Electric Power, 2040

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ENERGY OF THE FUTURE

"Human progress never rolls in on the wheels of inevitability; it comes through the tireless efforts of men and women willing to be co-workers with God." — MARTIN LUTHER KING, JR.

Humanity is on the threshold of a revolution. Not in a political sense, but in a transformation of the way we produce and use energy. In 2009, for the first time ever, the worldwide investment in renewable power generation exceeded the investment in conventional power plants. In their 2014 edition of their World Energy Outlook, the International Energy Agency projects that this trend will accelerate and in 2040, renewable's share of the global power mix will overtake coal to become the largest source of electricity.

We're going to change the way we produce and use energy and it's going to make us stronger and more prosperous. And when I say "us" I don't mean only the people in the United States and other developed countries—the end of oil is going to be the beginning of a global community that embraces every human being on Earth.

You may ask why we've depended on coal, oil and other fossil fuels for so long if other resources were available. We've known for a long time—certainly since the 1950s—that these fossil fuels would eventually diminish and we've also known that they cause pollution and ultimately global climate change. And, the resources that will replace them were not cooked up in a laboratory in the past few years—we've known about them for centuries. Is it possible that our greatest industrialists and leaders have ignored the obvious answers and led us into near-disaster when the solution was at hand?

In many cases, the answer is yes. On the other hand, there are brilliant scientists, industrialists, and leaders in the United States and all over the world who have advanced our abilities to create clean sustainable energy. These technologies are now coming of age—they are becoming more cost effective than the conventional fuels. In 2009, for the first time ever, the worldwide investment in new renewable power generation exceeded the investment in conventional power plants. Scientists and industrialists have been working on renewable energy for decades; they will become our leaders as the shortsighted people who have championed fossil fuels lose their power and political control.

CHANGING LANDSCAPE

Prior to the development of commercial airlines and construction of the interstate highway system, most commercial travel was done by rail. The railroad companies in this country and around the world missed an opportunity to reinvent themselves as transportation companies, instead of just railroad companies. For a long period of time, the railroads suffered from the loss of their passenger traffic, because of the competition from the airlines. This analogy helps us understand what is happening with the fossil fuel businesses. Although there are some exceptions, instead of embracing the coming revolution in the way we produce energy, they are lobbying hard against it, and filling the airways with misleading propaganda. This is not only a corporate strategic failure, but it is also slowing progress toward converting to a sustainable and domestic renewable power industry.

OIL: Big Oil has depended on two methods to acquire oil so that they could persuade Americans to keep their homes and cars running on this non-renewable resource. The first was to import oil from all over the world. Since 1970, we've been unable to produce enough oil for our needs and we now import more than half of the crude oil that we use every year. Our dependence on foreign oil, much of it from the volatile Middle East, has led to our involvement in foreign conflicts. I don't want to get into the politics of the Middle East here, except to say that our position would be much less complex if we didn't need these countries to keep producing oil. Besides which, even many of these countries are seeing a decrease in production.

The Deepwater Horizon oil spill in the gulf of Mexico, as photographed by NASA

The second way that Big Oil tries to maintain production is by drilling. In case I haven't made it clear, there really is no shortage of oil on the planet (at least not yet)—there's only a shortage of oil that we can get to with reasonable ease. It has been accepted that offshore drilling, particularly in the Gulf of Mexico, is a safe and economically feasible way of acquiring oil. Oil companies have promised that there's very little chance of catastrophic failure. Those promises will be looked at a bit more carefully after the oil spill off the Louisiana shore in 2010; we still don't know all the effects that we'll suffer from that disaster. But even if we accept the dangers of offshore drilling, we can't count on this source forever either—production from this source has peaked and is decreasing as well.

NATURAL GAS: The domestic natural gas industry has had a major reversal in the last several years. With the development of advanced drilling and hydrofracking techniques, many pundits in the industry claim that there is enough natural gas in shale deposits to "last 100 years." But that statistic does not consider the cost of extraction and distribution and the potential impact of environmental regulations of the hydrofracking methods. It also does not take into account the possibility that hydrofracking might cause health and other problems; it is difficult to determine how significant these problems will be.

Facing rising gas and heating costs, the public tends to wrap themselves with the shale gas story like a warm security blanket. Just a few years ago, during the massive pre-election banter about energy, many people took false comfort in the idea that Alaska could provide the nation with energy security. During my talks about energy, someone invariably asks: "What about Alaska?" or "What about natural gas?" or "What about nuclear power?" All of these energy sources are certainly there, but they are based on finite resources. And our work at the Energy Education Institute is about sustainable living, and the infinite resources which we will all rely on one day.

This book is about sustainable living. The case for conservation and sustainable energy will have been made within the next ten years. By then, the facts will have spoken. Our message will be common knowledge well before then.

COAL: Even though coal reserves are down drastically and it's fairly common knowledge that carbon emissions from coal are unacceptably high, the

coal industry is trying to rejuvenate itself. When all else failed, they tried advertising, paying for a 35 million dollar public relations campaign to make people think that there is such a thing as "clean coal." They even got the current federal government to invest almost two billion dollars in clean coal. The project has been shut down; coal is a commodity whose time has passed. A recent study concludes that coal production is reaching a peak, the same phenomenon that we are witnessing in global oil production.

NUCLEAR POWER: Though not a fossil fuel, nuclear energy is connected to oil, natural gas, and gas in that it's a power source that has no place in the modern world; it's just too inefficient. After studying the pros and cons of nuclear power, physicist Joshua Pearce of Clarion University of Pennsylvania determined that there are insurmountable problems that make it an unworthy option. There are also growth limits set by the grade of uranium ore.

Some utility companies are pushing hard for nuclear power. Nuclear power development would help support the status quo system—central generating stations connected to hub-and-spoke type transmission and distribution systems which are a remnant of the early days of electrification. Nuclear and coal help some of the big utility companies maintain their monopoly position over the market while essentially locking out the limitless and ever more cost-competitive renewable power sources—wind, geothermal, solar, and biomass.

Is nuclear power safe? Usually, it is--but there is potential for disaster, as we learned when an earthquake and tsunami hit Japan. How many nuclear power plants are located on fault lines in the U.S.? Above: A model of the Fukushima nuclear power plant in Japan.

THE GOVERNMENT'S ROLE

Every individual, household, corporation, university, city, Indian Tribe and state have roles to play in the conversion to sustainable energy. But the most critical player is our Federal Government and, unfortunately, our Federal Government is the most broken link in this interdependent circle.

Many people fervently believe that the only and best way for the Federal Government to act is to tweak tax credits. But tax incentives did not give us the interstate highway system, or put a man on the moon. The energy crisis that is coming right at us is going to demand far more from our Federal Government than anything we have seen since the Great Depression. In the 1930s, when the country was reeling from a financial crisis, the Federal project to electrify the South through the TVA jump-started the economy. We're in a similar situation today and we can achieve similarly spectacular results. The minimum that can be done by the Federal Government is to change the laws regarding interstate trans-

A MANIFESTO

In the May 2008 issue of *Vanity Fair* Magazine, Robert Kennedy Jr. outlined some ideas for our new President to adopt as a Manifesto. Describing it as a strategic masterstroke, he called on the President to "push to revamp the nation's antiquated high-voltage power-transmission system so that it can deliver solar, wind, geothermal, and other renewable energy across the country. Right now, a Texas wind-farm manager who wants to get his electrons to market faces two huge impediments. First, our regional power grids are over-stressed and misaligned. The biggest renewable-energy opportunities—for instance, Southwest solar and Midwest wind—are outside the grid's reach. Furthermore, traveling via alternating current (A.C.) lines too much of that wind farmer's energy would dissipate before it crossed the country. The nation urgently needs more investment in its backbone transmission grid, including new direct-current (D.C.) power lines for efficient long-haul transmission. Even more important, we need to build a new grid allowing it to intelligently deploy the energy along the way. Construction of this new grid will create a marketplace where utilities, established businesses, and entrepreneurs can sell energy and efficiency."

mission of electricity, and influencing the governance over the location of critical national electrical distribution infrastructure. Some suggest that a massive federal effort to develop renewable energy sources can and should be the way out of the economic downturn that has left so many people unemployed and in despair. In fact, seed money and incentives for sustainable power development is part of the economic stimulus packages, and the U.S. Department of Energy has become the largest power development bank in U.S. history. We know what has to be done—including the number one priority, building a national high voltage low loss electrical grid—and it's time for the politicians to be bold enough to make it happen.

ELECTRICITY AND WWS

With oil, gas, coal, and nuclear power off the table, what will we turn to? Here's where the whole focus of our search for energy has to change. Again, I'll stress the one-word answer: Electricity. And I'll add an acronym, WWS, which stands for Water, Wind, and Sun. The homes and cars of the near future will be powered by electric energy and that energy will be created by renewable sources. The role of our government, of industry, and of the world's leaders in developing and expanding these new sources of energy will be fully explored in Volumes II, III, and IV of The Oil Addiction Cure Book Project. But I'd like to briefly describe the most important elements of future power. Individually, we can't do very much to develop these elements right now—but knowing about them will allow us to think about our own energy solutions in an informed manner. And, at least for me, knowing that the solutions are available and sustainable is incredibly encouraging.

A recent study at Stanford, led by Mark Z. Jacobson of the Department of Civil and Environmental Engineering and Mark A. Delucchi of the University of California, Davis Institute of Transportation Studies concluded that there is enough energy on the Earth to give us all the power we need for centuries to come. Jacobson and Delucchi considered only sources that give us absolutely no carbon emissions and are fully renewable. They evaluated all the pros and cons of each technology and showed that, though there are hurdles to overcome, we're in excellent shape.

Based on figures from the Energy Information Administration, the world uses about 12.5 million watts of electricity every year; by 2030 we will need 17 million watts. Our current sources break down this way:

Oil: 35%
Coal: 27%
Natural gas: 23%
Nuclear power: 6%
Other sources: 9%

In other words, 91% of the energy we use today is derived from sources that are non renewable and unsustainable. In the long run, we will not be using significant amounts of these resources in the mix. In the future, the "other" sources that are giving us just 9% of our energy today—wind, water, sun, plus biomass and some other lesser technologies—will supply all our energy needs. And they'll do so without the carbon emissions that have been causing global warming and pollution.

WATER

The energy that can be derived from water falls into three main categories: Hydroelectric, tidal, and geothermal. Hydroelectric power is generated by water that drives a turbine when gravity forces it to drop; in most cases, a dam forces the water to flow and also stores the water. Tidal power uses the ebb and flow of the tides, which move turbines that are mounted on the floor of the sea.

There are already major hydroelectric dams in the Tennessee Valley and the West. Hydroelectric power is one of the least expensive sources of energy; small and even micro hydroelectric systems can be constructed to power individual homes and factories. This resource is limited because it needs to be connected to a water source such as river or stream and can damage the ecology of that waterway. But when it works, it's clean, green, and cheap. Small-scale hydro projects have been an economic boon for rural villages and communities in Africa. Experts estimate that there are 5 gigawatts of undeveloped hydropower potential in Tanzania, a country which only uses about 1 GW currently and where 85% of the population has no access to electricity.

The most exciting water-based new energy is geothermal; the word is a combination of "land" (geo) and "heat" (therm). The technology has

been used for centuries; the boiling core of the earth has provided heat since cavemen built homes around thermal springs. But we're now learning how to capture that heat and use it to create electricity. Geothermal power plants revolve around boreholes—one to access steam or hot water way beneath the Earth's surface, another to return the condensed, cooled water back beneath the surface.

An MIT report states that there are about 14 million quads of geothermal energy reasonably easy to access underneath the earth in the U.S.A. alone. That amount of energy is about 140,000 times our current annual usage.

Geothermal power plant

WIND

The wind that can be so destructive when it runs free can be harnessed to do our bidding, turning huge wind turbines that generate electricity. There's no shortage of wind in the world and it's been used for power for a long time, but it's come a long way from quaint windmills to the huge turbines that could supply a big chunk of our energy. There are many areas of the world—including the Great Plains between Texas and the Dakotas —where wind is particularly concentrated and blows reliably all year.

North Dakota is considered the Saudi Arabia of Wind Energy. Wind Energy in North Dakota alone could produce 55 times as much energy as the Nuclear Power plant being planned by Progress Energy in Florida. Combining the wind energy potential of North Dakota with Texas and Kansas could produce all of the electrical energy the U.S. needs!

Multi-turbine wind farms—some of the largest ones, such as the Roscoe in Texas and the Viore in Albania, have gathered hundreds of these turbines in relatively small spaces and connected them on a "super-

grid" of power lines. Wind farms have proliferated all over the world—China is building them at a steady pace and the United States is just behind them—and could supply up to 40% of our power in the future. The United States government's EPA has stated that 20% of all energy in the United States should come from wind power by 2030. Their vision, created with the input from a broad range of industry and government participants, is based on the development of a national high voltage overlay grid which would interconnect all of the renewable power sources in a smart grid system.

Wind power has strong advantages. It's totally renewable; we're never going to run out of wind, the planet just keeps making more. It's totally green, with no emissions or combustion. It's relatively easy to harness. The big disadvantage is that it needs those great big turbines, which are made of steel and other materials that have to be mined, milled, and otherwise created. Recently, there was a shortage of wind turbines and about a five-year wait for new ones. Running the turbines requires some non-renewable elements; there are substitutes and the elements can be recycled, but it's an issue that has to be considered. And there are environmental issues as well. Although wind power emits no carbon or other pollutants, it can be noisy and the turbines can disturb wildlife and farm animals (though some say that most animals ignore them). Locating wind farms in isolated areas removes that problem, as does creating offshore facilities. As improvements are made to the individual turbines used locally as well as to the devices that capture the energy that is generated by the wind, wind power will become a vital part of our new energy grid.

Above: A wind tower

Renewable power naysayers cite the problem of intermittency of wind power. But the wind is always blowing somewhere and our national laboratories, researchers, transmission companies,

manufacturers and developers are finding ways to store and distribute wind power. The U.S. Department of Energy has endorsed a vision for development of a national high voltage power grid, akin to an interstate highway system for renewable power. The first portions of that system are likely to appear between North Dakota and the population centers of the Midwest, and between Wyoming and Las Vegas. ITC Corporation is developing the Green Power Express, a 12,000 MW, 765 KW transmission

THE WIND STORY

In 1997, I owned and managed a small Construction Management firm that had a design-build construction management (CM) project with one of the Indian Tribes in South Dakota. While driving back and forth between Minneapolis and South Dakota every week for three years, I was blown off the highway more than once by the high winds. Unless you have experienced the constant and strong winds of the upper plains, you cannot imagine what that is like. So, why has North Dakota not been a leader when it comes to wind energy development? That is a fascinating question that I discovered while looking into a way to help the Tribe with some wind energy development.

Basin Electric is a large energy cooperative and producer that touches nine states in the upper plains states, with some of its primary production assets located in North Dakota. It has been and remains a vital entity in the economic development of that part of the country. Its structure is like a cooperative of cooperatives, encompassing a patchwork of "consumer owned" energy coops located in ten districts. There is very little room on the electrical grid for wind energy in Basin Electrics service area. In general, if a local coop wants to produce wind energy for itself, it cannot because of the take or pay contract that it has with Basin Electric.

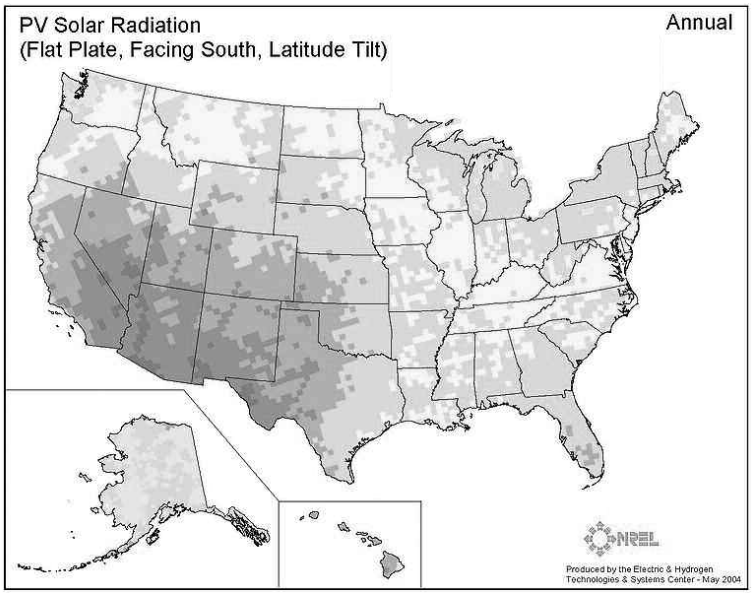
Our laws of free speech protect the right of the coal industry to make its case. The wind resource of North Dakota is staggering compared to the electrical power that is generated by coal in that state, so the stakes are quite high, to say the least. One can understand why the carbon interests in the U.S. have spent a half billion dollars in the first half of 2008 alone, through advertising and lobbying. Given the structure of Great Basin and its coops, the only way to get wind energy going in the Dakotas is to transmit it out of the region, and that is exactly what is happening now, ten years later.

system to link the extensive wind power of the Dakotas, to the major Midwest load centers. Oil and gas billionaire Phil Anschutz is investing in a $3 billion, 900-mile Trans West Express transmission line to strengthen the grid between the wind farms of Wyoming and Las Vegas. As these initial phases of the national grid are developed and linked together, they will provide a diversified supply from across a wide geographical area.

SOLAR

The sun has always been a major source of power in our lives; it provides abundant heat and light without any machinery or effort at all. It warms our homes for part of the year, lights up our world, dries our clothes, and provides the energy to stimulate the photosynthesis that gives us food. But it can do so much more, and we're learning new ways to use the unlimited, renewable power of the great ball of energy in the sky.

Solar thermal power plants now under development in the Southwest U.S. desert will be producing power for ten to fifteen cents per kWh when commissioned. The U.S. Department of Energy's Solar Energy Technologies Program aims to reduce the nominal levelized cost of energy (LCOE) of concentrating solar power (CSP) plants to a target of 7 to 10¢/kWh by 2015 and 5 to 7¢/kWh by 2020. Department of Energy (DOE)



Darker areas indicate the highest concentration of solar potential.

estimates that satisfaction of these cost targets could lead to installation of 16,000 to 35,000 megawatts (MW) of new generating capacity by 2030. This would result in a savings of 36 to 80 million tons of CO2 emitted to the atmosphere each year relative to coal plants of similar capacity. In fact, if all of the solar land claims in the Mojave Desert were to be developed with CSP plants, they would produce a whopping 65,000 MW of generating capacity, about double the total needs for the large state of California. A recent study by solar thermal energy company, Ausra concluded that it would only take a 94-mile by 94-mile square area in Nevada to produce enough solar power for the entire United States.

Solar power falls into two broad categories: solar photovoltaics (PVS) and concentrated solar power (CSP). A solar photovoltaic system uses materials such as silicon, arranged in cells to convert the sun's rays into electricity. Concentrated solar power is achieved by using mirrors and other reflective panels to focus the sun on a collector, usually passing a molten salt solution; the hot molten salt is sent directly to the power generating plant and converted to electricity. Some of the molten salt is stored in insulated tanks, and used to generate power during the night when the sun is not shining. Another form of solar power is passive solar energy—making use of the sun without material technology; this can be as simple as using the heated water in the garden hose for showers or washing dishes. One

STORING ENERGY

The national grid will alleviate a large part of the problems with intermittence and variability of the wind and solar plants. Energy storage solutions are also being deployed to fill in the gaps when there is no wind, such as the Iowa Stored Energy Park. When the wind power exceeds the demand needed on the grid, the excess power is used to compress air into air voids in underground rock formations. When the wind energy is less than needed by the grid, the compressed air is released and used to run power turbines on the surface. Xcel Energy is deploying a sodium sulfur battery storage system to provide peak demand power and alleviate the intermittence issue. Developed over more than two decades with Tokyo Electric Power Co., Asia's largest power generator, the system was originally sold to save energy produced overnight so it could be used during the day.

THE GRID TIMELINE

2001: Siemens and Black & Veatch proposed National Grid to Western Governors.

2003: Institute of Electrical and Electronics Engineers (IEEE) Advanced the Vision for a National Grid: "Shaping the Future of Global Energy Delivery"

2005: Sandia Lab sponsored multi-constituent study concluded need for a Nationalized grid. Energy Policy Act Called for National Congestion Study and Designation of National Interest Electric Corridors.

2006: National Electrical Congestion Study is published, identifying significant risks and opportunities related to the electrical infrastructure in the U.S. This overview map depicts the stranded nature of the multiple fuel types and resources we have.

2007: The American Wind Energy Association, in collaboration with American Electric Power, rolls out a vision for a national high voltage electric grid.

2008: DOE releases a report outlining a vision for generating 20% of our electricity by 2030, including a scenario to boost wind electric generation from its current production of 16.8 gigawatts (GW) to 304 GW by 2030. The analysis concludes that reaching 20 percent wind energy will require enhanced transmission infrastructure, streamlined siting and permitting regimes, improved reliability and operability of wind systems, and increased U.S. wind manufacturing capacity.

of the advantages of solar power is that it can be—and is—used in small doses. In millions of homes in areas of the world where the sun shines warmly most of the year, simple solar systems have been part of the energy system even before we talked of energy crises.

New materials for capturing solar power are being patented every day. They're becoming cheaper and easier to install. At the same time, more elaborate structures to collect solar energy and convert it to electricity are making solar power one of the most effective forms of energy. Areas such as the Atacama Desert in Chile are being developed as sun farms; these farms will amass huge amounts of power that can be distributed all over the world. When the full global energy grid is finally in place, solar power will be one of the biggest components in it.

ROOFTOP SOLAR AND GRID PARITY

2014 was the biggest year yet for solar PV rooftop installations. The cost of photovoltaic

installations has fallen dramatically over the last several years, and its cost is now competitive with grid power in many parts of the country. Photovoltaic electricity is benefitting from something we have seen in the advancement of computers, and aircraft manufacturing. Moore's Law is the observation that the number of transistors in an integrated circuit doubles every two years. In the aircraft manufacturing industry, the "learning curve" theory was first observed, and it describes a predictable pattern of cost efficiency and productivity improvement that occurs over time as the number of units of production increases. One of the advantages of rooftop solar is that you don't have to run the power lines long distances from the desert to the point of use.

House by house, building by building, we are just beginning to see a glimpse of the future, as more and more homes and businesses are going solar.

BIOMASS

Biomass is simply all the plant and other organic material that the Earth grows. If you've ever pulled weeds from your garden, you have some idea of how much plant material the Earth can sustain—even the poorest earth will send out an unlimited supply of new plants every year. So we'll never run out of biomass, and burning it will supply heat that can be converted into energy. There is work being done to refine this process; it's now more elaborate than throwing logs into the fireplace. On the other hand, it's still a combustion process, and combustion releases carbon and other greenhouse gasses. Compared to the technologies that emit no carbon and no pollution, biomass is less desirable. However, plant growth also removes carbon dioxide from the atmosphere, so, ideally, a biomass plant creates a circular loop of carbon dioxide, with a net zero effect on carbon dioxide in the atmosphere over the long term. But it's still a useful fill-in source of energy and some people think it can be refined to become a major source. An added bonus is that using biomass as fuel also eliminates the need to remove it as waste.

THE POWER GRID: THE NUMBER ONE PRIORITY

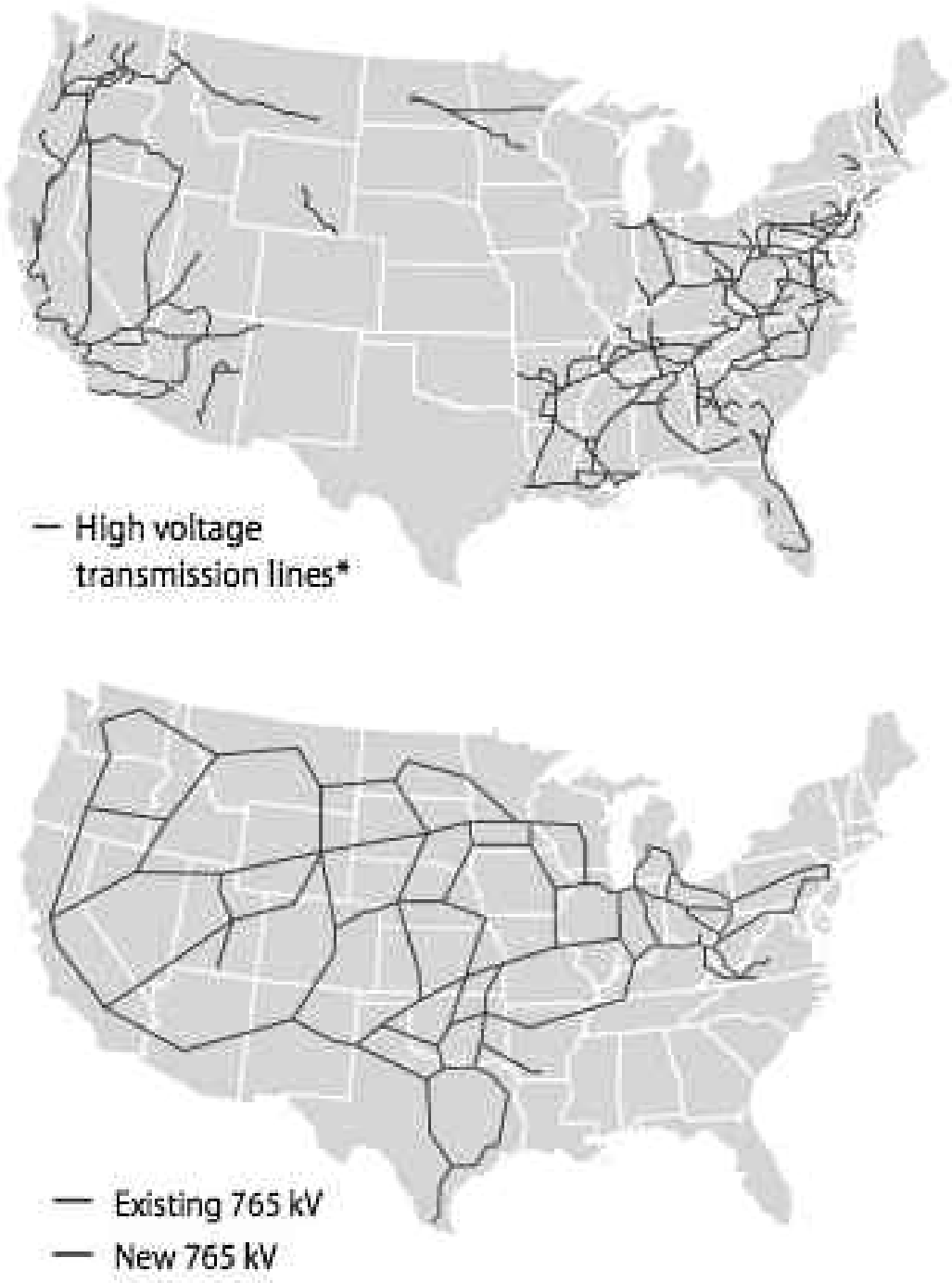
As you can see from the above review, the earth holds enough energy to give us all the power we need. But much of the energy exists in concentrated doses in specific areas and many of these areas are far away from where people live and where manufacturing plants need the energy to run their machines. A big part of the challenge of converting from fossil fuels (which are moved around by trucks) to electricity will be to find ways of transferring electricity to where it's needed. The interstate high voltage transmission system will be as important to America as the Dwight Eisenhower Interstate Highway System has been for our domestic economy since the 1950's, if not more so.

The National Electrical Congestion Study, published in 2006, identified significant risks and opportunities related to the electrical infrastructure in the U.S. This overview map depicts the stranded nature of fuel resources, including coal, wind, nuclear, and solar thermal. The development of our electrical transmission infrastructure resulted in a system that resembles a set of hub and spoke patterns, with electricity being generated at the hubs located near major population centers. The spokes coming out from these population centers reached out to rural areas as the system developed beginning during the Great Depression. Now, as the cost of renewable energy generation becomes less expensive than the non-renewable fuels such as coal, natural gas, and nuclear, we need a way to gather the energy from those sources where they are located and transmit it back into the urban areas.

In the very near future, power lines will deliver renewable energy from where it's available to where it is needed.

After the National Electrical Congestion Study was completed, the Department of Energy called on industry to collaborate in the improvement of the national electric grid. In 2007, the American Wind Energy Association, in collaboration with American Electric Power, rolled out a vision for a national high voltage electric grid that will accomplish several goals:

1. It eliminates the congestion in the existing electrical infrastructures.



Top map: **Right now, areas where wind and solar resources are strongest are not connected to the high-voltage power grid. That will change in the next decade.** ***Bottom map:*** **The future.**

CARS AND THE POWER GRID

The U.S. Department of Energy has conducted studies to evaluate the effect of a national fleet of battery based plug in cars, all connected to the grid. Using current technology and battery capabilities, the typical plug-in car with a 100 mile battery only range can store enough electricity to power the average home for a day. This array of millions of car batteries provides a cushion to smooth out the ups and downs of electricity demand and supply during the day, and with differing wind conditions.

Large electrochemical and high flux battery systems are being developed and deployed to connect to wind turbines, providing wind generators the opportunity to supply a more stable electricity supply, and return on their investment.

2. It provides a means to gather and transmit the renewable and abundant wind and solar energy.
3. It establishes a distributed energy system which, when interconnected, would reduce the problem of intermittence in wind and solar installations.
4. It links the solar energy of the Southwest, and the wind energy of the Midwest which ultimately will reduce the need for total installed capacity because of the seasonal nature of the sun and wind supply and the winter heating and summer cooling demand. The wind is strongest in the upper Midwest during the winter when the heating demand is the highest. And the sun is most intense in the summer when the cooling demand is the highest.

This interconnected system will reduce the capital cost of energy all over the country and its implementation is the most important energy-related job that our federal government can do in this century. It is also important to be able to store energy; many of the new energy sources are variable—they aren't available consistently; a cloudy or calm day reduces the amount of solar or wind power. But great strides are being made in the development of batteries that can catch energy and save it for a rainy day. In China, a battery the size of a railroad car is powering a small city. Although these batteries use rare elements such as lithium right now, this technology has the potential to smooth out one of the last barriers toward our transformation to sustainable energy.

Developing a national transmission highway is perhaps the number one national security issue facing us today.

Despite these obstacles, plans are moving ahead in many areas across the U.S. for the High Voltage Grid. In the Midwest, the Green Power Express is a $12 billion transmission project under planning to bring the wind power of the Dakotas to the heartland of Chicago and other Midwest energy loads. In 2008, the Anschutz Corporation acquired the rights to develop a $3 billion, 900-mile high voltage line to connect the wind resources of Wyoming to load centers in Las Vegas, Phoenix, and Southern California. That Phil Anschutz is an oilman, speaks volumes about the changing economics of renewable power.

ALL OVER THE WORLD

The United States is not alone in developing new energy sources:

- In 2008, the Queen of England purchased the worlds largest wind turbine, 100-metres high, that will supply 7.5 megawatts of power to the national grid when it is installed off the North East coast of England.
- Prince Hassan Bin Talal of Jordan presented the DESERTEC plan to develop a renewable energy network to transmit power to Europe from the Middle East and North Africa. It calls for 100,000 megawatts of CSP to be built throughout the Middle East and North Africa by 2050. The World Bank recently announced that they will fund the construction of an east west high voltage network spanning North Africa and the Middle East, coincidental with the DESERTEC vision. The development of CSP plants in the vast Sahara desert region presents an unparalleled opportunity to provide jobs and an industrial base for the North African and Middle Eastern societies, now stressed by the global economic slow down and rising food prices.
- China has rapidly become the number one wind power developer, and is among the first to accelerate development of high voltage lines from the heartland of the country where the wind and solar resources are located to the population centers in the East.
- At long last, the South American countries of Columbia, Peru, and Chile are entering discussions toward greater integration of their power generation sources, many renewable.

All over the world, in countries large and small, the changes are taking place. Our grandchildren won't remember gas pumps and coal chutes and their world will be cleaner, their lives happier because of it.

MIKE VALLEZ, P.E.

Mike Vallez is a senior director with Vivint Solar, the second largest solar installation company in the US. He started his engineering and construction career at the age of seven, when he helped his father build the family home. Since then, his work experience has ranged from carpenter, ironworker, and underground miner to project manager, director, chief operating officer, operations manager, company president and energy consultant. His projects have included mines, power plants, solar PV installations, chemical and process plants, oil and gas, commercial and residential complexes, high rise offices, hotels, manufacturing plants, river bridges, dams, highways, and other facilities. His capabilities are bolstered by an educational foundation including a BS in Engineering from Michigan Technological University and an MBA from the University of Utah, where he studied organizational and human performance. He holds a PE license, and is Lean Six Sigma Certified.

With experience on both the owner and engineer/contractor side of programs and projects, the clients served and companies he has worked for include Rio Tinto, Rocky Mountain Power, Kennecott Utah Copper, Anaconda Mining Company, Molycorp Minerals, Excel Energy, Union Carbide, Monsanto, IBM, Duke Energy, Exxon, Berkshire Hathaway, Ormat Technologies, Walter Resources, Kern River Gas, The University of Minnesota, the U.S. Army Corps of Engineers, Vivint Solar, and many others.

Mike is the father of four children, and lives in Salt Lake City, Utah where he enjoys his hobbies of writing, skiing, fishing, hiking, off-roading, and water sports. He is the author of three books on leadership and sustainability.

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