TESTIMONY OF
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BEFORE THE
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"ESTABLISHING THE ADVANCED RESEARCH PROJECTS AGENCY - ENERGY (ARPA-E)"
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Introduction

Good morning, Chairman Lampson, Ranking Member Inglis, and Members of the Subcommittee. My name is John Denniston. I am a Partner at the venture capital firm Kleiner Perkins Caufield & Byers, based in Silicon Valley California. Founded in 1972, Kleiner Perkins is one of America's oldest and most successful venture capital firms. I'm honored to be here today and to have the chance to share my views on federally-sponsored energy research.

Along with the rest of America, venture capital professionals – Republicans and Democrats alike -- are deeply concerned about the risks to our nation's welfare posed by our energy dilemmas. Worried as we are, however, we are also in a unique position to recognize that each of these challenges offers new opportunities to build our economy, creating innovation, jobs and prosperity.

Our daily work at Kleiner Perkins is to recognize emerging technology and market trends. We've funded more than 500 start-up companies over the years, backing entrepreneurs who have introduced innovative advances in such vital growth industries as information technology, medical products and services, and telecommunications. More than 170 of our companies have gone public, including Amazon.com, AOL, Compaq Computer, Electronic Arts, Genentech, Google, IDEC Pharmaceuticals, Intuit, Juniper Networks, Millenium Pharmaceuticals, Netscape, Sun Microsystems, Symantec, and VeriSign. Today, our portfolio companies collectively employ more than 275,000 workers, generate $90 billion in annual revenue, and contribute more than $400 billion of market capitalization to our public equity markets.

We now see a similar promise in the energy field – the potential to create jobs and new prosperity for generations to come. We refer to this emerging industry, encompassing clean power, transportation and water technologies, as "greentech."

Kleiner Perkins is a member of the National Venture Capital Association and a founding member of TechNet, a network of 200 CEOs of the nation's leading technology companies. I serve on TechNet's Green Technologies Task Force, which last month released a detailed set of policy recommendations to drive the development and adoption of technologies we believe can help solve some of the world's most pressing energy and environmental problems. My testimony today reflects my own views.

You've asked me specifically to address energy research and development, and in particular, H.R. 364, which proposes the establishment of ARPA-E. I applaud your consideration of this critical issue. I do believe focused federal funding through a new agency, in addition to increased research funding from the Department of Energy, should be an element of America's new energy plan, and am happy to offer some suggestions as to how that might happen. In my view, we will not be able to address our energy problems unless there is a strong public-private energy partnership, one element of which

must be a new commitment to federal leadership, including bold new policies and financial resources.

Before answering your questions, I'd like to first say something about the overall objectives of federal energy research. Specifically, I want to articulate what I believe are the energy dilemmas we need to resolve. Clarity of purpose will help shape our policy initiatives.

The Challenges

I believe there is an unprecedented degree of consensus in America today as to our three main energy challenges: the climate crisis, our dependence on oil, and the risk of losing our global competitive edge by failing to champion new technologies that are becoming a huge new source of economic growth, jobs and prosperity.

The Climate Crisis

In February of this year, a report of the more than 2,000 scientist members of the Intergovernmental Panel on Climate Change warned us, once again, that the planet is warming, glaciers are melting and sea levels are rising. The panel concluded, with ninety percent certainty, that human greenhouse gas emissions are fueling these dangerous trends.

The IPCC released a second report earlier this month, in which it predicted dire consequences for our increasingly unstable climate. Areas already without sufficient rain will become even drier, leading to less food production and more hunger. The world will face more serious floods and more severe storms. There's increased risk of disease.

Last week, a panel of a dozen of America's most respected retired military generals and admirals warned global warming poses a serious threat to America's national security. They urged the United States to commit to a stronger national and international role to help stabilize climate change at levels that will avoid significant disruption to global security and stability.

Many scientists predict we have only a short period of time to make dramatic cuts in our greenhouse gas emissions or risk irrevocably changing the climate. In fact, the IPCC report concludes temperatures and sea levels would continue to rise even if we were somehow able to immediately stabilize atmospheric concentrations. To date, we have failed to heed such warnings.

Energy Security

As for our energy security dilemma, this Subcommittee is well aware the U.S. imports about 30% of its overall energy needs, including approximately 60% of its oil. Rapid growth in worldwide energy demand has stretched supplies, tripling the price of both

crude oil and natural gas. And there is a significant risk this trend will continue, as world population and energy demand increase.

Global Competitiveness

Finally, our future prosperity is at risk, and here I speak from personal experience. In the past year, as I've traveled on business to China and Europe, I've witnessed how the rest of the world is striving, and often succeeding, to emulate the technology innovation that has been a hallmark of the U.S. economy and perhaps the single most important driver of our enviable standard of living. Increasingly, entrepreneurs overseas enjoy advantages in the form of determined government policies, including financial incentives and large investments in research and development.

Credible economic studies suggest our technology industries are responsible for roughly one-half of American GDP growth. Our country would look quite a bit different today had we not, several decades ago, become a global leader in biotechnology, computing, the Internet, medical devices, semiconductors, software and telecommunications.

Today, as our global energy challenges become ever more pressing, it's clear future economic growth throughout the world will depend to a great degree on new technologies to help us preserve our environment. Green energy technologies could very well become the economic engine of the 21st Century. Given its potentially massive market size, "greentech" could be the most powerful economic force of our lives. But will America again lead the way?

Subcommittee Questions

I'll proceed now to your specific questions:

1. If ARPA-E is established, what technology areas should be explored?

I believe there are two dimensions to this question: what stage of energy research should ARPA-E target, and what types of energy research projects should this new agency fund?

First, I believe there's a critical need for the federal government to pursue translational research in the energy field. Translational research differs from basic and applied research in that it begins with the project management team members identifying the most pressing market needs. Next, they select and fund the most promising scientific approaches that might enable breakthrough products, and finally work to push the best candidates through to the brink of production. This process is also known as "right to left" research since the ends determine the means.

Translational research is by no means a substitute for basic or applied research – both of these are also critically important. But when it comes to energy issues, translational research has received only scant federal support – thus, this is where a new research agency could make the biggest difference. Translational research on defense issues at

DARPA, after all, has resulted in the commercialization of many important technologies, including the precursor to the Internet, robotics, high-energy lasers, computer hardware, software and semiconductor fabrication.

To whatever degree possible, the legislation creating the new energy research agency should support a distinct culture and structure – with both, ideally, mirroring DARPA's successful traits. Like DARPA, the new agency should be small, nimble, unafraid of risk, and "flat" – i.e., non-hierarchical. It should also have cabinet-level sponsorship and support. This separate structure and identity would allow the new agency to create and sustain a culture suitable for translational research.

With respect to the energy source question, I recommend ARPA-E fund renewable energies and energy efficiency technologies, including advanced batteries, fuel cells, solar, wind, geothermal, and biofuels.

Given the urgency of reducing carbon emissions from coal-fired power plants, I believe ARPA-E should additionally have funding oversight for carbon capture and sequestration research. Other than this, however, I do not believe Congress should include fossil fuel technologies or nuclear power in ARPA-E's charter.

ARPA-E's mission should be to fund projects that can solve our urgent energy challenges: climate change, energy security and American competitiveness. And our best hope of doing so is to rapidly develop clean, alternative energy sources. Our experience with DARPA should encourage us to expect ARPA-E to identify and develop innovative and commercially viable energy technologies we have not yet even considered.

Fossil and nuclear energy sources already dominate our energy system, needing no regulatory push to achieve market adoption. Nor is the translational research process I've described above, and which I so strongly recommend for ARPA-E, designed to make incremental improvements to mature technologies such as these. On the other hand, translational research would be an excellent fit for emerging renewable energy, energy efficiency and carbon capture and sequestration technologies.

Finally, there is a question as to whether ARPA-E should also fund demonstration projects. There is no doubt the federal government should significantly increase its support for demonstration projects. In theory, ARPA-E could be the vehicle to do so. However, some have questioned whether this would confuse ARPA-E's mission and be contrary to the goal of creating a small, nimble organization. DARPA benefited enormously over the years from its focused mission and consistent culture. The Subcommittee should be mindful of this history as it thinks through the optimal approach to demonstration projects. One potential strategy would be to create a separate division within DOE to manage demonstration projects.

2. **What value can federal resources bring to technology investors and the private sector in developing innovative energy technologies?**

Federal resources can accelerate the adoption of innovative energy technologies in three ways: provide a level of research funding commensurate with the scope of our challenges; impose a price on carbon emissions that reflects their actual costs; and help create market conditions that are receptive to new energy solutions.

Accelerate Renewable Energy and Energy Efficiency Technologies by Substantially Increasing Federal Research Funds

The federal government should significantly increase funding for energy research and development. My understanding, based on a recent review by the American Association for the Advancement of Science, is the federal government currently provides roughly $1 billion annually for all non-nuclear, clean and renewable energy research. This is for our fast-changing energy and transportation industries, which account for more than $1.8 trillion of our current gross domestic product annually. Senior personnel at many of the top U.S. academic institutions have emphasized to me how little federal energy research funds are available for non-nuclear technologies – the cleanest, safest way out of our energy predicament.

In the health care sector, in contrast, the National Institutes of Health annually provide $28 billion in research funding. In the past three decades, while energy R&D spending has dropped by two-thirds, health care R&D has more than quintupled. The research-dollar discrepancy between the energy and health care fields is particularly striking when you consider that each accounts for roughly 15% of U.S. GDP. I want to be clear – I am not suggesting for a moment the NIH budget should be reduced. That would be a mistake. My point is we must find a way to increase federal sponsorship of clean energy research, several-fold, to build up this young industry sufficiently to give ourselves a fair chance of solving our three serious energy problems of climate change, energy security and global competitiveness.

Solving these problems will take all the leadership and financial commitment we can muster. Consider: America, in current purchasing power, spent over $20 billion on the Manhattan Project and over $135 billion on the Apollo Project. Further, when DARPA was created in 1958, it received a budget appropriation of $500 million, which is the equivalent of $3.5 billion in current dollar terms. This amounted to .67% of total federal spending that year. Today, our spending on all renewable energy represents less than .04% of current federal outlays. In other words, DARPA's initial appropriation was more than 16 times the federal budget share devoted to renewable energy research today.

Beyond increasing overall energy research funding, Congress should ensure the vast majority of new funding targets renewable energy and energy efficiency. Over the past 50 years, nuclear energy has received over 95% of U.S. funds spent on non-fossil fuel energy sources. We need to level the playing field.

Boosting our commitment to renewables today is the best investment we can make to guarantee our future economic competitiveness. I'm convinced the next global industrial revolution will depend on the substitution of renewable energy for incumbent sources. Countries that develop strong domestic greentech industries will surely advance their economies and provide the jobs of the future.

Will we be one of these leaders? After all, our standard of living today is the highest in the world, largely due to our leadership in technology innovation over the past half-century. But if we don't act decisively while we still have the time, we could easily be left behind in this new wave of innovation, eventually becoming a buyer, not a seller, of the pioneering energy technologies the world will demand.

Impose A Price On Carbon Emissions

Economists have been urging us for years to put a price on carbon that would accurately reflect its costs to society. Making fossil fuels more expensive will make newer, cleaner power sources relatively less costly, thus increasing demand for them. There are two ways to accomplish this: a carbon tax, and a carbon cap-and-trade system.

A carbon tax has the advantage of simplicity and speed of implementation, but there are two key shortcomings: taxes of any sort are politically unpopular, and we will not know for certain the reduction in carbon emissions that will result from any given level of taxation. As to the political issue, however, I would argue public sentiment has changed so dramatically in just the past couple of years, which brought us Katrina, "An Inconvenient Truth," and the last two IPCC reports, that policies once considered unacceptable may now be possible. Al Gore, when he was here, advocated an innovative "tax shift" that would achieve tax revenue neutrality by eliminating the payroll tax simultaneously with the adoption of a carbon tax. I recommend Congress explore Mr. Gore's idea.

A well-designed cap-and-trade system would address the second problem with a carbon tax: it would offer certainty in emissions reduction. An additional advantage is that while it penalizes companies that continue to pollute, it also rewards those that make progress in adopting clean energy. America had success with a cap-and-trade system in the 1990s, when it was used to curb sulfur-dioxide emissions causing acid rain.

In my view, Congress should consider a combined carbon tax/cap-and-trade package that would offer the implementation speed of a carbon tax, along with the predictable environmental outcome of a cap-and-trade system. This combination strategy would not result in a "double tax." Instead, it would ensure we establish a carbon price level that achieves the reduction target as quickly as possible. If the carbon tax reduces carbon emissions to at least the level required by the cap-and-trade system, there simply won't be as many trades.

Create Market Conditions Supporting Renewable and Energy Efficiency Solutions

There are several measures Congress should enact to accelerate the adoption of renewable energy sources, including:

- Renewable Portfolio Standard and Expanded Renewable Fuel Standard. A new federal RPS, and a substantially higher RFS threshold, would send a powerful signal to the private market. Entrepreneurs and investors could be confident a market will exist for innovative new products, even if they have not yet had a chance to achieve economies of scale.

- Federal Incentives to Drive Clean Energy Development. Potential mechanisms include tax credits, subsidies, and loan guarantees. In addition, Congress should consider creating incentives for U.S. greentech companies to manufacture their products in this country. European and Asian countries offer incentives for U.S.-based companies to establish manufacturing operations overseas, in some cases including government payment of 40% of upfront capital costs and 15-year tax holidays.

- Energy Efficiency Standards. The United States could make great headway in solving our energy challenges by simply combating wastefulness. To this end, Congress should strengthen CAFÉ standards, require energy efficiency standards for electronic equipment and appliances, and work with states to create similar standards for buildings. Congress should also evaluate how to work with utilities so their profit potential is driven as much by introducing energy efficiency as it is by selling power.

- Federal Procurement. The Federal government is the single largest U.S. energy consumer. As such, it can lead our energy transition by becoming the single largest green-technology user.

- Biofuels. Congress could take several steps to strengthen the rapidly emerging biofuels market. One of these should be an increase in the Renewable Fuels Standard consistent with President Bush's call to reduce gasoline consumption by 20 percent over the next ten years. Another contribution would be to restructure the existing blender's credit so it is paid to ethanol producers rather than gasoline distributors, provides a credit level that is inversely related to the price of gasoline (creating a safety net for ethanol producers in the case of a sudden drop in gasoline prices), and is made available to all alternative fuels, not just ethanol and specific molecular formulations of butanol.

3. Can you comment on the relationship between the federal, university and private industry sectors in energy research and technology development? Would an ARPA-E enhance this relationship to get more technologies into the marketplace?

Historically, the federal government, American research universities and private industry have collaborated to unleash innovation in the information technology and life science sectors. The federal government's indispensable role has been to fund basic and applied research, and in some cases, translational research.

I will share two examples. In the 1960's and 1970's, NIH funding for basic research in genetics at many U.S. universities helped launch what is today's flourishing biotechnology industry. Similarly, in the 1970's and 1980's, DARPA provided funding to U.S. universities to first research, and later create, a communications network to tie together the Department of Defense and the various groups around the country performing defense research. That network, known as DARPANET, was the precursor to the Internet. The federal government's funding role has had a mighty impact: without it, U.S. biotechnology and Internet industries would surely not be as advanced as they are today.

Today, however, with only a few exceptions, such as nuclear technology, the DOE provides very little energy research funding to American universities. As a result, there is very little government-university-industry collaboration in the alternative energy world. In fact, today's state of affairs may be discouraging American scientific talent from entering this important sector. Many senior university researchers have told me scientific talent would immediately flow into the renewable energy field if only federal research dollars were available to support projects.

Congress now has a chance to revive the productive partnership of the past. It can create a new agency to pursue translational research focused on renewable energy, energy efficiency, and carbon capture and sequestration projects. It can also demonstrate its commitment to solving our urgent energy predicaments by significantly boosting overall renewable energy funding – both within DOE and in this new agency - to a level commensurate with the scope of the challenge.

4. Is there a concern in the business and financial communities about commercializing technologies developed by the Department of Energy? If so, what steps should be taken to ensure that the technologies developed within ARPA-E will make a comfortable transition to commercial application?

The only concern of which I am aware is there have historically been few opportunities to commercialize breakthrough energy technologies sponsored by the Department of Energy outside of the nuclear field. I can assure you private industry will be eager to do its part if the volume of DOE-sponsored renewable projects increases.

As for the second part of this question, I'll repeat what I've said above. ARPA-E can play a vital role in ensuring technologies cross the divide from laboratory to market by introducing a translational research approach to federal research funding, focused on renewable energy, energy efficiency, and carbon capture and sequestration.

Additional Comments on H.R. 364

I'd like now to offer my thoughts on a few specific provisions of H.R. 364.

Goal

The expressed goal of HR 364 is to "reduce the amount of energy the United States imports from foreign sources by 20 percent over the next 10 years." There is a great advantage to having this kind of clarity, but I urge you to expand your objectives. While our reliance on foreign oil is a serious issue, it's just one part of our energy predicament. I do believe we must also keep in mind the serious problems looming for our nation if we don't act boldly to solve climate change and re-establish our technological leadership by leading the new green industrial revolution.

Furthermore, I see that part of the goal of the bill is to accelerate innovation in "both traditional and alternative energy sources…" As I have explained above, I strongly suggest ARPA-E's mandate focus on renewable energies, efficiency strategies and carbon capture and sequestration techniques.

Structure

H.R. 364 proposes placing ARPA-E within the Department of Energy. Others have suggested the agency might have more success if established as a quasi-independent agency outside of DOE. I'm not an expert in this area, but would urge Congress to adopt the organizational structure that would give the new agency maximum autonomy so it can foster a nimble, fast-moving, risk-taking culture, and at the same time, provide it with cabinet-level protection and support to keep it adequately funded and effective.

Funding

H.R. 364's proposal to create a fund which will receive $300 million in appropriations in 2007 and scale up to $915 million in 2012 is far short of what is required to solve our energy problems. I refer you to my answer to Question 2, above. While I do appreciate the difficulty of finding resources for new projects, we need to bear in mind the massive scale of the American energy and transportation industries, which account for more than $1.8 trillion in combined annual revenue, amounting to roughly 15% of U.S. GDP. The proposed $300 million in research funding would amount to less than 0.02% of these industries' annual revenues. We need to do much more, and move much faster, if we're to have any chance of solving our problems while we still can. We can and must do better than that.

Recoupment

Frankly, I believe the recoupment provision in H.R. 364 is inappropriate for translational research funding projects. It appears, moreover, to be a departure from past practices, with many unanswered questions about how it would work. Would an ARPA-E aim to recoup its investment from our research universities? From industry partners? The provision will likely deter some potential industry collaborators and almost certainly slow down the commercialization process. Let's not attach a string to these funds. If ARPA-E succeeds in commercializing breakthrough technologies, the federal government will be compensated many times over in the form of income and payroll tax revenues.

Review

H.R. 364 calls for the President's Council of Advisors on Science and Technology to evaluate ARPA-E just two and a half years after it is established, to determine whether it should be discontinued. To me, this seems counterproductive. If ARPA-E isn't working as well as it should, let's fix it. Let's not structure this new agency so that all translational research for renewable energy, energy efficiency and carbon capture and sequestration might cease because the agency fails to produce results in short order. Setting an unrealistic timeline would surely also make it difficult to hire top-flight talent.

Reason For Hope: The Opportunities

I would like to conclude my remarks by saying how confident I am we can solve our energy challenges through a new public-private partnership.

Kleiner Perkins has been investing in greentech for the past seven years, backing more than 15 innovative companies in the fields of biofuels, coal gasification, energy efficiency, energy storage, fuel cells, solar energy, thermoelectrics and transportation. In the process, we've witnessed how technological progress is already revolutionizing our relationship with energy, solving problems that only recently seemed all but intractable. Solar manufacturers are innovating their way around silicon shortages, with next-generation materials including pioneering thin-film technologies. The agriculture industry is producing transportation fuels from plant matter – even from microscopic algae -- and is developing exciting new way to convert weeds to biofuels. Nanotechnology breakthroughs are creating the promise of new ways to store energy, which in turn could dramatically speed up market adoption of solar and wind power.

At Kleiner Perkins, four accelerating trends have encouraged us to make greentech a core investment sector:

- We're already seeing exponential growth in the energy technology field, with a rapid cost-reduction curve sure to become ever steeper over time, making emerging sources of energy increasingly competitive;

- Rising prices for fossil fuels – oil and natural gas – are making competing alternative energy sources more attractive;

- World-class talent, with both missionary and monetary motives, is racing into the greentech sector;

- Americans are growing much more aware of and concerned by our energy crises, a development we believe will lend support to more sweeping policy solutions.

Moore's Law & The Pace of Technological Progress

In Silicon Valley, we often refer to a principle known as Moore's Law, which I'd like to explain briefly here, as it's fortunately quite relevant to what we see happening in the energy field. Intel co-founder Gordon Moore has been credited with predicting, back in the 1960s, that semiconductor performance would double every 24 months. That prediction was spot on, and helps explain the information technology revolution of the past three decades. Better, faster, and cheaper silicon chips led our transition from an era – remember, it was just 25 years ago! – of big, mainframe computers used principally by university researchers, to our capacity today to read the morning's headlines on our cell phones.

Today, we can already see a Moore's Law dynamic operating in the energy sector, giving us confidence the rate of greentech performance improvement and cost reduction will offer new energy solutions we can't even imagine right now. At Kleiner Perkins, we are excited by the technical breakthroughs we have seen in a host of scientific disciplines relating to the energy sectors, including material science, physics, electrical engineering, synthetic chemistry, and even biotechnology. We are particularly encouraged by innovations resulting from a combination of breakthroughs in several of these separate disciplines into single products.

Witness some of these examples of the greentech equivalent of Moore's Law:

- The price of wind power has plummeted by an order of magnitude since 1980, to the point where, in some regions, it is now very close to being able to compete with coal and gas power;

- Solar power costs have fallen by more than 60% over the past fifteen years;

- Ethanol production efficiencies per gallon have improved by more than 45% since 1982.

These and other improvements have occurred over a period of time in which there was relatively little government policy or entrepreneurial focus on these sectors.

Today, the high cost of many new energy sources, relative to the incumbent competition, represents the most serious barrier to greater capital investment and more rapid adoption

of clean power. Why does green power cost more? Primarily because it's so new. Being new, it is still at the very early stages of its cost-reduction curve, and is being produced in such low volumes that the industry has yet to benefit from economies of scale.

We can be certain American scientists and engineers will continually innovate to improve the performance and reduce the costs of these technologies going forward. But the speed at which they do so will depend to a large degree on government policy that is as bold and innovative as they are. With strong federal government leadership, imagine what American ingenuity will be able to accomplish in the future as more and more of our best and brightest devote their life's work to the greentech field.

Once again, I want to thank the Subcommittee for inviting me here today. I believe we all have an opportunity to be part of the solution to our country's energy crises. I look forward to today's hearing and to learning about how we can work together to build a more secure future.

John Denniston

John Denniston came to KPCB from Salomon Smith Barney, where he was a Managing Director and head of Technology Investment Banking for the Western U.S., and also served on the Investment Committee for Salomon's direct investment venture fund and its venture capital fund-of-funds. Prior to Salomon, John was a Partner with the law firm Brobeck, Phleger & Harrison, where he was the head of Brobeck's Venture Capital Practice Group, Co-head of its Information Technology Practice Group and a member of the Investment Committee for its venture capital fund.