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Inrate Sustainability Insight

Low-carbon economy: from a macro to a company perspective

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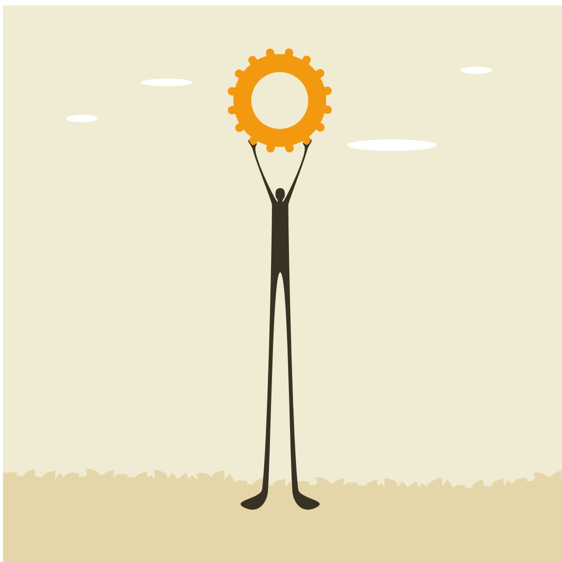


Summary

To limit human-induced climate change, global emission cuts of around 50% by 2050 are necessary to stabilize the global average temperature increase at 2°C. Unfortunately, the outcome of the international climate negotiations in Copenhagen in December 2009 failed to conclude in a global treaty with binding emissions reduction targets. However, becoming a low-carbon economy is not solely dependent on a global climate policy treaty. Peak Oil, rising energy prices as well as the dependency of few oil-exporting countries affect the energy security of many countries. Already at this stage, energy security and energy supply concerns are getting increasingly important and in combination with increased electricity demand is an important driving force for many countries' rethinking with regard to energy demand and supply patterns.

So far, the increase of greenhouse gas emissions and energy consumption has always been growing in line with the economic development of a country. Therefore, decoupling has been the overarching idea of all environmental policy since its earliest days, meaning that environmental damages should be decoupled from economic wellbeing. The vision of a low-carbon society can be described as a society that cuts its CO_2 emissions to 1 ton per capita and year (or its energy use to 2,000 watts) without lowering its standard of living. Such deep cuts of energy use and greenhouse gas emissions are possible at manageable costs and without undermining welfare. The transition to a low-carbon economy requires a fundamental change in the innovation system such as research, policy, education, standards, etc. and hence requires a systematic approach taking into account the entire value chain of a service or industry. It requires an optimal combination of efficiency strategies, substitution of carbon-intensive energy by renewables and sufficiency strategies. In terms of technical feasibility, 80 percent or five-fold improvements in resource productivity is perceived to be attainable cost-effectively throughout the main sectors. In order to achieve the vision of a low-carbon economy, the following entry points are highlighted: Decarbonizing electricity generation; energy efficiency in the use of electricity; more efficient vehicles, new fuels and demand containment in transport; energy efficiency and new energy sources in heating.

While transforming an economy to a low-carbon one, the level of greenhouse gas emissions and carbon intensities of sectors will become more important. Systematically assessing the greenhouse gas intensity of sectors and companies for the entire value chain is therefore a first step to identify their carbon-related risks and opportunities. Sectors and companies with relatively lower carbon intensities are less exposed to regulatory risks as well as volatile and increasing energy prices and therefore in a better position to handle the transition towards a low-carbon economy. In order to optimally exploit the existing mitigation potentials, a cross-industry effort is needed to cut down emissions. This means, not stand-alone measures shall be the aim, but rather a transformation of entire systems and industries towards a low-carbon economy needs to be aspired to. Promising technologies and solutions with high mitigation potential and a cross-sectoral character are discussed in form of smart grids, intelligent buildings and electrification of transportation.

To systematically track companies with low greenhouse gas intensities and, therefore, better competitive positions, envIMPACT® can provide a valuable solution. envIMPACT® is a quantitative methodology for assessing the greenhouse gas intensity of

sectors and companies for the entire value chain using an environmental extended input-output analysis database combined with life cycle inventories and life cycle assessments to quantify the greenhouse gas intensity of some 500 activities. To achieve a fair evaluation of companies' carbon intensities, taking into account carbon emissions of the entire value chain such as from the production, use and supply phases is crucial as there are significant differences among sectors and phases. Companies with low carbon intensities over the entire value chain are less exposed to regulatory risks and increasing energy prices.

Financial market conditions have been in favour of oil and gas stocks and are in some sense preserving the current energy structure. But this is not necessarily the future. Financial markets will rapidly adapt to changing conditions.

Two trends can be identified. First, the long period of cheap energy could find an end in foreseeable time. Between 1970 and today, the oil price increased from USD 2 to USD 62 which means an increase of 8.6 percent per year. In general, high energy prices are strong incentives for increasing energy efficiency and this will be in favour of "low-carbon" stocks (clean tech). Especially, as there is no evidence that oil will become as cheap as it was ten years ago.

Second: regulation and enforcing liabilities will shift costs towards energy users. Climate policy, whether globally coordinated or at national level, will add to the costs. Here, oil or "high carbon" energy sources are in a rather unfavorable position. The huge oil spill in the Gulf of Mexico will probably increase the pressure on regulators and the law system to enforce financial compensation. Integrating the now "external" costs of climate change and pollution into "high carbon products" will add to the pressure on profitability in this segment of the global economy and at the same time drive new energy sources, energy efficiency.

The sooner investors are moving more capital towards this direction, the earlier clean tech will become relevant also in quantitative aspects and the carbon intensity of the economy will be decreasing.

1. Introduction

Human-induced climate change poses a huge threat to humanity and human welfare. Without significant cuts of global emissions by about 50% in 2050, an increase of global average temperature by more than 2°C entailing major social disruptions and welfare losses is unavoidable. Strong political action and concerted response from the business world and individuals is therefore an imperative.

In a fair global climate deal, developed countries would have to cut their emissions by approximately 80% by 2050 compared to 1990 levels. This is a huge task which requires a fundamental change from a fossil-fuel-based society and economy towards a low-carbon society and economy.

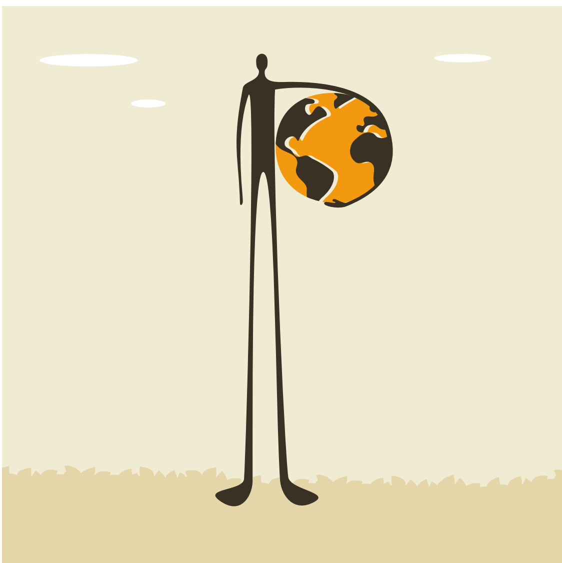
This report outlines several perspectives of a low-carbon economy from overall policy implications to the company level. It does not include adaptation to climate change but focuses on mitigation strategies only. Nevertheless, it goes without saying that stringent climate action must include both mitigation and adaptation. And even with strong mitigation action the already unavoidable climate change has to be managed.

Chapter 2 provides an overview of the mostly uncertain policy context at global level resulting after the Climate Conference in Copenhagen in December 2009. It also points out some general challenges which highlight the importance for companies and individuals to contribute to a low-carbon economy – despite the uncertain policy environment.

Chapter 3 illustrates the vision of a low-carbon economy and presents the main strategies and entry points for decarbonizing the economy. The focus is on entry points for developed countries and on energy-related strategies. Land-based emissions such as emissions from deforestation and forest degradation as well as non-CO_2 emissions are not taken into account.

Chapter 4 brings into focus the sectoral perspective. It identifies greenhouse gas emission intensities as a risk of opportunity factor for economic sectors and highlights sectors with high mitigation potential. Some promizing technologies and solutions with high mitigation potential – smart grids, intelligent buildings, electrification of transportation – are illustrated in more detail.

In Chapter 5, the report further specifies the implications of a low-carbon economy for companies. By assessing the greenhouse gas intensity of companies for the entire value chain, specific risks and opportunities of companies in comparison to their direct competitors can be identified. Finally, the role of the financial markets and implications for investors are outlined in Chapter 6.



2. Policy context

Implications of COP 15 in Copenhagen – the Copenhagen Accord

The climate negotiations of the United Nations culminating in Copenhagen in December 2009 have been predicted to be a turning point within the international climate policy. According to the Bali Roadmap 2007, a comprehensive negotiation process would have been concluded in Copenhagen and a new international agreement replacing the Kyoto Protocol would have been agreed upon. The agreement was supposed to cover the elements mitigation, adaptation, technology development and financial resources. The overall goal was to limit global warming to 2°C with regard to pre-industrial levels and to agree on emission reduction obligations up to 2020 and 2050.

The expectations to the outcome of Copenhagen were very high, and closely followed by the media. However, negotiations in Copenhagen resulted in a minimal consensus document referred as the Copenhagen Accord, which is a political declaration without any legally binding character. The Parties only "took note" of the Accord but did not reach consensus on its content.

The Copenhagen Accord does not include quantitative, global emissions reduction targets for 2020 or 2050 but only recognises the need to reduce global emissions to prevent global temperature from rising beyond 2°C. Several industrialized countries as well as emerging countries were not willing to commit themselves to legally binding reduction commitments or actions and thus reduced the chances for a legally binding treaty. The Copenhagen Accord only foresees voluntary emission reduction targets for developed countries and so-called nationally appropriate mitigation actions for developing countries. The result is a clear signal for a geopolitical shift away from EU countries as advocators of a strong international climate treaty towards the USA and the so called BASIC countries (Brazil, South Africa, India, and China).

One of the achievements of the Copenhagen Accord is the commitment of developed countries to provide new and additional financial resources approaching USD 30 billion for the period 2010–2012 with balanced allocation between adaptation and mitigation. Furthermore, developed countries commit to a goal of mobilizing jointly USD 100 billion per year by 2020 to address the needs of developing countries.

Gap between long-term goals and voluntary emission reduction targets and actions

55 countries, including China, India, the US and the 27 European Member States, have made publicly available their pledges regarding quantified economy-wide emission reduction targets for 2020 or mitigation actions. Most pledges by the key countries have been published already before Copenhagen and most of them have not been changed since then. The following table provides an overview of the pledges made by some important countries.

Emission reduction targets of selected countries for 2020 (pledges)

China	Reduction of emissions intensity (e.g. CO_2/GDP) by 40–45% compared to 2005
India	Reduction of emissions intensity (e.g. CO_2/GDP) by 20–25% compared to 2005
USA	Reduction of absolute GHG emissions by 17% compared to 2005
EU	Reduction of absolute GHG emissions by 20% compared to 1990, respectively 30% if other nations join
Brazil	Reduction of GHG emissions by 36–39% compared to a "business as usual" scenario
Japan	Reduction of absolute GHG emissions by 25% compared to 1990

Table 1 Pledges of selected countries. Switzerland states the same pledge as the EU (20% reduction by 2020 compared to 1990 and 30% reduction by 2020 provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities).

Pledges have been lively discussed and are widely perceived as being too weak. Meinshausen et al. (2009) conclude that in order to keep the achievement of the 2°C target "likely" (i.e. the probability to remain below a 2°C increase in temperature is more than 75%), cumulative total CO_2 emissions over the years 2000 to 2049 should be below 1 terra-ton CO_2 (see blue line in figure 1, left side). Pledges made by the Parties (red line, left side) are far away from reaching the global target[1] and will most likely lead to an exceeding of the 2°C target (see in figure 1, right side). Only some pledges are close to the reference scenario (e.g. China) or are perceived as sufficient, namely Japan and Norway with 25 percent and 30–40 percent below 1990 (Rogelj and Meinshausen 2010). The pledges would result in a significant temperature increase of more than 2 up to 5°C in 2100 compared to pre-industrial times. Very likely, such a temperature increase will lead to dangerous climate change with massive and irreversible disruptions of the global ecosystem and a dramatic increase of costs for climate change adaptation and damage repair.

Aspired and forecasted emission paths

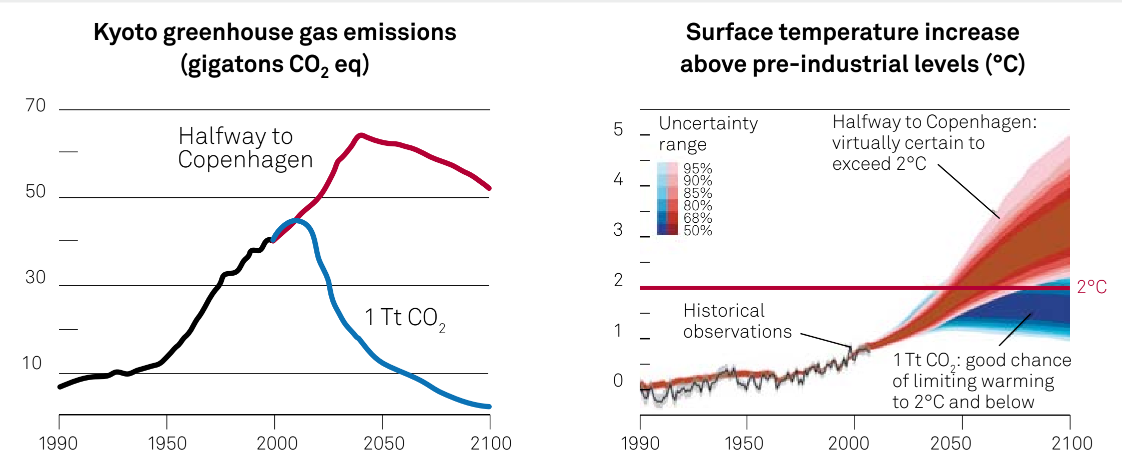


Figure 1 Nature Reports, Climate Change, July 2009. The graphs refer to GHG emissions per year. To achieve the blue curve and hence a 2°C target, maximum emissions budget would account to 1 Tt (10^{12} tons) for the time span between 2000 and 2050.

An uncertain policy environment and other challenges

The fact that in the foreseeable future no legally binding agreement will be in place enhances the uncertainty of the policy environment. Especially at a global level it is very uncertain to predict policy instruments that might be applied, for whom they will be relevant and what the implications for companies will be. This policy uncertainty might directly affect the carbon price and the demand for carbon instruments. However, despite these uncertainties over the future of the carbon market, positive signals are set. Several carbon funds offer opportunities for investing in low-carbon projects beyond the Kyoto period ending in 2012. Furthermore, the price for EU allowances traded under the European Emissions Trading Scheme (EU ETS) did not collapse after the outcome of Copenhagen and remained rather stable during the past 6 months. These signals show that future efforts with regard to transforming the current economy to a low-carbon economy, is not solely dependent on a strong global climate policy treaty. Some parties, as e.g. the EU, provide predictability by having set a unilateral emission reduction target of minus 20% by 2020 and maintaining its European Emissions Trading System independently from the form of a future global climate treaty.

Furthermore, crude oil is an important energy price setter on the world market. As the peaking of oil ("Peak Oil") production within the next two or three decades will approach, energy price levels are likely to increase substantially and exploiting of new oil fields will get more risky and more expensive. Increasing energy prices for oil, gas and coal enhance the trend towards renewable, less carbon-intense energies. And climate-efficient infrastructures are becoming relatively more cost-effective no matter whether a global climate policy framework is in place or not.

Another important driver is the dependency on imported fuels affecting energy security of many countries. Addressing energy security and energy supply concerns are getting increasingly important. In combination with increased electricity demand this concern could on one hand lead to further exploring the potential of renewable energy sources and energy efficiency. On the other hand, it could also result in exploring domestically available fossil fuels such as offshore oil, oil sands or even coal for power generation purposes. A massive fallback to coal would most probably jeopardize all efforts achieved with regard to climate protection.

1 Rogelj et al. (2009), analyses by the UN Environment Programme and UK economist Lord Stern (Stern 2009), analyses by McKinsey for Project Catalyst (Project Catalyst 2009), and by Ecofys and the Potsdam institute for Climate Impact Research (Höhne, N. et al 2009) draw similar conclusions.

3.

Low-carbon economy

The trend towards higher resource efficiency has already influenced the economy and society as a whole and will even more do so in the future. The need of higher efficiency in order to achieve less resource consumption, less emissions and more social compatibility is driving economic development in all sectors and on all levels. The need of substituting energy-intense resources, materials and technologies with climate-friendly ones is a challenge and chance for economies and societies. This ongoing, long-term process will entail new consumption patterns, sectoral shifts and many – often unspectacular but nevertheless effective – innovations.

The energy-related emission challenge of today's economies and societies

The energy sector accounts for the main share of greenhouse gas emissions, especially in developed countries. In Switzerland for instance, emissions from the energy sector accounted for over 80 percent of total greenhouse gas emissions in 2007 (FOEN 2009). In OECD countries, power generation accounts for the main share (40 percent) of energy-related CO_2 emissions (see figure 2). Emissions from energy generation vary significantly among countries due to their different electricity production structures[2]. The transport sector accounts for 27 percent of energy-related emissions and has increased in many industrialized countries during the last years. Manufacturing industries and construction as well as energy-related emissions in buildings account for another 12 percent each.

Energy-related CO_2 emissions in OECD countries

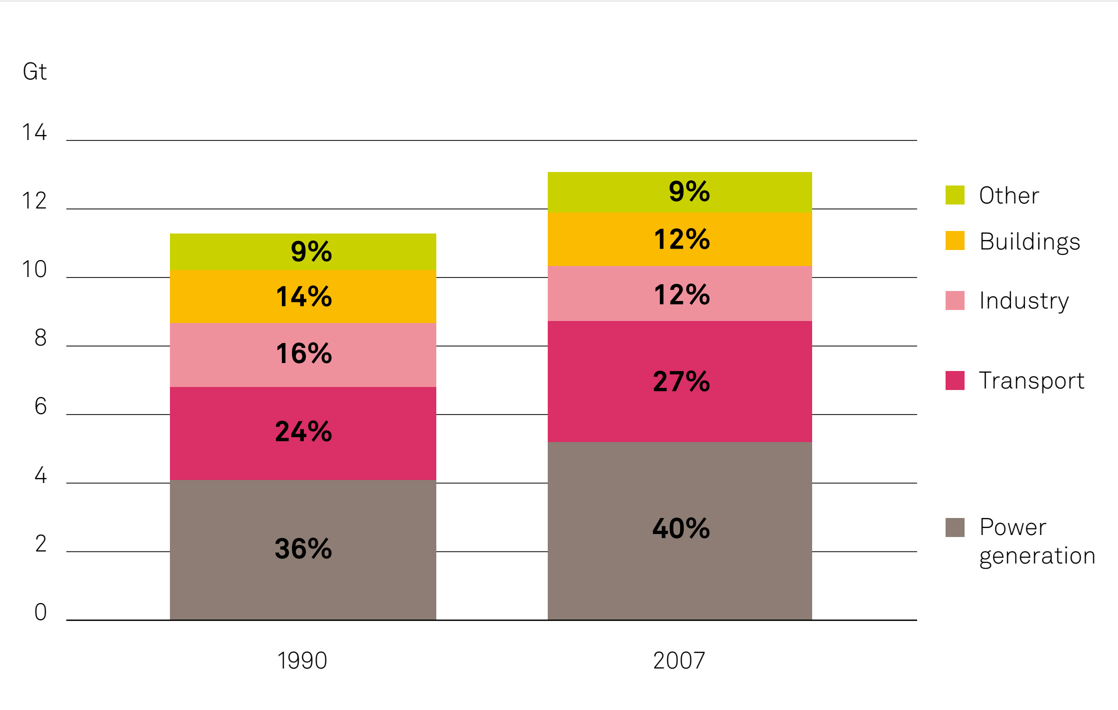


Figure 2 Source: IEA 2009

Until now, greenhouse gas emissions and energy consumption have always been growing in line with the economic development of a country. Efficiency gains are generally more than compensated by increased energy and resource use due to increased standards of living and changes in consumption patterns. Therefore, decoupling economic wellbeing from energy consumption or environmental damages has been the overarching idea of environmental policy since its earliest days.

Human development index and CO_2 emission per capita

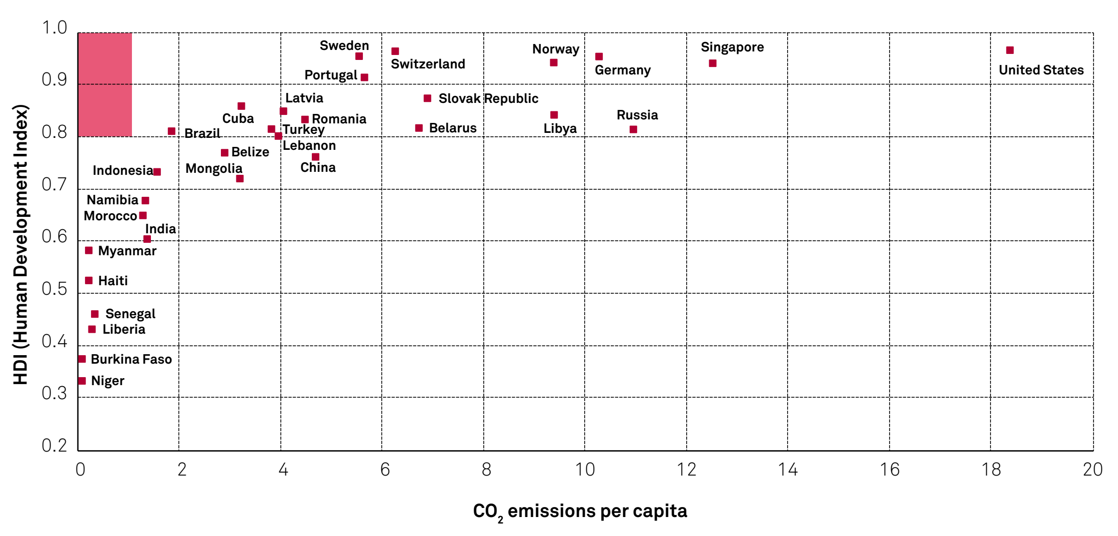


Figure 3 Indicator sources: Carbon Dioxid Information Analysis Center and UNDP. The Human Development Index is an indicator of social and economic development composed by the following elements: Life expectancy at birth, literacy rate of those over 15, education (primary, secondary, and tertiary) and gross domestic product per capita (http://hdr.undp.org).

Figure 3 relates human wellbeing represented in the Human Development Index (HDI) to the per capita CO_2 emissions of countries.

As shown in figure 3, no country has reached a level of a high HDI (more than 0.8[3]) combined with low emissions per capita (e.g. 1 tons per capita) which could be referred to as sustainable on a global level. Switzerland emits around 5.7 tons of CO_2 per person (FOEN 2009) corresponding to around 5,000 watts per person. The biggest emission emitters per person are the United States and oil-exploiting countries like the United Arab Emirates, Kuwait and Qatar (not indicated in the graph). Mainly Sub-Sahara African countries are emitting less than 1 ton of CO_2 per capita (referring to around 2,000 watts per capita and year of energy use). The majority of these countries show a middle to low grade of development.

2 In Switzerland, emissions from energy generation do not play a major role due to its electricity production structure (about 95.2 percent generated by hydroelectric and nuclear power plants in 2007) (FOEN 2009).

3 Countries with a HDI below 0.5 have a very low development standard. Between 0.5 and 0.799; middle standard of development, between 0.8 and 0.899; high developed countries, above 0.9 very high developed countries (UNDP).

The vision of a low-carbon economy (1 ton CO_2 per capita and 2,000-watt society)

In order to limit global warming to a maximum of 2°C, global emissions need to peak around 2015 and 2020 and decline then rapidly below an annual one ton CO_2 per capita as it is also postulated by the IPCC. This target is in line with the vision of a 2,000-watt society, originated by the Swiss Federal Institute of Technology in Zürich at the end of 1998, in which each person in the developed world would cut its overall rate of energy use to an average of no more than 2,000 watts (i.e. 17,520 kilowatt-hours per year of all energy use including renewable energies) by the year 2100 (or increase up to 2,000 watts for developing countries accordingly), without lowering its standard of living (www.novatlantis.ch). The limit of 2,000 watts or one ton of CO_2 per capita and year refers to around 500 watts of fossil fuels. If the fossil fuel energy needs are reduced in line with this vision, the ambitious CO_2 target can be achieved in the second half of this century or at the very latest, in the course of the next century. The energy and climate-related challenges are overlapping and closely related. It is therefore not solely important to enhance material and energy efficiency, but also to substitute fossil fuels by renewable energies in order to give CO_2 reduction a further boost. The overall aim of the vision (1 ton CO_2 per capita and 2,000-watt society) is that the quality of life does not undergo any restrictions. On the contrary, security, health, the comfort and individual development of people are all improved whereas incomes would rise by around 60 percent in 50 years (Novatlantis 2005). The overall goal is to reduce energy per capita demand by two thirds while increase energy services by two thirds, meaning that mainly the primary energy demand which is being lost in energy conversion would be drastically reduced.

What are the strategies for achieving a low-carbon economy?

There are three main strategies which need to be tracked and combined on the road to a low-carbon economy:

- **Efficiency:** autonomous technology development and additional increase in material and energy efficiency.
- **Substitution:** Substitution of fossil-based energy by renewable energies or switch to less CO_2-intense fossil fuels.
- **Sufficiency:** New living and consumption behaviors (e.g. using instead of owning).

A study published by WWF (WWF/Infras 2008) for Switzerland analyzes the possibilities of achieving national CO_2 emission reductions of 60 percent until 2035 with regard to 2001 taking into account today's available technologies and the three strategies and including CO_2 emissions from embodied energy. Figure 4 visualizes the logic of the strategies and shows that the lion's share of abatement can be achieved by efficiency developments including autonomous technology development (minus 50 million tons CO_2) followed by the strategy of substitution of oil and gas by renewable energies (minus 34 million tons CO_2). However, also behavioral changes in form of sufficiency strategies are needed to achieve such a substantial emission reduction. The potential is virtually much higher than displayed in figure 4 (as there is no limit for the extension of the sufficiency strategy), which only indicates the potential up to reaching the overall goal of minus 60 percent.

Strategies for the reduction of CO_2 emissions

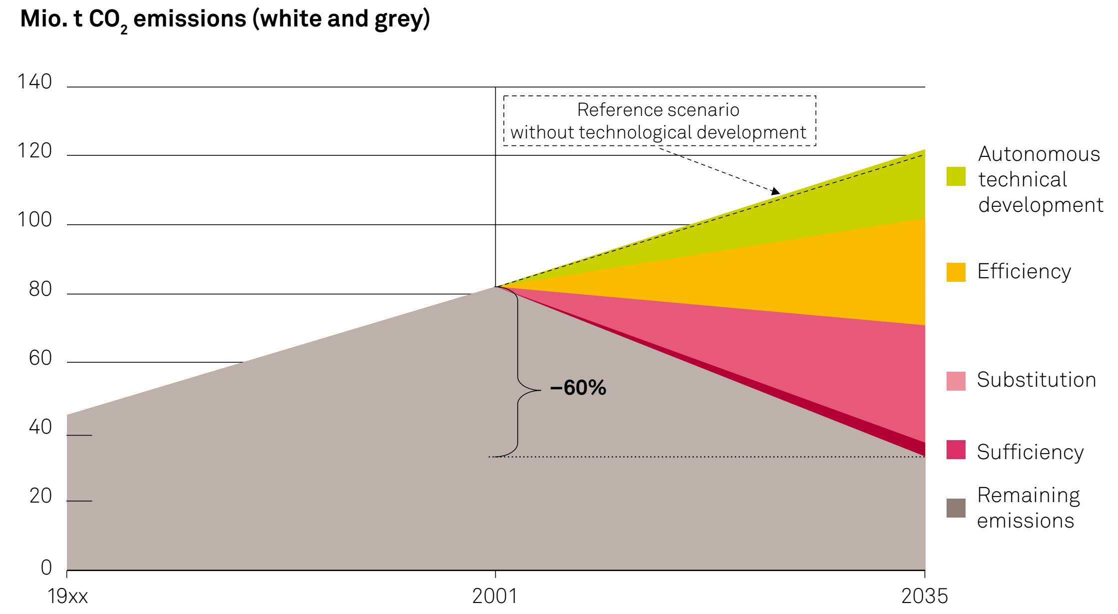


Figure 4 Strategies for the reduction of CO_2 emissions, Reference Condition 2035. Reference: WWF / INFRAS 2008.

What are the entry points to achieve the vision?

How can an economy achieve such drastic reductions as outlined in figure 4 and is such a vision politically and technically feasible? The transition to a low-carbon economy requires a fundamental change in the innovation system such as research, policy, education, standards, etc. These systems must be continuously extended and integrated into the country's policy on innovation and sustainable development. Furthermore, a low-carbon economy or a 2,000-watt society shall be a vision not only for one single country, but rather for the entire world because it enables the balance between industrialized and developing countries and thus makes it possible for all people to enjoy a good standard of living. As outlined by STO (2008), the following entry points can be named in order to achieve the vision of a low-carbon economy:

Decarbonizing electricity generation

Decarbonization of electricity generation has the biggest emission reduction potential mainly due to a combination of increase of renewables, carbon capture and storage, improved carbon efficiency and fuel switching.

› An important goal is the successful achievement of fuel switch, either between fossil fuels (for example gas rather than coal), or by deploying proven low-carbon technologies with costs already fully or close to competitive with fossil fuels (such as wind on best sites or hydro).

› In parallel, technology developments and support to exploit potentials from solar, tidal, wave and biomass are urgently required to help them catch up cost effectiveness and reduce fossil fuel dependency in the long run. Recent studies have shown that a 100% renewable electricity supply in Europe is possible by 2050 (PwC et al. 2010, SRU 2010). Such a rapid scaling up of all forms of renewable power could be achieved if supported by an efficient transmission grid, a single European power market united with similar grids and markets in North Africa (PwC et al. 2010).

Energy efficiency in the use of electricity

- Electricity demand varies significantly by season, day of the week, and time of day. Furthermore, renewable electricity supply from wind, tide, wave or solar varies in line with natural conditions. Therefore, management of the demand and supply of electricity, mainly via technologies which change the temporal relationship between electricity supply and demand is of great importance. To achieve the full potential of low-carbon energy sources and minimizing any additional costs incurred in moving to a low-carbon economy also depends on a range of technologies which make it possible to shift the timing of electricity demand (e.g. technology improvement for the central storage of electricity, or for converting surplus electricity into potential energy to be used for electricity generation at peak periods).

- Opportunities to increase efficiency in the use of electricity in residential and commercial housing play a major role. Greatest achievements could be made by applying energy-efficient end-use technologies in the field of air conditioning, lighting and appliances. Modern efficient air conditioning technologies could reduce electricity consumption, e.g. for up to 38 percent at negative costs in the EU. The global shift from incandescent to compact fluorescent bulbs would reduce electricity consumption by 18 percent at negative costs (STO 2008).

- The opportunities to reduce demand of electricity in industrial processes is less than in commercial and residential buildings, but still significant.

Transport: more efficient vehicles, new fuels and demand containment

- More efficient vehicles are one of the key technologies for emission reductions, even if the fuel source remains petrol or diesel (such as improved aerodynamics, light-weight materials, engine system improvements or hybrid systems).

- New transport fuels can play a further role in reducing emissions from the transport sector such as electricity, hydrogen and biofuels (second generation biofuels to be preferred as they are not competing food security).

- Influencing transport mode and behavior is another important focus. Although advances have been made in the transport sector with regard to energy efficiency (mainly regarding cars and airplanes), they are not keeping pace with the exponential growth of these modes. What is needed, on one hand, is a behavioral change with regard to consumption reduction either via substitution of mobility (e.g. video conferencing instead of face to face meetings) or by sufficiency (e.g. abandonment of recreational long distance flights). On the other hand, sustainable land use and transport planning can organize the transport system more efficiently and at the same time contribute to a reduction of carbon emissions.

Heating: energy efficiency and new energy sources

› Globally, the production of heat accounts for around 55 percent of final energy use.

› There is a huge potential for space and water heating in residential and commercial buildings mainly due to improvements of insulation, boiler efficiency or new sources of energy.

› The reduction opportunities for heat in industries are less than in the building sector. However, there are opportunities to improve the efficiency of industrial processes (mainly in iron and steel, non-metallic minerals, chemicals and petrochemicals, pulp and paper industries) to reduce heat demand either without changing energy source (e.g. switching to dry-rotary kilns for cement production would save 12 percent of emissions), or by switching from coal to gas in locations where this is feasible.

All reasonable scenarios of climate stabilization seem to lead to decoupling needs in the vicinity of factor five within the next couple of decades (von Weizsäcker 2010). As outlined in the recently published book "factor five" (von Weizsäcker 2009a), there exists now a real potential to cost effectively achieve 80 percent, or five-fold, improvements in resource productivity across most of the major economy sectors (buildings, industry, agriculture and transport) (sector potentials are summarized in figure 5). Factor five is taking into account a "Whole System Approach" meaning that large resource efficiency gains are achieved when the whole system is considered (e.g. not only think in the order of energy-efficient light bulbs but rather think in the order of the building as an entire systems (see also Chapter 4 "Efficient and Smart Building")).

Hence, for achieving the vision of a low-carbon economy all spheres of a society, such as different sectors, politics and individual behavior, have to be taken into account. The fact that renewable forms of energy play a central role here is self-evident in view of the declared target. Energy efficiency improvements and substitution of fossil fuels are turning keys to achieve significant abatements within the entire economy.

Figure 5 Source: von Weizsäcker 2009b

What are the implications on a macro level?

Technical and economic feasibility to transform current economies into low-carbon economies has been increasingly recognized in several studies. Welfare implications of such a transition have been assessed (e.g. by Bretschger et al. 2010, STO 2008, McKinsey & Company 2010), all resulting in similar conclusions: a transition towards a low-carbon economy is economically feasible and does not trigger welfare loss, but rather increases welfare. Many sectors such as renewable energies and energy efficiency technologies will experience significant increase in global investments within the next decades, whereof early movers can benefit by exploiting competitive advantages. The global market volume of energy efficiency and renewable energies for 2020 is estimated to reach a level of more than EUR 1,645 billion, in comparison with EUR 695 billion in 2007 (BMU 2009).

In order to achieve a low-carbon economy, investments need to be done in the short term. However, cost savings in the long run (e.g. from energy efficiency or other measures) would offset these additional investments to be done initially. Furthermore, inaction would trigger huge costs to society (Bretschger et al. 2010). Costs of adaptation have been estimated at around 5 to 20 percent of global GDP in 2100 if a "business as usual" growth of GHG emissions continues (Stern 2006). The road to a low-carbon economy requires a change of paradigm from increasing labour productivity to increasing resource productivity (von Weizsäcker 2010).

To achieve a successful transformation towards a low-carbon economy an optimal mix of policy instruments is needed. Putting a price on carbon (taxes or tradable permits) (UNDP 2007) is an important element of any climate change mitigation strategy, emphasizing the cost factor for any economic activity. Cap and trade system such as the European Union Emission Trading Scheme (EU ETS) are a pioneering instrument to find a market-based solution to incentivize cuts in greenhouse gas emissions. Efficiency standards can provide incentives to develop more efficient technologies (for instance in the building sector), whereas financial incentives such as subsidies and tax credits are used to stimulate the diffusion of new, less greenhouse gas-emitting technologies (IPCC 2007).

4. Implications for sectors

Greenhouse gas emissions as a risk or opportunity factor

With stronger climate regulations and increasing energy prices, the level of greenhouse gas emissions and carbon intensities of sectors will in the future become more important. Sectors providing the same service less carbon-intensive than other sectors (e.g. wind power sector providing less carbon-intensive electricity than coal power sector) will comparatively be better positioned with regard to regulatory and energy price risks.

Figure 6 provides an overview of the carbon intensity of selected sectors.

Sectors highly relying on fossil fuels such as coal, oil or gas power generation have a high emission risk. This is especially the case for sectors where less carbon-intensive alternatives are developing quickly and are getting more affordable, such as wind-powered electricity generation for example. In general terms, sectors relying on low-carbon technologies and products, such as renewable energies and sectors producing energy-efficient products (e.g. for the building sector) are in a winning position.

A challenge arises to sectors producing goods with high absolute direct and indirect CO_2 emissions (e.g. cement industry). They are increasingly under pressure to look for more efficient energy sources and substitution potentials to less CO_2-intense inputs in order to be able to reduce their overall CO_2 emissions. Mostly affected are

Carbon intensity of selected industries

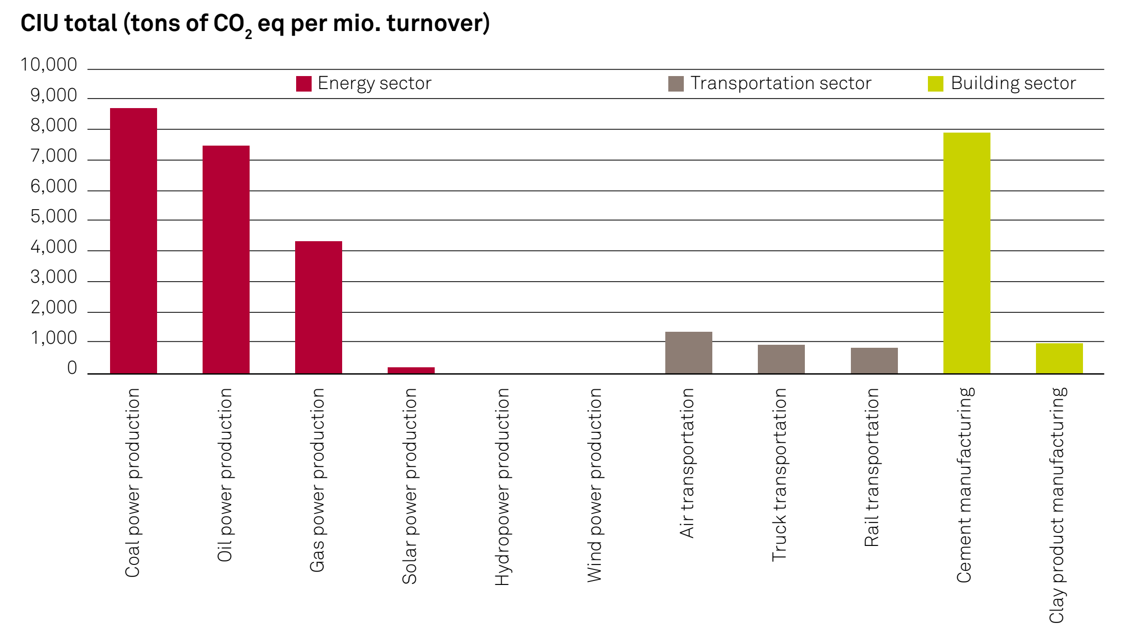


Figure 6 Carbon intensity of selected industries that are part of the energy, transportation or building sectors. The Carbon Intensity Unit (CIU) is defined by tons of CO_2 equivalents over the entire value chain per one million USD of turnover. Power production refers to the wholesale of self-generated electric power from the respective energy source (coal, oil, gas, hydro, etc.). Clay product manufacturing refers to brick, tile, and other structural clay product manufacturing.

industries which currently still profit from the relatively cheap provision of mineral oil, such as companies producing synthetic material. Some of these industries belong to the most carbon-intensive sectors, which increases their risk in terms of CO_2 restrictions.

In transportation, the picture also shows a broad range from the carbon-intensive air transportation and automobile sector to more carbon-friendly modes of transportation such as trains.

In general, companies that operate their own processes efficiently and therefore have a lower carbon intensity in production compared to their competitors within the same sector will have less financial burden caused by high energy prices or CO_2 taxes. Simultaneously, they are also reducing their dependency on fossil fuels. They can pass on these realized savings to their customers and therefore indirectly increase their competitiveness.

Mitigation potential of sectors

The carbon intensity alone does not give the full picture when assessing risks and opportunities arising from greenhouse gas related issues. The potential for emission reductions has also to be taken into account. In order to optimally exploit the existing mitigation potentials, a cross-industry effort is needed to cut down emissions. This means, that no stand alone measures shall be aspired, but rather a transformation of entire systems and industries towards a low-carbon economy need to be aimed.

There is substantial economic potential for the mitigation of greenhouse gas emissions in all sectors which could reduce emissions below current levels (IPCC 2007). For OECD countries, large potentials can be found mainly in the energy supply sector, the buildings sector and transportation whereas in developing countries a high mitigation potential is also identified in industries, agriculture and forestry. At a global level, technical mitigation opportunities at costs of less than EUR 60 / ton of CO_2 eq[4] related to energy efficiency, low-carbon energy supply and terrestrial carbon add up to a total potential of 38 gigatons of CO_2 eq per year in 2030 relative to an annual business as usual scenario of 70 gigatons CO_2 eq (McKinsey 2009).

Most of the mitigation options underlying these potential estimates are based on known technologies, but some of them are not expected to be competitive until the end of the 2020–2030 period. Strategies and entry points for achieving these mitigation potentials and therewith the vision of a 1 ton CO_2 society, are described in chapter 3.

Promising technologies and solutions with high mitigation potential can be found in all sectors. Some examples of the sectors energy supply, buildings and transportation are briefly illustrated below.

4 Equivalent carbon dioxide (CO_2 eq) is a measure for describing how much global warming a given type and amount of greenhouse gas may cause, using the functionally equivalent amount or concentration of carbon dioxide (CO_2) as the reference.

Smart Grids

Electricity demand is supposed to further increase due to various trends such as installation of more heating pumps, electrification of transport or an increased use of electronic devices. Technologies and systems that help to optimize the electricity supply system and monitor consumption are therefore getting increasingly important. An upgrade of the current electricity grid is required in order to be able to service distributed generation and large scale sources of renewable power (PwC et al. 2010).

In a sustainable electricity system, Smart Grids and Smart Meters will lead to an integrated electricity supply, decentralized power production (especially from renewable energy sources), storage optimization (e.g. plug-in vehicles) as well as minimization of losses and optimization of consumption. Electricity will increasingly be generated in decentralized small units; even buildings can become energy producers. Photovoltaic modules on the roof provide energy, which is directly fed into the grid. The Smart Grids interacts with consumer appliances and can balance the fluctuating electricity supplied by many decentralized energy providers, like wind and solar power plants. Figure 7 shows an example of a Smart Grid.

Smart Grid
A vision for the future – a network of integrated microgrids that can monitor and heal itself.

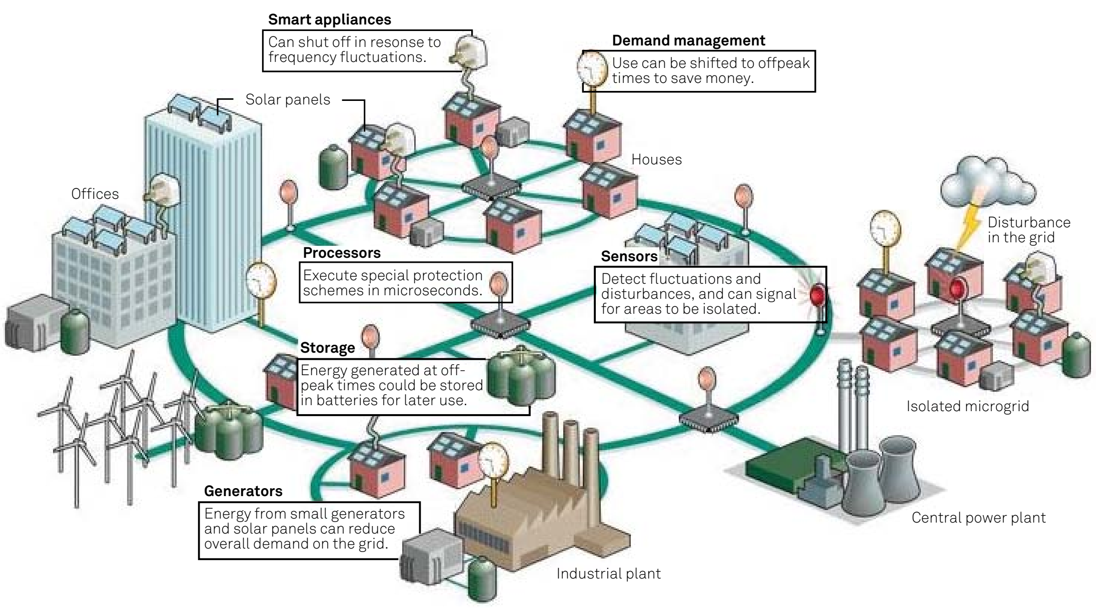


Figure 7 Example of a Smart Grid (Website tiny comb 2010)

With the "Smart Grid", electricity supply is optimized and integrated at all levels of the electricity supply system – from the production over transportation, distribution and storage. Furthermore, the consumption can be automatically regulated, e.g. consumption of water boilers as well as the activation of consumers like storage batteries in cars or PCs as energy storages.

Another central element to pave the way for a sustainable electricity system and data management are Smart Meters, which are metering systems based on modern technologies. They can read the meter of electric utilities over a long distance, communicate with energy providers and households, manage the data gained thereby and make them available for energy producers as well as energy consumers. As a result of the implementation of Smart Meters, user behavior might change and peak demand could be better managed (Infras/TNC Consulting AG 2010). Grid operators can make their customers tailored offers of cheap electricity at certain day times. So it would be possible to charge car batteries or use energy-intensive appliances like washing machines during such off-peak tariff periods (Infras 2009).

Efficient and smart buildings

The huge mitigation potential of the buildings sector can only be explored by applying an integrated approach, combining all relevant elements such as improved insulation, automated air conditioning, and use of renewable energies for heating or systems that reduce energy losses.

The so-called "Passive Houses" have the overall objective to reduce energy losses whenever possible. Passive Houses make use of solar and geothermal energy as well as of the warmth of people, lighting, electrical equipment etc. to heat the rooms. This is possible because in Passive Houses, up to 80 % of the heat in the used air can be recovered by a special ventilation system. In addition, the building is constructed without thermal bridging and with optimal proportions to avoid heat losses. The hot water demand is also met by renewable energies. Due to the combination of smart technologies in

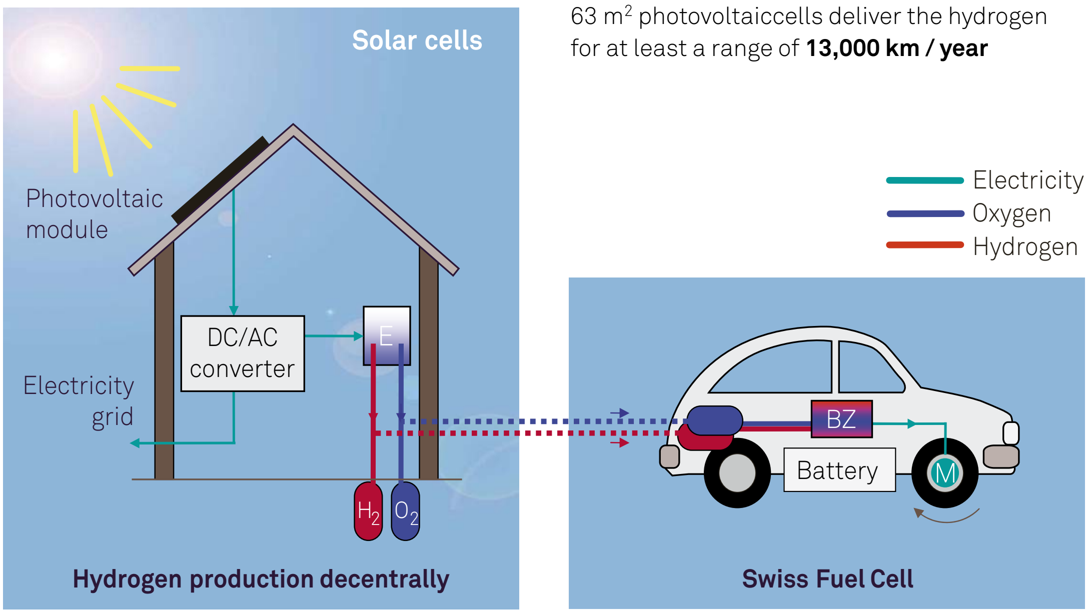


Figure 8 The vision of how houses and cars could be associated in symbiosis to build a clean energy system (SATW 2008).

Passive Houses, the energy consumption of single-family homes for example could be cut down to only 150 liters of heating oil per year (website IG Passivhaus). Latest developments even go towards the concept of so called PlusEnergy houses, which has been implemented in various communities. The PlusEnergy house has a positive energy balance, means that it produces more energy than it actually needs. The house generates its own electricity and heat based on solar energy, uses them intelligently, and retains them in the building's structure (www.plusenergiehaus.de).

Smart Buildings are buildings which are developed, built or operated with an integral use of information and communication technologies. With such automation and monitoring systems, energy efficiency can increase and energy consumption can be significantly reduced during the building's entire life cycle: heating, ventilation and air conditioning, lighting, and operation of electronic appliances.

In the future, also an interaction of smart buildings and clean, efficient cars is thinkable. Solar energy converted to electricity by photovoltaic cells on the roof of the buildings would not only meet the energy requirements of buildings but could also charge the battery of an electric car or be fed into the grid. Also possible, but a longer way off, is the symbiosis of a clean house and a hydrogen cell-fuelled car as proposed by Belenos Clean Power AG.

Electrification of transport

Greenhouse gas emissions of the transport sector continue to grow and account for 19% of total greenhouse gas emissions in Europe (EEA 2010). Energy efficiency gains of different means of transport and the introduction of renewable fuels were so far not sufficient to compensate the growth of transport volumes.

Electric and plug-in hybrid vehicles provide promising opportunities for the development of a more sustainable transport sector. In the last years, especially the hybrid technology has gained importance and greater efforts to develop affordable, high performing electric vehicles were made. But still, only a limited number of vehicle types are currently for sale, and commercially available plug-in hybrids have not been introduced yet.

Main barriers for a massive expansion of electric transportation are: Low energy content of the battery compared to gasoline, still high purchase costs, limited driving range, long charging time and a large charging infrastructure, which is still not available. The current combustion engine based system benefits from economies of scale and is well established, which makes it difficult for a new system to reach a critical mass.

On the other side, the advantages and potentials of electric transportations are significant. Electric vehicles have the potential to use a large range of energy sources. They could substantially cut CO_2 emissions or even provide carbon-neutral mobility if run on renewable electricity and thus improve local air quality.

Assumptions differ substantially with regard to the market potential of electric vehicles. Different studies and visions assume that electric vehicles and plug-in electric vehicles have a market share of 2 to up to 15% of the total passenger car fleet in Europe in 2020 (Enerdata 2009, McKinsey 2006, Alpiq 2010).

Share of EV and PHEV of total car fleet in Europe (in %)

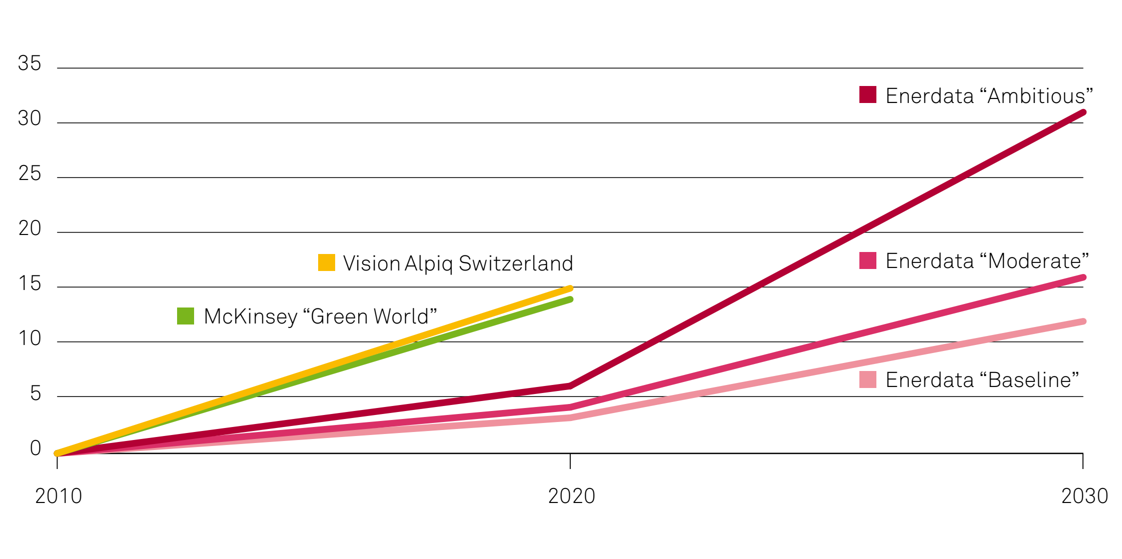


Figure 9 Source: Enerdata 2009, McKinsey 2006, Alpiq 2010.

Although the more ambitious scenarios seem to be extremely optimistic and need fundamental policy and behavior changes, the potential of electric vehicles (EV) and plug-in electric vehicles (PHEV) is significant.

Electrification of transport requires a change of the whole system and an optimal combination of efficient cars, appropriate infrastructure and provision of renewable electricity. It therefore not only offers business opportunities for the automotive industry, but also for component manufacturers (e.g. metering components), electricity producers and distributors and for infrastructure supplier.

New models could provide incentives to car users to charge batteries off-peak and with renewable electricity only. EV and PHEV batteries could be used for energy storage in times of excess renewable energy supply, which offers opportunities for providers of smart metering and smart storage technology solutions. Smart metering would enable concepts like smart charging of batteries whenever renewable electricity is available and charging when renewable electricity production exceeds demand (Kampman et al. 2010). Alternatively, models are already tested where car owners would not own the battery but would pay a subscription fee. Battery changing stations would allow them to have their depleted battery exchanged immediately (BEE 2010).

The effects of a strong electrification of transportation on the power supply sector are generally assessed as moderate. The additional energy demand from EV and PHEV will remain limited in the coming decade compared to the current electricity demand. For 2020, the electricity consumption by road transport will represent less than 1% of total power consumption, for 2030 between 2 and 4% of total power consumption (Enerdata 2009).

Appropriate policy instruments are required to ensure that the low carbon potential of electric transportation is fully explored and that additional electricity use for transportation is green.

5. Implications for companies

The transition to a low-carbon economy will both pose challenges and at the same time bring opportunities for companies. Low greenhouse gas (GHG) intensive companies and companies providing less carbon-intensive products and services are in a better position than their competitors to handle this transition (Maillard et al. 2007).

However, it is difficult to assess GHG intensities of companies because corporate reporting fails to provide consistent, comparable and full value chain data. envIMPACT® is a quantitative methodology developed by Inrate for assessing the greenhouse gas intensity of companies for the entire value chain (i.e. due to production, supply chain and product use). It uses extended environmental input–output analysis data combined with life cycle inventories and life cycle assessments to quantify the GHG intensity of some 500 process activities. By including the GHG emissions for the use and disposal phases of products, the methodology overcomes the problem of the availability of GHG emissions data published by companies (Figure 10). Whereas companies tend to consider direct emissions caused during production and eventually those induced by their supply chain as part of their management responsibility, indirect emissions caused by the use-phase of the products are often excluded from firms' strategic considerations.

envIMPACT® has been used since five years to assess companies in major industries and stock markets around the world. It allows investors to assess the exposure of companies, portfolios and assets to GHG risks and opportunities. It provides precious insights for identifying the least carbon intensive companies within a sector and for identifying those positioned on activities that are driving systemic changes towards a low-carbon economy. For analytical purposes, too, envIMPACT® allows identifying the source of companies' GHG impacts and therefore helps focusing on key part of the value chain (production, supply chain or products).

As shown in figure 6, GHG intensity differs largely between sectors but also between companies within the same sector (figure 11). The importance of the **use phase** for a company's overall carbon intensity can clearly be illustrated in the energy sector (figure 11). Companies that are primarily involved in the extraction of crude oil and natural gas exhibit higher carbon intensity during the use phase of products, as GHG is emitted when petroleum or gasoline is combusted. As a result, the total carbon intensities of oil and gas extracting companies are high. For companies involved in the oil and gas extraction process only (e.g. Noble Energy), the overall the carbon intensity is higher than for companies that refine petroleum prod-

Illustrative example of a value chain

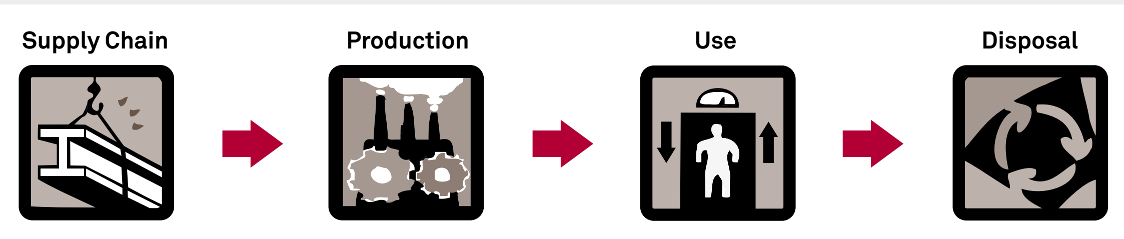


Figure 10 Illustrative example of the carbon intensity of a product over the entire value chain.

Carbon intensities of companies in the energy sector

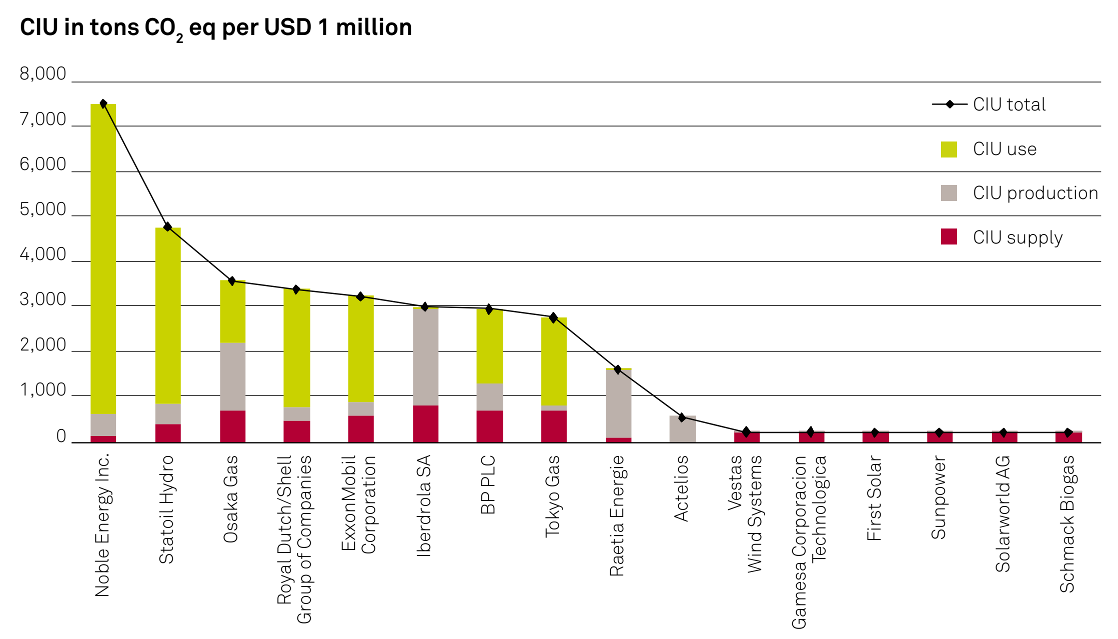


Figure 11 Carbon intensities of companies in the energy sector. The Carbon Intensity Unit (CIU) is defined as tons of CO_2 equivalents per million USD of turnover. The different colors of the bars indicate the carbon intensity of the supply, production and use phases of the products.

ucts and manufacture petrochemicals, since higher added values are generated with such manufacturing processes (e.g. Royal Dutch Shell and Exxon Mobil).

Other than for the oil and gas industry, the GHG emissions during the use phase of products are of minor importance or not relevant to some companies in the energy sector. In such cases, the carbon intensity during the **production phase** is more important, like for the gas utility Osaka Gas that produces electricity from natural gas (apart from their involvement in pipeline transportation and natural gas distribution which are important for these company's use phase carbon intensities). Because natural gas is combusted during the electricity production process, it causes GHG emissions during the production phase only.

Companies that produce electricity from renewable energies like hydropower, solar or wind power do not emit GHG during production and use phase. Only the **supply phase** where the production of supplied materials and technologies is taking place is carbon-intensive. Most electric utilities, however, have a mixed portfolio like Raetia Energie or Iberdrola that generate electricity from hydropower as well as from gas and/or wind. Such companies emit GHG both in the supply and the production phase.

The examples of the energy sector clearly show that taking into account carbon intensities of the entire value chain is crucial. Whereas for some companies direct production emissions are most significant, for others emissions during the use phase are most relevant (e.g. energy consumption of cars, electronic devices etc.). Even when these emissions occur outside a company's boundary system, they are in many cases crucial for assessing their true carbon risks and opportunities and exploring the available mitigation potential of an industry.

Companies with low carbon intensities over the entire value chain are less exposed to regulatory risks and increasing energy prices. They are therefore better positioned in the fundamental transition to a low-carbon economy.

6. The role of the financial markets

Before the global financial crisis, "clean tech" stocks started to show up in many portfolios. "Clean Tech" seemed to be the answer to the ever growing energy and resources demand of the global economy on one side and to lower carbon intensity of the world economy on the other. Today, in the middle of an emerging oil production crisis (Gulf of Mexico oil spill) and as a consequence of depressed stock prices of oil companies, investment reports advocate buy and hold recommendations for "high carbon stocks".

Will capital flows towards low-carbon technologies find appropriate and competitive financing conditions? Or is the transition to a low-carbon economy slowed down by capital markets because of this revival for "high carbon stocks"?

Risk of misallocation

The key role of financial markets is to allocate capital (i.e. resulting from savings) to its most productive and least risky use. Market theory assumes that this is the natural outcome if certain conditions are met: no major restrictions to the market, constant and friction-free adjustment to new information and shocks, minimal liquidity, access to information and transparency. Under such conditions, rational actors make sure that the market mechanism leads to reasonable results, meaning that a sector like energy production and distribution would find adequate and fair financing conditions according to return possibilities and risks involved. Practice can however deviate from this theoretical picture. All savings and investment decisions are about the future, therefore expectations are counting. First, expectations can shift rapidly according to new information and are not necessarily based on factual data. As a consequence, markets tend to overreact and lead to temporary misallocation of capital and disturbed prices.

Second, the misperception of risk and return potential of sectors can lead to capital bottlenecks. It took a long time until banks provided the necessary credits for the financing of clean tech infrastructures. Both effects are disturbing the proper allocation of capital to the "right" investments. This can favour or penalize certain branches and sectors. Investors with distinct expectations or preferences can counteract this and feed a new branch with capital, thus enabling the development of new technologies. Clean Tech is such a new branch which is rather growing under private equity investors. A distorted risk perception in the sense that new clean tech would be considered systematically too risky compared to traditional energy could therefore lead to a misallocation.

High importance of "high carbon stocks"

Energy stocks are attractive. They are offering above average return at – in some periods – even low risk. In the past five years, energy stocks outperformed by 2.9 percent the global equity market (MSCI World Index) while in the last ten years an extra return of 3 percent (p.a.) was generated. Graphical analysis is giving the impression that this extra return is in some way related to the peak in oil price between 2007 and 2008. So, why not invest in oil stocks?

Market capitalization of energy stocks is in fact considerably high. This sector's share of the world equity market became even more prominent during the past five years and is currently slightly above 10 percent. Among the ten largest companies by market capitalization we find two oil sup-

Prices of energy stocks

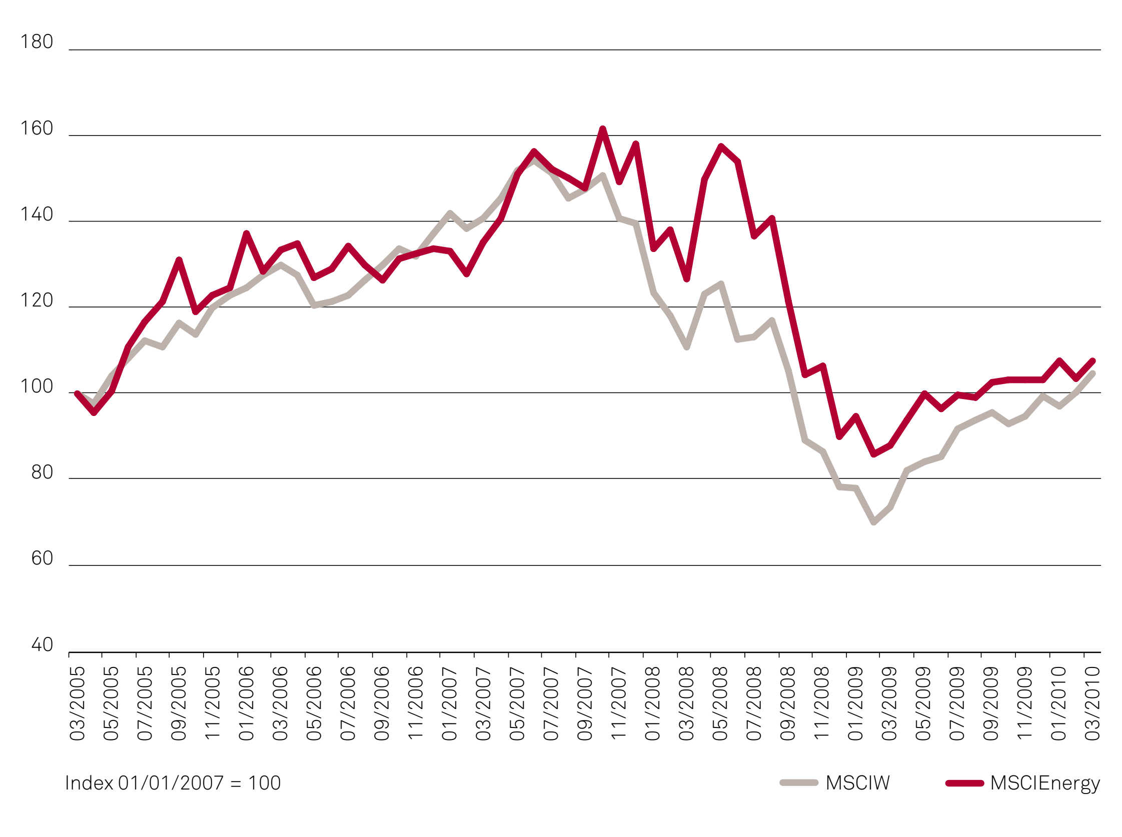


Figure 12 Calculation by Inrate

pliers, Exxon and British Petroleum (see figure 13). According to the Morgan Stanley Capital Market Index, the energy sector in the global equity market is exclusively composed of oil and gas suppliers, all "high carbon stocks".

Ten largest companies by capitalization and turnover

	March 2010	Capitalization (in Mio. USD)	Percentage in MSCI World
1	Exxon	697,220	1.4
2	Microsoft	520,460	1.1
3	Apple	466,450	1.0
4	General Electric	427,170	0.9
5	Protor & Gamble	407,530	0.8
6	Johnson & Johnson	392,800	0.8
7	Nestlé	387,890	0.8
8	BP	387,890	0.8
9	Bank of America	387,890	0.8
10	HSBC	387,890	0.8
	Total	**49,100,000**	**9.1**

		Turnover 2009 (in Mio. USD)
1	Royal Dutch	458,361
2	Exxon Mobile	442,851
3	Wal Mart	405,607
4	BP	367,053
5	Chevron	263,159
6	Total	234,674
7	ConcoPhillips	230,764
8	ING	226,577
9	Sinopec	207,815
10	Toyota	204,302
	Total	**3,041,163**

Figure 13 Sources: MSCI and Forbes

A quick comparison with the ranking of global companies according to turnover reveals that market capitalization does not simply reflects size, but also profitability and growth dynamics. None of the largest ten companies by turnover is appearing among the largest caps.

World energy supply and infrastructure requires high investments and is a very capital-intensive sector. Financial markets do provide the required capital. Often legal structures with high engagement of governments or political actors are contributing to a low risk profile, bringing more favorable conditions for energy suppliers with a high carbon product portfolio.

Drivers of capital markets

Roughly speaking, the market capitalization of a company is the result of profitability and size. But it is not the current profitability that counts but expected profits and profit growth. Compared to the average market, oil stocks did well. One of the drivers behind this was the increase in oil price.

Higher oil prices can also be an indicator of future scarceness. The costs for exploiting new oil fields are rising. Not only because off-shore is moving out into deep and high risk waters. Drilling goes deeper into soil, there is the need to add pressure to bring the oil up and transportation infrastructure has to be built. Consequences are simple: the expected profit margin increases but not in line with oil prices.

High oil prices are driving another sector of the economy too, namely alternative energy (see figure 14): A high oil price means that alternatives to oil are becoming more attractive. The higher the oil price the sooner they will reach profitability. This is even true for photovoltaic cells (PV) which financially are far less attractive than wind energy. Higher than expected oil prices bolstered by sinking installation costs per watt made solar cells and their fabricants look attractive for investors (see figure 14). The share of the largest solar US company, First Solar, developed far higher than the major oil stock, Exxon. Despite high volatility, “clean tech” or “low-carbon” stocks have already proven their financial attractiveness in equity portfolios.

Equity prices and oil: Exxon and First Solar

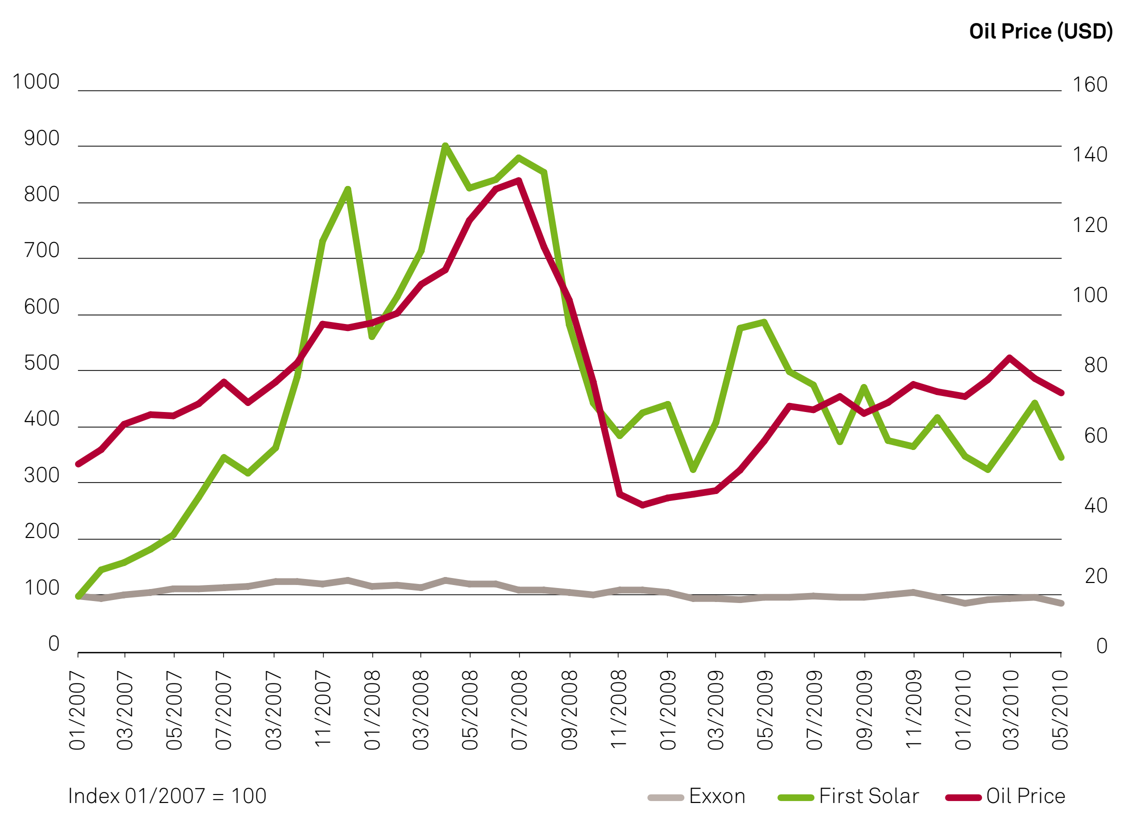


Figure 14 Source: American Stock Exchange (calculation by Inrate)

Shift towards "low-carbon" stocks

Financial market conditions have been favouring oil and gas stocks and are in some sense preserving the current energy structure. But this is not necessarily true in the future. Financial markets will rapidly adapt to changing conditions. The more alternative "low-carbon" companies are considered an attractive investment, the more capital will flow into this direction. Long-term investors will move first and thus accelerate the shift towards a low-carbon economy. And the faster "clean tech" companies will find better financing conditions, the more rapidly they will develop. This will have an impact of sector structures, as changing business volumes and valuations dislocate historical proportions between sectors and within sectors.

Two trends can be outlined. First, the long period of cheap energy could end. Between 1970 and today, the oil price increased from USD 2 to USD 62 (an increase of 8.6 percent per year) equivalent to a shift in the price level by a factor of four in the last 40 years (see figure 15). This is a remarkable increase. But the prices of other products increased, too. The real oil price takes this into account.

In general, high energy prices are strong incentives for better energy efficiency and making "low-carbon" stocks (clean tech) more attractive. Of course, the transformation towards other energy resources is slow. It needs considerable changes in capital intensive and long living infrastructure, innovations in many applications, change in consumption patterns (renewal of stocks) and a change in the key features of real es-

Real oil price

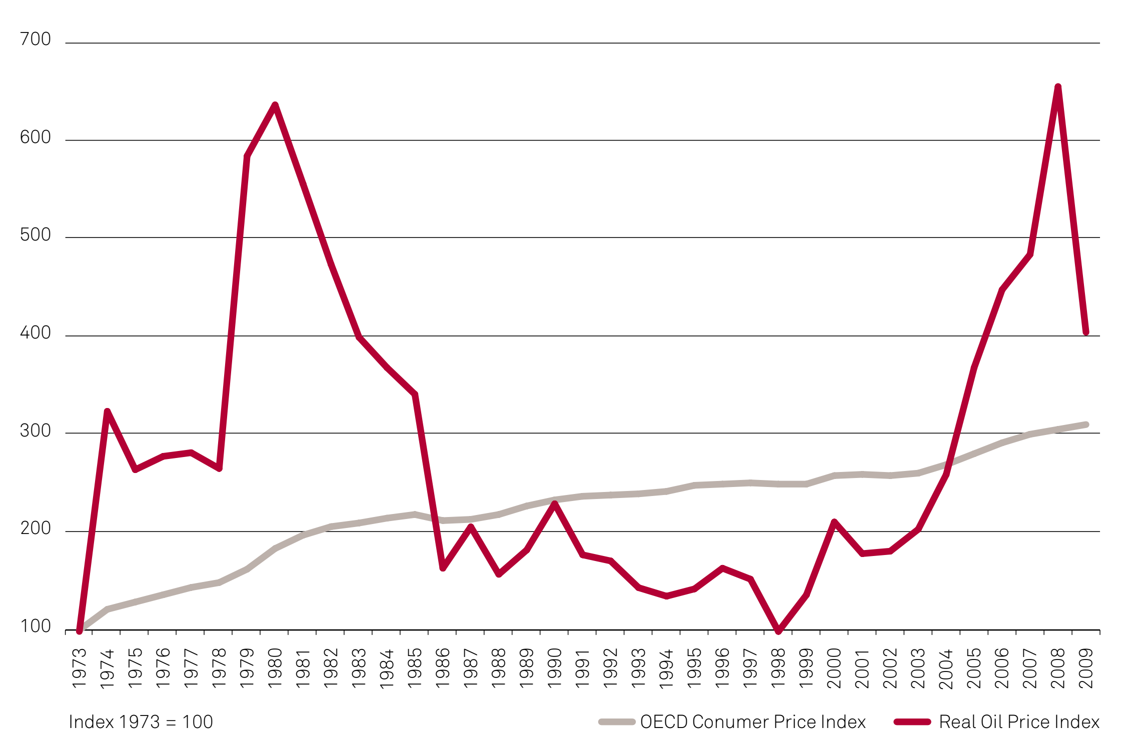


Figure 15 Source: International Energy Agency, OECD. Oil price deflated by OECD consumer price index (calculation by Inrate)

tates. These are all long lasting processes – and the trend towards higher energy prices started only two to three years ago. But there is no evidence that oil will become as cheap as it was ten years ago. As there are few to no evidences that oil and related primary energies will become cheap again, the already started processes should go on.

Second: regulation and enforcing liabilities will shift costs towards energy users. Climate policy, whether globally coordinated or at national level, will add to such costs. In this context, oil and other "high carbon" energy sources are in a rather unfavorable position. The huge oil spill in the Gulf of Mexico will probably increase the pressure on regulators to enforce financial compensations. First estimates are showing that around 10 percent of the annual turnover of the involved company (BP), the fourth largest in the world, is at stake. This would lower its profitability considerably. Integrating the now "external" costs of climate change and pollution into "high carbon products" will add to the pressure on profitability in this segment of the global economy and at the same time increase the attractiveness of new energy sources.

It's a long time process which can be taken into account by long term investors. The sooner investors are moving more capital towards this direction, the earlier clean tech will become relevant also in quantitative aspects and the carbon intensity of the economy will be decreasing.

7. Conclusions

Reducing global warming, and its risks and consequences require the stabilization of the global average temperature on not higher than 2 degrees Celsius compared to pre-industrial levels. Most likely, this target can only be achieved with significant greenhouse gas emission cuts of –50% at global level, –80% in industrialized countries by 2050 compared to 1990 level. Such a transition to a low-carbon economy requires fundamental change in lifestyles, economic and innovation system.

The vision of a low-carbon society can be described as a society that cuts its CO_2 emissions to 1 ton per capita and its energy use to 2,000 watts per year without lowering its standard of living. Such deep cuts of energy use and greenhouse gas emissions are possible at manageable costs without undermining welfare. The necessary elements and entry points are available. Regulatory instruments to path the way to a low-carbon economy such as CO_2 taxation, cap and trade systems as well as incentive structures have been successfully applied in different contexts. Strategies and technologies to cut emissions by a factor 5 are available and proven. Decarbonization of the economy requires a systematic approach taking into account the entire value chain of a service or industry. And it requires an optimal combination of efficiency strategies, large scale substitution of carbon intensive energy by renewables and sufficiency strategies. Such integrated approaches e.g. for smart energy supply systems, intelligent buildings or electrification of transport offer huge opportunities for several companies in the entire value chain.

For economic sectors and companies, their greenhouse gas emission intensities are getting increasingly important as a risk or opportunity factor. Systematically assessing the greenhouse gas intensity of sectors and companies for the entire value chain is therefore a first step to identify their carbon-related risks and opportunities. Sectors and companies with relatively lower carbon intensities are less exposed to regulatory risks, volatile and increasing energy prices and are better positioned to handle the transition towards a low-carbon economy.

Financial markets will adapt to changing conditions. The importance of “high carbon stocks” decreases as soon as estimation on profitability downgrade. The long term trend to a higher oil price is the driving factor also behind the capital markets, as investors will shift towards “clean tech”. The sooner investors are moving capital towards this direction, clean tech will become relevant, also in quantitative aspects and the degree of carbon intensity of the economy will decrease.

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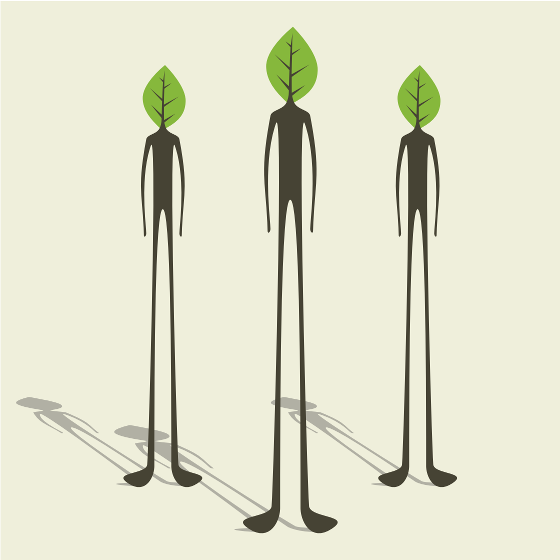

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