Center for Energy and Environmental Policy

Final Report

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A Review of U.S. Clean Energy Policy and Korea-U.S. Clean Energy Cooperation after the U.S. Presidential Elections

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Executive Summary

Energy policy is a dynamic field with continuously shifting contexts. One major shift was the 2012 U.S. presidential election cycle which has important ramifications both within the U.S. and internationally. This report details the ramifications of the reelection of President Barack Obama for his second term. Within that context, this report specifically covers the clean energy policy landscape within the U.S., how succesful it has been in promoting economic development and ecological progress, and how it is expected to change over the next few years. These findings are then utilized to reflect on the international ramifications of the U.S. (clean) energy strategy in general and for the case of South Korea in particular. To that end, the report reviews the level and direction of U.S. clean energy collaboration and cooperation with South Korea and attempts to distill lessons from other bilateral and multilateral agreements between the U.S. and countries such as China and India. The report concludes with recommendations for future U.S.-Korea collaboration and engagement and highlights the specific potential of the creation of an international clean energy center that can guide future collaboration efforts.

The report demonstrates that the first term of the Obama Administration quite dramatically repositioned the U.S. energy development pathway towards the accelerated implementation of clean energy sources. It becomes clear that the second term of the Obama Administration will aim to continue this focus but will remain hampered by domestic policy gridlock as power balances at the federal level go largely unchanged. Nonetheless, significant impacts are projected through the continued implementation of several flagship energy policies that were initiated in the first term of the Obama Administration. These policies will realize substantial energy, economic, and environmental targets. In addition, the report further identifies a range of domestic drivers – key within these is the ongoing revolutionary rise of shale gas production – that will affect the future U.S. energy policy landscape and, importantly, will determine the range of freedom the U.S. has in engaging international clean energy partners.

At the end, the report outlines how the U.S. and South Korea partner in their shared objective towards a green energy economy. Finding a significant foundation for such cooperation efforts, the report identifies a multitude of partnership initiatives that combine to a substantial clean energy link between the U.S. and South Korea. Drawing lessons from U.S. bilateral cooperation with several other nations, the report recommends further investigation into the creation of a joint research center between the U.S. and South Korea geared towards the facilitation of clean energy research, development, deployment, and dissemination. Other key recommendations are to consider long-term objectives and goals and to arrange technology management plans that outline intellectual property rights agreements to further accelerate the deployment and use of clean energy in both countries.

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Introduction

Throughout the four major debates of the 2012 U.S. Presidential elections, energy and energy development futures were a significant issue for debate and disagreement between the Republican Presidential candidate Mitt Romney and the Democratic Presidential candidate Barack Obama. These two dominant political parties value substantially different energy development futures and position wholly different emphasis for governmental action to realize such futures. These differences have domestic as well as international ramifications, thus highlighting the importance of the Presidential elections. For example, the development of a diverse, viable and competitive domestic renewable electricity market requires effective and consistent governmental support. Similarly, energy independence aspirations drive domestic energy production efforts which both informs and affects the international energy market.

This final report evaluates both the domestic and international ramifications of the U.S. presidential elections and particularly focuses on the relationship between the U.S. and South Korea. To that end, Chapter 1 first explores the current U.S. policy landscape for clean energy manufacturing, services, and research and development. This exploration elucidates the overall (clean) energy narrative as pursued by the Obama Administration and elaborates on the considerable support structure for renewable energy and energy efficiency. The overview of the U.S. landscape, however, also critically reviews U.S. rhetoric against actual commitment. Constrained by factors such as political will and economic conditions, the translation of ambition into practical action oftentimes faces considerable barriers.

The primary objectives of U.S. clean energy policy are to advance economic development, enhance energy security and improve ecological well-being. Chapter 2 turns its attention to the economic and ecological performance of the U.S. clean energy policy portfolio and analyzes it based on its contribution to overall economic growth, employment, and greenhouse gas emission reductions. In particular, chapter 2 focuses on key policy tools and mechanisms that are touted as flagship clean energy policies, such as the Production Tax Credit (PTC) and Section 1603 Grants, and assesses their performance.

Chapter 3 continues with a review of the Presidential elections and the major standpoints of the competing political parties. The chapter demonstrates the significant difference between the Republican viewpoint on energy development and energy futures and determines the potential consequences now that President Obama remains in office. After that, the chapter proceeds with a brief overview of the direction of Korean clean energy policy and how it overlaps with U.S. clean energy policy.

The international ramifications of U.S. clean energy policy are, in part, dependent on the extent of U.S. collaboration efforts in international (clean) energy bi- and multi-lateral agreements. Chapter 4, as such, details the U.S. clean energy engagement with South Korea in particular and several other key countries (e.g., China, India) in general. The fourth chapter thus provides insight into potential consequences of the U.S. presidential elections for South Korea and how future collaboration can take place. In particular, chapter 4 reflects on U.S. involvement in bi-lateral clean energy policy agreements with other nations and draws lessons for South Korea.

1.0. U.S. Clean Energy Policy During the Obama Administration

On January 20, 2009, President Barack Obama was inaugurated as the 44th President of the United States of America. Running on a narrative of "Hope and Change", the Obama Administration promised to fundamentally change the nation's discourse. The optimistic and ambitious rhetoric resulted in high expectations for change and an overall re-direct of the nation's development pathway (The Economist, 2008). Examples of indicative legislative acts that represent this ambition are the 2009 *American Recovery and Reinvestment Act*, the 2010 *Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act,* and the 2010 *Patient Protection and Affordable Care Act*.

Likewise, the Obama Administration promised to position clean energy more directly into the overall energy narrative. Ever since the oil crisis of the 1970s, U.S. (clean) energy policy has prioritized three key dimensions: security of supply, energy costs, and environmental protection (Behrens, Energy Policy: 113th Congress Issues, 2013). The means prescribed by U.S. energy policy have, similarly, revolved around the reduction of consumption through enhanced efficiency, the increased domestic production of conventional energy, and the advancement and development of new sources of energy such as renewable electricity and renewable fuels (Behrens, 2013). However, the amount of attention given to these three dimensions shows considerable fluctuation over time with early U.S. energy policy primarily directed towards security of supply and low energy costs. Environmental protection s increasingly awarded with more political and public attention. For instance, while congressional opposition and prioritization of other pressing public matters contributed to the fading of climate change as a high-ranking political issue during the first term of the Obama Administration (The New York Times, 2009), climate protection was recently reintroduced through the launch of President Obama's Climate Action Plan. An important pillar of this plan is regulation that enforces performance standards on conventional energy production facilities

This chapter provides an overview of a selection of relevant regulations, policies, and financial incentives that are currently in place to support the clean energy and energy efficiency industry. For instance, detailed attention is given to the 2009 *American Recovery and Reinvestment Act* (ARRA) stimulus package. This stimulus bill has, to date, paid out a total of $796 billion (Recovery.gov, 2013) and is estimated to provide $831 billion in stimulus funding over the 2009-2019 period (Congressional Budget Office (CBO), February, 2012). The stimulus bill covers many sectors such as infrastructure, education, health and energy and offers federal tax incentives for renewable energy and energy efficiency.

Cross-agency collaboration and partnerships with actors such as universities, private companies, and national laboratories can be seen as a pathway that supports the U.S. (clean) energy sector. Similarly, research and development (R&D) support indicates how the U.S. aims to position itself along future energy development pathways. As such, the chapter continues with an overview of R&D support in specific clean energy sectors and technologies and details cross-agency collaboration efforts.

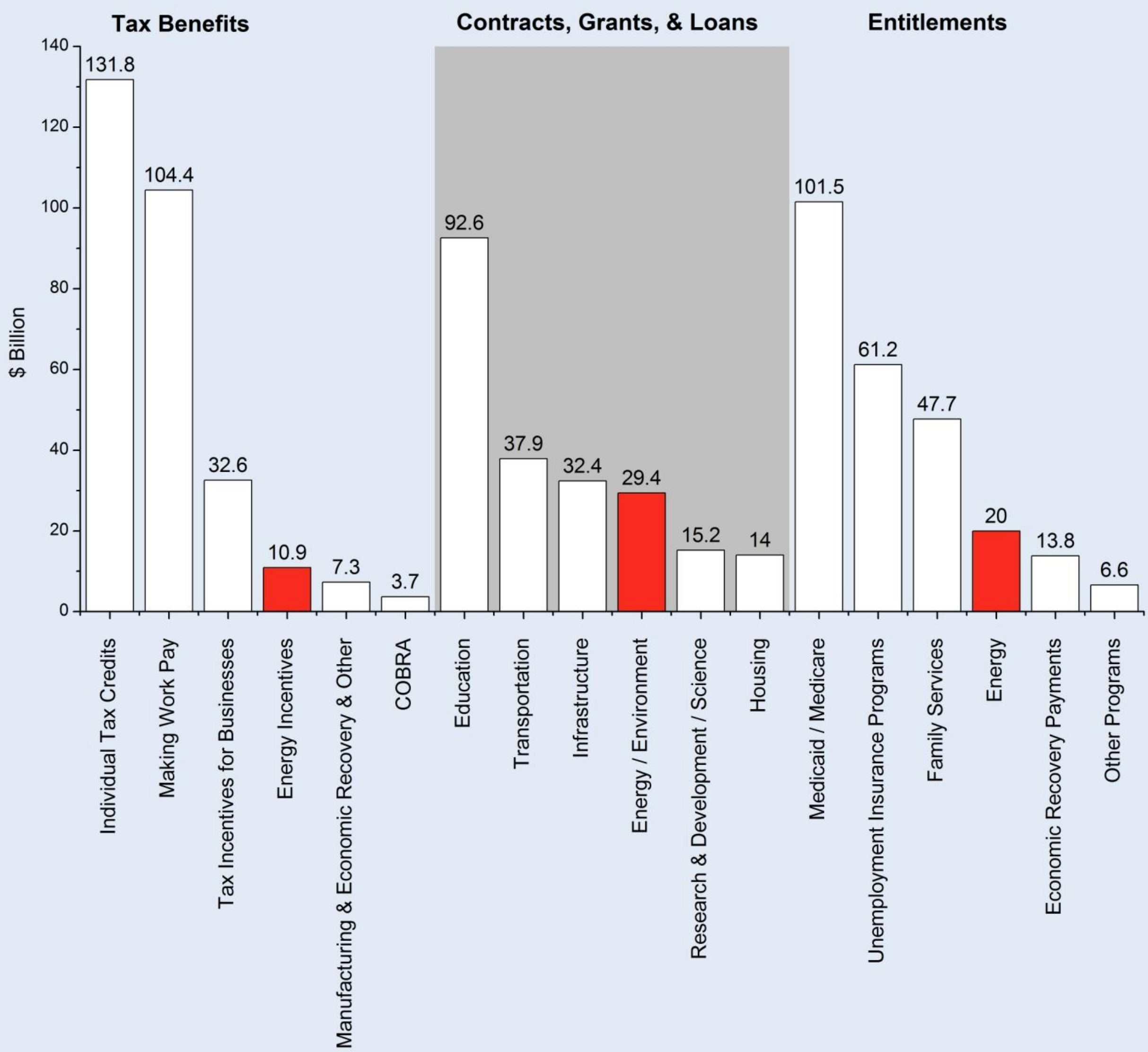
1.1. Regulatory Measures Affecting (Clean) Energy Technologies

A substantial number of regulatory measures and standards are in effect that, together, cover a wide range of clean energy and energy efficiency technologies and sectors. This section covers a selection of regulatory measures that stand out due to their importance and (expected) impact (see Chapter 2). While the regulatory measures discussed here, as such, by no means cover the entire gamut of regulatory measures that are in effect, they do offer key insights into the structure put in place to promote clean energy technologies and the development of clean energy sources.

1.1.1. American Recovery and Reinvestment Act (ARRA)

The challenging economic conditions brought on by the collapse of the housing bubble and subsequent deep global recession spurred the introduction of ARRA. Enacted in 2009, the act was to accelerate economic recovery. Among its immediate objectives, the act aimed to a) spur the creation of new jobs and save existing ones and b) accelerate economic recovery and activity and invest in long-term growth (Recovery.gov, 2013). To that end, the stimulus package provided substantial financial resources to R&D programs, technology-specific programs, and energy related incentives. As of March 31st, 2013, the stimulus funding that has been paid out amounts to $796 billion (Recovery.gov, 2013). Over the entire 2009-2019 period, ARRA is estimated to increase budget deficits by $831 billion (CBO, 2012). Figure 1-1 provides an overview breakdown of ARRA funds flowing to three categories: a) Tax benefits; b) Contracts, Grants, & Loans; and c) Entitlements. Figure 1-1 demonstrates that a considerable portion of the stimulus funding made available by ARRA has been directed towards energy-related provisions. For instance, out of the multi-billion dollar package, the U.S. Department of Energy (DOE) received $36.7 billion climate and energy related funds (Pew Center on Global Climate Change [PCGCC], 2009).

Figure 1-1. Breakdown of ARRA funds Energy-related provisions highlighted in red ($ billion)



Source: (Recovery.gov, 2013)

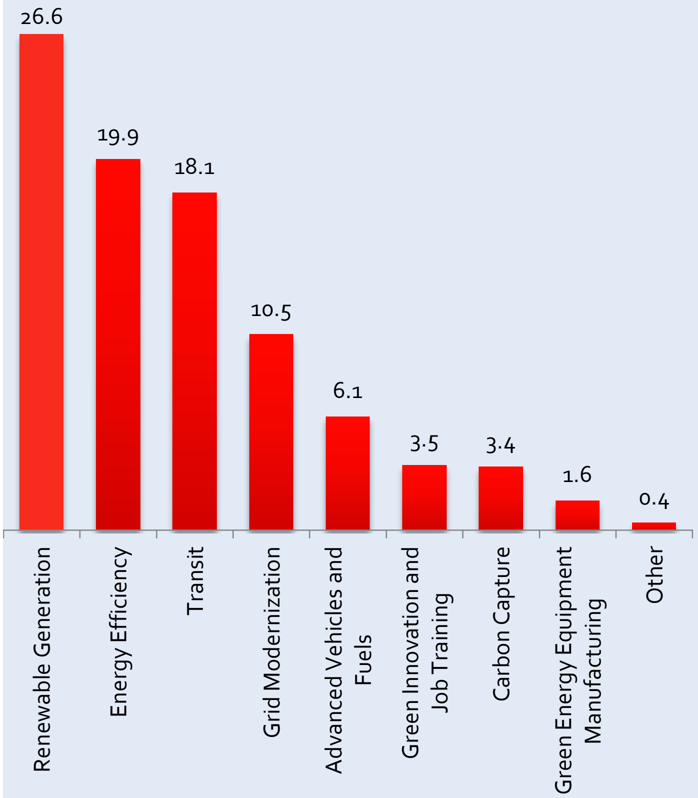
In Figure 1-1, energy-related provisions constitute $60.3 billion. However, many of the other provisions interact with energy-related provisions. For example, research & development / science also includes research and development on energy sources. In a special quarterly report on ARRA, the Council of Economic (CEA) outline how ARRA was used to accelerate the clean energy transformation. They outline eight thematic priorities of ARRA in this context: energy efficiency, renewable generation, grid modernization, advanced vehicles and fuel technologies, traditional transit and high-speed rail, carbon capture and sequestration, green innovation and job training, and clean energy equipment manufacturing (Council of Economic Advisors [CEA], 2010).

The CEA estimates than a total of $90 billion flows to these eight categories (CEA, 2010). The distribution of these flows is given in Figure 1-2. For instance, in terms of efficiency, strategic investment to reduce energy consumption takes place through programs such as the Weatherization Assistance Program that received $5 billion to fund up to $6,500 per household unit for energy efficiency retrofits in low-income households (CEA, 2010).

With these funds, the program weatherized nearly 300,000 homes in 2010, tripling the annual average over the 2003-2007 period (CEA, 2010). An additional 600,000 homes will be weatherized with ARRA funding.[1] Similarly, the electric grid modernization efforts are supported by ARRA through a $10.5 billion investment that enhances its efficiency

and ensures reliable electricity delivery (CEA, 2010). Car battery manufacturing, mass transit construction, and the retrofitting of heavy-duty diesel engines are some of the key focal points within transportation. In terms of clean energy itself, ARRA funded investments that are expected to contribute to the growth of the sector. For example, ARRA allocated $4 billion to the DOE's Loan Guarantee Program (CEA, 2009).

Figure 1-2. ARRA Clean Energy Appropriations by Category



Source: (Council of Economic Advisors [CEA], 2010)

1.1.2. Federal Leadership: Executive Order 13514

Shortly after his inauguration, President Obama launched Executive Order 13514 establishing that federal agencies should demonstrate leadership in energy efficiency efforts and greenhouse gas emission reduction measures. In October 2009, Executive Order 13514, entitled *Federal Leadership in Environmental, Energy, and Economic Performance*, came into effect and expands on earlier issued energy reduction and environmental performance requirements such as the 2007 Executive Order 13423. Among other objectives, the Executive Order outlines that "Federal agencies shall increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; [...] [and] leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services" (Department of Energy [DOE], 2009). The Executive Order outlines the following objectives for federal agencies:

- A 30% reduction in vehicle petroleum use by 2020;
- 26% improvement in water efficiency by 2020;

[1] Department of Energy Press Release. ―Secretary Chu Announces Major New Recovery Act Milestone: 300,000 Homes Weatherized,‖ January 19, 2011.

- 50% recycling and waste diversion by 2015;
- 95% of all applicable contracts will meet sustainability requirements;
- Implementation of the 2030 net zero energy building requirement;

In 2010, President Obama expanded the direct greenhouse gas (GHG) emission reduction target (e.g., fuel and building energy use) to 28% reduction by 2020 and indirect GHG emissions (e.g., travel and commute) by 13% by 2020 (The White House, 2010). With over 1.8 million employees, half a million buildings and half a trillion in annual purchasing power, the executive order to lead by example can deliver a substantial motivating force for the rest of the country to improve environmental, energy, and economic performance.

1.1.3. Clean Energy Standard Act

Another indicative act that provides insight into the overall energy-related narrative of the Obama Administration is the *Clean Energy Standard Act (CESA)* of 2012. While this Act has not been enacted – it failed to pass through Congress – it does give insight into the efforts to advance clean energy technology in the U.S. The CESA aimed to create a market-oriented standard for clean electric energy generation as it stipulates a target level for the year 2035. The Act would have mandated each utility to obtain a certain percentage of electricity from clean energy sources from 2015 onwards. Table 1-1 outlines the obligation to produce electricity from clean energy sources and the obligation increases year by year. By 2035, 84% of electricity would need to be produced by clean sources (World Resources Institute [WRI], 2012).

Table 1-1. Overview of CESA Targets by Year

Year	Percent of Electricity from Clean Sources
2015	24%
2020	39%
2025	54%
2030	69%
2035	84%

Source: WRI, 2012

In contrast to many of the popular Renewable Portfolio Standards (RPS) – in heavy use at the state level – the CESA also allows nuclear energy and clean fossil fuels (e.g. 'clean coal') to fulfill the standard. In addition, the CESA allows for a flexible market-based approach that enables businesses and entrepreneurs to achieve the target as clean energy production can take place at cost-effective locations. Utilities that produce clean electricity can sell credits to utilities that fail to produce clean electricity. With a differentiated scheme that offers varying amounts of credits depending on the clean energy source, the CESA is able to incentivize low-carbon energy production. Initially, the standard would cover utility-scale electricity production – sales need to be at least 2 million MWh in 2015 – but this threshold declines year by year to 1 million MWh of sales in 2025.

1.1.4. Renewable Fuel Standard

Renewable fuels forms a key component of the effort to make U.S. transportation more sustainable. The U.S. *Energy Policy Act* of 2005 established the first renewable fuel volume mandate in the U.S. at 7.5 billion gallons of renewable fuel by 2012. The *Energy Independence and Security Act (EISA)* of 2007 expands on the RFS in a number of significant ways. For the discussion here, the following are especially relevant:

- The second edition of the renewable fuel standard (i.e. RFS2) now is a volume requirement related to diesel and gasoline whereas it was previously only related to gasoline.
- The 2007 EISA created a new long-term target: 36 billion gallons by 2022.

The RFS2 aims to realize greenhouse gas emission reductions, reduce dependency on imported fuels, and aims to encourage the U.S. renewable fuel sector. The Environmental Protection Agency (EPA) issued new standards for renewable fuels in 2012 and 2013. As Table 1-2 shows, the EPA sets four targets: cellulosic biofuel, biomass-based diesel, advanced biofuel, and total renewable biofuel targets. Conventional renewable fuels (such as corn-ethanol) make up the remainder. Therefore, while the EPA does not set official targets for conventional renewable fuels, an implicit target can be found in the form of the difference between the total renewable fuels and the other three targets. As shown in Table 1-2, a total of about 10% renewable fuel is mandated in 2013.

Table 1-2. Renewable Fuel Standard Targets for 2012 and 2013.

Fuel Type	Actual Volume (Billion gal)	%*	Actual Volume (Billion gal)	%*
Cellulosic biofuel	0.0865	0.006%	0.014	0.008%
Biomass based diesel	1.0	0.91%	1.28	1.12%
Advanced biofuel	2.0	1.21%	2.75	1.60%
Conventional renewable fuel (e.g., corn ethanol)	12.1	7.1%	12.5	6.9%
Total renewable fuel	15.2	9.23%	16.55	9.63%

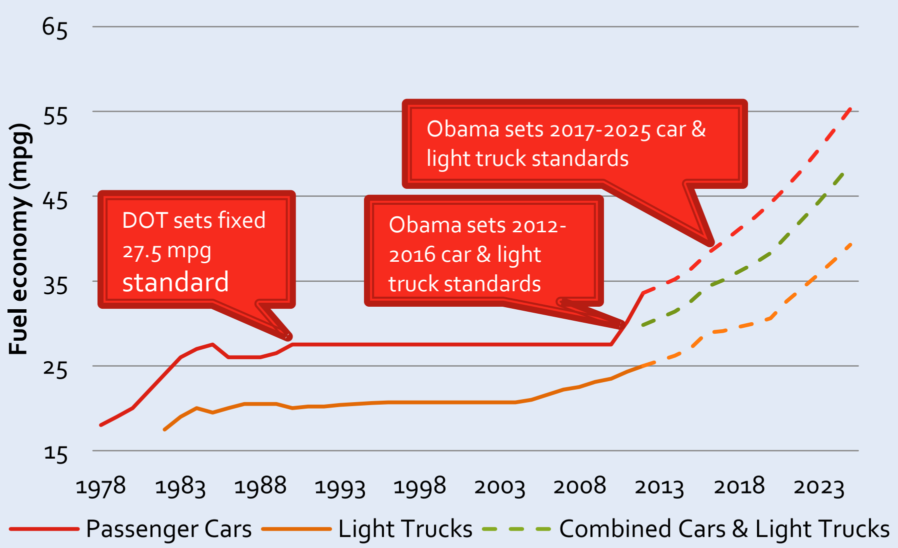
Source: EPA, 2011, 2012b
*: percentage represents a ratio of renewable fuel volume to non-renewable gasoline and diesel volume.

1.1.5. Corporate Average Fuel Economy (CAFE) and Greenhouse Gas Emission Standards

The introduction of new CAFE standards represents a major regulatory measure. In 2010, the federal government raised the CAFE standards for model year 2016 for new passenger vehicles to 34.1 miles per gallon (mpg); a 15% increase from 2011 standards. In August 2012, a second rule increased CAFE standards to up to 54.4 mpg for model year 2025; a >90% combined increase over 2011 levels (The White House, 2012; Center for Climate & Energy Solutions [C2ES]). Cross-agency collaboration between the EPA and the National Traffic Safety Administration (NHTSA), furthermore, has lead to the simultaneous introduction of new greenhouse gas emission standards for transportation. With greenhouse gas emission standard levels at 225 grams/mile in 2016, the 143 grams/mile in 2025 (a fleetwide level of 163 grams/mile) represents a 36% drop in emissions per mile. The renewed impetus provided by the updated CAFE standard becomes clear when the new standards are seen in the light of historic standards (see Figure 1-3).

At 28% of national greenhouse gas emissions, the transportation sector represents a significant source of the U.S. contribution to climate change (Environmental Protection Agency [EPA], 2013). Figure 1-3 shows how the newly updated standards represent a significant break with historic levels of the standards that remained stable for about two decades. A study done by the EPA and the Oak Ridge National Laboratory in 2007 estimated that, for every barrel of oil that is no longer needed, $13.91 (in 2011 dollars) in energy security benefits is produced (Leiby, 2007). As such, the newly introduced standards are expected to provide significant economic returns.

Figure 1-3. U.S. CAFE standards over time with several major turning points highlighted.



Source: NHTSA, 2012; C2ES, 2013
*DOT= Department of Transportation

1.1.6. New Source Performance Standards (NSPS) for Greenhouse Gas Emissions for Electricity Production

In an address at Georgetown University on June 26th, 2013, President Obama introduced his new Climate Action Plan (Obama, 2013). This plan demonstrates a recommitment to climate change, an issue that had fallen on the political agenda during the first term of the Obama Administration. The plan encompasses several initiatives and action measures such as increases in clean energy technology implementation, efficiency standards for transportation vehicles, reducing energy waste, and international leadership by example (The White House, 2013) (see also Chapter 3 of this report). For the purposes of this chapter, one measure stands out: the renewed commitment to new source performance standards (NSPS) for greenhouse gas emission reductions from the conventional electricity production facilities. In his address, President Obama called on the EPA to work closely with states, industry, and other stakeholders to develop new federal regulations for greenhouse gas emissions from new and existing power plants.

The NSPS outline a pathway with which the Obama Administration tries to address non-clean energy sources and limit their use. Fossil fuel power plants are the largest stationary source of greenhouse gas emissions in the U.S. and account for approximately 40% of national carbon dioxide (CO_2) emissions (Zhai & Rubin, 2013). During the first term of the Obama Administration, attempts to introduce a federal cap and trade system for greenhouse gas emissions failed to attract Congressional support. Since then, the EPA has been working to extend its regulatory reach over the emissions of greenhouse gases despite continued heavy opposition in the House of Representatives (Reitze, 2012). Through the use of Presidential Memorandums and Executive Orders, President Obama has directed the EPA to enact the NSPS regulations by June 2015.

Reitze (2012) explains the EPA strategy as it follows two paths to regulate greenhouse gas emissions in light of stalling legislative support. First, the Agency has moved to use its authority under the Clean Air Act to regulate CO_2 as a pollutant. When the Bush Administration challenged the EPA's classification, the Supreme Court ruled that CO_2 was to be classified as a GHG in the case *Massachusetts v. EPA* therefore upholding the EPA authority to regulate CO_2 (Richardson, Fraas, & Burtraw, 2010). The EPA's second path is to create more stringent environmental standards on conventional electricity generation. This second path is a key strategic pillar of the EPA approach as these measures have discouraged investment in new coal-fired power plants and encouraged the shutting down of old plants with high emissions of conventional pollutants (Reitze, 2012).

The address by President Obama signals the Administration's commitment to pursue the implementation of an earlier EPA March 27, 2012 proposal to set emission limitations on certain categories of stationary sources of air pollution (McCarthy & Parker, 2010; Reitze, 2012). This 2012 EPA proposal required new fossil-fuel electricity generating units with a capacity greater than 25 megawatt electric (MWe) to meet a 1,000 pound of CO_2/MWh output-based standard (Zhai & Rubin, 2013). As Reitze (2012) highlights, the new proposal sets a standard that is based on the emission level of a natural gas combined cycle facility therefore significantly complicating the economic viability of coal-fired electricity production. Realizing compliance with these standards will be difficult for many conventional power plants. For instance, according to Reitze's (2012) calculations, compliance with the standards will require a thermal efficiency of about 69 %. This efficiency level is effectively out of reach for even the most efficient coal-fired power plants unless they apply carbon capture and sequestration. Natural-gas powered plants, due to their lower emissions, need to realize a 37% thermal efficiency which is in reach for the natural gas industry (Reitze, 2012).

A similar analysis is performed by Pratson, Haerer, & Patino-Echeverri (2013) as they analyze the consequences for the economic viability of current coal capacity under NSPS. They conclude that the economic viability of 9% of current coal capacity is being challenged due to other economic circumstances (primarily low natural gas prices). Stricter emission regulations, meanwhile would challenge the economic viability of another 56% of current coal capacity (Pratson, Haerer, & Patino-Echeverri, 2013). The NSPS could also widen the competitive gap between natural gas and coal power by forcing coal-generated electricity's prices to rise steeply. Even if natural gas prices increase, they will still remain cost competitive relative to coal if the EPA regulations are enacted (Pratson, Haerer, & Patino-Echeverri, 2013).

1.2. Financial Support for the Clean Energy Industry

Many programs to support clean energy exist at the federal level. In addition, multiple financial incentives for the different sectors of the U.S. economy and for various technologies have been put in place. While the federal support structure has been in place since the early 1970s, many of the currently existing programs and financial incentives have been reauthorized, amended, and updated since they were first introduced to reflect changes in economic conditions, political circumstance, and public opinion (Cunningham & Roberts, 2011).

The Department of Energy (DOE) maintains and operates the bulk of the energy efficiency and clean energy programs (Cunningham & Roberts, 2011). The energy efficiency and renewable energy (EERE) office is the primary office of the DOE that, through a multitude of programs, engages clean energy technologies. The Department of Treasury, the Department of Agriculture (USDA), and several other U.S. federal government departments, also maintain a portfolio of financial incentives for clean energy and energy efficiency. The sections below outline the primary federal financial incentives and DOE EERE programs. For an overview of other programs and financial incentives currently put in place, see Appendix A.

1.2.1. DOE EERE Programs

Renewable Energy: DOE EERE Technology Programs

The primary objective of the DOE EERE Technology Programs is to engage multiple relevant actors in the technology-specific field and produce results that support the deployment and dissemination of the particular technology. For instance, the DOE EERE *Geothermal Technologies Program*, reauthorized by ARRA, supports the development and deployment of geothermal energy technology and, at around $44 million for Fiscal Year (FY) 2009 and FY2010 – supplemented by $393 million from ARRA – the program provides multi-million dollar support for geothermal energy technology (DOE Energy Efficiency and Renewable Energy (DOE EERE), 2012a; Cunningham & Roberts, 2011). In fact, ARRA provided a major financial input for the various technology programs (Cunningham & Roberts, 2011). In terms of renewable energy, the DOE EERE maintains technology programs for geothermal energy, hydrogen and fuel cell technology, solar energy, industrial technologies, vehicle technology, and wind and hydropower technology (DOE Energy Efficiency and Renewable Energy (DOE EERE), 2011a; 2012b; 2011b; 2011c, 2012c)

Renewable Energy: Biomass

ARRA reauthorized the *Biomass and Bio-refinery Systems Program* (see Catalog of Federal Domestic Assistance [CFDA], no. 81.087). With an average of about $220 million per FY over the period 2009-2010 – supplemented by a 2009 ARRA injection of $777 million – and $175 million per FY over the period 2011-2012, this program provides a significant support structure for biomass, biofuels, and bio-refinery research and development (R&D) (Cunningham & Roberts, 2011; Yacobucci, 2012). In particular, this program provides grants that support the R&D of cost-effective technologies and production systems to accelerate the U.S. capacity to use biomass energy as a primary energy resource. Additionally, the *Regional Biomass Energy Grant Programs* provides financial support; an estimated $4.8 million in FY2010 (Cunningham & Roberts, 2011). Table 1-3 presents a brief summary of several renewable energy programs. The U.S. Department of Agriculture (USDA) also operates several financial incentives relevant to biomass (see Appendix A). Also, Section 1.5 offers a more detailed description of R&D support from the federal government.

Table 1-3. Summary of Renewable Energy Programs of the Department of Energy (DOE).

Program		FY appropriation (millions)
Technology Programs: Partners DOE with industry, academia, and research facilities	Geothermal Technologies Program	2008: $19.3; 2009: $43.3 + $393 (ARRA); 2010: $44; 2011: $55

		(requested)
	Hydrogen and Fuel Cell Technologies Program	2008: $206.2; 2009: $164.6; 2010: $174; 2011: $137
	Solar Energy Technologies Program	2008: $166.3; 2009: $172.4 + $116 (ARRA); 2010: $247; 2011: $302.4 (requested)
	Wind and Hydropower Technologies Program	2008: $58.7; 2009: $93.5 + $138.6 (ARRA); 2010: $130; 2011: $163 (requested)
Regional Biomass Energy Programs:		2008: $0.075; 2009: $0.026; 2010: $4.8 (estimated); 2011: currently unavailable

Source: Adapted from Cunningham & Roberts (2011

Energy Efficiency

Similar to the other Technology Programs, the DOE EERE maintains several technology programs for energy efficiency specific applications. For instance, the *Building Technologies Program* aims to improve the energy efficiency of entire buildings and equipments, components, and systems within those buildings. The Program supports building' energy efficiency research and development efforts, and offers necessary tools, guidelines, training and access to technical and financial resources.

The DOE EERE maintains two other energy efficiency programs directed at the residential sector.[2] The *Energy Efficient Appliance Rebate Program (EEARP)* supports States' efforts to disseminate residential Energy Star rated appliances and to establish rebate programs in this context. With financial and technical support to establish such rebate programs at the state level, the program aims to reduce fossil fuel emissions, and to improve energy efficiency in the residential sector. The *Weatherization Assistance Program (WAP)* aims to reduce energy costs for low-income households by trying to increase the residential energy efficiency of their homes through weatherization efforts.

Directed at industry, the *Inventions and Innovations Program* supports research and development efforts towards innovative, energy saving ideas and inventions that can be commercially applied in the market in the future. Similarly, the *Industrial Technologies Program* works together with industry to realize industrial energy efficiency improvements. Finally, the *Vehicle Technologies Program* partners DOE with industry leaders to advance transportation technology towards vehicle fuel efficiency and utilizes domestically produced fuels. Table 1-6 presents a brief overview of several energy efficiency programs.

Table 1-4. Summary of Appropriations for Energy Efficiency Programs of the Department of Energy (DOE).

Program		FY appropriation (millions)
Technology Programs: Partners DOE with industry, academia, and research facilities	*Building Technologies Program*	2008: $107.4; 2009: $138.1 + $319.2 (ARRA); 2010: $222; 2011: $230.7
	Industrial Technologies Program	2008: $63.2; 2009: $88.2 + $261.5 (ARRA); 2010: $96; 2011: $100 (requested)
	Vehicle Technologies Program	2008: $208.4; 2009: $267.1 + $2800; 2010: $311.4; 2011:$325.3
Energy Efficient Appliance Rebate Program (EEARP)		2008:$0; 2009: $298.5 (ARRA); 2010: $0; 2011: $0
Weatherization Assistance Program (WAP)		2008: $227.2; 2009: $450 + $5000 (ARRA); 2010: $270; $385 (requested)

[2] Funding and technical guidance from DOE is provided, but the day-to-day operation of the program is executed by the states themselves.

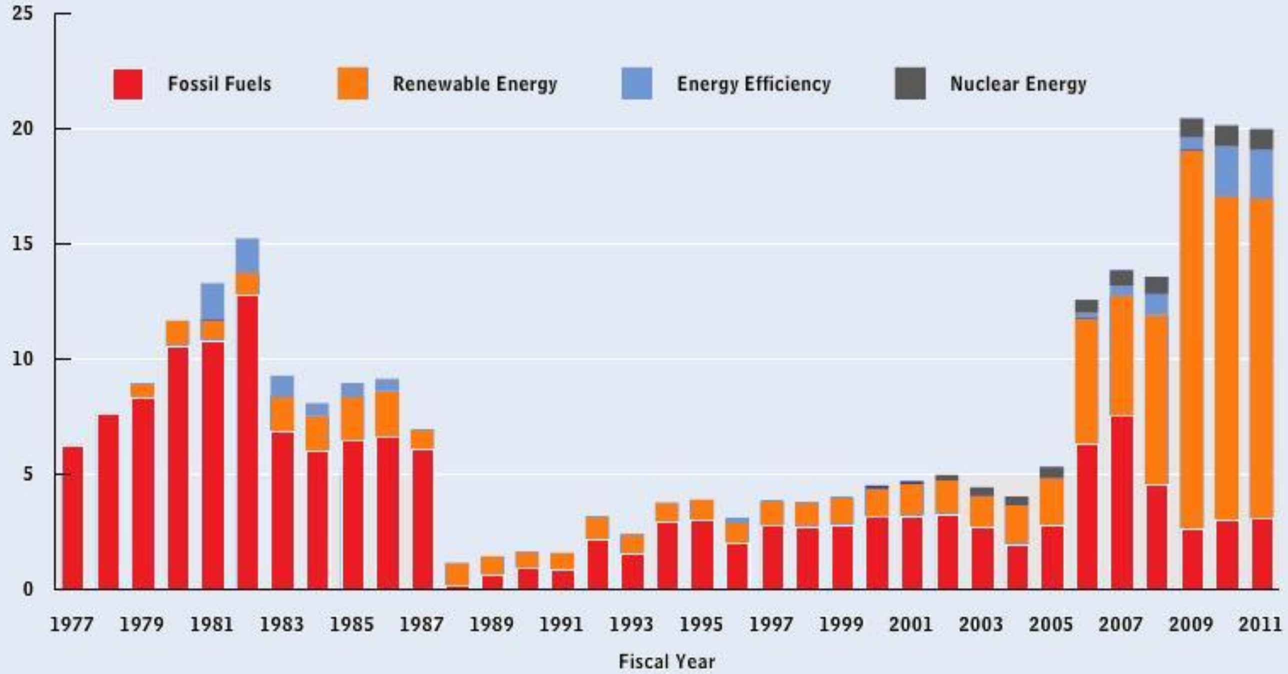
Inventions and Innovations Program	2008: \$0.145; 2009: \$1.8; 2010: \$0.102 (estimated); 2011: \$0.150

Source: Adapted from Cunningham & Roberts (2011

1.2.2. United States Department of Treasury Financial Incentives

Energy tax provisions form the core operational route for federal financial support for clean energy and energy efficiency. The breakdown of federal tax support has changed quite dramatically over time (see Table 1-4). Whereas the 1970s and 1980s primary supported the oil and gas industry, the breakdown has shifted toward an energy tax policy structure that more strongly favors renewable energy and especially unconventional fuels (Sherlock, 2010; Sherlock, 2012). Many energy tax incentives in the current policy portfolio are set to expire or have recently expired (Crandall-Hollick, 2012; Joint Committee on Taxation [JCT], 2012; Yacobucci, 2012). The main incentives that are set to expire or have recently expired are the incentives for alcohol fuels, for biodiesel and renewable diesel, and the Section 1603 Grants (Crandall-Hollick, 2012; Sherlock & Crandall-Hollick, 2012). However, many provisions that were scheduled to expire were temporarily extended by the 2010 *Tax Relief, Unemployment Reauthorization, and Job Creation Act* (Sherlock & Crandall-Hollick, 2012).

Figure 1-4. Energy-Related Tax Preferences, by Type of Fuel or Technology. Billions of 2011 dollars



Source: (Congressional Budget Office [CBO], 2012)

The federal financial support differs quite substantially within the different technologies of the energy sector. For instance, in 2010, out of the estimated \$19.1 billion of federal tax support, about a third (\$6.3 billion) was allocated to renewable fuels, \$6.7 billion to various renewable energy technologies, and \$2.1 billion to the support of energy efficiency (see Table 1-5) (Sherlock, 2012). Several financial incentives together form the bulk of the approximately \$19 billion allocation. The main incentives for renewable energy, for example, are the Production Tax Credit (PTC), the Investment Tax Credit (ITC), and the Section 1603 Grants (Sherlock & Crandall-Hollick, 2012). For an exhaustive overview of clean energy and energy efficiency financial incentives see Appendix A.

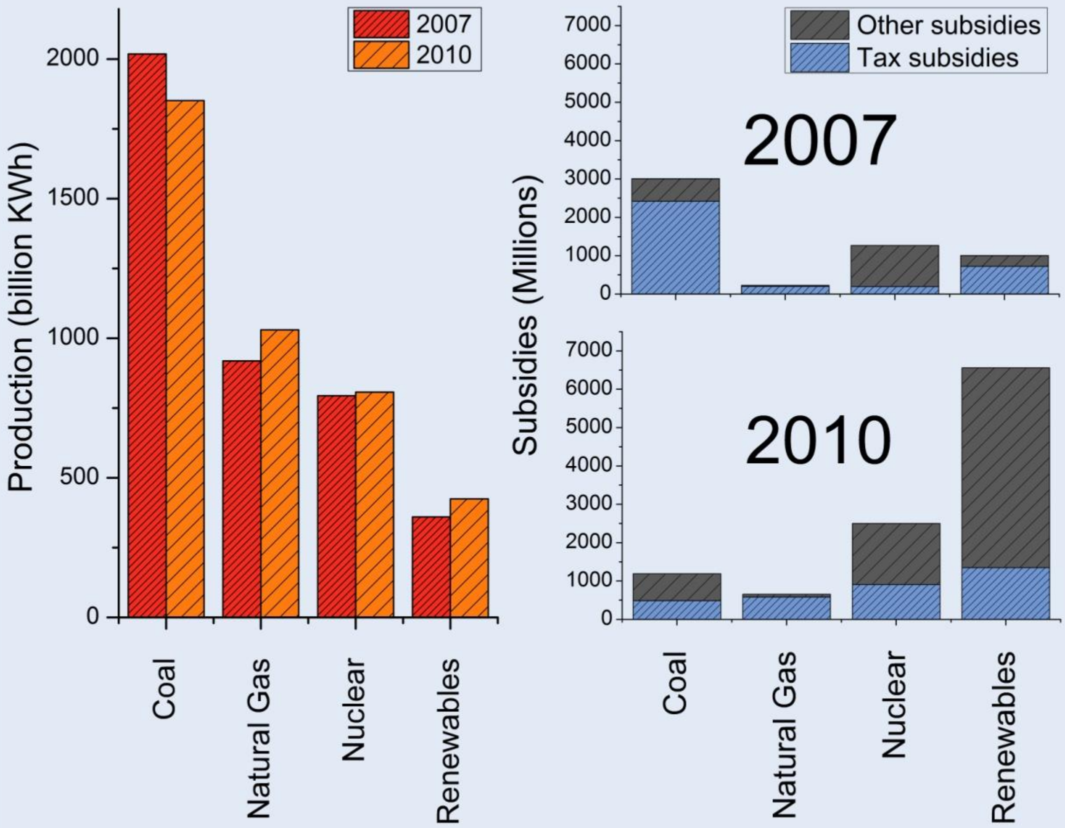
Table 1-5. Breakdown of the estimated revenue cost of the federal energy-related tax provisions over fiscal years 2010-2012 in billions of dollars.

	Provision	2010	2011	2012
	Fossil Fuels Total	**2.4**	**3.3**	**3.2**
Renewables	*Production Tax Credit (PTC)*	1.4	1.4	1.6
	Investment Tax Credit (ITC)	(i)	0.5	0.5
	Accelerated Depreciation for Renewable Energy Property	0.3	0.3	0.3
	Section 1603 Grants	4.2	3.5	4.1
	Credit for Clean Renewable Energy Bonds (CREBs)	0.1	(i)	(i)
	Residential Energy Efficiency Property Credit	0.2	0.2	0.2
	Credit for Investments in Advanced Energy Property	0.5	0.7	0.4
	Renewables Total	**6.7**	**6.6**	**7.1**
Renewable Fuels	Credits for Alcohol Fuels	0.1	0.2	0.1
	Excise Tax Credits for Alcohol Fuels	5.7	6.5	3.6
	Excise Tax Credits for Biodiesel	0.5	0.8	0.2
	Renewable Fuels Total	**6.3**	**7.5**	**3.9**
Energy Efficiency & Conservation	Energy Efficiency Improvements to Existing Homes	1.7	1.5	1.3
	Credit for Production of Energy Efficient Appliances	0.2	0.2	0.1
	Energy Efficient Commercial Building Deduction	0.2	0.2	0.2
	10-year depreciation for smart electric distribution property	(i)	0.1	0.1
	Efficiency and Conservation Total	**2.1**	**2.0**	**1.7**
Alternative Vehicles	Credits for Alternative Technology Vehicles	0.8	(i)	(i)
	Credits for Plug-in Electric Vehicles	n.a.	0.1	0.3
	Alternative Technology Vehicles Total	0.8	0.1	0.3
	Other	**0.8**	**2.3**	**0.4**
	TOTAL	**19.1**	**21.8**	**16.6**

Source: Sherlock, 2012
Notes: (i) denotes a positive estimated revenue loss of less than $50 million. Provisions that were not listed in the 2010 expenditure tables are indicated with n.a.

While fossil fuels in 2010 represented 78% of U.S. primary energy production, only about 12.6 % of the federal tax incentives target the fossil fuel industry (Sherlock, 2012). In contrast, while renewable energy supplied only 10.7% of the 2010 energy production, that sector received 68% of the federal financial support (Sherlock, 2012). In Figure 1-5 the subsidies to electricity production by fuel type are illustrated. Clearly, the share of the major electricity producing fuel types is not in relation to the share of financial incentives. Additionally, Figure 1-5 makes it clear that, between 2007 and 2010, a substantial shift in the financial incentive structure has taken place: while in 2007 the majority of financial resources were allocated to coal, the 2010 numbers show that renewables received the majority of financial resources. Finally, the level of support to electricity production was substantially higher in 2010 (about $11.8 billion) compared to 2007 (about $6.7 billion).

Figure 1-5 Subsidies to Electricity Production by Fuel Type over 2007 and 2010



Source: authors (data from (Energy Information Administration [EIA], 2011); Sherlock, 2012)
Notes: the 'other subsidies' category includes direct expenditures, research and development expenditures, federal electricity support, and loan guarantees. The figure includes Section 1603 Grants as tax-related federal financial support, since eligibility for Section 1603 grants is tied to the tax code. In 2010, $4.25 billion in Section 1603 grants in lieu of tax credits were awarded to renewable energy projects.

Support structure for renewable energy: The PTC, ITC, and 1603 Grants

The PTC and ITC were established to further the deployment of renewable electricity through either supporting the production of electricity or investments made in generation capacity. Prior to ARRA, the primary tax incentives for renewable energy were limited to the PTC and ITC (Brown & Sherlock, 2011). However, ARRA introduced a new opportunity for renewable energy projects in the form of the Section 1603 Grant.[3] Instead of tax credits that award production or investment, the Section 1603 Grants offer a one-time cash grant which reduces the need for third party tax equity investors (Brown & Sherlock, 2011). Originally set to expire at the end of 2010, Section 1603 Grants were extended to the end of 2011. ARRA also expanded the available options by making the PTC and ITC less mutually exclusive as project developers are now free to either claim the PTC or ITC on PTC-eligible property (see Table 1-6)

Table 1-6. The PTC, ITC, and the Section 1603 Grants and the main changes after ARRA.

Energy Property	Required in-service date	2010 PTC rate ($/KWh)	ITC/1603 % of eligible cost basis	Incentive Options	
				Before ARRA	After ARRA

[3] Section 1603 of the American Recovery and Reinvestment Act of 2009 (P.L. 111-5)

Wind	1/1/2013	$0.022	30%	PTC	PTC, ITC, Grant
Closed-loop biomass	1/1/2014	$0.022	30%	PTC	PTC, ITC, Grant
Open-loop biomass	1/1/2014	$0.011	30%	PTC	PTC, ITC, Grant
Geothermal energy	1/1/2014	$0.022	30%	PTC	PTC, ITC, Grant
Landfill gas	1/1/2014	$0.011	30%	PTC	PTC, ITC, Grant
Trash	1/1/2014	$0.011	30%	PTC	PTC, ITC, Grant
Qualified hydropower	1/1/2014	$0.011	30%	PTC	PTC, ITC, Grant
Marine & Hydrokinetic	1/1/2014	$0.011	30%	PTC	PTC, ITC, Grant
Small wind	1/1/2017	n.a.	30%	ITC	ITC, Grant
Solar	1/1/2017	n.a.	30%	ITC	ITC, Grant
Geothermal heat pumps	1/1/2017	n.a.	10%	ITC	ITC, Grant
Fuel Cells	1/1/2017	n.a.	30%	ITC	ITC, Grant
Micro-turbines	1/1/2017	n.a.	10%	ITC	ITC, Grant
Combined Heat & Power (CHP)	1/1/2017	None	10%	ITC	ITC, Grant

Source: Brown & Sherlock, 2011.

Recently extended for a eight year period under the *Emergency Economic and Stabilization Act* of 2008, the ITC offers qualified investments with a 10-30 % tax credit depending on the technology. [4] The ITC has found particular application in solar energy projects. In contrast, the PTC incentive tool has primarily found application in the wind energy sector (Wiser, 2007; Barradale, 2010). Established under the *Energy Policy Act of 1992*, the PTC generally offers a ten-year, inflation-adjusted, credit. [5] The PTC is subject to a process of expiration-to-renewal and the resulting uncertainty from the expiration cycle has lead to a "boom-and-bust" cycle in wind energy development (Barradale, 2010; Wiser, Bolinger, & Barbose, 2007; Wiser, 2007).

Section 1603 Grants were established due to the context of economic decline and reduced availability of tax equity (Brown & Sherlock, 2012). In contrast to the ten-year PTC, Section 1603 Grants offer quick grants up to 30% of the eligible project capital cost expenditures. The sidebar offers an initial insight into the multi-billion dollar incentive structure that is the Section 1603 Grant. Solar electricity projects (97%) received the majority of grants, while wind energy received the majority of cash grant dollars (79%) (see also Table 1-7). As of February 2011, 6299 grants totaling $593 million have been awarded to solar energy projects (DOE EERE, 2012). Of the 1109 solar renewable energy projects that have attracted Section 1603 cash grants as of December 6, 2010, over 700 were under $100,000 (Brown & Sherlock, 2012). Brown & Sherlock (2012) note the following advantages for solar renewable energy projects to opt for the Section 1603 Grant:

- Lower transaction costs;
- No competition for tax equity;
- Short duration of the grant process;
- Reduced taxable income risk.

[4] The complete history of the ITC can be found in U.S. Congress, Senate Committee on the Budget, *Tax Expenditures: Compendium of Background Material on Individual Provisions*, committee print, prepared by Congressional Research Service, 111th Congress, 2nd Session, December 2010, S. Prt. 111-58, pp. 185-190.
[5] The complete history of the PTC can be found in U.S. Congress, Senate Committee on the Budget, *Tax Expenditures: Compendium of Background Material on Individual Provisions*, committee print, prepared by Congressional Research Service, 111th Congress, 2nd Session, December 2010, S. Prt. 111-58, pp. 297-304.

A more detailed picture is given in Table 1-7 (next page) as it breaks the distribution of Section 1603 grants down per technology group based on the number of projects, nameplate capacity rating, funds awarded, and total eligible cost basis. It shows how the majority of nameplate capacity installed are large wind installations (89% out of over 14 GW of capacity) and that the total eligible cost basis of $32 billion also primarily is from large-scale wind energy. At 724 MW and 23, 692 projects (an average of 3 kW per project) it is clear that Section 1603 actively supports small-scale solar energy installations. In contrast to traditional tax equity financing (which requires a large taxable income), Section 1603 grants open up financing to non-profit enterprises and community-based groups (Bolinger, Revealing the Hidden Value that the Federal Investment Tax Credit and Treasury Cash Grant Provide to Community Wind Projects, 2010) as evidenced by the distribution shown in Table 1-7 on the next page.

Even though the Section 1603 Grant Program expired at the end of 2011, projects that began construction before or in 2011 will continue to be receive the cash grant. The Section 1603 program will continue to award projects as long as they are completed prior to the expiration of the ITC (2012 for wind, 2016 for solar) (National Renewable Energy Laboratory [NREL], 2012).

Biofuels support structure

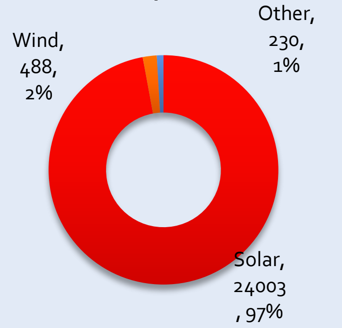
Biofuels constitute a major component of the federal biomass program. Ethanol and biodiesel – which together form the vast majority of biofuel production (Energy Information Administration (EIA), 2012) – received substantial federal government support (Yacobucci, 2012). As mentioned, the renewable fuel standard (RFS) provides the framework in which targets for future production of biofuels are outlined. Initially established under the *Energy Policy Act* of 2005, and expanded by the *Energy Independence and Security Act* of 2007, the RFS mandates the use of renewable fuels. The requirement set by the RFS was to realize 36 billion gallons of biofuels in 2022, of which at least 21 billion gallons had to be advanced biofuels (such as cellulosic biofuel). Many of the tax credits and other incentives for biofuel production and/or sale expired or were set to expire in 2010, but were extended through the end of 2011. However, support for the further extension of these incentives beyond the end of 2011 was limited (Yacobucci, 2012).

During recent years, the support structure for biofuels – and for biomass overall – has endured substantial strain as U.S. Congress has tried to grapple with budget deficits and the national debt (Yacobucci, 2012). Many of the incentives expired in 2011 and 2012 (JCT, 2012). It is due to such expiring incentives – and the challenging economic conditions that led to a further downgrading of existing incentives – that leads the EIA to conclude that the RFS will not likely be met. Especially, the lowering of the cellulosic biofuel mandate from 100 million (2010) and 250 million gallons (2011) to about 6 million gallons in both years significantly reduced the chances of realizing the original 36 billion gallon target (EIA, 2012). In the EIA projection, only 22.1 billion of the RFS credits will be generated in 2022, with the majority coming from corn-based ethanol. However, the RFS is still a significant element in the federal support structure and might even prove more beneficial to the biofuel industry than the tax credits for the production or sale of ethanol and biodiesel (Yacobucci, 2012).

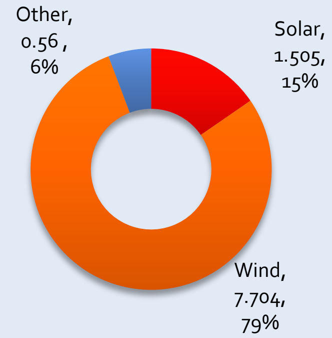
SECTION 1603 PER TECHNOLOGY

- SOLAR
  Receives vast majority of awards
- WIND
  Receives vast majority of finances

Number of Award Recipients



Value of Awards (Billions)



Source: (National Renewable Energy Laboratory [NREL], 2012)
Data from November 2011.
Note: "Other" is all eligible technologies next to wind and solar. In terms of value, 57 % of the 'other' category is geothermal electricity, 23 % is biomass (open loop, cellulosic) and 10 % is small wind.

Table 1-7. Overview of the Breakdown of Section 1603 as of November 2011 per technology.

Technology	Number of Projects	Nameplate Capacity (MWe)	Funds Awarded ($ millions)	Total Eligible Cost Basis ($ millions)
Wind – Large (>1MW)	197	12,810	7,680	25,601
Wind – Small (<1MW)	291	17	24	81
PV	23,692	724	1,305	4,352
Solar – Thermal	287	0	144	482
Solar – CSP	11	216	46	154
Solar – CPV	13	5	10	32
Biomass	47	246	172	576
Geothermal electric	13	229	276	960
Other	160	212	114	467
Total	24,711	14,458	9,771	32,706

Source: (National Renewable Energy Laboratory [NREL], 2012)

Energy efficiency support structure

The total cost of tax expenditures related to energy conservation and energy efficiency over the 2011-2015 time period is an estimated $4.5 billion (Sherlock & Crandall-Hollick, 2012). The main route in the U.S. for energy efficiency and conservation is by providing incentives for home-owners and commercial property when they undertake energy efficiency upgrades. The non-business energy property tax credit, for example, offers homeowners a 10% tax credit towards energy efficiency improvements and expenditures and the purchase of high-efficiency heating, cooling and water-heating equipment (Sherlock & Crandall-Hollick, 2012). The credit expired in 2011.

In terms of improvements to commercial property, the *Energy Efficient Commercial Buildings Tax Deduction* offers a $1.80 tax deduction per square foot to commercial business owners. Sherlock & Crandall-Hollick (2012) estimate the 2011-2015 cost for this incentive at $900 million.

Two additional tax incentives specifically designed to support manufacturers of energy efficient products both expired at the end of 2011. First, the *Energy Efficient New Homes Tax Credit for Home Builders* provides tax credits of up to $2,000 for builders of all new energy-efficient homes. Second, manufacturers of energy efficient appliances are offered a tax credit. This *Energy Efficient Appliance Tax Credit for Manufacturers* offers a tax credit for new appliances that meet Energy Star 2007 requirements. The limitation for manufacturers is that, in 2011, each manufacturer can only apply for a total of $25 million for all credits under this provision (Cunningham & Roberts, 2011).

Table 1-8. Several major energy efficiency financial incentives.

Program	Description	Examples of Qualifying Technologies	Value	Expiration Date
Residential energy efficiency tax credit	Provides tax credit to residents/individuals for the	Water heaters, furnace, boilers, heat pumps, air	$500 credit limit	12/31/2011

	installation of energy efficient equipment	conditioners, etc.		
Qualified Energy Conservation Bonds (QECBs)	Bond authority is allocated to state, local and tribal governments to finance a broad range of energy efficiency and renewable energy projects	Solar thermal electric; PV; landfill gas; wind; biomass; hydroelectric; geothermal electric; etc.	Bonds with 0% interest rate. Volume capped at $3.2 billion	None
Energy Efficient Commercial Buildings Tax Deduction	Tax deduction for certain systems and buildings that reduce energy and power cost	Equipment insulation, water heaters, lighting, etc.	$1.80 per sq. foot	12/31/2013
Energy Efficient New Homes Tax Credit for Home Builders	Provides tax credits of up to $2,000 for builders of new, energy-efficient homes	Comprehensive measures/whole building	Up to $2,000	12/31/2011
Energy Efficient Appliance Tax Credit for Manufacturers	Provides a tax credit for manufacturers of appliances that meet Energy Star 2007	Clothes washers, dishwashers, refrigerators	Each manufacturer is limited to a total of $25 million	12/31/2011

Source: adapted from Cunningham & Roberts, 2011

In order to encourage energy conservation, the federal government also established the Qualified Energy Conservation Bonds (QECBs) that subsidize the financing of energy conservation projects. The QECBs tool allocates bond authority to state, local, and tribal governments with which they can finance a broad range of energy efficiency and renewable energy projects (Cunningham & Roberts, 2011). While originally limited to $800 million, the volume of energy conservation tax credit bonds to be issued by state and local governments was expanded to $3.2 billion by ARRA (Cunningham & Roberts, 2011).Table 1-8 briefly presents several financial incentives for energy efficiency. Other incentives are given in Appendix A.

1.3. Partnerships and Initiatives

The federal government engages in many partnerships with the private sector, state and local governments, universities, and national laboratories with the aim to improve energy efficiency and commercialize clean technology. Through such agreements, the federal government can offer financial support on a smaller scale as many of these programs are technology-specific programs often focusing on small components of the technology pathway such as the manufacturing process or the installation phase.

Several of the partnerships, such as the SunShot Initiative, have an objective to increase domestic manufacturing and improve energy forecasts to bring down prices and ensure cost competitiveness. For instance, if the SunShot Initiative is successful, PV energy costs should be reduced by up to 75% (DOE Energy Efficiency and Renewable Energy [DOE EERE], 2012). Similarly, the Better Buildings Challenge has an objective to improve the efficiency of American commercial and institutional buildings and industrial plants by 20 percent or more by 2020 (DOE EERE, 2012).

The Obama Administration also places strong emphasis on inter-agency and inter-departmental collaboration for energy efficiency and renewable energy development. Examples of such collaboration are joint work between the Department of Transportation and the EPA, and work done by the Department of the Interior and the Department of Defense to identify suitable lands for solar and wind power development for use with military power applications. For a more thorough sampling and representation of different types of these partnerships, see Table 1-9.

These partnerships are ultimately designed to increase the speed and efficiency with which federal money is disbursed to the most efficient beneficiary towards a sustainable energy future. The federal grant money in this area helps to fuel these projects that may otherwise not have been funded or supported. Because these federal support funds cover nearly every area of renewable energy, they have met great collective success in proliferating their respective technologies at lower cost or higher efficiency, or simply decreasing overall energy usage and waste.

On a similar note, the Obama Administration has taken up many initiatives of its own since the President first took office. Most of these , like the partnerships described above, are tied to federal funds, but many of these initiatives are focused on stimulating competition and promoting education and awareness about these energy-centered issues. For instance, the National Clean Energy Business Plan Competition plays host to six student organizations, who participate in an EERE funded competition to produce promising renewable energy technologies for the future that will enable transition to a green economy. (DOE, 2012). Likewise, the Solar Decathlon program is a way for students and their communities to become aware of the financial and environmental benefits of clean energy products and design solutions. Both of these programs are two key examples of ways the federal government supports education and awareness for the benefits of investment in renewable technologies.

Table 1-9. Overview of several partnerships & Initiatives

Technology	Partnership/Initiative	Objective	Value
Solar	Bay Area PB Consortium, SVTC Technologies, and US Photovoltaic Manufacturing Consortium	Support U.S. development of advanced manufacturing processes for solar PV models	$112.5 million
	SunShot Initiative – Scaling Up Nascent PV at Home	Reduce PV energy system costs by 75%. Scaling Up Nascent PV At Home granted 2 year grant to increase domestic manufacturing.	$50 million
	University of California-Los Angeles and University of Arizona chosen to head DOE sponsored projects.	Advance CSP system efficiency and reduce costs	$10 million
	Department of Interior and Department of Defense	Collaborate to harness solar, wind, geothermal, and biomass technology to power military, reduce energy costs, and ensure energy independence	
	Solar Decathlon	Students and public become more aware of financial and environmental benefits from clean energy product and design solutions	
Wind	NOAA, DOE, and private companies	Promote a joint wind forecast improvement project	$ 6 million
	Choke Cherry and Sierra Madre Wind Energy Project	3000 MW power in Wyoming. Expected to create 1000 jobs in construction, operation, and maintenance sector.	
Tidal	NREL, Northwest National Marine Renewable Energy Center, Oregon State University, and University of Washington	Support wave and tidal energy development: research on wave energy forecast improvements, impacts on marine ecosystems, & compatibility of marine energy technologies	
Geothermal	DOE and U.S. Small Business Administration sponsored "Entrepreneurial Mentor Corps" Indie Energy	The reduction of energy waste through geothermal heating and cooling for Walgreens, Astellas Pharmaceuticals, and Medline Industries	
Biomass	Arizona State lead Algae Testbed Public Private Partnership	Tracks progress on algae biofuels commercialization	$15 million

	Project LIBERTY	Project LIBERTY is the first commercial scale cellulosic plant in the US. It should displace 13.5 million gallons of gasoline and produce up to 25 million gallons of ethanol per year in Iowa.	$105 million
	DOE, USDA and U.S. Navy	Produce advanced drop in aviation and marine biofuels	$510 million
Energy Efficiency	Better Buildings Program	Awarded 41 recipients money to improve building energy efficiency	$508 million
	Partnership for Sustainable Communites: HUD, EPA, DOT	Promote equitable affordable housing and transportation within existing communities.	
Fuel Cells	California	Built first tri generation plant (co production of hydrogen, electricity, & heat.	
	DOE and DOD	Create 18 fuel cell backup power systems at 8 military sites across the country. Test real world operations, identify tech improvements to enhance performance, and highlight benefits of fuel cell backup system	$6.6 million
	California, Oregon, and Washington	Advance hydrogen storage technologies for use in fuel cell electric vehicles	$ 7 million
Transportation	Clean Cities coalition	Advance energy, economic, and environmental security of the US by supporting local actions to reduce petroleum use in transportation	
	National Clean Fleets Partnership	Incorporate alternative fuels and advanced vehicles into the U.S. vehicle fleet. Representing over 275,000 vehicles current members are committed to deploy more than 20,000 advanced technology vehicles.	
	U.S. DRIVE is a public private partnership between DOE and car manufacturing industry	Accelerate development of advanced energy efficient technologies for cars and light trucks.	
	Google has partnered up with Clean Cities coalition	Promote commercialization of alternative powered vehicles.	$5 million
Economic Growth/Job Creation	Jobs and Innovation Accelerator Challenge	Accelerate bottom up innovation strategies encompassing urban and rural geographies. Coordinate Federal funding opportunities through a more efficient system. Develop a pathway for green jobs.	
	I6 Green Investment	Increase U.S. competitiveness and provide new jobs in support of a green innovation economy	$12 million
	National Clean Energy Business Plan Competition	Part of Obama's Startup America Program. Six student organizations participate in an EERE funded competition to provide promising energy technologies that will enable transition to a green economy	$2 million within a span of 3 years $100,000 annual prizes

Source: authors

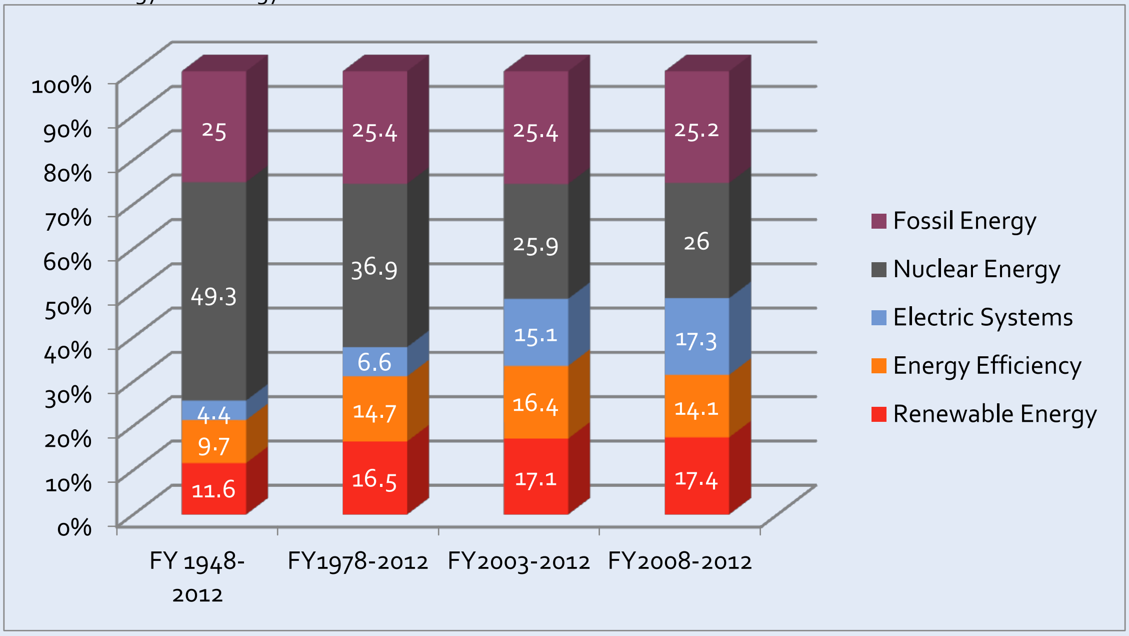
1.4. Research and Development

Another way in which the federal government engages clean energy and energy efficiency is to support the R&D process. Two basic categories are discussed here: a) basic scientific research which offers future potential for clean energy and energy efficiency technologies; and b) applied energy research which more specifically targets particular energy technologies.

A first insight into R&D funding allocations can be derived from reviewing the longitudinal evolution of R&D funding (see Figure 1-6). Similar to the tax incentive structure, the U.S. federal government primarily focused on R&D

support for fossil energy and nuclear power technologies from FY1948 through FY1977 (Sissine, 2012; 2011). Throughout that entire period, R&D spending on fossil energy technologies amounted to approximately $16.2 billion (in constant 2011 dollars) and $48.8 billion on nuclear fission and nuclear fusion R&D (Sissine, 2012). However, over time the federal government expanded its R&D program to include renewable energy and energy efficiency R&D. In FY2012, the DOE energy R&D funding budget amounts to approximately $3.3 billion (2011 dollars) (Sissine, 2012).

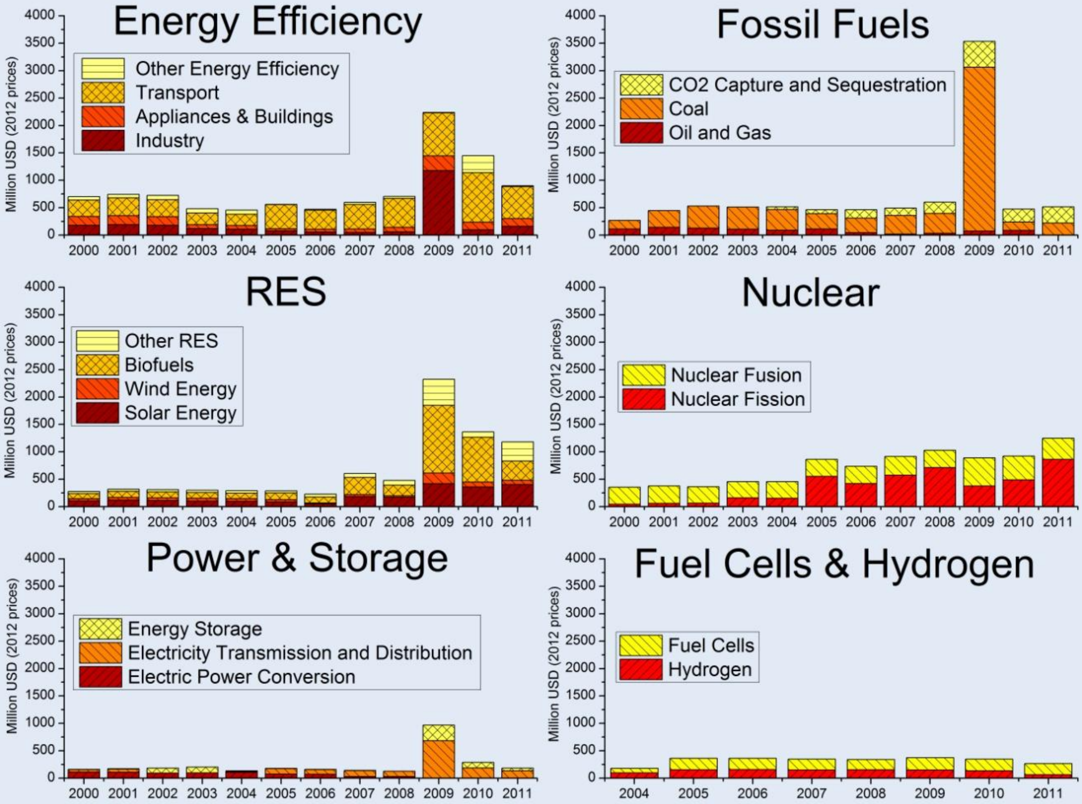
Figure 1-6. DOE Energy Technology Share Over Time.



Source: (Sissine, 2008; 2011; 2012)

The longitudinal breakdown as presented in Figure 1-6 can be further broken down into R&D support per target group. Figure 1-7 demonstrates how research, development, and deployment (RD&D) funding changed over time. The inflow of financial resources as provided by ARRA is clearly visible in 2009. Additionally, it can be seen that the 2009-2011 period saw a strong increase in both energy efficiency and renewable energy sources (RES) research funding. Whereas fossil fuel funding has essentially remained stable over the time period shown here, a slight increase in nuclear energy funding can be observed with nuclear fission as the main beneficiary of funding flows.

Figure 1-7. Research, Development, and Deployment (RD&D) funding per technology group over time.



Source: authors, data from IEA, 2013

Another insight can be derived from the R&D budget requests of the DOE (see Table 1-10). The enacted budget for the DOE Office of Science has remained relatively stable over the last three fiscal years (FY2010-FY2012) at around $5 billion. Budget requests are typically higher than the enacted budget (Sargent Jr., 2011). The fossil energy R&D budget has consistently been decreased over the three fiscal years and, in 2012, was enacted at $347 million – almost half of the 2010 budget. Such a decrease in R&D spending, however, can also be discerned for the other energy categories. For instance, energy efficiency and renewable energy R&D funding decreased to $1.6 billion in 2012, down from $1.9 billion in 2010.

Table 1-10. DOE energy related R&D funding.

$ millions	FY 2009		FY2010 (enacted)	FY2011 (enacted)	FY2012 (enacted)	FY2013 (enacted)
	Enacted	ARRA				
Basic Energy Services	1,572	555	1,636	1,678	1,688	1,800
High Energy Services	796	232	810	795	791	777
Biological and Environmental Research	602	166	604	612	610	625
Nuclear Physics	512	155	535	540	547	527
Advanced Scientific Computing Research	369	157	426	422	441	456
Fusion Energy Services	403	91	394	375	401	398
Other	504	244	499	420	396	410
ARPA-E	15	400	-	180	275	350
Basic Science Total	**4,773**	**2,000**	**4,904**	**4,843**	**4,874**	**4,992**
Energy Efficiency and Renewable Energy	1,676	5,500	1,973	1,564	1,682	2,072
Fossil Energy R&D	876	3,400	672	445	347	421

Nuclear R&D	515	0	787	726	765	770
Electricity Delivery and Energy Reliability R&D	85	0	125	105	99	103
Applied Energy Total	**3,152**	**8,900**	**3,556**	**3,019**	**3,168**	**3,717**

Source: (Sargent Jr., 2010; 2011; 2012a; 2012b).

The decrease in fossil energy R&D reflects the overall emerging picture from the analysis presented in this chapter: the Obama Administration has shifted attention away from fossil energy and towards energy efficiency and renewables. In terms of nuclear R&D, the budget remains relatively stable over the three fiscal years and in the FY2013 budget request. The Advanced Research Projects Agency – Energy (ARPA-E), a new program authorized by the *America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act* (America COMPETES) of 2007, was initiated to overcome long-term, high-risk technological barriers to the development of new energy technologies. Due to a $400 million injection from the 2009 ARRA, the ARPA-E didn't require a new budget in 2010, but for 2011 and 2012 $180 million and $275 million were allocated to ARPA-E, respectively.

1.5. A Brief Critical view on U.S. Action

While the previous sections describe the U.S. energy policy landscape and demonstrate U.S. commitment to a clean energy development future, a variety of factors can be identified with which to qualify the findings so far. Here, the report elaborates on three such factors: multi-level governance within the U.S., a comparison of the U.S. with other countries, and the development of the conventional energy market within the U.S.

1.5.1. State-level action in the U.S.

A key development within the U.S. in terms of climate and energy policy is the increasing prominence and activity of U.S. states and municipal governments. U.S. energy policy is now being formulated to a large extent by state governments through a multi-level governance policy scheme (Carley & Browne, 2012; Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Lutsey & Sperling, 2007). These state-level efforts to diversify, decarbonize, and decentralize the electricity market can now be seen as leading the U.S. energy policy portfolio. As such, with continued intransigence at the U.S. federal level on many energy and climate issues, the 'bottom-up' strategy that now emerges within the U.S. is a key development that is likely to drive the future U.S. energy policy landscape. This finding qualifies the importance of the Administration level actions and efforts as 'on-the-ground' efforts continue to advance (Bulkeley & Betsill, 2013) and perhaps creating sufficient momentum to break federal gridlock (Carley, 2012).

1.5.2. U.S. Renewable Energy Policy and Energy Efficiency Policy trails behind other nations in Europe and Asia

While this chapter of the report shows that the U.S: is strengthening its clean energy policy, in many respects it still trails behind other nations in the world with more advanced policy support structures for renewable energy and energy efficiency such as those found in, for instance, Denmark & Germany (Byrne & Kurdgelashvilli, 2011; Solangi, Islam, Saidur, Rahim, & Fayaz, 2011). For example, in terms of energy efficiency, the American Council for an Energy Efficient Economy (ACEEE) recently published an international scorecard in which the U.S. is ranked at ninth place out of the 12 nations they investigated (Table 1-11). A similar case can be made for renewable energy policy (REN21, 2009; REN21, 2013).

Table 1-11. Overview of the ACEEE scorecard.

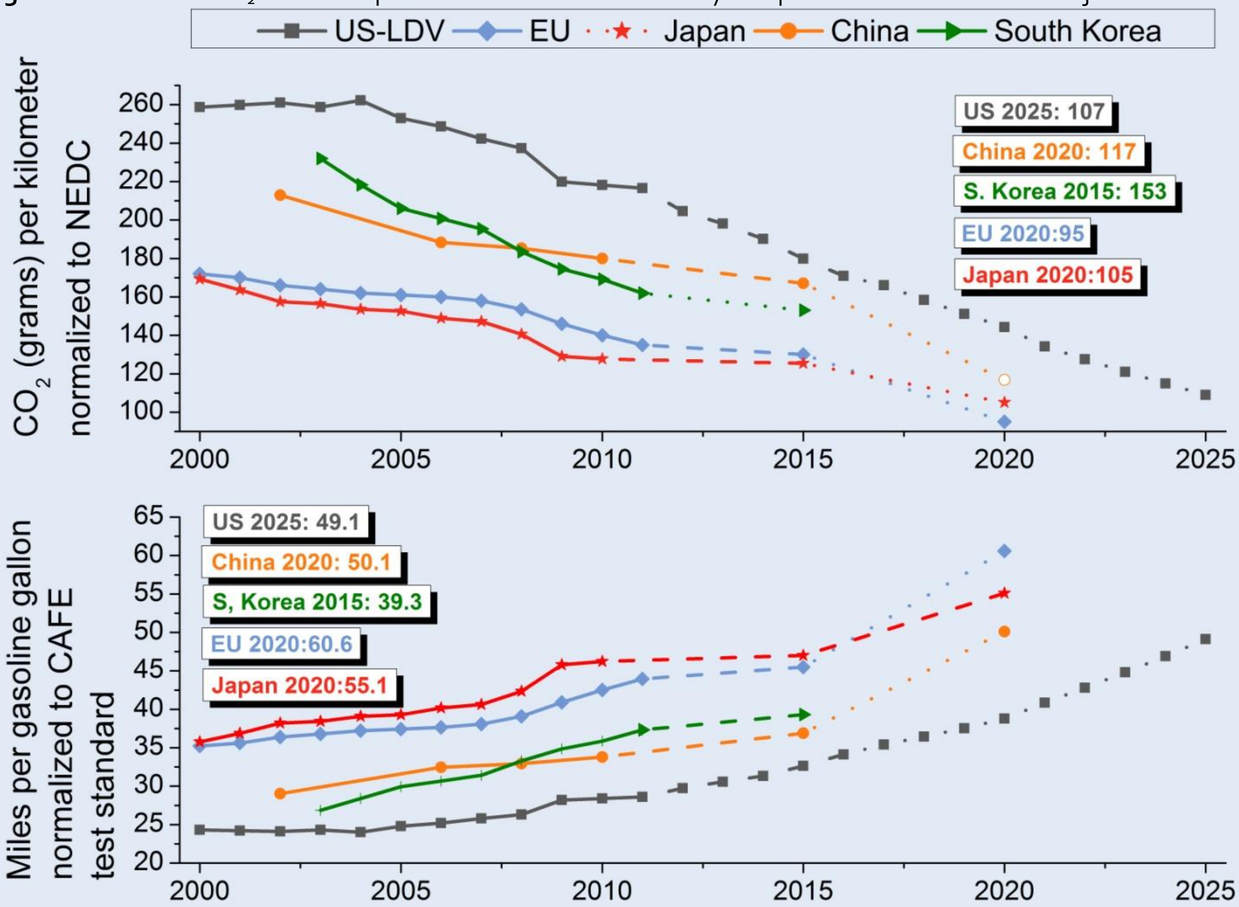
Country	National Effort	Buildings	Industry	Transportation	**Overall Score**
United Kingdom	2nd	4th	1st	1st	**1st**
Germany	1st	4th	5th	1st	**2st**
Italy	5th	7th	2nd	1st	**3rd**
Japan	2nd	9th	2nd	8th	**4th**

France	6th	7th	2nd	8th	**5th**
European Union	7th	3rd	7th	5th	**6th**
China	10th	1st	10th	1st	**6th**
Australia	4th	2nd	7th	10th	**6th**
U.S.	9th	4th	6th	12th	**9th**
Brazil	12th	10th	9th	5th	**10th**
Canada	8th	11th	10th	11th	**11th**
Russia	11th	12th	10th	5th	**12th**

Source: (Hayes, Young, & Sciortino, 2012)

As mentioned, the increased CAFE standards represent a significant break with historic CAFE levels. However, it is prudent to reflect on how the U.S. compares to other nations around the world. The International Council on Clean Transportation (ICCT) maintains a global update of passenger vehicle standards (see Figure 1-8). Out of the countries the ICCT maintains in its database, the U.S. ranks lowest in terms of both CAFE standards as well as greenhouse gas emission standards. While the U.S. can be seen to substantially advance its standards, the other nations around the world are expected to do the same slowing down the U.S.'s relative gain.

Figure 1-8. The U.S. CO_2 emissions per kilometer and fuel economy compared with several other major countries.



Source: adapted from ICCT, 2012

Notes: China's target reflects gasoline vehicles only. The target may be lower in terms of emissions per kilometer or higher in terms of miles per gallon after new energy vehicles are considered. U.S. figures includes light-commercial vehicles.

Solid dots and lines: historical performance;

Solid dots and dashed lines: enacted targets.

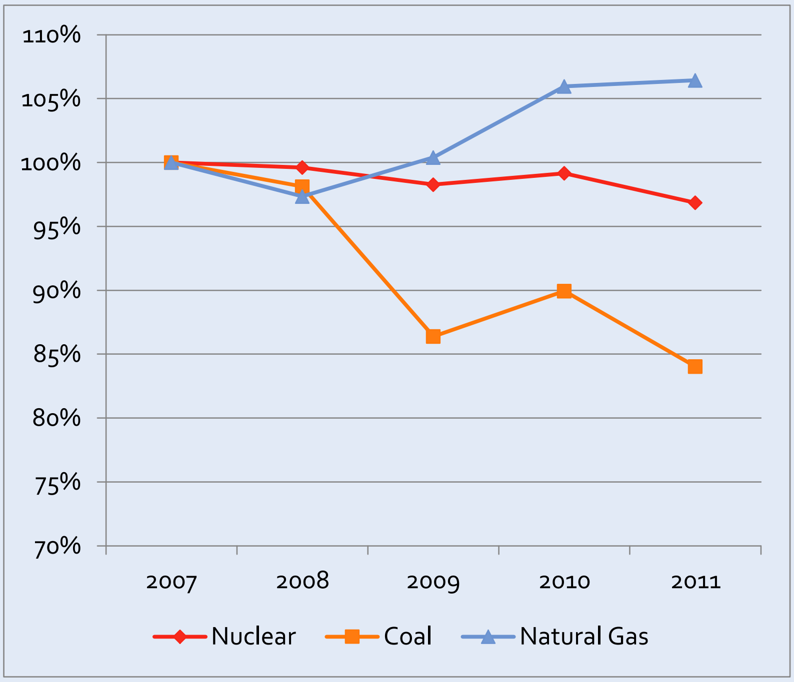
Solid dots and dotted lines: proposed targets.

Hollow dots and dotted lines: studied targets.

1.5.3. Conventional Fuels in the U.S.

Another key development is the strong growth in shale gas production. The maturation of new technologies – in particular, horizontal drilling and hydraulic fracturing – lead to an average growth of production of 48% throughout the 2006-2010 period (Energy Information Administration (EIA), 2012). In part due to the rapid exploitation of shale gas, natural gas prices reached historic lows in 2012 (Energy Information Administration [EIA], 2013). As a result, throughout 2012, natural gas was the preferred energy source of choice and frequently displaced coal-fired generation throughout the nation (see Figure 1-9) . This effect is compounded by the increasingly stringent electricity production standards (like the NSPS) that further diminish the viability of coal power relative to natural gas. The U.S., due to its low natural gas prices, has become a net exporter of natural gas rather than a net importer, thus considerably contributing to one of the U.S. core priorities of energy independence. The U.S. is currently undergoing a 'dash for gas' similar to the dynamic shift that occurred in the U.K.: over the last decade, U.S. shale gas production increased 12-fold and now represents approximately 25% of total U.S. gas production (Energy Information Administration (EIA), 2012). Moving forward, the EIA projects that shale gas will continue its rapid ascent, offsetting decline in the other main natural gas categories, and claiming a 46% share of the U.S. natural gas market in 2035 (EIA, 2012).

Figure 1-9. Capacity factors of major conventional fuels over time (2007=100).
The figure clearly demonstrates the fall in capacity factor in coal and the rising capacity factor in natural gas, highlighting the increased use of gas to substitute coal's role in the energy market.



Source: authors, calculated from EIA, 2013 data

1.6. Concluding Remarks

The overview presented in this chapter demonstrates the increased commitment to renewable energy and energy efficiency that occurred during the first Obama Administration. With his release of the Climate Action Plan, the introduction of the source performance standards, and other measures, it is clear that the second term of the Obama Administration will be at least equally ambitious. While a comprehensive shift to renewable energy and energy efficiency can be seen to take place in U.S. federal energy policy, much attention remains to be given to the dominant conventional energy sources as demonstrated, for instance, by nuclear's R&D budget totaling $3.5 billion over the 2009-2013 time period. Also, a brief critical investigation into U.S. energy policy additionally demonstrates that the U.S. still has much work that needs to be done. A historically dramatic increase in CAFE standards, for example, still trails many other developed nations and will continue to do so for at least another decade if not even more stringent targets are adopted.

The U.S. future energy policy landscape remains difficult to predict. While Chapter 3 attempts to discern some initial moving parts of the U.S. energy policy portfolio and the influence of the second term of the Obama Administration upon it, many dynamics – such as highlighted in this chapter – limit predictive capability. For instance, due to its relatively recent surge in production, regulatory efforts regarding shale gas production still need to crystallize out. At the federal level, the Bureau of Land Management (BLM) is trying to create updated regulations for shale gas development on federal lands, and the EPA has been performing research and establishing regulations for the (environmental) risks associated with shale gas production (Richardson, Gottlieb, Krupnick, & Wiseman, 2013). Similarly, state regulation demonstrates a high level of heterogeneity among the states, regulating shale gas production with different tools and strongly variable stringency (Richardson, Gottlieb, Krupnick, & Wiseman, 2013). Other key elements in shale gas regulation are: a) a lack of transparency; b) opaque case-by-case regulatory tools limiting insight into the effectiveness of these tools; and c) the potential for lax enforcement due to state dynamics limiting regulatory effectiveness (Richardson, Gottlieb, Krupnick, & Wiseman, 2013). These findings highlight the uncertainty associated with the rise of shale gas and what it will mean for the overall U.S. energy policy landscape.

The next chapters will determine how effective the applied policy portfolio has been (or will be) in meeting its targets (chapter 2), what the consequences of a second Obama Administration could be and how this relates to South Korea (Chapter 3), and how U.S.-South Korea collaboration might unfold (Chapter 4).

2.0. U.S. Energy Policy Impact Analysis

This chapter assesses the effectiveness of major clean energy policies and programs of the current U.S. administration in terms of job creation, economic impact, and greenhouse gas (GHG) reduction. The examined initiatives are drawn from the pool of the policies and programs that have been documented in Chapter 1, and grouped into three categories: National Standards, Financial Initiatives, and Other Initiatives. The rationale for this grouping is to offer a representative assessment of the overall U.S. clean energy initiatives in relation to economic and environmental benefits associated with important regulatory, economic and policy initiatives of the Obama administration. The initiatives that are included in analysis are summarized in Table 2-1. The featured initiatives were chosen based on three criteria: the potential to bring large economic and environmental impacts, availability of economic and environmental data, and diversity of initiatives, ranging from regulatory and financial incentives to market development initiatives. By taking this approach, the report provides a comprehensive view of the projected economic and environmental performance of the clean energy portfolio of the current U.S. administration.

Table 2-1. U.S. Clean Energy Initiatives under Analysis

National Standards	Financial Incentives	Other Initiatives
Corporate Average Fuel Economy Standards	Production Tax Credit	American Recovery and Reinvestment Act 2009
2012 Clean Energy Standards Act	Investment Tax Credit	Sunshot Initiative
Renewable Fuel Standards	Section 1603 Grants	

2.1. National Standards

As detailed in Chapter 1, several national standards are either in place or being considered to advance clean energy in the U.S. Here, this section analyzes three national regulatory standards that aim to promote clean energy development: the CAFE standards, the 2012 Clean Energy Standard and the Renewable Fuel Standard. These standards play an important role in renewable energy development and transportation and are indicative of the Obama Administration's efforts to advance clean energy.

2.1.1. Corporate Average Fuel Economy (CAFE) standards

The objective of the CAFE standards is to reduce U.S. dependence on foreign petroleum by enhancing the fuel efficiency of the transportation sector. As highlighted in Chapter 1, the Obama Administration introduced two recent updates of CAFE standards in 2009 and 2012 after a long time of CAFE standard stagnation. The model year (MY) 2012-2016 set a mandate of 35.5 miles per gallon (mpg) of nationwide fleet average fuel economy by 2016[6]; up from 25.5 mpg. Similarly, the Presidential Memorandum "Improving Energy Security, American Competitiveness and Job Creation, and Environmental Protection Through a Transformation of our Nation's Fleet of Cars and Trucks" (The White House, 2010) issued on May 21, 2010, expanded the January 26, 2009, Memorandum which established the CAFE Standards update for 2012-2016 Model Year (MY) by requesting improved federal standards for fuel efficiency. In response, the National Highway Traffic Safety Administration (NHTSA) and Environmental Protection Agency (EPA) jointly developed new rules for passenger vehicles and light trucks that outline new standards equivalent to 54.5 miles per gallon for 2017-2025 MYs (The White House, 2012).

The NHTSA CAFE standards are further complemented by the Environmental Protection Agency's (EPA) CO_2 emissions per mile standards. As noted by Anderson et al. (2011), the two standards aim to realize the same

[6] Anderson et al. (2011) suggest that automakers can meet the 2012-2016 MY CAFE standards with moderately costly technologies and other modifications (i.e. weight reductions) without any deterioration in power, acceleration, or other attributes.

outcome. Essentially, CAFE standards represent an implicit tax on inefficient vehicles (Anderson et al., 2011), and thus motivate changes in vehicle design and the introduction of attributes that realize reductions in fuel consumption. However, the fuel economy standards only affect new vehicle models, and therefore they only gradually improve the overall fuel economy (Anderson et al., 2011). In the short-term, more efficient cars might encourage additional driving. This so-called "rebound effect," however, has been shown to be moderate (Small & Dender, 2007).

While Anderson et al. (2011) note that it is too complicated to directly differentiate the economic effects of the CAFE standards, the authors do provide several considerations as to their potential effects. First, the binding characteristic of the CAFE standards has been able to spur better fuel economy specifications in new models produced by the automobile industry. This indicates that regulation such as CAFE can motivate action by private industry on more energy efficient transportation technology, which would not likely take place otherwise. Additionally, Anderson et al. (2011) note that the MYs 2012-2016 induced fuel economy increases from 25 to 35.5 miles per gallon have the potential to likely reduce long-run fuel consumption from the U.S. transportation sector by approximately 30%. Sarica and Tyner (2013a) find that the MY 2012-2016 standard is a cost effective measure resulting in a net decrease in crude oil imports of around 1.1 billion barrels of oil equivalent by 2045. However, Small (2010) argues that there are potential technological constraints to continued tightening of the standards which may result in manufacturers opting to pay the non-compliance fine rather than investing in more energy efficient technology.

A NHTSA (2010) study suggests that, from the perspective of the vehicle buyer, the economic benefits associated with purchasing a more efficient model significantly exceed the costs associated with making the model more efficient. The NHTSA assessed the total costs, benefits and net benefits of the MYs 2012-2016 standards. Table 2-2 presents estimated costs, benefits, and net benefits in billions of 2007 dollars from the implementation of the CAFE standards MYs 2012-2016 under two different discount rates, 3% and 7%.

Table 2-2. Estimated costs, benefits, and net benefits from CAFE standards MYs 2012-2016, billions of 2007 dollars

3 % Discount Rate	Costs	$51.8
	Benefits	$182.5
	Net Benefits	**$130.7**
7 % Discount Rate	Costs	$51.8
	Benefits	$146.3
	Net Benefits	**$94.5**

Source: adapted from NHTSA, 2010. For an evaluation of MY2017-MY2025, see also NHTSA, 2012

As Table 2-2 suggests, the NHTSA estimates that the CAFE MYs 2012-2016 standards will bring $95-$131 billion of net benefits to the U.S. economy over a vehicle's lifetime depending on the discount rate (NHTSA, 2010). The NHTSA has also estimated that the net economic benefits of the CAFE standard in the period MY2017-2025 could range between $326-$541 billion over vehicles lifetime depending on the discount rate (NHTSA, 2012). In addition, the CAFE MY2012-2016 standard is expected to create a cumulative 102,768 direct job-years for 2012-2016 (NHTSA, 2010), while the CAFE MY2017-2025 standard is expected to contribute to the creation of 30,300-148,800 direct job-years from 2017 to 2025 (National Resources Defense Council [NRDC], 2012).

The transportation sector accounts for 28% of the primary energy consumption in the U.S. and it is also responsible for 72% of the U.S. petroleum consumption, primarily for passenger vehicles and light trucks (NHTSA, 2012a). The NHTSA (2012a) notes that, through 2035, fuel consumption by the transportation sector will account for the main share of energy imports and as such the fuel economy standards are expected to contribute to reduced energy insecurity and energy imports. The reduction of energy imports through improved fuel economy is expected to save U.S. consumers $1.7 trillion in gasoline costs, and reduce oil consumption by 2.2 million barrels a day by 2025 (The White House, 2012). Assuming that car manufacturers will not voluntarily exceed standards set by the EPA and NHTSA, NHTSA performed a scenario analysis on fuel savings as a result of the implementation of the MY 2017-2025 standard. Depending on the level of stringency in the implementation of the new standard, fuel savings range from 751 to 1767 billion gallons over the 2017-2060 period under the non-voluntarily assumption[7] (NHTSA, 2012a). The NHTSA further estimated that the projected CO_2 reductions due to the CAFE Standard for MYs 2012-2016 would reach 665 million tons over the lifetime of the vehicles (NHTSA 2010). Modeling analysis by Sarica and Tyner (2013a) suggests that CAFE MYs2012-2016 has the potential to bring CO_2 emissions reductions in the order of 500 million tons by 2045 compared to their reference case. In case of the CAFE Standard for MYs 2017-2025, the NHTSA estimates that CO_2 reductions would reach 1.2-1.3 billion tons over the lifetime of the passenger cars and 0.7-0.8 billion tons over the lifetime of the light duty vehicles. Accordingly, the total CO_2 emissions reductions of the MYs 2017-2025 CAFE Standard are expected to reach 1.9-2.0 billion tons over the life of the vehicles (NHTSA 2012b). Despite accelerated vehicle development cycles, however, making the necessary changes will be challenging especially for MY 20112-2016 standards due to the relatively short timeframe available (Cheah & Heywood, 2011).

2.1.2. Clean Energy Standard Act

While the Clean Energy Standard act was proposed during President Obama's first term, the act did not (yet) attract sufficient Congressional support and has been redirected to a committee for further scrutiny. The objective of the proposed 2012 Clean Energy Standard Act was to achieve 84% electricity sales from clean electricity [8] at the national level by 2035. This has later become known as the '80% by 2035' proposal, as other proposals have also focused on targets around 80% clean electricity. A modeling study by the U.S. Energy Information Administration found only minor impacts associated with the implementation of the standard in terms of the economy and job creation (see Table 2-3). The EIA's findings show that there is no real significant difference between the reference scenario and the clean energy standard (CES) scenario for employment, Gross Domestic Product (GDP), and GDP/capita. However, in terms of electricity prices, a substantial increase of about 18.3% is projected under the CES scenario. Electricity prices remain about the same under both scenarios until around 2025. The rise in electricity prices is due to the notion that, prior to 2025, an energy shift to natural gas and biomass at existing facilities provides for relatively easy compliance with the standards. However, after 2025, new capacity additions in renewables, combined cycle, and nuclear energy become necessary to maintain compliance with the CES standard (EIA, 2012c).

Table 2-3. Key economic indicators under a Clean Energy Standard scenario compared to business as usual, 2025 and 2035

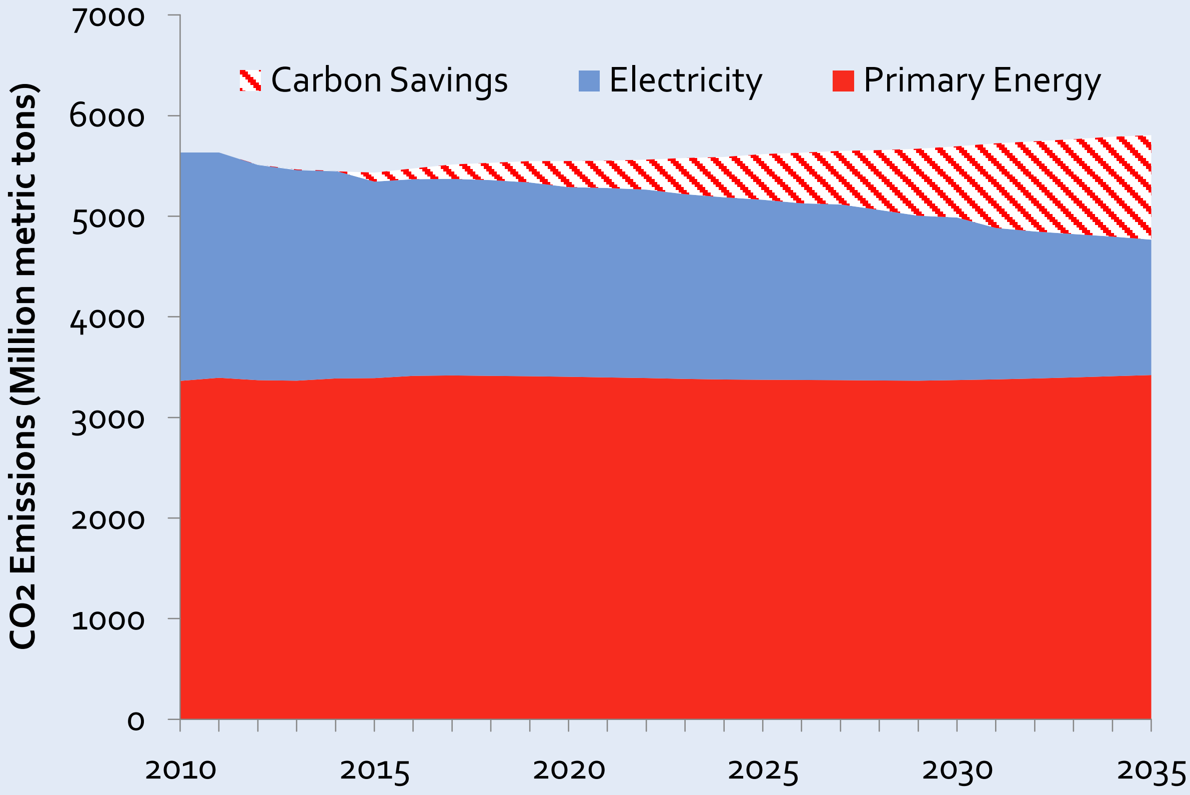
	2010	2025		2035	
		Reference	CES	Reference	CES
GDP (billion 2005 dollars)	13,088	19,176	19,135	24,639	24,508
Per capita GDP (thousand 2005 dollars/person)	42.1	53.6	53.4	63.2	62.8
Employment, non-farm (million)	129.8	153.3	153.3	166.7	166.2
Employment, manufacturing (million)	11.5	11.4	11.4	9.1	9.0
Average end-use electricity price (2010 cents/KWh)	9.78	9.29	9.65 (+3.9%)	9.54	11.29 (+18.3%)
Average delivered natural gas price (2010 dollars/mcf)	7.33	8.03	8.06 (+0.4%)	9.40	9.47 (+0.7%)

Source: EIA, 2012c

In terms of carbon emission reductions, the EIA modeling analysis estimates that implementation of the standard could reduce total U.S. energy-related CO_2 emissions by 8% in 2025 and 18% in 2035 compared to the reference scenario (Energy Information Administration [EIA], 2012c). Additionally, the report suggests that projected annual U.S. electricity sector emissions are reduced by 20% in 2025 and 44% by 2035 below the reference scenario (EIA, 2012c). Cumulative emissions reductions as a result of the implementation of the standard are projected to reach 10.5 billion tons of CO_2 equivalent (see Figure 2-1). Sarica & Tyner (2013a) too find that the application of CES could contribute to large CO_2 emissions reductions at around 1.8 billion tons of carbon dioxide equivalent compared to the reference case by 2045. Additionally, Sarica & Tyner (2013a) find that the RFS could result in a 50 million barrel crude oil import reduction by 2045.

[7] NHTSA ran also other scenarios on other assumptions. For instance, the B family of scenarios assume voluntary compliance by car manufacturers motivated by demand for efficient vehicles (NHTSA, 2012).
[8] The definition of 'clean electricity' includes nuclear and clean coal produced electricity (EIA, 2012).

Figure 2-1. CO2 emissions reductions due to the Clean Energy Standard, 2010-2035.



Data Source: (EIA, 2012c)

2.1.3. Renewable Fuel Standard

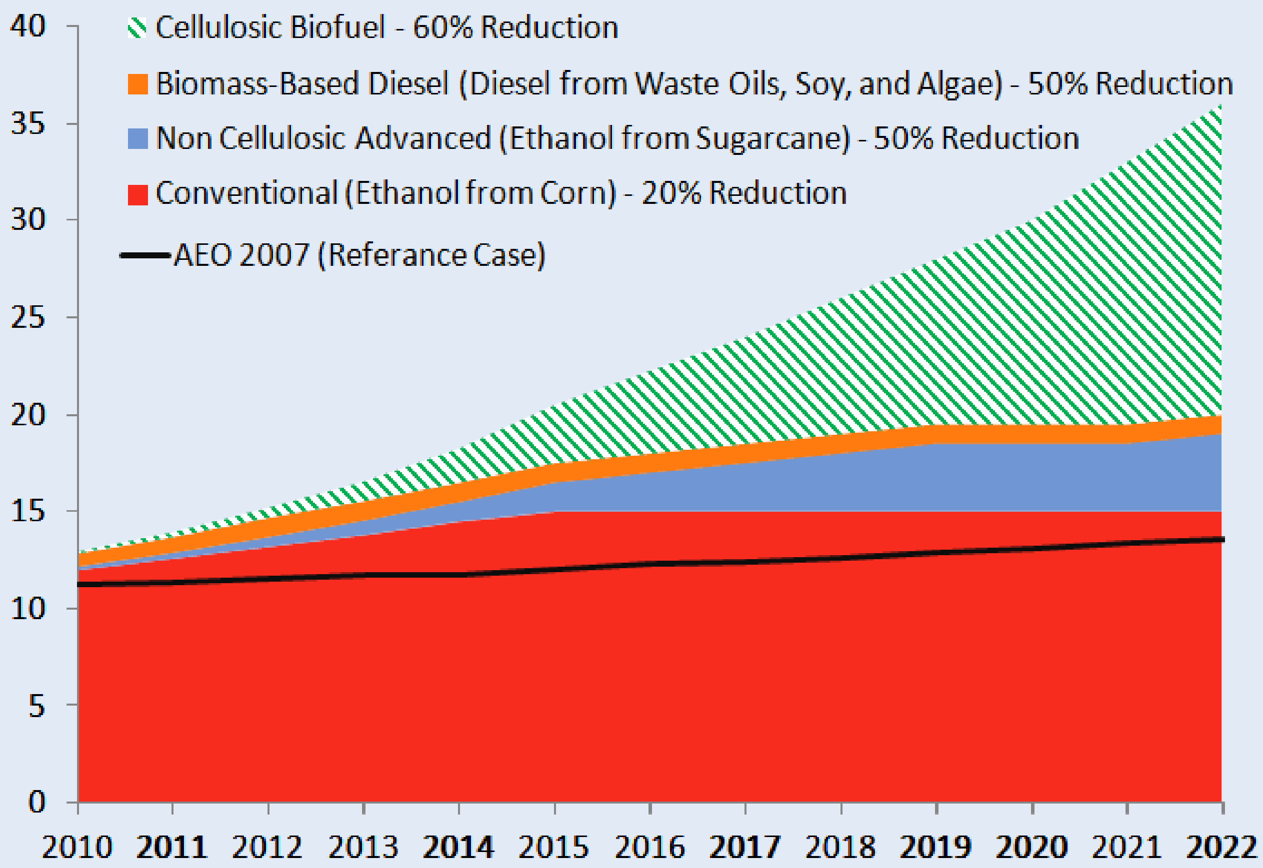
Similar to the CAFE standards, the objective of the updated Renewable Fuel Standard (RFS2) is to reduce the dependence of the U.S. transportation sector on petroleum. The original Renewable Fuel Standard (RFS), mandating minimum level of renewable fuel volume in transportation fuel sold in the U.S., was introduced by the George W. Bush Administration under the Energy Policy Act of 2005. The Bush Administration expanded the scope of the standard in 2007 by including the provision of an (extended) renewable fuel use that would amount to 12.95 billion gallons by 2010. In 2010, the Obama Administration finalized the regulatory specifications of the application of the standard, which mandates that biofuel use reach 36 billion gallons by 2022 (as part of the Energy Independence and Security Act of 2007) (EPA 2010a).

The standard covers four categories of biofuels, which are conventional biofuels, biomass-based biodiesel, cellulosic and non-cellulosic biofuels. The conventional biofuels include ethanol from corn. The biomass-based category includes biodiesel, and also 'renewable diesel,' as long as fats and oils are not co-processed with petroleum. The cellulosic biofuels includes renewable fuel produced from cellulose, hemicellulose, or lignin. The non-cellulosic biofuels include ethanol from sugarcane (Argyropoulos, 2010; EPA, 2010b).

Each above described category must meet a minimum life cycle greenhouse gas emission level threshold. The life cycle greenhouse gas thresholds are measured against greenhouse gas emissions from conventional fuels (i.e., gasoline and diesel fuels) being displaced by biofuels. As such, biomass-based diesel and non-cellulosic biofuels are to meet 50% of the life cycle greenhouse gas reduction threshold, non-cellulosic cellulosic biofuel is to reach a 60% level, and conventional biofuels (mainly derived from corn ethanol) need to meet 20$ of the life cycle greenhouse gas reduction threshold.

Biomass-based diesel, cellulosic and non-cellulosic biofuel together represent the 'advanced biofuel' category. The updated standard (RFS2) significantly increases the contribution of advanced biofuels into the total mandated renewable fuel volume (see Figure 2-2). The conventional biofuels are expected to increase from 12 billion gallons in 2010 to 15 billion gallons by 2015 and stay at this level. The total advanced biofuel are expected to grow from little less than 1 billion gallons in 2010 to 21 billion gallons in 2022. At the end of the evaluation period, three quarters of advanced biofuels are expected to come from cellulosic biofuels.

Figure 2-2. Renewable fuels under the Renewable Fuel Standard in million barrels, 2010-2022



Source: (Environmental Protection Agency [EPA], 2010b)

In economic terms, a main expected result of RFS 2 is reduced dependence on foreign oil. By 2022, compared to the reference case (based on EIA's Annual Energy Outlook, 2007) the mandated renewable fuel is expected to displace about 13.6 billion gallons of petroleum-based gasoline and diesel, which corresponds to around 7% of annual transportation fuel consumption in the U.S. (Schnepf & Yacobucci, 2012). In addition, the increased share of renewable fuel is expected to decrease the costs associated with gasoline and diesel by $0.024 and $0.121 per gallon respectively. Another positive expected economic contribution is an annual $13 billion increase in income in the U.S. agricultural sector due to the expanded demand for agricultural products such as corn and soybean. However, considering that biofuels and food products share the same base agricultural products – e.g. soy and corn – food prices may be negatively affected by the implementation of the standard by as much as $10 annually per capita by 2022 or a total of over $3 billion (Schnepf & Yacobucci, 2012; EPA, 2010). Sarica and Tyner (2013a) find that RFS could lead to a net decrease in crude oil imports of around 250 million barrel of oil equivalent by 2045.

Full implementation of RFS2 by 2022 is expected to result in annual GHG emissions reductions of 138 million metric tons of CO_{2e}, compared to the reference case scenario of the U.S. Energy Information Administration's Annual Energy Outlook which set the projected renewable fuel volumes in 2022 at 13.56 billion gallons (EPA 2010). Due to technical and environmental aspects of biofuels production, CO_2 emissions and some other GHG emissions such as carbon monoxide and benzene are expected to decrease. However, certain air contaminants are expected to increase including nitrogen oxides, acetaldehyde, and ethanol (Schnepf & Yacobucci, 2012). The 138 million CO_{2eq}

reductions is the net effect on emissions which is combined effect of 146.645 million tons of CO_2 emissions reductions and 8.234 million tons increases in non-CO_2 greenhouse gas emissions (i.e. due to land use changes associated with biofuels production) (EPA 2010). [9] Similarly, Sarica and Tyner (2013a) too find that the application of RFS would contribute to CO_2 emissions reductions: at around 100 million tons of carbon dioxide equivalent by 2045.

2.2. Financial Incentives

This section evaluates three financial incentives supported by the current administration to bolster renewable energy development: The Production Tax Credit (PTC), the Investment Tax Credit (ITC), and Section 1603 Grants. These incentives can have a significant impact on growth of renewable electricity generation in the U.S. and are discussed below.

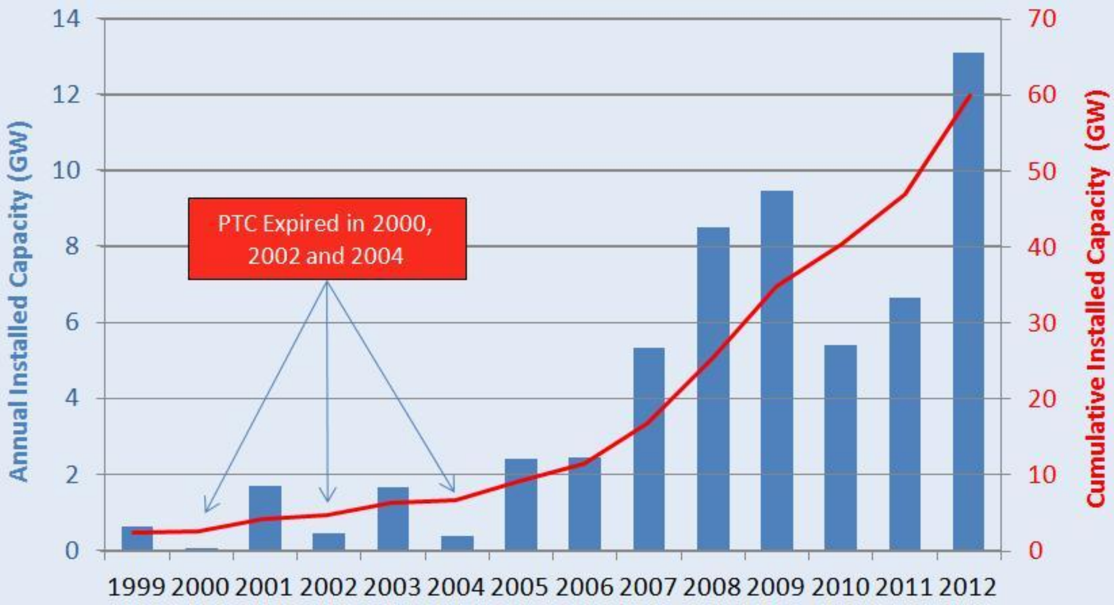
2.2.1. The Production Tax Credit (PTC)

Authorized by the Energy Policy Act of 1992 and amended over time, the Production Tax Credit is an inflation-adjusted financial incentive that aims to support widespread renewable energy development and clean electricity production including wind, biomass, geothermal, small hydropower, tidal energy, wave energy, ocean thermal, landfill gas, and muncipal solid waste. However, the effects of the Production Tax Credit (PTC) on the renewable energy market have been most prominently researched for the wind energy sector (see, e.g., Lu et al., 2011; Wiser, Bolinger, & Barbose, 2007; Wiser, 2007; Riti, 2010). This is due in part to the fact that the wind energy sector was awarded the vast majority of federal Production Tax Credits (Brown, 2012). The Obama Administration extended the PTC for wind turbines, which was set to expire in 2012, until the end of 2013, widely considered a positive decision, as 2013 wind capacity additions could have dropped to as low as 1GW if the PTC was not extended (Brown, 2012).

While the PTC has been shown to heavily support the U.S. wind power sector, the lack of consistency with which the policy is applied (the PTC was not renewed in 2000, 2002, and 2004) has damaged wind power industries (Platzer, 2012; Wiser, 2007). As it is not a permanent part of the U.S. tax code, the incentive needs to be periodically renewed. As can be noted in Figure 2-3, PTC lapse – expiration of the incentive prior to renewal – has led to deployed wind capacity collapse: compared to the previous year's installed capacity, deployed wind capacity slowed by 93%, 73%, and 77% in the lapse years (Platzer, 2012). In contrast, the years in which the PTC was re-installed, wind power capacity deployment jumped. This is a strong indicator of the influence of the PTC on the wind power market. Additionally, uncertainty drives market volatility as companies wait for renewal of the policy before continuing with proposed projects (Brown, 2012). A stable and long-term PTC incentive would introduce market stability but might, paradoxically, motivate smaller amounts of capacity additions: while, on the one hand, the uncertainty produces volatility, it also appears to push investors and developers to enter the market in order to capitalize on the financial resources made available (Brown, 2012).

[9] Yi et al. (2013) suggest that accounting for reductions in U.S. agricultural subsidies due to the RFS measure can have a significant effect on greenhouse gas emissions as ethanol production produces considerable land use changes. They find that, for the U.S. case, reductions in agricultural subsidies can diminish land use change by about 70%.

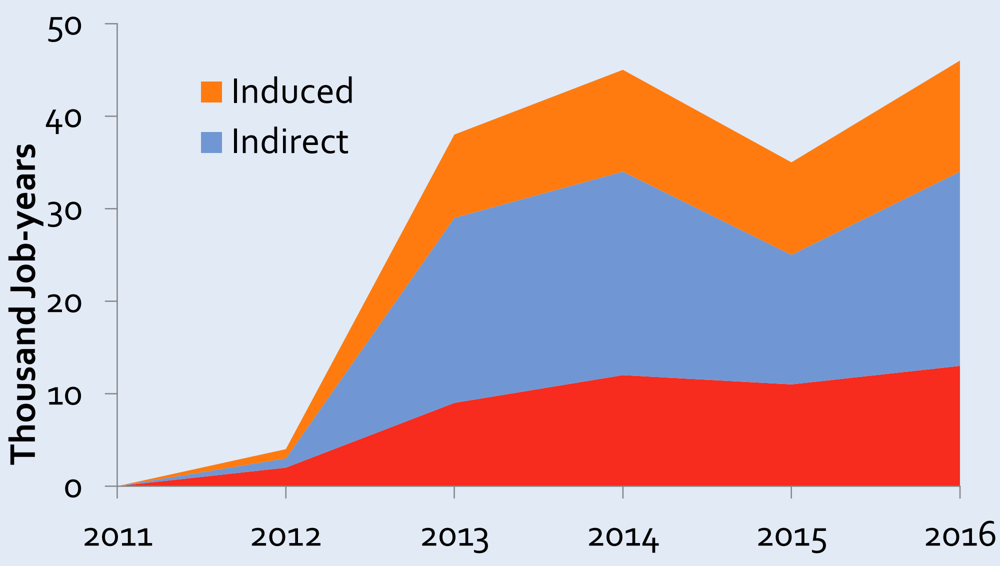
Figure 2-3. Wind Capacity in U.S. and PTC Lapse Years



Data Source: (Earth Policy Institute 2013 (http://www.earth-policy.org/data_center/C23); AWEA, 2013)

A Navigant (2012) study presented a comprehensive impact analysis for the wind energy market, detailing two scenarios: one in which the PTC for wind was extended to 2016 and one in which the PTC was allowed to expire in 2012. The study calculated that if the PTC is extended to 2016, the incentive would add a cumulative of 89,000 job-years in the manufacturing sector by 2016, as well as an additional 80,000 job-years for wind construction and O&M jobs in the same period. The resulting total job-years would be 169,000. As Figure 2-4 shows below, the category of jobs created are classified as direct, indirect and induced. For their analysis Navigant (2012) defined direct jobs as manufacturing of turbines, blades and towers, manufacturing of any other components were included in indirect jobs category. The indirect jobs are defined as employment created in the supply chain serving the direct manufacturers. The induced jobs are product of greater economic activity spurred by direct employment. Navigant estimated that with no PTC extension, the U.S. wind market would have shrunk significantly in 2013. Total wind supported jobs would have dropped by nearly half, from 78,000 in 2012 to 41,000 in 2013.

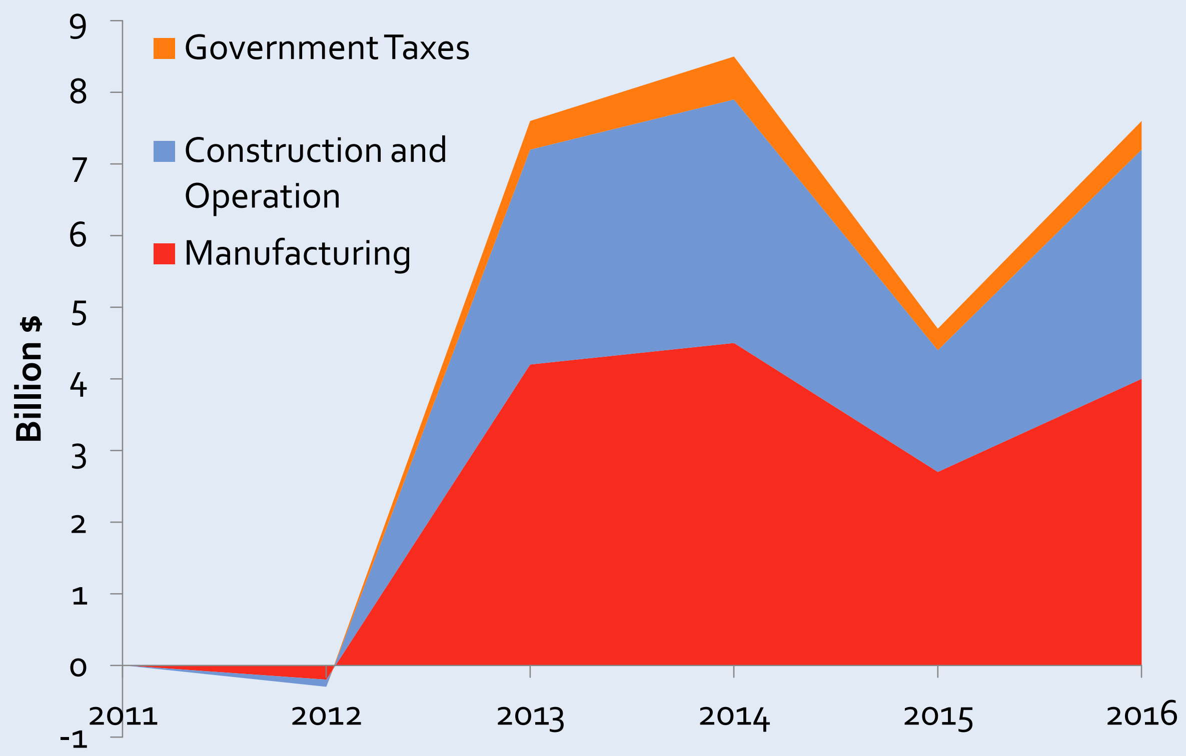
Figure 2-4. Job Creation as a Result of the PTC



Data Source: (Navigant, 2012)

Navigant (2012) also estimated that a four-year PTC extension would result in a $28 billion cumulative increase in economic activity through from 2012 through 2016 compared to the scenario in which the PTC was not extended. In the case that the PTC would not be extended it was estimated that the total wind sector investments would drop by nearly two-thirds, from $15.6 billion in 2012 to $5.5 billion in 2013.

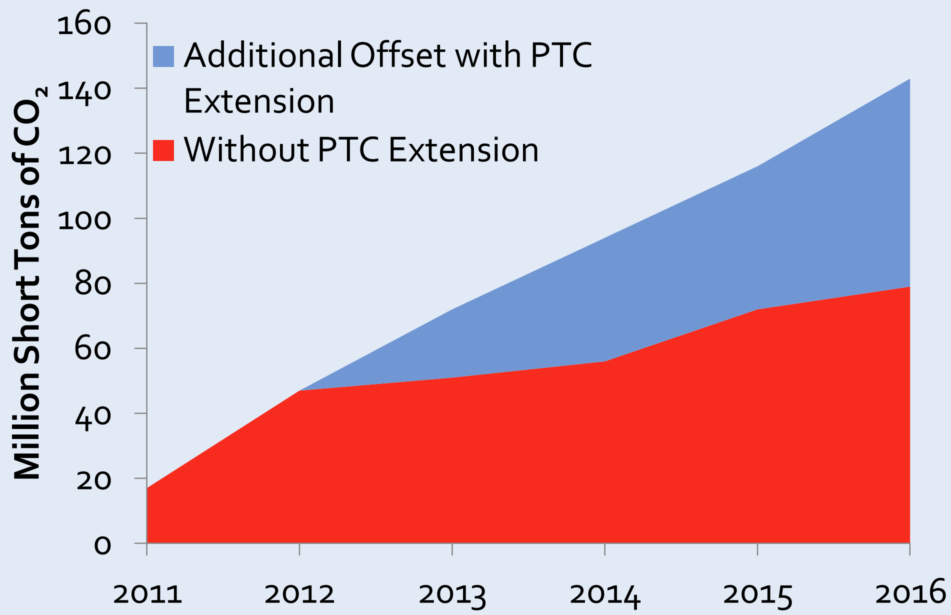
Figure 2-5. Economic Investment as a Result of the PTC



Data Source: (Navigant, 2012)

Navigant (2012) additionally determined the amount of CO_2 emission avoided with a PTC extension through 2016. A PTC extension would result in an additional 170 million short tons (154 million MT) of cumulative CO_2 emissions reductions compared with the scenario without extension (See Figure 2-6). Nordhaus, et al (2013), using a National Energy Modeling System (NEMS)-based model, however, find a less than 0.3% decrease in U.S. CO2 emissions as a direct result of the PTC from 2010-2035.

Figure 2-6. Emission reduction as a result of the PTC



Data Source: (Navigant, 2012)

2.2.2. The Investment Tax Credit (ITC)

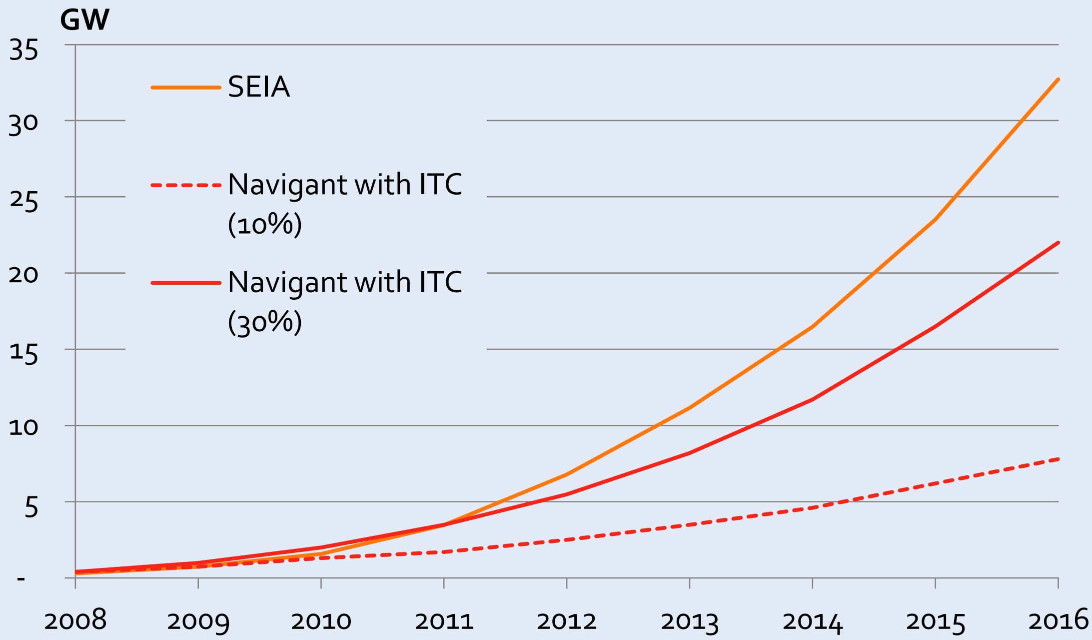
The Investment Tax Credit aims to offer 10-30% tax credit to qualified investments depending on the type of energy technology (30% for solar, fuel cells, small wind, and PTC eligible technologies, 10% for geothermal, micro-turbines and CHP). Under the current administration, the American Recovery and Reinvestment Act (ARRA) introduced in 2009, has extended in the ITC option to renewable energy developers previously limited to PTC, and also repealed restrictions on the ITC for projects that also received "subsidized energy financing" (e.g., tax exempt bonds). According to Cook et al. (2012), this change can have a significant impact on renewable energy project financing as the immediate provision of tax credits offered by the ITC (as opposed to one spread out over several years), is attractive to investors. Higher investments at lower discount rates are an expected result, benefitting both investor, project developer, and the renewable energy sector (Cook et al., 2012).

Solar electricity projects are ineligible for the PTC and, as such, have to rely on the ITC for federal funding. As a result, the ITC is a major component driving the growth of the solar electricity market (Solangi et al., 2011). In a (pre-ARRA) 2008 report Navigant investigated the ITC and its implications for the solar energy market (Navigant, 2008). The report concludes that the solar energy market is "highly dependent" on the ITC. Similarly, the Solar Energy Industries Association (SEIA) – instrumental in realizing the eight-year extension of the ITC in 2008 – produced *The Case for the Solar Investment Tax Credit* fact sheet in September 2012 in which they argue that one of the key advantages of the ITC is that it provides market certainty on the long-term (SEIA, 2012).

In October of 2008, the Energy Improvement and Extension Act of 2008 extended ITC until 2016. The eight year extension of the ITC removed the previous $2,000 cap on the residential credit and removed certain restrictions of the use of the ITC with other tax stipulations (such as the Alternative Minimum Tax). The modifications and extension of the ITC in 2008 substantially increased the value of the solar credits and continue to drive market growth in solar energy (Bolinger, Barbose, & Wiser, 2008). The stability offered through the "unprecedented" eight year extension of the financial incentive realizes a stable policy environment for solar energy (Bolinger, Barbose, & Wiser, 2008). The increased value of the ITC, and the stability offered through its long-term extension have, in part, contributed to the reduction in cost for solar energy and, as a result, supported – in combination with other incentives such as state renewable portfolio standards –strong market growth (e.g., Barbose, Darghouth, & Wiser, 2012; IREC, 2012).

Before the ITC extension Navigant (2008) conducted the analysis for two scenarios. The first was the "Current ITC" scenario, which assumed a 30% tax credit for residential systems (capped at $2,000 for qualified solar properties) and a 30% tax credit for commercial properties. The second was the "Reduced ITC" scenario, which assumed that the ITC would expire at the end of 2008, eliminating the residential credit and decreasing the commercial credit to 10%. The extension of the ITC was projected to yield energy market sizes three times larger than without extension (28GW vs. 9 GW installed from 2009-2016). The recent projection of the Solar Energy Industries Association (SEIA, 2013) showed that Navigant's projections under ITC extension were conservative, and actual PV installations might be even higher than originally were forecasted (see Figure 2-7). Therefore, projected economic and jobs values reported by Navigant (2008) can be seen as a conservative estimate.

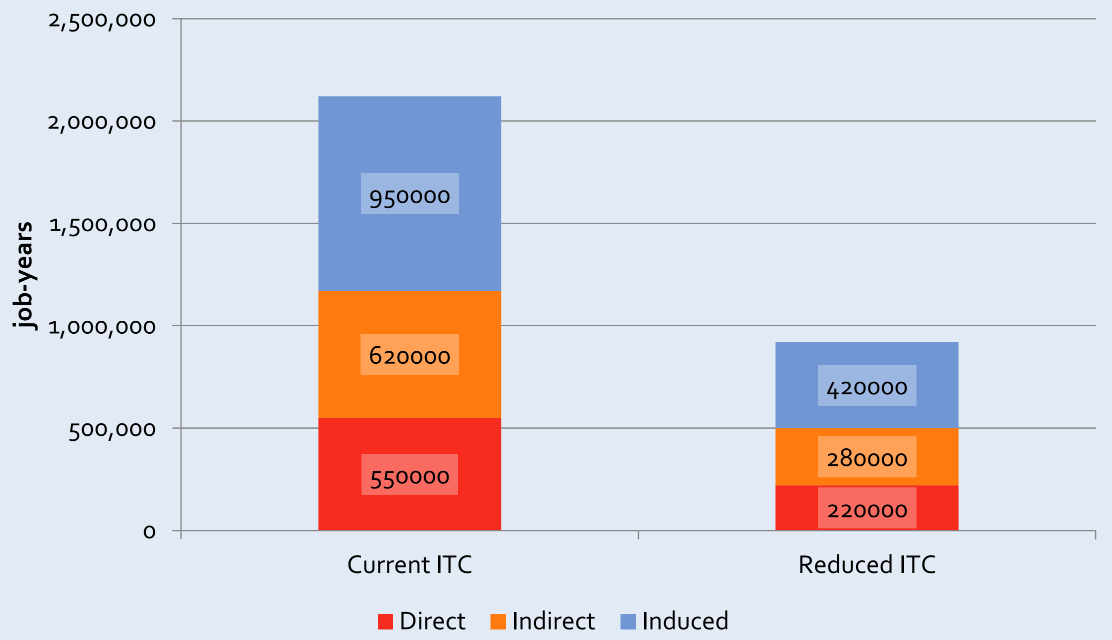
Figure 2-7. Scenarios for Current and Reduced ITC Incentives.



Date Sources: (Navigant 2008; SEIA 2013).

Navigant (2008) projected that during 2009-2016, the ITC extension could result in $232 billion in additional investment in solar energy. Extension of the ITC until 2016 has the potential to create an additional 1.2 million job-years between 2009-2016, from which 330,000 will be direct, 340,000 indirect and 530,000 induced jobs respectively (See Figure 2-8). However, Nordhaus, et al (2013) finds that the lost revenues (as a result of both tax incentives) per ton of CO2 emissions is less than $250, pointing to the likelihood that more efficient approaches exist.

Figure 2-8. Potential Increase in U.S. Solar Supported Employment – Gross Impact between 2009-2016 (job-years)



Date Sources: (Navigant 2008)

2.2.3. The Section 1603 Grant

As a part of the passage of American and Recovery and Reinvestment Act (ARRA), Section 1603 Grants came into effect in late 2009. Designed to overcome tax equity and economic decline implications for renewable energy developers (US Department of the Treasury, 2009), these developers could opt to apply for a Section 1603 Grant in lieu of a PTC or ITC application. Until they expired in 2011, Section 1603 Grants provided a billion-dollar support structure for renewable energy projects in America. In a review of the provision, Aldy (2012) concludes that Section 1603 has been successful. Key contributions of the provision are that it enabled longer term planning of renewable energy, it drove power generation from wind and solar power, and it provided a transparent application process. Another key contribution of Section 1603 was that it directly addressed the shortages on the tax equity market (Aldy, 2012), therefore enabling incremental investment that would otherwise have been constrained. A direct result of Section 1603 Grants was the installation of 2400 megawatts of new wind power in 2010, which represents one quarter of 2009 wind capacity installation (Aldy, 2012).

Wind and solar projects represented 96% of the number of the projects supported by Section 1603 Grants. They also received 92% of the total funding (NREL, 2012). Therefore, when the National Renewable Energy Laboratory (NREL) issued an impact analysis of the Section 1603 Grants, it focused on these two energy technologies. 2009 wind capacity additions significantly exceeded earlier estimates but it is difficult to attribute this to Section 1603 grants but Bolinger et al. (2010) assert that 64% of the new 2009 capacity had in fact applied for the grant at the time of their study. However, most of these projects can be seen as 'free riders' as many had already begun construction or likely would have proceeded with their project even without the grant (Bolinger et al., 2010). Another share of these projects would have used the PTC if the 1603 grants would not have been made available (Bolinger et al., 2010).

NREL (2012) found that the during construction and installation period (2009-2011) 27,000 direct job-years in both wind and solar were supported and about 120,000 to 190,000 indirect job-years were created. Employment effects further reverberate throughout society as such renewable energy projects support about 91,000 to 140,000 induced job-years in other sectors during this period. The operational period is projected to support several thousand additional jobs. It was estimated that about 4,200 to 4,600 indirect jobs per year and about 910 direct jobs per year were created. The summary of these values are presented in Table 2-4. [10] Similarly, Bolinger et al. (2010) estimate that the gross job-years gain in the wind power sector in 2009 reached over 133,000 job-years for the construction phase (short-term) and 9,970 job-years for the operational phase (long-term). Based on their modeling assumptions, however, Bolinger et al. (2010) reduce their estimate to 51,600 (construction) and 3,860 (operational) job-years in an attempt to directly attribute Section 1603's contribution.

In terms of economic impact, total economic output was estimated at $43 to $68 billion in 2009-2011 (NREL, 2012), with wind comprising between $37 to $60 billion and solar $6 to $8 billion (includes construction as well as operation periods). the construction and installation period had an economic impact of about $24 to $42 billion due to indirect jobs, and $2.4 billion in direct jobs. Additionally, the operational period contributed about $100 million to economic output due to direct employment and $1.6 to $1.7 billion due to indirect employment (see Table 2-4).

Table 2-4. NREL Job and Economic Impact Analysis

		Total Jobs		Total Economic Output (Billions $)	
		Construction, Job-years	Operation, Jobs per year	Construction	Operation
Wind	Direct	16,770	770	$1.4	$0.05
	Indirect	110,000-170,000	3,700-4,100	$21.0-$38.0	$1.55-$1.64
	Induced	77,000-120,000	3,900-4,200	$12.0-$19.0	$0.61-$0.65
	SUBTOTAL	**38,000-45,000**	**8,400-9,000**	**$35.0-$58.0**	**$2.21-$2.35**
Solar	Direct	11,000	150	$1.0	$0.01
	Indirect	13,000-17,000	460-480	$2.4-$3.7	$0.08-$0.09
	Induced	14,000-18,000	680-690	$2.2-$2.7	$0.10
	SUBTOTAL	**38,000-45,000**	**1,300**	**$5.7-$7.5**	**$0.19-$0.20**
Wind & Solar	Total Direct	27,000	910	$2.4	$0.1
	Total Indirect	120,000-190,000	4,200-4,600	$24.0-$42.0	$1.6-$1.7
	Total Induced	91,000-140,000	4,600-4,900	$14.0-$22.0	$0.7-$0.8
	TOTAL	**240,000-360,000**	**9,700-10,000**	**$40.0-$66.0**	**$2.4-$2.5**

Data Source: (NREL, 2012)

* Direct jobs and economic activity are jobs and economic activity associated with design, development, management, construction/installation, and maintenance of generation facilities. Indirect jobs and economic activity are the jobs and activity associated with manufacturing and supply of equipment, materials, and services for the generation facility, as well as the upstream suppliers of raw materials and services. Induced jobs and economic activity include jobs and economic activity that occur as a result of spending earnings by individuals directly and indirectly employed by the projects.

The environmental benefits of the Section 1603 grants lie in the direct contribution of installation of 12,827 MW of wind power, 724 MW of PV, and 924 MW of other renewable energy (including CSP, biomass, geothermal) (NREL, 2012). As Section 1603 Grants are a part of ARRA, see the ARRA section for more detailed environmental impact analysis.

2.3. Other Initiatives

This section evaluates two important initiatives of Obama's clean energy policy that promote energy efficiency and renewable energy deployment: The American Recovery and Reinvestment Act 2009 and the Sunshot Initiative.

2.3.1. American Recovery and Reinvestment Act 2009

The American Recovery and Reinvestment Act 2009 aims to support clean technology development through a dedicated funding for clean energy investments of $90 billion in stimulus allocation. ARRA's objective is to provide strategic resources towards long-term clean energy development, research and development on clean energy

[10] It needs to be noted that jobs created during the construction period are reported in job-years and jobs created during operations are reported on a per year basis. They are not directly comparable. For converting jobs per year to Job-years units the reported values need to be multiplied by assumed number of years of the power plant operation.

technology, create green jobs, and make available funding for energy efficiency and renewable energy programs and measures (Aldy, 2012). The $90 billion in funding has allocated $60.7 billion to 56 different projects and activities and $29.5 billion to 11 tax incentives (CEA, 2010) and leveraged over $100 billion in private capital towards manufacturing, power generation, and residential and commercial building investments (Aldy, 2013). As introduced in chapter 1, the key areas that are supported by ARRA are renewable energy development, which receives $26.6 billion, energy efficiency development, which receives $19.9 billion, and alternative transit transportation, which receives $18.1 billion (CEA, 2009). Table 2-5 presents the type of categories that ARRA supports, including data on funding allocation and job-years creation by category: As Table 2-5 suggests, the clean energy programs and initiatives that are supported by ARRA are expected to create 719,000 job-years over the period of 2009-2012, two-thirds of which are direct and indirect jobs while the remainder is in the induced jobs category (CEA 2010). The total job-years in the clean energy sector represent around 10% of total ARRA's 2009-2012 employment impact (Aldy 2012).

Table 2-5. Allocation of ARRA funding to various clean energy categories, including their projected impact on job creation (total job-years)

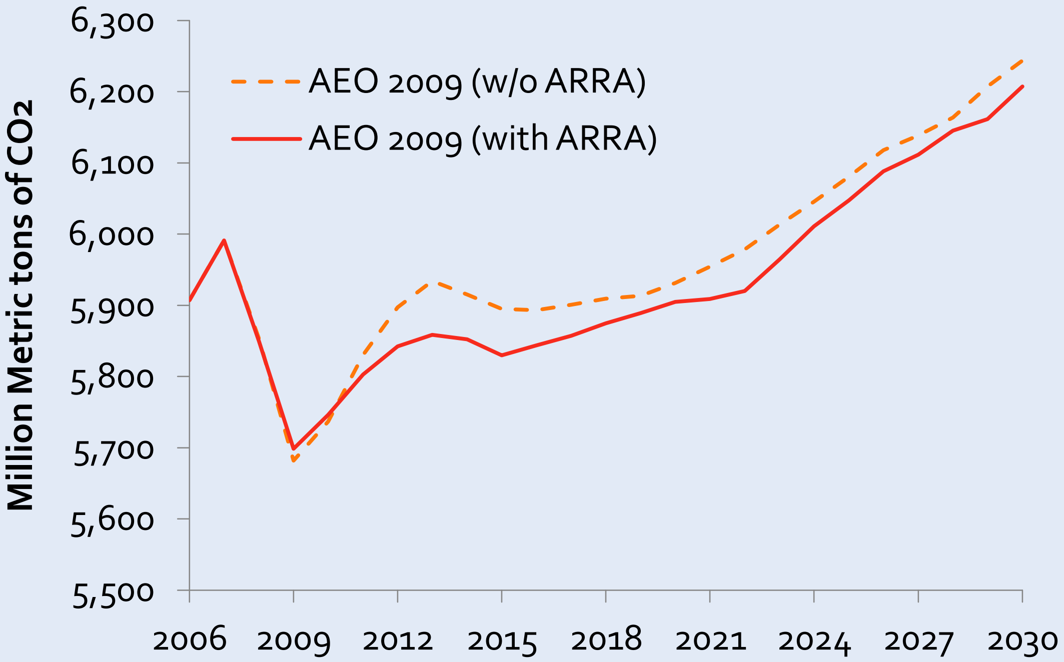
Category	Government Support Examples (Billion $)	Total Support (Billion $)	Job-years
Energy Efficiency	5.0 for WAP, 3.2 for EE&C block grant program	19.9	179,000
Renewable Generation	4.0 additinal funds to DOE's loan garanty program, PTC funding	26.6	192,900
Grid Modernization	10.5 for smart meters, energy storage, interconection planning	10.5	80,600
Advanced Vehicles and Fuels	2.4 for domestic manufactaring of advanced battaries for EV and PHEV, tax credist for PHEV (up to $7500 per vehicle)	6.1	37,000
Transit	8.0 for high-speed rail, 1.3 for Amtrak support, 7.0 for public transit	18.1	158,200
Carbon Capture	3.4 for CCS R&D Project	3.4	26,500
Green Innovation & Job Training	0.4 for R&D, 0.6 fzor job traning and placment	3.5	32,200
Clean Energy Manufacturing	30% tax credit for anvanced energy manufactring projects	1.6	9,500
Other		0.4	3,700
Total		90.2	719,600

Source: Aldy, 2012; CEA, 2009

In March of 2009 the U.S. Energy Information Administration (EIA) released its Annual Energy Outlook (AEO) without consideration for ARRA. One month later EIA released a revised AEO, which accounted for ARRA's impact on the energy sector. These two versions of EIA's AEO offer an excellent opportunity to estimate the likely effect of ARRA on the U.S. energy-related CO_2 emissions. Figure 2-9 compares CO_2 emissions between the AEO 2009 updated reference case (with ARRA) and the no-stimulus reference case (AEO 2009 case without ARRA) in order to assess the likely effect of ARRA on CO_2 emissions. Both 'with ARRA' and 'without ARRA' scenarios include updated macroeconomic assumptions to the AEO 2009 reference case scenario which was produced in November 2008, before the enactment of ARRA; for example, both include the same updated assumptions on population, exchange rates, trading countries' GDP, marginal tax rates, full-employment/unemployment rate, and some categories of government expenditures and depreciation rates throughout 2030. In addition, the 'with ARRA' updated scenario incorporates the effect of ARRA into EIA's National Energy Modeling System.

As Figure 2-9 shows, energy-related CO_2 emissions with ARRA are 1.3 percent lower in 2013 than in the no-stimulus case because of the stronger impact of ARRA on renewable electricity generation, and overall on energy consumption, in the short-term. For example, increases in renewable electricity generation are fostered in the short-term as a result of the extension of key federal tax credits and the new loan guarantee program in ARRA which both stimulate increased renewable generation relative to the no-stimulus case. By 2030, 'with ARRA' emissions continue to be lower compared the non-stimulus case, but only by 0.6 percent. Again, these emission changes largely result from ARRA's energy-efficiency and renewable incentives, which bring reductions in the use of fossil fuels (EIA, 2009). Comparisons of EIA's two scenarios reveal that 821 million tons of cumulative CO_2 emissions savings are expected over the period of 2009-2030 as a result of ARRA. A sizeable share of these emissions reductions, 309 million tons of CO_2, is expected to take place at an early stage, soon after the adoption of ARRA, over the period 2009-2016. In total, 96% of the CO_2 emissions reductions are expected to derive from the electricity sector (EIA 2009).

Figure 2-9. The impact of ARRA on energy – related U.S. carbon dioxide emissions, 2009-2030.



Date Sources: EIA, 2009

2.3.2. Sunshot Initiative

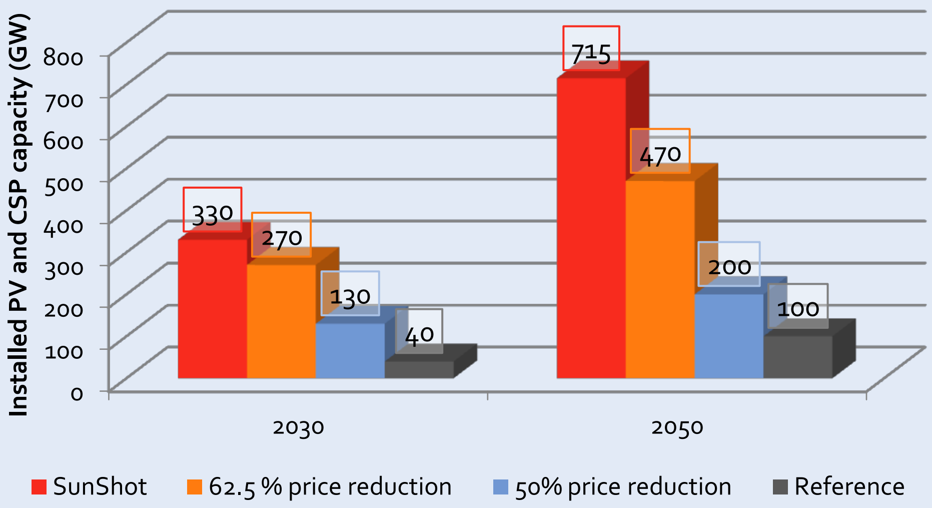
The SunShot initiative aims to increase the cost competitiveness of solar power in order to motivate the adoption of large-scale solar power technology. The objective of the program is to reduce the cost of solar power systems by 75% between 2010 and 2020. This translates into costs of: $1/watt (W) for utility-scale PV systems, $1.25/W for commercial rooftop PV, $1.50/W for residential rooftop PV, and $3.60/W for CSP systems with 14 hours of thermal storage capacity. These system costs represent very aggressive but technically possible targets that would result into similar levelized costs between the solar technology and competing electricity sources in each of these market segments (DOE, 2012). After 2020, no further reduction in the cost of the solar systems is assumed in the Sunshot initiative (DOE, 2012).

A key aspect of the realization of the SunShot initiative involves research and development for solar power technologies. The program provides technical and funding assistance along the entire photovoltaic development chain. One such initiative is the SunShot Incubator program which has allocated $59 million to twenty-four companies (EERE DOE, 2011b). Combined with an increasing demand for solar power, the new technological advances in the solar industry are expected to play a critical role in bringing the cost of photovoltaic systems down to the SunShot goal of $1 per Watt. Solar companies, such as SolarCity, active in the area of California, report that the $1/Watt target might be within the ability of utilities but for the residential and commercial sector a more realistic target for the price system is that of $3/Watt. Such a price reduction would, nevertheless, still be able to boost the solar industry as a whole (Laird, 2011).

To identify least-cost deployment and operation and other aspects of PV penetration pathways, DOE has employed a number of technical tools (e.g., to experiment with dispatch schedules of electricity generation sources) to test the real-world operability of the SunShot scenario (DOE, 2012). The modeling analysis assumes continuation of the federal ITC and PTC incentives for renewable energy development until 2016 and 2012 respectively. Additionally, the model assumes that the existing federal support for conventional technologies continues indefinitely. The modeling analysis finds that the Sunshot initiative can result in a solar market share of 14% in 2030 further developing to a 27% share by 2050 (DOE, 2012). In terms of cumulative installation, approximately 302 GW of photovoltaic power is expected to be completed by 2030, and 632 GW by 2050 (DOE, 2012). In order to meet the 2030 and 2050 SunShot solar goals, a cumulative amount of $25 billion and 44 billion would be required by 2030 and 2050 respectfully. On average, the spending would reach $1 to 3 billion per year (DOE 2012).

The Sunshot program can bring down retail electricity prices due to reductions in the cost of electricity production. The SunShot scenario estimates 6 cents/KWh lower electricity prices compared to the baseline scenario in 2030, and by 9 cents per kWh in 2050. As a result of these lower electricity prices, consumers are expected to save 30 billion USD in 2030 and 50 billion in 2050 (DOE, 2012). Another study finds that, even under strict emission reduction obligations, SunShot could yield an annual $20 billion in power costs reduction ($2010) and provide critical certainty in the market (Mileva, Nelson, Johnston, & Kammen, 2013). Sensitivity analysis has explored the impact variations of the Sunshot initiative where 50% to 62.5% reductions in the cost of the PV and CSP solar systems are achieved by 2020. The analysis finds that even with lower reductions in the cost of solar power systems compared to the 75% goal, the installed solar capacity as a result of the Sunshot initiative is substantially larger compared to business-as-usual, reaching around 200GW and 480GW by 2050 compare to around 100GW of the BAU, as shown in figure 2-10: (DOE, 2012). These scenarios demonstrate the critical importance of a continued cost reduction for solar technology (Denholm, et al., 2013), further confirmed by other studies on SunShot and possible U.S. electricity futures (NREL, 2012; Laird, 2011a, 2011b; 2011c) thus highlighting the potential of SunShot. Ongoing cost reductions provide confidence in the viability of the SunShot scenario as costs for distributed installation fell 33% over the last three years (12% cost reduction in 2012 alone) and utility-scale costs are falling even faster (Sherwood, 2013).

Figure 2-10. Impact of the changes in the cost of the solar power systems under Sunshot initiative on PV and CSP installed capacity, 2010-2035.



Source: (DOE, 2012)

The SunShot program is estimated to result in 290,000 solar-related (direct and indirect) jobs created by 2030, and 390,000 solar-related jobs by 2050 (DOE, 2012). On March 13, 2013, the Department of the Interior (DOI) aproved three large-scale renewable energy projects in Nevada and Arizona which are expected to produce 800,000 tons of CO_2 savings per year (DOI, 2013). These projects will add 1,100 MW of renewable power to the grid (900 MW solar and 200 MW wind), and create about 1,000 new construction and operation jobs (DOE, 2013). Further spurred on by the federal ITC, a continued reduction in costs, state Renewable Portfolio Standards, and the 1603 Grant Program, solar energy is growing rapidly which offers the potential for a considerable share of the electricity mix in the future (Sherwood, 2013). At a 26.9% market share for solar energy in 2050, a full realization of the SunShot initiative can yield an 8% reduction in U.S. electricity-sector CO_2 emissions (equivalent to 181 million tons) in 2030 and 28% (760 million tons) in 2050 compared to the reference case (DOE, 2012). In addition, the SunShot program can results in emissions reductions of harmful pollutants such as mercury, nitrogen oxides, and particulate matter (DOE, 2012).

2.4. Concluding Remarks

It is evident that following the U.S. financial crisis in 2008, the Obama administration placed a strong emphasis on economic development and job creation through clean energy initiatives, with ARRA being the major vehicle towards this goal. As the data reveal there is an observed sizeable job creation gain through clean energy initiatives that have been taken since the first term of the Obama administration in 2009. In addition to job creation, the analysis suggests that there is a positive impact on the diffusion of clean energy technology through federal top-down initiatives, as for example the case of wind power PTC reveals. Regarding greenhouse emissions reductions, the evaluation suggests that there is potential for both short and long-term emissions savings through federal clean energy initiatives. It should be noted, however, that the implementation of such initiatives, and thus the realization of associated economic, job creation and greenhouse gas reduction benefits, requires action by a range of policy and social actors, other than the federal government. Finally, it would be helpful if further analysis is undertaken on assessing the economic, job creation and greenhouse gas impacts of certain clean energy initiatives that have been introduced, or are currently promoted, by the Obama Administration. Such an exercise would provide a more accurate picture of the economic, job, and greenhouse gas performance of the clean energy portfolio of the administration. Table 2-6 summarizes the economic, job creation, and environmental impacts of the examined clean energy initiatives of the U.S. administration:

Table 2-6. Summary of economic, job creation, and environmental impacts of U.S. clean energy initiatives

U.S. Clean Energy Initiatives	Time Frame	Economic Activity ($Billion)	Cumulative CO_2 Emission Reduction Million Metric Tons	Job-Years		
				Direct	**Indirect**	**Induced**
CAFE Standards	2012-2016	Net Benefits: 95-131	655	102,768		
	2017-2025	Net benefits: 326-541	1,900	30,300-148,800		
2012 Clean Energy Standard Act	2010-2035	Negligible	10,500	Negligible		
Renewable Fuel Standard			138 annual [in 2022]			
Production Tax Credits	2013-2016	28	154	47,000	78,000	43,000
Investment Tax Credits	2009-2016	Additional investments in solar: 232		330,000	340,000	530,000
Section 1603 Grant	2009-2011	43-68		27,910	124,200-194,600	95,600-144,900
ARRA 2009	2009-2012		309 [2009-2016] 831 [2009-2030]	480,000	240,000	
Sunshot Initiative	2010-2020	Consumer savings through lower electricity prices 30 billion in 2030 and 50 billion in 2050	900 [2010-2030] 12,500 [2010-2050	290,000 annual [in 2030] 390,000 annual [in 2050]		

3.0. The U.S. Presidential elections and potential ramifications for U.S. – Korea energy collaboration

The Presidential election cycle of 2012 was, for a large extent, about energy and future development pathways. Whether the debates between the candidates emphasized energy independence, clean energy futures, or employment, energy (policy) was an integral part of the discussions. This section details some of the differences and similarities in the vantage points of the Republican and Democratic Parties as presented by their presidential candidates throughout the elections. It will become clear that, while the candidates showed a certain level of similarity in their energy positions, substantial differences exist which can have potentially major ramifications for the U.S. energy development pathway and for the way the U.S. positions itself internationally.

Special attention will be given to the potential impact of the reelection on Korea's clean energy policy and its interaction with the U.S. While this analysis is in particular geared towards energy policy, it will from time to time also incorporate wider insights from U.S. foreign policy in general.

3.1. The 2012 U.S. Presidential Elections

Even though President Obama secured a second four year term in the White House, several key observations can be extracted from a brief comparative analysis between the two narratives brought forward by the Republican candidate and the Democratic candidate. Essentially, these two narratives conceptualize two different potential energy development pathways as the U.S. moves forward. Promises and pledges made during the campaign are, to an extent, illustrative of the desired policy framework by both parties and, as such, provides information as to the U.S. energy future.

3.1.1. The Republican Campaign: Focus on Energy Policy

The Republican Presidential candidate Mitt Romney positioned three key points of criticism as integral to his energy policy if he would be elected:

a) Arguing that renewable energy technology is still immature and incapable to compete with conventional energy sources, Romney criticized Obama's emphasis towards renewable energy R&D stating that those resources could be better spent elsewhere such as basic science research;
b) Romney disputed Obama's performance record, stating that not enough effort was put into supporting domestic conventional energy production and that Obama unjustly blocked the Keystone XL pipeline project (see below).
c) The regulatory efforts introduced by the Obama Administration, such as the positioning of carbon dioxide as a pollutant available for regulation by the Clean Air Act, were unjustified and inappropriate (Behrens, Energy Policy: 113th Congress Issues, 2013).

In line with his three key points of criticism, Romney offered three key actions which he promised to pursue if elected. First, he would propose a range of regulatory changes such as the prevention of 'overregulation' shale gas development and extraction, accelerated approval of gas and oil production permits and nuclear power licensing, and the elimination of the current authority of the Clean Air Act to regulate CO_2. Second, Governor Romney planned to strongly support production increases in carbon-based energy resources and expressed support for additional pipeline constructions – such as the Keystone XL pipeline – to bring Canadian shale oil into the U.S. Finally, Governor Romney planned to direct R&D away from clean energy and towards basic research only based on the argument that the federal government has no business in steering investment toward new energy development pathways (Behrens, Energy Policy: 113th Congress Issues, 2013).

The fundamental spearhead regarding U.S. energy policy put forward by Governor Romney was the ambition to ensure North American energy independence by 2020 through the enhanced production of domestic conventional energy sources and discontinuing any energy imports from countries other than Canada and Mexico (Romney for President, 2012). In Governor Romney's energy white paper, this objective is laid out through the pursuit of the following agenda and policy prescriptions:

a) States should have the power to control onshore energy development;
b) Additional offshore energy development needs to take place;
c) The creation of a North American Energy Partnership with Canada and Mexico;
d) The private sector should lead the development of new energy technologies;
e) Permitting and regulation transparency and fairness need to be restored;
f) The available energy resources in the U.S. should be carefully mapped and assessed (Romney for President, 2012).

In terms of climate change, Governor Romney remarked: "the world is getting warmer, human activity contributes to that warming, and policymakers should therefore consider the risk of negative consequences" (as quoted in Behrens, 2013, p. 7). But, Governor Romney also noted that there is a "lack of scientific consensus [...] on the extent of the warming, the extent of the human contribution, and the severity of the risk" (as quoted in Behrens, 2013, p. 7). The sidebar summarizes the energy policy position of the Romney campaign.

ROMNEY ENERGY POLICY

- ADVANCE DOMESTIC ENERGY
  Expand the production of conventional energy sources
- REDIRECT CLEAN ENERGY R&D FUNDS TO BASIC RESEARCH
- PURSUE NORTH AMERICAN ENERGY INDEPENDENCE
  Collaborate with Canada and Mexico

"An affordable, reliable supply of energy is crucial to America's economic future. I have a vision for an America that is an energy superpower, rapidly increasing our own production and partnering with our allies Canada and Mexico to achieve energy independence on this continent. "

– Governor Mitt Romney
Romney's Plan for a Stronger Middle Class
(Romney for President, 2012)

3.1.2. The Democratic Campaign: Focus on Energy Policy

The 2011 State of the Union Address by Barack Obama positioned the challenge of accelerating the deployment of renewable energy as "our generation's Sputnik moment" (Behrens, 2013, p. 5). In fact, renewable energy was a key thematic focal point for Obama's campaign (Behrens, 2012). Through programs such as the Green Economic Recovery Program and New Energy for America Plan, the Obama-Biden team worked on providing strategies to increase renewable energy and ensure energy independence in the long run. The policies outlined in Chapter 1 demonstrate that the President's actions overall followed his intent to accelerate the implementation of renewable energy. For instance, the Department of Energy (DOE) received substantially more financial support to accelerate energy efficiency and renewable energy programs and new standards for GHG emissions were introduced (Behrens, 2013).

Early on in the Obama Administration, clean energy and energy efficiency was elevated to a prominent position. For instance, during his 2009 State of the Union Address, President Obama set a goal for the U.S. to double the use of renewably energy by year 2012 (The White House, 2009). Likewise, climate change is seen by the Obama Administration as "one of the biggest issues of this generation" (Behrens, 2013, p. 6).In order to make renewable energy more competitive and pursue climate protection, Obama requested Congress to support a cap and trade system on carbon pollution and annually invest fifteen billion dollars into clean technology and transportation (White House, 2009). However, this cap and trade mechanism was not accepted by Congress and, to date, no similar proposal seems likely to come in effect. Instead, the Obama Administration resolved to a regulatory approach through the EPA Clean Air Act authority.

In his 2013 budget proposal, President Obama proposes a number of measures indicative of the Democratic Party's preferred energy development pathway. For one, the budget proposal aims to repeal a number of tax preferences that benefit the oil, gas, and coal industries (Sherlock & Crandall-Hollick, 2012). In particular, President Obama proposed to repeal the percentage depletion allowance, the domestic manufacturing deduction, and the elimination of the expensing of intangible drilling and development costs for oil, gas, and coal producers (Sherlock & Crandall-Hollick, 2012). Effectively, these actions signal the Obama Administration's intention to raise the cost of coal, oil, and gas production and, therefore, improve the relative cost performance of renewable energy and energy efficiency (Sherlock & Crandall-Hollick, 2012).

Similar to the Romney Campaign, the Obama Campaign also highlighted the importance of energy security and independence and positioned this as a key driver of U.S. clean energy policy. Increasing the level of domestic production of energy is seen as a main pathway towards this objective and both parties professed to pursue a "all of the above" strategy (i.e. not excluding any energy options). Governor Romney, however, differs from President Obama in his emphasis towards conventional energy sources whereas Obama emphasizes the potential contribution of renewable energy and energy efficiency. Another key driver for U.S. energy policy has been international competition. A key discussion point throughout the elections was how the U.S. would "win the future". Recognizing the increasing international competition in the energy market place, primarily through rising superpowers such as China and India, the U.S. sees the need to innovate in alternative energy. The difference here, again, is how the two parties see such innovation to occur. Governor Romney, as mentioned, prefers to limit government support and instead offer opportunity for market competition. President Obama, in contrast, recognizes the non-market barriers for certain renewable energy technologies and argued for strong(er) governmental support.

OBAMA ENERGY POLICY

- "ALL-OF-THE-ABOVE" STRATEGY
  Expand the production of conventional and renewable energy sources
- PURSUE CLIMATE CHANGE ACTION
- STRONG EMPHASIS ON RENEWABLE ENERGY

"A secure energy future is vital to an economy built to last. When we use American energy to power our homes, businesses, and vehicles, we create New American jobs, grow new American industries, and safeguard our national security and our economic potential. As demand for energy increases worldwide, our Nation must continue to lead the world in a rapidly evolving energy market by pursuing safe and responsible domestic energy production, promoting efficiency, and developing clean energy and renewable fuels."

– President Barack Obama
Presidential Proclamation – National Energy Action Month 2012 (The White House, 2012)

3.2. A second term for the Obama Administration: domestic energy policy issues

With the re-election of President Obama for a second term, the President is awarded another chance to implement his narrative. Key dynamics within this will determine how climate and energy policy will be articulated. This section briefly covers a range of domestic issues that will influence the direction of domestic energy policy.

3.2.1. Public Opinion

U.S. public opinion holds that clean energy and climate change should be seen as priority issues as 87% say they prioritize clean energy (as 'medium', 'high', or 'very high') and 70% prioritizes climate change (Leiserowitz, Maibach, Roser-Renouf, Feinberg, Marlon, & Howe, 2013a). Additionally, in their sample, Leiserowitz et al (2013) find that 68% sees the regulation of CO_2 as justified. Another survey finds that this ambition is reflected in Americans' actions (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013b). Such findings offer a foundation for the Obama Administration's second term and support for their energy policy proposals. One such proposal, as described in Chapter 1, is the Clean Energy Standard Act (CESA). Public support for such a '80% by 2035' standard (representing 85% clean energy by the year 2035) is available as the average U.S. citizen is willing to pay about $162 per year in higher electricity bills in support of such a standard (Aldy, Kotchen, & Leiserowitz, 2012; Haneman, 2012). Depending on the configuration, the standard can limit price increases to this level (Paul, Palmer, & Woerman, 2011) suggesting the possibility for a renewed effort to introduce the '80% by 2035' standard. State experience with such standards, also, provides a rich foundation for future action (Carley, 2012). However, Congressional support for both climate and energy policy measures has become highly politicized, breeding gridlock at the federal level (Freed & Fitzpatrick, 2013).

3.2.2. Climate Change

Certain key events can significantly shift the public´s perception of an issue. For instance, regarding climate change, intense and hazardous weather events such as Hurricane Sandy can heighten the public´s perception of the issue as one that needs to be addressed (Brulle, Carmichael, & Jenkins, 2012). This can sometimes be directly translated into political action. After Hurricane Sandy President Obama requested Congress to draft a bi-partisan market-based solution to climate change (White House, 2013a). This request made during President Obama's State of the Union Address in 2013, suggests a renewed interest in climate change as a political issue. On June 25, 2013, President Obama followed up on this renewed interest and launched his climate action plan. The plan represents a further positioning of the issue of climate change within the realm of executive power as it outlines a wide variety of executive actions. Three pillars of action can be identified in the plan:

1) To cut carbon emissions through the introduction of regulatory measures and rules. As introduced in Chapter 1, the Obama Administration's regulatory approach towards climate change builds off of the greenhouse gas and fuel economy standards as it now plans to establish performance standards for conventional electricity production.
2) To advance climate change adaptation preparedness and capability;
3) To lead international efforts to address climate change (White House, 2013c).

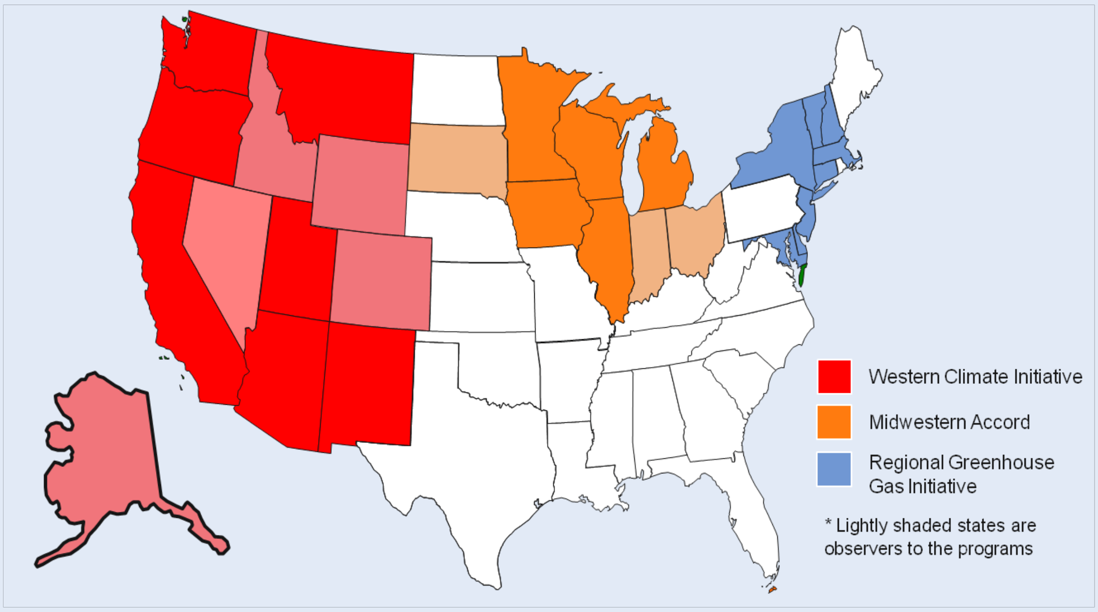
3.2.3. Nuclear Power

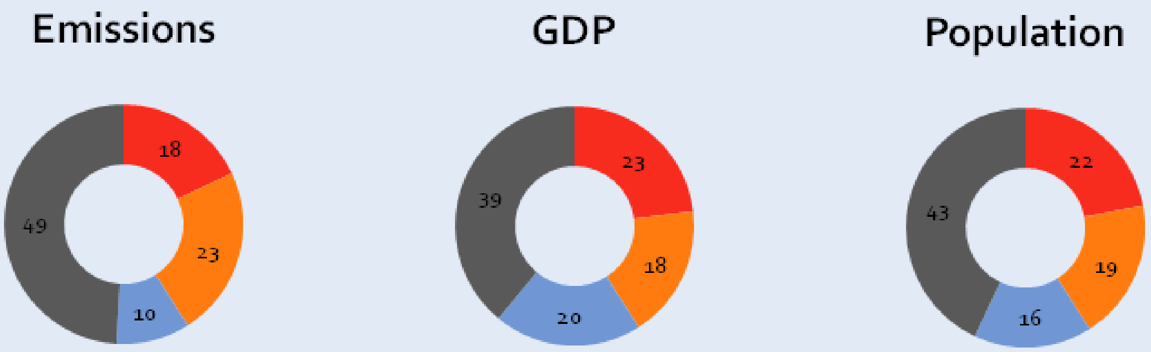
Before 2012, nuclear power was largely at a standstill in the U.S. as no nuclear power plant had been ordered since 1978 (Holt, 2012). However, in early 2012, four combined operating licenses for nuclear power plants were issued, for the first time in over 30 years (Felder, 2013). As part of the 'all-of-the-above' strategy and the pursuit for a national clean energy standard (which includes nuclear), nuclear power under the second term of the Obama Administration faces a variety of dynamics that both positively and negatively affect the market's development. Whether the national clean energy standard will be adopted, whether climate change policy will be enacted, whether progress on a newly proposed storage site for nuclear waste materializes, and whether the U.S. will export its now bountiful shale gas; all are factors significantly affecting nuclear energy development in the U.S. (Felder, 2013). While newly proposed fossil fuel production regulation (e.g., NSPS) and other climate change policy actions will advance the attractiveness of nuclear power (Felder, 2013), the strong rise of shale gas production presents substantial difficulty for the nuclear power sector as low natural gas prices drive down electricity prices threatening the economic viability of certain nuclear power plants (Smith, 2013). However, if the U.S. decides to export significant quantities of the abundant shale gas supply to the international market, this problem for nuclear power might be abated (Felder, 2013). Upon closing down plans to store nuclear waste at the Yucca mountain repository, the Obama Administration now employs a 'consent-based approach' to the siting of waste facilities (Felder, 2013). Compounded by the considerable financial risk inherent in the required loan guarantees to accelerate nuclear power which limits the federal government's options to revive nuclear energy, this decision undermines the viability of nuclear power in the U.S. (Baker, 2009).

3.2.4. Bottom-up Pressure

As hinted at in Chapter 1, federal energy and climate policy is not the only level at which meaningful action takes place. In fact, at the federal level the U.S. has so far been unable to implement comprehensive climate protection measures and instead has had to rely on executive power to motivate change. At the lower governmental levels of the U.S., a wide variety of actions and measures are being taken in both energy policy and climate policy (Database of State Incentives for Renewables and Efficiency (DSIRE), 2013). This bottom-up pressure takes a variety of forms such as through the widespread adoption of Renewable Portfolio Standards (RPSs), net metering, interconnection standard, and energy efficiency resource standards (EERSs) (Carley, 2012; American Council for an Energy Efficient Economy [ACEEE], 2013). Furthermore, the Western Governors' Assocation formed their own energy vision to complement President Obama's climate plan. The plan is meant to encourage states and the federal government to work together through the consideration of both costs and values associated with six energy policy goals: achieve North American energy security, diversify energy sources, increase energy efficiency from electricity and natural gas, improve infrastructure, protect wildlife and the environment, and take the lead in energy education and innovation (Yachnin, 2013). Another bottom-up approach is the implementation of regional cap and trade mechanisms. While such a mechanism failed to attract Congressional approval, many states have pushed forward with the design and implementation of such mechanisms on a regional level (see Figure 3-1). However, due to challenging economic conditions, some of these initiatives have had difficulty moving from the design stage to the implementation phase (Klinsky, 2012). For instance, while the Western Climate Initiative (WCI) started out as a cap and trade coalition comprised of several U.S. states and Canadian provinces, currently only California and Quebec intend to start their emission trade in 2013 (Klinsky, 2012). Nonetheless, as shown in Figure 3-1, significant portions of the U.S. population, U.S. emissions, and U.S. GDP now fall within these regional programs highlighting the substantial potential pressure applied by such bottom-up climate and energy movements.

Figure 3-1. Regional Cap and Trade Mechanisms in the U.S.



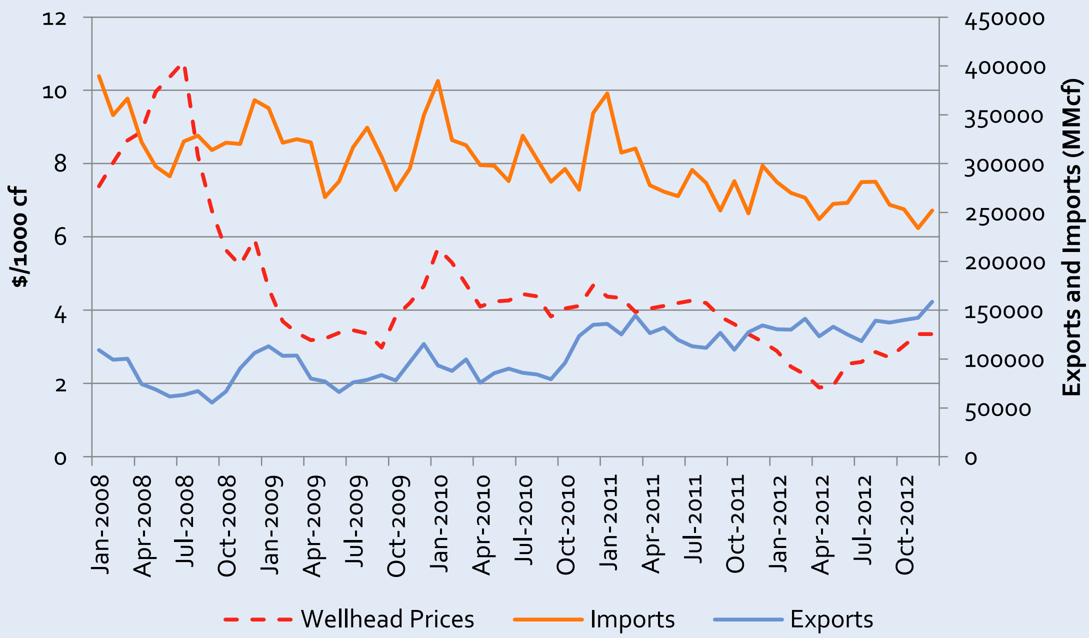


Source: (World Resources Institute (WRI), 2011)
* The lower three doughnuts represent the extent to which the regional cap and trade mechanisms cover these dimensions (%). Data for emissions (excluding land use change), GDP, and population is from 2007 numbers.

3.2.5. Fossil Fuels

The rapidly increasing production of shale gas and shale oil is slated to transform the U.S. to a net exporter of energy and energy products. In fact, the surge in domestic shale oil production has allowed the U.S. to drop oil imports to 42% of use, the lowest level since 1991 (EIA, 2013). Additionally, through the application of new technologies and increased experience with the extraction of shale gas, the price of natural gas has fallen considerably since Obama's first term (see Figure 3-2). Due to the strong rise in production of domestic natural gas, the U.S. has been able to scale back its import flows of natural gas and has even slightly increased its exports. As such, U.S. natural gas net imports have fallen to their lowest level since 1992 (EIA, 2013). The U.S. even surpassed Russia as the world's main producer of dry natural gas early in 2009 as Russian production faltered synchronously with the economic downturn and a reduction in demand (Energy Information Administration [EIA], 2012). Such trends are expected to continue as new shale gas production facilities come online and CAFE standards improve.

Figure 3-2. Natural gas prices, imports, and exports throughout the first term of the Obama Administration.



Source: EIA, 2013

An additional factor for domestic U.S. energy policy regarding fossil fuels is the ongoing approval process of the Keystone XL pipeline. President Obama has to decide on the construction of the Keystone XL pipeline project that, when constructed, symbolizes a significant defeat for the environmental movement in the U.S. as campaigns against the project have been widespread. In May 22, 2013, the House of Representatives passed H.R. 3 (*the 'Northern Route Approval Act')* which ensures that Presidential approval is no longer required virtually guaranteeing the implementation of the Keystone XL pipeline (Behrens, 2013). However, for the Act to come into effect, the Senate will still need to pass the act. The President has announced his support for the concept, making it virtually certain that Presidential approval will be available (Freed & Fitzpatrick, 2013). If the Keystone XL project is approved, it will strengthen U.S. domestic conventional energy and complicate competition for the clean energy sector.

3.2.6. Renewable Energy and Energy Efficiency

The Obama Administration will continue to pursue the development of clean energy through the provision of tax incentives and other financial support to the private sector. As detailed in Chapter 2, such support can have considerable economic and environmental impacts. However, it is clear that the level of support will be substantially lower in the second term of the Obama Administration compared to the first term as the significant financial resource of the American Recovery and Reinvestment Act (ARRA) is no longer available.

In terms of energy efficiency, the proposed budget for 2014 offers some indication as the requested $575 million transportation funding, $300 million for building technologies, $248 million for weatherization and intergovernmental programs, and $365 million for manufacturing represents a substantial increase over the 2013 actual budget ($312, $208, $122, and $110 million, respectively) (Nadel, 2013). While it remains uncertain whether these funds will materialize, it does provide insight into the commitment of the second Obama Administration to continue to support energy efficiency. As Nadel (2013) outlines, the newly proposed "Race to the Top" program, designed to promote forward-leaning efforts at the State level, offers a substantial promise as does the newly introduced $2 billion Energy Security Trust funded by royalties from the oil and gas sector and which aims to accelerate the transition to low-carbon transportation. To open up the necessary funds for these programs, the 2014 budget proposal of President Obama cuts tax breaks for the oil, gas, and coal industries and slightly reduces funding for the DOE's fossil fuel and nuclear program (Nadel, 2013). Additionally, the budget slightly cuts into the EPA's wastewater and drink water budget (Nadel, 2013). Overall, the proposed budget offers a promising account for energy efficiency, but it remains highly uncertain which provisions will survive Congressional scrutiny.

3.2.7. Obama Cabinet Changes

On April 2013, Sally Jewell was sworn in to fill Salazar's vacant position (Kershaw, 2013). As a proclaimed energy and natural resources expert and professional training as an petroleum engineer, there is a chance she may offer support for more offshore drilling and Keystone XL pipeline project (Kershaw, 2013). On May 16, Dr. Ernest Moniz was a shut out Senate vote of 97-0 confirmed his position as the new Energy Secretary (U.S. Department of Energy , 2013). As founding director of MIT Energy Initiative and MIT Laboratory for Energy and Enviornment, Dr. Moniz has a multidisciplinary background in the energy sector, which will be helpful for Obama's goal to enable an "all of the above" energy strategy (U.S. Department of Energy , 2013). Although it has yet to be confirmed, Anthony Foxx, mayor of Charlotte, North Carolina, has been nominated as the new Secretary for Transportation (Slack, 2013). Reasons backing the nomination include Charlotte's new streetcar project, expansion of the international airport and light rail system, and job openings, which took place under Foxx's administration (Slack, 2013). Finally, although the votes have yet to be finalized, Gina McCarthy, Environmental Protection Agency's assistant administrator, was nominated to be promoted and fill in the EPA administrator position (Bernstein, 2013). The choice for new secretaries and for a new EPA administrator may, to a certain extent, increase interest in offshore oil drilling, green transportation, nuclear power, and shale gas during the second term of the Obama Administration.

3.2.8. Concluding Remarks Domestic Energy Policy Under A Second Term of the Obama Administration

The highly politicized nature of both energy and climate policy limit the space for drastic changes in national energy policy (Freed & Fitzpatrick, 2013). The challenging economic conditions and the competing force applied by the strong developments in the fossil fuel sector will make advancements renewable energy and energy efficiency policy even more difficult and only leaves open a executive regulatory approach as the main strategy of change (Freed & Fitzpatrick, 2013; Kelly, 2013). Supreme Court backing of EPA's regulatory authority over CO_2 and the establishment of legislation to solidify this authority make it likely that clean-air regulations will continue to develop throughout Obama's second term and are scheduled for full implementation in 2015. While it remains uncertain what the consequences of these developments will be for both oil and gas, both now undergoing tumultuous change due to the advancements in hydraulic fracturing technology, it is clear that the regulatory approach will further diminish the U.S. reliance on coal as a energy source (further complicated by low natural gas prices and overall environmental regulations). Nuclear power faces its own problems, but these are compounded by the shale gas production boom. However, licensing approval for the first time in over three decades signals political willingness to support this industry.

Other recently announced initiatives and programs offer some indication as to the future direction of the U.S. energy policy landscape. For instance, the "Fix it First" proposal targets aging infrastructure and puts on hold new infrastructural projects such as high-speed rail (The White House, 2013) symbolizing the difficulty to realize major new clean energy projects in the U.S. In the 2013 State of the Union Address, President Obama did announce the ambition to reduce residential and commercial energy waste by half over the next two decades suggesting the rise of energy efficiency as a means to realize U.S. energy policy priorities of economic development, energy security, and environmental protection. Although it failed to pass, a group of former Senators and policy administrators have come together with a proposal to form a National Energy Strategy Council, which could encourage Congress and Obama administration to work together in creating a blueprint for Obama Administration's goals, budget, and energy agenda (Governors' Wind Energy Coalition , 2012)

3.3. A Second Term for the Obama Administration: International Energy Policy

The previous section highlighted that Congressional gridlock will likely severely limit the formulation of drastically new energy and climate policy measures. Similarly, the U.S. is expected to only limitedly engage the international energy policy field as the Obama Administration doesn't have the public mandate to engage critical issues such as climate change. With the Democratic majority in the Senate and the Republican control of the House of Representatives, continued federal gridlock can be assumed as the power balance remains largely the same as before the 2012 elections (Kelly, 2013). The mid-term elections in 2014 might change this power balance, creating new political conditions and possibly open up more degrees of freedom for the Obama Administration. Nonetheless, some expected actions and measures – or the lack of them – can be discussed.

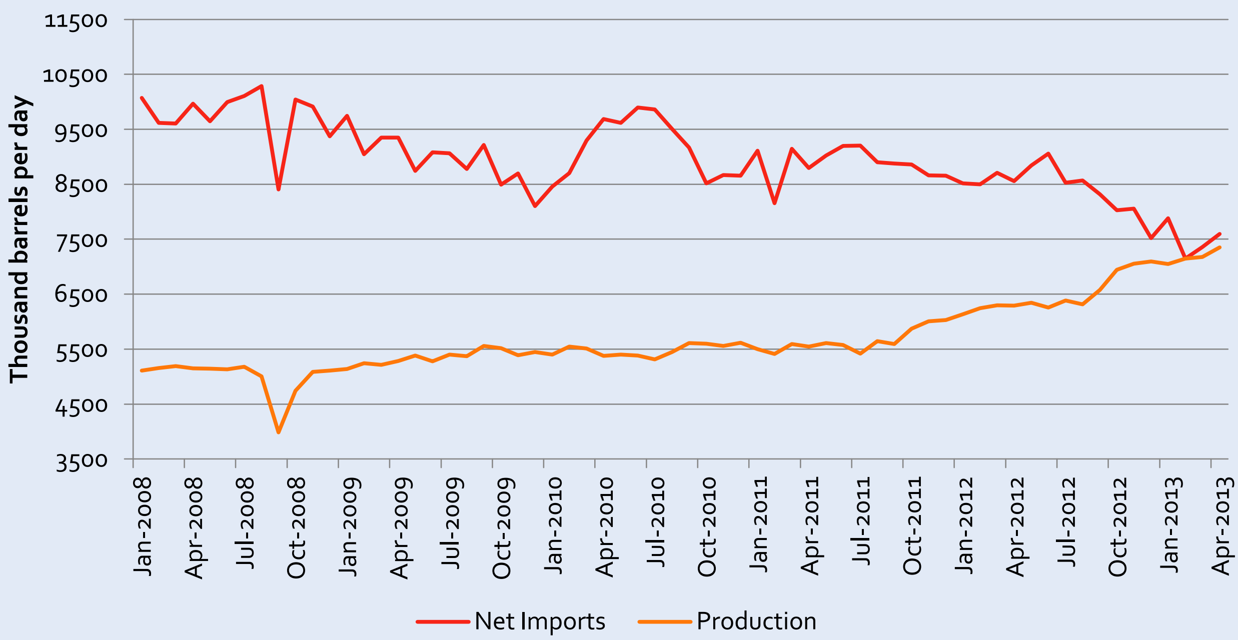
3.3.1. Energy Security and Independence

Priorities ever since the oil shocks of the 1970s, energy security and independence remain high on the political agenda. The strong rise in domestic production of energy bring in sight this ultimate objective. The International Energy Agency (IEA)'s World Energy Outlook 2012 outlined a scenario in which the U.S. becomes the world's largest global oil producer around 2020 – overtaking even Saudi Arabia – and becomes a net oil exporter around 2030 (International Energy Agency (IEA), 2012). Figure 3-3 demonstrates how net imports have fallen throughout the two terms of the Obama Administration, reversing the trend that was initiated in the early 1980s of increasing net imports. Additionally, Figure 3-3 shows how U.S. domestic production of crude oil has increased throughout the Jan-2008 to Apr-2013 period. This new reality, according to an optimistic Citigroup report, redefines old assumptions as the changed conditions can now be spelled out the following:

- U.S. oil consumption is projected to continue to decrease in part due to higher fuel efficiencies;
- U.S. (and Canadian) oil and gas production will continue to increase annually;
- The price of natural gas is likely to stabilize at a much lower level than it was previously;
- The costs of exploration and production of oil in deepwater, tight formations and oil sands are on a path toward declines (Morse, Lee, Bond, Fordham, Dray, & Fedluk, 2013).

While this will have several consequences – among others, it is likely to improve the currently crippling U.S. debt – the advancement towards energy independence has a strong consequence for U.S. foreign (energy) policy: whereas foreign policy was traditionally constricted by compromise because of bilateral interaction with critical oil exporting countries, a degree of freedom to move towards a more explicitly values-based foreign policy can be associated with the strongly rising domestic production of conventional fuels (Morse, Lee, Bond, Fordham, Dray, & Fedluk, 2013). One important factor in this is the strategic 'pivot' of U.S. attention away from the Middle East and towards the Asia-Pacific region, whether diplomatic, strategic, economic, or otherwise as outlined by Hillary Clinton's article "America's Pacific Century" (Clinton, 2011) and initiated in the first term of the Obama Administration. Considering the limited role of foreign policy in the Presidential election process, continuity from the first term into the second term can be expected (Pempel, 2013). Political efforts with key countries in the Asia-Pacific region, such as South Korea, China, and Japan, will revolve around hedging and engagement; for instance, Chinese influence in the region will need to be contained but financial and economic cooperation will be pursued (Pempel, 2013).

Figure 3-3. U.S. net imports and domestic production of crude oil



Source: EIA, 2013

3.3.2. Climate Change

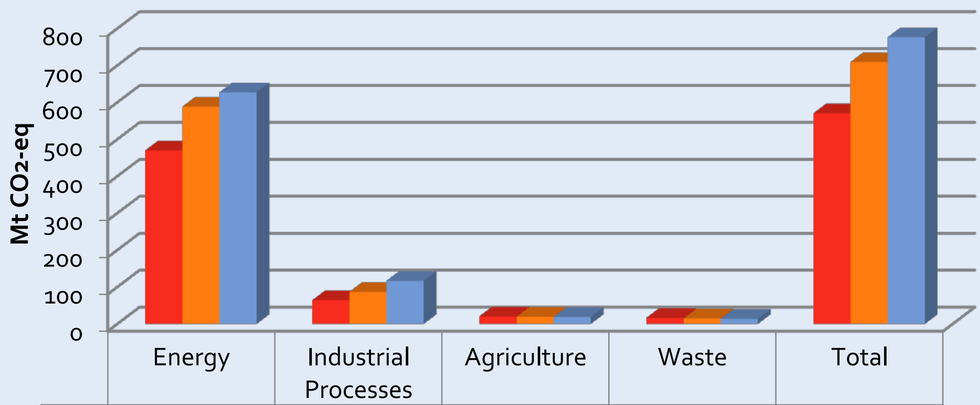
With the Durban Platform for Enhanced Action – the main negotiating outcome of the 2011 climate change talks in Durban – the international community agreed to engage on a new negotiation track towards a new global climate policy agreement to enter into effect by 2020. However, the U.S., with its continuity in domestic power balance between the two political parties, will continue to face the same restrictions as it did during the first term of the Obama Administration (Kelly, 2013). During that term, attempts to establish domestic climate change policy at the federal level failed due to Congressional opposition and there is no sign that, at least until the midterm elections in 2014, this dynamic will change. The constrained operation of the U.S. on the international stage regarding climate change policy might produce a 'lowest common denominator' negotiation process as other major emitters may present limited commitments in the face of U.S. non-participation (Kelly, 2013).

3.4. U.S. – Korea Energy Policy Interaction

3.4.1. Energy Policy in Korean Government of President Lee Myung-Bak

The 'Green Growth' strategy of South Korea forms the foundation of its clean energy policy measures and actions. Not only does the five-year green development strategy outline industrial and economic development and the creation of a technology export platform, it also builds a framework for greenhouse gas emission reductions (Matthews, 2012). While the green growth strategy was established in 2008 by President Myung-Bak Lee, the strategy has since developed throughout the 2009-2013 period to become the government's growth and development strategy centerpiece (Matthews, 2012). Two of the objectives adopted during President Lee's Presidency are to: a) improve South Korea's green economy world ranking (2020: 7th place; 2050: 5th place) and b) to reduce greenhouse gas emissions by 30% below a business-as-usual strategy by 2020 as documented in the international climate change negotiations (Matthews, 2012; Jones & Yoo, 2011). The strategy stands out as it translates the green (energy) into an economic opportunity rather than a costly threat and positions industrial growth policy at its core (Jones & Yoo, 2011). Climate protection, as such, is repositioned away from its conventional position as a oppositional force to economic development and towards a position as an engine for growth (Republic of Korea [ROK], 2012). Two strategic considerations form the strategy's emission reduction pathway: a) realizing improvements in energy efficiency to reduce emissions per unit of output by 30% and b) to reduce the use of energy-intensive industry to decrease emissions by 13% (Jones & Yoo, 2011). In an operational sense, three methods are considered to reduce the emissions of greenhouse gases: a) increasing energy efficiency; b) to deploy clean energy; and c) to produce more energy from nuclear power (Choi, 2011). For instance, in an effort to increase energy efficiency, Korea Electric Power Corporation plans to invest 4.7 trillion Korean Won (4.2 billion USD) in smart transmission and distribution systems to decrease energy losses (Choi, 2011). As of January 2012, the South Korean government has substituted the renewable portfolio standard (RPS) for the FIT. The RPS maintains a renewable energy share target of 2% of total electricity supply in 2012 and aims to increase this share to 10% by 2022. Renewable energy technologies with a lot of potential to fulfill such a target are solar PV and offshore wind (Jones & Yoo, 2011, p. 16-17). Korea is the fifth largest nuclear energy producer (151 TWh), generating 5.5.% of the world's total nuclear energy. By 2030, Korea projects to produce an estimated 59% of its domestic electricity from nuclear energy (Choi, 2011). However, economic development trends drive up greenhouse gas emissions (Kim, Shin, & Chung, 2011; Lim, Yoo, & Kwak, 2009; Oh, Wehrmeyer, & Mulugetta, 2010) and business-as-usual projections demonstrate a 36.1 % increase in emissions over the 2005-2020 period Figure 3-4 of which the majority stems from the energy sector. As such, aggressive policy measures, especially in the energy sector will be required.

Figure 3-4. Projected greenhouse gas emissions



	Energy	Industrial Processes	Agriculture	Waste	Total
2005	469.6	64.1	20.3	16.3	570.3
2015	588	86.7	19.5	14.8	709
2020	626.9	116.6	18.8	13.8	776.1

2005 2015 2020

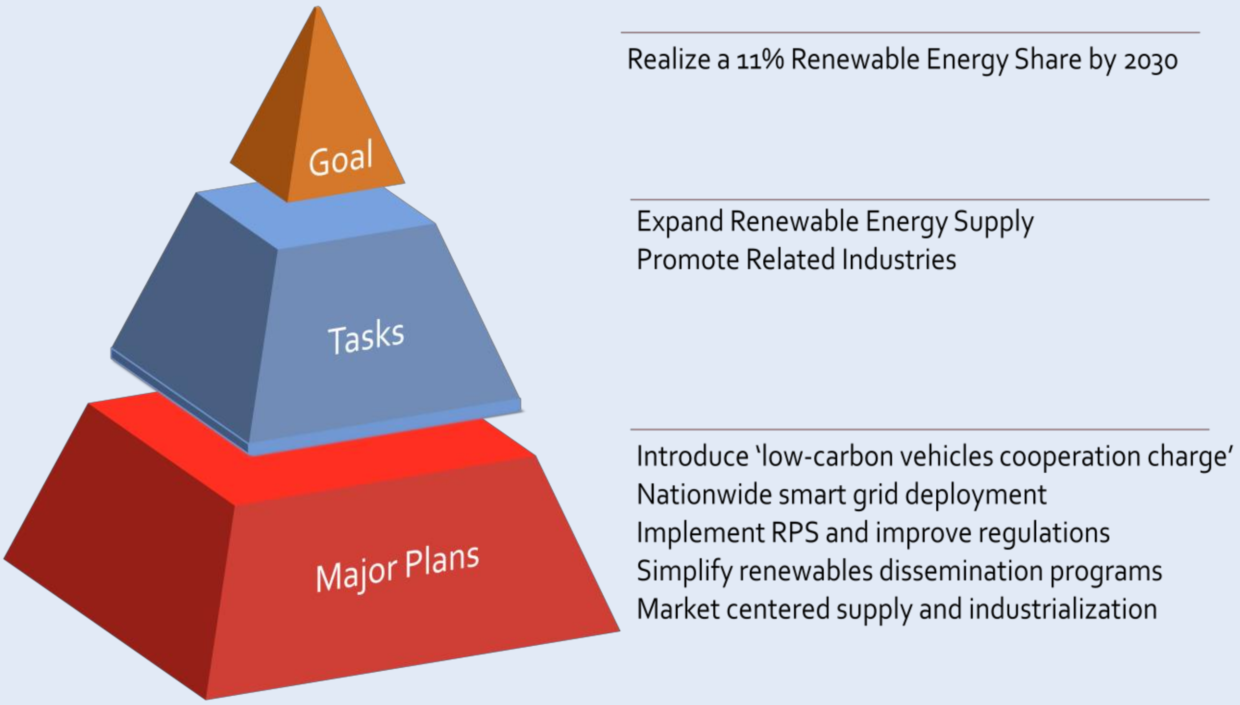
Source: (Republic of Korea [ROK], 2012)

The green growth strategy centers around three key objectives: a) transitioning to a low-carbon society with associated improved energy security; b) the creation of new 'green' engines of growth; and c) the improved quality of life for Korea's citizens and international leadership (Matthews, 2012). These three general objectives are translated in ten goals that, together, create a pathway towards sustainability. Examples of operational targets within these ten goals are the realization of 100% energy independence by 2050, improving food and water security, green technology R&D funding at 25% of all R&D by 2020, and smart grid development (Matthews, 2012).

3.4.2. Energy Policy of the Korean Government under President Park Geun-Hye

On December 19, 2012, Park Geun-Hye was elected as the new President of the Republic of Korea. On March 25, 2013, the transition committee of the newly elected President Park Geun-Hye published a White Paper that lays out the government's policy direction for the next five years. The manuscript includes the new government's vision and five administrative goals which are, in turn, elaborated by 21 strategies and 140 policy tasks of which eight relate to energy policy (Cheong Wa Dae, 2013). Building off of President Myung-Bak Lee's green growth strategy, the White Paper describes the ambition to expand the energy supply of renewable energy and to promote related green economy industries. This ambition realizes the importance of renewable energy as a key future energy source and, to realize this aim, a medium- and long-term renewable energy supply target and strategy will be established in 2013. In addition, the government plans a policy shift away from the current subsidy-centered approach and towards a market-based strategy. Barriers to the expansion of renewable energy will be removed or reduced while programs to disseminate and deploy renewable energy are to be simplified. President Park's clean energy policy, as identified within this 2013 White Paper, is visualized in Figure 3-5.

Figure 3-5. Visualization of the Energy Actions and Goals as laid out by the President's White Paper



Source: ROK White Paper (2013)

The White Paper also clearly positions nuclear power as a growth engine with which to boost economic development and ensure employment opportunities. In an attempt to expand the participation in foreign and international nuclear power plant construction projects, the new government will establish a tailored export strategy based on country-specific characteristics and demands. Regarding nuclear power, the White Paper stresses the safety considerations and concerns as the new government promises to strengthen the transparency of safety regulations through the disclosure of safety information to the general public. Additionally, the government aims to preserve the independence of the Nuclear Safety and Security Commission (NSSC) while it is repositioned to the newly established Ministry of Future Creation and Science.

Regarding climate change, the White Paper elaborates on the aim to create a virtuous circle between environment and development. To this end, Korea will strive to achieve its agreed upon greenhouse gas reduction target and play a leading role in resolving global environmental problems while reinforcing Korea's role as a donor of the international climate fund by supporting low carbon green growth in developing countries. In addition, Korea will secure climate change surveillance and forecasting ability and establish market-based greenhouse gas reduction policies. The new government also specified that it will re-establish a medium-and long-term energy supply and demand plan and advance the Korean energy market structure in order to ensure a sufficient and stable supply of energy. To accomplish this task, the electricity pricing system will be revised to enable rational power consumption. In addition, the overall energy industry will be restructured with emphasis on efficiency improvement especially in electric power and gas industry. At the same time, systematic energy conservation will be promoted instead of campaign- oriented conservation. .

Another energy focal point of the White Paper is to develop a smart grid to manage electricity demand and supply efficiently. New systems, such as the 'Low carbon vehicles cooperation charge' will be introduced in 2015 to induce the use of cars with low emission and high fuel economy. Under this system, vehicles[11] would be categorized into 3 groups (bonus, neutral and penalty group) according to their greenhouse gas emission levels. Essentially, the Korean government will provide a financial reward for low-emission vehicles while penalizing high-emission vehicles. Detailed standards and the level of the bonus and penalty will be determined this year (2013) after gathering opinions from various stakeholders including car manufacturers. This system is anticipated to accelerate the development and deployment of an environmentally friendly transportation fleet (Ryu, 2013). A similar system is to be put in place for the built environment to enhance building energy efficiency.

3.4.3. U.S. - Korea Energy Policy Interaction

From the above, it becomes clear that there is considerable ground for cooperation and collaboration between the U.S. and South Korea. One additional factor that will improve economic collaboration conditions is the U.S. – South Korea Free Trade Agreement (FTA) opening up investment opportunities. In Korea, for instance, the Ministry of Knowledge and Economy (MKE) has opened up six Free Economic Zones as suitable areas for foreign investment. While foreign investors are limited to an up to 30% stock in electricity capacity facilities and up to 50% stock in corporations and businesses within the electricity transformation and electricity sales sector, the opening up of public services to foreign investors in this manner is likely to attract substantial foreign investment flows. Economic collaboration in this way is slated to intensify as, on September 18, 2012, the third MKE foreign investment board agreed to add an additional eight foreign investment zones. These zones offer opportunities for export, joint ventures, high-tech industry and associated large scale job creation.

Despite the election of a new President, Korea's basic position on green growth has not changed and, based on the documents released by Park's Administration, Korea will likely strengthen its green growth strategy. Political conditions in the U.S., similarly, appear to motivate continuity rather than dramatic change. There is considerable similarity in both narratives. For instance, both Korea and the U.S. are promoting the transition to a green energy economy through the creation of new growth engines and jobs with green technologies and clean energy within local, regional and global markets. Similarly, both nations have expressed the desire to export equipment and services related to electricity production and energy efficiency improvements to the global market. However, U.S. clean energy exports seem to focus on solar and wind energy technology, while Korea appears to favor exporting technology related to nuclear power (Office of Public Affairs, 2012; National Export Initiative, 2010). Additionally, while Korea may improve trade balance from reduction in energy imports, the US might see a drastic change in energy trade balance as natural gas and renewable energy exports will slowly start to replace coal and nuclear power over time (Krauss, 2013).

Climate change, likewise is a topic that both nations are attempting to address through similar means. Sustainable transportation, for instance, is being pursued by both the U.S. (CAFE standards) as South Korea ('Low Carbon Vehicles Cooperation Charge'). The U.S. is incorporating various stakeholders – governments, think tanks, industry officials, etc. – into its effort to advance sustainable transportation through its initiatives such as the Workplace Charging Challenge and the Department of Energy's EV Everywhere Grand Challenge (IEEE 2013; 2012). The similarity in climate change narrative is evidenced by the May 2013 joint statement released by the U.S. and South Korea agreeing to enhance clean energy and climate change cooperation as an integral part of their bilateral relationship on the occasion of the visit by President Park Geun-Hye to the U.S.

Both South Korea and the U.S. are planning to advance the implementation and dissemination of smart grids along similar lines as they move to empower smart energy consumers, integrate clean energy sources, provide jobs, improve grid reliability, and improve energy efficiency (e.g., White House, 2011). For instance, South Korea released the National Smart Grid Roadmap in 2010 with the aim to construct a nationwide smart grid by 2030. Similarly, the U.S. also has its own nationwide smart grid plan ('Smart Grid 21') (White House, 2011) and demonstration projects are underway in both countries. The United States Trade Representative and the National Institute of Standards and

[11] Target vehicles would be passenger cars and vans weighing less than 3.5 tons and designed for ten or fewer passengers.

Technology are working with the Asia-Pacific Economic Cooperation to improve smart grid interoperability standards (White House, 2011). Furthermore, Korea and Illinois have teamed up to advance smart grid education and create more opportunities for electric vehicles (Olken, 2011).

These examples highlight the similarities between the U.S. and the South Korean energy development pathways. Some of these similarities are given in Table 3-1.

Table 3-1. Some of the similarities between the U.S. and South Korea. A comprehensive overview can be found in Appendix 3.

United States	Policy Issue	South Korea
17 % emission reduction by 2020 (2005 is baseline)	Climate Change	30% reduction of CO_2 emissions from BAU emissions by 2020
Double renewable power by year 2020 (base year 2012)	Renewable Energy	Expand renewable energy share to 11% by 2030
Double energy efficiency productivity by year 2030 (base year 2010)	Energy Efficiency	Improve energy intensity by 46% by year 2030 (improve 2.6% on annual average)
US trade balance: natural gas and renewable energy exports increase	Economy	Reduce energy imports by $34.4 billion by 2030 (2007 prices)

Source: Authors

3.5. Concluding Remarks

Even though both nations went through an election cycle, the policy narratives of the U.S. and South Korea appear maintain continuity. The election of President Park Geun-Hye creates a level of continuity and overlap with U.S. aims that would not have been the case if candidate Moon Jae-In had secured the Presidency (Pempel, 2013). Likewise, the reelection of President Obama sees a continued focus on renewable energy, energy efficiency and climate change issues but the Administration's ambition remains restrained by Congressional opposition. Out of the domestic energy policy issues, the strong rise in domestic conventional energy production stands out with potentially considerable domestic and international ramifications. Other elements that will affect the landscape of U.S. (clean) energy policy are the uncertain future of nuclear power, the continued support for and growth of renewable energy, and the expected increasingly restrictive regulatory policies diminishing coal's viability as a energy resource. On an international level, the Obama Administration is not likely to affect dramatic change as the Administration lacks a public mandate. Other than through partnerships and initiatives (see next chapter), therefore, this chapter outlines how climate change will continue to be an issue that will be addressed domestically through the expression of executive power but with limited engagement internationally.

The similarities between the U.S. and South Korea's energy development pathways yields the realization that there is much potential for collaboration and cooperation. On key issues such as renewable energy, energy efficiency, and climate change, the energy development pathways demonstrate great similarity. As such, the Obama Administration's clean energy ambitions and their pivot strategy to Asia combined with South Korea's pursuit for a green (energy) economy offers significant potential for collaboration and cooperation. Chapter 4 covers how such collaboration can take place.

4.0. U.S. – Korea Clean Energy Cooperation: Collaboration Options and Opportunities

So far, it has become clear that U.S. energy policy can be expected to stay on a similar course as throughout the first term of the Obama Administration (Chapter 1), that this course has considerable consequences for U.S. greenhouse gas emissions and economic development (Chapter 2), and that the Presidential elections in both South Korea and the U.S. produce a fruitful foundation for collaboration (Chapter 3). For instance, a Romney Presidency would have produced decisively different energy policies and would have established a U.S. energy policy focus geared towards North America.

The foundation for collaboration and the extent to which actors (whether public or private) are capitalizing on this foundation is explored in this chapter. To that end, this chapter employs a three track analysis. First, the chapter investigates the multi-lateral arrangements in which the U.S. and South Korea engage international energy policy. Second, the chapter covers results from a census of collaboration and cooperation efforts that are currently ongoing between the U.S. and Korea to gain insight into the depth and meaning of such collaboration. This census covers private-private partnerships, public-private partnerships, and public-public partnerships. Next, to further establish the options and opportunities provided by the U.S. – Korea interaction detailed in Chapter 3, this chapter explores several case studies of U.S. bilateral interaction with other relevant nations such as China and India. From these case studies, recommendations for future U.S. – Korea cooperation can be drawn.

4.1. Korea-U.S. Multilateral Energy Cooperation

4.1.1. Transnational Energy partnerships

Transnational multi-stakeholder or multilateral partnerships for sustainable development are new forms of global governance. Global governance is needed for the issues that are cross-border and no longer can be dealt with within a unilateral approach. These partnerships are operated by the cooperative participation of public actors (from governments or international organizations) and private actors (from businesses or civil society) to help implement intergovernmental commitments and working toward a specific, initially defined goal (Beisheim, 2012). The partnerships include various aspects of sustainable development such as energy, economy, environment, etc. Such partnerships are considered effective and participatory mechanisms to implement sustainable development and enhance international cooperation on sustainable energy issues. However, these partnerships are intended to facilitate, and strengthen the participation of relevant stakeholders rather than substituting government responsibilities and commitments.

Transnational partnerships are one of the tangible outcomes of the 2002 World Summit for Sustainable Development. The UN Commission on Sustainable Development (UNCSD) Secretariat keeps a database of multi-stakeholder partnerships. The UNCSD registry lists over 340 partnerships for sustainable development in the areas food security & sustainable agriculture, water, energy, climate change, biodiversity, forests & other ecosystems, chemicals & waste, etc. There are 28 partnerships in the areas of energy. The energy partnerships emphasize sustainable energy, the provision of energy from renewable energy sources. Most of the currently active partnerships in the area of energy seek cooperation through knowledge dissemination and technology transfer, building of institutional capacity and training, technical implementation, knowledge production and innovation and other planned functions (Szulecki, Pattberg, & Biermann, 2011). In this section, some of the influential transnational partnerships on renewable energy which include the participation of organizational partners from both the Republic of Korea and the United States will be listed and discussed. Based on aggregated output and an expert survey ranking partnerships, active energy partnerships with specific focus on renewable energy are selected (Szulecki et al., 2011).

4.1.2. Renewable Energy and Energy Efficiency Partnership (REEEP)

The Renewable Energy & Energy Efficiency Partnership is a non-profit organization established in 2002. Currently, REEP involves around 400 partners including 45 governments from both the developed and the developing world. Various other partners are involved in the partnership from a broad range of businesses, NGOs and civil society organizations. With heavier focus on energy issues of emerging economies and developing countries, government agencies and partners from developed world including Australia, Canada, Germany, Italy, Netherlands, Norway, South Korea and, the United States cooperate through the partnership. REEEP collaborates actively with some of the well-established international organizations such as the International Renewable Energy Agency (IRENA), the International Energy Agency (IEA), MEDREP, the Global Village Energy Partnership (GVEP), etc. The partnership's objective is to accelerate a global market for renewable energy and energy efficient systems (REES). The key activities of REEP are focused on the following: 1) Initiate and fund projects, which establish a favorable regulatory framework and provide financial and business support in partner countries; 2) Develop policy-maker networks through initiatives such as the Energy Efficiency Coalition (EEC), the Sustainable Energy Regulation Network (SERN) and Renewable Energy and International Law (REIL); and 3) build capacity and increase learning of sustainable energy growth though publications, websites and events.

4.1.3. International Solar Energy Society

The International Solar Energy Society is a global organization with a 50-year track record. ISES is a UN-accredited transnational non-governmental organization which is headquartered in Freiburg, Germany. ISES is currently active in 105 counties world-wide with members from Korea and the US, Korean Solar Energy Society (KSES) and American Solar Energy Society respectively. The organizations which ISES cooperates with are UNEP, IRENA, IEA, EU, World Council for Renewable Energy, REN21, EREC and others from universities and research institutes, NGOs, industry and service organizations and governments. ISES' partnership goal is to bring advancements in solar energy, both in research and applications to increase understanding and daily use of solar resource for decisions makers and the general public. ISES is actively engaged in publication, projects and events to advance the transition to a renewable energy world. ISES is focused on promoting renewable energy through following activities: 1) Promote solar research and development worldwide; 2) Support career growth of young ISES members; 3) Promote energy education at all levels; 4) Participation in international decision making meetings; 5) Build partnerships with other complimentary international organizations.

4.1.4. The Clean Energy Ministerial

The Clean Energy Ministerial (CEM) Initiatives are organized by the International Agency (IEA). This section will highlight cases including participation of both Korea and the US. The CEM is an international forum for sharing information and knowledge and forming commitments to action on clean energy development. A mechanism recommended by CEM in order to bring large scale development and implementation of clean energy technology is the development of public-private partnerships (CEEP, 2012). For this purpose, CEM has been conducting roundtable forums to bring together energy ministers, government officials, business leaders, and experts from NGOs. Korea and the US participates in clean energy ministerial initiatives in the following sectors: 1) Appliances (Super-efficient Equipment and Appliance Deployment (SEAD) initiative); 2) Buildings and Industry (Global Superior Energy Performance Partnership (GSEP)); 3) Carbon Capture (Carbon Capture Use and Storage (CCUS) Action Group); 4) Smart Grid (International Smart Grid Action Network (ISGAN)).

Table 4-1. Overview of transnational energy partnerships

Partnership/Organization	Description
Energy Working Group (EWG) of Asia-Pacific Economic Cooperation (APEC)	The Energy Working Group (EWG) of APEC was launched in 1990 to promote regional economic development by maximizing energy sector's contribution while limiting environmental degradation from use of fossil fuels. EWG is involved in several initiative categorized as Energy Security Initiative (ESCI), Energy Smart Communities Initiative, and Sustainable Development Initiative. Specific ESCI projects involving Korea and US are Low Energy Buildings Network, Materials Testing and Rating Centers, Cool Roof Demonstrations,

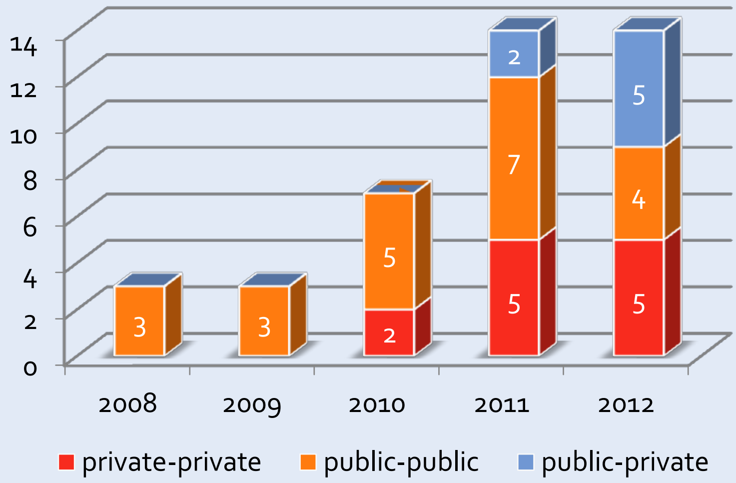
	Interoperability Survey and Roadmap, and Smart Grid Test Bed Network.
Clean Energy Ministerial (CEM)	The Clean Energy Ministerial Initiative is an international forum for sharing information and knowledge and forming commitments to action on clean energy development. Key governments including Korea and the US set ambitious goals for global development of clean energy technologies. The CEM promotes collaboration with present international initiatives on technology deployment, the International Lo-Carbon Technology Platform and EU Strategic Energy Technology Plan. Current participation of Korea and US in CEM Initiatives include following sectors: Appliances, Buildings & Industry, Carbon Capture, Smart Grid, and Solar & Wind.
Asia-Pacific Partnership (APP) on Clean Development and Climate	The Asia-Pacific Partnership aims to expand investment and trade in cleaner energy technologies, goods and services, and promote best practical technologies in its partner countries. The public sector task forces are following: 1) aluminum; 2)building & appliances; 3) cement; 4) cleaner fossil energy; 5) coal mining; 6) power generation & transmission; 7) renewable energy; 8) distributed generation; 9) steel. Korea and US participates in following projects: exploring construction of super high efficiency solar light station in critical scale; verifying commercialization of PEMFC for power generation; researching bioenergy for environmentally sustainable energy and water; advancing APP mega solar light project; supplying China with CHP systems using coke gas; building renewable energy hubs in rural districts of China and India.
International Renewable Energy Agency (IRENA)	The International Renewable Energy Agency, specifically dedicated to renewable energy development, shows active engagement from governments and non-governmental organizations and private sector

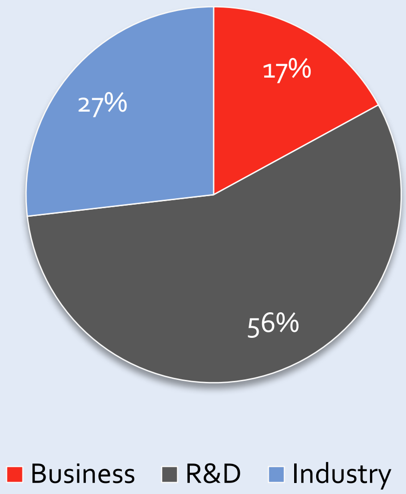
Source: Authors

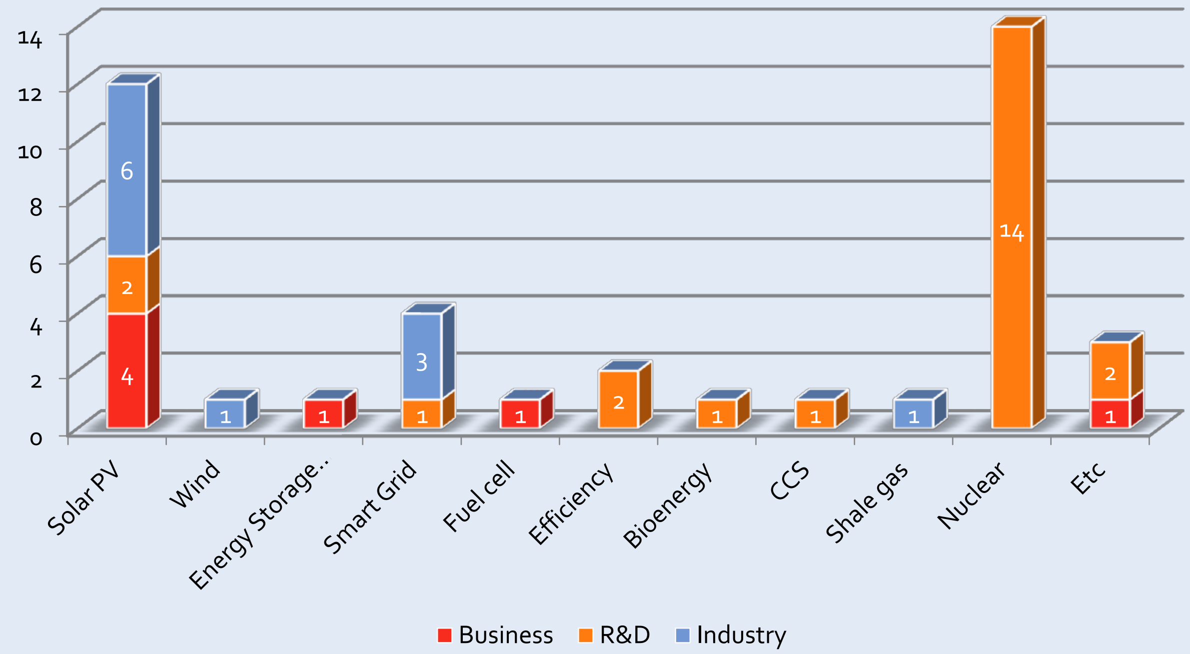
4.2. Korea-U.S. Bilateral Clean Energy Cooperation: Census Results

The census identified 41 clean energy partnerships between the U.S. and South Korea. The findings suggest that the depth and extent of collaboration is deepening as higher numbers of clean energy partnerships are found in the later years of the census: three partnerships were identified that were established in 2008, three in 2009, seven in 2010, fourteen in 2011, and another fourteen in 2012 (see Figure 4-1). This apparent acceleration might be due to the established U.S. South-Korea Free Trade Agreement (FTA) and President Myung-Bak Lee's green growth policy. Census results are summarized in Figure 4-1.

Figure 4-1. Census results: partnerships by year, by category and by technology.







Source: Authors
* In contrast to business partnerships, this report categorizes industry partnerships as efforts geared not towards producing actual products for sale, but rather focused on the construction of renewable energy systems or building systems for supporting energy production and efficiency.
* 'Public-public partnerships' circumscribe collaborations between the governments of Korea and the U.S.
* The term 'public-private partnership' is used here to detail collaborations between the Korean government and U.S. based firms or Korea based firms and the U.S. government.

4.2.1. Private-Private Partnerships

This section covers collaboration between U.S. corporations and Korean corporations from 2008 to 2012 and identifies 12 such partnerships: two that were initiated in 2010, five that were established in 2011, and another five that were started in 2012 (see Figure 4-1). The majority (7) of the identified private-private partnerships revolve around solar PV technology, indicating the substantial cooperation that occurs in this technology field. These partnerships are primarily geared towards technology and knowledge exchange and to disseminate technological advancements between the two countries. For instance, South Korea has made some significant technological improvements in solar PV and has engaged in contracts to construct – or to participate in the construction of – solar power plants in the U.S. For example, in 2012, OCI Solar Power – which operates together with a Korean-based private corporation (Nexolon Co. Ltd.) – contracted with U.S. based CPS Energy to build solar plants in San Antonio, Texas (CPS Energy, 2012). Their plan includes to construct a $700+ million 400 MW PV power plant – the largest such planned facility in the U.S. among municipal facilities.

The nature of private-private partnerships usually limits collaboration to the exchange of knowledge on deployment-ready technologies. However, the Memorandum of Understanding (MOU) between LG Electronics (Korea), Seowon University (Korea) and Dow Corning (U.S.) focuses on R&D on innovative PV systems. Established in October 2011, the MOU outlines the installation of a 1 MW system. Interestingly, the partnership between Hanwha SolarOne (Korea) and Silent Power (U.S.) articulates a co-marketing strategy to bring a combined package of SolarOne's PV panels and Silent Power's distributed energy storage system to the market (Renewable Energy Focus, 2012).

Another R&D partnership is between LG Chem. Ltd. and Southern California Edison for pilot program of lithium-ion battery packs provided by LG Chem. Ltd. (Green Car Congress, 2012). The United States Advanced Battery Consortium (USABC) and a Korean Company, Cobasys, got a subsidy to develop high efficiency Lithium-ion battery from USABC (SBLiMotive, 2011). KT Corporation and Intel signed another R&D partnership to research energy efficiency systems which can reduce energy consumption when temperatures are high (Huang, 2012).Energy efficiency collaboration is also strong. The census identified three such partnerships, such as building a smart grid system in Jeju Island based on the contract between Posco ITC and IBM (Korea IT Times, 2010). These two firms also collaborate in another energy efficiency partnership: the Smart Green Program (D.-k. Kim, 2012).

Table 4-2. Census results: private-private partnerships

Participants	Technology	Investment	Location	Description	Source
LG Chem, Ltd. Southern California Edison (SCE)	Energy Storage Systems	32MW		LG Chem, Ltd. to provide lithium-ion battery packs for pilot program involving energy storage systems for residential and small commercial applications.	(Green Car Congress, 2012)
POSCO, ICT IBM	Smart Grid		Jeju Island, Korea	Partnership to develop smart grid Renewable Energy Management System	(Korea IT Times, 2010)
Cobasys, (SB LiMotive), United States Advanced Battery Consortium (USABC)	Lithium-ion cell, EV	$8.4 million		USABC awarded Cobasys, a subsidiary of SB LiMotive to develop high-energy lithium-ion batteries for EV applications	(SBLiMotive, 2011)
Jusung Engineering, MEMC	Solar PV (postponed)	100 MW/ $32 million		Partnership to achieve low cost, high efficiency and capital efficient solar cell manufacturing facility.	(Jusung, 2011)
S-Energy Cenergy Power	Solar PV	5MW	California	Partnership formed to jointly develop 9MW scale PV complex. S-Energy targeting to build total 120MW solar power plants in US market.	(Solarbuzz, 2011)
LG Electronics, Seowon University Dow Corning	Solar PV	1MW	Seowon University, Korea	Signing of MOU regarding innovative PV systems. Starting with 15kW array for testing and evaluation, a larger array up to 1MW system installation is expected.	(Dow Corning, 2012)
POSCO Power Sustainable Energy Capital Partners (SECP)	Solar PV	300 MW/ $728 million	Boulder City, Nevada	Joint venture partnership to develop 300 MW PV power plant	(Cheney, 2010)
Samsung C&T, Lincoln Renewable Energy	Solar PV			Partnership forming a 50/50 joint venture company, Monument Power LLC to further advance business plan in US renewable energy.	(Lincoln Renewable Energy, 2012)
Hanhwa SolarOne, Silent Power	Solar PV	$8 million		Partnership featuring co-marketing strategy for bundling SolarOne's PV panels with Silent Power's distributed energy storage device	(Renewable Energy Focus, 2012)
OCI Solar Power, Nexolon Co Ltd, CPS Energy, (San Antonio Municipal Utility)	Solar PV	400MW/ $728 million	San Antonio, Texas	Partnership to construct 400-MW solar plant, the largest project in the nation among municipal utilities	(CPS Energy, 2012)
KT Corporation, Intel	Energy-efficient Data Center		KT-owned Data Centers	Partnership to research energy-efficient technology to operate data centers in temperatures higher than 30 degrees Celsius to reduce power consumption.	(Huang, 2012)
POSCO ICT IBM	Energy Efficiency			Partnership to develop "Smart Green Platform", to increase energy efficiency	(D.-k. Kim, 2012)

Source: Authors

4.2.2. Public-Public Partnerships

Within the census, eight public-public partnerships within the 2008-2012 time period were identified (see Table 4-3). Out of the identified partnerships, the public-public partnerships appear to show more diversity compared to the partnerships identified in other sections. The census identified one solar PV projects, two smart grid partnerships five partnerships revolving around renewable energy information and technology sharing and exchange, one concerning nanotechnology, one for bio energy, and one demanding the U.S. state government energy support for Korean companies in Nevada state of the US, and one about carbon capture and sequestration. Nuclear energy collaboration demonstrates strong representation among the public-public partnerships and, as such, special attention is given to nuclear energy cooperation below.

Most of the public-public partnerships are based on MOUs and, as such, these partnerships describe plans and objectives rather than actual, ready-to-be-implemented projects. Smart grid technology is one of the technologies that stand out in the identified partnerships as the purpose of increasing energy efficiency. The MKE and the Illinois Department of Commerce, for instance, have signed an MOU to establish a smart grid technology pilot facility at Jeju Island and, simultaneously, to construct an energy-saving facility in Chicago, Illinois with financial support from Korean companies LG Electronics and KT (Metering, 2010). Hawaii and the MKE also engaged in a 2012 smart gird research project in Hawaii (Pacific Business News, 2012). Excluding the solar PV partnership between Korea Institute of Energy Research and Underwriters Laboratories (U.S.) in 2009, the other partnerships are primarily focused on research and development collaboration.

Table 4-3. Census results: public-public partnerships

Participants	Technology	Location	Description	Source
Korea Institute of Energy Research (KIER), Underwriters Laboratories	Solar PV		MOU to establish cooperation in PV technology reliability, quality standards and certification service.	(Joonki Lee, 2009)
Korea Ministry of Knowledge Economy, Illinois Department of Commerce	Smart Grid	Jeju Island	MOU to set up pilot program to create smart grid technology at a facility in Jeju Island.	(Metering, 2010)
Korea Ocean Research and Development Center (KORDI) Institute of Marine & Environmental Technology (IMET)	Bio Energy		MOU for research cooperation between IMET and Marine Biotechnology Research Center of KORDI	(Hiles, 2011)
Korea Ocean Research Development Institute, National Energy Technology Laboratory (NETL)	CCS	Ulleung basin	MOU to cooperate on CCS & information communication and form research foundation for the large-scale CCS projects planned after 2016	(Jihee Lee, 2011)
Ministry of Knowledge Economy Hawaii	Smart Grid	Hawaii	Letter of intent to cooperate in a smart grid demonstration project in Hawaii	(Pacific Business News, 2012)
Korea Institute of Energy Research (KIER), Sandia National Laboratories (US DOE)	Energy systems		MOU to cooperate on energy conversion, new & renewable energy, transportation, energy efficiency, energy storage ,etc	(Chung, 2012)
Ministry of Education, Science & Technology, US National Science Foundation	Nanotechnology	Hanyang University	9th Korea-US Nano-forum held at Hanyang University to provide opportunities for collaboration among researchers.	(Ministry of Education Science and Technology, 2012)
Korea International Trade Association (KITA),	Renewable energy		Discussion on energy cooperation regarding renewable energy companies in Nevada.	(Lim, 2012)

State of Nevada
Source: Authors

In the climate change policy debate, nuclear energy plays a substantial role and has been stressed as a potential energy technology for the future by both the U.S. and Korean governments. In this, international cooperation between the U.S. and Korea plays a crucial role. The United States and Korea have cooperated in the peaceful use of nuclear power for over fifty years since they made an "Agreement for Cooperation between the Government of the Republic of Korea and the Government of the United States of America concerning Civil Uses of Atomic Energy" in 1956 (Sheen, 2011). The scope of joint research mainly consists of economics, technical feasibility, and nonproliferation implications of pyro-processing (a type of spent fuel reprocessing), which began in 2002 under the US DOE's International Nuclear Energy Research Initiative (I-NERI). Table 4-4 shows a breakdown of the number of bilateral collaborations by fiscal year. As of FY 2011, the continuous collaboration currently accounts for more than 40% of the total number of I-NERI joint research projects.

Table 4-4. International Nuclear Energy Research Initiative (I-NERI) bilateral collaboration.

Collaborator	Fiscal Year											Total
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Brazil	-	-	-	-	1	1	-	-	-	-	-	2
Canada	-	-	-	7	-	-	2	3	-	-	-	12
EURATOM	-	-	-	8	2	5	-	-	-	6	1	22
France	4	1	-	11	-	3	-	2	-	-	-	21
Japan	-	-	-	-	1	1	-	-	-	-	-	2
OECD-NEA	-	1	-	-	-	-	-	-	-	-		1
South Korea	-	6	5	6	4	4	7	3	2	4	5	46
Total	4	8	5	32	8	14	9	8	2	10	6	106

Source: U.S. DOE NE, retrieved from http://www.ne.doe.gov/INERI/neINERI_researchprojects.html

Additionally, Table 4-5 presents a listing of I-NERI research cooperation between the U.S. and Korea. Most projects are conducted by national research institutes or universities such as Korea Atomic Energy Research Institute, Seoul National University, and Ulsan National Institute of Science and Technology from the Korean side, and Idaho National Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, University of Wisconsin, Madison, University of California, Berkeley, and so on from the U.S. side. Every project initiated during FY2001-2008 have been completed (DOE NE, 2012).

Table 4-5. Census results: U.S.-Korea I-NERI Projects (2008-2011)

Participants	Date	Collaborators	Description
Korea Atomic Energy Research Institute Argonne National Laboratory	September 2011		Advanced Multi-Physics Simulation Capability for Very High Temperature Gas-cooled Reactors (VHTRs)
Korea Atomic Energy Research Institute Idaho National Laboratory	October 2011	Argonne National Laboratory, Seoul National University, Texas A&M University	Experimental and Analytic Study on the Core Bypass Flow in a Very High-Temperature Reactor
Korea Atomic Energy Research Institute Oak Ridge National Laboratory	October 2011	Korea Advanced Institute of Science and Technology	Nuclear Data Uncertainty Analyses to Support Advanced Fuel Cycle Development
Korea Atomic Energy Research Institute Argonne National Laboratory	October 2012		ZPPR-15 and BFS Critical Experiments Analysis for Generation of Physics Validation Database of Metallic-Fueled Fast Reactor Systems

Korea Atomic Energy Research Institute University of Wisconsin, Madison	September 2012	Texas A&M University, Seoul National University	Enhanced Radiation Resistance through Interface Modification of Nano-Structured Steels for Gen IV In-Core Applications
KAIST Idaho National Laboratory	October 2010		Experimental Validation of Stratified Flow Phenomena, Graphite Oxidation, and Mitigation Strategies of Air Ingress Accidents
Korea Atomic Energy Research Institute Idaho National Laboratory	October 2010		Development of Advanced Voloxidation Process for Treatment of Spent Fuel
Korea Atomic Energy Research Institute Idaho National Laboratory	September 2011		Development and Characterization of New High-Level Waste Forms for Achieving Waste Minimization from Pyroprocessing
Korea Atomic Energy Research Institute Idaho National Laboratory	September 2010	Seoul National University, University of Idaho	Development of Computational Models for Pyrochemical lectrorefiners of Nuclear Waste Transmutation Systems
Korea Atomic Energy Research Institute Argonne National Laboratory	November 2010		Sodium-Cooled Fast Reactor Structural Design for High Temperatures and Long Core Lifetimes/Refueling Intervals
Seoul National University Idaho National Laboratory	September 2013	Korea Atomic Energy Research Institute, University of Idaho	Investigation of Electrochemical Recovery of Zirconium from Spent Nuclear Fuels
Ulsan National Institute of Science and Technology Argonne National Laboratory	September 2013	Korea Atomic Energy Research Institute, Seoul National University	Advanced Instrumental Science-Based Approach to Nickel Alloy Aging and its Effect on Cracking in Pressurized Water Reactors
Korea Atomic Energy Research Institute Idaho National Laboratory	December 2013		Low-Loss Advanced Metallic Fuel Casting Evaluation
Korea Atomic energy Research Institute Oak Ridge National Laboratory	November 2011		Development and Characterization of Nanoparticle-Strengthened Dual-Phase Alloys for High-Temperature Nuclear Reactor Applications
Korea Atomic Energy Research Institute Colorado School of Mines	September 2014	University of Michigan, University of North Texas	Atomic Ordering in Alloy 690 and its Effect on Long-Term Structural Stability and Stress–Corrosion Cracking Susceptibility
Korea Atomic Energy Research Institute University of California, Berkeley	September 2014		Development of Microcharacterization Techniques for Nuclear Materials
Korea Atomic Energy Research Institute Argonne National Laboratory	September 2014		Verification and Validation of High-Fidelity Multi-Physics Simulation Codes for Advanced Nuclear Reactors
Korea Atomic Energy	September		Development of Diagnostics and Prognostics Methods for

Research Institute University of Tennessee	2014		Sustainability of Nuclear Power Plant Safety Critical Functions
Korea Atomic Energy Research Institute Oak Ridge National Laboratory	September 2014	Ultra Safe Nuclear Corporation, Inc.	Fully Ceramic Microencapsulated Replacement Fuel for Light Water Reactor Sustainability

Source: Department of Energy (DOE) Nuclear Energy, 2008, 2009, 2010, 2011

4.2.3. Public-Private Partnerships

The census identified seven public-private partnerships (see Table 4-6). Most of these partnerships focus on building energy facilities in Korea or the U.S. For instance, Daegu (city in Korea), Avaco (Korean firm) and Starion Energy (U.S. based firm) initiated a project of building a 300 MW thin film solar cell factory in the Seonsu Industrial complex in Korea with $320 million in funding. Avaco supplies the solar energy battery equipment to Starion Energy (Noh, 2012). Wind energy collaboration is also significant as the Korean government company Korea South East Power Co. Ltd has a partnership with a Korean company, Daewoo Shipbuilding & Marine Engineering Co., Ltd and its U.S. affiliate, DeWind Co. for building a 120MW-sized wind power plant Oklahoma (U.S.). This partnership is the first large-scale wind energy collaboration project led by Korea throughout the full process of the project from start to finish.

The remaining public-private partnerships are related to collaborations for industry. Only one partnership, about R&D, covers a ten-year collaboration between the Korea Institute of Energy Research and Smart Grid Energy Research Center (SMERC) and the UCLA to improve smart grid technology (Berst, 2011). Another significant partnership in this section is shale gas collaboration between KOGAS and Cheniere Energy Partners Ltd. signed in Jan 2012. This agreement will lead to the purchase of 3.5 million tonnes of shale gas every year from 2017 which is produced in Sabine pass liquefaction, Houston, Texas (PR Newswire, 2012). Even though shale gas is not categorized as renewable energy, the report indicates the importance of this partnership, since the highlighted role of shale gas in earlier chapters of this report.

Table 4-6. Census results: Public-private partnerships

Participants	Energy Type/ Technology	Date/ Duration	Size/ Investment	location	Further Information	Sources
Korea South East Power Co. Ltd. (KOSEP) Daewoo Shipbuilding & Marine Engeneering Co., Ltd (DSME) and its US affiliate, DeWind Co	Wind	2012/20yrs	120MW	Oklahoma	KOSEP g Do-soo) and DSME built the 80MW wind power generation farm, Novus I in Oklahoma, and launched its commercial operation. Currently Novus II wind power generation farms with a capacity of 40MW are being constructed.	(U.S. FERC, 2012)
Korea Midland Power Co. Posco Engineering Co. Nevada	Solar	2011	300MW	Boulder, Nevada	The 300-megawatt plant will be located in Boulder City in Nevada, and is expected to be completed by December 2014, Korea Midland Power Co.	(Bloomberg, 2011)
Korean Western Power partnering with DMP Energy	Solar	2012/33 months	120MW	Boulder Nevada	50-year lease of 884 acres	(Las Vegas Review Journal, 2013)
Korea Institute of Energy Research (KIER),	Smart Grid	December 2011			10-year partnership to collaborate on R&D of new technologies to develop a strong smart grid at	(Berst, 2011)

Smart Grid Energy Research Center, UCLA					international level.	
Korea Gas Corporation (KOGAS) Cheniere Energy Partners	Shale Gas	Jan 2012	3.5million tonnes Shale Gas annually for 20 years from 2017	Sabine Pass Liquefaction Huston, Taxas, The US	LNG Sale and Purchase Agreement, to be involved in Shale gas production and purchase for Korea. FTA between two countries helped to decide the US gives this chance to Korea to contract	(PR Newswire, 2012)
Korea Smart Grid Institute, Ministry of Knowledge Economy Oak Park Village	Solar	June 2012		Oak Park Village, Illinois	Signing of letter of intent discussing solar-powered demonstration sites on residential & commercial buildings around the community	(Oak Park, 2012)
Avaco, Daegu City Starion Energy	Solar PV	August 2012	300MW/ $320 million	Seongsu Industrial Complex, Daegu	Starion Energy will invest $320 million in Seongsu industrial complex to build a factory of 300MW size to produce thin film solar cells.	(Noh, 2012)

4.3. U.S. Bilateral Clean Energy Cooperation: Case Studies

The previous sections have described a range of cooperation measures and actions between the U.S. and Korea. It is clear that considerable collaboration takes place between the two nations with several large-scale, multi-million or even billion dollar projects. To gain further insight into the options and opportunities for Korea-U.S. collaboration, it is useful to reflect on other ways the U.S. engages international energy policy. To that end, this section details the bilateral clean energy collaboration efforts between the U.S. and other countries in order to draw implications from those cases. The U.S. engages in a wide variety of energy collaboration platforms focusing on a range of issues such as technology market development, trade and investment (NREL, 2008). The U.S. Department of State provides a listing of official bilateral climate and energy partnerships Table 4-7. Of the listed partnerships, two are analyzed in detail: U.S.-China, U.S.-India. A brief overview of U.S. – Japan collaboration is used to supplement the findings.

Table 4-7. Overview of U.S. Bilateral Climate and Energy Partnerships

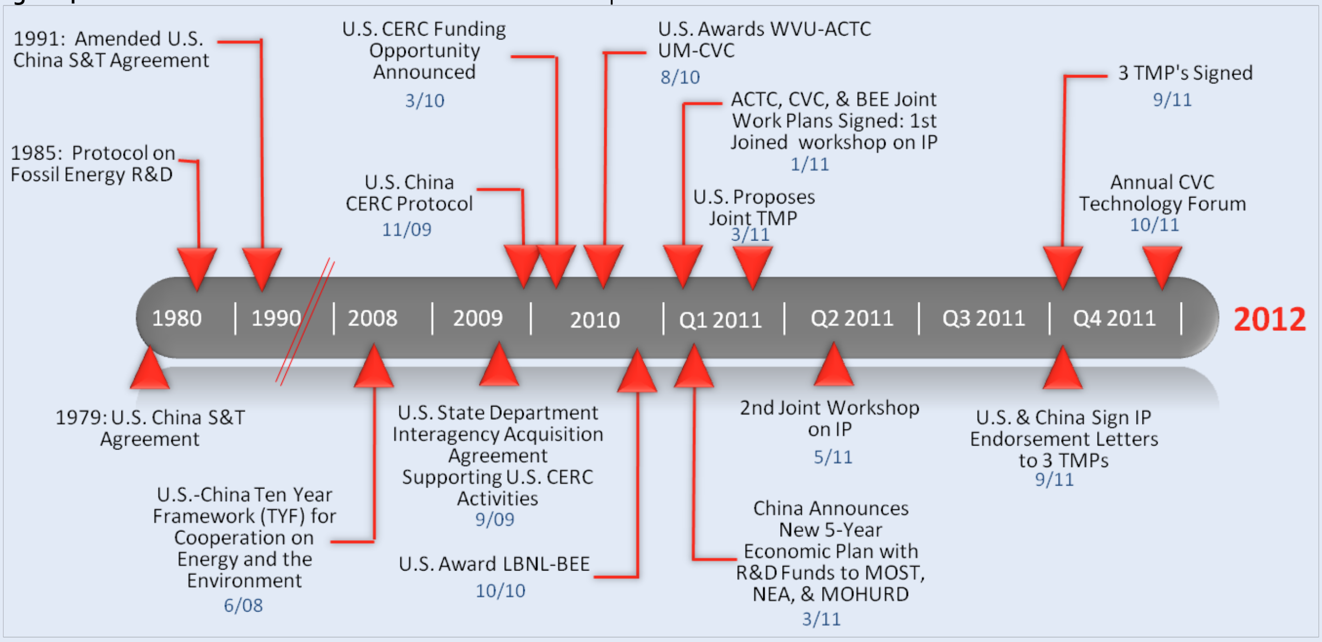
Partner Country	Description
India	Prime Minister Singh and President Obama agreed to strengthen U.S.-India cooperation on energy and climate change. White House Releases Clean Energy Security & Green Partnership
China	President Barack Obama and President Hu Jintao announced a far-reaching package of measures to strengthen cooperation between the United States and China on clean energy.
NALS	North American Leaders' Declaration on Climate Change and Clean Energy
Indonesia	President Obama and President Yudhoyono make enhanced cooperation on clean energy and climate change a key element of the new U.S.-Indonesia Comprehensive Partnership.
Canada	President Obama and Prime Minister Harper vow joint effort on North American economic recovery.
Mexico	U.S.-Mexico Announce Bilateral Framework on Clean Energy and Climate Change.

Source: U.S. Department of State, retrieved from http://www.state.gov/e/oes/climate/c22820.htm

4.3.1. Case Study I: U.S.-China Energy Partnership

China has established intergovernmental energy cooperation agreements with a wide variety of participants and countries as it has engaged in intergovernmental collaboration with around 40 countries and science & technology (S&T) cooperation with around 100 countries (Liping, 2011). Energy-related research and development is always a key area of such agreements (Liping, 2011). Also, the U.S. is China's most important energy R&D cooperation partner (Liping, 2011). Since the Science and Technology Cooperation Agreement of 1979 (S&T agreement), the U.S. and China have cooperated in diverse scientific and technological research projects including energy-related areas (see Figure 4-2). Growing global challenges such as energy security and climate change have recently further strengthened the U.S.-China partnership in the energy sectors for mutual benefits. In response to such trends, in June 2008, the "U.S.-China Ten Year Framework (TYF) for Cooperation on Energy and the Environment" was created in purpose of cooperation on energy efficiency, electricity, transportation, air, water, wetlands, nature reserves and protected areas. Namely, the TYF is essentially intended to promote the exchange of information and best practices in order to develop solutions to environmental and energy challenges which both countries commonly face. Zhao et al. (2011) point out that China and the U.S. have formed an intimate cooperative relationship in the energy sector since the 1990s. In particular, renewable energy cooperation between the two countries is well observed through various projects and agreements since the 2000s such as the U.S. – China Forum on Clean Energy Technologies and the annual China – U.S. Strategic Economic Dialogue that is focused on, among others, renewable energy and energy efficiency (Zhao, Zuo, Feng, & Zillante, 2011). An example of the topics discussed at the annual China – U.S. Strategic Economic Dialogue is the 2010 round on "China-US Joint Statement on Energy Security Cooperation" (Zhao, Zuo, Feng, & Zillante, 2011).

Figure 4-2. Timeline overview of a selection of U.S. China Cooperation.



Source: Authors, adapted from U.S.-China CERC, 2011: 10

* TMP= Technology Management Plan, ACTC= Advanced Coal Technology Center, CERC= Clean Energy Research Center, IP= Intellectual Property, MOHURD= Ministry of Housing and Urban Rural Development (China), NEA= National Energy Administration (China), MOST= Ministry of Science & Technology (China), BEE= Building Energy Efficiency program, CVC= Committee for Clean Vehicles

The U.S.-China energy cooperation can be seen to have moved through four distinct phases (U.S. China CERC, 2013). From 1979 to 1990, collaboration was limited to S&T agreements – such as the 1979 agreement on high energy physics and the 1985 protocol on fossil energy R&D. However, this phase was hampered by intellectual property rights issues which led to a reduction in cooperative efforts between the two nations in 1989. The second period (1991-2000) is a period in which collaboration was limited to energy policy consultations in which few milestone achievements were realized. The third phase (2001-2007) can be seen as one in which collaboration and partnership efforts were broadened as, for example, China joined the nuclear energy project ITER and the U.S. DOE opened up a office in China. Finally, the fourth phase (starting in November 2009) is one which can be seen as a deepening commitment to collaboration and research participation between the U.S. and China as President Obama and President Hu Jintao announced seven new U.S. China clean energy initiatives during the November 2009 Beijing summit:

1) U.S.-China Clean Energy Research Center (CERC), a joint research program that aims to facilitate accelerated research productivity on clean energy technology development. The program is initially focused on energy efficiency in the built environment, clean coal, and clean vehicles but is open to additional fields of research in the future;
2) Electric Vehicles Initiative, a research program that supports the joint development of standards for charging plugs for electric vehicles, testing batteries and other devices protocol, facilitate demonstration projects, develop technical roadmaps, and provide public education;
3) Energy Efficiency Action Plan that facilitates the development of energy efficient building codes and rating systems, industrial energy efficiency benchmarking, training, harmonization of test procedures and performance metrics, and the exchange of good practices;
4) Renewable Energy Partnership, a partnership that provides technical and analytical resources in order to support renewable energy deployment and facilitates state-to-state and region-to-region partnerships to share experience and best practices;
5) 21st Century Coal, a research program on high-volume carbon dioxide capture, sequestration, and utilization; advanced gasification and gas turbines; and advanced syngas conversion technologies;
6) Shale Gas Resource Initiative to assess China's shale gas potential, promote environmentally-sustainable development of shale gas resources, conduct joint technical studies to accelerate development of shale gas resources in China, and promote shale gas investment through industry forums, study tours, and workshops;
7) Energy Cooperation Program, a public-private partnership to leverage private sector resources for project development work in China across a broad array of clean energy cooperation projects in renewable energy, smart grid, clean transportation, green building, clean coal, combined heat and power, and energy efficiency (U.S. Department of Energy [DOE], 2011)

The U.S. and China share some characteristics in their economies that make collaboration between these countries highly valuable. For instance, both countries rely significantly on coal power as a their main energy resource, both are heavily reliant on foreign oil limiting their energy security, and both use scientific progress as a pathway towards economic development and a move towards a green secure energy economy. The case study analysis presented here focuses primarily on the U.S.- China Clean Energy Research Center (CERC) and the Energy Cooperation Program. The CERC is an innovative new approach towards research collaboration and the Energy Cooperation Program extends beyond academia and governmental efforts as it actively attempts to include private resources. As such, these two programs provide valuable insight into U.S. – China cooperation.

Clean Energy Research Center (CERC)

Established by President Obama and President Hu in 2009, the virtual "U.S.-China Clean Energy Research Center (CERC)" is viewed as a flagship of the U.S.-China clean energy partnership. With broad participation of consortia from universities, research institutions and industry, the energy-related technologies under development in the U.S.-China CERC include: 1)

Table 4-8. Five Year CERC Funding Plan (2011-2015). Five year totals (millions)

Focus	United States		China	Consortium Totals
	DOE	Partners	MOST & Partners	
Advanced Coal	$12.5	≥$12.5	≥$25.0	≥$50.0
Buildings	$12.5	≥$12.5	≥$25.0	≥$50.0
Clean Vehicles	$12.5	≥$12.5	≥$25.0	≥$50.0
Total	$37.5	≥$37.5	≥$75.0	≥$150.0

Source: Adapted from U.S.-China CERC, 2011: 4

advanced coal technologies including carbon capture, storage, and utilization; 2) building energy efficiency; and 3) clean vehicles including electric and alternative fuels. The U.S. and China will equally contribute to the $150 million funding plan over five years (2011-2015) as illustrated in Table 4-8. U.S. and China business partners and research institutions will invest at least $75 million in CERC collaborative research during this period whereas each government will commit itself to securing approximately $15 million in funding to support activities during the same period. Here, it is worth noting that U.S.-sourced funds flow only to U.S.-based participants; the same principal of funding separation is applied to China-sourced funds in China (U.S.-China CERC, 2011). A summary of research activities which are being conducted at CERC (as of February 2013) are given in Table 4-9.

Table 4-9. Summary of Research Activities at CERC.

CERC Technical Track	Joint Work Plan Research Areas	Number of Research Activities	Number of Researchers
Advanced Coal	7	44	U.S.: 40 China: 200
Buildings	7	27	U.S.: 127 China: 320
Clean Vehicles	7	35	U.S.: 79 China: 320
Total	21	106	1,086

Source: U.S. China CERC, 2013: 15-16

The CERC was created to support both nations in their efforts to meet their energy and environmental goals. As such, the CERC provides support through the facilitation of research, development, and commercialization of clean energy technologies (U.S.-China CERC, 2011: 3). In this context, CERC operates on the basis of five principles: 1) equality, mutual benefit, and reciprocity; 2) timely exchange of information relevant to cooperative activities; 3) effective protection of intellectual property rights; 4) peaceful, non-military uses of the results of collaborative activities; and 5) respect for the applicable legislation of each country (U.S.-China CERC, 2011: 3). One reason provided for the creation of a U.S. China energy research center, is the complementary strengths of the respective countries. For instance, the U.S.' world class universities and research centers and strength in theoretical work and computational models is complemented by China's strong basic and applied research and abundant facilities for experimental work (U.S. China CERC, 2013). The structure of CERC consists of a wide array of high level officials, governmental bodies and academic institutes as in Figure 4-5. CERC is governed at high political levels as it includes a Cabinet-level Steering Committee, a Secretariat represented by reputable executives from the U.S. and China, an Executive committee of technical experts and leaders for each of the three main research consortia.

Figure 4-3. Governance structure of the U.S.-China CERC

Source: U.S. China CERC, 2011:6

A critical component of collaboration is to articulate a solid intellectual property rights agreement framework.[12] Vital in promoting innovation, research activities of CERC are based on two key documents of the CERC IP framework – the CERC protocol and the IP Annex – which is expected to help both partners benefit from the products of the collective research. More specifically, researchers collaborate through jointly developed work plans and maintain interdependent relations, thereby enabling the research team to divide labor and resources accordingly, to leverage resources as a combined team, and to foster R&D breakthroughs. The benefits of such breakthroughs will be shared among the partners in accordance with the IP framework and commercialization interests (U.S.-China CERC, 2011: 3). Indicative of the productivity of international energy cooperation are internationally co-published publications in academic journals. In this metric, China's productivity has improved over time, with more and more internationally co-published articles each year (Liping, 2011). The majority of these co-publications are between the U.S. and China (Liping, 2011).

In the context of intellectual property rights, a series of workshops were held between the U.S. and China that, for example, explored the regulatory and legal differences in the two countries or that shared experiences of private sectors and their efforts to protect their clean energy inventions (Lewis, 2013). Lewis (2013) notes that, while the creation of such common understanding of the intellectual property framework takes time, it is worth the upfront investment prior to beginning work. Citing evidence of misunderstandings and problems in earlier collaboration efforts, Lewis (2013) (see also Tan et al., 2013) highlights the importance of the CERC as it may serve as a model in addressing intellectual property rights issues in bilateral relations.

International energy R&D cooperation is now a strategic pillar of China's economic strategy (Liping, 2011). In this, the joint research centers between the U.S. and China – next to CERC, there is also the U.S.-Chinese Energy & Environmental Technology Center established in 1997 – could provide a stable platform for continued research efforts between the two countries (Liping, 2011). The CERC program integrates research activities in both countries in an innovative international platform through a genuine public private partnership that advances prospects for new research breakthroughs (Forbes & Ziegler, 2011), such as for instance in the clean coal technology sector (Yuan & Lyon, 2012) which can provide substantial benefits for both nations (e.g., Lai, Ye, Xu, Holmes, & Lambright, 2012). The platform provided by the innovative joint research centers opens up a new way of doing research collaboratively

[12] The importance of intellectual property agreements was reaffirmed by a recent communiqué by the BRICS (Brazil, Russia, India, South Africa) countries emphasizing that intellectual property is a key priority (BRICS, 2013).

which can be distinguished from the traditional form of collaboration applied in earlier phases (see Table 4-10). CERC places a high level political emphasis on reciprocal cooperation on joint work with a strong connection and communication between researchers.

Table 4-10. Differences between cooperation and collaboration

Cooperation (traditional)	Collaboration (new)*
Work plans coordinated, but separate	Work plans developed jointly
Independent work on similar projects	Work together on same projects
Interactions characterized by research visits, personnel and student exchanges	Research characterized by division of labor among participants on joint tasks
R&D focuses on institutional strengths	R&D exploits complementarities
Relationships collegial	Relationships interdependent
R&D results shared externally	R&D results can arise jointly
Benefits mainly academic/Transfer of knowledge via technical papers & reports	Benefits are embedded among partners and extended by interests in commercialization
No guaranteed IP rights in other's territory/IP provisions not flexible	Guarantees a Right to IP in other's territory/IP terms & conditions may be negotiated
Few IP advantages for R&D partners	Potentially more attractive IP platform
Work plans coordinated, but separate	Work plans developed jointly

Source: U.S. China CERC, 2013

* Jointly funded research projects, as defined by mutually agreed-upon technology management plans

U.S.-China Energy Cooperation Program (ECP)

The U.S.-China Energy Cooperation Program (ECP) is a private-public partnership between government and industry dedicated to enhancing energy security and combating climate change (U.S.-China ECP, 2012). The fundamental goal of ECP is to leverage private sector resources and expertise to accelerate the deployment of clean energy technology (U.S.-China ECP, 2012). Founded in September 2009 by 24 U.S. companies, ECP's working group platform has grown to 48 companies including Chinese firms, through which it develops and realizes clean energy commercial opportunities. ECP is characterized as the only private sector-led nongovernmental organization committed to clean energy business development, market expansion, foreign direct investment, and job creation in both countries (U.S.-China ECP, 2012). The ECP sector working groups through which member companies join comprise: 1) clean coal, 2) clean transportation, 3) decentralized energy and combined cooling, heat & power, 4) energy financing & investment, 5) energy efficient building & design, 6) industrial energy efficiency, 7) nuclear power, 8) renewable energy, and 9) smart grid. With official support of the U.S. and Chinese governments, therefore, member companies within each working group can create a sector development roadmap and identify annual business development objectives and concrete initiatives for implementation (U.S.-China ECP, 2012).

The role of ECP is far-reaching. For instance, ECP has contributed to establishing new industries and markets such as the Sustainable Aviation Biofuel (SAB) project, Smart Grid Automatic Demand Response Pilot Project, Dialogue on Mercury Removal Standards, and so forth (U.S.-China ECP, 2012: 4-5). ECP also serves as a channel for member companies to provide recommendations to policy makers; for example, several roundtables have been held through ECP such as Dialogue on Diesel Engine Emission Regulation, Dialogue on Biofuels Technology and Industry Development, Green Building Standards and Prototype Building Benchmark Tool Cooperation, and so on (U.S.-China ECP, 2012: 6-9). Also, each ECP working group represents the industrial sectors in U.S.-China government collaboration such as U.S.-China Renewable Energy Partnership, U.S.-China Advanced Biofuels Forum, U.S.-China Energy Efficiency Action Plan, etc. (U.S.-China ECP, 2012: 10-11). Finally, ECP boosts commercial deals through market development, customer engagement, and project identification. With the support of ECP's bilateral government advisors, in particular, ECP member companies interact with local leaders and agencies in order to deploy commercial clean energy projects (U.S.-China ECP, 2012). According to the Progress Report, ECP is expected to expand new market opportunities including the establishment of new working groups and capacity building initiatives that enhance US-China commercial energy partnerships. Also, the Clean Energy Acceleration Program

(CENAP) will be newly established as an ECP platform-based systematic process that advances clean energy technology deployment and large-scale commercialization in both China and the U.S (U.S.-China ECP, 2012).

One significant success of the ECP is that it facilitates Chinese direct investments into the U.S. clean energy market, especially for wind and solar technologies (Tan et al., 2013). In part due to the market 'pull' created by the financial support system available in the U.S. (such as the PTC and ITC), the U.S. is the number one destination for such Chinese investments. New configurations of trade and investment are surfacing as Chinese banks start to participate: in November, 2011, Duke Energy signed a five year credit agreement totaling $6 billion with 30 financial institutions, including Chinese banks; the first time ever for Chinese banks to participate in this way (ECP, 2012). China's over $3 trillion foreign-exchange reserve is likely to continue to drive Chinese direct foreign investments and the U.S. needs these financial resources to fulfill its clean energy ambitions (Hart, 2013). Foreign investments can fill up finance gaps, boost local economies and create jobs. Political concerns for a 'Chinese takeover' might slow down these investment flows as evidenced by recent voiced rejections of trade deals by U.S. politicians on national security grounds (Hart, 2013).

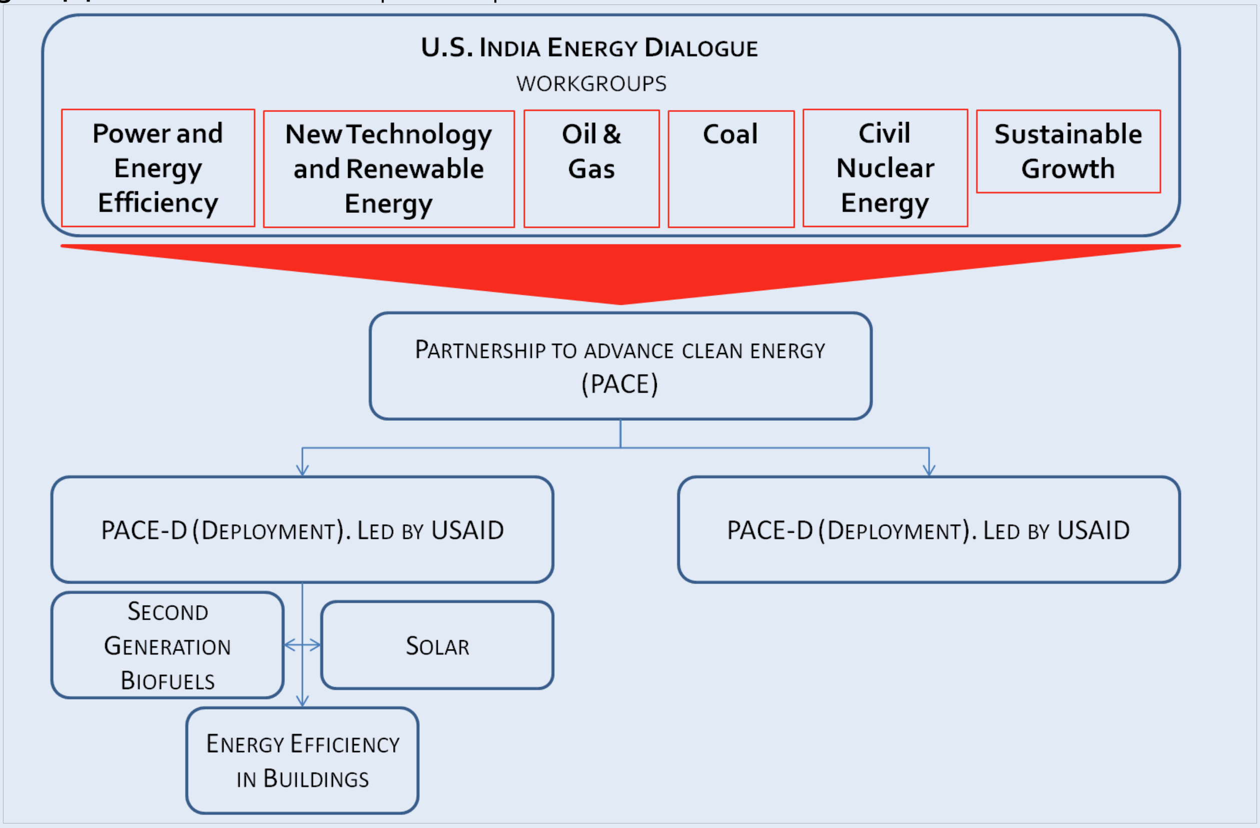
Another key success of the ECP is accelerated technology transfer and cooperation. The complementary strengths between the U.S. and China facilitate the flows of advanced technologies from the U.S. to China and vice versa. Indicative of this success are the 2007 General Electric Company (GE)'s participation in the Jiangsu Rudong Wind Power Plant (150 MW wind power plant; turbines manufactured by GE), the 2008 establishment of a R&D center by GE in China to conduct joint renewable energy research, and U.S. corporate involvement in the Tangshan City (Hubei Province, China) offshore wind farm development (Tan et al., 2013). These examples demonstrate how the ECP advances, at a macro level, micro-level partnerships and collaboration agreements. Recent development also show how local governments in China and the U.S. are getting involved. For instance, in November 2011, U.S. Ambassador Gary Locke led 10 ECP member companies to sign six MOUs – valued at $470 million – with Shandong Province (ECP, 2012).

Despite the growing clean energy partnerships between China and the U.S., Lewis (2013), in the report of "2013 Policy Recommendations for the Obama Administration," introduces three recommendations for U.S.-China relations in terms of energy and environmental policy: first, it is recommended that the second-term Obama administration promotes the U.S. and Chinese publics to be more involved in shared action to solve energy and environmental problems; second, the administration should make further efforts to incorporate China into the energy policy organizations such as the International Energy Agency; and third, the administration should deepen the existing information and research cooperation with Chinese central government energy regulators as well as broadening it to include local governments (Lewis, 2013: 63). A similar point is made by Seligsohn (2013). As demonstrated above, the ECP can contribute to the further advancement of these policy recommendations.

4.3.2. Case Study II: U.S.-India Energy Partnership

In 2005, the U.S. and India launched an Initiative of the U.S.-India Energy Dialogue as "a mechanism for cooperation designed to enhance mutual energy security, promote increased energy trade and investment, and facilitate the deployment of clean energy technologies" (U.S.-India PACE, 2013: 3) in both countries. Also, the Agreement on Science and Technology Cooperation (S&T Agreement) was signed by the two countries at Washington in October 2005. Work under the U.S.-India Energy Dialogue are organized into six working groups (WG): 1) Power and Energy Efficiency; 2) New Technology and Renewable Energy; 3) Coal; 4) Oil and Gas; 5) Civil Nuclear Energy; and 6) Sustainable Growth (See Figure 4-4).

Figure 4-4. Structure of U.S. - India partnership



Source: U.S.-India PACE, 2013: 7

As depicted in Figure 4-4, the U.S.-India Energy Dialogue has been further strengthened since President Obama and Prime Minister Singh had a summit in November 2009. At the summit, the two governments agreed on the "U.S.-India Partnership to Advance Clean Energy (PACE)" which is a Memorandum of Understanding to enhance bilateral cooperation on energy security, energy efficiency, clean energy, and climate change (U.S.-India PACE, 2013: 1). PACE is implemented and monitored through the U.S.-India Energy Dialogue. Focusing on the transition to high-performing, low-emission, and energy secure economies, PACE aims to facilitate the viability of existing clean energy technologies as well as to identify new clean technologies. It also focuses on promoting the private sector, local governments, industries, and other stakeholders to share best practices on low carbon growth (U.S.-India PACE, 2013). As seen in Figure 4-7, the structure of cooperation consists of two interconnected components: clean energy research (PACE-R) and clean energy deployment (PACE-D).

Table 4-11. Two components of the U.S. India Pace Partnership

The U.S.-India Partnership to Advance Clean Energy	
PACE-R **Research**	**PACE-D** **Deployment**
• A Joint Clean Energy Research and Development Center (JCERDC) established in November 2010 by the U.S. Department of Energy (DOE) and Planning Commission of India to promote clean energy innovation. • Supports R&D in three priority areas: (1) solar energy, (2) energy efficiency of buildings, and (3) second-generation biofuels. • A five-year initiative for which DOE and the Government of India (GOI) each are making USD 25 million available (subject to appropriations). Consortia members have	• Designed to tackle multiple clean energy deployment opportunities, including energy efficiency, renewable energy and cleaner fossil. • Supported by seven U.S. agencies: - Department of Commerce (DOC) - Department of Energy (DOE) - Department of State (DOS) - Export Import Bank of the United States (Ex-Im) - Overseas Private Investment Corporation (OPIC) - United States Agency for International

pledged matching funds of USD 75 million, for total public-private funding of USD 125 million. • Lead GOI Counterparts: Planning Commission and Ministry of Science and Technology.	- Development (USAID) - United States Trade and Development Agency (USTDA) • Lead GOI Counterparts: Ministry of Power, Ministry of New and Renewable Energy and Ministry of Petroleum and Natural Gas.

Source: U.S.-India PACE, 2013

PACE-R: Joint Clean Energy Research and Development Center (JCERDC)

In November 2010, under the category of PACE-R, the U.S. Department of Energy (DOE) and India's Planning Commission established a "Joint Clean Energy Research and Development Center (JCERDC)." Similar to the U.S.-China CERC, JCERDC is designed to foster clean energy innovation by consortia of scientists and engineers from both countries. In 2011, U.S. DOE and the Government of India each made $25 million available over five years for R&D proposals from the initial priority areas including solar energy, buildings efficiency, and second generation biofuels (U.S. DOE, 2012: 1). DOE's Office of Policy and International Affairs and the Indo-U.S. Science and Technology Forum are in charge of the Secretariat for JCERDC. In the Agreement of JCERDC, it is articulated that the research areas include:

1) energy efficiency of buildings;
2) smart grids;
3) unconventional natural gas;
4) second-generation biofuels;
5) clean coal, including carbon capture and storage;
6) an integrated gasification and combined cycle; and
7) solar energy (U.S.-India JCERDC, 2010: 4).

As a PACE-R initiative, for instance, the Solar Energy Research Institute for India and the U.S. (SERIIUS) is designed to develop a borderless environment for collaboration and research on solar electricity technologies (U.S.-India PACE, 2013: 12). In a long term, SERIIUS supports both India's Jawaharlal Nehru National Solar Energy Mission and the U.S. Department of Energy (DOE) Sun Shot Initiative. The SERIIUS project is led by the National Renewable Energy Laboratory (NREL) of the U.S. DOE and Indian Institute of Science-Bangalore focusing on three key areas: sustainable photovoltaic, multi-scale concentrated solar power, and solar energy integration.

Another example is the U.S. India JCERDC's contribution to advance India's building sector as it allows proactive efforts to control future CO_2 emissions. Through a regional energy efficiency center, the development of energy conservation building codes, energy performance labels and building envelope certification programs, the JCERDC supports collaboration that will advance building design (EERE, 2013).

PACE-D

The deployment component of PACE is designed to "support India's accelerated transition to a high performing, low emissions and energy secure economy (U.S. DOE, 2012: 18)." It mainly focuses on energy efficiency and distribution reform; scaling renewable energy technologies; cleaner fossil technology and management; enhanced greenhouse gas mitigation; planning and programs; and engaging the private sector and mobilizing investment. Based on two separate bilateral agreements between the U.S. and India, one between the U.S. Agency for International Development (USAID) and the Ministry of Power, and the other between USAID and the Ministry of New and Renewable Energy, USAID leads the overall approach to PACE-D with support of the U.S. Department of Energy (DOE), U.S. Department of State, U.S. Trade and Development Agency (USTDA), Overseas Private Investment Corporation (OPIC), Export-Import Bank (Ex-Im), U.S. Department of Commerce, and Office of the U.S. Trade Representative (USTR) (U.S. DOE, 2012: 18).

In July 2012, in order to help clean energy deployment in India, USAID established a five-year technical assistance (TA) program, in partnership with India's Ministry of Power and the Ministry of New and Renewable Energy. This $20 million program is focused on the establishment of institutional and regulatory frameworks, capacity building, and improvement of access to finance at the national and state levels (U.S.-India PACE, 2013: 9). The focus areas of the TA program include: 1) improving end-use energy efficiency; 2) increasing renewable energy supply; 3) accelerating the use of cleaner fossil technologies; 4) building the capacity of technical and nontechnical stakeholders; and 5) facilitating financial closure of clean energy projects. While PACE-D is a partnership that mobilizes energy and low carbon growth between the two nation's federal government sectors, it also provides India with an opportunity to engage state and local governments by encouraging them to develop sustainable business models (Powell, 2012). Finding a stable source of funding continues to be a struggle for clean energy expansion. However, according to U.S. Ambassador Nancy J. Powell, one of the supporting agencies under the PACE-D component, Overseas Private Investment Corporation, has committed $741 million towards clean energy projects in India driving clean energy expansion (Powell, 2012).

U.S.-India Energy Cooperation Program

Similar to the U.S.-China ECP, the U.S.-India Energy Cooperation Program (ECP) is a public-private partnership between member companies and the governments of the United States and India. Organized by the United States Trade and Development Agency (USTDA), the U.S.-India ECP was launched at the American Chamber of Commerce in India in 2010 (U.S.-India PACE, 2013: 31). It was established to promote commercial development of clean energy projects and to support the sustainable development of the energy sectors by leveraging private sector resources in both countries (U.S. DOE, 2012: 21). The ECP focuses mainly on smart grid expansion, solar power generation, green buildings/energy efficiency, and unconventional gas development (U.S.-India PACE, 2013: 31).

4.3.3. U.S.-Japan Energy Partnership

In 2009, the U.S. and Japanese governments had a summit meeting in Tokyo and confirmed their strong cooperative activities in clean energy research and development in the context of addressing global energy security and climate change issues. At the summit, the U.S. DOE and the Ministry of Economy and Industry (METI) of the Japanese government agreed to embark on the "Clean Energy Technologies Action Plan" which included joint activities and new research projects (METI, 2009a).

The focus areas of the Action Plan include: 1) acceleration of joint activities between national laboratories of both countries through R&D cooperation, exchanges of information, knowledge and researchers, workshops and conferences, and collaboration on standards research; 2) establishment of a task force evaluating the achievements of existing clean energy projects in Okinawa and Hawaii; 3) cooperation in the area of smart grid and carbon capture and storage; 4) strengthened partnership on nuclear energy including on advanced fuel cycle technologies, effective use of existing facilities and enhanced seismic safety technologies; 5) enhancement of cooperative research, development and deployment activities in additional areas including basic research, renewables, energy efficient buildings, and next generation vehicles; and 6) close cooperation on energy issues and the development of joint projects in multilateral frameworks (METI, 2009b).

4.4. Concluding Remarks

In October 2011, the U.S. DOE and MKE of South Korea signed an agreement to establish the "U.S.-Korea Clean Energy Technology Partnership". The agreement states that the U.S. and Korea will cooperate on clean energy research in areas including energy efficiency, renewable energy, smart grid technology, green transportation, carbon capture and storage, and energy storage systems. Under this partnership, researchers from both countries can exchange scientific and technical information, organize workshops, and propose joint R&D projects (U.S. DOE, 2011). The census presented in this chapter supports the conclusion that strong clean energy collaboration is already taking place between the U.S. and South Korea. Public-public, private-private, and public-private partnerships are taking place between the two countries, together representing a multi-billion dollar collaboration effort.

Based on the case studies, however, some findings can be extracted that can be considered for future improvement of U.S.-South Korea interaction. Here, the report highlights three such findings.

4.4.1. Clear Focus and Objectives

For successful bilateral cooperation, a clear focus and stated objectives are critical. For example, the U.S.-China partnership has established seven energy-related goals under the U.S. – China Ten Year Framework for Cooperation on Energy and the Environment thus outlining a multi-year collaboration strategy. The U.S.-India partnership has been also clearly geared toward six areas under the U.S.-India Energy Dialogue. A similar structure and framework for the U.S.-South Korea partnership could articulate more concrete focus areas and could defragment the currently defragmented landscape of clean energy partnerships.

4.4.2. Intellectual Property Rights agreements

Breakthrough research efforts can only be produced by joint research programs if the intellectual property rights are clearly established and agreed upon. Earlier phases between the U.S. and China, for instance, failed to produce long-lasting and productive agreements due to the lack of fully established and mutually agreed upon intellectual rights agreements. The new collaboration phase in which the U.S. and China now embark can partly be seen as innovative and promising due to its Technology Management Plans (TMPs) that are endorsed by intellectual property rights letters signed by both the U.S. and China. As the U.S. and India have successfully applied similar IP frameworks to their research cooperation in JCERDC, one potential way forward for Korea-U.S. collaboration is to consider the establishment of a similar clear IP framework to protect both countries' inventions while promoting innovation and synergy effects in clean technology development.

4.4.3. A Joint Research Center for Clean Energy

Chapter 3 established that there is a considerable overlap between the U.S. and South Korea in terms of long-term needs, objectives, and priorities. Long-lasting and stable research collaboration might be improved with the establishment of joint research centers such as those between the U.S. and China and the U.S. and India. Such a center can be a virtual agreement such as CERC, representing a bilateral agreement that allows research institutes close cooperation and provides the necessary (financial) resources to facilitate groundbreaking research and development. Such a center can facilitate knowledge exchange, mobilize investment funds by leveraging private industry, allow for joint data collection, facilitate commercial deals, accelerate the implementation of a 21st century energy infrastructure around advanced energy technologies, inspire economic competitiveness, and improve quality of life through innovation. Through such a center, the U.S. and Korea can focus on common interests and aspirations in energy policy and technology such as the deployment of smart grids and electric batteries for transportation.

5.0. Conclusions

The 2012 U.S. presidential elections were to a large extent, either directly or indirectly, about U.S. energy policy. Seen as a key vehicle to drive economic recovery, the Obama Administration had pursued vigorous stimulus of the (clean) energy sector (chapter 1) and, with U.S. economic recovery as the main focus of the debates, this approach fueled the critique and criticism of President Obama's opponents. Promises and pledges by President Obama's opponents, including those of Governor Mitt Romney, outlined a fundamentally different approach to energy and energy policy (Chapter 3). The reelection of President Obama, therefore, established a public mandate to continue with the chosen energy development strategy, offering much continuity between the two terms of the Administration.

This report set out to seek and analyze the key dimensions of the U.S. energy policy landscape and how it interacts internationally, particularly with the Republic of Korea. It has become clear that the first term of the Obama Administration established a narrative, particularly through the use of the American Recovery and Reinvestment Act (ARRA), that breaks with the previous Administration's focus and objectives. Instead, the first term of the Obama Administration aimed to redirect the U.S. energy sector towards the accelerated implementation of clean energy and energy efficiency measures. However, domestic dynamics such as Congressional opposition restrained the extent at which the Obama Administration could provide significant change as is evidenced by, among others, the failure to launch a federal strategy towards climate change. As a way forward, President Obama has decided to take climate change matters into his own hands and pursue a regulatory approach with the aim to reduce greenhouse gas emissions. This regulatory approach already has found its champions as, for the first time in over twenty years, fuel economy standards for the transportation sector have been aggressively raised. The impact analysis of the various regulations and legislative acts demonstrates that substantial effects can be expected from their implementation. Job creation, economic improvement, and environmental protection are supported by a variety of regulations and acts (Chapter 2) and, with the reelection of President Obama, can be expected to continue operation.

The narrative outlined by President Obama coincides with the strategy outlined by the Republic of Korea which creates a considerable foundation for current and future cooperation and collaboration. The performed census reports that substantial collaboration is already taking place between the two nations through a wide variety of measures and focused on diverse (end-use) energy sectors. This collaboration is shown to span several years and the census provides reason to think that collaboration between the U.S. and the Republic of Korea is deepening. Drawing upon performed case study analyses, it becomes clear that collaboration between the U.S. and the Republic of Korea can be further streamlined through the application of clear, long-term targets and objectives, the establishment of concrete and coherent intellectual property rights agreements, and the creation of a joint research center. Together, these measures can facilitate and accelerate clean energy research, development, deployment and dissemination and contribute to, among others, economic development, environmental protection, and a greater quality of life. Further investigation in the realization of these suggestions is, therefore, warranted.

6.0. Appendices

Appendix A: Overview of other programs and financial incentives of the Obama Administration

This appendix covers the programs and financial incentives not yet discussed in the main sections of this report.

Table A-6-1. Other energy efficiency, renewable energy and cross-cutting programs.

Program	Description	FY appropriation (millions)
Conservation Research and Development Grants	Grants to finance long-term R&D efforts in buildings, industrial, vehicle, and hydrogen/fuel cell technologies.	2008: $87.5; 2009: $203.7; 2010: $1.7 billion (estimated); 2011: $180 (estimated)
Energy Efficiency and Conservation Block Grants	Grants to finance energy efficiency and conservation programs/projects in local communities and renewable energy installations on government buildings.	2008: $0; 2009: $3200; 2010: $0; 2011: $0
Energy Efficiency and Renewable Energy Information Dissemination, Outreach, Training, and Technical Analysis/Assistance Grant Program	Provides financial assistance to stimulate increased usage of energy efficiency/ renewable energy technologies and to accelerate the adoption of these technologies	2008: $39.7; 2009: $38; 2010: $41.2 (estimated); 2011: $45
Energy Efficiency and Renewable Energy Technology Deployment, Demonstration, and Commercialization Grant Program	Provides financial assistance for deployment, demonstration, and commercialization of energy efficiency and renewable energy technologies	2008: $0; 2009: $21.8; 2010: $7.2 (estimated); 2011: not yet available
Renewable Energy Production Incentive	Provides incentive payments for electricity generated and sold by new qualifying renewable energy facilities	2008: $4.95; 2009: $5; 2010: $0; 2011: $0 requested
Renewable Energy R&D Program	Provides financial assistance to conduct R&D efforts in renewable energy technologies	2008: $520; 2009: $427.8; 2010: $1900 (ARRA); 2011: $475
State Energy Program	Provides grants to states to design and implement their own renewable energy and energy efficiency programs	2008: 44.1; 2009: $50 + $3100 (ARRA); 2010: $50; 2011: $75
Tribal Energy Program	Provides financial and technical assistance, education, and training to tribes to evaluate and develop renewable energy sources and energy efficiency measures	2008: $5.95; 2009: $$6; 2010: $10; 2011: $10 (requested)
Advanced research projects energy financial assistance program (ARPA-E)	Grants to finance sophisticated energy technology R&D projects to accelerate transformation technology advances	2009: $15 + $388.9 (ARRA); 2010: $0; 2011: $300 (requested)
Electricity delivery and energy reliability, research, development, and analysis grant program	Aims to develop cost-effective technology that enhances the reliability, efficiency, and resiliency of the electric grid.	2008: $82.8; 2009: $83.1 + $4500 (ARRA, primarily for smart grid development); 2010: $125; 2011: $144.3 (requested)
Federal Energy Management Program (FEMP)	Provides assistance to federal agencies in developing and implementing energy efficiency and renewable energy technologies to meet energy management goals	2008: $19.8; 2009: $22 + $22.4 (ARRA); 2010: $32; 2011: $42.3 (requested)
Financial Assistance Program	Grants support research in the basic sciences and advanced technology concepts and assessments in fields related to energy.	2008: $974; 2009: $1400; 2010: $1300; 2011: $1300

Loan Guarantee Program (Encourages commercial use of new or significantly improved technologies that avoid, reduce, or sequester air pollutants or greenhouse gas emissions)	Section 1703 Innovative Technology Loan Guarantee Program (permanent)	2008: $4.5; 2009: $0; 2010:$0; 2011: $500 (requested)
	Section 1705 Temporary Loan Guarantee Program	2008: $0; 2009: $0; 2010: $2500; 2010: $0; 2011: $0 (requested)
Small Business Innovation Research Program/ Small Business Technology Transfer Program	Grants for small businesses to develop and commercialize energy technologies, including energy efficiency and renewable energy technologies	2008: $116; 2009: $116; 2010: $94; 2011: not currently available
Assistance to High Energy Cost Rural Communities Program	Provides financial assistance to rural communities with high energy costs	2009: $18; 2010: $18; 2011: $0 (requested)
Bio-energy Program for Advanced Biofuels	Supports and ensures an expanding production of advanced biofuels by providing payments to advanced biofuels producers	2009: $55; 2010: $55; 2011: $85 Plus $25 discretionary for FY2009-FY2011
Biomass Crop Assistance Program (BCAP)	Provides assistance to support the production of eligible biomass crops on land within approved project areas	2010: Capped at $552; 2011: Capped at $432
Biorefinery Assistance Program	Assists in the development of new technologies for development of biofuels	2009: $75; 2010: $245 Plus $150 annually for FY2009-2011 in discretionary funds
Community Wood Energy Program	Provides grants to states and local governments to develop community wood energy plans or acquire or upgrade community wood energy systems	FY2009-FY2012: $0 appropriated FY2009-FY2012: $5 discretionary
New Era Rural Technology Competitive Grants Program	Provides grant funding for approved technology development, applied research, and training to develop bio-energy and agriculture based renewable energy resources	2010: $0.875; 2011: $0.875 (estimated); 2012: $0.875 (estimated)
Repowering Assistance Program	Provides financial incentives to bio-refineries in existence on June 18, 2008, to replace the use of fossil fuels used to produce heat or power by installing new systems that use renewable biomass or to produce new energy from renewable biomass	$2009: $35 FY2009-FY2012: $15 in annual discretionary funds
Rural Energy for America Program	Provides grants and loan guarantees to promote energy efficiency and renewable energy to agricultural producers and rural small business	2009: $55; 2010: $60; 2011: $70; 2012: $70 FY2009-2012: $25 annually in discretionary funds
Sustainable Agriculture Research and Education	Provides grants for research projects with the purpose of enhancing biomass energy crop production and increasing the energy efficiency of agricultural operations	2008: $9.1; 2009: $14.5; 2010: $14.5; 2011: $15 (requested)
Assisted Housing Stability and Energy Green Retrofit Investments Program	Provides grants or loans for energy retrofit and green investments in assisted affordable multifamily housing	2009: $0; 2010: $235; 2011: $0
Energy Efficient Mortgages	Provides backing of loans for energy efficient mortgages to finance the installation of energy efficiency or renewable energy technologies in new or existing homes	N/A
Energy and Mineral Development Program: Minerals and Mining on Indian Lands	Facilitate the inventory, assessment, promotion and marketing of both renewable and nonrenewable energy and mineral resources on Native American lands	2010: $18.62; 2011: $20 (requested)
Tribal Energy Development Capacity Grant	Grants to tribes to develop and sustain the managerial and technical capacity needed to	2008: $1; 2009-2010: No estimate available

	develop their energy resources and properly account for resulting energy production and revenues	
Program of Competitive Grants for Worker Training and Placement in High Growth and Emerging Industry Sectors	Intended to preserve and create jobs, promote economic recovery, assist those most impacted by the recession, provide investments and invest in infrastructure	2008: $0; 2009: $750 (estimated); 2010: $0; 2011:$0
7(a) loan guarantees to small business	Provides guaranteed loans from lenders to small businesses	2010: $80; 2011: $127.5; 2012: $129.8 (request)
Hydrogen storage research and Development Program	Provides grants for research and development of hydrogen storage technologies	2009: $0.214; 2010: $0

Source: adapted from Cunningham & Roberts, 2011

Table A-6-2. Overview of other financial incentives., see Cunningham & Roberts, 2011.

Program	Description	Qualifying technologies	Expiration Date	Value
Qualified Advanced Energy Manufacturing Investment Tax Credit	Provides Tax Credits to encourage a U.S. Based renewable energy manufacturing sector	Lighting, lighting controls/sensors, energy conservation technologies, smart grid, solar water heat, solar thermal electric, photovoltaic, wind, geothermal electric, fuel cells, geothermal heat pumps, batteries and energy storage, renewable fuels, micro-turbines, etc.	Applications were due to DOE by 9/16/2009 with final applications due to DOE by 10/16/2009.	The incentive is no longer available.
Residential Energy Conservation Subsidy Exclusion (Corporate or Personal)	Personal or corporate tax-exemption for energy conservation subsidies are provided by public utilities	Specific efficiency technologies not identified. Eligible renewables: solar water heat, solar space heat, photovoltaic	None	
Clean Renewable Energy Bonds (CREBs)	Bonds finance renewable energy projects	Solar thermal electric, PV, landfill gas, wind, biomass, hydroelectric, geothermal electric, municipal solid waste, hydrokinetic power, anaerobic digestion, tidal energy, wave energy, ocean thermal.	12/31/2009 (Old CREBs) 11/01/2010 (New CREBs)	Capped at $2.4 billion
Modified Accelerated Cost-Recovery System (MACRS) + Bonus Depreciation	Allows businesses to recover investments in certain renewable energy property through depreciation deductions	Solar water heat, solar space heat, solar thermal electric, solar thermal process heat, PV, landfill gas, wind, biomass, renewable transportation fuels, geothermal electric, fuel cells, geothermal heat pumps, municipal solid waste, CHP, solar hybrid lighting, direct use geothermal, anaerobic digestion, micro-turbines	5 year schedule for most solar, wind, and geothermal. 12/31/2011 (100% bonus depreciation), 12/31/2012 (50% bonus depreciation)	
Alternative Motor Vehicle Credit	Provides Tax Credit for hybrid and lean-burn vehicles	Hybrid gasoline-electric, diesel, battery-electric, alternative fuel and fuel cell vehicles, advanced lean-burn technology vehicles, plug-in hybrid electric vehicles	Varies by technology type	

Source: adapted from Cunningham & Roberts, 2011

Appendix B: Research and Development Breakdown

For FY2010 (Sargent, 2010), increases for energy efficiency and renewable energy R&D include $35 million for a new solar electricity innovation hub, $60 million more for vehicle energy efficiency, $98 million more for building energy efficiency, $35 million to establish a new energy innovation hub on electricity grid materials/devices/systems, and $115 million for RE-ENERGYSE – a new program to educate workforce in energy science and engineering. The increase was partly offset by a $100 million decrease for fuel cell technology and 30% reduction (equivalent to $258 million) for fossil energy, which is mainly due to no new funding for the Clean Coal Power Initiative. Funding for nuclear power was also declined, even though it requested $70 million to build innovations hubs on modeling and extreme materials. For FY2011 (Sargent, 2011), requested changes include increases of a $98 million for solar and wind energy, a $50 million for the RE-ENERGYSE program, a $37 million for energy efficiency, a $37 million for long-term nuclear R&D programs instead of short-term demonstration ones. Decreases of requested fund contain a $37 million for hydrogen and fuel cell technologies and no fund for natural gas technologies or unconventional fossil energy technologies. For FY2012 (Sargent, 2012), within energy efficiency and renewable energy, funding for hydrogen and fuel cell technologies would keep decreasing by $70 million, while most other activities would increase fast. For example, R&D on energy-efficient technologies for homes, vehicles and industries would double their sizes, solar energy R&D would increase 88%. Requested budget for coal program would go down by $100 million. For FY2013 (Sargent, 2012), there will be a significant requested budget increase for energy efficiency R&D, including $174 million rise for industrial energy efficiency, $91 million rise for vehicle energy efficiency and building energy efficiency each. In terms of renewable energy, biomass and bio-refinery system would increase by $71 million. As previous few years, proposed decrease funding include those for hydrogen and fuel cell technologies, and $105 million less for fossil energy program – mostly for coal.

Table B-6-3. Change of energy-related R&D budget by energy types and function (2010-2013).

<table>
<tr><th>By clean energy sources</th><th>2010 request relative to 2009 enacted</th><th>2011 request relative to 2010 enacted</th><th>2012 request relative to 2011 enacted</th><th>2013 request relative to 2012 enacted</th></tr>
<tr><td>Wind</td><td></td><td rowspan="2">$98 M</td><td></td><td></td></tr>
<tr><td>Solar</td><td>$35 M</td><td>88%</td><td></td></tr>
<tr><td>Biofuels</td><td></td><td></td><td></td><td>$71 M</td></tr>
<tr><td>Vehicle energy efficiency</td><td>$60 M</td><td rowspan="2">$37 M</td><td>Double</td><td>$91 M</td></tr>
<tr><td>Building energy efficiency</td><td>$98 M</td><td>Double</td><td>$91 M</td></tr>
<tr><td>Hydrogen and Fuel Cell Technology</td><td>$100 M</td><td>$37 M</td><td>$70 M</td><td>Decrease</td></tr>
<tr><td>Electricity Grid</td><td>$35 M</td><td></td><td></td><td></td></tr>
<tr><td>Fossil Energy</td><td>$258 M</td><td>0</td><td>$100 M</td><td>$105 M</td></tr>
<tr><td>RE-ENERGYSE program</td><td>$115 M</td><td>$50 M</td><td></td><td></td></tr>
</table>

Source: authors (data from Sargent, 2010, 2011). Note: color in red means budget decrease; colar in blue means increase; blanks means info not available.

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