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The Accelerating Transition

The energy economy that is now powered largely by coal and oil will be powered increasingly by solar and wind energy. During the last century the world relied heavily on coal mines and oil fields. This century is witnessing a shift to renewable energy.

Several forces are converging to advance this great transition. Economically, it is being driven by the falling costs of renewables. Technologically, it will be fostered by the ability to run vehicles on electrons instead of hydrocarbons. Socially, there is strong and growing public opposition to coal and nuclear power. And geologically, there are increasing limitations on the easy extraction of carbon-rich fossil fuels from the ground. These forces, coupled with limits on how much carbon the atmosphere can hold without the planet warming into a dangerously erratic climate regime, are presenting a challenge unlike any civilization has faced before.

The transition has many players. They include environmental groups, leading universities, forward-looking corporations and governments, and a committed collection of savvy investors. We are all stakeholders. In the

broadest sense, everyone who breathes cleaner air, drinks cleaner water, and benefits from a more stable climate will come out on top as the energy transition proceeds.

Rapid change is becoming a way of life. The very geography of the energy economy is changing. In the old one, the world was heavily dependent on oil, much of it concentrated in a few countries in the Middle East. For many importing countries, energy supplies were half a world away.

This century, as the world shifts to solar and wind, the energy economy is localizing. Our power source can be as close as the roofs over our heads. Instead of a small group of corporations and countries producing and controlling most of the world's energy, people everywhere will be in the energy business, meeting their own energy needs with solar panels.

Like any major transition from one era to another, there will be winners and losers. From a business vantage point, the companies that manufacture and install solar panels and wind turbines are expanding rapidly. For example, the market for solar panels is growing at a staggering 50 percent a year. As photovoltaic (PV) prices continue to fall, electricity markets are being turned upside down. In more and more places, electricity from solar panels is beating the average grid cost of electricity—and even coming in at half the cost or less. Old energy sources like coal are starting to lose out. As Amory Lovins of the Rocky Mountain Institute puts it, "Ordering new coal plants in the face of renewable mandates and emerging carbon trading is akin to buying up carriage-makers just as automobiles began to relieve London's horse-manure crisis."

The great transition involves changes within cities. This will mean a shift away from the near-total dependence on car ownership that dominated life in industrial countries over the last century, particularly in the United

States. The focus instead will move to car sharing, bike sharing, and walkable communities. Smart urban transport planning everywhere will focus on people instead of automobiles, systematically expanding not only the use of buses, subways, and commuter rail but also bike lanes, sidewalks, and bike and pedestrian trails.

As the need for cars diminishes and the world automotive industry shifts from internal combustion engines to electric motors that are three times more efficient, the market for oil will shrink. The pipelines that once linked oil fields with refineries will one day be worthless. Oil refineries will dwindle as the older, less-efficient ones are closed first. The corner gas station will be replaced by a battery recharging station for electric cars.

Government policies are still an important component of the energy transition. Governments have used several basic policy instruments to support the move to carbon-free renewable sources of energy. One is the feed-in tariff (FIT), which typically guarantees renewable energy producers—from rooftop solar owners to large-scale wind farm operators—grid access and a long-term purchase price for their electricity. By the start of 2014, some 70 countries, including many in Europe, were using FITs to encourage investment in renewables. In India, there are 14 state-level FITs in addition to a national one. Gujarat's feed-in policy, a prime component of its broader Solar Power Policy that went into effect in 2009, has helped crown it as India's leading solar state—with enough PV capacity as of early 2014 to power 825,000 Gujarti homes.

Another government measure is to mandate that a certain amount of electricity generation be from renewable sources. Called renewable portfolio standards (RPS) or quotas, these policies are in place at the national level in some two dozen countries. More than 50 states and

provinces in various parts of the world have them as well, including 15 states in India and 29 states plus the District of Columbia in the United States. Iowa, which now gets more than 25 percent of its electricity from the wind, in 1983 enacted the first RPS anywhere in the world.

RPS policies in the United States generally require utilities to get anywhere from 10 percent to 40 percent of the electricity they sell from renewable sources, with California and Hawaii at the upper end of that range. In his early 2015 inaugural address, Governor Jerry Brown proposed that California strive to increase its renewables mandate from 33 percent by 2020 to 50 percent by 2030.

Tax credits are also used to support deployment of wind and solar power. U.S. wind power installations historically have soared in years when there was a wind energy production tax credit of a couple of cents per kilowatt-hour—and plummeted when Congress allowed the tax credit to lapse. And for solar power, an investment tax credit worth 30 percent of the installed cost of a residential or commercial rooftop system has helped spur the recent rapid spread of PV. Some 36 other countries also have national production or investment tax credits for renewable energy.

Such pro-renewables policies help level the playing field with artificially cheap fossil fuels that have been subsidized long past their debuts on the energy scene. The energy transition would be supercharged by systematically putting a price on carbon to convey more accurately the true social and environmental costs of burning coal, oil, and natural gas.

Done right, pricing carbon sends a powerful market signal and guides decisionmakers toward more-sustainable choices. Imagine the effect of incorporating fossil fuels' full costs to society in fuel prices. From the marring of landscapes to water and air pollution and climate

change, we know that fossil fuel reliance is extraordinarily costly.

Putting a price on carbon can involve implementing a carbon tax, a cap-and-trade system, or a combination of the two. With cap-and-trade programs, regulators set a limit on emissions, and polluters can either reduce their emissions or buy emissions permits on the carbon market. The market sets the price.

A carbon tax, in contrast, is a far simpler instrument: a tax on each ton of carbon dioxide emitted. It could be applied at the wellhead or mine or at the point where fossil fuels are processed or used. Revenue from a carbon tax can go toward environmental, clean energy, or efficiency programs, can be offset by a reduction in taxes on labor, or can be returned to consumers directly via a dividend. A means of returning money to people helps ensure that most families, particularly lower-income ones, end up better off financially with the carbon tax than they were before.

Carbon taxes are widely endorsed by economists as a way to correct a market failure. N. Gregory Mankiw, who was Chairman of the Council of Economic Advisors under George W. Bush, writes that "cutting income taxes while increasing gasoline taxes would lead to more rapid economic growth, less traffic congestion, safer roads, and reduced risk of global warming—all without jeopardizing long-term fiscal solvency. This may be the closest thing to a free lunch that economics has to offer." Writing in the *Financial Times* in early 2015, former U.S. Treasury Secretary Lawrence Summers advocates a carbon tax in the United States, starting at $25 per ton of carbon dioxide (CO_2) (about 25¢ per gallon of gasoline), with revenue split between infrastructure improvements and labor tax credits.

Some 40 countries have either implemented or are planning national carbon pricing mechanisms, according

to a May 2014 World Bank report. They typically target one or more economic sectors; the power and industrial sectors are nearly always included. The Bank counted a further 23 subnational jurisdictions pricing carbon. Seven regional cap-and-trade pilot programs are already under way in China, for example. When China rolls out its planned national cap-and-trade program in 2016, roughly a quarter of global carbon emissions will then be priced.

Critics often warn that carbon taxes and cap-and-trade systems will be an economic burden, but examples to the contrary abound. Ireland set a carbon tax on natural gas and oil consumption in 2010, covering roughly 40 percent of national greenhouse gas emissions. By 2013, emissions had dropped by some 6 percent, even as the economy grew. In May of that year, Ireland expanded its carbon pricing to include peat and coal. Former Energy Minister Eamon Ryan summed up the situation: "We just set up a price signal that raised significant revenue and changed behavior. Now, we're smashing through the environmental targets we set for ourselves."

The province of British Columbia in Canada implemented an economy-wide carbon tax of $10 per ton of CO_2 in 2008, rising to $30 per ton by 2012. By design, the tax is revenue-neutral: cuts in other taxes, such as income and business taxes, offset the rise in fossil fuel prices. Since the carbon tax went into effect, British Columbia's per person consumption of gasoline and other petroleum products has declined 15 percent—three times the national rate—while its economic growth has kept pace with the rest of the country.

In the United States, data through 2013 show that the nine northeastern and mid-Atlantic states belonging to the Regional Greenhouse Gas Initiative (RGGI) cap-and-trade program reduced their power sector emissions

18 percent since the system was launched in 2009. Over the same period their collective economic growth outpaced the other 41 states, where emissions fell just 4 percent. If the RGGI states continue to spend most of the revenue from pollution permit auctions on efficiency measures, they could reap a net economic benefit of $8 billion by 2020.

Indeed, investing in energy efficiency is generally a good economic bet. While it is exciting that wind and solar power are increasingly cost-competitive with fossil fuels and nuclear power, it is generally cheaper to invest in energy efficiency than to build new generating capacity. The International Energy Agency reports that in 2011, efficiency gains since the 1970s in 11 of its member nations—including Australia, Japan, Germany, and the United States—saved those countries more than $740 billion in avoided energy costs.

There is an enormous potential to reap substantial energy savings in each of the major energy-consuming sectors: lighting, buildings, appliances, industry, and transportation. For example, about 20 percent of global electricity consumption goes to lighting. If all the world's lightbulbs were switched from traditional incandescents to compact fluorescents, which use 75 percent less electricity, some 270 coal-fired power plants could shut down. This shift is already starting. Going further, replacing incandescents with LEDs (light-emitting diodes) can reduce electricity use by up to 90 percent. For perspective, replacing a single 100-watt incandescent bulb with an LED can save enough energy over the bulb's lifetime to drive a Toyota Prius hybrid-electric car from New York to San Francisco.

The world's most dynamic system for upgrading efficiency standards is Japan's Top Runner Program. In this system, which was introduced in 1999, the most efficient

products marketed today set the standard for those sold in the future. Companies have 3–10 years to comply once a new standard is set. Depending on the technology, products have seen efficiency improvements of anywhere from 22 percent to 99 percent. Between 2005 and 2010, for example, refrigerators sold in Japan became 43 percent more energy-efficient. As of late 2014, some 30 product categories were subject to Top Runner standards, including air conditioners, computers, household appliances, industrial motors, lighting, and even light-duty cars and trucks. With the Top Runner Program continuing a decades-old commitment to energy efficiency in Japan, it is no wonder that consumers the world over associate Japanese automotive, appliance, and electronics brands with efficiency.

Some national governments are planning major changes to reduce fossil fuel use. India, for instance, wants to replace 26 million rather inefficient diesel- or grid-powered irrigation pumps with solar-powered pumps, potentially saving the government billions of dollars in fuel and electricity subsidies. The plan would require farmers to switch to highly efficient drip irrigation systems to qualify for the program, meaning that both fossil fuel and water use would drop. It is expected that these pumps will pay for themselves in one to four years. This massive prospective shift to carbon-free and water-efficient irrigation pumping is yet another building block in the new world energy economy.

The Indian government is also prodding several state-owned companies, including some in the fossil fuel and hydropower industries, to invest in solar power projects. Deploying large amounts of solar capacity will further reduce the cost of solar power through economies of scale. One of these companies, Coal India, which mines more coal than any other firm in the world, committed in

late 2014 to set up 1,000 megawatts of solar projects in Andhra Pradesh, Telangana, and elsewhere. The agreement was signed with another state-owned firm, Solar Energy Corporation of India, which will build, operate, and maintain the plants.

Even oil-exporting Saudi Arabia, a desert country of 29 million people, is planning to harness its wealth of solar radiation in a big way. If the 41,000 megawatts of PV and solar thermal power plants that are operating, under construction, and planned were online today, Saudi Arabia could generate up to two thirds of its electricity from the sun.

Some European leaders in the energy transition are looking to go even further. Denmark, getting 39 percent of its electricity from the wind as of 2014, aims to bring this share to 50 percent by 2020. By 2035 all electricity and heat in that country should come from renewable sources. And by 2050 the goal is for all energy, including that used for transportation, to be renewable. In Scotland, a net exporter of electricity, renewable sources account for some 30 percent of electricity generation. The target for 2020 is for renewables to generate the equivalent of 100 percent of Scotland's electricity usage.

Ireland, now generating 17 percent of its electricity from wind, plans to get 42 percent from renewable sources by 2020, mostly wind power. Europe's largest economy, Germany, plans to increase its renewable electricity share from some 25 percent in 2013 to at least 40 percent in 2025. By 2050, Germany wants this to reach 80 percent.

Many cities are establishing their own ambitious goals for renewables—setting an example for national governments to move more boldly to phase out fossil fuels. San Francisco, for example, plans to get all its electricity from renewables by 2020 while it also moves to a zero-waste

economy. Wellington, New Zealand, wants to get at least 78 percent of its electricity from renewables by that year. Munich, Germany, is aiming for 100 percent by 2025. Paris is planning to meet 25 percent of its total energy demand with renewables by 2020.

States are also propelling the energy transition. In Germany, four states now get half or more of their electricity from wind energy. Within the United States, Texas, California, Iowa, and South Dakota are providing wind power leadership. Japan's Fukushima prefecture, still recovering from the 2011 nuclear meltdown, has pledged to get 100 percent of its electricity and heat from renewables by 2040, partly by developing 1,000 megawatts of offshore wind capacity.

As of mid-2014, three provinces and three major cities in China have voluntarily committed themselves to reversing history by substantially reducing coal consumption by 2017. These include a 19 percent drop for Tianjin, 21 percent for Chongqing, and 50 percent for Beijing. These cuts could help China achieve its national goal of capping coal use by 2020 even sooner than that.

Although the planned reduction in coal use in China is both huge and unprecedented, the shift has rather obvious origins: the sheer effect of air pollution. For many—including the elderly, small children, and those with respiratory and cardiac illnesses—the pollution is so intense that breathing is literally life-threatening. Beijing has suffered through several major instances when pollution levels soared well beyond the margin of safety, termed "airpocalypses" by the media. As data on air pollution have become more widely available on the Internet, pressure for reducing coal use has intensified. Greenpeace China sums it up: "Citizens have started to demand a quality of life that cannot be measured in money—cleaner air and a healthier future for their kids. How long it will

take to achieve truly clean skies in Chinese cities will be influenced by these agents of change."

Tired of living in cities where breathing is dangerous, people from all walks of life in China are demanding change on the energy front. China is now also getting a wakeup call from the market. New regulations designed both to improve air quality and stabilize climate are making it more difficult for coal burning to continue in a business-as-usual fashion. The *South China Morning Post* reported in July 2014 that financial bonds tied to China's coal mining industry were facing the prospect of default as coal use slows down.

Some banks are waking up to the fact that getting involved in the energy transition can yield strong returns. Large investment institutions, such as Morgan Stanley and Goldman Sachs, are channeling tens of billions of dollars into renewable energy. Stuart Bernstein, who coordinates Goldman's investment in this area, talks about "a transformational moment in time" as renewable energy takes off. Thinking long-term by investing in the transition to a cleaner energy future, he says, "will be important from a societal perspective, and it will be good business for us and our clients."

The commitment of several billionaires to carbon-free energy is a promising driver of the energy transition. Warren Buffett, the wealthiest member of this group, had invested some $15 billion in the development of solar and wind energy by early 2014. This includes a giant solar complex in California that will be the world's largest when completed in 2015. In June 2014, Buffett announced, "There's another $15 billion ready to go." Also investing in energy from the sun is Ted Turner, who has teamed up with Southern Power—a subsidiary of the coal-heavy energy firm Southern Company—to acquire seven solar power plants. Turner is also looking at the potential for investing in wind.

Denver-based Philip Anschutz, who made billions in oil and gas, is committed to the construction of a 3,000-megawatt wind farm in south-central Wyoming and also to building a transmission line that will carry wind-generated electricity over 700 miles to California, Arizona, and Nevada. For wind developers in Wyoming, a state with a wealth of wind resources but only 580,000 people, California's 38 million residents represent a very attractive market.

Michael Bloomberg, one of the most successful entrepreneurs of his generation and a former three-term mayor of New York City, is also helping speed the transition. His $50 million donation to the Sierra Club's Beyond Coal campaign in 2011 has strengthened efforts to close coal-fired power plants. But perhaps even more important than the money itself was the symbolic statement it made, given Bloomberg's status in the business world. When Michael Bloomberg says coal must go, people listen.

Bloomberg, an independent, also teamed up with fellow billionaire Tom Steyer, a Democrat, and Republican Hank Paulson, former Secretary of the Treasury under George W. Bush, to chair a project called Risky Business that is designed to quantify the economic risks associated with a changing climate. Steyer, a former hedge fund manager turned climate activist, has launched a nationwide climate education campaign in hopes of countering the people who deny that the climate is changing, and thus help mobilize support for an all-out effort to switch to carbon-free renewable energy.

Businesses turning to renewable energy are reaping savings. A number of leading corporations are lowering their electric bills with emissions-free on-site solar power. In 2014, telecom giant Verizon installed solar PV systems totaling 10 megawatts across eight of its facilities in California, Maryland, Massachusetts, New Jersey, and New

York. This $40 million investment nearly doubled the solar power capacity the company had installed since it launched an on-site energy program in 2013.

Walmart, America's largest retailer, is also pressing ahead. By late 2014 it had installed roughly 260 solar power systems on its U.S. buildings, each one generating 10–30 percent of the facility's electricity supply. The company's goal is to install up to 400 more PV systems at its U.S. facilities over the next four years. In May 2014, CEO Bill Simon described Walmart's move to go solar: "It's a business decision. The renewable energy we buy meets or beats prices from the grid." By taking its renewable energy and energy efficiency goals to its global operations, Walmart estimates that it will reap $1 billion per year in energy savings by 2020.

Each quarter, the U.S. Environmental Protection Agency (EPA) releases a ranking of companies, schools, and municipalities using green power. In late 2014, the top five firms were Intel, Kohl's Department Stores, Microsoft, Google, and Walmart. Intel, Kohl's, Staples, and Unilever were among the 600 entities that generated or purchased enough electricity from renewable sources to satisfy all of their electricity needs. Apple was not far behind, at more than 90 percent.

One of Google's most recent renewable energy investments, an 82-megawatt solar PV array in southern California, provides some powerful imagery of the energy transition. The solar project is being installed on an abandoned oil and gas field, where production had declined precipitously and was no longer profitable. So instead of creaking derricks pumping a dwindling supply of oil, this 700-acre site will soon feature solar panels silently turning the sun's energy into carbon-free electricity.

Among the large industrial companies increasing their use of renewable energy is the aerospace giant Boeing.

Almost half of the electricity it uses across its operations now comes from renewable sources, including hydropower. At Boeing's facility in North Charleston, South Carolina, renewables provide 100 percent of the electricity needed, either from the 10-acre rooftop PV array on an aircraft assembly building or from purchased renewable energy certificates.

Another large firm using renewables is the global building efficiency and automotive technology company Johnson Controls. Close to 20 percent of its electricity comes from renewable sources. The company is also shifting its vehicle fleet to more-efficient hybrids and electric vehicles. By 2013, it was saving $1.4 million per year in fuel costs.

The EPA also publishes a list of companies and institutions that sign long-term contracts for renewably generated electricity. Many are specifically for wind-generated electricity. A major benefit of these purchase agreements is that a company can get a guaranteed low price. Among the entities keen to buy green power are Google, with two 20-year contracts totaling a stunning 720 million kilowatt-hours per year, sourced from wind farms in Iowa and Oklahoma, and the state government of Illinois, with a 10-year contract for roughly 50 million kilowatt-hours per year.

The University of Oklahoma, which sees itself as a leader in the energy transition, buys enough renewably generated electricity to satisfy three fourths of its needs. This facilitated the construction of the 101-megawatt OU Spirit Wind Farm near Woodward, Oklahoma. And Oklahoma State University is now getting 71 percent of its electricity from wind farms. To the east, Ohio State University, one of the largest U.S. universities, gets 23 percent of its electricity from green sources. Its goal, an ambitious one, is to become a carbon-neutral campus.

Aside from shaping the needed policies, governments are also huge energy consumers themselves. The U.S. government occupies nearly 500,000 buildings of various sizes and has almost 600,000 vehicles. Because it is far and away the country's—not to mention the world's—largest consumer, spending some $500 billion per year for goods and services, it can use its purchasing power to accelerate the energy transition. Various regulations require its buildings, vehicle fleets, and electronics purchases to meet certain efficiency standards. Besides saving energy, this also saves taxpayer money.

In December 2013, President Barack Obama announced that the federal government would require that 20 percent of the electricity it uses come from renewable sources by 2020. This is a near tripling of the earlier goal of 7.5 percent. In an earlier address to Congress, Obama acknowledged the economic and geopolitical importance of the energy transition: "The country that harnesses the power of clean, renewable energy will lead the 21st century. And yet, it is China that has launched the largest effort in history to make their economy energy efficient. We invented solar technology, but we've fallen behind countries like Germany and Japan in producing it. New plug-in hybrids roll off our assembly lines, but they will run on batteries made in Korea."

The U.S. government is also moving the market by requiring increases in fuel efficiency for all vehicle manufacturers. In 2013, the average new car got 24 miles per gallon. By law, this will rise to 54 miles per gallon in 2025, a doubling in 12 years. Part of the fuel economy improvement will come from having more hybrid-electric or all-electric vehicles (EVs) for sale. Further helping to facilitate the transition to cars that run on electricity, the United States is offering, among other incentives, a federal tax credit of up to $7,500 to encourage the purchase

of electric vehicles and plug-in hybrid electric vehicles (PHEVs). Additional tax credits in some states take that benefit even higher.

China, which got off to a slow start with electric cars, is now planning a major push. In 2013, its sales of all-electric cars totaled a meager 14,600 and the figure for plug-in hybrids was only 3,000. But with at least a dozen new electric car models coming to market in the next several years, China is expecting a huge jump in sales.

In Norway, the world leader in promoting electric vehicles, EV sales topped 6 percent of all car sales in 2013. In the Netherlands, where the government gives a 10–12 percent tax break for electric vehicle purchases and supports more than 400 charging stations, the figure was 4 percent. France uses fees on inefficient vehicles to fund rebates for electric vehicles. It will soon have 200 new charging stations along its highways as part of a European Union–supported pilot project.

Ultimately EVs and PHEVs will challenge the dominance of traditional gasoline- and diesel-powered vehicles, and this may happen sooner than most people realize. The global financial services firm UBS projects that by 2020 battery costs will be slashed in half, making electric vehicles cost-competitive with traditional cars. With annual savings of up to $2,400 expected on fuel costs, the electric car becomes the obvious choice.

Improving economics for solar power could also factor into the future of electric vehicles. As costs come down for both battery storage and home solar systems, UBS expects that in much of Europe the combination of rooftop solar power, battery storage, and electric vehicles will be extraordinarily attractive to the average customer. By 2020, the investment will pay for itself within six to eight years, after which electricity for home use and car charging is essentially free for the solar system's remain-

ing lifespan, a dozen years or more. UBS forecasts conservatively that as it becomes easier to "fill up" with solar energy, 1 in every 10 new cars registered in Europe will be all-electric a decade from now.

The energy transition is also being assisted by a vigorous divestment campaign directed at coal, oil, and natural gas companies. This campaign, which originated with Bill McKibben and the group he co-founded, 350.org, has helped open a major new front in the effort to phase out fossil fuels. It found fertile soil on college campuses. Focusing initially on university endowments, it has expanded to include pension funds and individual investment portfolios. Increasingly, fund managers are being urged to sell stocks in coal, oil, and natural gas companies and to invest in the energy sources of the future.

As the public mood regarding our energy future changes, companies involved in the coal, oil, and gas industries will carry a stigma. Just as tobacco firms were stigmatized a generation ago because of the health-damaging effects of smoking cigarettes, fossil fuel companies will suffer because of their role in disrupting the earth's climate. While the anti-tobacco campaign focused on personal health, this one is tied directly to the future of civilization itself.

The energy transition amounts to a massive restructuring of the global economy. Initially this energy transition was driven by government incentives, but now it is also being driven by the market. With the market today favoring both solar and wind energy in many locations, the transition is accelerating, moving much faster than anticipated.

The recent growth of renewable energy generation in an expanding group of countries makes it clear that solar and wind energy are no longer fringe energy sources. If Denmark can get over half of its electricity from wind for

an entire month, other wind-rich places can do the same. When wind eclipses coal on some days in the United Kingdom, we get yet another glimpse of what is possible. And when the electricity from wind farms overtakes that from nuclear power plants, as it has done in China, it becomes clear that wind is a mainstream source of energy.

Power systems everywhere will look different. They will be made up of millions of solar panels, in many cases tied into a smart and flexible grid getting power from wind turbines as well as from geothermal and hydroelectric projects. In one sense, developing countries have an advantage because they can take a shortcut to the new energy economy, building it as they develop. Just as they bypassed the need to install telephone wires and poles when they turned directly to cell phones, they can avoid the need for an electric grid by going directly to rooftop solar panels.

The biggest question facing civilization is, Will the energy transition proceed fast enough for the world to avoid catastrophic climate change? No one can say with certainty. Only time will tell. But exciting change is afoot. The industrial revolution set the stage for disrupting the earth's climate. This new energy revolution is setting the stage for stabilizing it. Ambitious renewable energy targets are being surpassed years ahead of schedule. National wind and solar power production records are routinely being shattered. As victories in shuttering coal plants mount, as new clean energy systems are built, and as transportation systems are electrified, a tipping point could be near.

The energy transition will change not only how we view the world but also how we view ourselves. With rooftop solar panels to both power homes and recharge car batteries, there will be a degree of personal energy independence not known for generations. Our relation-

ship with the natural world will change from one where we are in conflict with nature to one where we are more in sync with it. Coal plant smokestacks that dirty the air and alter the climate will be replaced by solar panels on our rooftops and wind turbines turning gracefully in the distance. Welcome to the clean energy era.

Data, endnotes, and additional resources can be found at Earth Policy Institute, www.earth-policy.org.