Jeremy Rifkin's Third Industrial Revolution

Economist and energy visionary Jeremy Rifkin is senior lecturer at the Wharton School’s Executive Education Program at the University of Pennsylvania, president of the Foundation on Economic Trends in Washington, D.C., author of 19 books, and an advisor to the European Union and to heads of state around the world. In his most recent treatise, The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and World (September 2011), Rifkin describes how the current Industrial Revolution is drawing to a close and why and how we should work to shape the next one. He spoke to us from Washington, D.C.

This article was created collaboratively with Mary Hoff, managing editor of Momentum—a magazine published by the Institute on the Environment at the University of Minnesota.

We had time to discuss The Third Industrial Revolution with Jeremy recently.

**How did you come up with this idea?**

My read on history is that the great economic revolutions occur when two phenomena come together. When we change energy regimes, it makes possible much more complex economic relations. When energy revolutions occur, however, they require communication revolutions that are agile enough to manage them. If you look at the 19th century, print technology became very cheap when we introduced steam power into printing. That decreased the cost and increased the speed, efficiency and availability of print material. At the same time we established public schools in Europe and America.
We created a print literate workforce with the communication skills to organize a First Industrial Revolution driven by coal and steam power.

Then we did it again in the 20th century with the convergence of communication and energy: Centralized electricity—especially the telephone and then later radio and television—became the communication vehicles to manage a more dispersed Second Industrial Revolution, organized around the oil-powered internal combustion engine, suburban construction and the creation of a mass consumer society.

Energy historians only deal with energy, and communication historians only deal with communications, but in history you can’t really do one without the other. That’s the framework that led me to this kind of search, and the Third Industrial Revolution really came out of that narrative on how history evolves.

**So, what exactly is the Third Industrial Revolution?**

First of all, it’s based on a new convergence of communication and energy. The Internet has been a very powerful communication tool in the last 20 years. What’s so interesting about it is the way it scales. I grew up in the 20th century on centralized electricity communication that scales vertically. The Internet, by contrast, is a distributed and collaborative communication medium and scales laterally.

We are in the early stages of a convergence of Internet communication technology with a new form of energy that is by nature distributed and has to be managed collaboratively and scales laterally. We’re making a great transition to distributed renewable energy sources. And we distinguish those from the elite energies—coal, oil, gas, tar sands—that are only found in a few places and require significant military and geopolitical investments and massive finance capital, and that have to scale top down because they are so expensive. Those energies are clearly sunsetting as we enter the long endgame of the Second Industrial Revolution.

Distributed energies, by contrast, are found in some frequency or proportion in every inch of the world: the sun, the wind, the geothermal heat under the ground, biomass—garbage, agricultural and forest waste—small hydro, ocean tides and waves.

The 27 member nations of the European Union have committed to establishing a five-pillar infrastructure for a Third Industrial Revolution based on this new convergence of
communication and energy. I was privileged to develop the plan that was formally endorsed by the European Parliament in 2007.

Pillar 1: The EU has mandated a goal of 20 percent renewable energy by 2020. That means a third of the electricity has to be green.

Pillar 2: How do we collect distributed renewable energy? The first thought in Europe was, let’s go to Spain, Greece, and Italy—because they have all the sun. Put in concentrated solar parks and ship the green electricity via high-voltage lines to the rest of Europe. Similarly, the Irish have the wind, the Norwegians have ample hydro. Therefore, set up large wind farms and hydro dams to capture the energy. While we believe that these more concentrated uses of what are essentially distributed energies are critical to get us off carbon, they’re not sufficient. Indeed, we can’t run a global economy solely on centralized, concentrated wind, solar, geothermal, hydro, etc. This forced us to ask an important question: If some form of renewable energies are found in every square inch of the planet, why would we only concentrate them in a few central points? That got us to pillar 2: buildings. We have 191 million buildings in the EU. The mission now is to convert the entire building stock of Europe to partial green power plants that can collect solar energy on the roofs, wind energy off the sides of the building, geothermal energy from the ground below the building, biomass energy from the conversion of garbage in the building, etc. This will jump start construction. Converting the entire building infrastructure of the EU will generate millions of jobs and create new opportunities for thousands of small and medium-sized enterprises stretching over a 40-year period. And all the business is local.

Pillar 3: How do we store distributed renewable energy? The sun isn’t always shining, and the wind sometimes blows at night when we need electricity during the day. Hydropower can be intermittent when water tables are down because of climate change—induced drought. So storage is critical when more than 15 to 20 percent of the power grid is made up of intermittent renewable energy. The EU is committed to many different storage systems: flywheels, batteries, water pumping, etc. But we’re putting most of our emphasis on hydrogen as the linchpin of the storage network. When the sun hits your roof and your photovoltaic panels generate green electricity, you can take any surplus electricity you are not using and put it in water, allowing the hydrogen in the water to be siphoned out into a tank. Then, when the sun isn’t shining on the roof, you can simply transform that hydrogen back to green electricity, with only a small thermodynamic loss.
Pillar 4: How do we share green electricity with each other? We take off-the-shelf IT and Internet technology and transform the power grid and electricity transmission lines into an energy Internet. So when millions of buildings are collecting distributed renewable energy, storing it in the form of hydrogen like we store media in digital form, they can then share any surplus electricity with others by selling back onto the energy Internet. Everyone becomes an entrepreneur in a collaborative energy Internet that spans whole regions and continents.

Pillar 5: How do we integrate transport into the TIR infrastructure? The idea is to plug in electric and hydrogen fuel cell vehicles to the buildings to power up our vehicles. And then wherever you travel, you can plug back in and get electricity from the grid—or sell your car’s electricity back to the grid if the price is right.

These five pillars are only components. It’s when they are connected that we create the synergies that transform them into a seamless new infrastructure for a new economic paradigm for the 21st century.

In the business community we’re seeing a real generational shift. Older men and women tend to think more in terms of organizing economic activity in a centralized, top-down fashion. Those who are 40 years old and younger gravitate toward an organizational style that is more distributed, collaborative and lateral. It’s analogous to what happened to the music companies: The old guard just didn’t understand the far-reaching significance of millions of young people file-sharing music—they didn’t get it. Then they shrunk or went out of business. And the newspapers weren’t ready for the distributed and collaborative nature of the blogosphere. Now newspapers are either going out of business or creating their own blogs.

Steve Jobs’ real legacy and that of his generation of innovators is they set up the communication part of the Third Industrial Revolution. However, the coming together of the Internet and renewable energy—the democratization of both information and power in one matrix—is what changes the whole frame of reference for everything we do in society.

You speak of “we.” How are you doing this?

I chair a group of more than 100 companies—many of whom are the main players in the renewable energy industry, the construction industry, urban planning and architecture, IT, and global logistics and transport—that comprise the Third Industrial Revolution
Global CEO Business Roundtable. We use a similar organizational model to the one used in the film industry. Everyone has their own expertise. We come together to help political jurisdictions, the local business community and civil society create a Third Industrial Revolution narrative and game plan—analogous to a script—that can help them transition their economies into the new economic era.

The Third Industrial Revolution Global CEO Business Roundtable is the outgrowth of the dramatic changes that have taken place in the recent past. We’ve had two events in the last three years that signal the beginning of the endgame for the Industrial Revolution based on fossil fuels. The first one was July 2008 when oil hit $147 a barrel and the costs of all the goods and services across the global supply chain went through the roof, purchasing power plummeted, and the entire global economy ground to a halt. That was the great economic earthquake that signaled the beginning of the endgame for an Industrial Revolution based on fossil fuels. The financial collapse 60 days later was the aftershock.

We’ve hit peak globalization in how far we can actually globalize the economy based on elite fossil fuels. Every time we try to re-grow the economy at the same growth rate we were experiencing before July 2008, oil prices will rise and the prices of all other goods and services will climb as well because all the economic activity of our global economy depends on fossil fuels. We grow our food in petrochemical fertilizers and pesticides. Most of our construction materials and the vast majority of our pharmaceutical products are made of fossil fuels as well as our packaging materials and clothes. Our power, heat, light and transport are also reliant on fossil fuels. The price of virtually every good and service in today’s global economy is dependent on the price of oil. That is why we are likely looking at four-year cycles of growth and collapse. Each time we try to restart the engine by replenishing inventories, oil prices will climb back up, all the other prices for goods and services will spike along with the price of oil, and at around $150 a barrel, purchasing power will plunge and the economy will shut down. That’s exactly what is happening now as we head to a second collapse of the global economy.

The second big event was the Copenhagen climate change summit. One hundred ninety-two countries came together to address the issue of global warming. Even though our scientists tell us we are in the early stages of a dramatic shift in the climate of the planet due to the emissions of industrial-induced carbon dioxide, methane and nitrous oxide, our world leaders couldn’t cut a deal on climate change. The rise in temperature on the
planet is playing havoc with the Earth’s hydrological cycle and imperiling ecosystems, threatening a mass extinction of plant and animal life in the 21st century. Yet most of the governments of the world appear unwilling to take the necessary steps to combat climate change, putting in doubt the future viability of our species on Earth.

With all of this in mind, after oil peaked at $147 a barrel in July 2008 I put together a meeting of CEOs and senior executives from global companies and trade associations, and we said we need to create a sustainable new economic vision and a game plan to re-grow the economy based on bringing the Internet together with renewable energy. All of our companies wanted to move quickly to turn the crisis to an opportunity. But they were going at it alone—and we realized it’s only if we move together that we can help create the essential infrastructure for the next Industrial Revolution. That’s how we put this Third Industrial Revolution global business network together.

**Endgame? A lot of big players are not going to like the message you’re delivering.**

The power and utility companies like to have control over the power supply and control over the transmission lines. They want to sell lots of electrons. What we’re saying to power and utility companies is, your model is not working for you. Fossil fuels are getting more expensive, and you’re going to be increasingly taxed because of the mounting bill for climate change—not to mention the fact that your old centralized electricity grids are inefficient and increasingly dysfunctional.

We already have hundreds of thousands of people making their own green energy, and pretty soon it’s going to be tens of millions and then hundreds of millions of people generating their own energy. And the cost curve of the collection technology—solar panels, small and large wind turbines, geothermal heat pumps, small hydro, tidal and wave technology, biomass converters—is following the same cost curve dynamics as when we went from centralized mainframe computers to desktop computers and from centralized telephone communication to distributed cell phone networks. As feed-in tariffs expand to countries around the world, allowing early adopters a premium price for the green electricity they generate and sell back to the grid, the collection technologies will become ever more efficient and cheaper. Twenty years from now the technology for collecting and distributing energy is going to be virtually free, just like information.
Millions of people are going to generate their own green electricity in the 21st century while we will leave it to the power and utility companies to run the energy Internet. The power and utility companies are going to make money by doing the exact opposite of what they did in the 20th century. That is, they are going to profit by selling as few electrons as they can. We’re going to use the IBM model as a case study of what needs to be done to transform the power and utility industry. When IBM’s cash cow, its retail computer, began to become less profitable because of the global competition among computer manufacturers, IBM needed to rethink its mission. IBM asked a simple question: What do we do as a company that is unique and that the world needs? It’s not making computers, it’s managing information—so now every company in the world has a chief information officer and IBM, Cisco, HP, and other companies manage their client’s information flows.

In an analogous sense, when millions of people are generating their own green electricity and sending some of it back to an energy Internet, the question facing power and utility companies is: What is the expertise they have that will allow them to stay in business? In the future, power and utility companies will set up partnerships with thousands of businesses to help manage their energy flows in their production processes, supply chains, and logistics networks. Whether any company flourishes or fails in the volatile period of transition between an aging Second Industrial Revolution and the emerging Third Industrial Revolution will depend, to a great extent, on their energy costs. The new mission for the power and utility companies is to help clients manage their energy flow so they save on their energy use, increase their productivity and improve their margins. The corporate clients in turn will share back some of their energy savings and the income generated from increased productivity with the power and utility companies. We call these “shared savings” agreements. There’s far more money to be made by the power and utility company managing energy, reducing the amount of energy their clients use, and then sharing the savings.

**What are the implications of the Third Industrial Revolution for developing countries?**

My sense is that developing nations can move quicker into the new economic era by leapfrogging directly into the five-pillar infrastructure, because in many instances they lack any kind of infrastructure.
What we learned with cell phones surprised all of us. We didn’t anticipate millions of people getting cell phones virtually overnight in sub-Saharan Africa where there wasn’t even a developed electricity grid. They just jumped in and then the cell towers came. So we think the developing countries are ideally suited to transition into the new economic paradigm. They have ample green renewable energy and they can scale locally and then, like Wi-Fi, connect their micro grids across regions. And that’s what’s beginning to happen.

**What is the governance model for this?**

The First and Second Industrial Revolutions, because they were centralized, their geographical reach was limited. The Third Industrial Revolution, because it’s nodal and scales laterally, likes to run uninhibited across all borders till it reaches ocean edges. The First and Second Industrial Revolutions favored national markets and national governments. The Third Industrial Revolution favors continental markets and continental political unions. Continentalization is the next stage of globalization.

**Where do we go from here?**

What we have to do now is to lay down The Third Industrial Revolution infrastructure. I don’t think there’s a Plan B—if this isn’t the way to do it, by creating a new energy/communication matrix and a five-pillar infrastructure to accompany it, then what is the plan for the world? We can’t stay in the Second Industrial Revolution. It doesn’t work anymore.

We need to bring the best entrepreneurial talent and scientific and technological know-how together, and work with local, regional, and national governments and their respective business communities and civil society organizations to transform the infrastructure of the global economy and prepare the world for the next great economic era.

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**This article is available online at:**

Beyond Austerity

A Sustainable Third Industrial Revolution
Economic Growth Plan For the European Union

(An Executive Summary of Jeremy Rifkin’s Keynote Speech for the Mission Growth Summit: Europe at the Lead of the New Industrial Revolution, hosted by The European Commission, May 29th 2012)

For months the international community has anguished over the future prospects of the European Union. The spreading credit crisis has raised the unthinkable question of whether the EU will survive in its current form. The European crisis is part of the larger global downturn affecting every nation. A mounting energy bill, the real time impacts of climate change on agriculture and infrastructure, the slowdown of the global economy, rising unemployment and escalating consumer and government debt have brought the world to the brink of a historic crisis of epic proportions.

Europe now finds itself caught-up in the maelstrom and is currently engaged in a fierce debate over how to save the Eurozone and, with it, the future of the European dream. Virtually everyone is in agreement that tough new austerity programs will have to be enacted in the member countries to reduce government debt, and new regulatory mechanisms put in place to oversee European financial institutions and markets. Any austerity programs however, have to be careful not to compromise the guiding values of the European Dream which include: the preservation of the social / market model; the commitment to sustainable economic growth; the advancement of quality of life for every citizen; and building a more just and peaceful world.

Still, there is a growing realization that austerity measures alone will be insufficient to assure the future of Europe and its member states. That’s because this time around the challenges facing the European Union and the world go well beyond regulatory, fiscal, and monetary policies. The Second Industrial Revolution, powered by ever more expensive fossil fuels, and organized around an aging electricity grid and an outmoded transport network, all embedded in a crumbling carbon-based infrastructure, is incapable of spawning thousands of new businesses and millions of new jobs. It is becoming increasingly clear that what Europe needs, above all else, is a bold new economic narrative that can take it into a more equitable and sustainable future.

Today, Internet technology and renewable energies are beginning to merge in Europe to create the infrastructure for a Third Industrial Revolution (TIR) that can revitalize the European market, advance the next stage of European economic integration and help solidify the European Union as a political space. In the coming era, millions of Europeans will produce their own green energy in their homes, offices, and factories and share it with each other in a green electricity Internet, just like we now generate and share information online.
Ironically, while the European public is clamoring for a new economic vision that can move Europe into a period of sustained growth, the European Council and European Commission have been quietly developing just such a plan. The Commission’s —Road Map for Moving to a Competitive Low Carbon Economy in 2050,‖ which will be reviewed by the member states during the Danish Presidency of the European Council, calls for the laying down of the five critical pillars that make up the Third Industrial Revolution infrastructure between now and 2050.

The five pillars of the Third Industrial Revolution are (1) shifting to renewable energy; (2) transforming the building stock of every continent into micro–power plants to collect renewable energies on-site; (3) deploying hydrogen and other storage technologies in every building and throughout the infrastructure to store intermittent energies; (4) using Internet technology to transform the power grid of every continent into an energy Internet that acts just like the Internet (when millions of buildings are generating a small amount of energy locally, on-site, they can sell surplus back to the grid and share electricity with their continental neighbors); and (5) transitioning the transport fleet to electric plug-in and fuel cell vehicles that can buy and sell electricity on a smart, interactive, continental power grid.

The creation of a renewable energy regime, loaded by buildings, partially stored in the form of hydrogen, distributed via an energy Internet, and connected to plug-in, zero- emission transport, opens the door to a Third Industrial Revolution. The entire system is interactive, integrated, and seamless. When these five pillars come together, they make up an indivisible technological platform—an emergent system whose properties and functions are qualitatively different from the sum of its parts. In other words, the synergies between the pillars create a new economic paradigm that can transform Europe and, in the process, create thousands of businesses and millions of jobs, making Europe the world’s most competitive economy.

The 2050 road map notes that reaching the goal of a low carbon economy by 2050 will require major and sustained public and private investment of approximately 270 billion annually—or around 1.5 percent of EU GDP per annum—on top of the overall current investment of 19 percent of GDP in 2009. While the particulars of financing the transition to a Third Industrial Revolution infrastructure will require additional discussions in the months and years ahead, it is essential that the European Council, during the Danish Presidency, take the opportunity to publicly articulate the TIR vision for advancing the next stage of European integration.

Let me emphasize this last point. While all five pillars of the Third Industrial Revolution are put forward in the 2050 Road Map, they are siloed and never connected to tell the story of a new industrial infrastructure for a new economic era. What is needed now is for EU leaders to connect the dots and explain how the five pillars of the Third Industrial Revolution fit together to create a seamless new economic paradigm.

The transition to the Third Industrial Revolution will necessitate a wholesale reconfiguration of the economic infrastructure of the European Union, creating millions of jobs and countless new business opportunities. Nations will need to invest in renewable energy technology on a massive scale; convert millions of buildings into green micro-power plants; embed hydrogen and other storage technology throughout the infrastructure; lay down a green electricity Internet; and
transform the automobile from the internal combustion engine to electric plug-in and fuel cell cars.

The remaking of each nation’s infrastructure and the retooling of industries is going to require a massive retraining of workers on a scale matching the vocational and professional training at the onset of the First and Second Industrial Revolutions. The new high tech workforce of the Third Industrial Revolution will need to be skilled in renewable energy technologies, green construction, IT and embedded computing, nanotechnology, sustainable chemistry, fuel-cell development, digital power grid management, hybrid electric and hydrogen-powered transport and hundreds of other technical fields.

Germany, the economic engine of Europe, is setting the pace in the transitioning of the continent into a Third Industrial Revolution. The country currently generates 20% of its electricity from renewable sources and is expected to produce 35% of its electricity from renewables by 2020. Equally impressive, more than one million buildings in Germany have already been converted into partial green micro power plants. Meanwhile, the German government is establishing hydrogen storage facilities across the country and testing the green electricity internet—the smart grid—in six geographic regions. Daimler, the company that invented the internal combustion engine that ushered in the Second Industrial Revolution, is readying hydrogen fuel stations in preparation for the mass production of its fuel cell automobiles in 2015.

For a younger generation of Europeans that has grown up on the Internet and is used to creating their own information and sharing it with millions of others in social commons in virtual space, the idea of generating their own energy and sharing it on a green electricity Internet across Europe is being enthusiastically embraced. When every European family, neighborhood, and business becomes a critical node in a distributed and collaborative energy network that encompasses the EU, the citizenry comes to feel vitally connected in the economic and political life of Europe.

The opportunity is clear. The European Union has 500 million consumers and an additional 500 million potential consumers in its partnership regions, giving it the prospect of becoming the largest and wealthiest internal commercial market in the world. The key is creating a seamless distributed renewable energy régime, a green electricity Internet, and a communication and transport network that will allow one billion people to engage in—sustainable—commerce and trade across the European continent and its periphery. To the extent that the European Union can effectively create a post-carbon Europe and transform the continent into the largest integrated market space in the world, it will prosper, and the European Union will come of age.

The problem, at this juncture in the EU journey, is that much of the new economic vision and development plan that has been painstakingly developed is obscured in arcane technical reports that fail to grab the imagination of the European citizenry and the international investment community. Thus, for the most part, the European public is virtually unaware of the years of work that have gone into shaping the next stage of European economic integration. If the EU is to accomplish the formidable challenge of transitioning its infrastructure into a sustainable Third Industrial Revolution economy, it will need to make the case in a very public way—especially for the younger generation. In short, EU leaders need to frame the overall narrative that puts all
of the programs and initiatives together into a Third Industrial Revolution growth plan for the next stage of European integration.

Over the past several months, I have met with President Barroso, Chancellor Merkel, Industry Minister Antonio Tajani, and Danish Prime Minister Helle Thorning-Schmidt, among others, and all have expressed a passionate interest in leading the EU and the world into the TIR era. The 2050 Road Map lays out the technical details of transitioning into a TIR infrastructure and requires no additional preparatory work by the European Commission and European Council. What is needed now is a clear and compelling presentation of the Third Industrial Revolution vision to rally public support across Europe.

About the author
Jeremy Rifkin is the author of The New York Times best seller, The Third Industrial Revolution, How Lateral Power is Transforming Energy, the Economy, and the World. Mr. Rifkin is an adviser to the European Union and to heads of state around the world. He is a senior lecturer at the Wharton School’s Executive Education Program at the University of Pennsylvania and the president of the Foundation on Economic Trends in Washington, D.C.
The Third Industrial Revolution: How the Internet, Green Electricity, and 3-D Printing are Ushering in a Sustainable Era of Distributed Capitalism

By Jeremy Rifkin

Our industrial civilization is at a crossroads. Oil and the other fossil fuel energies that make up the industrial way of life are sunsetting, and the technologies made from and propelled by these energies are antiquated. The entire industrial infrastructure built off of fossil fuels is aging and in disrepair. The result is that unemployment is rising to dangerous levels all over the world. Governments, businesses and consumers are awash in debt and living standards are declining everywhere. A record one billion human beings — nearly one seventh of the human race — face hunger and starvation. Worse, climate change from fossil fuel-based industrial activity looms on the horizon, imperiling our own species’ very ability to survive.

Since the beginning of the Great Recession in the summer of 2008, governments, the business community, and civil society have been embroiled in a fierce debate over how to restart the global economy. While austerity measures and fiscal, labor, and market reforms will all be necessary, they are not sufficient to re-grow the economy. Let me explain by way of an anecdote. Just months after arriving in office, the new Chancellor of Germany, Angela Merkel, asked me to come to Berlin to help her administration address the question of how to create new jobs and grow the German economy in the twenty-first century. I began my remarks by asking the chancellor, “How do you grow the German economy, the EU economy, or, for that matter, the global economy, in the last stages of a great energy era and an industrial revolution built on it?”

It is becoming increasingly clear that the Second Industrial Revolution is dying and that industrial induced CO2 emissions are threatening the viability of life on Earth. What we need now is a bold new economic narrative that can take us into a sustainable post-carbon future. Finding that new vision requires an understanding of the technological forces that precipitate the profound transformations in society.

A New Economic Narrative

The great economic revolutions in history occur when new communication technologies converge with new energy systems. New energy revolutions make possible more expansive and integrated trade. Accompanying communication revolutions manage the new complex commercial activities made possible by the new energy flows. In the 19th century, cheap steam powered print technology and the introduction of public schools gave rise to a print-literate work force with the communication skills to manage the increased flow of commercial activity made possible by coal and steam power technology, ushering in the First Industrial Revolution. In the 20th century, centralized electricity...
communication — the telephone, and later radio and television — became the communication medium to manage a more complex and dispersed oil, auto, and suburban era, and the mass consumer culture of the Second Industrial Revolution.

Today, Internet technology and renewable energies are beginning to merge to create a new infrastructure for a Third Industrial Revolution (TIR) that will change the way power is distributed in the 21st century. In the coming era, hundreds of millions of people will produce their own renewable energy in their homes, offices, and factories and share green electricity with each other in an “Energy Internet” just like we now generate and share information online.

The establishment of a Third Industrial Revolution infrastructure will create thousands of new businesses and millions of jobs and lay the basis for a sustainable global economy in the 21st century. However, let me add a cautionary note. Like every other communication and energy infrastructure in history, the various pillars of a Third Industrial Revolution must be laid down simultaneously or the foundation will not hold. That’s because each pillar can only function in relationship to the others. The five pillars of the Third Industrial Revolution are (1) shifting to renewable energy; (2) transforming the building stock of every continent into micro-power plants to collect renewable energies on-site; (3) deploying hydrogen and other storage technologies in every building and throughout the infrastructure to store intermittent energies; (4) using Internet technology to transform the power grid of every continent into an energy internet that acts just like the Internet (when millions of buildings are generating a small amount of renewable energy locally, on-site, they can sell surplus green electricity back to the grid and share it with their continental neighbors); and (5) transitioning the transport fleet to electric plug-in and fuel cell vehicles that can buy and sell green electricity on a smart, continental, interactive power grid.

The creation of a renewable energy regime, loaded by buildings, partially stored in the form of hydrogen, distributed via a green electricity Internet, and connected to plug-in, zero-emission transport, opens the door to a Third Industrial Revolution. The entire system is interactive, integrated, and seamless. When these five pillars come together, they make up an indivisible technological platform—an emergent system whose properties and functions are qualitatively different from the sum of its parts. In other words, the synergies between the pillars create a new economic paradigm that can transform the world.

The public/private financing of the Third Industrial Revolution infrastructure build-out across the world will be at the very top of the agenda for the international banking and financial community in the first half of the 21st century.

### The Shift To Lateral Power

The Third Industrial Revolution is the last of the great Industrial Revolutions and will lay the foundational infrastructure for an emerging collaborative age. Its completion will signal the end of a two-hundred-year commercial saga characterized by industrious thinking, entrepreneurial markets, and mass labor workforces and the beginning of a new era marked by collaborative behavior, social networks and professional and technical workforces. In the coming half century, the conventional, centralized business operations of the First and Second Industrial Revolutions will increasingly be subsumed by the distributed business practices of the Third Industrial Revolution; and the traditional, hierarchical organization of economic and political power will give way to lateral power organized nodally across society.

Lateral power is a new force in the world. Steve Jobs and the other innovators of his generation took us from expensive centralized main-frame computers, owned and controlled by a handful of global companies, to cheap desktop computers and cell phones, allowing billions of people to connect up with one another in peer-to-peer networks in the social spaces of the internet. The democratization of communications has enabled nearly one third of the human population on earth to share music, knowledge, news and social life on an open playing field, marking one of the great evolutionary advances in the history of our species.

But as impressive as this accomplishment is, it is only half of the story. The new, green energy industries are improving performance and reducing costs at an ever accelerating rate. And just as the generation and distribution of information is becoming nearly free, renewable energies will also. The sun, wind, biomass, geothermal heat and hydropower are available to everyone and, like information, are never used up.

When Internet communications manage green energy, every human being on earth becomes his or her own source of power, both literally and figuratively. Billions of human beings sharing their renewable energy laterally on a continental green electricity internet creates the foundation for the democratization of the global economy and a more just society.

### Distributed Capitalism

Energy regimes shape the nature of civilizations—how they are organized, how the fruits of commerce and trade are distributed, how political power is exercised, and how social relations are conducted. To understand how the new Third Industrial Revolution infrastructure is likely to dramatically
change the distribution of economic power in the twenty-first century, it is helpful to step back and examine how the fossil fuel–based First and Second Industrial Revolutions reordered power relations over the course of the nineteenth and twentieth centuries. Fossil fuels—coal, oil, and natural gas—are elite energies for the simple reason that they are found only in select places. They require a significant military investment to secure their access and continual geopolitical management to assure their availability. They also require top down command and control systems and massive concentrations of capital to move them from underground to the end users. The ability to centralize production and distribution—the essence of modern capitalism—is critical to the effective performance of the system as a whole. The centralized energy infrastructure, in turn, sets the conditions for the rest of the economy, encouraging similar business models across every sector.

Virtually all of the other critical industries that emerged from the oil culture—modern finance, telecommunications, automotive, power and utilities, and commercial construction—and that feed off of the fossil fuel spigot were similarly predisposed to bigness in order to achieve their own economies of scale. And, like the oil industry, they require huge sums of capital to operate and are organized in a centralized fashion.

Three of the four largest companies in the world today are oil companies—Royal Dutch Shell, Exxon Mobil, and BP. Underneath these giant energy companies are some five hundred global companies representing every sector and industry—with a combined revenue of $22.5 trillion, which is the equivalent of one-third of the world’s $62 trillion GDP—that are inseparably connected to and dependent on fossil fuels for their very survival.

The emerging Third Industrial Revolution, by contrast, is organized around distributed renewable energies that are found everywhere and are, for the most part, free—sun, wind, hydro, geothermal heat, biomass, and ocean waves and tides. These dispersed energies will be collected at millions of local sites and then bundled and shared with others over a continental green electricity internet to achieve optimum energy levels and maintain a high-performing, sustainable economy. The distributed nature of renewable energies necessitates collaborative rather than hierarchical command and control mechanisms.

This new lateral energy regime establishes the organizational model for the countless economic activities that multiply from it. A more distributed and collaborative industrial revolution, in turn, invariably leads to a more distributed sharing of the wealth generated.

The extraordinary capital costs of owning and operating giant centralized telephone, radio, and television communications technology and fossil fuel and nuclear power plants in markets is giving way to the new “distributed capitalism,” in which the low entry costs in lateral networks make it possible for virtually everyone to become a potential entrepreneur and collaborator, creating and sharing information and energy in open commons. Witness twenty something young men creating Google, Facebook, and other digital manufacturing revolution now allows millions of people to produce their own virtual information and energy, a new digital manufacturing revolution now opens up the possibility of following suit in the production of durable goods. In the new era, everyone can potentially be their own manufacturer as well as their own internet site and power company. The process is called 3-D printing; and although it sounds like science fiction, it is already coming online, and promises to change the entire way we think of industrial production. Think about pushing the print button on your computer and sending a digital file to an inkjet printer, except, with 3-D printing, the machine runs off a three-dimensional product. Using computer aided design, software directs the 3-D printer to build successive layers of the product using powder, molten plastic, or
metals to create the material scaffolding. The 3-D printer can produce multiple copies just like a photocopy machine. All sorts of goods, from jewelry to mobile phones, auto and aircraft parts, medical implants, and batteries are being “printed out” in what is being termed “additive manufacturing,” distinguishing it from the “subtractive manufacturing,” which involves cutting down and pairing off materials and then attaching them together.

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3-D entrepreneurs are particularly bullish about additive manufacturing, because the process requires as little as 10 percent of the raw material expended in traditional manufacturing and uses less energy than conventional factory production, thus greatly reducing the cost.

In the same way that the Internet radically reduced entry costs in generating and disseminating information, giving rise to new businesses like Google and Facebook, additive manufacturing has the potential to greatly reduce the cost of producing hard goods, making entry costs sufficiently lower to encourage hundreds of thousands of mini manufacturers—small and medium size enterprises (SMEs)—to challenge and potentially outcompete the giant manufacturing companies that were at the center of the First and Second Industrial Revolution economies.

Already, a spate of new start-up companies are entering the 3-D printing market with names like Within Technologies, Digital Forming, Shape Ways, Rapid Quality Manufacturing, Stratasys, Bespoke Innovations, 3D Systems, MakerBot Industries, Freedom of Creation, LGM, and Contour Crafting and are determined to reinvent the very idea of manufacturing in the Third Industrial era.

The energy saved at every step of the digital manufacturing process, from reduction in materials used, to less energy expended in making the product, when applied across the global economy, adds up to a qualitative increase in energy efficiency beyond anything imaginable in the First and Second Industrial Revolutions. When the energy used to power the production process is renewable and also generated on site, the full impact of a lateral Third Industrial Revolution becomes strikingly apparent. Since approximately 84 percent of the productivity gains in the manufacturing and service industries are attributable to increases in thermodynamic efficiencies—only 14 percent of productivity gains are the result of capital invested per worker—we begin to grasp the significance of the enormous surge in productivity that will accompany the Third Industrial Revolution and what it will mean for society.

Near Zero Cost Marketing and Logistics
The democratization of manufacturing is being accompanied by the tumbling costs of marketing. Because of the centralized nature of the communication technologies of the first and second industrial revolutions—newspapers, magazines, radio, and television—marketing costs were high and favored giant firms who could afford to devote substantial funds to market their products and services. The internet has transformed marketing from a significant expense to a negligible cost, allowing start-ups and small and medium size enterprises to market their goods and services on internet sites that stretch over virtual space, enabling them to compete and even out compete many of the giant business enterprises of the 21st century.

Consider Etsy, a brash, web start-up company that has taken off in the past seven years. Etsy was founded by a young New York University graduate, Rob Kalin, who made furniture in his apartment. Frustrated that he had no way to connect with potential buyers interested in hand-crafted furniture, Kalin teamed up with a few friends and put up a website designed to bring individual craftsmen of all kinds, from around the world, together with prospective buyers. The site has become a global virtual showroom, where millions of buyers and thousands of sellers from more than fifty countries are connecting, breathing new life into craft production—an art that had largely disappeared with the advent of modern industrial capitalism.

Connecting multitudes of sellers and buyers in virtual space is almost free. By replacing all of the middlemen—from wholesalers to retailers—with a distributed virtual network of sellers and buyers and eliminating the transaction costs that are marked up at every stage in the marketing process, Etsy has created a new global craft bazaar that scales laterally rather than hierarchically, and markets goods collaborative-ly rather than top-down.

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Etsy brings another dimension to the market—the personalization of relationships between seller and buyer. The website hosts chat rooms, coordinates online craft shows, and conducts seminars, allowing sellers and buyers to interact, exchange ideas, customize products, and create social bonds that can last a lifetime. Giant, global companies mass-producing standardized products on assembly lines operated by anonymous workforces can’t compete with the kind of intimate one-to-one relationship between artisan and patron.

Although still in its infancy, Etsy is a quickly growing enterprise. In 2011, Etsy’s sales topped nearly $500 million. In
a recent conversation, Kalin told me that his mission is to help foster “empathic consciousness” in the global economic arena and lay the foundation for a more inclusive society. His vision of connecting up “millions of local living economies that will create a sense of community in the economy again” is the essence of the Third Industrial Revolution model. Etsy is only one of hundreds of global Internet companies that are bringing together producers and consumers in virtual marketing spaces and, in the process, democratizing marketing costs across the global economy.

As the new 3-D technology becomes more widespread, on site, just in time customized manufacturing of products will also reduce logistics costs with the possibility of huge energy savings. The cost of transporting products will plummet in the coming decades because an increasing array of goods will be produced locally in thousands of micro-manufacturing plants and transported regionally by trucks powered by green electricity and hydrogen generated on site.

The lateral scaling of the Third Industrial Revolution allows small and medium size enterprises to flourish. Still, global companies will not disappear. Rather, they will increasingly metamorphose into primary producers and distributors to aggregators. In the new economic era, their role will be to coordinate and manage the multiple networks that move commerce and trade across the value chain.

New Business Models and Jobs in the 21st Century

Germany is leading the way into the new economic era. The Federal Government has teamed up with six regions across Germany to test the introduction of an energy internet that will allow tens of thousands of German businesses and millions of home owners to collect renewable energies on site, store them in the form of hydrogen, and share green electricity across Germany in a smart energy internet. Entire communities are transforming their commercial and residential buildings into green micro-power plants. To date, more than 1 million buildings in Germany have been converted into partial green micro power plants. Companies like Siemens, Bosch and Daimler are creating sophisticated new IT software, hardware, appliances and vehicles, that will merge distributed Internet communication with distributed energy, to create smart buildings, infrastructure, and green mobility for the cities of the future.

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The transition to the Third Industrial Revolution will require a wholesale reconfiguration of the entire economic infrastructure of each country, creating millions of jobs and countless new goods and services. Nations will need to invest in renewable energy technology on a massive scale; convert millions of buildings into green micro power plants; embed hydrogen and other storage technology throughout the national infrastructure; lay down a green energy internet; and transform the automobile from the internal combustion engine to electric plug-in and fuel cell cars.

The remaking of each nation’s infrastructure and the retooling of industries is going to require a massive retraining of workers on a scale matching the professional and vocational training at the onset of the First and Second Industrial Revolutions. The new high tech workforce of the Third Industrial Revolution will need to be skilled in renewable energy technologies, green construction, IT and embedded computing, nanotechnology, sustainable chemistry, fuel cell development, digital power grid management, hybrid electric and hydrogen-powered transport and hundreds of other technical fields.

Entrepreneurs and managers will need to be educated to take advantage of cutting edge business models, including distributed and collaborative research and development strategies, open source and networked commerce, performance contracting, shared savings agreements, and sustainable low-carbon logistics and supply chain management. The skill levels and managerial styles of the Third Industrial Revolution workforce will be qualitatively different from those of the workforce of the Second Industrial Revolution.

The lateral scaling of the Third Industrial Revolution shifts the fulcrum of power from centralized global companies to distributed small and medium size enterprise networks. The rapid decline in transaction costs brought on by The Third Industrial Revolution are leading to the democratization of information, energy, manufacturing, marketing, and logistics, and the ushering in of a new era of distributed capitalism that is likely to change the very way we think of commercial life. The Third Industrial Revolution offers the hope that we can arrive at a sustainable post-carbon era by mid-century. We have the science, the technology, and the game plan to make it happen. Now it is a question of whether we will recognize the economic possibilities that lie ahead and muster the will to get there in time.

About the author

Jeremy Rifkin is the author of _The New York Times_ best selling book, _The Third Industrial Revolution, How Lateral Power is Transforming Energy, the Economy, and the World_. Mr. Rifkin is an adviser to the European Union and to heads of state around the world. He is a senior lecturer at the Wharton School’s Executive Education Program at the University of Pennsylvania and the president of the Foundation on Economic Trends in Washington, D.C.