A CLEAN ENERGY ROADMAP:

FORGING THE PATH AHEAD

November 2010

Ewing Marion
KAUFFMAN
Foundation

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Introduction

If the United States fails to act now to harness its resources and ingenuity in clean-energy production, we risk falling far behind in the twenty-first century global economy. Other nations will seize the opportunity to capitalize on this rapidly growing sector. Businesses will be drawn away from the United States as startups, entrepreneurs, and innovators find more hospitable operating environments overseas. Unemployment in our country will steadily increase, while jobs are created in distant lands. And our dependence on foreign oil will continue, along with the conflict this dependence breeds.

China now leads the world with $34.6 billion in clean energy investments, nearly double that of United States' investments.[1] Denmark is the world's leader in wind power, power that generates more than 19 percent of its country's electricity.[2] And, based on its current momentum, Germany is set to become the world's first industrial country to use 100 percent renewable energy—a goal the country might reach as soon as 2050.[3]

In his State of the Union Address earlier this year, President Barack Obama said, "We need to encourage American innovation...(and) no area is more ripe for such innovation than energy." If we are to rise to the president's challenge, we must embrace the dynamism of our economy to emerge as a global leader in advancing energy innovation toward products and services in the commercial market. The economic impact of catalyzing the energy sector cannot be ignored: Experts predict 60 percent of the

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[1] PEW Charitable Trust, "Who's Winning the Clean Energy Race? Growth, Competition and Opportunity in the World's Largest Economies," http://www.pewtrusts.org/news_room_detail.aspx?id=57972.

[2] http://www.time.com/time/magazine/article/0,9171,1881646,00.html.

[3] http://www.renewableenergyworld.com/rea/news/article/2009/04/germany-the-worlds-first-major-renewable-energy-economy.

world's energy will come from renewable resources by 2070.[4] In many ways, energy technologies will define the twenty-first century. These technologies also will be a critical turning point in the history of the United States.

In Washington, most plans to "jump-start" the economy emphasize the need to increase job growth in existing companies. However, data suggest that new jobs are not created by older, larger firms, but, rather, by newer, smaller companies. According to Business Dynamics Statistics (a U.S. government dataset compiled by the U.S. Census Bureau), existing firms destroyed 1 million jobs per year on average between 1977 and 2005, while new companies created 3 million jobs per year. Moreover, during recession years, jobs created by new companies remained significantly more stable economically than jobs created by established firms.[5]

Although the United States' investment in basic energy research was at its highest this year, there is a notable lack of attention toward implementing policy that could boost the private energy market. Energy innovations as a whole do not receive adequate attention from investors, businesses, and states because of interconnection issues with utilities, limited financing options, and a cumbersome U.S. regulatory environment.

Also limiting progress in the energy sector is an unfortunate disconnect between its key players. In the United States, universities and research laboratories are our major centers of research and knowledge generation. But, despite our strength in producing new ideas, the current system is insufficient to identify those innovations with potential

[4] http://www.wrenuk.co.uk/.

[5] Tim Kane, Ewing Marion Kauffman Foundation, "The Importance of Startups in Job Creation and Job Destruction," and Dane Stangler, Ewing Marion Kauffman Foundation, "High-Growth Firms and the Future of the American Economy".

for commercialization and even more insufficient to get those technologies past financial or regulatory barriers. As a result, the new technologies developed by these centers often fail to realize their full commercial impact. Acceleration of the energy sector requires reform at all stages along the innovation pipeline—from research to development, deployment to adoption.

Reaching our nation's goals in the clean energy sector will rely heavily on the staying power of U.S. small businesses. As small businesses currently employ nearly 40 percent of the U.S. science and engineering workforce, they create fourteen times more patents per employee than large firms do. Moreover, between 1993 and 2008, small businesses created 64 percent of all net new jobs.[6]

Given the challenges our country faces, the ability to work together in creating ways to increase and sustain clean energy innovation is crucial if we are to move forward in this area. The scaling of energy firms in the United States is not a technological issue, but is very much an issue of policy. We need to prioritize new ways for state and federal government policy leaders to partner with private organizations, forge effective relationships with organizations across sectors, and build upon the existing networks of innovators and entrepreneurs. Only through collaboration will we be able to create and implement the policies and actions that will expedite progress toward our goal of securing our nation's future.

[6] Kristina Johnson, undersecretary of energy (Omaha summit).

The gathering of great ideas

In 2010, the Ewing Marion Kauffman Foundation co-convened three cross-sector summits to develop recommendations for growing energy innovation in the United States. The first summit was held in Washington, D.C., on May 7, 2010, in partnership with the White House. Gallup and the city of Omaha, Neb., hosted the second summit on June 16, 2010, and the last was held with Arizona State University and ARPA-E in Phoenix, Ariz., on October 18, 2010. Attendees included representatives from White House offices, federal departments and agencies, and state and local officials. Also in attendance were clean-energy entrepreneurs, representatives from academia, private-sector leaders, nonprofit leaders, and scientists.

The summits' main purpose was to explore how a diverse pipeline of actors might better work together to catalyze energy innovation and scale new energy firms. The sharing of ideas regarding current barriers and opportunities with such a varied group of participants generated a number of solutions. Among many topics of discussion were ways to better leverage federal dollars and foster collaboration between entities, while identifying areas for regulatory and statutory improvements. The summits represented part of the larger, national effort to drive clean energy innovation and propel economic development and job creation within the United States.

What follows is a summary of those ideas, along with additional thoughts gleaned from an intensive literature review of more than twenty scientific articles and interviews with fifteen of the top entrepreneurs in the clean energy industry. Ultimately, we have discovered five major policy strategies to accelerate the scaling of clean energy

businesses in the United States. Each of these recommendations is outlined in more detail in the pages that follow.

- **Foster interstate cooperation**. *Aligning policies and regulations between states*. *Developing interstate transmission lines and generation sites.*
- **Reduce market uncertainty.** *Developing consistent energy policies with clear implications for utility companies. Remodeling existing funding and financing structures.*
- **Democratize access to the power grid.** *Allowing customers to generate and store their own energy.*
- **Encourage inter-agency and cross-sector collaboration.** *Building upon regional clusters that transmit ideas and resources.*
- **Support human capital development.** *Focusing university research to support technology innovation, implementation of energy commercialization education, and development of policy supportive of commercialization. Strengthening the pipeline of entrepreneurship and STEM through higher education.*

Identifying areas of improvement is only the first step. If we are to strengthen the United States economy, create the jobs we need, and become the world leader in clean technologies, we must generate solutions. The following pages detail multiple suggestions for overcoming barriers and creating more opportunity within the industry—a map to forging the road ahead.

Foster interstate cooperation

Aligning policies and regulations between states

The fragmented framework of our state-to-state clean energy policies creates cumbersome barriers for clean energy entrepreneurs attempting to scale their businesses in the United States. Policies and regulations differ widely from one state to the next and, as a result, entrepreneurs are faced with the time-consuming and expensive task of investigating each state's particular set of requirements. This situation is among the most-cited reasons entrepreneurs move their businesses overseas. In countries like China or India, where there is a strong governmental commitment to clean technology, policies are consistent at the national level. Policies that align from one region to the next make scaling businesses a smooth and successful process. Policies that don't, create roadblocks.

From wind to solar power, biofuels to hydroelectricity—the problems that arise from state policy misalignment are found in every sector of renewable energy. A green building in Texas requires different codes than one in Florida. Solar panels in California have different zoning regulations than the same panels in Nevada. Even though twenty-nine of our states currently have a Renewable Portfolio Standard[7] that requires them to increase their energy reliance on renewable sources, this standard does little to alleviate the problem. In Arizona, for example, the standard is biased toward distributing solar energy, rather than building large solar plants.

[7] www.dsireusa.org .

Attempts have been made to address this problem, but, unfortunately, these attempts fall far short of creating solutions that allow firms to scale in our country. Some policies designed to stimulate clean energy technology actually accomplish the opposite. For example, federal and state governments often use income-tax credits as a tool to stimulate the deployment of clean energy technologies. In practice, however, the tax credit too often benefits only large, established companies and disqualifies newer startups. Clean energy technology innovators are still in the process of building a new industry. We need policies that support growth and positive change, not stagnation and status-quo.

More effective federal policy would allow radical innovation to be at the core of the energy industry, as we see with the pharmaceutical arena, where new discoveries provide nationwide profits. Why? Because many clean energy technologies require extensive infrastructures to succeed—a problem compounded by the existing complex framework that regulates the current energy market. This is also why the energy market is unable to sustain itself through only its smart ideas and innovation, as occurred in the information technology industry.

Working together to build a customer base

States are key players in strengthening the energy market, even more so than the federal government in many cases, because of the highly regulated nature of the energy sector and the resulting lack of customers. States have the opportunity to collaborate in shifting policies from subsidy approaches to the more-nuanced strategies of other

industries that enjoy a solid customer base. The development of state-supported incubators, for example, helps establish local markets and draws new businesses.

Another way states might work together to increase customer buy-in is to better communicate how the health, social, and environmental benefits of clean energy technologies produce long-term economic wins. In today's uncertain economy, it is unreasonable to expect the clean energy market to expand based solely on altruistic goals. The message must be sent that clean technologies can create jobs, strengthen our economy, promote national security, and position our country as a major competitor in the global marketplace.

The Chicago Climate Exchange, for example, created a customer base for energy efficiency by establishing a market for firms to buy and sell emission allowances as part of a private cap-and-trade program.[8] More than 110 firms and government bodies have committed to lowering emissions by 6 percent. These entities will be ahead of the curve if the government puts a price on carbon, but, more importantly, they are sending a strong public message regarding the economic benefits of clean energy solutions.

Elsewhere, the city of Omaha, Neb., is developing a comprehensive plan to reduce energy consumption—the Energy Efficiency Master Plan—the first of its kind for the city and one poised to bring thousands of jobs to the area.[9] Additionally, Omaha and the city of Lincoln are considering a partnership funded by the Recovery Act Energy Efficiency and Conservation Block Grant Ramp-up. Such a partnership would, they hope, create a

[8] Tom Cushing, Chicago Climate Exchange.

[9] Jim Suttle, mayor of Omaha, NE.

sustainable market in the area that focuses on job creation, green technology and entrepreneurship, consumer information, various financial mechanisms, neighborhood advocacy, and more targeted market strategies—all of which would spur great economic strides in the region.

Developing interstate transmission lines and generation sites

How do we bring the power of the sun to a wintry morning in Des Moines? How can the force of a thousand windmills in the California desert provide electricity to urban areas of New York? Scientists and engineers are creating exciting breakthroughs in harnessing sun and wind energy, but these breakthroughs are only half the journey. We must find ways to bring this energy to the places it is needed most and in doing so create scale firms and economic growth.

Another major stumbling block in the advancement and scaling of clean technologies is the high cost of extending transmission lines to remote generation sites. Wind and solar resources tend to originate in places where population density is low and far from congested cities with high energy need. The cost of extending transmission lines to these remote generation sites is one of the main barriers that prevent the widespread adoption of renewable energies.[10]

Clean energy entrepreneurs and companies in the large-scale renewable energy industry cite transmission issues of wind and solar power as an ongoing problem. Specifically, the problem lies within our fragmented and underdeveloped power grids. There are three regional grids in the United States—Eastern Interconnections, Western

[10] Heiman, et al. (2004).

Interconnections and the Electric Reliability Council of Texas (ERCOT). Not only is there a limited connection between the three grids, but also within the same regional grid. This lack of connection poses crucial concern for the renewable energy industry.

To address this concern, we need to build additional transmission lines that cross state boundaries, and connect solar and wind generation sites with the regional grids. However, the difficulty involved with obtaining permits and the cost of recovery for transmission makes expansion very expensive, and policy misalignment makes building interstate transmission lines very difficult.[11] California and Utah share transmission lines, as do many states along the eastern seaboard. These states can serve as an example of shared utility projects that can be scaled to other regions.[12] In the bigger picture, previously large-scale federal investments in projects such as the interstate highway system could serve as potential models for a project to modernize the power grid.[13]

Reduce market uncertainty

Developing consistent energy policies with clear implications for utility companies

Unlike other markets that are influenced by supply and demand, the renewable energy market instead relies upon a myriad of state and federal regulations and policies. The highly charged political climate surrounding the renewable energy industry makes its market susceptible to the unpredictable winds of election seasons and isolated storms

[11] Wolak.

[12] Richard Hayslip, Salt River Project.

[13] Joel Kurtzman, Milken Institute.

of interest. For entrepreneurs who want to invest in and scale their businesses, this market uncertainty makes their efforts understandably difficult.

By definition, many clean and renewable energy projects are smaller in size and, as such, have higher capital costs than do projects that utilize traditional power-generation techniques. This characteristic only adds to a reduced availability of much-needed financial resources. The small size of these green companies also means they are less able than larger companies to absorb high due-diligence and transaction costs. A dip in the market for major traditional energy company A means a loss, while the same dip for green company B might mean total disaster.

Regulation uncertainties also present a substantial challenge to building a solid energy market. Such uncertainties stall investment, which topples markets. Therefore, establishing clear energy policies is crucial to solving this problem. Clear policies will stimulate funding in the clean energy sector, and subsequently strengthen and better sustain its market.

We can look to Germany for an example of a government effectively creating and sustaining a market for renewable energy. Germany has established a largely effective feed-in-tariff policy that makes it an attractive home-away-from-home for foreign companies. Germany made such strides by guaranteeing grid access, providing long-term contracts for the electricity produced, and ensuring purchase prices that are methodically based on the actual cost of renewable energy generation. This feed-in-tariff allows entrepreneurs to rely on a long-term, predictable, and transparent market. Even this example has its challenges, however, due to the complexity of the policy itself.

Remodeling existing funding and financing structures

The energy sector's needs are distinct from those of the information technology and services sectors. The energy sector operates in regulatory uncertainty, with investments that are capital-intensive, and a customer base that is transitory and sometime nonexistent. As a result, more creative funding streams are needed to advance the innovation pipeline and sustain its market over many years. One way to do that is to spur investment in high-risk, high-reward clean energy projects.

For example, the Advanced Research Projects Agency—Energy (within the U.S. Department of Energy) funds research that is often too risky for private-sector investment, but could have a large commercial impact. In 2009, this agency received $400 million in funding to attract the best and brightest minds in the United States, and to spur innovation in energy research and industrialization.[14] The agency recently gave its researchers the goal of one dollar per watt fully installed solar by 2016—a goal that has been compared to President Kennedy's challenge of reaching the moon.

Democratize access to the power grid

Allowing customers to generate and store their own energy

Over the years, the energy arena has been characterized by a large degree of public intervention. Why? Because people need electricity. And electricity is not easy to come by. Electricity generation requires resources and infrastructures the private sector cannot afford, so local and state governments granted monopolies to utility companies

[14] http://arpa-e.energy.gov/About/About.aspx.

so that they could provide services to the people who needed them. In return, utilities were to ensure reasonably priced, reliable, and ubiquitous power to the regions they served. The relationship between utilities, people, and governments served all parties well. But with the advent of renewable energy sources, this relationship is destined to change.

Among the most burdensome barriers for entrepreneurs involved in the renewable distributed energy sector are the interconnection issues with utility companies. Entrepreneurs operating in customer-owned renewable energy systems have to satisfy a multitude of requirements if they are to access the grid—from technical, to metering and billing, to insurance and liability. The lack of transparency and clarity of these requirements leaves much room for interpretation, room that many in the clean energy industry believe utilities use to prevent the application of new, energy-saving technologies. Much of the research and information gathered points to the possibility that utilities seem more concerned with precedence-setting and legal issues than moving forward in clean energy technology.[15]

Additionally, the lack of standardization among utility requirements creates a lengthy and time-consuming process for entrepreneurs who must make themselves knowledgeable of each utility's particularities. Also, application and interconnection fees are frequently viewed as arbitrary and disproportionate, especially for smaller projects. At times, utility-imposed operational requirements not only hinder entrepreneurs from

[15] Florida Solar Energy Center, 2000.

scaling renewable energy solutions, but actually result in direct conflict between utility and customer needs.[16]

Many states have adopted renewable portfolio standards to motivate utility companies to buy and use renewable energies. Though these standards are meant to create a smoother process for the interconnection of renewable energy sources, there remains the risk that utility companies will manipulate the energy market to meet their own needs. In fact, large utility companies, by their very nature, have an incentive to obstruct renewables, since traditional energy resources benefit conventional and existing assets.[17] New standards alone will not solve the problem.

OPOWER is an energy-efficiency and Smart Grid software company that helps utilities meet their efficiency goals through effective customer engagement. Using cutting-edge behavioral science and patent-pending data analytics, the OPOWER platform enables utilities to connect with their customers in a highly targeted fashion, motivating reductions in energy use, increased program participation, and overall customer satisfaction. Six of the ten largest utilities in the United States use OPOWER to significantly improve the effectiveness of their energy-efficiency portfolios.[18]

While some utility companies may be hindering clean energy usage, many other companies are striving to meet their customers' demand for clean energy technologies. Arizona Public Service is one of many companies across the country that is struggling to create and sustain clean energy incentives. The customer demand often exceeds

[16] Alderfer et al., 2000.

[17] Neuhoff, 2005.

[18] http://www.opower.com/Company/AboutUs.aspx.

available funds, however, which causes frequently changing incentives and a negative impact on the economy. For example, when incentives for rooftop solar panels fluctuate, customer demand also varies, resulting in waves of job loss in the construction industry.[19]

Allowing customers to generate and store their own energy is another way clean energy solutions might be integrated into existing utility infrastructures. “Net-metering” is a simplified method of metering the energy consumed and produced at a home or business that has its own renewable energy generator, such as a wind turbine. Under net metering, excess electricity produced by the wind turbine spins the existing home or business electricity meter backwards. This process “banks” the electricity until the customer needs it, providing the customer with full retail value for all the electricity produced.[20] Since 2007, Europe has used net metering, along with different energy suppliers, to allow customers to choose utility service based on competitive fares.

Other solutions already exist that could begin to address the complex utility connection issues. Utilities could coordinate their efforts and set up easy-to-use connection procedures. A point of contact designated for each utility to specifically interact with distributed generation projects also would smooth out the process. These actions would greatly reduce the time and cost related to interconnection issues—for clean energy entrepreneurs and for the utilities themselves.

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[19] Ryan Randazzo, “Shifting solar subsidies hurts contractors,” *The Arizona Republic.*

[20] http://www.awea.org/faq/netbdef.html.

The rising need for renewable energy resources, coupled with our world's ever-growing reliance on electricity, will continue to drive utility companies to the forefront of the renewable energy arena. As enhanced storage options become feasible for more and more customers, utilities must restructure themselves if they are to adapt. They must re-assess their traditional role as service providers and instead move to meet customer demand.

Encourage cross-sector collaboration

Building regional clusters that transmit ideas and resources

Bringing renewable energy from the windy plains or sun-soaked deserts to the places where energy is needed most is only one of many challenges to transmitting clean energy solutions. The joining of resources, ideas, and people is another example of a barrier that slows or halts the progress and potential of this new industry. How do we connect clean energy businesses to markets that need them? What is required for talent to join with scalable technologies? Where can financial investors find and fund the new ideas that could change our world?

Regionally based innovation is one potential solution to the challenge of bringing together the key players and elements of the energy innovation industry to address transmission problems. Regional innovation has the potential to leverage existing assets with current opportunities because proximal firms, companies, startups, and public and private entities can come together to educate decision makers not only about investment opportunities, but also about needed policy changes. Such partnerships can

encourage job creation, result in increased efficiency of private and government energy investments, and help get more energy innovation to scale at the market level.

One example of such collaboration is the Energy Regional Innovation Cluster, a multi-agency federal initiative that attempts to spur regional economic growth while making buildings more energy efficient. A multidisciplinary team of researchers will conduct research and work to solve technology challenges that span from basic research, to engineering development, to commercialization readiness.[21]

Another example of a regional innovation cluster is the Sustainable Northwest—a highly successful collaborative network spanning California and Oregon that identified timber as a regional asset. This network developed a cluster in the forest and wood pellet industry and has distinguished itself in the natural resource sector by crafting and promoting sustainable solutions through a collaborative process.[22]

An important step in building regional innovation sectors is identifying the key players of a particular region. Identifying these “dealmakers” helps energy stakeholders leverage the regional social networks that propel business creation and growth. Dealmakers are crucial to generating new firms. In Silicon Valley, for example, more than 99 percent of the people who are making deals know each other. In contrast, only 60 percent know each other in the Research Triangle Park in North Carolina. There is a great need to bridge capital and integrate personal networks in the energy sector if we are to catalyze

[21] http://www.energy.gov/news/8637.htm.

[22] http://www.sustainablenorthwest.org/about/what-we-do.

regional entrepreneurial activity. The simplest solution to the transmission problem in the clean energy industry may be to just start talking with each other.

Support human capital development

Reframing university research to support innovation and commercialization

Regionally based innovation, by definition, requires an approach that bridges the fundamental sciences with use-inspired research. Creating partnerships between academia, research labs, and public and private entities is vital to bringing new technologies to scale. Enhanced interdisciplinary cooperation that is open, collaborative, and global is particularly important when first identifying the commercial potential of an idea.

Universities have great potential to become important players in regional innovation clusters by becoming centers of knowledge generation. Too often, potential innovations remain hidden in scholarly articles rather than being tested, piloted, and ultimately deployed into the commercial market. Before this can happen, we must first design and implement new models of higher education to achieve better connectivity from the university to the private sector, and increased transparency of research breakthroughs. Such remodeling and redesigning of institutions of higher learning will accelerate the speed of technology transfer and get innovations to market faster.

Simply reframing the university's research operations can help to meet this challenge. Suggestions include rewarding innovation that has commercial impact and measuring the value of research, not by the number of papers published or patents obtained, but by the number of new products and processes developed and moved to the market.

Universities also have the opportunity to teach faculty about the pathway from innovation to commercialization so that they may pass on knowledge about marketplace opportunities to their students.

In addition, even in environments committed to interdisciplinary collaboration, researchers and scientists could benefit from learning how to recognize and analyze commercial opportunities. The gap between insight and innovation will persist unless university researchers are trained in how to identify a potential commercial innovation in the lab, and have the skills to evaluate such innovations for success along the innovation pathway.

Strengthening the pipeline of entrepreneurship and STEM through higher education

The lack of connectivity from research to deployment, and the lack of retention of human capital is a significant barrier to accelerating energy innovation in the United States. The pipeline for industrial employees and academics in the energy sector is nearly empty. Compounding the problem is a dearth of U.S. graduates in the sector—two-thirds of U.S. engineering science graduate students are citizens of other countries. One way to address this issue is dynamic, forward-thinking immigration policy that will retain American-trained foreign talent.

If we are to attract and retain STEM students, we must reform curricula and develop more-responsive, interdisciplinary career pathways by joining STEM and entrepreneurship training. Undergraduate curricular options include creating interdisciplinary courses such as business leadership and management for engineers.

On a larger scale, universities can work with businesses to establish educational programs and develop apprenticeship programs.

Training for future innovators and entrepreneurs begins with the K-12 pipeline. Rigorous reforms in our education system should focus on embedding innovation and entrepreneurship in the educational experience of all students. Educators need more guidance in how to design school environments and create curriculum that will develop pupils who possess skills and knowledge related to STEM, entrepreneurship, and innovation. Engaging students in STEM topics in their early years will prepare them for a more-demanding university curriculum, encourage entrepreneurship, and spur the innovation that is so crucial in the energy sector.

Concluding Thoughts

The United States energy sector needs a clear direction, mission, and goals to align its efforts if we are to position our country as a global competitor in this burgeoning industry, and if we are to support entrepreneurs trying to succeed in this field. Radical transformation of our existing structures requires solutions that engage all stakeholders in a collaborative network. State and federal governments can create the legal and policy conditions for energy prosperity, draw on large-scale resources, and use its prestige, power, and ability to attract attention to drive market progress. Private corporations can play a productive and sustaining role in helping to tactically address structural and institutional challenges that inhibit the long-term success of proven models. They also can bring business acumen, innovation, and resources to the table to

achieve this goal. Philanthropic foundations have experience thinking strategically about effective ways of working with multiple stakeholders in addressing diverse challenges. Nonprofit and service organizations have the flexibility to generate new ideas and the on-the-ground experience and relationships to identify local problems and opportunities. Education institutions can provide the human capital and knowledge-generation ecosystems that feed an innovative energy market hungry for solutions.

We cannot foster and sustain the clean-energy sector and the entrepreneurs that will grow this sector without recognizing the need for better policies to address getting energy innovation to market. There is tremendous potential for this sector to create jobs, provide economic and energy security, stimulate our economy, and position the United States as a major competitor in the global marketplace. By connecting the innovation pipeline, we can navigate the road ahead.

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