CREATING A

CLEAN ENERGY CENTURY

Recapturing the lead in clean tech innovation

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Creating a Clean Energy Century

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$6 trillion.[1] That's the value of the global energy market, including both fossil and clean energy sources. While the energy market has always been driven by fossil fuels, it is moving slowly, but inevitably, toward clean energy as countries decide they can no longer tolerate the pollution costs and security risks of conventional energy or the threat of global warming. The great hurdle is making clean energy as cheap as fossil fuels. This will require major breakthroughs. Existing clean energy sources are too expensive and have technical limitations. The payoff is that the countries that are home to this next generation of affordable clean energy technologies will likely dominate the 21st century economy.

The choice is clear for the United States. As clean energy use expands, we can import foreign innovations, made in foreign factories, or we can create, build and sell them here at home. The United States can emerge as the dominant economy of the 21st century, just as it was in the 20th century. But we will not get there unless we change course and do so rapidly.

This report launches Third Way's Clean Energy Innovation Project, which will make a sustained case for American clean energy innovation. The report examines clean energy innovation policy and investment in the U.S. and around the globe. It also offers a number of ways to help jump start what we believe is lagging U.S. clean energy innovation efforts. Over the life of the Project, Third Way will build out many of these ideas in more detail in a series of follow up papers. Innovation alone will not bring about a clean energy revolution, so we will also explore other actions that the U.S. must take in subsequent papers.

EXECUTIVE SUMMARY

In 1969—when UCLA Professor Leonard Kleinrock sent the first Internet message from his laboratory—and for years after, companies like Google, Facebook, Amazon and Netflix were not even imaginable. Back then, DARPA, NIST, FCC and NASA were the drivers of the nascent Internet.

What does this tell us? That when we invest in research and innovation, the opportunities are boundless. That American capitalism can take a seed of an idea and create revolutions in our economy and society. That America can dominate economically, as it has with information technology, if we invest in innovation.

Looking back at the economic evolution from 1969 to today prompted a simple question: how can we drive a clean energy revolution in the United States? What we found is that:

- **Innovation is needed now**, because while the world is moving to clean energy, today's technology is neither cheap enough nor reliable enough to replace fossil fuels.
- **The United States has a lot of catching up to do**, thanks to market failures in the private sector and too little leadership, organization or investment from the federal government.
- **There is a roadmap for American innovation leadership** if we create a true public-private sector partnership to make clean energy cheap, reform existing structures, and commit to investing the necessary resources to get the job done.

SECTION 1
Innovation is Needed Now

The world is moving toward clean energy (wind, solar, nuclear, geothermal, biomass, and coal and natural gas with carbon capture and storage) and away from fossil fuels (coal, natural gas, oil) because nations have decided they are no longer willing to accept the costs of pollution, the security risks of importing oil or the threat of global warming. They also see a huge economic upside. The need for new technologies to meet existing, let alone future, clean energy demand has created a massive new market potentially worth as much as $2.2 trillion between now and 2020.[2] It could also mean as many as 20.4 million jobs worldwide by 2030 across all clean energy sectors.[3]

Unfortunately, the United States has fallen far from its position as the leader in clean energy in the 1970s. Today, China, Japan, South Korea and Germany have committed to policies and investments that put them in the lead. Whichever country or countries emerge as the leaders of clean energy will get the greatest economic benefits. Thanks to these efforts, we're getting closer to the moment when clean energy is as affordable and reliable as fossil fuels. If the U.S. doesn't act soon, however, it will find itself as permanent consumer, rather than producer of these new clean energy technologies.

INNOVATION

Webster's dictionary defines innovation as "a new idea, method or device."[4] But what sparks innovation? While it certainly starts with an idea, more often than not, innovation is also driven by a market need, whether a new service or technology.[5] The market for the new crosses both the public and private sector. Once a need has been established, the innovation process charts a course from research and development, to deployment and, ultimately, commercialization. Yet innovation is an inherently uncertain process. The challenge is that the reward for innovation must exceed, or at least match, the initial risk for the private sector to respond to the demand. As we will see in this paper, both the risks and potential rewards for clean energy innovation are high. Other countries around the world are already responding to this.

SECTION 2

America's Ambiguous Relationship with Clean Energy Innovation

American history is full of examples of major technological challenges that the private sector could not overcome on its own. This is because the financial, logistical and technological risks were too high for the private sector and there were not always markets driving the need for solutions. It took the federal government working with the private sector to help mitigate risk and stimulate demand to spawn many of the innovations, from the modern airline industry to the Internet, that we take for granted today.

The biggest challenge facing clean energy is money. The public and private sector are not investing enough to drive innovation. Compared to federal healthcare, defense R&D, or the Information Technology sectors, all energy—not just clean energy—is funded far below average. This is because conventional energy is cheap and reliable, and energy research, development and deployment are extremely expensive and inherently risky. Given the early stage of clean energy markets, it is of particular importance to fund innovation now to bring down technology costs. Moreover, we must clear away the thicket of bureaucracy facing companies that do receive federal R&D funding.

This is happening too slowly. Despite recent strides, we have not matched the global competition or the market's needs to get both the breakthroughs *and* incremental technology improvements that will make clean energy competitive.

SECTION 3

Renewing American Innovation

All is not lost. The U.S. can re-establish its leadership in clean energy. To do so, the public and private sectors must work together to develop a clear mission, share the financial risks and create the market demand that will bring down the price of next generation clean energy technologies.This is a five step process:

1. **Provide direction for clean energy innovation through a reformed federal clean energy infrastructure.** This would start with restructuring federal innovation under a National Institutes of Energy, with the singular mission of developing the affordable, commercial clean energy technologies of the future. This would enhance the innovation programs that are already working at the national labs, Department of Defense, and Advanced Research Projects Agency—Energy (ARPA-E). Creating an Inter-Agency Innovation Emissary would help cut through the federal bureaucracy and ensure we capitalize on good ideas.
2. **Create the early markets for private sector clean energy technologies until they are brought to scale and become affordable.** There are two critical steps for this. First, the U.S. should leverage the Department of Defense's large procurement budget and demand for clean energy to create an initial market for new technologies that meet both tactical defense needs and have potential for widespread commercial use. Second, it should provide access to capital for companies that want to move new technologies from the lab to the market and small and medium-sized businesses to develop and purchase clean technologies.

3. **Ensure that new clean energy technologies are manufactured in the United States and that every region of the country reaps the benefits.** The government can work with business by providing tax incentives and investments to companies that will manufacture clean technologies in the U.S. or retool their manufacturing processes. We also need to ensure that American-made clean energy goods have access to overseas markets by strengthening our export promotion and protection programs. Finally, to help transition conventional energy states and localities, the U.S. should create Innovation Clusters that would foster public-private clean energy research efforts in every state and incentivize clean energy businesses to move to areas economically disadvantaged by the transition.
4. **Educate the next generation of scientists and technicians to help America make the leap to clean energy.** To accomplish these goals, we are going to have to rebuild the next generation of engineers and scientists. The U.S. must assist schools in strengthening their science, technology, engineering and math programs. Federal policy could also provide colleges and universities incentives to retool their science and math programs to focus on developing innovative technologies and reward researchers who commercialize their ideas. Finally, to draw bright graduates to dedicate time to working on important clean energy technology problems, it could create a Peace Corps-style organization that would seed public, non-profit and emerging private sector institutions.
5. **Invest $15 billion in clean energy research, development, demonstration and deployment to bridge the capital gap in the private sector.** This funding would ensure that the U.S. could compete in the global clean energy marketplace by increasing the supply of innovative clean energy technologies for purchase around the world, and we can do it without increasing the deficit through a combination of funding streams. This could include an energy modernization fee on electricity, the redirection of some fossil fuel subsides, or even by setting a low price on carbon.

SECTION 1: INNOVATION IS NEEDED NOW

Fifteen years ago, Japanese automaker Toyota was just beginning to test the prototype of its hybrid vehicle, the Prius.[6] Ten years ago, Germany had only 76 megawatts of installed solar photovoltaic power nationwide.[7] Five years ago, China's wind power capacity was less than 1.3 gigawatts,[8] a small fraction of its total generation capacity. Today, Toyota has sold more than 1.8 million Priuses, two Japanese auto companies dominate the hybrid market, and a third is about to roll out its first all-electric vehicle.[9] Germany now is one of the world leaders in solar energy, with nearly 10 GW installed solar capacity, about half the global total.[10] China has over 23 GW of wind capacity[11] today and will add hundreds of gigawatts of wind power by 2020.[12]

The world is changing. But many types of clean energy are still not cheap enough or reliable enough to meet the demands of the developed world, let alone provide power to the 1.5 billion living without electricity.[13] The market for this next generation of clean energy could be worth trillions of dollars. The U.S. had the early advantage, leading the world in nuclear power, solar, and wind technology in the 1970s. But as Japanese hybrids, German wind, and Chinese solar power grew rapidly in the last 30 years, American industries and innovation lagged. We're already seeing the result of this in a growing U.S. clean energy trade deficit of $6.4 billion[14] and increasing numbers of clean energy technologies being imported rather than manufactured here. There's still time to determine whether clean energy is just another sector adding to America's trade deficit or the vanguard of new economic growth.

Why the World is Moving to Clean Energy

Nigeria's Niger Delta has been plagued by annual oil spills, each the size of the Exxon Valdez disaster, since at least 1960.[15] And in summer 2010, China faced a massive oil pipeline explosion in Dalian province and a coal mine explosion in Henan province that killed 46 miners.[16]

The U.S. has also had its share of conventional energy disasters in recent years. The Gulf oil spill will incur immeasurable costs to the U.S. economy, and will almost certainly impact fisheries and tourism for years.[17] But before the BP oil blowout, a coal ash spill in eastern Tennessee was the largest environmental disaster of its kind in the United States.[18] In December 2008, about 5.4 million cubic yards of coal ash spilled at the Tennessee Valley Authority's Kingston Fossil Plant, generating nearly four times as much debris as the World Trade Center collapse and releasing heavy metals and carcinogens into the water and air.[19]

Every year in the United States the economic cost of air pollution—caused by industrial processes and power generation reliant on fossil fuels—runs as much as $75 - $280 billion, to say nothing of the costs due to exhaust from cars and trucks.[20] This includes work time lost due to pollution-caused chronic and acute health issues, additional wages paid to workers in high-risk extraction industries, crops lost, impaired visibility and the deterioration of buildings and machinery due to pollution. The situation is similar in China, which loses approximately $240 billion a year (over 7% of GDP)[21] due to the costs of air and water pollution, much of which is caused by old, inefficient coal-burning power plants.[22] In India, air pollution from the burning of fossil fuels reduced its rice harvests by more than 14%.[23] Developing countries like China and India also need to add enough energy capacity to lift more than a billion people out of crippling poverty. The head of China's National Energy Administration has made it clear that, "If we fail to address the development of new energy from a higher horizon, we will regret to find ourselves falling behind others within 10 years,"[24] as pollution builds and others lay claim to the new clean energy market.

The United States and many other countries have also concluded that importing large amounts of foreign oil from unstable or hostile countries is a threat to their national and economic security.[25] This has been an almost 40-year struggle for the United States, which buys as much as 1.5 billion barrels of foreign oil a year from nations that the State Department lists as dangerous and unstable.[26] Kicking the import habit, however, has gained renewed urgency due to the rise of Islamic militancy, hostile petro-dictators and instability of oil-producing countries like Venezuela and Nigeria.

Are Today's Clean Energy Technologies up to the Challenge?

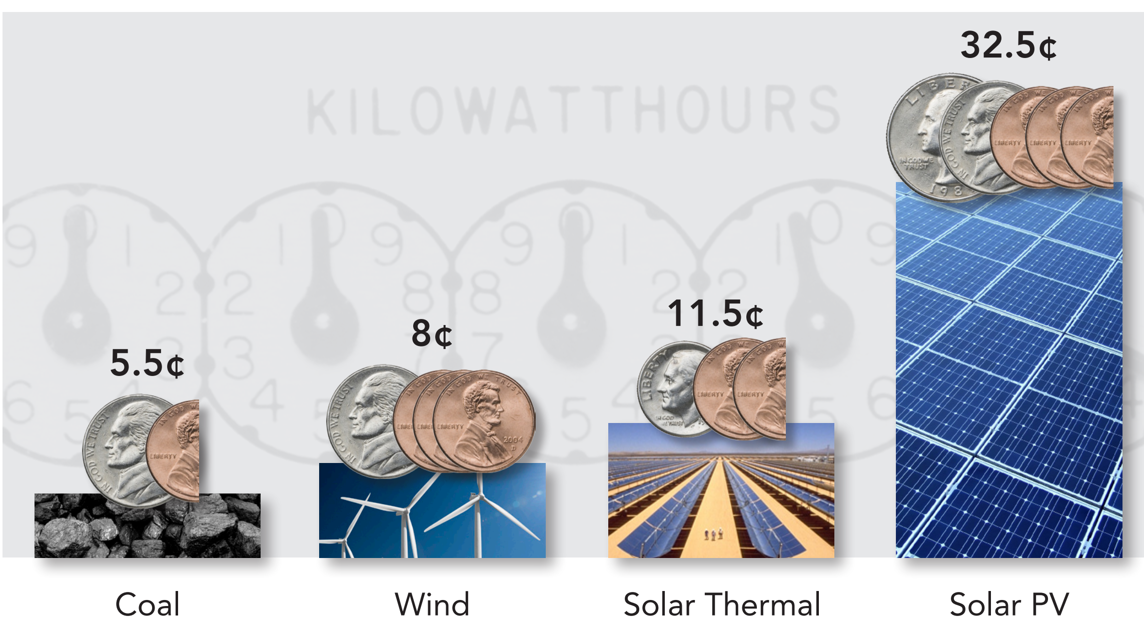
The numbers on clean energy are pretty simple. With electricity, for example, price and reliability are the only real variables, because regardless of the energy source on the wires, consumers see no difference in their electricity service. The lights go on whenever consumers want, and they receive sufficient voltage to power their belongings.[27] Thus, clean energy that costs more than conventional energy or is not always available simply cannot compete.

Clean Energy Costs More

Without large subsidies for clean energy or a price on carbon, coal is by far the cheapest source of fuel for electricity in the U.S. It costs roughly 2.5 cents per kilowatt hour (kWh) to generate electricity from coal for an existing plant and 5-6 cents per kWh for a newly constructed plant, compared to 7-9 cents per kWh for wind, 10-13 cents per kWh for solar thermal, and 28-37 cents per kWh for solar photovoltaic power.[28] And it's not just a matter of economies of scale; wind and solar are more expensive because component costs are high.[29] That's why, with the cost of clean energy and the absence of a clear policy signal like a price on carbon or national energy standard, more than 30 coal plants are under construction or being planned in the U.S.[30] The lifetime costs for oil are not nearly as stark in comparing conventional versus electric vehicles. But the upfront cost may present a significant hurdle for many consumers—and this is before even considering technological constraints or the need to build out recharging infrastructure. Without any subsidy, gasoline prices must rise to $8 to $9 a gallon before the average electric vehicle would be cost-comparable to a conventional vehicle.[31] Even after federal and state tax incentives, an electric vehicle is expected to cost over $4,000 more than the equivalent conventional car[32] and require an additional $1,100 or more for the installation of a home charging station.[33]

Cost of Electricity by Fuel Source

Cost in Cents per kW-h



Most Clean Energy is Not as Reliable as Conventional Energy

Today's generation of clean energy also have technological limitations, such as the storage capacity and recharging time of batteries or the intermittent ability to generate electricity. A typical wind turbine only generates electricity 20-40% of the time,[34] most often at night when the wind is most likely to blow but demand for power is lowest. Modern solar panels are only able to convert 15%[35] of solar energy hitting them into electricity and aren't even able to function constantly because the sun doesn't always shine. If wind or solar electricity generation surpasses demand, there are currently no storage technologies to capture the excess power for use when demand is higher.[36] Most immediately challenging, wind and solar projects require large amounts of land typically far from the urban centers where demand for power is highest.[37] America's antiquated transmission system was built decades ago to deliver relatively low amounts of electricity to rural areas—not carry high amounts to urban areas. It will require a massive infusion of money and the ability to navigate through a maze of local and state regulation to connect those clean energy sources to distant urban centers that need more power.[38]

Electric vehicles face similar technological limitations. Government efficiency requirements, like the Corporate Average Fuel Efficiency (CAFÉ) standard, are driving the private sector to improve battery technologies.[39] No equivalent standard exists in the clean electricity market. As they currently stand, batteries only have enough capacity for approximately 120 miles of travel per 8 hour charge.[40] As Shai Agassi, founder of Better Place and advocate of electric vehicles, lamented, "Affordable is not a $40,000 sedan. More innovation is needed as convenient is not something you can drive for an hour and charge for eight."[41]

Time and Capital Costs of Clean Energy Innovation

These technological hurdles led the International Energy Agency to make the sobering assessment that, "We will need in the coming decade a global revolution in the way we produce and use energy, with a dramatic shift in government policies and unprecedented co-operation amongst all major economies."[42] This was echoed by Energy Secretary Steven Chu, who said that it is a "myth [that] we have all the technologies we need to solve the energy challenge… We need new technologies to transform the [energy] landscape."[43] According to Secretary Chu, "Nobel-level" breakthroughs are required across several energy technologies, including transformative improvements in physical science, chemistry, biology, and materials science in order to commercialize affordable, reliable, and scalable solar panels, electric vehicle batteries, and sustainable biofuels.[44]

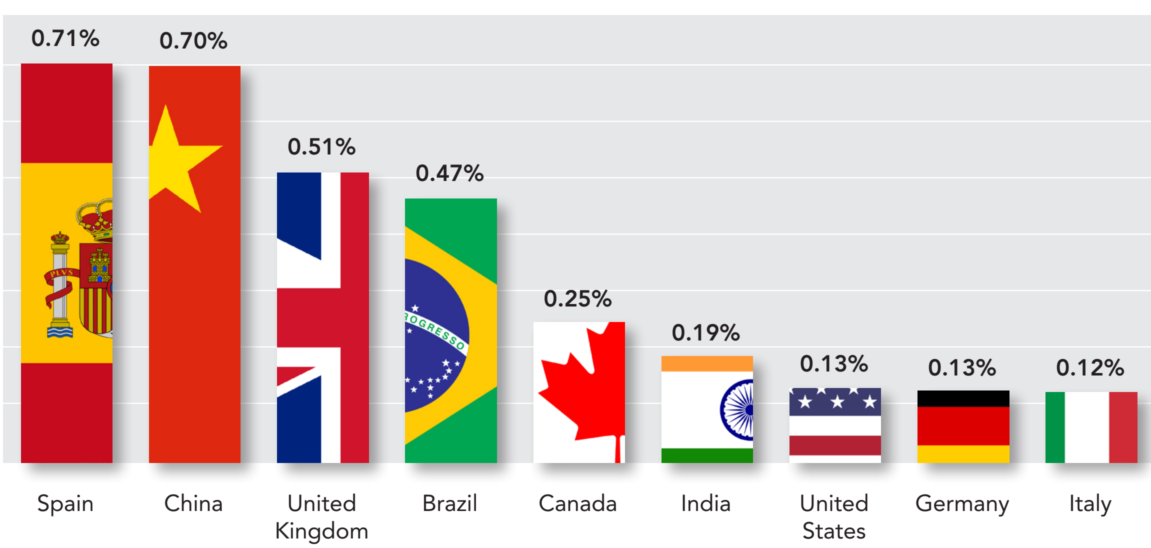
Compared to many other technologies, innovating in clean energy is the equivalent of sailing into a hurricane. Information Technology capacity increases every 18 to 24 months. It has taken on average 30 years for a new energy innovation to go from the drawing board to capturing just 1% of the market.[45] And an IT entrepreneur can follow the path of Hewlett-Packard and Google and literally develop a new Internet or computer innovation in the garage. You cannot do that with solar panels, next generation nuclear power or transmission. Clean energy innovation requires large capital investments in facilities, projects that can last for years at a time, research experts and scalable demonstration projects.

Our international competitors recognize these challenges and are tackling them head on. China announced in July 2010 it will invest a total of $738 billion over the next ten years in clean energy research, development, deployment and associated infrastructure.[46] China is also putting a very modest but real price on carbon in some sectors of its economy in 2011,[47] and mandating a 45% reduction in the energy intensity of the Chinese economy.[48] The Australia-based Climate Institute calculated that these policies taken together add up to an implicit $14.20 per ton price on carbon.[49] This has helped China attract more clean-tech financing this year than Europe and the U.S. combined,[50] and the Worldwatch Institute warns that, based on this trend, China will become the "undisputed global leader" in clean energy within two years.[51]

Japan will invest $30 billion over the next five years in clean energy technologies.[52] South Korea is investing heavily, $84 billion over five years, on a "Green New Deal"[53] to develop and utilize clean energy and to improve their IT infrastructure.[54] This is 9% of the country's gross domestic product (GDP),[55] comparatively dwarfing the U.S., which spends only a small fraction of 1% of GDP on energy innovation.[56] Investors in the European Union (EU) will also outspend the U.S. on clean energy development, spending $38.5 billion

Top Countries in Clean Energy Investment

Clean Energy Investment as a Percentage of GDP[64]



per year,[57] on top of the EU's existing carbon price[58] and a multinational 20% renewable electricity standard that will take effect in 2020.[59] And some EU member nations are going even further. Germany and Spain both drove clean energy deployment by providing renewable electricity at a price advantage through feed-in-tariffs that offer a favorable price for renewable energy and funds renewable deployment.[60] England provides financial support and venture capital to clean energy projects through its Carbon Trust[61] and new Green Investment Bank,[62] which, according to the Climate Institute, adds up to a $29.30 per ton implicit price on carbon.[63]

The U.S. is not standing still. Over the last two years, we have invested more than $70 billion in clean energy through the Recovery Act.[65] This money, however, will start running out by the end of 2010 and will completely disappear by 2015, at the latest. In its place, American investment is reverting to a paltry $3 billion per year. This is 0.4% of China's current level of investment and only 17% of the amount South Korea is spending. Other steps, including the creation of ARPA-E (a beyond-the-horizon technology research agency), loan guarantees for the deployment of renewable and nuclear power, a clean or renewable energy standard, and a clean energy deployment bank are all in the works. These policies remain stalled in Washington at a time when our competitors are moving forward at increasing speeds. This has left the U.S. with a relatively paltry $5.10 per ton implicit price on carbon.[66]

The High Stakes of Developing Clean Energy Technologies

A growing number of voices, from business leaders like Bill Gates and General Electric CEO Jeff Immelt, to organizations including the Breakthrough Institute, Brookings Institution and American Enterprise Institute, have warned of the economic threat the U.S. faces if it does not develop a robust clean energy sector.[67] Failure to do so could have three dire consequences: (1) we miss a huge opportunity for economic growth and job creation; (2) when we do adopt clean energy technologies, we will buy them from other countries rather than make them here and (3) it takes the U.S. much longer—and is much more costly—to reduce our fossil fuel use.

American fossil fuel consumption will increase

According to the U.S. Energy Information Administration's *Annual Energy Outlook* projections in 2010, without a transition to clean energy, the United States will increase our annual use of coal by one billion tons and our reliance on oil by 858 million barrels by 2035.[68] Oil demand, while in temporary decline because of the recession, is expected to increase by 1.8 to 2.2% for the rest of 2010 as a recovery takes hold.[69] We will see the amount the U.S. spends to buy oil increase—already $150 billion per year—from countries that the State

Department deems dangerous or unstable.[70] Contrary to popular perception that the era of new coal plants is over, in the last two years, thirty new coal fired power plants have been built or were begun to be built domestically.[71]

Missing out on the clean energy economic boom

Analysts estimate that cumulative investment in the clean energy market could reach as much as $2.2 trillion over the next ten years,[72] with the total market growing to $600 billion annually.[73] But that might not present much opportunity for the U.S. because there are not many American companies poised to seize this growing market. U.S. companies make up only one of the top five wind manufacturers in the world, and just one of the top ten solar energy companies.[74] Comparatively, five of the worlds' top ten information technology companies are American,[75] and the U.S. boasts four of the ten leading pharmaceutical companies globally, including the top two.[76]

This has ramifications across the American economy. According to the Apollo Alliance, $50 billion in investment in retooling and retraining could create 250,000 American manufacturing jobs, support 725,000 more indirect jobs, and generate up to $120 billion in revenue from new products and services.[77] In an analysis of global clean energy trade, Third Way found that aggressive U.S. leadership in global clean energy research and development could increase U.S. clean energy exports by up to $40 billion by 2020 and up to $200 billion in 2050.[78] This would more than double the current $14 billion in American clean energy product exports in 10 years,[79] resulting in up to 750,000 new jobs by 2020 and millions of new jobs by 2050.[80]

Countries like Germany, Japan, South Korea, and China that weathered the Great Recession—thanks to export-oriented economies—are pursuing aggressive energy development and trade policies to build their clean energy export capabilities. This is already having an impact. Over the past ten years, the U.S. trade deficit in clean energy skyrocketed from $300 million to $6.4 billion.[81] The U.S. share of this market was 38% in 2004, a decrease of 31% points in just six years.[82] The ramifications go far beyond energy. In 2010, the trade deficit helped slow the burgeoning economic recovery, reducing growth by almost 3.4% in just the second quarter—the worst trade-related impact on the economy in 63 years.[83]

Battery maker A123Systems is facing this reality. At a recent conference, A123 vice president Jason Forcier pointed out that, "Can we export our batteries to China? The answer is no. You have to build them in-country. And China's making sure that it happens by the way that they're structuring incentives."[84] University of California at Berkeley professor Dan Kammen has also noted that, "factory orders [in Europe] for solar, wind, and other low- and no-carbon technologies have produced tremendous job growth *and* long waiting lists from overseas buyers."[85]

SECTION 2: AMERICA'S AMBIGUOUS RELATIONSHIP WITH CLEAN ENERGY INNOVATION

Americans view our country as a nation of innovators, and innovation as the fuel that drives our economic growth. In many senses they are correct. The U.S. leads the world in the number of patents filed,[86] Fortune 500 companies founded[87] and the number of millionaires.[88] But the myth of the lone inventor in his or her shed creating the next big thing is too often just that, a myth. As far back as the 19th century, the lone inventor often lacked the resources, capital or know-how to solve great innovation challenges on their own. Even President Reagan acknowledged the role of the public sector in supporting private sector innovation. In 1983, he highlighting how the federal patent system, "initiated the transformation of the United States from an importer of technology to a world leader in technological innovation."

The history of American innovation is actually that of the public sector working hand-in-hand with business to solve market failures, provide needed expertise or raise the capital for a risky project to bring it to completion. Without such partnerships, the stories of the transcontinental railroad, the American aviation sector, the Internet, and biotechnology industries would be dramatically different.

But today, clean energy is taking a different course. The private sector is not structured or able to solve the clean energy challenge on its own. It is not investing sufficient amounts in research and development and lacks the incentives to do so. Additionally, federal investment in private sector clean energy R&D and innovation has been uneven over the past three decades, and where there has been funding, investors face a sometimes byzantine and unapproachable bureaucracy that can stymie even the most intrepid entrepreneurs. U.S. businesses are ill-equipped to create, develop, and deploy the new technologies that would make clean energy cheap and establish national leadership in the sector.

However, the last two years have seen some important steps to reverse this trend. Funding for public partnerships with clean energy businesses has jumped dramatically and the U.S. clean technology sector is slowly getting back on its feet with the help of federal investments. But these American entrepreneurs are facing a premature judgment day, as much of the funding that helped them get off the ground is set to expire just as their nascent businesses need it the most.

Innovation as Economic Driver

The long history of American public-private innovation partnerships

Time and again throughout our history, America has faced major technological challenges that the private sector was not able to overcome on its own. In each case, American business leaders and policymakers recognized the benefits to be gained if we could innovate our way through the obstacles. In just the last 150 years, these types of public-private partnerships gave birth to the transcontinental railroad, civil aeronautics industry, Internet and biotechnology, among many others.

Each of these advances had powerful impacts on America's businesses, economy and place in the world, to say nothing of the lives of its citizens. In fact, economists identify this innovation as the foundation for the U.S. becoming the world's economic superpower in the 20th century and the key ingredient for sustaining that status in the 21st century. Innovation created technologies that birthed entirely new industries, dramatically improved worker efficiency, reduced manufacturing costs, reduced travel times, created new goods and services, and eliminated costly health threats. A groundbreaking study by Nobel Economist Robert Solow found that innovation was responsible for 87.5% of the U.S.'s economic growth from 1909 to 1949, when the country went from relatively backwater to a bustling economic super power.[89] Noted economists Dale Jorgensen, Mun Ho, Jon Samuels, and Kevin Stiroh found that economic factors attributed to innovation—capital investment and increased efficiency—account for three quarters of U.S. growth in the second half of the 20th century as well.[90] The question today is whether the government is willing and able to work with the private sector to help companies overcome capital, research, and market challenges that are stifling our ability to find new ways to make clean energy cost-competitive with conventional energy.

Railroads in the 1800s

In the 1800's, the railroad emerged as a faster, more reliable, and more cost-efficient way to transport both people and goods.[91] However, rapid Westward expansion outpaced railroad construction, and Western products and commodities could not get to the Eastern populace in a timely or economical fashion. There were extreme risks and huge engineering obstacles to laying rails across the Rocky Mountains,[92] and because of that, private investors were understandably wary.

Even in the midst of the Civil War, President Abraham Lincoln and Congress recognized the economic and military importance of linking the country in iron rail. They passed the Pacific Railway Act to provide the upfront capital and long-term financing. This enabled the Central Pacific and Union Pacific Railroads to build the tracks that linked the continent's Eastern and Western railroads.[93]

But that's not the whole story. Building railroads across the Rockies and desert west was also one of the great technological challenges of the late 19th century. Most of the engineers involved in the transcontinental railroad were the direct consequence of "strategically targeted polices to support engineering science from the beginning of the 19th century."[94] The striking of the golden spike helped spur massive growth. American GDP jumped from $96 billion in 1869 to $152 billion in 1879 (in 2000 U.S. dollars).[95] Companies like Montgomery Ward and Sears Roebuck expanded, new industries and towns popped up near the rail lines, and Chicago—a small cow town at the center of cattle-grazing and railroad hubs—became the slaughterhouse capital of the world.[96]

Aviation in the 1900s

In 1903, thanks to the experiments of the Wright brothers, the U.S. gave birth to powered flight. By 1913, however, the U.S. fell far behind other countries in the emerging field of aeronautics, ranking 14th in government investment. Foreign companies took the lead in airplane development.[97] In response, the federal government created the National Advisory Committee for Aeronautics (NACA) in 1915, to fund and coordinate industrial, academic and federal R&D in flight.[98] A decade later, the investment was paying off. Research and testing at a NACA facility led Lockheed Aircraft to dramatically increase the maximum speed its airplanes could reach. "Record impossible without new cowling," Lockheed telegrammed to NACA, "All credit due NACA for painstaking and accurate research." This one breakthrough saved the airline industry $5 million at the time.[99]

New cowlings were the first in a long string of innovations in civil aviation, including metal construction, retractable landing gear, higher altitude flying, and greater airspeeds—most of which occurred in the teeth of the Great Depression. Companies simply could not have afforded this research on their own.[100] These innovations also led directly, in 1935, to the development of the Douglass Aircraft DC-3, the first plane that could compete with railroads for passenger travel.[101] Able to speedily fly large numbers of passengers in comfort, the DC-3 was quickly adopted by American, TWA, United, and Eastern Airlines, giving rise to the modern airline industry.[102]

Mid-20th century computing

Another need arose in the late 1950's that the markets were not equipped to handle. With the Cold War heating up, the Defense Department decided it needed a way for its increasingly important computer systems to share information across the globe. It funded in-house and private sector researchers to develop new solutions to reach this goal. By 1962, the U.S. was investing more in computing than all other countries combined.[103] Seven years later, the first two computers were successfully connected, and by 1972, the Defense Department's early version of the Internet was showcased at an international conference, putting it on track for commercialization.[104] Ultimately, it was the government's $1 million investment[105] that spawned the computer and information technology industries. Today's tech giants, like Microsoft, Google, Apple, and Netflix, generate almost $1 trillion in revenues[106] and employ over 1.5 million people would likely not exist, at least not in a form dominated by U.S. companies, without the Pentagon's investment.[107]

Late-20th century genomics

Finally, in 1990, the U.S. began the Human Genome Project (HGP), a joint venture of Department of Energy and National Institutes of Health, to sequence human DNA and map the almost 25,000 human genes.[108] The goal was to gain a much greater understanding of human development and medicine, leading to the next generation of biomedicines.[109] Government funding and leadership was viewed as critical because of the costs involved in the project and the desire to ensure that any interested researcher could have access to discoveries from the HGP. Total funding for the project exceeded $2.7 billion.[110] The resulting discoveries—which were available for license to any private sector company—helped launch the multibillion-dollar biotechnology sector and, so far, has led to the creation of over 350 new biotech products.[111] During the lifetime of the HGP, from 1993 to 2001, when the rough draft of the genome was completed, the government-funded project and open licensing of the resulting discoveries enabled the biotech industry revenues to triple from $8 billion to over $27 billion.[112] Over 300,000 new industry-related jobs were created, and employment in the biotech industry also more than doubled.[113]

Transcontinental rail service. Passenger air travel. Information technology. Biotechnology. These American successes might not have occurred, at least not in the U.S., without public-private partnerships. The government provided the capital, fostered the scientific and engineering know-how, created the initial market demand or conducted the research. Today, clean energy faces the same challenges as those sectors did earlier in the century. The question is: will the U.S. provide the same federal partnership for the private sector that has benefited us so many times in our past?

Existing Public and Private Sector Funding for Innovation is Insufficient

While the IT revolution can offer important lessons for clean energy development, there are major differences in maturity of the respective industries, scale of infrastructure needed, and initial capital required for clean tech today versus IT twenty years ago. King among these factors, of course, is cash. Existing companies and the private capital markets are not investing sufficient amounts in clean energy R&D and innovation because of the enormous upfront costs and the absence of current market demand in the U.S.

Without some other external driver, like the national policies in Europe and Asia, there is little incentive to spend money on the expensive pursuit of energy innovation. This mentality has left all private sector energy research and development funding—not just clean energy—in the basement. Public funding, though dramatically better in 2009-10, also remains anemic compared to leading countries like China, Japan, Germany, and Spain.

The private sector hardly invests in energy R&D

To understand the great capital challenge that clean tech innovation faces, we have to take a look at the bigger picture. In the U.S., the private sector barely invests in *any* energy research. Where U.S. industries, as a whole, spend an average of 2.6% of their revenue on R&D, the energy industry invests a paltry 0.23% of revenue on any kind of research—clean or conventional.[114] This includes funding for expensive research into conventional fuels, such as ultra-deep water drilling and new oil refining techniques, which is an important point. Forget about the pursuit of clean energy; the energy sector relies on the same fuel sources that have provided reliable, inexpensive energy for more than 100 years. There is not an economic imperative to spend more. This stands in stark contrast with the hyper-competitive pharmaceutical industry, where new drugs supplant old ones every year. Pharmaceutical companies spend 19% of revenues, or about $39 billion each year on R&D.[115] Even American automakers, despite tough economic conditions, still invest $17.5 billion in R&D.[116]

Energy innovation that *is* occurring is coming from much smaller startup companies that rely on venture capital and newly unleashed federal investments. This has helped give rise to the likes of Tesla Motors (electric vehicles), Bloom Energy (fuel cells), Better Place (electric cars) and Bright Source Energy (solar thermal power). The Great Recession, however, has greatly reduced the flow of venture funding to clean tech companies just as the global competition to foster new companies heats up.[117] After climbing steadily from $262 million in capital clean energy investments in 2003, venture capital investments peaked at $4.1 billion in 2008. It fell by over 50% in 2009.[118] The trend is not abating. The most recent venture capital investment reports show that funding has dropped 55% this year over the same period in 2009.[119]

Expecting private sector spending to support the entirety of clean energy innovation and R&D puts U.S. businesses on an unfair playing field with their international competitors. That's because private sector money, whether through direct corporate investment in innovation or through the capital markets, simply is not sufficient. Jeff Immelt sums up the private sector frustration well, "The United States is falling behind because we don't have the markets or the will—our policies are short-sighted and our markets aren't set up to reward energy innovation."[120]

The federal government presently lacks both the structure and the financing necessary to meet the energy challenge

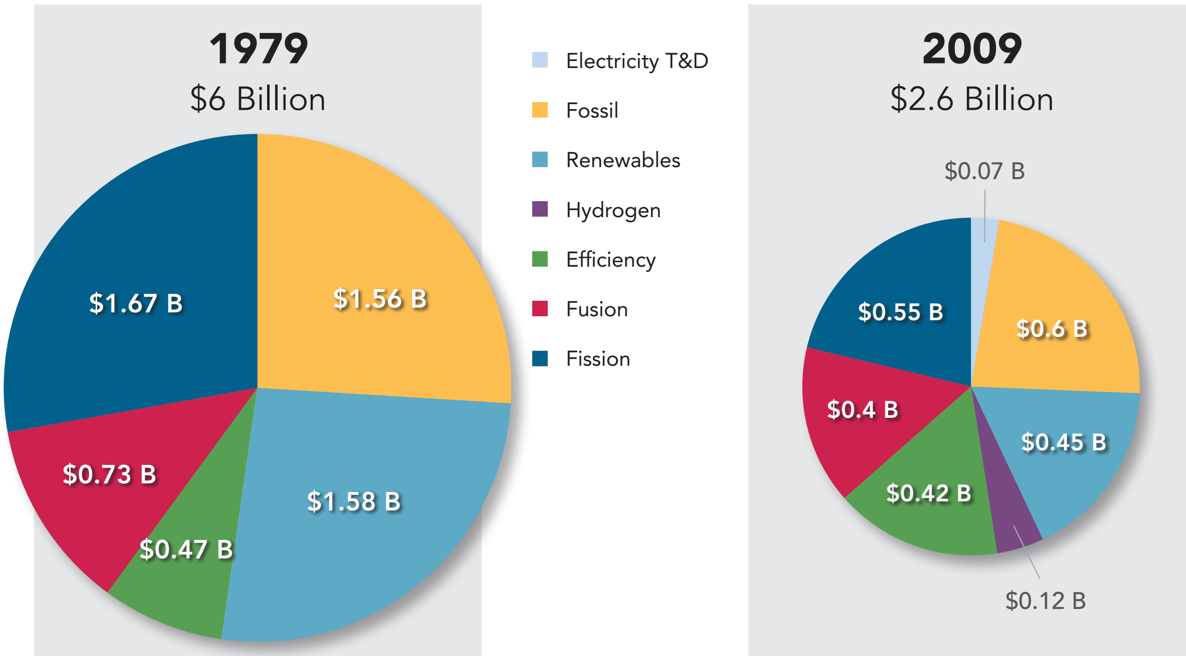
A public partnership to support innovation through the R&D, demonstration, deployment, and commercialization cycle is crucial. Norman Augustine, former Undersecretary of the Army and Chairman of Lockheed Martin, explained that "Endeavors of this type are generally unattractive investments for the private sector, yet clearly serve the public good. This is exactly the kind of effort for which government must step in and provide the needed financial investment."[121] Although the federal government has a long history of funding innovation and emerging technologies, investments in energy have always been low compared to other federal research efforts.[122]

There was one period when this was not the case. In the late 1970's, the federal government invested heavily in clean energy R&D in response to the oil crisis. OPEC's intransigence drove home the urgent need to move away from fossil fuels, resulting in energy R&D funding equaling 10% of total federal R&D spending in 1980. The urgency quickly declined with the price of oil and investment in energy R&D fell, hitting just 2% of total R&D spending by 2007.[123] Even with the renewed commitment to clean energy innovation in 2009-10, U.S. investment is only half of what it was in 1980.

This rollercoastering of R&D funding undermines the goal of developing new innovations. The dramatic funding decline after 1980 brought down private sector R&D funding and resulted in steep drops in the number of wind, solar, and nuclear energy patents filed.[124] This was the driving cause in the U.S. losing its lead in global clean energy technology. Talent also followed the money away from energy to other sectors. One solar researcher from the National Renewable Energy Laboratory remembers the frustration well: "They fired almost half our staff. They reduced our $135 million budget by $100 million. They terminated all our contracts with universities—including two Nobel Prize winners—in one afternoon."[125]

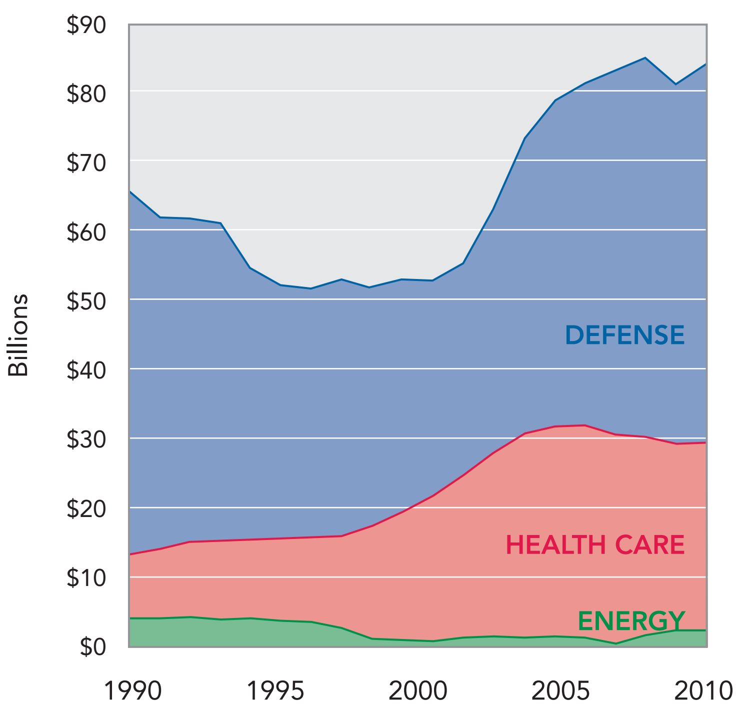
U.S. DOE Energy R&D Spending

FY 1979 vs. FY 2009 Request in FY 2000 Dollars[126]



R&D Spending in Energy, Health, and Defense

1990–2009 Constant 2009 Dollars, Excluding Stimulus



Federal investment in health and defense innovation has never faced the rollercoaster of uncertainty faced by energy. Over the past two decades, the government has invested $52 billion in energy, compared to $452 billion in health research and $1.3 trillion for defense.[126] Public energy innovation funding dipped then flat-lined beginning in 1998 while investment in health and defense increased by an average of $167 million a year. This has correlated into a 4% growth in the defense sector and 5% in healthcare compared to only 2.3% in energy in the U.S.

21st Century Challenges to Public Investment in Innovation

The American Recovery and Reinvestment Act of 2009 (ARRA) allocated over $70 billion toward clean energy, which is intended to leverage an additional $270 billion in private investment.[127] This provided a desperately needed cash infusion in 2009-10 to replace money lost from a downward trend in investment in the sector for most of the decade. But funding ends this year and the money will completely run out by 2015.[128]

The Clean Energy Agency Maze

Money is not the only stumbling block for companies seeking to partner with the federal government. The maze of programs dedicated to funding clean technology has added layers of unnecessary bureaucracy and confusion for many private sector innovators. In all, eleven departments and agencies have clean energy innovation programs. Combined, they host as many as 143 different programs that play a role in shaping clean energy innovation.[129] There is often little communication across agency lines and unclear decision-making authority.[130]

These agencies cover everything from smaller programs like the Department of Agriculture's Rural Energy for America Program, to the Small Business Administration's Small Business Innovation Research Program, to agency-wide programs in the Department of Energy and Department of Defense. The sometimes labyrinthine nature of innovation programs has also made interagency information sharing challenging and funding difficult to track. A recent Harvard report warns, "To achieve the maximum payoff for public investments in energy technology innovation, the United States will need to improve and better align the management and structure of existing and new energy innovation institutions and better connect R&D to demonstration and deployment."[131]

Some overlap of government function is useful. It creates a competitive environment among programs, can encourage risk-taking, and helps independent and creative thought. However, it is also critical to ensure that every taxpayer-funded program is absolutely necessary, has a clear mission, provides for transparency and accountability, and that its efforts are not being duplicated in the private sector. Foreign governments with fewer limits on funding and more streamlined R&D investment processes—like China—have a significant advantage they can use to entice entrepreneurs and manufacturing operations overseas.[133]

What's next?

Stimulus funding was never intended to provide the long-term investment the U.S. needs to spark private sector clean energy innovation and it should

The Clean Energy Maze

Clean Energy Funding Across Agencies/Programs[132]

DEPARTMENT OF ENERGY

Fossil Energy

- Fossil Energy R&D
  - » Natural Gas Technologies
  - » Petroleum - Oil Technologies
  - » Unconventional Fossil Energy Technologies
  - » Cooperative R&D
  - » Coal Technology
    - - Fuels and Power Systems

Energy Efficiency and Renewable Energy (EERE)

- Hydrogen Technology
- Fuel Cell Technologies Program
  - » Hydrogen and Fuel Cell Technologies
- Solar Energy
- Wind and Water Power Program
  - » Wind Energy
  - » Water Power
- Biomass Program
  - » Biomass and Biorefinery Systems R&D
- Geothermal Technologies Program
- Vehicle Technologies Program
  - » Alternate Fueled Vehicles
  - » Transportation Electrification
  - » Advanced Battery Manufacturing
- Building Technologies Program
- Industrial Technologies Program
- Weatherization and Intergovernmental Program
  - » Energy Efficiency and Conservation Block Grants
  - » State Energy Program Grants
- Federal Energy Management Program
- Conservation Weatherization Program (excluding training and technical assistance)
- RE-ENERGYSE (partnership with NSF)

Electricity Delivery and Energy Reliability (EDER)

- Research and Development
- Smart Grid Investment Program
- Smart Grid Regional and Energy Storage Demos

Office of Nuclear Energy

- Nuclear Energy
  - » Nuclear Energy Enabling Technologies
  - » Integrated University Program
  - » Reactor Concepts RD&D
  - » Generation IV Nuclear Energy Systems
  - » Nuclear Power 2010
  - » Fuel Cycle RD&D
  - » International Nuclear Power Programs
  - » RE-ENERGYSE (partnership with NSF)

Office of Science

- Science
  - » Basic Energy Sciences
  - » Fusion Energy Sciences Program
  - » Small Business Innovation Research Program

Title 17 - Innovation Technology Loan Guarantee Prog.

- Section 1705 Temporary Loan Guarantee Program

Advanced Technology Vehicles Manufacturing Loan Program

Energy Innovation Hubs

Energy Frontier Research Centers

Small Business Administration (EXTERNAL to DOE)

- Small Business Technology Transfer Program

DEPARTMENT OF DEFENSE RESEARCH, DEVELOPMENT, TESTING & EVALUATION (RDT&E)

Department-wide

- Applied Research
  - » Plasma Fusion (Polywell) AR
- Advanced Technology Development
  - » Energy Modeling ATD
  - » Wind Lift Power Generator ATD
  - » HPCM Maui Energy Improvement Initiative ATD
  - » Algal Derived Biofuel Program ATD
  - » Fuel Cells ATD
  - » Fuel Efficient Ground Vehicle Demonstrator
  - » Materials - Ceramic Matrix Composites
  - » Mobile Waste to Energy
- Advanced Component Development and Prototypes
  - » Energy Enterprise Management ACDP
  - » Solid Waste Gasification ACDP
  - » Anaerobic Digester Technology ACDP
  - » Landfill Gas Energy Capture ACDP
  - » Tactical, Deployable Micro-Grid ACDP

Army

- Applied Research
  - » Develop smaller, lighter cogeneration and absorption environmental control style AR
  - » High Temperature Silicon Carbide (SiC) Power Semiconductors AR
  - » Lightweight, Flexible, Cost Effective Solar Energy Photovoltaics AR
  - » Environmental Quality Technology AR
- Advanced Technology Development
  - » Ultra Low Energy Community Systems ATD
  - » Energy Security Audit & Islanding Methodology ATD
  - » Advanced Power Electronics Ground Systems Testbed Equipment ATD
  - » High Temperature Silicon Carbide (SiC) Power Semiconductors ATD
  - » Micro-Grid Field Scaled Demonstration ATD
  - » Environmental Quality Technology Demonstrations ATD
- Advanced Component Development and Prototypes
  - » Environmental Quality Technology ACDP

Navy

- Applied Research
  - » Plasma Fusion (Polywell) AR
- Advanced Technology Development
  - » Power Projection Advanced Technology ATD
- Advanced Component Development and Prototypes
  - » Advanced High Energy HVAC System ACDP
  - » Advanced Nuclear Power Systems
  - » Aircraft Energy Conservation RDTE Program ACDP
  - » Alternate Test Fuel and Cert Protocol Acceleration ACDP
  - » F18 Engine Efficiency Improvements ACDP
  - » Hybrid Electric Drive System Development for Surface Combatants ACDP
  - » Navy Shipboard Energy Program ACDP
  - » Ocean and Wave Energy Utilization - OTEC ACDP
  - » Environmental Protection
  - » Navy Energy Program
- Operational Systems Development
  - » Improved Environmental Control Equipment OSD
  - » On-board Vehicle Power Operational Systems Development (OSD)
  - » Integrated Generator/Environmental Control OSD

Air Force

- Basic Research
  - » Nanoscale Additives for Novel Fuels Basic Research
- Applied Research
  - » Adaptive Versatile Engine Technology (ADVENT) AR
  - » Aft-Body Drag Reduction
  - » Energy Efficient Small Scale Propulsion and Power (ESSP) AR
  - » Highly Efficient Embedded Turbine Engine (HEETE)
  - » Hybrid Electric UAV High Endurance Renewable Propulsion and Power System AR
  - » Improved Transparent Conductors for Solar Cell Applications AR
  - » Ultra-High Efficiency Multijunction Solar Cells for Space and Terrestrial Concen AR
- Advanced Technology Development
  - » Materials for Green Propulsion ATD
  - » Global Solar Prediction Model for Airbase Renewable Energy Design and Simulation ATD
  - » Greenhouse Gas Lifecycle Analysis for 2nd and 3rd - Generation Biomass-Derived Aviation ATD
  - » Development and Demonstration of High Efficiency Portable Fuel Cells ATD
  - » Deployable Multi-Fuels Electric Generator ATD
  - » Toxicology Assessment of Biomass-Derived Aviation Fuels ATD
- Advanced Component Development and Prototypes
  - » Alternative Fuels
  - » Pollution Prevention
- Operational Systems Development
  - » High Concentration Anaerobic Bioreactor OSD
  - » Demonstration of Self Sustaining Energy Technology for Basic Expeditionary Airfi OSD

Small Business Administration (EXTERNAL to DOD)

- SBIR/STTR Management Support

NATIONAL SCIENCE FOUNDATION (NSF)

Integrative Activities

- Science and Technology Policy Institute

Cross-Cutting Programs

- Long-Term Research Sites (LTER)
- Science and Technology Centers

Research Infrastructure

- Cornell Electron Storage Ring

Programs to Broaden Participation

- Comprehensive Broadening Participation of Undergraduates in STEM

RE-ENERGYSE

Cross-agency sustrainability research effort focused on renewable energy technologies and complex environmental- and climate-system processes

NATIONAL INSTITUTE FOR STANDARDS AND TECHNOLOGY (NIST)

Industrial Technology Services

- Technology Innovation Program
- Hollings Manufacturing Extension Program

Small Business Innovation Research Program

Smart Grid Interoperability Standards Project

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

Operations, Research, and Facilities

ENVIRONMENTAL PROTECTION AGENCY (EPA)

Research and Development Initiatives

- Science to Achieve Results (STAR) Program
  - » Hydraulic Fracturing Research
  - » Green Infrastructure Research
- Climate Change Initiatives
  - » CAA GHG permitting
  - » Renewable Fuel Storage

DEPARTMENT OF AGRICULTURE (USDA)

Departmental Activities

- Executive Operations
  - » Office of the Chief Economist

Research, Education, and Economics

- National Institute of Food and Agriculture (NIFA)
  - » Biodiesel Fuel Education Program
  - » Agriculture and Food Research Initiative
    - - AFRI global climate change research to develop mitigation capabilities and adaptive capacities for agricultural production
- Agricultural Research Service
  - » Environmental Stewardship

Rural Development

- Rural Business-Cooperative Service (RBS)
  - » Biorefinery Assistance Program
  - » Rural Energy for America Program (REAP)
    - - Guaranteed Loans
    - - Grants
  - » Biorefinery Assistance Guaranteed Loans
  - » Business and Industry Guaranteed Loans
  - » Bioenergy for Advanced Biofuels
- Rural Utilities Service (RUS)
  - » Electric Loan Program

Farm and Foreign Agricultural Services

- Commodity Credit Corporation
  - » Biomass Crop Assistance Program

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

Science

- Earth Science

Education

- Higher Education STEM Education
- K-12 STEM Education
- Informal STEM Education

Construction and Environmental Compliance and Restoration

Aeronautics Research

- Integrated Systems Research
  - » Green Aviation

DEPARTMENT OF TRANSPORTATION (DOT)

Federal Transit Administration

- Greenhouse Gas and Energy Reduction Total Clean Fuels and Environmental Research Greenhouse Gas and Energy Reduction
- Grants for Energy Efficiency and Greenhouse Gas Reduction
- Clean Fuels Grant Program (Section 5308)
- National Research and Technology
- Greenhouse Gas and Energy Reduction Deployment and Innovative Technology

National Highway Traffic Safety Administration

- Alternative Fuels Vehicle Safety (Hydrogen)

Research and Innovative Technology Administration

- Alternative Fuels R&D

Federal Railroad Administration

- High Speed Rail

Federal Aviation Administration

- Research, Engineering, and Development
  - » NextGen Initiative
    - - Environmental Research
    - - Alternative Fuels
  - » Improve Efficiency
  - » Reduce Environmental Impacts

National Infrastructure Innovation and Finance Fund

SMALL BUSINESS ADMINISTRATION (SBA)

Regional Cluster Initiative

- Regional Innovation Clusters

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

Energy Innovation Fund

not be. That is why there have been simultaneous efforts to modernize federal innovation, including funding of the Advanced Research Projects Agency–Energy (ARPA-E) and creation of the DOE Energy Frontier Research Centers (ERFCs).[134]

ARPA-E is modeled after Defense Advanced Research Projects Agency (DARPA) and is intended to engage in high-risk, transformational energy research that private industry is hesitant to undertake, because the cost risks and potential for failure are too great and current market demand too limited.[135] The EFRCs support teams of researchers conducting fundamental research on "grand challenges" identified within the scientific community, in order to provide a foundation for the new clean energy economy.[136] These programs set outcome goals but leave it up to researchers and entrepreneurs to determine the path they will take to achieve them. This is vital to inventing breakthrough energy technologies. Unfortunately, at $388 million,[137] funding remains well below the annual $1 billion experts believe is needed for ARPA-E alone.[138]

These efforts also represent a new federal ethos that clean energy innovation is a national priority. The ARRA injected needed capital into U.S. clean energy innovation efforts, financing 11 battery component factories and 10 electric drive component facilities for manufacturing advanced batteries for electric vehicles in several states, including Michigan, North Carolina, and Indiana.[139] Michigan based A123 Systems was awarded $249 million to build three factories for lithium-ion batteries for vehicles, electric grid storage, and other applications.[140] ARPA-E is providing $80 million for 20 R&D projects to develop next generation battery chemistry that could cut battery costs by 90% and multiply electric vehicle range six times.[141]

The stimulus, however, was a one-time investment. Once it runs out, clean energy funding will drop by over $65 billion to $3.5 billion.[142] This is a glide path very few new companies could succeed on. As Arno Harris, CEO of Recurrent Energy, a San Francisco based solar power company, warns, "The industry has just gotten out of the starting blocks. Letting the program expire at the end of 2010 will seriously undermine market confidence and disrupt project finance markets just as they are emerging from the ruins of 2009."[143]

SECTION 3: RENEWING AMERICAN INNOVATION

The Recovery Act was never meant to be a permanent funding stream. So how does the United States reinvigorate its energy sector to develop technologies that are clean and affordable?

Ultimately, it's up to the private sector. American businesses turn new ideas into useful products, make and sell them, and create the jobs that drive our economy. Because of the cost of research, development, demonstration and deployment of new technologies, the financial risk involved and the absence of market-demand, the private sector can't do it alone. The federal government can help remove financing roadblocks with smart, targeted policies and structures, but there is no one way to accomplish this. The government could, however, find ways to partner with the private sector to help overcome market failures and inefficiencies. These include[144]:

1. **Reforming the federal clean energy infrastructure** to provide direction for clean energy innovation;
2. **Creating the early markets for private sector clean energy technologies** until they are brought to scale and become affordable;
3. **Ensuring that new clean energy technologies are manufactured in the United States** and that every region of the country reaps the benefits.
4. **Educating the next generation of scientists and technicians** to help America make the leap to clean energy;
5. **Helping the private sector bridge the capital gap** by investing $15 billion in clean energy research, development, demonstration and deployment.

Providing Direction through a Reformed Clean Energy Infrastructure

After decades of stasis, America's clean energy innovation efforts have been reinvigorated over the last two years with new funding and programs. But in some cases, it has grown too quickly or without the organization and focus that are critical for long-term success. In an era of constrained budgets and suspicion of big government, this is a recipe for disaster. It is critical to our economy that the federal government is able to continue to help the private sector develop and commercialize the next generation of clean energy technologies. To do so, the government should reform the innovation infrastructure. It should reorganize the programs that work in a more coherent structure, eliminate those that don't, and make it easier for businesses and other innovators to get access to them.

Create a National Institutes of Energy

The National Institutes of Health (NIH) is an ideal model for a streamlined federal clean energy innovation system. Unlike the multi-headed energy research effort, NIH is the primary federal medical research body. It has a clear mission, strong public and Congressional support, and an efficient bureaucracy. As Third Way and the Breakthrough Institute detailed in our report, Jumpstarting a Clean Energy Revolution with a National Institutes of Energy, [145] we can do the same in energy by creating the NIE. [146]

The National Institutes of Energy should also have a singular mission: to fund and conduct groundbreaking energy research throughout the United States.[147] This could include specific goals, like cutting the recharging time of electric vehicles by 90% from today, or beyond-the-horizon objectives like pulling electricity directly from the air itself.[148] This would help effectively focus research efforts and funding toward the development of new, low-cost commercial clean energy technologies. Unlike NIH, however, NIE would focus on ultimately commercializing new innovation, not just securing patents and publishing research papers.

Enhancing What Already Works at DOE and the Pentagon

Creation of an NIE is not intended to replace the innovation already occurring at ARPA-E, the DOE run national labs and the Department of Defense. Rather, NIE would incorporate many of those innovation programs and function as a nationwide network of regionally-based, commercially-focused and coordinated public, academic and private sector innovation institutes. This would reduce overhead costs, increase efficiency, and establish a clear mission, without duplicating what is already working or creating a new bureaucracy.

ARPA-E and the National Labs

The U.S. already has 21 national laboratories, in addition to ARPA-E, many of which conduct invaluable clean energy research. These organizations should continue their excellent work, with sufficient funding, as part of the National Institutes of Energy structure. Today, they are conducting vital research in efficiency, nuclear power and renewable energy.[149] The basic R&D conducted at the labs like Oak Ridge, is complemented by the applied research done at the National Renewable Energy Laboratory, the Idaho National Laboratory and the advanced research conducted through ARPA-E. ARPA-E was funded for the first time in 2009, and is dedicated to developing technologies that will revolutionize the energy landscape, such as liquid batteries that could solve the intermittent energy storage problem.[150] Support for the work conducted at these institutions should continue, with a particular emphasis on furthering federal applied research efforts, which play a large role in the deployment of clean energy technologies.

Department of Defense

Reliable clean energy can help the Pentagon reduce costs and strengthen the security of its installation and operations in both the U.S. and abroad. Right now, our military combat operations in Iraq and Afghanistan require 8.16 million gallons of fuel every day,[151] while DOD as a whole consumes approximately 125 million barrels of oil annually.[152] Trucking fuel to military bases through hostile territory in vulnerable convoys exposes our troops to unnecessary danger and hampers our operational abilities. A report by the Army found that one soldier or civilian is killed for every 24 convoys of fuel in Afghanistan.[153] DOD leaders have already made clear that relying on fossil fuels is detrimental to their mission. As Navy Secretary Ray Mabus observes, "Energy reform will make us better fighters. In the end, it is a matter of energy independence and it is a matter of national security. Our dependence on foreign sources of petroleum makes us vulnerable in too many ways. The stakes are clear and the stakes are high. Our response has to be equal to that challenge."[154]

To drive innovation at DOD, clean energy technologies should be utilized by the department at every smart opportunity. In addition to its ongoing efforts to increase its efficiency,[155] DOD has already begun to move in this direction by entering into an agreement in July 2010 with the Department of Energy to speed innovation of secure clean energy technologies for military applications.[156] One priority objective of this program must also be to create products that could be spun off for civilian use. Through a partnership of this kind, both departments could develop new fuel and energy storage options, projects to ensure grid security, and speed the process of bringing online small modular nuclear reactors,[157] advanced solar power, and other distributed energy technologies to improve security and lower carbon emissions from military installations.

Open the Bureaucracy and Advocate for Researchers

The existing federal energy innovation structure crosses eleven agencies and departments and 143 different programs. This makes it difficult to track the impact of the programs and creates unnecessary barriers for innovators who want to work with the government. Streamlining this maze of programs under the roof of a NIE will help reform federal innovation programs. It will remain important for someone to ensure that businesses' needs are being met, both within an NIE and across clean energy innovation agencies outside of DOE. This could be accomplished by creating an Inter-Agency Energy Innovation Emissary.

The Emissary would serve as an advocate for grantees and researchers to cut through the federal innovation bureaucracy, much like the Small Business Administration's Office of Advocacy. With access to all of the 143 innovation programs, it could assess the performance of all of the programs and make recommendations on where to eliminate duplicative efforts and how to best allocate innovation dollars. This kind of review process could allow government programs to compete, just like businesses in the private sector. The best performing programs would receive greater support and poor performers would have to improve or get phased out. Finally, an Emissary could also help identify new technologies and place them at appropriate government facilities for demonstration, deployment and procurement. This could create healthy competition between agencies as they seek the best technologies and employ different funding methods and strategies. It would also help researchers and the general public by serving as a one-stop access to all of the federal clean energy innovation programs.[158]

Enable Layering of Incentives

The capital costs of clean energy innovation are often prohibitive without government loans or grants. Current rules, however, prevent companies that need assistance at different stages of the development, deployment, and commercialization effort or are eligible for funding from different programs to apply for it from multiple sources. This can unintentionally delay or even kill promising private sector innovation. To eliminate this risk, the government should allow companies to apply for and receive multiple streams of funding under strict guidelines. These limitations, overseen by the Innovation Emmissary, would help maximize incentives to worthy but expensive projects without wasting tax dollars on "double dipping."

Creating the Early Markets for Clean Energy Technologies

One of the biggest challenges for new clean energy technologies is getting them to commercialization. This requires large amounts of capital. It is hard to justify scaling-up new technology in an uncertain market that faces stiff competition from low-priced conventional energy sources.[159] As a National Renewable Energy Laboratory study noted, "In the 'cash flow valley of death' entrepreneurs face the dangerous convergence of high cash demands and low ability to raise it." That's because investors are understandably wary of putting money into a venture that requires large capital infusions while promising a long wait before profits might be realized.[160] Cost, however, should only be one factor. There is a real public interest for the federal government to leverage its capital and enormous procurement resources to help bridge the gap during this capital "valley of death." Improving health by reducing pollution is a significant intangible that influences government policy. The commodity prices of natural gas, oil and coal beyond five years is very hard to predict. There are economic and security justifications to further diversify our energy sources. The clean energy market is likely to get too big to ignore.

Finance the Deployment of New Clean Technologies

A Clean Energy Deployment Fund could provide companies access to funding when capital is short but the need for it is great to get new products to market. This fund breaks new ground by recognizing that innovation doesn't end at the lab, and serves as the first deployment-oriented agency designed to accelerate clean energy innovation. It would be able to take on riskier projects, thanks to explicit technology improvement goals, with objectives to drive lower prices and improve performance in an array of nascent clean technologies. To date, most clean energy deployment policies—such as renewable electricity standards and production tax credits—are focused almost entirely on driving up the numbers for the construction of clean energy facilities. This has a built-in bias for mature technologies that are more certain but may also be much more costly in the long run.

Much like a bank, the deployment fund would provide financing through a flexible suite of credit options, including loan guarantees, low interest loans, equity stakes, securitization, and insurance. The fund would also help businesses developing innovative new clean technologies to secure private-sector financing by increasing capital in this critical sector. Just as importantly, this fund would break out of the government's risk-adverse culture. To achieve the results we need, it is going to be necessary invest in high-risk/high-reward projects that are being starved for funding in the private markets. This would supplement—but not muscle out—venture funding that is often not available for the deployment stage.[161] While losses on some investments will be inevitable, the goal will be for the overall fund to maintain a positive cash flow. This will enable it to help the nation unleash the private sector ingenuity to meet our energy goals while also being a responsible steward of taxpayers' money.

Leverage the Military's Purchasing Power to Buy Clean Energy Technologies

The U.S. military consumes more energy than 85% of all nations, is the world's largest institutional oil buyer[162] and has the largest procurement budget in the federal government at $104 billion.[163] It has a clear need for clean energy to reduce its costly reliance on fossil fuels, the complex and dangerous logistics of supplying forward operating bases and combat operations and the security risks from facilities reliant on a national grid that is vulnerable to attack, natural disaster or accident.

The Department of Defense is already moving in this direction through its Green Procurement Requirements.[164] These rules require DOD to consider environmental factors in purchasing decisions, such as energy efficiency and alternative fuels. To jumpstart innovation, the Pentagon should build emerging technology considerations into these requirements for non-combat operations. DOD could leverage its position as a demanding customer in competitive procurement contracts to drive improvement in clean energy performance and price. This shouldn't be limited solely to technologies that generate clean energy. Requirements should also focus on conservation projects, building energy efficiency standards and non-combat vehicle platforms and fuels.

DOD could also give procurement preference to promising emerging technologies that might cost more initially but exceed the performance of older but cheaper technologies. This would be particularly helpful in developing new fuel and energy storage options, creating pilot or demonstration projects to increase grid security, and speeding the process of bringing online small modular nuclear reactors.

Unfortunately, many clean energy businesses are not getting access to DOD to bid on clean energy or efficiency contracts. Congress could set guidelines for DOD to improve its procurement process and for base commanders to have more flexibility in clean energy/efficiency procurement to build stronger vendor relationships with clean energy businesses. Of course, with a vast array of sites around the world, the needs at Pentagon facilities vary greatly. It is vital that these facilities remain a part of the communities where they are located, while also maintaining mission readiness. This should be kept in mind as the military incorporates clean energy technologies.

Just as DOD can set benchmarks for the adoption of clean energy technologies, it could also make clean energy procurement more likely for the rest of the federal government. The General Services Administration could use DOD as a model to establish government-wide standards and best practices to expand the market for clean energy and efficiency products.

Assist Small and Medium Businesses in Purchasing Clean Energy Technology

Another option is for the federal government to establish a Low Carbon Trust, similar to the British Carbon Trust,[165] to accelerate the development of markets for clean energy technology and support venture capital investments through the "valley of death." The government would capitalize the fund with appropriations of $50-$100 million per year for three years,[166] which the Trust would invest in small and medium sized businesses to develop and purchase clean energy technologies. It could also prioritize funding for different but important functions. First, it could provide low-interest loans could to small-and-medium sized businesses to purchase new clean energy and energy efficiency technologies. This will help expand the market for these products and in many cases reduce the energy expenses of businesses. Second, the Low Carbon Trust could work with clean energy venture capital funds to drive investments into high-risk/high-reward clean energy start-ups. The Trust would operate as a public-private partnership governed by a private board of directors and, after three years of initial funding, would be expected to operate off of revenues generated from its own lending and investments.

Provide Utilities Incentives to Adopt New Technologies

Ultimately, we are going to need utilities to adopt new clean energy generation technologies to get demand to the scale that creates new markets. The federal government can help encourage first movers by providing utilities that are first adaptors, with incentives that offset any increase in operating costs. This would ensure that customers and utilities would not have to pay more for electricity while building a new market. Similarly, the government could allow rural electric co-operatives to enter into long term power purchase agreements for electricity generated from new clean energy technologies, which would help drive deployment and commercialization without burdening customers.

Ensuring that American Innovations are Made in America

The world's two most recent technology revolutions—Information Technology and biotechnology—were driven by intellectual capital. In the U.S., this prompted most new businesses to open around the academic hubs of the Northeast and West Coast. Clean energy technology is different. Production of many clean technologies from wind turbines, to small and large nuclear plants, to advanced batteries require the skilled workforces and heavy manufacturing capabilities found primarily in the Midwest and South.[167] When these products come to market, American companies will purchase them. Regions reliant on conventional energy will take the steps necessary to capitalize on this transition.

Low Carbon Manufacturing Technologies Research Program

American manufacturing is susceptible to price swings in the natural gas market. The manufacturing process simply requires massive quantities of energy, primarily from natural gas. In fact, the heat derived from fossil fuel combustion accounts for 92% of the energy used by these industries.[168] Today, natural gas prices are at historic lows.[169] Thanks to improved extraction and new natural gas discoveries prices may remain low. This, however, is still a commodity market. Even a relatively small but sustained spike in natural gas prices could put American manufacturers at a competitive disadvantage. Their overseas competitors have lower operation costs and often have access to cheaper fuel.

To keep America competitive, we should identify ways to develop and make available affordable clean and efficient energy technologies for manufacturing. This is vital. Manufacturing processes likely will have to be modernized—adapting new technologies and increasing efficiency—in order to meet future clean energy standards. Establishing the development of technologies to reduce carbon emissions from the manufacturing sector can help bridge the industrial clean energy gap and providing low cost power should be a core part of DOE's research mission.[170] This could be integrated into the efforts of an NIE or ARPA-E, for example, to develop technologies to eliminate or sequester carbon from industrial practices. It could also include DOE support for research and development of an advanced Small Modular Nuclear Reactor, which would affordable produce process heat for manufacturing.

Create a Clean Energy R&D-Specific Tax Credit

Currently, companies are only able to deduct 14% of the money they spend on any research and development. This excludes capital expenditures—a huge contributor to overhead costs—and simply is not a sufficient incentive for expensive clean energy efforts which often take years to produce results. To align federal taxes with the nation's economic and policy goals, we should create a specific federal Clean Energy R&D credit. The credit would be for 50% of the qualified expenditures and could include capital investments that are integral to a research project. This would supplant the federal R&D tax credit for clean energy-specific research so that companies are able to finance the critical activities that lead to new innovations. The credit would be available for expenditures in nuclear energy, renewable energy, energy efficiency, transmission and smart grid, fuel cells and batteries, and carbon capture and sequestration.

Advanced Energy Manufacturing Tax Credit

Polices in *The American Recovery and Reinvestment Act* put the U.S. on this path by providing manufacturers with funding for the first time to retool and invest in building clean energy technologies through the Advanced Energy Manufacturing Tax Credit, also known as the Section 48C credit.[171] So far, $2.3 billion allocated by the 48C tax credit has been able to generate $7.7 billion in private sector clean energy investments and is expected to create over 17,000 good-paying jobs.[172] This funding has brought on line vital clean energy manufacturing capacity that is key to building and improving the technologies needed for a clean energy future. The tax credit, however, has been oversubscribed and expired in October of 2009.[173] Given the importance of the 48C tax credit, it should be preserved and expanded to $5 billion to meet demand.

Expand American Clean Tech Access to Foreign Markets

The U.S. faces a $6.4 billion[174] clean energy trade deficit. One significant reason is that American companies are locked out of foreign clean energy markets. The U.S. government must pursue a clear and forward-looking clean energy export strategy to put U.S. businesses on a fair playing field to compete and in overseas markets. Right now, many nations' trade-distorting policies and practices prevent U.S. exports from reaching foreign customers. For example, in China, for a foreign company to sell electric vehicles, a Chinese company must be "involved" in the most valuable parts of the vehicle: battery, motor, or power electronics.[175] While these impediments constrain U.S. clean energy exporters, their foreign competitors are backed by robust, highly strategic, and agile government export promotion efforts.

The U.S. clean energy export strategy should include the aggressive promotion of American clean energy businesses abroad, especially small and medium-sized enterprises, and a strategy to address practices and policies that distort trade and cause unfair business environments for U.S. firms. As detailed in Third Way's paper Getting Our Share of Clean Energy Trade, we can accomplish this by: (1) having the federal government set clear U.S. clean energy export goals, (2) establishing a clean energy export opportunity fund for small and medium-sized companies, and (3) requiring the U.S. Trade Representative to prioritize trade enforcement in the clean energy sector.[176]

Strengthen Energy Innovation and Manufacturing Clusters

Every region of the U.S. has unique strengths that can help accelerate innovation. Midwestern companies and universities are leaders in manufacturing research, science, and engineering.[177] Colorado and the Mountain West have knowledge and expertise in supporting low-carbon sectors, driving innovation through Renewable Energy Standards and research and entrepreneurship.[178] Southern states like North Carolina have excelled at research in solar power.[179] One good indication of how clean energy extends beyond the biotech and Internet capitals of Silicon Valley and Cambridge, Massachusetts is that among the top 10 clean technology universities are the Universities of Colorado, Michigan, Wisconsin and Georgia Tech.[180]

To draw on these resources, federal policies can ensure that energy innovation and manufacturing activities are not concentrated on the coasts through the formation of regional energy innovation and manufacturing clusters. These clusters would bring together investors, businesses, universities, manufacturers, suppliers, and government to establish productive relationships. Every state would have the opportunity to join a cluster, creating ecosystems for innovation and industry that would take advantage of each state or region's resources and expertise. For example, a cluster of coal states could focus on innovation in carbon capture and sequestration and other advanced coal technologies, the Midwest on manufacturing processes and auto innovation, and the Southwest on advanced solar. When all these facets of innovation, manufacturing, and commercialization are in close proximity, development and deployment occur more rapidly, which is critical if we are to lead global clean energy markets.[181]

Incentivize Clean Energy Businesses to Move to Conventional Energy Regions

The transition to clean energy will adversely impact some communities in the U.S. that are largely based on conventional energy exploration, mining, generation, or use. This will mean loss of businesses and jobs in places that can least afford it. But many of these same communities are well positioned to capitalize on the transition to clean energy. Incentives to attract clean energy businesses could help revitalize areas and produce both direct and indirect job growth. Creating Clean Energy Business Zones (CBiZ) would help attract clean energy investment and jobs in conventional energy cities, towns and regions.[182] Businesses would receive substantial tax incentives to establish clean energy research, manufacturing or production facilities in qualified communities. Industries could include fuel cell research, wind turbine or solar glass manufacturing, energy efficiency retrofitting, waste-to-energy generation, and clean coal technologies. Not only will these zones provide opportunities for job growth, but they will also stimulate development of clean energy industries, helping turn communities that would otherwise understandably view the transition to clean energy as a threat into breeding grounds for clean energy innovation.

Educating the next generation of clean energy innovators

China and India are graduating more and more engineers every year. Today, America's best minds flock to finance. We risk facing an innovation gap if the U.S. doesn't educate a new generation of scientists and engineers and attract foreign entrepreneurs.

Encourage Colleges and Universities to Focus on Scientific Innovation

Fifty years ago, following the launch of Sputnik, the federal government authorized the National Defense Education Act (NDEA). The goal was to inspire and train an entire generation to challenge the Soviet Union for scientific supremacy. That program provided billions in funding for science, technology, engineering and mathematics (STEM) education and student aid, and was a critical step toward the successes of the space race. Over its lifetime, it fueled the rise of new American aerospace, computing, and IT companies.

Clean energy demands a similar response. A modern NDEA for clean energy would provide funding for our nation's universities and colleges to retool science and math programs to create integrated centers of research, education and workforce training in energy-related fields.[183] These investments would expand clean energy education through new research grants, graduate fellowships and energy science and policy focused curricula. They would also encourage institutions of higher education to reward graduate students and professors engaged in research for the development and commercialization of their work, rather than just publications. It could help encourage this process by creating "innovation pipelines" to help connect promising research at colleges and universities with companies that could help commercialize new technologies.

Encourage American Students to go into Engineering

The U.S. is at a competitive disadvantage against India and China because we are producing fewer and fewer engineers. India graduates 600,000 engineers every year, compared to just 84,000 and dropping in the U.S.[184] In just one example, an Indian company with a major U.S. presence said it had more than 1,000 positions open but could not fill them—even in the midst of 10% national unemployment—because of a lack of qualified engineering applicants.[185] To help reverse this trend, the Obama Administration launched the RE-ENERGYSE initiative. Jointly funded by the National Science Foundation and Department of Energy, RE-ENERGYSE supports science and engineering by assisting colleges and universities in creating undergraduate and graduate programs that lead to careers in clean energy.[186] It will also focus on training the vitally needed next generation of workers for our nuclear industry, and provide fellowships and other research and training opportunities to recent graduates of colleges and graduate schools across the country.[187]

The government should also create a domestic Peace Corps-style organization to encourage bright graduates to work on important clean energy technology problems at public, non-profit and emerging private sector institutions. Companies could receive incentives to hire Energy Technology Corps alumni, to help encourage them to stay on this critical career path and to grow a larger homegrown pool of talented researchers for the private sector. Similar to the Peace Corps, students would be offered loan forgiveness upon completion of their time in the Energy Technology Corps. The program could also work in coordination with the Clean Energy Business Zones to help draw talented minds to areas that were previously reliant on conventional energy expanding innovation options for every state.

Attract the World's Talent to the US with Visa Reform and Fast-tracking Grad Student Green Cards

Historically, the U.S. has attracted scientists from all over the world to study in our universities. While this "brain draw" was once a source of strength, in recent years it has turned into a "brain drain." Thanks to a combination of domestic policy restrictions, the recession, and increased opportunities internationally, fewer highly skilled immigrants are coming to the U.S. for school or work.[188] And those highly skilled foreign students who are already here are finding it increasingly difficult to remain in the country after they graduate.[189] This is a problem for the U.S. economy. Studies have shown that the influx of highly skilled immigrants is directly correlated to economic growth.[190] Immigrants established "one of every four technology and engineering companies started in America from 1995 to 2005, and 52%of Silicon Valley start-ups."[191] Companies founded by immigrants employed nearly 500,000 in 2006.[192] By reforming our H1B and student visa process, we can strengthen our ability to retain the knowledge we create, which ultimately drives domestic private sector growth.

Investing $15 Billion in Clean Energy Innovation to Make this Happen

It is going to take at least $15 billion a year in innovation investments to get to a day when we can store unused electricity, generate wind and solar power as cheaply as fossil fuels or use small modular nuclear reactors to provide factories process heat and rural areas electricity. This is necessary to fund both the government's partnerships in innovation, and give the private sector access to the capital it needs to develop, deploy, and commercialize clean energy technologies. While $15 billion may seem like a large sum of money, it is only 0.14% of GDP. For context, this is only half the budget of NIH and 19% of the Pentagon's annual R&D budget.[193]

There is an emerging consensus that this level of funding makes sense. Business leaders including executives from Google,[194] Dow, General Motors and General Electric, entrepreneurs like Bill Gates,[195] 34 leading Nobel laureates and think tanks including the Breakthrough Institute, the Bipartisan Policy Center and the Brookings Institution have called for similar funding levels.[196] As University of California-Berkeley researchers Dan Kammen and Greg Nemet argue, an increase in research funding of this size is consistent with national needs and could easily and effectively be utilized. As important, they note, "Past experience indicates that this investment would be repaid several times over in technological innovations, business opportunities and job growth."[197]

Keeping Funding Deficit-Neutral

Increasing any portion of the federal budget by $15 billion is a tall order. While investing in innovation is critical to American economic growth—as a Congressional Budget Office analysis shows, each dollar invested drives productivity and growth, with a rate of return of as much as 28%[198]—it is equally important not to add even a dollar to the deficit. There are a number of prospective ways to do this. This is not intended to endorse any specific policy over another, but instead to present a number of directions the government could take to finance the public-private sector innovation partnership.

An Electricity Modernization Wires Fee

A simple way to finance the modernization of our energy system is to put a modest fee on the delivery of electricity, similar to how the Highway Trust Fund is used to pay for road maintenance and upgrades. Known as a wires fee, this would require utilities to pay a fee amounting to a fraction of a cent for each kilowatt-hour of electricity they deliver. Such fees have been proposed in the past as direct funding mechanisms for energy research, like the development of carbon capture and sequestration technology. They can be readily repurposed to fund broader energy innovation goals. In most cases, utilities would pass such a fee onto their customers—and it may make sense to ensure that utilities have the flexibility to do so. Every $0.59 increase in average residential electricity cost per month from a modernization fee would generate $1 billion per year in funding for innovation.[199] An $8.85 per month fee per household would fully-fund the entire cost of the innovation program, with no need to increase any other energy costs. Of course, the U.S. could also create a lower modernization fee and combine it with other options to ensure that costs are spread across energy sectors and consumers.

Reform Fossil Fuel Subsidies

In addition to not fully accounting for the impact of carbon emissions, the energy market is tilted towards fossil fuels through subsidies and preferential tax treatment from the federal government. Over the last eight years, subsidies for fossil fuels have outstripped support for non-ethanol renewable energy by $60 billion.[200] Since 1950, fossil fuels have received almost $350 billion in federal support, compared to less than $50 billion for renewable energy sources.[201] This trend is not abating. From 2011 through 2015, the federal government will provide over $31 billion in subsidies for the oil and gas industry and $19.2 billion for the coal industry.[202] Rather than supporting mature fossil fuel technologies to such an extent, redirecting some of the federal subsidies to clean energy innovation could help stand up a new generation of energy businesses.

Placing A Price on Carbon

Placing a fee on each ton of carbon emitted could generate sufficient revenues for innovation. This fee could be as low as $5 per ton of carbon and would have only a negligible impact on energy prices.[203] It would increase gas prices by at most $0.08 per gallon, which is well within the average monthly fluctuation in the price of gas at the pump.[204] Electricity prices per household would increase between $3.50 and $6.00 per month (or approximately 3-6% increase),[205] depending on the mix of conventional and clean energy sources the utility used.[206] A program like this could finance our nation's $15 billion clean energy innovation needs as well as deficit reduction or direct rebates to the consumers most impacted by an increase in conventional fuel prices. Policymakers could also determine whether to gradually increase the price to maintain a steady flow of funding for innovation as clean energy came online, or phase out the carbon price as clean energy technology costs came down.

There are many ways to implement a carbon price. Companies such as Dow, Ford, and General Electric,[207] and Senators John Kerry (D-MA) and Joseph Lieberman (I-CT) call for a cap-and-trade system. A carbon price could also be put in place through a carbon fee, as proposed by Senate Republicans like Bob Corker of Tennessee.[208] How we put a carbon price in place is less important ensuring that revenues raised go to innovation. The U.S. needs to support innovation in order to bring down the cost of clean energy to make it competitive with traditional fuels. With the right incentives and a commitment to innovation, we can develop clean-energy technologies that are as affordable as coal and oil, creating jobs and new industries.

CONCLUSION

The early 1980's were grim economic times for the United States. Factory jobs were moving overseas and nothing was on the horizon to replace them. Our great companies like General Motors, US Steel and Zenith appeared sluggish and unable to compete with the Japanese economic juggernaut led by the likes of Toyota, Nippon Steel and Sony. It was a certainty that the American Century was coming to a premature end. Today, there is similar hand-wringing about America's economic future. Many commentators, economists and policymakers fear that the Great Recession has sapped our ability to compete in the global marketplace against rising economies like China and India.

The U.S. did not, however, lose its economic edge thirty years ago. Even as the intelligentsia and the media ran America's economic obituaries, innovators were developing the next big thing in computer labs, garages and small start-ups in suburbs across the country. A similar turnaround could happen today. The question for America is: Do we want to make and sell affordable clean energy products like advanced batteries, next generation solar and nuclear components, or are we okay simply being a consumer of other countries' goods?

We know the global market exists and the reward for whomever dominates this market. We also know the path to take to re-establish American leadership in clean energy technology. But unlike the computer and Internet revolutions in the 1980's and early 1990's, the clean energy innovation road is already quite crowded. That is why America cannot afford to debate the direction we take any longer. The country needs to embrace clean energy innovation now and commit to a path that will make us a global leader. Otherwise, the fate that many feared for the U.S. may still arrive—just thirty years later than expected.

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ABOUT THIRD WAY

Third Way is the leading think tank of the moderate wing of the progressive movement. We work with elected officials, candidates, and advocates to develop and advance the next generation of moderate policy ideas.

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