

A Growing World Demands a Balanced Portfolio of Clean Energy Options

by John Rice
President and CEO
GE Energy

According to a recent forecast from the International Energy Agency, electricity demand will increase by about 30 percent in Europe and the United States by 2020, and it will more than double in Asia and the rest of the world. Not only does the global energy industry face the formidable challenge of finding ways to generate that extra power, we must do it while also protecting the environment and preserving our natural resources. Technology has allowed us to make great strides in that direction, but the journey has barely begun.



GE's H System is installed at the Baglan Bay Power Station in Wales.

The earth itself is full of energy. The movement of wind and water, the heat and light of the sun and the heat in the ground all are natural energy sources that can be turned into usable forms by taking advantage of today's renewable energy technologies.

Although renewable energy certainly holds great promise, no single solution will meet all of the world's energy needs. Satisfying that huge demand will require a balanced portfolio of energy options ranging from natural gas, coal and nuclear to wind and hydro, and in the future including new technologies such as solar photovoltaics or hybrid fuel cells. All could occupy a place in the overall energy generation portfolio.

A common theme runs through all of the disparate energy technologies available today: produce power while causing the least possible impact on the environment. That initiative takes on many shapes.

Cleaner, More Efficient Gas Turbines

In the gas turbine sector, the driving forces are higher fuel efficiency and advanced emissions control technology, a combination that leads to greatly improved output relative to emissions. Forty years ago, simple-cycle gas turbines operated at thermal efficiencies of 28-29 percent; today's natural gas-fired, combined-cycle systems can reach 60 percent. This results in tremendous increases in power output at a lower rate of fuel consumption.

During the past few months, GE Energy has achieved two milestones with our H System™, the first combined-cycle technology in the world designed to achieve 60 percent thermal efficiency. The world's first 50-hertz installation of the H System, featuring our 9H gas turbine, entered commercial service at Baglan Bay in Wales in September 2003. In January of this year, we announced that the first application of our 60-hertz H System, based on the 7H gas turbine, will be the Suroit project with Hydro-Quebec Production, the generation division of Hydro-Quebec.

Because of its high efficiency, the H System offers significant benefits in environmental performance. For every unit of electricity generated, the H System will use less fuel and produce fewer greenhouse gas emissions compared to other large gas turbine combined-cycle systems.

For both new gas turbines and for retrofits of older, installed machines, emissions technology continues to evolve and improve. In the 1960s, gas turbine NO_x emissions levels of 200 parts per million were common; today's advanced technology can drive gas turbine emissions into single digits.

That's great progress, but it's not enough. As part of a long-term vision for a cleaner environment, the industry must continue to develop products and services to further reduce emissions levels for NO_x, CO₂ and other potentially harmful substances. Government can do its part by providing a clear environmental regulatory structure that encourages energy producers to upgrade inefficient, polluting equipment.

Along with new, highly efficient gas turbines, upgrades and services for previously installed machines play an important role in improving power plant efficiency, with corresponding gains in environmental performance. Also playing into this arena are network solutions, substation automation, plant optimization systems and "smart" sensors, all designed for greater efficiency in the generation and transmission of energy.

Coal No Longer a Dirty Word

Coal is among the world's most abundant natural resources, but traditionally, it has been considered a "dirty" fuel. That is changing, however, as developments in selective catalytic reduction, flue gas scrubbers, fluidized bed technology and particularly coal gasification make it possible to burn coal with lower emissions than ever before. Other recent advances include GE's Dense Pack technology for steam turbines, which increases power plant efficiency, and plant optimization systems offering fuel, combustion and cycle optimization for improved efficiency and emissions.

Integrated gasification combined-cycle (IGCC) technology holds great promise. In an IGCC system, coal is converted into syngas, which, after cleanup, is used as the primary fuel for the combined-cycle's gas turbine. The IGCC cleanup process is more efficient and has a lower cost than post-combustion cleanup methods.

In addition to coal, the gasification process can be used to produce syngas from such alternative fuels as petroleum coke, orimulsion, biomass and municipal waste.

Broader use of these alternative fuels around the world could play a significant role in helping to reduce the drain on natural gas and other fossil-fuel resources.

A Role for Nuclear

Any discussion of clean energy should include nuclear power. The lack of carbon depletion and avoidance of millions of tons of emissions (NO_x, SO_x and CO₂) make nuclear power one of the cleaner energy sources capable of generating huge power output.

In the United States alone, nuclear power has generated approximately 13.7 trillion kilowatt hours of electricity and, at the same time, avoided the emission of 3.1 billion tons of carbon, 73.6 million tons of sulfur dioxide and 35.7 million tons of nitrogen oxides that would have been associated with fossil-fuel sources of power generation.

There are some key issues to be resolved, however, before nuclear energy will enjoy a resurgence, particularly here in the U.S. The first, of course, is finding acceptable solutions for the transportation and storage of nuclear waste. The second is the industry's need for a supportive administration over a long period of time. The third issue is that the technology's risks and rewards have to be thoroughly understood by the investing community.

Wind Fans the Rise of Renewables

After years of facing significant economic and technical challenges, renewable energy is making great strides forward. Today it is being increasingly recognized worldwide as a viable means to reduce the threat of global climate change, encourage development and create jobs.

As wind turbine technology continues to advance and the installed base of wind turbines grows, the cost of wind-generated electricity is becoming competitive with other energy options.

Much of the growth in the renewables sector has been driven by the rapidly expanding wind energy industry. As wind turbine technology continues to advance and the installed base of wind turbines grows, the cost of wind-generated electricity is becoming competitive with other energy options – a key factor in the growing acceptance of the technology.

Wind remains the fastest-growing electricity source in the world on a percentage basis. In the U.S., wind capacity has expanded at an annual rate of 28 percent

over the past five years. According to the American Wind Energy Association, nearly 1,700 megawatts of new wind-generating capacity – enough to serve approximately 425,000 homes – were installed last year in the U.S., making it one of the best years ever for the wind industry here. Current installed capacity in the U.S. is now more than 6,370 megawatts, with utility-scale wind turbines installed in 30 states.

Today's wind technology not only has grown in size, but also has become increasingly sophisticated and highly reliable. An example is GE's 3.6-megawatt wind turbine, the first wind turbine over three megawatts designed specifically for offshore applications. The machine offers patented power electronics and a variable-speed rotor for cost-effective, reliable operation.



GE wind turbines installed in the Irish Sea.

Seven of the GE 3.6-megawatt machines have been installed for the Arklow Bank Wind Park off the coast of Ireland, a project designed to be a global showcase for large-scale offshore wind power production. Ireland's Marine and Natural Resources Minister, Frank Fahey, has cited Arklow as a significant step toward Ireland's commitment to the Kyoto Protocol on limiting greenhouse gas emissions.

Fahey called the project "the dawning of a new age of clean energy, harvested from two plentiful resources, the sea and the wind." He voiced his optimism that the project "will be the first of many and will help establish Ireland as a world leader in this young industry."

More utilities are adding wind to their power-generation mix. With this increased level of wind-power penetration into electric power networks, wind turbine manufacturers face more stringent transmission standards. GE's response has been the development of a low-voltage ride-through (LVRT) capability that enables wind turbines to stay connected to the grid during system disturbances. It is the latest in a continuing series of technology advancements that are helping to make wind power increasingly competitive.

A Big Base for Hydropower

While wind power has the fastest growth rate, hydropower is the most established renewable energy technology. According to the U.S. Department of Energy (DOE), in 2003 hydropower supplied more than 75 percent of the electricity generated by renewable sources in the U.S., and about 10 percent of the country's total electricity capacity.

Hydropower will continue to play a significant role in the overall energy picture. The DOE forecasts a 56 percent increase in renewable energy use by 2025, with most of the increase coming from new, large-scale hydroelectric plants in developing countries. GE has designed some of the most efficient large turbines in the market today and continues to see strong activity in the smaller hydro arena and in the refurbishment of existing hydro facilities.

The advantages of hydropower are well known: it is a reliable, highly efficient renewable resource with the greatest power-generating capacity per square foot of equipment of any power technology. Hydropower projects also provide other benefits such as water supply, flood control, irrigation, navigation and recreation.

But hydropower projects also present some environmental challenges, including the risk of fish injury and changes to water quality and quantity below dams and diversions.

For more than a decade, GE has been working with customers to develop new environmental turbine technologies. A recent program was the development of a "fish-friendly" turbine blade designed to reduce fish injury and mortality. GE also has successfully developed and implemented designs to minimize or eliminate the use of oil in the hubs of Kaplan hydro turbines, preventing possible oil seepage into waterways.

Another new development is the X-Blade runner for Francis hydro turbines, designed for increased efficiency across a broad range of operation for hydropower plants with large variations in head. This technology was developed in response to the increased use of hydropower plants for flood control of large rivers. These plants require part-load operation at maximum head to obtain maximum energy production at a variety of water-level conditions.

Looking to the Future

In addition to the options already discussed, other renewable technologies such as solar, biodiesel and geothermal are expected to make increasingly significant contributions to the world's energy mix in the years ahead.

Solar, in particular, has strong potential, since solar cells can be placed nearly anywhere. Already the cheapest source of power in many remote, off-grid locations, solar cells could help meet the power needs of many of the 2 billion people worldwide who now lack access to modern energy services.

Despite their great potential, the various renewable energy technologies that exist today cannot come close to generating all of the new power capacity our world will demand in the future. So we must continue to pursue a balanced approach to meeting global energy needs, promoting an energy mix that includes efficient, natural gas-fired power generation, cleaner coal technology and nuclear power along with the promising array of renewable options.

As stated, there is no single solution capable of meeting all of our society's future energy needs. Instead, the answer will come from a family of diverse energy technologies that share a common thread: they do not deplete our natural resources or destroy our environment. ■

John G. Rice is president and CEO of GE Energy, one of the world's leading suppliers of power generation and energy delivery technology. He was named to his current position in November 2000. GE Energy is based in Atlanta, Georgia. Mr. Rice has previously served as president and CEO of GE Transportation Systems in Erie, Pennsylvania.



Hydropower continues to play a major role in the renewables sector.

He began his General Electric career in 1978 as a member of the Financial Management Program, moving to the Corporate Audit Staff in 1981. In 1984, he became manager of Materials at GE Appliances in Louisville, Kentucky. In 1986, he became manager of Quality Control Production Engineering and Materials Operation for GE Appliances.

Mr. Rice became president of GEM Products, Inc. in Garden City, California, in 1987. He subsequently held general management positions in Louisville in Consumer Service and Production Operations.

In 1992, Mr. Rice was named president and chief operating officer of Camco Inc., located in Canada. In 1994, he assumed leadership of the GE Corporate Audit Staff and a year later was appointed president of GE Plastics Pacific in Singapore. Mr. Rice was appointed president and CEO of GE Transportation Systems in Erie in September 1997.

Mr. Rice earned a bachelor of arts degree in economics from Hamilton College in Clinton, New York, and currently serves on the board of trustees there. In addition, he is a member of the Georgia Tech Board of Advisors and the board of trustees at the Walker School. He and his wife, Terrie, have two children, Steve and Tanner, and reside in Roswell, Georgia.