Policies for Financing the Energy Transition

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Abstract: Historically, energy transitions have occurred gradually over the span of several decades, marked by incremental improvements in technologies. In recent years, public interest in accelerating the next energy transition has fueled a clean-energy policy agenda intended to underpin the development of a decarbonized energy economy. However, policies to date have encouraged investors to fund renewable energy projects utilizing proven technologies that are not competitive without the help of government subsidies. A true transition of the energy mix requires innovations that can compete with conventional energy over the long term. Investments in innovative technology projects are scarce because of the "commercialization gap," which affects projects that are too capital-intensive for venture capital yet too risky for private equity, project, or corporate debt financing. Accelerating innovation through the commercialization gap will require governments to allocate public dollars to, and encourage private investment in, these riskier projects. Policy-makers will face a trade-off between prioritizing policies for accelerating the energy transition and accounting for the risks associated with innovation funding in a tight budgetary environment.

In recent years, concerns over energy security, climate change, and maintaining U.S. competitiveness have made the next energy transition a prominent topic in public debate. These concerns have led to calls to reduce dependence on foreign oil, decarbonize our energy supply, and create new "green" industries. Many believe that these goals can be addressed through a single solution: the creation of a robust clean energy industry. If successful at scale, this new market would accelerate the next energy transition to a low- or zero-carbon economy.[1] On the surface, it appears that the transition may be under way. In 2010, investment in clean energy technologies and projects reached a record $268 billion globally and $30 billion in the United States.[2] Annual growth rates have exceeded 25 percent over the past five years. Despite this boom in investment, clean energy still has far to go to make a dent in the energy mix: in the United States, renewable energy (excluding hydropower)

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made up 5 percent of the energy supply in 2009.[3] Furthermore, most renewable energy assets operating today can attract private investment only with significant public subsidies. In the short term, maintaining strong growth rates will depend on whether governments continue to provide sizable supports for the industry. In today's tight fiscal environment, robust government aid and the health of the current industry are questionable.

To make this next energy transition in an accelerated time frame, the United States and other economies must scale clean-energy technologies beyond the limitations of government funding and the boom/bust cycles that have characterized the industry to date. A true energy transition to a low-carbon economy will require innovations and new technologies that can compete with conventional energy on both cost and scale, without the crutch of government.[4] This essay addresses financing – the key challenge to accelerating the commercial adoption of new energy innovations – and what can be done about it.

Energy transitions permeate all sectors of the economy and have catalyzed major periods of economic growth, most notably the industrial revolutions in Western Europe and the United States in the eighteenth and nineteenth centuries. Energy transitions also provide noneconomic benefits including improved air quality (as in the case of cleaner-burning fuels) and improved geopolitical positioning, as energy supplies become more diverse and less reliant on foreign imports. These important effects explain why energy transitions are viewed favorably by society and have warranted R&D efforts in both the public and private sectors.

Large-scale energy transitions from one primary energy supply to another have characteristically been gradual, spanning several decades. Examples include the major transitions from biomass to coal and from coal to oil as the dominant energy supply. Improvements in the steam engine stimulated the transition from biomass to coal in eighteenth-century Europe. The steam engine, originally designed to pump water out of coal mines, had been used for this purpose as early as the late 1600s. But not until 1769 – more than a half-century later – did James Watt's more compact, portable design lead to the widespread commercial use of the coal-powered steam engine for railroad and steamboat transportation.

The U.S. transition from biomass to coal dominance occurred over the course of the nineteenth century. In 1800, wood and animal feed[5] supplied 95 percent of U.S. energy use; by 1880, wood comprised 20 percent of U.S. energy supplies, while coal made up 70 percent.[6] The Industrial Revolution played a major role in expanding the use of coal. In addition to railroad transportation, coal was used to fire iron blast furnaces for industrial steel production, beginning with weapons production during the Civil War.

Technology innovations, such as the steam engine, are often incremental improvements over old technologies or are borrowed from other applications. A more modern example of incremental, borrowed innovation in power generation is the combined cycle gas turbine (CCGT). CCGT owes its existence to military-backed R&D on jet engines in the 1950s. Major manufacturers such as Westinghouse and GE recognized that the jet engine expertise they were developing could be transferred to gas turbines.[7] Today, CCGT is one of the most prevalent technologies in new-build power generation.

The sheer capital intensity needed for developing and deploying new technologies is a major reason why innovation happens incrementally. Moving energy technology innovations from niche markets to market diffusion is challenging in large part because energy systems are complex value chains requiring major infrastructure investments – such as new power plants or storage infrastructure – to shift to new resources. Liquefied natural gas (LNG) – methane that has been temporarily converted to liquid form for storage or transport – is an example of an energy source that has great potential yet has taken decades to develop into a viable industry, given the large infrastructure challenges of building a global LNG value chain. Infrastructure investments in the hundreds of millions of dollars are necessary, for example, for building import capacity to receive and re-gasify LNG.[8]

In short, energy transitions occur over long time periods, are often marked by gradual improvements in technology, and require massive infrastructure investments. Transitions, and the investments that support them, typically ensue only when new innovations have superior cost advantages over the status quo.[9] Thus, history suggests that the next energy transition will be a multidecade process. Can the transition to a decarbonized energy economy buck historical trends? Politicians on both sides of the aisle have voiced a desire to see this happen. Clean-energy goals have been prominent features of presidential energy agendas since the turn of the twenty-first century, with calls for rapid change on ten- and twenty-year time frames. While in office, President George W. Bush announced goals to replace 75 percent of U.S. oil imports from the Middle East by 2025, and in 2007 called for a reduction in gasoline demand by 25 percent over ten years. President Obama's election agenda for energy included goals of putting 1 million plug-in hybrid cars on the road by 2015 and generating 25 percent of electricity from renewable sources by 2025.[10] More recently, in his 2011 State of the Union address, Obama announced a goal to generate 80 percent of electricity from clean-energy sources by 2035.

The bold goals and policies of the Bush and Obama administrations have played a part in growing the clean-energy market over the past several years. But the majority of investment activity over the course of these administrations has been concentrated in projects that cannot compete in the marketplace without government supports – an expensive path to an energy transition. In 2010, conventional clean-energy projects, which are quick to build and easy to commission – such as large-scale wind farms, solar parks, and corn ethanol plants – made up 61 percent of total new U.S. clean-energy investments. Corporate and government R&D accounted for less than 4 percent.[11]

Tax credits and accelerated depreciation benefits attract private-sector financial investors to conventional projects. Currently, these subsidies account for more than half the after-tax returns on investments in conventional wind farms and two-thirds of the after-tax returns on solar farm investments.[12] These rich supports have created an industry dependent on their existence in the short term, resulting in boom/bust cycles characterized by investment patterns that are highly correlated with the expiration and reinstatement of tax credits.

The 2008 financial crisis demonstrated the critical importance of tax credits to the sector's viability. Investors in clean energy lost much of their taxable earnings, crushing demand for tax credits and, therefore, investment in the sector. The 2009 American Recovery and Reinvestment Act (ARRA), signed by Obama, instated the emergency scheme Section 1603, which offered cash grants designed to "temporarily fill the gap created by the diminished investor demand for tax credits."[13] Section 1603 deployed $2.7 billion into the U.S. renewable-energy project market in 2010, covering 30 percent of the up-front capital costs of shovel-ready wind and solar projects. While one can justify these funds by viewing them as true stimulus dollars, developers using the cash grants had few incentives to cut costs in order to make these technologies more competitive over the long term.

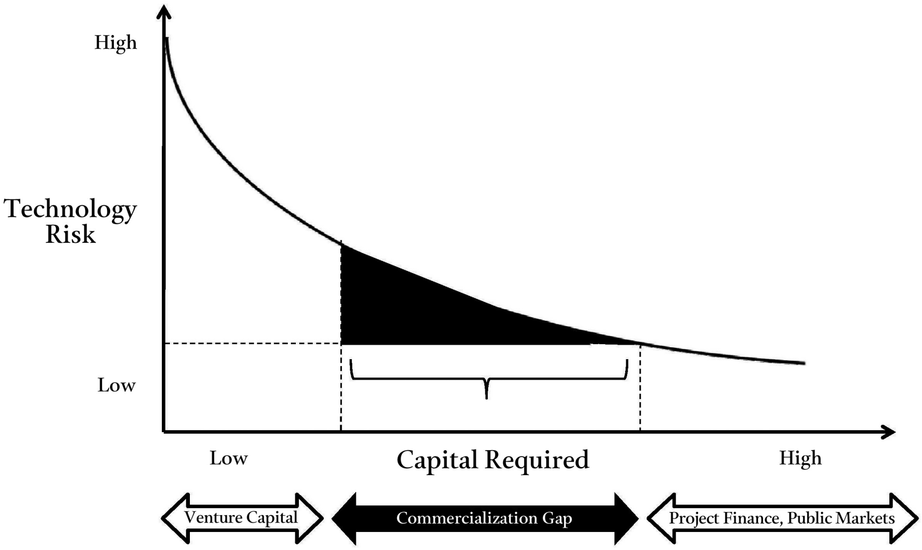
As stimulus dollars taper off over the next few years and government subsidies fall victim to budgetary cuts, the economic sustainability of a clean-energy industry that relies so heavily on short-term government supports is improbable. If government officials wish to accelerate the next energy transition, they will need a different strategy to develop an industry that can survive without major subsidies, one that prioritizes funding to develop decarbonized energy technologies that can compete dollar-for-dollar against carbon-based energy. Such technologies do not exist today, in part because of persistent financing challenges, or *financing gaps*, that impede their mass diffusion.

In the energy sector, financing gaps occur when the private sector does not get the investment returns it seeks. A *technology gap* occurs when university and government lab innovations lack financing for the next phase of development into potential commercial applications. This gap precedes funding by venture capital. In 2008, the government took steps to address the energy technology gap by establishing the U.S. Department of Energy Advanced Research Projects Agency-Energy (ARPA-E). Filling the technology gap is not a new role for government (the Department of Defense has funded similar programs with undisclosed budgets), but whether such a program will perform well within the Department of Energy (DOE) has yet to be determined, given that DOE programs are more subject to political winds and bureaucratic challenges.

The greater challenge is the *commercialization gap*. Technologies in this gap require massive investment to move beyond pilot and demonstration testing to commercial viability, at which point the private sector will take over full funding. Attracting private investment to these technologies is difficult. They are often too capital-intensive for venture capital yet too risky for private equity, project, or corporate debt financing (see Figure 1). Next-generation nuclear, clean coal, and large-scale solar technologies fall into the commercialization gap as a result of the sheer size of investment needed for proving their capability. To help close the gap, the government ideally would lower the financial risks for private-sector investors backing first-commercial technologies and projects. While the government role is critical in the commercialization gap, the risks and costs for taxpayers are high. Government funding in the form of financial guarantees or direct subsidies can add up to hundreds of millions, even billions, of dollars awarded to one company.

Nonetheless, the U.S. government has a history of supporting commercialization programs, beginning with nuclear energy programs in the 1950s and 1960s. The Atomic Energy Commission's Nuclear Light-Water Reactor Development Program contributed significantly to the commercialization of light-water reactors installed by electric utilities in the 1960s. In the aftermath of the 1973 oil embargo, federal investments in energy R&D grew dramatically – from $2.4 billion in 1974 to $7.4 billion in 1980 – causing a surge in commercialization activities. These programs included the $4 billion

Figure 1
Technology Risk versus Capital Required, showing the Commercialization Gap



Source: Tana Energy Capital LLC.

Synthetic Fuels Program and the $2 billion large-scale Solar Demonstrations Program.[14] Urgent concerns over U.S. dependence on foreign oil motivated the majority of these expenditures; 73 percent of funding from 1978 to 1981 was used to produce liquid and gas fuels from coal and oil shales.[15]

The government's track record in these and other commercialization programs has been mixed at best. Funding commercialization is thorny: it entails taking venture capital–like risk but also requires substantial capital commitments in the hundreds of millions of dollars for commercial-scale development – a difficult proposition to explain to taxpayers when such projects fail. Failures are often highly publicized; the recent case of solar company Solyndra is one example. Another much criticized government-funded failure, the Synthetic Fuels Corporation, was established in 1980 to finance the development of synthetic fuels plants, which were predicted to produce two million barrels of liquid fuel per day. Amid collapsing oil prices, the program was canceled within five years, having reached a production rate of only ten thousand barrels per day and incurring costs of $5 billion. Since the 1980s, the overall trend has been to support basic science instead of applied energy-technology development programs, with notable exceptions such as clean coal projects.[16]

Yet presidential administrations persist in supporting policies designed to accelerate the next energy transition, which requires closing the commercialization gap. In an era of depleted government budgets, policy-makers must ask: is funding the commercialization gap worth it?[17]

The risks of using scarce taxpayer dollars to accelerate new technology deployment must be weighed against potential benefits of creating competitive innovation industries over the long run.

The role of private-sector capital in technology funding has grown in recent years with the advent of venture capital and private equity funds. Venture capital, which was traditionally focused on the information-technology sector, has of late been invested in the clean-energy industry: venture investment in the energy sector increased from $0.4 billion in 2004 to $2.4 billion in 2010, a 35 percent annualized growth rate. Meanwhile, private equity investment, which is primarily concentrated in companies with proven technologies, grew from $0.3 billion to $3.1 billion, a 47 percent annualized growth rate.[18]

Despite the introduction of new types of capital into the funding picture for energy innovation, the commercialization gap remains. The risk/return profiles of commercialization do not fit the venture or private equity investment fund models, which seek returns exceeding 25 percent and paybacks within a five-year time horizon (see Table 1).[19] Capital-intensive commercialization companies rarely fit this profile. Projects have longer timelines and, in the case of project-based power generation investments, have limits on their investment returns due to the regulated nature of the power sector.

Corporate investment has also increasingly played a role alongside private funds. Given their strategic interests, long-term investment horizons, and cheaper cost of capital, corporations are ideally suited for funding commercialization in the private sector, as long as these risky investments are limited to a small portion of their capital budgets. Google, BP, Exxon, Chevron, GE, and Siemens are just a few of the large companies that in the past decade have launched energy-technology investment arms or bolstered their investment groups to focus on energy technologies and commercialization. U.S. power utilities – while not incentivized by their regulated business model to do so – have also of late invested in innovation. Utilities have started internal investment arms, developed commercialization projects, and made direct investments in funds or joint venture funds for strategic reasons.[20]

Aside from a handful of coal gasification and carbon sequestration projects, few DOE dollars were allocated to commercialization efforts in recent years. Section 1703 of the 2005 Energy Policy Act, which established the Loan Guarantee Program (LGP), changed this status quo. The LGP was designed to support a portfolio of new and improved technologies not yet available in the commercial marketplace with loan guarantees backed by the U.S. government. The purpose of these credit supports was to improve the risk/return profile for first-commercial, capital-intensive technologies, thereby motivating investment of private-sector capital in projects including nuclear, large-scale solar, geothermal, and energy storage. Although the program was authorized in 2005, Congress did not appropriate funding to implement it effectively; as a result, Section 1703 did not make any loan guarantees under the Bush administration.

The LGP was revitalized by 2009 ARRA stimulus funding, which amended the policy to also guarantee loans for commercial projects facing funding challenges as a result of dislocations in the credit markets. The revision was a significant departure from the original mandate of the LGP, as awards were not limited to commercialization gap projects and

Table 1
Energy Technology Financing: Investment Stage and Financing Participants

Stage of Development	Definition of Stage	Financial Characteristics	Financing Instruments/ Participants	Typical Investment Required/Target Return Profile*
R&D	Basic research	N/A	DOE/national labs; some corporate strategic investors	$0 – 2m (N/A)
Proof of Concept	Prove a concept/ qualify for start-up capital	N/A	Bootstrapping; angel funding	$2 – 5m (N/A)
Prototype and Pilot Scale Production	Complete product development	Losses Minimal assets Negative cash flow	Early-stage venture capital	$5 – 15m (10 – 15x, 40 – 50+%)
Prototype System Development	Initiate manufacturing; advance projects through pilot scale	Losses Minimal assets Negative cash flow	Venture capital; occasionally debt	$15 – 30m (10x, 40%)
Pre-Commercial Scale-Up	Scale up projects and manufacturing processes for technologies not yet proven at commercial scale	Losses Minimal assets Negative cash flow	**Commercialization gap**	$30 – 50m (5 – 10x, 35 – 40%)
Growth/ Commercial Scale-Up	Growth stage for expansion/capital used for working capital; expansion for commercial scale-up	Break-even to profitable Rapidly growing assets Negative or modestly positive cash flow	Corporate debt; leases (equipment); private equity	$50 – 200m (> cost of capital)
Commercial Replication (Maturity)	Mature, stable-growth businesses	Profitable Stable asset levels Positive cash flow	Self-sustaining; public debt and equity; markets; infra funds	+$200m (> cost of capital)

*Multiple of money or internal rate of return. Estimates assume a five-year hold for venture capital/private equity investments. Source: Table created by author.

applicants were judged on stimulus-related goals including short-term job creation. ARRA provided $4 billion for funding credit subsidy costs supporting $32.4 billion in loans.[21] As of July 2011, the DOE had issued conditional commitments for $35 billion in loans or loan guarantees to thirty-two projects. The projects span technologies related to wind, solar, advanced biofuel, geothermal, and nuclear energy as well as transmission and battery storage.

Despite the program's progress in deploying funds, the LGP has been fraught with an ambiguous mission, structural challenges, and front-page scrutiny of its first award recipient – Solyndra – which declared bankruptcy in September 2011. Evaluating the LGP program in detail – including the laborious interagency process that industry participants and the DOE itself have criticized – is beyond the scope of this essay.[22] However, it is important to consider whether the LGP, as the sole active U.S. government program designed to address the energy technology commercialization gap, is effective. It is also worth considering the extent to which the failure of Solyndra demonstrates the inadequacy of the program to identify high-potential technologies, or whether failures like Solyndra are simply "par for the course" in the difficult enterprise of funding the commercialization gap.

It is likely too early to tell if any company in the LGP portfolio will help accelerate a low-carbon energy transition through funding the commercialization gap. However, the LGP offers lessons that can help position future programs for success.

Commercialization programs ideally should focus on the persistent financing challenges of innovation acceleration – not short-term job creation goals. The LGP ultimately was amended to include commercial technologies and was funded by a stimulus program requiring the DOE to select companies that could facilitate the short-term goal of stimulating job creation. Thus, the DOE was incentivized to select companies with the greatest job-generation potential, such as large-scale project deployments or manufacturing operations. By contrast, commercialization gap manufacturing companies or projects without proven technologies or steady revenues are less likely to scale up headcount overheads before their business models can support them. Riskier commercialization companies that employ high headcounts – Solyndra being an example – do so risking failure, which can result in lost jobs. Critics of Solyndra's high-profile bankruptcy highlighted the 1,100 jobs lost when the company shut its doors, citing the failure of the LGP as a stimulus program. If the LGP had been laser-focused on the goal of promoting commercial innovation – rather than trying to be a climate change mitigant, job creator, and technology accelerator all at the same time – the program would have more appropriately been judged by the public as a tool for technology advancement.

Loans and loan guarantees are limiting and may not be the most appropriate mechanism for funding commercialization technologies. The LGP is limited to providing loans and loan guarantees, financial tools most suited to projects and companies that are commercially viable and have a contracted revenue stream in place, such as a long-term power purchase agreement (PPA). As a debt provider with a fixed return, the government has little incentive to take on projects that offer neither PPAs nor any monetary upside. Consequently, the majority of LGP awards funded projects using existing technologies.[23] However, higher risk projects (for example, first-commercial projects using a new coal gasification technology) may represent significant technological breakthroughs. If a government funding program could provide equity or quasi-equity instruments to projects, it could not only help these projects advance, it could also benefit alongside the private sponsor at an appropriate rate of risk/return and build a revenue stream to finance future program funding costs.[24]

Funding efforts would benefit from private-sector expertise and an arms-length relationship with the DOE. The LGP's multiagency review process suffers from long delays and funding awards that are easily politicized. The "check" on the DOE is understandable, given the difficultly in choosing the best portfolio of projects for government support. However, putting the investment decision-making function at arm's length from agencies and hiring private-sector technical and financial skill sets to award funds would remove bureaucratic and political agendas from the funding process, reduce conflicts of interest, and provide greater autonomy to investment decisions. Public information on the Solyndra investment process shows that this funding award – and potentially others – benefited from political involvement. While this sort of activity is nothing new in Washington, inside political tracks reduce the rigor and transparency of an investment decision-making process.

Another way to augment decision-making rigor is to align monetary compensation for investment managers with the performance of the portfolio – a common approach in the private sector. Linking pay to performance would better serve the goal of successful commercialization. A current plan to improve the commercialization funding process and the rigor of investment decision-making calls for a Clean Energy Deployment Authority (CEDA). This proposed (but still not approved or funded) administration could, among other things, partner with private-sector funds investing in the commercialization gap and would sit as an independent agency under the DOE.

The challenges of implementing commercialization programs offer a number of lessons about how difficult it is to speed a naturally incremental process, particularly amid competing agendas (such as short-term job creation) and the political nature of disbursing government dollars for high-cost, high-profile projects. The following are principles and recommendations to guide future policy-makers in funding energy technology commercialization.

- *Go big or go home: the massive scale of investment needed should not be underestimated.* Commercialization is risky; funding it entails a number of venture capital–like "bets." It is also capital-intensive: for example, demonstrating an advanced nuclear technology or utility-scale solar thermal facility requires hundreds of millions, or even billions, of dollars. If policy-makers want to accelerate innovation through the commercialization gap, they must be serious about taking on the sheer scale of effort needed to fill the gap that, given the risk/return imbalance, the private sector cannot. Programs must be well funded (unlike the 2005 loan program), placing investments across a range of technologies to provide multiple opportunities for success. Furthermore, additional investments in ancillary infrastructure (such as new transmission lines or electric car charging stations) are necessary to support commercial deployment of new innovations.

- *Stress the incremental benefits – and embrace the failures.* Inevitably, technologies demonstrated in pilot projects or pilot deployments will fail to reach commercial diffusion. This does not mean all is lost; historically, technological innovations are incremental and appropriated for other uses. An example of this phenomenon is the infamous Synthetic Fuels Corporation, which, although viewed as an expensive failure, laid the groundwork for coal gasification technology utilized today.

- *Leverage global investment dollars to encourage investment in commercialization.* Given the sheer investment needs and risks associated with commercialization, as well as the fact that energy is a global market, the United States is unlikely to create the next energy transition on its own. One solution could be the creation of a global commercialization fund that would pool the capital of ten countries instead of one, allowing for a large portfolio of multimillion-dollar demonstration and first-commercial projects. Putting aside complexities that could thwart this effort, such as intellectual property assignments and domestic industry development goals, a global innovation fund would pool risk among various participants, leveraging foreign dollars and limiting taxpayer exposure to risky government investments.

ENDNOTES

1 I define a *low-* or *zero-carbon economy* as an economy with a minimal output of greenhouse gas emissions, achieved through low-carbon energy use and improved energy efficiency.

2 The total includes mergers and acquisitions and equity reinvestment. New investments in 2010 represent $211 billion. See Bloomberg New Energy Finance and United Nations Environment Programme, *Global Trends in Renewable Energy Investment 2011 : Analysis of Trends and Issues in the Financing of Renewable Energy*, July 2011.

3 U.S. Energy Information Administration, *Annual Energy Review* 2009 (Washington, D.C. : Department of Energy, August 2010).

4 For a discussion of how innovation is necessary to meet goals to limit climate change, see David Victor, "Promoting Technological Change," in *Global Warming Gridlock : Creating More Effective Strategies for Protecting the Planet* (Cambridge : Cambridge University Press, 2011), chap. 5.

5 In this case, animal feed was the "input" for horse-drawn transport.

6 Vaclav Smil, *Energy Transitions : History, Requirements, Prospects* (Santa Barbara, Calif. : Praeger, 2010).

7 Diffusion of CCGT technology was also driven by policy and regulatory influences, such as the collapse of natural gas prices in the 1980s and the advent of the Public Utility Regulatory Policies Act in 1978 ; ibid.

8 The LNG value chain consists of natural gas production, liquefaction capacity, transport, shipping, and storage. While global capacity grew robustly between 2000 and 2008, the recent growth in shale gas production in North America and the dampening of natural gas prices have significantly slowed the industry's development.

9 Robert Fri has succinctly summarized technology innovation in the energy sector : "the process of innovation is typically incremental, cumulative, and assimilative" ; Robert W. Fri, "The Role of Knowledge : Technological Innovation in the Energy System," *The Energy Journal* 24 (4) (2003) : 51 – 73.

10 For the Obama energy plan as he articulated it while a candidate and as president-elect, see http ://change.gov/agenda/energy_and_environment_agenda/.

11 Bloomberg New Energy Finance and United Nations Environment Programme, *Global Trends in Renewable Energy Investment 2011.*

12 Author's calculations ; data are from Morgan Stanley.

13 See U.S. Department of Treasury, http ://eetd.lbl.gov/ea/emp/reports/lbnl-3188e.pdf.

14 James J. Dooley, "U.S. Federal Investment in Energy R&D : 1961 – 2008," Pacific Northwest Laboratory, October 2008. It is interesting to note that 24 percent of all federal R&D investments made during the half-century from 1961 to 2008 were made between 1974 and 1980.

15 Committee on Benefits of DOE R&D on Energy Efficiency and Fossil Energy, Board on Energy and Environmental Systems, Division on Engineering and Physical Sciences, National

Research Council, *Energy Research at DOE: Was it Worth it? Energy Efficiency and Fossil Fuel Research 1978 – 2000* (Washington, D.C.: National Academies Press, 2001).

16 Dooley, "U.S. Federal Investment in Energy R&D," 13.

17 See Committee on Benefits of DOE R&D on Energy Efficiency and Fossil Energy, *Energy Research at DOE*. The committee found that return on investment related to federal government support for energy R&D was positive.

18 Bloomberg New Energy Finance and United Nations Environment Programme, *Global Trends in Renewable Energy Investment 2011*.

19 Venture capital funds typically seek returns of 30 to 40 percent over five to eight years; private equity funds typically seek returns of 25 to 30 percent over that time frame.

20 Examples include Duke Energy and DTE Energy, which have invested in innovation companies and participated as investors in energy-focused venture funds. Duke and American Electric Power have been active in clean-coal demonstration projects in partnership with the DOE. California-based utilities, including Pacific Gas & Electric Company, have invested in solar-focused funds for residential rooftop solar projects.

21 The Congressional Budget Office forecast a 12 percent probability of default.

22 For critiques of the LGP, see Government Accountability Office, "Department of Energy: Further Actions are Needed to Improve DOE's Ability to Evaluate and Implement the Loan Guarantee Program," GAO Report 10-627, July 2010; and U.S. Partnership for Renewable Energy Finance, "The Clean Energy Deployment Administration (CEDA): Key Aspects and Improvements to the Department of Energy (DOE) Loan Guarantee Programs," July 2011.

23 Loan Guarantee Program Projects, https://lpo.energy.gov/?page_id=45.

24 Currently, the Federal Credit Reform Act (FCRA) limits the government to participating in project investments through debt instruments. FCRA was enacted in 1990 to improve the measurement of the budgetary costs of federal credit programs. The legislation requires federal credit subsidy costs to be calculated and accounted for on a net present value basis over the life of a loan.