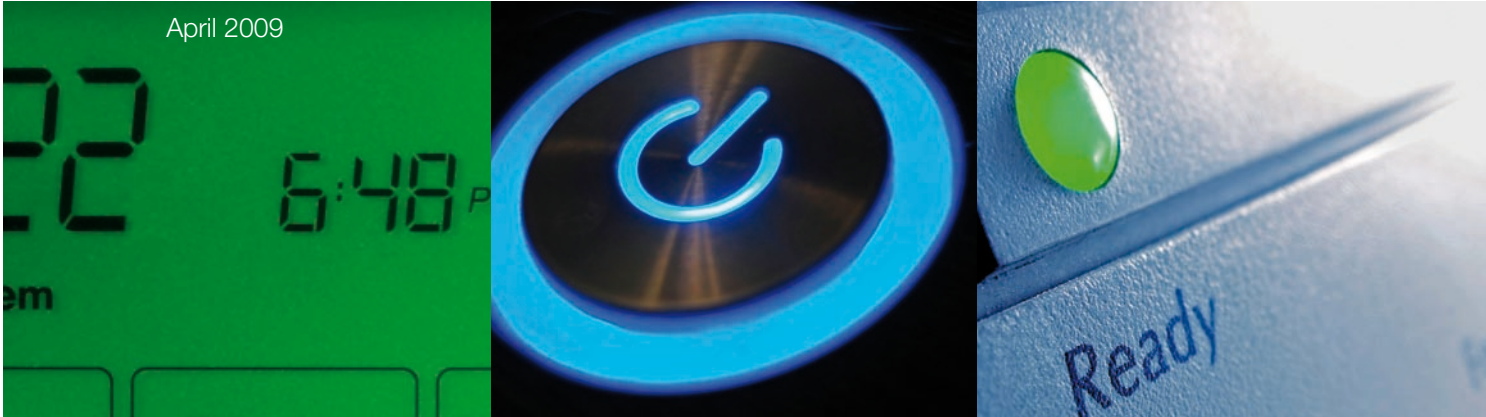


McKinsey Germany

April 2009



Energy: A key to competitive advantage

New sources of growth and productivity



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Preface

For much of the global economy, energy has become one of the strategic factors driving business decision-making. Businesses and consumers are increasingly considering the energy efficiency of the products and services they buy and use. In industrial production, companies are searching for the most energy-efficient process design solutions. In the energy industry itself, the demand for innovative, climate-friendly technologies to produce heat and power is also growing. These developments are the result of economic and political facts: the long-term depletion of fossil fuels and public policy decisions to curb greenhouse gas emissions (GHG). Thus, energy has become a key factor in gaining a competitive edge, and the relevant global markets are growing rapidly.

As energy is becoming a strategic factor in competition globally, it offers a special growth opportunity for Germany, the focus of this report. While the issues of energy and sustainability matter around the globe, many German companies are in a particularly good starting position to take the lead in the new arena of energy-related competition. Their knowledge and experience in the relevant technologies are advanced, and energy conservation and climate protection have enjoyed high public interest and acceptance in Germany for many years.

In focusing on economic growth as well as energy savings in Germany, this report takes up a prominent thread from our 2008 publication *Germany 2020 – Future perspectives for the German economy*. In that study, we argued that Germany needs faster economic growth not only to regain a leading position in Europe but also to master its social and demographic challenges. Across many of the opportunities we analyzed for Germany, one major source of growth was apparent across many sectors: energy efficiency and environmental technology. Because of the importance of this field, the German office of McKinsey & Company investigated the opportunities in more detail and synthesized the findings into an integrated perspective.

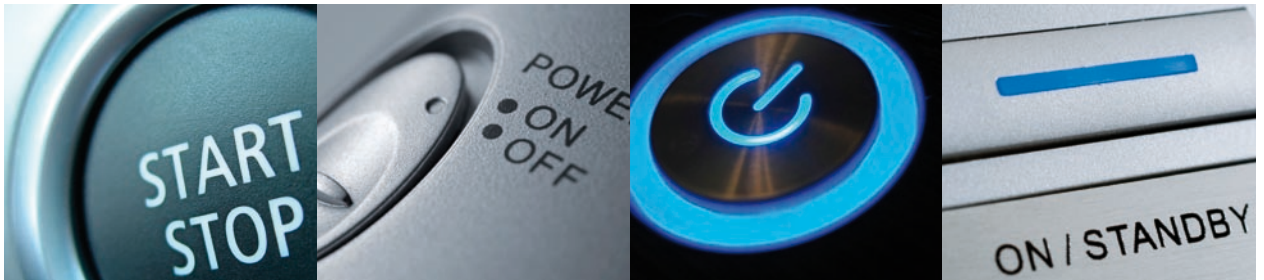
This report presents the results of those analyses. It describes how important sectors of the German economy can use energy as a factor to create competitive advantages, and what should be done to sustain and strengthen these efforts. In this, Germany is obviously not alone. All countries need to prepare for a world with scarcer and more expensive fossil fuels. They have to master the challenge of combining economic growth with GHG reduction targets. To include this climate perspective, our work is also based on McKinsey's 2007 study in cooperation with the Federation of German Industries (BDI), in which we examined the cost and potential of abating GHG emissions in Germany.

Throughout our analysis we look at our topic from two angles: on the one hand, we identify key success factors and develop approaches to realize the market potential of energy-related products and services. On the other hand, we show the energy savings potential that Germany can capture with economically viable measures, i.e., investments that are paid off within a few years by the related energy saving. Over the next few months, we intend to contribute actively to ensuring that the German economy succeeds in seizing these growth opportunities through joint initiatives with partners in business, academia, and politics. While the focus of this study is on Germany, most of the concepts and approaches discussed can be applied to other economies as well. Also, the growth potential is global and therefore relevant for any company operating internationally. The energy savings potential presented in this study refers to German companies and households, but a similar methodology can be applied to other countries.

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Energy is gaining importance as a strategic factor in global competition – especially for Germany. The world's export champion has what it takes to become the world's energy champion as well – if it takes action now



1. Introduction

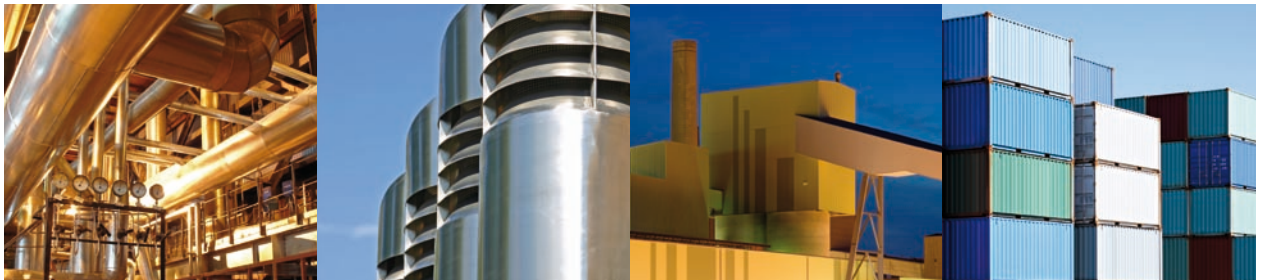
The German economy is at the dawn of a new economic era – and can actively shape it. Across the globe, more and more companies are trying to maximize the efficiency of their energy usage. The improvement potential is huge, because unlike labor or capital, the use of energy as a production factor is far from being optimized. Besides this development, the demand for energy from renewable sources is also increasing. These longer-term developments are now coinciding with the current global economic crisis. As a result, many industries are going through a phase of intensified reorientation that holds large opportunities for companies that successfully adapt to the new conditions. High-performance companies not only face risks, but also have new room for action (Chapter 2).

Right now, the German economy can focus on energy as a key factor in achieving competitive advantages and growth. Energy efficiency already plays a pivotal role in global markets that generate annual revenue of EUR 36,500 billion – EUR 2,380 billion of which is in Germany alone. The global export champion has what it takes to become the world's energy champion as well. German companies are in an excellent starting position thanks to their established technology base and well-developed awareness of energy and environmental issues. More than 12.4 million people in the German economy are employed in sectors where energy plays a decisive role. Germany thus has a huge opportunity to benefit from developments in energy and energy efficiency, and should pursue them (Chapters 3 and 4).

Companies and consumers will all gain a lasting cost advantage from optimizing the energy efficiency of their products and processes. Energy costs will rise in the long term; today's low oil prices will increase again. If German companies and households pull all economic levers known today to increase energy productivity, they can reduce their energy costs by EUR 53 billion a year as of 2020. By doing so, Germany could safeguard its international competitiveness, and – as a direct result – secure many domestic jobs (Chapter 5).

New markets and lower costs: this is the twofold potential that energy-efficient products and processes offer the German economy. Capturing this potential can help to lead Germany out of the crisis – if the right steps are taken immediately (Chapters 6 and 7).

Energy is becoming scarcer and more expensive, making it an ever more critical factor of production for companies as well as entire countries. Prosperity and growth are increasingly dependent on the efficient use of energy



2. Energy as a strategic factor in global competition

The prosperity and growth of modern societies depend to a large extent on having sufficient energy available wherever needed – as electric power, fuel, or feedstock. It was long taken for granted that fossil fuels – oil, gas, hard coal, and lignite – make up the majority of the global energy supply. The oil crises in 1973 and 1979 shook the foundations of this assumption for the first time. This period was followed by a surge of innovation in power generation (including renewable energy), as well as a marked rise in energy efficiency in many industrialized countries. However, the share of fossil fuels in the energy supply of western industrialized countries is still over 80 percent.

Since the first oil crisis, economic growth and energy consumption have stopped moving in tandem in many industrialized nations, but the world's energy needs have still grown steadily, and will continue to grow, especially in the large emerging economies such as China and India. The price of fossil fuels will also continue to rise over the long term as their scarcity increases – a scarcity linked not only to rising global energy demand, but also to the concentration of the world's major oil and gas reserves in just a few regions, not all of which are considered politically stable. The targets and policy measures agreed upon by governments to reduce GHG emissions are exerting further pressure to move away from fossil fuels – currently mainly in western industrialized countries.

As a result of these changes, many companies are now striving to outperform competitors in terms of energy usage in order to secure a cost advantage and increase their market share. For 40 percent of all global revenue, energy is now a strategic factor. For the companies that generate this revenue, “strategic” means that it is now crucial for managers to know the type, quantity, and cost of the energy used in their production processes and consumed in the use of their products. More and more companies have to include energy as a key variable in their decision making.

2.1 Sustainable use of energy: Key to success for companies and countries

World demand for energy continues to rise despite the high level of energy productivity that many countries have already achieved. At the global level, industry, transportation, and households currently consume a total of around 12 billion toe¹ p.a. Consumption is likely to rise to over 15 billion toe p.a. by 2020, corresponding to annual growth rates of 2 percent (Figure 1). Most of this growth is due to the world's increasing population and advancing industrialization in the large emerging economies. China, India, and Russia alone will be responsible for 55 percent of the increase by 2020. However, the per capita consumption of energy in those countries will still be far lower than that of the industrialized nations. In 2020, per capita consumption in the US will be 7.2 toe p.a., while the figure in Europe will be 3.5 toe, in China 2.3 toe, and in India 0.6 toe.

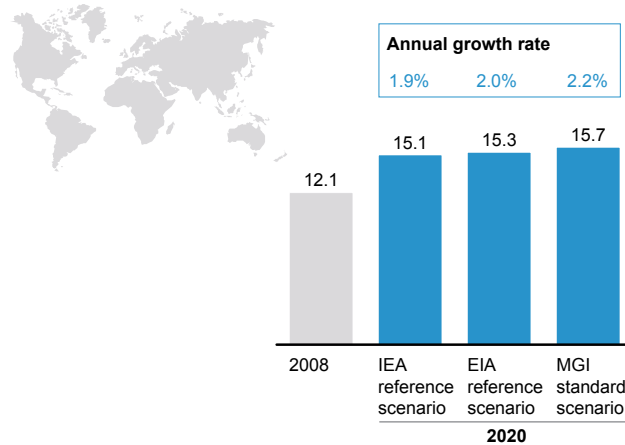
Fossil fuels will continue to be crucially important for meeting global energy demand over the coming decades. In 2020, oil, coal, and gas will soon cover approximately 80 percent of world energy demand. This share is unlikely to fall below 70 percent even by 2030.² However, pressure is mounting on business, government, and society – primarily in the industrialized economies – to develop alternatives.

1 Metric tons of oil equivalent

2 International Energy Agency, World Energy Outlook, 2008.

Global energy consumption

Primary energy, billions of toe¹ p.a.



¹ Metric tons of oil equivalent

SOURCE: IEA World Energy Outlook 2008; EIA International Energy Outlook 2008; McKinsey Global Institute

Figure 1

Making sustainable use of energy resources is becoming more critical for industrialized economies for three reasons.

- Rising prices of fossil fuels:* Since the early 1990s, the price of oil has increased much faster than general price levels. While prices in Germany generally rose by only 1.1 percent p.a. between 1991 and 2009, the oil price increased at an annual rate of 6.3 percent.³ The picture is similar in other countries, with the annual oil price increase far outstripping the general price increase of 1.9 percent in the US, 1.6 percent in the UK, and 1.1 percent in France. Despite the current decrease, the price of oil is unlikely to remain below USD 60/barrel. For 2020, the International Energy Agency (IEA) forecasts an oil price of around USD 110/barrel. It expects this increase because of underinvestment in oil field development during the current crisis. Supply will thus fail to keep pace with growing demand in the medium term.⁴ Rising oil prices will also mean that price fluctuations result in higher absolute price changes, making fossil fuel costs a larger and less predictable burden on companies and economies.

³ Assuming an oil price of USD 60/barrel in 2009.

⁴ International Energy Agency, World Energy Outlook, 2008.

- *Targets and policies to reduce GHG emissions:* In the 1990s, most industrialized nations began developing targets and policies to reduce greenhouse gas emissions. In 2007, a binding self-commitment was made at the European level to lower GHG emissions by 20 percent by 2020 (compared to 1990 levels). The EU countries committed to moving to a target of 30 percent as soon as other industrialized countries agree on similar targets. In the United States, the new administration is also preparing a Climate Protection Act. In the run-up to the COP15 negotiations in Copenhagen in December 2009, many countries are currently seeking an international commitment to reduce emissions by 25 to 30 percent by 2020. If worldwide emissions are cut by 35 percent (versus the 1990 baseline), this reduction will correspond to additional global investments in climate protection of EUR 810 billion p.a. in 2030.⁵
- *Geographic concentration of fossil fuels:* Today, Europe and the United States account for barely one-fifth of the global oil supply and around one-third of the world supply of natural gas. By 2020, two-thirds of global petroleum extraction will take place in the Gulf States, Africa, and the CIS (states of the former USSR) versus only a little more than half today. They will also be responsible for around half of the world's natural gas supplies in 2020 – the figure is only about 40 percent today. This growing dependence is viewed with some concern, and strengthens the desire of industrialized countries to become less reliant on imported energy.

Scenarios for the year 2020 were calculated using oil prices of USD 60 and USD 110 per barrel

Energy prices have fallen to a low level during the current crisis, but all forecasts suggest they will rise again. Recent crisis-adjusted analyses by the International Energy Agency (IEA), the Energy Information Administration (EIA), and Global Insight anticipate an oil price of between USD 60 and USD 180 per barrel in 2020 – with the most likely level being around USD 110 per barrel.

The key reasons for the renewed price increase are global economic growth after the crisis (particularly in India and China), and a backlog of investments in oil infrastructure as a result of the financial crisis. Price volatility and (to some extent speculation-driven) price fly-ups are likely. Technical reasons and the growing scarcity of oil alone make it very improbable that prices will remain below USD 60 per barrel long term. In the following, we therefore take USD 60 per barrel as our base scenario to highlight the potential available to German companies and households even under conservative assumptions about the price of oil.

5 McKinsey & Company, Pathways to a Low-Carbon Economy – Version 2 of The Global Greenhouse Gas Abatement Cost Curve, 2009.

2.2 Energy is of strategic importance for 40 percent of the world economy

In 2008, economic activity generated a total estimated revenue of EUR 90,750 billion worldwide. About 40 percent of the total – some EUR 36,500 billion – is attributable to companies for which it is of strategic importance to know the type, quantity, and cost of the energy used in their products and production processes (Figure 2). This share is likely to remain constant through to 2020.

Energy: A key to competitive advantage – relevant sectors

Global revenues 2008, EUR billions

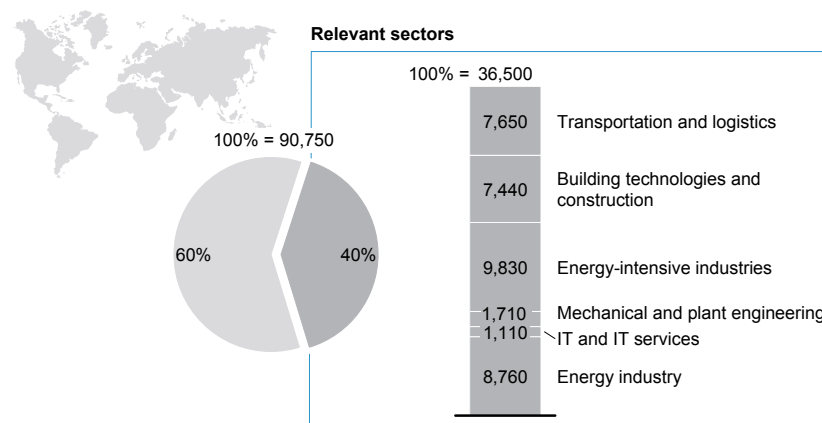


Figure 2

SOURCE: Global Insight, World Industry Monitor, February 2009; McKinsey

Energy plays a strategic role in many economic sectors (Figure 3).

- *Transportation and logistics (EUR 7,650 billion)*: Manufacturers of automobiles, trains, aircraft, and ships, and their suppliers, as well as transportation service providers (rail companies, airlines, logistics providers)
- *Building technologies and construction (EUR 7,440 billion)*: Companies that provide materials and services for the construction and renovation of buildings (including household electronics)
- *Energy-intensive industries (EUR 9,830 billion)*: Companies in sectors where energy costs account for more than 5 percent of the production value⁶ (particularly steel, non-ferrous metals, chemicals, pulp and paper)
- *Mechanical and plant engineering (EUR 1,710 billion)*: Manufacturers that supply companies in other industrial sectors with plant and machinery (such as motor systems or automation and control technology)

⁶ The production value corresponds to revenues plus the value of semi-finished and finished products and equipment manufactured in-house by these companies.

- *Information technology and IT services (EUR 1,110 billion):* Companies that develop and supply IT solutions, especially software programming and associated services such as installation, maintenance, and consulting
- *Energy industry (EUR 8,760 billion):* Companies that extract fuels (e.g., coal mining, oil and gas drilling) and/or process and transport fuels, as well as those that generate and transmit electricity, and industry segments that supply relevant plant and machinery (such as turbines, pipelines, and compressors).

Energy: A key to competitive advantage – relevant sectors

Global revenues 2008, EUR billions

Transportation and logistics	7,650	4,040	Transportation services and logistics
		2,070	Automotive engineering
		820	Rail, ship, and aircraft construction
		520	Mail and courier services
		200	Electronic vehicle components
Building technologies and construction	7,440	5,600	Construction and building services
		560	Office electronics
		500	TV, radio, and telephones
		250	Heating technology and domestic appliances
		530	Other building technologies
Energy-intensive industries	9,830	3,880	Metals industry
		2,870	Chemicals
		1,570	Paper and pulp, plastics
		1,510	Other
Mechanical and plant engineering	1,710	1,380	Mechanical engineering
		330	Measurement and control systems, electronic components
IT and IT services	1,110	1,110	Software programming and associated services
Energy industry	8,760	5,390	Oil, coal and gas extraction, refineries
		2,340	Energy supplies
		1,030	Power station technologies

SOURCE: Global Insight, World Industry Monitor, February 2009; McKinsey

Figure 3

Energy plays a less important role for the remaining 60 percent of the global economy. For example, it does not represent a significant share of the cost base for the retail trade (worldwide revenue in 2008: EUR 6,700 billion), the healthcare sector (EUR 3,300 billion), the education sector (EUR 2,200 billion), or the insurance industry (EUR 1,100 billion). Looking at their end products, energy efficiency is also not a relevant factor in a customer's purchasing decision. "Green" products in these sectors appeal to specific customer segments and can strengthen a firm's reputation and brand, but generally do not determine a company's overall competitiveness.

In the industries where energy is strategically important, it can be relevant to the products and services and/or to the production processes.

For some industries – automotive and construction, for example – energy efficiency is increasingly important in gaining customer acceptance of the product. The fuel consumption (and thus GHG emissions) of a car or the heating costs of a building have a direct effect on the customer's purchasing decision. Therefore, energy-efficient products help to maintain a company's competitiveness. The same applies to manufacturers of plant and machinery for customers in the energy industry or energy-intensive industries. The efficiency of a turbine is a key buying factor for companies that design, build, or operate power stations; similarly, the energy efficiency of a blast furnace is a very important part of the investment decision made by a steel mill.

In energy-intensive sectors such as steel, chemicals, and paper as well as in electric power generation, energy is important as a cost driver within the production process. Companies in these industries therefore focus on systematically optimizing energy efficiency in their production processes. In addition, as of 2013, the planned auction of CO₂ emission certificates in Europe will shift the cost curves in many of these industries considerably. As a result, alongside boosting energy efficiency, the reduction of GHG emissions from production processes is also gaining greater competitive importance.

The economic benefits of energy efficiency are twofold: it can help companies to capture new product markets and save costs for industry and households – without sacrificing performance or convenience

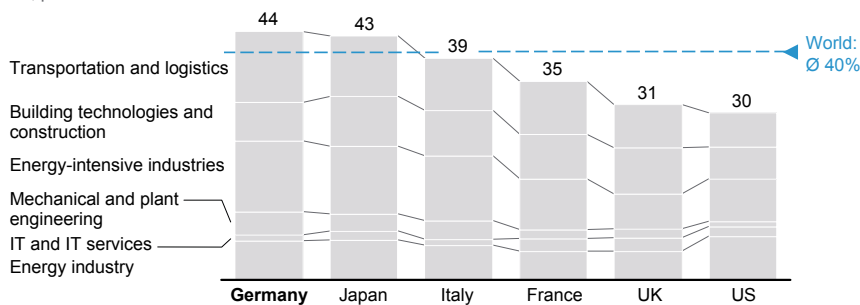


3. Using the energy factor to accelerate economic growth: The opportunity for Germany

In Germany, the share of industries in which energy is a key factor for gaining a competitive advantage is larger than in any other western industrialized nation. In 2008, these industries generated over 44 percent of German revenue – EUR 2,380 billion (Figure 4). In the industrialized nations, this share is matched only by Japan, with around 43 percent. The European average is much lower, and trailed by the US at 30 percent. The relevant industry sectors contribute nearly 32 percent to Germany’s gross domestic product (GDP)⁷ – close to 12.4 million people work for companies that have to include energy as an important factor in their strategic planning. Additionally, Germany like many other industrial countries is heavily dependent on imported energy. In 2006, Germany covered more than 60 percent of its primary energy requirements with imports, mainly of oil and gas.

Energy: A key to competitive advantage – share of revenues of relevant sector on total economy

2008; percent



Revenue from relevant sectors		Germany	Japan	Italy	France	UK	US
EUR billions p.a.		2,380	3,210	1,420	1,460	1,360	6,320
Total market							
EUR billions p.a.		5,380	7,460	3,640	4,170	4,370	21,070

SOURCE: Global Insight, World Industry Monitor, February 2009

Figure 4

3.1 Why the German economy is well positioned in the race for market share

In many of the relevant sectors, German companies are in a strong starting position to become long-term international leaders.

In some of these sectors, German companies are already market leaders. For example, in mechanical engineering Germany has the third-highest revenue worldwide after the US and China. In automotive engineering, Germany is number two, taking in 15 percent of total global revenue, after Japan. In metals processing, where Germany accounts for 12 percent of industry revenue worldwide, it is outranked only by the US.⁸

⁷ Global Insight, World Industry Monitor, February 2009.

⁸ Ibid.

Compared with other countries, Germany's energy productivity is already high. Its value creation in proportion to the energy it uses is matched worldwide only by Japan, Italy, and the UK⁹ – and those three countries partially owe their energy productivity to the high share of the service sector in their national economies. From 1 toe Germany generates EUR 5,500 in GDP. In Japan (where the share of heavy industry is much lower), this figure is nearly EUR 9,000. In the United States, on the other hand, it is less than EUR 4,500 – despite the much larger role of its service sector. If we consider only the energy consumption and value creation of industrial companies, Germany actually ranks as the world leader: on this basis, its energy productivity is around EUR 9,000/toe. This is a result of increased energy efficiency in companies and households since the first oil crisis.

Energy efficiency and energy productivity: Minimizing energy needs and maximizing economic value

Energy efficiency as a technical term refers to the share of input energy that a process converts to output energy, i.e., the ratio of usable energy output to energy used. One example is lighting a room with an electric lamp. The energy efficiency of the lighting increases if you manage to light the room just as brightly and for just as long, but using less energy.

Energy productivity considers energy as a production factor from an economic perspective. Just as with labor or capital productivity, the aim is to maximize the economic value created per unit used. The ratio of economic value (e.g., in EUR) to the quantity of energy used (e.g., in kWh) is referred to as energy productivity.

Selective government support for specific technologies has helped German companies to achieve a clear international lead in some sectors. This used to apply to nuclear technology, for example, or (in the more recent past) to solar technology, with the German "1,000 Roofs Program" and the *Renewable Energy Sources Act* (Erneuerbare Energien Gesetz, EEG). This law promotes the development of renewable energy sources with a feed-in tariff. As an incentive to encourage technological advancement and cost decreases for parts and installations the feed-in tariff drops annually by a fixed percentage.

In sum, German companies already have a head start over international rivals, and can leverage their competencies in energy and energy efficiency to expand their strong position on world markets.

3.2 How the German economy can win: New product markets, greater energy productivity, and innovative solutions

How can Germany actually achieve higher economic growth and become a world-champion provider of energy-efficient solutions? To turn the energy opportunity into economic reality, decision makers in business and government need to address three critical dimensions:

- *Take the lead in new product markets:* The industry sectors in which energy is a key to competitive advantage each contain segments that are small today, but growing at an above-average rate. Despite the uncertainty caused by the present crisis, these “growth centers” have the potential to grow at nearly 13 percent p.a. up to 2020, provided global economic growth in the same period averages out at just under 3 percent as currently forecast by economic research institutes.¹⁰ At this rate, the growth centers are projected to generate global revenues of EUR 2,140 billion in 2020. A long period of global economic decline would slow the absolute growth rates, but not diminish the relative lead of these highly dynamic segments. German companies need to position themselves early in these new product markets to participate in this growth as much as possible.
- *Improve energy productivity:* The energy productivity of Germany’s economy can be further enhanced if companies and households apply the available technologies to make better use of energy resources. By 2020, Germany’s current energy consumption can be reduced by 20 percent using financially viable initiatives, enabling the economy to save energy costs of around EUR 53 billion p.a. This would raise Germany’s energy productivity from its current level of EUR 5,500/toe to around EUR 7,000/toe.
- *Develop and test new solutions:* In order to convert Germany’s potential into value-creating business activities, some groundwork is needed. Companies have to adapt traditional business models so that they can actively manage energy as a competitive resource. They should also explicitly emphasize the economic value of analyzing the total cost of ownership to their customers. A prerequisite to accomplish this will be to orchestrate innovative modes of cooperation between business and government stakeholders. The large-scale introduction of electric cars, for example, can only succeed if companies from the automotive and energy industries jointly develop integrated solutions with the relevant political institutions, geared to the specific needs of each region. In some cases, policy frameworks can be put in place to support the changes required, such as promoting business start-ups and infrastructure investments. To create practical success stories in Germany, everyone involved will have to develop and test non-traditional solutions and try out new ways of organizing and managing cooperative projects.

10 Global Insight, World Industry Monitor, February 2009.

Energy efficiency can become a growth engine for the German economy: growth centers – still small today, but highly dynamic – provide large opportunities on global markets



4. New product markets: Fast-growing segments offer revenue potential of EUR 2 trillion p.a. by 2020

As a whole, the sectors in which energy plays a strategic role are expected to grow only slightly faster than global GDP up to 2020, i.e., at rates of 3.1 percent p.a. (versus 2.9 percent p.a. for GDP).¹¹ However, more granular analysis shows that these sectors each contain smaller segments that are growing much faster. These “growth centers” comprise innovative solutions to cut energy consumption or improve conversion efficiency. They are projected to generate annual revenue of EUR 2,140 billion by 2020.

Germany already has a certain edge in these growth centers, creating 10 percent of their total value added globally (versus 6 percent across all industries). If Germany can maintain its market share in these more dynamic market segments, it can increase employment from 260,000 people today to more than 1.1 million jobs by 2020, i.e., adding 850,000 new jobs. Even greater employment growth is possible if German companies succeed in taking the global lead in these growth centers early on and continually enlarge their market shares. This should be their strategic aspiration. The rest of this chapter discusses the new product markets in more detail.

Defining feature of the growth centers analyzed:

Achieving a 50%-improvement in energy efficiency over historical averages

At the heart of this chapter are new technologies and products that enable a much greater increase in energy efficiency (or decrease in CO₂ emissions) than previously possible in the given industry segment. Our selection criterion was that the relevant product delivers an energy efficiency gain (or decrease in CO₂ emissions) that is at least 50 percent higher than the historical average improvement rate for the relevant period. For automobiles, for example, simply projecting the past rate of improvement into the future results in an 11 percent energy efficiency gain in 2020 over today. In our study, we therefore only analyzed vehicles that deliver results at least 50 percent above this value, i.e., that are expected to be at least 17 percent more efficient than the current standard (Figure 5).

11 Global Insight, World Industry Monitor, February 2009.

Growth center analysis – example: Passenger car motor systems

Car with ...	Improvement in energy efficiency above historical average	Passenger cars sold Millions p.a.		Annual growth rate	
		2008	2020		
... standard combustion engine	< 50%	55	22	-7%	
... optimized combustion engine	> 50%	2	42	29%	Growth centers analyzed
... hybrid or electric motor		1	13	24%	

SOURCE: McKinsey

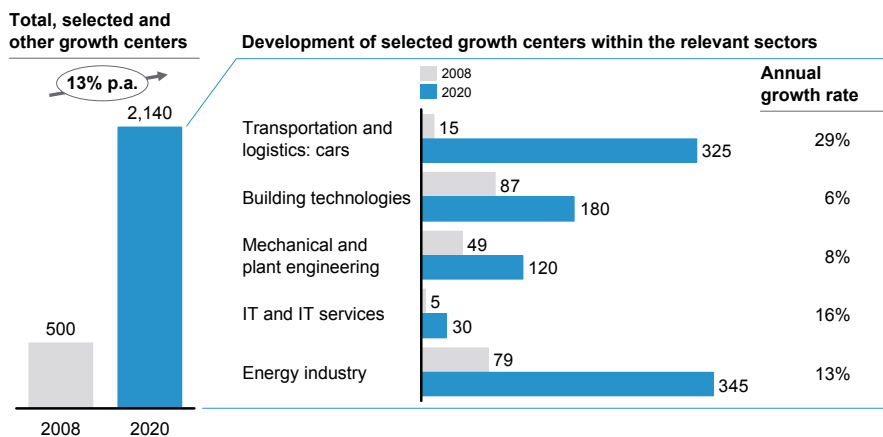
Figure 5

The threshold of 50 percent was selected because it makes it easier to distinguish incremental technology improvements from genuinely new developments. It is a particularly good metric for automobiles, building technologies, and industrial plant and machinery. However, this criterion is not suitable in some sectors (such as IT solutions in energy management). In these sectors, products were chosen as growth centers when they had a substantial potential to save energy and reduce emissions, and constituted a market with high expected growth rates.

The following five sections examine some of the particularly interesting growth centers from the sectors described in Chapter 2.2: efficient and low-emission passenger car technologies (in the transportation and logistics sector); efficient technologies for buildings (in the building technologies and the construction industry sector); efficient technologies for discrete and process production (in energy-intensive industries/mechanical and plant engineering); nuclear power, renewable energy, and CO₂ capture and storage (in the energy industry sector), and innovative IT systems in energy management (in the IT and IT services sector). The overall revenue potential in these growth centers as of 2020 amounts to around EUR 1,000 billion p.a. – assuming annual growth rates of just under 13 percent. Similar potential can also be expected in areas such as other transportation technologies (e.g., aircraft, truck, and ship construction), electrical equipment and devices, and in segments of the chemical industry. The extrapolation of the cumulative potential of the growth centers analyzed in detail onto these other areas adds up to a market potential of EUR 2,140 billion for all growth centers analyzed (Figure 6).

Global market potential in growth centers

Revenue, EUR billions p.a.



SOURCE: McKinsey

Figure 6

4.1 Transportation and logistics: Revenue potential of EUR 325 billion from more efficient low-emission automotive technologies

The preferences of automobile buyers are changing rapidly. Greater environmental awareness combined with the (long-term) rise in gasoline prices leads to higher demand for vehicles with low consumption. Stricter environmental legislation, such as the tighter CO₂ emission limits for new cars that the EU is gradually introducing by 2020, is also increasing the trend towards more energy-efficient vehicles.

The entire automotive industry is taking active steps to capture the resulting market potential for energy-efficient vehicles. Three trends can already be distinguished that will reduce fuel consumption significantly; these trends will provide opportunities in fast-growing and sometimes completely new submarkets.

- *Larger market share for smaller cars:* As fuel costs rise, climate- and cost-conscious customers are switching to smaller vehicles with less engine power.¹² At the end of 2008, high fuel prices had made the compact Honda Civic the best-selling car in America, displacing the big popular pickups Ford F150 and Chevrolet Silverado.
- *Improved energy efficiency of combustion engines:* The further refinement of Otto-cycle and diesel engines could enhance fuel efficiency by 20 to 40 percent in the future. By 2020, most vehicles with pure combustion engines will probably have technologies improving their efficiency. Even the higher manufacturing costs – which will rise by up to 17 percent – will not halt this trend.

¹² This trend does not include shifts in the model mix due to varying growth rates in the different regions (particularly traditional industrialized nations vs. BRIC countries).

- *Introduction of alternative motor systems:* Electric motors have repeatedly been examined since the beginnings of the automotive industry. Numerous manufacturers are now announcing tests and launches of hybrids or battery-electric vehicles in high volumes. Prototypes and models for certain niches are already available on the market. Despite a higher purchase price, electric cars could offer a better total cost of ownership than non-electric cars in the event of high oil prices. However, current battery technology still limits their range between recharging to 50 to 150 km. Therefore, electric motor systems are expected to initially expand in niche markets, such as city cars, delivery service vehicles, or as second cars.

These trends offer not only new market opportunities but also challenges for industry incumbents. Energy efficiency will create large new markets; however, it will also replace existing established technologies. Their impact will largely depend on oil price developments, the evolution of battery technology, and the availability of the infrastructure necessary for electric vehicles. At an oil price of USD 60/barrel, the market relating to passenger cars would amount to EUR 325 billion in the growth centers in 2020. At an oil price of USD 110/barrel, it would amount to even EUR 500 billion.¹³ This corresponds to around 23 percent of total OEM and supplier revenues in 2020 (Figure 7).

The projected market potential for efficient motor system technologies of EUR 325 to 500 billion p.a. includes three growth centers:

Hybrid vehicles, which still use a combustion engine as the main propulsion system supported by an electric motor, are likely to achieve a global market share (depending on the oil price) of 16 to 24 percent in 2020, with a revenue volume of EUR 270 to 360 billion p.a.¹⁴

Components of optimized combustion engines will create a market of EUR 30 to 35 billion for components that enhance energy efficiency and reduce fuel consumption.¹⁵

Electric cars and plug-in hybrid vehicles could account for 1 to 9 percent of all new vehicles sold globally in 2020. The corresponding revenue anticipated from new vehicles will be between EUR 20 and 110 billion. These figures show that electric and hybrid motor systems will by no means squeeze combustion engines out of the market, despite their growing role in the automotive industry.

13 In addition to the values of the scenario used throughout the report – a crude oil price of USD 60/barrel and moderate CO₂ regulation – this chapter also describes the results of a scenario with an oil price of USD 110/barrel and tight CO₂ regulation. As developments on the automotive market react very sensitively to higher oil prices, especially over USD 100/barrel, there is sometimes a wide spread between the different scenarios. Electric cars will become particularly appealing if oil prices rise above USD 100/barrel.

14 In the case of electric vehicles and automobiles with a hybrid drive, the entire vehicle was included when determining the market potential because extensive technological developments are taking place in this sector.

15 We only counted these components as growth centers in the sense of our definition because the vehicles otherwise have only limited technical refinements. The total market for new vehicles with an optimized combustion engine will be between around EUR 280 and 330 billion in 2020, depending on the scenario.

Energy-efficient cars – global market potential in growth centers

EUR billions p.a.

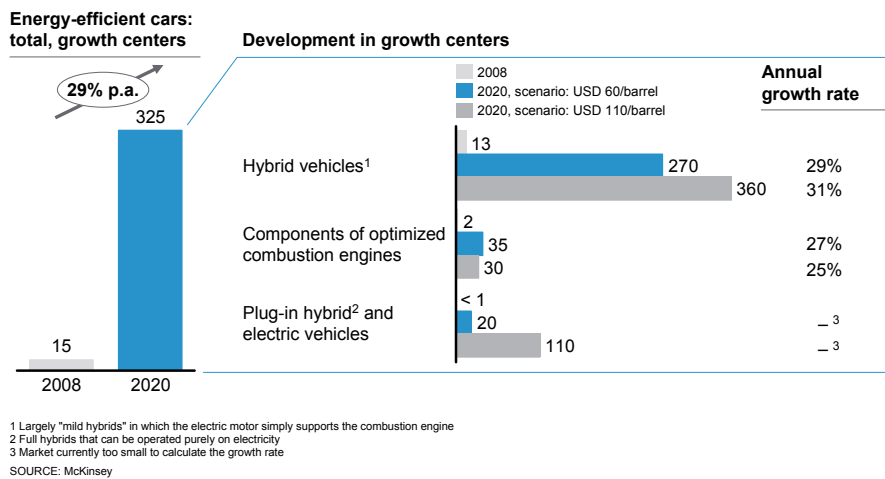


Figure 7

How will these developments affect Germany's automotive sector? German car makers (OEMs) and their suppliers are among the industry's worldwide leaders, with a global market share of roughly 17 percent. In Germany alone, OEMs employ approximately 390,000 people, and suppliers another 360,000. To maintain its strong position, Germany's automotive sector has to adapt to two main developments (Figure 8):

- *The trend towards smaller vehicles ("downgrading")* means that revenues and profits are not growing to the same extent as volumes. This trend threatens to reduce the revenue of German OEMs because they traditionally offer larger vehicles.¹⁶
- In contrast to this, the *trend towards optimizing the combustion engine* offers opportunities for German OEMs – as they have a particularly strong market and technology position for these engines – to partially compensate for losses from downgrading. To pursue this opportunity, the OEMs need to gradually expand and actively market their current technology leadership, especially for diesel technology and Otto-cycle engines. Even then, however, they would still face the challenge of increasing the customers' willingness to pay for more energy-efficient but also more expensive vehicles.

German OEMs that adapt successfully can capture around EUR 75 billion of the global market potential – EUR 325 billion in total – for more energy-efficient motor systems in 2020. With EUR 65 billion, hybrid and electric models will account for the largest share of this. In total, the EUR 75 billion represent around 28 percent of the overall revenue volume of German OEMs expected in 2020.¹⁷

¹⁶ No lost revenues are expected in the USD 60/barrel oil price scenario because this would not involve any large-scale downgrading.

¹⁷ If German OEMs manage to keep their market share by covering the demand for hybrid and electric cars, the additional revenue opportunities of EUR 10 billion will more than make up for revenues lost due to the trend to smaller cars.

As the electrification of the motor system requires high investments, innovative business models need to be established to sell electric cars profitably on the market. Electric vehicles could offer additional profit potential for German OEMs, but only if they succeed in converting the total-cost-of-ownership advantages of electric vehicles into a greater willingness of customers to pay.

Automotive industry – shift in revenue and profit volumes

SCENARIO: USD 60/BARREL

EUR billions p.a.

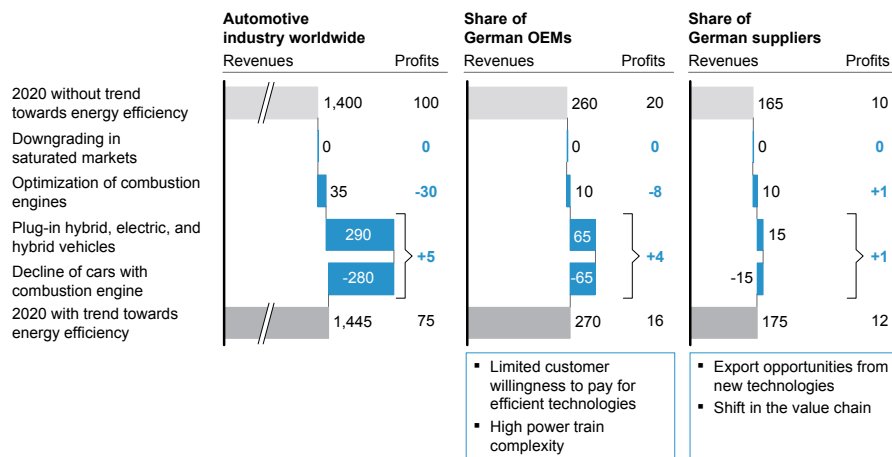


Figure 8

SOURCE: McKinsey

The developments described all imply clear strategic challenges for the German automotive industry:

- German premium OEMs need to “reinvent” the profitable compact car segment. If buyers switch to conventional compact cars, the profitability of OEMs will be threatened: the average return on sales in the compact segment is only 2 to 3 percent, instead of the 8 to 10 percent targeted by premium OEMs. Premium OEMs often have a lower profit margin in the compact cars segment because they tend to build these vehicles to higher quality standards and with more functions than customers are willing to pay for, and their unit sales are also often lower. They should therefore adapt compact cars more precisely to customer requirements and focus their innovation efforts on cost reduction. In addition, alliances could enable German companies to benefit from economies of scale by using joint platforms and industry-specific component modules.
- OEMs should leverage energy efficiency as a source of product differentiation to increase customers' willingness to pay. So far, OEMs have only been able to pass on part of the additional cost of more efficient technologies to customers. Options to increase customers' willingness to pay are greater brand differentiation via energy efficiency, new pricing models, and energy-efficient optional equipment.

- An attractive business model for electromobility that cuts across industries is essential. Electric cars can capture a mass market – but only if OEMs, infrastructure providers, and policymakers coordinate their work to establish the market. It is vital that they satisfy customers' electromobility requirements – mostly for driving in city traffic, initially – and leverage economies of scale, which will allow lower unit costs and a profitable infrastructure. Standards for components and infrastructure as well as cross-industry coordination of market entry are both essential to trigger the necessary infrastructure investments. This will have a huge impact on the value chain; challenges need to be acknowledged, and various stakeholders must cooperate to develop joint solutions. The goal is to develop a profitable, integrated business model for electric cars that offers customers a truly new and different “driving experience.”

The outlook for German suppliers is more promising than that for German OEMs. Overall, the suppliers can expect unchanged revenues and profit margins. If battery-operated vehicles take off, suppliers will even have opportunities to grow. Unlike OEMs, suppliers can also expect to earn the usual ROS from alternative motor system technologies, so additional market volume will translate into additional profit. Some suppliers will have disproportionately large opportunities provided they adopt the new technologies, as the change in technology will cause a significant shift in revenues and profits within the supplier industry:

- Suppliers of conventional components for combustion engines will suffer from declining sales. The more specialized they are in conventional components (such as transmission systems), the greater the challenge this decline and increasing cost pressure will pose.
- In contrast, innovative German suppliers with competencies in the field of electric motor systems will have a good chance of compensating for the possible loss of other business segments by gaining a share in the new markets – for example, by focusing on components, such as batteries, or services that help OEMs to develop electric motor systems. Large German systems suppliers are probably best equipped to shift their strategies in these directions.

The transformation in automotive value creation from mechanical to mechatronic and electrical components will also lead to a shift of 400,000 to 500,000 jobs worldwide. The German OEMs and suppliers need to focus on training and innovation as well as targeted investment to make sure they capture a large share of these new revenues.

These trends and their implications show the huge challenges that the new market for energy-efficient products represents for both OEMs and suppliers. The automotive industry needs to master the ever-growing complexity of the highly diversified motor system portfolio via cooperation between these two groups of players. One option is to expand existing alliances to cover the entire range of motor systems. The trend towards electromobility also requires the adoption of joint approaches by OEMs and energy companies as well as the development of a suitable regulatory framework. If these cornerstones are put in place, energy-efficient vehicles could well become a new German success story.

4.2 Buildings: Revenue potential of EUR 180 billion from more efficient building technologies

Buildings are the single-largest energy consumer in the world – private housing alone accounts for a quarter of the world’s energy demand.¹⁸ At the same time, this sector offers high savings potential. Securing this potential will involve a wide range of technologies and products: mature products such as materials for building insulation, products like domestic appliances that have become much more energy-efficient over the past few years, and very new solutions. The latter category contains products such as energy-efficient lighting and heating systems, innovative decentral combined heat and power (CHP) generation, or smart home solutions to control energy usage.

In 2020, the global market for energy-efficient building technologies is expected to amount to around EUR 180 billion. Starting from a revenue of EUR 87 billion in 2008, this submarket will grow by 6 percent p.a. – twice as fast as the construction industry as a whole (Figure 9). Of the many growth centers in this sector, the most important are the following.

Heat generation accounts for around 80 percent of the world’s energy consumption in the buildings sector.¹⁹ Therefore, key levers for improving efficiency – and thus also important technology markets – are heating system construction, insulation, and the technical optimization of heat consumption, particularly in regions with rough weather conditions.

Energy-efficient heating systems: The submarket for innovative heating technologies will grow at an average rate of 9 percent p.a. from its 2008 revenue of EUR 7 billion to around EUR 20 billion by 2020. This submarket includes solid fuel heating using renewable fuels (such as wood pellets) as well as other heating technologies that use renewable and decentrally produced energy (solar thermal heating and heat pumps, for instance).

Decentral combined heat and power generation: The submarket for decentral CHP is closely linked to efficient heating technologies. It enables households and the operators of public and commercial buildings to generate electric power from the unused thermal energy of their heating, thus enhancing the energy efficiency of the fuel they use. Although the development of CHP technologies is already advanced, costs still need to come down before a significant micro-CHP market can emerge. Assuming a cost reduction of 5 percent p.a., approximately 20 percent of the demand for conventional heating could be met with micro-CHP systems by 2020. This would yield global annual market potential of more than EUR 10 billion by 2020.

Building insulation: In technical terms, insulation materials for buildings such as foam, fiberglass, and mineral wools have not fundamentally changed over the last few years. However, more of these materials have been used in the refurbishment of buildings due

¹⁸ McKinsey Global Institute, *Curbing Global Energy Demand Growth: The Energy Productivity Opportunity*, May 2007.

¹⁹ Ibid.

Efficient building technologies – global market potential in growth centers

EUR billions p.a.

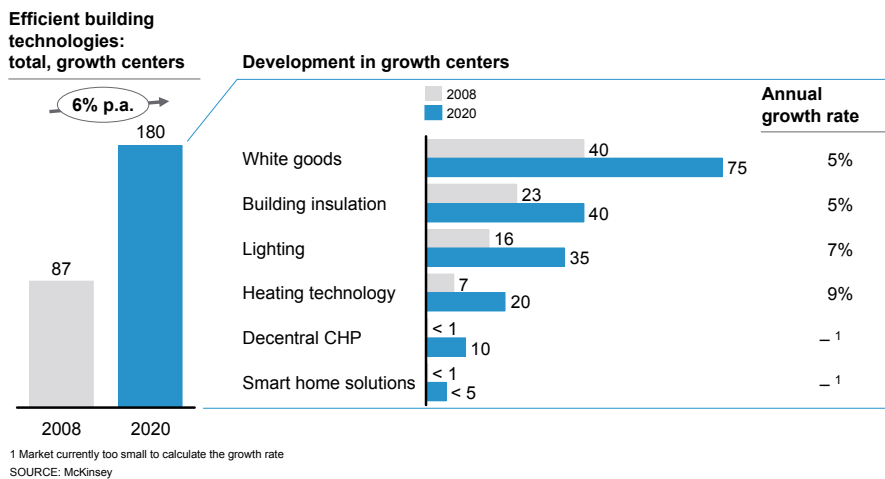


Figure 9

to regulatory standards and greater consumer awareness with regard to energy costs.²⁰ This trend will continue: from revenues of EUR 23 billion in 2008, the market is expected to grow at 5 percent annually, reaching EUR 40 billion by 2020. Another important growth area in energy-efficient refurbishment is heat insulation of doors and windows. But unlike some of the other subsegments, the market for door and window insulation refurbishment is structured more along regional than international lines. Looking at the German market, an expansion of energy-efficient refurbishments in private households would give this regional market a big boost. If Germany could increase the energy-efficient refurbishment of old, unrenovated private homes from the 1.3 percent p.a. to date to 3.0 percent, it would unleash an additional potential revenue in the window market of EUR 420 million p.a.,²¹ representing around 30 percent of the entire German market for building insulation.

Electric power, currently accounting for just under 20 percent of global energy consumption in the household sector, makes up only a small share compared to heat. Nevertheless, it is the main driver of increasing energy consumption in buildings due to the increasing number of electric domestic appliances, especially in emerging economies, leading to a rise in the share of electric power in household energy consumption to almost 30 percent by 2020. The importance of energy efficiency for electrically powered appliances in buildings will grow accordingly.

White goods (e.g., refrigerators, washing machines): Consumers are increasingly including energy efficiency as a criterion in their purchase decisions regarding electrical household appliances. This is especially true of appliances that have high energy consumption and are operated frequently or continuously, such as washing machines, dishwashers, and refrigerators. A survey conducted in the five largest EU countries in 2008 by GfK (a major German market research company) revealed that the energy consumption of

20 This could lead to a 50 percent increase in energy efficiency due to the greater spread of already existing technologies, but not via improvement of the energy efficiency of the technologies themselves.

21 McKinsey & Company, Capturing the European Energy Productivity Opportunity, July 2008.

washing machines, refrigerators, and freezers is a relevant purchasing criterion for 52 percent of the respondents.²² Over the past few years, classification systems have been developed throughout the world to provide consumers with clear ratings of the energy consumption of electric appliances. These systems include the “Energy Label” in the EU and China, the “Energy Star” in North America and Australia, and the “Selo Procel” in Brazil.

In 2008, the world market for white goods generated revenue of around EUR 130 billion. In Europe, 31 percent of this was for energy-efficient appliances in the categories A+ and A++, the share of which had risen by almost 50 percent p.a. in the two previous years.²³ Assuming the share of these efficiency categories will grow by another 20 percent worldwide by 2020, the global market for energy-efficient white goods will be around EUR 75 billion in 2020. Regulatory changes could accelerate this trend. In Italy, for example, the share of A+ and A++ refrigerators of all sales rose from around 10 percent previously to nearly 40 percent after the government granted 20 percent tax deductibility on these in 2007 as an incentive to purchase energy-efficient appliances.²⁴

Energy-efficient lighting technology: The market for energy-saving lighting will grow by 7 percent p.a. to around EUR 35 billion by 2020, influenced by three trends. First, energy-saving products – primarily compact fluorescent lamps (CFLs) – have become economically viable for consumers. Since the early 1990s, the average price of a compact fluorescent lamp has fallen from the equivalent of EUR 8 to EUR 3. CFLs use only one-fifth of the energy of conventional light bulbs, and their service life is 5 to 15 times longer. Second, CFLs are catching up with incandescent bulbs with respect to color rendering and start-up time, helping to overcome consumer reservations in these areas. Third, the climate protection concerns of consumers and governments are beginning to have an impact. At the end of 2008, the EU Commission decided that conventional light bulbs should be eliminated from households within the EU to reduce CO₂ emissions. The ban will be implemented gradually, and will help to prevent 23 million metric tons of GHG emissions annually once it is fully implemented in September 2012. Another future trend in the lighting market and a current R&D focus of the major manufacturers are light-emitting diodes (LEDs), which use two-thirds less energy than even CFLs.

Smart home solutions: This term describes technologies that intelligently regulate a household’s or company’s energy system and appliances (such as heating, ventilation, lighting, office equipment, and household appliances). These solutions can save energy by (for example) lowering the temperature or switching off lighting in rooms that are not in use. Smart home solutions are still in their early stages, however, and growth is currently inhibited by the lack of mature products and hesitation of potential customers. The global market for smart home products currently generates a total revenue of only around EUR 400 million. By 2020, however, the market may have picked up and offer revenue potential of around EUR 2 billion. This assumes that 10 percent of all households and 20 percent of all companies in industrialized countries would be equipped with smart home standard packages by then.

In many of these technologies, German companies already have a strong position on the world market. In the heating technology market, for example, Germany has a global

²² GfK (Gesellschaft für Konsumforschung) Group, International Consumer Electronics Conference, June 2008.

²³ The benchmark is that the new energy efficiency category A+ only consumes around three-quarters of the energy of a comparable appliance (same function, volume, etc.) in the A category; this figure falls to only one-half for an appliance with the energy efficiency category A++.

²⁴ GfK Group: Energy Labeling in White Goods, June 2008.

market share of 30 percent based on the sales of manufacturers such as Bosch Thermotechnik, Vaillant, Viessmann, and Stiebel Eltron. In the white goods segment, the largest German manufacturers BSH, Miele, and Liebherr currently account for over 7 percent of the world market. Germany has the opportunity to more than just defend its shares in these markets; it can achieve further gains provided that German companies remain or become still more competitive in the growth centers. Leading German suppliers are already developing innovative solutions; Bosch Thermotechnik is working on heating systems that combine renewable energies and the highly efficient condensing boiler technology. In the lighting market, Osram as the second largest supplier worldwide aims at generating around 80 percent of its revenue from energy-efficient lighting technology by 2020.

To maintain and expand their leading position, German companies need to continue investing in the development of efficient building technologies while also designing and testing more comprehensive business models.

- *Systematically develop/refine relevant technologies:* Product development cycles tend to be short in some segments (such as household electronics and lighting). In others, long refurbishment cycles slow down replacement rates (for insulation materials and heating systems). Growing customer awareness of the need to reduce energy consumption makes it vital that companies have the most efficient technologies in their portfolios for both types of development cycles. For short development cycles, having products on hand ensures that companies are not overtaken when the next technology wave hits. For products with longer development requirements, having the latest technology available gives companies a greater chance of winning contracts in connection with new building construction and renovation and thus maintaining or expanding their market shares. Some innovative technologies such as micro-CHP units still require further cost reductions before they can be marketed in higher volumes.
- *Design and test suitable business models:* In many countries, including Germany, the energy-efficient refurbishment of residential housing as well as commercial and public buildings offers great potential. Much of this is already being captured in commercial and public buildings: functioning business models exist. For example, energy contracting is a very common model, especially in the public sector. In this approach, providers carry out and finance all of the energy efficiency improvement measures themselves, and then cover their expenditure via a share of the energy cost savings. With residential property, however, only a limited share of homes are given an energy-efficient overhaul when they are renovated, despite the long-term economic profitability for property owners and occupants. The crucial challenge is therefore to also develop functioning business models for the energy-efficient refurbishment of private housing.

4.3 Mechanical and plant engineering: Revenue potential of EUR 120 billion from more efficient technologies

For decades, companies in energy-intensive industries have been working on optimizing the energy efficiency of their production processes – with success: coal-based steel production, for example, today consumes a lot less energy as better insulation techniques are used and heat loss from discharged air is prevented. In the chemical industry, refinements to systems control equipment have produced energy savings by delivering energy and chemicals in precise dosages. Plant insulation and steam generation have also been improved (i.e., adjusting the amount of steam generated more precisely to demand, and using accumulators). Increasing efforts are also being made to replace mechanical processes by energy-saving techniques such as ultrasound in cleaning and mixing processes.

However, tighter regulations to reduce GHG emissions are pushing these industries to further cut their energy usage and emissions. Many energy-intensive industries are therefore considering fundamental changes to production processes in order to achieve even greater savings than from previous improvements. Examples include the generation of electric power and heat from the incineration of waste in the paper industry (“reject power”), the Corex process in steel production, and dry production in the cement industry. In this dry process, surplus heat is used to preheat materials for further processing. The energy savings of this technique versus conventional technology can be up to 50 percent. Providers that develop and supply such customized solutions for energy-intensive industries are operating in a market projected to grow to around EUR 40 billion p.a. by 2020.

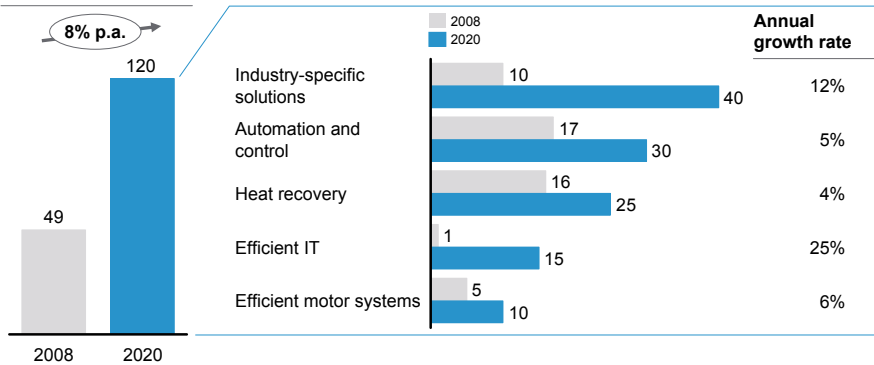
In addition to such industry-specific solutions, there is a growing demand for technologies and products to improve energy efficiency in any industry. These solutions are increasingly used in industries that previously paid little attention to energy usage, and are beginning to focus on energy costs right now. Many manufacturing industries, such as automotive engineering, are attempting to save energy via smarter systems control – shutting down equipment during production downtime, for example, and ensuring more optimal adjustment of machine performance to demand. Other techniques that are becoming increasingly widespread include heat recovery processes, CHP, and the incineration of production waste to generate heat and electric power. Besides decreasing energy consumption, these methods also reduce dependence on purchased energy. By 2020, a market of around EUR 80 billion will exist for suppliers that primarily focus on such cross-industry solutions to improve energy efficiency.

Four submarkets are of special importance in this context, and offer great growth potential (Figure 10). Together with the industry-specific solutions, these markets for general industrial energy savings form the growth centers in mechanical and plant engineering.

Efficient technologies in mechanical and plant engineering – global market potential in growth centers

EUR billions p.a.

Mechanical and plant engineering: total, growth centers



Source: McKinsey

Figure 10

Automation and control technology: Automation and control technology for energy management can significantly improve the energy efficiency across a wide spectrum of manufacturing industries. Until now, optimizing energy use has generally not been a focus for the producers of automation and control systems. This is set to change. Companies are already increasingly using IT-based automation components to optimize their energy consumption; the required components currently account for a world market revenue of around EUR 17 billion. Demand is expected to pick up over the long term despite the current sales decline due to the economic crisis. The average annual growth rate is likely to be around 5 percent, with market volume rising to around EUR 30 billion in 2020. Power management systems are already available for industrial plants. They will continue to grow in importance in the future, especially if they can be successfully incorporated into an integrated IT landscape. Beyond this, the role of automation and control technology will continue to grow, mostly as a result of two developments:

- More precise and faster control mechanisms increase energy efficiency. One example of this is a plastic injection molding machine that applies thermal energy with extreme precision. Germany's medium-sized manufacturers are particularly well positioned to seize the opportunities for such high-precision control equipment because of their detailed insights into the applications their customers are using, and large market shares already captured in the past using corresponding control technology.
- Changes in customer preferences require adapted, specifically tailored products (such as smaller package sizes for smaller households). Automation technology needs to regulate the related production processes more precisely to prevent the waste of materials and energy. This also entails faster equipment changeover and shorter ramp-up times for new launches. Mechanically controlled machines for automating these processes are already installed in most factories – and have only limited potential for further improvements. Demand for high-precision equipment (such as packaging machinery that can quickly be adjusted to the product via software) is therefore increasing. German companies are already leaders in this field.

Industrial drives: Drives and drive systems account for around a quarter of the total energy consumed and two-thirds of the electric power requirements for industrial production. Especially in industries that are not energy intensive, lower consumption in this area is therefore an important lever in increasing energy efficiency. Mechanical improvements (such as using materials with less friction) are one possible approach, another is the use of electronics, such as variable speed controls for electric motors. The extent to which energy-efficient drives can reduce energy consumption varies: for pumps and fans, the savings potential is around 35 percent, but for compressors only about 15 percent, and for other units approximately 25 percent on average. Worldwide, energy-efficient drives currently account for revenue of around EUR 5 billion. This corresponds to approximately 85 percent of the total revenues from new drives. At annual growth rates of around 6 percent and an increase in the penetration of energy-efficient models to nearly 100 percent, market potential in 2020 will be in the region of EUR 10 billion.

More efficient IT infrastructure: Desktop computers in large company networks can be replaced by "thin clients," increasing workplace energy efficiency by up to 50 percent. With a thin-client solution, only the hardware for operating the computer needs to be at the workplace: the actual processing takes place on central servers. This allows better utilization of processing capacity and economies of scale in energy consumption. Central servers are also becoming more and more energy efficient. Reasons include their improved capacity utilization (as a result of features such as virtualization) and more flexible cooling devices. The use of thin clients is growing fast because of their much-improved TCO compared to conventional solutions, combined with their advantages in terms of data currency and reliability. Around 10 million PCs worldwide will become virtualized along these lines by 2010, and as many as 80 million in 2020. Global revenues are likely to grow from approximately EUR 1 billion at present to EUR 15 billion in 2020.

Heat recovery: Heat recovery is already being used successfully in many energy-intensive industries where temperature differentials are high (in the chemical, steel, cement, and paper industries, for example), but the technology for exploiting small temperature differentials is still being developed. One approach is reusing steam in upstream process steps with methods such as non-corrosive heat exchangers, a method already being tested in the steel industry. Another energy-saving solution is to use surplus heat to generate electric power. Additional growth opportunities exist in retrofitting heat recovery units (also for use at higher temperatures) in emerging economies that did not focus on energy efficiency in the past. The global market potential for heat recovery units in 2020 will probably be around EUR 25 billion, corresponding to growth rates of around 4 percent p.a.

Companies in Germany's mechanical and plant engineering sector are already in a good position to be successful in these innovative markets. Mechanical and plant engineering has traditionally been one of the pillars of the German economy. In 2007, Germany was the third-largest machinery producer in the world, with revenues of EUR 190 billion, out-performed only by the US and China.²⁵ The industry experienced a remarkable boom phase from 2003 to 2008, increasing its production during this period by over a third. In 2007 alone, manufacturing grew by nearly 10 percent over 2006.

²⁵ German Engineering Federation (VDMA): Statistisches Handbuch für den Maschinenbau, 2008 (Statistical Handbook for Mechanical Engineering).

This success is largely due to exports: 70 percent of the sector's total revenue comes from other countries. With growth rates far above average, exports were the growth engine for mechanical and plant engineering in Germany.²⁶

As was to be expected, Germany's exports have been hurt by the current economic crisis. New orders in the mechanical and plant engineering sector have decreased by nearly half. In the medium term, the cyclical effects will even out again, but there is a further threat for mechanical and plant engineering companies in Germany. Suppliers primarily from emerging economies are increasingly capturing market shares with low-price, low-tech equipment. China has already overtaken Germany in the field of mechanical engineering to become the world's second-largest manufacturer. The market share of Chinese providers for simple standard models is especially high.

Germany's mechanical and plant engineering companies have strengths in the high precision and quality of their products. Siemens and Bosch have achieved strong positions in automation and control technology. Siemens alone has a market share of over 20 percent in the automation of discrete production lines (in the automotive industry, for example). In electric drives, Germany's two largest suppliers together have a world market share of over 20 percent; in the subsegment of energy-efficient drives, Germany's share is even higher. Germany's mechanical engineering sector earns about 30 percent of its revenue from special-purpose industrial equipment. German companies are global champions in this field, with around 25 percent of the market.

For companies that want to take advantage of opportunities in these growth centers, the most important ingredient for success is keen insight into what customers really care about. Knowledge of customer preferences is especially valuable in economic downturns when it is crucial to increase the economic value of energy-efficient products for industrial customers and consumers – and to make this value far more transparent than in the past. Several levers can be used to achieve this.

- *Enhance value to the customer via design-to-value:* This approach adapts existing product concepts to the customer's specific technological requirements without jeopardizing the product's scalability in production. The manufacturer focuses on the most value-adding components. One example developed for small paper mills is the modification of incinerators to use mill waste for more efficient heat and power generation. Papermakers and their suppliers jointly adapted existing technology so that it could handle a wide variety of fuel mixtures (depending on the different combustible components arising during the process). German companies should continue to focus on high-end technical products and solutions for customized requirements – both for specific industries and for general industrial use. These segments will see growing global demand, especially for complex systems solutions requiring (in addition to the machine itself) IT integration and interface management at the customer's site. Another strength of German companies is their expertise and experience in mechatronics, which can be used to custom-tailor software solutions (in electronic control units and other embedded software).

26 Ibid.

- *Develop innovative financing and operator models:* Although the use of energy-efficient products generally pays off over the entire lifetime of a product, the initial investments are often a barrier for industrial buyers – particularly given the current constraints in credit markets. Innovative financing and operator models are an opportunity to reduce or completely avoid the initial investments and thereby accelerate market development. A technology provider may take on the complete energy management of a production plant, for instance. The provider guarantees the customer a minimum percentage of savings, making the investment profitable sooner. The buyer can also benefit from additional savings after the contract expires. Such operator models may extend from energy management to complete operation and maintenance of a facility.
- *Communicate the value creation and cost reduction potential via value selling:* When making a purchase, end users may not consider the TCO perspective – the total energy savings over the product's life cycle. The value-selling approach aims at determining the customer-specific value of the product, including energy savings, establishing an appropriate price, and then communicating the value effectively. The first step in value selling may therefore be to estimate the savings potential of an automated solution together with the customer in a preliminary diagnosis. The findings can then be used to decide what expenditure on an energy-saving solution is justified.

4.4 IT and IT services: Revenue potential of EUR 30 billion from innovative IT systems for energy management

Customized IT solutions and associated services play a key role in increasing energy efficiency across industries. They help to reduce both energy costs and GHG emissions. In this respect, three applications are especially important (Figure 11).

IT-based traffic management systems for regional traffic networks or for logistics companies make it possible to optimize route planning and prevent energy waste during transportation. One example in truck fleet management is telematics via satellite (GPS) or radio (GSM). Systems of this kind for monitoring and evaluating traffic flows in real time already have a market volume of over EUR 1 billion. We expect this potential to grow by around 14 percent p.a. to approximately EUR 5 billion by 2020.

Smart grid solutions refer to ways to optimize the distribution of electric power so that different (and particularly decentral) power generation facilities can be connected to the network effectively, and energy losses in distribution are avoided. On the user side, smart grid technologies involve sophisticated solutions for measuring consumption – known as smart metering – that utility companies are increasingly using in day-to-day operations. The share accounted for by IT (special software and IT solutions) in today's smart grid investments is already as much as EUR 1 billion p.a. If the US spends the high investments currently planned and further regions follow its example, the annual investment level for IT in smart grids could amount to over EUR 10 billion by 2020. Even more optimistic estimates assume EUR 15 billion.

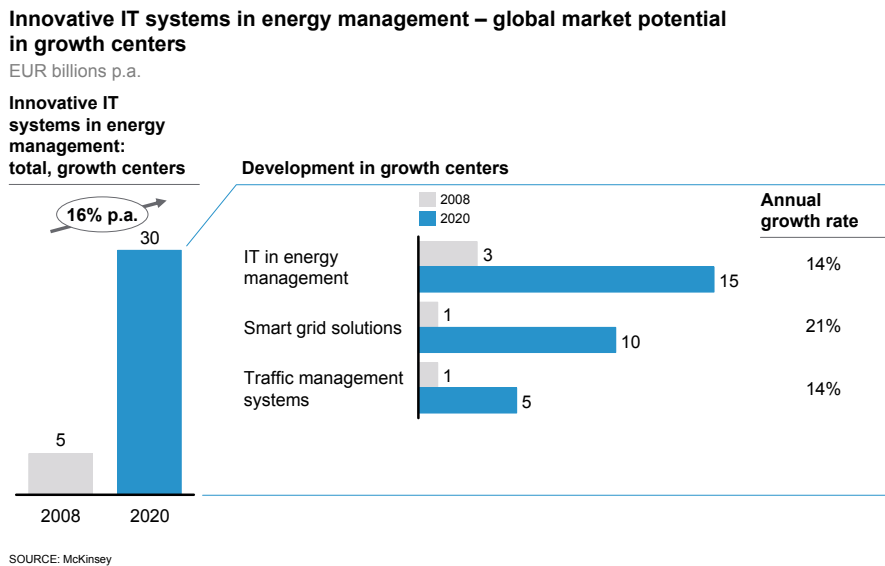


Figure 11

IT solutions for centralized energy management by companies and public-sector organizations concern both the infrastructure of buildings as well as managing the energy efficiency of production processes. IT solutions in this growth center are supplemented by specific services such as for energy reporting or “green” sourcing. The market potential for IT in energy management will be around EUR 15 billion in 2020.

IT-based energy management solutions support energy efficiency improvements in various industries and cover both energy conversion and energy consumption. They fulfill two key functions in these areas. First, they ensure comprehensive transparency on current energy consumption at various corporate aggregation levels, comparing consumption data with target levels and historical patterns. IT thus lays the basis for effective energy management. Second, IT solutions can help to run production processes in a more energy-efficient way. However, today there is still a lack of smart solutions to effectively manage processes in accordance with energy-efficiency criteria – let alone allow partial or complete automation.

Two key fields of application for IT in energy management are the public sector and the manufacturing industry.

- *The public sector* generates around 5 percent of all GHG emissions, in Germany as well as on a global level. Policymakers at various levels of the public sector have recognized this and have begun to reduce emissions for IT providers, especially in Europe and the US.²⁷ This creates two specific market opportunities:
 - The management of energy flows (e.g., electric power and heating) in schools, hospitals, public administration buildings, and in public lighting systems can only be optimized holistically by using IT that supports the central compilation, clear

²⁷ In Germany, this includes the resolutions of the National IT Summit in Potsdam, Bavaria’s 2020 Climate Program, and city initiatives, such as in Hamburg and Munich. A large share of the funds of the US and German economic programs are also flowing into public sector initiatives, such as renovating public buildings for greater energy efficiency.

presentation, and systematic comparison of data. As a second step, IT providers can supply data for determining and monitoring key performance indicators (KPIs) related to reduction targets.

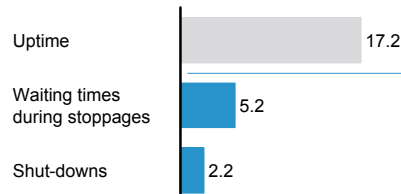
- The CO₂ footprint of public facilities can only be quantified reliably using IT. For example, for reduction targets, it is crucial to obtain precise and automatically updated information on how much GHG a city's public buildings are causing directly or indirectly (by consuming electric power). Other calculations are also possible, such as how much CO₂ is being emitted by a city as a whole, including its industry, transportation, and private power consumption. This reliable data can then be used as a basis for analyzing and communicating whether certain reduction targets – e.g., those agreed in the Kyoto Protocol – are being achieved. IT solutions are essential in these circumstances due to the complexity and dynamics of the data.
- IT will also play a central role in energy management in the *manufacturing sector*. This applies both for continuous production processes, as in the chemical industry, and for discrete production, as in automotive production. One type of IT-supported energy management is to record the energy usage per production step at short intervals and aggregate it for the line or for the entire plant. This would allow the quick shutdown of downstream machinery in the event of process malfunctions in the upstream production stages (Figure 12). Pilot projects in the production of consumer electronics have delivered energy savings of around 20 percent that only IT-supported analyses can provide. As in the public sector, IT can also provide comprehensive monitoring of CO₂ emissions in the manufacturing sector. For example, a CO₂ footprint can be drawn up per product category, which could become a regulatory requirement in the EU and elsewhere.

Savings potential from using IT in energy management

COMPANY EXAMPLE

Monthly electricity consumption before optimization

MWh



Savings from automatic shutdown during waiting times

6 months, cumulative; EUR

Waiting times	Savings
Up to 1 hr.	170,000
1 - 2 hrs.	50,000
2 - 3 hrs.	30,000
3 - 4 hrs.	20,000
Over 4 hrs.	170,000
Total	440,000

Figure 12

SOURCE: McKinsey

As this brief review of the areas of application in the public sector and manufacturing shows, the market for IT in energy management is one of the main growth centers for IT suppliers. It has already achieved revenue of approximately EUR 3 billion p.a. worldwide. Around 80 percent of this market consists of consulting services and IT implementation. License and maintenance revenues make up the remaining 20 percent. Assuming growth rates of approximately 14 percent p.a., the size of the market in 2020 will be around EUR 15 billion.

IT providers should continue refining their existing solutions to capture this market potential, especially by linking various functional levels. For production processes, this means creating an integrated solution, from recording consumption at individual machinery on the shop floor and implementing systems for management and optimization at the production unit level through to integration with the company's ERP (Enterprise Resource Planning) solutions. Some providers can already partially link their solutions at these levels. However, long-term success will only be possible by monitoring, visualizing, and managing data across all levels.

Global IT providers located in Germany are well positioned to play a key role in the market for IT in energy management. These players have a global market share of just under 50 percent in the ERP software sector and strong IT solutions capabilities in mechanical and plant engineering (embedded software), positioning them well to play a pioneer role in the field of IT in energy management. However, fast action is required. Various providers have already started to divide the market between them: established IT providers are competing with industrial companies' in-house solutions, particularly in the chemical and automotive industries, while international electrotechnology companies are expanding into the segment, too. Some of the latter are already offering partial solutions, such as for the steel industry, or remote-controlled energy management (hosted via the Internet) for small and medium-sized companies.

Joint development of customer-oriented solutions that include innovative financing models will allow global IT providers located in Germany to take on a frontrunner role in the market for IT in energy management. Their aim should be to adapt leading scalable software solutions to customer requirements so that the customer's investment is quickly amortized due to the energy savings.

4.5 The energy industry: Revenue potential of EUR 345 billion from technologies for nuclear power, renewable energy, and carbon capture and storage

Despite all improvements in energy efficiency, today's worldwide energy demand of around 12 billion toe p.a. will rise to more than 15 billion toe by 2020. The forecasts of all leading institutes currently assume that oil, gas, and coal will remain the most important global energy sources through 2020 and beyond. The growth rates of industries that extract, transport, and refine fossil fuels will therefore remain unchanged. Overall their market is growing at almost 3 percent p.a. – from around EUR 2,600 billion today to approximately EUR 3,600 billion p.a. in 2020.²⁸ The mechanical and plant engineering companies that supply equipment for these industries will benefit from this growth as well.

In Europe, energy demand will most likely slow down or stagnate over the next few years, depending on the extent and speed with which energy efficiency initiatives are implemented. However, the global growth of energy consumption will lead to a rising demand for power plant technology. The construction of conventional coal- and gas-fired power stations will continue to play an important role: these plants represent over half of all the new power plant capacity that becomes operational by 2020. German providers such as Siemens and Babcock-Borsig Service that offer these technologies are preparing for global growth by continually improving their products (e.g., highly efficient 700°C coal power plants).

Alongside the continued growth of traditional industries, new markets will develop from the global push to reduce GHG emissions, particularly in the field of electric power generation. The key technology trends in large-scale electric power generation are the global renaissance of nuclear energy, the expansion of renewable energy, and – even if only for a transition period – the development of technologies for carbon capture and storage (CCS). The market potential in 2020 for all these technologies is expected to be very large (Figure 13).

Nuclear power: An increasing number of countries are (re-)focusing on nuclear energy. Some, such as Sweden, the UK, and Italy, are reversing phase-out decisions made in the past. According to the World Nuclear Association, 108 reactors with a generation capacity of around 120 GW are planned to go on line worldwide by 2030. This corresponds to a cumulative investment volume for reactor and nuclear power technology of approximately EUR 360 billion by 2030. A total of 43 nuclear power stations are already under construction at present, mainly in China, India, Russia, and South Korea. According to forecasts, world market revenues in this field will be up to EUR 60 billion p.a. in 2020. Around 45 percent of this revenue will come from the “nuclear island” of a power station, i.e., the steam generation in the reactor itself. The remaining 55 percent will be revenue from turbines, generators, and other plant components.

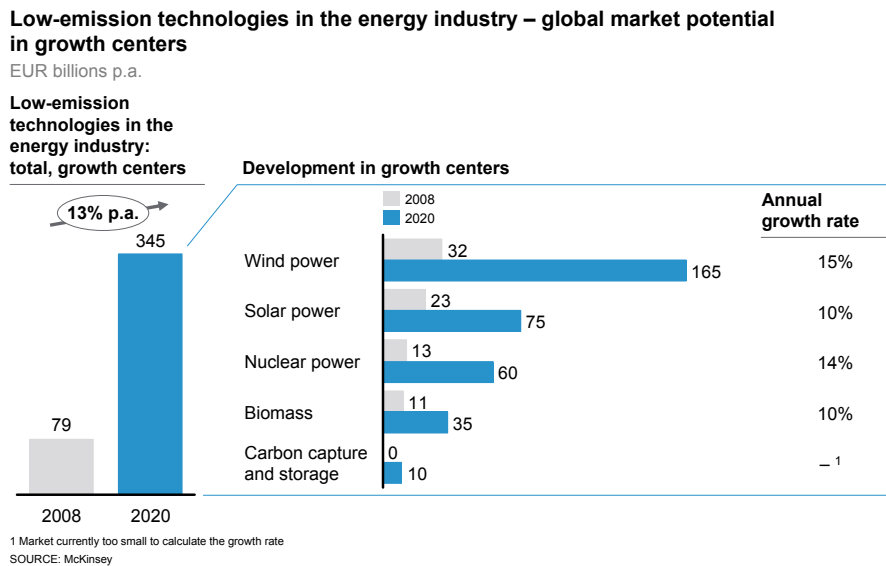


Figure 13

Although nuclear waste disposal remains an issue, the attractiveness of nuclear technology is being reassessed because of its large contribution to abating greenhouse gases. Furthermore, the countries where uranium is mined are also considered more stable than those where oil and gas are extracted. Finally, the third generation of pressurized water technology greatly improves the safety of nuclear power stations. Only a few companies worldwide have mastered this technology, or are in a position to do so. The Russian Rosatom Corporation has gained experience in recent building projects in Russia. The French provider Areva is building the Olkiluoto nuclear power station in Finland, which will be its new key reference project. Other companies operating in this market are the manufacturers Westinghouse, Doosan, and Mitsubishi Heavy Industries.

The critical bottleneck in implementing third-generation projects such as these will be the availability of technical know-how and engineers with the appropriate background. German companies currently lack the relevant experience and specialized knowledge of reactor technology regarding the nuclear island. German companies played a leading role in the worldwide planning and construction of nuclear power stations up to the 1990s. However, since then, they have only been completing existing projects – no new ones have been initiated. As a result, Germany has seen an entire generation of its engineers join foreign companies.

If a German company still wishes to participate in the market for nuclear island technology, now is the time to enter. Siemens has announced an alliance with the Russian Rosatom to gain a better position than previously in its joint venture with Areva. Engineers with the relevant technical expertise are still working in Germany – for the French energy group Areva. Assuming German companies could attract these experts, they might be able to regain some of their “lost” knowledge. German companies that wish to reenter the reactor technology market could benefit from still excellent knowledge of other nuclear power station components used outside the nuclear island. Whether they can catch up with the lead achieved by other countries in reactor technology, however, remains to be seen.

Renewable energy: Renewable energy plays a key role in most plans for abating GHG emissions. Even in the IEA's conservative market scenario with the highest share of fossil fuels, the institute assumes that by 2020 over 20 percent (around 5,900 TWh²⁹) of global electricity generation will come from renewable energy – implying annual growth of 4 percent from the 2008 figure. At less conservative assumptions, the share could rise to almost 30 percent (around 7,800 TWh) in 2020. While some technologies, such as tidal power plants, are more likely to be successful in niche markets due to the geographic circumstances required for their operation, three types of electric power generation are likely to grow significantly over the coming decades: solar, wind (especially offshore wind farms), and biomass.³⁰

German companies have achieved a strong market position in the field of *solar power systems* over the past two decades, largely because of the economic support of the “1,000 Roofs Program” and the feed-in tariffs of the Renewable Energy Sources Act (EEG). They operate in all areas of the value chain, from production of the base material silicon, photovoltaic cells, and assembled modules through to complete, large-scale systems. Q-Cells, the world's leading producer of solar cells, is a German company. In 2007, it sold solar cells with a capacity of around 390 MW, which represents 9 percent of the global market. The manufacturer Solarworld – also German – comes in at number seven, with a global share of 4 percent. In the market for solar panel sales to consumers, Solon (alongside Solarworld) is also among the world's top 10 by revenue. German companies such as Flabeg (parabolic mirrors) and Schott Solar (receivers) have leading positions in the production of Concentrated Solar Power (CSP) units.

In the years through 2020, the global capacity of solar power systems is likely to increase from 7 GW today to around 200 GW. As a result, the annual revenues in this market will rise from EUR 23 billion in 2008 to over EUR 75 billion by 2020, corresponding to growth rates of 10 percent p.a.. However, competition is becoming increasingly tough for German players. More and more Asian rivals are entering the market – from a strong technology base (e.g., Moser Baer, Kaneka) or a favorable cost position (e.g., Suntech Power). German companies have to master two challenges to maintain and, ideally, expand their shares in these dynamic growth markets.

- *Achieve a more competitive cost position:* Competition from Asia for silicon-based solar cells has been heating up in recent years. Their share of the world market rose from 7 percent in 2005 to almost 40 percent in 2007. Asian competitors are primarily relying on their advantage in terms of pure production costs of the cells, which (excluding the costs of the silicon) can be up to a third below those of the most expensive German manufacturers. European producers were able to balance out this cost disadvantage in the past because they had secured their supply of the base material silicon via long-term contracts, enabling them to hedge against short-term price fluctuations. But this advantage is dwindling. The production of silicon will quadruple by 2012, leading to a drop in the current world market price of EUR 360/kg. This means solar cells from Asia will become much less expensive, and European companies will have to greatly reduce their production costs to remain competitive on the world market.

²⁹ International Energy Agency, World Energy Outlook, 2008.

³⁰ Hydropower is not included in the following calculations because these large-scale projects have already been put out to tender and awarded for the period through to 2020 that is being analyzed here.

- *Continue refining thin-film technology:* The production cost for this relatively new technology is already at least 40 percent below that of silicon-based solar cells. This makes thin film a more favorable technology than classic silicon cells in many cases, even taking into account its lower efficiency. The world market share of thin-film technology will grow from the current 13 percent to over 30 percent by 2012 (corresponding to growth rates of almost 60 percent p.a.). The global leader in this market is First Solar in the US, but there are also large German companies operating in this field: Sontor, Solibro, and Ersol. If Germany wishes to retain an important role on the global market for solar energy, its companies will need to intensify their activities in this segment.

In contrast to Germany's high global rankings in the solar power arena, none of its companies are among the world's top 3 manufacturers of *wind power plants*. The largest German manufacturer Enercon ranks number four, with a global market share of around 15 percent in 2007. Besides, Siemens and Nordex are also among the top 10. In the supplier market, major German players are Winergy, Bosch Rexroth, and Voith. Overall, the global wind power market will grow rapidly, from more than EUR 30 billion in 2008 to over EUR 165 billion in 2020. Of this revenue, plant engineering itself will account for nearly EUR 80 billion, while related providers such as construction and financing companies will make up the other (approximately) EUR 85 billion. This intense growth is due to the fact that large markets are developing, and not just in Germany. The US and China also plan the large-scale use of wind power, and in parallel more offshore plants will go up off the coast of Europe as well. German players should therefore prepare for two developments:

- *Cost pressure due to global competition:* China is clearly making political moves to carve out a position for itself as a world leader in the wind power industry, which it intends to make into a Chinese flagship. For German plant engineering companies, this means heavy competition due to much lower production costs. It will be critical for German providers to lower their costs or maintain a quality lead.
- *Business models needed for offshore locations:* After years of uncertainty over risks and maintenance difficulties, the first offshore wind parks are now being set up. German companies are developing new business models for what are often large-scale international projects in order to overcome the special risks of these units and leverage their income opportunities.

Alongside solar and wind energy, the *combustion of biomass* (such as wood pellets) to generate electric power is a further growth segment for renewable energy. Annual global growth rates up to 2020 will be up to 10 percent, corresponding to revenues of over EUR 35 billion.³¹ Still more optimistic studies assume fourfold growth of the current market, to EUR 45 billion. In 2006, biomass energy³² had a global share of around 10 percent of the primary fuels deployed. This biomass can be fired in dedicated plants that produce electric power, heat, or both together. Alternatively, biomass can be a component in the blend used in other combustion units, such as in coal-fired power stations (co-firing).

³¹ Including EUR 10 billion in annual investments for biofuel plants through to 2020.

³² Also includes waste incineration.

Currently, the biomass market is heavily fragmented. German providers have specialized in small-scale plants because these receive subsidies under the *Renewable Energy Sources Act* (EEG), while large-scale plants do not. These regulatory parameters have strengthened the German market in the past; however, manufacturers and operators now need to liberate themselves from the EEG and develop business models that allow them to expand their positions on the global market. This means they will have to evaluate the opportunities of backwards integration of the supply chain. At present, hardly any suppliers on the world market can reliably serve large-scale plants with biomass requirements of 500,000 to 1 million t/year. To be able to sustainably supply and utilize such large volumes of high-quality biomass, continuous quantities have to be ensured on international markets via contracts with landowners. In addition, this biomass needs to be processed by major suppliers to improve its combustibility (pelletization, torrefication to reduce the degree of moisture). If German companies can master these logistical challenges, they will be able to operate large-scale plants efficiently.

Carbon capture and storage (CCS): Alongside the more intensive use of nuclear power and the expansion of renewable energy, it will be essential for low-emission electricity generation to implement the large-scale capture of CO₂ from coal- and gas-fired power stations, and to store it at safe locations. This could reduce global CO₂ emissions by up to 3,600 million t p.a. by 2030 – over 8 percent of the likely global emissions for that year.³³ Because of the lower conversion efficiency associated with CCS and the high degree of uncertainty relating to the storage of CO₂, the technology is often viewed merely as an interim solution until the broad availability of CO₂-free electric power generation. Nevertheless, forecasts of its medium-term market potential are substantial. The first CCS projects will already deliver annual market potential of over EUR 10 billion by 2020. This figure is likely to more than double by 2030.

Various technologies for realizing CCS are currently being tested, and several pilot and demonstration units are under construction. In Germany, Vattenfall and RWE, for example, are planning carbon capture projects at their sites at Schwarze Pumpe (near Cottbus), Jänschwalde, Niederaußem, and Goldenbergwerk. The first storage locations will probably be in the regions of Altmark and Schleswig-Holstein. At 60 to 90 EUR/t, the cost per t of CO₂ captured is still high in these pilot projects. However, with more experience and larger economies of scale, these costs will fall to 30 to 45 EUR/t by 2030. A market for CCS could then develop in Europe consisting of 80 to 120 units, connected to a joint transport and storage system.

The German pilot projects described have the opportunity to explore and establish these technologies. On the supplier side, Siemens, Alstom, and GE Energy are among the companies already running initial tests on using systems for CO₂ capture in power plants. If the pilot projects mentioned are successful, Germany could become one of the CCS pioneers. However, this also assumes fast clarification of laws and regulations for the transportation and storage of CO₂ and public acceptance of the technology. Some technical issues relating particularly to the safety of storage and the guarantees required still need to be clarified. If these issues can be resolved, Germany could play a forerunner role and achieve a competitive edge in the global market.

³³ McKinsey & Company, *Carbon Capture & Storage: Assessing the Economics*, September 2008.

Companies as well as the public sector and private households can greatly reduce their energy costs by systematically increasing their energy efficiency



5. Greater energy productivity:
Savings potential of EUR 53 billion p.a.
for German companies and households
by 2020

Germany's final energy consumption accounted for 2,400 TWh in 2007 – around 3 percent of global consumption. The primary energy deployed for this was 3,900 TWh, of which 34 percent came from petroleum, 26 percent from lignite and hard coal, 22 percent from natural gas, 11 percent from nuclear energy, and 7 percent from renewable fuels. While 40 percent of final energy consumption was for heat and electric power in buildings, 30 percent was accounted for by fuel consumption in the transportation and logistics sector, and the remaining 30 percent by heat and electric power consumption in industrial production. These consumption figures correspond to an energy expenditure totaling around EUR 180 billion – EUR 85 billion of which was spent on energy in buildings, EUR 65 billion on transportation and logistics, and EUR 30 billion on industrial production.³⁴ The combustion of fossil fuels (either directly in the case of fuels for transportation and heating, for example, or indirectly for electric power generation) resulted in GHG emissions of nearly 1,000 million t of CO₂ equivalent (t CO₂e).³⁵

Energy consumption and GHG emissions in Germany would largely remain stable through to 2020 if appliances and equipment were replaced at the end of their life cycle by products that meet current energy efficiency standards.³⁶ However, if companies and households systematically apply the products and solutions described in Chapter 4 and design energy-efficient processes in line with these solutions, they can reduce their consumption by 21 percent by 2020, saving 500 TWh³⁷ of energy annually (Figure 14).

The biggest savings potential is in the buildings sector at 250 TWh (EUR 21 billion) p.a., followed by industrial production at 160 TWh (EUR 7 billion) p.a., and transportation and logistics at 75 TWh (EUR 11 billion) p.a. plus traffic management systems at 15 TWh (EUR 2 billion) p.a. The international logistics chains and foreign facilities of German companies also have savings potential of around EUR 9 billion and EUR 3 billion, respectively. This adds up to overall energy savings potential of EUR 53 billion p.a. as of 2020.

These energy savings would raise Germany's energy productivity from today's EUR 5,500/toe to around EUR 7,000/toe, putting Germany almost on a par with Japan – despite the much higher share of industry in the German economy. Germany's dependence on imported energy would also fall, increasing the stability of its energy supply. In addition to this, annual GHG emissions would drop by over 200 million t CO₂e by 2020.³⁸ The efficiency improvements considered include only the investment cycles already planned and economically viable (for both companies and households) assuming usual payback times and cost of capital.

34 The differing ratios between savings in TWh and euros in the three sectors result from their divergent energy prices.

35 Federal Ministry of Economics and Technology, 2008 energy data, February 2009.

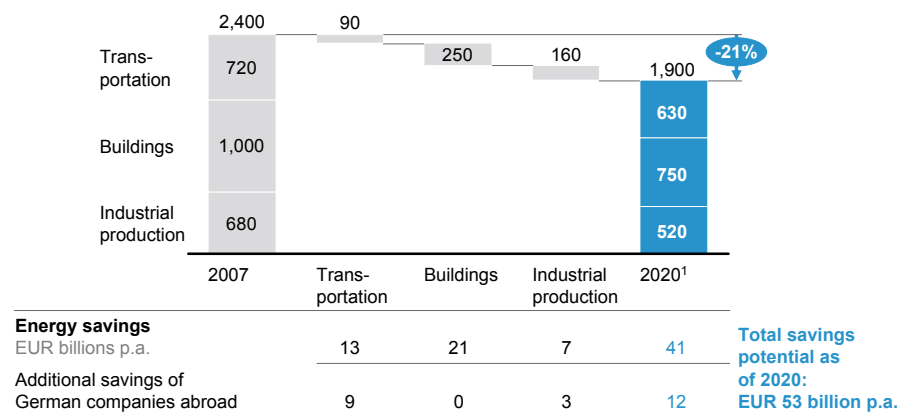
36 For methodology and assumptions, please refer to McKinsey & Company, "Costs and Potentials of Greenhouse Gas Abatement in Germany" on behalf of the Federation of German Industries' "BDI initiative – Business for Climate Protection," September 2007.

37 The savings potential cited here goes beyond the potential presented in "Costs and Potentials of Greenhouse Gas Abatement in Germany" because this current study also analyzed non-technical optimization levers, such as process improvements in production.

38 For a detailed explanation of the CO₂ abatement potential of specific initiatives, please refer to McKinsey & Company, "Costs and Potentials of Greenhouse Gas Abatement in Germany" on behalf of the Federation of German Industries' "BDI initiative – Business for Climate Protection," September 2007.

Potential for reducing energy consumption and costs – German companies and households

Final energy consumption in Germany, TWh p.a.



¹ To give a better illustration of the savings potential, the same usage patterns and economic performance as in 2007 were assumed
SOURCE: McKinsey

Figure 14

5.1 Transportation and logistics: Savings potential of EUR 22 billion from energy-efficient vehicles, supply chains, and traffic management

Two-thirds of Germany's energy consumption in transportation and logistics (automobiles, trains, aircraft, and ships) is accounted for by private transportation – largely cars – and one-third by the transportation of goods. By 2020, improvements in the energy efficiency of cars could lead to savings potential in this segment of around EUR 11 billion p.a. compared to 2007. German companies can save a further EUR 9 billion by optimizing shipping volume and distances. Smart traffic management systems for navigation and preventing traffic jams will capture further savings of EUR 2 billion in passenger and freight traffic.

Passenger traffic: If the trend towards smaller vehicles, low-consumption combustion engines, and a higher share of electric cars and hybrid vehicles continues, the fuel consumption of cars will fall by around 17 percent (7 million toe) by 2020 compared to present figures.

Freight traffic: German companies use over 1 million barrels of petroleum a day in their global logistics chains, with around 30 percent of that consumed in Germany (excluding seafreight). Three approaches can be used to optimize global supply chains and reduce energy costs. Each approach has several levers that can be implemented in different time frames. Short-term levers will become effective as soon as new planning approaches can be implemented with an altered transportation mix, different routes, and different speeds. Other levers such as reorganization of the complete supply chain will only take effect in the medium term, and will only be considered if oil prices are high.

- German companies can save 4 percent of the energy costs they incur in transportation (versus current levels) by *redesigning their production and products*. For example, a company can often gain strategic benefits by locating its production operations closer to its sales markets. In some product segments, manufacturing in Europe can be more cost-efficient than in Asian low-cost countries because the lower transportation costs compensate for the higher cost of wages. This comes into play once oil prices are around USD 130/barrel or above – particularly for products with a value density of USD 5 to 20/kg (such as refrigerators, washing machines, and furniture). While relocating complete factories takes a long time, companies can achieve faster results from increasing a product's value density. Lower per-product weight plus the reduction of packing and padding materials means each shipment comprises goods with a higher overall value. A key lever in achieving this is postponement: delaying adaptation of the product to the specific target market or customer for as long as possible. This means more compact packaging can be used on long transit routes because intermediate products can be stacked more easily, requiring less space. Bulky sales packaging is only needed close to the point of destination.
- *Using and combining improved modes of transportation* reduces energy costs by up to 11 percent. Technologically sophisticated vehicles and ships with more cargo capacity, optimized motor systems, and better aerodynamics allow significant energy savings on the tonnages transported. The modal mix is also important. An aircraft needs 330 l of fuel per kilometer transported for 1,000 metric tons of freight, while a train requires only around 8 l, and a ship uses less than 3 l. To reduce the total energy costs of a supply chain, companies can combine sea and air transport, for example, switching individual legs of the transport route to the most efficient means of transportation (e.g., using rail-to-air concepts), or using sea freight for baseload requirements and air freight for demand peaks.
- A further 9 percent of energy costs in transportation can be saved via *efficient transport processes*. Optimized route and capacity planning helps avoid unnecessary journeys and empty runs. Ships can also save an overproportional amount of fuel by slightly throttling their speed. Reducing the usual speed of a container ship by 10 percent lowers energy consumption by up to 25 percent. The improvements should be supported by structural measures that target an improvement in the transportation infrastructure. Reforming the architecture of European air traffic control via the "Single European Sky" initiative, for instance, would reduce the need for holding patterns and detours to such a great extent that aircraft would use 10 to 12 percent less kerosene. Although actions of this kind have to be decided on at a political level, companies can use joint initiatives to trigger and drive forward the decision-making process.

Smart traffic management: This approach positively affects both passenger and freight transportation, and could save 3 to 5 percent of energy consumption in German road transport by 2020. These solutions prevent the build-up of traffic jams using techniques such as traffic management systems that switch and activate freeway lanes. They also utilize navigation systems that help road users to avoid detours and heavy traffic.

5.2 Buildings: Savings potential of EUR 21 billion from energy-efficient refurbishment

Energy consumption in the buildings sector in Germany currently totals around 1,000 TWh p.a. Of this, 85 percent is for heat and 15 percent for electric power. Residential buildings account for about two-thirds (620 TWh), commercial and public buildings for the remaining third (380 TWh). Systematically improving the energy efficiency of new and renovated buildings could reduce consumption by around 25 percent (or 250 TWh) by 2020. This would correspond to savings of EUR 21 billion p.a. Over 70 percent of this savings potential (around 180 TWh, or EUR 15 billion) can be captured in private households (Figure 15).

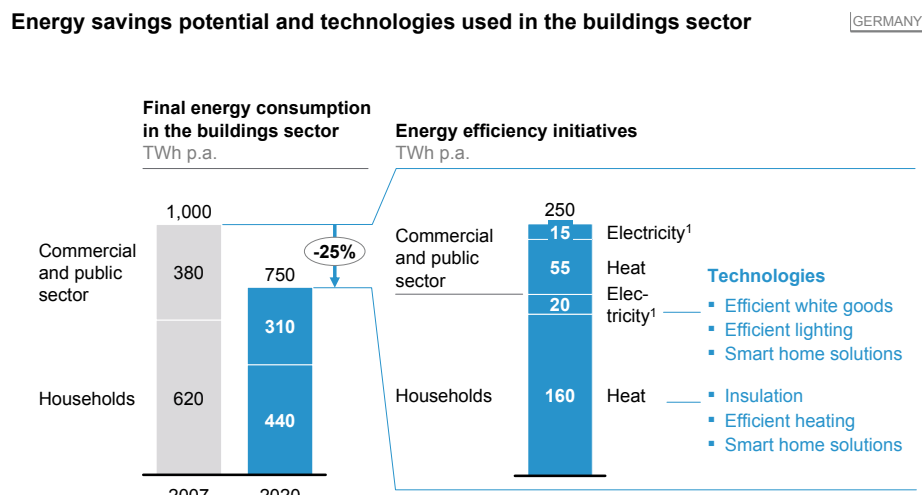


Figure 15

¹ Some of the electricity consumption in the buildings sector is used for heating (e.g., electric heating)
 SOURCE: Study "Costs and Potentials of Greenhouse Gas Abatement in Germany" by McKinsey & Company, Inc., on behalf of the Federation of Germany Industries' "BDI initiative – Business for Climate Protection"

Around 700,000 houses and apartments are refurbished in Germany every year, but only 300,000 include fitting out with energy-saving technology, despite the fact that these investments pay off in the long term by delivering lower energy costs. When buildings are refurbished, heat insulation and optimized heating systems offer the greatest savings, while CHP and heat pumps tend to be more appropriate for new buildings. The greatest hurdles for the installation of such technologies are the complexity of the work involved and a lack of awareness of the potential savings. According to a recent study, 75 percent of the people surveyed did not know how much energy they are using in their households.³⁹ To overcome these hurdles, companies should take the following actions:

- *Optimize the subsidies offered:* The KfW (a German public bank) has boosted the funds available for the refurbishment of buildings by EUR 3 billion as part of Germany's first economic recovery plan⁴⁰ for the years 2009 to 2011. It is now important to

³⁹ IBM Global Business Services together with the Center for Evaluation and Methods at the University of Bonn: "Preis, Verbrauch und Umwelt versus Komfort – der mündige Energieverbraucher," 2007 (a study on price, energy consumption, and the environment).

⁴⁰ A package of measures to ensure growth and jobs adopted by the Federal Government on November 5, 2008.

ensure that these funds are used effectively by making it simpler to obtain a subsidy. To simplify the process for applicants, the conditions should be expressed in a less complicated way. Loans and grants should also be better tailored to homeowners who have been reluctant to undertake energy-efficiency initiatives in the past. It would also be advisable to adapt the sales mechanism in a way that gives commercial banks greater incentives to proactively draw their customers' attention to the support that the KfW bank offers.

- *Intensify energy counseling:* General information campaigns are not sufficient to educate the public on savings potential. Techniques are needed for conveying to homeowners exactly what their savings would be if they used energy more efficiently. The measures implemented so far are not enough. Energy performance certificates were developed for this purpose, but have not been implemented comprehensively, and potential tenants and buyers are generally unfamiliar with them. One way of increasing transparency would be for utilities to provide customers with comparison data and benchmarks for energy consumption as part of the text on their energy bills. Such information could include comparisons with housing in the same size category and with a similar number of occupants. Bills could also contain tips on ways to make homes more energy efficient. A further initiative would be to provide targeted advice on energy-related issues via a panel of experts in every community. A government subsidy to defray the cost of this type of consultation would be helpful (provided the advice fulfilled minimum standards in terms of quality).

The energy-efficient refurbishment of buildings has already made far more inroads in the commercial and public sectors in Germany than in the fragmented household sector because profitable operator models, such as energy contracting, exist in these fields. By 2020, economically viable initiatives could reduce the annual energy requirements of the commercial and public sectors by close to 20 percent.

5.3 Industrial production: Savings potential of EUR 10 billion from integrated production systems

In addition to using the products and solutions described in Chapter 4, German companies can achieve particularly high energy savings from introducing energy-optimized production systems. The potential for their domestic sites alone totals EUR 7 billion in 2020, equivalent to 25 percent of today's energy costs. Since energy costs amount to around 2.5 percent of an industrial company's average costs, the savings translate into an increase in the typical EBIT margin from 3.5 to 4 percent. In energy-intensive industries such as cement, lime, and aluminum, the margin could more than double depending on the baseline. Implementing these energy savings initiatives at foreign locations, too, would result in further savings of around EUR 3 billion.

Many companies are already conducting comprehensive, rigorous optimization of their production using lean programs. These programs make an indirect contribution to reducing energy costs via streamlining and preventing waste (such as overproduction or scrap), but generally do not explicitly target energy efficiency. Substantial further energy savings can therefore be made with initiatives that are specifically geared to reducing energy consumption: 20 to 30 percent for discrete production, and 25 to 35 percent in

process industries (where the savings can even be up to 50 percent if combined with a conventional lean program).

To realize savings of this magnitude, it is essential to anchor energy efficiency centrally in the production system. Production systems generally cover the guidelines, principles, and levers of manufacturing. They describe the organization and workflows, and specify how individual activities should be carried out. A production system aligned to energy efficiency needs to incorporate energy consumption in the planning systems and provide processes and technologies to identify and prevent energy waste. At the operational level, production systems of this kind will link process and technological improvements.

- *Optimize processes, minimize energy waste:* Production processes often use more energy than necessary. Typical examples of this are the production of unnecessarily large amounts of steam in steam boilers, or devices waiting for a long time in stand-by mode. Relatively simple adjustments can often prevent this waste. Interfaces between different production stages of different products also have significant savings potential. The sequence of heating and cooling periods should be organized so that as little energy as possible is used, or as much heat as possible is fed back into the process. The waste heat of the production process itself can be used to preheat the feedstock, for example, or to generate electric power. Further examples of such optimized processes are the dry process for cement production mentioned in Chapter 4, or the Corex process used in steel production.
- *Apply energy-saving technologies, making full use of their potential:* A vast array of energy-efficient technologies is now available, with very impressive savings potentials. Electric drives for pumps or fans, for example, account for around two-thirds of the electricity consumed in industrial plants. Variable speed drives that limit their output to actual requirements save significant amounts of energy. Using this technology, one automotive OEM managed to reduce the energy required for coating machines in the paint shop by 12 percent. Lasers with disc-shaped crystals or hybrid and power-assisted technology for welding plants can also dramatically curb energy consumption.

Periods of economic crisis like the present one are a good time to optimize processes and production facilities, since it is easier to conduct improvement work if production lines are not running at full capacity anyway (i.e., do not have to be interrupted). Moreover, reducing energy costs directly improves a company's bottom line.

However, lowering energy consumption and costs is not just about making changes to a company's standard operating procedures. It is often much more crucial to align people's attitudes and actions and the corresponding management/leadership systems to the new notion of energy as a competitive resource. For top management, this may mean quantifying targets for energy consumption and systematically measuring their achievement. Employees need to be motivated and empowered to scrutinize energy efficiency in all the processes their work involves. Developing the skill and will for this requires training, more transparent data on energy consumption, and new incentive systems. It is only when companies combine improvements to technologies and processes with positive changes in people's mindsets and behaviors that they succeed in achieving sustainable energy savings.

Leaders in business, government, and academia should jointly create the foundations and frameworks to make energy a cornerstone of Germany's future competitiveness. Cooperation and entrepreneurial vision will be key



6. Innovative solutions: How to capture the potential

In terms of energy-efficient products and technologies, Germany is well equipped to achieve a competitive advantage and boost GDP growth. What counts now is to stay on top of the global developments outlined and take advantage of them, so that German companies can expand their strong starting positions into global market leadership. This will require foresight and determination, particularly from the companies themselves. Academic advisors and government policymakers can help to accelerate this development.

6.1 Success factors for companies

As described in Chapter 4, all the sectors in which energy is of great importance contain fast-growing segments – growth centers – with especially innovative product markets. These markets promise annual growth rates of just under 13 percent on average, and some are likely to expand at a pace of more than 20 percent p.a. Companies should incorporate these high-growth segments into their strategies early on.

One might expect that the start-up companies in these growth centers would have ambitious plans for their innovations, but start-ups based in Germany quite often lack a clear growth aspiration and typically do not start out aiming to grab a big share of the global market. In 2006, half of all German start-ups aspired to a maximum revenue growth of just 10 percent for the following year. Only one in ten intended to grow by 50 percent or more.⁴¹ “Young” companies in Germany are also less likely to achieve leading positions internationally. While in the US, 12 companies established after 1960 now earn revenues of over EUR 25 billion, not a single company in Germany has experienced similar success.

In a related vein, although many of Germany’s traditional companies are technology pioneers in numerous energy-related fields, they have rarely managed to achieve global market leadership. To give an example, German engineers and suppliers for wind power plants are quite strong, i.e., in 2007, they had a combined market share of more than 50 percent for core components such as drives. However, no German company has made it to the top 3 in the global market for complete wind power stations. The German company with the highest revenues, Enercon, is currently only number four worldwide, despite numerous wind power farms installed throughout Germany and the support provided by the EEG.

Another example is the approach to innovation taken by German automotive OEMs and suppliers. German OEMs invest more in R&D than the industry average. From 2004 to 2007, their R&D budgets were around 5 percent of their overall revenues; the global average was 4 percent. However, most of the German R&D investment went into improving the traditional combustion engine. At present, German OEMs have no innovative edge in electric motor systems. Although Germany created one of the very first hybrid vehicles (the Audi Duo in 1997), Japan now leads the market for hybrid and electric vehicles and the related components. The profitability of these products may still be questionable, but they have given Japan’s automotive industry a high profile and an edge in terms of production experience.

41 Global Entrepreneurship Monitor, National Report Germany 2006, March 2007.

Besides business acumen and entrepreneurship, another key factor for success are innovative business models. The key issue will often be to revisit traditional business models from the perspective of energy as a competitive factor, and to think beyond industry boundaries. After all, technology alone does not create a market. It will be critical to define products and business models so that they deliver genuine value to the customer, and to sharpen customer awareness of these benefits. Hurdles such as ignorance of energy consumption figures or savings potential in the household need to be overcome. One approach is to refocus customers' attention away from the sales price and towards the energy costs they can save in the medium and long term. Some examples:

Fuel consumption makes up around 30 percent of the costs over the entire lifetime of an automobile. Although this aspect is increasingly being factored into purchasing decisions, it is still not fully acknowledged. Electric cars are a particularly good case in point. *Operator models* could replace the pure sale of an electric vehicle and make the actual costs of usage transparent for the customer. At present, the costs incurred to produce state-of-the-art electric cars make them very expensive. One way to compensate for this disadvantage are state subsidies or zero-emissions regulation. However, models of this kind would likely result in high indirect costs for the national economy. So, what about developing an operator model for densely populated urban areas? People would rent electric vehicles, paying a basic usage fee plus an on-top per-kilometer charge. This would spread the high purchasing costs over a long period of time, and perhaps even among several users. The low operating costs would result in an attractive overall price tied to actual use. Regulatory concessions can further enhance the benefits of electric cars, too: one example would be allowing these vehicles to use bus lanes in rush hour traffic.

Energy-efficient refurbishing of buildings incurs high initial investments with payback periods often longer than a decade. Successful business models already exist for large-scale commercial buildings, but not yet for private households. What about transferring these successful models from businesses to residential housing? A service provider would finance the initial investment with a relatively long horizon and get repaid from the energy savings. Financing the refurbishment of homes for greater energy efficiency on this basis would be profitable for both parties to the contract.

In the *decentral supply of energy*, innovative operator models could also help existing technologies make a market breakthrough – solar and wind power for example, or CHP. As described in the two examples below, models of this type would distribute the costs and income related to installation and operation such that everyone received benefits. The distribution would, of course, need to reflect the competencies and financing abilities of all stakeholders.

- *Example of an operator model for decentral solar and wind power systems:* Facility management companies, which typically provide administrative services for large office buildings and residential housing complexes, have the opportunity to install these power generation units close to the consumers on land that has already been developed, so the technology will not harm the environment. However, facility management companies typically do not have the expertise to acquire and operate power generation technologies, and the investment costs are daunting. Instead, specialized operators of solar and wind power systems could take on this role, renting roofs or unused land and then refinancing their investments from the electricity generated,

at the same time leveraging economies of scale in the purchase, installation, and maintenance of the technology. These operators could be utilities, plant engineers, or independent firms. Real estate owners and administrators are already willing to rent out unused areas for similar purposes such as cell phone masts and billboards, so they are likely to do the same for power generation equipment as well. Operator models of this kind could also be used successfully abroad (and independent of feed-in tariffs) as soon as costs fall sufficiently to enable economically viable operation of solar or wind power systems at suitable locations.

- *Example of an operator model for micro-CHP systems:* As in the previous example, high acquisition costs and financing bottlenecks make it unlikely that homeowners will invest in micro-CHP systems of their own accord. However, gas providers could profit from this because CHP systems – unlike conventional heating systems – also produce electric power, based on gas-fired heaters. What about gas providers installing CHP units at their own expense, allowing private customers to use the electric power generated as an incentive? The providers could refinance their investments via the additional sale of gas that this arrangement would promote. The lower the price of the technology and the higher the feed-in tariffs for decentral CHP electric power, the more economical this model would be.

6.2 Effective policy frameworks

One might ask why the trend towards greater energy efficiency needs state support at all, when economic and ecological realities are pushing it anyway? But even so, governments should accelerate this development in business areas promising high growth rates. By doing so, Germany can help its companies achieve leading global market positions. However, strategies like these do not just generate opportunities: they also lead to higher risks. An effective public policy framework can reduce these risks without limiting entrepreneurial freedom.

But government support for would-be national champions in the form of tax incentives, direct subsidies, or barriers to foreign competitors has rarely delivered the desired results. The proper role of policymakers is to create favorable, stable frameworks within which businesses can start up and grow. There are two main areas where policies can pave the way for German companies to profit long term from the advantages of energy efficiency. One area is the regulation of industries in which market failure or negative social consequences can occur. The second is the revitalization of existing market structures (especially by supporting start-ups). In addition, government has traditionally supported education and can promote projects in energy-efficiency-related science and technology at public universities and research institutes. Public procurement – especially for infrastructure services – also has an important role to play.

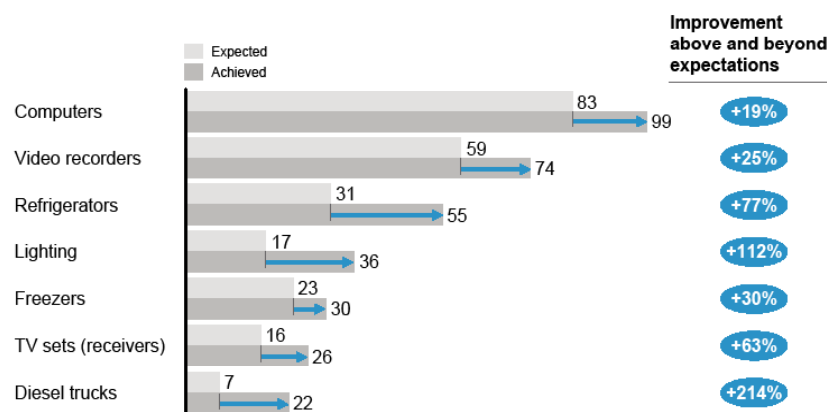
Regulation: Germany has played a very active role in the deregulation or – more precisely – the reregulation of the energy market and in the support of alternative energy, particularly with its Renewable Energy Sources Act (EEG). Despite some imperfections, this law is an example of effective regulation. It fulfills its primary purpose – increasing the share of alternative energy – while also attempting to make sure this growth is achieved efficiently in the long term, with a positive macroeconomic impact. The EEG achieves this by continually lowering the subsidy a producer may receive – in a planned and predictable manner, thus creating an incentive to continually reduce the given cost. (In some

instances, it would have been better if the Act had required a bigger decrease in unit costs as this would have spurred German companies to strive for early global cost leadership.) Future smart regulation in Germany will not only build on the positive elements of the EEG, but also set even higher standards for the continuous improvement of energy-efficient products. Planning stability for stakeholders over a sufficiently long investment period is vital, while making ongoing performance improvement a prerequisite for continued support. It is impossible to precisely estimate the actual economies of scale in the production of new technologies; therefore continuous, flexible adjustment of regulation and state backing is essential over the entire period, based on clear parameters.

Another example of smart regulation is the “Top Runner” program in Japan. Since 1999, Japanese manufacturers of vehicles, domestic appliances, and office machines have been required to design their products so they are at least on a par with the most efficient in the industry, and are given a specific deadline for accomplishing this. Products that do not achieve this benchmark have to be taken off the market after a transition period. This makes it attractive for companies to strive for energy efficiency. R&D expenditure is no longer considered a competitive disadvantage because every competitor needs to invest as well. The efficiency improvements this law has achieved have far exceeded expectations (Figure 16). To take just one example, the energy efficiency of refrigerators has improved by more than 55 percent.

Improvement in energy efficiency of products because of the “Top Runner” program in Japan

Percent¹



¹ Savings achieved across various periods of time
SOURCE: Energy Conservation Center, Japan

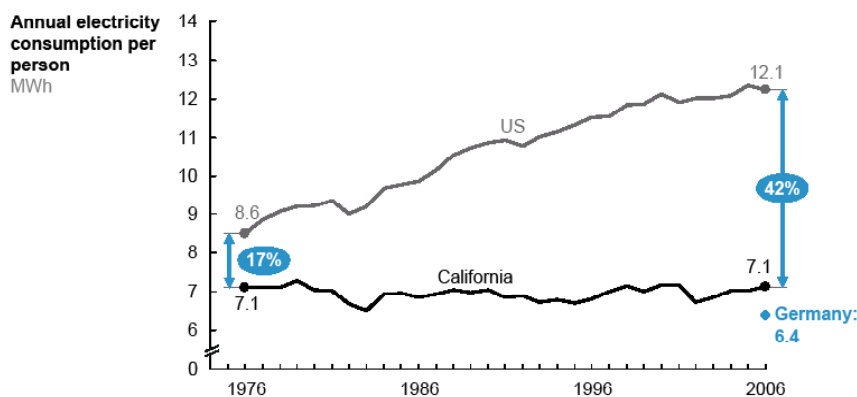
Figure 16

Along with such regulation designed to challenge and push industries to improve, information campaigns can also be very successful. The US Environmental Protection Agency has used the “Energy Star” label for especially energy-efficient products since 1992, and the EU has also been running a similar program in its member states since 2001. For example, for an electrical device to be awarded the Energy Star label, the manufacturer has to prove that consumption at idle speed is below a specific threshold. Since 1992, a total of 2.5 billion products have been sold in the US with the “Energy Star” seal of quality, saving consumers around USD 16 billion in energy costs in 2007. The

labeling campaign and increased consumer interest have made it profitable for companies to invest in developing energy-efficient products.

For the last three decades, California has also been a success story in terms of how government policy initiatives can contribute to enhancing energy efficiency. These initiatives extend from researching energy-efficient technologies and services to introducing efficiency standards for factories and compulsory energy-efficiency targets for all public buildings. Companies also receive a reward if they build or refurbish buildings for higher energy efficiency. These measures have contributed to keeping California's per capita electric power consumption stable for thirty years, while the US average has risen by 40 percent over the same period (Figure 17).

Development of electric power consumption in California



SOURCE: Energy Information Administration (EIA); Federal Ministry of Economics and Technology

Figure 17

Promoting start-ups: New companies are often especially good at commercializing innovations. Start-ups are therefore a crucial step in creating new jobs in Germany. The state can use various levers to boost the start-up rate in Germany (3 percent of all companies) to a level similar to that of the frontrunners – the UK (9 percent) and the US (8 percent) – as already described in our 2008 publication *Germany 2020*.

First, it is important to provide capital for fast-growing technology companies via experienced entrepreneurs (“business angels”). Business angels are especially relevant for small companies because they usually make earlier-stage investments than classic venture capitalists. They also coach or mentor these companies, often as a member of the supervisory board. To increase the number of business angels in Germany, the state could assist them by offering tax deductions on investments in new companies.

Furthermore, policy frameworks can support the commercialization of leading-edge technology and the promotion of clusters. Elements of both include exchanges between universities and entrepreneurs as well as support from lawyers and financiers. A key step in nurturing spinoffs (i.e., start-ups founded by universities, research centers, or companies) is to provide better business training for researchers and inventors. A curriculum

geared to practical studies and entrepreneurship helps to translate technological progress into growth and jobs. In tandem, funding in Germany should focus on cultivating a few clusters to achieve a critical mass of leading researchers, students, and venture capitalists to generate and grow successful spinoffs. Large clusters that are networked with each other are cornerstones for economic success. Examples of successful high-tech clusters in environmental technology are the Center for Sustainable Water Management in Singapore, “Clean Tech” in San Diego, and the solar industry in the state of Saxony-Anhalt in Germany.

Another direct lever that can be applied by the state are public procurement and tender processes that foster innovation. Conventional invitations to tender often contain long lists of standardized requirements, which can be a major roadblock to innovative start-ups. Invitations to tender that outline a problem and then request creative solutions would nurture an entirely new mentality, tapping into the strengths of original and inventive newcomers to the market. Introducing a new policy of this kind could have a direct impact on the prospects of success for companies offering out-of-the-box solutions.

Promoting scientific and technical R&D: When governmental institutions plan to support R&D programs, they often have problems selecting specific innovative technologies to promote. In our context, there are some topics of overriding importance, such as energy storage. Generally, however, it is unlikely that the state will have greater insight into research priorities than the researchers and companies involved. This limits the options of the state to fund specific projects. We therefore see two main approaches for state support of R&D:

- Overall research effectiveness and efficiency should be improved, especially at universities. They need to be given greater autonomy, making their own decisions on structures and staff in their research and teaching, so they can start competing for the best professors and students.
- Research on energy needs to be encouraged in Germany in a process similar to the current approach of selecting specific “research focus areas,” but with closer involvement of the business community to supplement what is otherwise an exclusively academic perspective. The German Science and Humanities Council is one entity that could fulfill this role.

The state initiatives required can only be implemented with sufficient consensus in society. Yet even extensive entrepreneurial strategies ultimately build on public acceptance or at least tolerance. If Germany aspires to use energy productivity and emissions reduction to fuel its growth, stakeholder debate on this topic has to be raised to a higher level. Trade-offs and conflicts over appropriate means to achieve ends have to be anchored in social and political discourse. A clear assessment of the technical implications is also crucial (such as the backup systems required for wind power) to ensure that decisions have a sound fact base, rather than being driven by wishful thinking that may lack economic viability.

Jointly with partners from business, academia, and politics, McKinsey wants to demonstrate how real-life solutions for greater energy efficiency can be implemented. The first initiative is an “Energy Model Factory”



7. Practical solutions: Pilot initiatives

Companies often need the support of other players and/or the government to capture the strategic potential of energy efficiency. Joint coordinated action by business, academia, and policymakers is essential particularly in heavily regulated markets. Political regulation and innovative business activity should go hand in hand. Only then can German companies be successful in the global growth markets for energy efficiency and emissions reductions.

McKinsey is contributing to this development in cooperation with partners from the relevant fields. We plan to launch initiatives to develop concrete, practical solutions in specific growth segments. With our efforts, we will be focusing on areas where success is dependent on the cooperation and coordination of multiple stakeholder groups.

Industrial manufacturing is at the heart of our first initiative: the Energy Model Factory. Increasing energy productivity is ever more important in manufacturing, and the energy savings potential is huge: up to 35 percent. Yet many companies are far from fully capturing this potential because they are neither sufficiently aware of their energy consumption and savings opportunities nor familiar with the optimization levers and instruments they could use. The Energy Model Factory is designed to close both of these gaps by imparting the latest knowledge on methods and technologies.

McKinsey is setting up this model factory jointly with the Institute for Machine Tools and Industrial Management (iwb) at Munich Technical University. The Energy Model Factory, which is scheduled to open in fall 2009, has a twofold mission: educate/train students enrolled at iwb, and provide training for engineers and managers. McKinsey will support the project with its global, cross-industry experience and expertise – especially in production optimization – in order to create a real-life learning environment. The iwb will contribute its experience from numerous studies on energy productivity as well as its expertise in manufacturing, assembly technology, and factory planning.

The model factory will provide a unique, hands-on learning environment to bring to life the topic of energy productivity in production. It will take a cross-industry perspective, looking at all types of energy and optimization levers. Students will engage in improving a production process while experimenting with theoretical and practical approaches. They will also learn to identify various kinds of energy waste by applying systems optimization and new technologies to capture additional savings, using a proven set of methodologies. Furthermore, the curriculum will be supplemented by techniques for sustainable realization of the potential, with a special focus on anchoring energy productivity in corporate strategy, HR management, and employee training. The model factory will also give students at the iwb the opportunity to gather practical experience during their studies and acquire management know-how alongside technical expertise.

McKinsey Germany has set itself the goal of providing solutions in real life together with selected partners from the worlds of business, academia, and politics. The first initiative is the Energy Model Factory outlined above. Further activities are currently being planned, and will be realized in the course of this year. Our aim, as stated in the Preface, is to help the German economy succeed in dynamic growth markets, while also reducing the country's energy consumption and GHG emissions. We hope this study and our future initiatives can make a significant and lasting contribution to achieving these aspirations.

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