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Policy Monitor

A Preliminary Assessment of the American Recovery and Reinvestment Act's Clean Energy Package[1]

Joseph E. Aldy*

Introduction

In December 2007, the US economy began to contract, and over the course of the following year, economic conditions deteriorated to an extent unseen in the country since the 1930s. Between the start of the recession and February 2009, the economy lost about 4.6 million jobs (Bureau of Labor Statistics 2011). Gross domestic product (GDP) experienced a greater percentage decline over the fourth quarter of 2008 and the first quarter of 2009 than during any six-month period since the late 1940s (Bureau of Economic Analysis 2011). Bond markets revealed expectations of default for nearly four in ten investment-grade corporate bonds (Summers 2009). By February 2009, consumer confidence had fallen to the lowest level recorded in the more than forty years of consumer surveys (Rooney 2009).

The American Recovery and Reinvestment Act of 2009 ("Recovery Act") provided a wide array of policy instruments to stimulate the US economy and establish a robust foundation for long-term economic growth, including a payroll tax rebate to increase household disposable income; an extension of unemployment insurance, which targeted the most vulnerable; and bonus depreciation for new investment to stimulate near-term business activity. To put the economy on a more stable footing for long-term growth, the Recovery Act also made strategic investments in clean energy, education, and health care. The Recovery Act's stimulus provisions were equivalent to about 5.5 percent of GDP over more than two years and represented the "boldest countercyclical fiscal action in American history" (Council of Economic Advisers [CEA] 2009, 1).

*Assistant Professor of Public Policy, Harvard Kennedy School; Nonresident Fellow, Resources for the Future; Faculty Research Fellow, National Bureau of Economic Research; e-mail: joseph_aldy@hks.harvard.edu.

[1]The author served on the 2008–2009 Presidential Transition Team and as the Special Assistant to the President for Energy and Environment at the National Economic Council and the Office of Energy and Climate Change in 2009 and 2010. Kevin Carroll, Jud Jaffe, Matt Kahn, Lori Krauss, Jeff Liebman, Alex Mas, and Billy Pizer provided helpful comments on an earlier draft. This manuscript was submitted in June 2011 and was provisionally accepted for publication in August 2011. Thus all analyses focus on public data available through December 2010.

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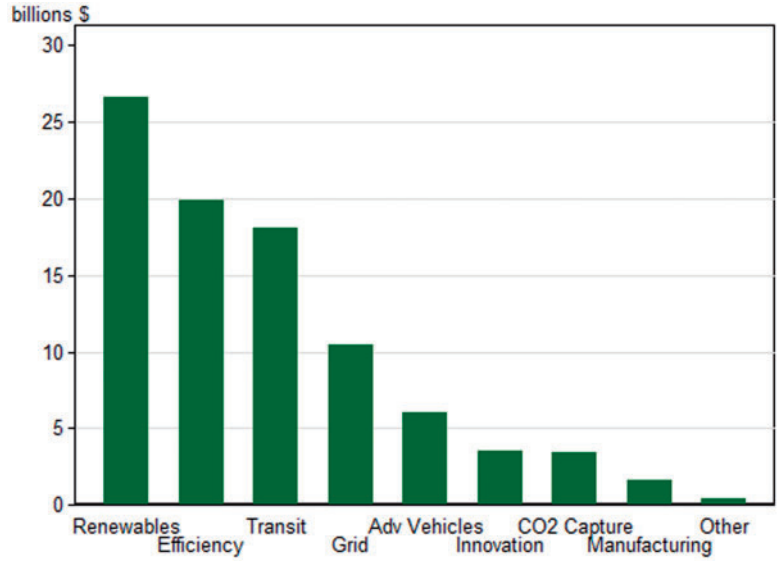

Figure 1 Appropriations and estimated tax expenditures by category of clean energy
Source: CEA 2010a, 36.

The Recovery Act included more than $90 billion for strategic clean energy investments intended to promote job creation and the deployment of low-carbon technologies (CEA 2010a; Figure 1). In terms of spending, the clean energy package has been described as the nation's "biggest energy bill in history" (*New York Times* 2009). The short-term supply-side support for clean energy technologies was the administration's first major step toward implementing President Obama's energy and climate policy and made a significant "down payment" on the energy investment necessary to cut greenhouse gas emissions and reduce reliance on oil. The second step focused on ramping up federal research and development (R&D) funding to improve the scientific foundation for new energy technologies. These two steps complemented the president's proposal for an economywide cap-and-trade regime implemented through allowance auctions to cut greenhouse gas emissions more than 80 percent by 2050 and finance R&D and lower effective labor taxes (Office of Management and Budget [OMB] 2009).

The Recovery Act represented an unprecedented investment in clean energy in the United States.[2] It also leveraged more than $100 billion in private capital for investments in manufacturing, power generation, and the residential and commercial building sectors to advance the deployment of energy efficiency, wind, solar, geothermal, biomass, low-carbon fossil fuel, and other technologies. The idea was that promoting a long-term transformation to a less polluting, more diverse, and therefore more robust energy economy would also strengthen the foundation for long-term economic growth.

This article provides a preliminary assessment of the rationale, design, implementation, and impacts of the Recovery Act's clean energy package. The next section examines the policy rationale for the clean energy stimulus. This is followed by a description of the process of crafting the clean energy package, which occurred during the 2008–2009 presidential transition.

[2]For example, the Clinton administration proposed a Climate Change Technology Initiative to invest $6.3 billion over five years.

Next I identify the key elements of the clean energy package and then review the initial economic and energy outcomes associated with these energy investments. This is followed by a case study that more carefully examines the Recovery Act's provisions to support renewable power through grants and loan guarantees. The final section discusses lessons learned from experience with the clean energy package and the implications for the design and implementation of future economic stimulus programs and energy policy.

The Policy Rationale for a Clean Energy Stimulus

Given weak aggregate demand and the already aggressive use of monetary policy tools in 2008, many economists argued that there was a strong case for enacting a fiscal stimulus (Feldstein 2008; Stone and Cox 2008). In July 2009, Lawrence Summers, director of the National Economic Council at the time, described the economic conditions that necessitated a fiscal stimulus: "Our policy approach started with a major commitment to fiscal stimulus. Economists in recent years have become skeptical about discretionary fiscal policy and have regarded monetary policy as a better tool for short-term stabilization. Our judgment, however, was that in a liquidity trap-type scenario of zero interest rates, a dysfunctional financial system, and expectations of protracted contraction, the results of monetary policy were highly uncertain whereas fiscal policy was likely to be potent" (Summers 2009).

A well-designed fiscal stimulus aims to increase near-term economic output to shrink the output gap without accelerating inflation. By using deficit spending to increase aggregate demand in the short term, the government tries to shift to the current time period some consumption and investment from the future when the economy is expected to be closer to full utilization of its resources. Several policy principles informed the design of the stimulus package.

The 3 Ts of a Fiscal Stimulus

A number of economists recommended a fiscal stimulus that was "timely, targeted, and temporary," known as the "3 Ts" (Bernanke 2008; Elmendorf and Furman 2008; Stone and Cox 2008; Summers 2008).[3] The idea is that a timely package pumps resources into the economy when they are needed most (i.e., when there is a large output gap). Ideally, a timely stimulus would have been enacted in 2008 (Auerbach, Gale, and Harris 2010).

A targeted stimulus directs resources to the economy in a way that maximizes the "bang for the buck." Those who are the most adversely impacted by the recession are likely to benefit the most from a given stimulus dollar and typically have the highest marginal propensity to consume, thus increasing the effective multiplier for that stimulus dollar.[4]

A temporary stimulus reduces the risk that the stimulus will become a permanent increase in deficit spending. Public perception of permanent and larger future deficits could

[3]In light of the legislative delay in 2008 and the depth and breadth of the recession, Summers (2009) revised his stimulus principles to "speedy, substantial, and sustained."

[4]The Congressional Budget Office (CBO) assessment of the Recovery Act showed that government purchase of goods and services (e.g., many components of the clean energy package) has the highest estimated GDP multipliers, followed closely by transfers to state and local governments (e.g., highway construction), and transfers to individuals (e.g., unemployment insurance), while tax cuts yield lower multipliers because some of the untaxed income is saved for future consumption (CBO 2009).

weaken business confidence and potentially increase long-term interest rates, which would counter the stimulus package's objective of promoting economic activity (Summers 2008).

Targeting Externalities

In addition to the 3-T principles that support a general fiscal stimulus, the Presidential Transition Team believed the design of a clean energy package should reflect the specific policy objectives of the clean energy agenda. This means that investments in clean energy should target various externalities, particularly carbon dioxide (CO_2) emissions. Although subsidies for zero-emitting sources and associated technology are not as efficient as taxing the emitting sources themselves (Metcalf 2009b), the obvious policy constraint of a stimulus package—to increase tax expenditures and government outlays, not raise taxes—focuses attention on subsidies. The need for public policy to promote innovation because of the public good nature of knowledge suggests orienting stimulus funds to R&D as well. The effective targeting of subsidies to externalities requires the government to minimize the investment of resources in those projects that would occur without public support or that would likely fail even with public support.

Weighting the Principles

In concert, these principles guided the design of the Recovery Act's clean energy package such that it focused on investments that could drive job creation and economic activity while reducing carbon pollution. The challenge in crafting an effective clean energy fiscal stimulus was to determine the proper weights for these various principles. Some clean energy investments can be timely, substantial, and mitigate pollution externalities (e.g., grants for renewable power projects), while others, although substantial and effective at combating climate change, would risk being neither timely nor temporary (e.g., nuclear power plant projects have licensing and construction time frames on the order of a decade). In late January 2009, the administration called on Congress to complete a general fiscal stimulus package that would spend 75 percent of the stimulus funds within eighteen months (effectively by the end of fiscal year 2010). For some programs, this trade-off between short-term and long-term funding resulted in a longer "tail" for clean energy spending (i.e., some stimulus activities occurred eighteen months or more after passage of the Recovery Act), while for others it meant exclusion from the stimulus package altogether.

Crafting the Clean Energy Package

Given the state of the US economy in the fall of 2008, it was clear that a significant stimulus bill would be a high priority for the next administration. The energy and environmental policy group held its first meeting a few days after the 2008 election, just as the formal Presidential Transition Team was being launched. We immediately began working on the economic stimulus, near-term executive actions and decisions, and legislative priorities. President Obama quickly decided that the economic recovery proposal should include strategic investments in clean energy. The discussion then turned to determining the necessary size of the overall stimulus proposal and the size and composition of the clean energy package.

The Scale of Initial Stimulus Proposals

As the depth and breadth of the economic recession evolved during the fall of 2008, so too did our understanding of what would constitute an appropriately sized stimulus. In October, public statements by members of Congress as well as prominent economists called for stimulus legislation on the order of $150 to $300 billion (Feldstein 2008; Smith and Ferraro 2008). By the end of the 2008, some economists were calling for a trillion-dollar stimulus bill (Kinsley 2008; Krugman 2009). These changing recommendations concerning the size of the stimulus challenged us to scale up some policy options (e.g., weatherization) and identify a larger set of investments that could deliver well-targeted boosts to aggregate demand.

Roles and Responsibilities of Transition Teams

Within the context of this moving target, policy teams worked together during the presidential transition in a manner that mirrored what would become the post-inauguration White House policy process. The economic team, what would become the National Economic Council, coordinated the efforts to compile, review, and integrate ideas for an economic stimulus, and they worked closely with the so-called shadow, or transition OMB, team on traditional stimulus measures. The transition policy working groups, which evolved into the Domestic Policy Council, the Office of Health Reform, and the Office of Energy and Climate Change, took the lead on the education, health care, and clean energy packages, respectively. Transition OMB and Treasury teams worked with the policy working groups to evaluate various proposals for investments and tax expenditures, and a transition CEA team analyzed the proposals' employment and economic impacts.[5]

The Energy and Environmental Policy Group

The Transition Team's energy and environmental policy group evaluated a large number of policy proposals for an economic stimulus including many unsolicited proposals from nongovernmental organizations, businesses, trade associations, academics, and private citizens. We also identified proposals from the presidential campaign that could be mobilized quickly, such as extending the renewable power production tax credit, increasing the weatherization of low-income homes, ramping up energy R&D, supporting clean coal technology, and advancing smart grid technology (such as smart meters that provide real-time consumption and price information to consumers, digitized transmission and distribution hardware, and utility software for better management of the grid). In addition, we held many meetings with energy, environmental, and financial stakeholders to identify the areas of greatest need and ways to address them effectively.

In our assessment of stimulus proposals, we asked a variety of questions motivated by the policy principles described earlier. Are the projects "shovel ready"? Do implementing agencies have the staff, experience, and capacity to deploy new resources effectively and promptly, or should the stimulus enhance agency capacity? Will an increase in federal support leverage private financing? Can the policies be implemented through existing authorities, or do we

[5]The CEA employed a common framework to estimate employment impacts across proposed Recovery Act policies and was the Transition Team's sole jobs "scorekeeper."

need new legislative authorities? Are these proposals earmarks (which the president opposed during the campaign)? How much bang for the buck, in terms of employment, economic activity, and changes in the energy system, will we get? Will the proposed policies reduce CO_2 emissions?

As the economist in the energy and environmental policy group, I served as the liaison with the transition economic teams. This meant that I undertook the initial economic and budgetary vetting of all ideas before our group decided whether to present them to the appropriate economic team staff. This became an iterative process: we would discuss how to match a given energy investment objective to a policy instrument and an existing authority (or a new authority, if necessary), assess the quarterly expenditure rate, and then score the potential appropriation required.[6] The target size and scope of the stimulus continued to shift throughout this process. For example, in one meeting with the OMB team, I was told that "we were not spending enough" on the clean energy package, which was smaller than what was eventually included in the Recovery Act.[7]

Negotiations with Congress

In December 2008, Transition Team staff began to brief and negotiate with congressional staff on the details of the envisioned Recovery Act. The energy and environment policy group provided an overview of the clean energy package and presented four major themes (or priorities) and the specific policies associated with them:

- Efficiency: reducing government energy consumption through building retrofits; residential weatherization; state block grants;
- The grid: deploying smart grid technology; enhancing transmission capacity in the Western Area Power Administration (WAPA);
- Transportation: supporting car battery manufacturing; investing in mass transit; accelerating replacement/retrofits of heavy-duty diesel engines; and,
- Clean energy: promoting renewable power through production tax credits and loan guarantees; demonstrating carbon capture technology at coal plants.

Negotiations with congressional committee staff continued in January, as we went through every detail of the proposed clean energy package. In this productive back-and-forth, we discussed policy priorities, spending levels, the applicability of existing implementation authorities, and the need to create new authorities. The staff from the authorizing committees identified provisions in the 2005 and 2007 energy bills that we could employ and/or modify to achieve several of our policy priorities. In the case of the energy loan guarantee program, we worked with congressional staff to expand the program to support conventional renewable technologies in addition to innovative technologies covered by an existing program (the section 1703 energy loan guarantee program). In some cases, we had an extensive discussion about the feasibility of spending a given level of resources on specific programs in a prompt manner.

[6]The "score" refers to the estimated net impact of the policy on the federal government's revenues. Technically, a negative score represents deficit spending, a positive score represents revenue raising, and a zero score represents a deficit-neutral policy. Thus the $90 billion estimated size of the clean energy package refers to the sum of the scores of the deficit spending associated with the components of the package.
[7]I have found no written evidence that these words have ever been uttered in the past by an OMB official.

For example, appropriators raised questions about the rate of expenditure in a ramped-up weatherization program (which did have a slow expenditure rate in 2009). On some issues, congressional staff recommended relying on alternative existing authorities to achieve our desired policy priority. For example, in lieu of channeling all state energy monies through the State Energy Program, we agreed to split funding between this program and the Energy Efficiency and Conservation Block Grant program, which could deliver monies directly to local entities and also set aside funds for competitive grant purposes.

The grid-related stimulus provisions involved significant work with congressional staff. Following the suggestion of congressional staff, we used, with some modifications, the smart grid provisions of the 2007 energy bill to advance the smart grid proposal. Some renewable power advocates in the stakeholder community called for an "interstate transmission highway system" of electricity transmission to bring remote renewable power resources to the market (e.g., American Wind Energy Association [AWEA] 2008). Although some likened this investment in electricity transmission to the investment in the Eisenhower interstate highway system, there are some fundamental differences that are important in the stimulus context. Unlike freeways, which rely almost exclusively on public financing, electricity transmission has a well-established history of private financing with regulated economic returns through the setting of transmission fees on consumers' utility bills. For those regions in which public financing is relevant (due to the presence of federal power marketing administrations), we worked to enhance the borrowing authority of the WAPA and the Bonneville Power Administration to increase transmission capacity. However, expanding the transmission system is constrained much more by siting and cost-allocation issues than by the availability of financing. Thus increasing funding for transmission will not necessarily overcome these nonfinancial constraints, and certainly not in the relatively short time frame of a stimulus. We did discuss various ways in which federal funds could be used to drive innovative thinking among states to resolve siting and cost-allocation issues, but the lack of an existing legislative authority and the absence of a consensus concerning the design and effectiveness of such an approach rendered it moot.

The House of Representatives introduced the American Recovery and Reinvestment Act of 2009 on January 26 and passed the bill on January 28. About two weeks later, after negotiations with the Senate resulted in a more limited bill, the House and the Senate passed a version of the bill that was agreed upon by a conference committee of the House and Senate. President Obama signed the Recovery Act into law on February 17, 2009. The final version of the clean energy package that was included in the Recovery Act reflected the general approach, major energy themes (efficiency, transportation, the grid, clean energy), and many of the specific policies proposed in our initial congressional briefing.

Components of the Clean Energy Package and Implementation Issues

The Recovery Act provided more than $90 billion in public spending and tax expenditures in support of clean energy activities (CEA 2010a). Support for renewable power generation exceeded $25 billion, and appropriations and tax expenditures dedicated to energy efficiency investments were nearly $20 billion (see Figure 1). Financing for transportation activities

including high-speed rail, mass transit, and advanced vehicles, fuels, and battery technologies amounted to about $24 billion. Appropriations for grid modernization, which included smart grid deployment and borrowing authority for two power marketing administrations to finance transmission capacity, exceeded $10 billion. The remaining funding for clean energy targeted carbon capture and storage technologies, job training, and clean energy manufacturing. The clean energy package employed a variety of policy instruments to promote the deployment of new technologies including grants, tax credits, subsidized bonds, and R&D (see Appendix Table 1).

The significant public spending and tax expenditures of the Recovery Act placed new demands on a number of government agencies, which resulted in delayed implementation of some programs. In particular, the Department of Energy received Recovery Act appropriations for clean energy activities in excess of $35 billion, more than triple the department's fiscal year 2009 appropriation for civilian energy activities (i.e., excluding national defense-related activities and cleanup of Cold War era facilities).

The clean energy package's focus on commercial technology deployment also required the reorientation of a department traditionally focused on science, applied research, and demonstration projects. Not surprisingly, the scaling up of the commercial technology deployment program encountered delays and obstacles to prompt implementation. For example, competitive grant programs required time to draft Funding Opportunity Announcements, time for applicants to submit funding applications, and time for agency staff to evaluate applications and make grant decisions. The Recovery Act included transparency provisions that required additional reporting and communication by implementing agencies and recipients of Recovery Act funds. Although these provisions are critically important for accountability and evaluation of the effectiveness of the Recovery Act's clean energy programs, they also required time and resources to implement well. Some programs, such as the State Energy Program, operate through the states, but a number of states had previously cut the relevant staffing to address budget problems. Finally, the rollout of funds for the Weatherization Assistance Program was delayed until the fall of 2009 due to the labor compensation requirements applied under the Recovery Act.[8]

Initial Impacts of the Recovery Act and Clean Energy Package[9]

The Recovery Act represented the largest economic stimulus in US history. As of the end of 2010, the federal government had made about $350 billion in spending outlays, $260 billion in tax reductions, and obligated another $125 billion of spending. According to the CEA (2011), the level of economic activity was 2.3 to 3.2 percent higher at the end of 2010 than it would have been in the absence of the Recovery Act. Independent analyses estimate a similar range, with some private sector estimates of the increased level of economic activity as high as 3.1 percent, and the high-end forecast by the US CBO at 3.6 percent (CEA 2011). The CEA also estimates that employment levels were about 2.5 to 3.5 million higher at the end of 2010 than they would

[8]These labor compensation rules require contractors and subcontractors to be paid local prevailing wages, which necessitates a formal determination of these wages.
[9]This preliminary assessment was undertaken in the spring of 2011 and focused on public data available through December 2010.

Table 1 Clean energy jobs by category

Category	Total job-years through 2012
Energy efficiency	179,000
Renewable generation	192,900
Grid modernization	80,600
Advanced vehicles and fuels	37,000
Transit	158,200
Carbon capture	26,500
Green innovation and job training	32,200
Clean energy manufacturing	9,500
Other	3,700
Total	719,600

Source: CEA 2010a, 38.

have been in the absence of the Recovery Act (CEA 2011). CBO and private sector forecasts for employment are very similar (CEA 2011).

Job Creation through the Clean Energy Package

The clean energy package plays an important role in the Recovery Act's job creation activities. The CEA (2010a) estimated that the entire clean energy package would support about 720,000 job-years through the end of 2012, representing about 10 percent of the Recovery Act's 2009–12 employment impact. Not surprisingly, the largest sources of job creation in clean energy are in renewable energy, energy efficiency, and transit, the categories of activity that received the largest shares of stimulus funds (see Table 1).

Leveraging Coinvestment

The Recovery Act leveraged significant "coinvestment" from the private sector, state and local governments, and nonprofits and universities. The CEA (2010b) estimates that about $46 billion in clean energy investments under the Recovery Act leveraged more than $100 billion in private sector and nonfederal government spending on clean energy. This represents more than 37 percent of all the coinvestment the CEA estimates was leveraged under the Recovery Act.

The leveraging of nonfederal resources for clean energy investment has taken several forms. Department of Energy cost-sharing grants for smart grid projects mobilized more than $4.5 billion of coinvestment from a $3.4 billion Recovery Act expenditure.[10] The Recovery Act's clean energy manufacturing tax credit, with a total tax expenditure cap of $2.3 billion, supported 183 manufacturing facilities with a coinvestment of as much as $5.4 billion.[11] By providing $1.6 billion in interest subsidies through the tax code, Clean Renewable Energy Bonds have leveraged investment in renewable power for public and quasi-public utilities.

[10]Department of Energy press release: President Obama announces $3.4 billion investment to spur transition to smart grid technology, October 27, 2009.
[11]Department of Energy press release. Fact sheet: $2.3 billion in new clean energy manufacturing tax credits, January 8, 2010.

Changes in the Energy System

These energy investments have begun to drive changes in the US energy system. Although the Weatherization Assistance Program encountered some initial delays, the program weatherized nearly 300,000 homes in 2010 (triple the annual average over 2003–7), and the Department of Energy expects to weatherize approximately 600,000 homes with Recovery Act funding.[12] The Recovery Act increased the per residence spending cap for weatherization from $2,500 to $6,500 to account for changes in material costs over time and to provide resources for more extensive energy efficiency improvements.[13]

President Obama set an ambitious goal for the Recovery Act to result in a doubling of nonhydroelectric renewable power generating capacity within three years.[14] The Energy Information Administration (EIA 2009) "no stimulus" reference case forecast wind capacity to grow from about 25,000 megawatts in 2008 to 29,300 megawatts in 2010 and to reach 40,000 megawatts no sooner than 2030. The Recovery Act promoted renewable power through tax credits, grants, loan guarantees, and accelerated depreciation. As a result, by the end of 2010, US wind-generating capacity had increased about 60 percent over two years to 40,000 megawatts, tripling the investment that was forecast under the EIA's business as usual (i.e., no stimulus) scenario (Figure 2). Wind power generation increased from 55 billion kilowatt hours in 2008 to 95 billion kilowatt hours in 2010 and was forecast to exceed 115 billion kilowatt hours in 2011 (EIA 2011). Likewise, grid-connected photovoltaic solar power capacity in 2010 was nearly triple the end-of-2008 capacity (Solar Energy Industries Association 2011).

Reductions in CO_2 Emissions

In addition to the objective of spurring economic activity, the clean energy package focused on investments that would reduce CO_2 emissions. Although total power generation was nearly identical in 2008 and 2010 (EIA 2010, 2011), CO_2 emissions from the power sector in 2010 fell nearly 4.5 percent below 2008 levels (6 percent below 2005 levels).[15] Some of this decline in emissions reflected coal-to-gas fuel switching. However, between 2008 and 2010, total fossil fuel power generation declined 1.6 percent, reflecting the increasing share of renewable power over this two-year period.[16] The increasing share of renewable power reduced CO_2 emissions from the power sector by about 2 percent, representing a 43 million metric ton reduction in CO_2 emissions in 2010.

[12]Department of Energy press release: Secretary Chu announces major new Recovery Act milestone: 300,000 homes weatherized, January 19, 2011.
[13]Although a variety of engineering-based studies (see Schweitzer 2005 for a meta-analysis) suggest that the weatherization program's efficiency improvements could meaningfully reduce energy consumption and energy bills, additional economic research could better estimate the potential energy-related benefits of the weatherization program.
[14]President-elect Obama's speech on American Recovery and Reinvestment, January 8, 2009, accessed August 8, 2011, http://change.gov/newsroom/entry/dramatic_action/.
[15]The author estimated 2010 power sector CO_2 emissions based on reported 2010 power generation by fuel type and 2009 average CO_2 intensity by fuel type (EIA 2010, 2011).
[16]Nuclear power generation was virtually unchanged between 2008 and 2010.

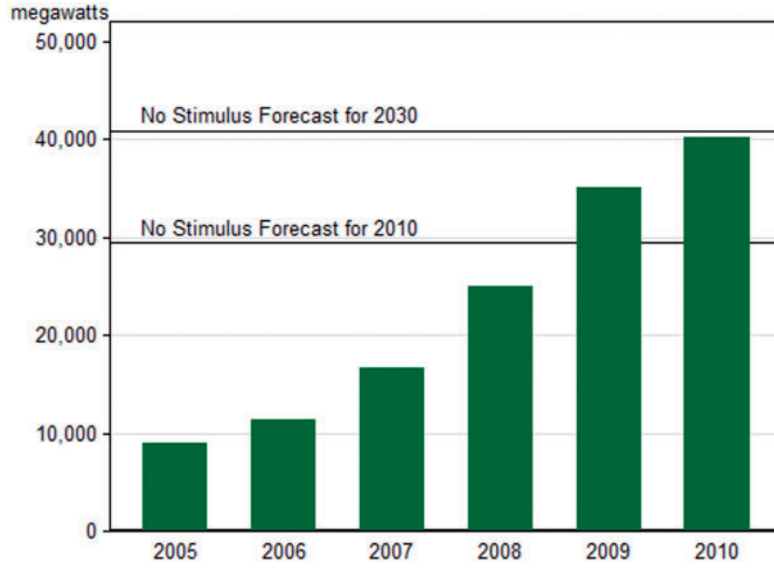

Figure 2 Cumulative installed wind power capacity, 2005–10
Sources: AWEA 2010, 2011; EIA 2009.

Case Study: Promoting Investment in Renewable Power

The largest share of the funding for the clean energy package was dedicated to renewable power generation. This section describes and compares the design and performance of the two primary policies aimed at promoting renewable power: the 1603 grant program and the 1705 loan guarantee program.

Investment Challenges

In late 2008, the prospects for investment in renewable power in the United States were poor due to three market challenges. First, project developers faced uncertainty regarding the future of the production tax credit (PTC) for wind, geothermal, and most other forms of renewable power and the investment tax credit (ITC) for solar power projects, which were scheduled to expire on December 31, 2008.[17] In October 2008, these tax credits were extended for one year for wind, for two years for most other renewables, and for seven years for solar. Although the PTC has subsidized wind power since 1992, investment in new wind-generating capacity collapsed on the three occasions during the 2000s when the credit lapsed (Metcalf 2009a). The one-year extension in late 2008 provided the wind industry a brief reprieve, but it was unlikely to spur much new investment in projects with development cycles of more than one year.

The second investment obstacle reflected the challenge project developers faced in taking advantage of tax credits. Historically, in order to use a PTC or ITC, a start-up company, a foreign corporation, or other business with insufficient income tax liability to claim tax credits

[17]The PTC provides a tax credit of 2.2¢ per kilowatt hour of wind generation for the first ten years of a facility's operation. It is indexed to inflation and is lower for some other types of renewable power. Solar projects are eligible for an ITC for as much as 30 percent of investment costs.

was generally forced to go to the "tax equity" market. To raise tax equity, these businesses entered into a financial partnership with a passive partner that provided equity and in return they claimed the tax credits, accelerated depreciation benefits, and other tax benefits against their taxable income. Given the size of the required income tax liability, renewable power project developers generally relied on large financial corporations (e.g., AIG, Lehman Brothers) for tax equity. However, during the financial crisis, the number of tax equity suppliers and the amount of tax equity available fell by more than half (US Partnership for Renewable Energy Finance 2010) while at the same time the cost of tax equity to project developers, reflected by the return on tax equity paid to the supplier, increased from about 7 to 15 percent (Schwabe, Cory, and Newcomb 2009). A tax credit extension would have had a very limited impact on renewable power investment in such a shrinking tax equity market.

The third investment obstacle was the tightening credit market. In meetings during the presidential transition, several renewable power project developers claimed that they could not raise new project debt for conventional wind farm development. The issue for the transition team designing the clean energy package was whether this reflected (1) general credit tightening across the economy that could be addressed through Federal Reserve or Treasury (Troubled Asset Relief Program [TARP]) operations, (2) the shrinking tax equity market, or (3) lender risk aversion specific to large long-term projects, such as power plants.

The Recovery Act's Response

In response to these economic challenges, the Recovery Act extended the PTC for three years and created two new programs to spur renewable power investment: the 1603 grant program and the 1705 loan guarantee program. The 1603 grant program offered a subsidy for investment in new renewable generation capacity. Under the Recovery Act, a developer for a PTC-eligible project could choose among the PTC, a 30 percent ITC, or a 1603 cash grant equal to 30 percent of investment costs (solar developers could choose between the ITC and a 1603 cash grant).

The 1705 loan guarantee program modified the existing section 1703 energy loan guarantee program created in 2005, which focused on providing government credit for innovative commercial-scale energy projects. The new program supported conventional renewable power, transmission, and biofuel projects, as well as innovative technologies eligible for loan guarantees under the 1703 program. The Recovery Act appropriated $6 billion to the 1705 program to enable the federal government to pay for the credit subsidy associated with loan guarantees.[18] By providing loan guarantees, this program increased the availability of government capital and lowered the costs of debt for commercial renewable project developers.

Impacts of the Grant Program

The 1603 grant and related tax credit extensions have been successful in several ways. First, the extension of the tax credits enabled longer-term planning by removing uncertainty about federal support. Second, thousands of renewable power projects entered into service and claimed the grant in 2009 and 2010 (see Table 2). The 1603 grant program supported

[18]Following congressional rescissions in June 2009 and August 2010, the 1705 program was appropriated only $2.5 billion.

Table 2 Summary of 1603 grant program and 1705 loan guarantee program through December 31, 2010

	1603 grant	1705 loan guarantee
Staff	5 Treasury FTEs, 15 DOE FTEs	100–200 FTE DOE staff and contractors
Evaluation process	Standardized, subject to eligible technology entering into service	Discretionary, reflecting deal characteristics and negotiations with sponsor
Typical length of review	4–6 weeks	6 + months
Total number of projects	4,750	8
Number of wind projects	252	2
Number of solar projects	4,404	1
Number of geothermal projects	28	1
Number of biomass projects	29	0
Number of other technology projects	37	4
Number of states with supported projects	48 states plus DC and Puerto Rico	8
Total capacity installed (MW)	~10,000	~1,161
Total investment supported	~$20 billion	~$4.7 billion

Notes: The 1705 loan guarantee figures represent those projects for which the federal government has closed on the loan guarantee through December 31, 2010. DOE, Department of Energy; FTE, full-time equivalent.
Sources: Memorandum to the President 2010, Department of Energy Loan Programs Office Web site (http://lpo.energy.gov), and Department of the Treasury Web site (www.treasury.gov/initiatives/recovery/Pages/1603.aspx).

investment in nearly every state and enabled installation of nearly 12,500 megawatts of capacity through 2010.

Third, the 1603 grant program processes applications with a lean administrative team in a timely and transparent manner. As shown in Table 2, with a small team of Treasury and Energy staff,[19] the 1603 grant program typically makes decisions on grant applications within four to six weeks, and it is legally required to do so within sixty days of receipt of an application (Martin et al. 2009). The 1603 grant program confirms that a given project qualifies for a grant (i.e., it employs an eligible renewable technology and it has entered into service) and then awards a grant.

Fourth, the 1603 grant served as an important way to address the problems posed by the shrinking tax equity market. Since renewable project developers did not need to turn to financial firms to monetize tax credits,[20] the 1603 grant enabled incremental investment that would have otherwise been constrained by the tax equity market. In an assessment of wind projects that applied for the 1603 grant in 2009, Bollinger, Wiser, and Darghouth (2010) found that about 2,400 megawatts of wind capacity came online as a direct result of the 1603 grant option for project developers, representing about a quarter of the 2009 wind capacity investment.[21]

[19]Although the Department of the Treasury administers the 1603 grant program, the Department of Energy assists with reviewing applications.
[20]Developers may still need a tax equity partner to maximize the value of accelerated depreciation and, if eligible, bonus depreciation.
[21]Some project developers chose the PTC, especially those with taxable income and for wind projects expected to operate with a high-capacity factor (Bollinger et al. 2009; Martin et al. 2009).

Impacts of the Loan Guarantee Program

The 1705 loan guarantee program has been much less successful than the 1603 grant program and has not had a meaningful impact on the US power sector. A pipeline of quality renewable power projects did not materialize for the 1705 program, and the program has focused its efforts on a small number of large wind and solar projects. In fact, the program closed on only eight projects through December 31, 2010, of which four focused on renewable power generation and the other four were for manufacturing facilities and energy storage. The 1705 loan guarantee program did not close on any deals for renewable power generation in 2009 when wind investment experienced its best year to date. Renewable project sponsors that have a conditional commitment or have closed a deal for a 1705 loan guarantee are expected to claim a 1603 grant or an underlying tax credit.

As shown in Table 2, the 1705 program also involves many more staff than the 1603 grant program and takes six months or more, rather than four to six weeks, to evaluate and work with a project developer before reaching a loan guarantee decision. This difference in timing reflects fundamental differences in the approaches of these two policy instruments. In addition, in the 1705 loan guarantee program, the government effectively becomes another financial partner in a project, and the staff must negotiate extensive terms and conditions with project sponsors. Many issues can complicate the negotiations, such as local, state, and federal permitting and licensing reviews; finalizing engineering, procurement, and construction contracts; the status of long-term power purchase agreements; and lifetime project monitoring. By definition, these issues have been resolved when a project enters into service and can be considered for a 1603 grant.

A failure to formulate explicit energy and investment policies for the 1705 loan guarantee program to inform the setting of priorities in the review of applications has also undermined the program's effectiveness. Moreover, the program poses long-term fiscal risk to the federal government, especially if project defaults occur in the future with greater frequency or with less recoverable value than currently expected, which would cause the program to exceed the resources set aside under the Recovery Act to guarantee the program's project debt.[22] Thus it appears that although the 1603 grant and underlying tax credits were necessary for renewable generation investment, the loan guarantees were neither sufficient nor necessary for the vast majority of renewable generation projects.

Efficiency of Renewable Power Policies

Multiple policy instruments promote renewable power in the United States. Estimates of the total cost of renewable power policies per ton of CO_2 abated would inform assessments of the economic efficiency of renewable policies overall. The share of a renewable power project financed by taxpayers or ratepayers (through higher electricity rates under a state renewable electricity standard) would likely exceed 60 percent for projects receiving tax benefits, grants, loan guarantees, and above-market rates due to state renewable mandates.

[22]The federal government's track record with energy credit programs, such as with the Rural Utility Service losses associated with nuclear power plant projects, illustrates that this is a real possibility.

The ITC and 1603 grant cover 30 percent of the investment costs of a renewable power project.[23] Accelerated depreciation benefits could amount to as much as 10 percent of project costs. The average subsidy under the 1705 loan guarantee program is assumed to be 14 percent (OMB 2011). The value of state renewable electricity standards varies significantly across the nation. For example, the Shepherds Flat, Oregon, wind farm secured an above-market rate, equal to about 10 percent of the project cost, for selling into the California market (Memorandum to the President 2010). Some states have much higher tradable renewable electricity credit prices (e.g., Northeast credits have traded at around $60/megawatt hour), and the implicit subsidy from a state renewable mandate could be well above 10 percent. The effective cost per ton of CO_2 abated will vary with the emission intensity of the power generation displaced by the new renewable source. The government estimated that the cost per ton abated for selling wind power from Shepherds Flat into California would be about $130 per ton of CO_2, about four times the social cost of carbon used by the US government (Interagency Working Group on the Social Cost of Carbon 2010; Memorandum to the President 2010). Thus the marginal cost to the taxpayer could be significantly higher than the marginal benefit of the CO_2 emissions reduction.

Conclusions and Lessons Learned

This review of experience with the Recovery Act's clean energy package offers several lessons for the design and implementation of both economic stimulus programs and energy policy more broadly.

The Clean Energy Package Has Resulted in Significant Job Creation

Given the dismal outlook and the limits to monetary policy in 2008, a significant economic stimulus was necessary. The clean energy package has played an important role in the Recovery Act's creation and the saving of millions of jobs throughout the economy, suggesting that a major fiscal push, including resources allocated to support the deployment of clean energy technologies, can create a significant number of jobs.

The Clean Energy Package Leveraged Private Investment

Through grants and tax credits, the clean energy package was effective in leveraging private sector investment, which is likely to enhance the payoffs from the package in terms of increased aggregate demand and clean energy outcomes. In addition, this approach improves the quality of the projects themselves because it engages private sector investors, who will bring their own due diligence in undertaking clean energy activities.

The Importance of Matching Investment Timing to Economic Needs

Strategic investments in clean energy did not occur as quickly as the near-term automatic provisions of the Recovery Act, such as tax rebates and unemployment insurance extensions.

[23]If a developer opts for the PTC instead of the ITC or grant, then it likely expects the present value benefits of the PTC to exceed 30 percent of investment cost.

The process was slower for some clean energy programs because of the need to identify high-quality projects, develop rules for the implementation of new programs, and ensure consistency with applicable constraints and requirements, such as labor compensation rules. Given the depth and breadth of the financial crisis and economic recession, having the strategic investments ramp up more aggressively in 2010 helped sustain aggregate demand as some of the near-term provisions of the Recovery Act declined. Thus, to ensure the effectiveness of future stimulus packages aimed at addressing recessions, it is important that they be designed so the timing, duration, and size of various elements of the package match the economic need.

The Challenge of Implementing a Stimulus Package in an Uncertain Regulatory Environment

The administration's clean energy policy strategy focused on near-term supply-side investments through the Recovery Act, with the expectation that comprehensive energy and climate legislation would drive long-term demand for clean energy. This approach was based on the idea that confidence about the availability of a future market in which to sell goods and services is the cheapest form of economic stimulus (Summers 2010). Businesses considering public-private coinvestment through the clean energy package would have benefited considerably from the regulatory certainty that energy and climate legislation would have provided. Thus the combination of a stimulus package and a well-designed greenhouse gas cap-and-trade program would likely have driven more investment during this time of weak aggregate demand. With only the fiscal stimulus in place, the uncertainty about the prospects for greenhouse gas regulation likely imposed a drag on potential investments in clean energy.

The Need for Rigorous Evaluation

The broad array of policy instruments and the significant variation in how states and local governments have been implementing the Recovery Act's energy-related funds provides an opportunity to evaluate the effectiveness of these programs. Rigorous program evaluation could assess the effects of different policy instruments on incremental investment, examine the impact of technology deployment on energy outcomes, and investigate the cost effectiveness of using multiple instruments to address a single market failure.

Here are four suggestions for conducting such evaluations. First, the Department of Energy developed quantitative metrics to rank project proposals under several programs, such as the Section 48C clean energy manufacturing tax credit and Advanced Research Projects Agency-Energy extramural research funding.[24] Since only the highest ranked proposals received funding, regression analysis could be used to compare the outcomes of those projects that "just made it" with those that "just missed it" (i.e., through a regression discontinuity empirical design). Second, to examine the effects of new technologies on energy outcomes (e.g., energy use), field experiments could be structured in coordination with local agencies and utilities. For example, field experiments could assess the impacts of smart meters on energy consumption

[24]The Department of Energy reported that the number of good-quality projects proposed under these programs exceeded the amount of available resources.

and weatherization on energy demand.[25] Third, decentralized implementation of several Recovery Act programs, including the State Energy Program, Weatherization Assistance Program, and the Energy Efficiency and Conservation Block Grant program, may yield natural experiments at state and local levels that would facilitate empirical evaluation of these programs.[26] Finally, further research is needed to explore whether the total government subsidy for a given activity exceeds its social benefits. A total subsidy of at least 60 percent for some renewable power projects raises questions about the efficiency and cost effectiveness of policies aimed at promoting renewable power.

Grants Deliver More Benefits per Dollar of Government Expenditure Than Tax Credits for Renewable Power

It is difficult to identify a public policy rationale for a renewable energy program that creates a tax equity market and provides large financial firms with 7 cents or more of every dollar of tax expenditure associated with renewable projects. Providing support for renewables through the tax code gives rise to this significant transaction cost because many renewable developers have no other option for monetizing the tax credits. However, under the Recovery Act's 1603 grant program, project developers receive more of a given amount of government expenditure than through the tax credit, and the government does not face a materially higher risk of fraud (i.e., it is not easy to fake a renewable power project sending electricity to the grid). Although originally intended to address the contraction of the tax equity market during the financial crisis, this option of taking a grant rather than a tax credit could be continued for as long as the government decides it is socially desirable to provide support for renewables through the tax code.

Grants and Tax Credits Are Significantly More Effective Than Loan Guarantees

Some advocates for energy loan guarantees have asked whether renewable project sponsors can raise debt. The question should be "Can these sponsors raise debt at a cost that makes the economics of the project work?" Although project risk affects the cost of debt, and therefore the risk–return balance for equity investors, a loan guarantee is not the only way to alter this risk–return balance. Providing certain government financing—through a tax credit or grant—can increase a project's returns by lowering the amount of private sector capital that needs to be raised for a project. Through the Recovery Act's grants and tax credits, thousands of renewable projects have moved forward and have lowered CO_2 emissions from what they would have been otherwise, indicating that these instruments are sufficient to mobilize incremental investment. In contrast, the Recovery Act appropriated $6 billion for energy loan guarantees. Yet twenty-two months later, Congress rescinded about 60 percent of this appropriation and the Department of Energy had closed on only eight projects, suggesting that these credit instruments are neither necessary nor effective.

[25]In 2009, when he was CEA chief economist, Michael Greenstone proposed including such field experiments in the Recovery Act to enable rigorous program evaluation. However, few agencies were enthusiastic about this proposal.

[26]The Department of Energy collects some relevant data (and some are available through www.recovery.gov), but some of the data would require outreach to state and local governments.

The American Recovery and Reinvestment Act represents the largest energy bill in US history, with an unprecedented focus on energy projects that lower US carbon emissions. By supporting thousands of energy projects across the nation, the stimulus has created jobs, leveraged private investment, and advanced the commercial frontier for many types of clean energy technologies. The implementation of the Recovery Act also presents opportunities for researchers and policymakers to evaluate the effectiveness of various programs in terms of job creation and energy investment, which can be used to inform future debates about energy and stimulus policies.

Appendix

Table 1 Illustrative clean energy package policy instruments

Instrument	Example	Budget score
Cost-shared grants	Smart grid grants support 100 projects with total investment costs in excess of $8 billion.	$3.4 billion
State block grants	Energy efficiency and conservation block grants support energy audits, energy efficiency retrofits, transportation programs, and so on, by state, local, and tribal governments.	$2.8 billion
Tax credits	Tax filers could claim 30% of the cost of residential energy efficiency investments up to a maximum of $1,500.	$2.0 billion
Subsidized bonds	To finance renewable projects, government-owned utilities issued no-interest Clean Renewable Energy Bonds that provide bondholders with a tax credit in lieu of interest.	$1.6 billion
Loan guarantees	The Section 1705 program provided loan guarantees for conventional and innovative renewable power projects, and related manufacturing and transmission.	$2.5 billion*
R&D	Supports a competitive program focused on high-risk/high-reward energy innovation through the Advanced Research Projects Agency-Energy.	$400 million
Federal infrastructure	The General Services Agency financed hundreds of federal facilities retrofits through the High Performance Green Buildings program.	$4.5 billion

* The Recovery Act initially appropriated the Section 1705 program $6 billion, but Congress rescinded $3.5 billion to finance the 2009 "cash-for-clunkers" program (Public Law 111-32) and the 2010 state fiscal aid bill (Public Law 111-226).
Sources: Joint Committee on Taxation 2009, 3; American Recovery and Reinvestment Act of 2009, Part I—Department of Energy Energy Programs, Part I—General Services Administration; Part II—Section 1111; Department of Energy Press Release referenced in footnote 10.

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