China's Energy Supply

Many Paths – One Goal

English Edition of „Energy for Germany 2005"
by WEC's German Member Committee

World Energy Council
CONSEIL MONDIAL DE L'ENERGIE

Table of Contents

Foreword: „Beyond Sydney“

„The history of the raw materials industry is being rewritten – by China“ was the conclusion the Association of German Industries (BDI) came to at the Raw Materials Congress in Berlin in March 2005. This is especially true for energy. China has a huge appetite for energy: if the Chinese economy grows as planned over the next few years, the country's primary energy consumption will increase to about 4.5 billion tons of coal equivalents (tce) by 2020. Energy conservation strategies are intended to limit that growth to 3 billion tce, but even then, China will have overtaken the largest producer of CO_2 emissions so far, the USA. China has already become one of the world's largest oil importers. With an estimated import demand of 400 million tons of petroleum by 2020, it would be able to absorb the entire current oil production quota of Saudi Arabia.

For these reasons, we have chosen the energy supply of China – an exemplary topic with international relevance – as the focus of this year's WEC German Member Committee publication. The German version of „Energy for Germany“, as this annual publication is called, contains additional information both about the German energy market and on the most recent trends and figures on a national level.

Power generation capacity and consumption in China will double by 2020. Despite broad and unrestricted diversification, China's domestic coal supply will have to cover two thirds of its energy needs in the future. The annual expansion of power plant capacity, which is equivalent to about a third of total power plant capacity in Germany, is being pursued for all sources of energy, from coal and nuclear power plants to increased use of gas, hydroelectric power and other renewable energy sources. Following the motto „more energy from all sources“, which is also endorsed by the World Energy Council, China is using all energy sources pragmatically and without ideology. This includes the new construction of two to three nuclear power plants annually over the next 15 years as well as the expansion of LNG terminals with a view to the increasing globalization of the gas markets.

What does this imply for national and European energy policy and for the energy industry itself? One thing is certain: if we are serious about reducing CO_2 emissions, we have to be aware of global developments. We have to put our limited financial resources to the best possible use, in the production industries, in the state budget, and with respect to all consumers. Only then, and if this happens in close alliance with other industrial nations can the global consequences of comparable developments such as in China be controlled. In concrete terms, this means preventing disproportionate price increases due to scarcity of resources as well as keeping the environmental impact under control.

In this context, it is important to recall that about 2 billion people in the world have to get by without a commercial supply of energy. Only shared, responsible efforts will allow future generations to enjoy sufficient affordable energy as well as a livable environment. What is the point of focusing on natural gas in large-scale power generation if tomorrow there are not enough raw materials for the chemical industry and decentralized heating?

Of what use is the current excessive emphasis placed on promoting wind and solar power generation in Germany for example, along with a proliferating array of policy instruments that become more confusing and contradictory by the year? As long as only six percent of the total wind power capacity installed in Germany can replace other power plants, it is clear that the use of this kind of energy in Germany is limited at this stage.

What are the possible consequences of closing down safe, environmentally sound nuclear power plants that could remain commercially viable for years, if there is not enough money to invest in researching and developing technologies that look promising for the future, including nuclear fusion? Postponing the phase-out of nuclear energy would improve market conditions to invest and further develop „clean coal technologies“ for example, which might then be able to replace the majority of old power plants.

Renewable energies are developing and becoming increasingly viable as an economic and ecological alternative in the energy mix, particularly as a decentralized form of energy in remote areas of the world and wherever geographical and climate conditions are favorable. Strong commitment to research and development is therefore necessary to foster innovation in all forms of energy supply and of course in intelligent, economic energy demand.

But rather than concentrating on the very expensive ideologization and further sophistication of measures in countries like Germany, it would be wiser – in terms of climate policy – to invest the money thus saved by not misdirecting energy policy in, for example, base funding of the latest coal power plants with high efficiency levels and low emissions. The same money spent on reducing a ton of CO_2 with solar power in Germany could improve the efficiency levels of coal power plants to such an extent that a reduction of 50–100 tons of CO_2 could be achieved. The same ratio for wind to coal is currently around 1:20.

Let it be perfectly clear: We too should use all types of energy to the most economical and ecological extent possible, we should continue developing all technologies in energy generation and in economic demand, and then transfer them to energy-hungry countries worldwide. We should therefore not demonize any source of energy. With a view towards what is feasible, and an awareness of our responsibility for current and future generations, we should use all our resources carefully. A livable global environment should remain our top priority, and we should use our financial means purposefully and efficiently to reach that target. Only thus can we be a persuasive role model for the world and have others follow our example.

Last year's World Energy Congress in Sydney clearly showed how important it is for supply security to have as broad an energy mix as possible in view of increasingly volatile price developments and a more regional concentration of production points. The global challenges of energy demand that will continue to increase rapidly in the future can only be met by a cross-national investment offensive. The International Energy Agency estimates the required investment needs at about $16 trillion by 2030. That capital will have to be predominantly private capital, which can only be mobilized on the basis of reliable framework conditions, competitive returns and open markets. This investment offensive will be accompanied by an innovation offensive for new technologies in energy supply and in economic demand strategies. In both fields, German technology suppliers can offer attractive solutions and they are already among the top players worldwide.

Following the passage of a regulatory framework for the electricity and gas markets in the EU and in Germany, we should therefore take a more regular look at developments in energy policy and the energy industry from an unbiased, international perspective. This may give us an early warning of the consequences of a national, single-handed effort. The World Energy Council and its German Member Committee hope to continue – „beyond Sydney" – to provide an outlook onto these international developments.

Berlin, May 2005

Juergen Stotz

President
German Member Committee (DNK)
World Energy Council

China's Energy Supply: Many Paths – One Goal

Using all Energy Sources and Efficiency to Keep People's Dream of Prosperity Alive

Paul Suding*

Executive Summary

Key statements about China's energy industry and energy policy:

- Since the 1990s, considerable progress in economic development. Large disparities in income remain. High migration of rural population to urban areas.

- Boost in consumption through increased production and higher incomes for more living space, convenience and mobility. Quality of air, soil and water severely threatened, acute water shortages. Immense pressure on biological resources and decreasing biodiversity. Ambitious environmental policy response.

- China's primary energy consumption increased since 1990 from 0.75 to current level of 1.5 billion tons of coal equivalents. Today, already the second largest consumer of energy worldwide. Given planned economic growth, by 2020 about 4.5 tons of coal equivalents. An energy conservation strategy aiming to limit increase to 3.0 billion tons of coal equivalents by 2020.

- Adjustment of exchange rates underway. A productive and flexible workforce potential as well as high investment means long-term growth prospects are good.

- National energy policy institutions streamlined. Implementation of policies dependent on strong provinces and municipalities. Energy policies test market and planned allocation at the same time. Pricing authorities generally set cost-based energy prices.

- Large reserves of coal and lignite in addition to potential renewable energy sources. Sharply increasing import requirements for oil and gas. Share of global CO_2 emissions rising.

- Oil requirements have doubled since 1995 to 300 million tons of oil equivalents currently. By 2020, about 550 million tons of coal equivalent expected, of which 2/3 will be imports. Chinese oil industry securing its import base through intensive efforts abroad.

*DNK thanks **Dr. Paul H. Suding**, Director of the Energy and Environment section of GTZ China, Beijing, whose work is the foundation of this report. Additions and editing by the DNK task force.

- Gradually increasing market share for natural gas. For 2020 consumption estimated at 200 million cubic meters, of which half will be imported, including via LNG.

- China's large coal resources make up about 12% of world coal resources. Current annual coal consumption 1.5 billion tons of coal equivalents. Spike in demand for steam and coking coal. Long-term production expansion possible to over 2 billion tons, with a correspondingly strong impact on global CO_2 emissions. Unclear market conditions in the course of reform in the coal sector.

- Electrification rate close to 100 percent. About 30 million in remote areas remaining. Available capacity in 2004 increased by 50,000 MW to 450,000 MW. Electricity consumption currently about 1,850 TWh/annum. Great expansion of power plant capacities, but power outages ongoing due to extreme load growth. Beginning of differentiated electricity prices in consumer sectors.

- Three-quarters of electricity output generated by coal. Hydroelectric power covers 1/6, new renewable energies 5%. Oil and gas make up a small share. Clear increase planned in nuclear power (from a current 2% share to 4%).

- By 2020, about 900,000 MW installed capacity and consumption of more than 4,000 TWh/annum expected. Change in electricity generating mix. Coal's share will drop to less than two-thirds. Strong growth in wind, biomass and natural gas. Proactive stance toward nuclear energy and development of renewable energies. Adherence to large hydroelectric projects. Great diversity of renewable energy sources for non-electric use.

- Institutional reform of the electricity sector continues. Generation and grids will be separated in the future. Currently no effective competition in electricity generation due to undersupply.

- Half of oil imports come from the Middle East. Diversification of the import structure. Efforts to import oil from Siberia. Development of an LNG infrastructure. Acquisition of rights and businesses in numerous countries by Chinese oil companies. Over the medium term, China could become an important coal exporter again.

- Despite a dynamically growing energy industry, requirement for imported energy technology equipment remains small. Imports of new generation of equipment are followed as quickly as possible by local production based on licenses or through joint ventures in China. Technology transfer and local production are top priority. Bottleneck factors are China's capacity for planning and building plants.

- Substantial investments in scientific activity for new technologies. Strong interest in collaboration with the research departments of foreign technology companies. But the current dynamic requires further investment in existing technologies.

- Rapid doubling of CO_2 emissions. China will be in an increasingly difficult position internationally as its development comes up against limits of a global dimension. Moving cautiously on international level. China ratified the Kyoto Protocol early, but without binding itself to emissions restrictions.

- For the most part, China sees the solution to its energy problems in its own country. Diversification of import risks is an additional consideration. Priority given to developing trust at an international level and maintaining cooperation.

- Long-standing, diverse forms of cooperation with Germany on energy. The resulting potential not yet fully explored in terms of German interests.

Source: T.Trinh, Deutsche Bank Research 2005

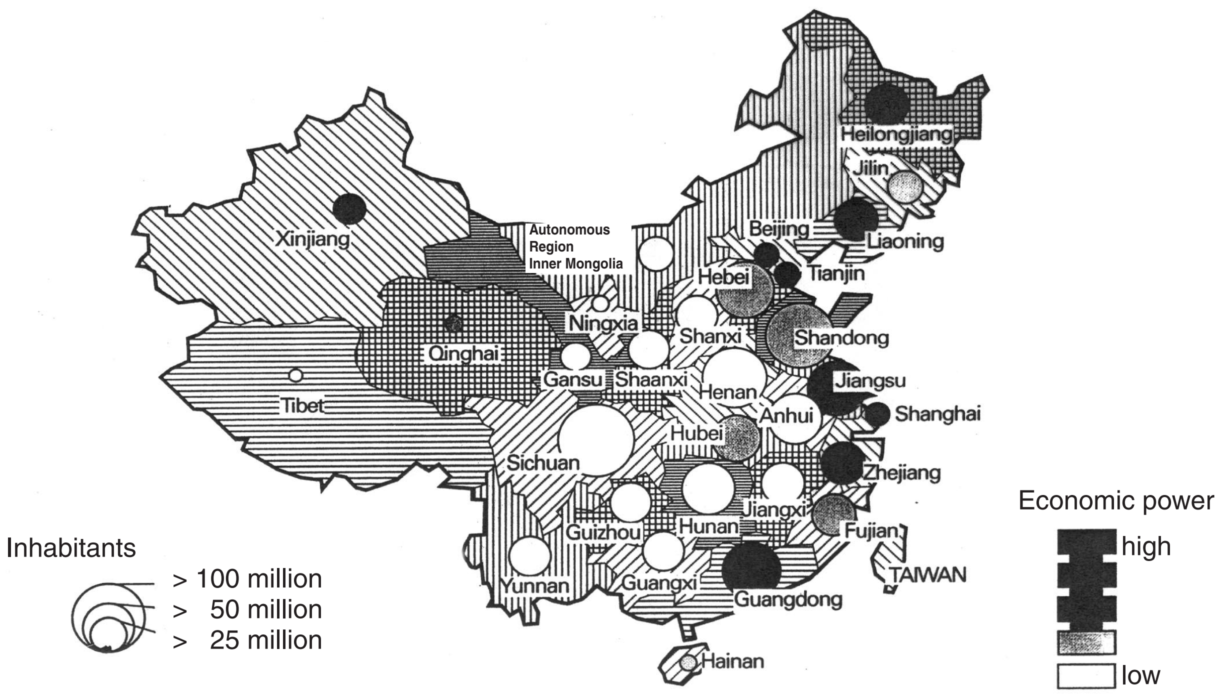
Macroeconomic and social development

The gross domestic product (GDP) of the People's Republic of China, calculated in constant 1985 US$, passed the threshold of $1,000 per capita in 2003[1]. Measured in terms of domestic purchasing power in comparison with other industrialized countries, however, this corresponds to four times that figure, i.e. $4,000 per person. This means that in 2000, the Chinese national economy reached the same development level that Japan had attained by the early 1960s and that South Korea had reached by the 1970s.

Today China is the second largest national economy in the world (GDP to purchasing power capacity). As part of its economic development over the last ten years, China has made significant progress: the number of its citizens living in extreme poverty was reduced from 360 million to about 200 million[2]. The rate of illiteracy has dropped substantially and will be reduced to 5% for adults by 2010, while the level of school enrolment reaches 95%. Population growth has clearly slowed. By 2010, China's population will not have exceeded 1.4 billion from the current 1.3 billion.

Income disparities in China are considerable. Top wages (about 10% of the labor force) were nearly three times as high as average wages in 2004 and ten times as high as the lowest wages (about 10% of the labor force)[3]. The average income in the fast-growing centers of Shanghai and its surrounding areas, as well as in Beijing and Guangdong was more than twice as high as in the five western provinces with low income. Incomes are growing for (almost) all citizens, albeit somewhat faster for the high earners, especially those in the IT sector. The slowest growing wages are in agriculture. In 2004, the income of the rural population was raised specifically, but remains far behind income levels in the cities.

People's Republic of China (PRC) – inhabitants and economic power of provinces



PRC total: 1,292 million

Source: Siemens AG/Reisach in: Reisach, Ulrike/Tauber, Theresia/Yuan, Xueli: China – Wirtschaftspartner zwischen Wunsch und Wirklichkeit (China as Economic Partner: Between Wish and Reality), 3rd edition, Frankfurt/Vienna 2004

Urban residents made up 40% of the Chinese population in 2003, or 525 million according to the statistical count[4]. Nevertheless, a large portion of the population statistically considered as rural lives in semi-urban settlements. Migration will continue, meaning that through the recognition of migratory workers and the rezoning of cities, two out of every three people in China will live in cities by 2020.

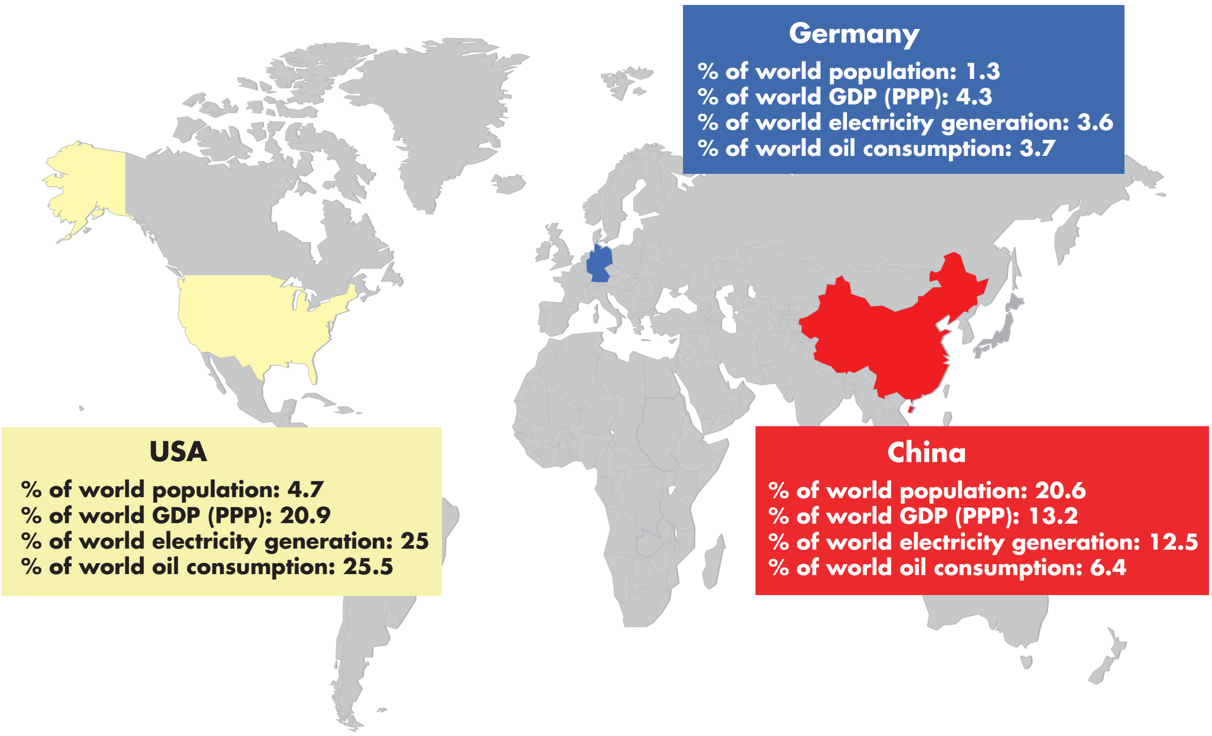
The urban unemployment rate is officially given as about 4%, although other Chinese sources estimate it at 9% to 10%. The underemployment rate in rural areas is estimated to be much higher than in the cities. It is the cause behind the movement of 100 to 150 million migratory workers. For China as a whole, an unemployment rate of more than 20% is considered realistic[5].

Dynamic economic growth, but with considerable environmental damage

The highest economic growth is in processing industries – also a consequence of foreign investment – but this is leading to accelerated growth waves in primary industries. China is still industrializing. Economic expansion is until now being driven by export demand meeting high supply potential. Rising incomes among the Chinese population will in the long run make domestic demand supersede export demand. At that point, in China too, the service sector will grow more quickly than the industrial sector.

This development is linked to a swell and diversification of material flows. Because the sustainable use of resources and the reduction as well as retention of pollutants has received so little attention until now, China's strong economic growth has led to a considerable deterioration of the environment. The quality of air, water and soil is gravely threatened. Active

Comparing China internationally



Source: db-research (2005), International Monetary Fund (2005), World Factbook (2005)

Chinese environmental policy since the early 1990s has succeeded in slowing this negative trend from about 2000 onward, and also in bringing about improvements in some areas through rehabilitation and the ban on certain pollutants such as lead. However, the negative trend has not been halted completely, as new threats are appearing in certain areas. About 30% of China's territory remains affected by acid rain, and in winter none of the cities in northern China can claim an air quality standard healthy for residential areas. About 400 of China's 600 cities also suffer water shortages.

China has set ambitious goals in terms of its environmental policy. Primary pollutants such as SO2 or industrial waste are to be reduced by 10% from the level of the last five years, and 60% of urban sewage is to be treated.

Consumption boosted by more living space, convenience and mobility

Over the next 15 years, China aims to achieve a standard of living („Xiao Kang" – modest prosperity) equivalent to that reached by its eastern neighbors: Japan at the end of the 1970s and South Korea in the mid-1990s. This does not seem unrealistic. Even at moderate rates of growth, the goal of about $10,000 per capita (on the basis of purchasing power) would be reached by 2020. That works out to a three-fold increase of GDP per head from 2000 to 2020, which would be 3.5 times real GDP compared to 2000, providing population growth can be curbed.

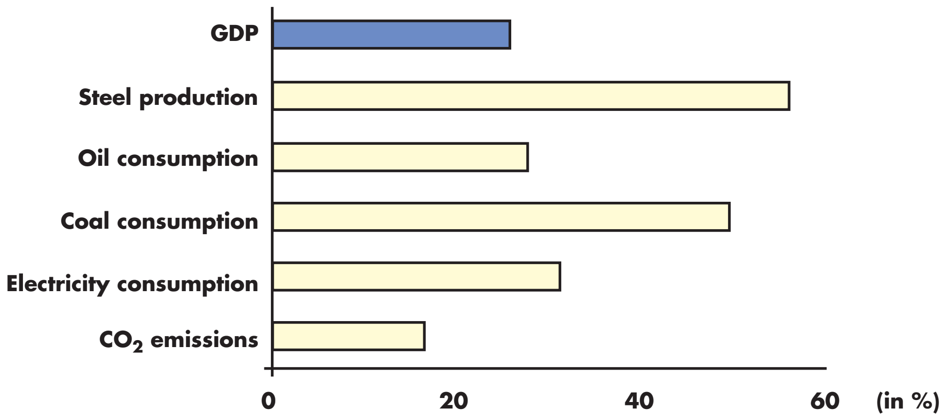
If strong commercial growth in the Chinese economy can be maintained, a considerable boost in consumption can be expected, particularly in the areas of living space, convenience and mobility. Despite modern communication systems and the growth of residential developments and industrial parks, the volume of traffic is increasing exponentially. A ten-fold increase in the number of cars is anticipated in the long term. China's building boom is evident. As the urban population doubles, and demands for greater convenience rise along with it, a four-fold increase in urban living space is expected.

Competitiveness and development potential

The great discrepancy between the internal and external value of the currency, which becomes apparent in purchasing power and exchange rate parity, indicates the need to adjust exchange rates. China has started the adjustment of exchange rates in a controlled floating in July 2005. In addition, domestic incomes and prices are being raised temporarily, which leads to a drop in the currency's value at home. This does not pose a risk to China's international competitiveness.

China's current rapid economic development is made possible on the supply side by a large labor

China's share of worldwide growth (1998–2003) in ...



Source: International Energy Agency (IEA) pool available at attractive wages and flexible conditions, which can also fulfil many qualitative requirements. Even once the rights of farm workers are established and incomes and living conditions are improved in rural areas, more and more educated people will stream into the labor market for industrial production, ensuring that the potential for productivity gains will remain high in the future.

On the capital side, very large investments – which account for about 40% of GDP – support an increase in growth potential. This corresponds to China's high private savings rate and substantial foreign direct investment. However, substantial investments with low productivity are also contained in that figure, particularly in the area of politically motivated infrastructure projects, but also in the private real estate market and the business sector.

Limited raw material resources and absorption capacity of environment and climate dim growth outlook

China's long-term growth outlook is also assessed as very good on the basis of these two factors – strong investment activity and a large, low-wage labor pool. However, China's natural resource endowment is relatively modest when measured against the size of the country and the growth prospects. For that reason, optimistic estimates made without considering limits to growth[6] deserve a more critical look.

Productive land resources are used very intensively. The strain of pollutants as well as erosion with desertification are eating away at the quality and substance of land resources. Sufficient water resources are found only in southern China. But even there, water quality has already been affected, putting pressure on the country's biological resources and reducing biodiversity. A corrective target is to raise the amount of forest cover from a current 13% of China's land area to 20%.

China has substantial stocks of coal and lignite as well as notable possibilities for renewable energy. Oil and gas reserves are relatively small. World markets for these and other natural resources for raw materials will be influenced more and more by China's import requirements as time goes on.

In addition to the risks to growth posed by China's need for raw materials as well as the local environmental burdens mentioned earlier, the evolution of international climate change policy could also become a barrier to growth. China could join the Kyoto Protocol without undergoing emission reduction. However, for the post 2012 period, it will have difficulties avoiding such obligations to limit greenhouse gas emissions.

Energy Consumption

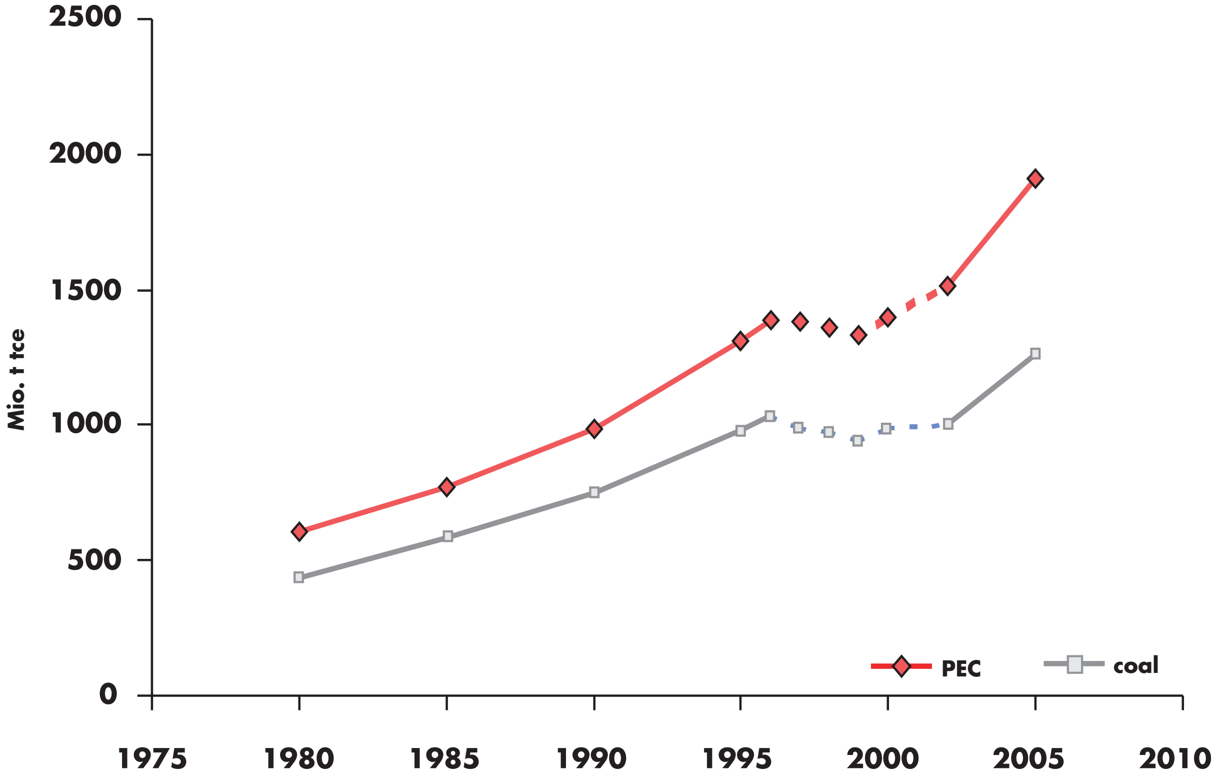
In 2003, China used about 1.7 billion tons of coal equivalents (tce) of primary energy[7] (to compare: Germany used 0.5 billion tce). The energy intensity of China's GDP is higher than that of OECD countries. However, inefficiency is not as dramatic as is often claimed. If GDP is measured in terms of purchasing power, the intensity indicator of primary energy consumption (PEC) per GDP unit for China is even lower than for the USA and only 30% more than for Germany. Only if GDP is measured in terms of the unrealistic exchange rate parity, is the indicator almost ten times higher than for Germany[8]. Per capita, the USA uses eight times as much energy as China, while Germany uses about four times as much. The energy intensity of industrial products is about 50% higher on average than in western industrialized countries.

Development and outlook for primary energy consumption

Since 1990, China's PEC has risen more than 70%. Statistical inaccuracies particularly in regard to coal consumption suggest that only data from 2002 onward should be taken as realistic estimates (see graph on primary energy and coal consumption). Although there are objective reasons for stagnation in the interval from 1996–2000 like the Asian crisis, the restructuring of the economy, and energy-related productivity increases in industries and processes, all these factors do not entirely explain the drop in PEC.

With the economic growth envisioned, PEC will rise sharply until 2020. Reference scenarios that take into consideration the strong growth of the last several years arrive at values for 2020 of nearly 4.5 billion tce[9]. As this represents something of a worst-case scenario for the Chinese government, which does

Primary energy consumption in the PRC



Source: Energy Research Institute of NDRC, calculations by GTZ China not, however, want to reduce planned growth, the official goal is to limit PEC to less than 3 billion tce by 2020 by means of a vigorous saving policy. In the figure below, one possible form[10] of this conservation scenario is laid out.

In 2003, two thirds of PEC was covered by coal and another quarter by oil. Natural gas contributed 2.5% and primary electricity from nuclear energy, hydroelectric power and wind energy made up 7.6%. This energy source mix will gradually change. The share of natural gas, nuclear energy, and renewable energy in the mix will increase over the long term, nibbling at the dominance of coal.

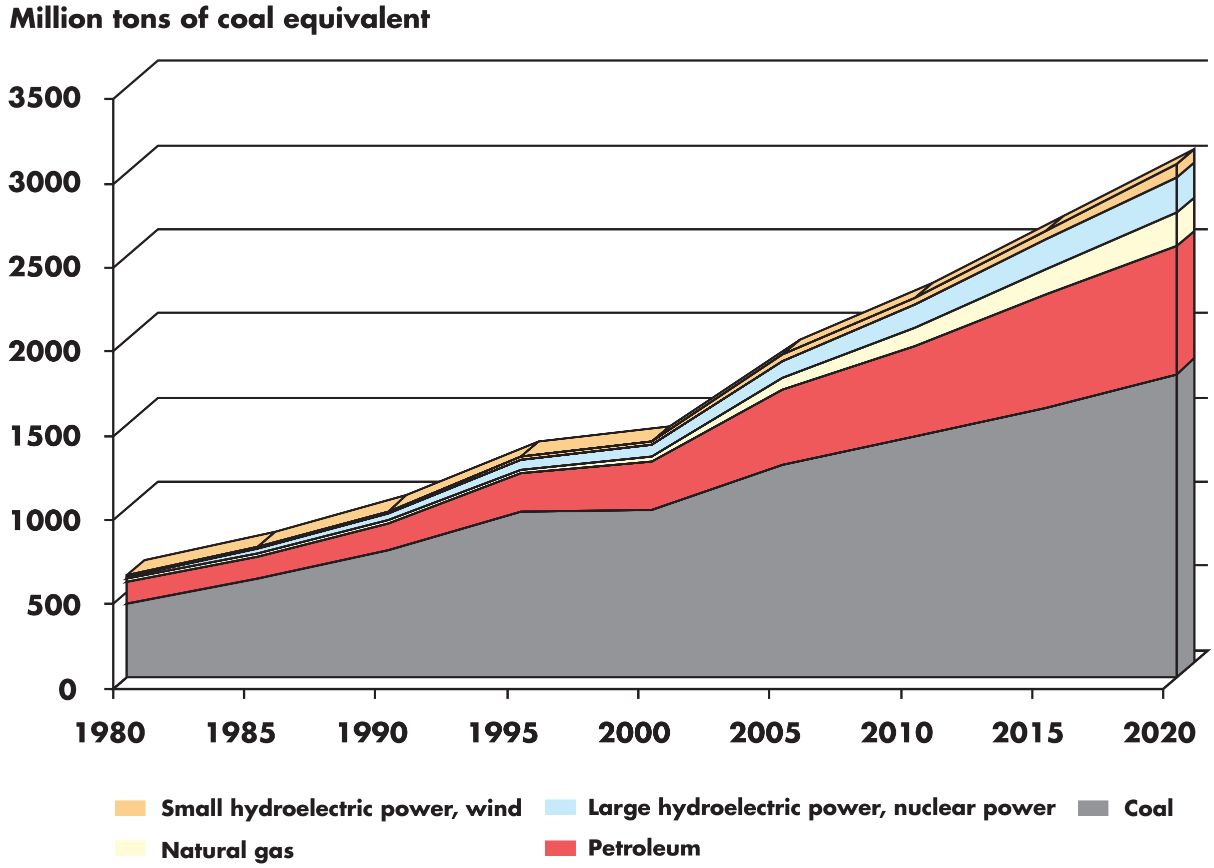
Even given the energy conservation scenario shown below, the Chinese energy sector will have CO_2 emissions of about 6 billion tons by 2020, as well as energy imports of about 700 million tons of coal equivalents, made up of about 100 billion cubic meters of natural gas and 400 million tons of oil. This corresponds to nearly the total current oil production capacity of Saudi Arabia. This would give China the same stature as the United States in both geopolitically important factors of energy policy, namely climate change and oil imports.

Energy efficiency: varying levels in consumer sectors

China's industry takes the lion's share of final energy consumption. By 1996, industry accounted for two thirds of energy consumption, and has only gone down slightly since then[11]. The energy intensity of Chinese industry is about 50% higher on average than in western industrial countries, according to

Growth of primary energy consumption in the PRC

Conservation scenario with the goal of limiting PEC to less than 3 billion tce by 2020



Source: Energy Research Institute of NDRC comparisons made for 2000 for selected sectors[12]. The energy intensity of steel is about 21% higher than the western level. Ammonia (31%), cement (45%), copper (65%) as well as cardboard and paper (120%) reveal how widely energy intensity varies across industrial sectors. By contrast, the efficiency of electrical motors and equipment is estimated to be only 5–10% lower than in industrial countries.

Building energy efficiency is low. The specific consumption for buildings is about two to three times higher than in comparable climatic zones of industrialized nations. The potential for conservation is high, but so is the risk of a sharp increase in energy consumption due to the building boom, inadequate enforcement of required improved standards for insulation (50%, and up to 65% in the future compared to 1983), as well as missing incentives. Consumption-based heating billing is hardly implemented[13]. The efficiency of household appliances, however, is at general world level since Chinese products are made for the global market, albeit largely in the low-price and low-efficiency segment.

The current specific energy consumption of vehicles is about 10% higher than in the USA and 20%–25% higher than in Japan and/or Europe. The modal split in the transportation sector is a stark contrast to the situation in Europe. Individual vehicles have a much smaller share of passenger transport, while in freight traffic shipping plays the dominant role while trains have an important function in domestic freight transport. A switch to road transport would be another driver for pollution and energy consumption.

Energy policy and environmental protection

In light of potential risks to economic development as well as foreign policy, which stem from rising demand for the world's raw material resources as well as threats to the climate, China has recently made energy conservation a top priority. In November 2004, an energy conservation plan was announced[14]. The goal of this plan is to conserve about 1.4 billion tce and to limit PEC by 2020 to about 3 billion tce given an unchanged prospect for economic growth (see figure on p. 16).

China's CO_2 emissions

By 2020, China is slated to have overtaken the USA as the world's largest producer of CO_2 emissions. The Middle Kingdom is planning new power plants totalling 350,000 MW, which will be largely fired by coal (by comparison, Germany's total power capacity is currently about 100,000 MW). According to calculations by the IEA, China's CO_2 emissions have risen from 2.67 billion tons of CO_2 (1994) to 4.08 billion tons CO_2 (2002). That already equals about 3.2 tons of CO_2 per inhabitant.

This plan is a wide-ranging program that sets conservation targets for end use sectors like industry, transport and buildings as well as for energy transformation, transmission and distribution. Specific consumption targets are given for important industrial products and transport services, and efficiency bands are planned for energy facilities and equipment. These targets are to be reached by a mix of energy policy measures. This policy is presented as a market economy approach and incentives are men-

Projected vehicle owners

	Vehicles, in millions			per 1,000 inhabitans		
Year	2002	2010	2020	2002	2010	2020
World	751	939	1,255	–	–	–
USA	234	260	288	812	826	837
Germany	48	54	60	586	655	725
China	21	80	209	16	59	146

Note: Vehicles include cars, trucks, busses and tractors per UN definition.

Source: International Monetary Fund, 2005 tioned as principal instruments. Nevertheless, the policy bears the stamp of the classical Chinese political method: on one hand, a campaign with the assignment of goals, guidelines, rules and standards; on the other, a technology-oriented process with a focus on key projects. Little detail is given about incentives.

Strong position of provinces and municipalities

The lack of incentive instruments in this national plan also has to do with the fact that in Chinese politics, targets and principles are announced at the national level but the concrete implementation and details of the policy required to reach these targets are left to the provinces, cities and rural districts. The local governments are usually politically more conservative than the national government, with a tendency towards reglementation and often to discretionary measures.

One striking difference in comparison to German conservation policy[15] is the high degree of intervention in the industrial sector, which in China also includes the energy industry itself. The goal is a growth pattern with low use of resources, which includes a deliberate change of the industry structure through curbing the growth of energy-intensive primary industries. The latter will also be subject to closer scrutiny with the aim of better energy efficiency, which would include monitoring the improvement of certain technologies and processes. Trust in self-regulation by means of higher prices, in voluntary commitments and the development of a market for energy services is not very high. Voluntary commitments and/or agreements are being experimented with on a local level.

While conservation policy in Germany has long used a variety of instruments to reach its goals, it is comparatively straightforward in China. With regard to room heating, the emphasis is on higher standards, which like consumption-based fuel billing, are to be implemented through increased pressure on local government. Incentives are rare. For household appliances, a policy of standards has been pursued for some time which consists of obligatory minimum requirements as well as labelling for improved consumer transparency.

Specific technologies have also been identified for the transportation sector, which are to be either introduced and encouraged or eliminated. Here some incentives are in preparation. For cars, the introduction of weight-dependent Motor Vehicle Fuel Economy Standard and taxation based on a European model is planned, accompanied by emission standards according to EURO categories as well as the required fuel quality standards. The introduction of a gasoline tax is also under discussion.

The preference for standards and the distrust of incentives must be seen in the context of the experience of Chinese policy makers. In China, central design institutes have traditionally had the role of innovation. They align themselves to the political orientation of the government. The Schumpeter entrepreneur is still an unknown species. It is difficult to imagine innovation being driven by the private sector without public direction. Unfortunately, in some sectors such as the real estate business, the number of players has been growing fast and it has become impossible to control the enforcement of standards.

Environmental protection and climate control gain in importance

These energy conservation measures are grounded in environmental protection and climate policy. In addition to an emphasis on energy efficiency, environmental policy in the energy sector is characterized by the implementation of air pollution control measures in energy transformation processes with end-of-pipe cleaning of waste gases and in controlling the quality of fuels. Increasingly, a more general kind of resource conservation is coming to the fore. In the mining sector, soil protection and rehabilitation are implemented and the problem of coal seam fires is being fought with the objective of extinction in the medium term With regard to power plants, the water issue is now being tackled in addition to air pollution control.

After being tried out in eastern China, emissions trading has become a central instrument of air pollution control policy for stationary emitters. From January 1, 2004, the limits for power plant emissions were significantly tightened. They apply to flue dust, SO_2 and NOx, and are assigned to plants on a sliding scale, according to year of construction and/or whether the plant is a new construction, an extended building or a conversion[16]. Limits based on EURO norms apply to mobile emitters too.

Progress is also being made in cleaner production processes and primary measures of pollution control. An important factor is the embodied technologies introduced through foreign direct investment, which increasingly prefers to use top class technologies that are available internationally. It is also being driven by the ministrie of science and technology (MOST) and the National Development and Reform Commission (NDRC), whose instruments include research as well as public tenders and licensure. Another driver is the requirement for cleaner production audits by the government.

Pricing authority largely sets cost-based energy prices

In principle, energy prices in China are created with a cost-based model and are still set and/or approved and regulated by a pricing authority (within NDRC). The pricing authority takes historical costs as a basis, and then factors in political criteria, especially where these would relieve private households of a financial burden. As a result, macroeconomic costs and short-term scarcity are not completely reflected in the prices. In contrast to electricity, petroleum products and gas, coal prices are no longer being controlled. However NDRC is still trying to create a functional market that would cover demand in this area without strong price variations.

Energy prices are an important cost factor in China both on the scale of prices for goods and services as well as in relation to income. Since commercial operations as well as private households no longer determine their consumption and/or production and factor input according to planned allocation but rather according to market conditions, income and assets, prices have come to take on an indicative role. District heating remains a complete exception, as it is still not billed by consumption.

Price spectrum for energy sources (1 € = 10 Y RMB) in China 2004

	Households	Business	Industry	Transport
Electricity per ct/kwH Daily rate	3.5 – 6.5	0.6 – 0.8	0.3 – 0.7	
Coal per €/t			250 – 500	
Natural gas € per m^3	0.2 – 0.3	0.17 – 0.25	0.11 – 0.15	
Gas ct per liter				about 40
District heating € per m^2/a	1.2 – 3.0 depending on energy source used			

From varius sources of information and data

Price-based incentives by way of consumption taxes have not been used much so far in Chinese conservation policy. Only in rare cases have tax incentives or allowances been granted. Fiscal incentives, that would either burden or support public budgets or special budgets, have not generally been customary in Chinese policy, but are starting to be considered.

Market mechanisms are to be used more frequently in the future, and are even supposed to become a „leading"[17] principle for allocation. Nevertheless, internal development policy is not yet prepared to relinquish price setting by the pricing authorities. The government and in particular NDRC tends to plan allocation in the energy sector. Quantities, internal availability and emissions are still assigned by the administration as indicator values. The government tends to over-determine the energy market results by fixing target quantities and prices at the same time. Contradictory signals are probable as the government is not a perfect market modeler. With increasing numbers of market actors these contradictions lead to allocation results at variance with market equilibrium. These differentials are exploited according to market conditions and political power dynamics.

Chinese energy administration institutions

In March 2003, the Chinese energy administration was reorganized when the new government was formed (see illustration below). This was another step following the major reform that was carried out in 1997, when the divisional ministries were abolished and political/administrative functions were separated from commercial/operational functions.

This large step forward in the reform process was intended to settle long-lasting conflicts of authority and promote the development of a coherent energy policy. The competences on energy-related matters in the executive branch of government that was vested in the former State Economy and Trade Commission (SETC) as well as development and planning (SDPC) were transferred to the National Development and Reform Commission (NDRC). National authority over energy supply was consolidated into a special department of the NDRC called the Energy Bureau, while issues about energy consumption and efficiency were referred to the environment department. In addition, the office for the coordination of climate control policy (ONCCCC), also appointed Designated National Authority (DNA) for the Clean Development Mechanism (CDM), is located in the NDRC´s regional department and works closely with departments of the Foreign Affairs MFA) as well as the Ministry of Science and Technology (MOST).

There are still strong regulatory and licensing authorities in NDRC. They are responsible for setting prices, overseeing investments, and awarding foreign credits. In addition, the State-Owned Assets Supervision & Administration Commission (SASAC) is tasked with supervising the management of state-owned enterprises (SOE), which are dominant in every part of the energy industry.

As part of the institutional reform of the electricity sector, seven new SOEs were created from the break-up of the State Power Corporation in addition to a regulatory authority, the China (Sino-) Electric power Regulatory Commission (SERC). SERC reports to the executive branch but is not a member of the cabinet.

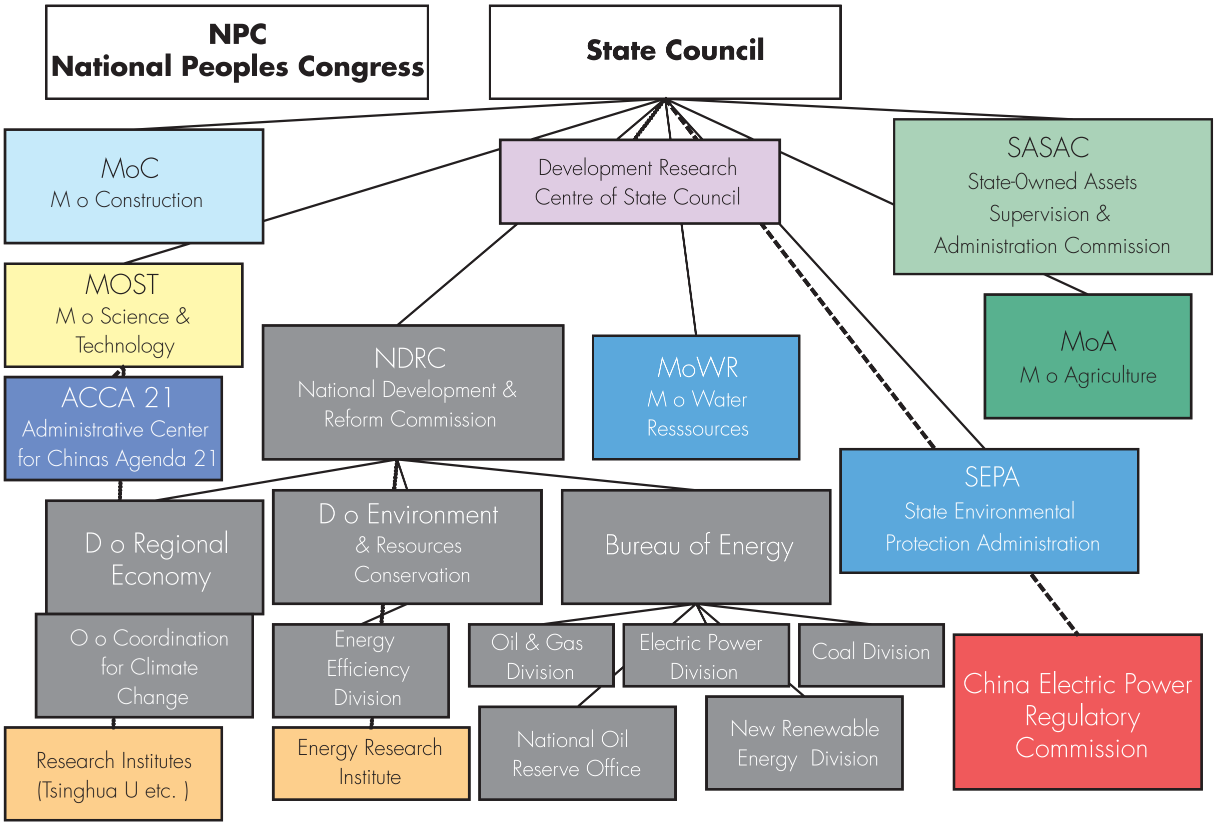
Political and administrative actors

Members of the cabinet (State Council), which provides directives and instructions on energy policy under the Minister President, are:

- NDRC (Energy Bureau, Department of the Environment, regional department with ONCCC – DNA for CDM, Department of Transportation, pricing regulation, investment regulation)
- MOST, which goes beyond basic research to promote new energy consumption and supply technologies, is supposed to work with NDRC to ensure sustainable development (Administrative Centre for China's Agenda 21, or ACCA 21) and is an integral part of climate control policy.
- The Ministry of Construction is responsible for construction and urban development but also district heating and gas supply as well as road transportation.
- The Ministry of Agriculture is responsible for rural industry (Town and Village Enterprises – TVA) and non-electric rural energy.
- The Ministry of Water Resources operates a large number of small hydroelectric plants and electrical island supply grids.
- The State Environmental Protection Administration (SEPA) is a combination of environmental ministry and regulatory agency.
- In addition, there is the Ministry of Finance, the Ministry of Foreign Affairs, and SASAC with various responsibilities.

The new institutional arrangement was not able to save the country from slipping into serious electricity supply shortages and edging towards a full blown energy crisis in 2003 and 2004 (see details below). The government became extremely worried and in spring 2005 set up a leading group on energy policy chaired by the deputy prime minister, of which all ministers relevant to the energy question became members. For the first time, the Ministry of Commerce (MOFCOM) was prominently included, indicating the new importance of foreign energy trade. Contrary to expectations, the Energy Bureau was not expanded and remained intact in the form of a department within a ministry. The secretariat of the leading group was based at the Energy Bureau of the NDRC. It remains in the driver's seat of China's energy policy, although it is watched very closely and has to follow frequent instructions from the cabinet.

Government organizations – Chinese energy policy



The legislative branch, i.e. the National People's Congress (NPC) committees are increasingly taking the initiative on environmental protection and renewable energy sources, and are insisting on legislative changes that are more or less supported by interested departments within the executive branch. Following the successful passage of a law promoting renewable energy sources in early 2005, amendments to the energy conservation law as well as to the electricity law were prepared.

The communist party organization, though fundamentally important at all levels of policy and state enterprise, has not voiced special demands in energy policy. However, the parallel institutional arrangements of the party in the energy sector are certainly instrumental in the orderly transformation and execution of sector reforms.

Change process creates conflict

Additional changes are being made to the institutional structure of the energy sector. Planned economy procedures are increasingly being replaced by market economy procedures. The organizational landscape of subsectors and market levels is being remodeled from the ground up. Property rights arrangements are also being changed, for the most part by cabinet resolution. Often the legal framework is only established once it is clear which rules should apply. The electricity sector reform for example started with a simple reallocation of assets.

By its nature, this process of change goes hand in hand with disagreements and conflicts. It is not only rules that are being changed: introducing a market economy increases the number of actors involved in every economic process. This means dealing with more and more competing interests, not only in the economic market but in the political „market" as well. With decentralization, central authorities are less able to crack down on local authorities who are inclined to have their own ideas. To ensure that the system keeps functioning while such thoroughgoing changes take place, the party works alongside the administrators and regulators. Recourse to court rulings is limited in the case of disputes, not because the courts are not independent, but because the rules of the emerging energy market are often not yet codified.

Status and outlook for energy sources

Petroleum

In 2004, the consumption of petroleum products passed the threshold of 300 million tons of oil equivalents (oe, 1 toe = 1.428 t ce), after it had previously stood at 150 million tons in 1995. The table (page 23) shows consumption characteristics and trends, confirming the strong growth pattern linked to expanding mobility.

In 2003, China had a refinery capacity of 5.5 million barrels a day, with cracker capacity taking a large share of that. In its scope and structure, this capacity was sufficient to cover the country's needs. The utilization of the refineries was nearly 80% in 2003, with an efficiency factor of 97%.

The product import balance amounts to approximately 25 million tons. The balance structure depends heavily on market conditions. For instance, the high demand for electricity in recent years led to an increasing need for heavy fuel oil and diesel to operate standby plants; some of these oil products had to be imported. While product prices are set by the NDRC, they are based on cost, and react relatively quickly to price changes on the global market and allows for margins for processing and sales. By international measures, prices fall in the low medium range, close to price levels in the USA and are thus not subsidized[18]. The introduction of a consumption tax is planned, which should reduce or replace the existing vehicle tax.

China is in the process of building a strategic oil reserve. Construction of a storage facility in the eastern province of Zhejiang began in 2003. By 2010, strategic storage facilities are planned on four to six sites with a total capacity equivalent to 50 days of oil imports. Included in that figure are the facilities of the oil companies, which are supposed to equal 21 days of consumption.

In 2010, China's oil imports will increase by another 200 million tons given anticipated demand of approximately 380 million tons, as domestic production will stagnate at 170 million tons. In 2003, net imports had already reached 80 million tons. Domestic oil production has not been able to meet demand since the mid-1990s.

Oil import needs increasing sharply

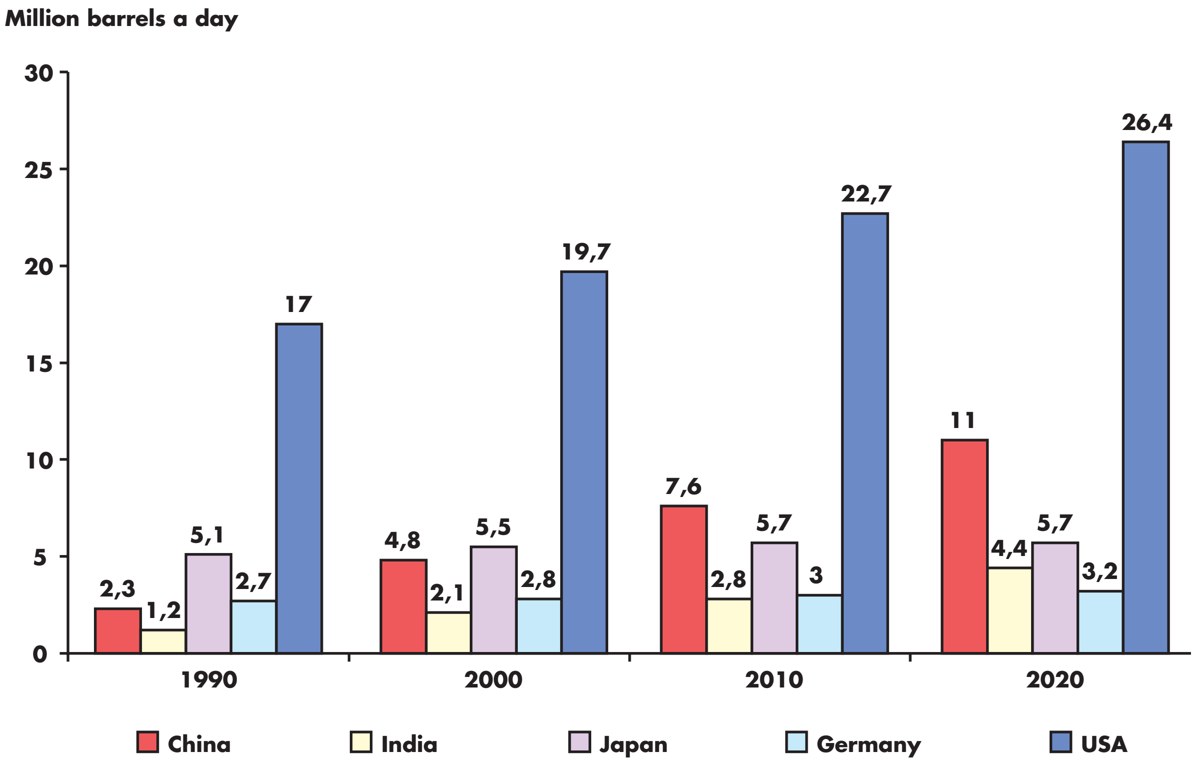
Chinese crude oil reserves are usually given as 2.5 to 3 billion toe[19]. Current production of 170 million tons of oil equivalent can hardly be increased. As consumption continues to increase, import requirements will grow more rapidly than before. In the conservation scenario described earlier, China will consume 760 million tons of coal equivalents, or about 550 million toe 2020, of which about 400 million toe will have to be imported annually.

As part of the institutional restructuring at the end of the 1990s, the State Oil and Chemical Industry Administration (SOCIA) was created on the political level. On the operational side, three national companies were each given a different focus: production, offshore production and processing. Policy control mechanisms as well as SOE control mechanisms were left at the national level. But SOCIA has been eliminated in the meantime. Political control, including administration of the national oil reserves, is now vested in the Energy Bureau. Since 2003, SASAC has taken on the role of partner here as well.

The Chinese oil industry has since been dominated by these three companies, which have become more and more vertically integrated and which are listed on international stock exchanges through their holding companies. They are China National Petroleum Company (CNPC – PetroChina), originally with a primary focus on production; Sinopec, with an emphasis on refineries; and China National Offshore Oil Corporation (CNOOC), with a focus on production offshore. These companies are also closely involved in the chemical industry as investors. Cooperation with foreign multinational firms such as ExxonMobil, Shell, BP, and BASF is intensive in this area as well as upstream in oil exploration and downstream in the gas station business. In spring 2005, there were signs of other players being granted access to the upstream business.

A 2004 WTO accord required the retail trade in petroleum products to be opened, with wholesale fol-

Comparsion of international petroleum consumption



Source: Energy Information Administration EIA

Petroleum product consumption in China

	Consumption in million of tons Oil equivalent	Share	Consumption trend	Consumption areas
Heavy fuel oil and crude oil, direct	About 50	20 %	Stagnating long-term Increasing short-term	Boilers in Industry, district heating, transportation
Light fuel oil (diesel)	About 100	40 %	Increasing sharply	Freight transport (road, ship, rail), passenger traffic in the future
Kerosene and jet fuel	About 10	4 %	Increasing sharply	Air transport
Gasoline	About 50	20 %	Increasing	Passenger traffic
Naphtha	About 25	10 %	Increasing sharply	Raw materials
LPG	About 15	6 %	Increasing	Industry, cooking gas, passenger traffic

Source: East West Institute: Statistical Yearbook, PR China lowing in 2005. SinoPec and PetroChina have entered the gas station market with a large number of facilities. In some provinces they have formed joint ventures with multinational oil companies. But access to the wholesale and refinery market remains difficult for foreign investors.

Natural gas

In the 1990s, China's consumption of natural gas remained steady with a PEC share of 2%. Gas produced from coal or petroleum still plays a more important role in China's end consumption than natural gas. Gas is used for cooking all over China, and there are gas grids in numerous cities. But the use of natural gas has only grown significantly since 2000. Until then, only natural gas reserves close to markets were exploited, particularly in Sichuan. In northern China, the heating markets of Beijing and other large cities are being connected successively to the Ordos Basin. Eastern and central China's industrial and power plant gas markets are being connected to western deposits as well as to offshore natural gas. Import projects with LNG continue to take on importance.

In 2003, about 34 billion cubic meters of natural gas was used. Of this:

- 34% went to the chemical industry as a raw material, primarily in fertilizer production
- 29% was used in industry as an energy supplier
- 23% went to the cooking gas and residential heating market
- 14% was used in electricity generation.

Gradual market penetration for natural gas

The commercialization of natural gas for large power users has met with considerable difficulty as a result of cost-based pricing. Only in the last several years has a certain price differential according to viability become accepted, allowing sales to be made to the chemical industry and power plants. Prices for these large power users had to be lowered to 1.1 yuan RMB per cubic meter, which is equivalent to about $ 0.13/cubic meter.

Natural gas can be commercialized in cities using existing gas grids. As heating plants can be converted very quickly from coal to natural gas, this is being ordered in several urban areas as an air pollution control measure. This policy giving priority to natural gas has created considerable market opportunities for gas residential heating which European manufacturers have been quick to recognize.

Such conversions limited to the heating market do not take advantage of combined heat and power (CHP), even though it would be more economical to use that combination to take care of air conditioning needs in summer. So-called trigeneration, the production of electricity, heating and cooling from natural gas is a useful extension to the sale of natural gas on the heating market, which is very seasonal, and leads to low utilization rates and high storage requirements. Gas suppliers are starting to allow lower prices for extended periods of use, which gives incentives to public facilities and commercial operations to build small block heating plants (Block CHP). The utility companies have so far been successful in stopping input from decentralized electricity generation, so that larger CHPs have not yet come to the fore.

China's commercially profitable gas reserves are estimated at 1.4 to 1.8 trillion cubic meters[20], and total resources at 7 to 14 trillion cubic meters[21]. In addition, an estimated 75 billion cubic meters of coal bed methane can be exploited. The natural gas deposits are concentrated in the Tarim and Qaidam Basins in the western province of Xingjian and are now being connected. The smaller deposits in the midwestern Ordos Basin in Shaanxi/Autonomous Region Inner Mongolia, in Sichuan and in the Songliao Plain in the northeast are already being exploited. In addition to the reserves near Shanghai and southern Hainan that are already being exploited, China hopes to discover even larger amounts from offshore deposits in the north. Using the largest deposit in the west requires the construction of important pipeline networks.

Building a pipeline network

In 2004, domestic production grew to over 40 million cubic meters. A small part of that is exported to Hong Kong. Production is to be expanded to 100 million cubic meters by 2020, which would be the foreseeable maximum. The backbone of the future supply of natural gas will be the East-West Pipeline, which will connect deposits and consumption centers. This pipeline will be increasingly networked to other deposits and extended over the next ten years to the west and the north to include natural gas from Kazakhstan and Siberia.

Natural gas use is expected to reach a total of about 200 million cubic meters by 2020, requiring imports of up to 100 million cubic meters. Imports of natural gas have already begun in the form of LNG. A series of LNG terminals is being planned on the south and east coasts for imported natural gas.

Until now, the upstream natural gas business as well as its chemical use has been controlled by the three national oil companies. Foreign companies are involved in exploration and production (e.g. for petroleum) and also in its use as a raw material and for energy in the chemical industry – the latter represents a sharply growing trend. The participation of foreign consortia in the East-West Pipeline was canceled in 2004, as the commercial requirements of the foreign companies could not be satisfied.

The city gas companies are involved in downstream distribution and sales. They are usually divisional companies associated with a holding company through the city asset company with district heating and through water suppliers. They are not associated with city electricity supply companies since these are vertically integrated with the regional electricity companies as part of the national utility company. In contrast to German city utilities which integrate the supply by various energy forms, the divisional organization represents something of an obstacle to making the best use of the energy system.

By a March 2005 decree of the state council, private companies working with state companies are now permitted to distribute gas, district heating and other public services, but not electricity.

Coal

After a drop in consumption from 1996 to 2001, coal requirements have been growing steadily since 2002. The Energy Bureau cites a level of approximately 1850 million tons for 2004, which equals a consumption level of almost 1500 million tce[22] (by comparison, Germany's consumption of coal and lignite in 2004 was about 122 million tce). About half of coal consumption goes to power plants and heating plants, whose share is growing. The share of cokeries, mostly for steel plants, is also growing and is currently about 15%, while the need for steam coal for industrial uses is stagnating and consumption by private households as well as for other uses is going down in terms of quantity.

Measured according to published figures, China's coal production went into a deep trough between 1996 and 2002. However, the statistical values for coal consumption and production from 1998 to 2001 are considered to be too low. From 2002 on, the values are believed to be more reliable. To see the effect of coal consumption data on total PEC data, see the figure on page 15.

The unreliability of statistical figures is an after-effect of the institutional upheaval in China's coal industry which began in 1997 with the abolition of the coal ministry. After a transitional period under an authority at the level of a vice-ministry (State Administration of the Coal Industry), responsibility for coal mining was given to the provinces and regulation was decentralized[23].

China's coal mines still dangerous

Each year, while China's mines produce 35% of the world's coal, they are the source of around 80% of all coal-mining accidents. The overall death rate per million tons mined is one hundred times higher than, for example, in the United States and ten times as high as in India. This makes China's 28,000 coal mines the most dangerous in the world. In 2004 alone, 6,027 people lost their lives underground. Policy-makers have recognized the problem and have now begun to raise the minimum standards, for example, by means of a mines law. Many Chinese still work in very small, privately operated mines with poor ventilation and a lack of maintenance. This makes inadequate methane extraction the main cause of explosions in mines. Despite the great demand for coal, the government has closed a series of the smallest mines, although some of them continued their operations illegally. The government has also invested over 4 billion Yuan (almost € 400 million) in ventilation equipment and monitoring systems since 2000, but the need is considered to be many times that amount. The aim is to merge the country's public and private mines into 13 large groups and to modernize them with help in part from foreign technology companies such as the RAG subsidiary DBT.

Source: Financial Times Deutschland, 2005

Reform in the coal sector

At the same time, the ownership of the state enterprises was transferred from the central government to the provinces. From a commercial view, management has been taken over by groups which merge more and more individual companies. These groups, which have developed at the province level and are becoming increasingly strong – even diversifying into power plant construction – are commercially oriented but remain for the most part in state hands (with the exception of subsidiaries listed on stock exchanges). They are regulated by the provincial offices of SASAC. This means that reform in the coal industry took a different path from petroleum: it is based on competition between a larger number of providers with decentralized regulation. On the national level, the Energy Bureau has responsibility for coal policy, while a State Administration for Coal Mine Safety (SACMS) was set up as part of the Security and Work Safety Administration (SAWS).

The number of mine operators is decreasing very rapidly[24]. Unprofitable small operations have been closed by the tens of thousands – while some continue to operate illegally or on the edge of legality with the approval of the local authorities – while medium and large operations with good coal quality have been expanded or newly opened up. Average work productivity is increasing substantially. Though in the medium and large operations it remains at only 100 to 150 tons per worker, this figure incorporates all people working in the operations. The closing of many small operations raised unemployment in coal mining areas with fragmented structures.

At the same time, environmental protection measures are coming into effect. The use of coal with high sulphur content (2%) has been forbidden, while old coal power plants with low capacity (50 MW) have been closed. Coal treatment before transport, i.e. sorting and washing, has been gradually improved. This could not be implemented completely in the short term. Currently there are still coal mines and small power plants being operated illegally, and coal with high sulphur content is being sold. The quantities of coal this covers are probably missing from the official statistics.

Demand spike for steam and coking coal

The domestic demand of power plants for steam coal has risen sharply. To cover the need, steam coal is being produced at and beyond capacity limits. This contributes to a lack of safety in large mines, where officially registered major accidents occur. Added to this is the large number of accidents in often illegal small mines, which are not officially registered. SAWS puts the number of deaths from mining accidents in 2004 at 6,027.

Domestic demand for coking coal has also increased dramatically in the last few years as steel production has doubled. Since there was a boom in the global steel market at the same time, export demand is also high. In 2002, China was the biggest exporter of coking coal as well as coke[25].

As a consequence of varying allocation regimens, conflicts arise in national as well as international coal trade. Only a small part of the steam coal is supplied by the state coal companies to state electricity generators on the basis of long-term agreed conditions. The largest quantities as well as prices are traditionally set at the annual coal order meeting organized by the government (see box page 27), but the future of this meeting is now threatened by the conflict between a price-controlled electricity sector and a market-oriented coal sector. This arrangement will likely give way to a permanent coal trading system with multiple coal trading centers.

Aside from the contract markets, there were always local markets that supplied smaller demand from heating plants, industry and domestic heating fuel. In these markets, prices are more sensitive to scarcity.

Coal production is spread over all of China. However, the largest deposits are even regionally fairly far away from industry and other consumption centers. This causes high transport costs. New large power plants will be built alongside mines or harbors.

On the coast of southern China, there is supposed to be a balance between the world market price and the domestic market price. At the end of 2002, a reference price for steam coal without transport costs was about 170 Y RMB/ton ($20.29/ton), while the price for imported steam coal for CIF Guangdong was $29.50/ton.

Steam coal and the coal trade in China, 2003 to 2005

At the annual coal order meeting under the auspices of NDRC, participants include the electricity generators, industry and the railway ministry. After the coal market became a seller's market worldwide in 2003, the Chinese coal industry in 2004 was reluctant to sell its coal much below the world market prices that had risen so quickly. For that reason, no agreement could be reached between the partners on prices at the 2004 meeting in Fuzhou, aside from small quantities. With the price increase limit set by NDRC of 12 yuan/ton, contracts for 480 million tons of coal were signed at first, but were never implemented in the course of the following year. Numerous coal companies refused to supply coal at the agreed price. For 2005, NDRC stipulated a maximum price increase of 8%. However, this was ignored from the start at the meeting in Qinghuangdao in January, and offers 20% more expensive were made instead. Without transport costs, Shanxi asked 255 yuan per ton, Henan more than 300 yuan. At the marine terminal of Qinghuangdao, coal cost about $50/ton. The meeting ended in discord. Given their own delivery obligations, the electricity generators have no alternative but to buy. As a consequence, NDRC decided to introduce a change in electricity pricing in the form of an index. According to this method, selling prices to industry can be changed when the coal price index fluctuates by more than 5%. NDRC raised electricity prices broadly two times in 2004, citing rising coal prices.

Source: Beijing News, Electricity News, GTZ China

Unclear market conditions

Since that time, the true price situation has been opaque. Official price changes for steam coal were given as $1.2/ton in 2003 and $1.5/ton in 2004. Prices vary greatly by region due to transport costs and capacities. With the dysfunction of the contract market, a gray area has developed. The mines report they cannot deliver but attempt to sell quantities on the spot market at much higher prices. In 2004, prices paid were said to be $3-$4/ton higher than reported.

In the current context of a seller's market, of the opacity of the contract market and with the short-term capacity limits in production and transportation, there is a danger that demand will not be fully satisfied. This is particularly true in those areas where demand is not solvent and cash-ready. In winter 2004/2005, plant stoppages were reported in various locations, even including thermal power plants that are essential for heating.

Exports of steam or coking coal to the world market would have been attractive because of even higher prices. But because the lack of coal had already started to affect electricity generation and steel production, and thereby the Chinese economy as a whole, the Chinese government made supplying the domestic market top priority and tightened exports. As a result, the quotas for export licenses were reduced and sales tax reimbursement was abolished for exports. After coking coal exports ground to a halt, the EU brought action against China before the WTO. China had to relent and permit exports again.

12% of world coal stock is in China

China's proven resources of coal are estimated at 1,020 billion tce[26], (about 12% of global reserves; most of which is in huge seams and flat areas). Although this coal is mostly at a shallow depth, underground mining is usually required to access it.[27] Proven exploitable reserves are estimated at 189 billion tons of coal equivalent (Ministry of Land Resources), 115 billion tons of coal equivalent (BP) or 71 billion tons of coal equivalent (BGR). With sufficient investment, it would be possible to raise production capacity in the medium term to 2 billion tons of coal equivalent and long term to 3 billion tons of coal equivalent, based on low reserve estimates. (By comparison, Germany's production of hard coal in 2004 was about 26 million tons coal units.) The government is currently trying to motivate companies to drive ahead expansion.

Annual losses due to coal seam fires are estimated at 20 to 100 million tons. Causes of the fires include improper sealing of mines as well as spontaneous combustion of seams near the surface in arid regions like China's northwest. These fires release large quantities of greenhouse gases. With German support, the Chinese government has started a program to put out coal seam fires[28].

Methane escapes unused from numerous mining operations. It is not just a climate-damaging greenhouse gas, but also contributes to mine gas explosions that increase the risk of accidents. Only now in certain mines is the mine gas being channeled off and used as energy. Coal bed methane is also now beginning to be used in deposits that are not being mined.

Large impact on global CO_2 emissions

Energy policy has given coal a significant role in the future. By 2020, aims are for coal to make up 60% of PEC. But aside from cokeries, its use is to be confined to large boiler plants as a way of controlling and reducing the impact on the local environment. End-of-pipe technologies like dust removal, desulphurization and deNO_x can all be implemented for large boiler plants at a reasonable cost. These large plants also offer better chances of making these measures most effective, but not to the point of combined heat and power.

For the foreseeable future, coal will remain the central energy source of the Chinese energy industry. Even in an ambitious conservation scenario, a rise in coal consumption to about 1.8 billion tons of coal equivalent is anticipated by 2020. Current rates of increase would predict even higher figures. Even if it is possible to reduce SO_2, NOx and dust emissions to the same degree as in Europe, greenhouse gas emissions will still rise dramatically, pushing China to the center of climate change discussions. It is becoming more urgent to implement technologies that allow for low to no-CO_2 generation of electricity and heating, if feasible CO_2 separation and storage (CO_2-sequestration)

China is also looking at ways to gasify and liquefy coal, not only as a way of expanding the number of areas where coal products can be used, but also as a means of securing its energy supply in view of its rising oil import requirements and the geopolitical consequences of oil dependency.

Electricity

The Energy Bureau estimates that gross electricity generation increased in 2004 to 2,187 TWh (to compare, Germany's consumption in 2004 was 600 TWh). For years, gross electricity consumption has been 15 to 20 TWh less[29]. This includes net exports (Hong Kong), which have dropped to less than 1%. Power plants' own consumption is 6.5%. Grid losses are given as 7.5%. Consumption of pumping electricity is negligible[30]. Net electricity consumption thus takes up nearly 85% of gross generation, i.e., 1,850 TWh in 2004.

Per capita, China's population has a net consumption of about 1400 kWh (compared to 6400 kWh in Germany). Nevertheless, electrification in China is very advanced. Ninety-eight percent of the population has access to electricity. For the remaining 30 million people, a very ambitious production program is supposed to provide about 23 million people with a basic supply by 2010, preferably with renewable energy, even in places far away from a grid[31].

In 2003, net electricity consumption broke down as follows:

– Primary industry	48%
– Light industry	18%
– Households	15%
– Public and commercial	11%
– Agriculture	6%
– Transport and communication	2%

In 2004, consumption growth continued at the rate of 10% annually that had continued since 1999, with especially high increases in primary industries such as steel, chemicals, cement and paper. A significant portion of demand could not be met even by timed delays. The missing portion of demand at current prices is 30 to 40 GW (estimated for 2004). This has worsened already strained market conditions.

Serious expansion of power plant capacities

Available capacity in 2004 was boosted further to about 450 GW. Energy Bureau figures report 50 GW went onto the grid after a growth of 30GW in 2003 and 12 GW in 2002. The illustration below shows how capacity development follows consumption growth. This decade will apparently witness a repeat of the cycle observed in the last several decades of demand growth: scarcity – capacity growth – oversupply – supply reduction (see box p. 32) but under very different institutional conditions[32].

Nuclear energy: China also building the HTR

In light of its rapidly rising electricity requirements, China intends to build 2-3 nuclear power plants annually until 2020. By that time, the total output of Chinese nuclear power plants will rise from 8,700 MW today to 40,000 MW, according to an April 2005 report in the state press. This would be 10% above previous plans. „We are accelerating development of our nuclear energy because it is a clean and green source of energy," said Zhang Fubao, deputy director of the Chinese atomic energy agency. In contrast to previous plans, nuclear power plants will not just be built in the densely populated coastal regions but in the interior of the country as well, in order to relieve transport capacities burdened by supplying coal.

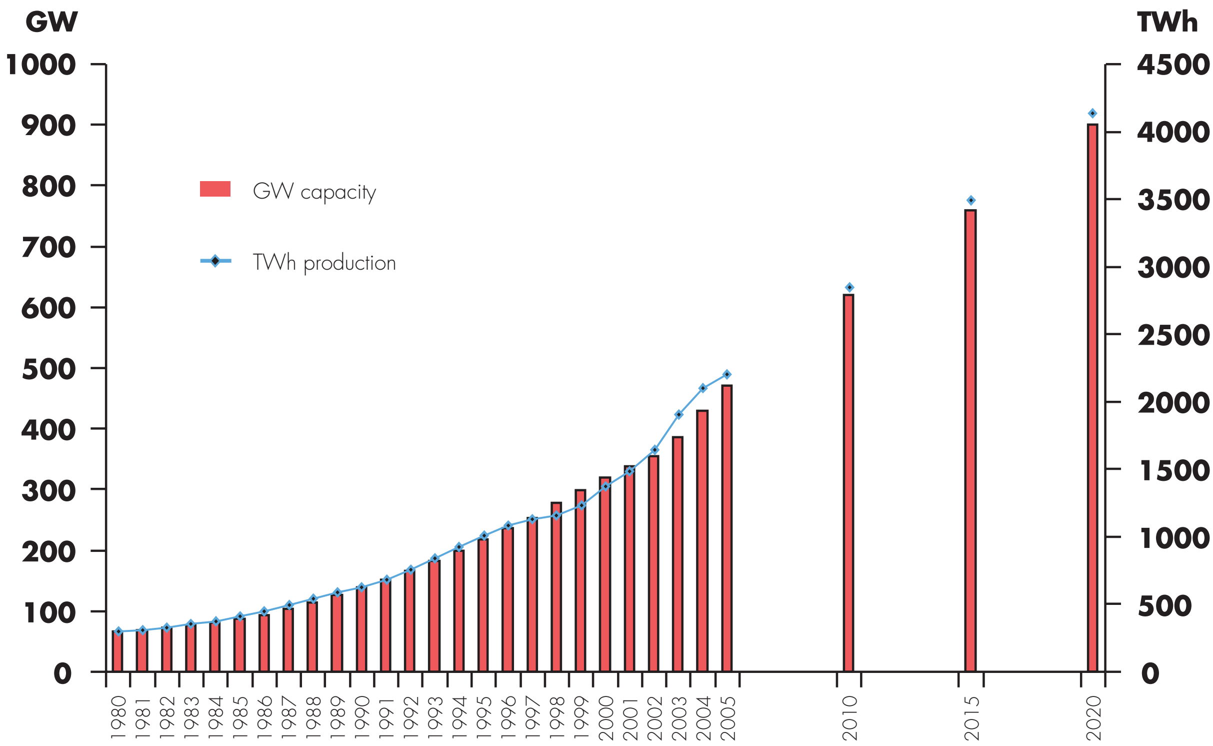
Since 2000, Tsinghua University in northwest Beijing has been operating a 10 MW high temperature reactor (HTR). Since the test plant worked without problems, the Chinese are now taking the next step. The prototype for an HTR is now being planned in Weihai, Shandong province, by an energy consortium along with the electricity generator Huaneng and Tsinghua University. In five years, the 195 MW plant is to be connected to the grid. It would be the first commercial implementation of the technology in the world, which would also give China the lead in the race to develop new, innovative reactor concepts. The HTR was originally developed in Germany.

Industrial combined heat and power, which is usually limited to small plants but which can now also include larger captive power plants in exceptional cases, has a total capacity of about 50 GW. The rest are public power plants and a few public CHP plants. In terms of generation, thermal power plants usually have a share of about 80%; more of generated energy and less of available output. In most cases the plants are coal-fired. Petroleum products are used as substitutes over the short term during times of scarcity. The share of natural gas is still low. Nuclear energy has a current share of 2% with a sharply rising trend. To double that figure, 2-3 new nuclear power plants are to be built annually over the next 15 years.

Hydroelectric power has played an important role in China for some time. Its share of installed output in 2003 was about 22%, but only about 16% on average in terms of generation. Contrary to earlier predictions, large hydroelectric projects have not changed generation structures to the point where the share of fossil fuels can be reduced, since four times as many coal plants are being built at the same time.

Small hydroelectric plants up to 25 MW make up China's largest share of renewable energy sources used in electricity generation, which is about 5%. In 2000, capacity stood at 27 GW. That is now being greatly expanded. Wind plants connected to the grid will reach the set capacity target of 1,000 MW by the end of 2005, after reaching 730 MW in 2004. Other renewable energy sources like biomass and solar power are not yet significant contributors to electricity generation. Solar power, small wind generators and micro-hydroelectric plants are used especially for village electrification in remote settlements of western China. Individual systems supply rural and nomad households[33].

Capacity and gross electricity generation in the PRC



Source: State Power Information Center and GTZ China

Coal-fired power plants becoming more efficient

The specific coal consumption of power plants is improving continually. According to sector statistics, specific coal consumption was 381 g/kWh in 2003[34]. In existing plants, specific consumption is constantly being improved.[35] Old plants are being shut down and replaced with newer, more efficient facilities. With the recent increase in power plant construction, the size of coal-fired power plants has also increased. Today, block sizes of 300 MW make up approximately half the capacity of thermal plants. In 2004, the first 900 MW block with super-critical steam parameters was put into operation.

According to sources, the standard price for generation costs from standardized Chinese plants is 0.3 Y RMB/kWh, which is approximately $0.25/kWh. Every technological leap is accompanied by a corresponding jump in costs. Although the transition from subcritical to supercritical plants increased prices by 0.01 Y RMB, it also boosted effectiveness to 41%, a six-percent improvement[36].

The FGD and DENOX environmental protection measures are increasing investment costs as well as power plants' own consumption. Furthermore, as a result of water shortages, cooling and air pollution control systems with low water consumption are becoming necessary[37].

Building a nationwide grid

The power grids are being integrated on a continuous basis which has brought down the number of regional grids from 16 to 12. Most of these regional grids have been incorporated into the six larger regional grids, with the exception of the remote provincial grids of Xingjian, Tibet and Hainan. A nationwide grid with substantial connections between regional grids is scheduled for 2006. Transmission lines are already in operation for transporting electricity (sometimes direct current) from large hydroelectric plants from west to east.

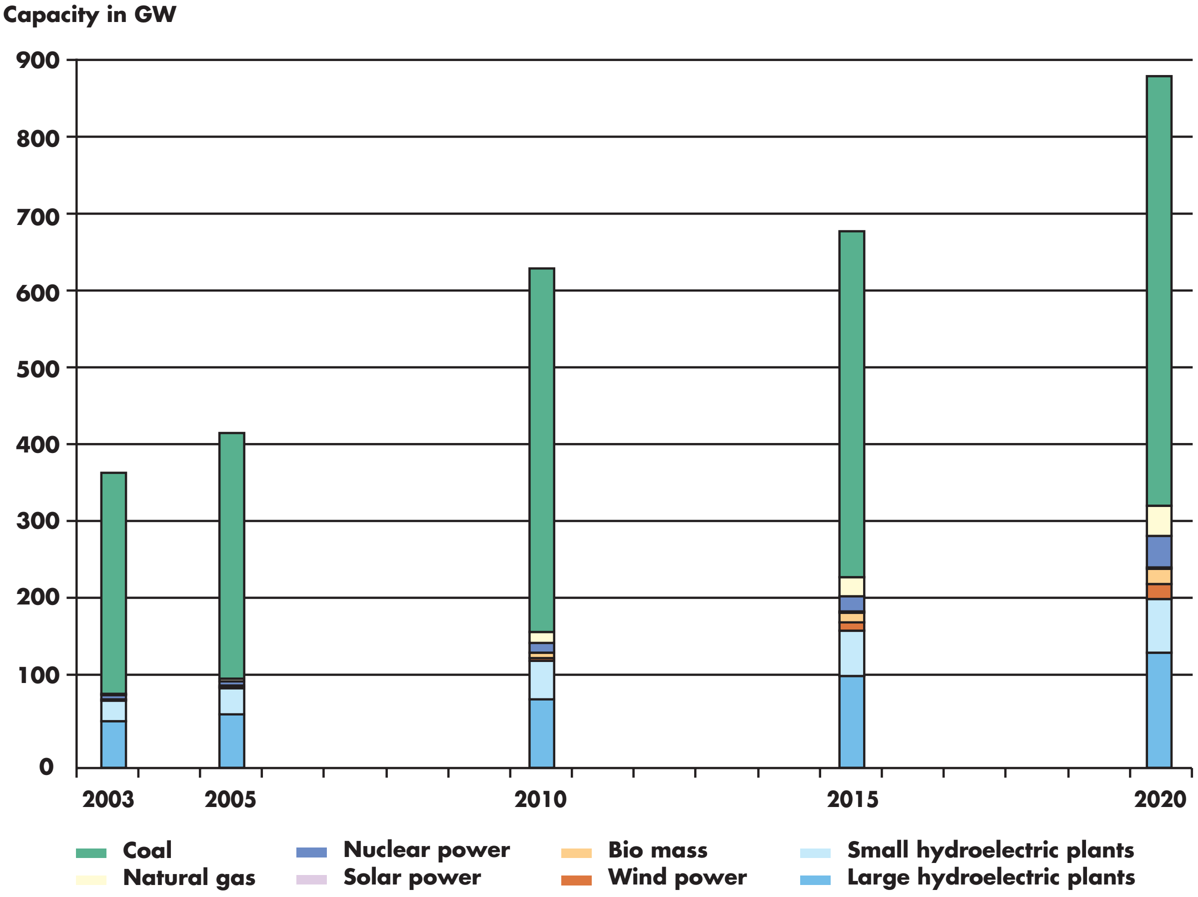
In the past, regional power supply imbalances, overcapacities and supply bottlenecks were not uncommon in many parts of China's developing grids. Rationing took place in agreement with load dispatching centers and industrial plants. There was a tendency to shield distribution grids from such measures. The usage period of peak loads was high because it was not based on demand peaks. In the past, priority was given to expanding generation capacity instead of grid capacity. Demand side management (DSM) was only employed in times of crises. In any case, sales was an area neglected by Chinese ESCs.

Prices for power plant supplies are monitored by both NDRC and SERC. SERC is pushing for greater overall control of pricing. NDRC fears loss of control and the decline of political pricing criteria.

Widely differentiated electricity prices in consumption sectors

In 2003, regulated average consumer prices (and distribution prices) for electricity were 420 Y RMB per MWh, a 4% increase over 2002. The regional averages ranged from 35% above average (Shanghai) to 40% below average (Guizhou). Household electricity prices are close to the mean average price. Electricity prices for small industrial customers, public customers and the areas of trade and commerce were 30%, 50 % and 80 % above the average. Large-scale industrial consumers pay only slightly less (1%) than average, whereas rural redistributors pay 14% less. Agricultural customers pay 15% below average. Since 2003, more time-dependent rates have been implemented, with day and night rates differing by a factor of two or three.

Structure of installed demand according to energy source in China from 2003–2020



Source: State Power Information Center and GTZ China

Although announced in spring 2005, plans for a new pricing system have not yet been implemented. The new system would define fixed rate and grid usage fees for generation, transmission and distribution. It is being tested in some provinces. Such changes would increase prices for residential customers and cannot be implemented at this time for political reasons.

By 2020, China's electricity consumption is expected to double, reaching more than 4,000 TWh. Installed demand is forecasted to reach some 900 GW. Such figures are in line with the government's goal of providing modest prosperity to its citizens. As a result, China's electricity consumption would be 3,000 kWh per head. 2020 target values were recently specified for some energy sources and electricity generation technologies (see illustration p. 31): Large-scale hydroelectric power: 150 GW, small-scale hydroelectric power (up to 25 MW): 70 GW, nuclear power: 40 GW, natural gas: 40 GW, wind power: 20 GW, bio mass energy: 20 GW, solar and other renewable energy sources: 2 GW.

Changing electricity generation mix

When totaled, these figures leave approximately 560 GW for coal-fired power plants in 2020 – a share of 63%. In this scenario, renewable sources of energy (at 102 GW) would make up 12% of demand. As a result, the demand for coal and hydroelectric power plants would double, nuclear power would increase seven-fold, natural gas twenty-fold and wind and bio mass would grow by a factor of forty. Solar power generation would reach significant levels. In light of the expansion of the past 15 years, a program for adding another 400 GW in the next 15 years would appear feasible, especially in consideration of recent events. However, it is still uncertain whether the necessary conditions will be created for achieving these goals.

A cycle of feast or famine in the electricity sector?

Since 2002, the discrepancy between electricity supply and demand in China has led to bottlenecks throughout the country. In 2004, there were cut-offs in 24 provinces – three more than in 2003. Peak cut-off loads were 30 to 40 GW in that year. Cut-off loads were highest during summer months. In eastern China alone, an 18 GW load with 6.8 TWh of electricity was cut off in 2004.

The clearly unexpected growth in consumption appeared mainly in the primary industry, which underwent considerable expansion. This growth was not organic. Instead, it was a structural effect which had accelerating effects on the national economy and led to high investment rates. This was a one-time effect that would be hard to repeat. As a result, industrial consumption growth is expected to level off – especially since the government has already slowed the upward trend using monetary policy devices.

Load requirements are defined by the increasing, largely temperature-based demand of residential and commercial customers. Increased buying power and refitted facilities are providing an opportunity for improving air-conditioning. Electronic devices are the most convenient target for improvement. Remote, densely populated areas of China experience high temperatures in the summer months.

The 2003 reforms are not the reason for the lack of foresight and insufficient capacities, however. The causes can be found prior to the reforms and are mainly the fault of the central government. Due to the overcapacities of the 90s, the administration placed a moratorium on the construction of new power plants. The government began loosening these restrictions far too late.

The reform, however, led to an overzealous building of new plants. The power producers and newcomers were suddenly allowed to join the competition and have increased annual access to capacities by 30 GW in 2003, over 50 GW in 2004, and an expected 68 GW in 2005. A further 200 GW are apparently under construction, a significant portion of which without the permission of authorities. Another contributing factor is that highly liquid Chinese banks evidently consider this sector to be especially creditworthy.

Evidently, the self-righting mechanisms of a competitive electricity market still do not work for risk evaluations, and state control mechanisms were no longer effective. The number of projects multiplied as a result. In late 2004, the state council is said to have issued another moratorium on the construction of power plants.

Sources: Electric Power News, compiled by Xu Zhiyong, GTZ China

China's proactive stance on nuclear energy is an important step in a new direction. Whereas only a few years ago China was talking about careful expansion, necessitated by costs and safety issues, in fall 2004 China launched the world's largest nuclear power program with the support of the country's highest leaders. Since this decision was not linked to any technological breakthroughs, it was probably made based on a re-evaluation of risks in the face of the future requirements. China will use leading technology for light water nuclear reactors. The fuel cycle will be coordinated with the IAEA. No information on permanent waste disposal has been publicized as yet. In the initial stages, China plans to use temporary storage.

High expansion goals for renewable resources

There has been another change in direction with regard to renewable sources of energy for power generation. In this sector, China abandoned its wait-and-see attitude with respect to increased costs. The declared objective is to reach a 10% share of electricity generation by 2010. Small hydroelectric power is the most important technology for reaching this goal. Existing hydroelectric plants were neglected in the 90s as island grids became absorbed by the expansion of electric utility services in rural areas. Now, private and public investors are setting up a range of small hydroelectric power projects to feed into the grid as costs are relatively low. Grid operators are reluctant to accept this development because such projects are not always sufficiently coordinated with river basin management.

Wind power, on the other hand, has received much more public attention. In 2005, China passed its target of 1,000 MW of demand. In concessions put out to tender in 2003 and 2004, electricity generation costs quoted in new wind farms were between 0.4 and 0.6 Y RMB/kWh. Still, the 0.5 Y/kWh benchmark is considered a difficult goal. Lower costs have so far only been possible under exceptionally favorable conditions and with risks of possible losses in the plants.

China also promotes the use of bio mass using combined heat and power. Only some of the country's geothermal resources are suitable for electricity generation. Photovoltaic conversion is receiving increased attention, and plans have been made to connect small power plants (ca. 5 MW) in desert areas to the grid for this purpose. These plants would far surpass the capacities of current village plants, which are rated below 50 kW.

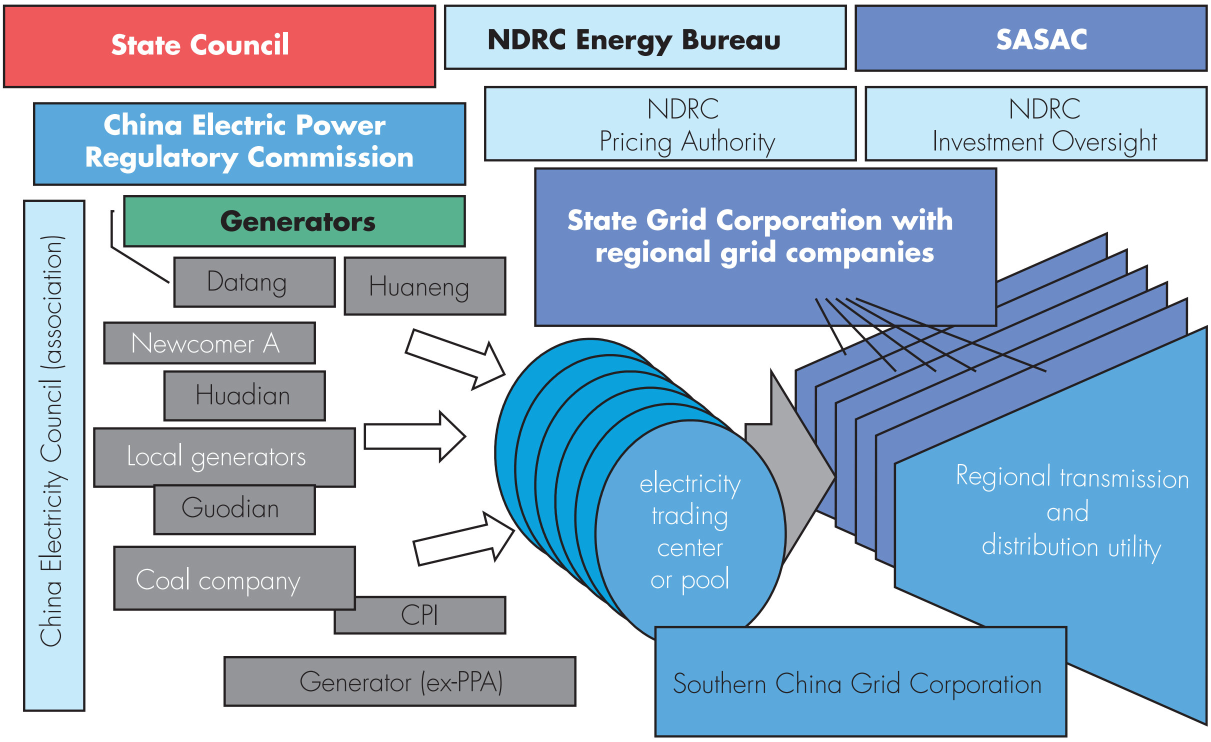
Renewable sources of energy are receiving strong support from legislators as well from an increasing number of scientists. At the end of February 2005, a law for the promotion of renewable energy was passed. It will take effect in early 2006. First, however, a number of implementing regulations must be passed and the institutional conditions necessary for realizing the plans must be established.

Holding onto large-scale hydroelectric projects

China's large hydroelectric potential will also be expanded at the demand of electricity generators. Additional plants are under construction and in preparation on the upper course of the Yangtze River. Plants are also being built on other rivers, especially the southern central regions of the southwest. After the debate over the Three Gorges project fizzled out, the ministries in charge of the projects – the NDRC and MWR – are paving the road for new large projects by seeking the support of the international community. At the local level, however, the projects are highly controversial. Some of them did not comply with SEPA conditions. For the first time, in February 2005, SEPA halted the construction of three large-scale hydroelectric plants (in addition to 19 coal-fired plants) due to lack of environmental compatibility certificates. The certificates were promptly submitted, enabling construction of most plants to resume. Minorities and conservationists fear that the highly profitable projects will be the „beginning of the end of bio diversity and traditional ways of life" in the tropical Yunnan region. The projects are receiving harsh criticism from scientists in particular.

Following the dissolution of the ministry in 1997 and the creation of a national, vertically integrated electricity company, State Power, under the control of the trade and economic council, the institutional reforms in the electricity sector caused State Power to be dissolved in late 2002. At the beginning of 2003, a new institutional arrangement[38] was defined and has taken root (see figure).

Electricity sector organizations in PRC after 2003



Source: GTZ China

Generation separated from transmission and distribution

In 2003, power generation was separated from grid operations. There are five large (ex-State Power) companies in the generation business, and several (at least 40) smaller and individual generators. The transmission and distribution levels still belong to two state-owned regional monopolies. South China Grid Corporation (SWCGC) has a monopoly on the five southern provinces and the State Grid Corporation (SCG) covers the remaining provinces including the administration of the Lhasa Power Grid in Tibet. Grid companies are still integrated across transmission and distribution levels, although vertical integration is intersected upstream. Downstream, cities and other regional bodies are usually junior partners.

Provinces which had a strong position in the State Power system are being weakened. They were considered guilty of impeding regional electricity wheeling. As a result, they not only lost their stake in generating companies, they also lost their prerogatives to regional grid companies and markets under the supervision of the central China Electric Power Regulatory Commission (SERC). As the owner of SOEs in the electricity sector, the central government is also assuming more control.

Generator SOEs as holding companies control affiliated companies which are quoted on the foreign and domestic stock exchange as joint-stock companies. As a result, they are also accountable to private shareholders.

Grid companies are responsible for expanding and operating grids. Up until now they have also been in charge of all aspects of trading. Load dispatch centres operate on five levels.

In the rural electricity supply, alongside the SGC, the Ministry of Water Resources (MWR) and its water offices are still operational with small hydroelectric plants and wind plants in island grids. In addition to these plants, there are also small island grids (mentioned above) which are run by village communities or their representatives.

The goal: competitive electricity generation

China is introducing electricity generation in a competitive mode. Therefore none of the generating companies in any of the six defined regions will be allowed to own more than 20% of the total generation capacity. The grid companies will operate as single buyers. The majority of energy supplies will be handled by long-term contracts. Competitive dispatching rules are still being established in cooperation with SERC. In 2005, every available kWh is needed. Effective competition will start only when market equilibrium is achieved or a buyers' market rules.

The vertical separation of generators and grids has not yet taken place in all locations. For example, the State Grid Corporation is also a holding company in which provincial utilities, city or county utilities operate and share generator capacities with regional authorities. In order to provide quality electricity, grid companies will also keep and operate power plants, particularly pump storage plants.

As a seller's market has existed since 2003, energy production has not yet become competitive. On the other hand, competition to enter the market has been very strong. Alongside the five main generators and their holdings, large coal companies, small generators as well as newcomers are trying to secure future market shares by building plants at the best available sites. Upstream, generators are forming alliances with coal companies to secure raw material supply. Due to high capacity needs, approval procedures for the construction of power plants were not always adhered to. This led to uncontrolled growth, with an apparent increase of 280 GW of capacity under construction. The generally strong NDRC, has intermittently lost control of this expansion, receiving heavy criticism from the State Council.

If this excess expansion causes the electricity market to become a buyer's market once again, as predicted by many experts, experience from other countries shows that this would be an ideal time to take further planned steps in the reform process. Transmission and distribution grids will be separated; and more importantly, grid and trading functions could be unbundled. Large-scale customers and electricity retailers could then procure electricity from generators and transport services from grid operators. Pilot projects are already underway in eastern and north-eastern China.

Traditional and renewable energy sources for non-electric application

In addition to the institutionally established oil, gas, coal and electricity subsectors, China uses a wide range of other materials or non-material sources to generate energy. Apart from the electricity produced by village plants (mini hydro, mini wind, photovoltaic, and diesel hybrid systems) and residential systems already mentioned, a variety of both traditional and new systems also contribute to the energy supply of the rural population. The Ministry of Agriculture (MOA) is the central coordinator for these projects.

Solid fuels such as firewood, crop residues and manure are very widespread sources of energy for cooking and heating. In ecologically fragile areas, however, such methods are spurring on critical situations. A ban on timber logging has been in effect since the late 90s, when forest resources were greatly depleted. Forest areas which can be used for firewood are in continual decline. Efficiency is improving through the use of better stoves. And in the future, better passive systems for utilizing solar energy will also improve efficiency. The biogas technology used on small farms is being promoted as an alternative source of energy for cooking. There are currently over 1.3 million such facilities in China. In western China, solar stoves are also already very common.

A wide range of technologies

An estimated 35,000 windmills are being used for water pumping in steppe areas. In other areas, simple micro hydroelectric plants are used for power generation.

By 2003, some 52 million m^2 of solar energy panels (more than half of the global capacity) had already been installed for generating solar-heated water, which is in increasing demand. The solar market is dominated by heavy competition. Solar heating is being promoted through certification programs and its incorporation into building regulations.

China also plans to integrate solar photovoltaics into its buildings, although such technology is only at the demo stage. The government is discussing a 100,000-roof program for Shanghai based on similar projects in Germany and Japan. In China, unlike in Europe and Japan, solar power is used and promoted mainly in villages as a means of electricity generation.

The use of biomass resources for large-scale applications is receiving increased support. On the one hand, there is a need for more environmentally friendly treatment of solid and liquid materials from intensive mass animal farming, waste management and agriculture. On the other hand, these materials offer significant potential as sources of energy. In addition to millions of small plants, there are currently more than 1000 large-scale biogas plants in use at animal farms, over 600 biogas facilities treating organic industrial waste and generating bio methane and bio diesel.

In addition to the use of biomass for electricity generation, current plans foresee the provision of more than 10 million tons of bio fuel, mostly bio methane, in 2020. The switch to these types of fuels enjoys the strongest political support as part of an attempt to decrease petroleum imports by all means available.

In China, the development of biomass energy is restricted by the limited land suitable for cultivation and the competition to produce food and other economically useful plants. For this reason, China plans to grow more plants that can be used for multiple products. Ultimately, recultivation efforts and measures to prevent desertification will be integrated with the goals of energy resource production.

Unlike the *EEG* (Renewable Energy Sources Act), in China, the law for promoting renewable energy resources is very comprehensive. It applies to all sources of renewable energy and their applications, and spans a wide range of measures for promoting such resources.

International Integration

Focus on secure energy supply

Since the mid-1990s, China's presence on the world market for crude oil has been marked by a steadily increasing import requirement. This is not limited to the purchase of crude oil and crude oil products, efforts are being made to secure bilateral supply contracts as well as own production rights. Thus, China does not put much stock in the „one big pool concept" used by many economists to represent the oil market. China continues to draw more than half of its imports from the Middle East, primarily Saudi Arabia, Oman and Iran. The other half is regionally diverse: Nigeria and Equatorial Guinea in West Africa, Sudan, Western Europe, and Asia, especially Indonesia.

Massive efforts have been made over the last few years to secure substantial oil imports from Siberia. The major pipeline project from Angarsk with a capacity of about 1 million barrels a day failed, to the benefit of the Japanese competition. China is to be served instead by considerable rail deliveries from Russia. Whether the exploitation of the Yukos fields holds promise for China is not yet clear. Russia is said to have offered CNPC a 20% stake in the new production company.

Diversification of energy sources – imports

Negotiations with Kazakhstan were more successful. PetroChina is the majority shareholder in the Aktyubinsk oil company, and also has a majority interest in the oil field. Previously, CNOOC and Sinopec had already acquired minority shares in fields. Other shares were purchased in Azerbaijan and Turkmenistan. In Indonesia, CNOOC has already acquired production rights from YPF-Repsol, becoming the largest foreign offshore producer. Share purchases in Australia include natural gas reserves.

After years of activity in Sudan and Angola and CNPC's acquisition of rights there, Chinese oil companies are now becoming more active in Latin America. In a first move, PetroChina (the holding company of CNPC) and SinoPec became operators in Peru and Venezuela, and service providers in Ecuador. All three oil companies are now participating in tenders for production fields in Ecuador. Judging by the intensification of contacts at the highest level, Latin American countries such as Mexico, Venezuela and Brazil are all becoming important partners in China's oil policy. Chinese oil companies are even trying to acquire firms in North America, the most spectacular case being the offer of CNOOC for UNOCAL; intensive negotiations have already been conducted in Canada.

In 2003, CNPC alone had over 800 million tons of oil reserves abroad and produced 25 million tons of crude oil and 2 billion cubic meters of natural gas overseas as well. Worldwide, CNPC operates in 32 countries.

Chinese policy is clearly aiming for a diversification of the increasing oil imports and is trying to reduce dependence on the Middle East as well as certain transport routes. This is also a reason behind the increased cooperation with Pakistan and India. The goal is not just to make the supply of energy more secure, but to keep the geopolitical implications of the Chinese energy import requirement under control despite high imports. China is also taking advantage of its ability to become involved in areas where western oil companies would confront greater risks or resistance. However, this amplifies the risk of foreign policy implications, as events in Sudan have shown.

Building an LNG infrastructure

Natural gas imports to southern China via LNG are currently in the planning stage. The LNG terminal in Guangdong will be supplied from north Australia starting in 2006, while the terminal in Fujian will be supplied from Indonesia. Another terminal is slated for Jiangsu in the Yangtze Delta. For future overland imports, the East-West Pipeline is to be extended north and south. Production rights and/or shares in production fields in Central Asia have already been acquired.

Western companies are working closely with Chinese oil and gas firms both inside and outside China. However, German firms are only involved in petrochemicals. Additional options will come about soon in other segments, particularly in grid-bound commercialization. German companies have not yet shown much interest in this area.

In contrast to the oil and gas sectors, economic and technical cooperation between Germany and China in the coal sector is long-standing, even predating the opening of diplomatic relations between the People's Republic and Germany's Federal Republic. Among others, RAG has been involved in the coal trade for years. But no other commercial involvement upstream by a German company stands out.

At present, China cannot take on the role of swing supplier which it had in 2002 in the world market for steam coal39, because of its domestic requirements. China did not even want to export coking coal. The WTO had to force China to open exports again. Over the short term, these strained market conditions will not change. However, it is not unlikely that China will become a relatively important coal exporter again, since this would be possible even with quantities that seem small in comparison to the volume of the domestic coal industry.

Asset markets, investments and financing

China does not import energy plants to the degree that one would expect given the pace of development. It generally only appears as a buyer where innovation or specialized plant parts are involved. In every significant equipment market of the energy industry, providers with production in China dominate. Aside from national companies, these can also be joint ventures (JV) or wholly foreign owned (WFO) companies where essential technologies are not involved. Foreign licenses are very common in this area.

Duplicating imported plants

Boilers, turbines and generators for power plants, for example, are usually produced domestically. However, the first plant with a new block size was always supplied from abroad, most recently a block size of 900 MW as well as the first supercritical plant with 600 MW. The first flue gas desulphurization equipment was imported from Germany, with later versions to be manufactured and assembled in China. The natural gas combined cycle plants were awarded as a package to consortia with domestic partners, under the condition of local manufacture and technology transfer. The large hydroelectric turbines for the Three Gorges project were made by WFOs in China. The first wind generators were imported; subsequent plants were manufactured in China on the basis of licenses or JV, as standardized as possible and at lower cost. Now that solar photovoltaic has taken on a certain importance, multiple production facilities have been set up, often with a completely imported production line; China will shortly become the biggest manufacturer of PV modules. Procedures in the transmission and distribution sectors are similar.

The picture observable in the value chain of the electricity industry is also reflected in the coal industry[40] as well as in oil and gas. District heating presents a similar scenario. Only specialized components are imported in relatively small quantities. Innovations are introduced through licenses, even with the support of export credits or development credits (where relevant to the environment) or by facility makers based in China. These innovations then become standard technology relatively quickly, which can then be mass-produced by Chinese industry at relatively low cost.

Technology transfer and local manufacture

The use of these mechanisms is no coincidence, but rather the result of Chinese industrial policy as driven by NDRC. Top priority is clearly given to local manufacture, with the aim of helping Chinese companies to benefit from technology transfer. This is made explicit in various public tenders, such as the one for combined cycle gas plants, as well as the tenders put out in recent years for wind concessions. Policy targeting technology transfer will also become apparent in the specific Chinese application of the Clean Development Mechanism (CDM), using the flexibility afforded by the Kyoto Protocol.

An export strategy based simply on exporting significant energy equipment from Germany or other countries to China therefore has little chance of sustainability. The two most promising routes for enterprises are the establishment of or entry into production in China or the granting of licenses. The official German promotion of exports in this sector for China should be reviewed accordingly.

Foreign investors and operators that are plant manufacturers themselves, such as Siemens, have the best opportunities in China. This combination is also encouraged by the Chinese government as well as local governments, especially in times of heightened scarcity or sluggish domestic investment. Nevertheless, the experiences of investors involved in this area have been very negative over the medium term, where the products of these plants have to compete on the market with plants made in China. Even firmly agreed prices in long-term Power Purchase Agreements (PPA) cannot be counted on if market conditions change and those prices are substantially higher than the prices of the Chinese competition. That was the case in the electricity sector at the turn of the millennium for the foreign independent power producers, who had secured PPA prices of just under 0.5 YRMB/kWh. The same is likely to apply to BOOT concepts in other areas.

Sufficient supply of capital but scarcity in expansion capacity

On the basis of these experiences, foreign investors in the energy sector have become extremely cautious and, not surprisingly, did not heed the call for renewed commitment during the current period of electricity scarcity. But it has since become clear that this was not necessary anyway, since investors from „Greater China," which includes Hong Kong in addition to the mainland, came up with enough capital to finance the required plants. It turns out that the bottleneck was not the supply of capital but rather the capacity for planning and building plants which could not be expanded from 1,000 to 50,000 MW per year without a great deal of extra effort (or without being stretched to the limit or incurring quality risks).

The high savings rate on one hand and the comparatively high creditworthiness of electricity generation on the other represent enough volume and incentives for the Chinese banking system to grant power plant investors generous lines of credit. For equity capital, there are the stock exchanges, both in Hong Kong and farther away. Complex project financing, also with the support of export credits or other instruments, is not the norm, but is considered when introducing innovations.

Both the innovation process described earlier and technology transfer, which is happening very quickly, have to be linked to the creation of expert technological skills. China's education system produces a large number of highly qualified experts in theory, but their knowledge of technology is not always up to date. The situation is similar for technicians and skilled laborers. The relevant practical skills and keeping these up to date must therefore be secured through supply and licensing agreements. To this end, China also takes advantage of scientific-technical cooperation as well as development cooperation. Cooperation with Germany is multifaceted in these fields: it is a relationship that can be used to the advantage of both sides, especially where innovation in environmental protection and energy conservation are concerned, as well as in the broader political context.

New energy technologies

The innovation mechanism described earlier does not exclude the possibility of China putting new technologies on the market that were developed at home. However, this is the exception. The research and development processes, as well as the introduction and marketing of new technologies and products up to market readiness, are not as fast or as flexible in China as they are in industrial countries. On the other hand, Chinese companies absorb new marketable technologies very quickly.

China invests heavily in its own academic institutions to create new technologies that are not yet on the market in other parts of the world, but also systematically tries to build cooperation with academic institutions overseas. Chinese scientists, whose high-ranking academies work closely with the political leadership, are very interested in cooperation with the research departments of technology companies. The focus of their interest at the moment is on new technologies for the efficient use of coal in power plants, coal liquification and coal gasification, CO_2 sequestration, and fuel cells for the transportation sector. To further these new technologies, agreements are made with companies with certain rights, such as the agreement with Shell for the integrated coal gasification and electricity conversion of IGCC.

It is not just for cost reasons that individual technologies have better chances of being implemented in China than in other countries. The state industrial policy and institutional set-up would be able to introduce new energy systems in fast growing markets where traditional systems are not yet established. Experts emphasize the necessity of such leapfrogging in energy systems, such as introducing a hydrogen economy or at least avoiding a transport system based principally on individual transport However, the current trends and policies do not indicate such entirely new options, as the build up of transportation, power plants and building systems all rely heavily on existing technology.

International conventions and politics

China's objective to develop a modest level of prosperity for its citizens is in conflict with the protection of the climate, environment, and resources[41], as China's growth would mean a doubling of its own greenhouse gas emissions as well as a higher strain on international raw materials and energy markets.

This level of development also has foreign policy implications, since access to global energy reserves is not just granted according to economic criteria, but is secured politically and militarily as well.

Existing international conventions such as the Millennium Goals, the Kyoto Protocol and the Johannesburg Action Plan do not cause China much concern, since they are not very demanding in their formulations. The Kyoto Protocol actually has a great deal to offer China in terms of technology flows and financial capital. Nevertheless, China has some very difficult years ahead of it internationally, as its development comes up against limits of a global dimension. Recognizing the problem, China has taken the offensive cautiously in international matters. The Kyoto Protocol was ratified early, and China is using the Clean Development Mechanism (CDM) to assist in creating emissions restrictions without being bound by them itself[42]. The impending 5 Pacific countries agreement is a sign that China is searching for favourable solutions in the medium term.

China is also preparing its supply of raw materials with a diplomatic offensive. It is increasing acquisition efforts worldwide, not least in Africa and Latin America. However, Chinese interests are coming up against powerful economic competition in Russia, Central Asia and the Middle East.

Diplomatic preparation for China's role as global player

China is aware that a large part of the solution to its energy problems can be found at home. The emphasis is therefore on a strategy of exploiting its own reserves of energy and raw materials, spreading out supply risks and achieving greater efficiency. But even internal activities have international implications, as the examples of nuclear energy and large-scale hydroelectric power show. China is therefore trying to build trust and increase cooperation. China's presence in the IAEA and on UN development committees can be interpreted in this way, as can its attempt to build trusted cooperation with the World Bank and other international institutions that play a role in forming public opinion even if they may not be very important in financing development. This also explains China's prominent participation in the World Conference on Renewable Energy that took place in Bonn in 2004 and its invitation to the international conference in 2005 China is present at many levels globally as a way of demonstrating its desire to share responsibility, even if it does not take on a pioneering role.

With regard to energy, the People's Republic of China has maintained longstanding cooperation with Germany on economic, academic and technical matters in the public sector as well as the private business sector. Cooperation in the coal sector goes back to the days before diplomatic relations. Newer areas include the electricity industry, energy efficiency and especially environmental protection. However, the potential arising from this cooperation has not yet been used to the greatest possible effect for German interests.

Conclusion

Given its rapidly increasing demand for energy, China is faced by enormous challenges in the energy sector. State and party leadership have made the issue of future energy supplies and the creation of a resource-conserving economy the highest priority. To this end, they have developed strategies that include the use of all energy sources.

There are great opportunities for Germany, which is viewed as a role model in the areas of energy efficiency, environmental protection and security. However, these can only be tapped in a mutually beneficial way with a realistic assessment of the Chinese institutions.

1 According to OECD statistics.
2 Criterion: availability of $1/day in purchasing power parity, according to the World Bank.
3 National Bureau of Statistics, PR China: Statistics Bureau Survey 2004.
4 National Bureau of Statistics, PR China: Statistical Communiqué on the 2003 National Economic and Social Development, February 26, 2004.
5 See Heike Holbig, Gelingt die politische Steuerung der wirtschaftlichen Dynamik in China? (Can Political Control of Economic Dynamics in China Succeed?). In: China Aktuell, January, 2003.
6 For example, Goldman Sachs, Dreaming with BRICS, The Path to 2050; Global Economics Paper No. 99, October 2003.
7 International convention does not include passive energy gains in this context, and only partially includes non-commercial energy sources.
8 See IEA, Selected Indicators, various years. This reveals the difficulty in comparing GDP values internationally. These values are not just sober statistics, but are used in the media and in politics to form opinions and as reasons. This is particularly true of the debate over climate change. When China is in the cross-hairs, the reasoning is based on CO_2 emissions per GDP in purchasing power parity. But when China is defending itself in the debate, it uses the figure of CO_2 emissions per capita, which is four times less than the United States. The UNDP, the World Bank, and respected Chinese institutes use both values: GDP in exchange rate parity and in purchasing power parity. The International Energy Agency has also used both values for some time for international comparisons of energy intensity and greenhouse gas intensity.
9 Personal communication with the Energy Research Institute, early 2005; the scenarios published in 2003 (see Development Research Center of the State Council (DRC): National Energy Strategy and Policies, in China Development Forum, Background Papers, Beijing November 15-17, 2003, Beijing) have to be revised in light of the strong PEC trend.
10 Since officials will only provide a target value, this is a plausible variant as calculated by GTZ China on the basis of DRC figures.
11 Statistical idiosyncrasies can also appear in relation to energy consumption (EC) values compared internationally. In China, EC is reported by plant units (danwei) that have traditionally had a broad spectrum of activity. Total EC of reporting plant units is assigned to the sector where the main activity takes place. Even when the EC of households and other small consumer groups are (partially) calculated out, the statistics for industrial EC come out too high and transportation EC too low.
12 Compare NDRC, PR China: China Medium and Long Term Special Program for China's Energy Efficiency and Conservation, November 25, 2004, translation of January 2004 with support from EU Project.
13 See GTZ China: Use the Carrot as well as the Stick, Publication No. 2 in Series Results – Experiences – Best Practices, Beijing April 2004 (published in Chinese).
14 The NDRC plan already cited, China Medium and Long Term Special Program for China's Energy Efficiency and Conservation, op.cit.
15 See Paul H. Suding, The development of Energy Conservation of China and Germany, in: Energy and Environment, Proceedings of the EnerEnv 2003 Conference Changsha China, edited by Gung-ming Zeng et al., Science Press, Beijing New York, 2003, p. 399 ff.
16 The GB 13223-2003 norm on emission limits for thermal power plants in China was published by the State Environmental Protection Administration (SEPA) on December 23, 2003 and came into effect on January 01, 2004.
17 E.g. in NDRC PR China: China Medium and Long Term Energy Conservation Plan, op cit. Translation of January 2005, p. 12.
18 See Gerhard Metschies, International Fuel Prices, GTZ Eschborn, 3rd edition May 2003.
19 Various sources, compiled by Philip Andrews-Speed, Energy Policy and Regulation in the People's Republic of China, Kluwer, The Hague/London/New York, 2004, p. 18.
20 An upward correction seems to be taking place compared to previously provided figures, compiled by Philip Andrews-Speed, op.cit. p. 18.
21 The trend is going up according to (official) resource estimates as well. The high number is from PetroChina.
22 Most of the coal (over 95%) produced in China is hard or anthracite quality. The rest is lignite.
23 See Philip Andrews-Speed, op.cit., p. 175.
24 See Hans Gruss, Entwicklung von Angebot und Nachfrage auf dem Steinkohlenweltmarkt (Development of Supply and Demand on the World Market for Hard Coal), in ZfE 1/2003, p. 12.
25 See Hans Gruss, op.cit.
26 See Fuchen Bai, Probleme und Reformmaßnahmen der chinesischen Kohlenwirtschaft (Problems and Reform Measures in the Chinese Coal Industry), in ZfE 4/2002, p. 283.
27 See Fuchen Bai, Kohlenförderung und Umweltschutz in der Volksrepublik China (Coal Production and Environmental Protection in the People's Republic of China), in ZfE 3/2002, p. 219.
28 The extinguishing of coal seam fires is supported by Germany's federal government from two sides: the BMBF (Federal Ministry of Education and Research) with research and the BMZ (Federal Ministry for Economic Cooperation and Development) through GTZ with consultation on precise extinguishing.
29 See State Power Center, Electric Power Industry in China 2004, Beijing; this is the annual report published in English by the electricity industry.
30 See Zhaoguang Hu, Sustainable Development of China's Electric Power Industry, SETC-GTZ Symposium on Efficient Use of Energy in China's Industry, Beijing December 2001.
31 Germany's federal government supports this program through the BMZ, as well as financial (KfW) and technical cooperation (GTZ). See Frank Haugwitz, Hansjoerg Mueller, China is slowly awakening, in: Sun & Wind Energy Special International Issue 2003, p. 58.
32 See Paul H. Suding, Zur aktuellen Reform des chinesischen Elektrizitätsektors (On Current Reform in the Chinese Electricity Sector), in: ZfE 2/2003, p. 14.
33 See China, in: Jens Drillisch (Ed.), Energy Policy Framework Conditions for Electricity Markets and Renewable Energy, 21 Country Analyses, GTZ Eschborn June 2004, p. 145.
34 State Power Information Center, Electric Power in China 2004, p. 1.
35 German know-how and measurement technology is being used as part of German-Chinese cooperation (GTZ and KfW acting on behalf of the BMZ), see T. Huffmann, H. Rall, J. Moczadlo, Einsatz moderner Messtechnik zur Prozessoptimierung in chinesischen Kohlekraftwerken (Implementation of Modern Measurement Technology for Process Optimization in Chinese Coal-Fired Power Plants), appearing soon in VGB PowerTech.
36 See World Bank (ed.) with MOST, GTZ, SECO: Clean Development Mechanism in China, Washington, 2nd edition, September 2004, p. 52.
37 Germany will also be providing technical assistance in the future here as part of an BMZ-financed conservation project in the power plant sector.
38 Illustrated in Paul H. Suding, Zur aktuellen Reform des chinesischen Elektrizitätssektors (On Current Reform in the Chinese Electricity Sector), in: ZfE 2/2003, p. 141.
39 See Hans Gruss, op.cit. p. 12.
40 See the study by China Marketing & Service Dr. Passarge GmbH: Der chinesische Kohlenbergbau, Chancen für den deutschen Zulieferer (Chinese Coal Mining, Opportunities for German Subcontractors), on behalf of VDMA, CD-ROM 2004
41 See Edgar Endrukallis, Paul H. Suding, Chinas Umweltpolitik nach Johannesburg (China's Environmental Policy after Johannesburg), in: Entwicklung und ländlicher Raum (Development and Agricultural Regions), 38th year, HEFT 3/2004, p. 24 ff.
42 On the options of China, also see the China CMD Study sponsored by the German federal government through the BMZ, drawn up by MOST, the World Bank, GTZ and SECO, see World Bank (Ed.) Clean Development Mechanism, op. cit.

Energy in the World

Energy in the European Union

Energy in the World

World energy consumption has nearly doubled since 1970. In 2004, about 15.5 billions tce were used to supply the world with energy. Compared to the 1970s and 1980s, growth in energy consumption has slowed remarkably since the early 1990s. One of the main reasons for this was the sharp drop in energy use by Eastern European transitional economies and the former republics of the Soviet Union. Another was the impact of wide-ranging reforms in China's energy industry in the mid-1990s. In 2004, world energy consumption increased by 2% over the previous year – according to initial calculations – primarily on the basis of substantial economic growth in China. It reported an increase of 9.5% in GDP in 2004 compared to 2003.

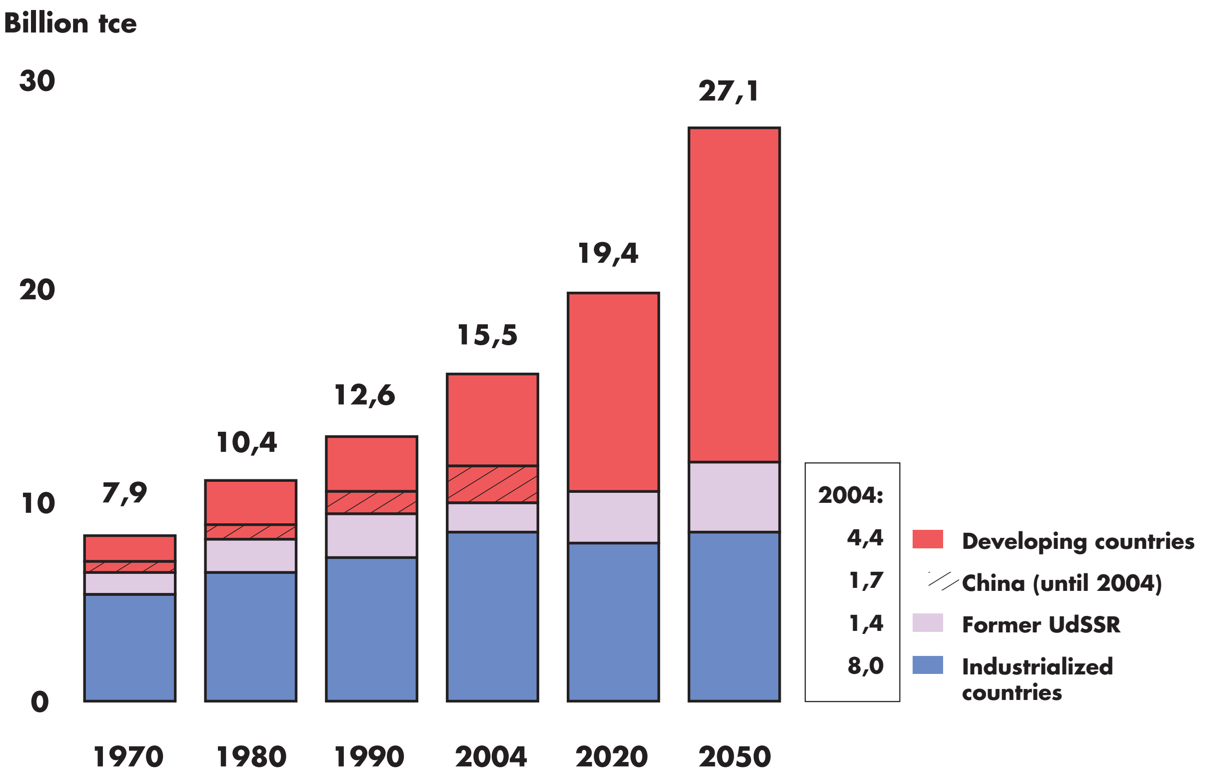
For the coming decades, most forecasts assume an ongoing increase in global energy requirements. By 2020, estimates put the increase at between 30% and 50%.

And that growth is set to continue beyond 2020 as well. The scenarios that extend farthest into the future assume a doubling of world energy consumption from 2004 to 2050.

Particularly high growth in energy consumption is anticipated for the emerging countries of Southeast Asia and Latin America, regions where both the economy and the population are set to experience ongoing growth. In the former republics of the Soviet Union and in other Central and East European countries, economic recovery following the transitional crises of the 1990s also means higher energy consumption. In comparison, the increases in consumption will be much smaller for western industrialized countries. Energy needs that increase with greater prosperity will be moderated by low population growth and a more efficient use of energy.

Worldwide, close to two billion people have no access to supply of commercial energy. Supplying

World energy consumption by region in billions of tce



Source: Until 2004, BP and own estimates (2004); from 2020, World Energy Council and own estimates these people with energy is the biggest challenge facing the global energy industry. Having access to a secure, economical, socially acceptable and environmentally friendly energy supply is the key to overcoming poverty. Industrialized countries in particular have the obligation to make a contribution to a sustainable supply of energy for the world through technology transfer to help meet the increasing demand for energy in developing and threshold countries.

Including non-conventional deposits of oil and natural gas, the WEC estimates there are sufficient energy reserves worldwide to cover the growing demand for energy until well into the 21st century. Figures concerning reserves, resources and availability of energy feedstock that were presented to the German Federal Institute for Geosciences and Natural Resources in March 2004 confirm this estimate. But the unequal regional distribution and consumption of energy feedstock means that the big consumer countries in Europe and North America will become increasingly dependent on imports from raw material producers, especially the Middle East and Russia.

To secure the energy supply in individual regions, every energy policy option and also every technical option has to be kept open. Only in this way can the need for security and reliability in energy supply be met.

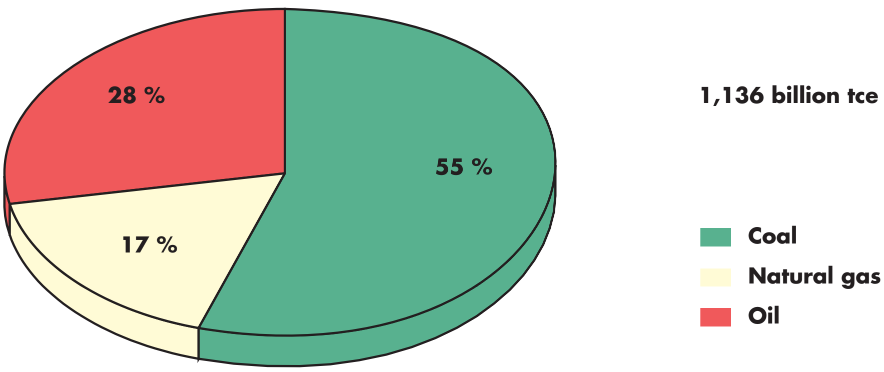
Coal, oil and gas will cover the greatest part of world energy needs in the coming decades. Today, oil has a 34% share of world energy supply, natural gas 22% and coal 26%. Forecasts assume that 90% of additional global energy needs will have to be covered by fossil fuels until 2030. Developing efficient technologies, especially raising the efficiency level of power generated by coal and gas and its distribution worldwide, will contribute significantly to ensuring an environmentally-friendly energy supply even with growing demand.

Nuclear energy currently covers nearly 7% of worldwide primary energy consumption. While a reduction of nuclear energy can be assumed for some countries, others – especially in Asia – are planning an expansion. Despite growth in absolute terms, its relative share worldwide will go down by 2020.

Hydroelectric power contributes about 2% to the global supply of energy. Its greatest potential for growth is in China and some African countries. The share of non-commercial traditional energy (burning cattle dung, wood etc) makes up about 10% of world energy consumption currently. This form of energy use, which stems from poverty and is extremely damaging to the environment, can only be reduced gradually, through increasing prosperity, particularly in developing and threshold countries.

Rapid development is expected in „new" renewable energy sources like wind power, biomass, geothermal power and solar energy. Although their current share of the world energy supply is 1%, this is set to grow – supported by state programs to promote their use – over the long term to about 5% by 2050.

Fossil fuel reserves



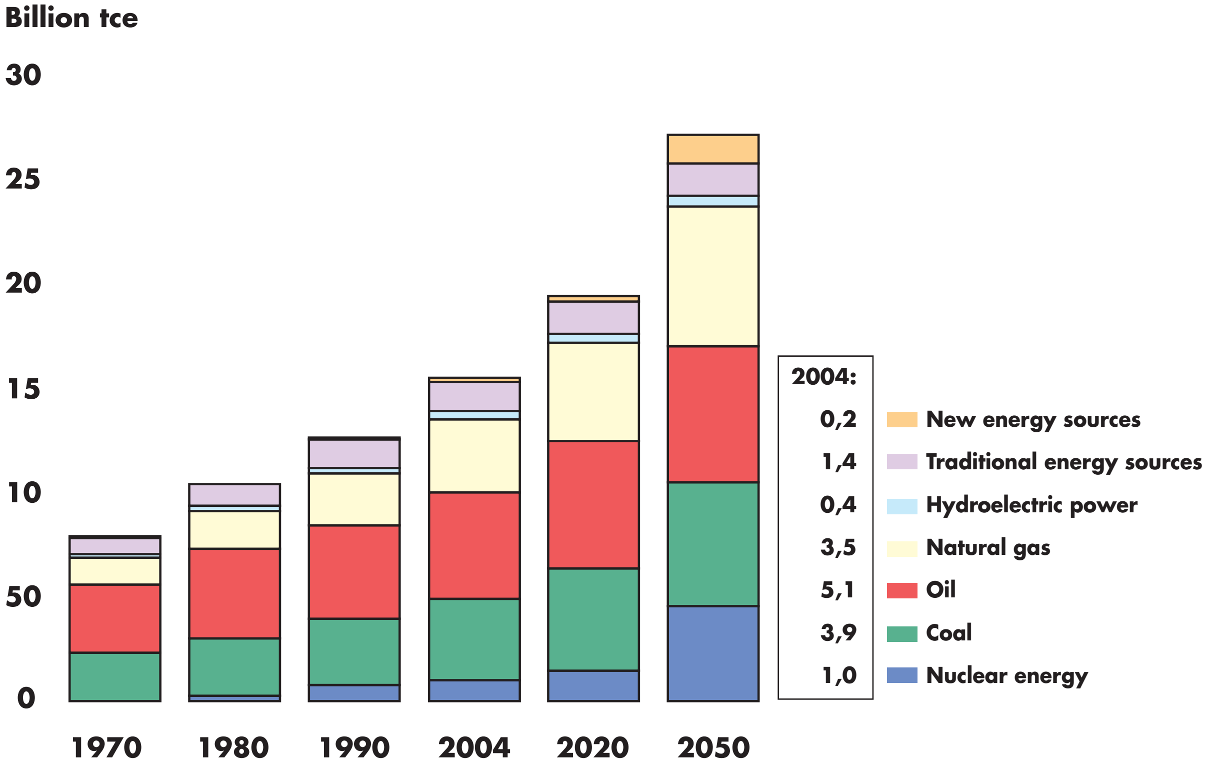
Source: Federal Agency for Geosciences and Raw Materials, 2004

A balanced energy policy is needed to meet the growing challenges of supplying the world with energy:

- All available energy sources will be required. Doing without fossil fuels and nuclear energies is not a realistic option for the coming decades; renewable energy sources are an important addition to the future energy mix. It would not make any sense to play different energy sources off against each other.
- Another indispensable factor is energy policy that favors investments in generation capacity, expansion of transportation and distribution systems, the research and development of new, environmentally friendly technologies, as well as global technology transfer. Governments and the energy industry will have to work together to reach these goals.

Beyond that, measures to conserve energy on the user side have to be identified and implemented appropriately and as comprehensively as possible. It is not least the environmental and climate protection requirements which mandate that every effort be made to keep additional increases in world energy consumption as low as possible.

World energy consumption by energy source



Source: Until 2004, BP and own estimates (2004); from 2020 on, World Energy Council

Energy in the European Union

On May 1, 2004, the European Union enlarged to include ten new member countries (Estonia, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, the Czech Republic, Hungary and Cyprus). About 75 million people live in these ten countries, raising the number of the inhabitants of the European Union from about 380 million to around 455 million which represents about 7% of the world population. In 2004, the EU had a Gross Domestic Product of 10,200 billion euros, an increase of 2.3% over 2003. The share contributed by the new member states, however, is disproportionately low: at 6,400 euros, GDP per capita is only about one quarter of the average in old member states.

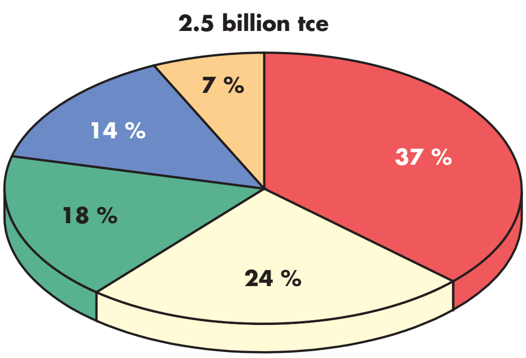
Energy consumption

In the enlarged EU, total primary energy consumption in 2004 amounted to 2.5 billion tcs, which corresponds to 16% of global energy consumption (all 2004 figures preliminary). Measured by population, the EU 25 has a disproportionately high share of global energy consumption. But compared to other industrialized regions, energy intensity is lower, as energy is used much more efficiently. The largest proportion of the total final energy demand of 1.6 billion tce is required by the transportation sector (31%), followed by the industrial sector with 28%, households (25%) and service and other sectors with 15%. The share of the transportation sector has been growing continuously for years, and has been higher than the industrial sector since the mid-1990s.

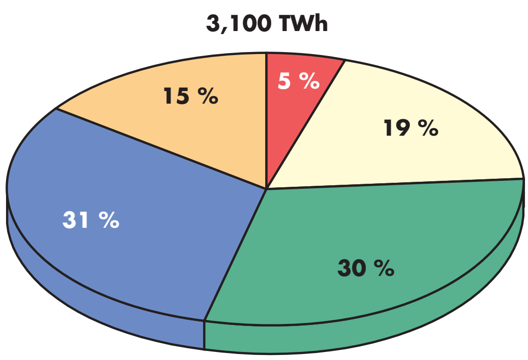
The most important energy sources in 2004 were petroleum and natural gas, followed by coal and nuclear energy, which are mainly used in power generation. Renewable and other energy sources covered a share of about 7%. The share of hard coal has continually decreased in recent years from 28% in 1990 to 18% in 2004 (based on all EU 25 countries). Shares of individual energy sources vary across the 25 member states: natural gas ranges from 1% in Sweden to nearly 50% in the Netherlands; petroleum does from less than 30% in Hungary to two thirds in Portugal; and coal ranges from 5% in France to 60% in Poland.

In the future, the European Commission anticipates a moderate increase in primary energy consumption to 2.8 billion tce in 2030 in the EU 25, which represents an increase of 19% over 2000. But there are considerable differences between individual member countries. While a mostly stable demand is assumed for Germany, Sweden and Denmark, considerable increases are expected – depending on the degree of economic development – for countries such as Greece, Portugal, Ireland, and the new member states. Overall, however, a decrease of more than 50% in energy intensity is expected.

Primary energy consumption in the EU 25, 2004



Power generation by energy source in the EU 25, 2004



Petroleum | Natural gas | Coal | Nuclear energy | Renewable energy sources

Source: European Commission 2004

In the EU 25, gross power generation was about 3,100 TWh in 2004. Of that, just under a third was contributed each by nuclear power and coal, with a fifth coming from natural gas. Oil is hardly used for generating electricity. Fifteen percent comes from renewable energy sources, primarily from hydroelectric power, which contributes 11%. The EU's share of world power consumption is about 18%. EU-wide per capita power consumption in 2003 was 6,800 kWh (for comparison: 14,800 kWh in the USA).

Energy reserves

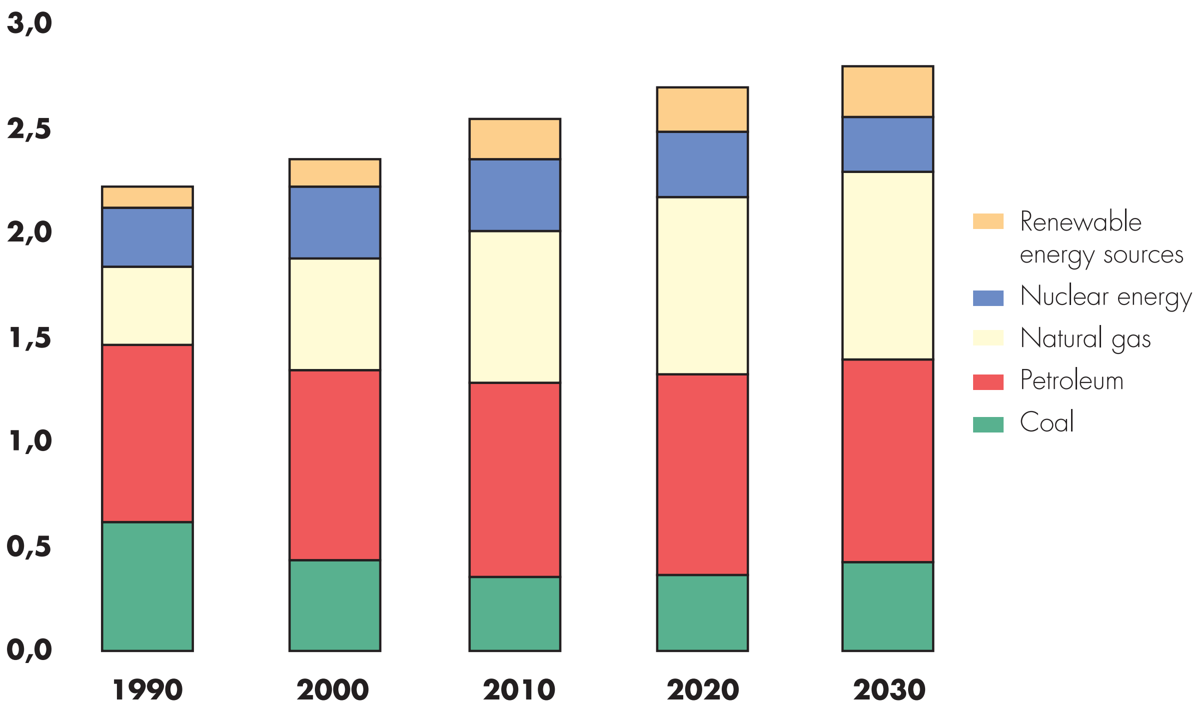
The EU's reserves of energy are comparatively small. Total reserves of fossil fuels are about 75 billion tce, which is less than 5% of globally known reserves. Within the EU, coal deposits make up the largest part of those reserves, with nearly 70 billion tce. They are equally divided between hard coal and lignite. Ninety-two percent of the hard coal reserves are in Germany and Poland, distributed approximately equally, while lignite reserves are located almost exclusively in Germany (80%). Other countries with notable coal reserves are the Czech Republic, Great Britain, Greece and Hungary.

Natural gas reserves (4 billion tce, about 1.8% of worldwide reserves) are concentrated primarily in the Netherlands and the British North Sea. The oil reserves located mainly in the British and Danish North Sea amount to around 1.3 billion tce. Production from these fields is largely exhausted and will decline significantly over the next few years.

Dependence on imports

A growing dependence on imports is one of the greatest challenges the European Union is facing. The current share of imports is 48%. Up to two-thirds of coal requirements can be met from internal sources, but three quarters of oil must be imported. The most important non-EU supplier nations are Russia and other CIS countries (oil and gas), the OPEC countries (oil), as well as South Africa, Colombia and Australia

Primary energy consumption in the EU 25 in billion tce



Source: European Commission - European Energy and Transport Scenarios on Key Drivers, Brussels 2004 (coal). The European Commission expects import dependency to rise to more than two thirds of total energy needs by 2030 if no measures are taken.

With the exceptions of Great Britain and Denmark, all EU member states are dependent on energy imports. The Netherlands, Sweden, Poland, Czech Republic and the Baltic states can cover more than 50% of their energy needs through internal sources, but all other EU member states largely rely on imports.

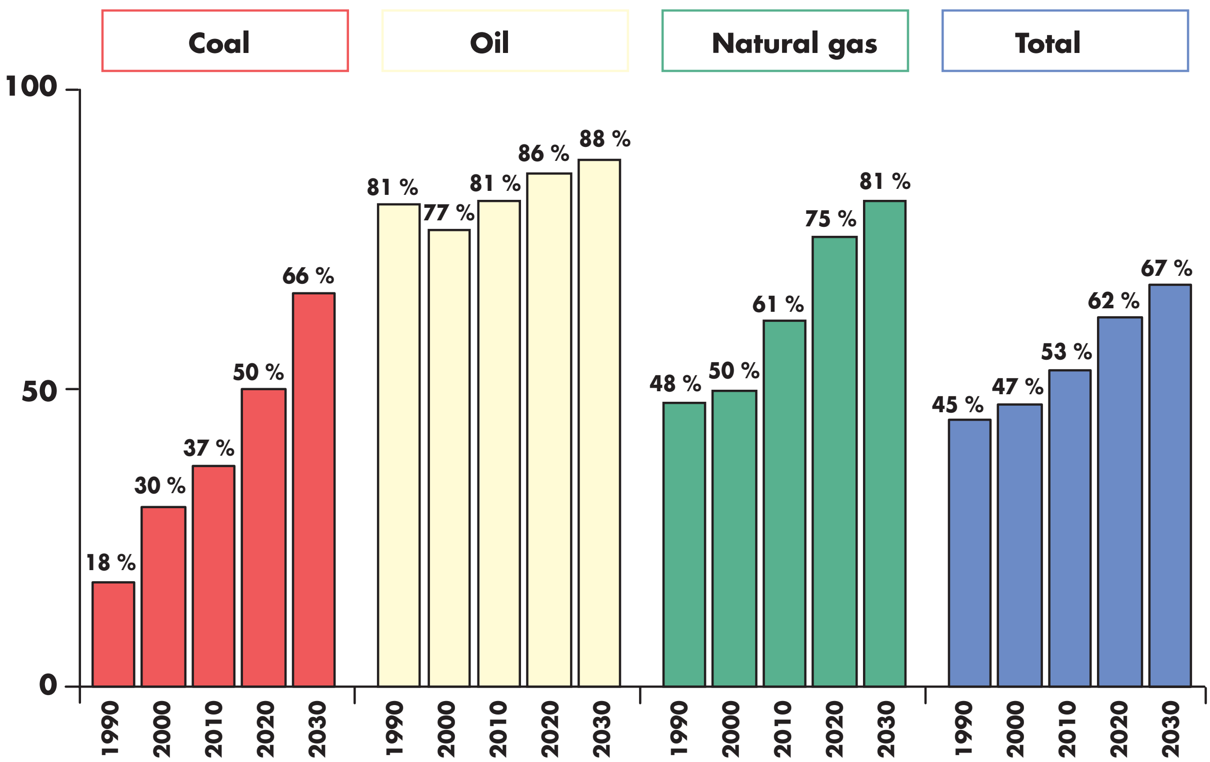
Energy and climate policy at the European level

Resolutions and decisions at the European level largely determine national energy and climate policies. As in other policy areas, member states have transferred part of their decision-making power to European institutions, which obligates them to implement regulations made at the European level into national law.

The most important institution in this context is the European Commission. It is primarily responsible for common EU policies and also administers the budget for these areas. The Commission is the only institution that can propose new legislation for the EU. According to the subsidiarity principle, the Commission only proposes action at the EU level if it believes the problem would be solved more effectively on this level than through national, regional or local measures. The EU Council of Ministers and the European Parliament can accept, change, or ignore a proposal. The Commission is also tasked with ensuring that the legislation adopted by the Council and Parliament is implemented into national law.

EU legislation encompasses both regulations which become valid and legally binding on all member states directly after their passage; and Directives, whose contents have to be implemented as national legislation (goal and timeline are assigned, but the means of accomplishing them are left to the member

The EU 25's dependence on energy imports



Source: European Commission - European Energy and Transport Scenarios on Key Drivers, Brussels 2004

New Energy Commissioner in Brussels

EU Parliament confirms new commission

The new EU Commission under Commission President José Manuel Barroso took office on November 22, 2004. As the successor to Loyola de Palacio, Latvian Andris Piebalgs (47) is responsible for energy issues. Piebalgs was the Education and Finance Minister of Latvia in the early 1990s and later represented his country as ambassador at the European Union.

At his hearing before the EU Parliament on November 15, 2004, he outlined the key priorities of his future work.

Energy policy

- Liberalizing the internal energy market is Piebalgs' main priority. Eighteen member states, including Germany, have not yet implemented the Directives (2003/54/EC and 2003/55/EC) to complete the internal market on electricity and gas. The Commission plans to draw an interim conclusion on the status of liberalization by the end of 2005 and then decide whether a third package of legislation is necessary. To strengthen the internal market, network interconnection capacity is to be further expanded. Piebalgs has not excluded the possibility that the Commission will renew discussions of separating owners' rights in grid operations.
- Piebalgs identified energy efficiency as another core objective of European energy policy. He stressed the importance of the Commission's plans to issue the Directive on Energy Efficiency and Energy Services. The proposal mandates an annual reduction of energy consumption of 1% for member states, and require energy companies to offer energy services.
- The new Energy Commissioner also intends to ascertain whether national programs to further promote renewable energy sources ought to be coordinated. However, harmonization of national promotion programs and expansion targets is not planned. An Action Plan is being prepared for biomass. The energy potential of biomass, seldom used in the past, needs to be realized in the power, cooling and heating markets. The Commission is also working on a study to evaluate combined heat and power technology. But it has not yet been decided whether an expansion target will be given through a new Directive.
- Beyond this, Piebalgs' priorities for European energy policy include closer integration with environmental and research policy, improved security in regard to nuclear power, and the consolidation of energy policy ties to Russia in particular.

states). In addition, there are case-by-case decisions which are binding on the party in question (member states, companies or individuals), as well as non-binding recommendations and statements.

The Commission publishes basic political goals as well as proposals for implementation measures in the Green and White Papers. These are intended to start discussions of individual issues. Proposals become, insofar as they are approved by the Council, action programs and/or legal regulations.

Within the Commission, energy policy along with transportation policy is pursued by a separate Directorate-General. The Directorate-General for the Environment is responsible for climate policy. The importance of energy policy for the European Union is confirmed by the fact that it was given its own article in the draft of the European Constitution. Top goals include ensuring a functional energy market, guaranteeing a secure supply of energy and the promotion of energy efficiency, as well as the development of new and renewable sources of energy.

The EU's basic orientation in regard to energy policy is summarized in the Green Paper „Towards a European Strategy for the Security of Energy Supply" (2000). The primary goal is to reduce the European Union's dependence on imports for its supply of energy. The strategy for reaching this goal includes:

- Reducing the growing demand for energy
- Promoting renewable energy sources
- Investigating the medium-term contribution of nuclear energy and
- Verifying strategic stocks of oil and natural gas, along with import options.

Agreement on EU Constitution

Shared responsibility for energy policy

On June 18, 2004, European heads of state agreed on a European constitution which summarizes previous European Union treaties into a legal foundation. For the first time, „energy" was given a separate chapter in the treaty text.

Assuming the Constitution is ratified by the member countries, the EU will receive primary authority in energy policy for the first time starting in about 2007, meaning it can initiate laws itself. While the EU has taken some regulatory action in the energy sector in the past through guidelines and Directives, member states had not transferred any responsibility to the EU for doing so. As an alternative, EU initiatives were based on its authority over individual internal markets, such as the Internal Market Directive for Natural Gas, or on its responsibility for environmental policy, as in emissions trading.

Basic contents

The Constitution delineates more systematically than before those areas for which the EU has responsibility and those which belong to national states. A primary distinction is made between exclusive, shared and supporting competence. The EU will have a shared responsibility in the future for energy. It will therefore have the prior right to pass legislation. Only where it does not exercise this authority or ceases to exercise it are the member states able to legislate. The principle of subsidarity is thus reversed.

The current prior right of the European Union only applies to the goals of energy policy as defined in the Constitution.

Article III – 256, Section 1

1. In the context of the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment, Union policy on energy shall aim to:

(a)ensure the functioning of the energy market;

(b)ensure security of energy supply in the Union, and

(c)promote energy efficiency and energy saving and the development of new and renewable forms of energy.

Pending further interpretation of the text, it is possible that the supporting competence could include co-determination, among other things, in supply and grid regulation and a Europe-wide harmonization of financial support programs, such as for energy conservation measures and the expansion of renewable energy sources.

The EU implements its energy policy goals with measures that are stipulated through European laws and framework laws. At the express wish of Great Britain and the Netherlands, member states will keep the right to decide how to use their own energy resources, the choice of energy sources and the general structure of their energy supply. The Council of Ministers has to approve unanimously laws with a financial impact, such as energy taxes. Prior to holding the vote on such a matter, the European Parliament may be consulted, but it is not otherwise involved in the decision.

Further proceedings

Before the Constitution can come into effect, it must be ratified by all 25 member states. In many countries, including Germany, the parliament will decide. In others, such as Great Britain, Denmark, and Ireland there will be a referendum. Since it is difficult to say when the ratification proceedings will be completed, the date for the Constitution to come into effect has not yet been set. If not all member states have ratified the Treaty by this date, which must still be set, the Constitution comes into effect „on the first day of the month following the submission of the last ratification document." It is not clear how proceedings will continue if some EU members reject the Constitution.

Evaluation

In the future, the EU's new competence could become a comprehensive responsibility for energy policy. From the point of view of the energy industry, it is questionable for the EU to be given authority over central issues of German commercial law such as competition and security of supply. It is also questionable whether the EU can pursue these goals without becoming involved in the general structure of energy supply and the choice of energy sources. Despite the explicit exclusion of these issues from the EU's goal catalogue, tensions are bound to arise.

To block resolutions in the Council of Ministers, the resolutions will have to be refused by four countries in the future. In the past, Germany was not supported by other member countries in its position on a series of energy policy decisions by the EU. It will become more difficult in the future for Germany to ensure that national particularities are taken into account in the legislation. National decision-making competence in energy policy would then be increasingly curtailed by centralized governance from Brussels.

The proposals contained in the Green Paper have already been introduced through a series of Directives and draft Directives. Furthermore, there are initiatives and Directives for strengthening the internal market for energy that focus on transparency of end consumer prices and the expansion of trans-European power and gas grids

Demand-oriented energy policy

Currently under discussion is a proposal for a Directive on energy efficiency and energy services which was presented in December 2003. The goal of this Directive is a more economical and efficient end use of energy. This is to be accomplished through a variety of measures: the creation of incentives and removal of barriers on one hand, and on the other, the development of a market for energy services as well as the creation of programs and measures that promote efficient energy use by end users.

A key issue of the proposal is to ensure that all member states aim for an annual end-use energy conservation target of at least 1%. The reductions would come from private households, agriculture, industry, service, and transportation sectors. Areas that are not included are energy-intensive branches of industry that are already engaged in CO_2 emissions trading. The public sector has a target of at least 1.5% to be reached through more energy-efficient facilities for example.

Energy distribution and energy retail companies are required to offer energy services as an integral component of their customer relations, not to obstruct energy efficiency programs, and to provide information about their end customers for the purpose of designing energy efficiency programs. The quality of energy services offered is to be guaranteed by qualification, accreditation and/or certification systems.

Criticism of the draft is primarily focused on making the stipulations of the Directive more flexible and less bureaucratic. Loosening the stringent requirements made on energy providers is also under discussion. The Directive is to be passed sometime during 2005 and would then have to be implemented by member states within one year.

The Directive on the energy performance of buildings came into effect at the end of 2002. According to this Directive, member states must set minimum requirements on the energy performance of buildings, and monitor these regularly. They also have to ensure that owners present a certificate of energy performance when building, selling or renting their buildings. One of the largest areas of efficiency saving potential is in the modernization of old buildings.

The Directive has to be implemented as national law by early 2006. The German government will amend current energy conservation regulations in 2005, in particular to fulfill the requirement for energy certificates for existing buildings.

The European Union has identified the use of combined heat and power as an important way of promoting energy efficiency. The Directive on the promotion of cogeneration based on useful heat demand went into effect in February 2004. While this Directive does not set a fixed target for the entire EU, it aims for an increase in the share of co-generated power in total power generation from the current level of 12%.

The Directive creates a framework for calculating co-generated power and defines which combined-heat-and-power plants (CHP) can be called highly efficient. Member states are called on to create appropriate measures for promoting highly efficient CHP. The Directive also asks member states to determine the national potential for implementing highly efficient CHP, as well as to send in regular reports detailing the progress made towards these goals. The Directive's specifications have to be implemented into national law within two years.

At first, the procedure for determining co-generated power was a source of contention. Now the Directive allows alternative procedures until 2010 in addition to the calculation method proposed in the text of the law. The German CHP law (law for the retention, modernization and expansion of CHP) from 2002 is thus mostly compatible with the Directive even though it is based on a different calculation method. No adjustments are required to implement the Directive as German law.

With the largest share of energy demand, and a clear dependence on oil imports, the transportation sector is a top area for promoting energy efficiency. In 2001, the Commission published a White Paper on European Transport Policy for 2010, which aims for sustainable development in the transportation sector. Given energy consumption, diversification of energy sources is a primary goal, especially the use of biofuels and the promotion of alternatives to road traffic.

Supply-oriented energy policy

Supply-side initiatives are mostly based on the target of doubling the share of renewable energy sources in the EU's gross energy consumption from 6% in 1997 to 12% by 2010. This target was formulated in a White Paper on the promotion of renewable energy sources in 1997, but without significant progress having been made by 2002. In September 2001 a Directive on the promotion of electricity produced from renewable energy sources was passed, which aims to increase the share of „green" power in the EU from 14% in 1997 to 22% by 2010. Since then, national governments have set national targets that make the overall target feasible by 2010, but implementation of the Directive has varied widely. With the exceptions of Greece and Portugal, the Commission certified almost all member states in 2004 as being „on track" or „about to be on track" to reach their targets. However, legal regulations promoting „green" power had not yet been introduced in France.

Germany has been certified as having generally good promotion options in addition to successfully reducing administrative and grid-specific barriers. Particularly as a result of greatly expanded wind power plant capacity, the target of 12.5% by 2010 is feasible.

As a means of diversifying energy sources in the transportation sector, a Directive promoting the use of biofuels was passed in 2003. The Directive calls on member states to issue statutory provisions and to take the measures necessary to ensure that biofuels make up a minimum share of 2% (increasing to 5.75% by 2010) of fuels consumed. Currently, biofuels only make up 0.3% of diesel and gas consumption. The Directive does not stipulate obligatory quantity targets or the compulsory mixing of biofuels with conventional fuels, as initially discussed. Germany, along with several other countries, has introduced tax breaks for biofuels that follow the Directive's recommendations.

Climate policy

An important climate policy milestone came about on January 1, 2005, with the start of certificate trading for greenhouse gas emissions. The emissions trading system is an important instrument for the EU to fulfill its obligation under the Kyoto Protocol to reduce its emissions of the six most important greenhouse gases between 2008 and 2012 by a total of 8% over 1990 levels. The targets for member states vary widely and result from the „burden-sharing" agreement. Most new members of the EU have set a 6% to 8% target reduction (see the comprehensive illustration in last year's WEC publication „Energie für Deutschland").

Within the EU, about 12,000 operators of power plants and industrial plants can participate in the emissions trading system. They are obligated to adhere to targets for emissions reductions defined in national allocation plans. These national plans were all submitted over the course of the year in 2004, and were approved by the Commission with the exceptions of the plans from Greece, Italy, Poland and the Czech Republic.

A further Directive from October 2003 (the so-called Linking Directive) regulates the linking of the emissions trading system with the other Kyoto Flexible Mechanisms, the Joint Implementation Mechanism (allows crediting of emissions reductions from projects between two industrial states) and the Clean Development Mechanism (projects where investors from industrial countries reduce greenhouse gas emissions in developing countries). This allows companies to execute projects outside the EU that reduce CO_2 emissions and to receive emissions credits for them that are included in the calculation of their targets.

Although the Kyoto Protocol came into effect through Russia's ratification in February 2005 and became binding on the 128 signatory states, its impact is limited. The USA and Australia are two important industrial states which together account for a third of greenhouse gas emissions, but did not sign the agreement. Also, developing countries (including large nations like China, India, Indonesia and Brazil) do not have any obligations to reduce emissions. The implementation of the Flexible Mechanisms is therefore a balancing act between giving companies bound by the trading system as much leeway as possible to secure their chances in global competition, and ensuring that the agreed targets are met.

List of abbreviations

BDI	Federation of German Industries
BP	British Petrolium
BGR	German Federal Institute for Geo-sciences and Natural Resources
BMZ	German Ministry for Economic Cooperation and Development
CEC	China Electricity Council
CHP	combined heat and power
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
CO_2	Carbon dioxide
CPJ	China Power International
ct	Eurocent
CDM	Clean Development Mechanism
DNK	Deutsches Nationales Komitee des Weltenergierates/German Member Committee WEC
EEG	Renewable Energy Sources Act
EIA	Energy Information Administration
EU	European Union
FDG	Flue Gas Desulfurization
GDP	Gross domestic product
GW	Giga Watt
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
JV	Joint Venture
kWh	kilo Watt-hour (= 3.6 MJ)
LNG	Liquified Natural Gas
m^2/a	square meter active surface
MOST	Ministry of Science and Technology
MW	Mega Watt
MWR	Ministry of Water Resources
NDRC	National Development and Reform Commission
OE	Oil equivalent
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of the Petrolium Exporting Countries
PEC	Primary Energy Consumption
PRC	People's Republic of China
PPA	Power Purchase Agreements
PPP	Purchasing Power Parities
RMB	Renminbi (Chinese currency)
SASAC	State-Owned Assets Supervision & Administration Commission
SAWS	Security and Work Safety Administration
SDPC	State Development Planning Commission
SEPA	State Environmental Protection Administration
SERC	China (Sino-)Electric Power Regulatory Commission
SETC	State Economy and Trade Commission
SGC	State Grid Corporation
SOCIA	State Oil and Chemical Industry Administration
SOE	State Owned Enterprises
TWh	Tera Watt hours
tce	tons of coal equivalent
toe	tons of oil equivalent
UN	United Nations
USD	US-Dollar
VDEW	German Electricity Association
WEC	World Energy Council
WFO	wholly foreign owned
WTO	World Trade Organization
YRMB	Yuan Renminbi

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World Energy Council

The World Energy Council (WEC) was founded in 1923 and is based in London. Today it has 96 national committees that collectively represent 90% of global energy generation. WEC is a forum for discussion of global and long-term issues in the energy industry, energy policy and energy technology. As a non-governmental, non-commercial organization, it is a global network of competence represented in industrial countries, threshold countries and developing countries all over the world.

The activities of WEC encompass the entire spectrum of energy sources – coal, oil, natural gas, nuclear energy and renewable energy sources – as well as the environmental and climate issues associated with them. This makes it the only global network of its kind. Since its foundation, the goal of WEC has been to promote the sustainable use of all forms of energy for the benefit of everyone, particularly the 2 billion people still without access to sufficient and affordable energy.

In line with this objective, WEC carries out studies and technical and regional programs which are presented every three years at the World Energy Congress:

19th World Energy Congress:
September 5–9, 2004 – Sydney

20th World Energy Congress:
November 9–15, 2007 – Rome

21st World Energy Congress:
2010 – Montreal

WEC: www.worldenergy.org

DNK

The DNK (German Member Committee) is the national member of WEC in Germany. It includes companies from the energy industry, associations, scientific institutions and individual persons. As a non-governmental, non-commercial organization, the DNK is an independent voice of the energy sector. All energy sources are represented on the board of the committee.

The DNK works in close cooperation with WEC on positions and studies. It also organizes its own events and annually publishes „Energy for Germany", providing an overview of the most important energy industry data and perspectives for Germany, Europe and the world.

„DNK Energy Day"
November 22nd, 2005 – Berlin

DNK: www.weltenergierat.de

Publisher:

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