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Capturing the European energy productivity opportunity

September 2008

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Preface

This report builds on a yearlong effort by the McKinsey Global Institute (MGI) and McKinsey's Global Energy and Materials Practice to understand the micro-economic underpinnings of global energy demand. Our report *Curbing global energy demand growth: The energy productivity opportunity* was published in May 2007 and identified the potential to abate energy demand growth by tapping available opportunities to boost energy productivity. This latest report, *Capturing the European energy productivity opportunity,* focuses on Europe's potential to increase energy productivity, as well as significant opportunities for businesses in increasing energy efficiency, not only in terms of future energy savings but also in new markets that will develop as a result.

Anja Hartmann, a principal in McKinsey's Hamburg office, Michael Graubner, an engagement manager in the Berlin office, and Jaana Remes, a senior MGI fellow based in San Francisco, have provided the leadership for this project. We benefited from thoughtful input and expertise of many McKinsey colleagues around the world. We would like to particularly thank Eric Beinhocker, Peter Berg, John Livingston, Tomas Nauclér, Jeremy Oppenheim, and Thomas Vahlenkamp for their input.

We are grateful for the essential research provided by Tim Beacom, Florian Bressand, Claudia Dittrich, Rahul Gupta, and Jaeson Rosenfeld. We would also like to thank Janet Bush, MGI senior editor, and Rebeca Robboy, MGI's external relations manager.

This work is part of the fulfillment of MGI's mission to help global leaders understand the forces transforming the global economy, improve company performance, and work for better national and international policies. As with all MGI research, we would like to emphasize that this work is independent and has not been commissioned or sponsored in any way by any business, government, or other institution.

Diana Farrell
Director, McKinsey Global Institute
September 2008
San Francisco

Capturing the European energy productivity opportunity

Europe faces multiple and pressing energy challenges. Rising oil prices are having a major impact on the continent, which imports more than 80 percent of the oil it consumes. Concerns about security of supply, notably natural gas from Russia, are persistent and growing. At the same time, unease among Europe's public and business leaders about the effects of increasing greenhouse gas (GHG) emissions on climate change is gathering force.

Despite the challenges, Europe wants to continue to be able to provide its citizens with stable and improving standards of living. Europe needs to find a way to decouple GDP growth from energy consumption in order to meet the twin objectives of achieving GHG emission targets while maintaining economic growth and welfare.[1] Europe can achieve this by focusing its efforts on improving energy productivity—the level of benefits we achieve from the energy we consume (see "What is energy productivity?"). The European Commission recognizes the imperative of using energy more productively as part of its road map to a low-carbon future, published in January 2008, in which the Commission sets a target of reducing energy consumption in 2020 by 20 percent below the base-case projections.

Research by the McKinsey Global Institute (MGI) and McKinsey's global energy and materials practice finds that Europe can achieve this target—and indeed has an opportunity to increase energy productivity that would halt energy demand growth in the region completely, compared with the 1.2 percent annual increase to 2020 projected today. The energy savings would total 17.4 quadrillion

1 *The carbon productivity challenge: Curbing climate change and sustaining economic growth,* McKinsey Global Institute, July 2008.

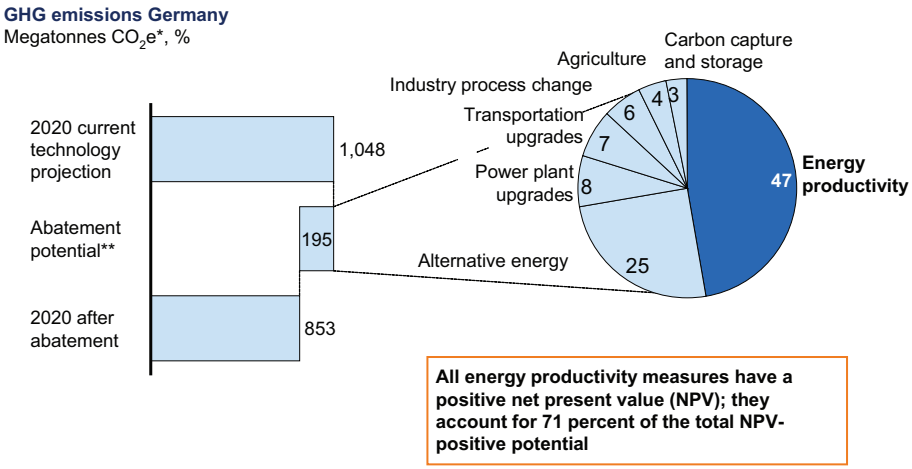
British thermal units (QBTUs) in 2020, equivalent to double the final electricity consumption of all EU-25 countries in 2003.[2]

Boosting energy productivity in such a way has a number of societal and economic benefits that make the case even more attractive. Increasing energy productivity is the most cost-effective way to reduce GHG emissions (Exhibit 1). By implementing the levers to boost energy productivity, Europe would simultaneously reduce its GHG emissions by almost 1 billion tonnes of CO_2 in 2020—more than the combined CO_2 emissions of the United Kingdom and France in 2003.

Exhibit 1

ENERGY PRODUCTIVITY IS THE BIGGEST AND MOST COST-EFFECTIVE LEVER TO ATTACK GHG EMISSIONS

EXAMPLE GERMANY



* Carbon dioxide equivalent, a standardized measure of GHGs that accounts for differing warming potentials of different GHGs such as methane.
** With abatement cost lower than €20/t CO_2e from a decision-maker perspective and change in energy mix.
Source: "Costs and potentials of greenhouse gas abatement in Germany," McKinsey & Company on behalf of "BDI initiativ — Business for Climate," September 2007

Compared with many of the alternative energy supply solutions, investing in energy productivity is cost-effective and faces less uncertainty. In many cases, investments in energy productivity are feasible with existing technical means and are economically attractive to consumers, businesses, and the government. To reflect this, our estimate of the potential to boost energy productivity includes only those opportunities that rely on existing technologies and that have an

2 1 QBTU equals 293 terawatt hours (TWh) or 25.2 million tonnes of oil equivalents.

internal rate of return (IRR) of 10 percent or more, paying for themselves in future energy cost savings.

Furthermore, investments in energy productivity reduce the need to expand energy supply. The IEA estimates that, on average, an additional €1 spent on more efficient electrical equipment, appliances, and buildings avoids more than €2 in investment in electricity supply. As Chevron CEO David O'Reilly recently pointed out, "energy efficiency is the cheapest form of new energy we have."[3] The earlier we reduce our energy consumption through boosting energy productivity, the larger the supply savings will be.

In addition, European businesses can benefit by innovating and creating new products and markets for energy-efficient products and solutions. We believe that a broad range of potential investors could productively invest close to €30 billion annually in energy productivity improvements across Europe.[4]

And finally, for the economy overall, capturing the energy productivity opportunity will provide a positive return that would free up resources to increase consumption or investment elsewhere—without compromising consumers' comfort and convenience.

In this paper, we first estimate the energy productivity opportunity in Europe using our microeconomic analysis of European energy demand growth in different end-use sectors to 2020. We then turn to the emerging policy landscape designed to overcome a range of current barriers to higher energy productivity that result in many economically attractive opportunities being left on the table today. Finally we suggest seven areas in which European companies can reap major business benefits from boosting energy productivity. These are building-technology products; electrical devices; fuel-efficient transportation; products that create transparency for end users; customized solutions based on products; energy services; and financing of energy-efficiency investments.

3 "Chevron's CEO: The price of oil," *Fortune,* November 28, 2007.

4 *The case for investing in energy productivity,* McKinsey Global Institute, February 2008.

What is energy productivity?

Any successful program to address today's mounting energy-related concerns needs to be able to rein in energy consumption without limiting economic growth. Higher energy productivity is the way to achieve this goal. It is also the most cost-effective way to curb energy demand growth and GHG emissions.

Like labor or capital productivity, energy productivity measures the output and quality of goods and services generated with a given set of inputs. We measure energy productivity as the ratio of value added to energy inputs, which is $79 billion of GDP per QBTU of energy inputs globally. The ratio in Europe is $116 billion (€93 billion) per QBTU. It is the inverse of the energy intensity of GDP, measured as a ratio of energy inputs to GDP. This currently stands at 12,600 BTUs of energy consumed per dollar of output globally and at 8,600 BTUs per dollar in Europe (10,800 BTUs per euro).

Energy productivity provides an overarching framework for understanding the evolving relationships between energy demand and economic growth. Higher energy productivity can be achieved either by higher energy efficiency that reduces the energy consumed to produce the same level of energy services (e.g., a more efficient bulb produces the same light output for less energy input), or by increasing the quantity or quality of economic output produced by the same level of energy services (e.g., providing higher value-added services in the same office building).[5]

Using energy more productively is more desirable than seeking exclusively to reduce end-use demand, which would risk compromising economic growth and denying consumers their legitimate aspiration to comfort and convenience, particularly consumers in developing economies for whom access to energy is a core component of rising living standards.

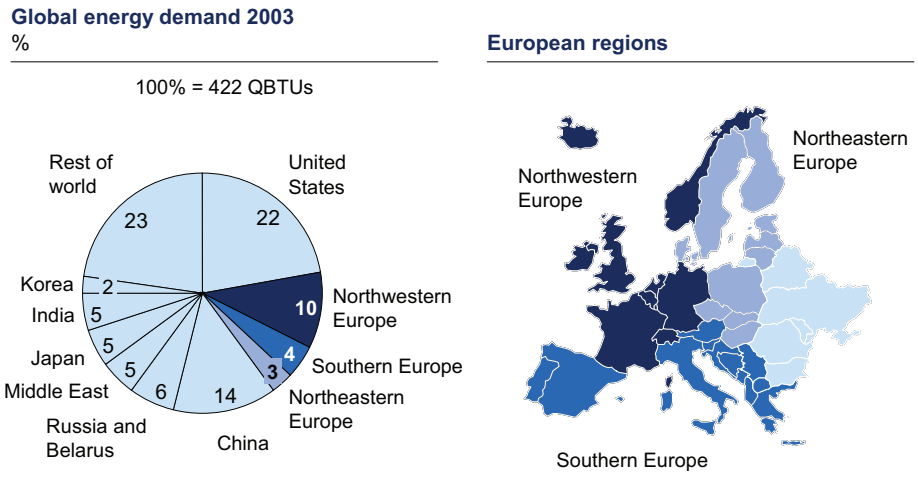
5 We use the term energy efficiency to refer specifically to the technical efficiency of translating energy inputs into energy services.

EUROPE ACCOUNTS FOR 17 PERCENT OF GLOBAL ENERGY DEMAND

In 2003, Europe's total energy consumption was 75.1 QBTUs, equivalent to 13 billion barrels of oil or 26 barrels of oil per capita. For the purpose of our analysis, we split Europe into three main regions that broadly display marked differences in their patterns of energy use.[6] Collectively Europe represents 17 percent of total global energy consumption, less than the United States, the world's largest energy consumer at 22 percent, but more than China with 14 percent (Exhibit 2). More than half of total European energy consumption—43.9 QBTUs—takes place in Northwestern Europe.[7] Southern Europe consumes 18.8 QBTUs.[8] The Northeastern region uses another 12.4 QBTUs.[9]

Exhibit 2

EUROPE ACCOUNTS FOR 17 PERCENT OF GLOBAL ENERGY DEMAND



Source: IEA; McKinsey Global Institute analysis

6 For consistency reasons, our regional groupings match McKinsey's internal energy supply model, which explains some differences to more typical regional cuts (e.g., Norway in a separate group from Sweden and Finland).

7 Northwestern Europe comprises Belgium, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Switzerland, and the United Kingdom.

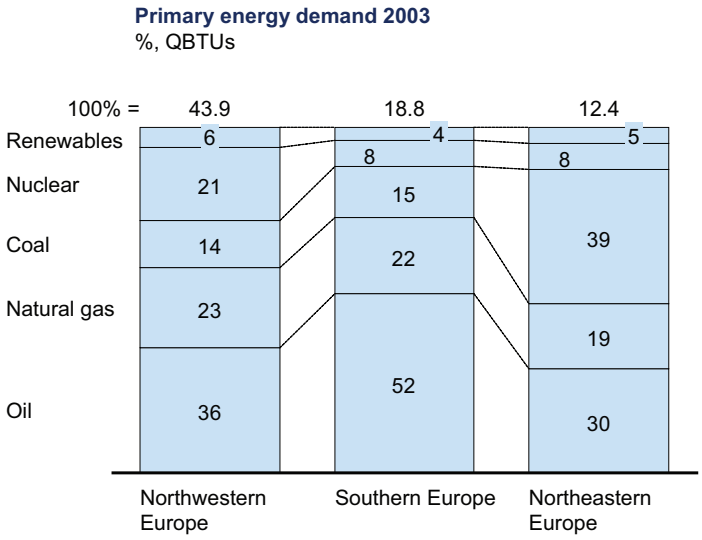
8 Southern Europe comprises Albania, Austria, Bosnia & Herzegovina, Croatia, Cyprus, Gibraltar, Greece, Italy, FYR of Macedonia, Malta, Montenegro, Portugal, Serbia, Slovenia, and Spain.

9 Northeastern Europe comprises the Czech Republic, Denmark, Estonia, Finland, Hungary, Latvia, Lithuania, Poland, Slovakia, and Sweden.

These regions also vary in the mix of primary fuels, particularly in their shares of oil, coal, and nuclear power (Exhibit 3). Northwestern Europe meets almost 60 percent of total energy demand with oil and natural gas and has a relatively high share of nuclear power, due largely to the importance of this energy source in France. The region's share of coal is quite low—and would be even lower without Germany, which meets a comparatively high 24 percent of its energy demand from coal, about half of which is locally available lignite. Norway boosts the region's share of renewables because hydropower meets two-thirds of the country's energy needs.

Exhibit 3

THE FUEL MIX VARIES SUBSTANTIALLY ACROSS EUROPEAN REGIONS



Note: Percentages may not add up to 100 because of rounding.
Source: IEA; McKinsey Global Institute analysis

Southern Europe derives more than half of its energy demand from oil. The mild Mediterranean climate reduces the amount of energy needed for residential heating, and this leaves transportation fuel demand—and thus oil—representing a higher share of overall demand. The share of nuclear power is low because most Southern European countries don't use this source of energy.

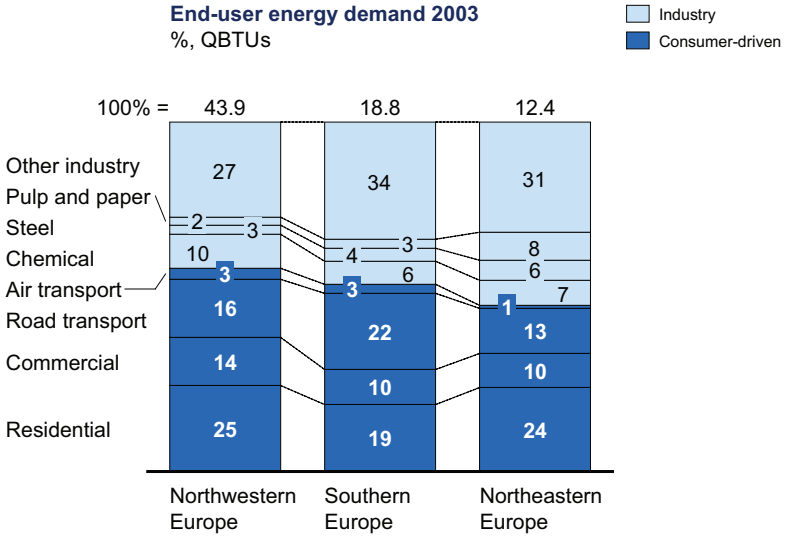
Northeastern Europe is the European region that relies most heavily on coal, driven by countries like Poland and Czech Republic that satisfy 61 percent and 46 percent respectively of their primary energy consumption from coal (largely in power generation). Sweden and Denmark boost this region's share of renewables.

More than one-quarter of Sweden's energy comes from hydropower, and more than 10 percent of Denmark's comes from wind power.

If we break energy demand in the three European regions into its different end-use sectors, we find that almost 60 percent of energy demand in Northwestern Europe comes from consumer-driven sectors, while in Northeastern Europe more than half of total demand comes from industrial sectors (Exhibit 4).

Exhibit 4

CONSUMER-DRIVEN SECTORS LEAD IN NORTHWESTERN EUROPE; INDUSTRY IN NORTHEASTERN EUROPE



Note: Percentages may not add up to 100 because of rounding.
Source: IEA; McKinsey Global Institute analysis

ENERGY INTENSITY AND CO_2 INTENSITY VARY SUBSTANTIALLY ACROSS EUROPEAN REGIONS

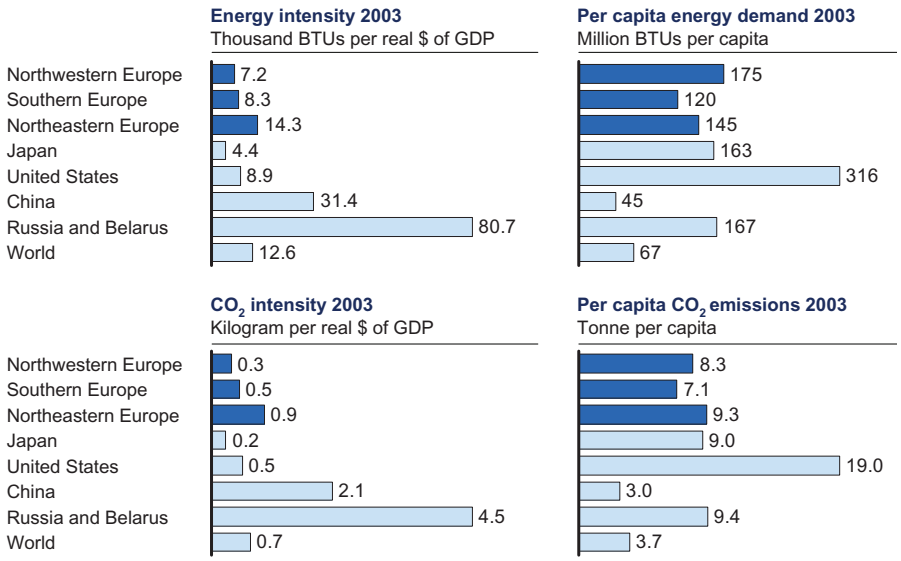
Northwestern Europe's economy runs at a relatively low level of energy intensity (the energy used to generate GDP) of 7,200 BTUs per dollar of GDP. The energy intensity of Northeastern Europe is almost twice as high, slightly above the global average of 12,600 BTUs per dollar of GDP. Meanwhile, Southern Europe falls between the two with an energy intensity of 8,300 BTUs per dollar of GDP, similar to that of the United States (Exhibit 5).

The CO_2 intensity of the three European regions understandably follows a very similar pattern to energy intensity. Northwestern Europe produces 0.3 kg of CO_2 per dollar of GDP. Only Japan, which embraced the concept of energy efficiency

earlier than many others and now has the highest energy productivity globally, produces fewer emissions per GDP. Southern Europe, which emits 0.5 kg of CO_2 for each dollar of GDP, is on a par with the United States. Northeastern Europe has the highest CO_2 intensity in Europe, courtesy of its heavy use of coal—CO_2 emissions depend not only on energy consumption but also on the fuel mix. The primary energy source for electricity generation is a critical factor. The GHG emissions of electric power generation in Europe range from more than 1 tonne of CO_2e per MWh in Poland to almost zero in Switzerland.

Exhibit 5

NORTHEASTERN EUROPE HAS DOUBLE THE ENERGY INTENSITY AND TRIPLE THE CO_2 INTENSITY OF NORTHWESTERN EUROPE



Source: IEA: McKinsev Global Institute analvsis

In per capita terms, the differences in energy demand between European regions are less marked. Per capita energy demand ranges from 120 million BTUs to 175 million BTUs—both well above the worldwide average of 67 million BTUs. All Europe's regions also produce substantially higher per capita CO_2 emissions than the worldwide average of 3.7 tonnes.

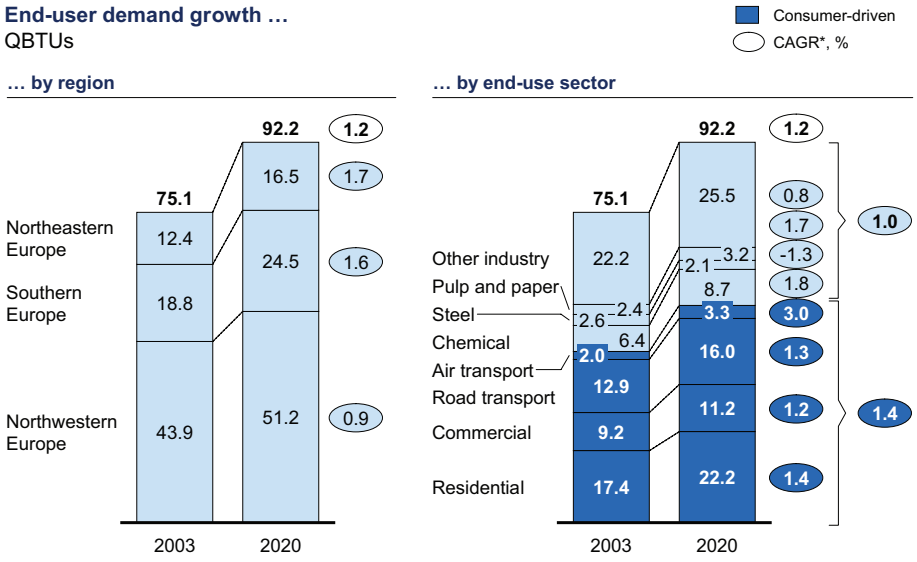
EUROPEAN ENERGY DEMAND WILL CONTINUE TO GROW, DRIVEN LARGELY BY SOUTHERN AND EASTERN EUROPE

MGI's base case, which assumes no change in policies, projects that European energy demand will grow by on average 1.2 percent a year to 2020, with annual

growth rates of 0.9 percent a year in Northwestern Europe, 1.6 percent in Southern Europe, and 1.7 percent in Northeastern Europe (Exhibit 6). These rates of energy demand growth are relatively modest compared with MGI's projection of global average energy demand growth of 2.2 percent a year. This reflects the fact that Europe's energy consumption starts from a higher level than the global average, and the mix of industries driving growth—with more services and less basic materials—is relatively "energy light."

Exhibit 6

ENERGY DEMAND WILL GROW BY 1.2 PERCENT TO 2020 DRIVEN BY NORTHEASTERN AND SOUTHERN EUROPE



* Compound annual growth rate.
Source: McKinsey Global Institute analysis

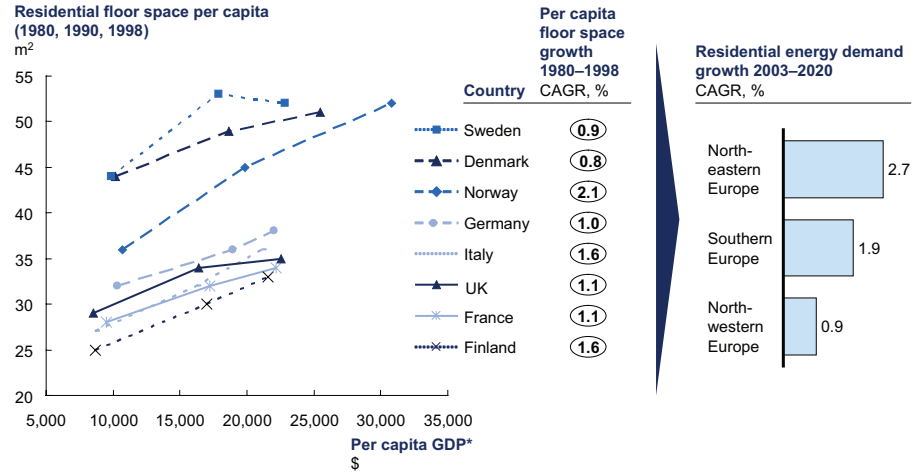
As in other developed regions, consumer-driven sectors—residential, commercial, and transportation—are driving growth in energy demand in Europe. MGI's base case projects that energy demand from these sectors collectively will grow by 1.4 percent a year compared with growth of 1.0 percent in demand from European industrial sectors. The fastest-growing single sector in Europe will be air transport with energy demand rising at 3.0 percent a year to 2020. However, air transport accounts for a small proportion of energy demand—only 2 QBTUs in Europe in 2003. The one sector in which we will see energy demand shrink is steel, reflecting an expected gradual shift of production capacity to Brazil and CIS states and a shift of Russian exports from China to Europe as China becomes increasingly self-sufficient.[10]

10 The Commonwealth of Independent States (CIS) is a loose confederation of former Soviet republics that today has ten members including Russia, Ukraine, Belarus, and Kazakhstan.

Residential sector—This sector's energy demand is projected to grow at 1.4 percent per annum to 2020. Northeastern Europe and Southern Europe will drive energy demand growth in the residential sector, while residential energy demand growth will be more modest in Northwestern Europe (Exhibit 7). Population is not a major driver of residential energy demand growth—we expect populations to be virtually flat in all three regions. However, per capita floor space is a key driver. Currently at 38 square meters, per capita floor space is likely to increase by 1.5 percent a year as a result of rising incomes. Increasing penetration of electric devices and consumer electronics as well as changes in usage patterns will also boost energy demand. Together, these factors outweigh the gains from base-case efficiency improvements mainly from better building insulation, improved heating, and more efficient electrical equipment.

Exhibit 7

RESIDENTIAL ENERGY DEMAND WILL GROW ACROSS EUROPE AS HIGHER INCOMES LEAD TO AN INCREASE IN FLOOR SPACE PER CAPITA



* At purchasing power parity.

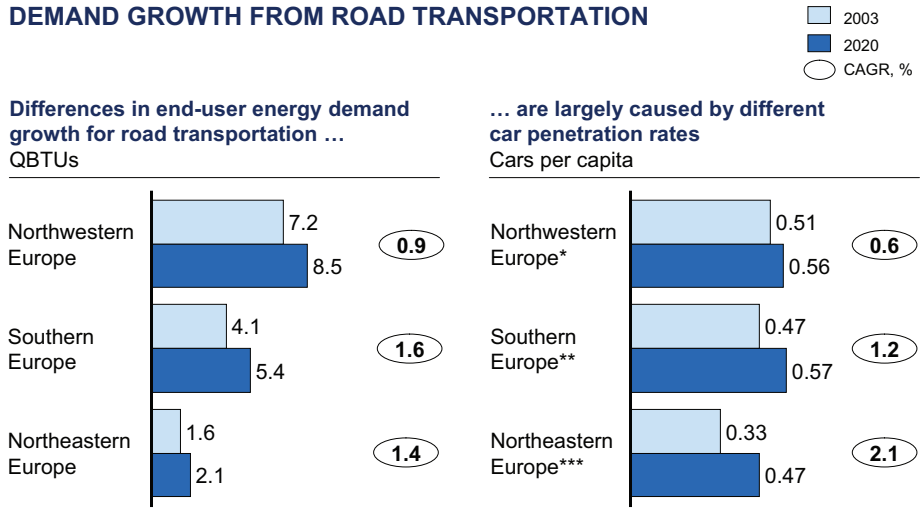
Source: IEA; McKinsey Global Institute analysis

Commercial sector—Commercial energy demand will grow at 1.2 percent annually. This sector is highly fragmented and includes energy use in hotels, business services, wholesale, communications, retail, and public services. Yet across them all, more than 80 percent of overall energy demand relates to building floor space. Although Europe is seeing improvements in the energy efficiency of lighting, heating, air conditioning, refrigeration, and office equipment, these will not be sufficient to compensate fully for the effects on demand of increasing floor space.

Road transportation—Energy demand from this sector will grow at 1.3 percent per annum overall, expanding most quickly in Southern Europe, followed by Northeastern Europe, and finally Northwestern Europe. Different growth rates are due primarily to varied rates of initial car penetration. Penetration will grow most strongly in Northeastern Europe, although substantial gains in fuel efficiency will mitigate some of the growth in the region. The transportation energy demand growth in Northwestern and Southern Europe comes partly from an increasing share of larger vehicles in new-car sales (Exhibit 8).

Exhibit 8

INCREASING CAR PENETRATION RATES DRIVE ENERGY DEMAND GROWTH FROM ROAD TRANSPORTATION



* Without Iceland and Luxembourg.
** Without Albania, Cyprus, Former Yugoslavia, Gibraltar, Malta.
*** Without Estonia, Latvia, Lithuania.
Source: Global Insight; McKinsey Global Institute analysis

EUROPE WILL MAKE LARGE ENERGY PRODUCTIVITY GAINS, BUT PER CAPITA CO_2 EMISSIONS WILL STILL RISE

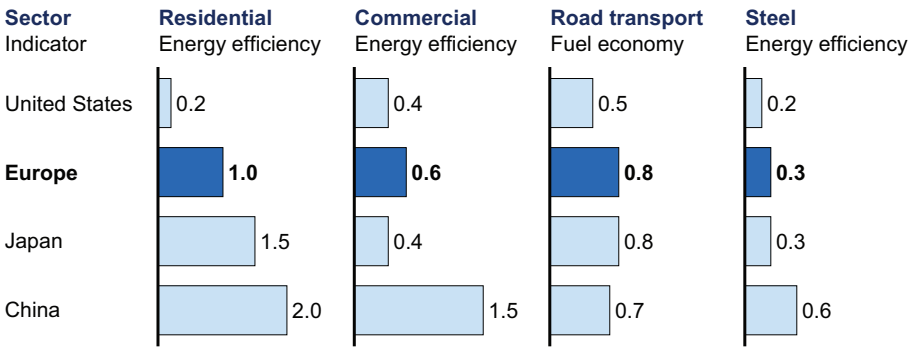
Under current policies, Europe will make substantial energy-efficiency improvements to 2020 (Exhibit 9). These improvements will go some way—but not the whole way—toward mitigating growing energy demand. As GDP outgrows energy demand in all three regions, energy intensity declines—a trend that we see in most regions in the world. Yet per capita energy consumption and CO_2 emissions will still rise, particularly in Northeastern Europe (Exhibit 10).

CO_2 intensity will remain flat or decrease only slightly, for example, because of the adverse shift in fuel mix in Northwestern Europe. Natural gas and coal partly fill the gap left by the phase-out of nuclear power in Germany.

Exhibit 9

SUBSTANTIAL EFFICIENCY IMPROVEMENTS WILL BE ACHIEVED ACROSS SECTORS IN EUROPE

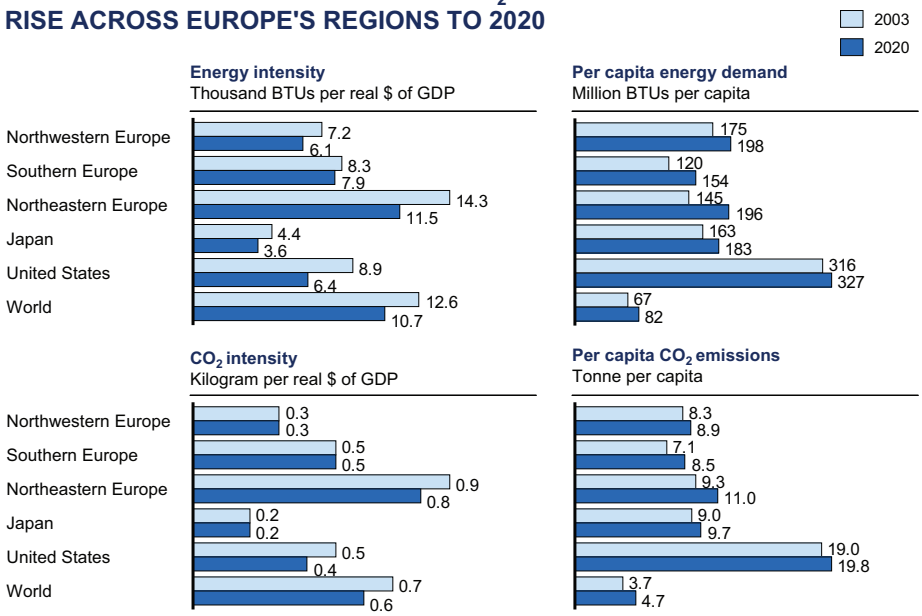
Annual improvement of energy-efficiency indicators, 2003–2020
%



Source: EIA; Lawrence Berkeley National Laboratory China Energy Group; McKinsey Global Institute analysis

Exhibit 10

PER CAPITA ENERGY DEMAND AND CO_2 EMISSIONS RISE ACROSS EUROPE'S REGIONS TO 2020



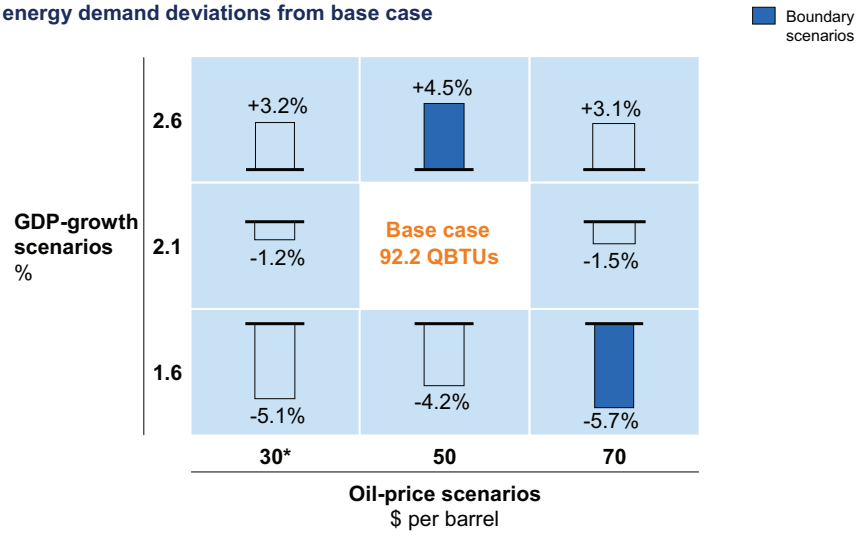
Source: McKinsey Global Institute analysis

MGI's base-case projections for European energy demand are moderately sensitive to the rate of GDP growth but respond only a little to changes in the oil price (Exhibit 11). In the base case, we project that European GDP will grow by 2.1 percent a year to 2020. With a GDP growth rate that is 0.5 percent higher or lower than our base case, we project that energy demand in 2020 would be correspondingly 4.5 percent higher or 4.2 percent lower.

Exhibit 11

GDP GROWTH HAS MUCH STRONGER EFFECT ON ENERGY DEMAND THAN OIL PRICE

2020 energy demand deviations from base case



* At $30 per barrel oil price, substitution of coal with natural gas for power generation; with higher efficiency of gas power plants, overall energy demand slightly decreasing over $50 per barrel scenario.

Source: McKinsey Global Institute analysis

However, with oil prices at $70 per barrel instead of our base-case assumption of $50 a barrel, energy demand in 2020 would only be some 1.5 percent lower.[11] There are two main reasons why the impact of higher oil price is rather small. First, Europe in 2020 satisfies approximately 40 percent of its energy demand through coal, nuclear, and renewables, none of which necessarily correlates with changes in oil price. Second, Europe taxes gasoline and diesel sales heavily, which insulates end-user prices from changes in the price of oil and results in a relatively low elasticity to oil compared with, say, the United States.

11 MGI's oil-price scenarios assume sustained oil prices of $50 and $70 per barrel to 2020 in the base case and high oil-price scenarios respectively. While these are below today's prices, they are within the range of long-term price expectations. We are currently assessing the impact of sustained higher oil prices on oil demand in forthcoming MGI research.

Taking GDP growth and oil prices together, we see energy demand swinging to 4.5 percent above our base-case scenario in a high GDP-growth, medium oil-price scenario, and 5.7 percent below our base case in a low GDP-growth, high oil-price scenario.

HIGHER ENERGY PRODUCTIVITY COULD CAP EUROPE'S PROJECTED ENERGY DEMAND AT TODAY'S LEVEL TO 2020

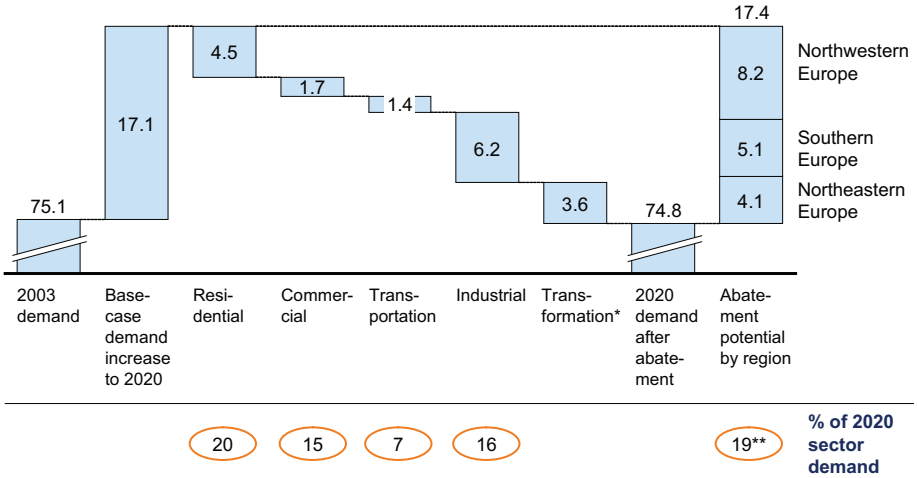
Embracing positive payback opportunities to improve energy productivity can make a significant difference in Europe, enabling the region's annual energy consumption to remain flat to 2020 at 75 QBTUs instead of increasing by 1.2 percent a year. Our research shows that enough opportunities are available to save 17.4 QBTUs of energy, more than the entire projected growth in end-use demand—17.1 QBTUs—between 2003 and 2020. The abatement in demand would be equivalent to 8 million barrels of oil per day, or 19 percent of 2020 demand in our base case (Exhibit 12). These positive payback opportunities alone have the potential of delivering most of the European Commission's consumption targets to 2020. Energy intensity would fall to 5,000 BTUs per dollar of GDP in Northwestern Europe (from 6,100 BTUs in the 2020 base case), to 6,300 BTUs in Southern Europe (from 7,900 BTUs), and to 8,600 BTUs in Northeastern Europe (from 11,500 BTUs).

Higher energy productivity alone would enable Europe to achieve an annual 0.5 percent cut in its CO_2 emissions instead of growth of 0.8 percent a year (Exhibit 13) (see "Germany could achieve a 31 percent cut in GHG emissions by 2020" for a summary of the opportunity in Germany).

Exhibit 12

LARGE OPPORTUNITIES TO BOOST ENERGY PRODUCTIVITY ARE AVAILABLE ACROSS SECTORS

Potential energy demand reduction in 2020 through energy productivity
QBTUs

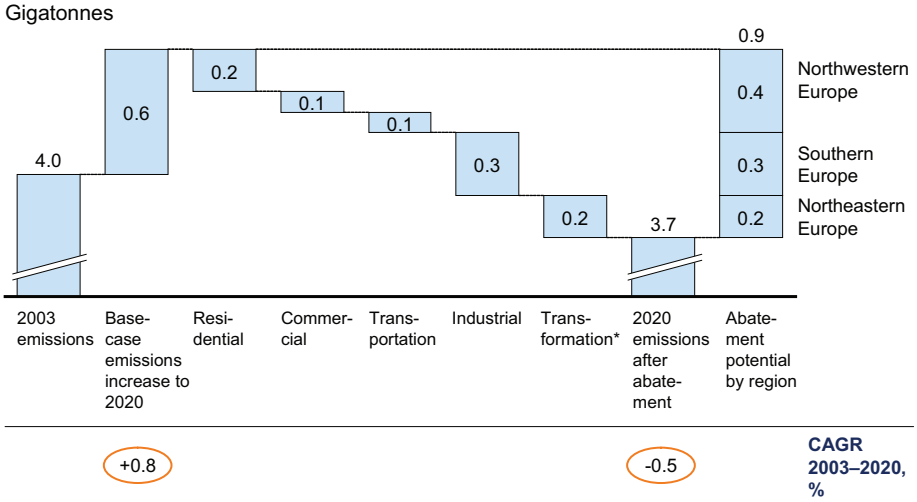


* Power generation and refining sectors.
** Percent of 2020 base-case demand, including potential from transformation.
Source: McKinsey Global Institute analysis

Exhibit 13

INCREASED ENERGY PRODUCTIVITY ALSO TRANSLATES INTO REDUCTION OF CO_2 EMISSIONS ACROSS SECTORS

Potential CO_2 emission reduction in 2020 through energy productivity
Gigatonnes



* Power generation and refining sectors.
Source: McKinsey Global Institute analysis

Germany could achieve a 31 percent cut in GHG emissions by 2020

Recent research published by McKinsey & Company on behalf of "BDI initiativ – Business for Climate" finds that reducing GHG emissions in Germany by 31 percent by 2020 (compared with 1990) is an ambitious, but possible, aim. In the first comprehensive, bottom-up analysis of all known climate-protection technologies and the cost in terms of euro per tonne of avoided GHG emissions, McKinsey finds that this level of reduction is economically achievable without hurting economic growth and the quality of life, even if the planned phase-out of nuclear power in Germany goes ahead. Indeed, McKinsey finds that reducing GHG emissions could have positive effects on business and employment in Germany.

A reduction of 31 percent is possible with measures that cost less than €20 per tonne of CO_2e or are part of the already planned change in energy mix. About two-thirds of the measures pay off within the investment's relevant lifetime. Most of the technologies needed are already available. The biggest measure for GHG reduction is improved energy efficiency in buildings. Other abatement measures exist, but McKinsey's analysis finds that significantly greater investments would be necessary. A reduction in GHG emissions by 36 percent would require much higher abatement costs of up to €1,000 per tonne CO_2e.[12]

The energy productivity opportunities that we have identified rely on existing technologies that have an IRR of 10 percent or more and would therefore free up resources for investment or consumption elsewhere. These opportunities can reduce energy demand in two main ways. First, they reduce the specific amount of energy consumed, for example, by adopting compact fluorescent lighting (CFL) and higher-efficiency appliances, pumps, compressors, and heating systems. Second, these opportunities optimize when and how we use energy in order to reduce waste—by controlling the timing and duration of energy consumption through smart control and management of lighting and space heating, demand-instantaneous water heating, and speeding up of processes in smelting or forging.

The residential sector offers the highest potential to abate demand relative to the size of these end-use segments. Tapping available energy productivity opportunities could abate 4.5 QBTUs of demand—equal to 20 percent of energy demand from this sector in 2020 in our base

12 For details of the full report, please see the back of this publication.

case. Higher-efficiency appliances, large and small, contribute about one-third of this potential. The remainder comes from high-efficiency heating and cooling systems, the replacement of incandescent light bulbs with CFL, and the reduction of standby energy consumption.

The commercial sector offers similar opportunities in heating, cooling, and lighting as the residential sector, albeit with less attractive economics as the initial energy-efficiency level is already higher. For example, commercial lighting is already more efficient and requires more complex upgrades. Overall, we have identified the potential to abate 1.7 QBTUs of energy demand, or 15 percent of 2020 base-case demand.

The transportation sector offers the opportunity to abate another 1.4 QBTUs, or 7 percent of this sector's 2020 demand in our base case. The proportion is relatively low because, with oil prices at $50 a barrel, many of the economically viable fuel economy opportunities have already been implemented. The remaining opportunity includes design choices that improve aerodynamics, as well as material choices that reduce weight.

The industrial sector offers the potential to abate 6.2 QBTUs—equivalent to 16 percent of 2020 demand. Several technologies and processes are available that would not only save energy across a large number of subsectors but would also reward those businesses that invest with rapid payback times. Three of the biggest opportunities are improved recovery of heat generated in the production of mechanical or electrical power, improved cogeneration, and the optimization of motor-driven systems such as pumps and compressors. There are also industry-specific opportunities, including near-net-shape casting in the metals industry, the use of membrane technology instead of mercury in chemicals, and speeding up processes in energy-intensive industries to reduce losses.

The transformation sector has the potential to abate 3.6 QBTUs. The bulk of these opportunities is in power generation with the rest coming from refining. The technologies are available to increase the efficiency of new power plants by up to 5 percent. Retrofits of existing plants that embed higher efficiency would also create energy savings by allowing these plants to operate at higher temperatures and pressures.

By region, the largest potential—8.2 QBTUs—lies in Northwestern Europe, equivalent to 16 percent of this region's base-case end-user demand in 2020. Southern Europe has a 5.1 QBTU opportunity, or 21 percent, while Northeastern Europe can abate 4.1 QBTUs, or 25 percent of 2020 demand. The reason behind the higher percentage of opportunities in Southern and Northeastern Europe is twofold. First, these regions start at comparatively lower technical standards; second, the higher energy demand growth provides more economically attractive potential to install higher efficiency solutions during initial investment than retrofitting already existing equipment and buildings. The story is somewhat different in transportation where the abatement opportunity is very similar across the three European regions at some 7 percent to 8 percent of base-case 2020 demand.

We believe that our assessment of the European energy productivity opportunity is a relatively conservative estimate of the overall potential that is available. Our hurdle rate of 10 percent IRR leaves out many available technologies that have a lower positive or slightly negative return—such as solar water heaters. And because we include only opportunities that are currently available, we do not take account of technological innovations, scale benefits, and the learning-curve effects that will accrue over time. Nor do we assess the potential available from more radical solutions, including those that could be obtained from more fundamental system optimizations in production processes or that would require changes in behavior or reduce the comfort level of consumers. The Wuppertal Institute, whose assessment includes measures that technically are not fully mature yet, are relatively expensive, or require substantial infrastructure investment, estimates that Europe could increase energy efficiency in the commercial sector by more than 20 percent, compared with our estimate of 15 percent of our base-case projection for commercial sector demand in 2020.[13]

POLICY MAKERS ARE STARTING TO PLAY A ROLE IN OVERCOMING MARKET BARRIERS TO ENERGY PRODUCTIVITY

The European Commission estimates that Europe wastes at least 20 percent of its energy. At current oil prices, this could be costing Europe some €200 billion a year, and the Commission's Action Plan for Energy Efficiency 2006 aims to save 20 percent of primary energy on top of business as usual.

13 Lechtenböhmer, Grimm, Mitze, Thomas, and Wissner, *Target 2020: Policies and Measures to reduce Greenhouse gas emissions in the EU,* Wuppertal Institut für Klima, Umwelt, Energie, September 2005.

A myriad of information barriers, market imperfections, and policy distortions today stand in the way of investors taking up economically attractive opportunities to invest in energy productivity and explain why consumers and businesses fail to capture the savings that higher energy productivity offers. These hurdles vary in type and seriousness in different geographies, but it is commonplace to find that consumers lack the information and capital they need to become more energy productive. In addition, the small and fragmented nature of energy costs tends to deter businesses from seeking higher energy productivity. Moreover, a range of policies dampen price signals and reduce incentives for end users to adopt energy productivity improvements, including widespread energy subsidies to state-owned enterprises and subsidies on fuel for consumers in some countries. Finally, a number of agency issues act against the adoption of higher-efficiency solutions.

Under these conditions, market forces alone will not capture the full potential for higher energy productivity, leaving a role for policy. The EU already has a broad array of directives and legislation in place to improve the energy efficiency of energy-using products, buildings, and services. National governments, too, are already active in co-financing of energy-efficiency improvements and in using their tax systems to help consumers and businesses to finance initial outlays. Governments also frequently design information campaigns and demonstration projects that encourage consumers and businesses to become more aware of the energy savings available to them. And last, Italy and France among other governments have set up white certificate programs to certify and potentially trade energy savings from higher efficiency.

MGI analysis suggests that there are four priority areas for further action that are more or less applicable to all geographic regions: setting energy-efficiency standards for appliances and equipment; upgrading the energy efficiency of new buildings and remodels; raising corporate standards for energy efficiency; and investing in energy intermediaries. These four together will play an important role in jump-starting efforts to boost energy productivity (see “Four key areas to get right”).

Four key areas to get right

Setting energy-efficiency standards for appliances and equipment—government efficiency standards are an effective, low-cost way to coordinate a transition to more efficient appliances and are most effective in white goods, appliances, standby electricity consumption, fuel efficiency in transportation, and arguably in lighting. With the implementation of such standards, economies of scale quickly emerge so that prices for energy-efficient products decline to the level of the old, less efficient products—and increase the market for more efficient products and services. Standards are more effective if they set targets for overall efficiency rather than the attainment of a specific technological standard; the latter can narrow markets and lead to distortions.

Upgrading the energy efficiency of new buildings and remodels—the efficiency of facility heating and cooling is one of the largest energy productivity opportunities. It is during the construction of new buildings when the economics are most attractive—it is much less expensive than retrofitting with higher energy-efficiency features at a later stage. The Republic of Ireland, for instance, is planning mandatory new home energy-efficiency standards covering insulation, lighting, and "future proofing" of new home construction to make them flexible for future upgrades; the aim is to cut energy consumption by 40 percent. The public sector can broker partnerships between building owners and suppliers of energy-efficiency technology and secure (typically performance-based) contracts between them.

Raising corporate standards for energy efficiency—for many companies, high energy costs alone can be a competitive disadvantage in today's high energy-price environment and sufficient motivation to focus senior management attention on energy efficiency. Some trail-blazing companies have already demonstrated the benefits. In Germany, Deutsche Telekom has initiated a range of energy-efficiency measures (e.g., the replacement of existing heating systems with heat generated from use of various IT products) and netted energy savings of 126 GWh in 2006.[14]

Investing in energy intermediaries—innovative power companies and energy service companies (ESCOs) can help consumers make more informed energy choices and profit from positive-return energy savings that they are not fully capturing today (see following section for a detailed discussion of the role of ESCOs in Europe). To enable this, utilities can implement technologies such as advanced metering and "smart" grids that allow consumers to see the actual cost of their appliance choice.

14 *Corporate Responsibility Facts and Figures 2007,* Deutsche Telekom

ENERGY EFFICIENCY OFFERS SIGNIFICANT NEW MARKETS AND INNOVATION OPPORTUNITIES FOR BUSINESS

In a recent survey among the 500 largest publicly traded companies globally, nearly 80 percent considered climate change—including extreme weather events or a tightening of government regulations—to present a business risk.[15] CEOs have identified climate change as one of the most important issues for their companies to address. In fact, increasing environmental concern and greater demand—and limited supply—of natural resources are the two most important trends influencing public expectations of business.[16] These executives see this topic as important, not just because they need to respond to increasing pressure from employees and customers, but arguably more importantly as an opportunity to gain competitive advantage.

The focus of companies' activities in this area thus far has often tended to be on alternative energy. Many businesses have pushed toward a "greener" image by using alternative energy sources to power their facilities. For instance, Michelin has installed eight hectares of solar photovoltaic panels on the rooftops of the company's four German sites.[17] Companies have bought renewable energy credits in order to become "carbon-neutral" by funding alternative energy projects elsewhere. Some have made large investments in solar-energy production capacity, fuel-cell research, or windmill parks, to name just a few.

Energy efficiency has long been the poor relation to renewables, but this is beginning to change. One recent report concluded, "Energy efficiency is a significant, but largely invisible market, attracting an increasing share of the limelight as investors realize that it has an important role to play in addressing growing global energy demand."[18] Businesses are beginning to see the benefits of higher energy efficiency, in terms not only of future energy savings but also of new markets that they can serve.

Cutting self-consumption—For companies the obvious starting point is to reduce their own energy consumption through higher energy efficiency and thereby enhance their profitability. There is a large opportunity to cut costs, especially in energy-intensive basic material industries such as aluminum,

15 Carbon Disclosure Project Report 2007 Global FT500, Carbon Disclosure Project, 2007.

16 "CEOs on strategy and social issues," *The McKinsey Quarterly,* October 2007 (www.mckinseyquarterly.com).

17 *Michelin: Performance and Responsibility Report 2005–2006,* p. 61, April 2007, (www.michelin.com)

18 *Global Trends in Sustainable Energy Investment 2007: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency in OECD and Developing Countries,* UN Environment Program and New Energy Finance, 2007.

chemicals, cement, copper, pulp and paper, and steel. The topic of energy efficiency has become a top priority in these sectors. Since the early 1990s, US-based chemical companies DuPont and Dow are reported to have saved as much as $2 billion and $4 billion respectively in energy costs as a result of their energy-saving programs.

The impact of energy efficiency can be substantial in other industries as well. For instance, Nokia Siemens Networks estimates that its customers, the operators of mobile networks, can save 30 percent on the electricity used to power base-station facilities with virtually no investment. A typical operator with 10 million to 15 million subscribers uses 580 billion BTUs at a cost of some €20 million per annum. Of this total, 170 billion BTUs can be saved simply by letting the indoor temperature of base-station facilities rise to 40° C (from the more usual 25° C), shutting down partial equipment during night hours, and implementing a few software features. With initial spending on efficient equipment, as much as 375 billion BTUs, or 65 percent of electricity, could be saved.[19]

Even in little energy-intensive service businesses, the potential energy savings are considerable. Citigroup has reported that it can save more than €7.5 per square meter of office space annually by using energy-efficiency improvements such as timed lighting, turning off escalators when not needed, changing settings on thermostats, and constructing "living" walls covered with plants to better insulate buildings from summer heat and winter cold (as adopted by one of the bank's data centers in Frankfurt). As Citigroup uses more than 10 million square meters of office space worldwide, the savings amount to €75 million annually.[20]

New markets in energy efficiency—Energy efficiency creates revenue-generating business opportunities that go well beyond mere cost reductions with bottom-line impact. European companies are well positioned to capture these opportunities as the efficiency standards in their home markets are often higher than those in other regions such as North America, Russia, or Asia's emerging markets. Prime examples include cars, household appliances, and windows. Companies can use energy efficiency to strengthen their position in their home market and also leverage their know-how in other regions of the world—depending on local market conditions and regulation.

Today's efforts by business to boost energy efficiency still constitute only a

19 "Telcos can save millions by energy efficiency," *Reuters,* December 5, 2007.

20 "Citigroup tries banking on the natural kind of green," *Wall Street Journal,* September 5, 2007.

fraction of the full potential that remains available. We have identified seven major categories of business opportunities: building-technology products; electrical devices; transportation; transparency-creating products; customized solutions; energy services; and financing of investments (Exhibit 14).

Exhibit 14

ENERGY EFFICIENCY CREATES SEVEN BASIC CATEGORIES OF BUSINESS OPPORTUNITIES

Building-technology products	Electrical devices	Transportation	Transparency-creating products	Customized solutions	Energy services	Financing of investments
• Space heating • Windows • Insulation • Elevators • Water boilers	• Appliances • CF lamps • Office supplies • White goods • Consumer electronics	• "Eco" cars • Locomotives • Carbon structure • Regenerative braking • Tires	• Advanced metering • Smart grids • Eco Drive program • Navigation devices	• HVAC* systems for buildings • City lighting • Measurement and control systems	• Energy consulting • Demand monitoring and mgmt. • Heat and power from cogeneration	• Earmarked loans • Leasing of equipment

* Heating, ventilation, and air conditioning.
Source: McKinsey Global Institute analysis

Building-technology products include space-heating, ventilation, and air-conditioning equipment, windows, doors, elevators and escalators, and building insulation, as well as end-product components such as heat exchangers and solar-control glass. Businesses can improve energy efficiency in this sector without regulatory intervention as upgrades in more energy-efficient buildings mostly pay for themselves over time. Improving the energy efficiency of building-technology products is becoming a key priority particularly when old equipment is due for replacement. Some firms have capitalized on this trend—it is not just manufacturers of building-technology products that benefit but also those who install and commission new technology. For instance, Otis, one of the worldwide leaders in elevators, escalators, and people-moving belts, introduced the Gen2 elevator type in 2000 and it has become the fastest-selling line in the company's history. Gen2 products use up to 75 percent less energy and are quieter and smoother than conventional elevators. Elevators had used essentially the same technical concept for more than 150 years, and the new generation of products represents a radical change. The permanent magnet gearless machine consumes

very little electricity; the flat polyurethane-coated steel belt that replaces steel cables minimizes friction; and the regenerative drives feed energy usually lost during braking back into the electrical grid.[21]

Residential sector offers a large market opportunity—German example

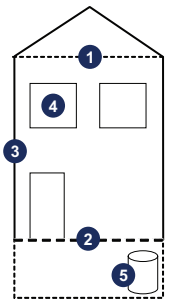
In Germany's residential sector alone, we see an additional annual market potential of €2.0 billion for insulation and €0.4 billion for windows (Exhibit 15). The latter equals approximately 30 percent of the 2003 residential windows market. We believe that our estimate of the abatement potential and the resulting business opportunity is rather conservative. The only change in our abatement case over our base case is a 0.9 percent per annum increase in the number of old, uninsulated houses refurbished at the "7-liter standard" rather than the normal standard. Our abatement case doesn't include an increase of the 3 percent of houses that are refurbished annually (every 30–35 years on average); nor does it include any potential from residential homes built after 1979 or houses built earlier but already with insulation.

Exhibit 15

ANNUAL MARKET POTENTIAL FROM RESIDENTIAL ABATEMENT IS €2.0 BILLION IN INSULATION AND €0.4 BILLION IN WINDOWS IN GERMANY

Additional cost for "7-liter standard" refurbishment over normal refurbishment*

GERMANY



Number of apartments	Residential building size, € per square meter living space: 1 - 2	3 - 6	> 6	Additional market potential**, € million
1 Upper ceiling	27	14	5	580
2 Basement ceiling	13	14	0	310
3 Outer walls	43	27	29	1,100
				1,990
4 Windows	19	16	0	420
5 Heating equipment	25	25	25	0***
Cheapest combination of 1 - 5 to reach "7-liter standard"	127	96	59	
Additional floor space refurbished** Million square meters	17.1	6.1	6.9	

Equals ~30 percent of residential windows market 2003

* "7-liter standard" refers to the requirements defined by the "Energieeinsparverordnung" (EnEV) according to which houses are heated with 7 liters of heating oil per square meter per year.

** Abatement case on top of base case.

*** Already included in base case; higher share of "7-liter standard" refurbishment in abatement case reduces number of heating-only upgrades at same magnitude.

Source: McKinsey Global Institute analysis

21 Otis (www.otisgen2.com).

Electrical devices span a large variety of products including household appliances, white goods, light bulbs, PCs, printers, TVs, home entertainment, and office supplies. An obvious example of promoting higher energy efficiency is CFL, which uses less than 20 percent of the energy of incandescent light bulbs and is becoming standard in countries around the world. The price of CFLs has fallen sharply from €8 per unit in the early 1990s to €3, and their performance in terms of illumination and start-up time has (almost) caught up with incandescent bulbs. Several countries and regions have already decided to ban incandescent bulbs (Australia in 2010, California in 2012) or are considering doing so (France 2010, EU 2012). Osram, one of the most profitable divisions of Siemens and the world's number two in lighting, today generates as little as 3 percent of its revenue from incandescent bulbs.[22] General Electric has recently announced that it will close seven plants manufacturing incandescent bulbs.[23] Both companies, as well as Philips, the market leader, are investing heavily in light-emitting diodes (LED) , the next generation of light bulbs that is currently still expensive but uses three times less energy than CFL.

A faster shift to CFL in the EU offers an additional market opportunity

In the EU-25, we identified additional market potential of €0.5 billion per annum from a more rapid shift from incandescent to CFL (Exhibit 16). This estimate is based on a doubling of the replacement rate compared to the base case. Such a development is likely if the currently discussed ban of incandescent light bulbs in the EU in 2012 comes into effect.

In transportation, fuel efficiency is an increasingly important priority for the buyers of cars, trucks, trains, or aircraft and therefore for original equipment manufacturers. For instance, General Electric won itself a head start in 2005 by introducing a new line of diesel-fueled Evolution locomotives that cut fuel consumption by 5 percent (and emissions by 40 percent) compared with peer products built just a year earlier. The company now plans a hybrid diesel-electric locomotive that captures the energy produced by braking and will improve mileage by another 10 percent.[24] However, the business opportunities directly linked to energy efficiency are more often at the component level where energy efficiency plays a much stronger role than it does in the case of entire vehicles. Suppliers

22 "Der Kampf ums Licht," *Süddeutsche Zeitung,* December 13, 2007.

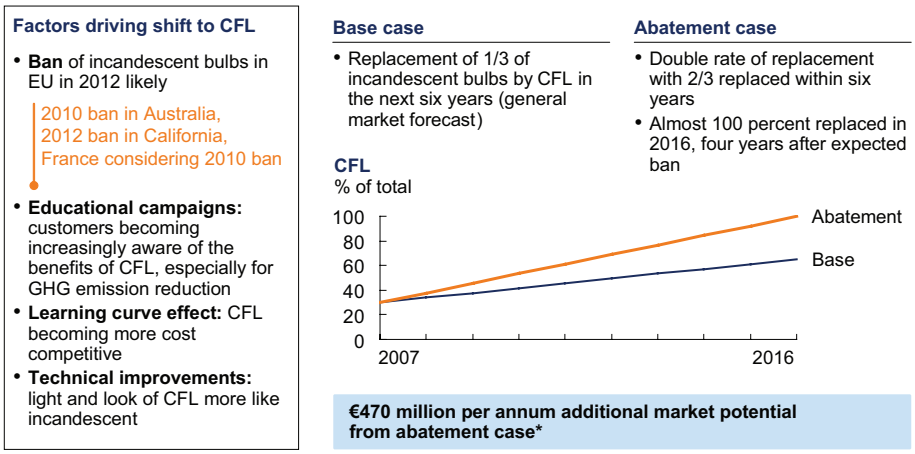
23 "GE restructuring operations to phase out low-efficiency incandescents," *Greenbiz.com,* October 8, 2007.

24 "50 ways to green your business," *Fastcompany.com,* November 2007.

of start-stop automatics, efficient air conditioning, regenerative braking, engines with variable valve control, lightweight carbon structures, efficient drives, tire-pressure-control systems, and low-rolling-resistance tires are poised to benefit from energy-efficiency advancements.

Exhibit 16

MORE RAPID SHIFT TO CFL WILL CREATE ANNUAL MARKET POTENTIAL OF €0.5 BILLION TO 2016 IN EU-25



* Assumes 180 million households in EU-25; average of 27 bulbs per household; price of incandescent bulb ~€0.5, price of CFL ~€3.0.

Source: Bertoldi & Atanasiu, *Residential Lighting Consumption and Saving Potential in the Enlarged EU*, 2006; Philips; Osram; "Light's labour's lost: policies for energy efficient lighting," IEA, 2006; DELight study, ECU, 1998; McKinsey Global Institute analysis

Transparency-creating products help to educate energy end users about the impact of their choices and behavior on their energy consumption and therefore encourage more conscious use of energy. Examples of products that perform this informative function include car navigation systems that help minimize travel distances and infrared cameras that detect heat losses in buildings. Transparency-creating products might be included as an integral part of an electrical device or vehicle. Fiat, the Italian car manufacturer, plans to roll out EcoDrive, a program developed by Microsoft that records performance data such as fuel consumption and CO_2 emissions. This data can subsequently be analyzed and eventually provide driving tips to cut both consumption and emissions.[25] Advanced electricity metering is the prime example today of a transparency-creating product. Automated meters at the consumer's location and smart grids allow for two-way communication between utilities and electricity users, telling energy users how much electricity a laundry dryer or a dishwasher will use and

25 "50 ways to green your business," *Fastcompany.com,* November 2007.

how much this will cost—in a particular minute. Differential electricity pricing for peak and off-peak consumption is a prerequisite for the effectiveness of advanced metering. Utilities such as CenterPoint Energy, Entergy, and Pacific Gas and Electric have already implemented this technology in the United States. Their early experience is that, armed with information on energy use, end users use energy-intensive devices somewhat less frequently, and more at off-peak times.

Customized solutions describe complex systems integrating numerous products such as large heating, air-conditioning, lighting, refrigeration, and ventilation systems. As in building-technology products, the customized solution market should function without regulatory intervention because energy efficiency in buildings largely pays for itself. We typically find large integrated systems installed in large premises, such as residential complexes, office and commercial buildings, industrial production facilities, or—especially for outdoor lighting—entire campuses or cities. Optimized overall system design together with smart management and control technology allows end users to run these systems with minimum energy consumption. Suppliers of customized solutions, including UTC-Carrier, Johnson Controls Building Efficiency, and Siemens Building Technology, often integrate such systems with each other and with other systems such as fire and security. Suppliers of solutions may offer to operate and maintain the systems or to finance them with performance-based contracts—thereby crossing over into energy services and financing.

Energy services comprise a multifaceted, labor-intensive, and decentralized field directly tied to energy efficiency. Here again, there should be no need for public-policy intervention as incentives are aligned between market participants. ESCOs offer a wide range of activities to energy users primarily in industrial and commercial sectors and to public institutions. ESCOs offer four major categories of services:

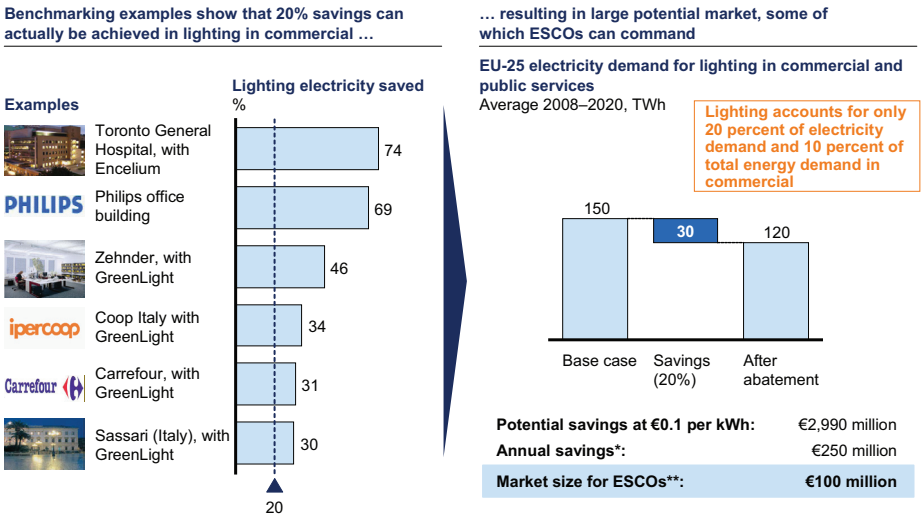
- Operation and maintenance of installations such as cogeneration, district heating units, and small-scale residential boilers
- Supply of energy, often in the form of power and heat from cogeneration but also gas sourcing
- Facility management in various areas ranging from technical management and cleaning to safety and security
- Energy management including energy audits, consulting, and demand monitoring and management

The overall market for energy services in Europe is estimated to be well in excess of €50 billion. Its continued growth will depend partly on the level of service outsourcing by energy end users. The market is currently very fragmented, with many small players, a few large companies such as Dalkia, RWE Solutions, and Elyo—some of which are (partly) owned by utilities—as well as divisions of utilities such as Enel, E.on, or Scottish Power. The economics of this industry differ depending on the type of service offered. Capital-intensive services such as cogeneration and district heating often command EBIT margins of approximately 10 percent, higher than industrial maintenance with margins of 3 to 4 percent, for instance. ESCOs may guarantee energy savings to their customers and receive their remuneration, often as part of long-term contracts, on the basis of a direct relation with savings achieved.

We estimate that energy services as a whole can generate an additional €100 million in annual revenues solely from electricity savings in lighting in the commercial sector (Exhibit 17). The potential becomes much larger when we take account of electricity consumption beyond lighting, energy forms other than electricity, and by including other end-user sectors such as industry.

Exhibit 17

LIGHTING IN COMMERCIAL ALONE OFFERS €100 MILLION ANNUAL MARKET POTENTIAL FOR ESCOs IN EU-25



* Assumes the total market can be tapped over the next 12 years (2008–2020).

** Assumes that ESCOs will be able to command 40 percent of the savings; the rest will be retained by energy users.

Source: Encelium, EU GreenLight Programme; IEA; McKinsey Global Institute analysis

Financing of investments in energy efficiency creates a business opportunity for banks and institutional investors. Financing may also be an option for utilities that often have low financing costs (or a significant amount of free cash) and long time horizons, particularly if utilities find themselves under pressure from regulators or the public to engage in energy savings and GHG abatement. Some examples already exist for financing of investments in energy efficiency. Bank of America has established an $18 billion fund for green investment that includes preferential loans to energy-efficient residential houses. Dutch banks have started to offer discounted loans for residential energy-efficiency upgrades.

Third-party financing may be a solution in the residential sector where split incentives between landlords (who pay for investments in energy efficiency) and tenants (who enjoy lower heating and electricity bills) can act as a hurdle to higher energy efficiency. This hurdle should naturally vanish over time as more efficient buildings command higher rents, but this process is likely to happen very slowly. There may therefore be a case for public-sector co-financing of investment in this area, but government could, in fact, overcome the split-incentive hurdle as effectively by implementing minimum efficiency standards to meet on a specific date or when assets change hands.

The seven broad areas of opportunity for business differ in many respects. Some focus on more or less standardized products; others describe customized solutions and services. Energy efficiency is a key purchase factor in some segments (e.g., housing insulation), but less important in others (e.g., cars, office supplies). The seven areas of business opportunities also differ in their applicability to the end-use segments. These significant differences mean that capturing the full energy productivity prize will require a range of business models and delivery mechanisms tailored to the specific barriers and opportunities in each segment. This is the main challenge that remains in order to capture the fullest energy productivity possible.

CAPTURING THE PRIZE WILL REQUIRE CONTINUING PUBLIC AND PRIVATE INNOVATION

The full potential for abating both energy demand growth and carbon emissions through increasing energy productivity is only achievable through continuing innovation in both public policies and business models. The main challenge is to find ways to overcome the information and incentive barriers and market failures that keep many of these opportunities from being captured today. While there are already a lot of innovations and trials in progress, there is large potential for more.

The range of potential solutions is broad and continuously expanding. One area is to find opportunities for players to collaborate in new ways. For example, improving building efficiency may require new ways to collaborate between building companies (with the technical energy efficiency expertise), mortgage companies (with long-term financing needed for investments), and ESCOs (with the capacity to tie housing energy efficiency to future energy-supply packages). To overcome the fragmentation of individual energy consumers, one can aggregate energy savings from a number of individual households and companies and securitize them into tradable energy-efficient mortgages, white certificates, or emission permits. More subtle changes in the way information and choices are provided can also change behavior. Beyond energy-efficiency labeling, user-friendly smart metering and appliances could translate choices directly into monetary implications—and encourage consumers into capturing the savings available to them.[26] And more thoughtful design of buildings, housing developments, and cities, as well as machinery and equipment, production processes, and plants, could make a large difference for the energy productivity of future economic activities.

Europe is in a unique position to play the role of catalyst in promoting higher energy productivity around the world. Many European businesses have pioneered global efforts to seek solutions to the challenges of climate change and are beginning to discover the potential of energy efficiency.

The case for prioritizing energy productivity has never been as strong. The expected financial returns are high because peak energy prices increase the value of future energy savings. At the same time, lower energy consumption reduces companies' exposure to energy-related risks, including those stemming from climate change. Energy productivity should now be a top priority for business and society in Europe.

26 See examples provided in Richard H. Thaler and Cass R. Sunstein, "Nudge: Improving Decisions About Health, Wealth, and Happiness," Yale University Press, 2008.

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