ENERGY FOR TOMORROW'S WORLD

by Tim Schröder

As the world's population grows, so too does demand for energy. Today, this primarily means more coal, oil and gas. However, reserves of fossil fuels are on the wane, and greenhouse gases such as carbon dioxide pose a threat to our climate. Here's a look at how we can satisfy our need for more energy while reducing our consumption of raw materials and cutting emissions. Without a doubt, one of the most hotly debated questions of the moment is how we are going to satisfy the growing demand for energy over the coming decades. It looks certain that the world's population will grow to around eight billion by 2030. Moreover, strong economic growth in Asia and other emerging economies will lead to a substantial increase in energy demand, particularly electricity. We therefore need to tap fresh sources of raw materials and open up regions with new resources. Supplying the world with electricity, heat and cooling systems poses a massive challenge—not least when this has to be achieved in an economically, ecologically and socially acceptable manner.

In a report entitled "World Energy, Technology and Climate Policy Outlook" (WETO) from May 2003, the EU Commission concludes that the consumption of primary energy will increase by around 70% between now and 2020. According to "World Energy Outlook 2002," a report published by the International Energy Agency (IEA) in Paris, electricity production in particular is forecast to increase substantially more quickly than the world's population (2.4% as opposed to 1% per year). The World Energy Council in London and the IEA forecast that if nothing is done, the global output of carbon dioxide (CO_2) will increase by almost 50% by 2020.

Other studies based on different assumptions and various factors—such as more efficient power-plant technologies or the increased use of renewable energy resources—come to similar conclusions. They all agree that energy consumption and CO_2 emissions will rise substantially unless economic growth can somehow be uncoupled from energy use worldwide.

King Fossil. According to a study by the Federal Office of Geosciences and Raw Materials (BGR) in Hanover, Germany, non-renewable sources of energy still cover around 90% of the world's primary energy needs. "Despite the enormous growth in the use of renewable energy, we'll still see non-renewable sources dominating over the coming decades," says Thomas Thielemann, a scientist at the Department of Primary Energy at the BGR. "And that's for the simple reason that renewable energy is still too expensive and won't be able to provide the required amount of electricity for some time to come."

China, for example, whose GDP has been growing at a breathtaking rate of between seven and nine percent for a number of years, plans to meet its energy needs largely with power generated from cheap coal. China is the world's biggest producer of coal, followed by the USA. Of the 3.5 billion tons of coal produced worldwide each year, China accounts for one billion tons. Despite the high level of consumption today, the BGR calculates that there will be enough coal to meet current demand for a good 200 years to come. "Calculated on a long-term basis, trade in coal will increase annually by an average of between one and two percent," says Thielemann.

Professor Rolf Kreiblich, Director of the Berlin-based Institute of Future Studies and Technology Assessment (IZT), calls for more-efficient power plants and increased efforts to save energy. "With efficiency as low as 25%, the standard of power plants in Eastern Europe, China and India is still disastrous," he says. Modern combined-cycle power plants achieve an efficiency level of almost 60%. And when they are allied with cogeneration—i.e. a district heating system—that figure reaches as high as 85%. "If the countries in question don't make their power plants more efficient, the current rate of economic growth will become untenable," Kreiblich predicts. In particular, it's the economies with high growth rates that need rapidly to enhance the efficiency of their production plants, power plants, and heating systems for buildings. "If not, high level of energy consumption will ultimately harm their economies, since it will cause serious environmental problems and have a major impact on public health. Things to worry about here include air pollution and contamination of water supplies, the ground, and the food chain."

Big Savings. Kreiblich is also seriously concerned about energy efficiency in industrial nations. "We've found that a more rational use of fossil fuels would bring about a radical reduction in energy consumption in Germany," he says, pointing out that renovating old buildings, sophisticated temperature-control systems and low-energy houses could help cutting energy consumption. "In Germany, we currently consume an average of 240 kWh thermal per square meter of occupied space. Targeted action would reduce that to between 50 and 60 kWh/m^2 in the coming decades," he says. All in all, this would cut total energy consumption in Germany by some 12 to 15%. But experts agree that more is required than increases in energy efficiency and energy savings if we are to meet the world's growing demand for power. The appetite for electricity is particularly large, as the emerging and developing economies strive to gain a stake in the prosperity enjoyed by the industrial nations. The IEA estimates that global power production will double from 15,500 TWh (billion kWh) in 2000 to more than 31,500 TWh in 2030. Providing that kind of capacity will require a sophisticated energy mix.

Powered with Gas. Experts at Siemens predict that power production will rise by 2.4% every year between now and 2020. At 2.1% per year, coal-fired power generation is expected to experience slightly less growth. Siemens anticipates that the majority of new, efficient power plants will run on gas. The company therefore forecasts the biggest growth in the power plant sector to be in gas-fired generation, which is expected to rise by 5.6% a year. Oil-fired generation—already comparatively low—is expected to decline even further in the future.

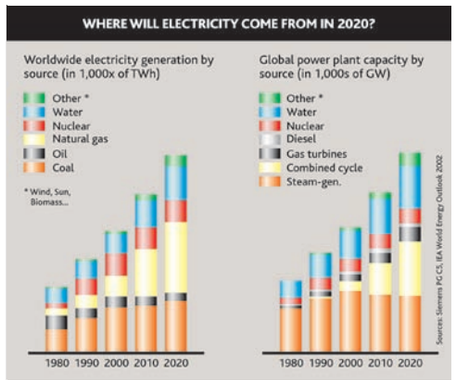
By contrast, nuclear power's contribution to the energy picture will grow until 2020, largely because the USA and Asia plan to increase the number of their nuclear power plants. Over the past two years, a number of nuclear power plants have entered service in China. In Finland, meanwhile, Framatome, a joint venture between Siemens and France's Areva, is building Europe's first-ever pressurised-water reactor with a rating of some 1,600 MW. The facility, which will be operated by utility TVO, is due to be completed in 2009. Nevertheless, the importance of nuclear as a proportion of the world's overall power supply is expected to decline as old plants are decommissioned and comparatively few new ones are built to replace them. As far as the long-term is concerned, the future of nuclear power remains unclear. Major factors here include not only public acceptance and the issue of how to dispose of spent fuel elements safely, but also economic considerations. For example, if a CO_2 tax leads to a substantial increase in the price of electricity generated from coal or gas, some experts expect that nuclear power

could experience a real renaissance. With the generation of hydroelectric power forecast to increase by 1.8% annually, its share in the world's power supply will remain the same or even decrease slightly. "On the other hand," points out Frank Haffner from the Strategic Energy Field at Siemens Corporate Technology in Erlangen, Germany, "renewable sources of energy, such as wind and solar power, will post the strongest growth at more than 6%/a. But their overall contribution is so small that it will still only account for approximately three percent of the world's total power supply by 2020."

Synthetic Future? According to the EU's WETO report, energy demand will grow at about the same rate in all major sectors of the world economy. Today, for instance, industry accounts for around 35% of total energy consumption, transportation a further 25%, and private households and other consumers the remaining 40%. In the transportation area, oil remains the number one source of energy. Assuming that demand stays at today's level, WETO predicts that "conventional oil reserves could reach alarmingly low levels after 2030." The Oil Depletion Analysis Center in London goes even further, forecasting that oil production will peak by 2010, so that the search for alternative oil supplies—including intensive processing of oil sand—will have to be greatly intensified in the near future. This, in turn, will inevitably lead to an increase in production costs. Siemens' studies predict that more and more synthetic liquid fuels, initially produced from natural gas and later coal, will help to meet growing demand.

But the question as to when fossil fuels will run out is ultimately irrelevant. In the final analysis, what should concern us is not how long the world's oil, coal and gas reserves will last, but rather the amount of carbon dioxide with which the international community proposes to burden the atmosphere. Today, engineers are working feverishly to develop power plants that are more efficient and emit as little carbon dioxide and as few pollutants into the air as possible. This has led to radically new designs for coal-fired power stations, which first convert the coal into gas before power generation—and can even be combined with gas-liquefaction techniques.

Such power stations will have to approach the high efficiency of today's combined-cycle power plants, which, in turn, will require even more intensive efforts to enhance turbine efficiency. The advantage of this type of power plant is that it produces hardly any emissions. In addition, it would be relatively easy to separate the carbon dioxide from such a plant and store it underground. New power plant technologies are also being developed for regenerative energy sources. These include geothermal plants that put the earth's heat to work or plants that use tidal currents.



Over the next 20 years, some 200,000 MW of generating capacity will have to be replaced in Europe alone. For the sake of comparison, a large coal-fired power plant produces around 1,000 MW. This prospect bodes well for the environment since, regardless of which technology is used, all new power plants will be high-efficiency facilities. In the WETO report, the EU Commission notes that "in 2030, more than half the electricity produced will come from technologies first developed in the 1990s." In other words, as the age of wasteful energy generation slowly but surely comes to an end, the future will belong to economical, high-performance power plants.

Comparison of Power Plant Electronics

Type	Electrical output (MW)	Efficiency (%)	Full-load hours p/a (h)	Investment(US$/kW)	Power generation (c/kWh)
Nuclear	1,600	36	8,000	2,600	6.7
Coal	700	46	7,000	1,100	5.2
Lignite	850	43.5	8,000	1,200	5.0
Natural Gas	700	58	7,000	600	5.8
Hydroelectric	700	-	5,000	2,800	8.5
Wind	-	>1	2,500	1,100	8.8
Photovoltaic	-	>1	2,400	9,100	66.4
IGCC*	700	51	7,000	1,900	6.4
IGCC/CO_2 separation	700	45	7,000	2,350	7.3
CC** /CO_2 separation	700	52	7,000	850	6.7

Costs have been calculated on the basis of an assumed operating life of 30 years (50 years for nuclear energy), an amortisation period of 15 years, 70% borrowed capital, and 8% discount. CO_2 separation has been considered without liquefaction, transport and disposal. ***Integrated Gas Combined Cycle.* ****Combined Cycle.***

Source: Siemens PG CS4