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Staying with the leaders
Europe's path to a successful low-carbon economy

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Europe is not alone …. A diverse group of countries and regions is now advancing policies to enhance energy efficiency in building, industry and transport; to increase deployment of and industrial capacity in renewables; and to price carbon.

… **and needs to remain part of this leading group** to secure energy supply, attract long-term investments and drive innovation that will enhance economic performance and unlock underutilised human and private financial resources to create new jobs. A stable European energy and climate policy environment, consistent with international climate goals, is crucial to future prosperity and will maintain the credibility of the European idea and its international legitimacy by accepting responsibility for its emissions. Falling behind would leave Europe more exposed to the inherent volatility in global fossil fuel markets. By staying among the countries leading the way in the low-carbon transition, Europe can instead benefit economically from a low-carbon economy.

European economic competitiveness is not determined by energy prices. For 92% of manufacturing, energy bills are on average less than 1.6% of revenue (based on data for Germany). While it is important to contain energy costs, they do not determine the international competitiveness of European industry, or of the European economy overall. Europe spends a similar proportion of its GDP on energy as the United States and other major competitors. Prices stimulate higher efficiency and countries with higher energy prices are often more energy efficient, which limits the impact of higher energy prices on bills.

… but a few key sectors deserve (and get) special treatment. 8% of manufacturing industries spend more than 6% of their revenue on energy. For some of their energy intensive processes, energy price differentials to the rest of the world can matter. To ensure that European firms are not disadvantaged on international markets where competitors are not subject to environmental costs, special provisions are and will remain in place to protect specific manufacturing processes from additional energy costs. However, energy price differences with competitors can remain due to differences in natural resource endowment. These can only be compensated for through additional efforts on energy efficiency and innovation.

Climate policy and European economic recovery can and should be made mutually reinforcing. The competitiveness indicator of the World Economic Forum puts 15% weight on the innovative capacity of a country and 1% on the electricity infrastructure. Several European countries are among the global leaders on innovation across all low-carbon technologies.

… **while acknowledging the differences between the Member States.** Now a Europe-wide effort is needed to ensure all European countries will benefit. A strategy is required to bring together public initiative and private investment, coordinated through a shared vision for a low-carbon transformation.

THE LEADING GROUP

The transition to a secure, affordable low-carbon economy requires action on three broad pillars of policy: measures to enhance energy efficiency; research and development of low carbon technologies, particularly for renewable energy; and proper carbon pricing, to ensure that the costs of environmental damage are reflected in market signals, and to enhance the value of investment in the other two pillars[i].

This section reviews international progress in accelerating energy efficiency in building, industry and transport; the rapid increase in renewable energy deployment and industrial capacity; and the spread of carbon pricing. Inevitably, progress is varied. What the data reveal is:

- for the different sectors and technologies a leading group of countries and regions are most advanced in their efforts on climate policies *(section 1.1)*.
- these countries are making significant progress in improving energy efficiency, increasing renewable energy generation capacity and inducing energy intensity *(section 1.2)*.

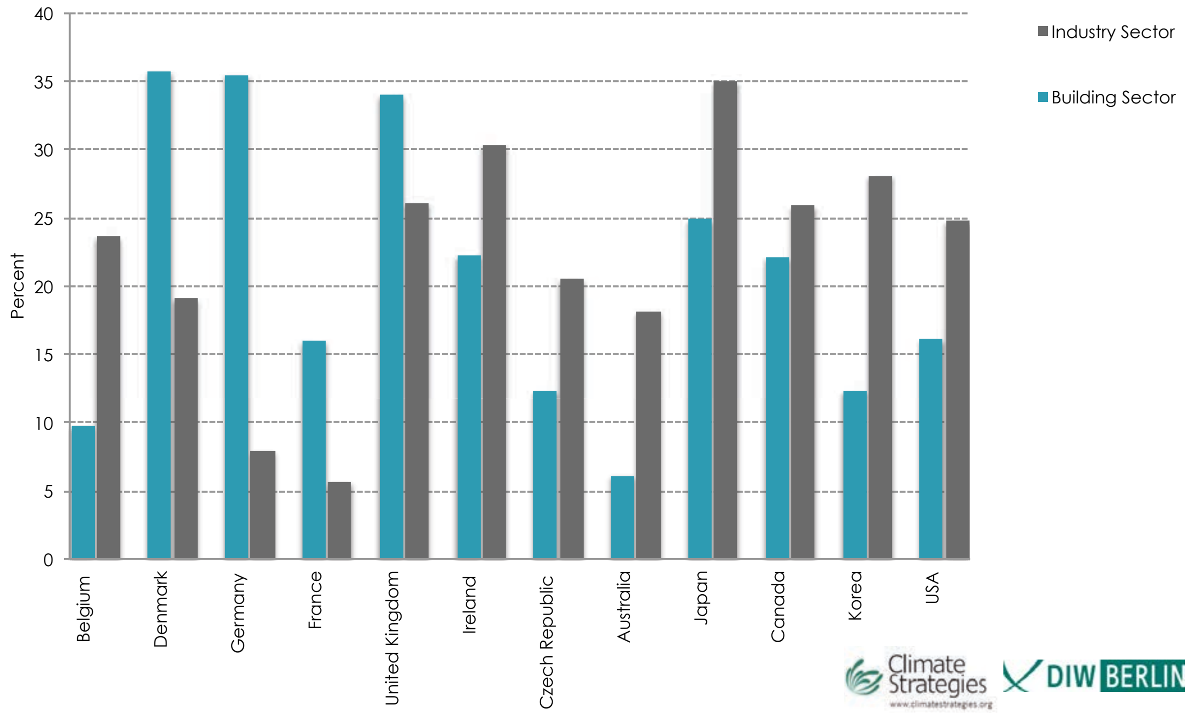
1.1 Europe is not alone with its energy and climate policies

Europe had taken global leadership in energy and climate policy with long-term renewable targets and the European Union Emissions Trading System (EU ETS). The EU has been joined by a diverse group of countries and regions that are pursuing effective energy and climate change policies in each of the key sectors of power, transport, buildings and industry.

>> Countries differ in their focus on energy efficiency policies

Unlocking energy efficiency potential in buildings, transport and industry is the stated objective of many governments. This requires a variety of policies to inform, incentivise and where necessary mandate consumers and industry to include energy costs in decisions on investment, purchase and use. Appropriate policy measures have so far mostly been implemented without a clearly specified energy efficiency target against which to track their success. This has contributed to there being only slight improvements in energy efficiency in many countries.

Figure 1: Implementation of internationally established policies for energy efficiency, 2011. [ii]
Japan pursues comprehensive energy efficiency policy in the industry sector.



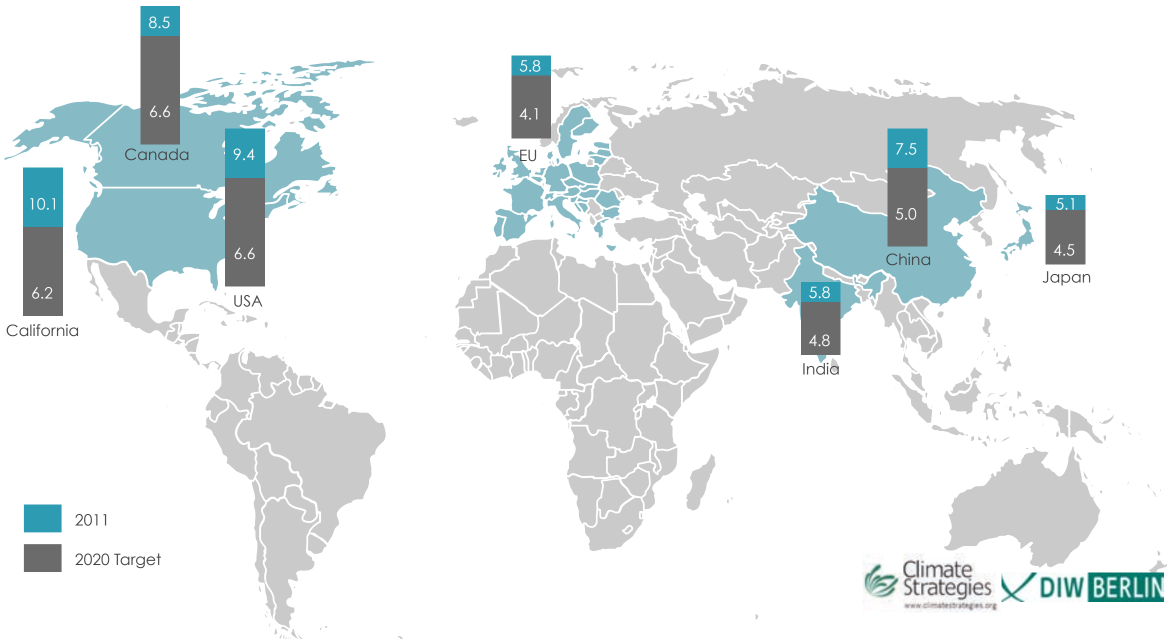
Source: Based on IEA, 2012.

The International Energy Agency (IEA) has developed an indicator system that allows a comparison of energy efficiency policies. The indicator measures the share of internationally established policies and programs to increase energy efficiency that have been implemented on a country-by-country basis. Some European countries perform well when it comes to implementing energy efficiency measures in the building sector (Figure 1), while in the industrial sector, Japan and South Korea have implemented more comprehensive energy efficiency programs.

In the transport sector, fuel consumption is the central indicator for efficiency of vehicles. Figure 2 shows average fuel consumption requirements for new vehicles in 2011 and targets for 2020 in selected countries. Historically, Japan has had the strictest fuel efficiency standards with average consumption for new vehicles of 5.1 litres per 100 km in the year 2011. For 2020, besides Japan, Europe, India and China have set themselves targets of less than 5 litres per 100 km. In addition, the United States and Canada have set standards to make significant improvements to the fuel efficiency of cars.

***Figure 2: Targets for improvement in vehicle fuel efficiency by 2020 (Litres per 100km).*[iii]**

In addition to Europe, Japan, India and China have targets of less than 5 litres per 100km.



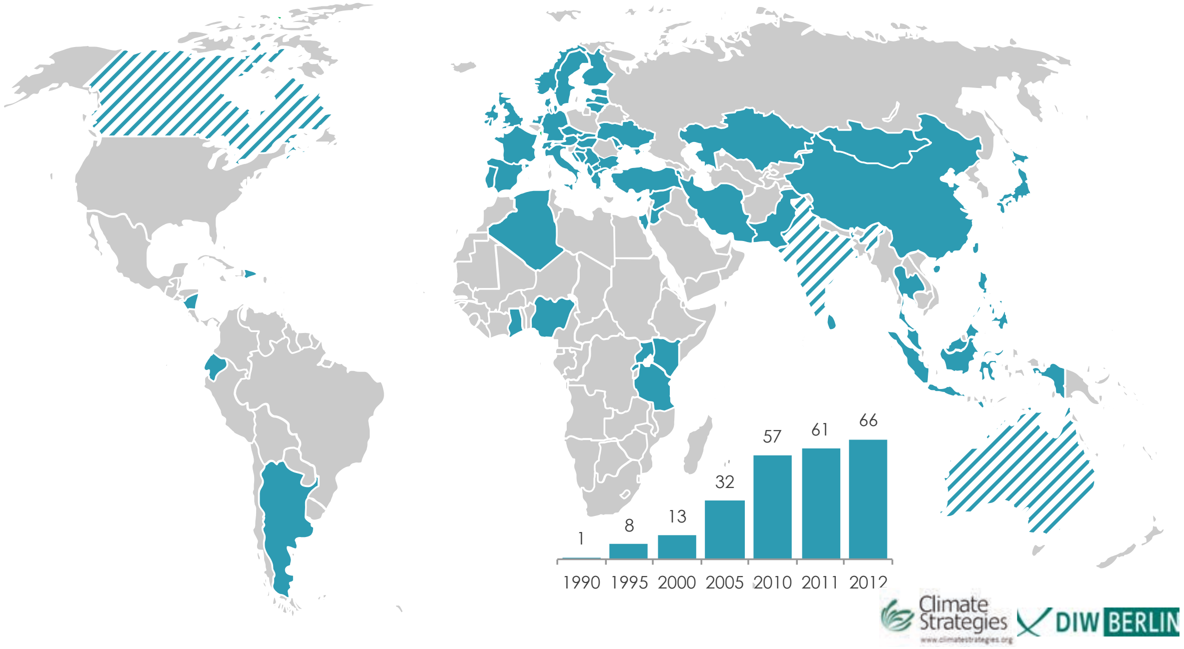
Source: Based on ICCT, 2013.

>> Renewable energy promoted worldwide

The increased use of renewable energy, especially with regards to the electricity sector, requires an efficient planning and approval processes, grid connection, and remuneration mechanisms for generated power. In light of these requirements, 138 countries have implemented renewable energy targets. One instrument often central to the effective deployment of renewable energy is the feed-in tariff. By 2013, the instrument had been implemented in 66 countries across the globe (Figure 3).

***Figure 3: Diffusion of renewable energy policy – illustrated by the use of feed in tariffs.*[iv]**

Policies to support renewable energy have spread globally.



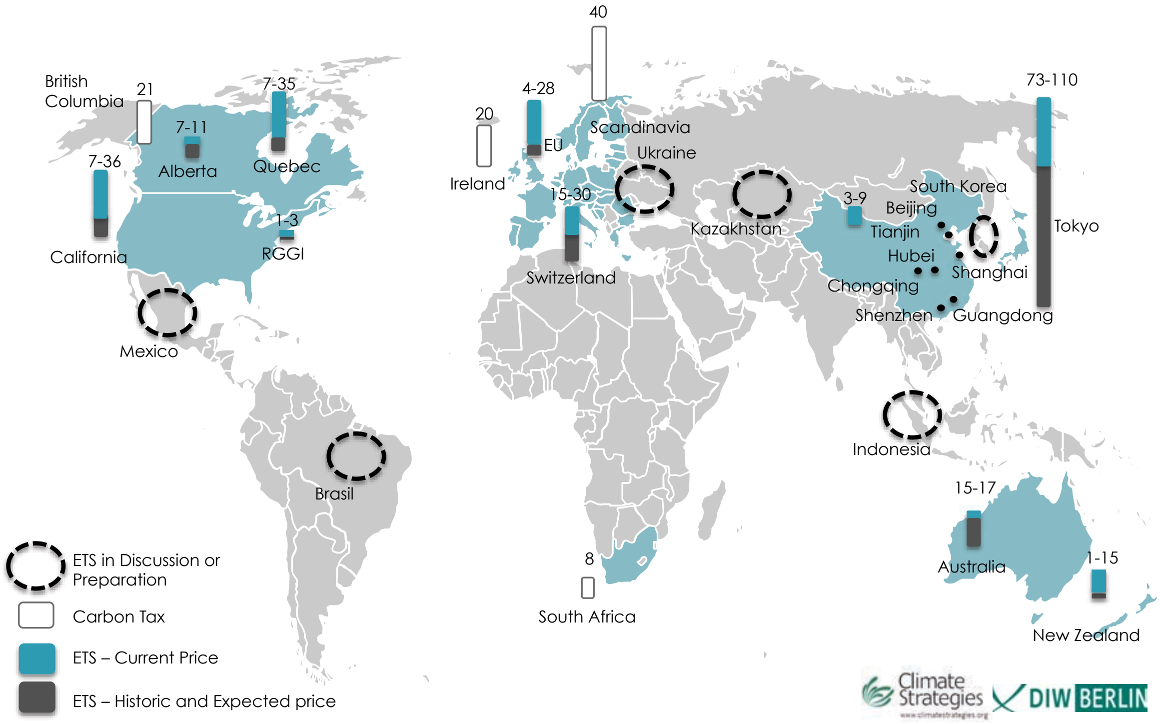
Source: Based on REN 21, 2013.

>> Different approaches towards pricing carbon

When the EU ETS was introduced it was hoped that it could serve as a blue-print for carbon markets in other countries and thus enable the global diffusion of emissions trading schemes. This expectation was disappointed when several attempts to introduce a national emissions trading scheme in the United States failed. However, California as well as several East-Coast states have implemented regional emissions trading schemes (Figure 4). A number of Canadian provinces have implemented a carbon tax or emissions trading scheme and several countries in the Asia-Pacific region have also recently launched (or are preparing to launch) emissions trading schemes, for example New Zealand, South Korea and several Chinese provinces. Australia's existing emissions trading scheme is currently under discussion. In addition, 16 countries, including Brazil, Indonesia, Mexico, South Africa and Ukraine are participating in the World Bank Partnership for Market Readiness program and are preparing themselves for the introduction of carbon pricing in the near future. While the EU ETS has motivated many countries outside of Europe to advance carbon pricing, each has developed policies that are tailored to domestic circumstances. Differences in scheme design, as well as local market conditions, are reflected in the achieved or expected carbon prices across countries.

Figure 4: Global carbon price policies and expected carbon prices (Euros/tonne CO2).[v]

Several countries and regions have implemented or are preparing carbon pricing.



Source: Based on Ecofys, 2013; OECD, 2013; Ptak, 2010; Rudolph and Kawatsu, 2012; Sopher and Mansell, 2013.

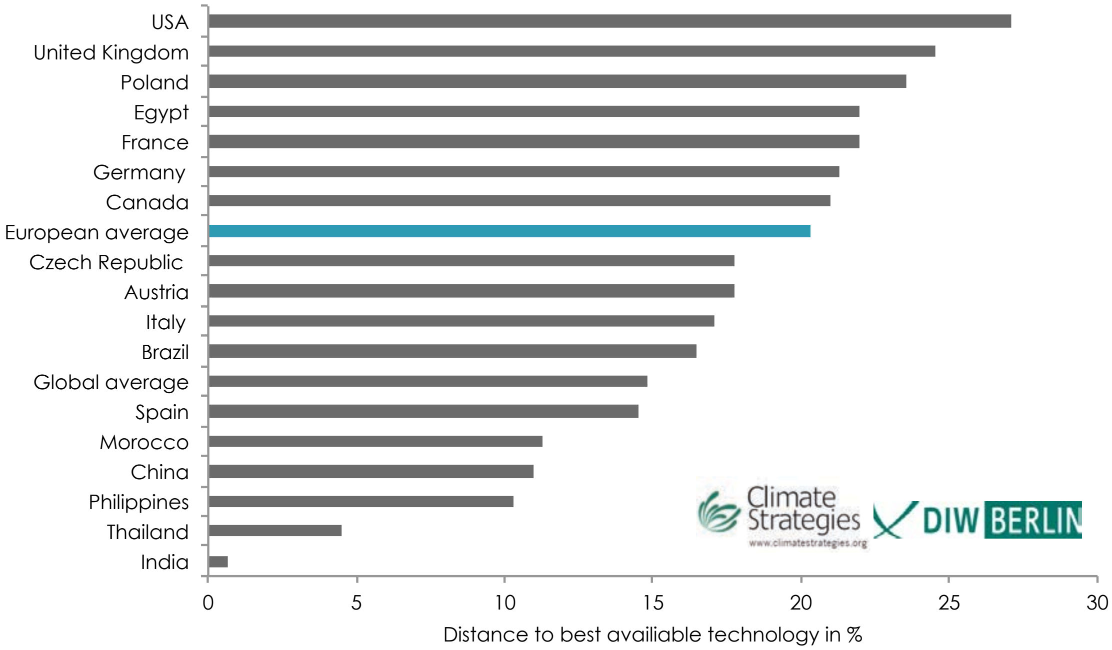
1.2 Countries across the globe are modernizing energy provision and use

>> Asian countries are leading on some energy efficiency technologies

In the industrial sector, cement production is one of the most carbon intensive activities. It constitutes 5% of global CO2 emissions.[vi] An international comparison shows that the most efficient cement production currently occurs in India and China (Figure 5).[vii]

Figure 5: Energy consumption per tonne of cement clinker above benchmark in 2011.[viii]

Cement production is particularly efficient in some Asian countries.



Source: Based on Cement Sustainability Initiative - GNR database.

The energy efficiency of the European cement industry lags behind its Asian competitors because most investment occurs in emerging markets where growth in demand for cement is the highest. Comparatively, the European cement industry still uses older and less efficient plants because there is no demand growth. This creates a risk that equipment suppliers for cement plants might move with the investment to other regions of the world. Climate policy could increase the incentives for additional investments and innovations in the European cement sector.[ix]

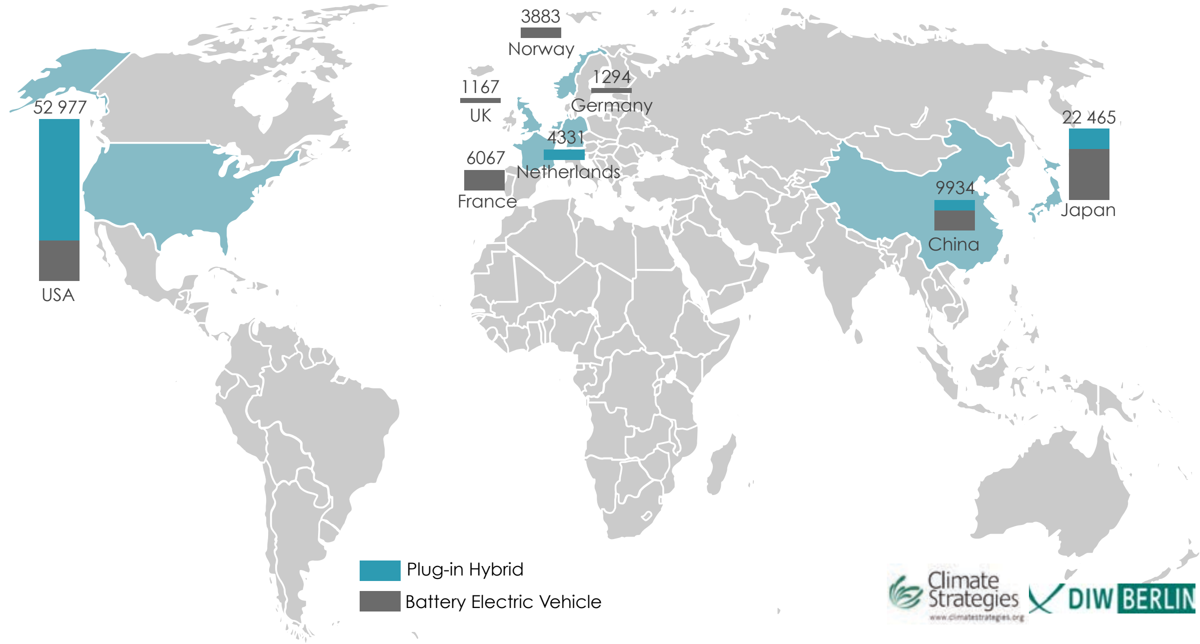
Steel production constitutes about 7% of global CO2 emissions.[x] Primary steel production relies mainly on blast oxygen furnaces and currently requires between 16 and 23 GJ per tonne of steel cast, averaging 19 GJ per tonne. Compared to the average, European installations are a little better in some cases but often are worse. Efficiency improvement potentials are linked both to investments in efficiency technologies and to benchmarking exercises to ensure efficient operation of existing assets. Some additional emission reductions are possible by enhancing the quality of raw materials through beneficiation (pre-processing), increasing scrap recycling and by reducing steel demand by increasing the efficiency of steel use.[xi]

For further emission reductions in steel production, breakthrough technologies are essential. Opportunities include carbon capture and sequestration as well as the use of lower carbon fuels. In search of breakthrough technologies, different programs are being pursued across the globe. Most prominent are the European Ultra low CO2 Dioxide Steelmaking program (ULCOS-Initiative) or the Japanese Course50 program (CO2 Ultimate Reduction in Steelmaking Process). But similar initiatives are being developed in the United States, South Korea and China.[xii] Demonstration plants are a critical component of the research and development process, for which public funding is required.

In the transport sector, there is significant potential for electric vehicles to reduce emissions. They can run on renewable energy and are more energy efficient than petrol or diesel fuelled vehicles. A number of countries are currently developing their Electric Vehicle (EV) markets. The United States has the highest sales of EV's with about 53 000 new vehicle registrations in 2012, including about 38 000 plug-in hybrid and about 15 000 battery electric vehicles (Figure 6). Japan recorded the highest registrations of battery electric vehicles (16 000 vehicles) in 2012. In European countries, except for France and Norway, the registration numbers were significantly lower.

Figure 6: Registrations of electric vehicles, 2012.

USA and Japan currently have the largest market for electric vehicles.



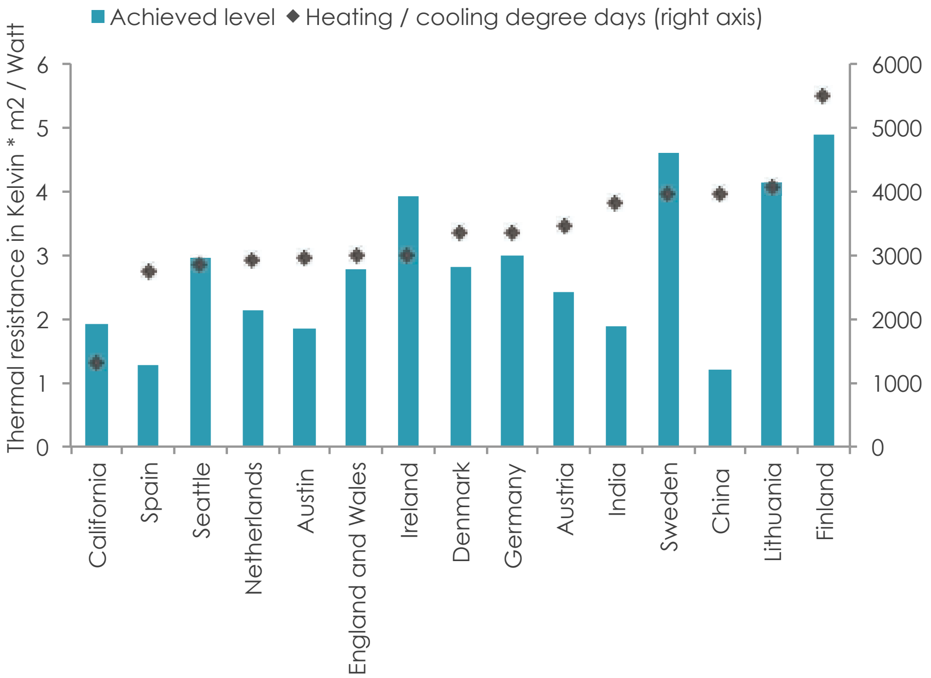
Source: Based on Electric Vehicle Initiative, 2013.

Buildings constitute about 40% of final energy consumption in OECD countries. [xiii] New insulation materials, windows and heating systems, and their effective use by trained craftsman, have resulted in marked improvements in the energy efficiency of buildings. As an example, final energy use (per m2) of new German residential buildings has been reduced by a factor of four in the last three decades.[xiv]

Thermal performance of walls and windows is central to energy efficient heating and cooling of buildings. Taking the building code requirements (total thermal resistance) as a proxy for common practice in new buildings shows that the energy efficiency across buildings varies greatly (Figure 7). For new buildings, energy efficiency is comparatively high in some northern European countries, California and Seattle, taking into account the demand for heating or cooling imposed by different climatic conditions.

Figure 7: Quality of thermal insulation in new buildings. [xv]

Insulation quality higher compared to insulation need (measured as heating cooling degree days) in Northern Europe and California.



Source: Based on Data from Global Building Performance Networks: Policy Comparative Tool.

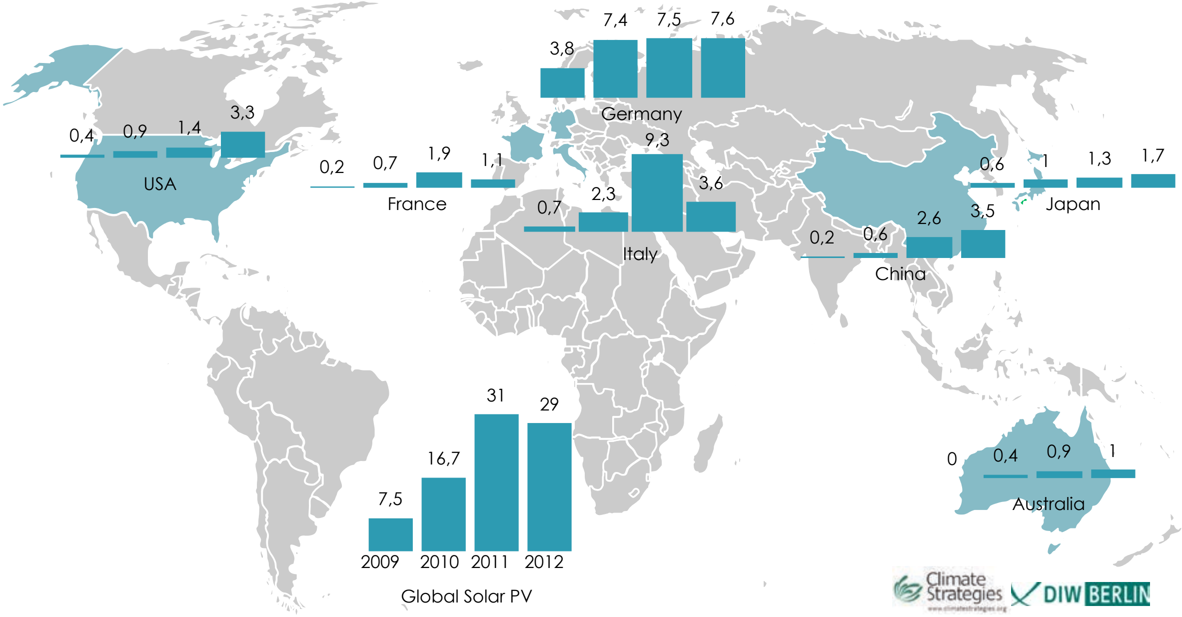
>> Renewable electricity generation is growing worldwide

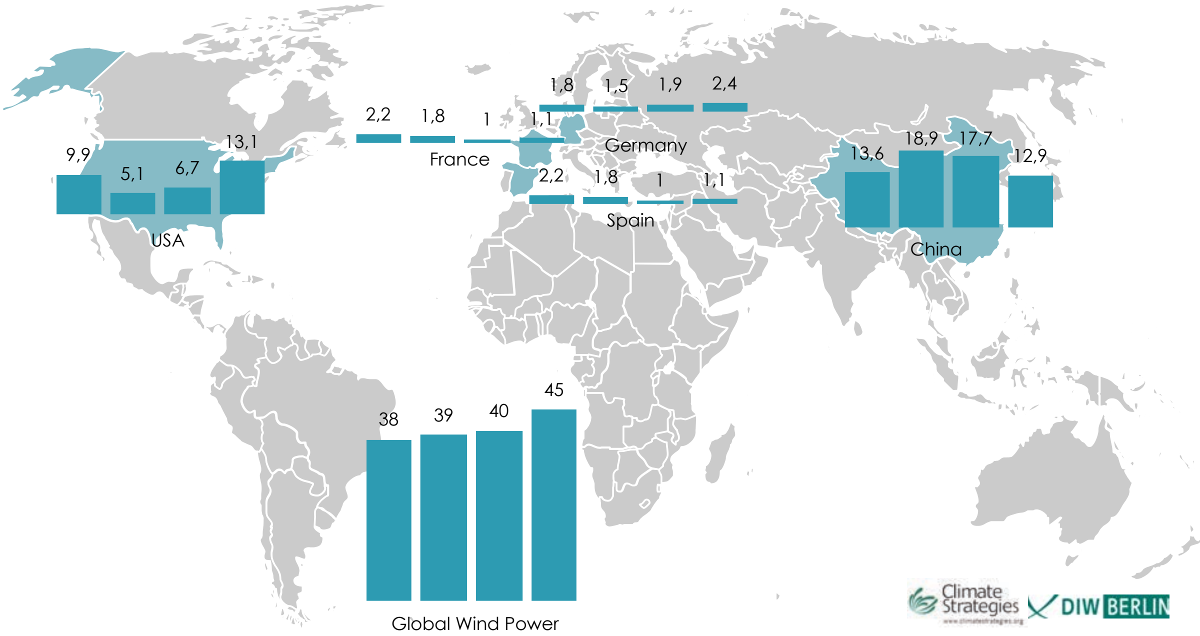
For those countries that have acted early, renewable energies such as wind power and photovoltaics are already an important part of their energy supply. Germany and Italy lead the world in terms of deployment of photovoltaic systems. However, both the United States and China have recorded high growth rates in photovoltaic investment in recent years (Figure 8), so that in 2012 already 40% of all photovoltaic modules were installed outside of Europe.

A similar picture emerges in the case of wind. The countries of the European Union have the largest share of the world's installed wind power capacity. The largest expansion in recent years, however, can be seen in regions outside of Europe: In 2012 already 70% of new wind was installed outside Europe, led by China and the US with 29% each.

Figure 8: Annual construction of photovoltaic (top) and wind power (bottom), 2009-2012.[xvi]

Renewable energy capacity is increasing globally.





Source: Based on REN 21, 2013.

With increasing shares of renewable energy sources, Europe can benefit from pooling the different renewable technologies across different locations using the integrated electricity system and power market. But it also faces the challenge of advancing transmission investments within and between countries. As many of the investments are required in eastern and southern European regions, a joined up European approach could facilitate access to low-cost finance for all countries and thus limit costs for consumers.

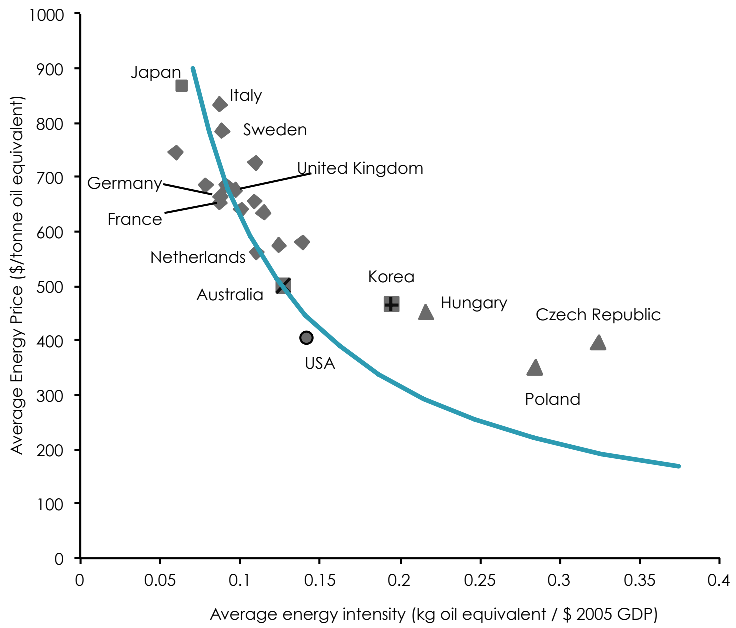
>> Carbon pricing increases emission efficiency

The EU ETS – before the recent price crash – motivated companies to assess the risks of a continued focus on carbon-intensive production techniques and the opportunities of lower-carbon production. The likely long-term impact cannot yet be empirically proven, hence we assess the possible impact by studying the response of economies to energy prices. Energy price differences have been prevailing across countries for decades, reflecting both differences in availability of domestic energy and taxation.

Figure 9 depicts for the OECD countries the average price for energy paid across all users and fuel types against the amount of final energy that is required to produce one unit of GDP. In general, higher energy prices go along with more efficient use of energy. Therefore, less energy demand is needed to deliver the same economic outcome. Hence, the share of cost of energy per unit of GDP stays almost constant across the countries.

Figure 9: Energy intensity and average energy prices 1990-2005.[xvii]

Countries with higher energy prices are more energy efficient.

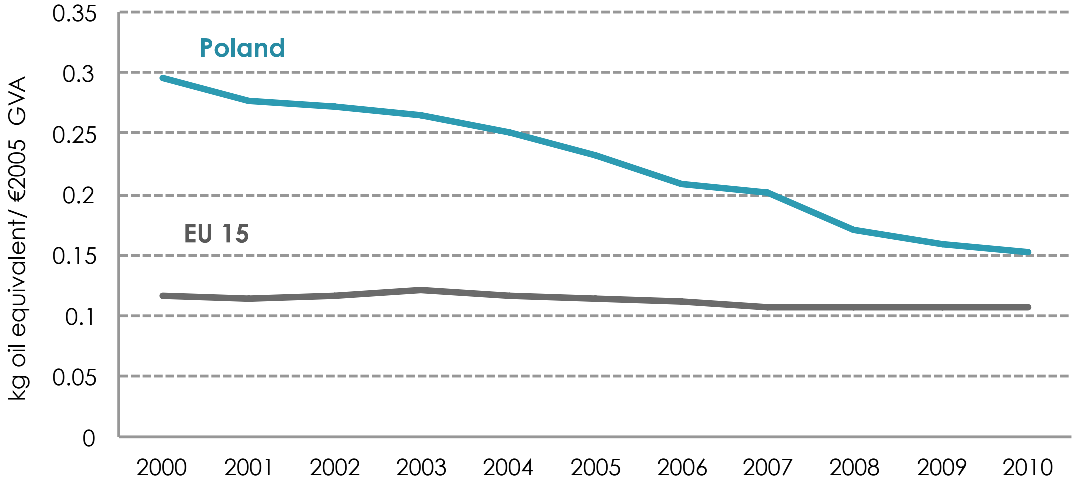


Source: Based on IEA, 2008; IEA, 2010; IMF, 2010; and EU KLEMS.

The prominent exceptions to the rule are the new European member states, the Czech Republic, Poland and Hungary. In the years 1990 to 2005 these countries were characterised by significantly higher energy demand per unit of GDP than would have been expected based on their average energy price level. This can partly be explained by the preceding history of central planning without strong incentives for energy efficiency. As Poland subsequently implemented similar energy prices to the rest of Europe, Polish industry has over the last decade rapidly reduced its energy intensity towards the average of EU15 countries (Figure 10). Thus, the exception does confirm the rule – energy prices matter for energy efficiency. Just as countries with higher energy prices have lower energy intensity, so it can be expected that they will respond to higher carbon prices by improving carbon efficiency.

Figure 10: Energy intensity of the Polish industry in comparison to the EU, 2000-2010.[xviii]

Polish industry has significantly improved its energy intensity.



Source: Based on Sartor and Spencer, 2013.

However, energy systems and energy use are linked to capital stock in buildings, industry and transport, and thus can only gradually adjust. This points to the challenge of the transformation – accommodating the needs of consumers where they face higher energy costs before the energy efficiency has improved. For the industrial sector, special provisions are required to protect very energy intensive production where it would otherwise be at risk of carbon leakage (See section 3.3). For European countries with lower GDP per capita, modelling by the European Commission shows large investment opportunities in energy efficiency, but emphasises different conditions for access to finance across the Member States[xix]. A joint European effort is therefore needed that builds on experience of EU the regional development funds and the European Investment Bank.[xx]

WHY NOT TO FALL BEHIND

The increased use of renewable energies, improving energy efficiency and advancing low-carbon technologies can deliver multiple economic benefits. This raises the question of whether the EU can afford to fall behind the regions leading the transition to a low carbon economy and how it can ensure that all its Member States are benefitting.

In this section, four arguments in support of continued ambitions European energy and climate policy are advanced, including:

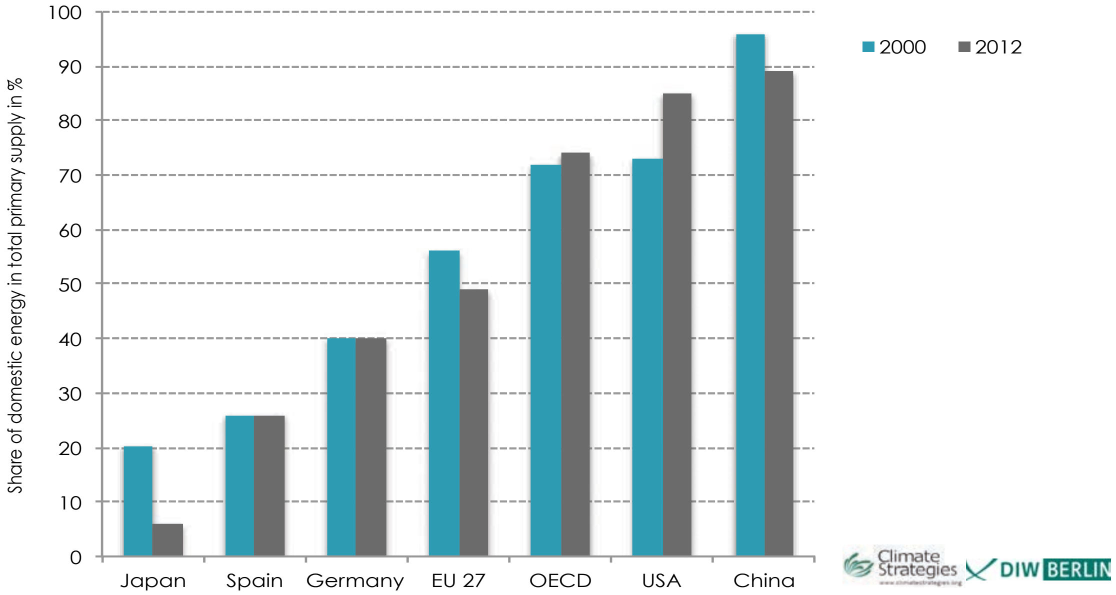
- Securing a long-term reliable & economic energy supply; *section 2.1*
- Creating jobs; *section 2.2*
- Promoting innovation in growth industries; and *section 2.3*
- Europe's credibility in global climate change negotiations. *section 2.4*

2.1 Securing a long-term, reliable and economic energy supply

European countries are among the least energy self-sufficient globally, relying on a high proportion of energy imports (Figure 11). This reliance renders the EU vulnerable to increases in the price of oil and other energy sources, as well as to instability in, or unwanted political pressure from, the respective exporting countries. Enhancing energy efficiency and increasing the share of renewable energy in the energy mix, together with greater deployment of indigenous energy sources, will help Europe to reduce its energy import dependence.

Figure 11: Energy self-sufficiency, 2000 and 2012. [xxi]

Europe is among the least energy self-sufficient regions globally.



Source: Based on IEA, 2013.

However, it is often argued that the costs of renewable energy are prohibitively high. While this may have been the case 10 years ago, the cost of fossil fuels imports have more than doubled since 2000 making renewable energy more attractive. EU Member States annually spend €350 billion importing energy, while the cost of using domestic renewable energy has recently dropped significantly. For example, the prices for photovoltaic assets fell by a factor of four in the period from 2000 to 2013.

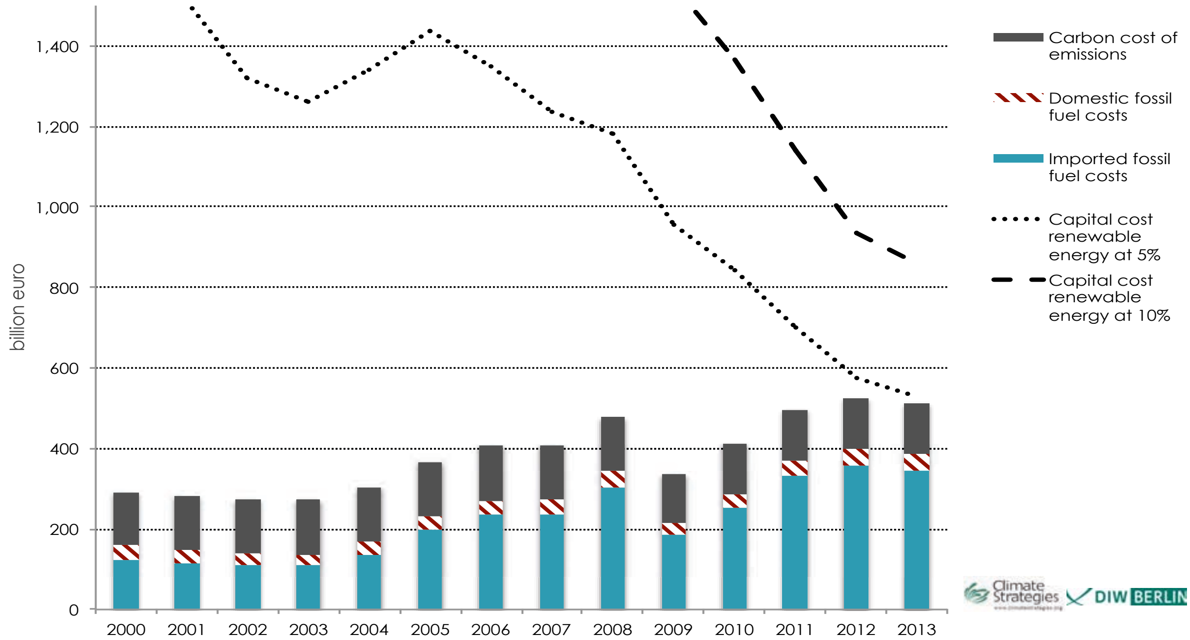
As part of the Energy Roadmap 2050, the European Commission produced a detailed assessment of the energy system costs. One of the scenarios anticipates renewable energy, contributing up to 75 percent of gross final energy consumption and 97 percent of electricity consumption by 2050.[xxii] The results for this scenario show similar total energy system costs to the reference scenario with much lower shares of renewable energy. The difference, however, is visible in the energy import bill and investments. Energy imports are reduced by about €160 billion in 2030, increasing to €550 billion in 2050. The fuel cost savings are matched by investments in renewable energy, power grids and energy efficiency.

The plausibility of the European Commission's calculations can be checked in a simplified example that puts aside current energy mix discussions and national politics. Assume all fossil fuel use in the EU was substituted with renewable energy. In 2013 the annualised investment cost in wind turbines and solar panels to deliver the same final energy would be of the same size as the fossil fuel bill (Figure 12). This assumes that the renewable generation mix consists of onshore wind power (two-thirds) and of photovoltaic (one-third) and that the final energy demand in all areas of use - including the transport sector – can be fully served with electricity. In addition, a CO2 price of €30 per tonne and a nominal interest rate of 5 percent are assumed.

The comparison is only illustrative. In a comprehensive system analysis, further aspects have to be considered. All energy transition strategies envisage a strong emphasis on energy efficiency to reduce energy demand. This would both reduce energy bills and the investment costs in new systems. Moreover, next to onshore wind power and photovoltaic, other renewable technologies are very likely to be required in the portfolio, such as offshore wind power, biomass or solar heating. In addition, the costs of energy storage devices, market flexibility, and additional grids - that become relevant in the case of high shares of fluctuating renewable generation – have to be considered. Finally, for the evaluation of an energy systems focused on renewables and energy efficiency, the opportunities to save on future infrastructure investment for fossil fuels also needs to be considered.

Figure 12: Comparison of European fossil fuel bill and capital costs for renewables (at purchasing prices in each year)-[xxiii]

By 2013, annualised capital costs for renewable generation to replace fossil fuels have declined to a level of the fossil fuel expenditures – (illustration excluding system cost).



Notes: Calculations based on the following assumptions: carbon cost of €30 per tonne, 2 % inflation, 50 % fossil fuel conversion loss; 66 % of energy from on -share wind and 33 % solar energy, operation & maintenance costs not considered.

While simple in nature, the example illustrates that the level of financing costs will be critical for the economic viability of a transition to a low-carbon economy. If the interest rate is 10 % instead of 5%, for instance due to political or regulatory risks, the costs of renewable energy would in 2013 not be in the order of magnitude of fossil fuel expenditures. Hence, credible and stable conditions for investors are necessary to limit financing costs. Feed-in tariffs have, for example, attracted investors that offer capital at low cost, while clear targets for the development of renewable energy have helped to reduce risks for project-developers and the supply chain.

2.2 Creating net-jobs is possible

Replacing fossil fuel imports with investments in renewable energy and energy efficiency implies that economic resources that would otherwise have been spent on foreign goods are spent on European products. This will to a large extent involve local activities such as project management, construction and operation and maintenance of assets. Such investments can contribute to the creation of jobs in the regions in which renewable energy technologies are installed, as well as along the supply chain.[xxiv] The resulting net-employment effects of such innovations in Europe, keeping in mind substitution effects, are widely discussed. A new study by DIW Berlin calculates, for example, that energy efficiency investment in Germany may create up to 180 000 jobs by the year 2020.[xxv] However, the net-employment effect could be reduced depending on productivity developments and the overall conditions on the labour market.

Several aspects will determine the effect on net-employment. First, investment in energy efficiency could crowd out other investment or expenditure. However, when investments are financed through future savings on energy imports, this effect should be small. Second, the investments could increase the productivity of the economy to the extent that the existing work force could deliver the additional investment and thus not create additional jobs. However, it is unclear to what extent investments in renewable energy, or increased energy productivity, could trigger overall higher labour productivity. Third, additional demand for labour could trigger wage increases and thus also productivity increases in other sectors of the economy, thus partially offsetting new jobs. Such an effect is particularly relevant in periods of high employment and utilization of other factors of production, but might be of secondary importance in the current European situation.

Due to the substitution of energy imports with domestic investments, it is likely that a large share of the new jobs linked to energy efficiency or renewable energy will constitute additional jobs for the European economy. This was also the conclusion of a comprehensive study commissioned by the European Commission Directorate General for Energy, exploring the impact of EU decarbonisation roadmaps. Major European research institutions and two very different modelling approaches all projected for Europe a net-employment increase of up to 1.5% compared to the base line.[xxvi]

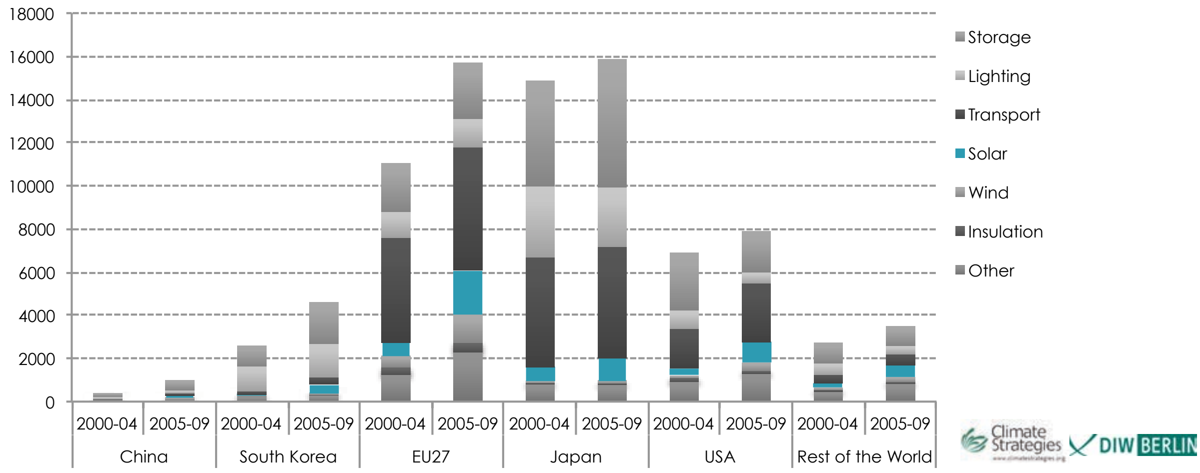
2.3 Increasing the innovation capacity of European economies

The competitiveness of European industry depends heavily on its innovative capacity. Europe and Japan lead the world on patenting green technologies. Also Europe's portfolio of green patenting activities is wider than that of other countries (Figure 13). [xxvii] These innovative activities can be mapped to European energy and climate change policy in recent years. For example, while Europe has taken a leading role in wind power for a long time, the strong drive on photovoltaic has allowed catching up with earlier initiatives in Japan and the United States. However, other countries such as China and South Korea are catching up very quickly, in particular in key areas of innovation such as energy storage and energy-efficient lighting. As a consequence, Europe might not remain the leader of the global green innovation race.

It is often debated whether innovation in green technologies is additional to, or in replacement of, innovation in other sectors. However, even if innovations in green technologies were to replace innovations in other sectors, this could still enhance productivity. This is because green patents are 40% more frequently cited than other patents[xxviii], thus generating much larger knowledge spill-overs which in turn enhance economic growth. [xxix]

Figure 13: Patent registration for green technologies[xxx].

Next to the EU, Japan has registered many patents for green technologies.



Source: Based on patent data from European Patent Office

Both the overall number of patents and the number of patens in green technology differs widely across EU member states. Enhancing the innovative capacity and decreasing the gap between EU member states should have political priority. In particular, the confidence of investors in market demand for low-carbon technologies has to be enhanced. Clear targets and strategies for the use of renewable energies, for increasing energy efficiency, and reducing greenhouse gas emissions provide clear signals to market participants. As part of the EU 2030 Framework for Climate and Energy it is discusses how to provide EU Member States with the opportunity to advance a low-carbon transformation that is specific to their own economic and political context, while also using the synergies and credibilty that a joined-up European approach can offer.

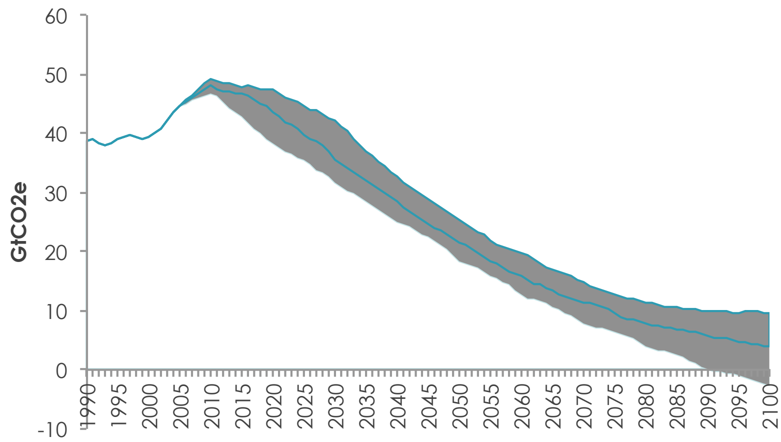
2.4 Maintain Europe's credibility in international climate protection

To limit the risk of temperature increases above 2°C, worldwide greenhouse gas emissions[xxxi] have to decrease to a level that corresponds to about two tonne CO2 per capita by 2050[xxxii] (Figure 14). This means that annual European emissions have to be significantly reduced from the current European average of 9.1 tonnes of CO2 per capita (Figure 15). In 2009, European heads of state agreed on an emission reduction target of 80-95 % by 2050 (against a 1990 baseline).[xxxiii] Europe's credibility with international partners and investors will depend on how persistently its governments implement policies and programs necessary to achieve this objective.

By formulating climate change policy targets, the EU can both take responsibility for its own emissions and the international challenges of climate change and, at the same time, create a credible and long-term framework for international climate negotiations and clean investments.

Figure 14: Necessary emission reductions to achieve the 2° C target.[xxxiv]

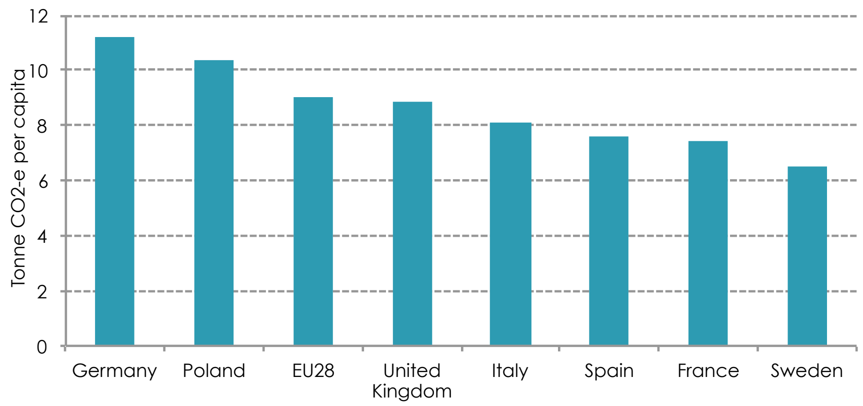
To achieve the 2°C target emissions will need to steadily decline over the next 100 years.



Note: Corridor represents required emission trajectory to achieve the 2°C target, at probability of 60 percent.
Source: Based on UNEP, 2013.

Figure 15: Per capita greenhouse gas emissions of European countries, 2011.[xxxv]

Within the EU, Germany has comparatively high per capita greenhouse gas emissions.



Source: Based on EEA, 2013.

CLIMATE POLICY DOES NOT THREATEN EUROPEAN COMPETITIVENESS

In a period of high unemployment across many EU member states, it is necessary to assess whether energy and climate policies risk the relocation of European jobs to countries with less stringent policies in place.

The Global Competitiveness Indicator of the World Economic Forum would seem a suitable starting point to assess such a risk – but it has for the last decades not considered energy prices as relevant explanatory variable for the competitiveness of a country (section 3.1).

This might be explained because the manufacturing industry on average only spends 2.2% of revenue on energy – not a major factor for most industrial competitiveness or locational decisions. But for some very energy intensive activities, energy costs can comprise a larger share of total costs – these warrant special attention (section 3.2).

For very energy intensive industries, some energy price differences exist and are linked to different wholesale price levels and ultimately the resource basis of countries. Energy efficiency and innovation are the only options to partially compensate these. Extra costs from energy and climate policies are addressed by special provisions in respective policies (section 3.3).

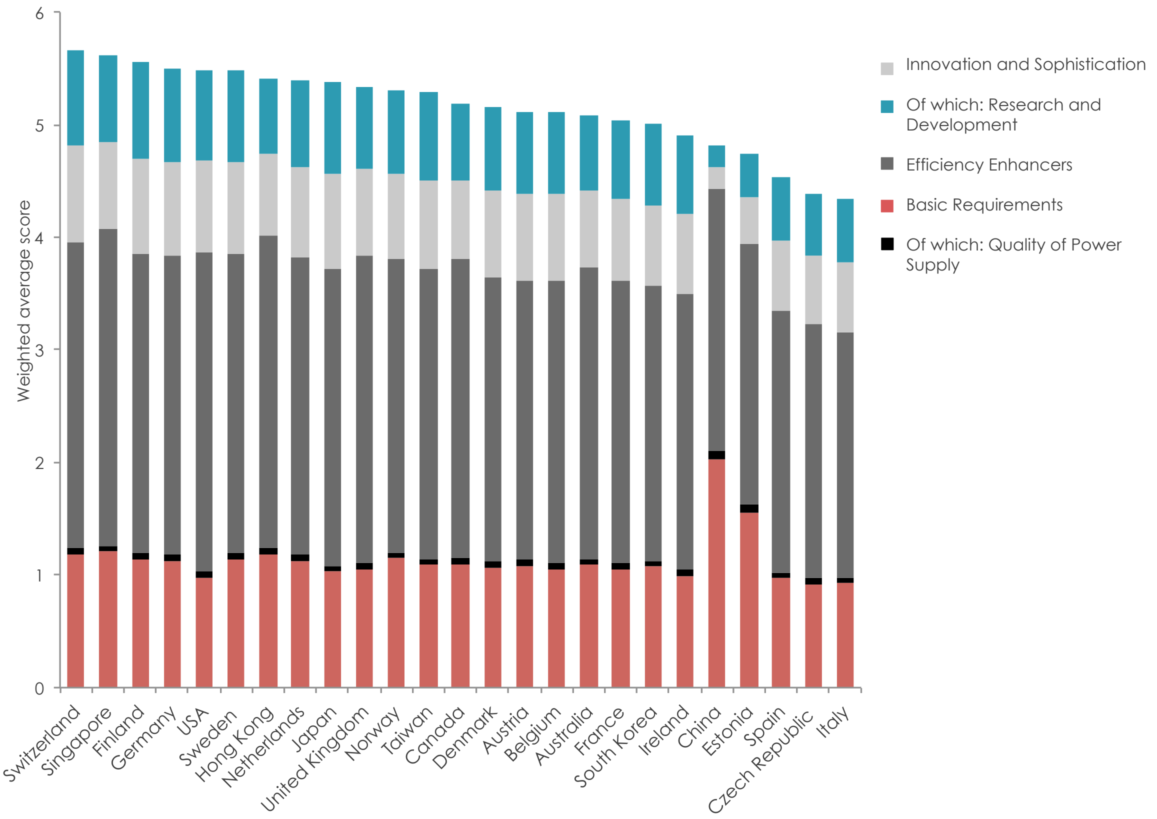
3.1 Energy prices are not the relevant indicator for competitiveness

For more than three decades, the World Economic Forum's (WEF) annual Global Competitiveness Reports assessed the many factors underpinning national competitiveness and summarised the results in a global competitiveness indicator. [xxxvi] Energy prices are not included among these indicators and only the quality of electricity supply is considered and contributes, with a weight of 1%, of the overall score. What is far more important for the productivity of European countries – and receives a weight of 15% in the WEF competitiveness index - is the innovative environment. A high quality business network, investments in research and development, and co-operations between research institutions, business and industry lay the foundations for an innovative and productive economy. Already the selection of indicators of the WEF study raises doubts about the general assertion that European competitiveness is vulnerable to increasing energy prices. Despite high energy costs, according to the results of the 2013 study, three European countries, Switzerland, Finland, and Germany, are among the top five in terms of global competitiveness (Figure 16).

Also a recent study by DG Enterprise concludes that European comparative advantage increasingly depends on high value-added goods, with a "high degree of sophistication or knowledge intensity".[xxxvii] This points to the key issue: the potential for a clean energy strategy to accelerate innovation.

Figure 16: Global Competitiveness Index, 2013-2014.[xxxviii]

Three European countries are among the top five most competitive globally.



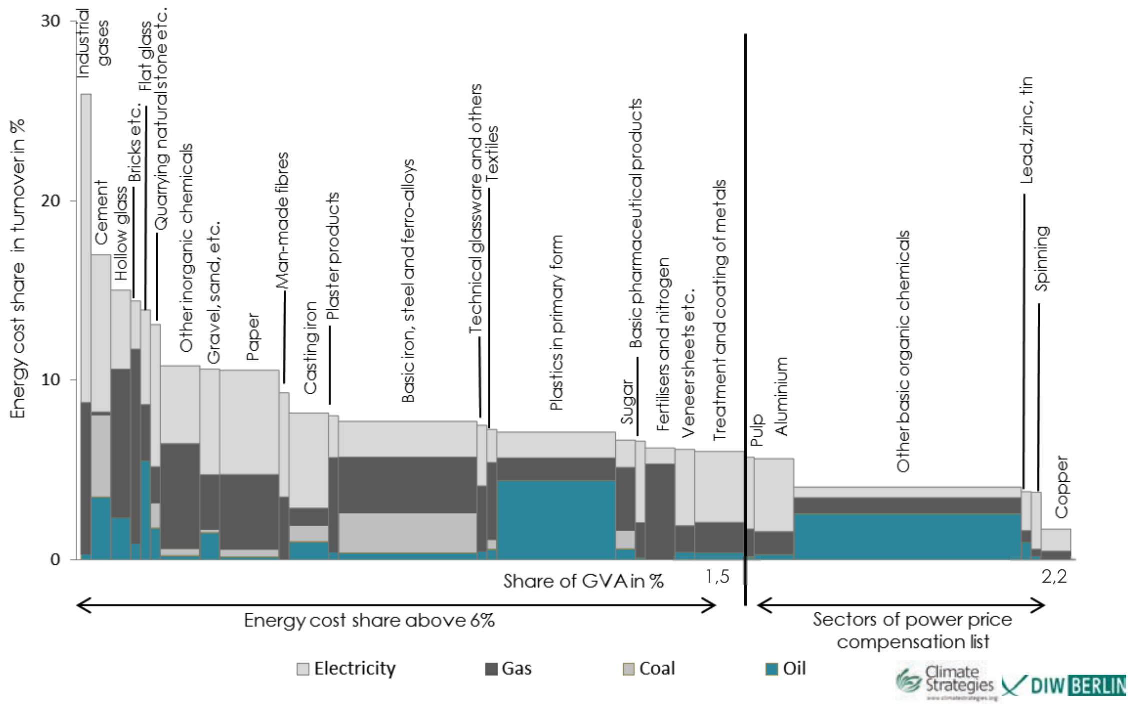
Source: Based on World Economic Forum, 2013.

3.2 Energy costs are a small share of total costs for most companies

For the majority of companies energy prices have very little impact on locational choices or global competitiveness. In Germany, for example, 92% of the manufacturing industry spends on average 1.6% of revenue on energy.[xxxix] However, for some sectors comprising about 8% of manufacturing industry or 1.5% of the overall economy (by value added), energy costs constitute more than 6% of total revenue (All numbers based on data for Germany). For example, in the production of paper, inorganic basic chemicals, flat and hollow glasses and cement more than 10% of revenue is spent on energy (Figure 17). For such energy intensive products energy prices are considered in investment choices, and could thus also impact the locational choices of firms.

Figure 17: Energy cost as share of turnover by energy carrier, German industrial sectors, 2011.[xl]

Sectors with energy costs above 6% account for less than 2% of German GVA.



Source: DIW calculations based on Destatis, 2013.

3.3 For energy intensive companies energy price differentials are determined mainly by resource endowment

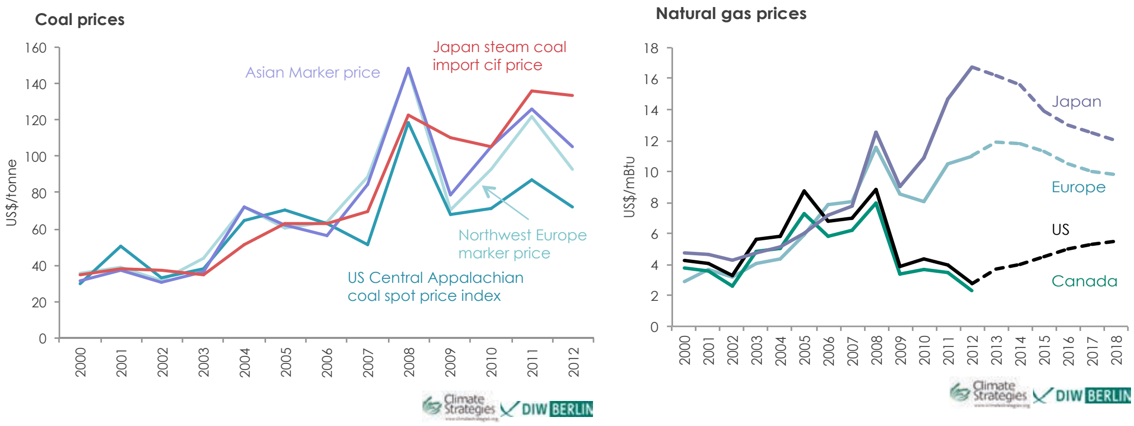
We compare the prices that energy intensive industries pay for coal, gas and electricity in different countries. As these companies are qualifying for special provisions and are largely exempt from energy and climate related charges and taxes, we use the wholesale price for the three energy provider as a proxy. Differences in energy prices can be traced back to the different structural features of each country, with energy resource endowments and international transport costs playing a major role.

>> Price differences particularly large for gas

When it comes to energy intensive industries, coal is heavily used for the production of cement and steel. As coal can be transported cheaply worldwide, price differences for coal have been small in the past (Figure 18).[xli] However, coal prices typically quoted for the main coal producing region within in the United States are currently lower than prices quoted for other parts of the world, due to constraints and transport costs on rail links required for the export of US coal.

Figure 18: International coal and gas prices.*xlii*

For gas prices, regional prices differ substantially.



Source: BP, 2013; Economic Intelligence Unit, 2013.

Gas is another major fuel for energy intensive sectors and is used for instance in the production of bricks, plaster and especially fertilizers. After a decade of co-movement of global gas price, the shale gas boom, global recession and the growing demand in Asia have resulted in large price discrepancies (Figure 18). The shale gas boom in the United States combined with very little infrastructure for gas exports meant that United States gas prices declined significantly, and hence gas costs much less than in Europe. At the same time in Asia, increasing demand in Asian economies has pushed up gas prices significantly, and gas costs more in Asia than it does in Europe. A reduction of this price gap is expected towards the end of the decade when, for instance, the United States constructs new terminals for the export of gas.[xliii]

Nevertheless, differences in resource endowments between Europe and North America, as well as inevitable transport costs mean that gas price differences are likely to persist. This is likely to be true even if Europe exploits its shale reserves in the future. As the European shale gas resource base is estimated to be significantly smaller than in North America, Europe will remain dependent on gas imports and the European gas prices will continue to depend on import prices. BP, for example, estimates that by 2035, shale gas will make up only 6% of European gas consumption.[xliv] Europe's strategy to secure industrial competitiveness therefore cannot be based on a goal of trying to compete with other countries with greater resource endowments.

Europe therefore needs an energy and industrial strategy that includes also other mechanisms to improve competitiveness and reduce energy costs. Such a strategy needs to include a focus on energy efficiency, reliable conditions for investment in energy infrastructure and energy intensive industries, as well as effective incentives for energy and climate related innovation. A robust package of climate change, energy, and industrial policies is therefore likely to better assist Europe's goals than a narrow focus on energy price differentials.

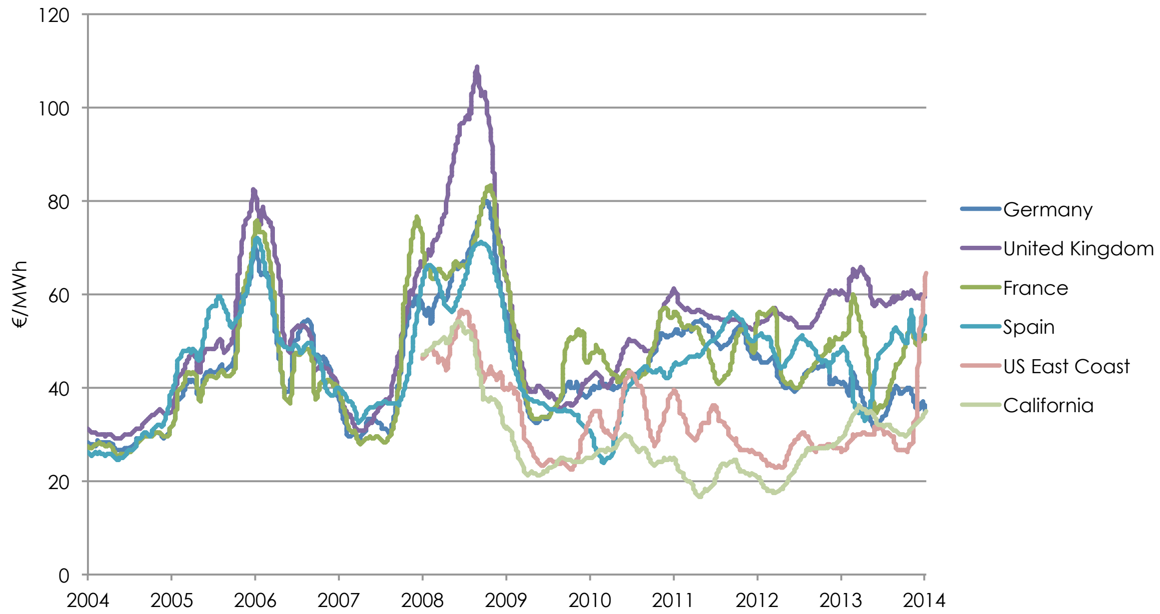
>> Electric power prices vary

Statistical offices do not publish prices relating to typical scale of electricity consumption by very energy intensive industries, for example for consumption exceeding 150 GWh[xlv] Hence, prices paid by smaller industrial users or households are frequently quoted. These are typically more than those paid by energy intensive users. For example, energy intensive users pay lower grid charges and are mostly exempt from various environmental taxes and charges. Therefore, we use the wholesale price for electricity as basis for an international comparison. This approach remains an approximation as, for example, additional costs linked to grid development for the system transformation are not included.

Compared to wholesale power prices for the years 2005 and 2008, which can be traced back to high global coal and gas prices and also to temporary high European carbon prices, European wholesale prices have stayed on a moderate level in recent years (Figure 19). Over the same period, the effect of unusually low gas prices has put downward pressure on electricity prices in the United States.

Figure 19: Wholesale electricity prices.

Price variations over time are of a similar magnitude to variation across regions.



Source: EEX Spot, APX Power UK Spot Base Load Index, EPEX SPOT, OMEL-Elec. Spain Baseload California ISO (SP15) and for United States East Coast PJM West Hub.

>> Policy programs do not raise energy costs for energy intensive companies

European energy and climate policy is not a price driver to energy intensive industries. Special provisions are in place in all EU countries to ensure that policies for the deployment of renewable energy and carbon pricing do not trigger relocation of such activities.

The European Emission Trading System (EU ETS) has two so called Carbon Leakage lists.[xlvi] For competitive distortions through costs of direct CO2 emissions, an extensive list of sectors has been identified, in which companies continue to be freely allocated a large share of the required allowances. There is a second (shorter) list if industrial products whose manufacturers are indirectly affected by increases in electricity prices due to emissions trading. Member States can grant compensation to manufacturers that make these products. This approach is based on sector-specific analyses - carried out by the independent Competition Directorate – and appears to be significantly more focused than previous attempts to identify the industries vulnerable to leakage. It could also be the basis for the future design of special provisions under renewable energy surcharges for the production of very energy intensive products or commodities.

As part of the EU ETS structural reform process, emission reduction targets for 2030 and mechanisms to stabilise the carbon price are currently discussed. This offers the opportunity to implement clear and focused regulations to avoid distortions of international competition for the period after 2020.

CONCLUSION

With regard to energy and climate change policy, Europe is part of a leading group. By 2013, 66 countries have implemented feed-in tariffs for power from renewable energy. Worldwide, efficiency programs in the building and industrial sector are implemented and efficiency standards are formulated, for example in the transport sector. Greenhouse gas emission reductions are now being pursued in many countries with carbon taxes and emissions trading mechanisms. With such policies in place, some non-European countries are greening their economies at a rapid pace. For example, the deployment of renewable energy technologies outside Europe has been booming recently, with 70% of new wind power capacity and 40% of new photovoltaic panels installed outside Europe in 2012. Cement production is particularly energy efficient in growing Asian economies. The United States Japan, and China have the highest registrations of new electric vehicles.

Europe should remain a part of the leading pack. This not only increases its international credibility in the field of global climate protection, but also has potential to create or maintain strategic economic advantages in sectors that are growing globally. The security of supply can be increased by reducing dependence on energy imports. In addition, clear climate change policy can create an attractive environment for investment in clean technologies, particularly insofar as it reduces policy uncertainty. Such investments can create new growth sectors and much needed jobs in Europe and thus also contribute to Europe's economic recovery.

The competitiveness of Europe is not based on low energy costs but on innovative, research-intensive products. Climate change policy measures can promote investment in such growth industries. Furthermore, for most industrial companies, energy costs represent only a small proportion of total costs. Energy price differences in very energy intensive industries are primarily caused by different resource endowments and not by climate change policies.

Some energy intensive and trade exposed companies do deserve and receive special treatment. Given the small number of affected industries, focused exemptions to energy and climate policies, which raise the cost of energy are necessary and possible, and will continue to be so in the future. With regard to the EU ETS, they can be further refined for the period post 2020 as part of the structural reform process.

The low-carbon transformation will have different investment costs and benefits across Member States. Given the importance of future investments, solutions that contribute to improved finance, connectivity, and innovation will also be required. This aspect is particularly relevant in new and southern Member States, and here European initiatives could be valuable in reducing financing costs. A joined-up vision of low-carbon transformation can thus help to reduce inequality between Member states.

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End Notes

[i] Grubb, M., Hourcade, J.C., Neuhoff, K. (2014): *Planetary Economics, Energy, Climate Change and the three domains of sustainable development*. Routledge, London.

[ii] **Figure 1 notes:** Score calculated from the IEA Progress in Implementing the IEA Energy Efficiency Recommendations 2011 Evaluation. A weighted score was calculated for the proportion of policies that were Fully implemented (2), Partially implemented (1) and where Implementation was underway (0.5), Plan to Implement, Not Implemented and Not Applicable (0). From this score a Policy Implementation percentage was calculated from the technically maximum score.

Figure 1 source: Based on International Energy Agency. (2012): *Progress Implementing the IEA 25 Energy Efficiency Policy Recommendations: 2011 Evaluation*. OECD/IEA, Paris.

[iii] **Figure 2 notes:** For California or Canada 2008 and 2010 data were used, respectively. India's target is set for 2021. China's target reflects gasoline vehicles only. The target may be higher after new energy vehicles are considered. For the United States, Canada, and Mexico vehicles include light-duty vehicles. Results based on NEDC test.

Figure 2 source: International Council on Clean Transport. (2013): *Global Passenger Vehicle Standards*. Washington DC, ICCT.

[iv] **Figure 3 notes:** Countries marked with strips have implemented Feed in Tariff policies at a state level. Countries that have discontinued FIT policies are not included (Brazil, Mauritius, South Africa, South Korea, and the United States).

Figure 3 source: Based on Renewable Energy Policy Network 21 (REN 21). (2013): *Renewables 2013 Global Status Report*. Paris, REN 21.
http://www.ren21.net/REN21Activities/GlobalStatusReport.aspx

[v] **Figure 4 notes:** Prices ranges reflect built in price floors and caps (California, Quebec, Australia), expectations by market participants (China and Tokyo) and historical prices (Europe and New Zealand). Scandinavian tax is an average with the actual taxes rate varying across countries and sectors. South African carbon tax is planned for 2015. RGGI stands for Regional Greenhouse Gas Initiative. Additional data from Ecofys. (2013): *Mapping*

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[vi] International Energy Agency and World Business Council for Sustainable Development. (2009): *Cement Technology Roadmap 2009: Carbon emissions reductions up to 2050*. OECD/ IEA, Paris.

[vii] The performance figures for China are uncertain, as coverage of the data base is small.

[viii] **Figure 6 notes:** The best available technology achieves 3100 MJ / tonne of cement clinker according to European Commission. (2013): Commission Implementing Decision of 26 March 2013 Establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the production of cement , lime and magnesium oxide , C (2013) 1728.

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[x] **Figure 6 source:** International Energy Agency. (2013): *Energy Technology Initiatives. Implementation through Multilateral Co-operation*. Paris, OECD/IEA.

[xi] See Milford, R., Pauliuk, S., Allwood, J., Müller, B. (2013): The Roles of Energy and Material Efficiency in Meeting Steel Industry CO2 Targets. *Environmental Science & Technology* 47 (7), 3455–3462.

[xii] USA: AISI Program on DRI, China Baosteel and China Steel Corporation on Oxy Fuel and CO2 Storage, South Korea POSCO CO2 exploring H2 based processes, and, Australia exploring use of bio-coal.

[xiii] United Nations Environment Programme. (2007): Buildings and Climate Change: Status, Challenges and Opportunities. Nairobi, UNEP.

[xiv] For a depiction of historic development see Friedrich, M., Becker, D., Gondey, A., Laskowski, F., Erhorn, H., Erhorn-Kluttig, H., Hauser, G., Sager, C., Weber, H. (2007): *CO2 Gebäudereport*. Berlin, Fraunhofer.

[xv] **Figure 7 notes:** Thermal resistance averaged over windows and walls in Kelvin * m2 / Watt; Heating and cooling degree days depict the actual heating and cooling requirements of buildings. They are defined as annual sum of the differences between so-called heating and cooling limits and the actual average temperature of a day.

[xvi] **Figure 8 source**: Renewable Energy Policy Network 21 (REN 21). (2013): *Renewables 2013: Global Status Report.* Paris, REN 21.

[xvii] **Figure 9 notes:** Energy prices including taxes weighted by consumption of different energy sources and uses, energy intensity relation to final energy

Figure 9 source: International Energy Agency IEA. (2008): Energy Prices and Taxes, 4th Quarter 2008. Paris: OECD/IEA. EU KLEMS. International Energy Agency. (2010): World Energy Balances. Paris, OECD/IEA, International Monetary Fund (2010): World Economic Outlook. Washington DC, IMF.

[xviii] **Figure 10 notes:** Energy intensity is measured as a share of final energy consumption in the gross value added in manufacturing

Figure 10 source: Based on Sartor, O. and Spencer, T. (20013): An Empirical Assessment of the Risk of Carbon Leakage in Poland, IDDRI Working Paper N°08/13.

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[xxi] **Figure 11 notes:** For EU 27 and China 2011 data was used.

Figure 11 source: International Energy Agency. (2013): Energy Balances of Non-OECD Countries. IEA Statistics 2013 Edition. August 2013. Paris, OECD/IEA.

[xxii] European Commission, (2011): *A Roadmap for moving to a competitive low carbon economy in 2050: Impact Assessment,* COM(2011) 112 final.

[xxiii] **Figure 12 source**: BP Statistical Review of World Energy 2013. Economist Intelligence Unit. European Union. (2013): Energy Statistics for the EU-27-2013. http://ec.europa.eu/energy/observatory/statistics/statistics_en.htm. Bundesverband Solarwirtschaft e.V. (2013): Statistische Zahlen der deutschen Solarstrombranche. International Energy Agency. (2012): Wind. Paris, OECD/IEA. European Wind Energy Association. (2011): Pure Power: Wind energy targets for 2020 and 2030. Brussels, EWEA.

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[xxviii] Dechezlepretre, A., Martin, R, Mohnen, M. (2013): Knowledge spillovers from clean and dirty technologies: A patent citation analysis, presented at DIW Applied Micro Seminar, 17.1.2014.

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[xxx] **Figure 13 notes:** Solar includes Solar PV and Solar Thermal; Storage includes storage and fuel cells; Transport includes bio-fuels, electric hybrid, and fuel efficiency; Other includes aluminium, cement, non-CO2, geothermal, efficiency distribution, marine, hydro, carbon capture and storage, hydrogen, hating, waste and clean coal.

[xxxi] From this point CO2 always refers to CO2 equivalents.

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[xxxiv] **Figure 14 source:** United Nations Environment Programme. (2013). The Emissions Gap Report 2013: A UNEP Synthesis Report. Nairobi, UNEP. Rogelj, J., Hare, W., Lowe, J., van Vuuren, D., Riahi, K., Matthews, B., Hanaoka, T., Jiang, K. and Meinshausen, M. (2011): Emission pathways consistent with a 2°C global temperature limit. Nature Climate Change 1(8): 413-418.

[xxxv] **Figure 15 notes:** Without LULUCF emissions (Land Use, Land -Use Change and Forestry).

Figure 15 source: European Environment Agency. (2013): EEA greenhouse gas - data viewer. Copenhagen, EEA.

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xxxvii DG Enterprise and Industry. (2013): European Competitiveness Report 2013: Towards Knowledge Driven Re-industrialisation. Brussels, European Commission.

[xxxviii] **Figure 16 notes:** The WEF annual global competitiveness report ranks countries according to the Global Competitiveness Index (GCI). It is based on 114 indicators grouped into three main pillars: basic requirements, efficiency enhancers and innovation and sophistication. The weights to each of the three pillars reflect the development stage of the respective country. The current GCI score is informed by public statistics and surveys of over 13.000 executives across the globe.

Figure 16 source: Based on Schwab, K., Sala-i-Martín, X. (2013). The Global Competitiveness Report 2013–2014. Full Data Edition. Geneva: World Economic Forum

[xxxix] Figure based on DIW calculations based on Destatis (2013): Kostenstrukturerhebung im Verarbeitenden Gewerbe, Bergbau 2011, Genesis. Destatis (2014): Erhebung über die Energieverwendung, Tabelle 2: Energieverbrauch nach Energieträgern 2011. Energy price assumptions wholesale 2011 later in the text.

[xl] **Figure 17 notes:** Industries with energy costs over 6% earn 1.5% of the German GVA and 8% of the GVA of the manufacturing sector; energy costs of the remaining industries are on average 1.6%

Figure 17 source: DIW calculations based on Destatis (2013): Kostenstrukturerhebung im Verarbeitenden Gewerbe, Bergbau 2011, Genesis. Destatis (2014): Erhebung über die Energieverwendung, Tabelle 2: Energieverbrauch nach Energieträgern 2011. Energy price assumptions wholesale 2011 later in the text.

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[xlii] **Figure 18 notes:** Gas prices in 2014-2018 based on Economist Intelligence Unit 2013

Figure 18 source: BP Statistical Review of World Energy 2013. Economist Intelligence Unit

[xliii] Although it is sometimes discussed whether the U.S. government will grant export licenses, which will lead to higher domestic gas prices, studies show for the U.S. Department of Energy's net income for the U.S. economy in such developments is likely to be small (See for example, NERA Economic Consulting. (2012): Macro Economic impacts of LNG exports from th United States. Washington DC.)

[xliv] BP. (2014): BP Energy Outlook 2035. London, BP.

[xlv] European Commission. (2007): Commission Decision of 7 June 2007 amending Council Directive 90/377/EEC with regard to the methodology to be applied for the collection of gas and electricity prices charged to industrial end-users, 2007/394/EC.

[xlvi] Carbon leakage refers to the migration of companies to countries with less stringent climate policies or lower carbon prices.

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