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Special Report

Making the Transition to a Low-carbon Economy

INTRODUCTION

Making the Transition to a Low-carbon Economy

Keeping climate change within manageable bounds will take a massive global effort, requiring the skills and resources of both public and private sectors. Whether or not we collectively can summon the will to succeed remains an open question. What is not open to debate is the critical need to answer two key questions: Do we have the technology to make the transition, and can we find a way to pay for it?

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Global power demand is increasing, which presents a challenge as the world seeks to switch to clean energy sources. There are significant hurdles, including the intermittent nature of renewables, high cost and siting problems. For many, the ultimate goal is replacing fossil fuels with 100% renewable energy, and plans to get us there are emerging. Nobody believes it will be either an easy or a quick transition, but many think it's possible.

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Uncertainty abounds as experts try to put price tags on various paths to a sustainable future. Calculations have to include both the investments needed and the potential paybacks, and factor in how technology improvements and increasing scale will affect future costs. By any accounting, the ultimate price tag is daunting, but maintaining the status quo incurs even greater costs, for the world economy and the environment.

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Increasingly, the public sector is looking to private investment to help fund the transition to a low-carbon economy. New financial instruments and strategies are being developed to tap growing market demand, allowing institutional and retail investors to do well by doing right by the environment.

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Can the World Run on Renewable Energy?

WITHOUT DOUBT, RENEWABLE ENERGY IS ON A ROLL. Denmark is producing 43% of its energy from renewables, and it aims for 70% by 2020. Germany, at more than 25% now and 30% soon, is going for 40% to 45% clean power by 2025, 55% to 60% by 2035, and an incredible 80% by 2050. China, despite many challenges, is the world's leading source of renewable investment, as well as the largest solar manufacturer.

The United States, with about 13% renewable energy generation, has some catching up to do, though California (where some developers are incorporating solar into every house they build) points the way forward. The Solar Energy Industries Association reports that the solar market in the U.S. grew by 41% in 2013, and that it made up 20% of all new generating capacity in that year.

Both solar and wind are making strides. A global Bloomberg survey predicted that solar will grow more than 20% internationally in 2014 (as it did between 2012 and 2013). And the Global Wind Energy Council projects that 2014 will be a very good year internationally for wind as well, with dramatic increases over 2013 and at least 47 gigawatts of wind installed around the world.

ROOM FOR GROWTH

But all this positive movement could obscure the fact that renewable energy is still a very small part of the mix both in the U.S. and globally. The big percentage increases start from a small base (even with its rapid growth, solar is still less than 1% of generation in the U.S., and the official consensus is that the world will run on fossil fuel energy for the foreseeable future). The International Energy Agency's "World Energy Outlook 2013" reports, "Today's share of fossil fuels in the global mix, at 82%, is the same as it was 25 years ago; the strong rise of renewables only reduces this to around 75% in 2035."

Business as usual is also predicted for the U.S. The U.S. Energy Information Administration (EIA) does envision a gradual emissions reduction through energy-efficiency and the use of renewables. The agency said, "Improved efficiency of energy use in the residential and transportation sectors and a shift away from more carbon-intensive fuels such as coal for electricity generation help to stabilize U.S. energy-related carbon dioxide (CO2) emissions." But the agency's projections of electricity generation by fuel to 2040 still show overwhelming dominance by natural gas, nuclear energy and coal. At the most, renewable energy could achieve parity with nuclear power, but remain well below the agency's projections for natural gas and coal. Today's low oil prices are another challenge to the rise of renewables.

> **"Renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050."**
>
> —National Renewable Energy Lab (NREL)

WHAT'S THEORETICALLY POSSIBLE

According to Sarbjit Nahal, head of thematic investing in the global strategy division of Bank of America Merrill Lynch, and Beijia Ma, a principal in the group, significant changes are needed to advance renewable sources of energy. The UN's Intergovernmental Panel on Climate Change (IPCC) said in a late 2014 report, "Continued

emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts." Because of a 40% increase in demand in energy by 2035, they say, we're "on a carbon dioxide (CO2) emissions trajectory consistent with global temperature increases of two to 4.5 degrees Centigrade, making irreversible climate change a reality."

They're hardly alone in this assessment. "A new world energy economy is emerging," said Lester Brown, president of Earth Policy Institute. "Our civilization needs to embrace renewable energy on a scale and at a pace we've never seen before."

And it's at least theoretically possible. A study by the National Renewable Energy Lab (NREL) concluded, "Renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the country."

Uncertainty resulting from intermittent renewables can be reduced by ramping up grid interconnections, enabling load sharing.

— Abyd Karmali

Under a rapid expansion program, the world could have nearly five million megawatts of wind power by 2020, Brown said. He added, "Combined with an ambitious solar and geothermal expansion, along with new hydro projects in the pipeline, this would total 7.5 million megawatts of renewable generating capacity, enabling us to back out all the coal and oil and most of the natural gas now used to generate electricity."

Mark Jacobson, a civil and environmental engineering professor at Stanford, and Mark Delucchi, a research scientist at the University of California, Davis's Institute of Transportation Studies, have devised an ambitious scenario for a renewable energy takeover. "Our plan calls for millions of wind turbines, water machines and solar installations," they wrote in *Scientific American*. "The numbers are large, but the scale is not an insurmountable hurdle; society has achieved massive transformations before."

Specifically, their global plan imagines 3.8 million large wind turbines, 90,000 utility-scale solar plants, 490,000 tidal turbines, 5,350 geothermal installations and 900 hydroelectric plants. They estimate that the cost of generating power with this network would be less per kilowatt-hour than generating it with fossil fuels or nuclear power.

Other plans concur. "It is technically possible to achieve almost 100% renewable energy sources within the next four decades," concludes the World Wildlife Federation's (WWF) 2011 Energy Report, which sees wind, solar, biomass and hydropower as the future major players. "Energy derived from the sun, the wind, the earth's heat, water and the sea has the potential to meet the world's electricity needs many times over, even allowing for fluctuations in supply and demand."

The WWF report estimates that a million onshore and 100,000 offshore wind turbines could meet a quarter of the world's energy demand by 2050.

MOVING PAST COAL

Experts believe that to keep global temperatures from rising more than two degrees Celsius from pre-industrial levels, a goal of the Copenhagen Accord, the world's energy emissions have to peak by 2020 and then quickly decline, reaching near-zero by approximately 2050.

One of the often-cited obstacles to achieving this goal is the world's reliance on coal for both power and jobs. According to Charles Mann in *The Atlantic*, coal causes 25% more emissions than oil globally, but cleaning up the sector may not be as difficult as it first appears. Forty percent of the world's climate emissions come from just 7,000 coal plants. And coal attrition is already happening. The Energy Information Administration reports that the combination of lower-cost natural gas and strong EPA standards for power plants is taking a toll. Not a single coal plant was opened in the U.S. in the first half of the year, and coal was only 39% of U.S. electricity generation in 2013, compared to more than 50% in 2004. The EIA reports that a big flurry of coal closings is expected by 2016.

The ongoing decline in coal has already lowered employment in the U.S. industry, lessening fears that a low-carbon future will kill jobs. So too has increased efficiency. Due in part to widespread mountaintop removal mining, which employs far fewer workers than underground mining, U.S. coalfield employment has slipped from more than 280,000 jobs in 1978 to less than 100,000 today—even as coal production increased in the same period to nearly a billion tons.

The global picture is complex. Although coal production internationally is still increasing robustly, and the International Energy Agency sees demand growth of 2.1%

annually through 2019, employment — at seven million jobs worldwide — has seen some losses. According to the Worldwatch Institute's Vital Signs, "Many hundreds of thousands of coal mining jobs have been shed in China, the United States, Germany, the United Kingdom and South Africa during the last couple of decades, sometimes in the face of escalating production."

Renewable power is already helping to compensate for coal industry job loss, with the Solar Foundation reporting 142,698 jobs in that industry in 2013, up nearly 20% from 2012. Global wind power could employ 2.1 million in 2030, at which time solar photovoltaics could have created another 6.3 million jobs.

Worldwide renewable energy employs 2.3 million people, either directly or in feeder industries, in part, says NREL's "Dollars and Sense" report, because the technology is labor-intensive (more jobs per dollar invested than conventional electric power). Overall, the Center for American Progress (CAP) estimates that making a 40% cut in greenhouse gas from 2005 levels by 2035 would create 4.2 million overall jobs, with 2.7 million net when "estimated contractions in fossil fuel sectors" are factored in. CAP said the overall effect would be a 1.5% reduction in the unemployment rate.

Despite reductions in coal use and projected increases in clean-energy employment, China's reliance on coal remains a formidable obstacle. Coal produces 70% of China's energy, and almost four billion tons were burned there in 2012 — a major reason that China has become the world's largest greenhouse gas emitter. From 2005 to 2011, China (with vast natural coal reserves) added the equivalent of two 600-megawatt plants every week, and from 2010 through 2013, it added coal plants roughly equal to half of all U.S. generation. (At the same time, China is committed to renewable energy — with hydropower included, it's already at 20%, compared to 13% in the U.S. But demand is rising and so is production: China is planning to double its power-generating capacity by 2030.)

TECHNOLOGY AND REGULATORY HURDLES PERSIST

The intermittency of wind and solar power remains a major hurdle, one that's addressed by Jacobson and Delucchi. To tackle intermittency in renewable energy resources, Jacobson proposes interconnecting geographically dispersed wind, solar and water resources (through a smart grid), and where possible using hydro power to fill in supply gaps. He also advocates demand-response management, over-sizing peak generation (and producing hydrogen with the excess), and storing electric power on site (in batteries) or in grid-connected electric cars.

Abyd Karmali, managing director, climate finance, at Bank of America Merrill Lynch, agreed that uncertainty resulting from intermittent renewables can be reduced by ramping up grid interconnections, enabling load sharing. "Also having the right mix is key, such as using hydroelectric for baseline power where possible," he said. "And, of course, it's also a misconception to say that only renewable energy suffers from volatility — fossil fuel plants get knocked out for various reasons, and that's not predicted in advance."

Daniel Esty, director of the Yale Center for Environmental Law and Policy, believes that better battery storage — a holy grail for scientists worldwide — is the key to solving the intermittency problem.

According to Arthur van Benthem, assistant professor of business economics and public policy at the University of Pennsylvania's Wharton School, current regulatory policy presents another critical obstacle to a low-carbon future. "Incentives for demand response such as real-time pricing for end users are often lacking, but would be instrumental to shift consumption from peak to off-peak hours." In addition, says van Benthem, "The renewable industry will be at a persistent disadvantage as long as we don't remove the elephant in the room: the fossil fuel electricity sector should pay the full social cost of their operations. In plain English, we need a carbon tax."

"The easiest way to reduce our large-scale carbon footprint is to become a lot more efficient, and there is still a lot of low-hanging fruit that businesses are beginning to recognize."

—Eric Orts

A GROUND-LEVEL VIEW

Some countries are already working toward phasing out fossil fuels, with Germany being the most prominent example. The country, which gets 15% of its energy from nuclear power now, wants to phase it out by 2021 — with help from legislation such as the Renewable Energy Sources Act, which provides feed-in tariffs and other financial support. And its goal is to supply 80% of its electricity from renewables by 2050.

In the first quarter of 2014, clean sources produced 27% of Germany's electricity, with 40.2 billion kilowatt-hours of generation. Nearly half of all new electricity generation in Europe is wind or solar, said George Washington

University's GW Solar Institute. But among the challenges to Germany's success are power-price surcharges that have raised utility bills for some (and led to unrest among German manufacturers), and at least short-term increases in coal use and imports of renewables are ramped up.

Germany's renewable portfolio is about double the 13% in the U.S., and Europe's commitment to a 40% carbon cut by 2030 will ratchet up its efforts substantially. Still, some states get a large percentage of their energy from renewables, often because of large hydro-electric resources.

The U.S. Energy Information Administration expects that electricity generation from renewable sources will increase to 16% in 2040. Renewable portfolio standards (which set percentage goals for renewable energy) are operating in 30 states (plus the District of Columbia), and form a significant incentive if they're heeded.

Corporations are also in the lead. Renewable energy is already providing power for 94% of Apple's corporate operations. Walmart launched on-site solar for its American operations in 2005, and made its first major wind power agreement in Mexico the next year. By 2013, Walmart had 335 renewable energy projects worldwide, producing 2.2 billion kilowatt-hours annually and meeting nearly a quarter of the company's energy needs. Walmart's goal is to reach seven billion kilowatt-hours and be close to 100% renewable by the end of 2020.

Smaller companies, too, are making important strides. Steve Melink of Milford, Ohio, founded Melink Corporation, originally a HVAC testing firm, in 1987. In 2004, he attended a green building conference and had a "moment of inspiration. It opened my eyes that we were not on a sustainable path." Today, Melink has deployed more than 100 strategies to get to its current net-zero energy status. In fact, the company's embrace of sustainability led it to create a lucrative new business in solar leasing, including installation of two three-megawatt systems in Indianapolis and the $12 million 1.56-megawatt solar canopy system it recently built over the parking lot at the Cincinnati Zoo. According to Sophia Cifuentes, the zoo's sustainability coordinator, having the solar system has resulted in 50 days a year that are effectively off the grid.

THE CHALLENGE OF GETTING THERE

Transportation is actually the fastest growing source of CO2 globally, and as such can offset the gains from installed renewable energy. The world car population topped one billion in 2011, and the International Transport Forum thinks it could reach 2.5 billion by 2050. Clearly, that's not a sustainable number. Daniel Sperling, founding director of the Institute of Transportation Studies at the University of California, Davis, believes that the 87 million barrels of oil produced globally each day could climb to 120 million barrels under that scenario.

The transition to electric vehicles has the potential to blunt the oil consumption and climate impacts of the world's cars, but there's a long way to go. In the U.S. in 2014, 119,710 plug-in vehicles were sold out of 16.5 million total, and the numbers are smaller around the world. Electric cars are currently expensive, but with battery prices dropping, their momentum is likely to increase. Lower-cost (and longer range) cars, which cost much less to operate than conventional cars, will be attractive to buyers globally. Lowering emissions becomes a virtuous circle when the power running zero-emission electric cars comes from plants fueled by renewable energy.

Making cars more energy-efficient, as in the U.S. goal of 54.5 mpg fleet averages by 2025, is important, as is moving away from cars altogether. Mass transit is key, but other innovative urban policy is also pointing the way forward: The U.S. remains highly auto-centric, but cities such as Helsinki and Hamburg in Europe have ambitious, technology-aided, plans to go car-free or as close to it as possible. In place of private cars will be telephone-dispatched bus services, ride sharing, municipal bicycles and multiple rail options.

Virtually all the experts agree that the transition to a clean energy economy will be difficult. Carl Pope, the former executive director of the Sierra Club, points out that if clean energy investments result in a 5% reduction in global fossil fuel demand, the law of supply and demand would result in a sharp 25% to 30% drop in fossil fuel prices, increasing non-renewables' appeal to consumers.

Robert Giegengack, professor emeritus of earth and environmental science in the School of Arts and Sciences at the University of Pennsylvania, agrees the transition won't be easy, "but it is inevitable."

Moving to renewables could take as long as 100 years, Esty said. Eric Orts, the director of Wharton's Initiative for Global Environmental Leadership (IGEL) and a law professor at the University of Pennsylvania, also sees a fairly hard road ahead, but it's an achievable goal. "I don't think it's an easy transition at all," he said. "But I do think it's possible, and we definitely need to move in that direction."

Orts adds, "Even with wind and solar, it's not simply zero emission — there are manufacturing costs, mining and maintenance issues. It should be said that the movement toward renewables has to be coupled with energy-efficiency efforts. The easiest way to reduce our large-scale carbon footprint is to become a lot more efficient, and there is still a lot of low-hanging fruit that businesses are beginning to recognize." ■

A Renewable World: What Will It Cost?

GLOBAL POWER DEMAND TODAY IS ABOUT 12.5 TERAWATTS, which is likely to grow to 17 terawatts by 2030, the U.S. Energy Department reports. Meeting that demand with renewable power certainly won't be cheap. Mark Jacobson, a civil and environmental engineering professor at Stanford, and Mark Delucchi, a research scientist at the University of California, Davis's Institute of Transportation Studies, estimate that construction of a worldwide wind, water and solar system would cost $100 trillion over 20 years, including upgrades to the grid.

But, Jacobson and Delucchi write, "This is not money handed out by governments or consumers. It is investment that is paid back through the sale of electricity and energy." And the authors contend that because electrification is more efficient than using fossil fuels, a drop in global energy demand occurs from 17 terawatts to 11.5 in 2030.

According to a new report from the University of California at Davis and the Institute for Transportation and Development Policy, all of this spending and more could be saved if the world's urban population made the transition from automobile dependence to reliance on mass transit, walking and cycling. (A co-benefit would be a 1,700-megaton annual reduction in CO2 emissions by 2050.) But that rosy future is dependent on a massive change in consumer behavior.

The Global Commission on the Economy and Climate puts a slightly lower price tag on the global infrastructure expenditure necessary to reach renewable energy and climate goals by 2030—$89 trillion—but also envisions $2 trillion savings to that date from "reduced investment in fossil fuel power plants in a low-carbon scenario." And it sees further savings accruing from energy-efficiency gains, reductions in transmission and distribution investment, and drastically lower costs for fossil fuel exploration and transportation, among other things.

Those savings could add up dramatically. "Overall, the net incremental infrastructure investment needs from a low-carbon transition could be just $4.1 trillion, if these investments are done well," said the Global Commission report. It even imagines a scenario that would result in net savings of $1 trillion. Some disagree. Ottmar Edenhofer, a German climate economist who served as an advisor to the Global Commission but was not an author of its report, told *The New York Times* that the assumptions necessary to reach that no-net-cost outcome are "overly optimistic."

> **"The price of electricity sold to utilities under long-term contracts [in 2013 and 2014] from large-scale solar projects has fallen by more than 70% since 2008, to $50 per megawatt-hour on average."**
>
> — Mark Bolinger, Lawrence Berkeley National Laboratory

HIGH UP-FRONT COSTS

In 2011, President Obama outlined a goal of 80% renewable energy for the U.S. grid by 2035. Reaching that ambitious target could mean adding 20 gigawatts a year for 20 years, then 45 gigawatts annually until mid-century.

The Energy Information Administration (EIA) estimated that President Obama's scenario would raise average utility bills in 2035 by 29% (higher in some areas). A megawatt-hour of electricity could rise from $9 to $26 in 2030, and from $41 to $53 per megawatt-hour by 2050, the Renewable Electricity Futures study said.

According to that federal report, "Higher electricity prices associated with the high renewable scenarios are

driven by replacement of existing generation plants with new generators (mostly renewable), additional balancing requirements reflected in expenditures for combustion turbines, storage and transmission; and the assumed higher relative capital cost of renewable generation, compared to conventional technologies."

A new "Green Growth" report from the Center for American Progress (CAP) and the University of Massachusetts Political Economy Research Institute estimates the cost of reaching a similarly ambitious goal — 40% reduction in U.S. greenhouse gas emissions from 2005 levels by 2035 — at $200 billion annually from both public and private sources (with public investment averaging about $55 billion per year).

However, the CAP report notes that the projected public spending under its plan would be only 0.3% of current U.S. GDP, and approximately 1.4% of the federal budget. Some $90 billion of the annual expenditures would go to energy-efficiency measures for buildings, transportation and industry — with the potential of reducing American energy use by 30%.

Utility-scale solar in the U.S. has dropped from $3 per installed watt in the first quarter of 2012 to $1.85 in the first quarter of 2014.... Commercial solar prices dropped 20% ... and residential solar 25%.

— The Solar Energy Industries Association,

Looking to recent history for guidance, the Environmental Defense Fund (EDF) reports that there's little evidence that a 40% increase in renewable energy on the grid since 1994 has raised electricity prices in the U.S. EDF reports that those rates have "remained steady" during this period, even as coal plant sulfur dioxide and nitrogen oxide emissions declined by more than 75%.

THAT COULD EXCEED PROJECTIONS ...

Critics say the actual increases from committing to renewables will be higher than the federal estimates. For instance, the Manhattan Institute said in 2011 that reaching the 20% wind goal for the U.S. national grid would "impose a tax on U.S. electricity consumers of $45 to $54 for each ton of carbon dioxide that was removed," and it claimed that electricity consumers in coal-dependent regions would end up paying as much as 48% more for electricity."

Meeting British renewable energy goals, said Britain's Renewable Energy Foundation in 2014, would require $211 billion in subsidies by 2040, with peak annual costs of around $10 billion. The country's Committee on Climate Change estimates expenditures of $10 billion per year.

The German goal of 40% to 45% renewable energy by 2025 (and 80% by 2050) is proving costly to achieve. According to the *The Wall Street Journal*, "Average electricity prices for companies have jumped 60% over the past five years because of costs passed along as part of government subsidies of renewable energy producers. Prices are now more than double those in the U.S."

The International Energy Agency has put a price tag on confronting climate change at $10.5 trillion by 2030. That's the global investment in low-carbon energy (plus energy efficiency) that's needed, the agency estimates, to hold greenhouse gas concentrations in the atmosphere to 450 parts per million and world temperature rise to 2 degrees Celsius.

According to Mark Moro, a fellow at the Brookings Institution, "The figure $10.5 trillion by 2030 declares objectively and indelibly that the battle against climate change requires remaking the world energy system with new technologies, many of which don't exist, or don't exist cheaply enough, and that we'd better get to work on that in earnest."

... BUT PRICES ARE COMING DOWN

Yet, renewable energy costs are already dropping. The Lawrence Berkeley National Laboratory reported in 2014 that the average, upfront installed price for utility-scale photovoltaics dropped by more than a third since the 2007-2009 period, with an attendant increase in project-level performance. And, said report author Mark Bolinger of Berkeley Lab, "The price of electricity sold to utilities under long-term contracts [in 2013 and 2014] from large-scale solar projects has fallen by more than 70% since 2008, to $50 per megawatt-hour on average."

According to Lazard Freres & Company's "Levelized Cost of Energy (LCOE) Analysis 7.0," LCOE for wind and solar in the U.S. has declined more than 50% between 2009 and 2013. Lazard estimates that utility-scale solar photovoltaics are competitive with fossil fuel for peak energy in much of the world, even without subsidies. *The New York Times* concludes that Germany's fast-paced purchase of wind turbines and solar panels is bringing large Chinese

manufacturers into the space and "driving down costs faster than almost anyone thought possible just a few years ago." That development is threatening to electric utilities, which have seen few challenges to their business plans.

According to the Solar Energy Industries Association, utility-scale solar in the U.S. has dropped from $3 per installed watt in the first quarter of 2012 to $1.85 in the first quarter of 2014. And, in the same period, commercial solar prices dropped 20% (to $3.72 per watt) and residential solar 25% (to $4.56 per watt).

Wind farms are also competitive. Bernard David, an entrepreneur and author who is also a senior fellow at Wharton's Initiative for Global Environmental Leadership (IGEL), agrees that, although there are some technical constraints, the aggressive Chinese push into renewable energy is bringing with it the economies of scale necessary to compete with fossil fuels.

Wind costs have dropped 90% since 1980 and, reports the Motley Fool, "Wind energy is now cheaper than many conventional fuels." According to Mandy Warner, an EDF climate specialist, "New coal-fired power plants are one of the costliest generation options even without considering the significant pollution they generate. If built in the next five years, they would cost about 19% more than onshore wind, 44% more than combined cycle natural gas, and significantly more than energy-efficiency measures."

TARGETING COAL

Addressing coal-burning power plants has become an effective strategy for reducing emissions, and the Obama Administration's Clean Power Plan aims to cut U.S. power carbon by 30% below 2005 levels. And EPA modeling shows that implementation of its Clean Power Plan for older coal plants will result in bills $8 per month lower in 2030 than they would be without the plan.

In The Guardian, Felix Kramer and Gil Friend report that $50 billion "is the surprising low price to buy up and shut down all the private and public coal companies in the U.S., breaking the centuries-old grip of an obsolete, destructive technology that threatens our present and our future." The authors claim that such a move would "generate $100 billion to $500 billion in benefits every year," and imagine "a few shrewd and enlightened investors" taking the lead on funding and structuring the Coal Buyout Fund.

THE PATH NOT TAKEN?

And any analysis of energy generating costs has to include consideration of the costs of not taking the renewable path. That's the focus of the Risky Business Project, co-chaired by former New York mayor Michael R. Bloomberg, former Treasury Secretary Henry Paulson and hedge fund manager/environmentalist Tom Steyer.

Just $50 billion "is the surprising low price to buy up and shut down all the private and public coal companies in the U.S., breaking the centuries-old grip of an obsolete, destructive technology that threatens our present and our future."

— Felix Kramer and Gil Friend, in *The Guardian*

"If we continue on our current path," the report says, "many regions of the U.S. face the prospect of serious economic effects from climate change."

- Because of higher sea level and aggravated storm surge, the average annual cost of coastal storms on the eastern seaboard and the Gulf of Mexico could reach $3.5 billion in 15 years, with hurricane activity taking that figure to $7.3 billion. By 2050, $66 billion to $106 billion in coastal property could be underwater, and up to $507 billion worth by 2100.
- Midwestern and Southern farmers could see their corn, wheat, soy and cotton yields drop 10% over the next five to 25 years. There's a one in 20 chance the losses could top 20%.
- Temperature changes because of climate change might require the construction of up to 95 gigawatts of new power generation in the next five to 25 years. That translates to 200 coal or natural gas power plants.

Some of the projections may underestimate the cost of switching to renewables, but the more pessimistic reports probably downplay the offsetting benefits and consequences of not taking steps. ■

Financing the Transition to a Low-carbon Economy

OVER THE PAST 20 YEARS — well before the recent U.N. Climate Summit in New York — reports have been written, conferences held and committees formed looking for ways to avoid catastrophic climate change. Yet the international community has made little progress as it tries to control global warming emissions.

> **"Fully half of BAML's clients say that their portfolios are a manifestation of their values and the kind of impact they would like to have on the world."**
>
> — Surya Kolluri

With public spending on clean energy actually in decline (it dropped 20% from 2011 to 2013, according to Bloomberg New Energy Finance) many have decided that the time has come to look past the limited budgets and political paralysis of national governments and engage the private sector in the struggle to fund the world's transition to a low carbon economy.

Daniel C. Esty, professor of environmental law and policy at Yale and former commissioner of the Connecticut Department of Energy and Environmental Protection, says in an interview, "It makes much more sense to use limited government money to leverage private capital than it does to spend it directly on projects." In a *New York Times* op-ed just prior to the U.N. Summit, Esty added that the private sector offers the additional advantage of allowing market forces, rather than government bureaucrats, to pick winners and losers, while encouraging competition that lowers prices.

The sheer size of the financial sector offers enormous potential. According to a recent study by PwC, "Asset Management 2020", global assets under management will rise from a 2012 total of $64 trillion to roughly $102 trillion by 2020. And the appetite for clean tech investing is growing stronger each year. Already, high net-worth individuals worldwide are investing $3.74 trillion in environmental, social and governance issues (ESG). And, according to Surya Kolluri, managing director of policy and planning, personal wealth and retirement at Bank of America Merrill Lynch (BAML), "Fully half of BAML's clients say that their portfolios are a manifestation of their values and the kind of impact they would like to have on the world."

The challenge is coming up with the investment opportunities needed to satisfy this demand. Investors "are not willing to trade off returns for impact," says Kolluri. While most investors are hungry for yield in today's low-yield environment, all demand investments that offer both liquidity and returns commensurate with the risk. Fortunately, innovative new strategies and financial instruments are being developed to meet these requirements.

FAMILIARITY BREEDS ACCEPTANCE

"Green bonds" are simply bonds that are used to finance environmental initiatives. The most successful so far have been "use-of-proceeds" bonds, which owe much of their appeal to how much they resemble everyday fixed-income instruments. As with other bonds, this innovative form is backed by the full faith and credit of the issuer. What makes them green is the issuer's promise to use all of the proceeds from the investment for green projects exclusively.

The first such bond was issued in 2007 by the European Investment Bank and underwritten by Merrill Lynch. Since then, BAML and other banks have underwritten use-of-

proceeds green bonds for numerous issuers, almost all of which have been "very safe, AAA-rated super sovereigns [multi-lateral development banks]," notes Abyd Karmali, managing director of climate finance at BAML.

The success of a green bond issued by the Export-Import Bank of Korea (KEXIM), which is neither AAA-rated nor a super-sovereign, "signaled that investors were interested in a variety of opportunities," and paved the way for corporations to enter the market, Karmali says. In November 2013, just nine months after the KEXIM issuance, Bank of America became the first corporation to issue a use-of-proceeds green bond.

Interest quickly grew. Within days, a European utility issued bonds of its own, followed in short order by Unilever, Toyota, some U.S. real estate companies and others.

Interest in green bonds is soaring, with the total of use-of-proceeds green bonds growing dramatically between 2013 and 2014. Whether the green bond market will reach, or even exceed, $100 million next year depends, in large part, on how much the corporate segment of the market grows and whether municipalities — which include cities, states and counties — follow the lead of Massachusetts and California in joining the market.

As fast as the market for these green bonds has grown, Suzanne Buchta, managing director of high-grade capital markets for Bank of America Merrill Lynch, believes that use-of-proceeds bonds are likely to play an even greater, more pivotal role in the future. "The beauty of the use-of-proceeds green bonds is that investors can participate without having to change their mandate or do new additional credit analyses," she says. "The bonds provide a product that is immediately accessible."

THE EXPANSION OF GREEN BONDS

Once investors grow accustomed to use-of-proceeds green bonds, they often begin to venture further out into the green investment space. "We are starting to hear investors say, 'This is interesting, but I want to start to look at how I can directly invest in projects,'" Buchta says. "That's something you would not have heard five to 10 years ago, because green projects were considered too risky for many investors."

For these investors, there are now project green bonds, which compensate for higher project risk by offering higher yields. There haven't been many issuances yet, but in 2013 MidAmerican Energy Holdings Company, a unit of Warren Buffett's Berkshire Hathaway Inc., completed a $1 billion bond offering to fund continued construction of its 579-megawatt Solar Star project in Southern California.

Asset-backed green bonds bundle together a pool of green collateral in much the same way the mortgage-backed securities bundle together home loans, and they carry similar risks. But their appeal is growing, especially in the solar industry. With the federal tax credit for solar energy projects scheduled to drop from 30% to 10% in 2016, SolarCity, a solar system installer, broke important new ground when it issued $54 million in bonds backed by residential and commercial solar power contracts last year. Now that the SolarCity deal is done, *Forbes* reports that other solar companies are exploring similar bond offerings.

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A fourth type of green bond is known as a pure-play bond, because corporations that issue them are considered to be entirely, pure-play green companies. Think of Tesla, which is 100% dedicated to electric cars, or Sun Power, which manufactures solar panels and nothing else. Such companies do not have to use all the proceeds of the bonds they issue for specifically green purposes because everything the company does is in the service of its green business.

Buchta says there are hardly any of these pure-play green bonds so far, because most of the eligible companies are not yet rated as investment grade. "But we envision that in the next couple of years some of these companies may come up the credit scale to the point where they could issue either high yield or high grade bonds."

BUILDING ON SUCCESS

In the low-carbon economy of the future, most of our energy is likely to come from wind and solar power. Standing in the way of that future is the relatively high cost of financing utility-scale renewables, which makes them uncompetitive with fossil fuel power. One answer is to drive up the cost of fossil fuels, with a politically difficult carbon tax or indirectly through cap-and-trade mechanisms. While some are following these paths, the outcome remains in doubt.

The alternative is to lower the cost of financing renewables, thereby lowering their cost and increasing

their competitive vigor. One innovative approach that shows promise is the use of yield companies or YieldCos. According to a report by the Climate Policy Initiative, "The Roadmap to a Low-Carbon Electricity System in the U.S. and Europe," such "new investment vehicles designed around the unique financial characteristics of renewable energy could reduce its costs by up to 20%."

YieldCos take advantage of the fact that wind and solar projects typically have high upfront costs but low operating costs and, with the help of purchase-power agreements, long-term predictable cash flows. A company can spin off the relatively stable operating part of its energy business as a YieldCo, and raise capital by selling stock, with dividends funded by the spin-off's cash flow. The parent company uses the money it raises in the equity market to fund further growth.

"This is a watershed moment, because, by doing this deal, it proves that energy efficiency is able to attract private capital."

—John Kinney

In October 2013, the utility NRG became the first firm to actually create a YieldCo. NRG Yield, Inc. includes three natural gas plants, eight utility-scale solar and wind generation facilities and two portfolios of distributed solar facilities (totaling about 1,324 megawatts of generation capacity). Since its IPO last year, the new company's price per share has risen about 60%.

Other utilities have followed suit, including most recently NexEra Energy, a subsidiary of Florida Power & Light Company and the nation's largest solar and wind operator, which raised $442.7 million in its initial public offering. According to InvestorPlace.com, various solar panel producers, including SunPower and SunEdison, also intend to start YieldCos.

USING PUBLIC FUNDS TO LEVERAGE PRIVATE CAPITAL

Green bonds and YieldCos are attracting private investors without recourse to public money. But increasingly, governments are finding ways to use their treasuries to help mobilize investment dollars.

Important elements in this effort are occurring at the local level, says Esty. He points to the international group C-40, which now includes the mayors of 69 major cities, representing 18% of global GDP. These local leaders, says Esty, have "committed their cities to real action," as have "400 to 500 mayors across the U.S." The international nature of this local movement was made clear at the U.N. Summit, where several other international groups of local officials agreed to provide a single annual report on the progress being made by state and regional governments worldwide.

Here in the U.S., green banks are at the leading edge of such local efforts. No two are alike, but the first two in the nation provide a good sense of what these institutions can accomplish.

Connecticut was the first state to launch a green bank, creating the Clean Energy Finance and Investment Authority (CEFIA) in 2012. According to the organization's 2013 annual report, CEFIA has generated about $10 in private investment for every one dollar contributed by the state's taxpayers.

Much of the heavy lifting in Connecticut has been done by Connecticut's Property Assessed Clean Energy (PACE) program. PACE allows property owners to finance up to 100% of clean energy improvements to their homes and repay the investment through an increase in their property tax bill. An upfront evaluation helps ensure that energy savings more than compensate for the additional tax charge.

PACE loans can in turn be used to attract private investors. Earlier in the year, California securitized $104 million in residential PACE loans, and in May, Connecticut's CEFIA sold bonds backed by a portfolio of $30 million in commercial PACE loans. "This is a watershed moment, because, by doing this deal, it proves that energy efficiency is able to attract private capital," says John Kinney, CEO of Clean Fund, which purchased the bulk of the CEFIA portfolio.

Rather than offering a PACE program, or any specific program of its own, New York's Green Bank will provide a range of financing support for projects that meet its goals but can't be completed with private investment alone. Among other strategies, the bank will use public funds to provide credit enhancements, which reduce the risk on clean energy loans and leases, and aggregate numerous clean energy projects that are otherwise too small to warrant attention into investible portfolios.

APPROACHES FOR THE DEVELOPING WORLD

Many of the financing strategies that show promise in the developed world face daunting challenges in other parts of the globe, including political and regulatory risks, currency and interest rate volatility, and technology and infrastructure risks. National, regional and supra-national agencies are increasingly looking for ways to use their funds to help overcome these challenges.

The Green Climate Fund (GCF), a U.N.-sponsored entity, is one such group. GCF's first challenge is securing the working capital it needs to succeed. When it was launched in 2009, donor countries pledged to come up with $100 billion from public and private sources by 2020. But the first step, known as the Initial Resource Mobilization (IRM), is to reach $10 billion over the next three years. Just $2.4 billion has been pledged so far (most of it at the U.N. Climate Summit), but hopes are high that the remaining $7.6 billion will be forthcoming in time for the official IRM meeting.

GCF's second challenge is how to use the money that is collected most effectively. The World Resources Institute (WRI) has spent 12 years researching financial instruments that public institutions can use to mobilize private sector investment and is now exploring the experiences of large funding organizations. According to Giulia Christianson, associate for the climate finance project at WRI, the Institute is encouraging GCF "to have a suite of instruments. What we've seen in the research is that it's not enough just to have concessional loans or grants," which is all that the GCF board has so far allowed.

"Everyone is trying to think of how to bring public and private financing together, to make that the norm rather than the exception," notes Christianson. But GCF is likely to be cautious, looking first to see its initial loans repaid. Still, says Christianson, the GCF board will likely be talking about how to phase in additional instruments at its next meeting, most likely beginning with loan guarantees and both political and regulatory risk insurance.

Other groups are looking to move faster. The Global Innovation Lab for Climate Finance is drawing on expertise from both the public and private sectors to design and pilot the next generation of climate finance instruments. The first seven ideas to be piloted include long-term currency swaps (to help reduce the risk posed by volatile currency exchange rates), insurance for energy savings (to protect against the risk that energy-efficiency projects might not achieve projected savings) and a debt fund for prepaid energy access (to help scale up a proven model for prepaid off-grid renewable energy). By quickly developing and demonstrating the real-world effectiveness of such tools, the Lab hopes to build new markets and attract new investors to climate financing in developing countries.

The Lab is part of broader government and private-sector efforts to scale up climate finance. Another such effort, Finance for Resilience (FiRe), is designed to identify the best existing ideas and ensure that they are scaled up as quickly as possible. While FiRe's focus is global, it is currently developing four strategies aimed specifically at challenges in the developing world. Among these are: the expansion of an energy-efficiency financing program into China, Brazil and India; the establishment of a guarantee mechanism for green energy bonds in emerging markets, and an attempt to raise $1.4 billion for investments in developing countries by scaling up a public-private fund-of-funds established by the Global Energy Efficiency and Renewable Energy Fund.

It's too soon to tell how effective all these efforts at climate financing will be at breaking the gridlock, but the growing collaboration between public and private sectors at least promises a way forward. ■

Special Report

Making the Transition to a Low-carbon Economy

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