

# **The Next Phase of European Integration:**

## **Will The European Union Lead the Way to the Hydrogen Era and a Third Industrial Revolution?**

*by Jeremy Rifkin*

The recent row between Russia and the Ukraine over natural gas is sending shudders across Europe. The European Union relies on Russia for 25 percent of its natural gas and 30 percent of its oil supplies. When Russia temporarily cut its gas supplies to the Ukraine on January 1<sup>st</sup> in a dispute over a price hike, the rest of Europe suddenly found itself without sufficient natural gas because the pipeline from Russia to Europe runs through the Ukraine. The crisis raised eyebrows again in official EU policy circles about over-reliance on outside suppliers for meeting Europe's energy needs.

Energy has quickly moved to the top of the political agenda in countries across the European Union, and particularly in Germany, where Chancellor Angela Merkel is in the process of drafting a "National Energy Strategy" and has announced that her government will convene an energy summit in 2006, bringing together German businesses and policy makers to inaugurate new energy initiatives.

The Russian-Ukraine gas dispute is the latest in a series of energy shocks which has unnerved the business community and forced EU member states to sit up and take notice of their increasing vulnerability as Europe and the world enter the twilight of the oil era. Oil prices are currently hovering at \$65 US a barrel on world markets, and geologists predict that global oil production could peak as early as 2010, and probably no later than 2040, even assuming the most optimistic forecasts. The global production of natural gas is likely to peak even earlier. Goldman Sachs is already warning of oil spikes of up to \$105 US a barrel.

Adding to the woes, we now find ourselves in "real-time global warming". Hurricanes Katrina and Rita that slammed into the US gulf coast last fall, record flooding in the European Alps last summer, and spreading drought in the southern hemisphere are warning signals that the earth's atmosphere is rapidly heating up as a result of burning massive amounts of fossil fuels over the past century. Scientists reported in the November 25<sup>th</sup> issue of *Science* that the concentration of greenhouse gases in the Earth's atmosphere is greater now than at any time in the last 650,000 years. No wonder political leaders and the business community are running

scared. For the first time, the question being asked around the world is how do we prepare society for a post-oil era?

The discussion around energy security in Brussels in the coming months will be a critical test as to whether the European Union can break loose from the pack and introduce a new energy vision for the world in the 21<sup>st</sup> century. The reality is that the technological and commercial opportunity now exists to open the door to a new energy era, and the European Union is in the ideal position to lead the way.

We are on the cusp of a new energy regime that will alter our way of life as fundamentally as the introduction of coal and steam power in the 19<sup>th</sup> century and the shift to oil and the internal combustion engine in the 20<sup>th</sup> century. The hydrogen era looms on the horizon, and the first major industrial nation to harness its full potential will set the pace for economic development for the remainder of the century. 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.

Setting a goal to become the first fully integrated hydrogen economy in the world is a grand idea worthy of the next phase of European integration. Indeed, preparing the EU for a third industrial revolution gives the grand European Union a fresh new cooperative operational roadmap that can not only address the critical priorities and objectives of each of the member nations, but in a way that complements the aspirations of each country without compromising the aims of the other: a kind of win-win scenario for both the member states and the European Union as a whole.

The historic shift to a hydrogen economy will spur commercial growth, create millions of new jobs, facilitate the integration of Europe, ensure sustainable development, and foster energy security.

Qualitative leaps in productivity, economic development, and employment always occur during periods in history when new energy regimes are being established and accompanying infrastructures are being laid out. The harnessing of coal and steam power and the laying down of a rail infrastructure in the late 19<sup>th</sup> century and the introduction of the oil-powered, internal combustion engine and the laying down of roads in the 20<sup>th</sup> century spawned great leaps in productivity, created millions of jobs, and made possible all sorts of new goods, services, and

markets. Today, hydrogen energy and fuel cell technology is entering the commercial arena. Its widespread dissemination will likely have a greater impact on the global economy than any other single development in the foreseeable future.

In 2003, the European Union unveiled a two billion Euro R&D plan—The European Hydrogen and Fuel Cell Technology Platform—for making the transition out of the fossil fuel age and into a fully integrated renewable energy based hydrogen economy. I was serving, at the time, as an informal, personal advisor to Romano Prodi, the President of the European Commission, the governing body of the European Union. In that capacity, I provided President Prodi with the initial strategic memorandum that led to the EU hydrogen energy initiative. President Prodi said that the transformation of Europe’s energy regime would be the next great development in European integration after the introduction of the Euro, and likened the effort to the American Space program in the 1960s and 1970s, which spawned the subsequent high-tech economic revolution of the 1980s and 1990s.

Leaders of all 6 major European political parties - The Popular Party, The Party of the European Socialists (PES), The Alliance of the Liberal Democrats of Europe (ALDE), The Green Group, The European United Left (GUE), and The Union for Europe of the Nations (UEN) - have made the commitment to push ahead on plans to make the EU the first renewable energy hydrogen economy in the world. The EU Parliamentary Leadership Group for a renewable energy, hydrogen economy includes the President of the European Parliament, Joseph Borrell. The European Parliament Hydrogen initiative is also being supported by the EU Environmental Commissioner, Alexander Dimas. Moreover, the European Parliament Hydrogen Group is led by Dr. Vittorio Prodi of the Liberal party, a world-class physicist with 40 years of experience on energy-related issues, and an expert on Hydrogen Energy. I currently serve as the principle senior advisor to the EU Parliamentary Leadership Group for a renewable energy, hydrogen economy .

Hydrogen has the potential to end the world’s reliance on imported oil and help diffuse the dangerous geopolitical game being played out in the oil-rich Persian Gulf. Hydrogen will dramatically cut down on carbon dioxide emissions and mitigate the effects of global warming. And because hydrogen is so plentiful, every human being could be “empowered,” making it the first truly democratic energy regime in history.

Hydrogen is found everywhere on earth, yet it rarely exists free floating in nature. Instead, it has to be extracted from either hydrocarbons, water, or biomass. Today, the most cost-effective way to produce commercial hydrogen is to harvest it from natural gas via a steam reforming process. Yet the supply of natural gas is as finite as our oil supply, and therefore not a dependable source. Hydrogen could also be extracted from coal and oil sands, but that would mean a dramatic increase in the emission of carbon dioxide into the atmosphere. Nuclear power could also be utilized, but that would vastly increase the amount of dangerous radioactive waste, pose serious security threats in an age of terrorism, and greatly increase the cost that taxpayers and consumers have to pay for their energy.

But there is another way to produce hydrogen—one that uses no fossil fuels in the process. Renewable sources of energy—solar cells, wind, hydro and geothermal—are increasingly being 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, agricultural waste and forestry waste, and organic garbage—so called biomass—without going through the electrolysis process. (A partial shift in subsidies away from agricultural crops and toward energy crops could provide a long-term solution to the question of how to address the agricultural subsidies issue within the European Union.) Once produced, the hydrogen can be stored and used, when needed, to generate electricity.

The important point to emphasize is that a renewable energy society is impossible unless the 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 when agricultural yields are high, and similarly stored.

Brazil stands as an object lesson for other countries of the consequences of relying on intermittent renewable energy for electricity, without factoring in the need to store some of the energy in the form of hydrogen in order to assure a steady supply of electricity to the grid. Nearly 95% of Brazil's electricity is generated from a renewable source of energy—hydro. In

2001, Brazil experienced a drought. The flow of water slowed, and electricity generation sputtered, causing electrical outages in various parts of the country. Had a hydrogen infrastructure been in place, Brazil could have used some of its surplus electricity, generated when the water table was high, to electrolyze water, and store hydrogen for back-up generation during the drought.

The European Union has already agreed to a goal of generating 22% of its electricity and 12% of its energy from renewable energy by 2010, and 20% by 2020. When the renewable energy contribution to the electricity output becomes significant- more than 5% of the mix— even a temporary lull in solar flow, wind, and water flow, can result in a shortage of supply, a spike in prices, and even brownouts and blackouts. Using hydrogen as a “storage carrier” for renewable energy will be essential if the European Union is to ensure a reliable supply of energy.

While the costs of harnessing renewable energy and extracting hydrogen are still high, new technological breakthroughs and economies of scale are dramatically reducing these costs every year. Moreover, hydrogen powered fuel cells are 2 times more efficient than the internal combustion engine. Meanwhile, the direct and indirect costs of oil and gas on world markets are going to continue to rise. As we approach the nexus between the falling price of renewables and hydrogen and the rising price of fossil fuels, the old energy regime will steadily give rise to the new energy era.

Commercial fuel cells powered by hydrogen are just now being introduced into the market for industrial, office, and home use. Large stationary fuel cells are being purchased by manufacturing and service related companies to provide backup power generation during periods of peak electricity load on the grid or in case of rolling brownouts or blackouts. Linde AG installed a state-of-the-art hydrogen fuel cell power plant recently at the Munich Airport. Hitachi and Toshiba are planning to bring the first portable fuel cells to the market in 2007. Consumers will be able to power up their cell phones, lap top computers, digital cameras, Mp3 players, and PDA's for 8 to 35 hours with a single cartridge. The major automakers have spent billions of dollars developing hydrogen-powered cars, buses, and trucks. Hydrogen powered buses and automobiles are currently being test driven on roads across Europe and the first mass-produced vehicles are expected to be in the showrooms between 2010 and 2012.

The hydrogen economy makes possible a broad redistribution of power, with far-reaching beneficial consequences for society. Today's centralized, top-down flow of energy, controlled

by global oil companies and utilities, becomes obsolete. In the new era, businesses, municipalities and homeowners could become the producers as well as the consumers of their own energy—so-called “distributed generation.” Even the automobile itself is a “power station on wheels” with a generating capacity of twenty 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. If just 25 percent of drivers used their vehicles as power plants to sell energy back to the grid, all of the power plants in the European Union could be eliminated.

In order for millions of people to become producers, as well as consumers of energy, it will be necessary to redesign the power grid. That’s where the software and computer revolution converge with the new hydrogen energy regime. The communications revolution will play a critical role in ushering in a new energy era. The great pivotal 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. For example, 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 and early twentieth centuries, the telephone converged with the introduction of oil and the internal combustion engine, becoming the command and control mechanism for organizing the second industrial revolution.

A great communications revolution occurred in the 1990’s. Personal computers, the internet, the world wide web, and wireless communication technologies connected the central nervous system of more than a billion people on Earth at the speed of light. And, although the new software and communication revolutions have begun to increase productivity in every industry, their true potential is yet to be fully realized. That potential lies in their convergence with the new distributed hydrogen energy regime.

The same design principles and smart technologies that made possible the internet, and vast, decentralized global communication networks, will be used to reconfigure the world’s power grids so that people can begin to share energy peer-to-peer, just like they now share information, creating a new, decentralized form of energy use. The coming together of

decentralized communications technology and distributed hydrogen energy technology marks the next great turning point in the way people organize the energy of the planet.

National hydrogen associations now exist in fifteen leading industrial nations. All the major automobile and chemical companies, as well as many of the world's leading electronic companies are in a race to the hydrogen era. Energy companies like BP and Dutch Shell sport hydrogen divisions. Japan is making hydrogen technology a critical national priority in its energy plans. The state of California—the world's fourth largest economy—is operationalizing a broad program to become a fully integrated renewable energy-based economy over the next two decades. Local regions across Europe are introducing hydrogen R&D projects. Seventeen of the twenty governing regions of Italy have endorsed the vision of a renewable energy, hydrogen economy. In January 2006, the city of Potsdam, Germany introduced an ambitious renewable energy hydrogen project.

European industry has the scientific, technological, and financial know-how to spearhead the shift to a hydrogen economy and lead the world into a new economic era. The EU's world class automotive industry, chemical industry, engineering industry, construction industry, software, computer and communication industries, and banking and insurance industries, give it a leg up in the race to the hydrogen era. The European Union also boasts one of the world's largest solar markets and is the world's leading producer of wind energy. The European Union and its member states should establish a deep collaboration with the business community and civil society organizations to begin mobilizing the public, private, and civic resources of the country to the task of establishing an infrastructure for a 21<sup>st</sup> century hydrogen economy.

How do we pay for a new hydrogen energy regime and infrastructure? Serious consideration ought to be given to expanding "tax-shifting" legislation. The idea is to tax environmentally destructive practices and activities and earmark the revenues to positive economic activity. In the future, "tax shifting" laws could be directed to raising revenue to help subsidize the development of renewable energies and hydrogen fuel cell technologies.

Environmental Fiscal Reform (EFR), as it is sometimes referred to, has been taken up successfully by a number of countries including Sweden, Denmark, the Netherlands, the U.K., Finland, Norway, and Italy. Germany, which is among the most enthusiastic supporters of "tax shifting," has phased in an increase in taxes on gasoline, heating oil, and electricity, and used the

revenue to reduce payroll taxes. The gasoline tax resulted in the decline in motor fuel use by 5 percent in 2001 over 1999 and a growth in carpooling by 25 percent.

At present, environmental tax shifting comprises only about 3 percent of tax revenues worldwide, but the potential is enormous. A tax on fossil fuels alone could raise more than a trillion dollars annually. Ending environmentally harmful subsidies to polluting industries could free up an additional \$500 billion per year globally. The revenue, in turn, could be used to invest in the shift to renewable energies and a hydrogen future.

Interestingly, the evidence shows that while increases in taxes on corporate pollution is not very well received by the companies, it forces them to eliminate resource inefficiencies and makes them more competitive in world markets. Studies show that many of the countries “that have the highest levels of environmental taxes also have industries that are the best in international competitiveness.”

Along with “tax shifting” legislation, the European Union and the member states should provide generous tax credits and incentives to industry, small businesses, local regions and municipalities, as well as to homeowners and consumers, to encourage both research and development and early adoption of renewable energies and fuel cell related technologies.

Reconfiguring the energy infrastructure of the European Union will create millions of new jobs over the next twenty-five years. And because the installation of renewable resource technologies and the establishment of a hydrogen infrastructure is geographically tied, the employment generated will all be within Europe.

Equally important, launching a third industrial revolution and making the transition to a green hydrogen era can help facilitate the integration of Europe’s infrastructure to realize the EU-Lisbon agenda of making Europe the most competitive economy in the world. While there’s been much talk about implementing a Services Directive to ensure greater labor mobility across the EU, far less attention has been paid to the mutually important task of creating a seamless transportation grid, power grid, communication grid, and an energy policy to ease the flow and exchange of information, goods and services, across the 25 EU member states. By fostering a European-wide, renewable energy, hydrogen infrastructure, the EU and its member states can help create a sustainable economic development plan and make the European Dream of a single integrated market a reality for its 455 million citizens in the first half of the 21<sup>st</sup> century.

Being first to market will also position the European Union as a leader in the third industrial revolution, giving it the commercial edge in the export of H<sub>2</sub> technological know-how and equipment around the world. Reinventing the automobile, reconfiguring the electrical power grid, manufacturing portable and stationary fuel cells, and producing a new generation of renewable energy technologies, as well as all of the accompanying technologies, goods and services that make up a high-tech hydrogen economy, will have an economic multiplier effect that stretches well toward the mid decades of the 21<sup>st</sup> century.

The transition to a fully integrated, hydrogen energy regime will not occur overnight. It will take 25 to 30 years to put the infrastructure in place. In the interim, the European Union—and every other country—needs to establish a parallel track for radical energy efficiency and conservation. The European Commission has laid out a detailed survivor’s guide—a roadmap of what every individual, family, community, and country can do immediately to cushion the cost shock of rising oil prices. It’s called “The Green Paper on Energy Efficiency”. According to the report, the European member states alone, could save at least 20% of their present energy consumption, for a net savings of 60 billion euros per year, by enacting tough energy conservation programs across the swath of European society—in homes, commercial buildings, factories, and transport. The average EU household could save as much as 1000 euros per year in cost-saving energy efficient practices, thus offsetting much of the increased price of oil.

The EU green paper is replete with detailed information on how to overhaul every aspect of our lives to achieve more energy-efficiency. Proposals include: incentives to purchase energy-efficient cars, reducing the national speed limit to 55 milers per hour, making alterations in homes and commercial buildings, like installing special insulation and storm windows, using long-lasting electric light bulbs, introducing software into appliances to save energy, renovating the nation’s power grids to be more efficient, and other energy-saving practices.

Governments will need to employ a range of strategies including taxation, public subsidies, economic incentives, and partnerships with industries, communities, and homeowners to make the transition to a truly energy-efficient society.

While government, industry, and consumers will have to spend some money up front to usher in literally thousands of energy efficient “best practices,” the investment will boost the EU economy by creating upwards of a million new jobs across the EU. Moreover, the cost savings

of improved energy-efficiency will mean more money will be freed up to invest in renewable energy technologies and the hydrogen infrastructure.

Leading the way to a hydrogen economy and a third industrial revolution should be an urgent priority and the next phase of European integration. Opening the door to a new energy era is the best contribution the European Union can make to the world in the coming global era.

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