U.S. POLICY

U.S. DEPARTMENT OF ENERGY'S RECOVERY ACT INVESTMENTS

CENTER FOR CLIMATE AND ENERGY SOLUTIONS

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The American Recovery and Reinvestment Act of 2009 (ARRA) appropriated an unprecedented $90 billion to "lay the foundation for a clean energy economy of the future," of which the U.S. Department of Energy received $35.2 billion. U.S. DOE's appropriations have gone towards a number of programs, including home weatherization and state energy efficiency programs, renewable deployment, smart grid investment, primary research for breakthrough technologies, and loan guarantees for innovative companies. Most of DOE's funds have been outlaid as planned, although about 1.6% of the money spent in financing now-bankrupt companies. This brief reviews the status of DOE ARRA funds and key programs nearly four years after their authorization.

OVERVIEW

The American Recovery and Reinvestment Act of 2009 (P.L. No. 111-5, Recovery Act, ARRA) is the economic stimulus package passed by Congress on February 13, 2009 and signed by President Obama four days later. As of January 2012, the government was expected to spend $831 billion on the package from its enactment through 2019, through a combination of federal tax cuts, temporary expansion of economic assistance provisions including unemployment benefits, and domestic investments to advance economic recovery.[1]

More than $90 billion from the Recovery Act targets government investment and tax incentives to create the "foundation for a clean energy economy."[2] This funding has provided an unprecedented investment in clean energy in the United States.[3] Recovery Act money for energy programs is distributed among a handful of federal agencies with jurisdiction over key areas such as the U.S. Department of Transportation, which oversees $18 billion appropriated for the high-speed rail program, and the U.S. Department of Treasury, which oversees tax credits for solar and wind deployment.

However, most direct investment in energy infrastructure and businesses is through the U.S. Department of Energy (DOE).[4] DOE received funding for

approximately $35.2 billion in direct grants and contracts under ARRA, and an additional $6.5 billion in loan options that DOE power administrations (Bonneville Power Administration and Western Area Power Administration) can choose to exercise.[5] Outlays have progressed smoothly – from February 2011 to February 2012, DOE has averaged monthly outlays of nearly $900 million in line with a targeted range between $800 million and $1 billion per month,[6] although certain DOE programs have faced problems in getting awardees to spend outlays immediately.[7] As such, most DOE Recovery Act funding has been spent, providing significant short-term stimulus to the economy, while the long-term effects remain to be seen.

The Center released its first paper on ARRA in December 2009, which detailed DOE's intended investments. A second version of the paper, released in June 2011, summarized DOE ARRA investments and its effects on employment by updating and adding to the original paper.

This updated paper includes new financial information and statistics and offers a preliminary review of DOE Recovery Act spending, in the section titled *Recovery Act Project Review and Highlights*. The *Review and Highlights* section examines DOE's progress in reaching some of the stated goals of the Recovery Act: to provide immediate stimulus for jobs, to provide investments for increasing economic efficiency by spurring technological advances, and to make investments that can contribute to long-term economic growth.

Finally, with respect to terminology, the following terms found throughout this brief are used by the federal government to describe the status of funds within the processes of disbursement and investment. Funds that are '*authorized*' are made available by Congress for a specific purpose; funds that are '*awarded*' are committed to a specific project or activity and will likely result in payment; funds that are '*outlaid*' have been paid to the recipient.[8] As of August 27th, 2012, nearly 98 percent of DOE's total authorized ARRA funds had been awarded and 76 percent of total funds had been outlaid.[9]

ARRA INVESTMENTS BY DOE PROGRAM OFFICE

Nearly every office in DOE received some ARRA appropriations. As of August 27th, 2012, the Recovery Act funds have been authorized, awarded, and outlaid by DOE program offices as follows in **Table 1**.

TABLE 1: U.S. Department of Energy Recovery Act Funding by Office in Billions of Dollars

DOE PROGRAM OFFICE	AUTHORIZED	AWARDED (%)	OUTLAID (%)
Advanced Research Projects Agency-Energy (ARPA-E)	$0.387	$0.380 (98%)	$0.274 (70.8%)
Office of Energy Efficiency and Renewable Energy (EERE)	$16.7	$16.6 (99.9)	$13.8 (82.6)
Office of Environmental Management (EM)	$5.99	$5.99 (100)	$5.82 (97.2)
Office of Electricity Delivery and Energy Reliability (OE)	$4.49	$4.48 (99.8)	$2.98 (66.4)
Office of Fossil Energy (FE)	$3.38	$3.24 (95.9)	$0.724 (21.4)
Office of Science (SC)	$1.67	$1.67 (100)	$1.40 (83.8)
*Loan Guarantee Program (LGP)**	$2.47	$1.90 (76.9)	$0.867 (35.1)
*Western Area Power Administration (WAPA)***	$0.010	$0.010 (100)	$0.010 (100)
Total	**$35.2**	**$34.3 (97.4)**	**$25.9 (73.5)**

Of the $2.47 billion authorized to LGP, $2.435 billion is held as a "credit subsidy cost" to pay back private financiers in the case of default. See Loan Guarantee Program (LGP) below for more information. For WAPA, the amount authorized is to cover the administrative costs of its transmission infrastructure program. The primary funding for its transmission infrastructure program is $3.25 billion in borrowing authority, or the right to borrow, from the U.S. Department of Treasury. The Bonneville Power Administration has a similar $3.25 billion line of credit. Borrowing authority is not considered authorized funding.

Source: DOE. (2012, August 24). Energy.gov. *Retrieved September 4, 2012, from Recovery Act Recipient Data: http://energy.gov/downloads/recovery-act-recipient-data*

ADVANCED RESEARCH PROJECTS AGENCY-ENERGY (ARPA-E)

ARPA-E awards go to high risk and high payoff energy technologies in all stages of development.[10] Projects span transformative technologies in energy storage, carbon capture, advanced biofuels, renewable power, and other areas.

ARPA-E was established under the America COMPETES Act of 2007 (Pub. L. No. 110-69) as a new agency within DOE that aims to fund cutting-edge energy research. However, ARPA-E did not receive any initial funding until the Recovery Act authorized $387 million for FY 2009 and FY 2010. ARPA-E has received continued appropriations in subsequent fiscal years after its initial funding from ARRA. ARPA-E received an additional $15 million from the FY 2009 budget, $0 in FY 2010, $179.6 million in FY 2011, and $275 million in FY 2012. With $387 million from the Recovery Act and $469.6 million from regular appropriations over four years, ARPA-E has so far received $856.6 million.[11]

ARPA-E has awarded all of its Recovery Act funding to 141 projects.[12] As of December 2011, an additional 56 projects have been funded through annual appropriations. (For more information, please see C2ES's brief on ARPA-E.)

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY (EERE)

EERE Recovery Act money supports a wide span of programs and initiatives, including advanced energy-efficient building technologies, advanced biofuels, vehicle, and geothermal research. The EERE projects most heavily funded with Recovery Act money are state and local government programs, including the following:[13]

- Energy Efficiency Conservation Block Grant (EECBG) Program, which awards grants to states, territories, and local governments, to implement and manage energy efficiency programs. This program was authorized $3.2 billion. All funds have been awarded and 83 percent have been outlaid, although state governments often did not meet benchmark deadlines for spending federal outlays. As a result, the DOE extended benchmark deadlines and gave stronger guidance on how states could spend outlaid ARRA funds.[14]
- State Energy Program, which funds state-level energy program grants for projects such as energy efficiency retrofits and renewable energy installations. This program was authorized $3.1 billion. All funds have been awarded and 92 percent have been outlaid.[15]
- Weatherization Assistance Program, which provides weatherization for homes. This program was authorized $5 billion and set a target goal of 600,000 homes to be weatherized over the life of the Recovery Act. This represents a fivefold increase from the 104,000 homes weatherized in calendar year 2009. The Weatherization Assistance program has since exceeded the 600,000 goal over the three-year period ending March 2012 set by the Administration, with 650,000 low-income homes weatherized nationwide as of December 2011.[16] All funds have been awarded and 95 percent have been outlaid.[17]

Federal requirements initially slowed investments under the major state energy initiatives and the EECBG Program and State Energy Program. Requirements under the National Environmental Policy Act (Pub. L. No. 91-190),[18] Davis-Bacon Act (Pub. L. No. 71-798),[19] ARRA's Buy American[20] terms, and the National Historic Preservation Act (Pub. L. No. 89-665),[21] have held up investments as the awards are contingent upon meeting these laws' conditions.[22] For example, investments for the Weatherization Assistance Program were stalled because the prevailing local wage determinations as required under the Davis-Bacon Act were not established until late summer 2009.

OFFICE OF ENVIRONMENTAL MANAGEMENT (EM)

ARRA funds for the Office of Environmental Management (EM) focus on the environmental impact of nuclear waste. The funds accelerate cleanup of soil and groundwater, transportation and disposal of waste, and demolition of former weapons complex facilities. As of August 2, 2012, EM has completed 103 of 129 projects in over 12 states. EM is scheduled to complete all of the remaining projects in FY 2013. More than 90 percent of the Recovery Act projects met budget and timeline requirements, indicating that EM ARRA projects provided economic stimulus in a timely fashion.[23]

OFFICE OF ELECTRICITY DELIVERY AND ENERGY RELIABILITY (OE)

Recovery Act funding for the Office of Electricity Delivery and Energy Reliability(OE) supports smart grid[24] initiatives and provides assistance for state and local governments for electricity policy review, transmission planning and analysis, and workforce development. Funding primarily supports previously unfunded provisions in the Energy Independence and Security Act (EISA) of 2007 (Pub. L. No. 110-140) that aim to improve electricity transmission and develop the smart grid. Specific EISA provisions receiving ARRA funds are:

- Smart Grid Regional Demonstration Initiative, which solicits and funds projects through competitive funding opportunity announcements for large-scale smart grid demonstration projects that verify technology viability, quantify costs, and validate smart grid business models at scale so they can be replicated. This project was authorized $0.68 billion.
- Interoperability Standards and Framework, which aims to set development and implementation standards for smart grid technologies to ensure effective and consistent application. This project was authorized $12 million.
- Smart Grid Investment Matching Grant Program, which creates a competitive, merit-based matching funds grant program that can cover up to 50 percent of investments planned by electric utilities and other entities for the deployment of smart grid technology. This project was authorized $3.5 billion, by far the most funding of all OE projects.

OFFICE OF FOSSIL ENERGY (FE)

The Office of Fossil Energy's (FE) Recovery Act initiatives focus on research, development, and deployment of technologies to use coal more cleanly and efficiently. FE received a total of $3.4 billion from the Recovery Act.[25]

FE appropriations have generally centered on a few large projects. $1.52 billion or 45 percent of the total FE appropriations is to fund carbon capture and energy efficiency projects in industrial facilities such as cement plants.[26] Although a total of 25 projects are supported by these appropriations, $633.6 million of the $1.52 billion was awarded to three large-scale projects in Texas, Illinois, and Louisiana.[27]The $1.52 billion also included a $100 million subset for carbon capture and utilization projects such as CO_2-enhanced oil recovery.[28]

Complementary to the funding for industrial carbon capture projects is an additional $800 million for exploring carbon capture and sequestration for coal power plants under the Clean Coal Power Initiative, which began in 2002.[29] While all of the funding has now been awarded, this program has encountered implementation delays – of the six project awardees, three have withdrawn, primarily due to uncertainty of U.S. climate policy and the continued weakness of the economy. These funds will remain available until expended as pursuant to the Energy Policy Act of 2005.[30,31]

An additional $1 billion, one of the largest Recovery Act appropriations to a single project, was awarded to FutureGen 2.0, a planned advanced coal-fired power plant in Meredosia, Illinois that will use oxy-combustion technology and capture and sequester 90 percent of its carbon dioxide emissions. FutureGen 2.0 and earlier iterations have also faced delays in implementation, but appears to be progressing as of late 2012.[32]

OFFICE OF SCIENCE (SC)

The Office of Science's (SC) Recovery Act funding supports a variety of U.S. laboratory facility upgrades and research projects. Thirty-two percent, or $0.54 billion, of the money is authorized for Energy Frontier Research Centers,[33] Science Laboratories Infrastructure Construction, and National Synchrotron Light Source II.[34] Additionally, 5.8 percent of the SC's total funds, or $0.097 billion, is authorized for Energy Sciences Fellowships and Early Career Awards to stimulate

research careers in energy and environmental sciences. The rest of the awarded money has been distributed among 49 specific lab facilities and project areas.

LOAN GUARANTEE PROGRAM (LGP)

Loan Guarantee Program (LGP) funding supports advanced technology projects through Sec. 1705 of the Loan Guarantee Program, which was established by the Recovery Act. Sec. 1705 is a temporary program funded by ARRA that authorizes DOE to make loan guarantees to certain renewable energy systems, electric transmission systems, and cutting-edge biofuel projects that begin construction no later than September 30, 2011.[35] Because it was designed to be temporary, the program expired on September 30, 2011, and was not renewed in FY 2012.

Out of the $2.47 billion authorized by the Recovery Act for LGP, $2.435 billion covers the "credit subsidy cost" for the Section 1705 loan guarantee program, while the rest covers the administrative costs of the Section 1703 and Advanced Technology Vehicles Manufacturing program. The credit subsidies are reserve funds designed to cover private loans in the case the companies default. Recovery Act loan guarantees have so far supported $16.3 billion in private loans, in nearly a 7:1 private-public financing ratio. Importantly, these funds are not outlaid unless a default occurs.

The $2.435 billion in credit subsidies complements other loan programs administered by the Loan Guarantee Program office, none of which received funding from ARRA. These programs are the Sec. 1703 Loan Program, and the Advanced Technology Vehicles Manufacturing Loan Program.[36] The Advanced Technology Vehicles Manufacturing program was authorized to give direct loans as opposed to loan guarantees. ATVM obtained authorizing funding September 30, 2008. Section 1703 funding goes towards "new or significantly improved technologies" as opposed to commercial technologies covered under 1705, and obtained appropriations for its credit subsidy cost in FY 2011. Neither program is considered part of the Recovery Act.[37]

As of September 4, 2012, the Sec. 1705 Program had awarded $1.9 billion and outlaid $0.867 billion in order to support $5.5 billion in loan guarantees and an additional $5.6 billion in partial loan guarantees.[38]

WESTERN AREA POWER ADMINISTRATION (WAPA)

Aiming to increase renewable energy deployment, the Recovery Act authorizes WAPA to borrow up to $3.25 billion from the U.S. Treasury to construct multistate transmission lines to help deliver renewable power in the West, and provides funding to carry out this activity. WAPA has partnered with two renewable energy projects by providing transmission lines, and is in the planning stage for others.[39]

Office of Inspector General

A support office rather than one administering programs, DOE's Office of Inspector General has audited DOE ARRA investments. The Office received $15 million in Recovery Act funds to pursue, "a strategy designed to present and detect inefficient, ineffective and abusive Recovery Act expenditures."[40] As of April, 2012, the Office of Inspector General had conducted 80 reviews and a number of investigations regarding the efficacy of Recovery Act funding. The latest comprehensive report, titled "Lessons Learned/Best Practices during the Department of Energy Implementation of the American Recovery and Reinvestment Act of 2009," was released in January 2012 to review past successes and failures and inform future spending efforts.[41]

SHORT-TERM JOBS SUSTAINED BY RECOVERY ACT INVESTMENTS

One of the primary goals of the Recovery Act was to inject the economy with funds that would immediately sustain jobs. The quick movement of funding from congressional authorization to worker payrolls was necessary for maximizing the effect of the stimulus.

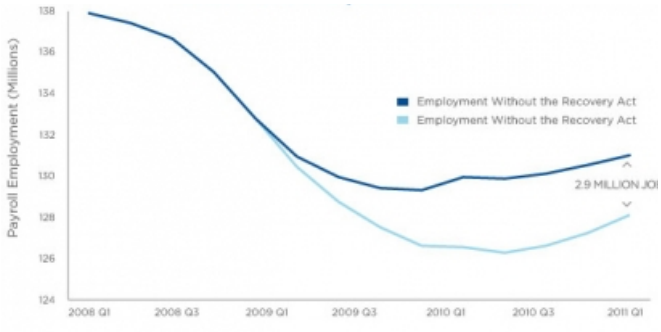
Short-term jobs from ARRA were tracked through "recipient reports," which are mandatory job reports submitted to the federal government by all ARRA grant or loan recipients. The Recovery Act requires that recipients report the total amount of funds received, a list of projects funded (including description, completion status, and estimates on jobs created or retained), and

details on sub-awards and other payments.[42]

According to recipient reports, at its peak in Q2 2010, ARRA directly supported 750,000 jobs.[43] DOE's effect on jobs peaked nearly a year later in Q2 2011. ARRA appropriations for DOE initiatives directly sustained 46,000 jobs at their peak effect through most of 2011.[44,45]

In order to examine the effect of ARRA on the economy as a whole, the Council of Economic Advisors, which is under the White House, and the Congressional Budget Office, which is an independent agency, were required to produce quarterly job reports, although neither examine job creation from individual agencies or programs. Unlike the recipient reports, CEA and CBO reports use modeling to examine indirect job creation, including jobs attributable to the consumption of those directly supported by ARRA.

FIGURE 1: Total Jobs Sustained by ARRA Investments against Benchmark



Source: Congressional Budget Office, "The Recovery Act", from The White House. Accessed December 12, 2012. http://www.whitehouse.gov/economy/jobs/recovery-act

Figure 1 shows the employment trend evaluated against job estimates if no stimulus occurred according to median CBO estimates. The trend of employment over time from CBO, CEA, and other organizations are displayed in **Figure 2**. CEA's *The Economic Impact of the American Recovery and Reinvestment Act of 2009 Eighth Quarterly Report*, released in December 2011 as CEA's last report, estimates that at its peak effect in Q2 2010, the Recovery Act had increased the number of jobs relative to what it otherwise would have been by between 2.55 and 3.86 million.[46]

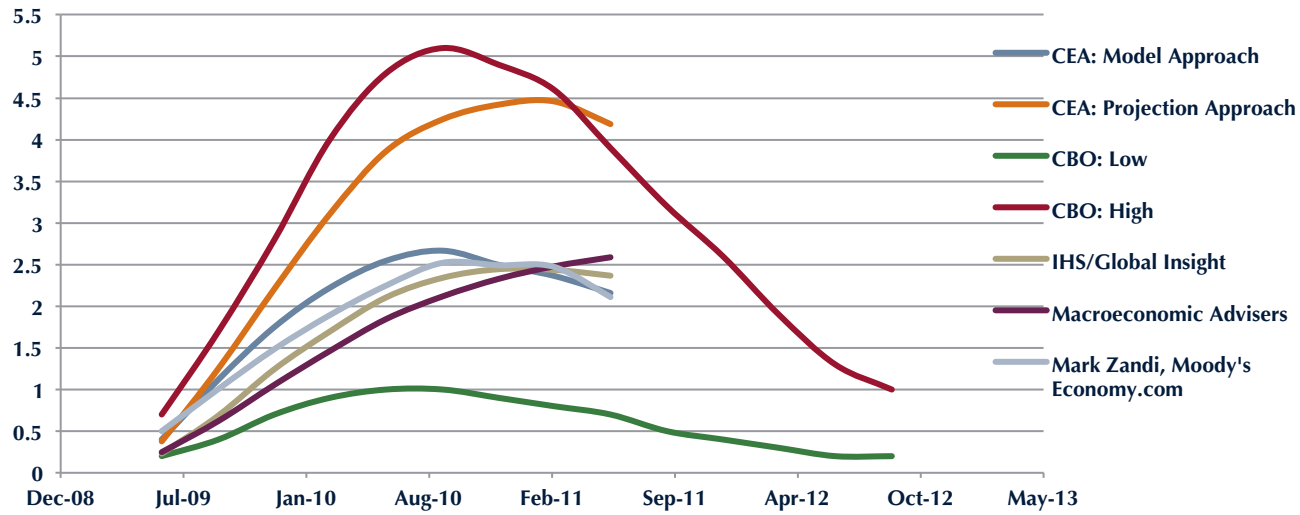
CBO's report, *Estimated Impact of the American Recovery and Reinvestment Act on Employment and Economic Output from April 2012 through June 2012*, was released in August 2012 and estimates that, following the fourth quarter of 2010, ARRA increased the number of people employed by between 1.3 and 3.5 million overall (jobs created), and by between 1.8 and 5.0 million compared to what employment figures would have been. The data represent ARRA funding for all agencies and are not broken down by agency or office.[47]

Since the Recovery Act is a short-term stimulus, the number of jobs attributable to Recovery Act stimulus funding declines over time. CBO and CEA do not quantify the long-run impacts of the Recovery Act beyond when money is spent.[48]

As such, the success of DOE investments regarding employment is only quantified for short-term jobs, which depends on the speed at which funding is awarded and the job-creation potential of the spending. The DOE initially encountered challenges in moving funding in the first year. The Government Accountability Office (GAO), which was mandated by ARRA to provide oversight over agency use of funds, found that rapid deployment of weatherization funds, for example, was hindered by Davis-Bacon, the National Environmental Policy Act, and the National Historic Preservation Act. The need to establish guidelines and procedures for new programs as well as the straining of staff capacity also slowed the movement of funding.[49]

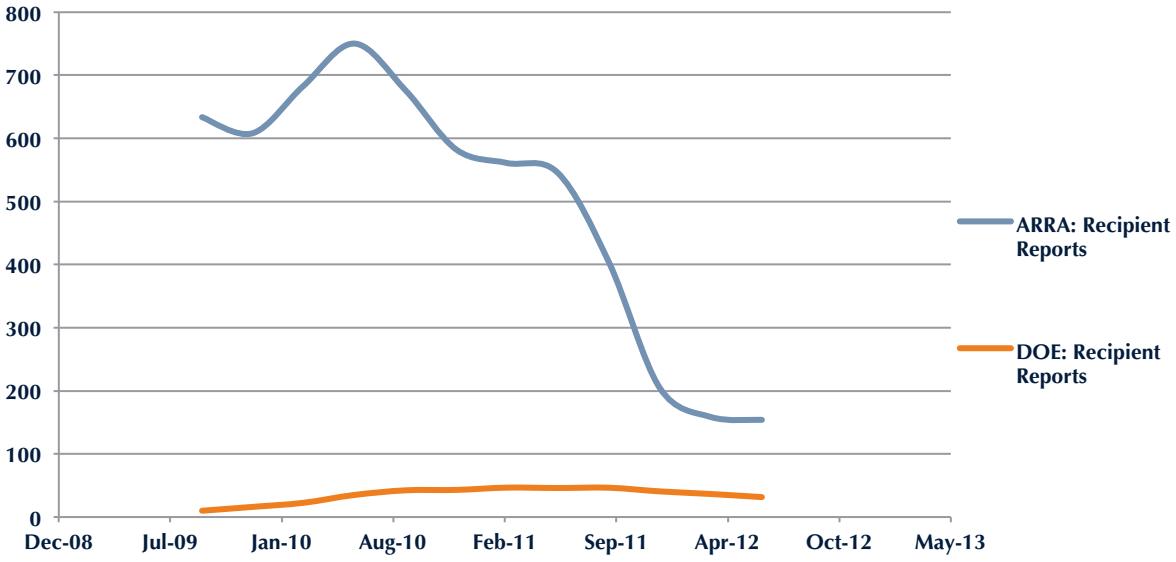
However, more than two years after the Recovery Act, GAO found significant progress in disbursing Recovery Act funding in two separate reports.[50,51] The DOE, as of August 2012, has awarded 75 percent of Recovery Act funds. As of April 2012, the GAO had no new recommendations for DOE but suggested that implementing prior recommendations could improve the efficacy of programs.[52] For example, DOE suggested that ARPA-E could strengthen its reporting requirements regarding private funding of grant awardees. The DOE also recommended that LGP could require more data to facilitate oversight of funds and also adhere more closely to its stated process for reviewing applications.

FIGURE 2: Total Jobs Sustained by ARRA Investments (low and high estimates; in millions)



Source: Council of Economic Advisers, "The Economic Impact of the American Recovery and Reinvestment Act of 2009, Eighth Quarterly Report". Accessed December 12, 2012. http://www.whitehouse.gov/sites/default/files/cea_8th_arra_report_final_draft.pdf

FIGURE 3: Estimates of Jobs Directly Sustained by ARRA Funding According to Recipient Reports. Jobs in Thousands



Source: Data from ARRA recipient reports, "Jobs Summary – National". Accessed December 12, 2012. http://www.recovery.gov/Transparency/RecoveryData/Pages/JobSummary.aspx

RECOVERY ACT: DISCUSSION AND HIGHLIGHTS

The Recovery Act set ambitious goals across multiple sectors of the clean energy economy. A number of high-impact projects have come to fruition or are in development, including weatherization for low-income housing, smart meter installation, state-level energy programs, and potentially game-changing technology research.

However, at the same time, a small number of private companies receiving DOE loans, loan guarantees, or grants have undergone financial trouble and even high-profile bankruptcies. While loan programs are risky by their very nature, these events have negatively affected perceptions of the DOE's Recovery Act programs. The following is an overview of various projects and programs funded by the Recovery Act, with highlights of major successes as well as opportunities for improvement.

SECTION 1705 LOAN GUARANTEE PROGRAM

Despite receiving the least funding out of any DOE office besides the Office of Science, DOE's Loan Programs Office (LPO) has attracted the most scrutiny among various DOE Recovery Act programs.

In August 2011, Solyndra, a solar manufacturer that received a $535 million loan guarantee under the Section 1705 program, announced it was filing for bankruptcy.[53] Critics alleged that the department rushed through the approval of the loan to Solyndra for political purposes, and the House Energy and Commerce Committee launched an investigation of DOE stimulus funding, with a focus on the Solyndra loan guarantee. Senior DOE officials, including Secretary Steven Chu were summoned to testify in front of the House Energy and Commerce Subcommittee on Solyndra and the Section 1705 program, although no impropriety was found.[54] The LPO's second bankruptcy under Section 1705 occurred with Beacon Power, which manufactured spinning flywheels for energy storage. Beacon Power received a $43 million loan guarantee. Finally, Abound Solar, another solar manufacturer, went bankrupt in June 2012 after receiving a $400 million loan guarantee, although it only drew $70 million of the loan guarantee.

All three of these bankruptcies occurred under the Section 1705 program. An analysis by Bloomberg New Energy Finance found that losses under the 1705 program with the exception of Beacon Power have been concentrated in solar manufacturing, in which Chinese oversupply of solar modules led to solar module price declines at an unforeseen pace.[55]

While the bankruptcy of these companies is undesirable, any loan or grant bears some risk of default. The federal government accounted for potential defaults under Section 1705 by setting aside $2.47 billion to cover any potential losses. These funds, called credit subsidy costs, budgeted for a failure rate of 15 percent; most commercial banking budget a failure of about 3 percent.[56] Moreover, nearly 90 percent of the loan guarantee amount was awarded to very low-risk generation and transmission projects. These projects stand a low risk of default because they are directly supported by utilities.

So far, after asset liquidation, Solyndra is estimated to return $24 million to private creditors, and Beacon Power is estimated to return about $30.5 million. DOE expects the Abound Solar's final loss to the taxpayer to be between $40 million and $60 million.[57]

As such, the total cost to the taxpayer for the three bankruptcies is less than $583.5 million, which is far below the $2.4 billion awarded to cover defaults. By the numbers, this number is roughly 1.6% of the total amount appropriated to DOE under ARRA, 3.6% of the total private financing that was supported by loan guarantees, and 23.8% of the amount set aside to insure against defaults.

Overall, the Section 1705 program primary success has been in accelerating renewable energy deployment. For example, the Loan Programs Office funded the world's largest photovoltaic installation (NRG's Agua Caliente) and the world's largest concentrated solar power plant (NRG and Brightsource's Ivanpah) at the time they were announced. Together, these solar projects will power the equivalent of 143,000 households. However, the job creation potential of these projects is mostly temporary via construction. Agua Caliente has supported 400 construction jobs but will only support 10 permanent jobs. High-risk loans to relatively new solar manufacturers, designed to create a permanent base of advanced U.S. manufacturing jobs, have been less successful; 55% of the funds of the loan guarantee amount to solar manufacturing and non-generation/transmission projects were a loss to the taxpayer, although these funds were roughly 10% of the total LGP funds.[58]

The Section 1705 program expired in September 2011. Moving forward, experiences with the Section 1705 program can inform implementation of Section 1703 as well as ARPA-E grants. A report on Section 1705 by the Government Accountability Office found that the Section 1705 could not "always readily demonstrate, through systematically organized records, through contemporaneous notes, how it resolved or mitigated relevant risks prior to granting loans, risk management, financial management and accounting and reporting."[59] The report pointed at the sudden need to manage and outlay large amounts of money in a short time strained available resources. Regular appropriations to loan and grant programs over a period of time, as opposed to short-term stimulus aimed at quickly closing loans, could diminish future risks.

STATE PROGRAMS: REVOLVING LOAN FUNDS AND APPLIANCE REBATES

A revolving loan fund (RLF) is a supply of money from which funds are borrowed. The loan repayments are then added back into the supply, allowing the loan program to last indefinitely. Multiple RLFs have been created or funded by the Recovery Act.[60]

The 'Green Bank of Kentucky' is a Recovery Act-funded RLF established in late 2009. The first loan from the Green Bank, valued at $1.3 million, was made in December 2009 for the Kentucky Department of Education. The advanced technologies implemented for the Kentucky Department of Education include lighting system upgrades, equipment control systems, and mechanical system improvements. The upgrades are delivering an estimated $140,000 in annual savings and an annual reduction of 1,383 tons of carbon dioxide over approximately 15 years.[61]

Another highlight of program funding under the Recovery Act was the $298 million devoted to the energy efficient appliance rebate program. To encourage the purchase of energy-efficient appliances, heating equipment, and weatherization materials, ENERGY STAR partners, including businesses, schools, organizations, and governments, sometimes offer rebates or sales tax exemptions or credits for qualified appliances. Through the Recovery Act, U.S. states and territories to set up rebate programs for ENERGY STAR qualified appliances. As of the end of August 2011, 1.6 million consumers redeemed $245 million of rebates. The rebates stimulated an estimated $1.9 billion in spending and $105 million in state sales tax.[62] The annual energy savings of these purchases are an estimated 1.6 trillion Btu (British thermal units), or 469 gigawatt hours, which is enough to power more than 16,000 typical U.S. households for one full year.[63,64,65] Rebate programs have proven to be highly popular among consumers. For example, Arizona launched its $6.2 million program on April 12, 2010 and closed it within four hours.[66] The North Carolina Energy Efficient Appliance Replacement and Rebate Program used up its $8.8 million of funds by selling 62,972 appliances worth $64 million. Because of the program's success, the state transferred $2 million more of its Recovery Act funds to sell 89,670 appliances, generating more than $89 million in total sales.[67]

ELECTRIC VEHICLE DEPLOYMENT

One of the largest investments made with Recovery Act funds is the $2.4 billion designated to support rolling out the next generation of electric vehicles and advanced batteries. ARRA funds complemented the LPO's Advanced Technology and Vehicle Manufacturing (ATVM) program's $8.4 billion in direct loans. ATVM was authorized as part of a continuing budget resolution as opposed to ARRA. ATVM gave loans to manufacturers such as Fisker Automotive, Ford Motor Company, Nissan Motor Company, and Tesla Motors.

Administered by EERE, the Electric Drive Vehicle Battery and Component Manufacturing Initiative supports 48 projects in 20 states set to advance the development, manufacturing, and deployment of electric drive vehicle components and lithium-ion batteries. These ARRA funds were matched by private finance of grant recipients. The following awards were made by the DOE as part of its Recovery Act awards[68,69,70]:

- $1.5 billion authorized to U.S.-based manufacturers to produce lithium-ion batteries and expand battery recycling.
- $500 million authorized to U.S.-based manufacturing for the development and production of electric drive vehicle components, including motors and drive train components.
- $400 million authorized for the demonstration and deployment of plug-in hybrid and all-electric vehicles. This includes installation of charging stations and workforce training to support the

transition to electric transportation systems.

Electric vehicle and battery manufacturing grants have faced scrutiny similar to the Section 1705 loan guarantees. For instance, Ener1, which received a $118.5 million grant from EERE, went bankrupt, and A123, which received a $249 million grant, was purchased by China's Wanxiang Group when it went bankrupt. These bankruptcies are primarily because demand for electric vehicles has not ramped up as quickly as forecasted in 2009.

Table 2 below highlights a few ongoing electric vehicle projects funded by the Recovery Act and their projected job impact[71,72]

TABLE 2: Electric Vehicle Deployment Highlights

AWARD RECIPIENT, LOCATION, PROJECT DESCRIPTION	ARRA FUNDING	EXPECTED TOTAL JOBS SUSTAINED[73,74]
DOW KOKAM MIDLAND, MI		
• *Construction of battery manufacturing facility* • *Eventual production of enough affordable lithium-ion batteries to power 60,000 vehicles per year*	$161 million	1,000 construction jobs 800 permanent jobs expected
JOHNSON CONTROLS HOLLAND, MI		
• *Construction of lithium-ion battery manufacturing facility previously considered for Asian locations* • *Supply contracts with Ford and Azure Dynamics*	$299 million	100 jobs sustained 500 permanent jobs expected
COMPACT POWER, INC. HOLLAND, MI		
• *Construction of lithium-ion battery manufacturing facility* • *Contracts to supply batteries for Chevrolet Volt*	$151 million	300 construction jobs 300 permanent jobs expected

Source: The White House, "100 Recovery Act Projects That Are Changing America". Accessed December 12, 2012. http://www.whitehouse.gov/sites/default/files/100-Recovery-Act-Projects-Changing-America-Report.pdf

REVIVING AMERICAN MANUFACTURING

The Northeastern, Mid-Atlantic, and Midwestern United States have been a historical base for manufacturing. However, with the migration of manufacturing plants to other countries and increased worker productivity from assembly line automation, these regions and the United States as a whole have lost many manufacturing jobs over the past decade. From 2001 until August 2008, the United States lost an average of 19,557 manufacturing jobs per month. The economic recession exacerbated unemployment, and significantly decreased manufacturing output; from August 2008 to December 2009, the United States lost an average of 131,600 manufacturing jobs per month. However, since January 2010 the economy has gained an average of 17,500 manufacturing jobs per month. Between December 2009, when manufacturing employment was at its lowest in the last decade, and August 2012, the manufacturing sector grew by 504,000 jobs to 11.9 million. This number is equal to the number of manufacturing jobs in April 2009.[75]. However, this number remains far below the more than 16,000,000 manufacturing jobs present in 2001.[76,77,78] The current administration has emphasized the importance of manufacturing jobs moving forward.[79]

While the steady growth in manufacturing jobs since December 2009 is attributable to many factors, the stimulus played an important role in supporting domestic manufacturing during the recession.[80] However, of the Recovery Act's manufacturing investments, investments by the U.S. DOE have had relatively small payoffs. Indeed, as evidenced in the Section 1705 loan guarantee program, investments in relatively new clean tech companies have led to a higher share of defaults and

bankruptcies. On the other hand, U.S. DOE's investments may also have the longest-term payoff, considering that companies focused on, for example, advanced batteries or smart grid equipment may have significant room for growth in the future.

The following awards are just a few of the nascent manufacturing projects supported with ARRA funds aimed at spurring growth in the clean energy economy.[81]

TABLE 3: Alternative Energy and Smart Grid Manufacturing Jobs

AWARD RECIPIENT, LOCATION, PROJECT DESCRIPTION	ARRA FUNDING	EXPECTED TOTAL JOBS SUSTAINED[82]
BREVINI WIND MUNCIE, IN		
• *Will increase wind turbine gearbox production in United States* • *Gearboxes are primarily produced overseas and are one of the most expensive parts of wind turbines*	$12 million	450 expected jobs through 2012
GENERAL ELECTRIC LOUISVILLE, KY		
• *Expand production of energy efficient home appliances* • *Will bring back one of its production lines from China*	$600 million	800 jobs expected through 2013
DUPONT CIRCLEVILLE, OH		
• *Will expand manufacturing of thin-film solar application*	$50 million	1,300 jobs preserved
CITY OF NAPERVILLE NAPERVILLE, IL[83]		
• *Installation of infrastructure and software to support smart grid, including deployment of 57,000 smart meters* • *Will complete automation of the city's smart grid, saving an estimated $30 million in electricity costs over 15 years*	$11 million	70 jobs expected during the project
STREATOR CAYUGA RIDGE WIND FARM LIVINGSTON, IL		
• *Construction of 150 wind turbines to generate 300 MW* • *Preservation of component factories in PA, WI, and ND*	$170 million	300 construction jobs

Source: The White House, "100 Recovery Act Projects That Are Changing America". Accessed December 12, 2012. http://www.whitehouse.gov/sites/default/files/100-Recovery-Act-Projects-Changing-America-Report.pdf

FUNDING POTENTIAL BREAKTHROUGH TECHNOLOGY WITH ARPA-E

ARPA-E has used its Recovery Act funds to research potential breakthrough energy technologies. Modeled after the successful Defense Advanced Research Projects Agency (DARPA)[84] with its mandate to support high-risk/high reward projects, ARPA-E's $386 million funding authority from the Recovery Act supports research that might not receive financial support otherwise. While the future of ARPA-E beyond 2011 was uncertain because of potential budget cuts[85,86,87] ARPA-E has so far been given funds through FY 2012. Continued appropriation of ARPA-E may make it a legacy of the Recovery Act. Moreover, both Republicans and Democrats have highlighted the importance of continuing ARPA-E. For example, presidential candidate Mitt Romney's presidential platform said that basic research through ARPA-E holds the "most potential for achieving significant advances in the energy sector."[88]

Although ARPA-E breakthroughs will ultimately be a long-term value proposition, one early success story is the discovery of a cheaper and denser battery by Envia Systems, which received $4 million from ARPA-E in

December 2009 in addition to $12.4 million obtained earlier from private investors.[89] Though the battery is several years away from mass-scale applications, at 400 Wh/kg and at a cost of $150/kWh, Envia's battery has the potential to halve the cost of battery packs while doubling the density. Another early success story is the discovery of a more efficient solar panel manufacturing process. A company called '1366 Technologies' received $4 million dollars from ARPA-E and developed a more cost-efficient way to produce silicon wafers for solar panels. Silicon wafers represent about 50 percent of the cost of making solar panels. The current wafer production process wastes approximately half of the silicon, whereas the newly developed process, "Direct Wafer" technology, reduces silicon waste and cuts the price of solar panels by 40 percent. 1366 Technologies is currently raising money to commercialize a process that will help lower the cost of solar electricity. The company's goal is to construct a factory and start producing the new wafers at a commercial scale by 2013.[90]

Other technologies being researched with funding from ARPA-E include electronically tinting energy-efficient windows, low-cost production of light-emitting diodes (LEDs), and advanced vehicle battery technology.

CONCLUSION

The American Recovery and Reinvestment Act provided the unprecedented amount of $90 billion to prepare the country for a clean energy economy, of which $35.2 billion is being invested by the U.S. Department of Energy. DOE's ARRA investments have met with several setbacks. Some companies and projects under some programs, particularly those providing loans to start-up manufacturing companies, have failed. Moreover, moving appropriations from, for example, the Energy Efficiency and Conservation Block Grant to worker payrolls encountered delays. A number of initial clean coal initiative awardees have canceled projects, while advanced battery manufacturing has struggled due to unrealistic projections of electric vehicle demand.

However, it is important to remember that the vast majority of funds were appropriated to projects that provided the short-term stimulus needed by the economy. According to estimates by the CBO and CEA as well as Moody's, IHS, and Macroeconomic Advisers, the Recovery Act in total has likely sustained between 2 and 4.5 million jobs for Americans through the economic recession (see **Figure 3**). ARRA initiatives supporting the development of clean energy technology and energy efficiency programs have resulted in 168,771 direct jobs according to the DOE.

While the short-term stimulus of DOE's investments was effective – albeit delayed in some instances – the long-term impacts of ARRA in "laying a foundation for the clean energy economy of the future"[91] remains to be seen. One clear and direct long-term benefit is the annual savings delivered by the various energy efficiency programs under the Recovery Act. For example, rebate programs have helped deploy more than one million ENERGY STAR appliances in a very short period and are expected to result in annual energy savings of 1.5 trillion Btu. Revolving loan funds will also continue to support new projects for many years to come. These initiatives put money in consumer pockets.

On the other hand, the long-term effects of research through agencies such as ARPA-E and the Office of Science are still uncertain. Early breakthroughs such as those from Envia Systems show promise, but commercialization, if it occurs, will likely take many years. The long-term effect of investments in certain industries such as electric vehicle deployment, advanced battery manufacturing, and solar manufacturing are also unclear. These industries continue to rely on government incentives. While several ARRA-funded companies have failed, the survival of at least some companies could result in the development of major new industries as solar power and electric vehicles mature.

C2ES CENTER FOR CLIMATE AND ENERGY SOLUTIONS

The Center for Climate and Energy Solutions (C2ES) is an independent nonprofit organization working to promote practical, effective policies and actions to address the twin challenges of energy and climate change.

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