Change and Innovation: The Evolving Energy Industry

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Conventional resource limitations and social and economic and environmental requirements will probably necessitate the utilization of new energy resources not now in widespread use, as well as innovative methods of delivery and utilization of those energy resources.

In the last third of the 20th century, and probably longer than that in our country and in many other countries around the world, some of the most costly energy policy decisions made were based upon an under-estimation of the size and cost of our remaining conventional energy resources. This led, in our country, to the establishment of the synthetic fuels corporation in 1980, at that time the cornerstone of this country's energy policy. That resulted in costing our government and our taxpayers approximately $90 billion, and of course, private energy companies billions of additional dollars and produced virtually no incremental energy.

The same under-estimation of conventional energy resources and their costs in our country and many other countries led to the prohibition of the use of natural gas for power generation—based upon the conclusion we were running out of natural gas and it needed to be husbanded and rationed. Instead, we now know we have abundant supplies of natural gas in this country and around the world.

Over the past two decades, as consumption of natural gas has increased by about 60 percent from about 1,400 billion cubic meters to 2,200 billion cubic meters, our proved supplies have far outstripped that

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Mr. Lay's article was first delivered as a keynote address at the World Energy Congress, September 1998

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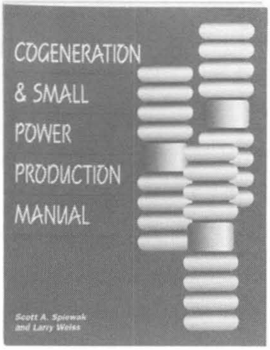

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growth in consumption by almost doubling from 72,000 billion cubic meters to 142,000 billion cubic meters. Based on most estimates, our probable resources of oil, gas and coal are forecast respectively to be about 114, 200 and 1,884 years at current consumption rates. These are probably still very conservative estimates, particularly as technology continues to drive down the cost, and increase our ability to recover a larger and larger percent of these resources.

Moreover, the real prices of these commodities—and of course, most commodities—have been declining, not increasing over the past 20 years, and well may continue to decline for the foreseeable future. Serious thought should be given to just how limited our conventional resources are, not just the next 20 to 40 years, but also much beyond that.

But clearly, whether we continue to rely very heavily on conventional energy resources or not, well into the next century there are some underlying fundamental trends that will dramatically change the energy marketplace and the energy industry. In many ways, the opportunities for the energy industry of the 21st century are the most compelling ever in our history. To begin with, despite the recent financial crisis in many emerging markets, for the most part, these countries will continue to liberalize, privatize and open markets for private investment and competition.

INTERNATIONAL PERSPECTIVES

In Latin America alone, power demand has been increasing approximately 6 percent per year, about three times the rate of growth in the United States. Brazil, the largest market in Latin America, is aggressively embracing privatization with plans to sell 18 state-owned utilities this year. These assets, combined with the assets already sold in 1997, represent about $50 billion in privatizations, the most aggressive privatization program of any country thus far.

Argentina recently granted its first power marketing license, allowing new competitors such as Enron to purchase and sell into its electricity pool and thus bring more competition and innovation to commercial and industrial customers in Argentina. This is much the same type of competition and innovation we are already experiencing in many states in this country, and of course, in the UK and the Nordic countries.

Between 1993 and 1997, direct foreign investment in all of Latin America increased from a little over $10 billion to a little over $50 billion—a five-fold increase, and much of that in energy infrastructure. It is expected to reach the $50 billion level this year even with the financial turmoil.

Moving to the sub-continent of India, which is home to one-sixth of the world's population, we're seeing increases in demand for electricity of about 7.5 percent per year, and India's power needs over the next 10 years are estimated to require about $120 billion in new investments.

Throughout Asia, despite the recent turmoil in the financial markets, in the longer term these economies will resume growth and will need enormous energy infrastructure and supplies. Asia could represent about one half of the world's economy by the year 2020 as compared to one-third of the world's economy today, and in the process will need an additional 60 million barrels per day energy equivalents to satisfy its economic growth.

And of course, in industrialized countries we're also seeing an opening up of energy sectors for more competition. In the U.S. from 1990 to 1996, as competition has gained a foothold, large industrial users have seen their electricity costs decline by an average of 3.5 percent. Medium-size industrials have reduced their costs by 6 percent, and small industrials have benefited most, having reduced their electric costs by nearly 8 percent. Liberalization of the European electricity and natural gas markets are under way and will also lead to significant reductions in costs as well as much-needed innovation.

MAJOR TRENDS

So, the first underlying trend that will continue to impact the energy business well into the next century is the liberalization of these markets, the growth in these markets, and the need for significant additional energy infrastructure and supplies. But as these markets open up to more competition, lower costs and stronger economic growth, there is and will be a strong push also for cleaner energy, and this will be the second major trend.

For the next several decades, this will lead to strong growth for natural gas and renewable energy, in particular, with these two forms of energy growing at about one-and-a-half to two times the rate of growth of oil and coal.

Natural gas will replace coal as the second most-used fuel behind oil, sometime between 2005 and 2010, and continue to gain on oil as the most-used fuel beyond that. The strong growth in natural gas demand is driven first and foremost by the technological advances in natural gas combined cycle power plants. Many plants already in operation or under construction will achieve 55 percent or higher conversion efficiency rates compared to 40 percent or less for most coal and oil steam plants around the world.

The next generation of combined cycle technology, currently being tested, will drive this conversion efficiency rate to 60 percent or higher. This results in substantially cleaner generation, including about 60 percent less carbon dioxide emissions—the emission that is of most concern to the environmentalists as far as global warming—than a new technology coal plant. But of course, it also leads to cheaper electricity.

As a result of its superior economic and environmental characteristics, 60 percent of all new installed power generation capacity in this country since 1990 has been combined cycle technology. This trend is likely to continue, and the combined cycle share is even likely to increase unless governments unwisely intervene, as we have seen to some extent recently in the UK.

RENEWABLE ENERGY

But in addition to the increased use of natural gas, growing demand for cleaner fuels as well as improved economics will lead to strong growth in renewables. Renewables, including hydro, currently represent a little over 6 percent of the world's energy supply, and many energy companies believe that renewable energy is becoming increasingly viable. Shell has indicated it could become a 50 percent fossil fuels and 50 percent renewables company within 50 years.

Enron owns two large wind turbine companies, and is currently building the two largest wind generation projects in the world, each over 100 megawatts, and Enron also owns 50 percent with Amoco—and I suppose soon with BP—of the largest photovoltaic manufacturing company in the U.S. The world's solar market is a $1 billion market today and could be a $6 billion market by 2010 because the cost of photovoltaics has dropped by more than half over the past decade due to better production and design and greater efficiency. The world's wind generating capacity is currently about 8,000 megawatts, and with costs dropping by one-half just since 1990, is expected to grow rapidly in coming years.

This growth in renewables will be further stimulated by government support. President Clinton has proposed that 5.5 percent of electricity in the U.S. come from renewables by 2010. That's about nine times the present amount. The UK government wants to see a five-fold increase in renewable energy to 10 percent of its total energy demand by 2010. Germany has underwritten a 15-fold increase in wind power since 1990.

TECHNOLOGY

The third major trend impacting the evolving energy industry of the 21st century is technology. As we near the end of the 20th century and enter the 21st century, the rate at which technology is evolving and impacting our world is more rapid and more profound than any time in our history.

Much of this is being caused by substantial advances in computer and communications technology. The average desktop computer today is more powerful than many mainframes just a few years ago. Computing power in general will increase 50 to 100 fold or more over the next decade. Where only 4 million people used the Internet just four years ago, 100 million do so today.

Already, communication technology is moving past the Internet to a public multimedia network for high bandwidth applications, high intelligence information devices and portability that will provide access to any information at any location and forever change the way we run our businesses and conduct our personal lives. This will be the final blow to hierarchical organizations, as any employee can have access to virtually as much information as the highest ranking employees in the company.

This is leading to great technology advances throughout our industry. Where horizontal drilling and 3-D seismic were viewed as remarkable leaps just 15 to 20 years ago, we're now moving on to a "Downhole Factory" combining fiber optics, robotics, artificial intelligence, and other technology, and the development of 4-D seismic. Technology will impact not only the way we find and produce primary energy, but also the way we convert it to usable energy and deliver it to the customer.

As markets deregulate and we rely more heavily on telecommunications, a global 800 number, the Internet and electronic commerce, the distance between our homes and businesses will become virtually nonexistent. Consistent with this effect, our need for central power stations and electricity distribution monopolies will decline while our desire for high quality, high reliability power near the home or office or factory through distributed generation will increase.

As micro-turbines, fuel cells and other technologies continue to improve their efficiencies and reliability, the reliability edge that most electric distribution companies see as their main competitive advantage today will begin to erode. Some of these technologies, particularly fuel cells, will also open the door to hydrogen, perhaps ultimately one of our most attractive energy options.

NUCLEAR ENERGY

Nuclear energy must become competitive or it will not be a viable option. The most recent nuclear plants to come onstream in the U.S.—granted with undue but currently required regulatory costs—are generating electricity for an all-in cost in excess of 10 cents per kilowatt hour, and in many cases, 12 to 14 cents per kilowatt hour. This compares to the all-in cost of electricity from a new combined cycle power plant in the U.S. today of 3 cents per kilowatt hour or less. Even using LNG in developing countries, electricity costs of approximately 5 cents per kilowatt hour can be achieved with combined cycle technology, again, significantly below current all-in costs for a new nuclear plant.

First, nuclear must become economically competitive before it can be considered a viable energy alternative. If it achieves this threshold, then it must become environmentally and safety acceptable. As the debate over global warming continues, and will probably escalate, the role of nuclear power must be considered. It is also a low CO_2 method of generating electricity, if it can become cost effective.

But the same forces that are most avidly proposing substantially lower CO_2 emissions are also strongly opposed to nuclear. Many of these same forces are also strongly opposed to large hydro projects. If both nuclear and large hydro are eliminated from the future energy supply equation, then even with rapid development and growth of small hydro and other renewables, it probably means that for the foreseeable future, conventional fossil fuels will need to maintain or maybe even increase their current market share for well into the next century... which brings me back to the question "Just how limited, if at all, are the world's conventional energy resources for the next 50 to 100 years?"

This could be a very critical, if not determining, question as we consider our energy options.

CONCLUSION

The successful energy companies of the 21st century will not only be those companies that are prepared to move early and aggressively into markets that are opening to competition—markets such as in the U.S., Europe, Latin America, Africa and Asia—but they will also be able to provide what is needed to be competitive in rapidly changing markets where technology allows entrepreneurs and new entrants to be competitive, and in many case, even more competitive than well-established incumbents.

Increased competition in these markets will result in tremendous opportunities for visionary global energy companies. Our success at tapping into these opportunities will depend on our ability to utilize technology and innovation to make our customers' lives easier and more productive. In many cases this will mean utilizing technology to enable developing countries in Asia, Africa and Latin America to bypass old technology and go straight to the most efficient and lowest cost technology, the same way many of these markets went straight to cellular telephones and bypassed traditional telephone systems.

Our success in the 21st century also requires tremendous vision on our part, vision to link new skills and capabilities with a virtual sea of untapped potential products and services waiting to be identified and sold and perfected.

With technology, innovation, and vision, our transition to a cleaner world will be seamless.

Our products and services will be greatly improved.

We will protect the environment from millions of tons of harmful emissions, and consumers will save billions.

And we will finally, truly establish a sustainable energy future.

ABOUT THE AUTHOR

Kenneth L. Lay is chairman and chief executive officer of Enron Corp. He was named to that position in February 1986, following the merger of Houston Natural Gas and InterNorth, Inc. in July 1985. Previously, Lay was president of Continental Resources Company (formerly Florida Gas Company) and executive vice president of the Continental Group, the parent company of Continental Resources Company, before joining Transco Energy Company in May 1981, as president, chief operating officer, and a director. He joined Houston Natural Gas in June 1984 as chairman and chief executive officer.

A native of Missouri, Lay was a Phi Beta Kappa graduate in economics from the University of Missouri, where he also received a master's degree in economics. Upon graduation, he began his career in 1965 as a corporate economist with Exxon Company, USA. Subsequently, he earned a Ph.D. in economics from the University of Houston.

Lay served as an officer in the U.S. Navy, and held the positions of Technical Assistant to a Commissioner of the Federal Energy Regulatory Commission and Deputy Undersecretary of the U.S. Department of Interior. Additionally, while in Washington, Lay was an assistant professor at George Washington University, teaching graduate courses in micro- and macro-economic theory and government-business relations.

Currently, Lay serves on the Board of Directors of Compaq Computer Corporation, Eli Lilly and Company, and Trust Company of the West. He is a member of the President's Council on Sustainable Development, The Business Council, and the National Petroleum Council. He is a member of the Board of Trustees of the H. John Heinz III Center for Science, Economics, and the Environment, the American Enterprise Institute and the First United Methodist Church in Houston. Lay was named one of the 25 top managers for 1996 by *Business Week,* was selected to receive the Private Sector Council's 1997 Leadership Award and received the 1998 Horatio Alger Award. Lay is a member of the Texas Business Hall of Fame.

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