

No matter what, we're focused
on protecting the environment.

Clean energy solutions from Siemens

Answers for the environment.

SIEMENS



According to the UN, the world's population will grow by 1.1 billion to reach 7.5 billion by 2020. This growth will be accompanied by a trend towards further growth and industrialization of transitional countries. This trend, as well as an additional increase in urbanization, will lead to a rapidly increasing demand for electrical energy.

Electric power is the primary most suitable carrier that can meet the challenges of the future. The highest efficiencies in generation and utilization, as well as the inclusion of renewable energy sources, represent indispensable advantages in the struggle against climate change. While fossil fuels, and especially coal, will continue to play a central role in power generation, the future, more than ever, calls for a diversified energy mix. Therefore, more efficient use of fossil fuels has to be combined with an intensified reliance on renewable energy sources. At Siemens, we are ready to meet this global challenge.

Solutions for a global challenge

With over 140 years of experience in power generation, transmission and distribution, Siemens provides excellent energy-efficient technologies to meet the world's growing need for clean, sustainable energy. Our comprehensive portfolio includes technologies that use a variety of fuels, from fossil fuel to renewable energy sources. We are constantly seeking and researching new and better technologies to solve future energy challenges.

Sustainable development demands a clean energy mix



We have set up a network of innovations to develop individual and customized application solutions, drawing on our long-term experience in the power business. Siemens is the partner you can rely on – today and tomorrow.

Above all, we have to respond to this challenge with innovations. Innovative technologies are fundamental to meeting the energy demands of our rapidly changing world. Our people are committed to facing these needs and helping our clients to respond to changes.

At Siemens, we take pride in our worldwide network of highly skilled and trained employees. They provide the ideas fundamental to our innovation and research, and serve as experienced local partners for our customers. They are ready to answer the essential questions with their expertise and dedication. Therefore, Siemens technologies are, in fact, “powered by people”.



Low-loss power transmission is a prerequisite for higher efficiency. Our modern AC and DC transmission systems portfolio offers ideal solutions for all applications.



Combined-cycle power plants can be combined with upstream gasification technology. The combination is called IGCC. Siemens supplies sophisticated solutions for highly efficient IGCC applications.



Meeting the world's growing need for energy demands exceptional efficiency in power generation, transmission, and distribution. Optimizing existing power plants as well as power grids and introducing new, highly efficient technologies in all areas of the energy business is a fascinating assignment we are glad to accept.

We at Siemens have a clear goal: minimizing the environmental burden while at the same time ensuring and maximizing the benefits to our customers. Employing our technologies allows for a considerable reduction in fuel consumption. In addition, reducing transmission losses is among our major concerns, and we provide the means to achieve this.

Siemens technologies today demonstrate that the protection of the environment and an increase in efficiency and output go hand in hand. We pride ourselves on offering cutting-edge ideas and solutions to realize both objectives. Furthermore, we are constantly developing new and improved technologies for future applications. Among these are highly efficient gas turbines and the supercritical steam technology for power generation. Further innovations include highly efficient transformers as well as ultra-high-power transmission and gas-insulated underground power lines for low-loss transmission of vast power quantities into metropolitan areas.

Clean energy means efficient energy



High efficiency from generation to consumption: In addition to our plant optimization technology, our gas-insulated power-line technology provides a high output transmission method which reduces transmission losses by two-thirds, compared to an overhead line.

The new Siemens gas turbine – designed to achieve more than 60% efficiency in combined cycle operation. Our step into a new dimension of sustainable power generation.



At the heart of efficiency: The profiles of the blades and vanes employed in our steam and gas turbines mirror the latest scientific findings. Therefore, energy input can be used to produce optimum output.



By focusing on the energy efficiency of power plants, Siemens offers new possibilities to save substantially on fuel and emissions. Other important tools in this field include our innovative Air Pollution Control, the capture and storage of carbon dioxide and the use of renewable energy sources.

Coal is readily available all over the world and has risen only moderately in price compared to gas. As a result, coal-fired plants are a fundamental element of the world's energy supply. Accordingly, technologies have to be employed to lower the carbon dioxide emissions of these plants. Siemens offers technologies which can capture and store carbon dioxide effectively. Our portfolio also includes air pollution control solutions and advanced burner technologies, which ensure better combustion and, therefore, reduce emissions. In addition, Siemens focuses on renewable energies such as wind, solar thermal, photovoltaic, biomass, and geothermal power.

Clean energy through lower emissions

Our commitment includes technology for renewable power plants as well as highly efficient solutions for grid access. Thus, we supplement fossil-based power generation and establish a truly diversified mix of sustainable and economical energy supply technologies.

As part of the portfolio, Siemens has developed tools for the comprehensive control of combustion processes. This allows for continuous analysis, monitoring, and optimization of the overall process and key components to reduce both fuel consumption and emissions.



Siemens rises to the challenge of low-emission power generation with a unique solution portfolio ranging from better combustion process control to highly efficient filter technologies.



The intelligent and consumption-optimized coupling of plant capacities is yet another Siemens approach that cuts emissions right at the point of generation.



Maximum output for peak demands

Gas-fired combined-cycle power plants (CCPP) can cover medium and peak loads in a clean energy scenario. Their fast start-up time and high efficiency combine to provide large quantities of energy on short notice with notably low emissions. CCPP already operate at an efficiency level of more than 58 percent. However, we at Siemens constantly strive for even greater efficiency by searching for further improvements and researching new technologies.

Breaking the 60 percent barrier

With our new, highly efficient gas turbine, we are headed towards breaking the magical 60 percent efficiency barrier in combined cycle operation. Our cutting-edge turbine is currently being tested in the test plant Irsching 4 in Germany. Tests are scheduled to end in 2009, and by then our 340-MW turbine, which is completely air-cooled, is expected to contribute to savings of an estimated 40,000 tons of carbon dioxide per year in a combined-cycle application that has been compared to the best combined cycle plant currently in operation. Of course, even after setting this milestone, Siemens will continue to research technologies that could reach even higher efficiency.

Fit through retrofit

Due to high operating temperatures, the blades and vanes of gas turbines are subject to massive wear and tear. Their resulting short lives unfortunately entail frequent replacement of worn parts. However, our engineers use this opportunity to modernize and upgrade the turbines with the latest developments. Siemens employees constantly work on refining the designs of our blades and vanes to improve their overall efficiency. Additionally, our customers can choose from other upgrade options, for example, the implementation of water/steam injection, or the installation of advanced burners.

Recovering waste heat

Combined heat and power facilities are exceptionally efficient regarding the conversion of fuels into usable energy. Combining power generation with the utilization of gas turbine waste heat for district heating and/or industrial processes allows for an overall efficiency of up to 95 percent. Thus, cogeneration plants sustainably relieve the environmental burden and, at the same time, boost cost-effectiveness.



Cutting emissions – saving our atmosphere

Aware of the threat posed by climate change, people expect large corporations, and particularly energy providers, to take a leadership role in protecting the environment. Even though renewable energy sources allow for emission-free power generation, today's energy supply largely depends on coal-fired plants. At Siemens, we feel it is imperative to minimize the emissions of these existing plants. We gladly accept this responsibility by offering practical solutions for this task.

Capturing carbon dioxide – two promising methods

Two promising methods for the capture of carbon dioxide lie in post-combustion and pre-combustion technologies. Post-combustion capture technology can be retrofitted in existing as well as newly built coal-fired plants, if space is available. For more flexibility regarding fuel and products, Siemens' Integrated Gasification Combined Cycle (IGCC) offers a low-carbon power-generation solution. Using pre-combustion capture, the IGCC technology facilitates broader operating flexibility, better emissions performance, lower water use, and lower cost of carbon dioxide capture than today's state-of-the-art coal plants.

Intelligent coupling reduces carbon dioxide

In addition to the methods of carbon dioxide abatement in power generation, the Siemens portfolio features an intelligent network coupling technology. This flexible coupling technology offers a variety of possibilities to lower carbon dioxide emissions. It can be employed to connect medium voltage power networks in order to cope with peak demands flexibly. Thus, the power for peak demands can be produced in a more economical and environmentally friendly fashion. Another carbon-dioxide-sparing application featuring intelligent coupling is the shore-based power supply for large vessels in harbors. Rather than using the ship's engines to generate power inefficiently, the vessel can be connected to the local power supply network.



Renewables – sustainable technologies against climate change

Renewable energy sources share one obvious advantage: their environmentally friendly and emission-free power production. Siemens is aware of this benefit and has established itself as a leading contractor for large renewable energy plants, especially wind farms. In addition, we specialize in optimizing power transmission from remote renewable-energy plants to industrial or urban load centers and in combining a variety of small renewable-energy plants into bigger, more efficient virtual power plants.

Riding the wind

In 2004, Siemens entered the wind energy market with the acquisition of Bonus Energy A/S, and has established itself as a leading contractor for onshore wind energy projects, and as the world leader in offshore wind farms. By making use of the steady sea breeze and allowing for much larger projects, these offshore applications clearly show location advantages.

Innovation from experience

Our offshore wind projects make use of a variety of excellent innovations; for instance, the patented Integral Blade® technology which allows us to produce sturdy, seamless rotor blades, capable of withstanding gale force winds. In addition to their outstanding mechanical properties, Siemens' rotor blades can easily be recycled after a long, trouble-free service life. Using these high-output rotor blades, we have developed larger and more efficient wind turbines. Our turbines also feature our proven lightning-protection technology and our patented cast-resin transformers. These do not utilize oil for insulating purposes and thus are ideal for offshore applications. With our strong

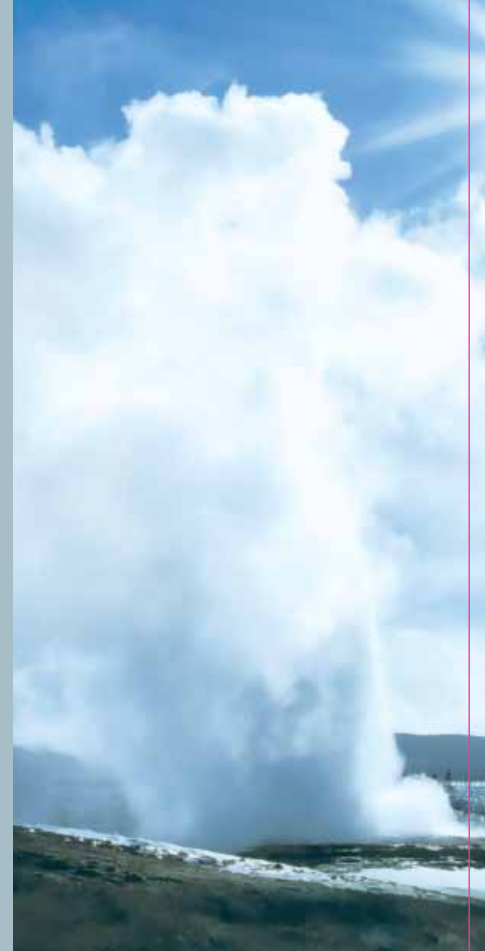
commitment to wind energy, we have realized major projects in Europe, Asia, and the Americas. Large-scale future projects attest to our continuing dedication as well as our expertise in wind energy.

Solar thermal power plants

The parabolic trough power plant is a state-of-the-art solar thermal technology. Long rows of parabolic mirrors transfer concentrated heat to a special fluid. A heat exchanger then generates steam, which is used to power our high-efficiency steam turbines. By employing modern storage technology, the steam turbines are able to run at full load virtually all the time – even during unfavorable weather or at night. Therefore, the plant operates at maximum efficiency, at any time. And since the steam is generated from sunlight, the technology is emission-free.

Photovoltaic power plants

It is first and foremost the world climate that benefits from photovoltaic power plants. But there are also economic



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reasons for entering the photovoltaic sector, and especially the construction business. Photovoltaic power plants clearly show a trend towards an integrated solution for the electrical part, a development Siemens has been involved in for many years. As an example, with our partner City Solar we have built the world's largest photovoltaic power plant, featuring an installed power output of 20 MW.

Biomass power plants

Biomass technology also uses a carbon-dioxide-neutral power source. To create biomass power, our high-efficiency steam turbine is driven by the use of biofuels. These fuels are obtained from the cultivation of so-called energy crops, such as canola, corn, or wood pellets. Energy crops not only supply biofuels, they also facilitate agricultural development. Thus, with biomass power plants, every global zone is given the opportunity to contribute to a carbon-dioxide-neutral energy supply while at the same time opening up new markets for their crops.

Geothermal power plants

Another technology for power generation from renewable energy sources is used in geothermal plants, which excel in their independence from weather conditions. Because of that, the plant's steam turbines work at a steady efficiency level. At Siemens, we can proudly claim to have put this technology into practice in many leading projects.

Grid access for renewables

Yet another environmentally friendly solution is the employment of high-voltage direct-current grid access. With this technology, large offshore wind farms can be connected very efficiently to the power grid via an offshore substation. Thanks to the substation's relatively low magnetic field, marine wildlife is hardly affected. By the way, the very same technology can also be used to transmit power with minimum losses from remote hydro power plants in mountainous areas to industrialized regions.

Virtual power plants

A possible drawback of renewable energy sources is their comparatively low energy density. However, Siemens has developed the idea of a virtual power plant to overcome this problem. By combining a number of small renewable energy sources, we create a virtual power plant, which can be controlled more easily and operates most efficiently. Furthermore, the virtual power plant grants access to modern energy trade centers, which allows for higher prices in times of peak demand.

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