1/-1TWh change vs. average climatic conditions, EBITDA changes by +15/-15m. -EUR50m negative weather impact in Belgium	-3.2TWh vs. H1 2010 and 13% below the 10-year lowest point. -EUR145m impact.		Negative impact of ca. EUR700m compared to 2010 due to exceptional unfavourable weather conditions. This difference can be explained by -EUR480m for year to date 2011 vs. +EUR220m for the same period in 2010	4% of group EBITDA 2011E
Centrica	Average residential gas consumption fell by 18% in the first six months of the year, partly due to the milder weather				-
Gas Natural	Retail gas sales down 30% as a result of milder weather in 2011	Hydro production down 30%			
RENEWABLES					
Acciona		Lower hydro (attributable production down 31% in 9M 2011)	9M 2011 load factor 1.5pp below comp. 2010 (exceptionally high in H1 2010)	Price effect more than compensated for adverse availability of natural resources	-
EDPR			Slightly lower wind resources in Europe in 9M 2011 (-1 pp vs. 9M 2010 and ca. -2pp vs. historical average)		Ca. +2.5% on 2011E EBITDA

Source: Companies, CA Cheuvreux

GDF Suez comes second in terms of financial impact. Based on the climate impact reported by the group at end 9M 2011 and our own estimates for Q4 2011, we reckon that **a normalisation of climate conditions in 2012 could add +EUR650m to the EBITDA** in 2011E. This represents more than 40% of our 2012 EBITDA growth forecast.

IMPACT OF WEATHER ANOMALIES ON GDF SUEZ'S EBITDA – CHEUVREUX'S ESTIMATES FOR Q4 2011

	H1 2011			Q3 2011		Q4 2011E		FY 2011E
	EUR m	TWh	EBITDA/TWh	EUR m	EUR m	TWh	EUR m	
Energy France (incl. -145m hydro)	-305				-125		-430	
- gas sales	-160	-16.1	10		-80	-8	-240	
- hydro production	-145	-3.2	45		-45	-1	-190	
Energy Europe infrastructures	-50	-3.1	16		0		-50	
	-110	-18.2	6		-48	-8	-158	
Weather impact in domestic markets	-465			-15	-173		-653	

Source: GDF Suez, CA Cheuvreux

For EDF, we estimate that a scenario of weather normalisation in 2012 in France offers +EUR450m upside to EDF's EBITDA for 2011E. A less significant impact from higher sales due to slightly lower temperatures in 2012 could come on top of that.

■ Climate normalisation: reasonable guidance for 2012?

Several institutions around the world provide seasonal forecast either freely or on a subscription basis (see table below). Their seasonal forecast products differ in terms of the model they use (most institutions have their own model, some provide a blend of several models and/or methods). Most of the time, a benchmark of results is difficult because forecasts are shown as “departures” from a reference period deemed to be average conditions (the so-called “climatology”).

The accuracy of seasonal forecasts is highly dependent on location and time of the year. It is reliable in the tropics, but very uncertain for higher latitude zones such as Europe.

**Climate models
suggest warmer than
usual conditions
ahead across northern
Europe**

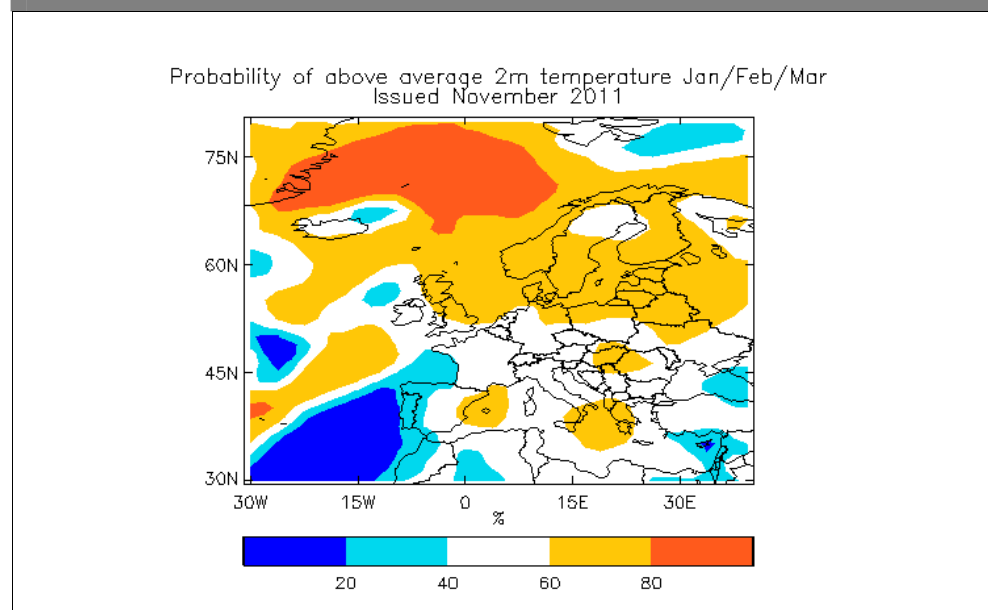
Generally speaking forecasts are more accurate for winter than for summer conditions. Moreover, they are presented as a probabilistic forecasting (e.g. the probability of exceeding a threshold) and not as a deterministic forecasting ("one number") as for the weather forecasts provided in the press or on television. Therefore, seasonal forecasting should be used with extreme caution as a trend indicator.

Insights on weather forecasts for Q1 2012

In the tropical Pacific, since August, the El Niño Southern Oscillation (ENSO) has shown unusual cold conditions. Current forecasts predict, with reasonable reliability, continuing cold conditions throughout the winter with moderate intensity. Over Continental Europe, this situation is known to favour cold temperatures with dry conditions in the south and wet conditions in the north in early winter, as it did last year (even though the ENSO cold conditions occurred at a higher intensity).

But ENSO conditions are not the only driver, and thus seasonal forecast models have to be trusted to account for all other climate processes influencing winter conditions. The three major models (ECMWF, UKMO, and NCEP) tend to confirm the precipitation forecasts but with significant spatial differences among them (a larger dry region for ECMWF, not shown). In terms of temperature conditions, the three models suggest warmer than usual conditions over northern Europe, Scandinavia and the Baltic countries with possible cooler conditions on the western and southern edges of Europe (see for example the UK Met Office forecasts). Confidence in this forecast is considered as average thanks to the ENSO conditions and relatively good agreement between models.

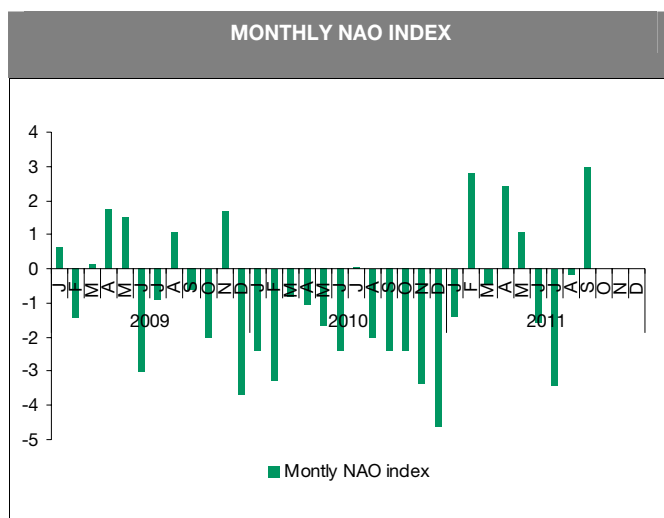
FORECAST OF THE JAN-FEB-MARCH MEAN AVERAGE SURFACE TEMPERATURE OVER EUROPE



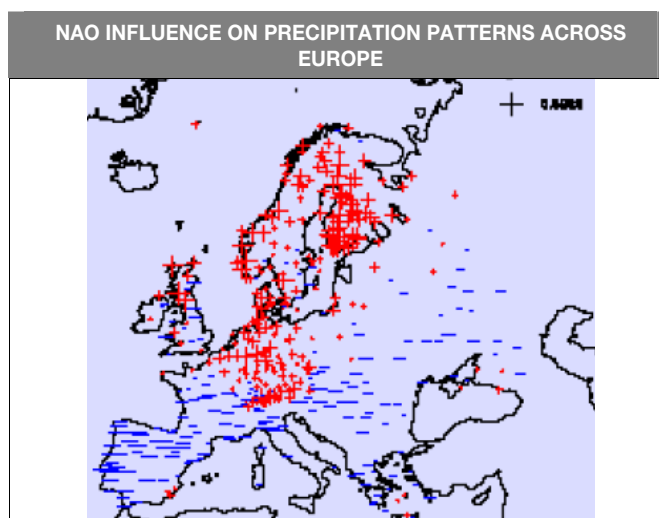
Source: UK Met Office

Precipitation is even more difficult to predict

We still note that the NAO has a strong influence on precipitation patterns (see right-hand picture below). Positive NAO phases tend to lead to higher than normal precipitation in northern Europe and lower-than-normal precipitation in southern Europe (and vice versa during negative NAO phases).



Source: CRU, Tim Osborn

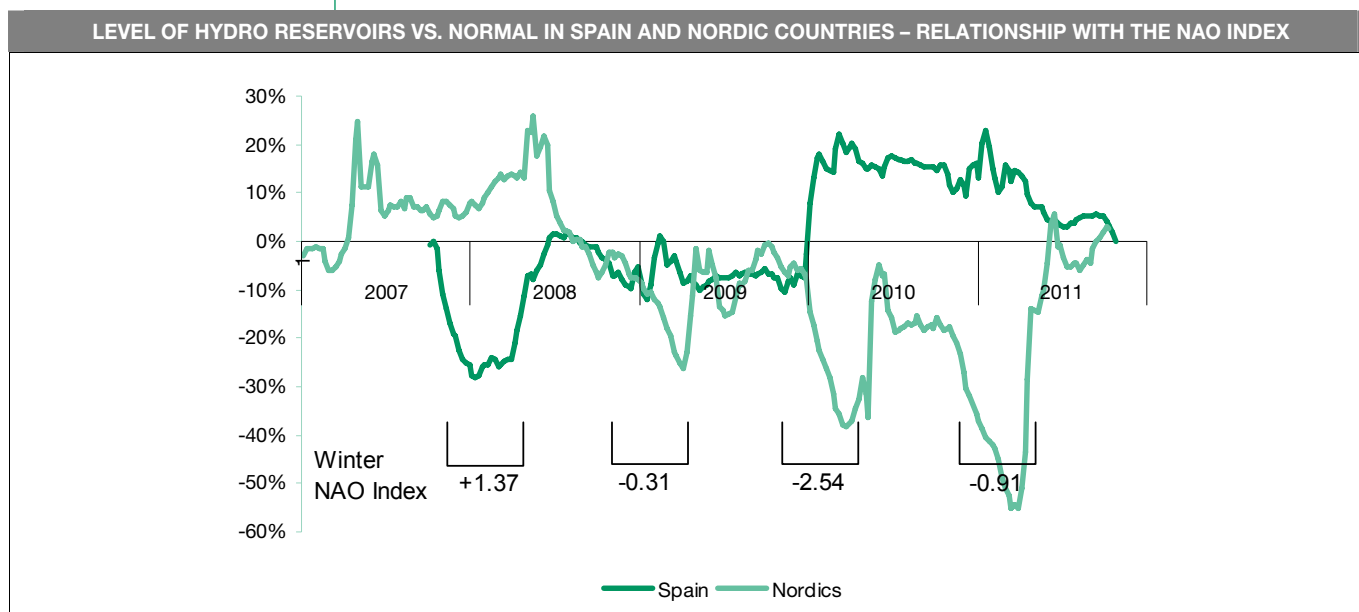


Source: A. Dlugolecki et al. (2009), "Coping with climate change: risks and opportunities for insurers"

The NAO index can be a guide for hydro conditions

Our analysis of historical data of hydroelectricity reservoir levels of Spain and Nordic countries suggests that they are indeed influenced in opposite ways by variations of the North Atlantic Oscillation Index.

The two last winters (2009-10 and 2010-11) were marked by a low NAO index, which actually corresponded to higher hydro availability in Spain and well below normal hydro resources in the Nordic countries (see chart below).



Source: CA Cheuvreux

Check out weather conditions to avoid climate-driven profit warnings

NAO forecasts are not reliable beyond 7 to 10 days, but we note that NOAA's (a US federal agency) forecasts a continued positive NAO for December 2011.

Avoiding climate-driven profit warning

In July 2011, Verbund communicated to the market that 2011 guidance would be missed, notably due to lower hydro availability. The market immediately reacted to the statement and the share price plunged 11.5% in one day. We believe that weather monitoring tools (precipitation, levels of hydro reservoirs) can prevent investors being caught by such adverse effects.

V – Climate change stress tests to long-life assets

■ Exposure of European electricity utilities to adaptation costs

Vulnerability of power generation technologies to changing climate conditions in Europe

A recent report written by consulting firm ECORYS for the DG Energy of the European Commission and notably based on interviews of utilities and power plant operators of all generation technologies across Europe concludes that there are four main risks due to climate change requiring preventive investments from power generation companies Europe.

Two of the main risks are due to the gradual shift in climate conditions:

■ **A decrease in precipitation for hydro power plants in the Mediterranean region.** The report estimates that maintaining current load factors of hydro plants would require increasing reservoir storage capacity by 12% to 38% in 2050. The investment cost for preventive investments is estimated at EUR250m/GW.

■ **An increase in the sea level for offshore wind power plants in all European seas.** The current 20-year return period wave in the North Atlantic may occur every 4-12 years instead by 2080. This would require wind farms to adapt with alternative foundations with an investment cost estimated at EUR500m/GW.

The two other are due to the increased probability and/or severity of extreme weather events:

■ **An increase in the occurrence of floods for thermal generation technologies** (incl. nuclear and biomass) all over Europe, except for the North Sea region. The investment cost needed is estimated at EUR100m-150m / GW if floods were to become 25% more intensive.

■ **An increase in the occurrence of storms for networks all over Europe,** except for the North Sea region. Estimates of cost impact from storm damage range from EUR1,600 per fault to EUR17,000 per pylon and attached lines.

Other climate change impacts are estimated to have a medium to minor impact on power generation output in Europe.

Multi-billion cost for adaptation investments

Hence the ECORYS report estimated that adapting to new climate conditions as forecast for 2080 would incur a EUR15bn-19bn cost p.a. to finance the investment needs over time.

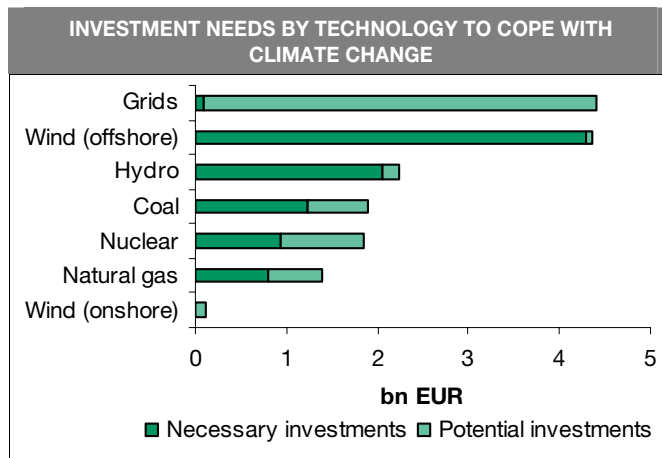
More than half of these investments are deemed necessary (as opposed to potential). This means that climate thresholds are likely to be overshoot hence requiring investments in order to avoid severe disruption of plants' production (as opposed to loss in efficiency).

We underline that due to higher precipitation forecast for Baltic countries, the estimated monetary impact is positive for hydroelectricity thanks to the higher load factors anticipated.

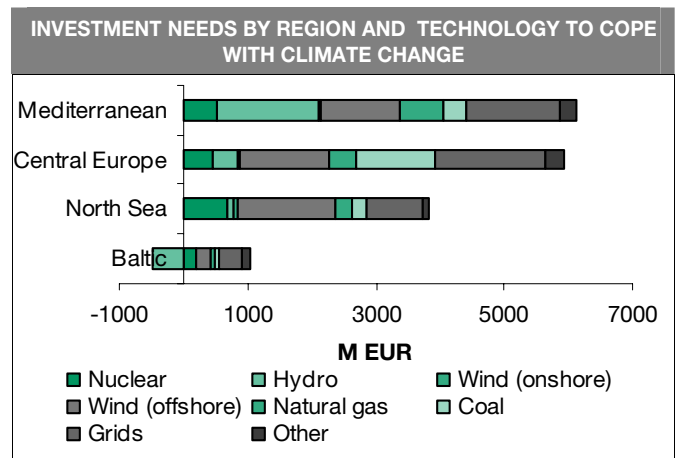
Hydro power plants in the Mediterranean region...

...and offshore wind farms seen the most at risk

EUR15bn-19bn of adaptation costs estimated in a report to the DG Energy



Source: Based on ECORYS, Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to effects of climate change



Source: Based on ECORYS, Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to effects of climate change

Thanks to its geographical and energy mix, Fortum appears the least at risk from adaptation costs

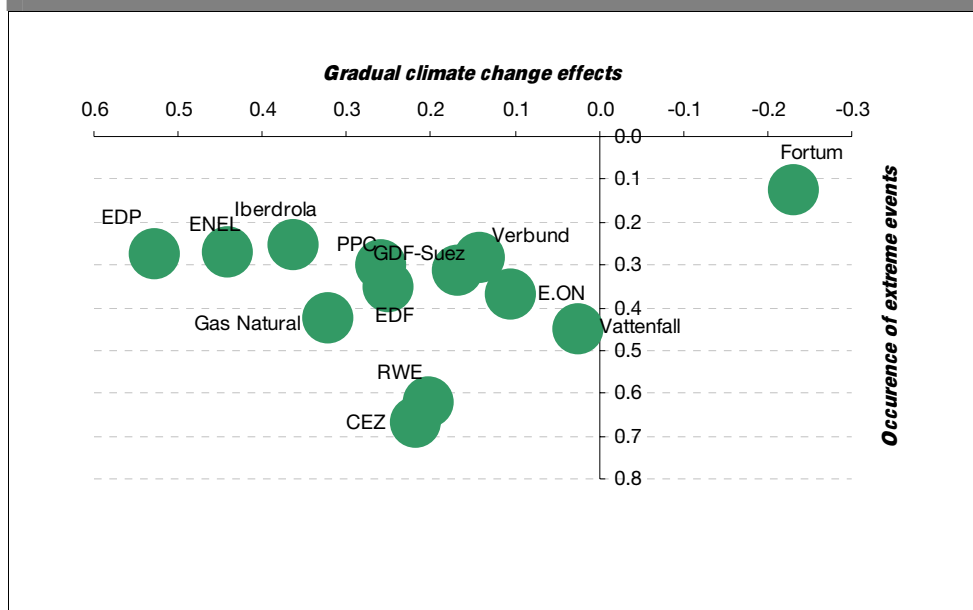
Fortum stands out as the most climate-proof company

Based on the assessment by the European Commission of the monetary impact of climate change effects on power generation assets in different parts of Europe and the location and type of the generation portfolio of European electricity utilities, we have drawn the following climate change risk mapping chart.

EDP and to a lesser extent ENEL appear the most adversely exposed to the gradual shift of climate conditions notably with fewer hydro resources to run hydroelectric capacities, while CEZ and RWE's thermal capacities appear relatively more at risk of exceptional flooding events in central Europe.

Fortum distinguished itself on the mapping as the only company that would be positively impacted by the forecast trend in climate patterns in Europe, notably due a potential increase in hydro resources in Sweden. We note that this analysis takes into account the power generation portfolio and not the exposure of T&D assets discussed below.

EXPOSURE OF THE EUROPEAN GENERATION PORTFOLIO OF ELECTRICITY UTILITIES TO CLIMATE CHANGE EFFECTS



Source: CA Cheuvreux

■ Hydro resources: a regional shift

Load factors of hydro capacities: a regional shift

Climate models generally predict a regional shift in precipitation across Europe, with wetter conditions in the Baltic countries and much lower precipitation levels experienced in southern Europe.

EDP in Iberia: annual river runoffs seen down to 60% in some climatic scenarios

In Spain, a preliminary assessment report by the MMARM predicts a decrease in water resources mean values, with a decrease in runoff of between 9% and 25% depending on the river basin districts (assuming a 5% decrease in mean annual precipitation and a 1°C increase in mean annual temperature).

In Portugal, the climatic simulations run by the SIAM project funded by the Portuguese Minister of Sciences indicate a progressive reduction in river runoff during the 21st century. The reduction may be small in the northern region (0 to -10%) but increasingly severe in southern areas (-42 to -59% for the Algarve river). Most of EDP's hydro capacities are located north of the Douro and on the River Tagus (incl. the Sorraia affluent). In the charts below, we show that **most of EDP's hydro capacities and repowering projects are located above the Tagus (in latitude), i.e. in regions we believe could be relatively spared.**

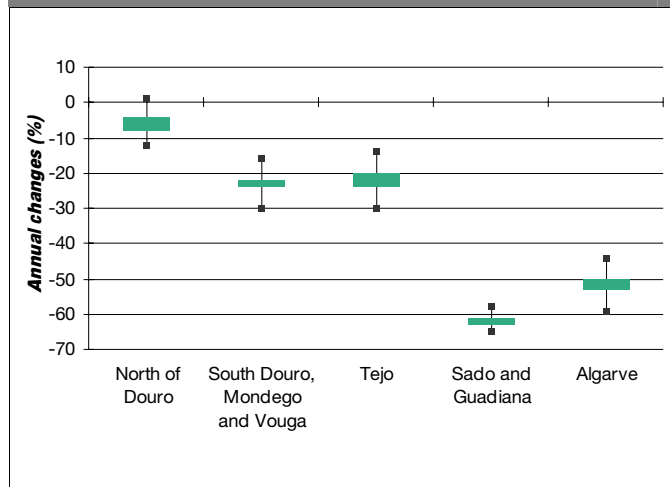
A 9% to 25% decrease in water resources projected for Spain

EDP'S HYDRO CAPACITIES IN PORTUGAL (BLUE SPOTS)



Source: EDP

CHANGE IN ANNUAL RUNOFF BY REGION BY 2100 UNDER CLIMATE CHANGE SCENARIOS



Source: Adapted from SIAM

68% of Fortum's hydro capacities in regions seen as benefiting from higher hydro resources due to climate change

Fortum – may benefit from higher precipitation

In the long term, the Swedish government has estimated that hydropower production potential could increase by 15-20% by the end of the century as a consequence of predicted successive increases in precipitation throughout the century.

Locally, the results of climatic modelling (based on IPCC models and main scenarios) can be seen in the chart below (right-hand side).

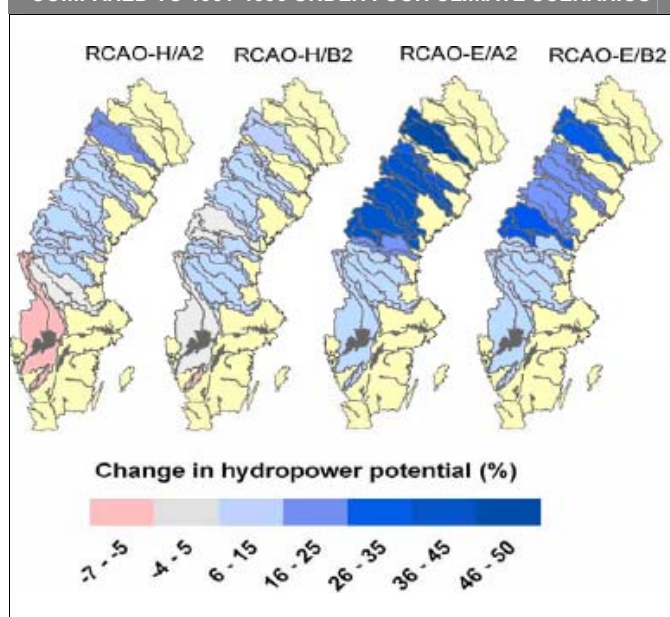
68% of Fortum's hydro capacities are located in central Sweden and the Dal River (Dalälven) is Fortum's largest flow area, which comprises 40 hydropower plants. On average, the simulated increase of hydropower potential in this region is clearly positive.

LOCATION OF FORTUM'S HYDRO POWER CAPACITIES



Source: Fortum

ANNUAL INCREASE IN HYDROPOWER POTENTIAL 2071-2100 COMPARED TO 1961-1990 UNDER FOUR CLIMATE SCENARIOS



Source: Andréasson, 2006; Climate and Energy, 2007

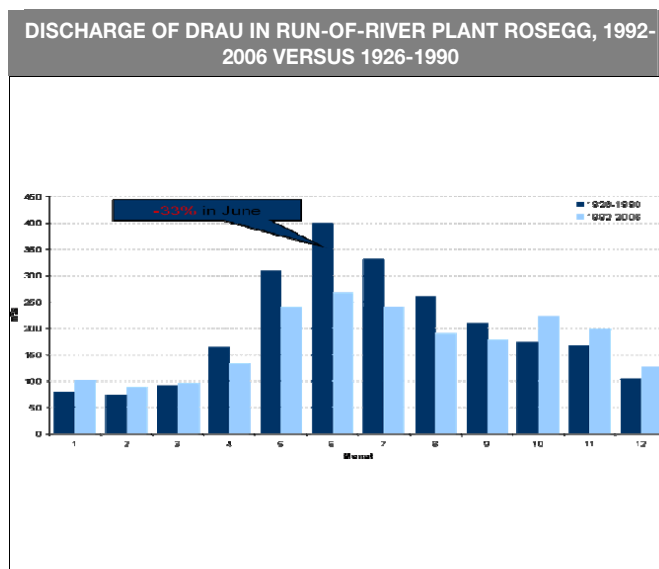
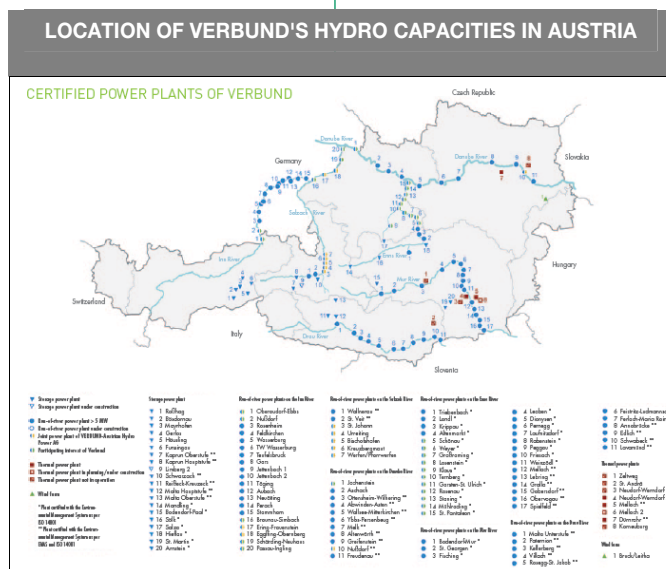
Neutral to positive effect depending on interferences with electricity prices

While on the one hand, Fortum may benefit from higher hydro power generation in the long term, such a positive effect could be offset by lower electricity prices on the other hand (as analysed in the previous section). Indeed, Nordpool electricity spot prices tend to decline when hydropower generation increases.

Therefore, the net gain for Fortum is likely to depend mostly on the potential convergence of Nordic electricity prices with electricity prices in Continental Europe as interconnection capacities increase. However, we have been unable so far to detect any clear evidence of such a convergence and remain cautious on such a scenario.

Verbund: Looking forward

In the long-term, climate simulations tend to indicate hydropower generation potential below the reference scenario in Austria. According to the DG Energy, Verbund did not yet identify an overall trend in hydropower generation in Austria. However, decrease in the river discharge and intra-annual shifts have been noticed in some regions. As shown in the chart below (right-hand side), hydro conditions at Rosegg (southern Austria) has decreased by 33% in June in average since the nineties.



Cooling for thermal capacities

Water availability is also an issue for the cooling requirements of thermal plants (incl. nuclear). We deplore a lack of useful KPI on this topic, i.e. expressed in intensity terms (water consumption/KWh thermal) rather than absolute water consumption for the whole company.

Wind power: What climatic models suggest

A sea level rise could also affect the foundation loading of off-shore wind facilities, which tend to be built in shallow waters. Further climate change impacts on the wind energy sector are presently little explored and wind resource magnitudes are not expected to become severely affected in the short and medium term, since wind speeds are generally variable, with annual variation of 10-15%. However, small changes in a given location could have a significant – positive or negative – impact on the production of wind parks, since a change in wind speed at turbine hub-height of 0.5 m/s leads to an increase in energy density of over 30%. In general, with regard to wind energy, experts expect to see “winners” and “losers” – regions where wind energy development may benefit from climate change and regions, or where the wind energy industry may be negatively impacted.

**European countries
have varying exposure
to storm risks**

Some efforts are under way to measure and predict wind speeds more precisely and thus support investment decisions for new wind farms. According to the new measurements available, wind speeds in the southern part of the North Sea are rapidly increasing in the summertime, so that energy outputs are up 50% compared to 1990 levels. However, wind speeds are also becoming lower in other regions, and this data needs to be taken into account for sites with wind potential that is close to the lower threshold of 5 m/s at which wind turbines need to operate.

Further uncertainties are related to the possible need for design changes in the turbines to withstand extreme weather events, or the possible positive effect of declines in sea ice and icing frequencies in northern locations, which are presently not appropriate for installing wind parks. Lastly, the expected pole-ward displacement of storm tracks and fewer but more intense mid-latitude cyclones may have to be considered in the planning phase of wind parks.

Storms pose a dangerous threat to off-shore and near-shore facilities, as hurricane Katrina and other recent events have demonstrated. This includes gas and oil production platforms, but may extend in the future to off-shore wind parks and, especially, ocean power projects. The resistance of off-shore wind parks to hurricanes is already being considered in the authorization procedure and planning phase of projects in the US (REF). Models are available to take the likelihood of hurricanes into account when analysing the financial viability of off-shore wind farms (REF) but it is not clear if the reference values for decision-making consider the likelihood of more extreme conditions or are based on historical data.

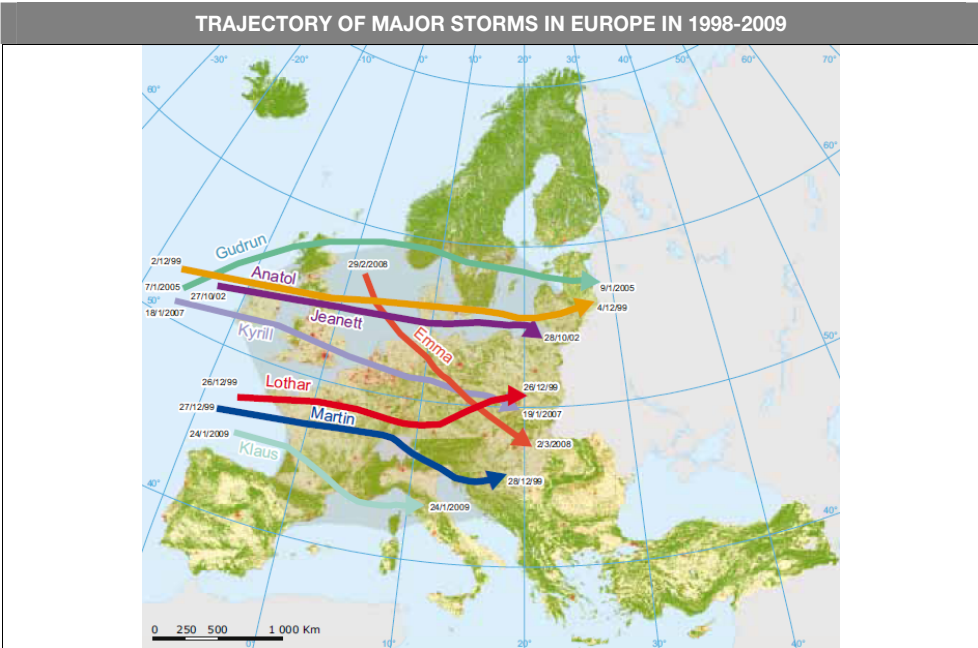
■ Building climate-resilient networks against the storm risk

Climatic risks on T&D infrastructures

Windstorms are the most significant climatic risk for overhead lines of T&D networks operated and/or owned by electricity utilities. One of the most visible climate impact on electricity transmission (high-voltage) and distribution (low- and mid-voltage) networks is the destruction or damage associated with winter windstorms, such as Lothar and Martin in Dec. 1999 or more recently Klaus in 2009.

The exposure to storm risk greatly differs among European countries, however. Over the past decade, Poland, Germany, Austria, Denmark, the UK, France, Sweden and Switzerland have been the most often crossed and hit by major winter storms. Conversely, southern Europe (Italy, Spain, Greece) appears less exposed, although not immune, since both Spain and Italy were significantly hit by the storm Klaus in 2009.

EUR1.16bn of storm damage for EDF in 1999/2000



Source: In grey, areas affected by winds stronger than 116 km/h Source: EEA technical report – Mapping the impacts of natural hazards and technological accidents in Europe

Looking at storm damage reported by companies, we find that EDF has been the most hit by winter storms, with record costs estimated at EUR1.16bn associated with the Lothar and Martin storms in 1999.

E.ON, and to a lesser extent Fortum, also incurred relatively significant costs related to the damage of winter storms crossing Sweden, where they operate electricity distribution networks.

COSTS REPORTED BY COMPANIES RELATED TO DAMAGE DUE TO LARGEST STORM EVENTS SINCE 1999

Event	Year	Main area affected	Impact	Reported costs
Lothar and Martin	1999	France, Switzerland, Germany	More than 10,000km of destroyed or heavily damaged lines	EDF (EUR1.16bn, incl. half for consolidation of the distribution network)
Gudrun, Erwin	2005	Southern Sweden	20,000 km of grid damages, 2,000km of destroyed grid, 10,000 damaged poles	Vattenfall (SEK425m / EUR47m), E.ON (EUR140m), Fortum (EUR11m)
Per	2007	Sweden	-	E.ON (EUR95m); Fortum (EUR13m); Vattenfall (SEK290m / EUR31m)
Kyrill	2007	Germany, Austria, the UK	Most severe in its scale and impact for 17 years (Metoffice)	SSE (GBP2m)
Klaus	2009	France, Spain and Italy	Most damaging since 1999	EDF (EUR160m)

Source: CA Cheuvreux, company data

Underground distribution networks limit storm vulnerability

It is interesting to note that German operators E.ON and RWE did not report on any significant cost due to storms for their German grid operations, even in 2007 when the storm Kyrill hit Germany.

How to mitigate exposure?

This can be explained by the relative lower exposure to damage from storms of the German network, which as a much higher rate of underground cables than the French network for instance. A study of DIW Berlin (German Institute for Economic Research) assumes that 38% of the distribution network in France is underground compared to a ratio of 85% for German distribution lines.

Still a costly and technical challenge for transmission networks

Underground cables may therefore appear to be a sensible solution to build storm-proof networks. We list in the table below the length of T&D grid lines operated by utility company and the share of underground cables.

Operators of transmission grids (as opposed to distribution lines) show low percentages of underground cables. Underground cabling of high voltage transmission lines remains technically challenging and largely more expensive than low-voltage distribution lines (10 to 20 times more expensive than overhead lines versus only 4 to 5 times for low voltage).

It also appears that operators of electricity distribution grids that are relatively less exposed to storms in Italy and Spain show a lower share of underground cables.

LENGTH OF GRID LINES OPERATED BY COMPANY AND SHARE OF UNDERGROUND CABLES

Company	Total km of T&D lines	% of underground cables	Comment
ENEL	1 810 951	31%	-
EDF (ERDF)	1 293 400	40%	In 2010, 6,000 km of overhead lines were placed underground, and 11,000 km of new underground lines (MV and LV) were built.
Iberdrola	829 700	18%	Maps showing the fire risk level of all the medium voltage pylons present in the Autonomous Regions have been completed and reviewed.
E.ON	455 000	N/A	-
Vattenfall	449 000	N/A	In the cities of Berlin and Hamburg, the networks are mainly served by underground cables.
RWE	406 600	N/A	Underground lines make for a more resilient network that cannot be knocked out by falling trees in wooded areas, for example. After the experience in 2010, and especially the floods in Hungary and Poland, RWE has begun planning improvements to the flood protection of these plants.
EDP	242 582	N/A	-
Fortum	157 300	N/A	In grid construction Fortum favours underground cables rather than overhead lines. Grid reliability is also improved by replacing overhead lines with underground cables and by moving power lines away from forested areas.
SSE	127 000	N/A	-
Gas Natural - Spain	117 256	24%	-
Scottish Power*	117 222	60%	*Iberdrola group.
Terna	57 638	2%	Laying cables underground eliminates or reduces the negative impact on the landscape that is typical of the overhead stretches of lines. For this reason, local institutions often request underground cables as their first option for the construction of new lines.
Red Eléctrica	38 393	N/A	Transmission grid
National Grid	14 777	4%	The group released a special climate change adaptation report in Sept 2010. Following a risk assessment, the group believes that electricity transmission assets are resilient to climate change.

Source: Companies

NB: The length of above and underground T&D lines by regulatory regime is an indicator included in the Electric Utilities Sector Supplement of the GRI (code: EU4). As shown in the table above, only a few companies provide this indicator.

Underground cables not a climate-proofing panacea though

Underground cables are also praised for their advantage with regard to the visual aspect and site preservation. However, we note that this remains a costly option that moreover is not immune to other adverse climate impacts.

According to Terna (network operator in Italy), construction costs are normally 5 to 10x higher than those of overhead lines. In addition, underground cables "are less reliable over time than overhead lines and take much longer to repair in case of malfunction". This suggests higher maintenance costs and service continuity problems. This may hold true for transmission grids only, however, as the DIW study and Fortum state on the contrary that underground cables improve grid reliability and require lower maintenance costs.

**And underground
cables are exposed to
other climate risks**

RWE notes that buried lines can be adversely affected by more frequent flooding (such as the one experienced in 2010, notably in Poland) and therefore require preventive improvements.

From a climate-change perspective it is worth highlighting that underground cables can also be damaged by soil subsidence in the event of severe droughts.

Network strengthening and/or insurance represent sensible alternatives to the costly option of burying lines. In 2011, EDF issued a EUR150m natural catastrophe (nat cat) bond to insure its T&D network against storm damage. This insurance coverage lasts until May 2016. This mitigates the risk of seeing the group's P&L impacted by one-off storm costs.

Are events predictable? Here comes the NAO again

The North Atlantic Oscillation pattern (NAO) is a key driver of the trajectory and intensity of European winter storms.

There is a positive correlation between storm activity and the NAO. Most central European storms occur during winter with a positive NAO index (please refer to section 2 of this report for further details on the NAO index).

The Lothar/Martin storms in December 1999, Kyrill and Per in 2007 and Emma in March 2008 all occurred during highly positive NAO phases (respectively +1.85 in 1999/2000; +1.83 in 2006/2007; +1.37 in 2007/2008. This does not prevent intense storms from occurring during negative NAO phases (e.g. Klaus in January 2009).

Looking forward: climate change effect on storm occurrence and tracks

Academic research findings suggest that storm intensity has increased locally during recent decades. However, there is no clear trend regarding the frequency of European storms.

For the future, several climatic models predict an increase in severe storms by the end of the century, and some models a shift of storm tracks towards higher latitudes.

**The NAO index
influences storm
frequency and
direction**

**Climate change may
exacerbate storm
intensity**

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CRÉDIT AGRICOLE CHEUVREUX – AMSTERDAM BRANCH
 JOHANNES VERMEERSTRAAT 9
 1071 DK AMSTERDAM
 TEL: +31 20 573 06 66
 FAX: +31 20 573 06 90

FRANCE

CRÉDIT AGRICOLE CHEUVREUX S.A.
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CRÉDIT AGRICOLE CHEUVREUX ESPAÑA S.V. S.A.
 PASEO DE LA CASTELLANA 1
 28046 MADRID
 TEL: +34 91 495 16 48
 FAX: +34 91 495 16 60

SWEDEN

CRÉDIT AGRICOLE CHEUVREUX NORDIC AB
 REGERINGSGATAN 38
 10393 STOCKHOLM
 TEL: +468 723 5100
 FAX: +468 723 5101

SWITZERLAND

CRÉDIT AGRICOLE CHEUVREUX – ZURICH BRANCH
 BAHNHOFSTRASSE 18
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 TEL: +41 44 218 17 17
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TURKEY

CRÉDIT AGRICOLE CHEUVREUX MENKUL DEGERLER A.S.
 BUYUKDERE CAD. YAPI KREDİ PLAZA C BLOK KAT:15
 LEVENT 34330 - ISTANBUL
 TEL: +90 212 371 19 00
 FAX: +90 212 371 19 01

UNITED KINGDOM

CRÉDIT AGRICOLE CHEUVREUX INTERNATIONAL LIMITED
 12TH FLOOR
 MOORHOUSE - 120 LONDON WALL
 LONDON EC2Y 5ET
 TEL: +44 207 621 5100
 FAX: +44 207 621 5101

DISTRIBUTION CENTRES

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 TOKYO 105-0021
 TEL: +81 3 4580 8522
 FAX: +81 3 4580 5534

UNITED STATES

CRÉDIT AGRICOLE CHEUVREUX NORTH AMERICA, INC.

BOSTON

99 SUMMER STREET, SUITE 220
 BOSTON, MA 02110
 TEL: +1 (617) 295 01009

NEW YORK

1301 AVENUE OF THE AMERICAS 15TH FLOOR
 NEW YORK, NY 10019
 TEL: +1 (212) 492 8800
 FAX: +1 (212) 492 8801

SAN FRANCISCO

50 CALIFORNIA STREET, SUITE 860
 SAN FRANCISCO, CA 94111
 TEL: +1 (415) 255 9802
 FAX: +1 (415) 956 9940

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