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The "Grand Experiment": An early review of energy-related Recovery Act efforts

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Abstract

The American Recovery and Reinvestment Act injected approximately $840 billion into the U.S. economy for job creation, technological advancement, and infrastructure development. This grand experiment of stimulus support targeted education, health care, unemployment assistance, the environment, and energy programs, among other areas. This study examines energy-related Recovery Act program implementation between 2009 and 2013; areas of inquiry include how funds were allocated and disbursed, which programs were targeted, and the impacts of the Recovery Act. Results indicate that the Recovery Act provided many immediate benefits to the economy, environment, and the energy sector, but also suggest that implementation was hindered by the coordination required between federal, state, and local agencies; reporting and transparency requirements; pre-existing layoffs and furloughs; inexperience with new programs; and inconsistencies with pre-existing laws and regulations. Although some economic and environmental impacts have already been assessed, not all will be known for some time due to the time horizon of the energy-related funding. Further study will be required to quantify the economic and environmental benefits of the renewable energy and energy efficiency programs.

Keywords: American Recovery and Reinvestment Act, Energy policy, Renewable energy, Energy efficiency

JEL Code: H50, O3, Q4Q, 48

1. Introduction

The American Recovery and Reinvestment Act (ARRA or "Recovery Act") was passed by both houses of Congress on February 13, 2009 and signed into law on February 17, 2009, less than one month after President Barack Obama assumed office (U.S. Library of Congress, 2009). This grand experiment was the first effort of its kind in the U.S. since President Franklin D. Roosevelt's New Deal to inject a significant amount of money into the economy to target job creation, technological advancement, and infrastructure development. Over the course of two years, the Recovery Act was designed to inject $840 billion into the U.S. economy (RATB, 2012b).

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One of the most prominent recipients of stimulus funding was the U.S. energy sector. As of the fourth quarter of calendar year 2011, nearly $43.8 billion in ARRA funds (approximately five percent) were assigned to energy-related contract, grant, and loan projects (CGLs), including energy efficiency, green jobs, smart grids, advanced fossil energy, the environment, and renewable energy. Some of the energy efforts that the Recovery Act supported were not new, such as low-income weatherization programs, but other efforts initiated new programs, such as the Energy Efficiency Conservation Block Grant program. What was unprecedented, however, was the significant amount of money offered to the energy sector, and how the funds were spread across a variety of programs that received relatively little past support. In a time of budget cuts and fiscal austerity, when sub-national governments were preparing to weather the 2007-2009 economic downturn, the Recovery Act injected life into the energy sector in innovative ways. This influx of money into energy science and the advancement of technologies, many renewable or energy efficient, will have economic and environmental impacts for many years; some of these impacts have already been measured, but others have yet to be researched.

The reviews of ARRA that have been published to date offer several insights about the allocation and use of stimulus funds, including estimates of benefits as well as evidence of the limitations of such a massive, short-term spending experiment. Reports on energy-related ARRA funding and administration in particular, almost exclusively originating from the government, are more detailed and numerous than other topic areas. No studies to date, however, present a comprehensive overview of ARRA energy funding and programs. This study seeks to provide such an overview with an evaluation of the distribution of funding across project types and locations, as well as the challenges and accomplishments documented thus far. The analysis is informed by a thorough review of the relevant literature on the impacts and implementation of ARRA documented to date. This review is also informed by descriptive data analysis from an ARRA funding database, as compiled through the Recovery.gov website (RATB, 2011b).

2. The Recovery Act and Energy-Related Projects

2.1. Recovery Act Context

The economic downturn of 2007 to 2009 recorded the worst post-World War II loss of employment in the U.S., at 8.8 million jobs from January 2008 to February 2010 (Goodman and Mance, 2011). This recession was also longer than every post-War downturn except the 2001-2003 downturn. Worldwide output in several sectors, along with trade and stock market indicators, fell farther during the 2007-2009 recession than during the Great Depression (Alumniaet al., 2010).

The process of crafting ARRA began in 2008 with extensive consultations between economic, energy, and environmental experts (Aldy, 2013). The Act was then passed halfway through the recession with the guiding objectives of job creation, recession relief, science, health, and technological advancement, sub-national government budget stabilization, and transportation, infrastructure, and environmental investment (U.S. Government Printing

Office, 2009). It is important to note that this list of goals includes both short-term and long-term items; recession relief and job growth, for example, are short-term goals, while technological and scientific advancement are longer-term goals. These multiple and overlapping objectives made for an ambitious effort, or "grand experiment."

Several other countries also adopted stimulus policies. Table 1 shows the amount of stimulus funding provided in different countries between 2007 and 2009, including stimulus funds for energy and the environment. By percent of GDP, the U.S. enacted the greatest stimulus of the Organization for Economic Cooperation and Development (Armingeon, 2012).

Table 1. Stimulus funding in different countries.

	Total Stimulus (US$ billion)	Year Stimulus Bill Adopted[a]	Energy- and Environmental-related Stimulus (US$ billion)	Energy and Environment Spending as % of Total Stimulus
Argentina	13.2	2008		
Australia	43.8	2008	9.3	21.2
Brazil	3.6	2008		
Canada	31.8	2009	2.8	8.3
China	647.5	2008	216.4	33.4
France	33.7	2008	7.1	21.2
Germany	104.8	2009	13.8	13.2
India	13.7	2008		
Indonesia	5.9	2009	0.1	1.7
Italy	103.5	2009	1.3	1.3
Japan	639.9	2009	36.0	5.6
Mexico	7.7	2009	0.8	9.7
Russia	20.0	2008		
Saudi Arabia	126.8	2008	9.5	7.5
South Africa	7.5	2008	0.8	10.7
South Korea	38.1	2008	36.3	95.2
United Kingdom	34.9	2008	3.7	10.6
United States[b]	787.0	2009	94.1	12.0
European Union[c]	38.8	2008	22.8	58.7
Global total	3016.3		463.3	15.4

Source of information: This table adapted from Barbier (2010) and Robins et al. (2009).

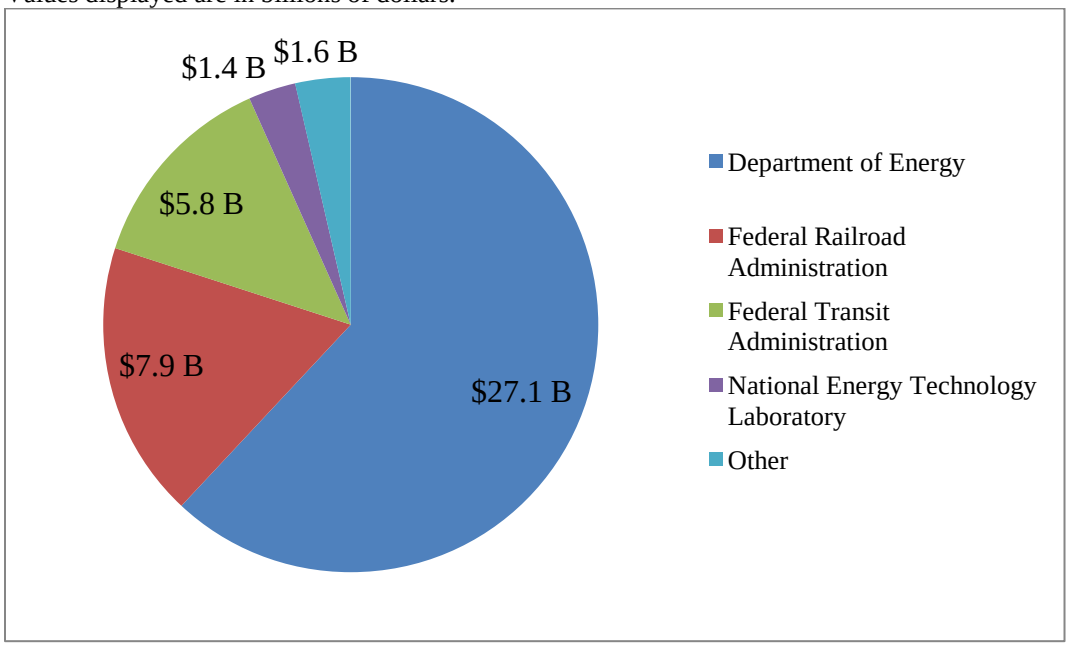
[a] Most countries passed their stimulus packages in waves that came in both late 2008 and early 2009. Carley et al. (forthcoming) used the following criteria when choosing an adoption year: when one wave was more closely or prominently (i.e., in the press) associated with energy or environmental stimulus funding, Carley et al. selected the year for that wave; when energy or environmental stimulus was not a significant factor, but one wave was greater in dollar terms, Carley et al. selected the larger.

[b] From the February 2009 American Recovery and Reinvestment Act only. The October 2008 Emergency Economic Stabilization also included US$185 billion in tax cuts and credits, including US$18.2 billion for investments in wind, solar, and carbon capture and storage. The value provided in this table was the original estimate for ARRA, and has since been revised to $840 billion, in keeping with the President's 2012 budget.

[c] Only the direct contribution by the European Union is included.

The cost of the Recovery Act was $840 billion. As of the fourth quarter of calendar year 2011, approximately $283 billion went toward CGLs. The present analysis focuses exclusively on the $43.8 billion in energy-related CGLs offered through the Recovery Act, as shown in Figure 1; the number is different than the amount noted on Recovery.gov due to what the authors have determined to be energy-related projects, and varies in other estimates (see, for example, Aldy, 2013). The majority of this funding was dispersed through the Departments of Energy (DOE) and Transportation (DOT) in project areas including weatherization, smart grids, and transit.

Figure 1. Energy-related contract, grant, and loan funds awarded under ARRA 2009 as of first quarter calendar year 2013 for the four highest-awarding agencies.
Values displayed are in billions of dollars.



Source: RATB (2013a).

2.2. A Technical Overview of Transparency and Fund Allocation

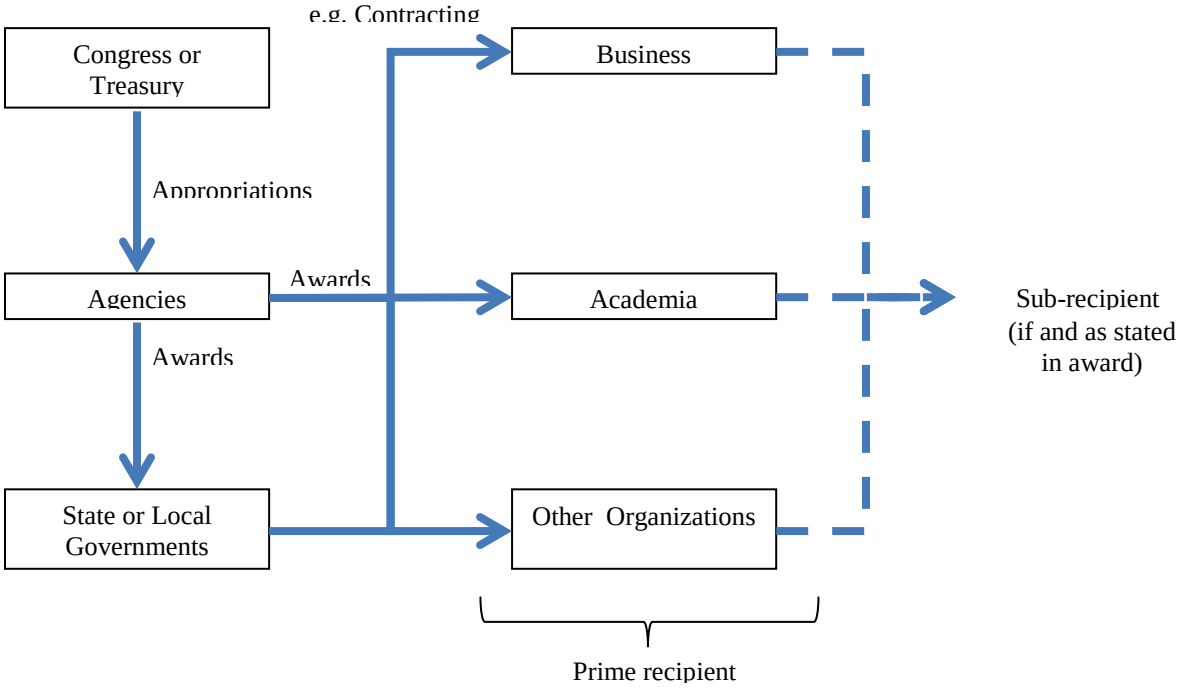
In assessing the challenges and accomplishments of ARRA, it is important to understand some of the technicalities of how the stimulus program was implemented. We focus our discussion on transparency, reporting, and fund allocation.

President Obama emphasized transparency both in his presidential campaign and during the beginning of his first term in office (Coglianese, 2009). The president signed several memoranda on open-government initiatives and his administration extended Freedom of Information Act provisions. Similarly, ARRA was adopted with significant transparency requirements, such as recipient reporting and oversight by the Inspector Generals (IGs) of several agencies and the U.S. Government Accountability Office (GAO) (Coglianese, 2009; RATB, 2012a). President

Obama also signed a memo that banned "conversations between government officials and lobbyists over economic stimulus funds and requiring Internet-based disclosure of written communications" (Obama, 2009, in Coglianese, 2009). Contract, grant, and loan recipients were required to report the funding amounts obligated, amounts received, and a variety of other data every quarter for public posting on the Recovery.gov website (RATB, 2011c). The Inspector General of the various oversight agencies were also required to monitor fraud, waste, and abuse (RATB, 2012a) and the GAO reported every two months on state and local use of funds (RATB, 2012c).

Different programs involved different funding allocation mechanisms. All ARRA funding was first channeled through an appropriate federal agency. In the case of energy-related programs, most funds went through the DOE. Agencies then determined the allocation mechanism for each program. Some programs dispersed funds through the state and local governments, and then through business, academic, or other organizational recipients, and sometimes then again through another sub-recipient (RATB, 2013b). Other programs sent funding straight to the recipients. This generalized process is represented below in Figure 2. The process of identifying which recipient would get funding also varied by program. Table 2 below provides information on allocation mechanisms of various DOE programs to illustrate the range of allocation approaches.

Figure 2. Representation of money flows during Recovery Act allocation process.



Source: Adapted from figures at RATB (2013b).

Table 2. Department of Energy Program Allocations.

Recipient Program	Amount (US$ million)	Allocation Method
Energy Efficiency and Renewable Energy	3500	Agency discretion: staffing and operational expenses (ARRA, 2009)
Energy Efficiency and Conservation Block Grants	3200	$2800 million by population; $400 million by competitive award (42 U.S.C 17153)
Weatherization Assistance Program (WAP)	5000	State applications, non-competitive (42 U.S.C. 6864)
State Energy Program (SEP)	3100	State applications, non-competitive (10 C.F.R. 420)
Manufacturing of Advanced Batteries and Components	2000	Competitive awards (42 U.S.C. 17011 et seq.)
Electricity Delivery and Energy Reliability	4310	Competitive awards (US DOE, DE-FOA-0000058 and DE-FOA-0000098)
Worker Training Activities	100	Competitive awards (US DOE, DE-FOA-0000152)
Resource assessment and an analysis of future demand and transmission requirements	80	Competitive awards (US DOE, DE-FOA-0000068 and U.S. DOE Office of Energy Delivery and Energy Reliability (OE), 2010))
Additional funding for smart grid research	10	Direct funding of existing functions (U.S. DOE, OE, 2010)
Fossil Energy Research and Development	3400	Competitive awards; private and public recipients, including universities (U.S. DOE, Office of Fossil Energy, 2009)
Non-Defense Environmental Cleanup	483	Direct funding of existing functions (U.S. DOE, Office of Environmental Management (EM), 2009)
Science	1600	Direct funding of existing functions (U.S. DOE, 2009)
Advanced Research Projects Agency – Energy (ARPA-E)	400	Competitive awards (U.S. DOE, ARPA-E, 2010)
Innovative Technology Loan Guarantee Program	6000	Competitive awards (U.S. DOE, LPO, 2009)
Office of the Inspector General	15	Direct funding of existing functions (ARRA, 2009)
Western Area Power Administration	10	Direct funding of existing functions (42 U.S.C. 7152)

Sources: U.S. Code, Code of Federal Regulations., ARRA, U.S. DOE Program-Specific Recovery Plans, U.S. DOE Funding Opportunity Announcements

2.3. Energy-Related Programs and Projects under the Recovery Act

Energy-related ARRA programs, as categorized in this analysis, include all ARRA activities related to renewable energy, conservation, transmission and distribution, non-defense energy program clean-up, energy-related housing retrofits, high-speed rail and intercity passenger rail, and other energy-related transportation funding. An illustrative sample of the types of energy programs and offices funded through the Recovery Act is described below. These cases present a broad mix of prominent and well-funded offices and programs, and provide information on the manner in which funds for these programs were allocated, if known, and which metrics are used most often to evaluate program effects. The potential impacts of these programs also have implications for U.S. environmental science and policy, since many of these programs support basic scientific research.

2.3.1. Office of Energy Efficiency and Renewable Energy

The Office of Energy Efficiency and Renewable Energy, within the DOE, managed ten Recovery Act programs with approximately $15.55 billion of ARRA funding and $1.25 billion in research and development (U.S. DOE, 2010). These programs include: Biomass, Building Technologies, Community Renewable Energy Deployment, Federal Energy Management, the Weatherization Assistance Program, Energy Efficiency and Conservation Block Grants, and the Wind Energy Technology Program. The evaluation metrics used for these programs include energy savings and tallies of installed hardware or capacity. The Weatherization Assistance Program and the Energy Efficiency and Conservation Block Grant programs are discussed further due to their prominence and relatively high funding levels.

The Weatherization Assistance Program existed prior to ARRA, but was aided by the additional $4.98 billion in funding provided through the Act. Through financing and support to 900 local agencies, the program provided energy savings for low-income families; under ARRA, the program funded weatherization expenses up to $6,500 per house, an increase from $2,500, and extended the program to reach a greater number of low-income households (U.S. DOE, 2010). After deducting training and technical assistance and each state's base allocation from congressional appropriations, DOE determined Weatherization Assistance Program allocations based on the number of low-income households in a state, local heating and cooling degree-days, and low-income residential energy costs (U.S. DOE, Office of Weatherization and Intergovernmental Programs, 2011). DOE appropriated funds to recipients incrementally: recipients received the first ten percent to begin operations, the next 40 percent after submitting plans, and the remaining funds after weatherizing 30 percent of their homes and performing certain oversight tasks (U.S. GAO, 2011c). This allocation approach ensured that recipients progressed in weatherizing homes and maintained quality control. Program milestones focused on the total number of weatherized homes, with 304,000 planned by the end of 2010, 444,000 by the middle of 2011, 553,000 by the end of 2011, and 593,000 by the end of March 2012 (U.S. DOE, 2010). Based on the most recent statistics from January 2012, over 650,000 homes were weatherized through ARRA support (U.S. DOE, 2012).

The Energy Efficiency and Conservation Block Grant program—created by the Energy Independence and Security Act of 2007 but first funded by ARRA—included $3.2 billion in formula and competitive grants, allocated by sub-national governments across a variety of energy efficiency, job creation, and manufacturing projects (U.S. DOE, 2010). Activities under this program included efficiency and conservation strategies, technical consultant services, energy audits, building retrofits, and renewable energy technological support (U.S. GAO, 2011b). While all applicants had to undertake "Energy Efficiency and Conservation Strategies" to state and measure how they planned to use ARRA funds, the most common applications of the funds included energy efficiency retrofits, financial incentive programs, and building and facility conservation programs. All funds were to be obligated by the end of September 2010, with monitoring and oversight to proceed through September 2011 (U.S. DOE, 2010). All funds were obligated by DOE on time (U.S. GAO, 2011b), but by March 31, 2011, almost one third of formula grants were not obligated by recipients (U.S. DOE, Office of Inspector General, 2011).

2.3.2. Office of Electricity Delivery and Energy Reliability

The Office of Electricity Delivery and Energy Reliability within the DOE, which supports seven programs, was allocated $4.5 billion in competitive ARRA funding for electric grid and technology research and management (U.S. DOE, 2010; U.S. DOE, Office of Electricity Delivery and Energy Reliability, 2009a, 2009b). The goals and expected benefits of ARRA-related efforts in this program included upgrading the nation's power grid, creating a more secure and reliable transmission system, increasing grid efficiency, allowing buyers and sellers to access use and cost data, increasing demand responsiveness, reducing grid-related emissions, and facilitating the penetration of alternative energy technologies onto the grid. Metrics used by the Office of Electricity Delivery and Energy Reliability to measure smart grid deployments and their economic and environmental impacts included assessments of the amount of hardware deployed, energy and cost savings, and pollution reduction.

The majority of the ARRA funding for this office, $3.5 billion, was allocated toward matching grants for smart grid infrastructure by utility and other investments under the Smart Grid Investment Program of the Energy Independence and Security Act, Section 1306. Thirty-two Smart Grid Regional and Energy Storage Demonstration Projects, 16 of each, were also funded with $620 million appropriated under the Energy Independence and Security Act's Section 1304 (U.S. DOE, 2009; U.S. DOE, 2010). The Workforce Development Program used $100 million to train laborers to install and work with smart grids, as well as train specific subsectors such as veterans, the unemployed, and utility workers from the old grid economy (U.S. DOE, 2010).

2.3.3. DOE Loan Programs Office

The DOE's Loan Guarantee Program was originally established under Title XVII of the Energy Policy Act of 2005 to provide loans to commercially advanced environmentally-friendly technologies (Massouh et al., 2009). The Recovery Act added $3.94 billion to the Section 1705 program to provide competitive loans to emerging technology and commercial-scale renewable and transmission technologies (U.S. DOE, 2010; U.S. DOE Loan Programs Office, 2009). Of this amount, $25 million was reserved for administrative costs and ten million dollars for the Advanced

Technology Vehicle Manufacturing program, which provided financial backing to qualified manufacturers of alternative vehicles. Eligible applicants for the Section 1705 loan guarantee program included renewable energy and incremental hydropower systems users and manufacturers, electric transmission systems users, and promising biofuels projects. All Section 1705 loan guarantees had to be closed with projects started by the end of September 2011. The first conditional commitment, for Solyndra, Inc., was completed on March 20, 2009 (U.S. DOE, 2010); by June 2013 there were 26 closed loans under the 1705 program and five closed loans under the vehicle manufacturing program (U.S. DOE, LPO, 2013). The LPO lists a combined $34.4 billion in guaranteed loans to date (2013). The DOE used several evaluation metrics for its loan guarantees: project financing or operation, greenhouse gas savings, and electricity generation or manufacturing capacity (U.S. DOE, 2010).

2.4. Contract, Grant, and Loan Data on Recovery-Act Energy Projects[3]

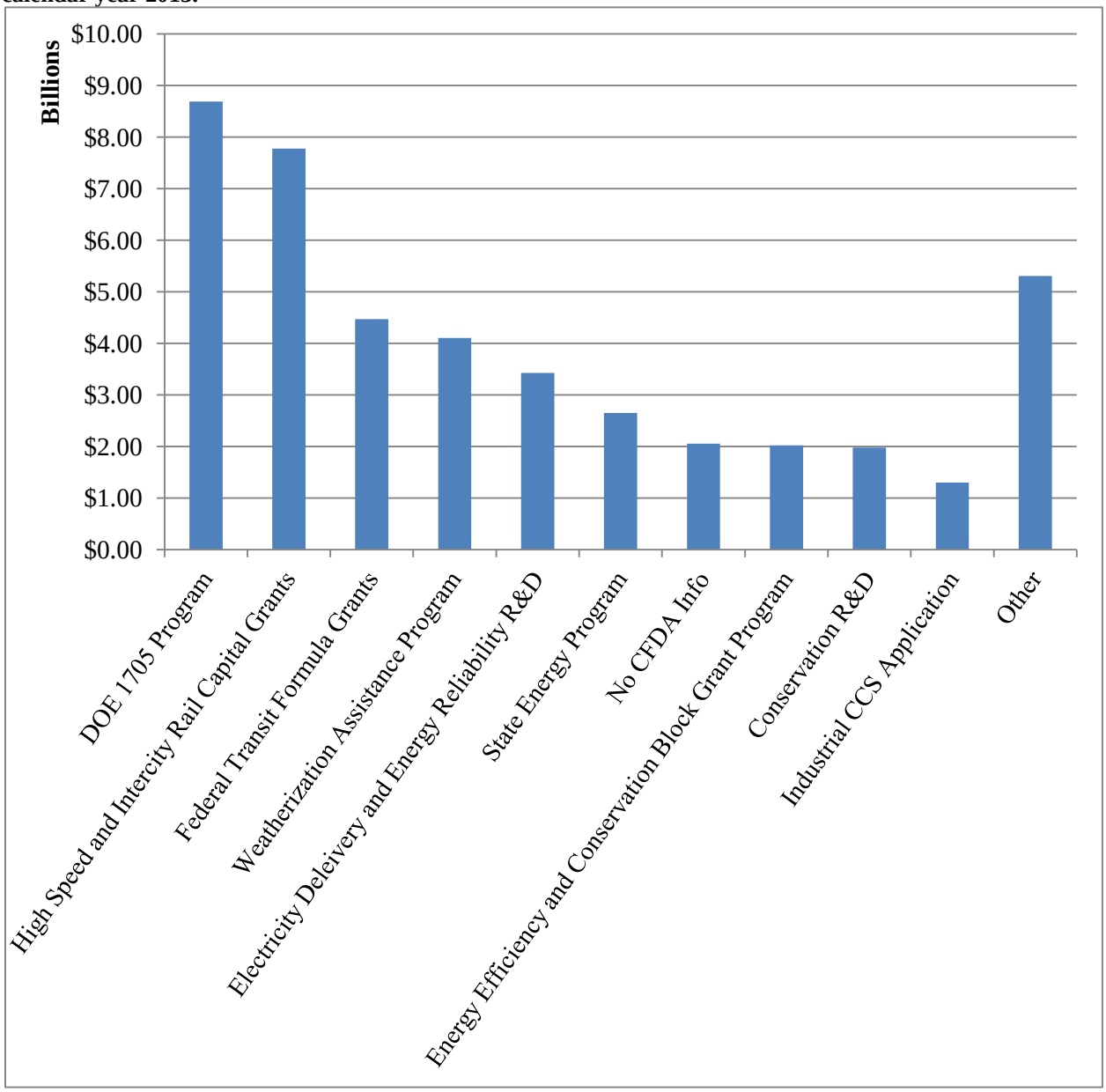
This broad overview of selected energy-related ARRA programs hints at important variations in allocation and spending of ARRA funding across programs and locations. Figure 3 below presents data on program-level[4] awards[5] for energy-related CGLs as of fourth quarter 2011. The majority of awards (more than $8.6 billion) went toward the DOE's 1705 Loan Guarantee Program, with the second highest award amount (over $7.7 billion) toward grants for intercity passenger and high-speed rail. Two of the Office of Energy Efficiency and Renewable Energy's programs, the Weatherization Assistance Program and the Energy Efficiency and Conservation Block Grant Program, combine for over $6 billion in awards. A significant amount of award money ($2 billion) is missing at least some program information.

[3] The programmatic, agency, and state-level CGL charts presented in this paper come from recipient-reported data on Recovery.gov.

[4] CGL spending categories break down into programs, distinguishable by program sources or treasury account symbols. Program sources are categories found in the General Services Administration's Catalogue of Federal Domestic Assistance (CFDA) (U.S. General Services Administration, 2011), whereas treasury account symbols may be referenced in the Department of the Treasury's Federal Account Symbols and Titles Book (U.S. Department of the Treasury, Financial Management Service, 2011).

[5] In the Recovery.gov website data, "awarded" denotes what the government has given to a recipient, while "received" denotes the award which the recipient has obtained; an "outlay" is what a federal agency has paid to a recipient (RATB, 2011a). "Expenditures" refer to what states have spent.

Figure 3. Energy-related contract, grant, and loan funds awarded under ARRA 2009 as of first quarter calendar year 2013.

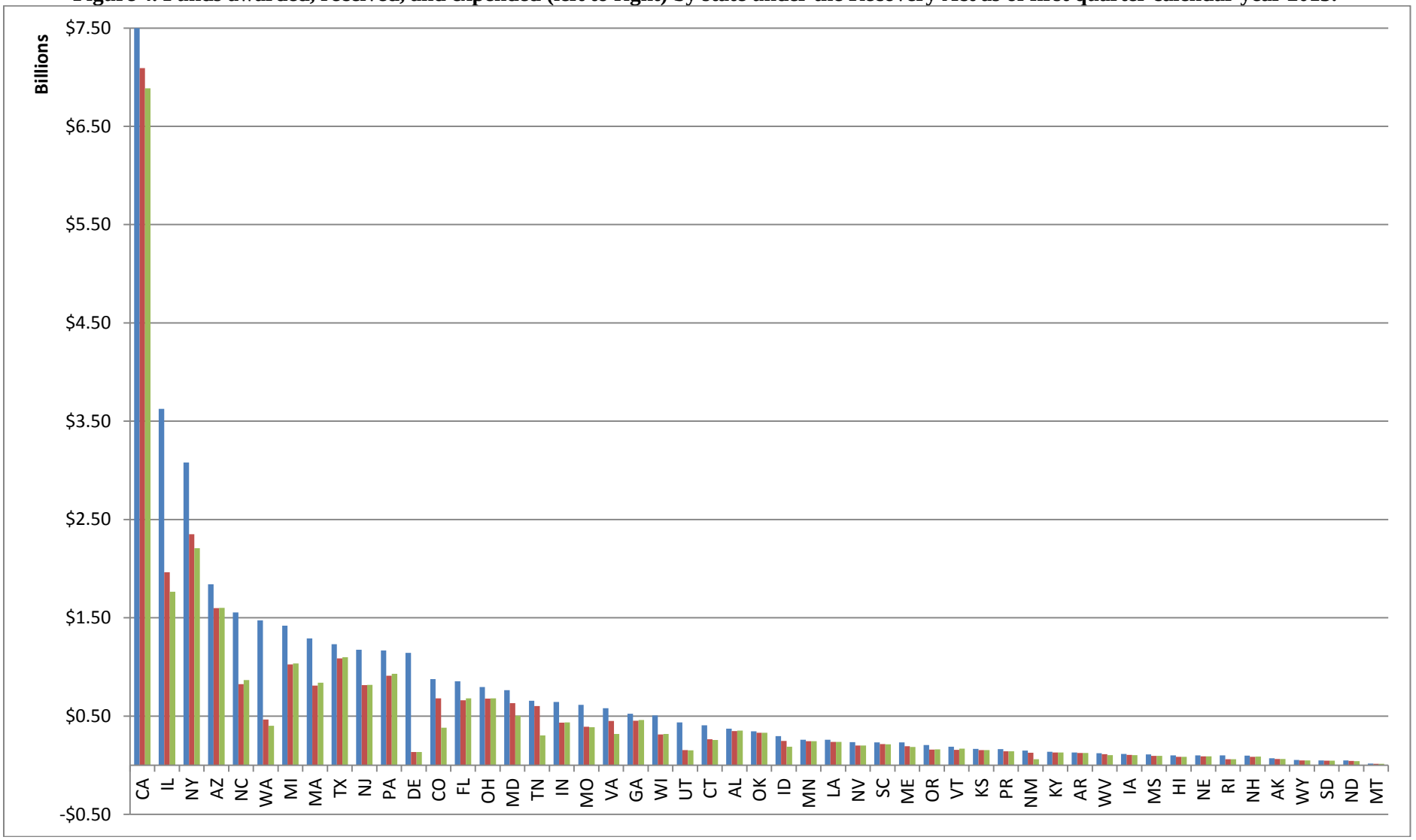


Source: RATB (2013a).

State energy data are also available on the Recovery.gov website; these data are summarized in Figure 4 below. California has the most funds awarded and received, and has expended the largest amount. Of the 50 states, Montana and North and South Dakota have the least awarded and received, and have expended the least. There is extensive variation in the percent of funds that states have received and expended, compared to what has been awarded or received. Delaware, for example, has both received and expended the least of its awarded funds, while New Mexico has expended the least of its received funds. Though Arkansas has received and expended the most of its awarded funds, Vermont has expended the most of its received funds. What percentage of funds states have received or expended is noteworthy, since $2.5 billion in ARRA funding has expired due to not being spent by legally specified

dates. Of this amount, over $690 million fell under the DOE's purview (RATB, 2012d). In the next section, reasons for the gaps between funds awarded, received and expended due to issues with ARRA implementation are examined.

Figure 4. Funds awarded, received, and expended (left to right) by state under the Recovery Act as of first quarter calendar year 2013.



Note: California's awarded funds (approximately $11.8 billion) are truncated.
Source: RATB (2013a).

3. Implementation and Early Effects

3.1. Assessments of Impacts

Many studies have estimated the potential and actual effects of the Recovery Act, including economic impacts, such as employment outcomes, as well as various benefits, such as energy savings. The evaluation metrics and methodologies used in these studies are not uniform, although they typically estimate job multipliers and job-creation based on ARRA obligations, spending, or other variables. Methods employed in these program evaluations generally involve macroeconomic forecasting models, general equilibrium models, historical data, or combinations of these techniques (U.S. Congressional Budget Office, 2011); other evaluation methods include input-output and analytical models (Wei et al., 2010).

The Congressional Budget Office (2011), using output multipliers determined from macroeconomic models and historical data, conducted modeling of the employment and GDP impacts of ARRA. The highest multipliers, 0.5 to 2.5 and 0.4 to 2.2, were associated with direct federal purchases and transfers to other levels of government for infrastructure, respectively, both of which encompass the programs in this study. Wilson (2011) estimated local multipliers from funding notification and financial activity reports and found that $1 million in spending resulted in between 4.3 and 8.3 jobs created or saved per state. His estimates of job creation and retention roughly align with those generated by the Congressional Budget Office (2011) and the Council of Economic Advisors (2011). Others have estimated slightly different multipliers, such as Feyrer and Sacerdote (2011), who calculated the range as 0.47 to 1.06 for CGL projects. Feyrer and Sacerdote also found that infrastructure spending, such as that undertaken by DOE, had a high multiplier of 1.85. The Congressional Budget Office (2011), using ARRA expenditures and the multipliers mentioned above, estimated that real gross domestic product rose 0.3 to 1.9 percent in the third quarter of 2011 due to the Recovery Act.

Some studies focus on the job or GDP impacts of different types of energy investments. An input-output modeling study that incorporated data from Recovery.gov, the Bureau of Labor Statistics, the Current Population Survey, and infrastructure multiplier data from Mark Zandi (2010) found that $93 billion in “green” economic investments from ARRA including but not limited to energy programs increased GDP by $146 billion and added or maintained 997,000 direct, indirect, and induced jobs (Walsh et al., 2011). Other studies suggest that energy-related ARRA funds significantly helped the renewable energy and energy efficiency industries by providing financing during a time of financial stress and when energy project developers otherwise might have had a difficult time securing funding (Hargreaves, 2010). Financial support for energy investments from the Recovery Act also leveraged additional private and public funding; according to state officials that participated in a 2010 Environmental and Energy Study Institute panel, for every $1.00 of ARRA funding for energy projects, states and private sources contributed $10.71 (EESI, 2010).

Not all ARRA evaluations measure job impacts. Others calculate effects on energy savings, energy security, environmental benefits, and innovation. Brandon J. Pierce (2011) found that ARRA programs reduced the

Department of Defense's energy use, which saved money, promoted broader technological development in the U.S., and increased energy security in ways that saved the lives of troops on the battlefield both directly and indirectly. Virjee (2010) found that, as of the time of this writing, EPA used $600 million in Recovery Act funding for Superfund cleanup at more than twenty sites, with work continuing at new or old sites as well. Project outcomes included the removal of arsenic from residential neighborhoods, the removal of contaminants from New York City waters, and the dredging of a mining byproduct from the Sacramento River. Eisenberg (2010) found that ARRA support of the weatherization assistance program could save each household approximately 29 million British Thermal Units of energy, 2.65 metric tons of carbon dioxide, and between $104 and $174 in avoided energy costs.

It is important to note, however, that not all ARRA impacts will be realized and measureable in the short-term, as is common with science, technology, and innovation investments (Lane, 2009). Most studies that have estimated the effects of the Recovery Act were conducted either *ex ante* or without a counter-factual, so it is difficult to ascertain the true significance and magnitude of ARRA's effects at this time. In addition, most measures of ARRA's success studied to date rely on short-term metrics, such as directly-created construction jobs or short-term economic growth. Many of ARRA's energy-related benefits and economic effects, therefore, have yet to come to fruition but could significantly affect the size of measured output multipliers and other impacts. Despite the various methodological challenges associated with measuring effects to date, studies on the topic reveal that this grand experiment had significant potential and has already produced economic, environmental, and other benefits.

3.2. Implementation Reviews

Both government and peer-reviewed articles evaluating ARRA's implementation emerged soon after the Act's passage, and the Inspector Generals' offices (OIGs) of various departments continue to conduct significant monitoring activities. The Recovery.gov website links to much of this literature, which provides a public-sector perspective of the progress made by the Recovery Act, some of its effects, and its strengths and weaknesses. The discussion below pulls from GAO and the DOE OIG's documents as well as other literature and highlights some of the common themes, including concerns about federal, state, and local administrative capacity, compliance with federal and state laws, monitoring and reporting issues, data and record quality, and issues with the pace of implementation.

Lack of staff capacity on the eve of ARRA's passage made the attraction and management of ARRA funds difficult at all levels of government (Johnson, 2009; U.S. DOE, OIG, 2011; U.S. GAO, 2011b). Several local communities and states were not prepared to handle the administrative requirements of ARRA funding, particularly given state furloughs that accompanied the economic downturn. ARRA's sudden passage and implementation exacerbated these requirements, and required that several locations add staff and administrative structures to handle new procedures (Wyatt, 2009). The DOE was similarly unprepared to implement the Act's requirements so rapidly and found itself overextended (U.S. DOE, OIG, 2011), as was the case with the Energy Efficiency and Conservation Block Grant program, which had no permanent director before April 2010 (U.S. GAO, 2011b). In 2010, the GAO found that

states were unable to obligate regular highway funding on time, an activity generally considered particularly "shovel-ready," due to the need to dedicate new staff quickly to ARRA highway funding obligations (U.S. GAO, 2010a).

Pre-existing national, state, and local laws constrained the speed and manner in which some ARRA funds were spent. For example, fair wage and "buy American" requirements, along with the National Historic Preservation, the National Environmental Policy Act, and state, local, and tribal laws, hindered some DOE projects by making it more difficult to satisfy timelines and benchmarks (U.S. GAO, 2010b). These additional constraints were particularly problematic for the implementation of State Energy Programs in some states, and were cited as one of the main reasons that only about 30 percent of these funds were spent by November 2011 (U.S. Department of Energy, OIG, 2011).

Early in the implementation of the Recovery Act, Wyatt (2009) noted that the burdens associated with monitoring and reporting requirements were significant, but found that states handled them well. Wyatt's assessment, however, proved overly optimistic: many sources have since noted the problems and difficulties associated with these ARRA requirements (U.S. DOE, OIG, 2011; U.S. GAO, 2010a; U.S. GAO, 2011b; U.S. GAO, 2011c). The DOE Inspector General noted in his 2011 testimony that recipients thought the reporting requirements were too burdensome (U.S. DOE, OIG, 2011). A 2011 GAO report on the Energy Efficiency Conservation Block Grant program found significant variation in recipient monitoring, partly due to differences in project size, and lack of recipient staff and knowledge of federal monitoring and reporting requirements (U.S. GAO, 2011b).

The calculation and reporting of ARRA results, particularly those associated with job outcomes, was also inconsistent across organizations (U.S. GAO, 2011b) and, in some cases, possibly reflected poor recordkeeping (U.S. DOE, OIG, 2011). One GAO report (2011c) noted that ARRA recipients did not always use acceptable means to calculate full-time equivalents when reporting job data during the first quarter of disbursement, but that reporting quality was improving. Additionally, both the DOE Loan Guarantee Program (U.S. DOE, Office of Audits and Inspections, 2011) and the Federal Railroad Administration's Intercity Passenger Rail grant-making processes (U.S. GAO, 2011a) were faulted for poor recordkeeping, though the latter was also noted for maintaining better records than many other ARRA programs.

In order to receive ARRA funding, some projects required shovel-ready status. "Shovel readiness" means that work can begin on a project within a short time frame after receiving funding. The concept and reliance on this measure, however, has drawn criticism for two reasons. First, some believe the concept itself is flawed, since all projects require planning (Personal interview, 2011), as well as capacity building (U.S. DOE, OIG, 2011), particularly projects related to the energy sector, where planning horizons typically span decades. The new planning and capacity building demands placed on sub-national governments required time and effort; thus, the concept of shovel-readiness was considered impractical by some. These planning demands were not limited to sub-national

governments, however: the DOE also noted the significant increase in planning needs necessary to channel funds through the Department and on to recipients (U.S. DOE, OIG, 2011). Second, whether or not projects were able to conform perfectly to the shovel-ready concept, several have raised additional concerns about whether the requirement was an unrealistic expectation to place on sub-national governments (U.S. DOE, OIG, 2011). Due to the inability of municipal governments to handle shovel-ready requirements, in conjunction with other challenges reviewed above (U.S. GAO, 2010b ; Wyatt, 2009), actual ARRA funding levels were much lower than expected (Johnson, 2009).

4. Discussion and Conclusion

The descriptive data and literature reviewed above highlight several trends about the manner in which Recovery Act funds were allocated and spent. Early evaluations of Recovery Act impacts find that the Act already produced significant economic and energy-related benefits. On the other hand, this "grand experiment" also suffered from implementation delays, where, as of the first quarter of 2013, only 63.6 percent of awarded energy-related funds were expended and $690 million of DOE funds were expired entirely as of December 2012. There are several possible reasons for these implementation difficulties, including the coordination requirements in a federalist system, administrative requirements, preexisting institutional capacity, and time inconsistencies between ARRA projects and stimulus relief.

The Recovery Act required actors within several layers of the government—as well as outside of the government—to coordinate on projects of varying sizes and time frames. Miscommunication and administrative challenges may have been inevitable, but there are other instances that were unique to ARRA, because of how it was implemented and the sheer magnitude of the effort. For example, reporting requirements were a challenge to communicate to recipients from the federal level, and staffing shortages at all levels of government hindered implementation. Laws and regulations varied by locality, as did local- and state-level experience with the implementation of energy-related projects. The speed of implementation of an ARRA project rested with its implementation by each participant, thereby confounding efforts to expedite these projects at the other levels.

As noted above, the coordination of these layers of participants depended on a variety of factors, including reporting and transparency requirements, institutional capacity, and federal, state, and local laws and regulations. While necessary for ensuring that the Recovery Act was implemented in an open manner, the reporting and transparency requirements of ARRA were not always implemented in a manner that was clear to recipients, thus causing project delays. The implementation of these requirements also led to inconsistencies in Recovery Act data through the Recovery.gov portal. State and local officials also faced several institutional problems, including a lack of experienced staff due to recent furloughs and layoffs resulting from budget cuts. Variations in state and local energy policies may also have factored into the pre-existing institutional capacity. Other federal, state, and local laws, such as "buy American" requirements and the National Environmental Policy Act, factored into Recovery Act implementation as well.

"Shovel readiness" ultimately proved to be a difficult concept to achieve for energy-related projects due to the planning requirements required to implement shovel-ready projects by sub-national governments. Further, the energy industry, one of the main targets of ARRA support, commonly requires long-term investments in infrastructure, such as power plants that last for decades, as well as research and development, which produces benefits for society after several years or decades. Many other long-term benefits are environmental in nature, such as reductions in carbon emissions or other forms of pollution. Most, but not all, of the energy projects implemented under the Recovery Act provided short-term support for energy infrastructure and innovation based on a long-term strategy to improve the foundation upon which future energy development can build. Consequently, the stimulus relief sought under ARRA, as well as environmental and other impacts, may not be noticed from these energy-related projects for some time. Further research will be required to measure in particular the benefits from reducing greenhouse gases and other pollutants as a result of implementing cleaner energy and energy efficient technologies under ARRA. One possible metric could include tons of carbon mitigated per dollar expended.

The Recovery Act has suffered from implementation challenges and administrative issues. Even so, this "grand experiment" has resulted in the awarding of $840 billion in funds, approximately $43.8 billion of which have been devoted to energy-related contract, grant, and loan projects. The money from ARRA has already had positive environmental, economic, and other benefits, and will likely continue to do so into the future. Further studies can highlight reasons for variations in the energy-related funding within programs and states, as well as the impacts of this variation on spending and the continued quantification of economic and environmental benefits.

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