Energy, the Environment, and Delaware Jobs:

The Economic Impact of Delaware's Green Business

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This is the fifth in a series of reports titled "Energy, the Environment, and Delaware Jobs". The entire series is comprised of the following five titles:

Energy Efficiency and the Manufacturing Sector

Defining and Describing Green Businesses

An Analysis of Delaware's Green Educational Pipeline

Households and Energy Efficiency

The Economic Impact of Delaware's Green Business

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Executive Summary

The Center for Applied Demography & Survey Research at the University of Delaware conducted this study to explore the broader economic impact of green business in Delaware. The study was made possible by a grant from the American Recovery and Reinvestment Act. The authors are solely responsible for the report’s design and execution. Below is a summary of the most important facts and findings discussed in the report.

Although many people dispute the definition of the green economy, it is fair to say that it is a complex system of laws and organizations. The two major organizations in Delaware are the Department of Natural Resources and Environmental Control (DNREC) and the Sustainable Energy Utility (SEU). DNREC funds, encourages, and monitors many different types of green activities in the state, from cutting energy to conserving wildlife habitats. The SEU’s primary responsibility is to promote energy-efficiency, and to a lesser extent renewable energy. The Regional Greenhouse Gas Initiative is the primary vehicle to fund the SEU and select energy efficient and renewable energy programs administered by DNREC. The Renewable Portfolio Standards is scheduled to play an increasingly prominent role in the future. As it does, the decisions made by the Public Service Commission will be increasingly important to the size of the green economy.

Using the results derived in a previous report, we explored a hypothetical scenario of making energy efficient investments in the manufacturing sector. The impact of this policy is forecasted to increase Delaware's employment steadily over time, reaching a maximum of 189 additional jobs in 2015. Gross domestic product (GDP) also adds nearly $33 million (2010 $) per year at its peak. However, this scenario makes some fairly conservative assumptions. Under more liberal assumptions, the net economic benefits are nearly twice as large. The model was also useful in drawing policy conclusions regarding energy efficient investments.

The main result is that the most profitable energy-efficient investments produced the greatest net benefits to the economy, despite the fact that not much labor or capital was needed to implement the investments. In other words, most of the economic gains due to energy efficiency do not come from those green jobs that actually perform installations or upgrades, they come from having lower energy costs. However, as the profitability of the assumed investments falls, the economic gains also fall. In fact, even investments that have relatively high returns by any conventional standard have negative short-term net economic effects. This should come as no surprise, as the nature of investing usually means incurring a short term loss for larger, long-term gains.

Another important consideration in determining the efficacy of a policy is whether it simply pays for investments that would have occurred anyway. When a policy crowds out private investment, the benefits that occur are mostly not attributable to the policy, because the policy is effectively a transfer payment, not an investment. We assumed a relatively conservative crowd-out rate in the base model (25%), and still found that investing in energy efficiency produced net economic gains. This was largely due to the profitability of the investments and the importance of energy costs in the manufacturing sector.

Also, how one pays for energy-saving investments matters a good deal to the economic impact. The least costly way of funding these initiatives is if it is done privately as an increase in production costs. Raising funds via an electricity tax generally has more negative impact on employment than raising funds via an income tax. However, raising income taxes has worse effects on real disposable income in the short term, implying a tradeoff between the two policy options. All other funding scenarios are substantially better than broadly cutting government spending.

Moving on, next we forecasted the expected private demand from Delaware homeowners who will likely make ENERGY STAR remodeling improvements over the next ten years. Using current characteristics of Delaware's housing stock and other national data, we projected homeowner replacement needs for water heaters, heating systems, air conditioning units, roofs, insulation, and doors and windows. Assuming that the market penetration of ENERGY STAR appliances is the same in the future as it is today, we estimate nearly 575 jobs are directly associated with these projects, 350 of which are in the construction sector. These improvements contribute between $57 and $63 million to GDP and between $14 million and $17 million of consumption each year. These net benefits are likely conservative, as the figures do not reflect the added benefits of lowering energy costs to households.

We then used industry and employment records from a previous survey of Delaware businesses to estimate the total contribution that green businesses have to the economy. That survey found that 16,261 persons work for a company selling a green good or service, and in this report we estimate that those companies indirectly caused or induced another 11,168 jobs in Delaware. Most of these jobs are in construction, professional and technical services, and the administration services and waste management sectors of the economy. The impact of green businesses was attributed to be $2.9 billion in the state's GDP (4.7%), $1.4 billion in wages, and $0.9 billion in personal consumption expenditures. Companies selling energy efficient goods and services are responsible for nearly three-quarters of those benefits.

Finally, we analyze the probable impact associated with the more immediate spending plans of three government programs; the Weatherization Assistance Program, the Greenhouse Gas Reductions Project, and any unspent funds from the American Recovery and Reinvestment Act (ARRA) for energy efficiency and renewable energy installation projects. We find that these programs will likely add 530 jobs to the economy within the next year. As the ARRA funds expire, the remaining two programs will contribute between 45 and 60 jobs per year. These estimates are also conservative, as they only reflect the benefits from spending money, and not the advantages of lowering energy costs.

To understand the economic effects of increasing or reducing electricity costs in the economy, different policy scenarios were conducted that imposed higher electricity costs on various sectors of the economy. The analysis shows how imposing electricity taxes to finance a green project negatively impacts the economy. By the same token, reducing electricity costs can stimulate the economy. Keep in mind that funding an energy-saving investment with a tax on electricity will have both effects.

We find electricity costs in the commercial or the industrial sectors are far more important to the economic health than they are to households. Of course, issues of fairness arise if a policy transferred dollars from households to businesses. Also, the more equitable solution of raising tax revenues by imposing costs on utility companies produces negative economic effects that are just slightly less than placing the burden entirely on the commercial or industrial sectors. This makes sense, because presumably utilities will pass the increased cost on to all of its customers, including businesses.

Introduction

In this report, we evaluate the economic impact of various components of the green economy. The report is the fifth part in a series of reports that the Center for Applied Demography & Survey Research (the Center) is conducting for the Delaware Department of Labor. The project is funded by a grant from the American Recovery and Reinvestment Act.

Many people describe the green economy using a list of specialized occupations, goods and services, or work activities. This report does not take that approach. Instead, we focus on how certain green elements impact the larger economy. In order to do this, we need to understand the green economy's design. Therefore, we begin the report by conducting an overview of influential government agencies and policies affecting Delaware's green economy. That process is more than just instructive… it is crucial to proper economic modeling. The first section of the report characterizes Delaware's green economy.

Just as the green economy is a relatively complex system, the overall economy is even more complex. Single changes can reverberate within it and cause substantial second and third-order effects. In order to follow these effects throughout the economy, economists often rely on economic simulations. We adopt the REMI PI+ model of the economy to aid us in following these linkages. The simulation software is essentially a laboratory for policy, because it allows hypothetical policies to be simulated and compared to other policies. The second chapter of this report describes the REMI PI+ model in greater detail.

The REMI model is used to explore four green topics. The first topic is a hypothetical policy that invests in energy efficiency in Delaware's manufacturing sector. The manufacturing sector is critical to Delaware, because it employs so many blue-collar workers and consumes nearly a third of the state's energy use. In addition, current policies attempting to understand energy efficiency should naturally look to the largest energy users for investment opportunities.

The second topic concerns the future private household demand for green home remodeling projects. We focus on this group in part because historical data is available, and also because the demand seems mostly independent of unknown future policies. Therefore we estimate the direct economic impact of purchasing ENERGY STAR water heaters, heating systems, roofs, air conditioning systems, insulation, and windows and doors over the next 10 years.

Then we analyze the effect that green businesses have on the larger economy more broadly. By 'green business' we refer to those Delaware companies that sell green goods or services. The analysis is more in line with traditional economic impact studies that assign multipliers to account for the direct, indirect, and induced effects.

The last topic we deal with explores the probable short-term impact that selected programs will have on the economy. We shy away from forecasting longer-term impacts of relatively new and untested green policies, and instead focus on those programs where expenditures have a higher degree of certainty. Specifically, we analyze the economic impact of the Weatherization Assistance Program, the Greenhouse Gas Reduction Project, and any remaining American Recovery and Reinvestment Act (ARRA) funds.

Much like the regular economy, the green economy is a very complicated system. There are many unknown factors and no single analysis or report can answer every single question. The four topics addressed in this paper barely scratches the surface. However, we believe that the questions answered in this paper are valuable to current directives and provide important information to policy makers and the public.

An Overview of Delaware's Green Economy

An economy consists of many different elements; workers, households, businesses, banks, nonprofit organizations, consumers, producers, goods, services, and governments. Through the organization of labor and capital, the economy adds value to natural resources. It is vital in keeping a growing population above a subsistence standard of living. The environment is an even more complex system that physical scientists are trying to understand. It supports life, and provides the natural resources for our economy to exploit. The relationship between the environment and the economy is incredibly complex. Although that relationship is not understood perfectly, it is generally accepted that growing the economy has meant polluting the environment. Assigning costs and damages to that pollution is an active area of study and debate.

The "green economy" refers to the organization or proposed reorganization of the economic elements to induce economic growth without causing the same amount of pollution to the environment. The "greener" the economy, the less pollution is done to the environment for the same amount of economic growth. The ideological goal of the green economy is for the economy to reach a level of organization and technological sophistication where the tradeoff between economic growth and the environment does not exist, because they both grow in the same direction.

There is much debate over the green economy. Critics question whether the ideological goal is a worthwhile pursuit due to the expected costs and benefits of transitioning to a green economy. Proponents counter that the environmental costs of *not* making that transition are much larger than anything that must be paid to make it.

There is also ample disagreement whether the green economy can even be defined. For example, some argue that nuclear power is part of the green economy because it produces power but emits less nonradioactive waste products. Others argue that nuclear power should not be considered green because it harms aquatic life, is ill-equipped to dispose of its waste, and places the population at risk of radiation exposure. Similar debate exists on applying the green label to other goods, services, jobs, and policies (see Brown and Ratledge [2], 2011 for further discussion).

The point is that what does or does not "count" as green is driven by context-specific perceptions and proposed changes in the economic organization. The green economy is actually much more than simply labeling goods, services, jobs, and businesses as green due to their perceived environmental impact. This is indeed important, because ultimately the green economy is a proposal to change the economic framework in order to favor green elements over other, non-green elements. The underlying belief is that by making these changes, the rate of environmental degradation will slow without forsaking economic growth or our standard of living. In the remainder of this section we focus on the organization of Delaware's green economy.

Important Agencies and Legislation in Delaware's Green Economy

In Delaware, as in the country as a whole, the prioritization of the green economy is underway. The Department of Natural Resources and Environmental Control (DNREC) leads these efforts.[1] In 2003, the Delaware Energy Act established the State Energy Office (aka Delaware Energy Office, DEO) within DNREC to ensure that Delaware has a stable source of energy resources and to encourage green policies, including alternative energy (Delaware Energy Act). DEO administers the Green Energy Fund, a rebate program that subsidizes renewable energy installations. DEO also administers the Regional Greenhouse Gas Initiative (RGGI), a regional cap and trade program.

The Sustainable Energy Utility (SEU) is another important entity created by an amendment to the Delaware Energy Act ("An Act to Amend Title 29…"). The SEU works in contract to the DEO, but is overseen by a board of various Delawarean stakeholders. The SEU's mission is to encourage energy efficiency improvements among households, businesses, and utilities, and also encourage the adoption of alternative energy. The state is mandated to achieve a certain level of energy efficiency savings, and the SEU is one of the major instruments it intends on using to achieve that objective (Energy Efficiency Resource Standards Act of 2009).

[1] Historically, DNREC was created to house the Board of Game and Fish Commissioners, Commission of Shell Fisheries, State Park Commission, Soil and Water Conservation Commission, and the Water and Air Resources Commission under one roof. The scope of DNREC's regulatory framework included issues related to wildlife, watersheds, parks, air quality, water quality, waste management, and boiler safety (Natural Resources and Environmental Control).

The Renewable Portfolio Standards (RPS) is legislation that requires electricity suppliers to purchase a certain number of renewable energy certificates (RECs) and solar renewable energy certificates (SREC's) (Renewable Energy Portfolio Standards Act). Each year, the demand of RECs and SRECs is mandated to increase by a certain percentage. RECs and SRECs are created when a green activity is verified to save energy. The Public Service Commission regulates the purchase of RECs and SRECs.

Many other entities are vital to supporting Delaware's green economy. For example, the University of Delaware provides technical support for the design and implementation of green initiatives, as well as performing research and development of green technologies. Delaware Technical and Community College conducts training programs to prepare the workforce for green-related jobs, as do the vocational high schools in each county. Delmarva Power plays a critical role in advising and implementing rate and regulatory changes, as well as processing the collection of electricity taxes and fees. Other electric utilities fulfill similar roles. Certain nonprofit organizations, for-profit lobbying groups, and citizen-activists exert their influence to affect certain parts of the green economy. Ultimately, the executive and legislative branches of the federal and state governments control much of the design, taxes, and funding of the green economy.

To better understand the interrelationship between these entities and the markets, we developed a diagram of the financial flows within Delaware's green economy (see Figure 1) related to energy efficiency and renewable energy. Each box or circle represents an important entity within the green economy, and each arrow represents a financial flow. Even though the diagram is a simplification of reality, a quick glance demonstrates that even a simplification is still quite complex.

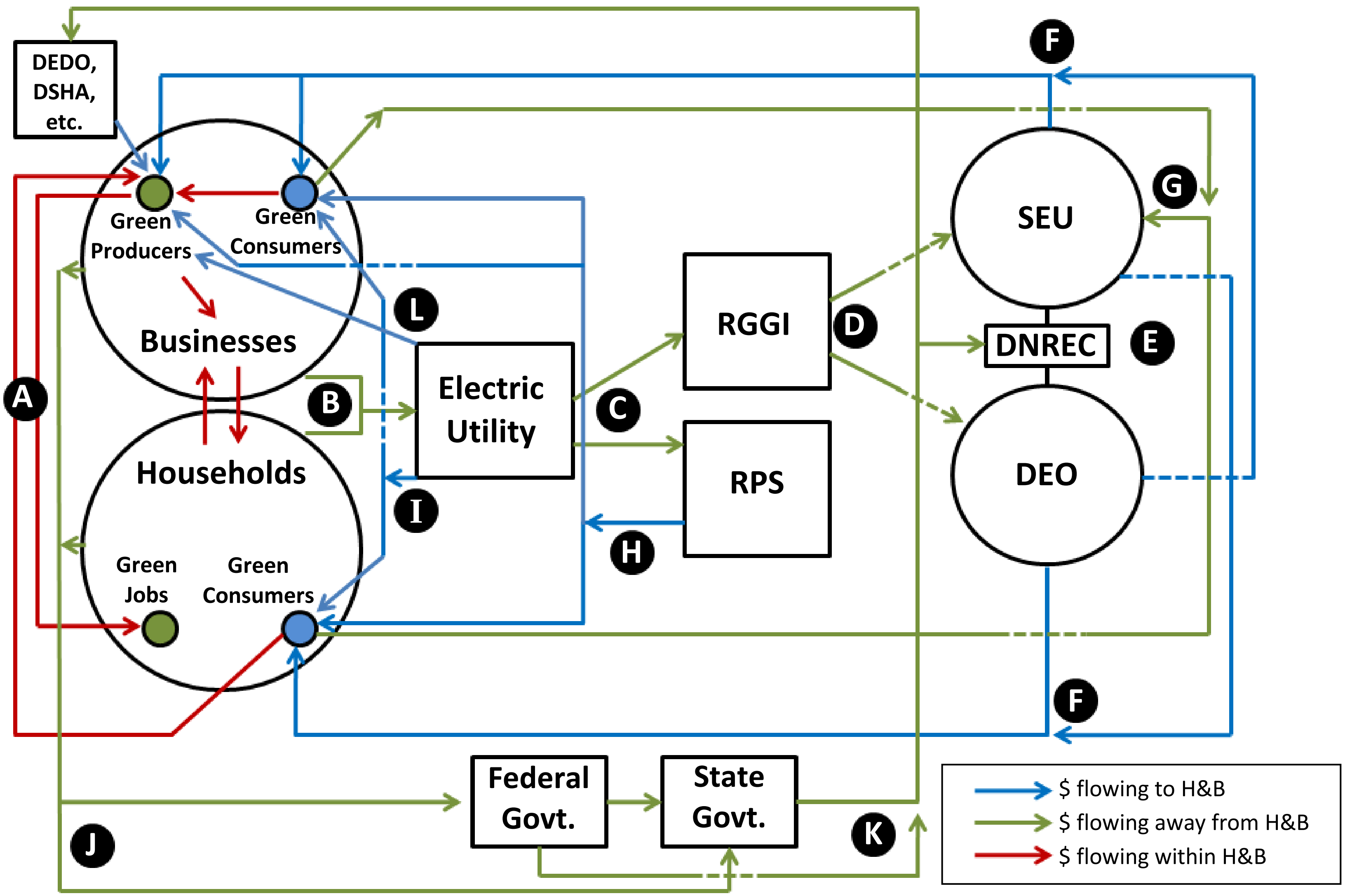
As an example, consider households and businesses. Part of their electric bill includes a fee to pay for green activities (B). The utility companies use these fees to fulfill the legal obligations of the RGGI and the RPS (C). Sales in the REC or SREC markets (part of RPS legislation) generate revenue for any green consumer or producer with a certificate to sell (H). RGGI proceeds are sent to the SEU and DEO (D), both of which are influenced by DNREC (E). The SEU or DEO uses these proceeds to fund green initiatives for green producers and green consumers (F). Some of the SEU initiatives are lending programs requiring the green consumers to undertake and repay debt (G).

In addition, the federal and state governments may tax households and businesses directly (J) and use that revenue to fund green programs (K) in DNREC, the Delaware Economic Development Office (DEDO), the Delaware State Housing Authority (DSHA), and other institutions. Other legislation requires that electric utilities purchase renewable energy directly, either through net metering (I) or through power purchase agreements with utility-scale green energy companies (L).

In the private markets (A), green producers pay wages directly to their employees (green jobs) and purchase intermediate goods and services from other, non-green businesses. In turn, these non-green businesses draw resources from other parts of the economy, generating what are known as "indirect effects". Also, those households that receive more income feel wealthier and spend more money in the economy, generating "induced effects". The combination of indirect and induced effects is referred to as the "multiplier effect".

However, recall that households and businesses paid for these green initiatives with additional electricity fees (B) and taxes (J). As a result of increased costs, businesses lower output, use less labor, and reduce demand for other inputs. Households also cut back their consumption and investment. These economic declines multiply within the economy due to the same indirect and induced effects discussed earlier. Whether the benefits outweigh the costs is an empirical question determined by the specific details underlying each transaction.

Figure 1 Heuristic Diagram of Monetary Flows in Delaware's Energy Efficient and Renewable Energy Economy



In the diagram of the green economy in Figure 1, the monetary flows are described as follows.

A.	**Private markets**	Producers sell and consumers purchase goods and services. Producers pay wages to households in exchange for labor (green producers employ green jobs).
B.	**Electric fees**	Households and businesses pay additional taxes and fees for electricity.
C.	**Utility costs**	Electric utilities buy allowances under regional cap and trade policy (RGGI). They also buy renewable energy certificates (REC's & SREC's) to comply with renewable portfolio standards (RPS).
D.	**RGGI proceeds**	Proceeds from RGGI are divided between the SEU and the DEO.
E.	**DNREC**	Policy and funding decisions are influenced / administered.
F.	**Direct incentives**	The SEU and DEO offer rebates and grants to fund green initiatives.
G.	**Lending**	The SEU establishes lending programs for green purchases (energy-saving investments and renewable energy). Green consumers pay the SEU via indirect payments to an energy service company (not included).
H.	**Market trading**	REC's and SREC's trade in tightly regulated markets. Green consumers receive revenues by selling certificates to power generation utilities.
I.	**Net metering**	Businesses and households that produce alternative energy sell unused power to the grid.
J.	**Taxes**	Businesses and households pay taxes to the federal, state, and local governments (local governments omitted from diagram).
K.	**Govt. policy**	Federal and state policies fund and direct green policies which are administered by various state and local agencies (shown: DNREC, DEO, Delaware Economic Development Office (DEDO), and Delaware State Housing Authority (DSHA))
L.	**Power Purchases**	Utilities mandated to make a long-term power purchase agreement from utility-scale renewable energy companies.

As one might surmise from Figure 1, the financial flows occurring within Delaware's green economy are not simple. Given that complexity, it is not obvious whether the system produces net economic gains or net economic losses. Studies that focus on the financial flows moving away from households and businesses (green lines) will undoubtedly reach negative conclusions. Studies that analyze only those funds flowing to households and businesses (blue lines) will reach positive conclusions.

Next we detail important programs and participants in the green economy in more detail.

Department of Natural Resources and Environmental Control

Environmental concerns weigh heavily on the current administration's strategic plans for Delaware, and the Department of Natural Resources and Environmental Control (DNREC) is the primary organization to achieve those plans. DNREC has an operating budget of nearly $132 million and employs 795 persons with some of these funds according to the 2012 state budget ("An Act Making Appropriations for the…", 2011). Although we will primarily address DNREC's role in energy efficiency and renewable energy, their activities are far more extensive in the overall green economy. An organizational outline of DNREC is provided in the appendix.[2] The appendix also provides a list of selected DNREC programs that promote and conserve natural resources, mitigate, control, and remediate pollution, and recycle.

The Delaware Energy Office (DEO) is a division within DNREC's Office of the Secretary. DEO is in charge of administering programs related to energy efficiency and renewable energy. This includes the Weatherization Assistance Program (WAP), Greenhouse Gas Reductions Project (GGRP), and the Green Energy Fund (GEF). DEO is also in charge of marketing various green initiatives throughout the state and administering Delaware's Energy Assurance Plan. The Sustainable Energy Utility (SEU) also contracts with DEO. Below we summarize relevant information regarding green programs in DEO.

[2] The outline of DNREC's organization was assembled via numerous links on its website. See DNREC's homepage at http://www.dnrec.delaware.gov/Pages/default.aspx for more information.

Weatherization Assistance Program

This program provides weatherization services to low income residents. Funding comes from the following five sources (Department of Natural Resources and Environmental Control [1], [2], and [3], 2011).

1. U.S. Department of Energy provides recurring funds to the WAP (recently $510,856). Of those funds, $345,271 went to energy efficient improvements, $30,000 went to health and safety improvements, $90,000 went to training and technical assistance, and $45,586 went to administrative costs.
2. Utility funds allocation transferred from Delaware Health and Social Services (DHSS). Estimated at $1.3 million annually.
3. 10% of the Regional Greenhouse Gas Initiative (RGGI) proceeds are allocated to the WAP. This is estimated to be $1.3 million, but recently proceeds have been much lower. Last year, we estimate this to be between $600,000 and $740,000 (RGGI Inc., 2011).
4. 10% of Low Income Heating Assistance Program funding transferred from DHSS. Estimated to be $1.7 million annually.
5. The WAP also received a one-time award of $13,733,668 from the ARRA. The award stipulated that $8,774,751 be spent on energy efficiency improvements, $961,357 was spent on health and safety improvements, $2,598,064 went to training and technical assistance, $1,371,496 went to administration, and $28,000 was allocated for other expenses. The WAP had stalled recently due to a transfer of responsibility from the DHSS to DNREC. As of March 2011, approximately $4,532,149 of ARRA funds had been spent.

Green Energy Program

The Green Energy Program (GEP) is a program to incentivize renewable energy projects, primarily solar and geothermal. The program has been scaled back recently, in light of the large accumulation of liabilities and change in policy. Given the current funding decisions, we project that residences served by Delmarva[3] must wait an expected 2 years to be reimbursed, and businesses served by Delmarva must wait an expected 3.75 years for reimbursement (Department of Natural Resources and Environmental Control [4] and [5], 2011).

In addition, five changes have recently been made to the GEP for Delmarva customers that are expected to significantly lower the demand for the program (Department of Natural Resources and Environmental Control [6], 2011).

1. Applicants must get an energy-audit performed (priced between $400 and $600 for residential audits) and spend at least $500 in recommended improvements.
2. Any new homes or existing commercial buildings applying for funds must be rated as an ENERGY STAR building or equivalent.
3. The size of the monetary incentives for solar rebates has fallen.
4. Persons receiving a grant are allowed to enter a power purchase agreement. Additional eligibility criteria apply for this agreement.
5. Solar PV projects greater than 50 KW are no longer eligible.

While the demand for the GEP program will likely fall due to these changes, the GEP may remain an important component to Delaware's green economy because the Renewable Portfolio Standards require that companies purchase SRECS, but only if the price is low.

[3] Delmarva customers comprise the overwhelming majority of electricity sales. See Table 8 in the "Delaware Energy Plan: 2009-2014"

Greenhouse Gas Reductions Project

The Delaware Greenhouse Gas Reduction Project (GGRP) allocates 10% of proceeds from the RGGI to various projects with a specific aim to lower the greenhouse gas reductions in the state. In January 2011, the GGRP program awarded $1.2 million of grants for various projects. Almost all of the awards go to non-profit and municipal organizations. We estimate that approximately $640,000 was attributed to energy efficiency ($490,000) or renewable energy projects ($150,000) (Department of Natural Resources and Environmental Control [7], 2011).[4]

Other Funding

DEO was recently awarded $9.6 million of an $11.1 million ARRA Energy Efficiency and Conservation Block Grant (EECBG) (Recovery.gov [2], 2011). Approximately $1.24 million was to be administered to local municipalities for energy efficiency and renewable energy projects based on a formula involving municipal population. DEO plans on using $3.64 million to create an account with the state's Division of Facilities Management that will be used to make energy efficient repairs in different state buildings. $4.22 million was to be administered on a competitive basis.

Closely associated with DNREC and DEO is the Sustainable Energy Utility (SEU). The SEU is a quasi-public institution chaired by members from government, business, and academia. We discuss it next.

[4] Renewable energy projects include 1, 5, 11, 13, 19, 23, and 24. Energy efficiency projects include 1, 6, 8, 10, 11, 14, 21, 22, 23, and 26. The costs of programs 1, 11, and 23 were evenly divided between energy efficiency and renewable energy.

The Sustainable Energy Utility

The SEU is a program that is expected to encompass much of Delaware's energy efficiency programs.[5] Although its main goal is energy efficiency, the SEU also incentivizes renewable energy to some extent. The SEU offers both direct incentive and lending programs, but has mostly engaged in direct incentives thus far. While the direct incentives are similar to other green programs, the plan to initiate lending programs for energy efficiency makes the SEU relatively unique.

In these lending programs, the SEU pays for part or all of a green investment (either energy efficiency or renewable energy) and is repaid with interest via future installment payments. These payments are negotiated upfront based on expected energy savings. A third party, called an energy service company (ESCO), performs the services and is also responsible for repaying the SEU. Client payments to the ESCO are contingent on the client meeting agreed to levels of energy efficiency, which are validated periodically by the SEU and the ESCO. This method of payment is reinforces the idea that lower energy use implies cost reductions that more than offset debt payments. If successful, the SEU's lending program could be self-sustaining.

The SEU is exploiting a potentially profitable opportunity. Since the paybacks on many energy saving investments are quite low, there should be relatively fast and easy profits of which to take advantage. In addition, since businesses overwhelmingly claim that up-front costs are the main reason they do not invest in energy efficiency, an organization that finances these investments could overcome that barrier. It is certainly possible that both the SEU and the client gain from the transaction. The model derived in the first report in this series implies that many opportunities could exist in the manufacturing sector alone.

[5] The SEU's website is located at http://www.energizedelaware.org/. Currently the Applied Energy Group administers the operational aspects of the SEU, but Applied Energy Group was recently acquired by Ameresco Inc. on July 14, 2011. http://www.appliedenergygroup.com/news

In addition, a self-sustaining entity is also more likely to overcome the inherent risk embedded in future political wrangling. Moreover, the SEU has increased flexibility in choosing which green projects to administer compared to other programs like the Green Energy Fund. However, there are also reasons to be cautious regarding the future prospect of these lending programs (see the appendix for an elaboration of the risks).

For the purposes of this paper, it is difficult to conclude what the market size of the SEU will be. The SEU's near term strategy is to seek out institutional organizations for their lending programs. In particular, the SEU intends to target state and local municipality buildings that received an ARRA Energy Efficiency and Conservation Block Grant (EECBG) (Recovery.gov [1], 2011). That strategy would pass a proportion of the EECBG grants back to the SEU via installment payments, in effect recycling those funds. We fully expect this to occur, as DNREC is in control of administering the competitive EECBG grants.

The SEU received a $24,231,000 grant from the ARRA. According to the fund description, money will be allocated to "Energy Efficiency and Renewable Energy Financing ($11 Million), Residential Energy Efficiency Incentives ($5.7 Million), Non-Residential Energy Efficiency Incentives ($2 Million), Renewable Energy Incentives ($2 Million), Energy Efficiency in New Construction ($300,000), Evaluation, Measurement and Verification ($1 Million) and Program Administration ($2.3 Million)" (Recovery.gov [2], 2011). Approximately $11.7 million of ARRA funds remains to be disbursed to the SEU. In addition, 65% of RGGI funding will go to SEU, which we estimate was approximately $4.7 million last year. It also has stated plans to sell $60 million of bonds (Sustainable Energy Utility, 2011).

The SEU states it had approximately $25.4 million in assets at the end of May 2011, $14.7 million of which is held in cash or cash equivalents (Belfint, Lyons, & Shuman, 2011). Assuming that the remainder of the ARRA funds is disbursed and the $60 million in bond sales occur, the SEU may have between $80 to $100 million of assets. Based on the financial records released by the SEU, most of the expenditures thus far have been spent on direct incentive programs, setup costs, and administrative costs. The SEU will reduce the amount of funds allocated to incentive projects and divert those resources to lending programs (Sustainable Energy Utility, 2011). How and when that money will be reallocated has not been made publicly available.

Existing SEU Programs

- Appliance Rebate Program – Direct incentives for purchasing energy-efficient appliances. This program is over.
- Efficiency Plus for Business Incentives – Direct incentives for non-residential and multi-family energy-efficiency projects.
- Home Performance with ENERGY STAR – Incentives for home energy efficiency projects. The program requires that an energy audit be performed and investments be made to reduce energy use.
- Residential Lighting – Rebates given to energy efficient light bulbs. Energy efficient lighting is highly effective at reducing energy at relatively low costs. The program was primarily intended to raise awareness of other SEU programs.
- Green for Green – This is a pilot program that used $300,000 of ARRA funding to retrofit existing home sales or in constructing new buildings to be energy efficient. Individual awards range between $3,000 and $6,000. Pilot program expires in March 2012, and currently $92,000 of available funds are left.

Future SEU Programs

- Performance contracting – These are energy efficient lending programs designed for institutional organizations (e.g. municipals, universities, schools, and hospitals). This is the first phase of transitioning the SEU away from direct incentives and towards lending.
- Multi-family Low Income Construction Loan Program – This program offers reduced interest financing for energy efficient low-income housing projects.
- Other Financing – A major long-term goal of the SEU is to pool resources with other lenders. The SEU would engage in performance contracting that would have a high-enough interest rate to be self-sustaining and not erode capital over time. It currently does not have any willing customers owing to a variety of market, design, and regulatory factors.

The other major government program that affects Delaware's green economy is actually legislation. The Renewable Portfolio Standards (RPS) requires that conventional utility companies purchase renewable energy certificates based on the type and amount of electricity they sell.

Renewable Portfolio Standards

When renewable energy projects are performed, certificates are awarded to the person or group that funded the project. The state's Renewable Portfolio Standards (RPS) requires that conventional power generation utilities purchase Renewable Energy Credits (RECs) and Solar Renewable Energy Credits (SRECs). The total amount that must be purchased is based on the percentage of total electricity generation.[6] The purpose of the RPS is to encourage renewable energy sales (primarily solar PV), since the person or group owning the RECs and SRECs can sell them to utility companies.

Currently for every 1,000 MWH of electricity sold, each utility must purchase 70 RECs (7%) of which at least two must be SRECs (0.2%).[7] These requirements are mandated to increase incrementally each year. By 2025, the utilities will have to purchase 250 RECS (25%) per 1,000 MWH, of which at least 35 must be SRECS. Clauses do exist to halt the scheduled increases if the costs of obeying the law are deemed to rise too quickly ("Renewable Energy Portfolio Standards Act", 2011).[8] Since their inception, the average price for one SREC has ranged between \$200 and \$350 (nominal) and the average price for an REC has fallen from \$18 to just under \$5 (PJM Energy Information Systems, 2011; Energy Efficiency and Renewable Energy, 2011). There are also price ceilings (i.e. maximum levels) legislated to prevent costs from being too burdensome, but so far these caps have not been binding.

[6] Net metering and power purchase agreements are two other, more direct methods of transferring funds from the utilities to renewable energy suppliers.
[7] There is some flexibility in the tradeoff between RECs and SRECs, as legislation currently imposes a price differential. Unlike a normal market, the quantity and relative prices of RECs and SRECs are determined by both legislation and market forces.
[8] The Public Service Commission is responsible for deciding whether the costs are too onerous.

In terms of the program's costs, Delmarva projects that meeting 2% of the state's electricity consumption from solar photovoltaic technology by 2019 will require a minimum of $627 million and a maximum of $1.1 billion to achieve, depending on the policy design (2008 prices) (Stockbridge, 2011).[9] To put this in context, Delaware's 2010 GDP was $61 billion in comparable 2008 prices.[10] The higher cost reflects the extra expense of using small-scale residential solar, while the lower cost reflects a policy of installing larger, utility-scale solar parks such as the one recently constructed in Dover. Delmarva also projects that the more expensive policy option would initially require 224 direct jobs in 2015, eventually rising to 469 jobs by 2019. The cheaper policy option would require 88 jobs in 2015 and 191 jobs in 2019.[11]

Peter Olmsted (2011) from "The Vote Solar Initiative" used a different set of assumptions that attributed between 234 (nonlocal spending) and 443 (local spending) direct job needs each year. If the policy chosen by the administration is to encourage small scale solar initiatives to meet the 2020 RPS goals, Olmsted estimated that between 444 and 607 employees would be needed each year. If the policy preferred utility scale solar PV plants, Olmsted estimated that nearly twice as many jobs would be needed than the Delmarva presentation. A presentation from the Delaware Solar Energy Coalition (2010) estimated that between 160 and 250 jobs would be needed each year to meet the 2020 RPS goals.

[9] These dollars assume a discount rate of 10%.

[10] Real GDP for Delaware obtained by the Bureau of Economic analysis in 2005 chained dollars. It was inflated to 2008 prices using factor of 8.26%. See http://www.bea.gov/newsreleases/regional/gdp_state/2011/pdf/gsp0611.pdf

[11] Delmarva's recommended a policy option (70% utility, 20% commercial, 10% residential) has a good chance of being adopted, not only because it is endorsed by an influential player in the state (Delmarva), but also because it balances economic efficiency with political concerns.

The Olmsted and the Delaware Solar Energy Coalition reports were “benefits-only” reports, meaning that they only concentrated on the benefits that accrue from spending the money while ignoring the costs imposed by collecting it. On the other side of the coin, the Caesar Rodney Institute funded a report by the American Traditions Institute that was largely a “costs-only” model (American Traditions Institute, 2011). That report ignores the benefits associated with spending those dollars and focuses on the funding costs. The report concluded that funding the RPS will decrease Delaware employment between 1,660 and 2,650 by 2026 due to increased electricity prices. The costs and benefits found in both reports are not comparable, however, because they are based on different assumptions and different models.

Other Important Government Programs

There are a few remaining programs that are important to Delaware's green economy. The Delaware Economic Development Office's (DEDO's) mission is to strategically attract businesses to locate to Delaware and incentivize them to remain in the state. Green businesses are part of that strategic development. DEDO's more publicized list of green businesses include Motech Americas, Fisker Automotive, and more recently, Bloom Energy.

According to various newspaper articles, the employment expected to come from these companies is substantial. It has been said that Fisker Automotive will employ up to 2,000 persons, Motech Americas would keep the 70 employees previously employed by General Electric and employ an additional 75, and Bloom Energy will employ 900 persons (Meier, 2010; Delaware Economic Development Office, 2010; Ruth, 2011). Because the size and timing of these businesses' labor demands depend largely on unknown economic and political factors, we will not evaluate their specific impact in this report. However, strategic economic development is still an important component of Delaware's green economy.

Another important source of funding comes from the American Recovery and Reinvestment Act (ARRA) of 2009. Funding for most of the ARRA programs expires in the spring of 2012, so we expect that any unspent funds will likely be expended over the next year. Table 23 in the appendix lists those energy-efficiency or renewable energy installation projects that have been awarded to Delaware.[12,13] As of March 2011, nearly $46.4 million had yet to be expended on renewable energy and energy efficient installation projections.

[12] Projects related to research and development have not been included in this list.
[13] Many other green projects were also funded by the ARRA, but fell outside our more narrow focus.

The Renewable Greenhouse Gas Initiative (RGGI) is a main source of funding for the energy efficiency and renewable energy components of the green economy. The RGGI is a regional cap and trade program that requires electric power utilities[14] to purchase CO_2 allowances in a multi-state auction in which participating states sell allowances. States use those proceeds to fund green projects.[15] The minimum allowable price of allowances is currently $1.89 per ton of CO_2. Recently the market has had a surplus of allowances, and they have traded at the minimum allowable price (Potomac Economics, 2011).

RGGI contributed $6,012,632 to Delaware during auctions 9 through 12 (2011 FY) but proceeds from the last auction (12) were particularly low (RGGI Inc, 2011). In auctions 8 through 11, proceeds were $7,422,447. Since utility companies are allowed to pass these payments along to the consumers, these revenues are effectively an electricity tax. Because that adds to household expenses and business costs, by itself the RGGI is clearly a disincentive to economic development. Of course, if the RGGI funds are used to reduce energy costs by investing in energy efficiency, it is not clear whether the net economic effect is positive or negative.

[14] The Christiana Substation (Calpine Mid-Atlantic), Edge Moor (Calpine Mid-Atlantic), Hay Road (Calpine Mid-Atlantic), Indian River, McKee Run (City of Dover), NRG Energy Center Dover, Van Sant (City of Dover), and Warren F. Sam Beasley Power Station (Delaware Municipal Electric Corp.) must purchase allowances. See http://regulations.delaware.gov/AdminCode/title7/1000/1100/1147.pdf.

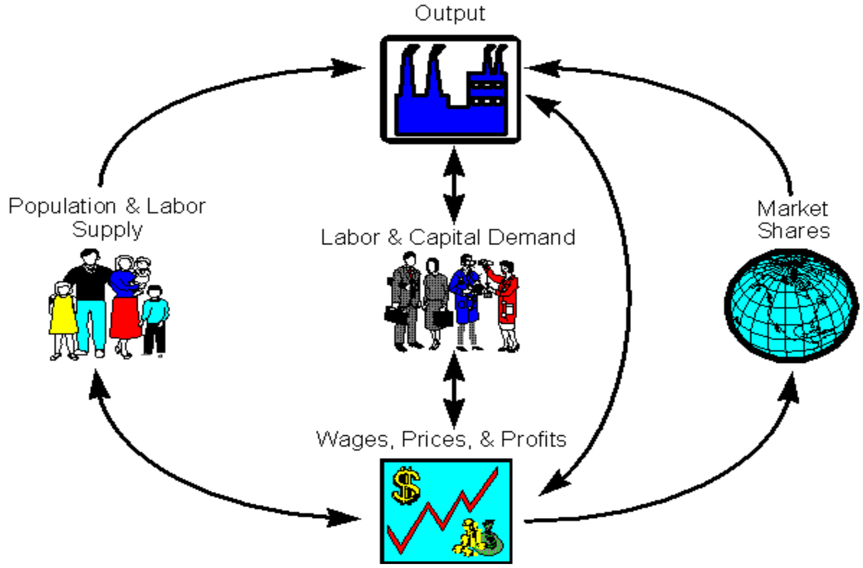
[15] Delaware's current allocation of auction proceeds is 65% - SEU, 15% - WAP & LIHEAP, 10% - Delaware Greenhouse Gas Reductions projects, 10% - DNREC's administration and discretionary projects.

Overview of the REMI PI+ Model

Although the green economy is a complex system of legislation and policies, the immediate and direct effects of a policy can generally be modeled using available information. However, understanding the indirect and induced effects in the larger economy is not so easy. Economic modeling tools help us navigate through those critical linkages in the economy by breaking the complex system down into a series of simplified equations. This section describes the economic model that we use to estimate the larger macroeconomic impacts of green business in Delaware.

The REMI PI+ software is a dynamic and structural model of Delaware's economy that is capable of estimating causal relationships. It is a regionalized version of a benchmarked national model. Ten sub-regions are in the model, including each of the three counties in Delaware; Salem County, NJ; Burlington, Camden, and Gloucester counties in New Jersey (combined); Bucks, Montgomery and Philadelphia counties in Pennsylvania (combined); Delaware and Chester counties in Pennsylvania (combined); Cecil County, MD; Harford County, MD; and the combination of 10 counties in Maryland and Virginia that constitute the remainder of the Delmarva peninsula. Each sub-region is treated as an independent, fully functioning economy that interacts with every other sub-region specifically and with the nation in general.

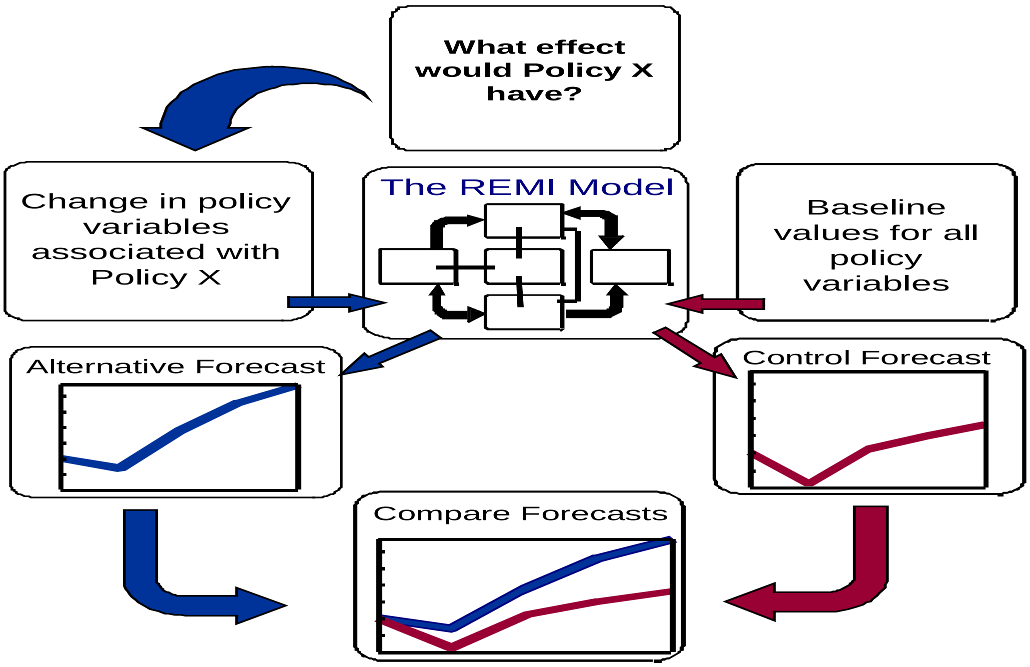
Figure 2 Illustration of the REMI PI+ Model



The model is founded on conventional economic assumptions, such as households maximize utility and firms maximize profits. Hundreds of equations have been developed over the last 25 years to describe the economy's structure mathematically. These equations can be organized into five major components: Output and Demand, Labor and Capital Demand, Population and Labor Force, Wages-Prices-Costs, and Market Shares. Figure 2 illustrates REMI's main structure and components.

The equations assume that businesses use labor, capital, and fuel as inputs to supply goods and services as output. Households (and some businesses) supply the inputs of production and generate the demand for goods and services. Wages, prices, and profits adjust to form equilibriums in each market, but the equilibrating process might take more than one year to achieve. High market shares can generate cluster effects that influence factor productivity and input prices.

Figure 3 Illustration of a Policy Forecast in REMI



REMI PI+ is a general equilibrium model with feedback. This means that the model describes the entire economy as it changes over time. For example, changes in population, demographics, and wages each influence the labor supply at any moment, but are themselves influenced in the future by changes in the labor supply. Adjustments happen gradually, so the economy does not statically jump from one equilibrium to another. This is a major advantage of using REMI versus other economic simulation models (RIMS II, IMPLAN).

The general equilibrium model can capture the multiplier effect due to the repeated interaction in other parts of the economy. In a sense, the multiplier effect is the cumulative impact of any single change to the economy. For example, as final demand generates intermediate demand, one dollar of retail sales will increase sales in construction 0.28¢, sales in fabricated metal product manufacturing 0.30¢, sales in utilities 1.1¢, etc. The total impact from these effects can be quite large.

Figure 3 illustrates how REMI estimates the effects of a policy. First, the REMI model is calibrated and a standard future scenario is predicted. This is called the control forecast. Then a policy is proposed that changes the economy. A modeler adapts this change into REMI by selecting input variables and simulating the outcome. This alternative forecast is then compared to the control forecast. Differences between the two forecasts are attributed to the policy.

In the upcoming sections of this report, we employ the REMI PI+ model to understand the economic effect due to various green policies. Although many macroeconomic variables can be considered, particular attention will be paid to the impact on employment.

Before proceeding, we should be clear that the REMI model is *not* a model of the green economy, but rather a tool to understand certain elements within it. Since the green economy is too complex to analyze every issue in one model, we focus on four specific topics. First, we use the REMI model to better understand the economic impact of making energy saving improvements in the manufacturing sector. Next, we explore the probable impact that households will make through energy efficient home improvements in the future. Then we explore what impact Delaware's green companies have on the larger economy. Finally, we address the short term impact that selected government programs will likely have on the economy.

Energy Efficiency and Manufacturing

Energy efficiency is a critical area within Delaware's green economy, especially considering the SEU's primary mission is to promote energy efficiency within Delaware's households and commercial businesses. Moreover, Delaware's manufacturers consume a large portion of the state's energy. Using the results from the first report in the series, we now seek to understand what implications investing in energy efficiency will have for the current design of the green programs.

In the first report (Brown and Ratledge [1], 2011), we estimated that just more than $120 million could potentially be spent on energy efficient investments in Delaware. In Table 1, we decompose those investments (inflated to 2010 dollars) based on the payback[16], the technological area within the manufacturing plant, and the geographic location of the manufacturer. Most of the potential expenditures are in heat recovery, combustive processes, and air compressors. They have paybacks between 1.4 and 5 years, and the companies are located in New Castle County.

[16] An investment's payback refers to the amount of time that must pass before the sum of nominal benefits from the investment equals the nominal costs. Lower paybacks imply the investments recover their costs quickly and are therefore more profitable.

Table 1 Estimated Potential Expenditures for Energy Efficient Investments (2010 $)

	0 < Payback ≤ 1.4			1.4 < Payback ≤ 5		
	New Castle	Sussex	Kent	New Castle	Sussex	Kent
Furnaces, etc.	$4,758,738	$1,958,402	$728,886	$15,983,717	$5,965,688	$3,186,421
Heat Recovery	$8,154,612	$3,875,285	$1,535,745	$13,738,977	$6,381,979	$2,318,630
Steam, hot water, etc.	$1,129,425	$628,503	$140,587	$1,237,652	$576,129	$113,926
Insulating, Equipment,	$830,398	$263,890	$130,004	$1,545,980	$541,448	$254,285
Space heating, etc.	$1,043,840	$370,040	$145,309	$316,180	$161,167	$53,591
Electrical Power	$11,012	$5,338	$1,872	$4,441,542	$2,404,220	$979,446
Lights	$995,093	$471,140	$199,632	$2,364,307	$1,094,493	$422,930
Motors	$619,808	$274,124	$121,186	$2,887,785	$1,256,028	$514,327
Air Compressors	$175,013	$84,184	$37,028	$12,063,589	$5,576,672	$2,350,218
Other Facility	$2,546,699	$1,110,084	$477,288	$222,111	$89,926	$39,763
Total	$20,264,637	$9,040,992	$3,517,537	$54,801,840	$24,047,749	$10,233,537

- Source: Center for Applied Demography & Survey Research

The estimates in Table 1 reflect the *potential* for relatively profitable investments, not necessarily the *expected* investments that will take place. The literature suggests that an 'implementation gap' is pervasive in manufacturing, implying that seemingly profitable investments are not undertaken. Explaining the implementation gap is currently under debate. (See Gillingham, Newell, and Palmer (2009) for a review of these issues.)[17] A survey of Delaware businesses (Brown and Ratledge [2]) suggests that manufacturers are mostly concerned about the high up-front costs, waiting too long to recover those costs, obtaining cheap financing, and causing delays to their operations.

[17] As part of an exploration of the implementation gap, we found that time, technological area, and implementation costs significantly predicted the decision to implement a set of recommendations. Three digit industry code and geographical effects were not significant and the explained variance was very low (R^2 between .05 and .09). Firm-specific fixed effects greatly increased the overall fit of the model (R^2 between 0.53 and 0.58), which is both unsurprising and relatively uninformative.

Table 2 Average Implementation Rate and Payback, by Technological Process (2004-2009)

	Average Implementation Rate		Average Payback (years)	
	0 < Payback ≤ 1.4	1.4 < Payback ≤ 5	0 < Payback ≤ 1.4	1.4 < Payback ≤ 5
Furnaces, etc.	29%	26%	0.34	2.49
Heat Recovery	22%	41%	0.59	2.59
Steam, hot water, etc.	31%	14%	0.32	2.48
Insulating Equip., etc.	47%	37%	0.33	2.48
Space heating, etc.	30%	40%	0.50	2.77
Electrical Power	18%	32%	0.52	2.68
Lights	54%	43%	0.60	2.56
Motors	38%	30%	0.58	2.79
Air Compressors	53%	41%	0.28	2.30
Other Facility	46%	29%	0.48	2.74

- Source: Center for Applied Demography & Survey Research

Table 2 shows the historical average implementation rate for each of the technological groups we identified. Businesses implemented energy-saving investments to lighting systems, air compressors, equipment insulation, and other facility improvements (e.g. building envelope, glazing, roofs, etc.) more often than other technologies.

Of course, past decisions of whether to invest in energy efficiency may not apply if a policy is specifically designed to encourage these investments.[18] Current proposals by the SEU intend to split the upfront costs and the energy savings as well as offering low interest financing. This could encourage greater adoption of energy saving technology, but absent actual data on these issues, we could only speculate as to how businesses will respond. For the purposes of this hypothetical policy, we assume that historical adoption rates apply.

[18] Taken to the extreme, a policy that completely pays for all energy saving investments with no condition of repayment will undoubtedly have high adoption rates.

Table 3 Parameters Chosen for Baseline Economic Model

	Parameter Values	
	0 < Payback ≤ 1.4	1.4 < Payback ≤ 5
Program Duration (Years)	5	5
Inflation Parameter (2008-2010)	1.0128	1.0128
Commercial Electricity Usage	37%	37%
Residential Electricity Usage	38%	38%
Industrial Electricity Usage	25%	25%
100% - Depreciation Rate	70%	95%
100% - Discount Rate	95%	95%
Crowd Out Rate	25%	25%
Energy Savings as % of Total Savings	93%	88%
Administrative Costs	15%	15%
Percent of Investment Labor Intensive	50%	50%

- Source: Center for Applied Demography & Survey Research

To derive the economic impact, we need to model how the investments initially impact the firm and the economy. For the base scenario, we assumed that the entirety of the investment costs was paid for via an economy wide tax on electricity.[19] More specifically, we assumed that:

1. 50% of the expenditures are exogenous sales in nonresidential maintenance and repair (labor), and 50% of expenditures are durable equipment investments (capital). We also assumed that administrative fees added a premium of 15% to the program.
2. Energy savings and other savings occur in the industrial sector by an amount that depends on the average payback of each technology. Each technology group impacts the manufacturer's electricity, natural gas, and residual fuel expenditures differently, and this was calculated from historical averages.
3. 100% of the expenditures and administration costs are paid via electricity taxes on the residential, commercial, and industrial sectors of the economy.

[19] More details on these assumptions are provided in the appendix.

4. The policy crowds out a portion of private investment. That portion is treated as a transfer payment from the tax payers to the manufacturers, causing total production costs to fall by the transfer payment. Energy savings and direct spending attributable to the policy are also reduced.
5. Benefits occurring after the investment are discounted, both due to the opportunity cost of time and the depreciation of capital or equipment.
6. The program is administered over a five year period.

Based on these assumptions and parameters, we estimated the economic impact of making the baseline energy saving investments in manufacturing over the next five years. Table 4 shows the assumptions for the most profitable energy-saving investments (investments with paybacks between 0 and 1.4 years). The first four columns indicate how much additional energy costs Delaware manufacturers are expected to save due to the program. The next three columns indicate how much money would have to be raised through electricity fees to pay for the investment. The two columns after that represent how much construction and capital investment spending are required in the baseline model, and the final column represents how much production costs have fallen due to transfer payment induced by the crowding-out effect.

It is worth pointing out that the energy savings in Table 4 are much larger than the upfront investment costs. The reason is that this table reflects only the most profitable investments available. Comparing these assumptions to those less profitable investments in Table 5, one can see a relatively large difference in energy savings relative to costs. For the less profitable investments, the net economic returns only accrue after the initial investment period. At first, the cost of these investments creates larger economic burdens than whatever energy savings are obtained. The tables also indicate that more money is expected to be spent on the less profitable investments.

Table 4 Modeled Inputs into REMI PI+ Model, Expected Recommendations with Low Paybacks (More Profitable Investments)

	Change in Industrial Energy Costs				Direct Costs (Increases in Electricity)			Direct Spending		Transfer
	Electricity	Natural gas	Res. Fuel	Other Cost	Commercial	Industrial	Residential	Labor	Capital	Other Costs
2011	-$1,049,853	-$2,040,310	-$72,706	-$238,065	$863,361	$881,070	$593,349	$762,320	$762,320	-$508,213
2012	-$1,748,005	-$3,397,117	-$121,055	-$396,379	$863,361	$881,070	$593,349	$762,320	$762,320	-$508,213
2013	-$2,212,276	-$4,299,393	-$153,207	-$501,657	$863,361	$881,070	$593,349	$762,320	$762,320	-$508,213
2014	-$2,521,016	-$4,899,406	-$174,588	-$571,667	$863,361	$881,070	$593,349	$762,320	$762,320	-$508,213
2015	-$2,726,328	-$5,298,416	-$188,807	-$618,224	$863,361	$881,070	$593,349	$762,320	$762,320	-$508,213
2016	-$1,813,008	-$3,523,446	-$125,557	-$411,119	$0	$0	$0	$0	$0	$0
2017	-$1,205,650	-$2,343,092	-$83,495	-$273,394	$0	$0	$0	$0	$0	$0
2018	-$801,758	-$1,558,156	-$55,524	-$181,807	$0	$0	$0	$0	$0	$0
2019	-$533,169	-$1,036,174	-$36,924	-$120,902	$0	$0	$0	$0	$0	$0
2020	-$354,557	-$689,056	-$24,554	-$80,400	$0	$0	$0	$0	$0	$0
2021	-$235,781	-$458,222	-$16,329	-$53,466	$0	$0	$0	$0	$0	$0
2022	-$156,794	-$304,718	-$10,858	-$35,555	$0	$0	$0	$0	$0	$0
2023	-$104,268	-$202,637	-$7,221	-$23,644	$0	$0	$0	$0	$0	$0
2024	-$69,338	-$134,754	-$4,802	-$15,723	$0	$0	$0	$0	$0	$0
2025	-$46,110	-$89,611	-$3,193	-$10,456	$0	$0	$0	$0	$0	$0
2026	-$30,663	-$59,591	-$2,124	-$6,953	$0	$0	$0	$0	$0	$0
2027	-$20,391	-$39,628	-$1,412	-$4,624	$0	$0	$0	$0	$0	$0
2028	-$13,560	-$26,353	-$939	-$3,075	$0	$0	$0	$0	$0	$0
2029	-$9,017	-$17,525	-$624	-$2,045	$0	$0	$0	$0	$0	$0
2030	-$5,997	-$11,654	-$415	-$1,360	$0	$0	$0	$0	$0	$0

- Source: Center for Applied Demography & Survey Research

Table 5 Modeled Inputs into REMI PI+ Model, Expected Recommendations with High Paybacks (Less Profitable Investments)

	Change in Industrial Energy Costs				Direct Costs (Increases in Electricity)			Direct Spending		Transfer
	Electricity	Natural gas	Res. Fuel	Other Cost	Commercial	Industrial	Residential	Labor	Capital	Other Costs
2011	-$755,188	-$855,200	-$34,979	-$224,368	$2,643,435	$2,697,656	$1,816,714	$2,334,067	$2,334,067	-$1,556,045
2012	-$1,436,745	-$1,627,019	-$66,548	-$426,861	$2,643,435	$2,697,656	$1,816,714	$2,334,067	$2,334,067	-$1,556,045
2013	-$2,051,851	-$2,323,585	-$95,039	-$609,610	$2,643,435	$2,697,656	$1,816,714	$2,334,067	$2,334,067	-$1,556,045
2014	-$2,606,983	-$2,952,236	-$120,752	-$774,541	$2,643,435	$2,697,656	$1,816,714	$2,334,067	$2,334,067	-$1,556,045
2015	-$3,107,991	-$3,519,593	-$143,958	-$923,392	$2,643,435	$2,697,656	$1,816,714	$2,334,067	$2,334,067	-$1,556,045
2016	-$2,804,962	-$3,176,433	-$129,922	-$833,361	$0	$0	$0	$0	$0	$0
2017	-$2,531,478	-$2,866,731	-$117,255	-$752,109	$0	$0	$0	$0	$0	$0
2018	-$2,284,659	-$2,587,224	-$105,822	-$678,778	$0	$0	$0	$0	$0	$0
2019	-$2,061,904	-$2,334,970	-$95,505	-$612,597	$0	$0	$0	$0	$0	$0
2020	-$1,860,869	-$2,107,310	-$86,193	-$552,869	$0	$0	$0	$0	$0	$0
2021	-$1,679,434	-$1,901,848	-$77,789	-$498,964	$0	$0	$0	$0	$0	$0
2022	-$1,515,689	-$1,716,417	-$70,205	-$450,315	$0	$0	$0	$0	$0	$0
2023	-$1,367,910	-$1,549,067	-$63,360	-$406,409	$0	$0	$0	$0	$0	$0
2024	-$1,234,538	-$1,398,033	-$57,182	-$366,785	$0	$0	$0	$0	$0	$0
2025	-$1,114,171	-$1,261,725	-$51,607	-$331,023	$0	$0	$0	$0	$0	$0
2026	-$1,005,539	-$1,138,706	-$46,575	-$298,748	$0	$0	$0	$0	$0	$0
2027	-$907,499	-$1,027,683	-$42,034	-$269,620	$0	$0	$0	$0	$0	$0
2028	-$819,018	-$927,484	-$37,936	-$243,332	$0	$0	$0	$0	$0	$0
2029	-$739,164	-$837,054	-$34,237	-$219,607	$0	$0	$0	$0	$0	$0
2030	-$667,095	-$755,441	-$30,899	-$198,196	$0	$0	$0	$0	$0	$0

- Source: Center for Applied Demography & Survey Research

Before proceeding, the reader should know that the analysis makes two important assumptions. First, the technological areas of the recommendations are based largely on correlations between employment and industry of medium sized manufacturers. Actual industrial assessments may show that factors which were unobservable at the time of modeling are more important than these two factors. Energy usage and composition are crucially important factors that had to be estimated due to lack of data availability.

Second, historical energy savings were modeled in real dollars, not physical units. To the extent that future energy prices are higher (lower) than historical energy prices, the actual savings from these energy-efficient investments would be greater (lower). Similarly, the change in profitability would affect which investments are recommended and adopted. Should future models desire to better predict the long run savings, better data from Delaware's manufacturers as well as energy costs projections would be needed.[20]

[20] Projecting energy prices is not a trivial issue. Increased volatility in the energy futures markets and the debate over speculators reflect just how difficult and uncertain this can be. And yet, manufacturers considering energy efficiency investments will need to consider the potential levels of future energy prices if they are to act rationally about their investments.

Table 6 Predicted Economic Impacts Due to Energy-Saving Investments, Base Scenario

	Employment			Gross Domestic Product (GDP)			Real Disposable Income (RDI)		
	PB≤1.4	PB>1.4	All	PB≤1.4	PB>1.4	All	PB≤1.4	PB>1.4	All
2011	30	20	50	\$3.3	\$0.3	\$3.7	\$1.6	-\$2.6	-\$1.0
2012	58	26	84	\$7.5	\$1.4	\$9.1	\$3.9	-\$1.5	\$2.5
2013	83	37	123	\$11.9	\$3.4	\$15.8	\$5.6	-\$0.3	\$5.5
2014	103	51	159	\$16.1	\$6.1	\$22.9	\$7.0	\$0.9	\$8.2
2015	117	66	189	\$19.9	\$9.1	\$29.9	\$8.0	\$2.1	\$10.5
2016	99	63	165	\$19.8	\$12.0	\$32.7	\$7.2	\$6.0	\$13.4
2017	80	70	151	\$18.4	\$14.2	\$33.3	\$5.5	\$5.8	\$11.5
2018	59	70	130	\$16.3	\$15.4	\$32.2	\$4.2	\$5.6	\$9.8
2019	41	67	107	\$13.9	\$16.0	\$30.3	\$3.1	\$5.4	\$8.4
2020	25	63	86	\$11.7	\$16.1	\$28.0	\$2.2	\$5.0	\$7.2

- All dollars are in millions of 2010 prices.
- Source: Center for Applied Demography & Survey Research

Table 6 shows the predicted economic impact of making the energy saving investments. As the investments occur over five years, an increasing number of jobs are added to the economy reaching a maximum of 189 in the last year of investment (2015). The model also predicts that Delaware's GDP rises by nearly \$33 million in 2017 and real disposable income rises by a maximum of \$13.4 million in 2016. Also, most of the net benefits accruing to the economy occur from investing in the most profitable investments (PB≤1.4). The reasoning is simply that the most profitable investments create the largest dollar-for-dollar reductions in energy costs. Similarly, energy-efficient expenditures in the less profitable investments show meaningful economic benefits only after a period of time has passed. Such is the nature of investing.

Table 7 Predicted Economic Impacts Due to Energy-Saving Investments, Alternative Scenarios

	Self-Financed			Cut Other State Spending			Increase Income Tax		
	Emp.	GDP	RDI	Emp.	GDP	RDI	Emp.	GDP	RDI
2011	111	$10.0	$7.0	-178	-$8.3	-$3.4	42	$4.9	-$5.0
2012	172	$19.3	$12.2	-126	-$0.4	$0.2	93	$12.8	-$0.9
2013	232	$29.9	$16.6	-71	$8.6	$3.4	142	$21.3	$2.4
2014	286	$40.9	$20.6	-21	$17.8	$6.3	187	$30.1	$5.3
2015	330	$51.6	$24.1	21	$26.6	$8.7	222	$38.4	$7.8
2016	252	$50.6	$19.4	226	$42.7	$14.3	207	$40.9	$14.7
2017	218	$49.9	$16.5	200	$41.8	$12.4	179	$39.8	$12.4
2018	178	$47.3	$13.9	167	$39.4	$10.7	146	$37.4	$10.4
2019	141	$43.8	$11.8	135	$36.2	$9.2	115	$34.3	$8.8
2020	108	$40.0	$10.0	105	$32.8	$7.8	86	$31.0	$7.3

- All dollars are in millions of 2010 prices.
- Source: Center for Applied Demography & Survey Research

Table 7 shows the results when alternative assumptions change the baseline scenario. The first three columns indicate the economic impact if manufacturers decided to finance the investments using 100% of their own funds. This assumes that there would be no electricity tax to finance the investments and no transfer payments. Instead those investment costs increased production costs for the first five years. In addition, the government no longer crowds out private investment. We find that this is the most optimistic scenario for the investment considered. In this case, employment rises to a maximum of 330 jobs in 2015 which is just less than double the base case. GDP and RDI are also much larger in this example.

In the middle three columns, the investment expenditures are paid via broad cuts in government spending instead of an increase in electricity costs. The model predicts that this policy will have immediate and severe employment losses as the money gets invested, but jobs also come back quickly once the investment spending stops and government spending in the other areas returns to normal. GDP and RDI decline initially when government spending is cut, though they do rise after the third year.

The final three columns in Table 7 assume that the energy-saving investments are paid by levying an income tax. There is generally more employment and more GDP compared to the base scenario (paid via electricity fees). However, less disposable income is available. This indicates that the funding decisions of these programs matters to the economic health. Electricity rates fall on both households and businesses directly, while income taxes affect households directly and businesses indirectly. So raising electricity rates hurts businesses more than simply raising income taxes, and this has a greater impact on employment.

The first three columns in Table 8 isolate the negative effects of imposing the electricity tax. They show that increases in electricity costs cause fairly substantial and negative effects relative to the program's benefits. However, because these are energy-efficient investments, lowering energy costs in manufacturing will have the opposite effects on the economy. Both effects have been modeled in the baseline scenario, and the net effects are positive.

The second group of columns in Table 8 reflects the economic impact of privately funding the investments.[21] Increasing production costs to pay for the investments actually burdens the economy much less than if an electricity tax was used. This implies that policies using tax revenues to fund energy saving investments would have the least costs in the economy if they offered just enough of an incentive to encourage private funding, but no more.

The next three columns show the impact of assuming the 25% crowd out rate. The crowd out effect was included in the model to properly account for a policy's impact. Intuitively, a policy that pays for an investment that would have happened anyway should not be given credit for any economic gains. The 25% crowd out rate that was assumed in the initial scenario effectively reduced employment by a maximum of 89 persons in 2015 and more than $100 million in GDP over the next decade.

[21] Costs are modeled as a temporary increase in production costs.

Table 8 Predicted Economic Impacts Due to Energy-Saving Investments, More Alternative Scenarios

	Electricity Taxes			Production Cost			Crowd Out Effect			Base + Govt. Admin		
	Emp.	GDP	RDI	Emp.	GDP	RDI	Emp.	GDP	RDI	Emp.	GDP	RDI
2011	-49	-$5.5	-$7.4	-16	-$1.7	-$1.3	-28	-$2.5	-$1.8	57	$4.9	-$0.8
2012	-68	-$7.9	-$8.1	-25	-$2.9	-$1.7	-45	-$5.0	-$3.2	91	$10.3	$2.7
2013	-80	-$9.8	-$8.6	-33	-$3.8	-$2.0	-61	-$8.0	-$4.5	129	$17.0	$5.8
2014	-87	-$11.4	-$9.0	-38	-$4.5	-$2.3	-77	-$11.0	-$5.6	165	$24.1	$8.5
2015	-91	-$12.6	-$9.3	-41	-$5.1	-$2.5	-89	-$14.0	-$6.6	195	$31.1	$10.8
2016	-47	-$8.0	-$2.3	-29	-$3.9	-$1.5	-69	-$13.7	-$5.3	165	$32.7	$13.4
2017	-30	-$6.2	-$1.9	-22	-$3.1	-$1.3	-59	-$13.4	-$4.5	151	$33.3	$11.5
2018	-18	-$4.8	-$1.5	-17	-$2.5	-$1.1	-47	-$12.6	-$3.7	129	$32.2	$9.8
2019	-9	-$3.7	-$1.1	-12	-$1.9	-$0.8	-37	-$11.6	-$3.1	107	$30.2	$8.4
2020	-3	-$2.9	-$0.9	-9	-$1.5	-$0.7	-28	-$10.5	-$2.6	85	$27.9	$7.2

- All dollars are in millions of 2010 prices.
- Source: Center for Applied Demography & Survey Research

One may have noted that the base scenario does not consider any direct spending due to the administration in the government sector. We purposely omitted that spending to better reflect the economic impact in the private markets. The final three columns in Table 8 re-estimate the baseline scenario and model the administrative costs (assumed to be 15% of the investment) as spending for administrative services. One will note that the three measures of economic health are each slightly larger than the base case. Of course, they are still noticeably lower than the scenario in which private funds pay for the investment (first three columns in Table 7). This is partially due to the added costs from the electricity tax and partially due to crowding out.

The main conclusion is that energy-efficiency investments have the potential for net employment gains and net economic benefits, but that potential is not guaranteed. While employment is stimulated initially as a result of performing the energy efficient repairs and replacements, most of the gains come from lowering industrial energy costs. Although the net effect in the short term depends on which investment is chosen and how it is funded, lower energy costs continue to pay dividends to the economy well beyond the initial investment period.

We also find that if an electricity tax pays for these investments, there will be a relatively large and offsetting effect. However, even with the fairly conservative assumptions embedded in the initial scenario, the offsetting effect was still smaller than the gains due to lowered energy costs. This result was largely driven by the assumption that many profitable opportunities are both *available* and *exploitable*. Of course, as the profitability of the investments fall (paybacks increase), the offsetting effects are more onerous to the economy. An investment with a much longer payback, say 15 years, would likely create 15 years of net economic costs before any net benefits are observed. In addition, as the government program pays for investments that would have occurred anyway (an increase in the crowd out rate), the policy's net economic benefits fall even further.

The scenario with the greatest benefit to society would be one in which the private companies chose to invest in their own companies. History, however, indicates that there is resistance by businesses. This implies that the ideal program would offer just enough of an incentive to convince the manufacturers to undertake the most profitable investments they would not already do on their own. A program that is too generous with its incentives will also encourage less profitable investments be performed, and runs a greater risk of producing net losses to the economy.

Energy Efficiency and Residential Remodeling

In this section we explore the estimated economic impact that green remodeling expenditures of Delaware homeowners will have in the next ten years. As in the previous section, the initial assumptions were derived in another report in the series (see Brown and Ratledge [3], 2011).

Our survey of Delaware homeowners established information related to household size, type of home, age of home, and other important characteristics for each county in Delaware. In that survey, we asked homeowners for their opinions on topics important to the green economy. One particularly relevant question was whether homeowners were willing to replace a working appliance before it failed. The overwhelming majority of persons answered that they would not replace a functioning appliance.

Under the assumption that water heaters and heating equipment would not be replaced until the end of their useful life, the potential demand for these three home remodeling projects was estimated for the next decade. This was done using two approaches. The first approach rolled the age of each county's existing residential equipment stock forward through time and calculated how much equipment would fail and need to be replaced. The second approach constructed a national predictive model of household demand, and then fed Delaware specific survey data into that model. Table 9 shows midpoint of these two estimates, as well as the average expected expenditure per project.

Table 9 Forecasts of Annual Future Consumer Demand for Energy-Related Residential Home Improvement Projects

	Kent	New Castle	Sussex	Total
Insulation	1,800	6,269	2,315	10,384
Water Heater	3,526	12,862	4,608	20,996
Air Conditioning	1,886	7,235	2,587	11,707
Heating System	2,527	9,379	3,520	15,426
Windows and Doors	4,950	18,214	6,524	29,688
Roof	3,442	11,795	4,696	19,932

	Kent	New Castle	Sussex	Total
Insulation	$1,846,284	$6,873,643	$2,314,077	$11,034,003
Water Heater	$2,416,923	$9,485,375	$3,071,128	$14,973,425
Air Conditioning	$7,573,795	$29,218,271	$10,459,787	$47,251,852
Heating System	$7,416,190	$28,172,794	$10,349,824	$45,938,808
Windows and Doors	$12,301,025	$51,507,935	$15,938,323	$79,747,282
Roof	$16,318,224	$60,144,963	$22,054,756	$98,517,943
Total	$47,872,439	$185,402,980	$64,187,894	$297,463,312

- Source: Center for Applied Demography & Survey Research

Table 10 Percent of Residential Expenditures Assumed to Go to Professional Contractors, by Project Type

	% Professional
Insulation	70.9%
Water Heater	77.0%
Air Conditioning	91.3%
Heating System	87.4%
Windows and Doors	82.0%
Roof	89.9%

- Source: Author's tabulations of the 2009 American Housing Survey.

Of course, not all of the homeowner expenditures will enter into the economy via the construction sector, as some homeowners perform projects on their own. Table 10 indicates the percent of expenditures on these projects that are assumed to go to professional construction contractors. The estimates were created via national tabulations of homeowners in the 2009 American Housing Survey.

Table 11 ENERGY STAR Market Penetration Estimates

Appliance & Equip.	Type	Total Shipments	Market Penetration	Est. Market Size
Water Heater	Residential Electric	10,500	0%	4,810,500
	Residential Gas	623,100	12%	5,323,100
Boilers	Residential Gas	109,605	57%	192,289
	Residential Oil	75,151	62%	121,211
Furnaces	Residential Gas	987,869	43%	2,297,370
	Residential Oil	7,055	12%	58,792
Air Conditioning	Air Source Heat Pump	410,065	21%	1,952,690
	Central Air Conditioning	740,228	19%	3,895,937
	Geothermal (market % of all heat pumps)	81,362*	4%	2,034,053*
Roof	Residential (sq. ft.)	483,326,073	11%	4,393,873,391
Windows and Doors	Residential	n/a	57%	n/a
Insulation	Residential	n/a	75%*	n/a

* Estimates Calculated / Assumed

- Source: ENERGY STAR Unit Shipment and Market Penetration Report: Calendar Year 2008 Summary; Water Heater Market Profile, 2009; US Department of Energy, ENERGY STAR Qualified Windows, 2010 Partner Resource Guide.

The next step was to estimate how much of the remodeling expenditures going to professionals would be considered green. On the one hand, energy is saved merely by upgrading old equipment. On the other hand, "green" appliances and equipment must be substantially better in energy efficiency than existing alternatives. We adopt the latter interpretation for this report and further assume that equipment certified by the Environmental Protection Agency's (EPA's) ENERGY STAR is the appropriate green criteria.

The ENERGY STAR program collects annual shipment information to determine market penetration of ENERGY STAR certified appliances and equipment. Table 11 shows the most recent estimates for that market penetration.

Table 12 Estimated Heating and Cooling Equipment Composition for Homeowners, by Heat Source

Primary Heating Source	Furnace	Boiler	Central Air	Heat Pump
Natural Gas	83%	10%	66%	3%
Electricity	44%	0%	39%	43%
Fuel Oil	42%	54%	24%	0%
Wood	8%	1%	28%	7%
Propane / LPG	69%	5%	54%	4%
Kerosene	43%	0%	14%	0%
Solar	0%	0%	0%	0%
Steam	12%	18%	52%	0%
Other	0%	0%	16%	0%

- Source: Author's Tabulations of 2005 Residential Energy Consumption Survey microdata

Using recent reports released by the EPA, we estimated that approximately 58% of water heater replacements were natural gas units and 42% were electric units (Water Heater Market Profile, 2009). We also assumed that homeowners replaced their roofs, windows and doors with an ENERGY STAR brand with the same proportion as its most recent market penetration. Because the ENERGY STAR recommendation for insulation varies by climate and project-specific characteristics, there was no analogous data set detailing which insulation was destined for ENERGY STAR projects. Therefore, we assumed the market penetration for insulation administered according to ENERGY STAR standards was 75%.

Next we estimated how many households had a boiler, furnace, and central air conditioner based on the main energy source used to heat a home. Microdata from the 2005 Residential Energy Consumption Survey was used to create distributions of heating equipment (furnace, boiler, stove, etc) for each heating source (Energy Information Administration, 2011). For example, 83% of homeowners using natural gas to heat their home used a furnace to heat their homes, and 54% who used fuel oil to heat their homes also had a boiler (see Table 12). We further estimated those people using central air conditioners and heat pumps based on the heating fuel type.

Table 13 Composition of Heating Sources by Delaware County, Homeowners

	NCC	KNT	SSX
Natural Gas	49.3%	42.2%	16.8%
Electricity	27.4%	26.1%	38.8%
Fuel Oil	19.0%	15.3%	17.5%
Wood	1.1%	3.5%	3.3%
Propane	2.4%	11.4%	19.1%
Other	0.7%	1.6%	4.5%

- Source: Center for Applied Demography & Survey Research

Table 14 Estimated Expenditures for ENERGY STAR Certified Home Improvement Projects, per year

	NCC	KNT	SSX	Total
Water Heaters	$472,114	$120,297	$152,859	$745,269
Heating	$7,022,156	$1,844,437	$1,969,973	$10,836,566
Roof	$5,947,735	$1,613,709	$2,180,995	$9,742,439
Air Conditioners	$3,245,229	$834,788	$1,024,235	$5,104,251
Insulation	$3,655,060	$981,762	$1,230,510	$5,867,332
Windows and Doors	$24,074,809	$5,749,499	$7,449,572	$37,273,880
Total	$44,417,102	$11,144,492	$14,008,144	$69,569,738

- Source: Center for Applied Demography & Survey Research

Finally, each county's energy composition for heating source (Table 13) was cross referenced with the appropriate distribution from the RECS and finally the relevant ENERGY STAR market share in order to derive estimated expenditures for total ENERGY STAR qualified projects each year. Assumed ENERGY STAR expenditures are given in Table 14 above. In total, we assume that nearly $70 million are spent by Delaware homeowners each year on residential projects that involve ENERGY STAR products.

Table 15 Economic Impact of Delaware Homeowners' ENERGY STAR Remodeling Projects

	Employment				
	Construction	Total	GDP	RDI	PCE
2011	352	574	$63.2	$18.2	$14.3
2012	357	568	$63.1	$19.1	$14.9
2013	355	553	$62.4	$19.3	$15.3
2014	350	533	$61.5	$19.6	$15.6
2015	342	512	$60.5	$19.7	$15.9
2016	333	490	$59.6	$19.7	$16.1
2017	324	469	$58.8	$19.7	$16.3
2018	315	450	$58.1	$19.7	$16.5
2019	307	437	$57.6	$19.8	$16.7
2020	300	428	$57.1	$19.8	$16.9

- Source: Center for Applied Demography & Survey Research

Next, we used the REMI PI+ model to estimate the impact these sales will likely have on Delaware's economy over the next 10 years.[22] Table 15 indicates that between 300 and 350 jobs in the construction sector and between 430 and 575 overall jobs will be attributable to ENERGY STAR related home improvements. The installations are expected to contribute between $57 and $63 million in gross domestic product (GDP) each year. In addition, the services are responsible for between $18 and $20 million in real disposable income (RDI) each year and between $14 and $17 million in personal consumption expenditures (PCE) each year.

The economic impact just discussed applies to estimates derived from the existing housing stock. When the market for new construction returns, there will undoubtedly be an additional effect due to new green construction. However, given the current macroeconomic conditions, it is not clear when that will be. Another important point to make regarding these expenditures is that ENERGY STAR certified products change over time, so the market penetration of energy star products in five years may not resemble that of today.

[22] The expenditures were modeled as residential maintenance and repairs.

Another observation to make is that the estimated economic impact does not reflect any benefits intrinsic to the ENERGY STAR brand. In fact, as long as households continue to purchase water heaters, roofs, air conditioning systems, etc., jobs will be needed to replace the old equipment. Of course, the ENERGY STAR brands do confer environmental benefits and economic benefits by reducing the energy consumed and the cost of those energy bills.

Finally, the analysis assumes that there are no negative effects due to funding the ENERGY STAR program or influencing market penetration. On the one hand, any government program requires tax revenue or debt, and both of these will have distortionary effects. On the other hand, many of those funds come from the US EPA and are therefore difficult to tie directly to state-specific taxes.

The Impact of Green Businesses in Delaware

In this section, we discuss the economic impact of Delaware businesses that sell green products and services. Like the previous sections, the economic impact uses data obtained from another report in this series. Specifically, this section bases its estimates on a survey administered to Delaware businesses. In that survey, businesses identified their products and services, and these were matched to a list of green output defined by the Bureau of Labor Statistics.

Table 16 below indicates the reported size of the green industry in terms of establishments and employees.[23] The 95% margin of error indicates that a high degree of uncertainty exists in these estimates, but the point estimates suggest that approximately 16,250 persons work for a company that sells green output.

Table 16 Estimated Size of Delaware's Green Industries

	Total Green	Energy Efficiency	Renewable Energy	Pollution Reduction & Recycling	Natural Resource Conservation
Establishments	1,280 (287)	881 (207)	164 (70)	450 (150)	233 (198)
Employees	16,261 (4,095)	11,713 (3,904)	2,281 (1,455)	6,467 (2,262)	2,544 (1,529)

- Source: Center for Applied Demography & Survey Research
- 95% Margin of Error in parentheses[24]

[23] A detailed discussion of the green definition is in the second report of this series.
[24] The 95% confidence intervals and 95% margins of error are ways of expressing statistical confidence in our results. The larger are either of these measures, the less confidence we have in the value of the point estimates. Technically, the 95% confidence interval is a numerical range of a sample parameter. Since these ranges were created from repeated sampling, the unknown true population parameter will fall in 95% of those ranges. The 95% MoE is half the range of the confidence interval.

Table 17 Overlapping Relationships between Different Sectors of Green Businesses

		Energy Efficiency		Renewable Energy		Natural Resource Conservation		Pollution Reduction	
		Yes	No	Yes	No	Yes	No	Yes	No
Energy Efficiency	Yes	11,713	0						
	No	0	324,036						
Renewable Energy	Yes	1,977	304	2,281	0				
	No	9,737	323,732	0	333,469				
Resource Conservation	Yes	1,012	1,532	957	1,586	2,544	0		
	No	10,702	322,504	1,323	331,883	0	333,206		
Pollution Reduction	Yes	3,443	3,024	484	5,983	791	5,676	6,467	0
	No	8,271	321,012	1,797	327,486	1,753	327,530	0	329,283

- Source: Center for Applied Demography & Survey Research

Table 16 also shows employment within the four sectors of Delaware's green economy (see Brown and Ratledge [2], 2011 for details underlying each sector). Energy efficiency is clearly the largest component to the economy, followed by the pollution reduction and recycling sector. Companies in the natural resource conservation sector and the renewable energy sector employed the least number of persons.

Careful reading of the numbers in Table 16 reveals that the individual green sectors sum to more than the total employment in the green industry. This is largely due to the fact that some companies sell products that fall in more than one sector. Table 17 decomposes the four green sectors and evaluates how much overlap exists within Delaware's economy. The renewable energy and energy efficiency sectors overlap heavily. Of the 2,281 persons working in the renewable energy sector, 1,977 persons also worked for a company in the energy efficiency sector. In addition, the energy efficiency and pollution reduction sectors also significantly overlap.

Table 18 Total Employment Impact of Green Companies in Delaware

	Green	Energy Efficiency	Renewable Energy	Pollution Reduction & Recycling	Natural Resource Conservation
Construction	8,536	6,864	1,373	2,570	275
Prof. & Tech. Services	3,518	2,853	1,086	1,306	1,438
Admin. & Waste	2,020	826	142	1,274	526
Wholesale Trade	1,974	1,704	47	1,045	41
Manufacturing	1,837	1,618	42	444	28
Other Services	1,820	1,206	119	1,123	129
Retail Trade	1,459	1,137	189	550	195
Health Care/Soc. Assist.	986	768	130	355	139
Real Estate / Leasing	786	332	56	164	420
Total	**27,429**	**20,110**	**3,672**	**10,601**	**4,082**

- Source: Center for Applied Demography & Survey Research

In Table 18, we present the estimated impact that each of these green sectors have on Delaware's employment.[25] The first column reflects the total impact of all green businesses. Construction is clearly the largest industry affected by the green economy, followed by professional and technical services and the administrative and waste management sectors. In total, companies selling green output in Delaware contribute nearly 27,500 jobs to the economy and directly employ nearly 16,250 persons. This implies that the green economy has an employment multiplier of approximately 1.69.

[25] The economic impact was tallied by effectively removing these companies from the economy and simulating how the economy responds. For the purposes of this exercise, firms maintained the same industrial codes as in the survey sample. For particularly small samples, such as renewable energy and natural resource conservation, there is a greater degree of uncertainty in the industrial codes than there is for larger industries.

Table 19 Total Economic Impact of Green Companies in Delaware

	Green	Energy Efficiency	Renewable Energy	Pollution Reduction & Recycling	Natural Resource Conservation
GDP	$2,864	$2,172	$327	$1,041	$418
Wages	$1,355	$1,037	$184	$515	$199
RDI	$1,155	$898	$153	$417	$163
PCE	$906	$706	$121	$328	$129

- Source: Center for Applied Demography & Survey Research
- All dollars are in millions of 2010 price levels.

The second half of Table 18 indicates four important measures of economic health; gross domestic product (GDP), wages and salary disbursements (wages), real disposable income (RDI), and personal consumption expenditures (PCE). The clear result is that businesses in the energy efficient sector are again the most important sector to the green economy. These companies contribute nearly $2.2 billion to GDP and nearly $1 billion in wages. Overall, the companies in the green economy add $1.2 billion in RDI and $900 million in PCE.

The Impact of Select Government Programs

Recall from the earlier discussion of the green economy's organization, that there is a large injection of government programs and policies in Delaware's green economy. Some of the program effects can be forecasted with a reasonable degree of assurance. In this section, we explore the expected impact that selected energy efficiency and renewable energy programs have in Delaware.

Unlike our analysis that focused on energy efficiency in the manufacturing sector, this section mainly focuses on the spending aspects of green projects. We do this because the programs addressed in this section receive most, if not all, of their funding from federal sources. To Delaware policy makers, there is not much that can be done to prevent the market distortions of federal taxes. This implies that any federally funded program is best judged on how money is spent. Of course, such spending still impacts the nation, but the national debt and tax policy is far beyond the scope of this report.

Given that our focus is on the more predictable near term impact of green programs, we chose to focus on assessing the likely impact of the Weatherization Assistance Program (WAP) [26], the Greenhouse Gas Reductions Project (GGRP), and the remaining funding from the American Recovery and Reinvestment Act (ARRA). Each of these programs has money dedicated to the immediate purchases of energy efficient services or renewable energy projects. In addition, fund and award descriptions are available, so the modeling assumptions used in the REMI PI+ model are more concrete.

[26] As the exception to the rule, 10% of RGGI initiatives help fund the WAP. These are not federal funds.

To summarize from an earlier section of the report, WAP receives nearly $4.8 million from various sources. Approximately 67.6% of its U.S. Department of Energy funding is spent on operating expenses, 5.9% on health and safety, 17.6% on training and technical services, and the remaining 8.9% on administrative costs. Under the assumption that three other recurring sources of funding have similar compositions, we estimate that $3.25 million is spent each year on energy-efficient repairs, $0.28 million is spent on health and safety repairs, $0.84 million is spent on training and technical services, and $0.43 on administrative costs.

The GGRP has an operating budget of $1.2 million, and it recently expended all of that on projects consisting of energy efficiency and renewable energy installations, advertising, feasibility studies, and research and development (Department of Natural Resources and Environmental Control [7], 2011). Based on the project descriptions, we estimate that $490,000 was spent on energy efficiency projects and $160,000 was spent on solar energy projects (see footnote 4 on page 16). We assume that the remaining money will be spent evenly between advertising, environmental and technical consulting, and architectural, engineering, and related services. Similarly, the remaining funds in each of the ARRA grants shown in Table 23 were sorted into various expenditures based on their descriptions.

Table 20 shows how we modeled these programs and grants into the REMI PI+ simulation.

Table 20 Assumptions Related to the Weatherization Assistance Program, Greenhouse Gas Reductions Project, and ARRA Expenditures

Entity	Award Number	Residential Maintenance and Repair	Nonresidential Maintenance and Repair	Residential Structures	Other Nonresidential Structures	Internet Publishing	Total
WAP (recurring funds)	non ARRA	$3,528,000	$0	$0	$0	$211,200	$4,800,000
GGRP (recurring funds)	non ARRA	$220,500	$220,500	$67,500	$67,500	$0	$1,200,000
SEU (lending not included)	DE-EE0000342	$2,954,820	$1,036,779	$1,036,779	$0	$0	$6,894,580
WAP	DE-EE0000174	$6,619,654	$0	$0	$0	$441,611	$9,337,625
DNREC	DE-EE0000775	$0	$5,375,830	$0	$1,791,943	$0	$7,964,193
Wilmington Housing Authority	DE00100001909G	$3,957,953	$3,957,953	$0	$0	$0	$7,915,905
Wilmington Housing Authority	DE00100000209R	$1,332,600	$1,332,600	$0	$0	$0	$2,665,199
New Castle County	DE-EE0000774	$0	$2,393,850	$0	$0	$0	$2,393,850
DelDot	DE-77-0001-00	$0	$0	$0	$1,125,000	$0	$1,500,000
City of Wilmington	DE-OE0000164	$0	$0	$0	$0	$0	$653,858
Kent County	DE-SC0001263	$0	$464,346	$0	$154,782	$0	$619,128
Sussex County	SC0003124	$0	$293,301	$0	$0	$0	$293,301
DelTech	17973013	$0	$177,848	$0	$59,283	$0	$237,131
New Castle County	B-09-UY-10-0001	$0	$172,812	$0	$0	$0	$172,812
New Castle, City of	EE0002952	$0	$50,000	$0	$0	$0	$50,000
University of Delaware	DE-EE0002686	$0	$0	$0	$0	$0	$27,999
Dover, City of	EE0002910	$0	$12,336	$0	$4,112	$0	$16,448
DE State Housing Authority	DE00400000309R	$0	$0	$0	$10,742	$0	$10,742
State of Delaware	S397A090053	$0	$6,340	$0	$0	$0	$6,340
		$18,613,526	$15,494,495	$1,104,279	$3,213,362	$652,811	$46,759,111

- Source: Center for Applied Demography & Survey Research

Table 20 Assumptions Related to the Weatherization Assistance Program, Greenhouse Gas Reductions Project, and ARRA Expenditures (cont.)

Entity	Award Number	Junior Colleges, Colleges, etc.	Environ. & Technical Consulting	Architectural, Engineering, and Related	Office Admin.	Advertising and Related Services	Insurance Agencies, Brokerages, etc.	Total
WAP (recurring funds)	non ARRA	$422,400	$211,200	$0	$427,200	$0	$0	$4,800,000
GGRP (recurring funds)	non ARRA	$0	$168,000	$168,000	$120,000	$168,000	$0	$1,200,000
SEU (lending not included)	DE-EE0000342	$0	$0	$673,906	$1,192,296	$0	$0	$6,894,580
WAP	DE-EE0000174	$883,222	$441,611	$0	$932,491	$0	$19,037	$9,337,625
DNREC	DE-EE0000775	$0	$0	$0	$796,419	$0	$0	$7,964,193
Wilmington Housing Authority	DE00100001909G	$0	$0	$0	$0	$0	$0	$7,915,905
Wilmington Housing Authority	DE00100000209R	$0	$0	$0	$0	$0	$0	$2,665,199
New Castle County	DE-EE0000774	$0	$0	$0	$0	$0	$0	$2,393,850
DelDot	DE-77-0001-00	$0	$0	$375,000	$0	$0	$0	$1,500,000
City of Wilmington	DE-OE0000164	$0	$0	$653,858	$0	$0	$0	$653,858
Kent County	DE-SC0001263	$0	$0	$0	$0	$0	$0	$619,128
Sussex County	SC0003124	$0	$0	$0	$0	$0	$0	$293,301
DelTech	17973013	$0	$0	$0	$0	$0	$0	$237,131
New Castle County	B-09-UY-10-0001	$0	$0	$0	$0	$0	$0	$172,812
New Castle, City of	EE0002952	$0	$0	$0	$0	$0	$0	$50,000
University of Delaware	DE-EE0002686	$0	$27,999	$0	$0	$0	$0	$27,999
Dover, City of	EE0002910	$0	$0	$0	$0	$0	$0	$16,448
DE State Housing Authority	DE00400000309R	$0	$0	$0	$0	$0	$0	$10,742
State of Delaware	S397A090053	$0	$0	$0	$0	$0	$0	$6,340
		$1,305,622	$848,810	$1,870,764	$3,468,406	$168,000	$19,037	$46,759,111

- Source: Center for Applied Demography & Survey Research

Table 21 Timeline of Modeled Benefits from Selected Green Government Programs

	2012	2013	2014	2015	2016	2017
Total Employment	532	60	54	49	46	44
Construction Emp.	307	29	25	23	22	21
Professional and technical services Emp.	42	9	9	8	8	8
Administrative and Waste Services Emp.	22	2	2	2	2	2
Other Services, except Public Admin Emp.	14	1	1	0	0	0
Retail Trade Emp.	40	5	4	4	4	3
Health Care and Social Assistance Emp.	15	1	1	0	0	1
Total Wage and Salary Disbursements**	$21.8	$3.7	$3.2	$2.9	$2.7	$2.6
Personal Consumption Expenditures	$13.8	$2.1	$2.0	$1.9	$1.9	$1.9
Real Disposable Personal Income	$17.6	$2.6	$2.5	$2.4	$2.2	$2.2
Gross Domestic Product (GDP)	$43.2	$5.1	$4.6	$4.3	$4.1	$4.1

- Source: Center for Applied Demography & Survey Research
- Unless otherwise noted, all dollars are in millions of 2010 prices

** Dollars are in millions of current prices.

We assumed that any currently unexpended ARRA funds would be spent by 2012, and that the recurring annual funding for the WAP and GGRP continued each year thereafter. Table 21 shows the results of this "benefits-only" simulation. The remaining ARRA funds are expected to have a very large impact relative to the WAP and GGRP. Employment is expected to increase by 530 persons and GDP is expected to increase by $43.2 million. Real disposable income and consumption also increase significantly due to the federal stimulus. The longer term employment effects due to the WAP and GGRP ranges between 45 and 60 while the state's GDP rises between $4 million and $5 million.

It is important to keep in mind that it is difficult to project the energy reductions based on financial expenditures alone, so the benefits reflected in Table 21 do not factor into account any impact due to energy savings. Therefore they understate the total economic impact.

Because we do not want to neglect the impact of electricity savings, in Table 22 we analyze how electricity costs impact the economy. Four different policies were modeled in which $1 million was collected via an electricity tax in each Delaware county. In the first policy, the tax was levied only on households. In the second and third policies, the tax was levied on commercial businesses and industrial businesses, respectively. In the final model, we assumed that the utility companies paid tax as an increased cost of production.

Before we proceed, we should point out that these four tax policies also indicate how $1 million of energy savings in each county impacts the economy. If one simply reverses the direction of each estimate in Table 22, the new table would indicate the potential change for reducing energy costs by $1 million. To avoid that redundancy, we chose not to include a second table.

Table 22 indicates that market distortions are as small as possible when the fees are levied primarily on households. Employment, GDP, disposable personal income, personal consumption expenditures, and optimal residential capital stock fall by the least amount in this policy. However, if that money was financed via an increase in commercial sector electricity prices, then the economy is greatly affected. The optimal value of the housing stock (residential capital stock) was expected to decrease the most if the commercial sector paid the entire electricity tax.

If the industrial sector were levied with an electricity tax, Table 22 shows that the loss in employment would be nearly three times worse than if the tax were levied on the household, but still not as bad as if the tax were levied on the commercial sector. In addition, the optimal nonresidential capital stock decreases, which greatly reduces each worker's productivity as firms slow their capital investment.

Table 22 Estimated Impact of Levying a $1 Million Electricity Tax in each County each Year, by Policy

Total Employment	2011	2012	2013	2014	2015	2020
Households	-8	-10	-10	-10	-10	-9
Commercial Sector	-22	-32	-38	-43	-45	-43
Industrial Sector	-17	-25	-30	-32	-34	-29
Utility Companies	-7	-13	-18	-22	-25	-31
Labor Productivity (2010 $, units)						
Households	-$1.94	-$1.64	-$1.47	-$1.41	-$1.36	-$1.28
Commercial Sector	$2.45	$3.02	$3.22	$3.14	$2.88	$0.31
Industrial Sector	-$1.36	-$3.00	-$4.58	-$6.12	-$7.65	-$14.32
Utility Companies	-$1.06	-$1.41	-$1.65	-$1.79	-$1.87	-$1.81
Gross Domestic Product (GDP)						
Households	-$1.3	-$1.4	-$1.4	-$1.4	-$1.4	-$1.4
Commercial Sector	-$1.7	-$2.6	-$3.2	-$3.8	-$4.2	-$5.4
Industrial Sector	-$2.1	-$3.3	-$4.3	-$5.1	-$5.8	-$7.7
Utility Companies	-$1.0	-$1.6	-$2.2	-$2.7	-$3.0	-$4.1
Real Disposable Personal Income						
Households	-$0.4	-$0.4	-$0.4	-$0.5	-$0.4	-$0.5
Commercial Sector	-$2.0	-$2.3	-$2.5	-$2.8	-$2.9	-$3.3
Industrial Sector	-$1.7	-$1.9	-$2.1	-$2.3	-$2.4	-$2.5
Utility Companies	-$1.0	-$1.2	-$1.4	-$1.7	-$1.8	-$2.4
Personal Consumption Expenditures						
Households	-$0.3	-$0.3	-$0.3	-$0.4	-$0.4	-$0.4
Commercial Sector	-$1.5	-$1.7	-$1.9	-$2.1	-$2.2	-$2.6
Industrial Sector	-$1.2	-$1.4	-$1.6	-$1.7	-$1.8	-$1.9
Utility Companies	-$0.7	-$0.8	-$1.0	-$1.2	-$1.3	-$1.8
Nonresidential Optimal Capital Stock						
Households	-$7.1	-$7.6	-$7.7	-$7.9	-$8.1	-$9.0
Commercial Sector	-$1.7	-$2.4	-$3.0	-$3.5	-$3.9	-$4.4
Industrial Sector	-$8.2	-$9.3	-$10.2	-$10.9	-$11.6	-$13.5
Utility Companies	-$5.6	-$9.8	-$13.3	-$16.4	-$19.1	-$28.4
Residential Optimal Capital Stock						
Households	-$0.7	-$0.8	-$0.8	-$0.9	-$0.9	-$1.0
Commercial Sector	-$3.8	-$4.7	-$5.0	-$5.5	-$5.9	-$7.2
Industrial Sector	-$2.7	-$3.4	-$3.7	-$4.0	-$4.2	-$4.7
Utility Companies	-$1.8	-$2.5	-$2.9	-$3.3	-$3.7	-$5.2

- Source: Center for Applied Demography & Survey Research; REMI PI+ software.
- Except for Labor Productivity, all dollars are in millions of 2010 prices

If the utility sector in each county paid an additional $1 million in costs each year, then the decline in employment would be on par with the decision to tax the industrial sector. However, GDP, disposable income, and consumption would fall, but by less than the outcome of taxing the commercial sector or the industrial sector. This is reasonable, since the utility company would pass a substantial portion of those increased costs to households, which generated the least market distortions.

Table 22 also implies that reducing electricity costs for households generates the least economic benefits, but reducing electricity costs for businesses have the greatest benefits for the economy. Of course, lowering energy costs in businesses will mean that the cost of operating machines is lower relative to other inputs, and could paradoxically lead to more energy use due to both the output and the substitution effects of basic microeconomic theory.

The point of this section is to indicate how policy affects electricity costs (either positive or negative) and how that has ramifications on the economy. If that spending is well targeted, the economic benefits of the program may exceed the costs. If poorly targeted, the opposite will be true. The difficulty facing such targeting is to find enough economically profitable investments that would not have been done privately, and fund those investments in the least burdensome way possible.

Observations and Conclusion

The primary intention of this report was to understand the economic impact of relevant issues within the green economy. To help in that respect, we provide an overview of the design and organization of Delaware' green economy. Then we use economic simulations to address four important topics. First, we model a hypothetical policy that uses tax revenue to make energy efficiency investments in the manufacturing sector. Although the model is hypothetical, important policy conclusions are relevant to Delaware's existing policy. Then, we evaluate what probable impact there will be in the future due to Delaware homeowners investing in energy-efficient home improvements. After that we explore what the total economic impact is of those Delaware companies that sell green goods and services. Finally, we discuss the more immediate employment impact that selected energy-efficient and renewable energy programs will have on Delaware.

The first section reviews the organization of Delaware's green economy and shows that it is a relatively complex system intended to channel resources towards green producers and green consumers. But economics teaches us that since resources are scarce, any reallocation of resources requires a tradeoff. By reallocating resources into the green economy, Delaware is sacrificing any alternative use of those resources. If people are *forced* to make that sacrifice, then that implies that the market values the alternative use of those resources more than it values the promise of environmental benefits.

Of course, it is also well known that the free market does not value everything appropriately. Pollution is the classic example, because market participants can make the rest of society pay these costs. Green policies, such as the Regional Greenhouse Gas Initiative and the Renewable Portfolio Standards, confer environmental benefits in two ways. First, by making households and businesses pay for pollution, they will have to forego any alternative uses of those resources, and those alternative uses generally emit pollution. Secondly, money collected to pay for those costs will be spent on pollution-reducing activities.

Whether such a reallocation of resources is efficient depends on whether the value lost by sacrificing the alternative is less than, equal to, or greater than the value gained in their new use. How we value changes in pollution is crucial to assessing a policy's merit. To date, there is no consensus on what value should be attached to these benefits due to the complex relationship between the environment and the economy. However, if we believe it best to sacrifice economic benefits in exchange for cuts in pollution, then economics offers some commonsense advice.

First, society should reduce pollution in a way that minimizes costs. Economists have long viewed cap and trade or carbon taxes as efficient mechanisms of reducing pollution, and Delaware has adopted the cap and trade approach. However, the "trade" part of cap and trade means that auction prices can respond to the competitive market forces of businesses seeking the cheapest ways of cutting pollution. Legislative interference with those competitive forces, for example by price controls (e.g. minimum RGGI price of $1.89 per allowance) necessarily increases the cost of cutting pollution. In addition, we found that the costs of collecting a fixed amount of revenue (to spend on pollution-reducing activities) are highest when other government spending is broadly cut. Costs are also very large when the commercial or industrial sector pays them, and placing the tax on utilities effectively passes most of these costs along to commercial and industrial sectors.

Second, an environmental policy should maximize the environmental gain per dollar spent (assuming a fixed amount of economic loss). Energy efficiency is often described as the 'lowest hanging fruit' in the green economy, because large environmental benefits can be achieved at very low costs. Of course, there are many different possible investments within the energy-efficiency universe, and we show that the most profitable ones have the greatest economic benefits. However, as investments become less profitable, costs increase relative to benefits, and measures of economic performance, including employment, are reduced.

Third, economic benefits and economic impacts are not equivalent. While any job can be created by spending money, not all jobs are as productive as others, and it is inefficient to pay more wages than a job's worth. Since jobs are viewed as a cost in economics, they should only be "created" if more value can be gained in exchange for the wages paid to them. This means that policies should be assessed in terms of how much more valuable their output is compared to their input, not by the size of their input. Along these lines, we show that the biggest employment gains made by investing in energy efficiency come from lowering energy costs (i.e. adding value to production), not from employing people to perform those repairs and new installations. We find this is true both in manufacturing and with respect to green residential remodeling.

Consider, for example, that green remodeling is expected to use approximately 575 jobs, 350 of which are in construction. These jobs are attributable to household spending that is going to occur anyway when equipment needs replacement. The jobs are only labeled as green if the household decides to replace the old appliance with a green one. Therefore, the 575 jobs are *attributable to* green activities, not *additional because* of green activities. Actual job creation from these activities depends on how much money homeowners save by making the investment and how much the programs convinced households to do projects they would not otherwise do. The REMI model finds that $1 million in residential electricity savings in each county ($3 million in Delaware), will add nearly 10 additional jobs in Delaware and $1.4 million in GDP.

Fourth, there are always costs involved when transferring resources within the economy. The report shows that a green investment made privately produces the greatest economic benefits. This is because a government program that transfers dollars between households and businesses is not valuable in and of itself. Just like banks, the benefit of such a program depends on whether it can use those funds to exploit any valuable and otherwise unexploited opportunities. Net economic benefits occur when the policy chooses the most valuable investments, does not crowd out much private investment, and imposes the least cost on the rest of society.

Ultimately, Delaware cannot escape the fact that our policies implicitly assign values to environmental benefits that are never known directly or with certainty. However, cutting pollution is how society reaps these environmental benefits, not through the endorsement of any particular technology. The adoption of a particular technology is a secondary issue that should depend on each technology's "bang for the buck", not the other way around. Paying higher costs for cutting pollution simply means that less pollution can be cut. Of course, it also means that greater economic sacrifice is needed to achieve a given amount of environmental benefits, and that is antithetical to the stated goals of the green economy.

The green economy has become an important issue for the state, so thoughtful and rational deliberation is prudent. Our Center conducted this research to better inform the public on important policy matters. We hope that this report will support policy makers and the public in that regard.

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Appendix

Department of Natural Resources and Environmental Control’s Organization

Office of the Secretary

- *Regulatory Advisory Service*
- *Pollution Prevention Program*
- *Small Business Assistance Program*
- *Coastal Zone Act Program*
- *Land Use Planning*
- *Public Affairs*
- *Human Resources*

Delaware Energy Office *(administered by the Office of the Secretary)*

- *Delaware Greenhouse Reductions Project*
- *Delaware Energy Assurance Program (with DEMA)*
- *Green Energy Program*
- *Delaware Energy Plan*
- *Weatherization Assistance Program*
- *Energy Assistance Program*

Office of Environmental Protection

- *Division of Air & Waste Management*
    - Air Quality Management Section
        - Air Surveillance
        - Engineering & Compliance
        - Planning

- Office of Environmental Protection (cont.)
    - Emergency Prevention & Response Branch
        - Accidental Release Prevention
        - Emergency Planning & Community Right-to-Know
        - Emergency Response
    - Environmental Crimes Unit
    - Waste Management Section
        - Site Investigation & Restoration Branch
        - Solid & Hazardous Waste Management
        - Tank Management Branch
- *Division of Water / Water Resources*
    - Division Management Section
    - Financial Assistance Branch
    - Environmental Laboratory Section
    - Surface Water Discharges Section
    - Ground Water Discharges Section
    - Water Supply Section
    - Wetlands and Subaqueous Lands Section

Office of Natural Resources

- *Division of Fish & Wildlife*
    - Coordination Section
    - Fisheries Section
    - Mosquito Control Section
    - Wildfire Section
    - Enforcement Section
- *Division of Parks and Recreation*
    - Administration and Support Office
    - Planning Preservation and Development Section
    - Operations and Maintenance Section
- *Division of Soil & Water Conservation / Watershed Stewardship*
    - Drainage & Stormwater
        - Drainage Program
        - Sediment and Stormwater Program
        - Dam Safety Program
    - Shoreline & Waterway Management

<u>Office of Natural Resources (cont.)</u>

- District Operations
    - Conservation Districts
    - Nonpoint Source Program
    - Debris Pit Program
    - Ecological Restoration
- Delaware Coastal Programs
    - Delaware Coastal Management Program
    - Delaware National Estuarine Research Reserve
    - Delaware Coastal and Estuarine Land Conservation Program

Selected DNREC Initiatives Unrelated to Energy Efficiency and Renewable Energy

Green Industries Program – Incentives to companies that use recycled industrial materials or reduce industrial waste. Works with the Delaware Economic Development Office (DEDO) to promote the migration of these businesses into Delaware via tax incentives.

Delaware Nonpoint Source Pollution Program – Promotes resource conservation and pollution reduction for nonpoint sources. The program promotes pollution mitigation projects for dairy and poultry producers with low interest financing through the **Nonpoint Source Loan Program** (AgNPS loans). Clean Water Act grant money ("**319 Grants**") also funds similar projects designed to clean waterways. **Conservation Reserve Enhancement Program** (with USDA) designed to mitigate pollution/agricultural runoff in streams and watershed habitat. **Agricultural Best Management Practices Loans** offer low interest financing to support environmentally conscious dairy and poultry waste control programs.

Delaware Green Lodging – Campaign to promote hotels and motels that 'go green'.

Delaware Envirothon – Encourages high school students to study natural resource conservation by means of a statewide competition, the winners of which move on to national competition.

Delaware Green Infrastructure – This program conducts natural resource conservation projects and makes decisions over land use intended to preserve natural resources. Natural resources termed "green infrastructure".

Delaware Private Lands Assistance Program – Encourages private landowners to consider biological impact of wildlife on their property. Funding available through **Delaware Landowner Incentive Program**, largely targeted at agricultural owners. Also the **Wildlife Habitat Enhancement Program** pays agricultural farmers not to use land for agricultural purposes in order to provide wildlife habitat (pays $70.00 per fallow acre). The **Delaware Phragmites Control Cost-Share Program** pays a portion of the cost of spraying phragmite (invasive wetland plant) herbicide on private properties.

Delaware National Estuarine Research Reserve **–** Protects and conserves estuaries in Delaware. Primary role is research and education.

Delaware Heritage and Endangered Species Program **–** Monitors and protects endangered species. Multiple plant and animal species included.

Open Spaces and Natural Places **–** Program is akin to "Green Infrastructure" to promote land remaining undeveloped. Program deals with land use issues and conservation easement.

Coastal Management Assistance Grants – Grants awarded to preserve and manage Delaware's coast and discuss issues relevant to land use and planning, such as sea level rise.

Site Investigation & Restoration (SIRB) Loans and Grants **–** Financial assistance for remediating polluted properties. Loans include the **Brownfield Revolving Loan Fund** and the **Hazardous Substance Site Cleanup Loan Program**. Grant money is also expended via the **Hazardous Substance Cleanup Act Brownfield Grants** program.

Underground Storage Tank (UST) Programs– Programs are designed to remediate underground storage tanks. The **Fund for the Inability to Rehabilitate Storage Tanks** program pays the remediation cost when there is no present owner or when the present owner is unable to pay for remediation. The **UST Remediation Loan** program provides low interest financing for remediating UST's.

Waste Treatment Grants and Loans – Programs are also designed to repair or build residential and commercial waste. The **Septic Rehabilitation Loan Program** offers low interest financing options to repair damaged and degraded septic systems and cesspools. The **Delaware Water Pollution Control Revolving Fund** offers low interest financing to construct wastewater facilities. The **21st Century Fund's Wastewater Management Account** also offers low interest financing for wastewater facility construction projects, as well as grants. Grants are also available for municipal planning purposes through the **Grants for Wastewater Facility Planning** program.

Potential Hurdles Facing the Sustainable Energy Utility

If companies choose not to invest in energy saving opportunities due to financing and credit issues, then the SEU could play a very important and beneficial role in reallocating economic resources into projects that have better use. However, there are reasons to be cautious regarding the SEU's future success. This section elaborates on those risks.

First, it is not clear when, or if, households and businesses will be receptive to the proposition of incurring more debt. According to the two economists from the San Francisco Federal Reserve, historically high household indebtedness prior to the banking collapse is likely a contributing factor to the weakness of the recovery (Mian and Sufi, 2011). So far, the SEU has mostly offered direct incentives and rebates, so this has not been much of an issue to date (Sustainable Energy Utility, 2011). However as lending programs take priority, the SEU may face a market still hesitant to take-on additional debt. In addition, energy efficient investments will compete with other investment opportunities, so if energy prices do not increase, the investments are relatively less profitable. Of course, energy prices facing the consumer are subject to market and legislative forces.

The SEU may also face a number of programmatic challenges. As with any investor, the first challenge is the risk of client default. If the SEU lends money to businesses at greater risk of default, it raises the potential for taking a write-down on its assets. The SEU can combat default risk by offering risk-adjusted interest rates or by limiting credit to less risky clients. Of course, this could also limit program adoption. The SEU is currently attempting to sell $60 million in bonds, so there will be a need to service upcoming interest payments, presumably with investment returns. The SEU needs to consider carefully how it balances the for-profit financial motives it needs to be self-sustaining with the nonprofit environmental motives of reducing energy use.

The second challenge facing the SEU is that the market may be too small for its size. If the SEU is limited to investing in energy efficiency or renewable energy projects, it will have to forego other, potentially more profitable investment opportunities, or change its mission. In addition, the SEU's is presumably restricted to Delaware, which limits market size and reduces any cost advantages due to economies of scale. Finally, the SEU will have to invest strategically to guarantee future funds are available as payments are scheduled. If the SEU exploits its safest and most profitable opportunities first, it will be harder to remain self-sufficient when market penetration is larger.[27,28]

There may also be issues that stem from asymmetric information, moral hazard, and risk burdens in the contractual design. For example, many of the SEU's potential clients may not know enough about energy cost projections to agree in advance on a long term price of energy. Potential clients may also not have energy engineers on hand to verify or dispute energy savings. Both risks may limit demand. In addition, if the investment is successful, and energy costs do fall for the client, there will be the natural economic incentives to use more energy.[29] This offsetting behavior will make the verification of energy savings more difficult, and possibly contentious.

[27] The rate of investment depreciation is a critical factor here.
[28] There is also the risk that the SEU can be too successful. In this case, the SEU could lower the perceived risk of investing in energy efficiency so much that, only companies facing credit constraints ask for the SEU's assistance. Of course, if the SEU makes energy-efficient investing part of the state's private management culture, then its ultimate objective would be achieved.
[29] These incentives are called the 'substitution effect' and 'output effect' by economists, and are part of the core microeconomic theory.

Finally, the SEU largely depends on the funding from the Regional Greenhouse Gas Initiative. The future of the RGGI depends in part on the commitment of other states. It is not clear if the RGGI is a regionally stable strategy, because companies have the incentive to move to locations or establish new locations where relative costs are lowest.[30] Thus, unless the SEU, the DEO, the DEDO and other policies in the green economy can collectively offset the added cost differential of energy, RGGI will likely be opposed for economic development reasons.

On the one hand, many of these contractual issues may be mitigated through less aggressive policy design. Profitability issues would seem to play a relatively minor role as long as the SEU receives funding from 65% of the state's RGGI proceeds. There is also the added flexibility of moving funds between the SEU's different programs. In addition, the Delaware Economic Development Office (DEDO) could theoretically offset any cost increases due to green policies.

On the other hand, the RGGI is a politically contentious issue, with variable proceeds, and recently decreased participation from other states. In addition, external funding (e.g. ARRA) may restrict how the SEU can spend money, and it is not clear whether economic development policies could offset the environmental policies.

In light of these factors, we feel it is difficult to predict the long term impact of the SEU. Time will tell whether any of the potential obstacles listed above materialize, and if so, whether they are surmountable.

[30] If every state (or country) required companies in their region to pay for environmental costs, then any one state (or any one country) would have the unilateral incentive to relax that requirement and be rewarded with an inflow of companies in pursuit of maximum economic profits. An analogous situation applies to Delaware's zero-sales tax policy.

Table 23 Installation Projects Related to Energy Efficient and Renewable Energy Paid for by American Recovery and Reinvestment Act

Award Number	Award Description	Award Total	Award Expended	Award Remaining	Entity
DE-EE0000342	Delaware proposes to use ARRA SEP funding in the following program areas: Energy Efficiency and Renewable Energy Financing ($11 Million), Residential Energy Efficiency Incentives ($5.7 Million), Non-Residential Energy Efficiency Incentives ($2 Million), Renewable Energy Incentives ($2 Million), Energy Efficiency in New Construction ($300,000), Evaluation, Measurement and Verification ($1 Million) and Program Administration ($2.3 Million). The financing and incentives programs will largely be offered and managed in coordination with the Delaware Sustainable Energy Utility through the Energize Delaware Programs.	$24,231,000	$11,669,904	$12,561,096	SEU
DE-EE0000174	This award funds the approved ARRA WAP, as described in Part I of the Financial Assistance Funding Opportunity Announcement for the U.S. Department of Energy's (DOE) Weatherization Formula Grant. The purpose of the WAP is to install energy efficiency improvements in the homes of low income Delawareans	$13,733,668	$4,396,043	$9,337,625	WAP
DE-EE0000775	DNREC's Energy Office was awarded $9,593,500 for the EECBG (Award No. DE-EE0000775) on September 24, 2009. Of this total, approximately 40 percent is for State projects ($3.640M) and approximately 60 percent ($5.460M) will be allocated to smaller municipalities.	$9,593,500	$1,629,307	$7,964,193	DNREC
DE0010000190 9G	Lincoln Towers is a high-rise WHA public housing facility consisting of one hundred and twenty (120) units composed of 60 efficiency and 60 1-bedroom apartments located within the Trolley Square community in the City of Wilmington, Delaware. WHA had concluded that no reasonable program of modifications is cost-effective to renovate Lincoln Towers to useful life as a residential dwelling area. As a result, WHA intends to develop a mixed financed project for the demolition and redevelopment of Lincoln Towers into a mixed-use and mixed income development. WHA was also subsequently awarded a $10 million HUD American Recovery and Reinvestment Act (ARRA) competitive grant for the transformation of Lincoln Towers that includes the demolition and redevelopment of the property. A HUD approved Relocation Plan has transferred all of the Lincoln Towers residents. Most residents selected the option of moving to the newly upgraded and renovated Crestview Apartments. Lincoln Towers, which when completed, will yield approximately 88 units of age-restricted elderly mixed-income population of public housing, low-income, and Section 8 households. In addition to the Residential portion of this site, WHA has teamed up with the City of Wilmington to include a new firehouse on the site. This firehouse will be a new state-of-the-art facility that will house the exiting Fire Company No. 5.	$10,000,000	$2,084,095	$7,915,905	Wilmington Housing Authority

Table 23 Installation Projects Related to Energy Efficient and Renewable Energy Paid for by American Recovery and Reinvestment Act (cont.)

Award Number	Award Description	Award Total	Award Expended	Award Remaining	Entity
DE0010000020 9R	Green Energy Grant: The WHA was approved for a $3.6 million Green Energy Grant to renovate all 180 units in Southbridge Family Development. Renovations include installation of high efficiency 92% furnaces, 16 seer air conditioners, tankless water heaters, energy star appliances, over the range microwaves and electronic ignition stoves. Bio based spray foam insulation in walls and ceilings as well as exterior facade improvements which include siding and porches will improve weatherization, sun shade and increase R value. Other energy conservation measures will reduce water consumption and compact fluorescent lighting will reduce kilowatt hours of electrical usage.	$3,623,152	$957,953	$2,665,199	Wilmington Housing Authority
DE-EE0000774	Implementation of energy conservation measures in New Castle County facilities: reducing energy demand.	$3,746,200	$1,352,350	$2,393,850	New Castle County
DE-77-0001-00	The project focuses on retrofitting Delaware Transit Corporation facilities with solar panels, which generate costs savings through fossil fuel energy reductions. The solar panels are comprised of photovoltaic cells, comprised of ultra-thin layers of silicone. When sunlight strikes the surface of the cell, an electrical field is created resulting in a flow of electricity. Once installed, solar energy is captured by the photovoltaic modules, then converted from direct current (DC) power to alternating current (AC) power, and finally used to power lighting, computers, air conditioning, and other electric loads in the building. The environmental benefits of integrating solar energy within the facilities are: Annual reduction of approximately 367,000 pounds in carbon dioxide (CO_2); The annual equivalent of removing approximately 31 automobiles from our highways; The annual equivalent of 1,236 acres of trees. The investment in solar energy will return dividends based on the reduction in annual building usage of kilowatt hours of purchased electricity. The return on investment of the reduction in energy consumption will be approximately $91,222 per year with a full payback on the system in 15 years.	$1,500,000	$0	$1,500,000	DelDot

Table 23 Installation Projects Related to Energy Efficient and Renewable Energy Paid for by American Recovery and Reinvestment Act (cont.)

Award Number	Award Description	Award Total	Award Expended	Award Remaining	Entity
DE-OE0000164	This program will create capacity on Staff to engage in electricity system modernization in the long-term and allow for regulatory support in the transformation of the electric grid, in coordination with other agencies in Delaware and other states in our region. It will facilitate timely consideration by the PSC of dockets, notices of inquiry, integrated resource plans, and other regulatory actions pertaining to the listed electricity-related topical areas. It will create two (2) new full-time jobs for limited term of service for one administrative electricity specialist and one entry level electricity specialist. Two full-time or a combination of full- and part-time advanced electricity specialists will be retained on a contractual basis for terms of one to three years. Staff has found in the past that the labor pool with the necessary specialized knowledge and education for these advance positions is very limited in Delaware. Six PSC Staff and the two new electricity specialists will receive training in key emerging areas that will give regulators the information needed for effective regulatory decision-making and streamline regulatory approval in modernizing and ensuring a reliable and affordable electric system. Additional equipment such as computers, scanner, and copier will be purchased that will allow the inflow and outflow of the documents associated with the ARRA-related dockets to be handled expeditiously.	$772,254	$118,396	$653,858	City of Wilmington
DE-SC0001263	EE Conservation Block Grant Program. Development and Implementation of a Comprehensive Energy Strategy and solar field to save energy costs at the Emergency Operations Center.	$688,600	$69,472	$619,128	Kent County

Table 23 Installation Projects Related to Energy Efficient and Renewable Energy Paid for by American Recovery and Reinvestment Act (cont)

Award Number	Award Description	Award Total	Award Expended	Award Remaining	Entity
SC0003124	Kent County will use the EECBG funds to implement a wastewater effluent HVAC system utilizing the thermal properties of the wastewater by heating and cooling the administration building(s) at the treatment plant. The projects have the goal to lower Kent County's energy consumption and reduce green house gas emissions. It is estimated that the energy consumption be reduced by 8% (900,000kWh's) and green house gas emissions by 650 metric tons. Kent County will benchmark the energy usage before the improvements are made using the EPA's Energy Star Portfolio Manager tool.	$411,600	$118,299	$293,301	Sussex County
17973013	The $800,000 EDA grant will help build Energy House on Delaware Technical & Community College's Owens Campus in Georgetown, DE. Energy House will be a learning center for alternative technologies, focusing on renewable energy products for homes and workplaces. The 4,559 +/- sq ft house will feature a living green roof over the garage, solar systems, wind turbine, radiant floor heating, geothermal options, and efficiency in construction and appliance usage. The facility will house three first floor classrooms and a second floor green technologies laboratory, allowing students and the public to see and touch renewable energy in action. As a demonstration facility, Energy House will collect and provide data on costs and benefits of various forms of energy generation so students and the public can evaluate options and make decisions. The House will have see-through, glass-wall galleries showing the technologies in operation, which will allow demonstration of installation, operation and maintenance best practices. Through credit and non-credit programs, the facility will train workers in new green jobs like energy auditing and energy management and will contribute to the region's economic growth.	$800,000	$562,869	$237,131	DelTech

Table 23 Installation Projects Related to Energy Efficient and Renewable Energy Paid for by American Recovery and Reinvestment Act (cont.)

Award Number	Award Description	Award Total	Award Expended	Award Remaining	Entity
B-09-UY-10-0001	CDBG-R will be used to meet New Castle County Consolidated Plan goals for housing rehabilitation including emergency housing and special needs housing; goals for crime prevention including extra police hours and supervised after-school youth programs; and goals for strengthening communities through grassroots leadership training. Recovery Act goals will also be met by New Castle County's use of CDBG-R: 76% of CDBG-R funds will be used for hard development costs of housing rehabilitation, resulting in the equivalent of 2.75 full time construction jobs (over one year) retained by these renovations to approximately 12 single family homes and one facility for homeless ex-offenders. Energy conservation technology will be a component of all renovation activities. Additionally, approximately 2 full time jobs will be retained by non-renovation activities. All CDBG-R activities support Recovery Act goals for smart growth through housing renovation and community revitalization activities in safe and stable neighborhoods of modestly priced homes close to employment centers, shopping, and services.	$639,766	$466,954	$172,812	New Castle County
EE0002952	Energy retrofits for City Administration Bldg	$50,000	$0	$50,000	New Castle, City
DE-EE0002686	Award supplies funding for performing energy efficiency audits of local industrial plants, with the goal of reducing energy consumption by 21400 MMBTU for large plants and 7400 MMBTU for medium plants. This quarter one medium plant was done, with recommended savings of 62,900 MMBTU equivalent, well exceeding the target. We have implementation reports on assessments done last year. DL0052 (medium): 4479 MMBTU; DL0053 (large): 101,045 MMBTU !; DL0054 (medium): 3098 MMBTU. So, implemented savings is not meeting target for the medium plants, but for the large plant greatly exceeds the target. Our SOW was for two Technical Assistance events and one more medium plant. We have asked and been approved to convert this to one TA and one large plant.	$125,000	$97,001	$27,999	UD
EE0002910	To reduce the amount of energy used by installing solar panels, LED street lights, and upgrading well and pump station motors, to high efficiency motors.	$180,400	$163,952	$16,448	Dover, City of

Table 23 Installation Projects Related to Energy Efficient and Renewable Energy Paid for by American Recovery and Reinvestment Act (cont)

Award Number	Award Description	Award Total	Award Expended	Award Remaining	Entity
DE0040000030 9R	Award is to install electric producing solar panels at Mifflin Meadows to produce electricity for the Community Building, Daycare and Offices. Other Energy Saving projects will also be included-replacement of HVAC system in Community Building, Replacement of Hot Water heaters in Community Building, Replacement of Parking Lot Lights with LED lighting and replacement of all refrigerators with Energy Star appliances.	$184,813	$174,071	$10,742	Delaware State Housing Authority
S397A090053	Government Services Fund for public safety and other government services, which may include assistance for elementary and secondary education and public institutions of higher education, and for modernization, renovation, or repair of public school facilities and institutions of higher education facilities, including modernization, renovation, and repairs that are consistent with a recognized green building rating	$24,545,540	$24,539,200	$6,340	State of Delaware
DE0040000130 9R	Award is to install electric producing solar panels at Hickory Tree Apartments to produce electricity for the Community Building, Daycare and Offices.	$184,813	$184,813	$0	DE State Housing Authority
DE-EE0002369	City of Newark has completed Energy Efficient retrofits through it Energy Efficiency & conservation project	$147,800	$147,800	$0	Newark, City of
DE-EE0002906	EECBG Grant DE-EE0002906 The City of Milford will be replacing (60) sixty 175 Watt High Pressure Sodium Metal Halide lights with energy efficient 100 Watt LED lights in the downtown Milford area. This lighting change will save the City of Milford approximately $2,381.00 per year, plus an estimated reduction of 40,748 pounds of CO2 equivalents. In addition, LED lights will reduce maintenance costs, have a longer service life, provide manageability of illumination levels, and focus light specifically where needed reducing light pollution.	$50,000	$50,000	$0	Milford, City of
DE-EE 0002308	Energy Efficient Window Replacement	$50,000	$50,000	$0	Elsmere
EE0002444	Project will replace existing incandescent and HID street light fixtures with energy efficient street light fixtures using technologies such as LED (light emitting diodes) or induction. Efficiency gains are expected to be at least 40%.	$50,000	$50,000	$0	Seaford, City of
B-09-DY-10-0001	The Community Development Block Grant Recovery (CDBG-R) program funds will invest in energy-efficient housing rehabilitation.	$537,718	$537,718	$0	Delaware State Housing Authority

Table 23 Installation Projects Related to Energy Efficient and Renewable Energy Paid for by American Recovery and Reinvestment Act (cont.)

Award Number	Award Description	Award Total	Award Expended	Award Remaining	Entity
DE-SC0002101	This Energy Efficiency and Conservation Block Grant award will be used in a project to replace incandescent light bulbs with Light Emitting Diode (LED) lights at City intersections and pedestrian signals. A total of 2,353 fixtures containing 5,088 LED modules will be installed. The grant award of $800,600 will cover the installation cost of approximately 2250 LED modules. Energy efficiency will be achieved through the lower wattages of the LED lamps as compared to the existing incandescent lamps. LED lights last for approximately 100,000 hours, compared to incandescent bulbs which have filaments that burn out and may last only 8,000 hours before needing to be replaced. Not only are replacement costs and schedule for incandescent light bulbs expensive, but the replacement process inhibits traffic flow which can result in traffic congestion and safety risks. It is estimated that the change to LED traffic signals will save the City $127,949 annually in traffic signal power costs, the equivalent of 1,199,901 kwH/yr. The reduction in energy usage is expected to reduce the City's annual CO_2 emissions by 740 tons.	$800,600	$800,600	$0	City of Wilmington
DE26S00250109	WEATHERIZATION OF PUBLIC HOUSING UNITS	$611,790	$611,790	$0	Dover Housing

Assumptions Behind the Calculation of Cost and Benefit Streams in Manufacturing

In this section, we more fully detail what mathematical assumptions were made regarding the model that estimates the future stream of costs and benefits for investing in energy efficiency. The model assumes that one dollar invested in year t will have an infinite lifetime of benefits, however future benefits will be less valuable due to capital depreciation and discounted values of time. In addition, it assumes that the distribution from historical savings, in dollars, will be the same in the future as it was in the past. This implicitly assumes constant energy prices, which should be relaxed in the future.

In the next pages, we present definitions and descriptions of the parameters and variables in the model. The mathematical derivation of our assumptions follows.

<u>Parameter definitions:</u>

$PotInv_i$ – Potential investment in technology 'i'

$ImpRate_i$ – Historical implementation rate of technology 'i'

$CPI_{08\text{-}10}$ – Inflation conversion parameter between 2008 and 2010

Length – Duration of program (in years)

CrowdOut – Rate at which private investment does not occur due to public investment

$Payback_i$ – Average payback on energy efficient investment for technology 'i'

DepRate – Depreciation rate of energy saving investment

TimeVal – Discount factor for opportunity cost of time, analogous to $(1+r)^{-1}$

Admin – Percent of investment that pays for administrative costs of public program

$TotalSav_i$ – Average historical savings ($) for investing in technology 'i'

$EnergySav_i$ – Average historical energy savings ($) for investing in technology 'i'

$ElecSav_i$ – Average historical electricity savings ($) for investing in technology 'i'

$NatGasSav_i$ – Average historical natural gas savings ($) for investing in technology 'i'

ResFuelSav – Average historical residual fuel savings ($) for investing in technology 'i'

PctCom, PctRes, PctInd – Percent of Delaware's electricity consumption in the commercial, residential and industrial sectors, respectively.

LaborExp, – Proportion of investment dollars assumed to go to labor expenditures

Variable Definitions

Inv$_{i,t}$ – Total dollars invested in energy technology 'i' in year 't'

Return$_{i,t}$ – Expected return in year 't' for investing in technology 'i'

ΔEnergyCost$_{i,t}$ – Change in energy costs in year 't' for investing in technology 'i'

ΔElecCost$_{i,t}$ – Change in electricity costs in year 't' for investing in technology 'i'

ΔNatGasCost$_{i,t}$ – Change in natural gas costs in year 't' for investing in technology 'i'

ΔResFuelCost$_{i,t}$ – Change in residual fuel costs in year 't' for investing in technology 'i'

ΔOtherCost$_{i,t}$ – Change in non-energy costs in year 't' for investing in technology 'i'

ΔElecFinCom$_{t,}$ – Change in electricity costs to finance green investment, commercial sector

ΔElecFinRes$_{t,}$ – Change in electricity costs to finance green investment, residential sector

ΔElecFinInd$_{t,}$ – Change in electricity costs to finance green investment, industrial sector

Construction$_{t}$ – Total dollars being spent in the construction sector in time t

Capital$_{t,}$ – Total dollars being spent on capital investment in time t

CostOffset$_{i,t}$ – Decreased O&M costs due to policy crowding out investment in technology 'i' in time 't'

Variable Equations

Variable Equations (cont)

Abbreviations Used in this Report

ARRA – American Recovery and Reinvestment Act

DEDO – Delaware Economic Development Office

DEO – Delaware Energy Office

DHSS – Department of Health and Social Services

DNREC – Department of Natural Resources and Environmental Control

DSHA – Delaware State Housing Authority

EECBG – Energy Efficiency Community Block Grants

EPA – Environmental Protection Agency

GDP – Gross Domestic Product

GEF – Green Energy Fund

GEP – Green Energy Program

GGRP – Greenhouse Gas Reductions Project

HVAC – Heating, Ventilation, and Air Conditioning

JCHS – Joint Center for Housing Studies

MWH – Megawatt-Hour

PSC – Public Service Commission

PCE – Personal Consumption Expenditures

RDI – Real Disposable Income

REC – Renewable Energy Certificate

RGGI – Regional Greenhouse Gas Initiative

REMI, PI+ – Regional Economic Models Inc., Policy Insight +

RPS – Renewable Energy Portfolio Standards / Renewable Portfolio Standards

SEU – Sustainable Energy Utility

SREC – Solar Renewable Energy Certificate

WAP – Weatherization Assistance Program