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The Role of State Expenditure and Accumulated Experience for Successful Implementation of Green Energy Policies

지방정부의 재정역량과 축적된 집행경험이 정책의 성공에 미치는 영향력에 관한 연구

: 미국의 회생 및 재투자 법안을 통해 집행된 녹색에너지 정책사례를 중심으로

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목 차

This paper examined five factors that affect the success of green energy policy, including 1) subnational government capacity, 2) the level of American Recovery Reinvestment Act(ARRA) funding, 3) accumulated knowledge of sustainable energy policy implementation, 4) performance ability and 5) political influence. This research used panel data from 49 U.S. states between 2003 and 2013. Results suggest that state and federal energy expenditures are correlated with green energy jobs' growth. Federal funding allocated under the American Recovery and Reinvestment Act of 2009 also led to successful policy implementation. The effects of ARRA funds is found to be more robust over time compared to other types of federal,

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state, and local government expenditures. Accumulated knowledge in certain energy policies is found to be correlated with new green jobs', but only when a longer period is considered. Political factors and performance ability are not statistically significant in the estimates.

□ Keywords: Successful Policy Implementation, American Recovery and Reinvestment Act(ARRA), Job Creation, Decentralized Expenditures

본 논문은 지방정부 재정역량의 정도와 축적된 집행경험이 정책집행의 성공에 미치는 영향력을 미국의 회생 및 재투자 법안을 통해 집행된 녹색에너지 정책사례를 중심으로 실증분석하였다. 본 연구에서는 정책집행의 성공이라는 개념을 정책의 목표를 달성하는 것으로 정의한 선행연구의 접근(Pessman and Wildavsky, 1973; Ong, 2012; Carely et al., 2014; Terman et al., 2016)을 바탕으로 미국의 녹색에너지 분야에서의 일자리 창출이라는 정책목표가 달성되는 것을 정책집행의 성공으로 간주해, 이에 영향을 미치는 요인을 탐색하는데 연구의 초점을 두었다. 총 2003년부터 2013년까지 10년간의 패널데이터를 토대로 장기적인 측면(2003-2013, 모형1), 중기적인 측면(2007-2013, 모형2), 단기적인 측면(2009-2013, 모형3)으로 세분화하여 분석을 실시하였다. 분석결과, 지방정부가 중앙정부의 간섭 없이 자율적으로 사용할 수 있는 지방정부의 재정역량이 클수록 정책집행의 성공에 유의미한 긍정적인 영향력을 주는 것으로 나타났으며, 녹색에너지 정책에 대해서 더 오래된 집행경험을 보유하고 있는 지방정부일수록 녹색에너지 관련 정책집행의 성공에 유의미한 긍정적인 영향을 주는 것을 확인할 수 있었다. 또한 지속적인 정부의 투자 뿐만 아니라 일시적이고, 단기적인 정부의 투자 역시 녹색에너지 분야에서 관련된 일자리 창출 효과를 이끌어 낼 수 있음을 실증적으로 확인할 수 있었다.

본 연구는 미국사례를 통해 일자리 창출이라는 정책목표가 성공적으로 달성되는데 있어서 지방정부의 분권화된 재정역량이 성공적인 정책 집행을 이끌 수 있다는 것을 실증적으로 확인했다는 점에서 연구의 의의를 찾을 수 있을 것이며, 동시에 지방정부의 축적된 집행 경험으로부터 나오는 노하우와 전문성이 정책집행 성공에 긍정적인 영향력을 줄 수 있음을 경험적인 측면에서 확인했다는 점에서 연구의 의의를 찾을 수 있을 것이다.

□ 주제어: 성공적인 정책집행, 미국의 회생 및 재투자 법안, 일자리창출, 재정분권

Ⅰ. Introduction

Green energy policy is a key driver in sustainable energy and climate protection. In recent years, federal and state-level government in the U.S. are actively promoting green energy technologies including renewable energy sources such as solar, wind, geothermal, biofuels, and hydropower. Simultaneously, using government expenditures to promote job creation in the green energy area, is one of the important benefits of a green growth framework(Hynes and Wang, 2012). Green energy, specifically, has become a major policy focus within the sustainable area over the past several years in the United States. Both green economic development and green energy job creation were at the center of the Obama administration's American Recovery and Reinvestment Act(ARRA). Between 2009 and 2013, federal ARRA funds for energy programs were allocated to various state and local governments to stimulate economic development by creating and retaining green energy jobs. This spending has been described as the nation's biggest energy bill in history(Herbert 2009). Recently, performance assessment of the energy programs created under ARRA have received considerable attention(Carley et al., 2014; Terman et al., 2016). Researchers have studied the ARRA implementation process(Carley et al., 2014; Terman et al., 2016), state experiences with ARRA (Carley, 2016), and the effect of ARRA funds on specific programs such as the Weatherization Assistance Program(WAP)(Tonn et al., 2016). Still, no study has estimated how well these Recovery Act funds performed in creating jobs, one of the ARRA's ultimate objectives. Accordingly, this analysis focuses specifically on the effectiveness of such major, but temporary government investment on creating green energy jobs in the period when such funds were available(between 2009 and 2013).

Much of the existing literature on policy implementation has focused on how the theoretical and empirical capacity of state or local governments to implement programs has led to different policy outcomes, despite equivalent levels of per capita federal funds and uniform federal policy goals(Terman and Feiock, 2014; Carley et al., 2015; Krause, 2010; Krause et al., 2014). They highlighted that the differences

in state or local governments' capacity and behavior can play a crucial role in determining the success of energy policy implementation. However, the attention paid to, and motivation to implement green energy policy by state and local governments has not yet been evaluated in the longer-term. To fill this gap and contribute to knowledge on successful policy implementation, this article additionally examines the factors that influence the success of green energy policies implemented at the state level in the shorter and longer time periods. This research measures "success" with the number of green-energy jobs created. To the best of knowledge this paper is also the first empirical work that studies differential effects of federal, state, and local expenses on the creation of green energy jobs.

This research begins by briefly reviewing the definition of implementation and the meaning of its related "success". Next this study describes a theoretical approach to successful implementation. This study then describes and statistically test the hypotheses related to the factors that influence green energy policy implementation success in the short-term(2009-2013 years), as well as in mid-term(2007-2013 years) and long-term(2003-2013 years) periods. In the short term approach, additionally, this study assesses the impact of ARRA funds on creating green energy jobs. This study investigates a relatively rare occurrence, in that ARRA funds are a one-time significant but temporary injection into a policy area. This study analyzes whether such a program had the intended effect on green energy policy at the state level.

Ⅱ. Theoretical Framework

1. Successful Implementation of Federal Green Energy Policy

Policy outcomes are dependent on well-designed interventions and successful implementation(Pressman and Wildavsky, 1973). Successful implementation requires several factors such as purposeful attention, procedures and processes to overcome internal and external barriers, explicit and quantifiable objectives to monitor progress, ongoing assessments to identify implementation problems, and a willingness to revise and refine efforts when required(Ong, 2012). In this regard, current literature has focused on both the effective implementation of the goals and the effectiveness of governmental actions as the concept of successful implementation.

A common definition for successful policy implementation is that stated goals are accomplished in the planned timeframe and without exceeding budgetary constraints. Implementation delays are one factor that hinders policy performance and thus successful policy implementation(Carley et al., 2014; Terman et al., 2016). Similarly, the achievement of the stated objectives is critical. Therefore, this research recognizes that successful implementation can be measured by assessing whether the desired results were met.

This study judges whether government funds allocated for green energy projects are successfully implemented, in terms of the number of jobs created in the following: the process of green energy production, demand for efficient energy, and demand for energy from renewable sources. New clean energy jobs were one of the tasks of the American Recovery and Reinvestment Act(U.S. Government Printing Office, 2009). To quantify the number of green jobs created, this study uses the category of “Green Goods and Services”(GGS) as defined by the U.S. Bureau of Labor Statistics(BLS). This category includes jobs in energy efficiency, energy from renewable sources, pollution reduction and removal, greenhouse gas reduction, and recycling and reuse. This research focuses only on the first two categories of energy efficiency and energy from renewable sources, as main interest in this paper is on

jobs directly related to green energy.

In practice, the federal government allocates financial resources to expand the development and deployment of new and existing green energy technologies, and simultaneously sets policy goals for creating or maintaining green energy jobs. State governments should then be engaged in the implementation of the federal program to achieve stated goals within the allocated budget.

In order to examine the specific circumstances under which green energy policies are implemented, this study considers that each state government has different capacity, organization, accumulated experience, and intentions regarding green energy policy(Neil and Morris, 2012; Terman and Feiock, 2014). These different characteristics of state governments have been linked to the achievement of policy goals and successful implementation(Kwon et al. 2014; Krause et al., 2014; Terman and Feiock, 2014). States develop and implement programs that may not be passed at the national level. The extent of accumulated implementation experience may be relevant to policy-specific expertise. This paper measures accumulated experience in years passed since adoption of a relevant energy program. Longer-term implementation is assumed to be indicative of a higher relevant accumulated expertise(or experiences). This research understands that years passed since policy adoption may not be the best indicator of accumulated experience, as quantity may not well correlate with quality. But, this indicator may still add value to existing literature that has focused more on a state's level of financial capacity.

2. American Recovery Reinvestment Act Funding

Funding and investment at the intersection between economic development, energy policy and planning has been on the rise over the last decade(Carley et al. 2016). Most recently, ARRA provided a wide array of policy instruments to stimulate the U.S. economy and establish a robust technological infrastructure for long-term economic growth(Aldy, 2013). ARRA was designed to emphasize the connection between economic development and energy policy by specifically targeting the

energy sector. Approximately $60 billion were spent on the energy sector(U.S. Government Printing Office, 2009) on renewable energy, energy efficiency, smart grids, and advanced fossil fuel energy programs among multiple others. Much of the ARRA funding was designed to support existing energy programs, but some funds were dedicated to new energy programs focused on energy planning and economic development(Carley et al., 2011).

The Council of Economic Advisers(Executive Office 2016) estimated that ARRA clean energy-related programs supported roughly 900,000 jobs in innovative clean energy fields between 2009 and 2015. Link and Scott(2012) discussed how Small Business Research(SBIR) programs in the U.S. created and administered by such agencies as the Department of Defense, and the National Institutes of Health, NASA, and the U.S. Department of Energy can be credited with an average of about 42 new jobs per $1,000,000 of government award funding. Yi(2013) indicated that every additional clean energy policy adopted by a state is associated with a 1 percent growth in green energy jobs.

Hypothesis 1: State governments that receive a larger amount of ARRA funds are more likely to successfully implement a green energy policy

This paper includes the amount of a state's obligated ARRA funds that were actually spent for energy programs each year by all DOE recipients(See Appendix A). ARRA data were collected from Department of Energy Data Reported by the American Recovery and Reinvestment Act(www.recovery.gov).

3. Accumulated Implementation Experience on the Sustainable Energy Policy

A comprehensive energy policy plan entails long-term commitments to enhance social values and goals toward green(sustainable) energy(Baumol and Oates, 1988). States differ by existing policies and expertise accumulated through experiences in energy policy implementation toward green or sustainable energy. For this reason,

motivation to implement green energy policies tends to vary between state and municipal governments. Some states respond with minimal efforts towards green energy policies, other states have implemented programs early and actively provided resources and diverse policy instruments. The American Council for an Energy-Efficiency Economy(ACEEE) reports(ACEEE, 2017), for example, that by the end of 2016, 26 states implemented the State Energy Efficiency Resource Standards(included as one of the variables of interest in current estimates). Some of them, like Hawaii and California, started implementation in as early as 2004, and New Hampshire joined the list only in 2016. All 26 states have implemented policies requiring electricity savings. Some of these states additionally have policies related to natural gas and utilities.

Previous scholars have recognized the importance of accumulated knowledge and experience in policy implementation(Pressman and Wildavsky, 1973; O'Toole, 2004) and feedback from organizations and hierarchies(Lipsky 1984; May and Winter, 2009). By learning from policy implementation experience, government officials improve policy direction and practical implications. These processes are closely related to the notion of "continuous improvement"(Dixon, 1994). Importantly, accumulated knowledge is embedded in the organizations through long-term implementation or experience, and it is developed over a long period of time through trial and error because "the organization does not know what it knows"(O'Dell and Grayson, 1998, p.154). In this context, one might expect that governmental agencies with more experience in green energy policy implementation, have more accumulated knowledge on how policies can be better implemented, what is feasible or preferable, when agencies should act to implement a policy, and what should be changed for better performance. Until now, previous studies on energy policy implementation have not accounted for accumulated knowledge towards green energy policies such as Renewable Energy Portfolio Standards, Energy Efficiency Resource Standards and Energy Efficiency Mandates for Public Buildings. The above argument leads to the following hypothesis:

Hypothesis 2: States with more accumulated implementation experience related to renewable and energy efficiency policies, are more likely successfully implement

a green energy policy.

State governments in the U.S. have adopted various energy policy tool to achieve various green energy objectives. These policy tools are typically market-based tools to provide support for renewable energy or energy efficiency. This research focused on three most important policy tools toward green energy, including state Renewable Energy Portfolio Standards(RPS), Energy Efficiency Resources Standards(EERS), and Energy Efficiency Mandates for Public Buildings(EEMPB), As was earlier shown, all state started renewable and energy efficiency policies in different years. Longer duration of relevant policies was indicative of more time for the planning and implementation process as well as institutional knowledge to influence successful green energy. Thus, this research hypothesized that states with more accumulated policy implementation experience related to renewable and energy efficiency, are more likely to have successful policy implementation toward green energy. In each case, duration is measured as the difference between the current year and the year of adoption.

Renewable Portfolio Standards(RPS) policies legislatively promote the adoption of renewable energy in state electricity market. RPS establish minimum percentages or amounts of electricity produced or consumed in the state that must by a given date come from renewable sources. Currently, twenty nine states have mandatory RPS programs(or voluntary RPS target), and eight have non-binding program.

Energy Efficiency Resource Standard(EERS) is a market-based mechanism to encourage more efficient generation, transmission, and use of electricity and natural gas. An EERS consists of electric and gas energy savings targets for utilities, often with flexibility to achieve the target through a market-based trading system. Currently, twenty five states are implementing EERS policies requiring electricity savings.

Energy Efficiency Standards for Federal Buildings established minimum energy efficiency requirements for federal buildings. New federal buildings are required to perform 30 percent better than the baseline standard when doing so is cost-effective within the life cycle of the building.

4. Subnational Government Capacity

Scholars have long recognized that the capacity of subnational governments is essential to the implementation of federal policy(Derthick, 1970; Elazar, 1966; Gamkhar and Pickerill, 2012; Hall et al., 2011; Jennings et al. 2012; Carley et al. 2015). The term capacity is broadly defined as the ability of organizations to carry out their missions and achieve their goals(Joyce & Donahue, 2003). Capacity, defined in various ways, has been shown to correlate with implementation success for all three levels of government, federal, state and local(McDermott, 2006). State capacity is especially crucial to the efficiency with which federal dollars are spent(Carley et al., 2015). Subnational capacity includes inputs such as labor and finances(Honadle, 1981; Hall, 2008; Carley et al., 2015), and depends on the stock of institutional, organizational, and individual resources(Honadle, 1981; Bowman and Kearney, 1988). The presence of greater capacity of all types in subnational governments can lead to greater progress toward their policy goals and implementation(Hall 2008).

Terman and Feiock(2014) investigated the relationship between energy policy outcomes and local administrative capacity based on a principal-agent theory. Specifically, they estimated administrative capacity in terms of the number of financial management staff members in a municipal government per 1000 residents. They measured implementation timing, defined as the deviation in days of delay for each energy project implemented, and used it as a dependent variable. Their result has showed that lack of staff capacity had a statistically negative effect on energy policy implementation. Although the federal government provides increased funding with various training and technical support opportunities to help implement energy efficiency and conservation projects, it is important to ensure sufficient local staff for proper policy implementation.

Krause et al.(2014) assessed the sustainability programs in US cities based on interest group support, governmental capacity, policy characteristics, and institutional structures. The authors suggested that relationships among numerous specialized departments and agencies are important to facilitate sustainability

efforts, and those institutional environments shape the motivations of local government officials. Furthermore, they linked fiscal resources to policy performance. They argued that establishing an office focused exclusively on sustainability is likely to involve substantial start-up costs. One of their areas of interest, the support from local environmental groups, was measured based on data the Integrated City Sustainability Database(ICSD) of 2005. The results showed that local governments with greater financial resources and institutional environments with greater support from environmental groups had a significantly positive effect on sustainability policy management in the executive branch at the city level. In terms of ARRA, Carley and Hyman(2014) asserted that multiple local and state governments, much like the U.S. Department of Energy(DOE), were unprepared to implement ARRA's requirements(in terms of lacking sufficient qualified personnel, or relevant policies and procedures to handle extensive amount of ARRA funds) in the required time frames. Government data, provided by the Recovery Accountability and Transparency Board, demonstrated that there were spending delays both within and outside of government and that ARRA was significantly more difficult to implement in a timely manner than policymakers intended; some states also encountered more difficulties than others. The article concluded that added staff is an important factor that affects successful implementation of ARRA. Carly, Nicholson-Crotty, and Fisher(2015) additionally examined a set of factors that led some states to spend a larger proportion of their ARRA funds than others. Data between 2009 and 2012 was used for that research. This research tests the following two hypotheses based on the above discussion:

Hypothesis 3: State governments with greater financial capacity are more likely to successfully implement a green energy policy

Hypothesis 4: State governments with greater environmental staff capacity are more likely to successfully implement a green energy policy

Two attributes of subnational government capacity are considered in this study. The first one is financial capacity. It focuses on magnitude of federal expenditures

on environmental protection and sustainable energy. The magnitude is assessed using annual expenditures allocated by the federal government, specifically, (1) total amount of federal expenditures by the U.S Environmental Protection Agency(EPA); and (2) total amount of federal expenditures allocated by the Department of Energy(DOE). In addition, this study includes the total amount of direct expenditures from DOE and EPA to each state during the studied period. State spending includes expenditures by state and local(non-federal) governments. The second attribute related to subnational government capacity is staff capacity. Staff capacity is measured based on the number of EPA staff at eh state level. Relevant data were gathered from USA Spending[1], the U.S. Census of Governments[2] and Open the Book[3]

5. Performance Ability

All governments and administrators seek to meet performance goals, and they set conditions that must be met to maximize performance during implementation (Terman 2015). Earlier studies mentioned that program performance targets are often based on administrative capacity(expertise and number of administrative staff members)(Dubick and George, 2011; Courty and Marschke, 2007; Carley et al., 2015). Administrative capacity is also linked to organization's ability to establish goals, acquire resources, reconfigure internal management processes, and adapt to change(Wang et al., 2012).

Some scholars have suggested that overall achievement is associated with incentive or regulatory structures(Terman, 2015). For example, California's robust incentives structure and regulations for renewable energy development predisposes the state to successful implementation of renewable electricity standards(RES) (Goulder and Stavins, 2011). Well-developed energy policy tools and goals enable and facilitate successful implementation(Terman 2015). The reverse may also be

1) www.usaspending.gov

2) www.census.gov/govs

3) www.openthebooks.com/

true; administrative actors can be less motivated to achieve performance goals when the goals are set ambiguously. These findings are supported by previous empirical research. Specifically, Bowen, et al.(2013) empirically forecasted the influence of state renewable energy portfolio standards(RPS) on the green economy. Their study focused on outputs of stringency targets and goals achieved by RPS by measuring the difference between each state's RPS goal/requirement in a given year and the RPS compliance capacity of the starting year in that state, as well as the yearly fractional goals of RPS. They concluded that states with a higher ability to achieve RPS goals were more likely to have higher levels of green business and green job growth. The RPS percent and increment were also statistically significant predictors of the number of green businesses and green job growth in a state. Recently, Terman(2015) also tested whether the degree of achievement of performance goals will be greater in states that use energy efficiency and conservation policy tools that facilitate implementation. This research used the ratio of total Weatherization Assistance Program(WAP) completed as compared to total WAP planned as the dependent variable. The results suggested that the degree of achievement of performance goals was significantly influenced by applied policy tools. The author emphasized that the various state administrators have different tools, and that these tools influence their capacity to achieve performance goals.

However, although the above findings indicate that setting performance goals is influenced by a state's capacity and incentive structures, this literature does not explore the consequences of implementation in terms of maximizing program goals. Particularly, ARRA requires a higher overall performance(in terms of job creation and development of innovative technologies), and ARRA-funded programs may pressure states towards higher levels of goals' achievement. In this context, the following hypothesis setted up in this paper may contribute to understanding the role of state governments in the implementation of public energy projects.

Hypothesis 5: State governments with high degrees of performance goal achievement are more likely to successfully implement a green energy policy

To measure performance goal achievement, this research uses the State Energy Efficiency Scorecard provided by the American Council for an Energy-Efficient Economy(ACEEE). ACEEE's energy efficiency scorecard ranks the states and Washington DC based on their ability to achieve policy goals related to energy efficiency in homes, businesses, industry, and the transportation sectors. In 2016, California and Massachusetts were tied for the first place, while North Dakota was ranked last #51. This research creates a dummy variable equal to one for the 17 highest ranked states(one third of the states with highest reported ACEEE scores) and equal to zero for the states with medium and low scores.[4] The state Energy Efficiency Scorecard Database is updated annually, and a more detailed explanation of the measurement and data sources of the State Energy Efficiency Scorecard may be gathered from the State Energy Efficiency Scorecard report[5].

6. Political Influences

It is generally argued that liberal political ideology is associated with green energy policies and renewable energy programs(Yi and Feiock, 2014). The ideological propensity of the governor and the legislators not only shapes the support for green energy regulations, but also influences innovative green energy technologies' development and diffusion(Coley and Hess, 2012). Stable and predictable political circumstances are essential for the deployment and development of green energy. Recent research has analyzed the direct relationship between states with a democratic governor and policy implementation outcomes(Carley et al., 2015; Jennings et al., 2012; Delmas and Montes-Sancho, 2011; Lyon and Yin, 2010). These studies have argued that democratic governors may have tighter goal alignment with the Obama administration's stimulus program and seek to implement the programs more efficiently and effectively. According to Jennings, Jennings and Zhang(2012), ARRA was a highly politically-charged policy. Democrats strongly supported

4) The number of categories in 2011 is 21, as 4 states, including, Arizona, Illinois, Michigan and Utah, were tied up for the 17 place in ACEEE scoring map.

5) http://aceee.org/state-policy/scorecard

President Obama's claims that ARRA would create jobs, while zero Republicans in the House and only three Republican senators cast votes in favor of the bill. In this context, the findings of Jennings, Hall and Zhang, Carley, Nicholson-Crotty, and Fisher(2015) confirm a relationship between political affiliation and states' ability to spend on energy. Delmas and Montes-Sancho(2011) demonstrated how political influence can affect energy policy by showing that the percentage of House and Senate seats in the states' government occupied by Democrats is positively and significantly related to the effectiveness of RPS policies. Lyon and Yin(2010) also found that states with a strong democratic presence were more likely to adopt an RPS. Based on these findings, this study tests the relationship between the political party of a state's governor and successful energy policy implementation. This research expects administrators in democratic-controlled states to be more focused on successful green energy policy. The above argument leads to the following hypothesis:

Hypothesis 6: States served by Democratic governors are more likely to successfully implement a green energy policy

Ⅲ. Research Methods

The purpose of this research was to analyze the factors that influence the success of the implementation of federal green energy policy(through ARRA funds). Success is measured by the number of jobs created in the processes of green energy production, demand for efficient energy, and producing energy from renewable sources. The unit of analysis is state governments. The analysis is limited to 49 states and excluded Hawaii and Washington D.C[6]. the factors that influence the success of the implementation of federal green energy policy through ARRA funds were tested in the following two models:

$$Y_t - Y_{t-i} = \beta_0 + \beta_1 DOE_{st} + \beta_2 EPA_{st} + \beta_3 State_{st} + \beta_4 after * DOE_{st} + X_{st}^{'}\delta + \beta_5 T + \beta_6 * S + \epsilon_{st} \quad (1)$$

$$Y_t - Y_i = \beta_0 + \beta_1 DOE_{st} + \beta_2 EPA_{st} + \beta_3 State_{st} + \beta_4 ARRA_{st} + X_{st}^{'}\delta + \beta_5 T + \beta_6 * S + \epsilon_{st} \quad (2)$$

where Y is the number of green jobs. Since this study are interested in green energy jobs only, this research do not include all 5 categories of green jobs and services as defined by the Bureau of Labor Statistics(energy from renewable sources; energy efficiency, pollution reduction and removal; natural resource conservation, and environmental compliance), but limit this research to the first two energy categories. i is a time period equal to 1 in Table 3, 2 in Table 4, and 3 in Table 5. Table 3 shows the estimates of the job growth between current and previous year $Y_t - Y_{t-1}$. Table 4 presents growth in the number of jobs between current year and two years back $Y_t - Y_{t-2}$, and Table 5 between current year and three years back $Y_t - Y_{t-3}$. This study uses time lags to account for potential delayed effects between energy spending and other factors that may have affected job creation, and the number of jobs created in the process both green energy production and demand in respect to energy efficiency, and energy from renewable sources. $Y_t - Y_{t-i}$

6) There are no complete data on energy expenses and policy for the state of Hawaii. Washington DC is excluded because this analysis is limited only to the states.

is the number of jobs created between current year and previous year(Table 3), current year and two years prior(Table 4), and current year and three years prior(Table 5). DOE, EPA, Stateare the expenditures on environmental protection by the Department of Energy, Environmental Protection Agency, and the states respectively. $after*DOE$ in equation(1) is the interaction dummy between financial capacity and years(when ARRA funds become available) post-2009 to account for potential effect of the total federal fund spent by the DOE since implementation of ARRA. ARRA in equation(2) is the actual amount of ARRA funds. X' is the vector of control variables including accumulated knowledge(duration of relevant policies), political, economic controls, staff capacity, and performance ability. T and S are the year and state specific fixed effects. ϵ is the state and year specific error term.

Since not every variable of interest was available for the full considered time period(2003-2013 years), this paper estimated three models. The longer-term model, Model 1(equation(1)), is estimated for the period between 2003 and 2013. This model does not include "staff capacity" and "performance ability" variables as the data for these variables are available only from 2007. Model 1(and Model 2) also does not include the dollar amount of ARRA funds, which became available only in 2009. Model 2(equation(1)) is estimated for the period between 2007 and 2013, and Model 3(equation(2)) is for the period between 2009 and 2013.

In addition to the main variables of interest discussed earlier this research control for population density and state economic characteristics, including per capita Gross State Product(GSP) and per capita personal income. Previously published research suggests that population density influences the higher level of energy consumption(Balbo, 1993). Less densely populated areas tend to consume less energy. More densely populated areas are expected to consume more energyin general(this, however, may or may not affect production of green energy and, consequently, the number of green energy jobs). Population density is measured by the number of people residing per square mile of land. The population statistics were collected from the U.S. Bureau of Economic Analysis(BEA), and the data on square mileage of the states come from the U.S. Census of Governments.

State's economic characteristics have been previously found to influence administrative implementation and behavior(Portney, 2003). States' wealth might

impact the proportion of their funds allocated for energy programs(Carley et al., 2014). Park(2105) argued that during the Great Recession administrators were forced to slow down the increase in the green energy sector and shift expenditures to social policies and elsewhere. Thus, states with vibrant economies may be more likely to successfully implement green energy policies. The conditions of the state economies are measured by per capita GSP and per capita personal income. Economic data were derived from the U.S. Census and Bureau of Economic Analysis(BEA), and U.S. Census of Government.

The regression analyses also include year dummies and state fixed effects to account for other state and year specific factors potentially affecting the number of green jobs that may not have been captured by the employed set of independent variables. This research uses cluster-robust standard errors to adjust for potential heteroscedasticity and serial autocorrelation in the models(Wooldridge, 2003).

Table 1 provides a detailed description of how each variable was measured, and the source of data for each variable. Table 2 provides the information of the descriptive statistics. Tables 3-5 offer the results of the regression estimates of Models 1-3.

Table 1. Variable Measurement

Variables	Measurement	Sources
Dependent Variable Implementation Success	The number of jobs created in energy efficiency and energy from renewable sources	Bureau of Labor Statistics
Independent Variable Government Capacity	Financial Capacity: Total amount of federal spending awarded by the U.S. Environmental Protection Agency(EPA)($10,000,000)	Environmental Protection Agency
	Financial Capacity: Total amount of federal spending awarded by the U.S. Department of Energy(DOE)($10,000,000)	USA spending.gov
	Financial Capacity: Total amount by the U.S. Department of Energy(DOE) and the U.S. Environmental Protection Agency(EPA) at the non-federal level($10,000,000)	
	Staff Capacity : Number of Environmental Protection Agency(EPA) management staff members in a state government	Open the Book
ARRA Funds	Total amount awarded in Energy Projects at the state level under ARRA, 2009-2013 ($10,000,000)	Department of Energy Data Reported by the American Recovery and Reinvestment Act
	DOE financial capacity of Post-2009 ($10,000,000)	USA spending.gov
Accumulated Knowledge of Implementation	Duration of Renewable Portfolio Standards(RPS) policy, in years	Database of State Incentives for Renewable & Efficiency Energy(DSIRE)
	Duration of Energy Efficiency Resource Standard(EERS) policy, in years	
	Duration of policy on Energy Efficiency Requirements for Public Buildings, in years	
Performance Ability	Measured as two categories: high and others within states earned up to 50 points in energy efficiency policy area(dummy)	American Council for an Energy Efficient Economy (ACEEE)
Political Influence	State with a Democratic governor (1 indicating the governor is a Democrat and 0 if not)	Multistate Associates Incorporated
Economic and Demographic Conditions	Population Density	Census of Governments and Bureau of Economic Analysis
	Per Capita real GDP by State adjusted in 2013 dollars	
	Per Capita Personal Income adjusted in 2013 dollars	

Table 2. Descriptive Statistics

Variables	Mean	SD	Min	Max
Implementation Success	273523.5	357975.1	7272	2731977
Financial Capacity: Total amount of federal spending awarded by the U.S. Environmental Protection Agency(EPA) ($10,000,000)	18.286	18.090	1.308	146.111
Financial Capacity: Total amount of federal spending awarded by the U.S. Department of Energy(DOE) ($10,000,000)	78.880	143.065	-57.076	1203.958
Financial Capacity: Total amount by the U.S. Department of Energy(DOE) and the U.S. Environmental Protection Agency(EPA) at the non-federal level ($10,000,000)	9.689	29.910	-43.087	387.578
Staff Capacity : Number of Environmental Protection Agency(EPA) management staff members in a state government	261.3936	395.7298	1	1387
Total amount awarded in Energy Projects at the state level under ARRA, 2009-2013 ($10,000,000)	11.41898	23.88579	-5.448177	149.9911
DOE financial capacity of Post-2009 ($10,000,000)	51.94703	125.4801	-49.70079	1257.069
Duration of Renewable Portfolio Standards(RPS) policy, in years	3.363636	5.039016	0	30
Duration of Energy Efficiency Resource Standard(EERS) policy, in years	1.19666	2.457503	0	14
Duration of policy on Energy Efficiency Requirements for Public Buildings, in years	1.948052	2.636795	0	12
Performance Ability	0.4772	0.5006	0	1
Political Influence	0.52	0.499	0	1
Population Density	5224.836	5432.428	279.0224	22889.19
Per Capita real GDP by State adjusted in 2013 dollars	51100.86	9834.053	31777	81352.77
Per Capita Personal Income adjusted in 2013 dollars	42042.86	6728.065	29661.65	66189.96

Ⅳ. Empirical Results

The results in Table 3 show that expenditures by the federal DOE(but not EPA), and state expenditures play a statistically significant role in green job creation. For example, in the period between 2003 and 2013(Model 1) every $10,000,000 spent by federal DOE generated about 15.7 jobs in green energy sector in one year. This number gets higher if only a few, more recent years are considered. For example, if this research looks at the period between 2009 and 2013(Model 3) the number of jobs generated each year with the same amount of money increased to about 20 jobs(about half million dollars in DOE expenditures were associated with each green energy gob created). This effect is, however, not long lasting. When a two-year lag(the difference between the number of jobs in green energy sector in current year and two years back)(Table 4), or a three-year lag(Table 5) are considered, all federal expenditures by both DOE and EPA become statistically insignificant. State and local energy expenditures in a given year are found to have a more robust and long lasting effect on green energy job creation. In all models(Tables 3-5) state and local expenditure estimates are positive and statistically significant. The largest effect on green energy job creation is observed two years after the expenses are made(Table 4), but even in a third year(Table 5) the effect is still higher than in the first year. Every $10M in state expenditures(Table 3) were associated with 15.7 new jobs(about $637 thousand per job) in the first year between 2009 and 2013, or with 11.4 new jobs(about $880 thousand per job) if a longer(2003-2013) time frame is considered(Table 3, Model 1). These numbers increase to 43.4 new jobs(about $230 thousand per job) in the period between 2003-2013, 59.8 new jobs($167 thousand per new job) between 2007 and 2013, and 64.7 new jobs($155 thousand per new job) between 2009-2013 in the second year after the expenses are made(Table 4). Three years after the state and local expenses in energy sector are made(Table 5), every $10 million in such expenses are associated with 19(between 2003 and 2013) to 28(between 2009 and 2013) new green energy jobs.

The interaction variables for DOE expenditures and the period post 2009(when ARRA funds became available) are not statistically significant in Tables 2 or 3

which consider a longer life span(2003-2013 in Models 1 and 2007-2013 in Models 2) and estimate a one and two-year differences in green energy jobs respectively, but become significant in Table 5 when a three-year increase in green energy jobs is considered. The coefficient estimates for the dollar amount of ARRA funds in Models 3 are statistically significant and substantively high in all three tables 3-5. Every 10 million dollars in ARRA funds were associated with 36.7 annual new green energy jobs' increase(Table 3). This number increased to 48.8 green energy jobs(just over $200,000 in ARRA funds spending) created between current year and two years prior(Table 4), and, 45.2 jobs when three-year lag is considered(Table 5). ARRA funds, compared to any other expenses by federal, state, and local government agencies demonstrated more robust effect on green job creation over time. Almost twice as many green jobs were created with ARRA funds compared to state and local expenditures three years after such expenses were made(federal DOE and EPA expenditures were not statistically significant in three-year lag models).

As to the other, non-monetary variables, the accumulated knowledge, except for the couple of statistically significant estimates for the duration of EERS policy between 2003 and 2013 in Tables 4 and 5, none were found to be correlated with new green energy jobs. The EERS variable is important only in Models I when a job growth over a longer period of time(between 2003 and 2013) is considered. This may indicate that the duration of EERS policy might have been more important in the earlier years this research considered(before the Great Recession of 2008). The other potential explanation is that the effect might be elevated when other important variables(such as ARRA funds and staff capacity) are included in the analysis in later years(in Models 2 and 3). The EERS coefficient also becomes more statistically and substantively significant when a longer lag between the policy duration and job growth is considered. The states that had EERS policy in place for another year had on average 210 more jobs when a two-year lag is considered, and 410 new jobs when a three-year lag in job creation is considered. Estimates turn insignificant when shorter year spans are considered(in Models 2 and 3).

Population density, as measured by the number of people residing per square mile of land, is another non-monetary variable that was also found to be positive

and significant when a longer time-frame was considered(Models 1 and 2), meaning that more densely populated states, on average, had more green energy jobs.

The coefficients for staff capacity, showing the number of EPA staff members in state government, are positive and significant in the models that consider two- and three-year lag in employment(Tables 4 and 5 respectively). The results in Table 5, for example, indicate that if a state employed an additional EPA staff member in a given year, it had, on average, about 46 new green energy jobs three years later.

None of the other controls seem to play an important role in green jobs' creation either excepting population density. Results support the stated hypothesis that a greater population density in a state would undertake more green energy jobs. Year dummies expectedly show that fewer green jobs were available amid a Great Recession in 2008 and 2009 compared to the base years. As the country recovered from the recession, more green jobs were available in 2010 whether compared to 2003(Model 1), 2006(Model 2), or 2009(Model 3).

The other, non-expense categories, such as governor's party affiliation, performance ability, and economic variables are not statistically significant.

Table 3. Change in Total Number of Jobs Between Current Year and Previous Year

Variables	Model1 2003-2013	Model 2 2007-2013	Model 3 2009-2013
	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Financial Capacity			
Federal DOE Expenditure	15.696** (7.058)	19251* (10.351)	19.993* (11.381)
Federal EPA Expenditure	-31.370 (14.540)	-39.865 (12.667)	-86.442 (32.049)
State Expenditure	11.369** (10.312)	18.480*** (10.998)	15.752*** (14.537)
ARRA Investment			
Post-2009 Expenditure	0.633 (2.118)	-1.391 (2.732)	-
ARRA Funds	-		36.667*** (15.193)
Accumulated Knowledge			
Duration of RPS	-6.138 (29.177)	-100.535 (80.510)	-283.432 (162.303)
Duration of EERS	59.891 (38.929)	32.667 (74.170)	82.377 (188.155)
Duration of EERPB	32.770 (47.004)	-30.298 (59.581)	-144.694 (165.638)
Political Influences			
Democratic Governor	89.002 (140.141)	50.897 (193.885)	370.252 (606.571)
Economic Conditions			
Per Capita GSP	-0.002 (0.031)	0.068 (0.063)	0.107 (0.078)
Per Capita Personal Income	0.029 (0.043)	-0.087 (0.090)	-0.093 (0.135)
Population Density	0.665* (0.375)	1.715** (0.812)	-0.361 (2.216)
Staff Capacity	-	-1.615 (7.416)	-1.119 (4.698)
Performance Ability	-	73.578 (308.678)	-21.474 (579.688)
Year_Fixed	Yes	Yes	Yes
Constant	-5028.760* (2636.884)	-8086.207* (4309.125)	2931.128 (13910.683)
R-square	0.61	0.64	0.67
Number of states	49	49	49
F-test	F(20,48)=32.29	F(19,48)=25.51	F(17,48)=14.36

Note: Number in parentheses are robust standard errors
*p<0.10, **p<0.05, ***p<0.01

Table 4. Change in Total Number of Jobs Between Current Year and Two Years Back

Variables	Model1 2003-2013	Model 2 2007-2013	Model 3 2009-2013
	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Financial Capacity			
Federal DOE Expenditure	-1.732 (5.819)	-4.471 (4.985)	-9.462 (5.529)
Federal EPA Expenditure	-23.211 (24.069)	-27.389 (23.241)	-75.729 (38.702)
State Expenditure	43.416** (21.174)	59.833*** (19.853)	64.661*** (21.271)
ARRA Investment			
Post-2009 Expenditure	4.587 (3.100)	2.331 (2.448)	-
ARRA Funds	-	-	48.778* (25.080)
Accumulated Knowledge			
Duration of RPS	-13.505 (75.879)	26.803 (127.918)	75.442 (170.861)
Duration of EERS	210.398*** (74.196)	48.962 (121.756)	-217.466 (185.557)
Duration of EERPB	76.066 (113.899)	-90.987 (132.576)	-369.526 (241.075)
Political Influences			
Democratic Governor	45.722 (148.098)	58.133 (173.188)	77.376 (323.601)
Economic Conditions			
Per Capita GSP	-0.032 (0.046)	0.002 (0.073)	-0.026 (0.103)
Per Capita Personal Income	0.079 (0.076)	-0.079 (0.128)	-0.092 (0.189)
Population Density	1.674** (0.832)	2.089* (1.089)	-2.673 (2.898)
Staff Capacity	-	28.862** (10.888)	28.309*** (10.391)
Performance Ability	-	-32.522 (367.607)	-300.725 (747.508)
Year_Fixed	Yes	Yes	Yes
Constant	-9838.394* (5210.602)	-1.39e+04** (6721.351)	15547.938 (19919.115)
R-square	0.63	0.68	0.69
Number of states	49	49	49
F-test	F(19,48)=24.88	F(19,48)=19.00	F(17,48)=27.61

Note: Number in parentheses are robust standard errors
*p<0.10, **p<0.05, ***p<0.01

Table 5. Change in Total Number of Jobs Between Current Year and Three Years Back

Variables	Model1 2003-2013	Model 2 2007-2013	Model 3 2009-2013
	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Financial Capacity			
Federal DOE Expenditure	4.334 (7.858)	1.493 (6.601)	-1.979 (5.872)
Federal EPA Expenditure	-75.762 (28.529)	-80.479 (23.151)	-154.851 (36.385)
State Expenditure	19.122* (10.911)	27.481*** (9.681)	28.007** (10.733)
ARRA Investment			
Post-2009 Expenditure	6.463** (4.586)	4.451*** (3.776)	-
ARRA Funds	-	-	45.240** (19.503)
Accumulated Knowledge			
Duration of RPS	-31.060 (117.199)	67.364 (166.077)	49.639 (211.258)
Duration of EERS	409.598*** (132.717)	207.172 (169.992)	-101.930 (208.558)
Duration of EERPB	162.246 (194.054)	0.640 (197.339)	29.644 (274.191)
Political Influences			
Democratic Governor	10.641 (220.249)	137.852 (206.004)	325.848 (320.641)
Economic Conditions			
Per Capita GSP	-0.054 (0.096)	-0.056 (0.110)	-0.166 (0.162)
Per Capita Personal Income	0.153 (0.149)	0.074 (0.170)	0.094 (0.249)
Population Density	3.570** (1.746)	3.450 (2.189)	-2.384 (2.310)
Staff Capacity	-	46.079** (18.737)	46.479*** (17.302)
Performance Ability	-	119.681 (353.008)	370.261 (493.349)
Year_Fixed	Yes	Yes	Yes
Constant	-2.10e+04*** (10457.665)	-2.78e+04** (12573.0.17)	6148.656 (14266.525)
R-square	0.57	0.61	0.59
Number of states	49	49	49
F-test	F(18,48)=20.65	F(19,48)=37.67	F(17,48)=30.67

Note: Number in parentheses are robust standard errors
*p<0.10, **p<0.05, ***p<0.01

V. Conclusions and Implications

From energy security(Valentine, 2011) and mitigation of climate change(Edenhofer et al. 2011; Liang and Fiorino, 2013) to boosting economic growth(Bowen et al. 2013; Yi 2013; Apergis and Payne, 2010) and employment(Lambert and Silva, 2012), sustainable energy has been found to positively affect multiple aspects of our lives. Federal, state, and local government has been offering numerous programs and financial provision to support and further encourage the production of renewable energy. This paper, is one of a very few, if any empirical works that studies if and how, many of these combined government efforts affected the creation of new green energy jobs. This study has additionally provided a new policy insight by investigating the effectiveness of the major one-time government investment, funds allocated through the American Recovery Reinvestment Act(ARRA), on creating green energy jobs.

Specifically, this research demonstrates that, on average, state and local energy expenditures play a more important role in green jobs' creation compared to federal expenses. Unfortunately, most energy policy legislation still appears to be stalled at the federal level in the United State even if states and local government work more pointed towards positive green energy policy outcomes. This study has shown that efforts to coordinate different levels of government can improve energy program implementation. in this study, the empirical results suggest implications for understanding the role of state and local government support and intervention for successful energy policy implementation. While federal DOE or EPA costs, in general, were found not to be significantly correlated with new green energy jobs, one of the federal efforts, a more targeted financial assistance provided by American Recovery and Reinvestment ACT(ARRA) of 2009, was viewed important both statistically and substantively, and its effect remained robust over time.

The duration of any considered state energy efficiency policies, such as the Energy Efficiency Requirements for Public Buildings, Energy Efficiency Resource Standard(EERS), and Renewable Portfolio Standards(RPS) policies, were largely found not to be correlated with new green energy jobs, except for limited evidence of

the effect of EERS policy duration on green energy jobs. The state supported renewable energy-related efforts(as rated by the ACEEE, the American Council for an Energy-Efficiency Economy), were similarly not found to be correlated with new jobs. Perhaps, new energy efficiency-related efforts initially contribute to jobs' creation(this possibility was not tested in this analysis), but the duration of the policies do not seem to matter.

The higher number of EPA members in state government was found to be correlated with higher number of new green energy jobs, especially when longer year lags were considered. The higher number of EPA workers may additionally indicate states' interest in green energy initiatives.

This study does not find the correlation between economic variables and green energy jobs growth. Although, the effect might be somewhat captured by the year dummies that indicate a lower number of newly created green energy jobs when national economy was down and the higher number when economy began to recover after the Great Recession of 2008. As previously discussed, This study also demonstrates that higher population density can significantly positively affect implementation of energy policy in the long-term. And, a governor's party affiliation does not seem to matter.

This research has limitations, First, including local expenditures in some way adds another level of complexity to intergovernmental implementation as local governments may need to be resolved. Second, this research may need to consider whether use of the party of the governor as one of the variable for the influence of state level politics on implementation is the best way of capturing. Future studies should consider testing the relationship in the context of political circumstances and implementation outcome.

Despite these limitations, several theoretical and methodological contributions to the literature on successful implementation are offered here. The link between subnational financial capacities and successful implementation identified in this research begin to fill a lacuna in the policy implementation scholarship. This research contributes to the theory that intersect directly with issues of decentralized funds and policy outcomes in the intergovernmental relations.

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〈Appendix A〉 Categories of Energy Programs Reported by Department of Energy

1	Innovative Technology Loan Guarantee Program
2	Fossil Energy Research and Development
3	Energy Information Administration
4	General Science and Research Activities
5	Science
6	Energy Efficiency and Renewable Energy
7	Advanced Technology Vehicles Manufacturing Loan Program
8	Electricity Delivery and Energy Reliability
9	Non-defense Environmental Cleanup
10	Energy Transformation Acceleration Fund
11	Isotope Production and Distribution Program Fund
12	Innovative Technology Guarantee Loan Financing Account
13	Uranium Enrichment Decontamination and Decommissioning Fund

〈Appendix B〉 States with High Energy Efficiency Scorecard Provided by Evaluation of the ACEEE(The American Council for an Energy-Efficiency Economy), 2007-20i3

Year	State	Total
2007	California, Connecticut, Massachusetts, Minnesota, New Jersey, New York, Oregon, Rhode island, Vermont, Washington, Texas, Wisconsin, Iowa, Pennsylvania, Colorado, Maine,(Hawaii)	17
2008	California, Connecticut, Idaho, Massachusetts, New Jersey, Oregon, Rhode island, Vermont, Washington, Wisconsin, New Hampshire, Minnesota, New York, iowa, Nevada, Colorado,(Hawaii)	17
2009	California, Colorado, Connecticut, Maine, Maryland, Massachusetts, Minnesota, Nevada, New Hampshire, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont, Washington, Wisconsin	17
2010	Arizona, California, Connecticut, Iowa, Maine, Maryland, Massachusetts, Minnesota, New Jersey, New York, Oregon, Pennsylvania, Rhode island, Utah, Vermont, Washington, Wisconsin	17
2011	California, Colorado, Iowa, Maine, Maryland, Massachusetts, Minnesota New York, New Jersey, Oregon, Rhode island, Vermont, Washington Wisconsin, Connecticut, Utah, Illinois, Michigan, Arizona,(Hawaii)	20
2012	Arizona, California, Colorado, Connecticut, illinois, iowa, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, Oregon, Rhode Island, Vermont, Washington, Wisconsin	17
2013	Arizona, California, Colorado, Connecticut, illinois, iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, Oregon. Rhode Island, Vermont, Washington	17

※Notes to the table:
The scorecard examines and ranks states in six state energy efficiency policy areas: (1)utility-sector and public benefits programs and policies; (2)transportation policies; (3)building energy codes; (4) combined heat and power; (5)state government initiatives; (6)appliance efficiency standards. States can earn up to 50 possible points in these six categories.
Based on the ACEEE ranking from highest to lowest scores, 50 states and the District of Columbia are classified into the three equal groups: "high" group, states ranked 1 to 17; "medium", states ranked 18 to 35; and, "low", states ranked 36 to 51.
Hawaii was excluded from the analysis as the rankings of the state are not available in 2007 and 2008. 20 states were ranked "high" in 2011, as four states, including Utah, Illinois, Michigan, and Arizona were tied for the 17th place.

임 태 경: Cleveland State University에서 도시 및 공공정책학 박사(Ph.D. in Urban Studies and Public Affairs, 2017) 학위를 받고 현재 한국지방행정연구원 지역포용발전실 부연구위원으로 재직 중이다. 박사학위 논문은 "Multilevel Governmental Efforts for Energy Efficiency: Policy Adoption, Implementation and Evaluation under the American Recovery and Reinvestment Act"이며, 주요 연구 관심분야는 지역경제, 재정분권 및 지역발전정책 등이다. 최근의 논문으로 "Evaluation and Determinants of Local Energy-Efficiency Initiatives from the American Recovery and Reinvestment Act(Review of Policy Research, 2018)","Rhetoric and Reality: Jobs and the Energy Provisions of the American Recovery and Reinvestmen Act(Energy Policy, 2020)" 등이 있다(Email: tklim@krila.re.kr).