Energy Eighteen Wheelers

The Technological Revolution Within Utility Restructuring

by Wayne R. Gould

Ladies and Gentlemen, Good Afternoon. As mentioned, my name is Wayne Gould. I am the youngest of the Gould children. It is an honor to represent the family on this fifth anniversary of the Gould Lecture.

Behind me is a beautiful picture of my mother and father. The picture of my mother is particularly striking and inasmuch as I will refer to my father and my grandfather in my remarks, I would like to speak about my mother for just a few minutes. I love my mother. I love her as only a small boy can love his mother.

In the evenings, when it was time to settle down and go to bed, my mother would sit by my bedside and visit. We would discuss the events of the day, the challenges of tomorrow, and she would use the time to express her love for me and to make sure that all was well in my world. She could, with well chosen words spoken in reassuring tones, make everything right when everything was wrong. Often, in these settings, particularly when I was younger, she would read to me. Together we learned what it was like to live in a box car with orphan children, to travel the Oregon Trail with horses and covered wagons, and to swim near an island with blue dolphins. We even spent Spring time on an Arctic island. Later as I began to read for myself she would still sit by my bedside and discuss the events of my day. Always during these sessions she would express her love for me and her absolute conviction that her children could be anything that they wanted to be. Above all else, she would encourage me to pursue new knowledge. Her expectation was absolute. I and my siblings were to pursue new knowledge and experiences.

Each afternoon, upon arriving home from school, she would quiz us. What did we learn today? This was not a casual question--she wanted to know! Perhaps it was her way of making sure that we were learning. More likely, it was her way of learning as well vicariously through her children. This quizzing did not stop as we grew older. After all of us were grown and married she would quiz us at every opportunity. I always envisioned family reunions as a time to relax, eat, and catch up with family through small talk. This was not the case in our family. She used to send out topics that we were to study and then present at the reunion. Often seated together, she would point her finger at one of us and demand that we tell her and the others what

we had learned on either the assigned topic or on one that was of equal interest.

With this as background let me say that I wish she were here today. I would like to have her point her finger at me and demand that I tell her what I have learned. In fact, I know she would like what I am going to say today. For the past 3 years I have had the privilege of addressing one of the most exciting energy problems that can be imagined. I have been tasked with deploying a distributable renewable energy system on a commercial basis to potential customers who are economically too distant to serve with conventional power. This assignment has not been limited to domestic markets. My activities have allowed me interview the premier energy experts of the world. It has been a fascinating adventure. In addition to energy experts I have interviewed everyone from Wesleyan Missionaries to the financial experts of the World Bank. My mother would have loved to hear what I have learned so it is to her that I dedicate this speech.

In 1919 both my father and my mother were born. My mother's father had died before she was born in the infamous influenza outbreak of 1918-1919. My Grandfather Gould was a steam locomotive engineer on the Utah Railway. His job was to push and pull long trains of coal from the Price area over Soldier Summit to Provo for transfer to the Union Pacific. My grandfather took great pride in his profession and in the equipment he operated. His steam locomotive was impressive and specifically designed for hauling coal on the grades and curves of the Utah mountains. It was 70 feet long and 19 feet high. The locomotive was not an "it", but rather a "her" and he loved her. He called her "Fan" -- short, I suppose, for "Fanny". They were together from the time she was new until the time she was scrapped. She was a part of the family. Her brass whistle stands proudly in my family room to this day.

Another event occurred in 1919. Fresh from the battlefields of World War I, General John J. Pershing ordered Lt. Col. Dwight D. Eisenhower to determine how fast U.S. troops could be moved from one side of the country to another. He had been impressed with Germany's use of her highway system to supply their troops with the material to wage war. In response to the order, Eisenhower assembled a 81 vehicle convoy and set out with 258 soldiers and 39 officers to find out. He left Fort Meade on July 7 and spent 7 hours and 15 minutes going 46 miles. It took him 62 days to travel from Washington DC through Salt Lake City to the Presidio in San Francisco. The convoy averaged 50 miles per day. During the journey his troops had to fight bad road conditions and to repair 88 bridges that wouldn't bear the weight of the tanks or trucks. At the end of the 62 day ordeal, it was generally concluded that they would have done better

transporting their convoy on the rails rather than the roads. In his memoirs, Eisenhower titled this chapter "Through Darkest America with Truck and Tank." In 1922, as a result of this exercise, General Pershing proposed the construction of an 8,000 mile interstate highway system. His proposal was ignored by bothCongress and the White House.

Twenty years later my grandfather and "Fan" continued to haul coal from Price up and over Soldier Summit to Provo. The intervening depression years had presented an economic challenge, but with the winds of war beginning to blow, it appeared as though the markets for coal and rail transportation would grow. Eisenhower, as a career Army officer, was also preparing to go to war. And on March 20 1940 my parents were married here in Salt Lake City. My mother was dressed in a beautiful white wedding dress and my father wore a double breasted blue suit--complete with the insignia of a Naval Officer.

I was born in 1953. My birth followed those of Bill Jr., Erlyn, and Gilbert. At that time, my grandfather was still coaxing Fan up and over Soldier Summit. Both he and she were older. He referred to her now as "Old Fan". But, both were far from retirement. If she showed her age and needed attention, she was rebuilt and was good as new. General Eisenhower, who had risen to become the Supreme Allied Commander of the European Theater of War had retired from the Army. He entered politics and was elected President of the United States. Like Eisenhower my father was no longer in uniform. He had left the Navy and was employed as an engineer for the Southern California Edison Company. He was building power plants along the Southern California coast as quickly as possible to meet Edison's growing electrical load. Each subsequent power plant was bigger, more efficient and more sophisticated than the previous one. Like "Old Fan" each was custom designed to meet the unique needs of their operational environment.

Somewhere during this time period an interesting event took place largely unnoticed. It occurred as a result of discussions held between the railroads and those in Detroit who made diesel engines. I was not there for these discussions, but I am convinced that they took place. At the table were Detroit manufacturing interests and the railroads. The conversations probably took place as the railroads were making routine calls upon Detroit to renew shipping contracts. I can even suggest to you what was said. After a few pleasantries Detroit changed the direction of the discussions.

"We have been thinking" Detroit said, "During the War we built a great deal of diesel

manufacturing capacity to fill the needs of the Navy's destroyer escort and submarine programs. The Navy isn't building destroyers or submarines like they used to and when they do they won't be powered with diesel engines. After investing so much in diesel manufacturing capacity, we need to find other markets and applications for our diesel engines. As such, we have decided to accelerate our plans to build and market diesel locomotives. We would like you to buy some."

"Interesting", said the Railroads, "We have looked at the concept of diesel locomotives ourselves. The idea of one size fits all needs on all railroads is difficult. Our steam locomotives are designed specifically to meet our grades, and curves and applications. What if your diesels are not big or powerful enough?"

"Oh, that's not a problem" said Detroit, " If one is not big enough, buy two, or three, or four, and couple them all together!."

"Yes" said the Railroads, "But you must understand that our steam locomotives have not reached the end of their economic life. The purchase of your diesels at this time would "strand" our investment in our locomotives. When we have achieved the full value of our investment in our existing equipment, we will certainly buy your diesels."

"We understand the concept of 'stranded' investment all too well" countered Detroit, "We respect your position, but you must respect ours. In order to provide a market for our new diesel locomotives, we will be forced to preferentially ship our products on those roads which utilize our diesels."

"I see" said the Railroads, "In that case, how many diesel locomotives would you like us to buy?"

Now, the actual words spoken are not important. What is important is that both the Railroads and Detroit had entered into a difficult negotiation that would change their businesses dramatically. Both thought they had won the negotiation. The Railroads thought that by conceding to the diesel replacement of their aging but not yet obsolete steam locomotives they had preserved their traditional markets. Detroit thought that they had successfully opened a new and promising market for their diesel locomotives.

Both were wrong. In fact, they couldn't have been more wrong. Shortly after these

hypothetical negotiations took place and while everyone was trying to get back to business, something happened that would change everything.

The Congress began to debate the creation of an interstate highway system. The proposal of the system immediately received the support of President Eisenhower. Having fought two wars on the European Continent and having spent 62 days moving a convoy across the nation, Eisenhower became convinced that the United States needed an interstate highway system for military reasons. He told Senator Albert Gore, a Democrat from Tennessee, that Hitler's ability to move military convoys along the autobahn at fast speeds had allowed Hitler to maintain the war two years longer than would have been normally expected. Citing military and civilian commerce as justification, he successfully moved the Interstate Highway legislation to enactment.

No one--not the Railroads or Detroit or their customers--could foresee the impact that the Interstate Highway system would have on the traditional railroad transportation markets. Shortly after the Intestate Highway system was built, Detroit began to build trucks. Ultimately these trucks would develop into the large diesel eighteen wheelers that continue to crowd our highways today. These large eighteen wheelers would drive the railroads almost to brink of extinction and change the transportation markets beyond any conceivable assumption or forecast.

Now, you may wonder why I tell this story. It is for the value of the lessons learned. My industry, the electric utility industry, is being de-regulated and restructured. In California we are just now completing a negotiation similar to the one which the Railroads and Detroit had. The stakes are equally high. The utilities want to preserve their traditional markets and customers and to avoid stranding their capital investments. Special customer interest groups want to open these traditional markets to new "merchant" providers of electricity. And consumers want an energy price reduction. After a long drawn out negotiation, most of the parties have proclaimed victory--in many cases a great victory. Following California's example the restructuring activity is moving across the nation at a rapid rate. Legislation is being introduced both nationally and at the state levels to create new markets and rules to play them by. In all the excitement assumptions are being made that limit the number of restructuring outcomes. My fear is that the limiting assumptions are based upon traditional concepts of generation systems. No one appears to be looking at outcomes that are not obvious or that are not based upon past utility industry structure. In other words no one is looking for the equivalent of "Energy Eighteen Wheelers".

It will certainly not be a surprise when I say that I believe they are there. In fact, I believe that there is a technological revolution underway that will change the outcome of utility restructuring beyond any outcome that is currently being envisioned. If you look closely you can see evidence of this occurring. Indeed, if you listen closely you can hear the engines of these new "Energy Eighteen Wheelers" idling just beyond the horizon. So what form then do these "Energy Eighteen Wheelers" take and what impacts will they have on us?

These new "Energy Eighteen Wheelers" are not large. They are small energy systems which can be easily sited where there is no conventional electrical or supply infrastructure and can be operated by the technically unsophisticated. Because of their small size they are referred to generally as distributable generation technologies. A well known example are the family of Japanese built gas powered generators used to provide power for mobile homes or campsites or remote construction sites. Some of the more sophisticated and perhaps less developed include multi-fueled micro turbine generators, solar dish Stirling engines, micro hydro generators, small wind turbines, and photovoltaics. Though acquainted with them all generally, I am most familiar with photovoltaics. As I mentioned earlier, I have spent the past few years pursuing their commercial development and deployment.

Most people don't know much about these technologies--their applications or their economics. These technologies have not found broad scale application where there are established electric grid systems. But, beyond the established grid, photovoltaics and other distributable generation technologies are being used as the primary power source in many villages and developing communities. These developing countries are what is fueling the investment in the research of these distributable generation technologies and the US manufacturing capacity to build them.

Over two billion of the earth's inhabitants have no electricity. Their energy needs are met by batteries or by burning dung, wood, candles or kerosene. It is estimated that as much as $20 billion is spent on batteries, candles, and kerosene. And beyond this usage, tonight as the sun goes down, hundreds of millions of open fires will be lit to provide heat and light. This is not a new situation, nor is it news to us. However, the penetration of today's communication technologies-- primarily the satellite cell phone -- into the jungles and deserts have made those who have no readily available source of energy aware, in may cases for the first time, that they do not have the quality of life that others do. In particular they do not have light at night, or entertainment, or education. There is the perception that with electricity their quality of life

would increase significantly. Not only do they now want electricity, they are demanding it of their governments. In addition to satisfying the energy needs of their citizenry, these governments need energy to meet the needs of their growing economies. Their economies are growing at tremendous rates. For example, China's economy has increased 57% between 1991 and 1995, raising the income per person of 1.2 billion people by more than 50%.

With energy their economies could grow even faster. It is reported that their are over ten million treadle sewing machines being used in the countries of India, Bangladesh, and Sri Lanka to turn out dress shirts which you and I purchase in the quality department stores in our communities. Can you imagine how many more shirts a villager could produce in a day with an electric sewing machine? Such a conversion would benefit not only the villager, but also the community, and the community's nation.

To satisfy this increasing energy demand, developing countries are scrambling. They are building large fossil fired generation plants where the population density warrants the investment. In the rural areas, the need for power cannot be satisfied by conventional generation. The cost of its transmission and distribution infrastructure is just too great.

In many countries electricity is sold at a postage stamp rate. That is, all customers pay the same rate irrespective of the cost of service. It is similar to mailing a letter here in the United States. Whether the letter is being mailed across the street or across the country the cost of the stamp is the same. To provide a postage stamp rate many governments subsidize their electricity rates. To extend the existing electrical system would require not only the capital associated with the system addition, but also an increase in government subsidy. This added cost plus the associated environmental costs and liabilities constitute real roadblocks for the expansion of these systems.

There is another cost factor. Fossil fuels are becoming too valuable as a chemical feedstock and too costly as an environmental liability to burn. Historically, the United States has been the primary importer and user of fossil fuels. No one has even come close to competing with the volume purchases which we have made. This is changing. China has, within the last year or two, become a net importer of fossil fuels. As China and other developing nations enter the fossil fuels markets the value and the environmental cost of these fuels will continue to increase at an alarming rate.

As such, efficient and renewable distributable generation technologies will play a significant role in meeting the growing energy needs of developing countries. For the most part these technologies do not require a large or sophisticated infrastructure. They can be incrementally deployed and operated in remote locations more cheaply than expanding the existing electrical systems. And, there are "second order" social benefits to providing these systems. By providing distributable generation technologies in remote areas, governments can accomplish many of their social goals as well. With a local power supply, governments can provide fundamental education to their children and their parents. Cottage industry is encouraged, thereby slowing urban migration. And in the countries that ring the earth's equator, where there are twelve hours of daylight and twelve hours of darkness everyday, governments have found that by lighting the homes of their people they can realize a 12% decrease in their runaway birthrates. (An additional 8% decrease in birth rates can be realized by adding a small television.)

Many countries have embarked on aggressive deployment programs. For example, India plans to power 100,000 villages with renewable energy and to provide solar-powered telephones in each of its 500,000 villages. Mexico plans to electrify 60,000 villages with photovoltaic energy systems, and Argentina intends to spend $300 million to electrify 80% of its rural villages by the year 2000. To accomplish these goals, countries are paying a premium price for simple photovoltaic and other distributable generation technologies. The increasing purchases of photovoltaic energy systems by these countries have placed greater demands on the existing United States photovoltaic manufacturing capability.

Domestically, photovoltaics are providing solutions to costly remote energy installations as well. The United States government agencies of Department of Defense, the Bureau of Land Management, the National Park Service, and the Forest Service are all looking for environmentally responsible solutions for their remote energy needs. These agencies comprise incredibly large markets. The Department of Defense alone has identified some 3,400 megawatts of potential projects, and the National Park Service has identified 643 potential photovoltaic projects having an estimated cost of $28.6 million.

Closer to home, photovoltaics are being deployed to serve niche applications. There are about 35 independent service providers who make their living selling and providing photovoltaic systems within our service territory. These local applications include: remote residential power systems, power to construction sites, cell phone repeaters, bus stops, outdoor advertising, street lighting, emergency call boxes, and traffic control equipment. Of particular

note, the Sacramento Municipal Utility District is meeting some of its needs by managing a solar program in which hundreds of their customers are siting roof-mounted photovoltaic systems.

Admittedly, where an integrated electrical system exists, photovoltaics are not yet cost competitive with conventional electrical service. On a comparative basis photovoltaic energy ranges from $0.15 to $1.00/kWh. This is more expensive than the average electrical rate of any utility of which I am aware. However, this comparison is meaningless. People do not buy Photovoltaics to obtain electricity. They purchase photovoltaics to provide a light in the night, or entertainment or manufacturing capability. I cannot stress enough that it is not the electrical commodity that is being purchased, but rather the service. For example, my teenage daughter wears a pager. She tells us that it allows us to contact her when we need her. In reality she wears it so that her friends can reach her. The pager is powered by a AA battery. The battery costs somewhere between $0.70 and $1.00. The energy from the battery costs about $220.00/kWh. Do you think for an instant that my daughter compares th $220.00/kWh cost of energy with the $0.14/kWh that I pay for electricity at my home. Or do you ever stop to think that you are paying over $14,000.00/kWh for the electricity that powers your wristwatch? Of course not. These are purchases of service rather than commodity.

Currently, photovoltaics and other distributed generation technologies are serving niche applications within Edison's system and are expanding into Edison's more conventional markets all the time. As a result of world demand, the cost of PV power is steadily decreasing. The cost of photovoltaic modules has dropped 90% from $52.38/Watt in 1976 to $5.29/Watt in 1994. The costs are now sufficiently low that rural utilities are installing PV systems at remote sites instead of installing conventional distribution facilities. I have a very good friend that manages a rural electrical cooperative. He is actually identifying expensive distribution lines that can be replaced and removed by installing photovoltaics and other distributable generation systems at the load site. Shell International Petroleum Company estimates that PVs will be fully competitive with conventional power by 2015. And Christine Ervin, former Assistant Secretary for Energy Efficiency and Renewable Energy of the Department of Energy, estimates that renewable energy will supply 50 percent of the world's needs by the year 2040 and that there is money to be made in solar technologies for those companies who are farsighted enough to make the investment.

Many of the world's largest companies would fit the Assistant Secretary's definition of being

farsighted. Siemens, Daimler Benz, British Petroleum, Sanyo, Sumitomo, EBARA, Canon, Enron, Amoco and numerous smaller companies have established or are building photovoltaic manufacturing capacity in the United States. Over the past 15 years these companies' sales growth has been a steady 20-25%. In 1995, in response to recent international demand, their sales have jumped to between 40 and 100%. Every one of these entities is building or expanding its U.S. facilities to meet the existing international and the anticipated domestic demand for their products. In short, the premium international prices being paid for energy systems are fueling the development of distributable technologies. As the development of these technologies continue, their costs will continue to come down. Ultimately they will be cost competitive with conventional service, and our traditional utility customers will be offered a wireless alternative to utility service by either the utilities themselves, or their competitors.

On June 26, 1997, President Bill Clinton, in a speech delivered to the United Nations' Special Session on Environment and Development, announced a new solar initiative that will result in a significant increase in the application of photovoltaics in the United States. "We will," he stated, "work with businesses and communities to use the sun's energy to reduce our reliance on fossil fuels by installing solar panels on 1,000,000 more roofs around our nation by 2010."

Without attempting to compare the effectiveness of President Clinton's statement with Eisenhower's support of the Interstate Highway system, may I suggest that if the current government follows through on this statement. The photovoltaic energy industry will continue to flourish and accelerate the deployment of cost effective energy systems. These distributable generation technologies will ultimately provide the traditional utility customer an economic alternative to conventional utility service.

I live in an older home. In my neighborhood the houses are served by overhead wires. The lowest and most accessible wires are those for Cable Television. The middle set of wires belong to the telephone company, and the uppermost wires are those which carry electricity. Together or individually, this collection of wires and their laterals into each and every house are ugly. My company, like most electric companies, has a beautification program that will eventually underground these wires. Before the company is able to get around to underground the wires in my neighborhood, they may be taken down. One has only to look at the wires for cable television to realize that the eighteen inch RCA satellite dish has obviated the need to string new cables making the existing cable system obsolete. In a similar fashion the deployment of the

cellular telephone technology precludes the need to extend conventional telephone systems into developing countries. It is not a giant leap to believe that these distributable generation technologies will make the existing electrical distribution systems obsolete.

Armed with these thoughts, I went to my father's house. My father has spent his professional career building large and sophisticated power plants and electrical systems. His industry credentials are both impressive and impeccable. I went to discuss the future role of distributable generation technologies in servicing the traditional utility customer. In the middle of our conversation I paused.

"Dad," I said, "These distributed generation technologies are developing so quickly and the costs are decreasing so rapidly that before the utilities get around to undergrounding our overhead wires, they may have to take them down."

Having made my statement, I was ready for the argument. It was not to be. He looked at me thoughtfully for a moment, smiled and said, "Son, I agree. I've known it for 10 years."

Now the only question in my mind is how fast will these technologies be developed and who will develop and deploy them? In 1879, Western Union, through formal written agreement, gave away its rights to the development of the telephone communication technology to National Bell Telephone Compan. National Bell Telephone Company was later to become the American Telephone and Telegraph Company (AT&T). Western Union looked at the crude embryonic telephone technology of the day and could foresee neither the sophisticated technology nor the markets of our time. It decided to stay the course with its existing technology and competencies. As a result of this decision, this past corporate communications giant watched as the telecommunication industry bypassed it. In a similar fashion, the current distributable generation technologies--my Energy Eighteen Wheelers-- that are being researched, and deployed in the developing countries of the world may also appear both crude and expensive. Nevertheless, they are being developed. It is unlikely that the development process will stop or that these technologies will go away. Instead, it is likely that the international markets will continue to fuel the development of these technologies to the point that they will rebound back into our domestic markets and change the traditional, conventional electric utility industry far beyond anything that we can possibly envision today.

As may be imagined, not everyone shares my views. The Solar Industry often steers

journalists my way stating that I am a "visionary". Many of those in my own industry suggest that my decision to pursue photovoltaics and other renewable distributive generation technologies was foolish and that I have damaged my utility career. Perhaps both statements are true--only time will tell.

Ladies and Gentlemen, during this exciting period of electrical industry restructuring be aware. There are "Energy Eighteen Wheelers" out there. And they are coming.

This original lecture was given at the William R. and Erlyn J. Gould Auditorium in the J. Willard Marriott Library at the University of Utah. October 9th, 1997.

RETURN TO:
The Lectures Index | The Lecture Series Main Page