

Executive summary

As this innovation atlas clearly shows, the already strong link between ecology and economy, between employment and the environment, has been further reinforced. The **ecological industrial policy** has been instrumental in this development. The updated edition of GreenTech made in Germany mirrors this development, presenting the following core messages:

Green tech made in Germany

- All around the globe, green tech is proving to be a successful model. With its development on the world's markets outstripping the forecasts of industry experts, the sector has flourished beyond the predictions voiced in the first edition of this atlas.
- The economic crisis will briefly flatten this development trajectory. Even so, revenues in environmental technology industries – driven by megatrends such as a growing global population, the ongoing industrialization of emerging countries and worldwide aspirations toward prosperity – will more than double to EUR 3,100 billion by 2020.
- In the political realm as in the business community, most decision makers have long since discarded their view of environmental technology as a passing fad. Instead, they now have high hopes that this industry will make up for the stagnation of other industries, cushioning its impact on the economy as a whole while also addressing the climate and raw materials crises. This analysis forms the basis of green programs to turn around the economy and thoughts on how to bring about a **global green recovery**.
- Germany's environmental technology industry has already carved out global market shares that range from 6% to 30% in various segments. In the future, companies based in this country will increase these shares as they participate ever more forcefully in global growth.
- Environmental technology generated around 8% of Germany's GDP in 2007. By 2020, this share will have climbed to 14%.
- Environmental technology is also creating jobs in Germany, which will remain highly attractive in the future as both a production base and a sales market for green technology.
- Environmental technology ranks as one of the most innovative industries in Germany. While the government traditionally supports research and development in Germany, the corporate sector will also ramp up its R&D spend in the future.

- A highly skilled labor pool, alongside R&D activities, is fundamental to the environmental technology industry. Realizing this, German companies attach great importance to the availability of skilled workers. A lack of this vital resource in Germany would have negative consequences.

The lead markets for environmental technology

- Energy efficiency and sustainable water management are currently the two largest lead markets for environmental technology. Together, they account for nearly two thirds of the global market volume of EUR 1,400 billion.
- The energy efficiency sector is worth just under EUR 540 billion and is therefore currently the top-ranking lead market. This volume is expected to almost double to around EUR 1,030 billion between now and 2020. German companies in particular number among the world's leading producers of heating and air-conditioning systems (where they boast a 10% global market share) and energy-efficient white goods (15%).
- Worldwide, the lead market for environmentally friendly power generation and storage generated revenues of some EUR 155 billion in 2007 – a markup of almost 40% on forecasts made as late as 2006. By 2020, this volume will have surged to around EUR 615 billion. In the meantime, German businesses are excellently placed to benefit from this vast market potential. German makers of biogas plants occupy an especially dominant position, having cornered as much as 90% of the global market.
- Growth in the lead market for material efficiency is being driven primarily by the increasing significance of biotechnology. Revenues in this market totaled close to EUR 95 billion in 2007 and are forecast to rise to EUR 335 billion by 2020. In the biodiesel segment, German firms already have a very strong market share of more than 40%.
- Global population growth and the booming economies of China, India and other aspiring Asian countries are driving market growth in the waste management and recycling sector. A quarter of the EUR 53 billion global market volume currently goes to the account of German companies. Heavy government regulation has brought forth high standards, which are now fueling the success of German enterprise.

- The worldwide market volume for sustainable water management is currently estimated at around EUR 361 billion, making this the second-largest lead market. At present, German companies' have a market share of 10%. German market leaders in the distributed water management segment in particular will benefit handsomely as this lead market grows to a forecast level of EUR 805 billion by 2020.
- The global lead market for sustainable mobility was worth just under EUR 200 billion in 2007. Already very mature, this market is expected to grow to EUR 300 billion by 2020. Germany's share of this growth will mostly center around innovations in efficient engine technology and exhaust filters.

Environmental technology in Germany's federal states

- Environmental technology is growing vigorously in every one of Germany's 16 federal states. Going forward, companies throughout the country anticipate further positive business development.
- At the same time, both the thematic and international focus of green technology varies from state to state. Clear distinctions can be drawn between north and south and between east and west.
- The lead market for environmentally friendly power generation and storage is the second-largest lead market in Germany. The largest lead market – energy efficiency – is concentrated primarily in the western German states.
- Although companies in higher revenue brackets are mostly based in western Germany, the market structures between west and east are converging visibly. On average, companies in the eastern German states are growing at a rate 3% faster than their counterparts in the western German states.
- Environmental technology is a successful economic model in eastern Germany too, where it is expanding very rapidly. Green tech has emerged as an undisputed engine of employment in the eastern German states. Companies in the lead market for environmentally friendly power generation are pioneering this development. Experts see internationalization as the major source of potential for eastern German companies.
- Two trends in internationalization are observable. One is that companies in southern Germany tend to do more business outside Germany than their competitors to the north. In an east-west com-

parison, this difference is even more striking. Internationalization has reached 36% among western German companies – fully 11 percentage points more than for businesses in eastern Germany. Among the eastern German states, Saxony nevertheless bucks this trend. 40% of the companies based in this state see international markets as the focus of their business activity.

- Compared to other branches of industry, the environment ministries in Germany's states already attach considerable significance to environmental technology as a driver of growth and employment. In the future, this sector is expected to become even more important.
- Regional governments in the individual states create a very heterogeneous array of conditions for this industry. This is attributable essentially to the different focuses that prevail in the individual states.
- Across the board, the regional and local activities and subsidization programs backed by all state environment ministries paint a positive picture.

Environmental technology in international markets

- In light of their current standing on the global market and/or their future potential, the USA, Japan, Brazil, Russia, India and China are tremendously important to developments in the world's environmental technology industry. These six countries also serve as a reliable barometer of future megatrends and social developments: rising energy consumption accompanied by increasing emissions of greenhouse gases as a consequence of population and economic growth.
- The USA presents huge potential to German companies in almost all lead markets. At present, however, its various market segments are largely dominated by domestic incumbents. Energy-efficient white goods and biofuels form the focus of production activity. Strong demand exists primarily for biofuels and wind power. Most German companies that operate on the US market are niche providers armed with a vast store of knowledge in their specialist fields.
- In Japan, both production and demand primarily center around high-tech products. The country has a strong supply of and demand for photovoltaic technologies and energy-efficient white goods. Successful German players on the Japanese market are technology leaders whose expertise gives them an edge in their segment.

- Biofuels and hydropower are the focus of both demand and production in Brazil. The hydropower market in particular has a relatively thin base in Germany. German companies on the ground in Brazil thus tend to be “technology exporters” that transfer technologies and knowledge from Germany.
- Russia’s green tech market is still in its early stages. Supply and demand both gravitate strongly toward thermal insulation and energy-efficient white goods. Successful German companies in this market are those that cultivate markets in the long term, and – above all – that intelligently exploit the potential to market German technology to this region.
- As far as environmental technology is concerned, different regional structures and needs make the Indian market decidedly heterogeneous. Successful German players are diversified companies that respond to varying requirements. Hydropower – an area in which India’s geographical potential is certainly worth exploring – is one of the products in their portfolio.
- In spite of massive environmental problems, demand for environmental technology is growing only very slowly in China. The same cannot be said of supply, however, which is expanding at a very rapid pace. China’s green tech industries are highly competitive on global markets. Their primary focus is on photovoltaics and wind power. Successful German companies here are first movers who respond swiftly to shifts in market conditions and are more willing than their direct rivals to take calculated risks.
- There are many good reasons why German companies are likely to go on enjoying considerable success on international markets in the future. Environmental technology will therefore continue to drive employment in the years ahead – provided that environment policy remains progressive and innovation-friendly.



Green tech made in Germany

Ecology – A business opportunity

The world in the 21st century faces **two structural challenges**. One is the need to satisfy the economic and material demands of a growing world population and deal with real economic problems. The other is the need to take resolute action to halt climate change and contain pollution.

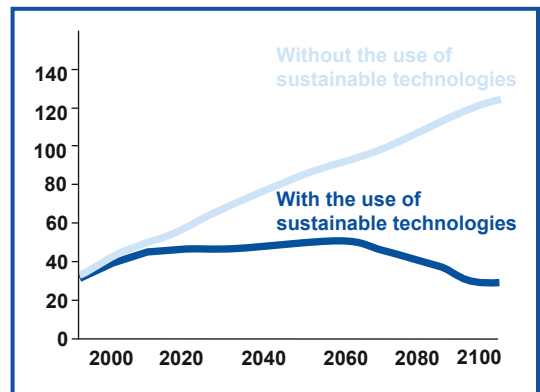
For too long, economics and the ecology were regarded as antithetical. That the two aspects are inseparably intertwined is now becoming abundantly clear, however. Raw materials are in ever shorter supply. On the other hand, the economic consequences of climate change and pollution are growing ever more costly. The environment and the economy will therefore interlock ever more closely in the future. Constant **growth in the world's population**, the **advance of industrialization in emerging countries** and the **worldwide desire to increase prosperity** will be the main drivers of this development.

These megatrends will necessarily be accompanied by growing demand for forms of production that use less natural resources, and for efficient technologies that ease the burden on the environment. **Environmental protection and economic growth is no longer a contradiction in terms**. Rather, each needs the other. Because let us face the facts: Unless we reduce our consumption of resources in absolute terms and avoid emissions, prosperity and healthy development will, for many, many people, remain a dim and distant dream.

The six lead markets for environmental technology play a pivotal role. They constitute attractive business propositions; and they can also do a lot to preserve the very basis for all human life. These markets can help us uncouple the carriages of pollution from the engine of economic growth. Witness the **double-digit growth** rates that still prevail – and the size that our lead markets have already attained. Moreover, using energy and resources efficiently will create competitive advantages for the more traditional branches of industry too. Environmental technology, in other words, is the key to solving the world's biggest ecological problem: reducing CO₂ emissions. Especially the use of technologies to improve energy efficiency, generate power in ways that are kind to the environment, and capture and store CO₂ will be instrumental in arresting the rise in CO₂ emissions (see figure, page 11).

The second edition of the innovation atlas for green technology in Germany begins by analyzing the German market. It seeks to understand the logic, the forces that drive this market in Germany. The next chapter looks at the technology in each of the six lead markets. Glo-

bal technology trends are explored, market data and success stories in each lead market are presented, and selected lines of technology are discussed in considerable depth. Then comes a chapter that, for the first time, concerns itself exclusively with Germany's federal states and the country's regional markets for environmental technology. Profiles of the relevant state ministries round off this section. The final chapter is then devoted to the most important international markets for environmental technology – from both a sales and a production perspective.



Forecast trend in global CO₂ emissions through 2100 [gigatons of CO₂ equivalent per year]

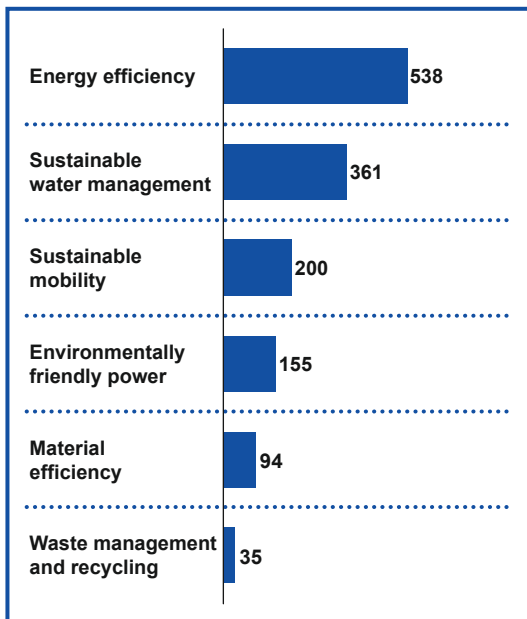
Source: IPCC 2007

Environmental technology – An established global market

Our investigation of the global structure of environmental technology and its development trajectory leads to one unequivocal conclusion: **Green technology is a recipe for success – all over the world.** On the markets of the world, environmental technology has outstripped the forecasts presented in the first edition of this atlas. Beyond that, it has even surpassed the predictions of industry experts.

The lead markets outlined in this atlas were worth a total of around EUR 1,400 billion in 2007. Such a figure already puts environmental technology in the same bracket as key global industries such as chemicals, automotive engineering and electrical/electronic engineering (see figure, page 12).

The lead market for energy efficiency accounts for more than a third of this total volume (over EUR 500 billion). Environmentally friendly power generation and storage adds up to just under EUR 155 billion. In this segment, wind power and photovoltaics are the main engines of growth. The volume of both of these markets has doubled since the first edition. Waste too has become a valuable resource. Worldwide, waste management and recycling plants worth more than EUR 35 billion were sold in 2007. In the same year, companies in the lead market



Global market volume for environmental technologies in 2007 [EUR bn]

Source: Market studies, interviews with experts, Roland Berger

for material efficiency turned over nearly EUR 95 billion. Bioplastics are increasingly emerging as one of the drivers of this market. Since the last survey, sustainable water management too has expanded much faster than predicted and now has a total market volume in excess of EUR 360 billion. Water treatment and distribution in particular have pushed up the volume, fueled above all by demand in the Asian region. Over the past two years, the lead market for sustainable mobility has expanded by slightly over 14%, in line with the forecast rate of growth. This global market is currently worth some EUR 200 billion in all. Here, improved efficiency in existing technologies has been the mainstay of growth.

In the political realm as in the business community, most decision makers have long since **discarded their view of environmental technology as a passing fad**. Instead, they now have high hopes that this industry will make up for stagnation and shrinkage in other branches of industry, cushioning their impact on the economy as a whole.

Megatrends driving global markets in the environmental technology industry

Three megatrends will continue to drive growth in the environmental technology industry worldwide: **population growth**, the advance of **globalization** and the **world's desire to increase prosperity**.

According to UN forecasts, the world's population is set to grow from 6.8 billion today to more than 9 billion by 2050. At the same time, the world is converging, becoming ever more deeply integrated. Globalization is driving economic growth, the networking of the planet, the increase of urban sprawl and, hence, mobility too. These phenomena affect the emerging countries in particular. For example, forecasts by

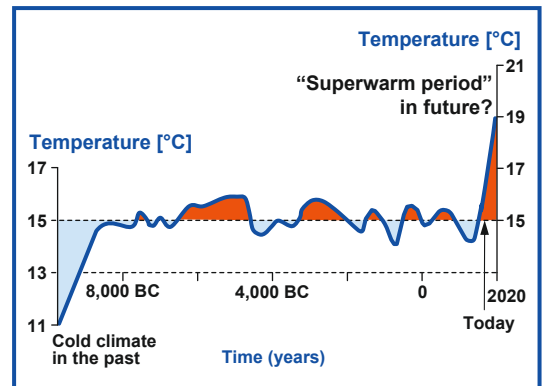
the United Nations indicate that the number of people who live in cities will surge from 2.5 billion today to around four billion two decades from now.

The increase in greenhouse gases correlates closely with the world’s desire for prosperity. It is thus fair to say that this desire is one of the major causes of global warming. The rapid pace of economic growth in some emerging and developing countries is making the problem all the more acute. In China, energy consumption has doubled since the year 2000. In 2007 alone, the country’s consumption rose by nearly 150 million tons of oil equivalent – half as much as Germany uses every year. Few people would still seriously dispute that mankind is responsible for climate change. Around a third of all the greenhouse gases that are belched into the Earth’s atmosphere is attributable to industry and transportation. Another quarter comes from power generation.

Modern environmental technology can help us consume resources more sparingly in production and make greater use of renewable materials, instead of squandering finite materials. Such approaches also reduce harmful emissions, which in turn slows the process of climate change. Green tech made in Germany is already making a significant contribution to this development.

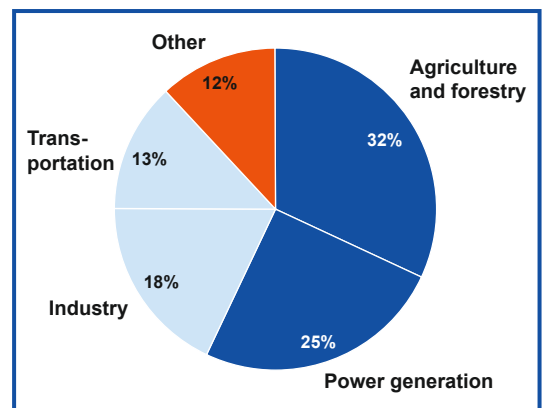
Rapid growth in environmental technology to continue

Revenues in environmental technology industries will more than double to **EUR 3,100 billion** between now and 2020. Aided by the megatrends



Forecast of a possible “superwarm age” caused by the human-induced greenhouse effect

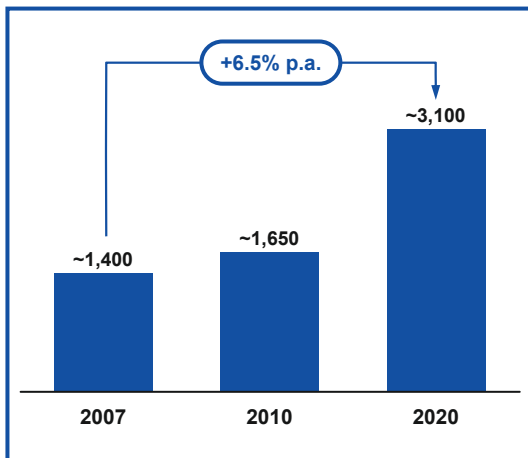
Source: Derived from the IPCC in 2007



Sources of greenhouse gas emissions

Source: World Resources Institute 2005, Roland Berger

described above, ever more intensive political discussion of environmental issues and a growing public awareness of related concerns, markets for environmental technology will continue to grow at an unprecedented rate into the future.



Projected development in the global market for environmental technology, 2007–2020 [EUR bn]

Source: Market studies, interviews with experts, Roland Berger

Accordingly, forecasts in the **lead market for environmentally friendly power generation and storage** have been revised sharply upward, due above all to towering growth in wind power and photovoltaic technologies. By the year 2020, these two segments will probably have further increased their lead on other renewable energy sources. Forecast growth of 20% per annum for these technologies is attributable mainly to the high price of fossil fuels. Government subsidies and grants, principally in emerging countries such as China and India, will likewise drive future market growth. In absolute terms, wind power will see the largest

increase in its share of new power generation capacity. According to forecasts, sufficient new wind turbines to generate around 140 GW of electricity will be built in 2020 – almost 117 GW more than in 2007.

The volume of the **lead market for energy efficiency** will double again by 2020. Annual growth will average more than 5%. At first glance, this may appear a modest rate of expansion. Understanding the maturity of the technologies involved brings this impression into perspective, however. The key drivers in this lead market are measurement and control systems and electric motors, which can expect to see their market volume double. White goods will not be able to keep up with this pace of growth.

Though still relatively small today, the **lead market for material efficiency** is slated to triple in volume between now and 2020. Huge advances in biotechnology will be the main engine of this vigorous growth.

The **lead market for waste management and recycling** will be driven primarily by successful key technologies. Examples include automatic separation systems that, according to estimates by Roland Berger

Strategy Consultants, will experience annual growth of 15% through 2010. Ever more legislation worldwide to protect human life and safeguard the environment will also fuel growth in this market to a considerable degree.

The **lead market for sustainable water management** will expand by a moderate 3% per annum through 2020. Most of this growth will take place as emerging countries develop new infrastructure and modernize existing facilities.

Recent widespread discussion of mobility in the 21st century gives reason to anticipate strong growth potential for the **lead market for sustainable mobility**. The current volume of EUR 200 billion is set to rise to around EUR 300 billion by 2020. New technologies such as electric motors and fuel cells will become more widely used – and will change our whole concept of mobility. In light of these developments, the established market for hybrid vehicles will nearly double in size by 2020.

Even in an economic downturn, environmental technology is evidently a robust industry. The business outlook for German companies in this sector makes this point. More than 80% of the respondent companies expect to see their business outlook remain “unchanged” or become even “better” in the future. Green tech is thus bucking the macroeconomic trend in Germany, which had already lost considerable momentum in fall 2008. At this time, the ifo business climate index dipped to its lowest level for two years.

