Leading the Way to the Third Industrial Revolution:

A New Energy Agenda for the European Union in the 21st Century

-The Next Phase of European Integration-

By Jeremy Rifkin

We are approaching the sunset of the oil era in the first half of the 21st century. The price of oil on global markets continues to climb and peak global oil is within sight in the coming decades. At the same time, the dramatic rise in carbon dioxide emissions from the burning of fossil fuels is raising the earth's temperature and threatening an unprecedented change in the chemistry of the planet and global climate, with ominous consequences for the future of human civilization and the ecosystems of the earth.

While oil, coal, and natural gas will continue to provide a substantial portion of the world's and the European Union's energy well into the 21st century, there is a growing consensus that we are entering a twilight period where the full costs of our fossil fuel addiction is beginning to act as a drag on the world economy. During this twilight era, the 27 EU member states are making every effort to ensure that the remaining stock of fossil fuels is used more efficiently and are experimenting with clean energy technologies to limit carbon dioxide emissions in the burning of conventional fuels. These efforts fall in line with the EU mandate that the member states increase energy efficiency 20 percent by 2020 and reduce their global warming emissions 20 percent (based on 1990 levels), again by 2020. But, greater efficiencies and mandated global warming gas reductions, by themselves, are not enough to adequately address the unprecedented crisis of global warming and global peak oil and gas production. Looking to the future, every government will need to explore new energy paths and establish new economic models with the goal of achieving as close to zero carbon emissions as possible.

The great pivotal economic changes in world history have occurred when new energy regimes converge with new communication regimes. When that convergence happens, society is restructured in wholly new ways. In the early modern era, the coming together of coal powered steam technology and the print press gave birth to the first industrial revolution. It would have been impossible to organize the dramatic increase in the pace, speed, flow, density, and connectivity of economic activity made possible by the coal fired steam engine using the older codex and oral forms of communication. In the late nineteenth century and throughout the first two thirds of the twentieth century, first generation electrical forms of communication—the telegraph, telephone, radio, television, electric typewriters, calculators, etc.—converged with the introduction of oil and the internal combustion engine, becoming the communications command and control mechanism for organizing and marketing the second industrial revolution.

Similarly, today, the same design principles and smart technologies that made possible the internet, and vast "distributed" global communication networks, are just beginning to be used to reconfigure the world's power grids so that people can produce renewable energy and share it peer-to-peer, just like they now produce and share information, creating a new, decentralized form of energy use. We need to envision a future in which millions of individuals can collect and produce locally generated renewable energy in their homes, offices, factories, and vehicles, store that energy in the form of hydrogen, and share their power generation with each other across a Europe-wide intelligent intergrid. (Hydrogen is a universal storage medium for intermittent renewable energies; just as digital is a universal storage mechanism for text, audio, video, data and other forms of media)

The question is often asked as to whether renewable energy, in the long run, can provide enough power to run a national or global economy? Just as second generation information systems grid technologies allow businesses to connect thousands of desktop computers, creating far more distributed computing power than even the most powerful centralized computers that exist, millions of local producers of renewable energy, with access to intelligent utility networks, can potentially produce and share far more distributed power than the older centralized forms of energy – oil, coal, natural gas and nuclear – that we currently rely on.

The creation of a renewable energy regime, loaded by buildings, partially stored in the form of hydrogen, and distributed via smart intergrids, opens the door to a Third Industrial Revolution and should have as powerful an economic multiplier effect in the 21st century as the convergence of mass print technology with coal and steam power technology in the 19th century, and the coming together of electrical forms of communication with oil and the internal combustion engine in the 20th century.

Renewable forms of energy—solar, wind, hydro, geothermal, ocean waves, and biomass—make up the first of the four pillars of the Third Industrial Revolution. While these sunrise energies still account for a small percentage of the global energy mix, they are growing rapidly as governments mandate targets and benchmarks for their widespread introduction into the market and their falling costs make them increasingly competitive. Billions of Euros of public and private capital are pouring into research, development and market penetration, as businesses and homeowners seek to reduce their carbon footprint and become more energy efficient and independent.

While renewable energy is found everywhere and new technologies are allowing us to harness it more cheaply and efficiently, we need infrastructure to load it. This is where the building industry steps to the fore, to lay down the second pillar of the Third Industrial Revolution.

The construction industry is the largest industrial employer in the EU and, in 2003, represented 10 percent of the GDP, and 7 percent of the employment in the EU-15. Buildings are the major contributor to human induced global warming. Worldwide, buildings consume 30 to 40 percent of all the energy produced and are responsible for equal percentages of all CO2 emissions. Now, new technological breakthroughs make it possible, for the first time, to design and construct buildings that create all of their own energy from locally available renewable energy sources, allowing us to reconceptualize the future of buildings as “power plants”. The commercial and economic implications are vast and far reaching for the real estate industry and, for that matter, Europe and the world.

In 25 years from now, millions of buildings – homes, offices, shopping malls, industrial and technology parks – will be constructed to serve as both “power plants” and habitats. These buildings will collect and generate energy locally from the sun, wind, garbage, agricultural and forestry waste, ocean waves and tides, hydro and geothermal– enough energy to provide for their own power needs as well as surplus energy that can be shared.

A new generation of commercial and residential buildings as power plants is going up now. In the United States, Frito-Lay is retooling its Casa Grande Plant, running it primarily on renewable energy and recycled water. The concept is called “net-zero”. In France, Bouygues, the giant French construction company is taking the process a step further, putting up a state-of-the-art commercial office complex this year in the Paris suburbs that collects enough solar energy to provide not only for all of its own needs, but even generates surplus energy as well.

The Walqa Technology Park in Huesca, Spain is nestled in a valley in the Pyrenees and is among a new genre of technology parks that produce their own renewable energy on-site to power their operations. There are currently a dozen office buildings in operations at the Walqa Park, and 40 more already slated for construction. The facility is run entirely by renewable forms of energy, including wind power, hydro, and solar. The commercial park houses leading high tech companies, including Microsoft and other IT companies, logistics companies, and renewable energy companies, etc.

The introduction of the first two pillars of the Third Industrial Revolution- renewable energy and “buildings as power plants”- requires the simultaneous introduction of the third pillar of the Third Industrial Revolution. To maximize renewable energy and to minimize cost it will be necessary to develop storage methods that facilitate the conversion of intermittent supplies of these energy sources into reliable assets. Batteries, differentiated water pumping, and other media, can provide limited storage capacity. There is, however, one storage medium that is widely available and can be relatively efficient. Hydrogen is the universal medium that “stores” all forms of renewable energy to assure that a stable and reliable supply is available for power generation and, equally important, for transport.

Hydrogen is the lightest and most abundant element in the universe and when used as an energy source, the only by-products are pure water and heat. Our spaceships have been powered by high-tech hydrogen fuel cells for more than 30 years.

Here is how hydrogen works. Renewable sources of energy—solar cells, wind, hydro, geothermal, ocean waves—are used to produce electricity. That electricity, in turn, can be used, in a process called electrolysis, to split water into hydrogen and oxygen. Hydrogen can also be extracted directly from energy crops, animal and forestry waste, and organic garbage—so called biomass—without going through the electrolysis process.

The important point to emphasize is that a renewable energy society becomes viable to the extent that part of that energy can be stored in the form of hydrogen. That's because renewable energy is intermittent. The sun isn't always shining, the wind isn't always blowing, water isn't always flowing when there’s a drought, and agricultural yields vary. When renewable energy isn’t available, electricity can't be generated and economic activity grinds to a halt. But, if some of the electricity being generated, when renewable energy is abundant, can be used to extract hydrogen from water, which can then be stored for later use, society will have a continuous supply of power. Hydrogen can also be extracted from biomass and similarly stored.

The European Commission recognizes that increasing reliance on renewable forms of energy would be greatly facilitated by the development of hydrogen fuel cell storage capacity. So, in October 2007, the European Commission announced an ambitious public/private partnership to speed the commercial introduction of a hydrogen economy in the 27 member states of the European Union, with the primary focus on producing hydrogen from renewable sources of energy.

By benchmarking a shift to renewable energy, advancing the notion of buildings as power plants, and funding an aggressive hydrogen fuel cell technology R&D program, the EU has erected the first three pillars of the Third Industrial Revolution. The fourth pillar, the reconfiguration of the European power grid, along the lines of the internet, allowing businesses and homeowners to produce their own energy and share it with each other, is just now being tested by power companies in Europe.

The smart intergrid is made up of three critical components. Minigrids allow homeowners, small and medium size enterprises (SMEs), and large scale economic enterprises to produce renewable energy locally—through solar cells, wind, small hydro, animal and agricultural waste, garbage, etc.—and use it off-grid for their own electricity needs. Smart metering technology allows local producers to more effectively sell their energy back to the main power grid, as well as accept electricity from the grid, making the flow of electricity bi-directional.

The next phase in smart grid technology is embedding sensing devices and chips throughout the grid system, connecting every electrical appliance. Software allows the entire power grid to know how much energy is being used, at any time, anywhere on the grid. This interconnectivity can be used to redirect energy uses and flows during peaks and lulls, and even to adjust to the price changes of electricity from moment to moment.

In the future, intelligent utility networks will also be increasingly connected to moment to moment weather changes—recording wind changes, solar flux, ambient temperature, etc.- giving the power network the ability to adjust electricity flow continuously, to both external weather conditions as well as consumer demand. For example, if the power grid is experiencing peak energy use and possible overload because of too much demand, the software can direct a homeowner's washing machine to go down by one cycle per load or reduce the air conditioning by one degree. Consumers who agree to slight adjustments in their electricity use receive credits on their bills. Since the true price of electricity on the grid varies during any 24 hour period, moment to moment energy information opens the door to "dynamic pricing", allowing consumers to increase or drop their energy use automatically, depending upon the price of electricity on the grid. Up to the moment pricing also allows local minigrid producers of energy to either automatically sell energy back to the grid or go off the grid altogether. The smart intergrid will not only give end users more power over their energy choices, but also create significant new energy efficiencies in the distribution of electricity.

The intergrid makes possible a broad redistribution of power. Today's centralized, top-down flow of energy becomes increasingly obsolete. In the new era, businesses, municipalities and homeowners become the producers as well as the consumers of their own energy—so-called "distributed generation." Even the hydrogen- powered fuel cell automobile is a "power station on wheels" with a generating capacity of twenty or more kilowatts. Since the average car is parked most of the time, it can be plugged in, during non-use hours, to the home, office, or the main interactive electricity network, providing premium electricity back to the grid. Fuel cell powered vehicles thus become a way to store massive amounts of renewable energy in the form of hydrogen, that can, in turn, be converted back to electricity to fuel the main power grid. If just 25 percent of drivers used their vehicles as power plants to sell energy back to the intergrid, all of the power plants in the European Union could be eliminated.

IBM and other global IT companies are just now entering the smart power market, working with utility companies to transform the power grid to intergrids, so that building owners can produce their own energy and share it with each other. Centerpoint Utility in Houston, Texas, Xcel Utility in Boulder, Colorado, and Sempra and Southern ConEdison in California are laying down parts of the Smart Grid this year, connecting thousands of residential and commercial buildings.

The new EU energy plan is preparing the way for the intergrid, with the demand that the power grid be unbundled, or at least made increasingly independent of the power companies that also produce the power, so that new players—especially small and medium size enterprises and homeowners—have the opportunity to produce and sell power back to the grid with the same ease and transparency as they now enjoy in producing and sharing information on the internet. The European Commission has also established a European Smart Grid Technology Platform and prepared a long-term vision and strategy document in 2006 for reconfiguring the European power grid to make it intelligent, distributed, and interactive.

A continent-wide, fully integrated intelligent intergrid allows each EU member country to both produce its own energy and share any surpluses with the rest of Europe in a "Network" approach to assuring EU energy security. Italy can share its surplus solar energy with the United Kingdom, and the United Kingdom can share its excess wind power with Portugal, and Portugal can share its abundant hydropower with Slovenia, and Slovenia can share its culled forestry waste with Poland, and Poland can share its agricultural biomass with Norway, etc. When any given region of the European Union enjoys a temporary surge or surplus in its renewable energy, that energy can be shared with regions that are facing a temporary lull or deficit. Hydrogen - buttressed by other niche storage media – provides a universal carrier for all forms of renewable energy, for use in transport, or for conversion back to electricity when needed to feed the power grid.

The key to achieving the European Union goal of integrating a single European market and becoming the worlds' most competitive economy, is to create a seamless logistics infrastructure – buildings, transport, communication, power generation – and to build a green energy regime across the continent. With its 500 million consumers, and the additional 500 million consumers that live in the surrounding countries that make up its relational partnerships, the EU is potentially the "wealthiest internal market in the world". If goods and services can move efficiently and sustainably across the 27 member countries and associated regions by the laying down of a Third Industrial Revolution infrastructure, Europe can become the world's first post-carbon energy economy.

Being first to market will position the European Union as a leader in the Third Industrial Revolution, giving it the commercial edge in the export of green technological know-how and equipment around the world. Producing a new generation of renewable energy technologies, transforming Europe's millions of buildings into power plants to produce renewable energy for internal consumption or distribution back to the grid, manufacturing stationary fuel cells to store renewable energy, and reconfiguring the electrical power grid as a intelligent utility network, as well as producing all of the accompanying technologies, goods and services that make up a high-tech Third Industrial Revolution economy, will have an economic multiplier effect that stretches well toward the mid decades of the 21st century.

For a younger generation that is growing up in a less hierarchical and more networked world, the ability to share and produce their own energy in an open-access intergrid, like they produce and share their own information on the internet, will seem natural and commonplace.

The half century transition from the second to the Third Industrial Revolution is going to dramatically change the globalization process. The most significant impact is likely to be on developing nations. Incredibly, over half of the human population has never made a telephone call and a third of the human race has no access to electricity. Today, the per capita use of energy throughout the developing world is a mere one-fifteenth of the consumption enjoyed in the United States. The disparity between the connected and the unconnected is deep and threatens to become even more pronounced as world population is expected to rise from the current 6.2 billion to 9 billion people in the next half-century.

Lack of access to electricity is a key factor in perpetuating poverty around the world. Conversely, access to energy means more economic opportunity. In South Africa, for example, for every 100 households electrified, 10 to 20 new businesses are created. Electricity frees human labor from day-to-day survival tasks. It provides power to run farm equipment, operate small factories and craft shops, and light homes, schools and businesses. Making the shift to locally generated renewable energy, loaded by buildings, partially stored in the form of hydrogen, and distributed via smart intergrids holds great promise for helping to lift billions of people out of poverty.

The shift from elite fossil fuels and uranium based energies to distributed renewable energies, takes the world out of the "geopolitics" that characterized the 20th century, and into the "biosphere politics" of the 21st century. Much of the geopolitical struggles of the last century centered on gaining military and political access to coal, oil, natural gas, and uranium deposits. Wars were fought and countless lives lost, as nations vied with each other in the pursuit of fossil fuels and uranium security.

If millions of individuals and communities around the world were to become producers of their own energy, the result would be a profound shift in the configuration of power. Local peoples would be less subject to the will of far-off centers of power. Communities would be able to produce goods and services locally and sell them globally. This is the essence of the politics of sustainable development and re-globalization from the bottom up. The ushering in of the Third Industrial Revolution will go a long way toward diffusing the growing tensions over access to ever more limited supplies of fossil fuels and uranium and help facilitate biosphere politics based on a collective sense of responsibility for safeguarding the earth's ecosystems.

The central question that every nation needs to ask is where they want their country to be in twenty five years from now: In the sunset energies and industries of the second industrial revolution or the sunrise energies and industries of the Third Industrial Revolution. The Third Industrial Revolution is the end-game that takes the world out of the old carbon and uranium-based energies and into a non-polluting, sustainable future for the human race.

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