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END-USE EFFICIENCY (Y WANG, SECTION EDITOR)

Implementation and Impacts of Intergovernmental Grant Programs on Energy Efficiency in the USA

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Abstract

Purpose of Review We review recent studies on intergovernmental grants for energy efficiency in the 2009 American Recovery and Reinvestment Act (ARRA)'s clean energy package, which has been the biggest federal investment in the energy sector over the past few decades. Our review provides a holistic picture of the implementation process of ARRA's energy intergovernmental grants and their impacts on energy efficiency.

Recent Findings State and local governments experienced challenges on implementing their grant programs efficiently. The implementation delay was affected by recipient administrative capacity, political support, use of contractors, and red tape in grant compliance. Existing evaluation studies are mostly conducted for two programs that subsidize the weatherization of low-income homes and the purchase of Energy Star appliances. The impacts of these programs on energy efficiency adoption and energy savings vary across jurisdictions. However, low participation and marginal energy savings are reported as common issues, which might be related to program designs and implementation.

Summary There has been a lack of integration between implementation studies and grant program evaluation. To better inform energy efficiency intergovernmental grant design, further research is needed to understand the link between program design, implementation, and program effectiveness. In addition, rigorous evaluation regarding other outcome metrics, such as energy efficiency, technology innovation, and green jobs, are desirable.

Keywords Energy efficiency · Intergovernmental grants · Recovery Act · Policy implementation · Program evaluation

Introduction

Government intervention plays an important role in the development and deployment of energy efficiency (EE) technologies. A variety of policy incentives have been implemented around the world to address market failures related to energy efficiency, which include the non-priced externalities of fossil fuel consumption, knowledge spillovers that lead to underinvestment in EE innovation from the private sector, and less optimal adoption of EE due to imperfect information [1–3]. In the USA, there has been an increasing trend over the past two decades that federal support for clean energy is implemented through "indirect governance" tools, such as intergovernmental grants, instead of direct administration from the federal government [4, 5]. While intergovernmental grants to state and local governments may lead to responsive implementation and improve program effectiveness by utilizing local knowledge on policy priorities and preferences [6, 7], prior empirical research on large-scale federal initiatives shows that this "indirect governance" model has imposed great challenges to the implementation and performance of federal programs in other policy fields, such as education and economic development [8–10].

In the energy sector, perhaps the most salient intergovernmental grant programs in the USA were implemented as part of the clean energy package in the American Recovery and Reinvestment Act of 2009 ("Recovery Act" or ARRA). To stimulate the economy and facilitate long-term economic growth from the recession, the Recovery Act made strategic investments in clean energy, healthcare, and education [11].

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As a major component of the Recovery Act, the clean energy package accounts for approximately $92 billion of the $840 billion total ARRA expenditures. In the clean energy package, approximately $58 billion was spent on energy efficiency [3, 11, 12]. Much of the ARRA investment in renewable energy and energy efficiency was distributed to state and local governments through intergovernmental grants. State and local government recipients had the authority to allocate and administer the funds to finance their own clean energy policy agendas that aligned with the broad goals set by the federal government.

Implementation of those ARRA intergovernmental grants can influence their effectiveness on stimulating clean energy technology innovation and adoption. It is important to understand the link between implementation through indirect governance tools and program effectiveness [5]. While there has been an emerging body of knowledge about the ARRA clean energy package implementation and its impacts, existing studies are quite fragmented. To our knowledge, there has been one comprehensive review on the broad effects of stimulus programs on renewable energy [13]. However, prior studies on energy efficiency programs in ARRA only focus on early-stage implementation [3, 11] and lack understanding of the overall implementation process and their impacts. Thus, the purpose of this review is to provide a holistic picture on the implementation of ARRA intergovernmental grant programs on energy efficiency and their impacts. We review these two streams of literature published in the past 5 years. The intergovernmental grants we review in this paper include the Energy Efficiency and Conservation Block Grant Program (EECBG) program, the Weatherization Assistance Program (WAP), the State Energy Program (SEP), and the State Energy Efficient Appliance Rebate Program (SEEARP) [14]. Table 1 briefly describes the goals and total amount awarded in each program.

In the following sections, we summarize the key factors for successful implementation, review various impacts of those intergovernmental grants on energy efficiency-related outcomes, and propose future research agenda.

Table 1 Selected intergovernmental grants for energy efficiency in ARRA

Grant program	Description	Total awarded
Weatherization Assistance Program (WAP)	Intergovernmental grant program designed to allow low-income families to reduce their energy bills by making their homes more energy efficient	$4,974,632,000
State Energy Program (SEP)	Intergovernmental grant program designed to enhance energy security, advance state-led energy initiatives, and maximize the benefits of decreasing energy waste	$3,084,474,000
Energy Efficiency and Conservation Block Grant Program (EECBG)	Intergovernmental grant program designed to develop, promote, implement, and manage energy efficiency and conservation projects	$2,801,729,000
State Energy Efficient Appliance Rebate Program (SEEARP)	Intergovernmental grant program designed to support state-level rebate programs for residential Energy Star appliance purchases by covering up to 50% of overhead costs associated with administering the rebate program. States choose which appliances qualify	$296,086,000

Implementation Factors for Success and Complications

The two main objectives for the implementation process of ARRA's intergovernmental grants for energy efficiency were timely implementation and increased government accountability [15]. Most of the research to this point has focused on the timely aspect of implementation, as even government accountability efforts impacted rapid spending. Many recipients of Recovery Act funding for energy efficiency projects reported that the time limits imposed on spending resulted in complications and stress [15]. These problems most commonly occurred in local and state governments with limited experience and insufficient administrative capacity to implement clean energy programs [15, 16, 19]. The decision to utilize third-party contractors [17, 18], local political leadership [19, 20], red tape in grant compliance [15, 17], and clarity of federal guidance [15] are all factors that influenced the timely implementation of ARRA intergovernmental grant programs.

Experience With Energy Policy and Administrative Capacity

A government's previous experience with clean energy programs and related administrative capacity, including human and financial management capacity, is expected to influence the implementation of intergovernmental grants [16, 19]. Carley et al. [16] find that state governments lacking experience with energy policy and administrative capacity, measured as financial management capacity, rely more heavily upon administrative guidance from the federal government. Important to note, however, is that studies at the local level

suggest that lack of staff capacity on energy efficiency unexpectedly resulted in quicker implementation. The researchers accounted for this surprising outcome by considering the types of projects that an agency with limited staff would pursue [19]. In other words, governments and organizations with less staffing capacity were more apt to apply for projects that did not require a large staff.

In addition to quantitative empirical analysis, research based on interview data with state agency representatives discusses the mechanisms between administrative capacity and implementation progress. ARRA funding was directed towards "shovel-ready," pre-established programs that were expected to be able to utilize funds as soon as they became available [15]. However, pre-existing was not a sufficient condition for shovel ready in the early stage of grant implementation. Many grant recipient programs were operating at minimum levels due to the recession, so when funds arrived, the programs struggled to adapt to the rapid expansion of their budget. Administration and oversight of a massive budget require a large, well-trained staff, which many of these programs did not have access to. Whereas some agencies brought back old employees, others were forced to mass hire and train new individuals to advance the program's spending capacity [15], which further delayed the implementation.

Third-Party Contractors

The presence of third-party characters in the implementation process for energy efficiency projects is not uncommon [21]. In the implementation of the EECBG programs, empirical analysis suggests that third-party contractors had an adverse impact on timely implementation [17]. However, third-party contractors were not only frequently used during the implementation process, but some governments also relied on outside sources for contract monitoring. A study by Anguelov [18] investigates the factors that explain why state agencies made the decision to outsource oversight. The findings suggest that increased workload associated with the Recovery Act increased the probability of outsourcing oversight.

Local Political Leadership

Studies at the state level and local level suggest that the political leadership support at both levels positively affects the implementation progress of intergovernmental grants supporting energy efficiency programs [15, 19]. Terman et al. [20] advance this theory and find that local incentive structures impact the desire of local government leaders to carry out federal goals, more specifically, the goal of rapid spending. Their study confirms that cities with mayor-council government structures have less implementation delay when the political actors are satisfied with the federal grant management in the approval phase than cities with council-manager structures [20]. Adversely, cities with council-manager forms of government experience fewer implementation delays when the political leadership is satisfied with the federally provided technical assistance regarding energy efficiency program management than cities structured as mayor-council governments. This is because council-manager institutions are focused on long-term benefits, so their interests lie in program quality. Mayor-council governments, on the other hand, can claim credit for short-term successes and are assumingly more concerned with simply obtaining the funding [20]. By confirming these assertions, the researchers show the importance of political leadership incentive structures in timely implementation. These findings are not surprising considering the significant role political leadership plays in program implementation.

Red Tape in Grant Compliance

Recent studies suggested that red tape intended to increase government accountability, a main goal of the Recovery Act, was inconsistent with the federal government's other goal of rapid spending. Red tape in the context of Recovery Act energy programs refers to excessive mandatory procedures and guidelines, including reporting and flow-down requirements, prevailing wage and Buy American provisions, and all pre-existing regulations for historic preservation [15].

For each intergovernmental grant program, the federal guidelines required the state and local grant recipients to report awarded project progress to the Department of Energy (DOE) and the Office of Management and Budget (OMB) separately, on a regular basis. Interviews with state grantees suggest that different reporting requirements by the two federal departments resulted in an unnecessary and taxing workload for the states at the early implementation stage [15]. While the DOE eventually changed their metrics to match those of the OMB to reduce reporting burdens, we expect that the early differences in reporting metrics may account for some inconsistencies in evaluations of ARRA's impacts on energy efficiency described later.

The prevailing wage provision of the Recovery Act further delayed grant implementation. Prevailing wage required the states to pay all contractors and program contributors wages that were equivalent to the hourly wages and benefits most commonly paid for that specific occupation in their region. In the case that a prevailing wage was not pre-established, projects were delayed as the states waited for the Department of Labor (DOL) to determine and publicly release the wages [15]. In some cases, prevailing wage information from the DOL took up to 9 months to receive [15]. Tonn et al. [22••] report that the process averaged 6 months for Weatherization Assistance Programs, which led to unfavorable media attention. Unfavorable media attention reduced public support for the WAP, thus potentially reducing political leadership support

and implementation timeliness. Furthermore, required weekly submission of prevailing wage forms was found to discourage WAP participation because subgrantees were sometimes incapable or reluctant to comply [15].

The Buy American provision was included to enhance the manufacturing industry, but also served as a source of implementation struggles. In addition to the hassle of reporting requirements, the Buy American provision incited the challenge of acquiring all American-made products [15, 17]. Subgrantees further struggled with questions regarding whether a system qualifies as American made if it contained parts made in other countries [15]. Acquiring products that meet Buy American guidelines and addressing related confusion once again resulted in implementation delays.

State and local governments were also required to abide by all pre-existing local rules and regulations [15]. Carley [15] provides the example that if a state wanted to update a public facility with energy-efficient appliances, the state would have to comply with all local building regulations, in addition to all ARRA requirements. The inability to bypass these protocols added to the challenge of spending funds in an efficient manner.

Due to ARRA's stringent red tape, numerous state and local government subgrantees relied heavily upon the federal government for guidance. A reoccurring theme in interviews conducted to obtain information about state and local implementation of ARRA funding is the effectiveness, or rather ineffectiveness, of the federal government. Respondents to Carley's [15] interviews explained their struggles to obtain useful guidance on grant stipulations during the preliminary stages of ARRA funding. While some information was unclear or unavailable, respondents also described contradictions in federal guidance. Interviewees reported that federal guidance improved over time, suggesting that lack of preparation is responsible for the initial miscommunications [15]. While Terman and Feoick [19] determined that the EECBG was not operationally different from other intergovernmental grant programs, the stimulus' pure size and tricky requirements seemed to create issues the federal government did not anticipate addressing.

Impacts of Intergovernmental Grants for Energy Efficiency

Very few researchers have evaluated the various impacts of intergovernmental grants supporting energy efficiency, which we assume is due to the difficulty of isolating the results of a single program. The limited yet emerging body of knowledge is primarily focused on assessing the effects of the Weatherization Assistance Program (WAP). This program is the largest residential energy efficiency program, under which grants flow from the DOE to the states, and then to local agencies that weatherize low-income homes for free [22••, 23•]. Because local weatherization agencies design their programs with regard to regional weather conditions, a large variation in results from different regions is expected. We have also included studies assessing intergovernmental grants for the State Energy Efficient Appliance Rebate Program (SEEARP) because this program is solely focused on energy efficiency and directly impacts energy-efficient appliance adoption. The SEEARP is a stimulus program that encourages the replacement of old appliances with newer and more efficient "Energy Star" models [24]. The program's rebates were also expected to decrease participant's energy and water bills and increase innovation and jobs in the energy efficiency sector by increasing demand for energy-efficient appliances [24]. In this paper, we review studies evaluating the impacts of these two programs on energy efficiency technology innovation, adoption, energy savings, and green job market.

Technological Innovation

Advancements in energy efficiency are reliant on technological innovation and progression in the sector. Consequently, promoting these developments was one of the major objectives of ARRA's clean energy package. While limited research has been conducted on the topic of innovation, Cleantech's patent data from 2009 to 2013 shows a significant increase in energy efficiency patents, coinciding with the implementation of the Recovery Act. From 2004 to 2008, energy efficiency-related patent applications per year averaged between 4000 and 5000, while between 2009 and 2013, the number of patent applications rose from 6000 to 11,000 [25]. While there has been no research establishing the causal relationship between this sharp rise in patent applications for energy-efficient technologies and the ARRA intergovernmental grants, it is possible that the ARRA's funding for energy efficiency programs from 2009 to 2013 stimulated the innovative activities in the energy efficiency sector during this time frame. However, further empirical evaluation is required to estimate the impacts of ARRA intergovernmental grants on technology innovation in energy efficiency.

Energy Efficiency Adoption

In addition to technology innovation, adoption of energy efficiency is another key goal of ARRA intergovernmental programs supporting energy efficiency. Among those programs, the WAP and the SEEARP directly target energy efficiency adoption. The WAP makes low-income homes more efficient by climate-based weatherization and lighting and appliance upgrades. The SEEARP directly impacts energy efficiency adoption by subsidizing consumers who purchase energy-efficient appliances through rebates.

Per the DOE, WAP production goals reached 115% in 2012, with 730,906 units weatherized compared to the 634,956 planned [26]. Research conducted by Tonn et al. [22••] illustrates that ARRA's intergovernmental grants supported the weatherization of just under 90,000 units in the fourth quarter of 2011. This was nearly equivalent to the total number of units normal WAP funding supported for all of 2008. Important to note is that formula unit weatherized by normal program funding dipped well below pre-ARRA amounts going into the second quarter of 2014, which puts program continuation and future success at risk [22••].

Despite reports boasting of WAP's success, numerous studies have suggested that the program experienced low participation. A study assessing participation in WAP in Michigan found that despite the program bearing no cost to participants, participation among eligible households remained low. In the study, researchers tried to boost participation by reducing application barriers, but saw limited success [27•]. The researchers suggest that this is due to the costs of the program, i.e., time and effort required to participate, outweighing the perceived benefits [23•, 27•].

A study conducted by Reames [28•] explores some of the other barriers to energy efficiency adoption that may be present when finances have been accounted for. The study focused solely on Kansas City, Missouri, but found that social barriers play a significant role in low-income decisions to participate in local Weatherization Assistance Programs. One such barrier is public priorities. Local WAPs must convince low-income individuals to pursue efficient sources of energy, even though most already have coping mechanisms in place for dealing with energy costs (i.e., limiting energy use and defaulting on payments). For individuals who struggle to afford their dinner, green initiatives are not economic priorities. Another factor that diminishes participation is public distrust. Low-income individuals typically exert limited trust of government and others, making them unwilling to participate in these programs [28•].

The limited research on the SEEARP also suggests that the program struggled to entice participants, yet managed to contribute to energy-efficient appliance adoption. The program issued a total of 1,783,425 product rebates, 1,575,406 of which were for major appliances [29]. Houde and Aldy [30••] suggest that issues with participation are due to program design. The researchers examined the sale of "Energy Star" refrigerators, clothes washers, and dryers and found that rebate incentives averaged only 12–15% of product costs. The idea of minimal savings on major appliances during a recession is unlikely to prompt individuals to make any unplanned purchases [30••]. Consequently, the free-rider phenomenon is a major concern for SEEARP [30••, 31, 32]. The free-rider problem occurs when program participants are rewarded with rebates for purchases they would have made anyways [30••, 31, 32]. Houde and Aldy [30••] estimated that 73–92% of SEEARP participants were free-riders, which if true, would greatly reduce the impact of the program on energy efficiency adoption. The American Council for an Energy-Efficient Economy (ACEEE) recommends that the solution to limiting the free-rider problem is to limit the eligible appliances to only the most efficient appliances with minimal market share [33].

Cost Effectiveness

Most available research on the cost effectiveness of the ARRA energy efficiency programs has been conducted on the WAP, and little is known about the SEEARP. A study based on Michigan's eligible households for WAP suggests that weatherized homes reduced energy consumption by an average of 10–20%, which was only 39% of the savings predicted by engineering models [27•]. Assuming these findings were correct, the value of the weatherization-prompted energy savings was only half the value of the total investments per household [27•]. Nadel critiques this study by stating that the researchers used a small sample, tried to generalize their findings beyond the scope of their study, and did not give a fair evaluation of the benefits of WAP [34]. Considering Fowlie et al.'s [27•] sample was limited to Michigan households, Nadel's critique of the study is fair. However, a study on San Diego's WAP finds that only 79% of energy savings predicted by engineering models were actually realized [35]. While this is a greater proportion of estimated savings realized than that in the Michigan case [27•], one is still led to question why engineering models are consistently overestimating savings. Fowlie et al. [27•] suggest that calibrating energy audits to account for actual energy use would significantly increase accuracy.

Tonn et al. [36•] agree that the cost effectiveness of the WAP was not at desirable levels. From 2008 to 2010, the significant increase in the number of homes weatherized resulted in more than three times the energy savings in the site-built home sector [36•]. From a per unit perspective, however, energy savings decreased at a moderate level. The researchers attribute this phenomenon to four implementation factors. First, prevailing wage requirements increased wages for weatherization staff and administrative costs, thus increasing weatherization costs. Second, necessary increases in oversight resulted in increased administrative costs. Third, the numerous factors that prevented efficient implementation increased administrative costs. Lastly, the cost savings typically realized by economies of scale were only attributable to larger subgrantee recipients [36•].

Houde and Aldy [30••] suggest that the energy savings of SEEARP also fell below projected levels. The ACEEE attributes the researcher's findings to problems with the individual state's program designs [24]. For example, some state's program goals specifically aimed to produce energy savings, but the appliances selected to qualify for the rebates did not always align with these goals [24]. The free-rider problem

referenced in the "Energy Efficiency Adoption" section contributed to relatively low energy savings because these free-riders do not contribute towards energy savings beyond typical levels. Houde and Aldy discover that appliance sales only increased 1–2% above what expectations would be in the absence of SEEARP [30••].

In addition to the free-rider problem, the rebound effect is a potential factor in actualized energy savings. Nadel [37••] provides that the rebound effect may be direct or indirect. Direct rebound refers to the phenomenon that consumers of energy-efficient products tend to use their EE appliances more due to the energy-saving features. Consequently, the energy savings produced by those products are mitigated. The indirect effect can be explained by what has been referred to in economics as the income and substitution effects. The money saved from adopting energy efficiency appliances may be used by the household on other goods or services. The rise in demand for other goods results in increased production, thus increasing energy usage. Nadel suggests that incorporating these rebound effects into future savings estimates will result in more accurate predictions [37••].

Green Jobs

As a stimulus package, another important goal of ARRA's clean energy investments is to stimulate the economy through creating jobs in emerging industries, such as the clean energy sector. Due to a range of factors that influence the job market, however, existing research has not provided a causal analysis of the number of jobs created from ARRA-funded energy programs. Additionally, one study recognizes considerable variation in evaluation and reporting methods for jobs resulting from Recovery Act funding [38]. Many of the jobs "created" were simply transformed versions of already existing jobs [13, 38]. With that in mind, we are not surprised to find limited literature with low-confidence levels regarding green job outputs from Recovery Act efforts.

Given the data availability, prior research has only evaluated impacts of WAP on green job creation. Estimates from Tonnet al. [22••] suggest that ARRA directly supported just over 15,000 weatherization jobs in the fourth quarter of 2010. They find that roughly 26,000 jobs were indirectly and directly supported by WAP. Important to note, however, is the longevity of these positions. Interviews with state officials involved in the implementation of ARRA grants suggest that funding deficits following the conclusion of the stimulus program resulted in employment cuts [15]. Similarly, while the availability of weatherization employment training dramatically increased during the ARRA period, many of these training centers were closed as funding was no longer available [36•].

Table 2 Measurements and data source for key implementation factors

Factors	Measurements	Data source	References
Experience with energy policy and jurisdictional capacity	(i) Presence and characteristic of state renewable portfolio standard (ii) Financial management capacity	Government Performance Project financial management capacity measures; Database for State Incentives for Renewables and Efficiency	Carley [16]
	(i) Overall capacity (ii) Managerial capacity (iii) Dedicated sustainability staffing (iv) Lack of staff and information resources to reduce energy consumption	International City/County Management Association Municipal Form of Government 2011; 2011 EECBG Implementation Survey	Terman and Feoick [19]
Third-party contractors	(i) Use of different types of contractors (ii) Availability of qualified contractors (iii) General procurement problems	2011 EECBG Implementation Survey	Terman and Feoick [17]
Local political leadership	(i) Mayoral/City Council involvement in grant application (ii) Council support of energy conservation/sustainability efforts	2011 EECBG Implementation Survey	Terman and Feoick [19]
	(i) Subgrantee satisfaction with grant processes (ii) Local government structure	DOE Administrative Records for EECBG Grants; 2011 EECBG Implementation Survey	Terman, Kassekert, Feoick, Yang [20]
Red tape in grant compliance	(i) Clarity of federal guidelines (ii) Ease of compliance with ARRA transparency requirements (iii) Added implementation complexity due to pre-existing laws	Semi-structured phone interviews with state energy officials.	Carley [15]

Conclusion

The ARRA's clean energy package has been an unprecedented federal investment to promote the clean energy sector over the past few decades. Much of the ARRA investment in energy efficiency was distributed through intergovernmental grants to state and local governments to help them finance their energy efficiency programs. During the past 5 years, significant efforts have been made from both the academia and the government to study the implementation and impacts of those intergovernmental grants for energy efficiency. Among studies on grant implementation, the researchers have reached a consensus that there were challenges for state and local governments to implement their grant programs in a timely manner. The efficiency in implementation was mostly affected by recipients' administrative capacity for managing energy programs, local political support, use of contractors, and red tape in grant compliance. Table 2 summarizes the measurements and data sources used in existing studies for each of those implementation factors.

Evaluation studies on those intergovernmental grants were mostly conducted for the WAP and the SEEARP with a focus on only two program outcomes: energy efficiency adoption and energy savings. According to existing evaluations, the WAP seems to achieve its target in terms of units being weatherized. However, the energy savings were less than the savings predicted by engineering models. The SEEARP was reported as only providing marginal energy savings. Both programs experienced issues related to low participation. While researchers discussed some program design and implementation factors which may result in less optimal outcomes, there has not been any empirical studies that test the link between program design, implementation, and the impacts. To better inform energy intergovernmental grant program design, future research can contribute to the following areas: (1) rigorous causal analysis that evaluates grant impacts on energy efficiency technology innovation and green job creation; (2) investigation on the relationship between specific grant program designs, implementation issues, and program outcomes across jurisdictions; and (3) modeling the free-rider problem and rebound effects to address the energy savings estimation gap between engineering and econometric models.

Compliance with Ethical Standards

Conflict of Interest Tian Tang and Hunter Hill declare no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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