FINAL Report:

Connecticut's Economic Benefits from CCEF Small Solar & OSDG Programs

Prepared for:
Connecticut Clean Energy Fund

Prepared by:
Economic Development Research Group, Inc.

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Table of Contents

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EXECUTIVE SUMMARY

Economic Benefits from CCEF's Small Solar & OSDG Programs
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The CCEF *Small Solar* and *OSDG* programs to date (completed projects through August 2008) produce energy and capacity savings over the life of installed renewable energy systems in Connecticut's homes, businesses and institutions.

Table ES-1: Gross Energy & Capacity Savings through 2027

	Lifetime Savings		
Program Completes through 8/2008	**Energy (KWh)**	**Capacity (KW)**	**Energy & Capacity (*thous.* 2008$)**
Small Solar	48,089,877	49,782	$28,748
OSDG	156,774,004	69,193	$48,252
Total	**204,863,882**	**118,976**	**$76,999**

To achieve these savings (therefore extending existing generating and transmission infrastructure), participants of these two programs incur costs (net of state incentive payments and likely federal tax credit dollars) to make these investments.

Table ES-2: Project Costs – Total and Net

Program Completes through 8/2008	**Total Project Cost**	**CT Incentive**	**Federal Tax Credit, *est.***	**net Project Cost to Participant**
Small Solar	$21,782,583	$10,848,989	$873,781	$10,059,814
OSDG	$34,717,839	$21,458,492	$2,658,458	$10,600,889
Total	**$56,500,422**	**$32,307,481**	**$3,532,239**	**$20,660,703**

Currently, 36.6% of the total investment dollars from these projects support Connecticut manufacturers - solely fuel cell OSDG projects are sourced from in-state firms. This indicates a high degree of *economic leakage* and missed opportunity for manufacturing jobs and income growth. A majority (73%) of installation dollars are kept in-state.

Table ES-3: CT Spending on PV and Fuel Cell manufacturers & Installation Services

Program Completes through 8/2008	Total Project Cost	Portion for Equipment	Portion for Installation
Small Solar	$21,782,583	$15,247,808	$6,534,775
OSDG	$34,717,839	$23,689,955	$11,027,884
Total	**$56,500,422**	**$38,937,763**	**$17,562,659**
orders for CT firms	*$20,701,421*	*$7,962,922*	*$12,738,499*
leakage of project $	63%		

The resulting economic benefits from household and businesses' *net energy savings* (after project costs), and new demand for RE components and installation (including an assumed potential reduction in personal taxes when public institutions/agencies save on energy expenses, preserving public monies) is shown in Table ES-4.

Table ES-4: CT's Total Economic Impacts from Small Solar & OSDG

2002 to 2027	Small Solar	OSDG	*Combined*
Job Years	95	161	256
Income (thous.2008$)	$5,698	$11,418	$17,116
GSP (thous. 2008$)	$11,543	$17,040	$28,583
Output (thous. 2008$)	$20,248	$36,753	$57,001

Under the OSDG program, the participant pool is more heterogeneous than for the small solar program. It is comprised of non-residential energy customers – businesses in different industries, agencies and institutions. Of the $37 million of total output impact under OSDG, $15 million was direct equipment and installation purchases from CT businesses, another piece was some portion of the $4 million of direct net energy savings converted into market share growth as CT becomes a relatively more cost competitive location for its businesses, an assumed personal tax reduction from any budget saved at participating public buildings also creates direct consumer demand (more disposable income with fewer taxes), an import substitution effect from reduced purchases of out-of-state fuel generation inputs, and the remaining output growth from indirect and induced economic multiplier responses.

There is a remaining benefit produced as a result of these installed RE systems – namely air pollutant emission reductions (CO2, NOx, Sox, and CO). When all but the last pollutant are *monetized* using historical, current and projected auction prices (per ton), the programs combine to yield an air quality benefit worth $1,055,000. This program benefit remains outside of the economic multiplier consideration.

An expanded benefit:cost test, comprised of

- **Benefits =** *gross energy_capacity saved ($), $ of emission benefit, import substitution, Federal Investment Tax Credits, Depreciation Deductions, and economic multiplier impacts ($ of GSP[1]) from participants' net energy savings, and from project investment*
- **Costs =** *CCEF annual budgets to administer the programs, total[2] project costs faced by households, businesses and institutions,*

results in a value of 1.44 for both programs combined. The programs are returning $1.44 for every $1 spent. Evaluated separately, the Small Solar and OSDG programs produce benefit cost ratios of 1.34 and 1.5, respectively.

Table ES-5: Benefit-Costs Results from Small Solar & OSDG

Program	Benefit Cost Ratio
Small Solar	1.34
OSDG	1.5
Combined	**1.44**

A sensitivity test for the B:C ratio was developed to recapture the economic leakage on manufactured PV components. If 50% of the now entirely '*stranded'* PV equipment demand ($15.5 million of $31 million) could be captured as new manufacturing activity CT[3], the result would be a B:C ratio of 1.79 for the combined programs. This demonstrates that there are opportunities for energy programs such as *Small Solar* and *OSDG* to accomplish more than key energy, sustainability objectives. Forward looking economic development efforts by the agencies charged to pursue these can create synergies with other agencies' endeavors to advance new technology adoption. These synergies will create/retain more jobs and income for Connecticut.

[1] GSP = gross state product, a measure of the state's value-added.
[2] Incentive dollars do not enter any part of the B:C test since the participants as energy consumers are responsible for generating the revenues that fund the CCEF incentive – namely through a *combined system benefits charge* on monthly utility bills.
[3] The *direct* employment from these additional stimuli (2002 through 2008) is 69 job years. While this result may appear modest, it is explained by the level of labor productivity and its forecasted growth in the sector that manufacturers PV panels – NAICS 33441_.

1 INTRODUCTION

The Connecticut Clean Energy Fund is performing its first evaluation of its Solar Photovoltaic (PV) Rebate Program for residential, non-profit, and governmental PV installations and the On-Site Renewable Distributed Generation (OSDG) Program (OSDG) for commercial, institutional, and industrial installations. These are installed renewable energy capacity programs. A component of the overall evaluation is to measure the economic benefits that result for Connecticut from the programs' energy conserving investments. In addition to presenting those economic benefits, this document will also present a benefit:cost test comparing the resulting economic benefits to the agency's program-related costs. The economic analysis focuses on "completed" renewable installations occurring from 2002 through 2008. The time span for the analysis extends to the technology-specific useful life, 20 years for photovoltaic projects and 10 years for fuel cell installations in the OSDG program.

This report proceeds as follows: a presentation of the *analysis method* (CH.2), a description of each program's *direct participant effects* (CH.3), a presentation of the *estimated economic impacts* for each program (CH.4), and *conclusions* (CH.5)

2 ANALYSIS METHOD

2.1 Overview

The approach to this analysis is to translate each of the documented program-specific effects (referred to as *direct* effects in impact analysis) into various economic or social benefit catalysts for the Connecticut economy. Once those catalyst mechanisms have been defined, many can be introduced into an economic impact measurement tool, calibrated to reflect the state's economy, and additional economic effects are estimated. The latter depict a type of *multiplier response* that includes not just the ripple effect of a new dollar of demand from CT's household/business segment for solar components, but also captures how businesses ultimately reaping net energy savings become relatively more competitive and expand their sales. The resulting economic impacts are measured in terms of *change* in the following: jobs, economic output, value-added (Gross State Product) and personal income (billions of dollars). They can be shown for the state as a whole, or by specific industries. The economic impact measurement tool used is a model developed by Regional Economic Impacts Models, Inc. (REMI). Not only does this model have a long history of use in the state[4], it is uniquely suited because it does capture the cost/price change feedback on an economy. The appendix to this document provides background technical information on the REMI model.

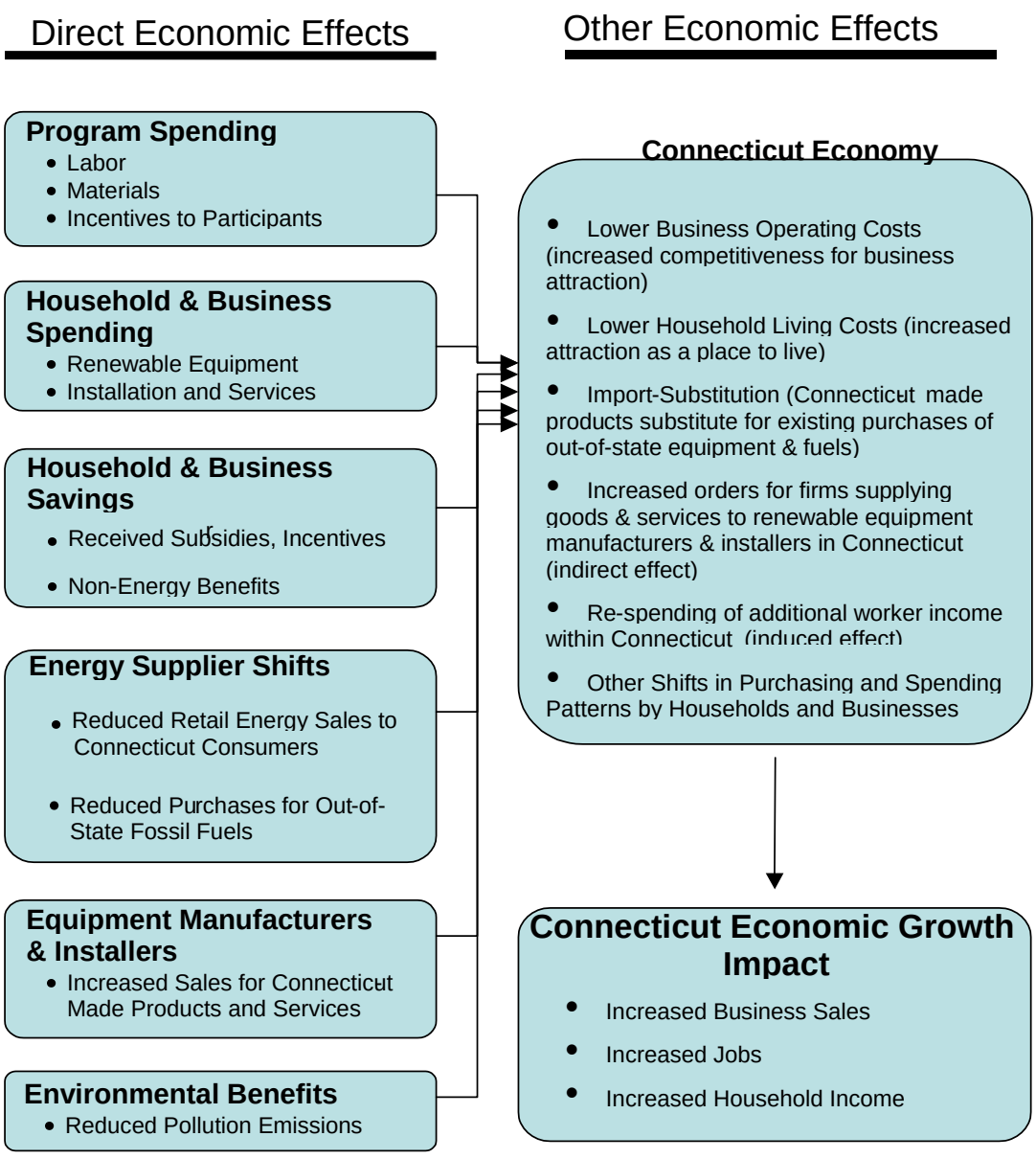
2.2 Translating CCEF Program Data into Economic Events

Each program will create a unique economic impact response on the state's economy since they (a) target different participants (some overlap exists), (b) promote different technology adoption - hence different levels of investment and demand for in-state manufactured components as well as installation contractors, and (c) produce different outcomes in terms of long-term energy expenditures.

Figure 2.2.1 represents this collection of direct economic effects that exert an influence on the state's economy. A brief articulation of the set of program-related direct economic influences is provided.

[4] Both Connecticut DCED and UCONN – Storrs CEA use REMI models to provide information into agency or legislative decision-making processes.

Figure 2.2.1 Analysis of CCEF Direct & Indirect Program Effects



REEM Framework for Energy Impact Analysis

***Program Spending* –** the annual expenditures that the CCEF makes to administer the programs are ultimately a cost when considering the benefit-to-cost ratio. However the program budget is spent on labor, marketing services, supplies, and incentive dollars to program participants. All except the incentive dollars represent at minimum new demand for, if not a direct provision from Connecticut-based, suppliers, and households for the labor component. These will be associated with multiplier impacts. The role of incentive dollars is discussed below with *net project costs*.

***Participant Project Costs* –** whether a household or business/institution is making the installation, the full amount represents demand for photovoltaic and fuel cell components. The specific technology chosen for each completed project determines whether it represents a sale from a Connecticut manufacturing facility or an *import* - domestic or otherwise. We have proceeded on the premise that none of the photovoltaic equipment is manufactured in-state, and all of the fuel cell equipment is Connecticut made. The portion of the project cost that is for installation (predominantly spent on labor) goes to contractors from Connecticut and elsewhere as the CCEF data have identified. *Net project costs* reflect the portion of the total project cost that remains after state rebates and potential federal tax credits. It is this *net* amount that households and businesses need to finance.

Energy and (Generating) Capacity Displacement – over the life span of each installed system, the renewable energy created will displace traditionally-generated energy (the majority using imported primary fossil-fuel inputs such as coal, and some from petroleum), and postpone generating capacity additions. The energy and capacity displaced by local renewable energy each have an *avoided cost* which represents a savings on energy purchases. For households, the energy savings comes in the form of additional discretionary income while for businesses this savings represents a reduction in production cost.

To the extent that the completed project required Connecticut manufactured components and/or used in-state contractors for its installation defines the "*import substitution"* of energy consumption by local equipment and labor. Even if all the equipment and installation was sourced from outside the state, traditionally generated energy is substituted by households, businesses and institutions generating their own energy needs.

Air Pollutant Emission Changes – installed photovoltaic systems will be attributed with reductions (lbs per MWh replaced) of four air pollutants – CO2, CO, NOx and Sox. Fuel cell systems will reduce emissions for CO, NOx and Sox, while increasing CO2 emissions according to information provided by the CCEF. For all but the carbon monoxide pollutant, tradable credit markets or allowance auctions provide an indication of the value of averting emissions ($ per ton). These valuations represent a *non-energy benefit*, specifically a social benefit.

3 DIRECT EFFECTS FROM CCEF PROGRAMS

This chapter presents an aggregated view of data collected by the CCEF regarding completed projects. They are aggregated by participant type – *residential* and specific business (institutional) types which are denoted by their respective NAICS code[5]. Much of this information provides the basis for identifying the programs' *direct effects* which ultimately interact with other aspects of the Connecticut economy.

3.1 Installed Technology - Energy & Emission Implications

Program Participants and Technology Use

There are 519 completed projects from 2002 to August 2008, 472 through the Small Solar program and 47 through the OSDG program. The OSDG program encompasses large solar projects (41 in total) in non-residential settings and fuel cell installations (6 completed).

Table 3.1 shows the industries that adopt each technology. The range of users includes government offices, hospitals, distribution centers, and several types of manufacturing worksites.

[5] *North American Industrial Classification Code* as defined by the Office of Management and Budget.

Table 3.1: Technology Adoption by Commercial Participants

	Years of Useful Life	Industry (NAICS code)
Fuel Cell	10	Food Manu. (311)
		Healthcare (621-624)
		Arts and Recreation (711-713)
		Government (92)
Photovoltaic	20	Agriculture (111-112)
		Beverage Manu. (312)
		Fabricated Metal Manu. (332)
		Transportation Equip. Manu. (336)
		Wholesale Trade (42)
		Retail (44-45)
		Real Estate (531)
		Rental, Leasing Service (531)
		Prof. and Tech. Services (541-551)
		Waste Management (562)
		Education (611)
		Arts and Recreation (711-713)
		Personal Services (812)
		Government (92)

The equipment installed with each project has a given capacity (kilowatts) and annual energy generation capability (kilowatt hours). These derive from the STC[6] ratings of the equipment based on product testing. However, to achieve a more accurate depiction of power generation, a realization rate (estimated by KEMA) was applied to the kilowatt hour rating (see Table 3.2 below).

Table 3.2: Realization Rates by Program Type

Program	Realization Rate
Small Solar	1.07
OSDG (PV)	1.09
OSCG (Fuel Cell)	.96

[6] *Standard Testing Conditions*

It is assumed that each project uses the estimated capacity and full generation potential for the technology's useful life. The kilowatts and kilowatt hours provided by each project will displace those of the utility. Dollars values for past and projected capacity and energy costs are derived from two sources: reports of estimated avoided energy supply costs (consisting of capacity cost and energy costs) for utilities in New England[7] by Synapse Energy Economics for data points 2002 through 2008, and KEMA's estimates for the projected values. Table 3.3 shows the per unit avoided costs used. Shaded portion of the time-series derived from the earlier (2001) Synapse report.

Table 3.3: Annual Avoided Cost of Energy (kWh) and Capacity (kW)

Year	$ per kWh	$ per kW
2002	$0.05	$36
2003	$0.05	$36
2004	$0.05	$61
2005	$0.05	$73
2006	$0.05	$73
2007	$0.09	$73
2008	$0.12	$54
2009	$0.17	$136
2010	$0.22	$136
2011	$0.25	$255
2012	$0.25	$361
2013	$0.25	$410
2014	$0.25	$410
2015	$0.25	$410
2016	$0.25	$410
2017	$0.25	$410
2018	$0.25	$410
2019	$0.25	$410
2020	$0.25	$410
2021	$0.25	$410
2022	$0.25	$410
2023	$0.25	$410
2024	$0.26	$410
2025	$0.26	$410
2026	$0.26	$410
2027	$0.26	$410

[7] *Avoided Energy Supply Costs in New England,* Synapse Energy Economics, Inc. and Resource Insight, Inc. (2001, and 2007 reports)

The gross energy savings ($) for each project is calculated by applying these per unit cost valuations to the installed kilowatts and to the kilowatt hours produced annually. Dollars of net energy savings (used for measuring the *spin-off economic effects*) for households or worksites deducts their portion of amortized project costs from the value of energy produced over the life of the RE investment. Sections 3.2 and 3.3 present each program's investment levels and energy/capacity displacement outcomes.

Air Pollutant Emissions

A reduction in KWh and KW also has an associated reduction in emission pollution and we included a valuation to account for the cost of this externality. The primary emissions from coal-based electricity production are Sulfur-Dioxide (SO_2), Nitrogen Oxide (NOx), and Carbon Dioxide (CO_2). Collectively, they are considered to be Green House Gases which adversely affect the environment[8]. The CCEF data provided the change in emissions (as pounds of emission per MWh) related to each installed RE project.

The difficulty can be quantifying or restating these air quality changes in terms of the monetary cost of the damage caused these pollutants. To estimate a valuation for these costs, we used historical and forecasted prices (adjusting for inflation) for allowance permits currently traded in auctions or climate exchanges. Historical allowance pricing was taken from EPA auctions, CantorCO_2e, and the Regional Greenhouse Gas Initiative (RGGI). Forecasted allowance pricing was sourced from PA Consulting estimates. Pricing adjustments were made for the conversion from the NOx State Implementation Plan (SIP) program to the NOx Clean Air Interstate Rule (CAIR) program which will take effect in 2009[9].

The price per (ton) trading allowance of pollutant (shown in Table 3.4) is multiplied times the KWh saved due to the instillation of PV and Fuel Cells to aggregate a total dollar value of estimated environmental savings due to the program.

[8] *http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php*
[9] *http://www.epa.gov/cair/basic.html*

Table 3.4 Trading Allowance per Ton

Year	Value per Ton		
	SO2	NOx	CO2
2002	$190	$1,181	$0
2003	$198	$8,085	$0
2004	$293	$2,250	$1
2005	$751	$3,809	$1
2006	$907	$2,372	$2
2007	$444	$1,845	$3
2008	$380	$1,693	$3
2009	$696	$1,344	$6
2010	$738	$995	$7
2011	$788	$1,062	$7
2012	$838	$1,130	$7
2013	$887	$1,197	$8
2014	$937	$1,264	$9
2015	$987	$1,332	$11
2016	$1,050	$1,416	$12
2017	$1,113	$1,502	$13
2018	$1,176	$1,586	$14
2019	$1,222	$1,165	$16
2020	$1,266	$744	$17
2021	$1,312	$744	$16
2022	$1,358	$744	$17
2023	$1,403	$744	$16
2024	$1,448	$744	$17
2025	$1,448	$743	$16
2026	$1,449	$744	$17
2027	$1,449	$742	$16

The Role of Federal Investment Tax Credits (ITC)

The Federal Investment Tax Incentive, if applicable to a specific applicant pursuing a solar installation, can help reduce the overall project cost to the household or business. From a state-level evaluation perspective dollars of Federal incentive are considered a benefit. The CCEF does not track whether participants of its two programs applied to receive the Federal ITC. For residential installations, the 30% ITC only began on Jan 1st 2006 and had a $2,000 limit[10]. For commercial entities, a 10% credit applied to installations before Jan. 1st, 2006 and 30% after[11], neither of which had a monetary cap. Depending on the year in which the installation occurred, we applied the appropriate ITC to reflect the net amount of investment if applicable. The new provisions contained in the

[10] http://www.seia.org/cs/federal_issues/the_investment_tax_credit_itc
[11] http://www.seia.org/cs/federal_issues/the_investment_tax_credit_itc

recently passed Emergency Economic Stabilization Act of 2008 (H.R. 1424) while significant will affect projects installed after December 31, 2008 and therefore do not apply to the completed projects in this analysis.

3.2 Small Solar Program Implications

There are 472 Small Solar projects examined in this study. This represents 93% of the CCEF projects analyzed. As seen in Table 3.5, the total cost of these projects exceeds $21 million all of which are residential installations. The state incentives (a *transfer* within a benefit:cost consideration) provided by CCEF helped the Small Solar participants pay for almost half of all costs ($10 million) and we estimate another $810,000 in federal tax credits would further defray project costs. With the advantages of incentives and tax credits, the users, on average, incur approximately 46% of the project cost.

The Small Solar program only uses photovoltaic panels, none of which are produced in Connecticut. As a result the equipment purchases, which represent 70% of the project cost, do not generate any economic activity in the state. However, CCEF records indicate 86% of the installation costs (which represent 30% of project costs) go to in-state firms. This means that 26% of the total project cost (nearly $5.7 million) is spent on installation performed by Connecticut firms. This portion is a direct stimulus to the state economy.

Table 3.5: Small Solar – Projects Installed 2002 through 2008 ($ 2008)

Participant Type	Total Project Cost	*% Equipment*	*% Installation*	CT Incentive	Estimated Federal Tax Credit
Total Cost	$21,782,583	*70%*	*30%*	$10,848,989	$873,781
Total Project Cost to CT firms	*$5,619,907*	*0%*	*26%*		

Table 3.6 shows the annual energy and capacity that is saved from the Small Solar program. Projects started to come on-line in 2005 and the amount drastically increased in both 2007 and 2008. By the time all projects are on-line in 2008, there are 2.6million kilowatt hours in energy and 2,489 kilowatts in capacity saved each year. After 2024, the projects start to come off-line as their 20-year useful lives have elapsed.

Table 3.6: Small Solar – Energy (kWh) and Capacity (kW) Avoided Annually, Cumulative

Year	kWh	kW
2002	0	0
2003	0	0
2004	0	0
2005	135,539	129
2006	554,289	528
2007	1,485,495	1,419
2008	2,597,002	2,489
2009	2,573,629	2,489
2010	2,550,466	2,489
2011	2,527,512	2,489
2012	2,504,764	2,489
2013	2,482,222	2,489
2014	2,459,882	2,489
2015	2,437,743	2,489
2016	2,415,803	2,489
2017	2,394,061	2,489
2018	2,372,514	2,489
2019	2,351,161	2,489
2020	2,330,001	2,489
2021	2,309,031	2,489
2022	2,288,250	2,489
2023	2,267,656	2,489
2024	2,247,247	2,489
2025	2,113,902	2,360
2026	1,744,374	1,961
2027	947,337	1,070

The energy and capacity savings shown translate into gross savings after applying the "avoided cost" prices above (Table 3.3). In Table 3.7, the (gross) value of energy and capacity displaced amounts to $29 million over the years due to the Small Solar program.

Table 3.7: Small Solar – Annual Energy and Capacity Saved, Cumulative (,000's $2008)

Year	Total
2002	$0
2003	$0
2004	$0
2005	$17
2006	$68
2007	$245
2008	$457
2009	$798
2010	$930
2011	$1,302
2012	$1,573
2013	$1,673
2014	$1,668
2015	$1,661
2016	$1,659
2017	$1,661
2018	$1,653
2019	$1,644
2020	$1,645
2021	$1,640
2022	$1,641
2023	$1,638
2024	$1,636
2025	$1,549
2026	$1,287
2027	$702

After subtracting amortized[12] costs for projects, the net energy savings by 2027 is just over $1.9 million for the program (shown below in Table 3.8). The cumulative annual net savings become positive by 2013 when projects are mostly paid for and the value of energy savings surpasses any remaining project cost. It is the net energy-related savings available to households which is a stimulus to the state's economy and is used to create additional *spin-off* economic impacts.

Table 3.8: Small Solar – Annual Net energy & capacity-related Savings (,000's $2008)

Year	Total Annual Saving
2002	$0
2003	$0
2004	$0
2005	-$170
2006	-$745
2007	-$1,987
2008	-$3,373
2009	-$3,032
2010	-$2,900
2011	-$2,528
2012	-$2,070
2013	-$1,344
2014	$70
2015	$1,661
2016	$1,659
2017	$1,661
2018	$1,653
2019	$1,644
2020	$1,645
2021	$1,640
2022	$1,641
2023	$1,638
2024	$1,636
2025	$1,549
2026	$1,287
2027	$702
Total 2002-	***$1,937***

[12] Project costs are assumed to be amortized over 7 years. The interest rate for residential project amortization was based upon prevailing home equity line of credit rates for the completion year, and for commercial installations Prime Rate plus one was the basis.

2027	

Table 3.9 shows emission reductions and the associated value of the tons averted.

Table 3.9 – Emission Reductions from Small Solar Installations ($ and tons)

	Value			Tons		
	SO2	NOx	CO2	SO2	NOx	CO2
2002	$0	$0	$0	0	0	0
2003	$0	$0	$0	0	0	0
2004	$0	$0	$0	0	0	0
2005	$109	$157	$88	0	0	80
2006	$562	$402	$696	1	0	330
2007	$744	$839	$2,724	2	0	886
2008	$1,119	$1,350	$4,662	3	1	1,554
2009	$2,051	$1,072	$9,107	3	1	1,554
2010	$2,174	$794	$10,386	3	1	1,554
2011	$2,320	$847	$11,602	3	1	1,554
2012	$2,467	$901	$11,342	3	1	1,554
2013	$2,614	$955	$12,472	3	1	1,554
2014	$2,760	$1,008	$13,547	3	1	1,554
2015	$2,906	$1,062	$17,215	3	1	1,554
2016	$3,094	$1,130	$19,417	3	1	1,554
2017	$3,278	$1,198	$20,245	3	1	1,554
2018	$3,463	$1,265	$22,264	3	1	1,554
2019	$3,598	$929	$24,182	3	1	1,554
2020	$3,730	$593	$26,002	3	1	1,554
2021	$3,865	$593	$25,417	3	1	1,554
2022	$3,999	$593	$25,975	3	1	1,554
2023	$4,133	$593	$25,391	3	1	1,554

2024	$4,265	$593	$25,899	3	1	1,554
2025	$4,054	$562	$24,006	3	1	1,473
2026	$3,369	$467	$20,306	2	1	1,224
2027	$1,839	$254	$10,833	1	0	668
Total Emissions Benefit	***$62,512***	***$18,160***	***$363,777***	***59***	***16***	***31,077***

3.3 OSDG Program Implications

OSDG projects represent only 9% of all CCEF projects in this study. However, due to their large size and energy capacity, they represent a larger investment. These projects cost over $34.7 million compared to $21.7 million for Small Solar projects. A large portion of this cost is from the 6 projects that use fuel cells which cost over $12 million. A larger portion of the OSDG projects are covered by incentives from CCEF, 62% as compared to 50% for Small Solar. This is due in part to participating state and local institutions that were given full incentives covering all costs. Including the federal tax credits (which do not apply to institutions) in excess of $2.6 million, participants in the OSDG program are compensated 71% of total project costs.

The OSDG program uses both fuel cell and photovoltaic technology, the former is made in Connecticut while the latter comes from outside the state. Therefore, only the equipment purchases of fuel cells have an effect on the local economy. Table 3.10 presents the investment in fuel cell and photovoltaic systems. Fuel cell equipment costs represent 21% of total project costs or $8 million. Fuel cells also use all in-state installers while photovoltaic panels may be installed by workers from within or outside Connecticut. In-state installation represents 21% of total project costs or $7.1 million. Equipment and installation of OSDG projects create $15.1 million in direct economic activity in the state.

Table 3.10: OSDG Investment – Projects Installed 2002 through 2008

Participant Type	Total Project Cost	% *Equipment*	% *Installation*	CT Incentive	Estimated Federal Tax Credit
Government	$12,307,737	67%	33%	$9,149,697	$0
Commercial	$22,410,101	69%	31%	$12,308,794	$2,658,458
Total	**$34,717,839**	**68%**	**32%**	**$21,458,492**	**$2,658,458**
Total Project Cost to CT firms	*$15,081,515*	*23%*	*21%*		

Table 3.11 shows the annual energy and capacity that is saved from the OSDG installations. The first project comes on-line in 2002, several years before the first Small Solar projects. At the peak of realized energy and capacity benefits (from 2008 to 2011), there are 13 million kilowatt hours generated and 4,110 kilowatts of capacity provided annually. After 2011, the energy savings starts to dwindle quickly as the fuel cell projects start to surpass their 10 year useful life. From 2015 onward, the energy savings is completely generated by photovoltaic projects until they surpass their 20 year useful life.

Table 3.11: OSDG - Energy (kWh) and Capacity (kW) Avoided Annually (Cumulative)

Year	kWh			kW		
	Gov't	Commercial	**Total**	Gov't	Commercial	**Total**
2002	1,576,800	0	1,576,800	200	0	200
2003	3,153,600	3,550,954	6,704,554	400	453	853
2004	3,177,883	3,558,809	6,736,692	423	461	884
2005	4,754,464	5,557,819	10,312,283	623	737	1,360
2006	4,754,248	5,844,315	10,598,563	623	1,010	1,633
2007	4,854,444	7,464,002	12,318,446	719	2,554	3,272
2008	5,245,740	7,934,273	13,180,013	1,092	3,018	4,110
2009	5,241,102	7,912,534	13,153,636	1,092	3,018	4,110
2010	5,236,506	7,890,990	13,127,496	1,092	3,018	4,110
2011	5,231,951	7,869,641	13,101,591	1,092	3,018	4,110
2012	3,650,637	7,848,483	11,499,120	892	3,018	3,910
2013	2,069,364	4,279,716	6,349,079	692	2,568	3,260
2014	2,064,930	4,258,937	6,323,868	692	2,568	3,260
2015	483,737	2,267,346	2,751,083	492	2,318	2,810
2016	479,384	2,246,940	2,726,324	492	2,318	2,810
2017	475,069	2,226,717	2,701,787	492	2,318	2,810
2018	470,794	2,206,677	2,677,471	492	2,318	2,810
2019	466,556	2,186,817	2,653,373	492	2,318	2,810
2020	462,357	2,167,136	2,629,493	492	2,318	2,810
2021	458,196	2,147,631	2,605,828	492	2,318	2,810
2022	454,072	2,128,303	2,582,375	492	2,318	2,810
2023	449,986	2,106,516	2,556,502	492	2,315	2,807
2024	425,670	2,080,977	2,506,647	469	2,307	2,776
2025	421,839	2,038,789	2,460,628	469	2,280	2,749
2026	418,042	1,781,040	2,199,082	469	2,008	2,476
2027	330,478	410,792	741,270	373	464	837

There is over $48 million in gross energy savings through 2027. Table 3.12 indicates that Government worksites and *Wholesale trade* are the largest benefactors of the program with $12.8 million and $13.8 million in gross savings, respectively.

Table 3.12: OSDG – Annual Gross Savings on Energy and Capacity (,000's $2008), Cumulative

Year	Gov't	Agri.	Food Manu.	Bev. Manu.	Fab. Metal	Trans. Equip.	Wholesale	Retail	Real Estate	Rental, Leasing	Prof. and Tech.	Waste Mgmt.	Educ.	Health	Arts and Rec.	Pers. Svcs.	**Total**
2002	82																**8**
2003	164	0	0	0	0	0	0	0	0	0	0	0	0	82	102	0	**34**
2004	176	0	0	0	0	0	0	0	0	0	0	1	0	87	109	0	**37**
2005	275	0	113	0	2	0	0	0	0	0	0	1	0	91	115	0	**59**
2006	276	0	114	0	2	0	27	0	0	0	2	1	2	91	119	0	**63**
2007	469	0	187	34	3	0	210	3	1	0	39	1	23	149	197	0	**1,31**
2008	651	3	233	36	6	58	223	3	2	5	41	1	29	191	251	1	**1,73**
2009	1,000	5	350	63	11	100	390	5	3	9	72	2	51	287	381	1	**2,73**
2010	1,254	6	445	73	13	117	455	6	3	11	84	3	60	364	481	1	**3,37**
2011	1,532	8	530	102	18	163	635	8	5	15	118	4	83	435	581	2	**4,23**
2012	1,220	10	567	123	21	197	766	10	6	18	142	5	100	467	628	2	**4,28**
2013	788	11	568	131	23	209	814	11	6	19	151	5	107	15	65	3	**2,92**
2014	788	11	569	131	23	209	812	11	6	19	151	5	106	14	65	2	**2,92**
2015	331	11	0	130	23	208	808	11	6	19	150	5	106	14	65	2	**1,88**
2016	331	11	0	130	23	207	808	11	6	19	150	5	106	14	65	2	**1,88**
2017	331	11	0	130	23	208	809	11	6	19	150	5	106	14	65	2	**1,88**
2018	330	10	0	129	22	207	805	11	6	19	149	5	105	14	65	2	**1,87**
2019	328	10	0	129	22	205	800	10	6	18	148	5	105	14	64	2	**1,86**
2020	328	10	0	129	22	206	801	10	6	19	148	5	105	14	64	2	**1,87**
2021	327	10	0	128	22	205	798	10	6	18	148	5	105	14	64	2	**1,86**
2022	327	10	0	128	22	205	799	10	6	18	148	5	105	14	64	2	**1,86**
2023	327	10	0	128	22	205	797	10	6	18	148	5	104	14	62	2	**1,86**
2024	311	10	0	128	22	204	796	10	6	18	148	0	104	14	62	2	**1,83**
2025	310	10	0	128	11	204	795	10	6	18	147	0	104	14	56	2	**1,81**
2026	310	10	0	128	11	204	657	10	6	18	136	0	93	14	35	2	**1,63**
2027	247	10	0	0	11	203	0	0	1	18	1	0	18	14	27	2	**55**
Total 2002-2027	**12,813**	**189**	**3,675**	**2,238**	**378**	**3,724**	**13,805**	**182**	**102**	**335**	**2,572**	**74**	**1,828**	**2,458**	**3,854**	**45**	**48,27**

After accounting for amortized[13] project costs, the OSDG program generates nearly $3.8 million in net energy savings (Table 3.13). This amount represents a decrease in the cost of doing business for these participants. When these savings are *positive* they can generate economic activity in the Connecticut through more production for industries (as a result of greater cost competitiveness) and for government worksites/institutions enable either increased spending or tax reductions.

[13] Project costs are assumed to be amortized over 7 years. The interest rate was based upon *Prime rate plus 1* for the completion year. This is typical of the rate associated with a business loan.

Table 3.13: OSDG – Annual *Net* Savings on Energy and Capacity (,000's $2008)

Year	Gov't	Agri.	Food Manu.	Bev. Manu.	Fab. Metal	Trans. Equip.	Wholesale	Retail	Real Estate	Rental, Leasing	Prof. and Tech.	Waste Mgmt.	Educ.	Health	Arts and Rec.	Pers. Svcs.	**Total**
2002	-289																**-289**
2003	-548	0	0	0	0	0	0	0	0	0	0	0	0	-279	-283	0	**-1,110**
2004	-596	0	0	0	0	0	0	0	0	0	0	-11	0	-274	-277	0	**-1,158**
2005	-806	0	-241	0	-25	0	0	0	0	0	0	-11	0	-270	-288	0	**-1,641**
2006	-805	0	-241	0	-25	0	-278	0	0	0	-24	-11	-25	-270	-342	0	**-2,021**
2007	-795	0	-168	-241	-24	0	-1,566	-18	-12	0	-325	-11	-161	-211	-286	0	**-3,818**
2008	-1,162	-19	-121	-239	-46	-368	-1,553	-18	-15	-40	-325	-11	-200	-205	-298	-5	**-4,624**
2009	-441	-17	-5	-212	-42	-325	-1,387	-16	-13	-36	-294	-10	-178	-108	-168	-4	**-3,256**
2010	152	-16	90	-202	-40	-309	-1,322	-15	-13	-35	-282	-9	-169	329	318	-4	**-1,525**
2011	492	-13	175	-173	-35	-262	-1,142	-13	-12	-31	-249	4	-146	401	418	-3	**-588**
2012	489	-12	567	-152	-4	-229	-1,010	-11	-11	-28	-224	5	-129	432	483	-3	**163**
2013	56	-11	568	-144	-3	-217	-657	-11	-10	-26	-189	5	-95	-20	-22	-3	**-778**
2014	238	-11	569	131	-3	-217	812	11	3	-27	148	5	61	-20	-1	-3	**1,696**
2015	331	11	0	130	23	208	808	11	6	19	150	5	106	14	65	2	**1,888**
2016	331	11	0	130	23	207	808	11	6	19	150	5	106	14	65	2	**1,886**
2017	331	11	0	130	23	208	809	11	6	19	150	5	106	14	65	2	**1,889**
2018	330	10	0	129	22	207	805	11	6	19	149	5	105	14	65	2	**1,879**
2019	328	10	0	129	22	205	800	10	6	18	148	5	105	14	64	2	**1,869**
2020	328	10	0	129	22	206	801	10	6	19	148	5	105	14	64	2	**1,870**
2021	327	10	0	128	22	205	798	10	6	18	148	5	105	14	64	2	**1,864**
2022	327	10	0	128	22	205	799	10	6	18	148	5	105	14	64	2	**1,865**
2023	327	10	0	128	22	205	797	10	6	18	148	5	104	14	62	2	**1,860**
2024	311	10	0	128	22	204	796	10	6	18	148	0	104	14	62	2	**1,838**
2025	310	10	0	128	11	204	795	10	6	18	147	0	104	14	56	2	**1,817**
2026	310	10	0	128	11	204	657	10	6	18	136	0	93	14	35	2	**1,635**
2027	247	10	0	0	11	203	0	0	1	18	1	0	18	14	27	2	**553**
Total 2002-2027	***122***	***37***	***1,193***	***314***	***10***	***744***	***1,370***	***34***	***-11***	***18***	***9***	***-10***	***226***	***-310***	***12***	***7***	***3,763***

Tables 3.14 and 3.15 show the distribution of energy and capacity saved by industry (excluding government). In the first few years, the savings accrue to *Food manufacturing, Arts and recreation,* and *Healthcare services* establishments —all single, fuel cell projects. After these fuel cells pass their useful lives, other types of business establishments (installing solely photovoltaic systems) participate. The *Wholesale trade* industry has five participants in the program that all have sizeable projects which total $5 million in project cost. This industry gets the majority of the energy savings from 2015 to 2026.

Table 3.14: OSDG Commercial Participants - Energy (kWh) Avoided Annually- % by Industry

Year	Agri.	Food Manu.	Bev. Manu.	Fab. Metal	Trans. Equip.	Wholesale	Retail	Real Estate	Rental, Leasing	Prof. and Tech.	Waste Mgmt.	Educ.	Health	Arts and Rec.	Pers. Svcs.
2002															
2003	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44%	56%	0%
2004	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44%	55%	0%
2005	0%	35%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	28%	36%	0%
2006	0%	34%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%	27%	35%	0%
2007	0%	26%	3%	0%	0%	17%	0%	0%	0%	3%	0%	2%	21%	27%	0%
2008	0%	25%	3%	0%	4%	16%	0%	0%	0%	3%	0%	2%	20%	26%	0%
2009	0%	25%	3%	0%	4%	16%	0%	0%	0%	3%	0%	2%	20%	26%	0%
2010	0%	25%	3%	0%	4%	16%	0%	0%	0%	3%	0%	2%	20%	26%	0%
2011	0%	25%	2%	0%	4%	15%	0%	0%	0%	3%	0%	2%	20%	26%	0%
2012	0%	25%	2%	0%	4%	15%	0%	0%	0%	3%	0%	2%	20%	26%	0%
2013	0%	46%	5%	1%	7%	28%	0%	0%	1%	5%	0%	4%	1%	2%	0%
2014	0%	46%	4%	1%	7%	28%	0%	0%	1%	5%	0%	4%	0%	2%	0%
2015	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2016	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2017	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2018	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2019	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2020	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2021	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2022	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2023	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2024	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2025	1%	0%	8%	1%	14%	53%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2026	1%	0%	10%	1%	15%	50%	1%	0%	1%	10%	0%	7%	1%	3%	0%
2027	3%	0%	0%	4%	66%	0%	0%	0%	6%	0%	0%	6%	5%	9%	1%

Table 3.15: OSDG Commercial Participants - Capacity (KW) Avoided Annually- % by Industry

Year	Agri.	Food Manu.	Bev. Manu.	Fab. Metal	Trans. Equip.	Wholesale	Retail	Real Estate	Rental, Leasing	Prof. and Tech.	Waste Mgmt.	Educ.	Health.	Arts and Rec.	Pers. Svcs.
2002															
2003	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	44%	56%	0%
2004	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	43%	55%	0%
2005	0%	34%	0%	2%	0%	0%	0%	0%	0%	0%	1%	0%	27%	36%	0%
2006	0%	25%	0%	2%	0%	21%	0%	0%	0%	2%	1%	2%	20%	29%	0%
2007	0%	10%	8%	1%	0%	47%	1%	0%	0%	9%	0%	5%	8%	12%	0%
2008	1%	8%	6%	1%	10%	40%	1%	0%	1%	7%	0%	5%	7%	11%	0%
2009	1%	8%	6%	1%	10%	40%	1%	0%	1%	7%	0%	5%	7%	11%	0%
2010	1%	8%	6%	1%	10%	40%	1%	0%	1%	7%	0%	5%	7%	11%	0%
2011	1%	8%	6%	1%	10%	40%	1%	0%	1%	7%	0%	5%	7%	11%	0%
2012	1%	8%	6%	1%	10%	40%	1%	0%	1%	7%	0%	5%	7%	11%	0%
2013	1%	10%	8%	1%	12%	47%	1%	0%	1%	9%	0%	6%	1%	4%	0%
2014	1%	10%	8%	1%	12%	47%	1%	0%	1%	9%	0%	6%	1%	4%	0%
2015	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2016	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2017	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2018	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2019	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2020	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2021	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2022	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2023	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2024	1%	0%	8%	1%	13%	52%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2025	1%	0%	8%	1%	14%	53%	1%	0%	1%	10%	0%	7%	1%	4%	0%
2026	1%	0%	10%	1%	15%	50%	1%	0%	1%	10%	0%	7%	1%	3%	0%
2027	3%	0%	0%	4%	66%	0%	0%	0%	6%	0%	0%	6%	5%	9%	1%

Table 3.16 shows the emission reductions and the associated value of the tons averted.

Table 3.16 – Emission Reductions from OSDG Installations ($ and tons)

	Value			Tons		
	SO2	NOx	CO2	SO2	NOx	CO2
2002	$291	$452	$0	2	0	(47)
2003	$1,296	$13,142	$0	7	2	(197)
2004	$1,922	$3,680	-$200	7	2	(178)
2005	$7,553	$9,537	-$290	10	3	(267)
2006	$9,420	$6,151	-$196	10	3	(93)
2007	$5,494	$5,772	$2,919	12	3	949
2008	$5,086	$5,760	$4,445	13	3	1,482
2009	$9,321	$4,573	$8,684	13	3	1,482
2010	$9,879	$3,385	$9,903	13	3	1,482
2011	$10,544	$3,614	$11,064	13	3	1,482
2012	$9,923	$3,411	$10,815	12	3	1,482
2013	$6,083	$2,128	$11,893	7	2	1,482
2014	$3,184	$2,247	$14,656	3	2	1,681
2015	$3,353	$1,222	$19,794	3	1	1,787
2016	$3,569	$1,300	$22,326	3	1	1,787
2017	$3,782	$1,378	$23,279	3	1	1,787
2018	$3,994	$1,456	$25,600	3	1	1,787
2019	$4,150	$1,069	$27,805	3	1	1,787
2020	$4,303	$683	$29,898	3	1	1,787
2021	$4,458	$682	$29,226	3	1	1,787
2022	$4,613	$682	$29,867	3	1	1,787
2023	$4,762	$682	$29,165	3	1	1,785
2024	$4,861	$674	$29,424	3	1	1,765
2025	$4,814	$668	$28,486	3	1	1,748
2026	$4,338	$602	$26,126	3	1	1,575
2027	$1,468	$203	$8,635	1	0	532
Total Emissions Benefit	***$132,462***	***$75,153***	***$403,325***	***164***	***43***	***32,438***

4 TOTAL ECONOMIC IMPACTS

The direct impacts related to project costs (equipment and installation), net energy savings, and the CCEF program spending that were reported in Chapter 3 subsequently lead to additional impacts on the Connecticut economy. So too do the foregone purchases of imported fuel inputs for electricity generation allow for local economic impacts when money is channeled into *local* spending for additional utility-driven energy conservation and load management programs. In-state spending on project costs creates additional economic activity for businesses related to the production and servicing of the equipment. The net energy savings for businesses and consumers represents further stimulus to the state economy as more dollars can be spent elsewhere which were not previously available.

Additionally, these direct impacts generate multiplier (i.e. spin-off) impacts in the economy as the initial dollars flow throughout the state. When the direct impact is spent with Connecticut businesses they too require supplies and labors' contribution. *Indirect impacts* represent the new business generated by suppliers of the directly affected industries. *Induced impacts* represent the new business generated by workers in the affected industries spending their wages in the local economy. The direct, indirect and induced impacts, when summed, represent the *total economic impacts*. These impacts can be measured in terms of changes in job years (since some jobs will be carried over from year to year), income, value added (gross state product) and/or business sales in the state.

We present the economic impacts that result from investment spending (on equipment and installation), and the net energy savings by program. Since we were provided the annual CCEF budget data for the combined programs, we will present the associated impact generated in a separate section (Section 4.3). Finally, the gross energy savings, spin-off effects and emissions effects of the Small Solar and OSDG programs are analyzed using a benefit-cost method.

4.1 Economic Impacts - Small Solar Program

The Small Solar program generates impacts for CT when local contractors are hired for project installations and when savings on energy expenditures get reallocated to other forms of household spending. Table 4.1 shows the economic impacts from installation of the equipment for this program. This occurs when the projects come on-line (2005 to 2008). The direct impact of this activity is $5.6 million of in-state spending (see Table 3.5). The total economic impact is $8.9 million in total sales of which $5.1 million is value-added (GSP). Also, an estimated 75 job years are created which provide $3.3 million in real disposable personal income.

Table 4.1: Small Solar – Economic Impact from Installation (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	0	$0	$0	$0
2003	0	$0	$0	$0
2004	0	$0	$0	$0
2005	4	$166	$239	$478
2006	12	$552	$791	$1,472
2007	27	$1,159	$1,932	$3,239
2008	31	$1,417	$2,153	$3,754
Total 2002-2008	***75***	***$3,294***	***$5,115***	***$8,944***

The net energy savings from Small Solar installations create spin-off activity by households spending their savings elsewhere in the economy. Table 4.2 shows the total economic impacts of this activity. Over the interval, the sum of *net energy savings* is a little nearly $2 million (see Table 3.8). This amount is available for consumers to reallocate which over the interval supports $5.1 million of business sales, a cumulative $3 million in GSP (*value-added*) from those sales. The Job impacts are negative however when summed over the interval. As exhibit 4.2 shows once the net savings turn positive (in 2014) positive annual job impacts occur along with positive income changes. Though the 2014 through 2028 interval experiences $20 million of *net savings* for consumers to reallocate, creating jobs and income, the initial interval with $18milion in *dis-savings* (installed projects are being paid down) is an interval of lower labor productivity (higher labor utilization). So a dollar of foregone consumer spending in 2010 will displace more labor than a dollar added to household spending in 2016 will require labor.

Table 4.2: Small Solar – Economic Impact from Net Energy Savings (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	0	$0	$0	$0
2003	0	$0	$0	$0
2004	0	$0	$0	$0
2005	-1	-$18	-$110	-$184
2006	-6	-$147	-$515	-$699
2007	-14	-$405	-$1,232	-$1,987
2008	-23	-$644	-$2,135	-$3,386
2009	-21	-$662	-$1,914	-$2,981
2010	-20	-$626	-$1,896	-$2,870
2011	-16	-$515	-$1,564	-$2,393
2012	-13	-$534	-$1,288	-$1,876
2013	-8	-$386	-$773	-$1,141
2014	1	-$37	$184	$368
2015	11	$313	$1,252	$2,061
2016	11	$331	$1,252	$2,061
2017	11	$423	$1,214	$2,024
2018	10	$534	$1,141	$1,876
2019	10	$331	$1,252	$1,803
2020	10	$460	$1,214	$1,729
2021	10	$423	$1,030	$1,767
2022	9	$442	$1,104	$1,693
2023	9	$368	$1,104	$1,693
2024	9	$442	$1,141	$1,693
2025	8	$423	$1,104	$1,620
2026	7	$386	$920	$1,472
2027	4	$239	$589	$736
Total 2002-2027	***-2***	***$1,141***	***$3,074***	***$5,079***

The savings on foregone purchases of imported fuel inputs into generation allows utilities to redirect those dollars into running additional energy conservation and load management programs. Those programs direct dollars to local sectors providing computer & electronic mfg products, construction, professional services and for utility administration. The savings is based on the amount of spending on fossil fuels tied to the avoided power generation, and is approximately $2.9 million over the 25 year span. The total impacts are shown below in Table 4.3. A total impact of slightly over $6.2 million in business sales results for CT when a

reduced demand for imported fuel purchases allows utilities to do other things with their money.

Table 4.3: Small Solar – Economic Impact from Import Substitution (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	0	$0	$0	$0
2003	0	$0	$0	$0
2004	0	$0	$0	$0
2005	0	$1	$2	$4
2006	0	$3	$8	$14
2007	0	$8	$21	$39
2008	0	$10	$27	$51
2009	1	$25	$68	$128
2010	1	$26	$68	$128
2011	1	$47	$128	$240
2012	1	$66	$181	$339
2013	2	$75	$205	$383
2014	1	$76	$203	$380
2015	1	$76	$202	$376
2016	1	$76	$200	$373
2017	1	$76	$199	$371
2018	1	$75	$199	$369
2019	1	$75	$198	$368
2020	1	$75	$199	$368
2021	1	$75	$199	$369
2022	1	$75	$200	$370
2023	1	$75	$201	$372
2024	1	$76	$202	$374
2025	1	$73	$193	$355
2026	1	$62	$161	$295
2027	0	$38	$89	$159
Total 2002-2027	***22***	***$1,263***	***$3,354***	***$6,225***

When combined, the total economic impacts of installation and net energy savings from the Small Solar program generate $20 million in business sales, $11.5 million in GSP, $5.7 million of real disposable income and 95 jobs. In looking at

the impacts by year, there are initially a few years where the positive impacts from demand for installation services outweigh the negative net energy savings (participants incur more of their project costs than they do their energy-related savings). The interval from 2009 to 2013 is characterized by negative impacts - after all projects have been installed (hence no more demand for installers), and program participants are still paying off their investments. However, after 2013, all projects exhibit positive net energy savings.

Table 4.4: Small Solar – Total Economic Impact (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	0	$0	$0	$0
2003	0	$0	$0	$0
2004	0	$0	$0	$0
2005	2	$148	$131	$298
2006	7	$408	$284	$788
2007	14	$762	$720	$1,291
2008	9	$783	$45	$419
2009	-20	-$637	-$1,846	-$2,853
2010	-19	-$600	-$1,827	-$2,742
2011	-15	-$468	-$1,436	-$2,152
2012	-12	-$468	-$1,107	-$1,537
2013	-7	-$311	-$568	-$758
2014	2	$39	$387	$748
2015	12	$389	$1,454	$2,437
2016	12	$407	$1,452	$2,434
2017	12	$499	$1,414	$2,394
2018	12	$609	$1,339	$2,245
2019	11	$406	$1,450	$2,171
2020	11	$535	$1,413	$2,098
2021	11	$498	$1,230	$2,136
2022	11	$517	$1,304	$2,063
2023	10	$444	$1,305	$2,065
2024	10	$517	$1,343	$2,067
2025	9	$496	$1,297	$1,975
2026	8	$448	$1,081	$1,768
2027	5	$277	$678	$895
Total 2002-2027	***95***	***$5,698***	***$11,543***	***$20,248***

4.2 Economic Impacts - OSDG Program

The OSDG program generates impacts through the purchase of equipment (i.e. fuel cells) from manufacturers in Connecticut, hiring local installers, and creating savings on energy spending for businesses and institutions. Table 4.5 shows the economic impacts from equipment and installation for this program. This activity starts in 2002 and ends with projects completed in 2008. The direct impact from these activities is $15 million (see Table 3.10). The total economic impact is $36.7 million in sales of which $18.3 million is value-added (GSP). This also creates 165 job years and $6.5 million in personal income. Not surprisingly, the impacts are much larger than those for the Small Solar program partially because the fuel cells used for OSDG installations are manufactured in-state and represent a significant investment.

Table 4.5: OSDG – Economic Impact from Equipment Purchases & Installation (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	25	$929	$2,908	$5,998
2003	70	$2,797	$8,520	$17,450
2004	1	$37	-$18	-$74
2005	38	$1,564	$4,969	$10,194
2006	2	$55	$74	$74
2007	20	$754	$1,252	$2,172
2008	9	$386	$552	$920
Total 2002-2008	***165***	***$6,523***	***$18,255***	***$36,735***

The net energy savings for OSDG affords businesses an opportunity to lower their cost of doing business in Connecticut and that makes them able to compete (against out-of-state firms) for larger market share. It also may afford governments the ability to either reallocate spending elsewhere or cut taxes. Table 4.6 shows the total economic impacts from the pattern of net savings and assumes that the savings associated with public institutions is used to increase other government program spending.

With $3.7 million in net savings (see Table 3.13) the year by year results indicate that through 2010 the CT economy experiences a drag as projects are being paid off. By 2010 however, Government worksites are the first participants to experience positive net savings. The subsequent positive job impacts after 2010

reflect a stimulus of more government workers amidst added government spending. It is not until 2016 that all metrics show positive impacts. It is important to note too that some aspects of public spending have the potential to *crowd out* private-sector functions. The timing of when public versus private establishment in the economy actually realize positive savings determines the totals shown for the 25 year interval. The cumulative GSP impacts that befall the State & Local Government sector accounts for 51% of the overall GSP effect. This is the only reason that the GSP impact is more pronounced than the Output metric (*Output* is solely a s private-sector metric).

Table 4.6: OSDG– Economic Impact from Net Energy Savings – *Increased Gov't Spending Scenario* (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	-5	-$175	-$313	-$184
2003	-18	-$662	-$1,049	-$920
2004	-19	-$699	-$1,104	-$994
2005	-23	-$920	-$1,435	-$1,325
2006	-25	-$1,178	-$1,711	-$1,729
2007	-33	-$2,116	-$2,705	-$3,533
2008	-44	-$2,447	-$3,864	-$5,116
2009	-30	-$1,858	-$3,349	-$4,969
2010	-10	-$994	-$2,393	-$4,306
2011	-1	-$515	-$1,896	-$3,937
2012	2	-$239	-$1,693	-$3,607
2013	-13	-$810	-$2,687	-$4,416
2014	0	$386	-$1,214	-$2,135
2015	7	$810	-$294	-$662
2016	11	$1,030	$368	$405
2017	14	$1,104	$994	$1,325
2018	17	$1,270	$1,288	$1,914
2019	18	$1,343	$1,729	$2,502
2020	19	$1,399	$1,914	$2,944
2021	19	$1,417	$2,172	$3,386
2022	20	$1,472	$2,393	$3,607
2023	20	$1,399	$2,540	$3,828
2024	19	$1,380	$2,613	$3,975
2025	19	$1,453	$2,797	$4,196
2026	18	$1,252	$2,650	$4,122
2027	14	$846	$2,061	$3,239
Total 2002-	***-4***	***$3,948***	***-$2,190***	***-$2,392***

2027				

Table 4.7 shows the total economic impacts of net energy savings from the OSDG program with a tax decrease. This is assuming that the tax decrease is passed to state residents and, therefore, increases their disposable income that can be spent in the local economy. In the case where *positive* installation-derived net savings exist for public institutions (starting in 2010) and results in a tax reduction, the total economic impacts are somewhat ameliorated compared to supporting more government spending. The year by year results below predominantly show the staggered persistence of negative net savings for non-institutional installations (i.e. CT worksites). By 2010 the job loses lessen as tax reductions become available. Those reductions (and its positive effects) will continue in a tapered pattern as long as the installed OSDG systems at public institutions have useful life. By 2016 jobs, real income, GSP and output all experience positive impacts. The totals shown for the 25 year interval should be understood from the perspective labor utilization is heavier earlier in the economy than later when labor productivity gains are assumed to characterize the CT (and National) economy, and that real income impacts further out in the analysis interval are diminished due to inflation assumptions. Overall public worksite savings funneled into tax reductions have a greater ability to support income increases by (a) simply taking fewer wages away from households in the form of taxes and (b) more household income drives further income creation through consumer spending.

Table 4.7: OSDG– Economic Impact from Net Energy Savings - *Tax Reduction Scenario* (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	-2	-$405	-$184	-$294
2003	-9	-$1,252	-$754	-$1,141
2004	-10	-$1,362	-$883	-$1,325
2005	-13	-$1,675	-$1,030	-$1,656
2006	-16	-$1,969	-$1,417	-$2,135
2007	-24	-$2,852	-$2,466	-$4,011
2008	-32	-$3,478	-$3,643	-$5,778
2009	-27	-$2,373	-$3,386	-$5,521
2010	-18	-$810	-$2,870	-$4,601
2011	-13	$18	-$2,502	-$4,122
2012	-10	$294	-$2,319	-$3,790
2013	-16	-$902	-$3,017	-$4,821
2014	-5	$515	-$1,582	-$2,466
2015	2	$938	-$552	-$883

2016	6	$1,196	$37	$147
2017	10	$1,270	$662	$1,104
2018	12	$1,527	$994	$1,767
2019	14	$1,656	$1,435	$2,429
2020	15	$1,693	$1,656	$2,834
2021	16	$1,729	$1,987	$3,313
2022	16	$1,785	$2,172	$3,533
2023	16	$1,711	$2,355	$3,828
2024	16	$1,675	$2,540	$4,048
2025	16	$1,729	$2,723	$4,269
2026	15	$1,546	$2,576	$4,196
2027	11	$1,104	$2,098	$3,386
Total 2002-2027	***-31***	***$3,311***	***-$5,373***	***-$7,690***

The total impacts from import substitution are shown below in Table 4.3. A total impact of slightly over $7.7 million in business sales results for CT when a reduced demand for imported fuel purchases allows utilities to do other things with their money.

Table 4.8: OSDG – Economic Impact from Import Substitution (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	0	$1	$1	$3
2003	0	$2	$6	$12
2004	0	$4	$11	$20
2005	0	$8	$20	$37
2006	0	$9	$24	$44
2007	0	$18	$47	$89
2008	0	$17	$44	$83
2009	1	$42	$112	$210
2010	1	$42	$112	$210
2011	2	$78	$211	$396
2012	2	$104	$284	$531
2013	2	$99	$267	$499
2014	2	$100	$265	$494
2015	2	$87	$226	$419
2016	2	$86	$224	$415

2017	2	$86	$223	$413
2018	1	$85	$223	$413
2019	1	$85	$223	$413
2020	1	$86	$224	$414
2021	1	$86	$225	$416
2022	1	$86	$227	$419
2023	1	$86	$228	$421
2024	1	$86	$227	$418
2025	1	$86	$227	$417
2026	1	$79	$206	$377
2027	0	$35	$72	$124
Total 2002-2027	***28***	***$1,584***	***$4,158***	***$7,709***

When combined, the total economic impacts of equipment purchases, installation, net energy savings, and import substitution from the OSDG program (using the tax reduction scenario) generate $36.8 million in business sales, $17 million in GSP, $11.4 million in income and 161 job years. There are tremendous impacts in the first several years as large projects (mainly fuel cells) are being installed. However, from 2006 to 2013 the stimulus to put additional projects in place does not outweigh the costs on program participants. After 2013, the benefits gradually increase as users largely complete the pay off of their investments and reap their energy-related savings.

Table 4.9: OSDG – Total Economic Impact - *Tax Reduction Scenario* (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	22	$525	$2,725	$5,707
2003	61	$1,547	$7,772	$16,321
2004	-9	-$1,321	-$891	-$1,379
2005	25	-$103	$3,958	$8,575
2006	-13	-$1,905	-$1,320	-$2,017
2007	-4	-$2,080	-$1,167	-$1,750
2008	-22	-$3,074	-$3,047	-$4,775
2009	-26	-$2,332	-$3,274	-$5,311
2010	-17	-$767	-$2,758	-$4,391
2011	-11	$96	-$2,291	-$3,726
2012	-8	$398	-$2,036	-$3,259

2013	-14	-$802	-$2,750	-$4,323
2014	-3	$615	-$1,317	-$1,972
2015	4	$1,025	-$327	-$464
2016	7	$1,283	$261	$563
2017	11	$1,356	$885	$1,517
2018	13	$1,612	$1,216	$2,179
2019	15	$1,741	$1,658	$2,842
2020	16	$1,779	$1,880	$3,249
2021	17	$1,815	$2,213	$3,729
2022	17	$1,871	$2,399	$3,952
2023	17	$1,798	$2,583	$4,248
2024	17	$1,761	$2,767	$4,467
2025	17	$1,815	$2,950	$4,686
2026	16	$1,625	$2,782	$4,573
2027	12	$1,139	$2,170	$3,511
Total 2002-2027	***161***	***$11,418***	***$17,040***	***$36,753***

The impacts by industry are shown below in Table 4.10. The first column shows the direct net energy savings incurred by each industry (see Table 3.13). The second column represents the allocated direct spending for equipment (computer and electronics) and installation (construction contractors). Finally, both these direct impacts generate additional indirect and induced impacts in the state economy creating a total impact. The largest economic impact occurs in the *Computer & Electronic Equip. manufacturing* industry $20.6 million in output. This mainly results from the direct spending for locally manufactured fuel cells but is also in part due to indirect spending effects by other (program participating) Connecticut industries which have leveraged their net energy savings into enhanced increased market share at differing rates.

Table 4.10: Direct and Total Output Impacts on Industries - Tax Reduction Scenario, (,000's $2008)

Industry	Direct Net Energy Savings	Direct In-State Purchases	Direct Import Substitution	Total Impact
Construction	$0	$7,119	$1,259	$6,822
Computer and Elec. MFG.	$0	$7,963	$1,259	$20,606
Agriculture	$37	$0	$0	$133
F. Metal MFG.	$10	$0	$0	$162
Food MFG.	$1,193	$0	$0	$801
Bev. MFG.	$314	$0	$0	$23
Trans. Eq. MFG	$744	$0	$0	($661)
Wholesale	$1,370	$0	$0	$364
Retail	$34	$0	$0	$1,658
Real Estate	-$11	$0	$0	$1,474
Rental and Leasing	$18	$0	$0	$366
Prof. and Tech. Svcs.	$9	$0	$630	$1,737
Educ.	$226	$0	$0	($121)
Health Srvcs.	-$310	$0	$0	($134)
Arts & Rec.	$12	$0	$0	($20)
Gov't	$122	$0	$0	$0
Other	$$0	$0	$419	$3,543
Total Output	***$3,765***	***$15,082***	***$3,566***	***$36,753***

Clearly there are industries which neither participated in the OSDG program nor received project investment as new orders, yet they experience a non-direct economic impact. This is because they are linked to industries which are participating (i.e. reaping net energy savings) or they supply a contractor or a manufacturer. Non-manufacturing industries that have a net energy savings larger than its reported total (output) impact reflect a low elasticity response to a change in cost factors to the annual services they provide.

4.3 Economic Impacts - CCEF Program Spending

The Connecticut Clean Energy Fund provides incentives for the Small Solar and OSDG projects but also requires funds for administration and maintenance of its programs. In recent years, the budget for CCEF has averaged to nearly $1 million annually (not including project incentives)[14]. This funding is used for employee compensation, inspectors and consultants along with typical business costs such as electricity and telecommunications.

The expenses needed to support the CCEF generate some added economic activity. For 2002 through 2008, the estimated impact on Connecticut from the program spending is over $5 million in output, $6.6 million in GSP[15], $3.4 million in income and 35 job years.

Table 4.11: Economic Impact from CCEF Program Spending (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	1	$101	$276	$221
2003	5	$396	$846	$626
2004	0	$37	$37	$0
2005	7	$626	$1,252	$994
2006	6	$681	$1,214	$883
2007	9	$865	$1,656	$1,288
2008	8	$699	$1,306	$1,141
Total 2002-2008	***35***	***$3,404***	***$6,587***	***$5,152***

[14] The annual budget was only available for 2005 through 2008. Therefore, the budget for 2002 through 2004 was estimated based on the $ per kW of added capacity from 2005 through 2008. The estimated cumulative amount of annual program spending was $4.6 million (nominal).

[15] Normally, the GSP impact is lower than the output impact. However, since a sizeable portion of the annual program spending is government workers' compensation (which is a value-added component) less output impacts are created once tax dollars and fringe benefits are excluded.

4.4 Combined Economic Impacts attributed to CCEF

The previous three sections have shown estimates of the economic impacts of Small Solar and OSDG programs as well as the budgetary spending by the CCEF. When combined (in Table 4.12 and assuming a tax reduction response), these economic impacts amount to nearly $62 million in output, $35million in GSP, $20.5 million in income and 292job years. From 2009 onward the impacts are generated by the persistence of net energy savings for households, businesses, and institutions.

Table 4.12: Economic Impact from Small Solar, OSDG and Program Spending (,000's $2008)

Year	Job Years	Income	GSP	Output
2002	23	$626	$3,001	$5,928
2003	66	$1,943	$8,618	$16,947
2004	-9	-$1,284	-$854	-$1,379
2005	35	$671	$5,341	$9,867
2006	-1	-$816	$178	-$346
2007	18	-$452	$1,209	$829
2008	-6	-$1,592	-$1,696	-$3,215
2009	-46	-$2,969	-$5,120	-$8,164
2010	-36	-$1,367	-$4,585	-$7,133
2011	-26	-$372	-$3,727	-$5,879
2012	-19	-$69	-$3,143	-$4,796
2013	-20	-$1,114	-$3,318	-$5,080
2014	-1	$654	-$930	-$1,224
2015	16	$1,414	$1,127	$1,973
2016	20	$1,689	$1,713	$2,997
2017	23	$1,855	$2,299	$3,912
2018	25	$2,221	$2,556	$4,425
2019	26	$2,148	$3,108	$5,013
2020	27	$2,314	$3,293	$5,346
2021	28	$2,314	$3,443	$5,865
2022	28	$2,388	$3,703	$6,015
2023	27	$2,241	$3,889	$6,313
2024	27	$2,278	$4,110	$6,534

2025	27	$2,311	$4,247	$6,661
2026	24	$2,073	$3,863	$6,340
2027	17	$1,416	$2,848	$4,405
Total 2002-2027	***292***	***$20,521***	***$35,171***	***$62,154***

4.5 Benefit Cost Test of the CCEF Program

A benefit-cost test is included to evaluate the efficiency of the Small Solar and OSDG programs since 2002. The test considers the stream of benefits and costs that occur over an interval depicting the useful life of an installation. This type of analysis quantifies the long-term effects of the programs by increasingly discounting the benefits and costs with each year. The further out in the analysis interval a benefit occurs more will be forfeited in terms of potential return on initial capital. Likewise, project costs postponed further out, the more potential returns have been generated by delaying costs.

The total benefits generated from the Small Solar and OSDG programs are valued at over $104.7 million (before discounting). The benefits are comprised of the following:

Gross energy savings – the dollar value of avoided energy supply costs.
Spin-off economic activity – the multiplier impacts generated from net energy savings, import substitution and in-state manufacturing and installation of projects.
Emissions – the dollar value of SO2, NOx, and CO2 emissions saved.
Federal Income Tax Credit & Depreciation Deduction– credit and tax deduction received by households (credit only) and businesses for investing in solar technology.

A more "traditional" benefit-cost analysis would only include the gross energy savings as a benefit. However, part of the justification of the CCEF programs is to (a) consume/generate electricity with smaller air quality impacts, (b) augment existing generating and transmission infrastructure, (c) reduce electric consumers' price risks, and (d) cultivate new opportunities for the renewable technology manufacturing and related services in Connecticut-- which is still in its infancy. Therefore, the benefit-cost version in this study also includes the value of averted air pollutant emissions, and economic multiplier impacts, measured as dollars of value-added (V-A) or GSP, from energy savings and from in-state sales on equipment and installation services due to projects.

Table 4.13: Benefits from Small Solar and OSDG programs
(,000's,$2008)

Year	Small Solar Gross Savings	OSDG Gross Savings	Small Solar V-A Impact	OSDG V-A Impact	Small Solar Import Sub.	OSDG Import Sub.	Federal ITC + Depr. Deduction	Emission Benefit	Total Benefits
2002	$0	$82	$0	$1,857	$0	$1	$0	$1	**$1,941**
2003	$0	$348	$0	$5,395	$0	$5	$169	$14	**$5,931**
2004	$0	$373	$0	-$138	$0	$9	$109	$5	**$359**
2005	$17	$598	$87	$3,145	$2	$17	$294	$17	**$4,176**
2006	$68	$635	$333	-$265	$7	$20	$742	$17	**$1,557**
2007	$245	$1,316	$718	$219	$18	$40	$2,778	$18	**$5,352**
2008	$457	$1,734	$811	-$655	$23	$38	$1,744	$22	**$4,174**
2009	$798	$2,730	$70	-$1,328	$57	$95	$830	$35	**$3,288**
2010	$930	$3,375	$57	-$1,857	$57	$95	$743	$37	**$3,437**
2011	$1,302	$4,238	$159	-$2,030	$108	$178	$652	$40	**$4,648**
2012	$1,573	$4,281	$233	-$2,263	$153	$240	$152	$39	**$4,407**
2013	$1,673	$2,924	$249	-$2,385	$173	$227	$0	$36	**$2,898**
2014	$1,668	$2,919	$260	-$2,527	$173	$227	$0	$37	**$2,758**
2015	$1,661	$1,887	$352	-$1,612	$173	$196	$0	$46	**$2,702**
2016	$1,659	$1,885	$351	-$316	$173	$196	$0	$51	**$3,999**
2017	$1,661	$1,887	$323	-$353	$173	$196	$0	$53	**$3,941**
2018	$1,653	$1,878	$241	$54	$173	$196	$0	$58	**$4,253**
2019	$1,644	$1,868	$215	$448	$173	$196	$0	$62	**$4,606**
2020	$1,645	$1,869	$164	$682	$173	$196	$0	$65	**$4,794**
2021	$1,640	$1,863	$179	$989	$173	$196	$0	$64	**$5,105**
2022	$1,641	$1,864	$141	$1,146	$173	$196	$0	$66	**$5,226**
2023	$1,638	$1,859	$143	$1,333	$173	$195	$0	$65	**$5,407**
2024	$1,636	$1,837	$147	$1,509	$173	$193	$0	$66	**$5,561**
2025	$1,549	$1,816	$152	$1,790	$164	$191	$0	$63	**$5,725**
2026	$1,287	$1,634	$203	$1,777	$137	$172	$0	$55	**$5,264**
2027	$702	$552	$74	$1,794	$75	$58	$0	$23	**$3,278**
Total 2002-2027	***$28,748***	***$48,252***	***$5,664***	***$6,409***	***$2,879***	***$3,567***	***$8,213***	***$1,055***	***$104,786***

The costs of the Small Solar and OSDG programs total over $56 million. While the investment related to these projects occur in the first few years, households and businesses likely finance their purchase and spread these over several years.

Table 4.14: Costs from Small Solar and OSDG programs

(,000's $2008)

Year	Total Costs
2002	$2,168
2003	$6,388
2004	$429
2005	$5,090
2006	$5,768
2007	$20,911
2008	$15,762
2009	$0
2010	$0
2011	$0
2012	$0
2013	$0
2014	$0
2015	$0
2016	$0
2017	$0
2018	$0
2019	$0
2020	$0
2021	$0
2022	$0
2023	$0
2024	$0
2025	$0
2026	$0
2027	$0
Total 2002-2027	***$56,516***

The total benefits and costs are shown with discounting (i.e. present value) in Table 4.15. The difference between the present value of benefits and costs is the net present value of $21,751. The ratio of the present value of benefits to costs is 1.44.

Table 4.15: Benefit-Cost Test for Small Solar and OSDG Programs
(,000's $2008, discounted at 3% annually)

Year	Benefits PV	Costs PV
2002	$1,941	$2,168
2003	$5,758	$6,202
2004	$338	$404
2005	$3,822	$4,658
2006	$1,383	$5,124
2007	$4,616	$18,038
2008	$3,496	$13,200
2009	$2,673	$0
2010	$2,713	$0
2011	$3,562	$0
2012	$3,279	$0
2013	$2,093	$0
2014	$1,934	$0
2015	$1,840	$0
2016	$2,644	$0
2017	$2,530	$0
2018	$2,650	$0
2019	$2,787	$0
2020	$2,816	$0
2021	$2,911	$0
2022	$2,894	$0
2023	$2,906	$0
2024	$2,902	$0
2025	$2,901	$0
2026	$2,590	$0
2027	$1,566	$0
Total 2002-2027	***$71,546***	***$49,795***
NPV	**$21,751**	
BC Ratio	**1.44**	

These (economic development) benefits could increase if CCEF sponsored programs help build sustained demand concomitant with (development) efforts in the state to reduce out-of-state leakage of project costs. This involves establishing an in-state manufacturing presence for PV components.

To demonstrate this point, we consider what the effect would be on the benefit :

cost test if 50 percent of the PV equipment costs went to Connecticut manufacturing firms. The implied $15.5 million of PV equipment purchases to potentially recapture represents a 1.5% increase in the size of the state's current manufacturing activity in NAICS 33441. This would represent new business to Connecticut manufacturers and installers, and it would have a subsequent economic multiplier effect. The result would yield a benefit: cost ratio of 1.79. This demonstrates that it is not only valuable to displace fossil-fuel generated electricity with local (on-site) renewably generated energy but that it can have a positive double-barrel effect for job growth. Clearly it rests upon statewide economic development efforts to retain/retool shrinking but compatible manufacturing firms, retrain their workforces, or recruit from outside the missing parts of an industry – for example photovoltaic panel manufacturers.

5 CONCLUSIONS

This study has presented the economic impacts generated for the Connecticut economy from completed installations under CCEF's *Small Solar* and *On-site Distributed Generation (OSDG)* programs. The programs' direct stimuli on the economy begins in 2002 for OSDG, and 2005 for the Small Solar program, while the *net* energy savings persist to 10 or 20 years depending on the technology adopted. Applying a REMI model of the Connecticut economy we have portrayed how (i) annual budget spending by CCEF, (ii) net dollars of energy savings by households and commercial entities (businesses, institutions and government worksites), and (iii) increased demand for PV and fuel cell manufactures, as well as installation services creates jobs, wage income and value-added (GSP).

The energy and capacity saved (*averted*) by locally installed renewable generation provides an emissions improvement valued at $1,055,000 over the analysis interval. This is an environmental benefit. Table 5.1 summarizes key attributes of the programs over relevant time intervals.

Table 5.1: Summary of CCEF Program Direct Effects & GSP Impacts

	Small Solar	***OSDG***
Lifetime Gross Energy Savings	$28,747,658	$48,251,503
Participant Costs (2002 to 2008) before amortization	$21,782,583	$34,717,839
CT Incentives	$10,848,989	$21,458,492
CCEF Goal 1 Budget (2002 to 2008) est.	$4,935,235	
mulitplier impact - net energy savings		
added Gross State Product	$3,074,181	-$5,372,662
added Jobs	-2	-31
added Labor Income	$1,141,227	$3,310,682
multiplier impact from new demand for manufactured components and installation		
added Gross State Product	$5,115,093	$18,255,363
added Jobs	75	165
added Labor Income	$3,293,968	$6,522,934
multiplier impact from import substitution		

added Gross State Product	$3,353,980	$4,157,630
added Jobs	22	28
added Labor Income	$1,262,921	$1,583,977

Note: all dollars are expressed in 2008 constant. They are cumulative and shown without discounting.

Having identified the broad set of economic development (multiplier) benefits, we also evaluate the combined programs through a benefit: cost test. We consider an expanded form of the benefit : cost ratio, namely a *societal perspective*, which accounts for the value of emission reductions and the economic development stimulus that results for a region when households and businesses investment in energy improvements they would otherwise not have undertaken. Table 5.2 shows the breakdown of benefits and costs for Small Solar, OSDG and the combined programs. The present value ($) of lifetime gross energy and capacity saved, along with emission reductions, purchases from import substitution, federal tax credits, depreciation deductions and the economic multiplier impacts (expressed as $ of value-added) related to *net* energy savings and the demand for RE manufacturers and installation, divided by the sum of CCEF program outlay and participants' total project costs yields a B:C ratio of 1.44 (for the combined programs). The Small Solar program alone generates a present value of $25 million in benefits and $18.7 million in costs; the difference of the two is the net present value of $6.3 million and the ratio is 1.34. The OSDG program generates a present value of $46 million in benefits and $31.8 million in costs for a net present value of $15.4 million and a benefit: cost ratio of 1.5.

Table 5.2: Summary of CCEF Program Benefits and Costs
(,000's $2008, discounted at 3% annually)

	Small Solar	OSDG	Combined
Gross Energy Savings	$28,748	$48,252	**$76,999**
Emissions Benefits	$444	$611	**$1,055**
Federal ITC & Depr. Deduction	$874	$7,339	**$8,213**
Import Substitution	$2,879	$3,567	**$6,446**
Spin-off Value-Added (GSP)	$5,664	$6,409	**$12,073**
Total Benefits	**$38,610**	**$66,177**	**$104,786**
Present Value of Benefits	*$25,077*	*$46,470*	***$71,546***
Total Costs	**$21,783**	**$34,733**	**$56,516**
Present Value of Costs	*$18,712*	*$31,083*	***$49,795***
Net Present Value	***$6,364***	***$15,387***	***$21,751***
Benefit Cost Ratio	***1.34***	***1.5***	***1.44***

There is opportunity to improve this result from an economic development perspective. One opportunity would be realized if the state's agencies charged with business recruitment could attract/build a PV components manufacturing presence for Connecticut. Between the Small Solar and the OSDG programs all ($31 million) of the PV investments are fulfilled by out-of-state firms. If 50 % of this amount could be recaptured for the CT economy, the B:C ratio improves to 1.79 (for the combined programs) and more importantly signifies (manufacturing) job creation for the state. The challenge to establish this industry is the same that CT faces in retaining or recruiting other types of manufacturing – namely the cost environment. Despite relatively superior workforce productivity and the state's quality of life, the cost environment for manufacturers (labor costs - wages and health benefits, and energy costs) rank worst among the 50 states.[16] Even a state with superior solar attributes, such as Arizona, has lost out over several years in 8 different bids to recruit a foreign solar manufacturing firm because other western states offer significant incentives. A potential PV components manufacturer that could view compelling reasons to do its business from Connecticut would ideally not just fulfill in-state demand created by the CCEF program but have specialized product that could create export opportunities as well.

[16] *The MAC Index 2004 – 05*, and *Manufacturing Competitiveness and Job Growth*, 2007, by CCEA, CERC and the Manufacturing Alliance of Connecticut.

APPENDIX I – REMI MODEL BACKGROUND

The application of economic impact models to measure impacts of programs and policies is widely used and accepted around the nation. Nearly all, if not absolutely all, of the states use such models. The specific application of these models for renewable energy investment, energy efficiency adoption, and energy pricing policies is also widely applied and proven.

- The most basic type of economic model is known as an "input-output (I-O) model" – an accounting table that traces the pattern of how households and industries buy from and sell to each other. This type of model is useful because it allows us to trace how changes in spending and business sales lead to indirect spin-off (or "multiplier") effects on other aspects of the economy. A statewide input-output model can also trace program impacts on the net flow of money going into and out of the state.

  Input-output models have been applied to assess the impacts of energy efficiency and renewable energy programs over a period of 28 years. Most of these studies used one of two input-output modeling tools -- RIMS (developed by the US Dept. of Commerce) or IMPLAN (originally developed by the US Dept. of Interior and now offered by a private sector spin-off). Applications of RIMS include studies for the Nebraska, Florida, Wisconsin, and New York. Applications of IMPLAN include reports for Sacramento, Central Illinois, California, Ohio, Oklahoma, four Midwest states, and the nation. Applications using other I-O models include reports for California, the Pacific Northwest, British Columbia, Spain and China.

- A more advanced type of economic model is known as a policy analysis and forecasting simulation model, which combines an input-output mode with an additional ability to forecast shifts in prices, competitiveness factors and business attraction over time. The REMI model (developed by Regional Economic Models, Inc.) is the most well-known and widely used policy analysis and forecasting model in the United States. A REMI model of the state of Connecticut was chosen for this study and is used by both CT DECD and UCONN-CCEA for over a decade.

  Applications of the REMI model for assessment of energy efficiency, renewable energy and energy pricing policies include reports for California, Wisconsin, Iowa, Wyoming, Massachusetts and New Jersey. Other applications using the REMI model to assess impacts of regulatory changes and shifts in energy fuels and technologies were reports for Maine, Missouri, Illinois, Michigan, Connecticut, Vermont, New Jersey, Florida, New York, and the Midwest.

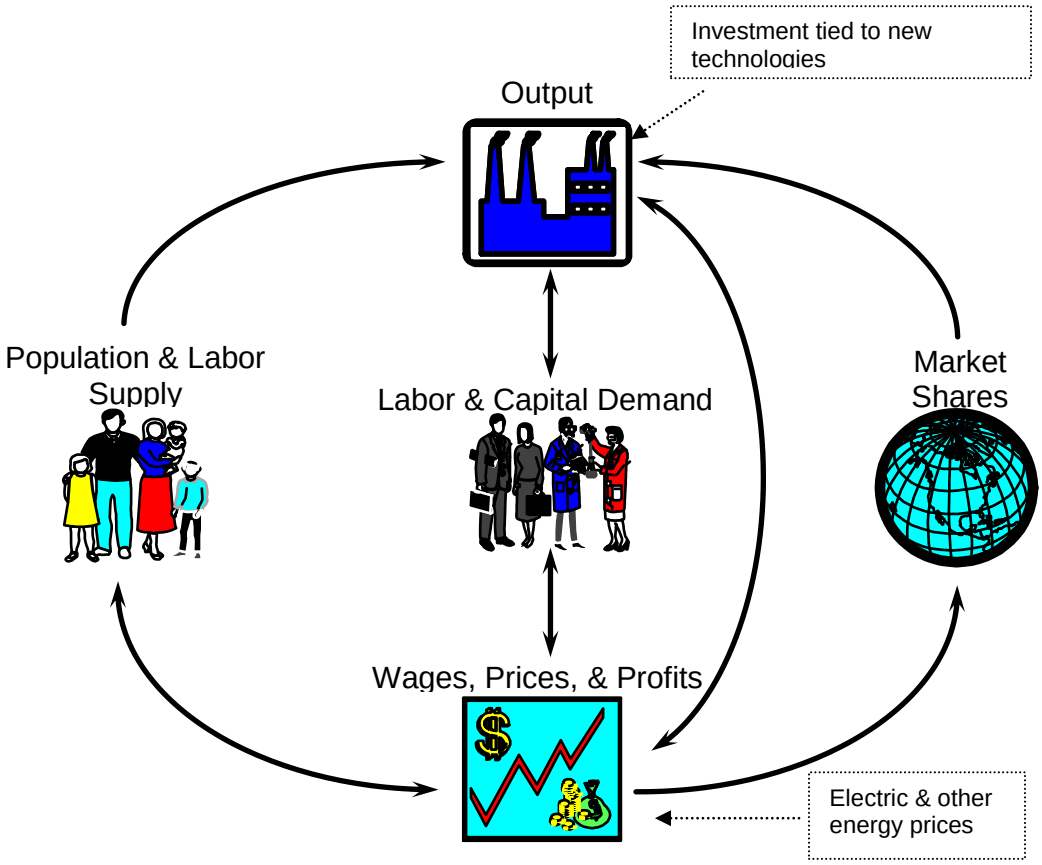
While there are differences in capabilities of the various types of models, they are generally consistent in their underlying structures and are built on similar foundations – (1) the inter-industry technology matrices and purchasing patterns provided in the US national input-output accounting tables, and (2) US Census and Commerce Dept. data on state and regional economic patterns. The findings on economic impact of energy programs are also generally consistent in showing that economic impacts will vary widely depending on the type and magnitude of

the program effort, the form of program assistance or intervention, the focus on specific technologies or economic sectors, the level of program participation, the breadth and nature of the program impact area, and time periods covered by the analysis.

Economic Analysis Process

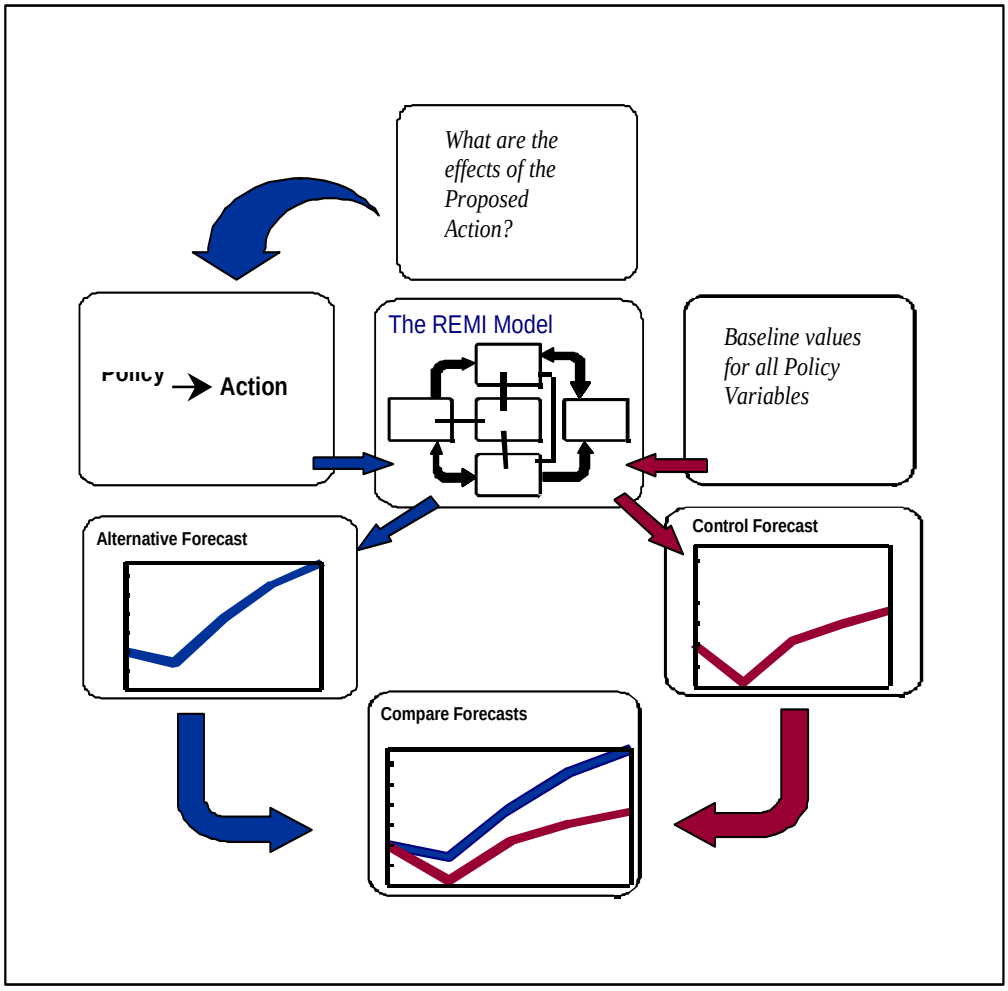
REMI calculates the economic effects from CCEF programs on the state economy by tracking the flow of dollars, changes in purchasing and sales patterns, and impacts on prices and costs resulting from both the small solar and OSDG programs. This process of mapping the immediate effects of the RE programs into economic catalysts was illustrated in Figure 2.2-1 in CH.2. These mappings can be considered due to the REMI model's structural representation of an economy and the feedbacks encompassed in the model's comprehensive equation set. A diagram depicting the model *logic* – albeit at a gross level – is shown in Figure A-1.

Figure A-1: Simplified Portrayal of REMI Model Feedbacks



Using this capability an economic forecast can be generated under the influence of a program/policy, proposed or already in effect. The economic impact (as jobs, or business output, or labor income etc…) is defined as the difference in Year **T's metric** with and without the program/policy. Figure A-2 depicts this

Figure A-2: Identifying Annual Economic Impacts with a REMI Model



The end result is that the REMI model forecasts year-by-year changes in four key types of results on the Connecticut economy:

- Business Sales - Increasing output and hence sales volume of goods and services provided by Connecticut firms.

- Gross State Product (GSP) - This is calculated as the value added portion of business sales, which is the business sales minus cost of materials. It essentially represents the sum of worker income and corporate (profit) income.

- Jobs - The number of jobs (both salaried workers and self-employed individuals) that is generated by expansion in business sales. Summed over an analysis interval the concept becomes job years.

- Real After-tax Income - Household disposable income reflects the direct program savings in any given year as well as the after-tax wage income that results from the state's economy experiencing a positive growth response under CCEF programs. Since the latter source of household income comes from a portion of the business sales, the income benefit cannot be added to the business expansion or GSP benefit.