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Climate Change and Sectors: Some like it hot!

Two dimensions of climate change. Climate change has not just an environmental-climatic dimension but also a regulatory-market economy dimension. The latter includes government measures that are supposed to tackle climate change and its negative consequences. This dimension will affect most sectors much earlier than the climate dimension.

The energy industry is in a particular focus of politics. Without doubt, renewable energy sources will be amongst the winners from climate change, as they will continue to gain from climate-policy-motivated subsidies in the next few years. In contrast, government measures will tend to make fossil fuels more expensive. Research and development of new and more efficient energy technologies will play a leading part in the future.

Climate effects already noticeable in agriculture and forestry. Prices for agricultural products could rise due to the increased demand for biofuels. Competition between food production and biofuels is anticipated. In higher latitudes (e.g. Scandinavia) increasing harvests are likely. In countries with increasing water shortages (e.g. Spain) conditions are worsening. Agricultural irrigation and genetic technology will gain in importance.

The construction industry can profit in the long term. There is enormous potential for the construction industry and related sectors in the energy-related refurbishment of existing buildings (e.g. insulation). Repairing the damage from extreme weather events can trigger temporary and regional special business activities.

Major potential for industrial sectors. Many industrial sectors could contribute to tackling climate change and its negative consequences. These include mechanical engineering (e.g. air-conditioning, heating and ventilation engineering, irrigation technology) and electrical engineering (e.g. energy control equipment, energy-efficient household appliances). They have enormous growth opportunities and are therefore amongst the winners from climate change. Cross-section industries like the chemical industry could also benefit. Even more jobs will be created in the booming environmental technology sector. The car industry faces major challenges but has an opportunity for international success with energy-efficient vehicles.

Shift of demand in the services sector. In the services sector there will be heavier government burdens on the transport industry. The tourism business will have to deal with considerable regional and seasonal variations in tourist flows. In the financial sector the assessment of risks will be more difficult, although wide-ranging new business options (e.g. sustainable investments) will be opened up.

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1. Introduction: The dimensions of climate change

Uncertain elements in the investigation:

- The extent and speed of climate change
- The magnitude of technical advances
- The adoption of instruments for environmental policy
- Behaviour modifications by market players

The earth's climate is changing. It always has done. However, the prevailing majority of scientists now think it very probable that human actions, in particular through the burning of fossil fuels but also through agricultural and forestry activities, are contributing decisively to climate change. There are still a few scientists who consider that the anthropogenic influence on climate change is slight or non-existent, although today they are clearly in the minority. Nevertheless, this diversity of opinions illustrates the extreme uncertainties that are related to the process of climate change.

Finally, no climate model can predict with certainty how quickly or to what extent the earth's climate will change in the next few decades, or which regions will be the most severely affected. However, even now some climatic trends are emerging. These include the increase in the global average temperature and, in the longer term, an appreciable rise in sea level. A change in global rainfall patterns is also anticipated, as is an increase in extreme local weather events. These include hurricanes, torrential rain, or longer dry periods and more frequent heat waves, with their corresponding negative consequences such as storm damage to buildings, floods, loss of harvests, more frequent forest fires, desertification, erosion and also human casualties. Many scientists also fear that there will be a reduction in the earth's biodiversity.

At the moment, climate change can at best be slowed

These events and processes are probably not just in the distant future but might be increasingly evident in the short to medium term. Many extreme weather events in the recent past, such as the mild winter in Europe, the dry April in 2007 and the speed of global temperature increase, are being interpreted as an indication of a change in climate significantly brought about by human activities. For the foreseeable future, energy provision on Earth will still be based primarily on fossil fuels. During the next few decades, therefore, the process of climate change cannot be stopped but only, at best, slowed. Even if all emissions were to be suddenly halted, time lag effects from already-emitted greenhouse gases would noticeably increase the average temperature.

Anticipated climate changes in Germany, Europe and the world

Germany will have less rain in summer, more precipitation in winter

Climate projections by the Federal Environment Office predict an increase in average temperatures of around 2°C by the end of the present century, compared with the average for the years 1961 to 1990. This will be accompanied by considerably fewer “frost days” (days when the minimum temperature is 0°C or less) and more “summer days” (i.e. with temperatures higher than 25°C). According to these models, precipitation will decrease by an average of around 20% in summer and increase by 20-30% during the winter months. In winter, precipitation will fall less frequently as snow. Torrential rains are more probable in summer. The authors of the projections reiterate that the conclusions are subject to a high degree of uncertainty.

According to Intergovernmental Panel on Climate Change (IPCC) models, in Europe there will be increased risk of floods as a result of heavier and more persistent precipitation. The situation in central and eastern Europe could be aggravated by faster snow melt after the winter months. The projections indicate that there will be more storm surges near the coasts as a result of more frequent storms. There are supposed to be more frequent very hot summers, with little rainfall, in southern Europe and the Mediterranean region. The risk of desertification is not to be underestimated. Overall,

agricultural yields will fall in southern Europe. At the same time, however, an increase in crop yields is projected for northern Europe.

Danger to the water supply in east and southern Asia is feared

At global level, the IPCC has designated four regions in which the effects of climate change will be particularly apparent. These are: the Arctic (e.g. retreat of the sea ice, thawing of the permafrost soils, faster melting on the edges of the Greenland ice sheet); Sub-Sahel Africa (principally increase in aridity); the areas around the estuaries of the major rivers in eastern and southern Asia (threat to water supplies from a gradual melting of the Himalayan glaciers, higher likelihood of floods and landslides, more storm surges on the coastal side, lower crop yields); and the South Sea Island countries (higher probability of flooding, evacuations required in the long term due to the rising sea level).

Fewer deaths from cold and larger harvests expected in higher latitudes

Not all changes in the climate necessarily have negative consequences. For example, an increase in average temperatures and a fall in the number of frost days should result in fewer deaths from the cold in the northern hemisphere. More fruitful crop yields and generally better conditions for vegetation in higher latitudes will also contribute. However, according to the opinions of the majority of scientists, if the global average temperature rises by much more than 2°C the negative consequences will clearly predominate.

Further increases in energy prices and shortages of fossil fuels expected

Thirst for energy in emerging countries is leading to higher energy prices

Although these climatic effects will probably not have a major effect on life on Earth until the distant future, in the last few years energy prices have already risen noticeably. Unlike the first two oil price shocks, the main reason for this is not shortage of supply but rather, to a large extent, increased demand for energy from the expanding economies of the developing countries, particularly China and India. The thirst for energy from these and other up-and-coming economies will continue to increase. In the foreseeable future this will be satisfied primarily by fossil fuels.

The days of permanent low prices for fossil fuels have gone

In addition, in coming decades an ever-increasing number of easily-accessible and therefore cheaply exploitable oil and gas fields will dry up. Their exploitation will tend to be more expensive, even on the assumption that technological progress will continually improve production opportunities. What cannot be ignored is that large quantities of global oil and gas reserves are in politically-charged areas. This is another risk factor, influencing security of supply and price volatility, that should not be underestimated. Finally, as a consequence of increasing global demand and only limited growth in supply, permanent low prices for fossil fuels are now a thing of the past.

Major need for action by policy-makers

The Stern Review: Early action is better than waiting

Both the danger of climate change and the ensuing changing energy supply conditions mean that there is need for action by policy-makers. The assertions in the Stern Review are an important reference point for political decision-makers in this respect. According to Stern, the earlier that measures are taken to tackle climate change and to curb its negative effects, the lower the cost. In contrast, a wait-and-see policy would give rise to higher economic costs. The rapid increases in the Earth's assets during the past few decades mean that the potential damage that could result from e.g. an increase in extreme weather events is in any case enormous.

In the face of these prospects, many of the world's governments are now giving considerably higher importance to climate protection

than they were only a few years ago. Many longer-term targets indicate that this is not just a flash in the pan but rather a lasting shift in political priorities. The EU, still a pioneer in this respect, is prominent in the implementation of emissions trading and other instruments of environmental policy. The EU Climate Summit in Brussels, in March 2007, formulated very ambitious targets for reducing greenhouse gases (by 20%), increasing energy efficiency (by 20%) and promoting renewable energy sources (to increase to 20% of overall energy provision).

Change in US climate policy likely after the 2008 presidential election

The USA and other countries are concentrating on technological solutions but do not want to put a quantitative limit on their absolute emissions of greenhouse gases. At the same time they are increasingly recognising the dangers of climate change. In the USA, ideas are gradually changing. The inspiration for this is mainly coming from individual states, such as California; municipalities; companies; and civic action. A reorientation of environmental policy at federal level is also likely after the presidential election at the end of 2008. Increased use of biofuels (an increase to 20% of total fuel consumption) is also a declared aim of the USA. Admittedly, ecological interests are not the only centre of attention in this respect: efforts to be less dependent on oil imports are also important.

China is intensifying its efforts in climate protection

Even in China, which in the near future will be the largest emitter of greenhouse gases, environmental topics are now much higher on the agenda. However, like other developing countries, China still has many, much more pressing, problems to solve: for instance adequate provision of food for its population. In the future the country will considerably intensify its efforts in the areas of energy efficiency and climate protection. This is because, in China as well, there are increasing misgivings about the possible negative effects of climate change – for example on agriculture and the economically prosperous coastal region, in particular the mega-cities (e.g. Shanghai, Guangzhou). Increased environmental protection is playing an important part in the Chinese government's plans, even if implementation is still problematic in practice.

Increasing importance of climate and environmental policy is programmed internationally

In the next few years, a worldwide increase in climate and ecopolitical measures is anticipated. The course has already been set for many changes in this direction. Although there is uncertainty about the specific nature of government activities, it is likely that the whole environmental and climate policy armoury will be brought into play. This includes both fiscal policy (e.g. taxes, duties, charges, subsidies, certificate systems) and regulatory law (e.g. statutory orders, bans).

Adaptation to the negative effects of climate change necessary

In principle it is to be expected that governments will, on the one hand, tend to raise the price for consuming carbon-intensive fuels (for electricity production and heating as well as for transport) and on the other hand encourage activities that help climate protection. It is also the task of politicians to prepare citizens for the negative effects of climate change through suitable measures. Another important role is to use targeted information to persuade the population of the advantages of environmentally-aware behaviour. In the second chapter, the effects of potential ecopolitical measures on particular sectors will be examined in greater depth by means of concrete examples.

Two dimensions of climate change

Climatic-environmental and regulatory-market economy dimensions of climate change

On the bottom line, there are two fundamental "dimensions" of climate change: These are the "environmental-climatic" and the "regulatory-market economy" dimensions. Whereas the former embraces the changes in climate, the latter includes all government measures to slow climate change and to adapt to its negative consequences, as well as changes in prices, supply and demand on the international raw materials markets and market players' reaction to them.[1]

2. Sectors under the "climate focus"

Analysis limited to qualitative ceteris-paribus statements

In the following, economic sectors are analysed using both the above-mentioned "dimensions of climate change". They form, as it were, the axes of a system of coordinates, in which the sectors can be positioned depending on their positive and negative effects (see page 27). We have carried out a qualitative description and assessment of the possible effects of climate change. A plausible quantitative or monetary analysis does not appear to be useful, however, in view of the multiple uncertainties already mentioned. A rough allocation into winning and losing sectors is, however, possible.

Forecast horizon to 2030 at the latest

We have come to "ceteris paribus" conclusions, i.e. the impacts of individual effects have been separately considered, while all other factors were held constant. In geographical terms we have limited ourselves to Europe, although in a few special cases global aspects have also been taken into account. The forecast horizon of our analysis varies between different sectors, depending on climatic and regulatory effects, from a few years to over two decades. It therefore extends to 2030 at the latest.

Overall, this method should reduce the enormous complexity of the topic. We therefore do not claim to show an exact vision of the future. We are far more concerned with providing economic players with food for thought and pointing out possible directions for future development.

It is important to note that, in many cases, sector boundaries are fluid and there may well be overlaps. In addition there are many multi-sector technologies. The investigation does not claim to be able to cover all the sectors in detail. The analysis is rather to be understood as an introductory report that should allow an overview. Follow-up studies by Deutsche Bank Research are planned, focussing particularly on the effects of climate change on individual sectors and on other aspects of the topic.

2.1 The energy sector

Over a quarter of global greenhouse gas emissions are from the energy sector

The energy sector (power stations) is particularly strongly in the political focus because of its importance as a source of greenhouse gas emissions. Worldwide, the power supply industry is responsible for over a quarter of all greenhouse gas emissions. Regulatory measures naturally affect fossil energy sources in a different way from renewables. The latter will continue to benefit from climate-policy motivated government subsidy programmes and will increase their worldwide market share. Their price competitiveness compared

[1] Sectors can of course also be affected by changes in the behaviour of market players that are not caused by government measures or price changes. For instance, individual consumers might demand less air travel or do without their own cars in order to make an individual contribution to slowing climate change. Such effects are even more difficult to forecast, which is why they will only be mentioned in passing here.

with fossil fuels should however also improve, through technological progress, the achievement of economies of scale, the more efficient application of renewables (e.g. large wind turbines, better choice of locations for wind turbines or solar energy installations) and as a result of the expected higher prices for fossil fuels.

Auctions of emission certificates likely in EU emissions trading

On the other hand, in the future it is likely that governments in industrialised countries will increase the prices of fossil fuels, e.g. for heating and electricity production. In Europe it is therefore very probable that the upper limit for the output of CO_2 will be steadily reduced in the next few years, as part of EU emissions trading. After 2012 it is possible that a large proportion of the necessary certificates will be auctioned. Currently emission rights are mainly allocated free of charge. As a result, CO_2 would become a real cost factor for power station operators and will need to be more strongly reflected in future investment decisions. This detracts from the relative price competitiveness of carbon-intensive fuels like lignite and hard coal, compared to gas or the low-CO_2 renewable energy sources. A shift in the market share of fossil fuels, from coal to gas, can therefore be expected.

The swan song of fossil fuels is still a long way away

Efficiency increases programmed for the modernisation of existing power stations

This of course does not mean that existing coal-fired power stations will be shut down in the near future, or that planned new stations will not be built. Instead, forthcoming modernisations will place even more importance on efficiency aspects than before. Research efforts to increase efficiency and to reduce specific CO_2 emissions will be considerably intensified. The potential for CO_2 savings from an improvement of only a few percentage points in the efficiency of coal or gas-fired power stations is, in any case, very large. Combined heat and power generation will further increase in importance.

CO_2 capture and storage is focus of research

Great hopes are resting on low-CO_2 coal-fired power stations, of which only the first pilot projects now exist. The development of a suitable process for CO_2 capture and storage should be given high priority in the next few years, even though its consequence will be a reduction in the efficiency of power stations. State research and development programmes are likely, in parallel with initiatives that are already under way by a few energy companies. There is the chance that Europe could become the leading research location in this area. The bottom line is that, even by 2030, coal will still be making a substantial contribution to European energy production.

Export opportunities for modern power station technology

Coal still in international demand

At global level, the demand for fossil fuels will nonetheless continue to grow. In many developing countries coal will play the primary role in energy provision for the foreseeable future. Coal will be the No. 1 fuel in China for the next few decades, not least because of the size of the country's own reserves. However, in the future, the target of more efficient energy production will be energetically pursued world-wide, both on grounds of cost and for ecological considerations. This will provide major opportunities for the export of modern power station technology from Germany and Europe.

Flexible mechanisms of the Kyoto protocol gaining in importance

Important leverage in this respect could result from the project-related flexible mechanisms in the Kyoto Protocol (Clean Development Mechanism [CDM] and Joint Implementation [JI]). These allow e.g. for German energy groups to generate emissions certificates that they could credit against their own reduction targets, by carrying out climate protection measures in developing countries or other industrial countries. As such climate protection works are

usually cheaper to carry out abroad, in the end both sides benefit. In the future, the Kyoto flexible mechanisms will be more robustly applied. Reliable and transparent certification procedures are important for this, in order to prevent misuse of these instruments. CDM and JI could allow the growing demand for energy in expanding countries to be satisfied in a more climatically sustainable way. At the moment, they use largely outdated power station technology. In China, coal-fired power stations have an efficiency degree of less than 30%, while in Germany up to 45% is achieved.

Renewables particularly dependent on government regulation

Global development of renewable energy sources expected

Renewable energies are the clear winners from the regulatory components of climate change. State-subsidised construction in the last few years has already been mainly ecologically motivated. Renewable energy sources play an important part in future plans, not just in the developed world such as the US and the EU but also in many developing countries like China. All of them want to steadily increase the market share in the energy mix. In the EU, for example, they should increase to 20% of primary energy supply by 2020 – three times the current percentage. The USA is primarily backing biofuels for the next few years but wind and water power, as well as solar energy, will also be promoted. California is the trailblazer in this respect. In China, where the natural conditions for wind power or solar energy are considerably better than e.g. in Germany, the government is also planning to strengthen renewable energies. With guaranteed net metering (feed-in tariff), similar mechanisms to those in Germany are being applied.

At global level, investment in renewable energies in the next few years will be in billions, at least part of which is based on climate policy. Other advantages of renewables are the possibility of decentralising energy supply, reduced dependence on fossil energies and increased security of supply. German suppliers could benefit from these trends, as – favoured by generous subsidies – they are among the leading nations in many areas of technology and can export their products.

Planning reliability of government support for renewable energies particularly important

The influence of subsidies is particularly large in the whole sector, although this is quite usual for many new industrial sectors, especially in energy supply. However, this represents a major risk for renewable energies, as a major change in subvention can lead to considerable strain for whole sectors. Planning reliability as regards programmes of government subsidies is therefore of major importance. For instance, for biofuels the readjustment from tax free status to compulsory blending, carried out in Germany a few months ago, has resulted in surplus capacity: the competitiveness of pure biofuel has been reduced by the new legal regime. Demand for it has therefore collapsed. This example demonstrates just how vulnerable these industries are to changes in the legal framework.

Multitalented bioenergy probably has most potential

Second-generation biofuels belong in the future

Not least because of their very varied fields of application, bioenergies have a particularly large growth potential in the next few years. They can make an appreciable contribution not only in electricity and heat supply (e.g. the use of biogas in combined heat and power plants; pellet heating in residential buildings) but also for the transport sector (biofuels). “Second-generation biofuels” are the present hot topic. In expert opinion they are the way of the future, as the whole plant – and even vegetable waste – is converted to energy or fuel. In contrast, first-generation biofuels in principle use

only the fruit of the plant (e.g. bioethanol from corn or biodiesel from rape). The advantages of second-generation biofuels lie in better total balance of CO_2 and lower competition with food production (see section 2.2). In addition, they make it easier to comply with industrial requirements, e.g. for the quality of biofuels. However, this technology is only in its infancy.

Price rises likely for biomass as raw material for energy

Considering the increased demand for bioenergies, the potential for competition already mentioned (including food production) and the limited acreage of land for growing them, increasing prices for the raw material, biomass and a shift in relative prices – depending on the use – are likely. This affects price competitiveness with other fuels, including fossil fuels. As an example: after the expansion of demand in 2006, the prices of pellets rose sharply, for a while reaching the same price level as heating oil. Prices have since fallen again. Such possible price variations should be taken into account by market players. In contrast, with wind or solar radiation there is no price risk attached to input factors but "only" a risk of volatile quantities.

Sensitivity based on price volatility can be increased by erratic government regulation. Policy decisions are conceivable, for instance to restrict the (supposed) negative side effects of bio-energy. An example would be prohibiting wood-fired installations or pellet heating in urban areas, or increasing requirements for filter systems to reduce particulate emissions. This demonstrates that a one-off grant of subsidies for renewable energies is not carte blanche for the future.

Measures to increase efficiency are the priority

Steady reductions in subsidies for renewable energy sources call for advances in production

In the future, when considering state subsidies for renewable energies, governments will put more emphasis on more efficient allocation of resources. They may, therefore, link the subsidies more tightly to the specific CO_2 avoidance costs of individual energy sources. In any case, renewables will increasingly have to manage without state subsidies in the next few years. As soon as they matched the competitiveness of fossil fuels (as is already to some extent the case with wind power) it is difficult to present an argument for further subsidy. It also cannot be ruled out that support will be cut off from energy sources without long-term prospect of survival in the market without subsidy; whose potential CO_2 savings are small; or for which CO_2 avoidance costs are high.

Technological progress and economies of scale improving competitive ability of renewable energies

The rates of subsidy for renewable energy sources e.g. in Germany are already structured on a declining scale. This should be continued in principle by the coming amendment to the Renewable Energies Act, although temporary exemption from the decreases is being discussed for e.g. offshore wind farms. Other governments may also try to avoid giving long-term subsidies to renewable energies on a non-selective basis and give incentives for efficiency and advances in productivity instead. This forces the companies continually to increase efficiency through technological progress and to achieve economies of scale in production. Depending on the degree of competition and the type of government subsidy, advances in productivity must be passed on to customers, to a greater or lesser extent, in the form of lower prices.

Choice of location of major importance

Germany not the ideal location for solar energy

In the future, when subsidising renewable energies, more attention will probably be paid to the "best" locations. Germany is not the ideal location for e.g. wind energy or solar power stations. Nevertheless, the country is one of the leaders in terms of installed capacity and is actually a net importer of solar cells. This shows that subsidies always create free-rider effects. However, it also illustrates the enormous potential in countries having much better natural conditions for wind and solar energy, in which these sources of energy are currently still insignificant or non-existent.

Offshore windfarms have major potential

On the bottom line, policy makers need to pay additional attention to the utilisation of renewable energies in locations where natural conditions are favourable. For wind power this should primarily be coastal regions. Offshore installations are certainly part of the future, although even they will be dependent on subsidies at first. No industrialised country has come close to exhausting its wind power potential – to say nothing of developing countries. Thanks to the higher solar radiation, primarily south European countries will go for solar energy. However, wind turbines and solar modules do not have to be manufactured on site. On a global view, all the countries around the equator have good prerequisites for solar energy. It can make an important contribution to providing electricity for rural areas or local water treatment. In the future, such projects could be more strongly promoted as part of foreign aid, as they will also moderate the negative consequences of climate change in poor countries.

Technologies for energy storage and transport needed

As particularly good conditions for wind and solar energy are often found in locations where energy demand is low or even non-existent, intelligent methods of storing and transporting energy will gain in importance. A great future is predicted for hydrogen storage. The construction of offshore installations will require investment in electricity grids.

The challenge to bioenergies is to grow the right plants in the right locations and to develop the right processes in order to guarantee a high level of efficiency of energy production. Research on this is only in the initial stage.

Geothermal and hydropower important energy sources in many countries

Geothermal power has proved that it can make a very large contribution to energy supply in locations where the geological prerequisites are good (e.g. in Iceland or New Zealand). It should also benefit from subvention programmes in the future, for example in heating residential buildings. The potential for traditional hydro-electric power has already been largely exhausted in Europe. Dam projects also persistently throw up questions about their social and ecological compatibility. Nevertheless, large projects like the Three Gorges Dam in China show that – despite this reservation – there is still growth potential for hydro power in many regions of the world.

Nuclear is still an important component worldwide – although politically volatile, above all in Germany

Great differences in dealing with nuclear power

Internationally, very different levels of importance are attached to nuclear power. In a few countries (e.g. France) it is of course one of the most important energy sources. In other countries – also taking into account its low greenhouse gas emissions and therefore on climate grounds – an "exit from the phasing out" is being discussed (e.g. the United Kingdom, Sweden). On the other hand, some countries have already completed the phasing out of atomic energy (e.g. Italy, Austria). 11 EU countries now have no nuclear power stations. China, India and Russia are among countries that are

planning and/or building new atomic power plants. This energy source will also play an important future role there.

Discussions on lengthening service lives of suitable nuclear power stations also motivated by climate policy

In Germany, the federal government is sticking to its predecessor government's decision to phase out nuclear energy. However, it is widely known that there are divergent opinions on nuclear energy in the grand coalition. The CDU/CSU considers that a longer service life would be sensible. The SPD would like to keep to the timetable for the phase-out. Supporters of nuclear power are stressing the low CO_2 output of this energy source. Extended utilisation would ease the transition to a supply more strongly based on renewable energies. In contrast, critics point out a serious of as yet-unsolved problems (e.g. final storage of atomic waste, the finite supply of uranium).

The bottom line is that, under different political configurations in Germany, an extension of the service life of suitable nuclear power plants in excess of the currently valid phase-out plan is conceivable. A “reconciliation” of nuclear energy with renewables might be successful if the (unplanned) surplus earnings of the energy companies from an extended utilisation of atomic power stations were to be used, in an appropriate way, for the promotion of renewable energies. This is a policy option for the future. New construction of atomic power stations in Germany within the forecast period appears unrealistic from the present perspective, in particular because of the high population density in Germany.

Many other countries will continue with nuclear energy. Research in the area of fourth-generation nuclear power stations and nuclear fusion, which get by with less nuclear waste and less uranium, should also be further intensified. These technologies will not, of course, be marketable until well after 2030.

Decoupling of economic growth and energy consumption in Europe sought

Reductions in energy consumption a declared political aim

The EU's declared aim is to reduce energy consumption at least 20% by 2020, by increasing potential savings. As a result, wasted energy, which EU energy commissioner Andris Piebalgs puts at around 20% of consumption, should be considerably reduced. In the end there should be a stronger decoupling of economic growth and energy consumption. If this target is reached, the whole energy sector will have to adapt to falling demand for electrical and heat energy. Worldwide energy demand is, however, continuing to increase.

Research, Research, Research!

Stiffer competition for best scientists and engineers expected

The above comments make clear that, in the future, research and development of new and more efficient energy technologies will play a leading part. Scientific institutions with a corresponding focus of research will profit from this – either through ever-increasing state subsidies or by cooperation with industries that will be increasing their investments in this field. Competition for the most talented people from scientific disciplines can therefore be expected. The founding of new science-based companies will also increase. Overall, the energy research field will be one of the major winners from climate change.

Climatic effects not to be ignored

More frequent damage to the energy infrastructure possible

Of course, the power supply industry is also not unaffected by climate change. For example, insurance costs may rise for power stations in locations that are exposed to more frequent extreme

weather events. There could be more frequent damage to the infrastructure (e.g. storm damage to overhead power lines). Disturbances to the oil supply caused, for example, by hurricanes in the Gulf of Mexico trigger, or amplify, short-term price variations on the commodity markets. In the very long term, the transport facilities for energy feedstocks in high latitudes might improve. More frequent checks of the stability of pipelines built on permafrost, like those in Siberia, could be necessary.

Low rainfall and high temperatures make power station cooling more difficult

If there were an increase in the number of so-called "hundred year summers", like that of 2003, high water temperatures in rivers, or low water levels, could temporarily threaten adequate cooling of power plants. At the same time, demand for energy to run air conditioning installations increases with high summer temperatures. With winters as mild as the last one, this would be compensated by reduced demand for heating energy in the winter months. Longer periods of solar radiation and more wind (as a result of higher temperatures) increase output from renewable energies.

On the bottom line, however, the negative aspects of the climatic effect could predominate. Nevertheless, in the near future the energy sector will probably be influenced more by government actions than by changes in the climate. The regulatory-market economy dimension of climate change could therefore have stronger influence on the power supply industry than the environmental-climatic dimension, at least for the next two decades.

2.2 Agriculture and forestry

Agriculture and forestry part of the problem and part of the solution

Agriculture and forestry are a quite decisive factor where climate change is concerned. Firstly, with over 30% of global greenhouse gas emissions, they make a significant contribution to the climate problem. Secondly they are directly affected by the anticipated climate changes. Thirdly, there are great hopes that they will be able to make a major contribution to coping with the coming challenges, in view of the potentials of bioenergy and the ability of plants to extract carbon dioxide from the atmosphere.

Agriculture faces major adaptations to changed climatic conditions

Climatic effects on agriculture are likely to be evident very quickly. In the future, farmers may be forced to adapt the cultivation of their land to the changing climatic conditions. Plants with high demand for water may be grown less in southern countries, where, in principle, higher temperatures are likely to reduce crop yields. On the other hand, in higher latitudes the conditions for many agricultural crops could improve. In Germany, higher yields could be achieved with heat-resistant plants that are relatively undemanding in terms of water consumption (e.g. corn or millet). The conditions for potatoes or oats ought to deteriorate, however. Farmers are suffering from problems of planning reliability, as a hot and dry summer in one year does not mean that similar weather conditions can be relied on for the next. Sowing and harvesting times will shift. Large variations in crop yields are considered to be very likely. More frequent extreme weather events, such as hurricanes or hailstorms, lead to crop damage.

Large variations in the size of harvests likely

In the final analysis, however, agricultural production in Europe is likely to be relatively little affected, in comparison with many southern hemisphere countries and many developing and emerging nations. If the longstanding drought in eastern Australia is a harbinger of climate change, this illustrates the extent of possible negative consequences. In the long term, China could also be confronted with losses in the irrigation-intensive production of rice.

Irrigated agriculture increases in importance

Increased irrigation raises the price of agricultural products

It can be anticipated that irrigated agriculture will gain massively in importance, not just in southern Europe but also in latitudes like those of Germany. The same will apply worldwide. Considerable investments are necessary in this area, as well as for the modernisation of existing irrigation technologies (see also the conclusions about mechanical engineering in Chapter 2.4). In many arid zones of the Earth these are already outdated, resulting in considerable losses from leaking pipes. The investment required will make agricultural products more expensive. The additional water consumption by agriculture could also lead to resource conflicts: there are already water shortages in many regions.

Increased use of fertilisers and pesticides

In addition, the usage of fertilisers and pesticides must be adapted to the changing conditions (e.g. more and different types of pests). Additional usage can be expected. This is another reason why the prices of agricultural products will tend to rise. As this will tend to increase the prices of forage crops, meat products could also become more expensive as a result.

Genetic and biotechnology gaining in importance

Research efforts in the field of genetic- and biotechnology will probably be intensified in many countries. The objective will be to make agricultural crops more resistant, to adapt them better to changing environmental influences and to increase crop yields per hectare. This will require a certain degree of open-mindedness to these technologies from politicians and the population.

Competition between food and energy crops

Increasing prices for agricultural products resulting from greater demand for bioenergy can spark moral/ethical discussions

The increased importance of bioenergies is having particularly noticeable price effects on agricultural products. As the global acreage of arable land is limited, there is a resource conflict between crops to be used for food and those that are intended for energy production. Up to now, at global level there has been overproduction of agricultural products, which can also be explained by generous subsidies in industrialised countries. In the past, crop yields per hectare have risen in many regions of the world. Further potential is available. It therefore cannot be ruled out that the intensive cultivation of energy crops in some regions could result in fewer food crops being grown. Prices would rise steeply, at least temporarily. The situation could be aggravated by the fact that buyers of energy crops will continue to have greater ability to pay for them than buyers of food crops. A controversial ethical-moral discussion about the utilisation of agricultural products therefore cannot be ruled out, as the so-called "tortilla crisis" in Mexico has intimated.

Government control on emissions from agriculture is limited

Limiting agricultural greenhouse gas emissions extremely difficult

The promotion of bioenergies is, by a large margin, the most important climate-policy motivated exercise of government influence on agriculture. Alternative measures to restrict greenhouse gas emissions from this sector could, however, be difficult. It would be very difficult to restrict the cultivation of rice in the paddy-fields of Asia, or cattle breeding, both of which produce high methane emissions. Higher taxes on corresponding foodstuffs are not popular and are therefore unlikely. It is, however, conceivable that European governments would support the sector, e.g. financially in the case of failed harvests or for the restructuring of agricultural production.

Forestry also needs to adapt

Higher temperatures and reduced rainfall aggravate cultivation conditions for trees such as spruce

In the next few years, the climatic changes will also make themselves felt in forestry. Spruce, a favourite both with foresters and the timber industry because of its straight growth, could lose importance in Germany, as it requires a damp and relatively cool climate. Spruce is also more susceptible to pests (bark beetle) and storms. Pure spruce plantations, for example, were particularly badly affected by Hurricane Kyrill at the start of 2007. If such extreme weather events become more frequent in the future, spruce monoculture, in particular, could be amongst the losers. The consequence would be considerable financial losses. The clearance of storm damage runs up costs that often cannot be covered by the sale of what is, in many cases, lower value storm-damaged timber. Not the least consideration is that the work involved is one of the most dangerous of all forestry operations.

Increased risk of forest fires

In addition to an increase in storm damage, the danger of forest fires could increase across Europe. This was always so for southern countries, in which forestry will be faced with major challenges. Nevertheless, a higher risk of forest fires must also be reckoned with in eastern Germany (less rainfall and a higher proportion of pine woods). Outside Europe, the southwest of the USA is one of the regions in which more frequent forest fires may occur.

Forestry must grow tree species appropriate to the location

Changing climatic conditions will call for a different style of forestry. The cultivation of tree species may need to be more closely adapted to local conditions (precipitation, soil characteristics, temperature and altitude). The long growth cycles in forestry mean, however, that this can only occur gradually. Measures to control tree pests will play a more important role in the future. The advantages of mixed woodlands are frequently stressed as these are less susceptible to climatic changes. However, the costs of harvesting timber are higher in mixed woods than they are in monoculture. An alternative to spruce, the most commonly grown tree species in Germany, is the Douglas fir, originally not a native species. Oak and beech – the latter with exceptions because of its water requirements – are regarded as relatively insensitive to changes in the climate.

Growth conditions in Scandinavia could improve

In higher latitudes (e.g. Scandinavia), increasing temperatures and the higher CO_2 content of the air could accelerate the growth of existing forests. As in agriculture, improved yields are also possible here. Scandinavia's importance as a timber supplier for the remainder of Europe could increase as a result.

Higher timber prices to be expected

Increased demand for timber leads to higher prices

In the future, forestry will benefit from the government-subsidised increase in the importance of bioenergies. Increasing prices are likely in the next few years, as the demand for timber as a fuel will rise and the supply (e.g. by reafforestation of uncultivated land) can be adjusted only slowly. Even for poor-quality (e.g. storm-damaged) timber a dramatic fall in price like those in earlier years is less likely. In the last few years the price of wood for fuel has already risen in Germany, because of increased demand. Forestry might also be able to push through higher prices to the timber processing industry. In the short term, higher timber prices will mean an increased annual rate of felling and, in the longer term, an expansion of the area under cultivation. In the last few years, more woodland has been replanted in Europe than has been cut down.

The higher prices for timber sales have to be viewed against the costs of e.g. the adaptations to forestry mentioned above and the

increased risk of storm damage or forest fires, including rising insurance costs. As the public authorities are the owner of around 30% of the woodland in Germany, as with agriculture it is conceivable that the state would support the forestry sector in its coming tasks or in the event of major damage.

Increased importance of forests as natural CO_2 sinks?

Reforestation programmes could increase worldwide

Globally, the area covered by forest has steadily fallen in the last few decades. From a climate point of view, the clearing and burning of tropical rain forests, e.g. in Brazil or Indonesia, is particularly critical, as at global level this releases more CO_2 than the transport sector does. All attempts to brake or halt this trend have so far failed. It is not unlikely that new attempts will be launched in the future through political initiatives. Countries with large amounts of forest could be offered financial incentives, in the form of credits for emission certificates, to stop "slash and burn" or to commence reafforestation programmes. These could take place e.g. as part of CDM projects. This would not only strengthen the function of the forests as natural CO_2 sinks but would protect against erosion and desertification, as well as stabilising the local hydrological cycle. It would also make a contribution to the maintenance of biodiversity.

Relatively low CO_2 avoidance costs for reforestation programmes

Although forests cannot take CO_2 out of the atmosphere forever, a steadily increasing area of forest would inevitably be positive for the global balance of this gas. CO_2 avoidance costs for either reafforestation or the avoidance of felling are also considerably lower than more demanding technological methods, such as photovoltaics. It is therefore probable that, in the future, reafforestation programmes will increase in importance in many countries. According to the latest reports by the FAO, the UN food and agriculture organisation, the forest resources of many rich countries have grown in the last few years. The example of China, where extensive reafforestation measures are taking place, shows that this can be done successfully even in developing countries.

Agriculture and forestry: Winners and losers

Higher prices for agricultural and forestry products against lower planning reliability

In the final analysis the whole of agriculture and forestry benefits from the additional demand for bioenergies. As a result, the chances of farmers being able to achieve higher prices for their produce are increasing. The sector is therefore a winner in terms of the regulatory-market economy dimension of climate change. In terms of the environmental-climatic dimension, however, the sector will face rising costs arising from the adaptation measures required and from lower planning reliability. Although some regions will reap the benefit of higher crop yields, on the bottom line negative effects may predominate. This is particularly true of developing and emerging countries, where there are already water shortages. In these regions it is likely that there will be an increase in development aid projects, financed by western countries and incorporating firms from the donor states.

2.3 The construction industry and associated sectors

Existing buildings have enormous potential for CO_2 reduction

Existing buildings and their heating account for about 8% of global greenhouse gas emissions. The traditional, main construction business, with its concentration on newbuild schemes, is not, however, the focus of examination. This is because there are hardly any other areas for which investment in climate protection is as worthwhile as in the energy-related refurbishment of existing buildings. Improved insulation of buildings, for instance, normally pays for itself after only a few years. In other words, the investment

costs that must be raised for the insulation of the roofs and walls are on average less than the savings in heating energy costs. According to the federal ministry of the environment, optimal insulation and more efficient heating technology could save an average of 50% of the energy costs of residential buildings in Germany.

Better insulation of older buildings can reduce energy consumption considerably

It is therefore not surprising that the renovation and refurbishment of older buildings is a focus of climate policy in Germany and other industrialised countries. In Germany, for instance, the funds for the CO_2 building refurbishment programme, which runs to 2009, have been substantially increased, to EUR 1.4 billion. In the future, rising energy prices will also cause private households to invest much more in insulating buildings. The important thing is that the resulting saving in energy costs should benefit the person who financed the investment. This will require attention e.g. in the case of lease contracts. The introduction of the so-called “energy passport” in Germany increases transparency concerning the heating costs of buildings. For commercial property, in addition to improved insulation, building management targeted at energy efficiency will increase in importance. Intelligent control systems for heating, cooling and lighting are in demand for this. This also includes measures taken by production complexes for better utilisation of process heat. The federal government plans to make an amendment to the energy savings order in order to reduce the energy consumption of new buildings by 30%.

Sectors contributing to energy modernisation of buildings on the winning side

All sectors that can make a contribution to increasing the energy efficiency of buildings could be viewed as profiting from climate change in respect of the regulatory-market economy dimension. This includes parts of the subcontracting sector and the building trades (e.g. heating installers, roofers, specialist insulation and energy-related refurbishment contractors), the manufacturers of insulation materials and other energy-efficient building materials as well as of modern heating and air conditioning installations. Business options will also broaden for consultancy firms, architects and consulting engineers concentrating on energy efficiency (e.g. on energy contracting) as well as the suppliers of low- and zero-energy houses. Firms that are able to supply a complete package will provide important added value for their clients. There is certainly still room for further research and development.

As there is a very great potential for energy savings in the built environment, at relatively reasonable cost, it can be assumed that government subvention measures and private initiatives should give a noticeable impetus to demand in these sectors.

Increased investment in coast protection

In order to protect against what is presumably an increased danger of storm surges, for example on the North Sea coast, the construction and refurbishment of coast protection works may well be intensified in the next few years. This will particularly involve building dikes and will provide extra contracts for this section of the construction industry. Investments in coast protection will also increase at global level. In countries that lack the funds and the expertise, such measures could increasingly be financed by development aid projects, in which European companies may take part.

Climate effects limited, but tending to the positive

Fewer working hours lost through weather conditions in mild winters

From a climate point of view, in the future the construction industry could benefit from milder winters. If there are more frequent mild winters like that of 2006/07 in Europe, the conditions for building will be improved, primarily for civil engineering but also for other

construction sectors. Fewer losses of working time caused by the weather and, on the bottom line, greater planning reliability would then be the result. However, mild winters cause less damage to the road infrastructure (fewer frost days, reduction in the amount of road salt). Repairs would then be required less often. On the other hand, extreme heat more quickly produces ruts in the roads, which must be rectified more frequently. Construction industry productivity can suffer, or need long mid-day breaks, in very hot summers.

More frequent regional and temporary booms for the construction industry after extreme weather events

Extreme weather events such as storms or floods usually cause damage to buildings and the infrastructure, which result in contracts for the repair of the damage by the construction industry. Hurricane Kyrill resulted in an exceptional boom for roofing contractors in many regions of Germany. The floods on the river Oder in 1997 and the Elbe in 2002, which caused damage costing around EUR 10 billion in Germany and destroyed many buildings, resulted in extensive contracts for the construction industry. If similar events occur more often in the future, such exceptional temporary and regional booms may possibly be more frequent. On the bottom line, the construction industry could be amongst the winners from the expected climate changes.

2.4 Manufacturing industry

Extending emissions trading to more industrial sectors is a future policy option

Almost 20% of worldwide greenhouse gas emissions are accounted for by industry. A few general statements in connection with climate change apply to all industrial sectors. As far as the regulatory-market economy dimension of climate change is concerned, in the next few years all sectors will be affected by higher energy prices. In the medium term, participation in emissions trading by all sectors of industry is a policy option. In principle, energy-intensive sectors like metals, building materials, paper and the chemical industry will be more heavily affected than e.g. mechanical and electrical engineering and the automobile industry, for which energy costs are a lower proportion of the total. Firms will therefore continue to invest in improvements to the energy efficiency of their production processes in the future, as higher energy prices mean that these costs can be amortised more quickly. The energy efficiency of their respective products will also increase markedly in importance and will become a real competitive factor (e.g. lower fuel consumption in the automobile industry).

With regard to the environmental-climatic dimension of climate change, potential climate risks could be an important deciding factor in choosing locations for factories. Sectors with a high demand for water could be forced to reassess their choice of location if they are established in areas where there are water shortages. Of course, other criteria in the choice of location (e.g. wage costs, infra-structure) will still be more important in the future. For most industrial sectors, the purely climatic effects on decisions affecting location could be limited, at least in Europe and up to the end of our forecast period.

In the following section the implications for both dimensions of climate change on individual industrial sectors will be analysed.

Increased raw material prices for foodstuff likely

For the reasons described in Chapters 2.1 and 2.2, the entire **food industry** could suffer from higher raw material cost prices for foodstuffs. In view of the market power of the food retailers, it is doubtful whether these higher costs could be entirely transferred to customers. Despite the low price elasticity of demand, higher retail prices would force down the sales of some products. However, price fluctuations caused by weather conditions are already not unusual in

the sector, although mainly affecting fresh foodstuffs. Some sections of the food industry could profit during particularly hot summers. These include e.g. mineral water bottlers, soft drinks producers and ice cream manufacturers. The losers from more frequent “hundred year summers” could include the manufacturers of (salted) snacks and chocolate products. A degree of reluctance to buy such items was noted in 2003. In the long term, the very high water requirements of some sections (e.g. meat, fish, and fruit and vegetable processing) could make it necessary for them to relocate.

Planning reliability for the clothing industry falls

In the **textiles and clothing** sector there may be differing effects. For manufacturers of particularly fashionable clothing, fashion cycles are more difficult to predict if the weather “acts up”. Experience shows that retail sales of clothing drop noticeably if the goods on offer do not correspond with actual or expected weather conditions. With up to 12 fashion cycles each year, this will complicate production and sales planning. For example, last autumn and winter, sales of winter and winter-sports clothing in Germany were very sluggish due to continuing high temperatures. This naturally affects both manufacturers' and retailers' returns. Their planning difficulties are also passed on to the textile industry. High-quality technical textile products with specific characteristics could however benefit. Increasingly, in many fields of application, new types of material are being used, in order to reduce weight and therefore energy costs (e.g. in vehicle construction). Breathable fabrics could further increase in importance for clothing.

Higher timber prices put a strain on the timber trade and furniture industry

Like the food industry, increasing cost prices for the (energy) raw material, timber, could affect the **timber processing industries**, including the **furniture industry**. There is, however, stiff competition in this sector. Furniture retailers, the furniture industry's most important customers, have tremendous market power over the manufacturers. On the bottom line, the profits of the sector could suffer, as higher costs might not be able to be passed on adequately. A positive point for the sector is that in the use of timber, e.g. as a building material, for floor coverings or for furniture, carbon is extracted from the atmosphere on a lasting basis. Timber is an important raw material in the construction of zero-energy houses. Government support programmes for timber as a building material therefore cannot be ruled out.

High water consumption by the paper industry can spark relocation considerations

As the **paper industry** uses organic raw materials, the increased importance of bioenergies may also result in an increase in its raw material prices. However, strong cyclic price variations are in any case typical of this sector. Price variations will also be moderated by the increasing use of recycled paper: Germany is the European leader in this field. The sector also requires vast quantities of water, which in the future could disadvantage locations in dry regions. Higher paper prices could lead to price increases in the **printing and publishing industry** and could therefore reduce demand.

Falling demand for mineral oil products declared political aim

According to government intentions, in the future there should be lower demand for the products of the **oil industry**. At the same time, the prices of raw materials are increasing as a result of expanding global demand. However, depending on the degree of integration of the value creation chain, it should be easier to pass these higher costs on to the customers. Also, in the future there will be increasing competition between the traditional oil refineries and refineries for biofuels (and their respective end products). Biofuels will benefit from government subvention measures. This will of course provide opportunities for established suppliers to enter this new field of

business. Increasing energy costs will put a strain on **coking plants** in particular. Important customers like the steel industry will also have to contend with higher energy prices.

Varied application of chemical products in climate technologies

The **chemical industry**, as a traditional cross-section technology with many areas of application, will be both negatively and positively affected by the consequences of climate change. Increasing prices for important (fossil) raw materials will naturally be a burden. However, the products of the chemical industry could be used in many climate technologies, in the development of new materials and in aiding the acceleration of technical advances (e.g. photovoltaics, fuel cells, LEDs, surface coatings). The sector will also benefit from the increased demand for pesticides and fertilisers. The **pharmaceutical industry**, as a section of the chemical industry, could profit if forecasts that diseases or pathogens unknown for many years in Europe (e.g. malaria, ticks) might extend further northwards are correct. Appropriate vaccines or medicaments would then be in greater demand. On the other hand, there might be reduced demand for influenza medicines if fewer people suffered from colds and flu in milder winters. In the future, genetic and biotechnologies will be a focus of the chemical industry. This is also backed up by climate change.

Increased demand for medicaments and vaccines to be expected

Falling mileage per motor vehicle reduces demand for tyres

The **rubber industry**, which is primarily comprised of the tyre industry, could, in the next few years, put more effort than before into reducing the rolling resistance of tyres. This is an important requirement from the car industry and from customers, in order to reduce the fuel consumption of vehicles. Very high fuel prices result in a considerable reduction in the yearly mileage travelled per car. As a result there would be less tyre wear and tyres would not need to be changed so often. In the long term, more frequent mild winters could reduce the use of winter tyres. The **plastics industry** will discover the effects of higher prices for its most important raw material, crude oil. However, it is a cross-section technology that has applications in many areas in which the aims are weight reduction and energy saving (e.g. the automobile industry, other types of vehicle construction).

High production-related emissions put a strain on the building materials industry

The **building materials industry** (glass, ceramic, stone and brick) is one of the most energy-intensive sectors and is therefore negatively affected by rising energy prices. The products of the sector will therefore tend to become more expensive. A particular problem for the sector is its partly very high process-related CO_2 emissions, for instance from the lime and cement industry. If, in future emissions trading, CO_2 certificates are 100% auctioned, this could result in considerable cost increases for the firms. The sector will have to have confidence that politicians will take process-related emissions into account accordingly. If not, Europe's competitive ability will fall considerably in comparison with countries that do not take part in emissions trading. The sector can benefit from the coming energy-related modernisation and refurbishment of buildings. There is a need for research in order to be able to offer energy-efficient products. The coming, partly climate-policy-motivated investments in new power stations and coastal defence works will naturally also benefit the building materials industry.

Increased energy costs mean concentration on high-quality metal products

In a similar way to the building materials industry, the **metal production** and **metal processing** industries primarily belong to the energy-intensive sector. They will have to expect higher energy prices. The competitiveness of e.g. the European steel industry will therefore fall further, in comparison with companies that manu-

facture in countries with considerably lower energy prices. Stronger concentration on high-grade types of steel is therefore also a consequence of differential energy costs, to continue with this example. There are many examples where the dimensions of climate change have positive or negative effects on sales of metal products: The erection of wind farms clearly favours the metal industry. So does the replacement of heating installations and the construction of new power stations. In contrast, the automobile industry could be keen to reduce the proportion (by weight) of metal per vehicle, which can of course partly be compensated for by higher quality materials. Substitution within the metal industry is also likely (e.g. aluminium to replace steel).

Mechanical and electrical engineering can contribute to slowing climate change and to moderating its negative effects

The trend towards higher energy efficiency means that **mechanical and electrical engineering** will certainly be among the winners from climate change. It is anticipated that they will be able to deliver technological solutions that will contribute to the slowing of climate change and to mitigating its negative consequences. The boundaries between the two sectors are therefore fluid. These branches of industry are also favoured by their lower proportion of energy costs. Naturally, particular impetus is to be expected from the construction of power stations and large-scale plants. This applies equally to power station technologies for both fossil and renewable fuels. The manufacturers of heating and air conditioning installations could also benefit; the former from the high demand for refurbishment and the latter from increasing summer temperatures, even in northern latitudes. For instance, sales of air conditioning installations for private households in Germany increased rapidly in the summer of 2003. In addition, all technologies associated with water supply and distribution will be gainers (water treatment plants, sewage plants, seawater desalination plants, irrigation technologies, pumps, compressors). The list of "winners" in the capital goods fields of mechanical and electrical engineering could go on further. Energy efficiency is also the keyword for household electrical appliances.

Energy consumption of household appliances increasingly important

The policy is to endeavour to reduce considerably the electricity consumption by such appliances. An improved obligation to label goods precisely, in terms of their respective energy consumption, is under discussion. The stand-by function on many appliances (e.g. TVs, PCs) is also being debated. In the future, energy-saving light bulbs will increase their market share, to the detriment of traditional incandescent bulbs. This could be partly supported by political measures. Overall, heavier regulation is to be expected for this sector. Lasting high energy prices will mean that consumers pay a great deal of attention to energy efficiency when buying new or replacement goods. This will therefore become one of the most important competitive factors.

Considerable reduction in fuel consumption by cars planned

From a climate policy point of view, the **automobile industry** will be a policy focus. As CO_2 emissions from road vehicles have steadily risen in the last few years and advances in the improvement of specific fuel economy have slowed, the EU is planning an obligatory upper limit of CO_2 emissions, for newly registered cars, of 120 grams per kilometre from 2012 (compared with the average of around 160 grams for new cars today). In Germany, a changeover of the basis of assessment of vehicle tax to CO_2 emissions is being discussed. Restrictions on the company car regulations are also under consideration. These government measures will drive up investment in research and development in the sector. The manufacturers will work even more intensively on newer and potential propulsion technologies for the future (electric cars for city traffic, hybrids,

Reduced mileage per car reduces need for replacements

hydrogen technology); on new materials; and on the reduction of rolling resistance and air resistance. Suppliers to the automobile industry could benefit from additional orders as a result. Efficiency improvements for traditional methods of propulsion, e.g. by direct injection of petrol engines or automatic engine stop-and-start, appear to be very promising in the short term. Preparations to cope with an increasing proportion of biofuels are in progress. Of course, all this will result in increased costs, which in the end will lead to higher car prices. In the medium term, however, energy-efficient vehicles offer possibilities for success, including abroad, as the success of German suppliers in the USA is already demonstrating. The fuel efficiency of the car will become an important decision criterion, particularly for private car buyers. In the future, long-term higher fuel prices may further reduce the annual mileage per car. Lower mileage also means a reduced need for replacements. In the medium- to long term, the (government subsidised?) increase in car sharing; the increased importance of car pools; and teleworking could strengthen this trend towards reduced annual mileage per car. The bottom line is that, of all branches of industry, the automobile industry is the sector facing the greatest challenges from climate-policy-motivated government measures.

Energy efficiency in other types of vehicle construction also the centre of research activities

In the rest of the **vehicle manufacturing industry** (ships, railway vehicles and aircraft construction) there is no doubt that energy efficiency will be an even greater priority in the future, as growth in these fields of transport will also be linked to lower energy consumption. Like the automobile industry, research and development will also be a priority here. Policies may tend to favour rail transport and to increase the fiscal burden on air travel – with corresponding effects on the respective industries (see also the conclusions on the transport sector in Chapter 2.5).

Producing industry: interim conclusions

Research is a decisive success factor for industry too

The analysis of the individual industrial sectors shows that, not surprisingly, the regulatory-market economy dimension of climate change will clearly predominate up to the end of the forecast horizon. Only in the food industry is the environmental-climatic dimension of climate change already having a noticeable effect. Many sectors will be faced with higher prices for raw materials. Margins could be under pressure and demand for the affected products could fall. It is, of course, not possible to identify the discrete effect of climate change. In most cases, however, it should be rather small. It is also clear that research and development will be a deciding factor in future success, as it already is in the energy sector. The government will be challenged to create better conditions for the education of young scientists, in particular engineers, and also of other qualified personnel.

2.5 Services

The services sector is less energy-intensive than industry

In the following section, the possible effects of both dimensions of climate change on the services sector are examined. In doing so, we have assumed a very wide definition for the term “services”. As with the industrial sectors, there are some points regarding the effects of climate change that are generally valid for services. On the cost side, for instance, energy prices will increase, although the services sector is in principle less energy-intensive than industry. Exceptions to this are e.g. the transport-intensive fields. More severe regulatory measures are similarly to be expected. However, the overall degree of susceptibility – except for the transport sector – is less than that of producing industry. Firms providing services will

also take more account of possible climate risks in their choices of location.

Reduced planning reliability for individual fields of wholesaling and retailing

In some sections of **wholesaling** and **retailing**, more frequent extremes of weather and the more intensive use of bioenergies are likely to cause more pronounced price fluctuations or rising prices. This is true first and foremost of food retailing, where the prices of fresh foodstuffs are already greatly dependent on weather influences. For clothes retailers, it could become more difficult to react quickly to unusual weather situations with the appropriate ranges. In advertising, it will become more important to emphasise the energy efficiency of the goods on offer (e.g. in electrical retailing). Transport costs will rise considerably for wholesale and retail firms having their own extensive fleets of vehicles, as fuel prices will tend upwards in the future. In the car dealership and repair shop sector, firms that have a heavy concentration on tyre services could be put under pressure. This is because, in some regions, there will be greater use of all-weather tyres and therefore there will be less need to change between summer and winter tyres. The need for replacement tyres will also be reduced as mileage per car falls. Sales of two-wheelers are very weather-dependent and generally benefit from higher temperatures early in the year.

Extensive regulatory measures on the transport sector to be expected

The **transport sector** is amongst the fields for which the most rigorous regulatory measures can be expected in the next few years. At global level the transport sector accounts for “only” about 13% of all greenhouse gas emissions. Of decisive importance, however, is the very high growth rate in this area, which can be observed worldwide in both freight and passenger transport. This is a consequence of the increasing international division of labour, the liberalisation of trade relations and the basic human need for mobility. The continual expansion of the transport sector, despite the reduced specific emissions of greenhouse gases by all modes of transport in the past, explains the need for action by policy makers. They will aim to make mobility more expensive and therefore to curb growth in the demand for transport. Probable measures are higher fuel taxes (e.g. in countries that still have very low rates of tax on petroleum) and road pricing for trucks and cars. In sectors where it would be practical, emissions trading might also be introduced.

Inclusion of air transport in EU emissions trading on the political agenda

Global **air transport** is growing particularly dynamically, at around 5% p.a., and will continue to expand. The emissions from this sector also cause greater damage to the climate, as they are discharged at higher altitudes. In the EU, voices are increasingly being raised in favour of including air transport in emissions trading from 2011. An air ticket tax, such as already exists in France and the United Kingdom, is also up for discussion. The introduction of a European kerosene tax in the EU may fail for the moment, however, due to resistance from a few southern European countries. Although it is not yet possible to give information on the specific burdens that will be put on air transport, it appears certain that political actions will make this mode of transport more expensive. This will curb the sector's growth potential. As air transport is actually an international sector, it might be that European airlines – depending on the design of the measures – could be more heavily burdened than their non-European competitors, which would damage their competitiveness. There are also ecological grounds for creating a single European air space and expanding the capacities of heavily overloaded airports as quickly as possible: this would shorten flight paths and cut down on holding patterns.

Higher taxes on road transport likely

Road transport, by a wide margin the most important mode of transport, is also continually growing. This is particularly true of cross-border freight transport. Even in the past, many government measures had an ecological background. All countries have eco-taxes, which are usually included in the petroleum tax. In the future a further rise in petroleum tax is likely, particularly in eastern European countries, as the EU is striving to drive gradual increases to a minimum level. In some countries road tolls, graduated according to ecological criteria, are under discussion even for cars. A changeover of the basis of assessment of road tax in Germany to CO_2 emissions may be only a question of time. The political aim is therefore also perceptible for road transport: to curb the growth in demand by higher prices. As a consequence, a faster elimination of bottlenecks in the German and European motorway network could reduce tailbacks and the associated waste of fuel.

Rail transport can benefit from government subsidy programmes

Rail transport would clearly be one of the major beneficiaries from potential ecopolitical measures in the transport sector. The ecological merits of rail have always been emphasised by politicians of every colour. It was therefore always opportune to encourage a transfer of (freight) traffic to rail. Nevertheless, in practice, road transport prevails, due amongst other things to its speed and flexibility. At the moment, considerations include e.g. a reduced VAT rate for rail transport. Exemptions from the eco-tax are also conceivable for the medium term. The whole rail system in Europe would experience a stimulus if competition on the rails could be quickly intensified and more new firms could become established in the market. Steps to improve the interoperability of European rail transport would also considerably increase the attraction of the railways (latest positive example: links between Paris and Frankfurt, and Paris and Stuttgart, by ICE and TGV).

Increased fuel costs will make buses and trains more attractive

Local public transport, as an environmentally friendly mode of transport, will continue to benefit from government subsidies in the future (e.g. infrastructure grants, exemption from the eco-tax). In addition, rising fuel prices could make it more lucrative e.g. for commuters to transfer from cars to buses and trains on cost grounds. The global trend towards urbanisation also favours local public transport. In the last few years the transport services provided by local public transport undertakings in Germany have been steadily increasing.

Inland navigation affected by more frequent floods and low water

Inland navigation is an environmentally friendly mode of transport, which has already been exempted from petroleum tax. In this sense it is already benefiting from government exemption stipulations. Inland navigation is particularly susceptible to extreme weather events. The “hundred year summer” of 2003 led, for instance, to low water levels on important waterways such as the Rhine. As a result, inland navigation transport services fell by more than 9% in 2003 as a whole. Low water means that payloads must be reduced, which results in higher costs per unit load. Conversely, there is an increasing probability of high water on many navigable waterways, which also interferes with or prevents navigation. The sector will have to adapt to being confronted with such situations more frequently in the future.

Emissions trading for ocean shipping as well?

International **ocean shipping** carries, by a large margin, the majority of long-distance freight transport. Unlike global air transport, up to now it has hardly been in the focus of the climate discussions, although the amounts of greenhouse gas emitted by each sector are roughly similar. In addition, ocean shipping often uses low-grade fuels (heavy oils with high sulphur content) that are still largely exempt from taxes. Not least, some areas of ocean shipping have

very high growth rates. Container shipping, for example, could continue expanding worldwide at almost 10% p.a. until the middle of the next decade. For the sake of consistency, political measures are also required here. In Europe, the first considerations are being given to including ocean shipping in emissions trading. Stricter conditions in relation to the efficiency of ships' engines are also conceivable.

More frequent extreme weather could affect traffic flows

As well as the possible interference with inland navigation resulting from extreme weather that has already been described, the environmental-climatic risks from climate change are increasing for all modes of transport. At the start of 2007, for example, Hurricane Kyrill caused numerous flight cancellations in Europe. Rail transport, e.g. in Germany, temporarily came to a complete standstill. Road transport was also affected, for instance by fallen trees, in some regions. This must be contrasted with fewer restrictions on traffic flows, resulting for example from icy roads, if there are more frequent mild winters like the last one. More frequent storms could also increase the risks to ocean shipping. On the other hand, in the medium to long term the navigability of the Northwest and the Northeast Passage could improve, resulting in shorter transport times and lower fuel consumption.

Regional and seasonal shifts of tourist flows likely

The effects of climate change are expected to be particularly noticeable in the area of **tourism**. As local weather conditions are a decisive factor in the choice of a holiday destination, in the future, changes in the climate – and therefore the weather – will play a more important part in holidaymakers' decisions. Overall, there is no doubt that tourism will continue to be a growth sector. However, a regional and seasonal shift of tourist flows is very likely. As a result, the Mediterranean region could experience fewer bookings in the middle of summer (i.e. in what is now the high season) but could be more popular in spring or autumn instead. In contrast, holiday regions in northern latitudes (e.g. the North Sea and the Baltic) could benefit as holiday destinations from the higher temperatures and lower rainfall in the summer months. The Alps are predicted to have less snowfall in the winter months in the coming years and decades. Artificial snow is already necessary in many winter sports resorts. This trend could continue in the future, despite considerable reservations about the energy consumption of snow cannons. The high-altitude winter sports resorts will be among the winners, as they will have increased certainty of snow and also a longer season. Holidaymakers who have had bad experiences with the amount and quality of snow in lower regions could give higher priority to the certainty of there being snow when deciding on future holidays. Although lower-lying regions could improve their attractiveness by offering alternative activities (e.g. wellness, hiking, culture) in the final analysis people on skiing holidays want to go skiing, so that the possibilities for alternative pursuits are limited. In the whole tourism sector, the already observable trend towards late bookings could be further reinforced because of increasing uncertainty over the weather. This aggravates the planning reliability of the sector. From the regulatory side, the rise in the price of mobility described above is putting a damper on the tourism sector, in particular for long-haul routes.

High-altitude winter sports resorts favoured by better snow conditions

Consultancy services for energy saving gain in importance

In the future, new fields will be opened up for **corporate service providers**. Consultancy and implementation associated with the subjects of energy saving and energy efficiency will therefore gain considerably in importance. This is also the case for companies with expertise in emissions trading and in the support and certification of

CDM and JI projects. A promising business model involves making it possible for firms and even private households to offset their greenhouse gas emissions by investing in climate protection projects overseas.

Public investment in water supply and waste management necessary

The **public sector** is also affected by climate change. The challenges to water supply in many European countries could increase in the future. The changing climatic conditions will make investments in supply infrastructure necessary. Investments will also be necessary for many refuse dumps, in order to avoid the emission of landfill gas (mainly methane and carbon dioxide). In terms of technical standards, Germany is the leader in Europe. Other countries have an enormous amount of catching-up to do. More frequent extreme weather events (primarily storms and floods) also lead to increased deployment of fire-fighters, technical aid organisations and similar facilities. These measures are associated with higher costs. However, more frequent mild winters should reduce the deployment of gritting and snow-clearing services. In the future, the state, as a purchaser of goods and services, will pay more heed to climatic aspects. Particular challenges for the public sector include the intensification of research and development at universities and universities of applied science. Previous comments have stressed the great need for science and engineering expertise in order to be able to react appropriately to climate change and to secure the position of Germany and Europe as leaders in climate protection and suppliers of solutions to tackling climate change and its negative consequences.

Promotion of research and development one of the most important tasks for politics

Calculation of risks by the insurance industry considerably harder

Finally, climate change also affects **finance**. For the **insurance industry**, for example, climate risks are extremely hard to calculate, as the future cannot be inferred from historic experiences. This increases the uncertainty of the sector, for example in the calculation of insurance premiums and possible payments for insurance claims. Major damage resulting from extreme weather results in insurers and reinsurers having to pay out hefty amounts to their respective clients. A recent example of this is Hurricane Katrina, which destroyed large sections of New Orleans in 2005. Demand for property insurance could tend to rise. The insurance of catastrophic risks in highly endangered regions could, however, sometimes not be possible for insurers on the basis of existing insurance products and business models. The use of innovative instruments for transferring risk (see below) can extend the limits of insurability and create additional supply. Insurers and in particular reinsurers are already using these instruments and will do so increasingly in the future. However, some risks will be uninsurable on economic grounds even then. For the **banks**, the risks and opportunities for their customers stemming from both dimensions of climate change will be increasingly spotlighted. This will apply to the assessment of risk for countries as well as for sectors and firms. Finally, climate risks will be included in the assessment of clients' creditworthiness and in credit ratings. An ever-increasing number of stock indices are taking account of firms' activities in the areas of environmental protection and social commitment. These include the Dow Jones Sustainability Index. There are opportunities for the banks e.g. in the financing of renewable energies and of measures against the negative consequences of climate change. Emissions trading, on their own behalf or for clients, as well as consultancy in this area, present new business opportunities. Banks also take part in the development and operation of financial products that make it possible for climate risks to be insured or transferred from firms or

New business opportunities for banks, e.g. through sustainable investments

countries to the capital market (e.g. weather derivatives, catastrophe bonds, GDP-linked bonds). This is indubitably a growth market. In addition, the supply and demand for investment products with a connection to climate change are rapidly increasing. For the second half of 2007, Deutsche Bank Research is planning a more extensive report, on the role of the financial markets in coming to terms with climate change.

3. Summary

Regulatory-market economy dimension of climate change is more important

Despite the major uncertainties mentioned at the beginning that afflict both dimensions of climate change, this analysis has demonstrated a clear trend: the regulatory-market economy dimension of climate change will affect most sectors much earlier than the environmental-climatic dimension. This is true for Europe at least. If this is the case, policy makers must be clearly responsible for creating planning reliability for all economic players, by announcing climate policy measures as early as possible. This is essential for all the sectors that are affected, as they will then be able to gear up for the coming tasks much more easily and efficiently. The analysis has also shown that, for many sectors, the opportunities presented by climate change outweigh the risks. This is particularly true of sectors that could make an important contribution to the tackling of climate change and its negative consequences. These “winning” sectors have enormous export opportunities. Finally, companies or sectors that prepare earliest for the regulatory, price and climatic changes will have the greatest opportunities to assert themselves in this changing environment.

Firms who prepare early for the coming challenges have good chances of success

Technologies that nobody has yet considered and that will not be developed and discovered for the next few years were naturally not the subject of this examination. The human race has often proved its ability to react to major challenges with technological breakthroughs. A healthy dose of optimism for the future is therefore needed. Research and development are the keys to success in this respect.

The concluding graphic on the next page shows, in a simplified, schematic way, the division between winning and losing sectors based on the two dimensions of climate change that have been examined.

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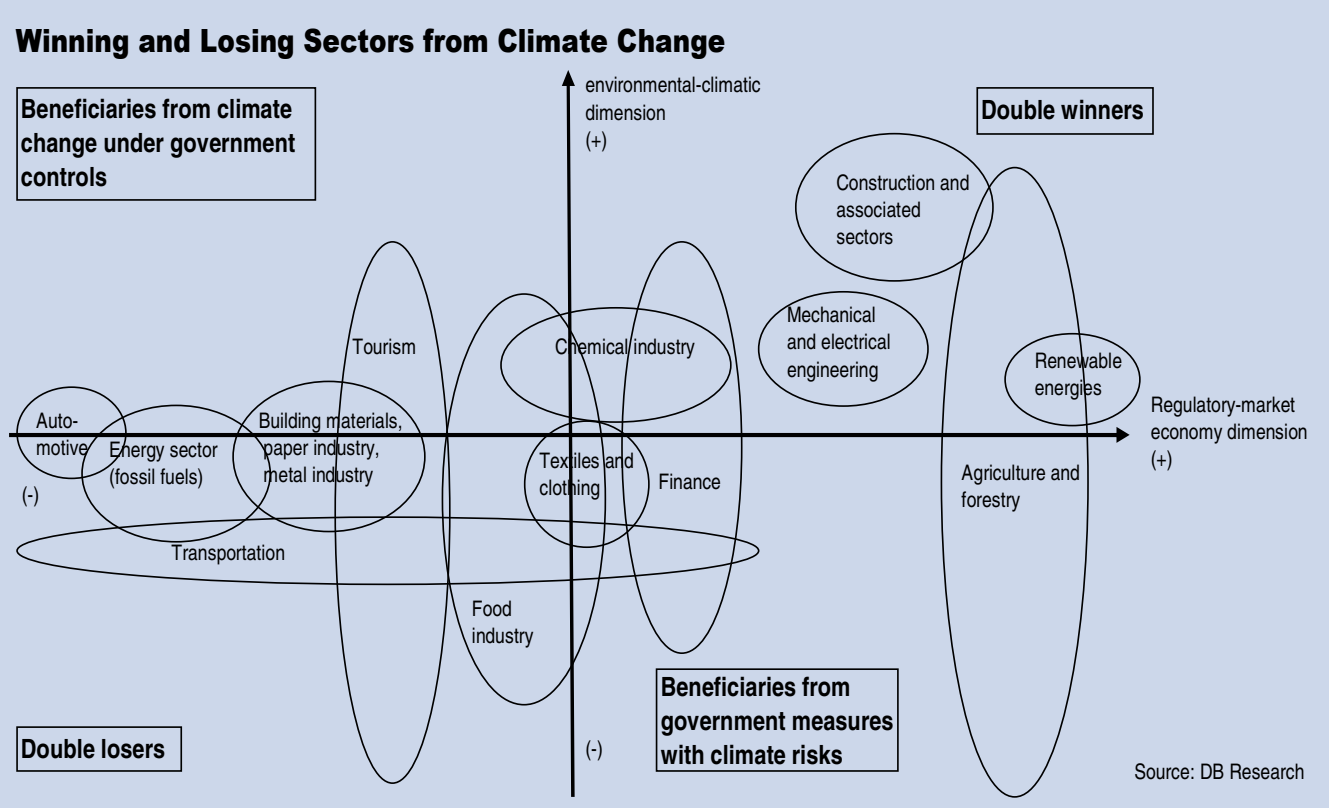

The size of the circles and ellipses does not reflect the importance of the sectors but rather the extent that they are affected by the two dimensions of climate change. For example, agriculture and forestry benefits from the regulatory-market economy dimension. As far as the environmental-climatic dimension is concerned, however, there are regions in which the risks predominate (southern Europe) and also those in which the opportunities of climate change are greater (northern Europe).

Selected bibliography

Auer, Josef (2001). Pinning hopes on renewable energies. Deutsche Bank Research. In Frankfurt Voice No. 4/2001. Frankfurt am Main.

Auer, Josef (2003). Weather derivatives heading for sunny times. Deutsche Bank Research. Frankfurt Voice. Frankfurt am Main.

Auer, Josef (2005a). Boom industry solar energy. Deutsche Bank Research. Current Issues. Frankfurt am Main.

Auer, Josef (2005b). Bioenergies after the petroleum age. Deutsche Bank Research. Current Issues. Frankfurt am Main.

Auer, Josef (2005c). The US's new energy policy – barely a start. Deutsche Bank Research. Current Issues. Frankfurt am Main.

Auer, Josef (2007). EU energy policy: High time for action! Deutsche Bank Research. EU Monitor 44. Frankfurt am Main.

Auner, Norbert (2004). Silicon as an intermediary between renewable energy and hydrogen. Deutsche Bank Research. Research Notes No. 11. Frankfurt am Main.

Baker, Jeremy et al. (2007). Climate change: beyond weather. UBS research focus. Zurich.

BMU (2007). Klimaagenda 2020: Der Umbau der Industriegesellschaft. Hintergrundpapier. Berlin.

Enkvist, Per-Anders et al. (2007). A cost curve for greenhouse gas reduction. The McKinsey Quarterly 2007 Number 1. Stockholm.

Heymann, Eric (2007). EU emission trading: Allocation battles intensifying. Deutsche Bank Research. Current Issues. Frankfurt am Main.

IPCC (2007a). Climate Change 2007: The Physical Science Basis. Summary for Policymakers. Geneva.

IPCC (2007b). Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability. Summary for Policymakers. Geneva.

IPCC (2007c). Climate Change 2007: Mitigation of Climate Change. Summary for Policymakers. Geneva.

Kemfert, Claudia (2007). Klimawandel kostet die deutsche Volkswirtschaft Milliarden. DIW-Wochenbericht Nr. 11/2007. Berlin.

Kemfert, Claudia et al. (2007). Breites Maßnahmenpaket zum Klimaschutz kann Kosten der Emissionsminderung in Deutschland deutlich verringern. DIW-Wochenbericht Nr. 18/2007. Berlin.

Stern, Nicolas (2006). The Stern Review: The Economics of Climate Change. Cambridge.

Umweltbundesamt (2007). Neue Ergebnisse zu regionalen Klimaänderungen. Das statistische Regionalisierungsmodell WETTREG. Dessau.

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