# Sustainable Solar Strategy for Connecticut Prepared for the Long-Term Sustainable Solar Strategy Workgroup

Prepared for the Connecticut Clean Energy Fund

Burlington, Massachusetts, April 8, 2009

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# Table of Contents

# Table of Contents

# Table of Contents



**List of Exhibits**

# Table of Contents

# 1. Executive Summary

Solar power works in Connecticut, and likely represents the greatest potential for Connecticut to capitalize on in-state renewable resources. Solar has a demonstrable track record of growth in the state and the potential for further growth is significant. To date, about 8.6 MW of solar have been installed in Connecticut, and other projects have been approved but not yet completed. However, increased demand in the existing incentive programs, particularly in 2008, has led to their suspension due to a lack of available funding. The impact of the program suspensions will soon be dramatically felt. In the absence of additional funding, the rate of PV installations is expected to plummet, threatening the viability of many of the existing in-state PV installation firms.

To preserve the solar industry that has been developed, and to further leverage solar as a renewable resource, Connecticut needs to immediately develop additional programs and initiatives to better serve a broader group of stakeholders, including state and local governments, utility stakeholders, as well as residential and commercial consumers.

This report presents a long-term, sustainable solar strategy for Connecticut intended to grow solar through a set of programs and initiatives designed to reduce existing barriers to solar energy development. Taken together, the recommendations are intended to benefit all ratepayers, including residential, commercial, and government consumers of electricity, as well as utilities who can benefit from an enhanced role in solar development.

With a well-developed strategy for growing the in-state solar energy market, Connecticut can become a leader in helping to drive the cost of solar to parity with traditional forms of generation. In doing so, Connecticut can further capitalize on the economic and environmental benefits of a clean, renewable energy resource.

Solar energy provides a broad array of benefits:

- For users:
    - Solar is a widely available, carbon-free energy source
    - Solar can offset high retail electricity rates for consumers in “behind the meter” applications
    - There are no fuel costs, therefore consumers can create a hedge against future energy price increases

- Solar has low operating and maintenance costs

- For the overall utility system:
  - Solar is a cost-effective peak generation resource
  - Solar installations can ease congestion in regions where energy demands have stressed the grid

**Solar Goals in the RPS**

As a first step, Connecticut should implement specific and aggressive goals for solar installations that grow over time. Connecticut should add a solar component (a "carveout") to its existing RPS, requiring that certain MW goals are met through the installation of in-state solar energy systems. We recommend a goal of 300 MW of solar by 2025, which would satisfy about 3.5% of the projected energy demands of Connecticut's major distribution utilities by that time.

**Strategies for Growing Solar**

The workgroup examined a suite of strategies to meet these goals, including:

- Residential Solar Incentives – This program would be similar to the existing CCEF Solar PV Rebate program, providing $/watt incentives to residential and potentially small commercial customers to reduce the up front cost of solar systems.

- Solar Lease Program – This program currently exists, and targets low to moderate-income households which would otherwise be unable to come up with any portion of the upfront capital costs of a solar energy system.

- Zero Net-Energy Homes - Providing grants for solar installations on newly constructed "zero net-energy homes" through a combination of CCEF funding and the energy efficiency program infrastructure would further encourage development of model energy efficient construction.

- Solar Renewable Energy Credits (SRECs) – SRECs are tradable certificates that represent all the clean energy benefits of electricity generated from a solar PV system.

- Installation of Solar PV systems on Government Buildings – This program would use state-issued bonds to reduce the upfront cost of solar PV systems, and subsequently leverage the solar PV tax incentives available to private-sector developers, including potentially utilities, to contract for long term Power Purchase Agreements at reduced rates.

- Utility-Development of Solar – This scenario considers allowing the distribution utilities to integrate expenditures on solar into their rate base through development of projects on their land or facilities with a cap each year. The purpose of such development would be to encourage the utilities' role in using solar to strategically enhance upgrades to the distribution system and to create hybrid approaches to peak load management. Development on other properties, such as brownfields or other properties identified for strategic placement of distributed generation may also be considered.

## Benefit:Cost Analysis

This report considered a state-level *societal* definition when assembling the Benefit:Cost (BC) test for each scenario considered in this study. This definition is the most comprehensive in that it considers the costs and benefits to ratepayers, project developers/owners, and all of Connecticut's citizens (with respect to air quality improvements). The state-level perspective stipulates that any existing or new CT funding mechanism to stimulate an outcome (e.g. solar system adoption) be recognized as creating as *transfer* between developer and ratepayer/CT taxpayer, or between participating and non-participating ratepayers, or between participating ratepayers and CT taxpayers. Therefore these transfers should be excluded from consideration. The federal incentives can be included as a benefit since the BC guidance for a test with state-level perspective is that federal taxpayers have no standing in state-level policy choices. The benefits are comprised of the following:

- Avoided energy savings – the dollar value of avoided energy and capacity supply costs and any potential electric price effect tied to a scenario.

- Spin-off economic activity – the multiplier impacts generated from energy-related savings, import substitution effects, and in-state installation stimulus from solar projects.

- Emissions – the dollar value of SO2, NOx, and CO2 emissions saved

- Solar Generation's import substitution effect – utility sector's reduction in fuel input purchases

- Federal Incentives – related to accelerated equipment depreciation and/or investment tax credit

The costs are comprised of the following:

- Gross Project Cost – the project costs paid by participants equal to total project costs.

- New In-state Funding mechanism – cost of bond issue, or differential in traded solar energy certificates, or rate-based financing depending on the scenario.

A REMI model (Regional Economic Modeling, Inc.) of the Connecticut economy was used to calculate the spin-off economic effects from the proposed scenarios by forecasting:

- 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.

The results of the BC analysis suggests that each of the modeled programs has a BC ratio greater than 1. In other words, the lifetime benefits of the programs are greater than the lifetime costs. Table 1-1 below summarizes the results of the BC analysis, by program.

**Table 1-1**
**Summary of BC Analyses**

| Program | BC Ratio |
|---|---|
| Residential Rebate | 2.87 |
| Zero Net Energy Homes Pilot | 2.13 |
| Solar Lease | 1.92 |
| Solar RECs | 2.39 |
| State Government Installations | 1.90 |
| Utility Ownership Pilot* | 1.92 |

* KEMA notes that the REMI model used for this analysis does not encompass the full range of potential costs and ratepayer benefits involved with ratebasing generation resources (such as the potential value of deferring investments in distribution upgrades), therefore the BC analysis for utility development should be considered preliminary.

As a result, KEMA recommends that Connecticut develop a suite of such programs, targeting different aspects of the marketplace that together will provide a comprehensive, sustainable, and cost effective approach to developing solar energy in the State.

In addition, the workgroup recommends several other initiatives and policies, including:

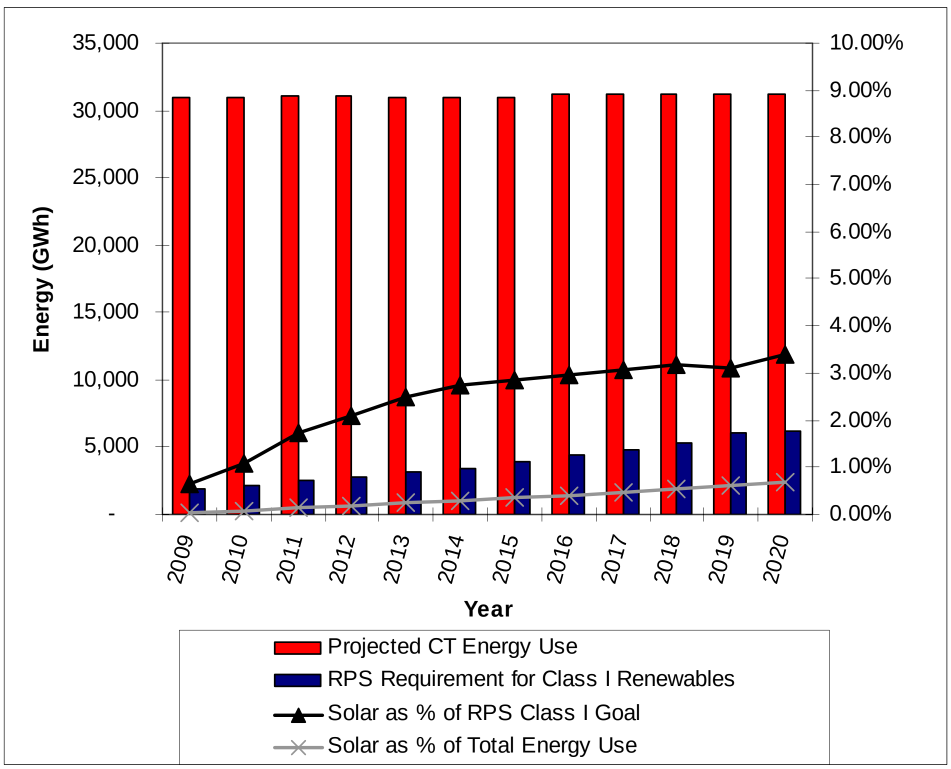
- Education and Training – Continuing and expanding education and training programs to further develop an in-state solar workforce and to encourage solar energy businesses to locate in Connecticut.
- Energy Efficiency Requirements – Energy efficiency is the cheapest form of generation, and CCEF has recognized this through a requirement in their current commercial incentive program that participants complete an energy audit to be eligible for renewable energy incentives. We support this concept, and recommend that it be expanded to all other consumers as a prerequisite for participation in future programs. Energy efficiency must be promoted and recognized as the best way to maximize the value of solar energy to customers.
- Virtual Net Metering – Allowing community-based or privately-developed solar installations to offset electricity accounts that are not directly "behind the meter"

This report also examined Feed-In Tariffs as a replacement for all other non-residential incentive programs. Feed-In tariffs have been employed in Europe and are currently being considered in some portions of the United States. The implementation of Feed-In Tariffs would set a fixed 15-year $/kWh rate for solar energy projects based on production costs of solar energy plus a rate of return for the developer. Additional modeling will be necessary to identify the appropriate cost for such a tariff and to model the resulting BC ratio.

## Impact

The modeled solar carveout would result in approximately 3.5% of the Connecticut RPS requirements being met by in-state solar development by 2020, as shown in Figure 1-1. As a percentage of overall electricity use, 300 MW of solar would account for about 0.7% of estimated electricity use by 2020.

**Figure 1-1**
**Contribution of Solar RPS**




Development of up to 300 MW of solar through the recommended suite of programs would have minimal ratepayer impact. Table 1-2, below, summarizes the estimated impact of the suggested programs above and beyond the current system benefits charges that are in place. Therefore, the program costs of the Residential Rebate, Solar Lease, and Zero Net Energy Homes programs are not included, since incentives for those programs are currently funded from the existing system benefits charge. The impact of the SREC-eligible and estimated net costs of the utility-developed solar programs would be less than $10 per household annually.

**Table 1-2**

**Estimated Ratepayer Impact of Recommended Additional Solar Programs**

| | Utility Developed Solar | | | SREC-eligible Programs | | | | Ratepayer Impact | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Installation Costs | Federal ITC | Depreciation | Value of SRECs | Solar Program Premium Cost* | Total CT kWh Sales (includes C&LM) | Typical Household Usage per Year (kWh) | Annual Program $/kWh | Annual Program $/Household |
| **2009** | $ 7,140,000 | $ (2,142,000) | $ (297,381) | $ 1,267,747 | $ 5,845,113 | 31,011,000,000 | 7,500 | $0.0002 | $1.41 |
| **2010** | $ 20,563,200 | $ (6,168,960) | $ (1,153,838) | $ 4,241,976 | $ 17,018,412 | 31,009,000,000 | 7,500 | $0.0005 | $4.12 |
| **2011** | $ 32,901,120 | $ (9,870,336) | $ (2,524,170) | $ 9,838,230 | $ 29,268,788 | 31,021,000,000 | 7,500 | $0.0009 | $7.08 |
| **2012** | | | $ (2,524,170) | $ 12,738,018 | $ 8,621,596 | 31,113,000,000 | 7,500 | $0.0003 | $2.08 |
| **2013** | | | $ (2,524,170) | $ 17,474,622 | $ 12,766,124 | 31,015,000,000 | 7,500 | $0.0004 | $3.09 |
| **2014** | | | $ (2,226,789) | $ 18,487,794 | $ 13,564,868 | 31,003,000,000 | 7,500 | $0.0004 | $3.28 |
| **2015** | | | $ (1,370,332) | $ 22,220,859 | $ 17,609,985 | 30,996,000,000 | 7,500 | $0.0006 | $4.26 |
| **2016** | | | | $ 21,795,244 | $ 17,981,077 | 31,150,000,000 | 7,500 | $0.0006 | $4.33 |
| **2017** | | | | $ 25,250,277 | $ 20,831,479 | 31,171,000,000 | 7,500 | $0.0007 | $5.01 |
| **2018** | | | | $ 23,114,629 | $ 18,058,304 | 31,183,468,400 | 7,500 | $0.0006 | $4.34 |
| **2019** | | | | $ 26,188,579 | $ 20,459,827 | 31,195,941,787 | 7,500 | $0.0007 | $4.92 |
| **2020** | | | | $ 22,073,836 | $ 15,635,634 | 31,208,420,164 | 7,500 | $0.0005 | $3.76 |
| **2021** | | | | $ 24,640,898 | $ 17,453,969 | 31,220,903,532 | 7,500 | $0.0006 | $4.19 |
| **2022** | | | | $ 18,233,866 | $ 10,256,550 | 31,233,391,894 | 7,500 | $0.0003 | $2.46 |
| **2023** | | | | $ 20,141,474 | $ 11,329,579 | 31,245,885,250 | 7,500 | $0.0004 | $2.72 |
| **2024** | | | | $ 11,078,108 | $ 1,384,764 | 31,258,383,604 | 7,500 | $0.0000 | $0.33 |
| **2025** | | | | $ 5,489,203 | $ - | 31,270,886,958 | 7,500 | $0.0000 | $0.00 |

*Does not include funding for rebates from programs funded by SBCs, and only includes difference between SREC and traditional REC prices

# 2. Introduction

Solar power works in Connecticut. It has a demonstrable track record of growth in the state and the potential for further growth is significant. However, that growth has been threatened by a lack of funding and sustainable incentive levels, and the need for additional programs and initiatives to better serve a broader group of stakeholders, including utilities, state and local governments as well as residential and commercial consumers.

The CCEF[1] and DPUC[2] convened a Workgroup to develop a plan to maximize the use of solar power and create a self-sustaining solar industry in Connecticut, pursuant to Section 4 of Public Act 08-168 (PA 08-168), An Act Concerning Energy Scarcity and Security, Renewable and Clean Energy and A State Solar Strategy. Section 4 specifically requires:

> *Sec. 4. (Effective from passage) (a) The Renewable Energy Investments Board, established pursuant to section 16-245n of the 2008 supplement to the general statutes, in consultation with the Department of Public Utility Control, shall convene a working group to develop a plan to maximize the use of solar power and create a self-sustaining solar industry in Connecticut that will help meet renewable portfolio standard requirements and the greenhouse gas emissions limits of the Regional Greenhouse Gas Initiative. Said plan shall identify a target megawatt goal and a timeline for achieving this target and shall include recommendations regarding workforce development and job training necessary to build an in-state solar workforce and regarding coordination with other programs where appropriate.*[3]

[1] The Connecticut Clean Energy Fund (CCEF), administered by Connecticut Innovations, Inc. ("CI"), was created under 16-245n of the Connecticut General Statutes to promote investment in and growth of renewable energy sources. Expenditures of the funds may include, but are not limited to, grants, direct or equity investments, contracts or other actions that support renewable energy technologies such as wind, solar energy, fuel cells, wave power and biomass

[2] The Connecticut Department of Public Utility Control (DPUC) was established under Title 16, Chapter 277 of the Connecticut General statutes. The DPUC is statutorily charged with regulating to varying degrees the rates and services of Connecticut's investor-owned, electricity, natural gas, water, and telecommunication companies and is the franchising authority for the state's cable television companies. In the industries that are still wholly regulated, the Department must balance the public's right to safe, adequate and reliable utility service at reasonable rates with the provider's right to a reasonable return on its investment.

[3] Section 4 of Public Act 08-168 (PA 08-168), An Act Concerning Energy Scarcity and Security, Renewable and Clean Energy and A State Solar Strategy

The 12-member working group includes economic, environmental, utility, education, policy, finance and solar industry representatives. Specifically, the makeup of the workgroup is summarized in Table 2-1. T he workgroup was tasked with creating a plan to describe the benefits of and the costs associated with achieving a self-sustaining solar industry and maximizing the use of solar power, including, but not limited to, (1) types and amounts of incentives to maximize in-state solar installations; (2) methods of residential solar financing; (3) estimated energy production; and (4) solar benefits, including avoided fossil fuel combustion, reduced congestion and peak power production, job creation, air quality and reductions in global warming emissions. Additionally, the workgroup includes Vote Solar, a national non-profit assisting cities and states across the country to bring solar energy into the mainstream.

**Table 2-1**
**Long Term Sustainable Solar Strategy Workgroup Members**

| Workgroup Representative | Association | Role/Representing |
|---|---|---|
| Tim Bowles | Chairman, CCEF Board of Directors | Workgroup Co-Chair |
| Kevin DelGobbo | Commissioner, DPUC | Workgroup Co-Chair |
| David Goldberg | Director of Strategic Initiatives, CCEF | Workgroup Facilitator |
| Devang Patel | United Illuminating | Electric Distribution Companies |
| Justin Lindenmayer | Connecticut Light & Power | Electric Distribution Companies |
| Roger Smith | Clean Water Action | Environmental Non-profits |
| Andy Bauer | People's Action for Clean Energy, Inc. | Environmental Non-profits |
| Ron French | Solar Works, Inc. (now Alteris Renewables, Inc.)* | Residential Solar Industry |
| Robert Chew | SolarWrights, Inc. (now Alteris Renewables, Inc.)* | Large Commercial Solar Integrator |
| Paul Gromer | Solar Energy Business Association of New England | Solar Trade Association |
| Lise Dondy | CCEF | Designee of CT Innovations Exec Dir. |
| Tracy Babbidge | DEP | Designee of DEP Commissioner |
| Steve Unker | DECD | Designee of DECD Commissioner |
| Dr. David Cooper | Gateway Community College | Community College offering Solar Training |
| Jerry Peters | TD Banknorth | Renewable Finance |

* Solar Works, Inc. and SolarWrights, Inc. merged to form Alteris Renewables, Inc. during the course of this study

The CCEF, on behalf of the workgroup, engaged KEMA Inc. (KEMA) and it's subcontractor Economic Research Development Group Inc. (EDRG) to create a study that will provide the necessary tools for the workgroup to develop an effective strategy, and will also provide the Governor and State legislators valuable information as they weigh potential action.  This will be used during deliberations by the workgroup in preparing recommendations for the respective Legislative committees.

The overarching aim of this process was to provide a detailed study and plan, including critical analysis, and ultimately a defensible recommendation to the Legislature. The goals for a solar energy market transformation in Connecticut are to drive down solar energy costs to parity with the costs for development of traditional forms of energy, to provide economic and job growth, and allow the industry to develop into a vibrant, self-sustaining marketplace.

Specifically, this study is intended to:

- Identify options, benefits, costs and barriers for a sustainable solar industry
- Prioritize recommended incentive programs based on BC analysis
- Quantify costs, megawatt (MW) goals, and timelines associated with the proposed solar initiatives.
- Present a detailed plan for the Legislature's consideration

To effect a solar energy industry transformation, KEMA has proposed policy initiatives and assessed their impact under different economic scenarios. EDRG is assisting the KEMA team and has a long established practice of measuring the macro-economic impacts of regional investment programs (e.g. energy and transportation infrastructure) as well as integrating other direct effects (*co-benefits*) into a cost benefit evaluation.

This study contains three primary phases:

1) The first phase involved a survey of the existing Connecticut solar energy industry including regulatory matters and associated policies. Additionally, this phase included a cursory overview and literature review of relevant state, national and international initiatives.

2) The second and main phase consisted of detailed policy analysis regarding program strategies, funding and incentives, and analysis of total benefit/cost to the state/ratepayers as well as the customer/owner of the solar energy system.

3) The third phase will involve interaction with workgroup members to provide additional analysis and assistance crafting Connecticut-specific strategy/recommendation(s) and creating the final solar strategy report.

## 2.1 Background

Solar energy provides a broad array of benefits:

- For users:
    - Solar is a widely available, carbon-free energy source
    - Solar can offset high retail electricity rates for consumers in “behind the meter” applications
    - There are no fuel costs, therefore consumers can create a hedge against future energy price increases
    - Solar has low operating and maintenance costs
- For the overall utility system:
    - Solar is a cost-effective peak generation resource
    - Solar installations can ease congestion in regions where energy demands have stressed the grid

In the last several years, in response to rising electricity prices, environmental goals and energy security, there has been an increased national focus on developing solar energy to take advantage of these benefits. In 2006, as part of the Advanced Energy Initiative, President Bush introduced the Solar America Initiative (SAI) aiming to bring together a broad spectrum of stakeholders to identify policies and strategies to bring solar power to parity with other forms of generation. In 2008, federal tax incentives were extended to 2016 in order to provide stability and encourage development. In Connecticut, favorable policy initiatives such as the existing net metering rules as well as high electricity prices suggest that the cost of solar is already closer to parity with traditional forms of generation, when considering the long-term cost of electricity, than in other parts of the country, even with relatively lower insolation values (the daily number of hours that the sun would be expected to shine on an ideally configured solar panel)..

Connecticut is committed to the long-term growth of renewable energy in its portfolio of electricity generation sources. In 1998, Connecticut established a Renewable Portfolio Standard (RPS) requiring a gradual increase in the amount of renewable energy used to serve the state’s electricity needs. The RPS currently calls for 20% of electricity generation to be fulfilled by Class I (e.g. solar, wind, small hydro, low-emissions biomass) renewable resources by 2020.

However, the RPS does not specify that the renewable resources must come from in-state installations.

More recently, in 2007 the Connecticut legislature enacted several pro-solar initiatives, including the sales tax exemption for solar energy equipment, and the expansion of net metering to 2 MW.

However, because of its relatively small geographic size, and without a mandated contribution from in-state renewable resources, Connecticut will primarily fill its RPS obligations through out-of-state resources. With relatively low wind speeds and few hydropower resources available, solar power likely represents the greatest potential for Connecticut to capitalize on in-state renewable resources.

## 2.2 Solar Resources in Connecticut

Connecticut has a much more moderate resource than some other parts of the country and world, which may ultimately affect the economics, applicability, and penetration of certain technologies such as concentrating solar. However, in Connecticut, favorable policy initiatives such as the existing net metering rules as well as high electricity prices suggest that the cost of solar is already closer to parity with traditional forms of generation, when considering the long-term cost of electricity, than in other parts of the country, even with relatively lower amounts of sunshine.

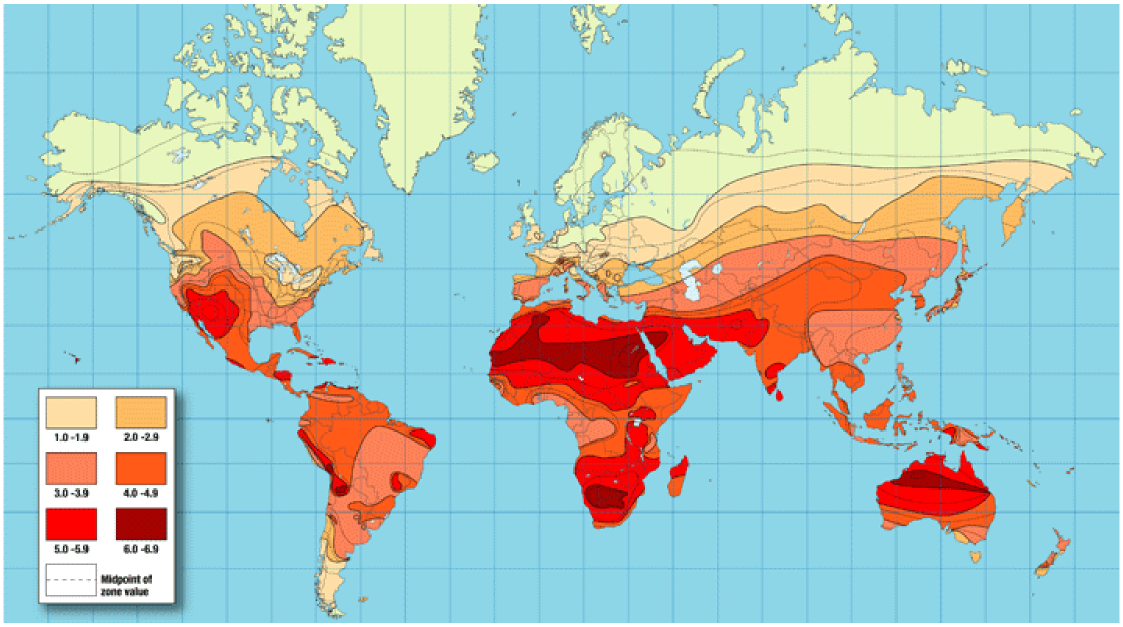
We note that Germany, which is internationally regarded for its success in incentivizing the development of solar power, has lower insolation values than Connecticut. This shows that solar markets can be established in areas with moderate resource potential with targeted and focused policies.

Navigant, Inc. performed a national study of market penetration for rooftop PV for the National Renewable Energy Laboratory (NREL) in February 2008. That study estimated both the technical potential for rooftop PV installations in each state and the likely market penetration under a variety of cost and policy scenarios.

The technical potential for rooftop solar photovoltaic (PV) installations in Connecticut, which is simply a measure of the estimated number, configuration, and area of rooftops on residential and commercial buildings, was estimated at about 4,200 MW in 2008. Based on expected energy production, this would represent about 17% of Connecticut's current energy use, and 25% of Connecticut's peak demand. Therefore, at least in theory, even with just rooftop PV installations, Connecticut could supply a significant percentage of its electricity demands through solar power. Additional potential lies in unused properties, such as redeveloped brownfields. In reality, of course, the actual market penetration will be dependent upon a number of other factors.

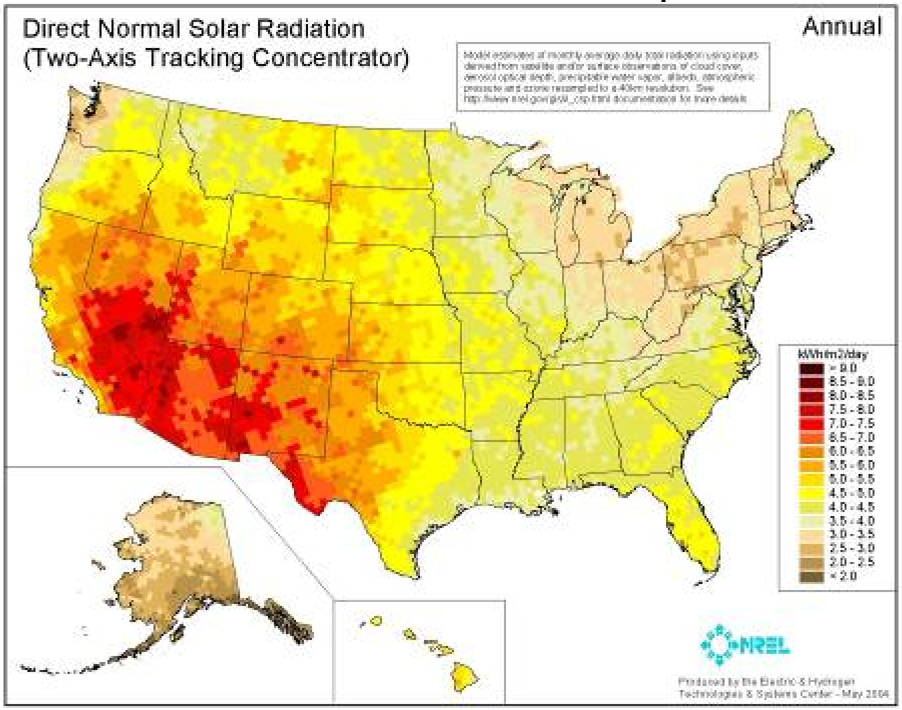
Figures 2-1 and 2-2 show worldwide and national insolation values.

**Figure 2-1**
**Worldwide Insolation Values**




(Figure courtesy of AltE, Inc.)

**Figure 2-2**
**National PV Solar Radiation map**




(Figure courtesy of NREL)

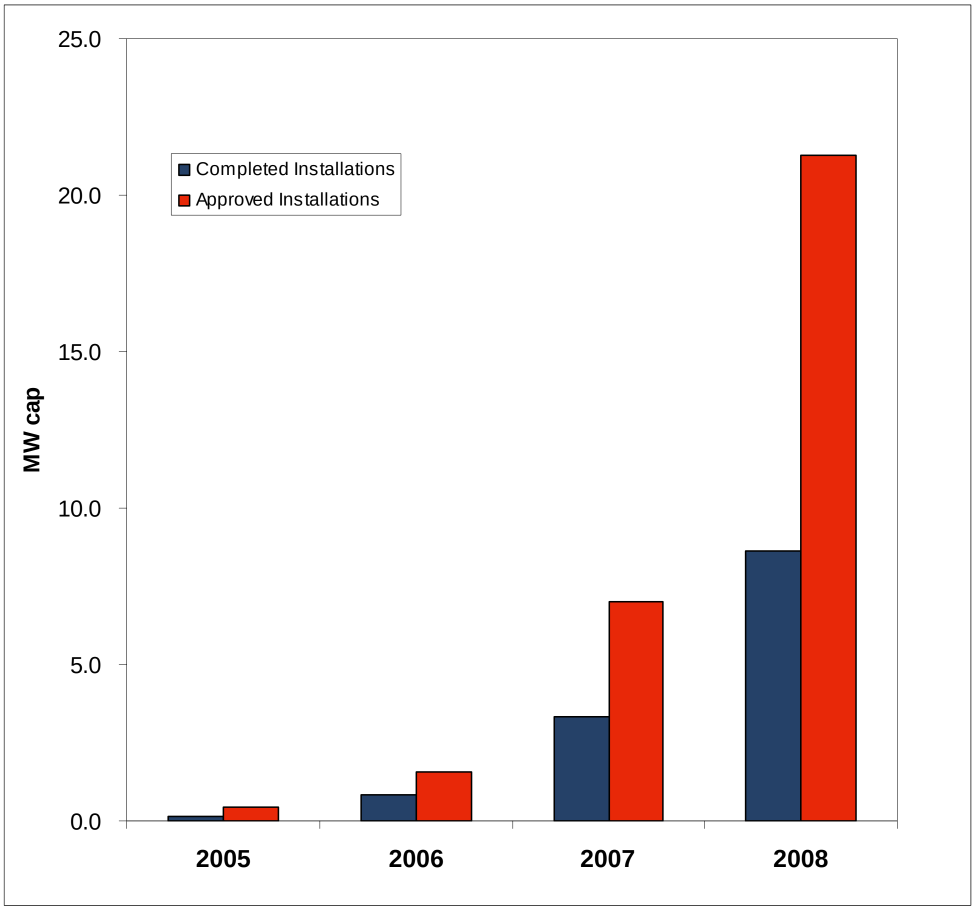
## 2.3 Growth of Solar Power in Connecticut

Connecticut has been proactive since 2004 in developing a solar infrastructure through residential and commercial incentive programs provided by the CCEF. In addition, there has been active involvement in the community college system in offering training which has attracted mid-career or senior level students who have identified solar energy as a new line of their electrical, plumbing, and construction businesses.

The combination of these efforts has been successful in establishing a growing in-state solar power market. Figure 2-3 below shows the growth in completed and approved (which includes completed and in-progress) installations in the two primary in-state solar incentive programs, the Solar PV Rebate program, targeting residential installations, and the On-Site Distributed Generation (OSDG) program, targeting commercial installations, from 2005 to 2008. To date, about 8.6 MW of solar have been installed, and overall over 21 MW have been approved, suggesting a “backlog” of about 12.5 MW. However, some portion of the backlog of projects is not expected to move forward; therefore, in our analysis we assumed that 50% of the backlog of OSDG projects and 80% of the backlog of Solar PV projects would be installed. Those projects are estimated to total 7 MW.

Overall, the average rate of growth in the combined programs has been about 250% per year.

**Figure 2-3**
**CCEF Solar PV Rebate and OSDG Programs**
**Completed and Approved PV Projects, 1/05 to 12/08**




However, the increased demand in these programs, particularly in 2008, has led to the suspension of both programs due to a lack of available funding. Currently, solar installers are working on the backlog of approved projects, but the impact of the program suspensions will soon be dramatically felt. In the absence of additional funding, the rate of PV installations is expected to plummet, threatening the viability of many of the existing in-state PV installation firms. Insufficient funding, leading to “boom and bust” cycles, will prevent the sustainable growth of the solar industry in Connecticut and other states.

In addition, Connecticut's previous programs focused on "behind the meter" installations, where the primary objective is to offset onsite energy use that would be otherwise priced at retail rates. Such programs do not serve to leverage a variety of sites that could be otherwise developed for grid-connected solar, including vacant lots, brownfields, or rooftops of buildings such as parking garages or warehouses that could generate power much greater than their onsite load would demand. To access those markets, and to encourage the development of utility-scale installations (>1 MW), solar power sold into the wholesale electricity market has to be attractive. For that reason, new programs that allow developers of such generation capacity to capture the benefits of their investments must be developed.

## 2.4 Future Growth of Solar in the Absence of State Incentives

Due to relatively high electricity prices, favorable net metering rules, and the extended federal tax incentives, in the absence of any state incentives installations of solar power are still anticipated to continue growing in Connecticut, though by much smaller amounts than have been observed with the addition of the state incentives.

In the absence of state incentives, the current paradigm in Connecticut, including installations to date, high existing energy prices, federal tax incentives through 2015, gradual predicted reductions in the installed cost of solar PV, and current policies related to net metering and interconnection, supplemented by conservative assumptions regarding escalation in electricity prices, suggest an approximately 10-15% future rate of growth in solar installations, which would result in about 55 MW of solar installations by 2025. This would represent about 0.5% of total estimated electricity demand in 2025. Tables 2-2 and 2-3 summarize the assumptions and estimates which formed the Base Case for this study.

**Table 2-2**
**Base Case Assumptions**

| Base Case Assumptions | |
|---|---|
| **System Pricing Scenario** | Business-as-usual (gradual reductions) |
| **Interconnection Policy Scenario** | Current rules |
| **Net Metering Availability Scenari** | Currently Available |
| **Net Metering Cap Scenario** | Current 2MW Cap |
| **Cap and Trade Scenario** | State Level (RGGI) |
| **Electricity Price Escalation** | EIA Projections |
| **Federal Tax Credit** | Extended to 2016 |
| **Time-of-Use Rates** | Current Availability (avail in CT) |
| **RPS Solar Set Aside & Enforcem** | No |

**Table 2-3**
**Base Case Estimates of Solar PV Installations 2008-2025**

| Year | Assumed Annual Installations in the Absence of State Incentives | Base Case Installations (Cumulative) |
|---|---|---|
| 2008 | Installations to date | 9 |
| 2009 | 4* | 13 |
| 2010 | 3* | 16 |
| 2011 | 1 | 17 |
| 2012 | 1 | 18 |
| 2013 | 1 | 19 |
| 2014 | 2 | 21 |
| 2015 | 2 | 22 |
| 2016 | 2 | 24 |
| 2017 | 2 | 26 |
| 2018 | 2 | 29 |
| 2019 | 3 | 31 |
| 2020 | 3 | 34 |
| 2021 | 3 | 38 |
| 2022 | 4 | 41 |
| 2023 | 4 | 45 |
| 2024 | 4 | 50 |
| 2025 | 5 | 55 |

* 2009 and 2010 installations include estimates of viable backlog from previous state incentive programs.

## 2.5 Recommended Solar Carveout

To continue to grow and secure a sustainable in-state solar industry, Connecticut needs to implement specific and aggressive goals for solar installations that grow over time. To drive solar development and better capture the benefits of renewable energy in-state, Connecticut should add a solar component (a "carveout") to its existing RPS, requiring that certain MW goals are met through the installation of in-state solar energy systems. We recommend the following goals, which by 2025 would satisfy 3.5% of the projected energy demands of Connecticut's major distribution utilities. Those goals would require approximately 30% sustained annual growth in the number of MW installed through 2025.

Table 2-4 identifies these goals, and the incremental MW of solar installations that would be required to meet them.

**Table 2-4**

**Recommended Solar Carveout (MW) in CT RPS and Percent of Forecast Load**

| | Utility Forecast of CT Electric Load (MW) | Recommended Required Solar RPS Carve-Out (MW) | Solar as % of Total Forecast CT Load | Incremental Solar to meet Solar RPS Carve-Out (MW) |
|---|---|---|---|---|
| **2009** | 6,778 | 10 | 0.1% | 1 |
| **2010** | 6,880 | 24 | 0.4% | 15 |
| **2011** | 6,983 | 39 | 0.6% | 15 |
| **2012** | 7,088 | 55 | 0.8% | 16 |
| **2013** | 7,194 | 71 | 1.0% | 16 |
| **2014** | 7,302 | 88 | 1.2% | 17 |
| **2015** | 7,412 | 105 | 1.4% | 17 |
| **2016** | 7,523 | 122 | 1.6% | 18 |
| **2017** | 7,636 | 140 | 1.8% | 18 |
| **2018** | 7,750 | 159 | 2.0% | 19 |
| **2019** | 7,866 | 178 | 2.3% | 19 |
| **2020** | 7,984 | 197 | 2.5% | 20 |
| **2021** | 8,104 | 218 | 2.7% | 20 |
| **2022** | 8,226 | 238 | 2.9% | 21 |
| **2023** | 8,349 | 260 | 3.1% | 21 |
| **2024** | 8,474 | 281 | 3.3% | 22 |
| **2025** | 8,601 | 300 | 3.5% | 25 |
| **2025 Total** | 8,601 | 300 | 3.5% | 298 |

### 2.5.1 Economic Stimulus

Recently, President Obama has committed to using a portion of federal economic stimulus funds to jumpstart a “green” economy, including installations of renewable energy as well as required upgrades to transmission and distribution systems to allow for greater integration of renewables onto the electric grid. Because of the limited time frame for the use of any such funds, which are primarily designed to stimulate economic activity, we don’t consider such funds to be part of a sustainable strategy for Connecticut. However, we note that there may be an opportunity for federal economic stimulus funds to accelerate the installation of renewable energy systems in the short term which could accelerate employment growth for in-state solar installers and large installations from such an effort could expand the scale at which solar is considered for development in Connecticut. In order to preserve an ongoing incentive for solar development in Connecticut, we recommend that the total MW of any such “stimulus” installations not be eligible to count against the solar RPS carveout, or that the solar RPS goals be adjusted upward to account for them.

## 2.6 Background to Benefit:Cost Analysis

The Benefit:Cost (BC) test considers the stream of benefits and costs to CT stakeholders that occur over an interval depicting the useful life of a solar installation, which we presume to be 25 years. This type of analysis quantifies the long-term effects of the programs by increasingly discounting[4] the benefits and costs with each year (bringing each data point into a *present value*). The further out in the analysis interval a benefit occurs, the more will be forfeited in terms of potential return on initial capital. Likewise, the further project costs are postponed, the more potential returns are generated by delaying those costs.

This analysis used a *societal* definition when assembling the BC test for each scenario considered in this study. This definition is the most comprehensive in that it considers costs and benefits to ratepayers, project developers/owners, and all of Connecticut’s citizens (with respect to air quality improvements). The benefits are comprised of the following:

- Gross energy savings – the dollar value of avoided energy and capacity supply costs and any potential electric price effect tied to a scenario.
- Spin-off economic activity – the multiplier impacts generated from *net* energy savings and in-state installation of projects.
- Emissions – the dollar value of $SO_2$, $NO_x$, and $CO_2$ emissions saved

[4] As noted in the assumptions for the BC analysis, the discount rates are different for the Residential initiatives and Commercial initiatives. An argument can be made that a different type of discount rate – i.e. a *social discount rate (SDR)*- could be applied. The role of the SDR is to make more stringent the likelihood of committing public funds when ample benefits are realized. While there is debate in the academic literature on the value of that rate, one source indicates that if a proposed project would not last more than 50 years (intergenerational) and not crowd out private investment, then 3.5% should be used. This rate is slightly higher than the discount rate we use for Residential scenarios but dramatically lower than the rate we invoke for Commercial scenarios. The Commercial scenarios however really depict the leveraging of private funds so the 7.5% discount rate is understandable. However, if the Commercial scenarios were evaluated at a rate of 3.5% their BC results would increase between 10 and 27 percent depending on the scenario.

The costs are comprised of the following:

- Out-of pocket expenses – the project costs paid by participants equal to total project costs net of federal tax credits and/or CT incentives and/or federal depreciation deductions.
- Funding mechanism – cost of bond issue, or traded energy certificates, or rate-based financing depending on the scenario.

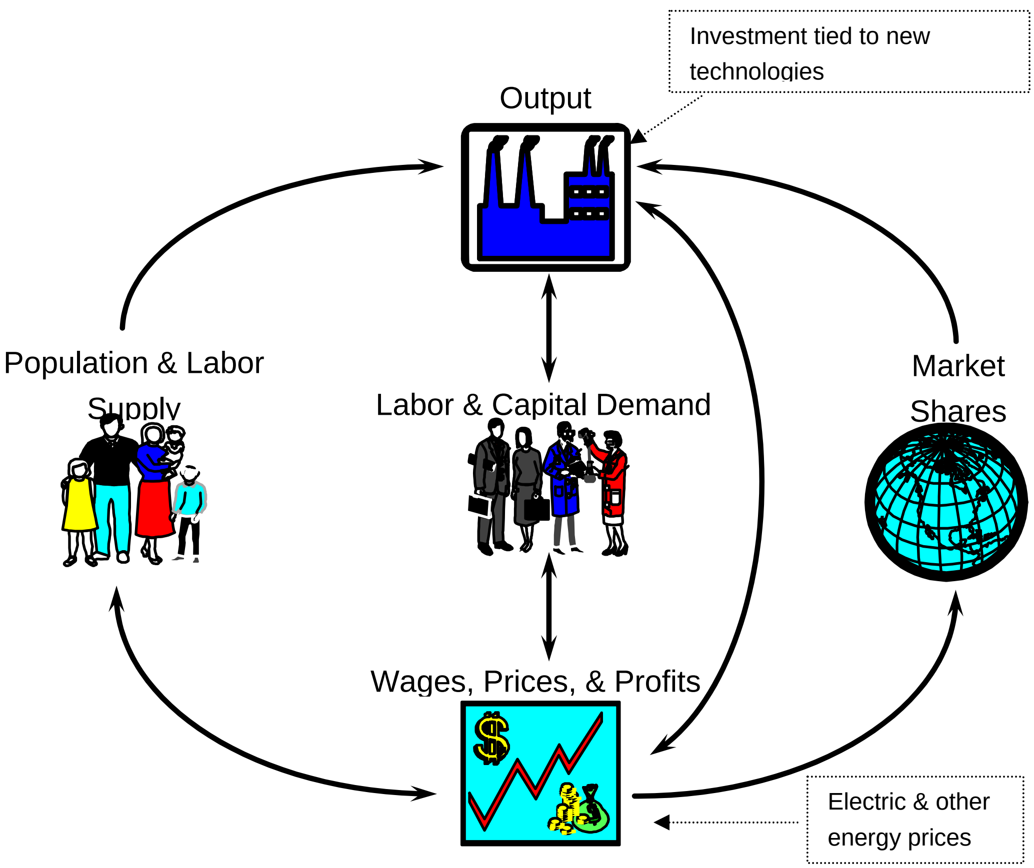
Table 2-5 summarizes additional assumptions made for the BC analyses.

**Table 2-5**
**Assumptions for BC Analyses**

| **Assumptions for Benefit:Cost Analyses** | |
|---|---|
| **System Pricing Scenario** | Gradual reductions |
| **Interconnection Policy Scenario** | Current rules |
| **Net Metering Availability Scenario** | Currently Available |
| **Net Metering Cap Scenario** | Current 2 MW Cap |
| **Cap and Trade Scenario** | None |
| **Electricity Price Escalation** | 2.2%, Based on report "Avoided Energy Supply Costs in New England: 2007 Final Report", prepared by Synapse, Inc. |
| **Federal Tax Credit** | Extended beyond 2016 |
| **Time-of-Use Rates** | Current Availability (avail in CT) |
| **RPS Solar Set Aside & Enforcement** | Yes |
| **Discount Rates (for opportunity cost of money)** | 3.0% Residential<br>7.5% Commercial |
| **Equipment Depreciation** | Federal MACRS 5-Year Schedule up to 60% of the total project cost (0.85 basis of the equipment outlay) |
| **System Degradation** | 80% efficiency remaining after 25 years |
| **Emission rates (lbs per MWh)** | 1,110 $CO_2$, 0.57 $NO_x$, 2.11 $SO_2$ |
| **Emission price forecasts** | See Appendix C |

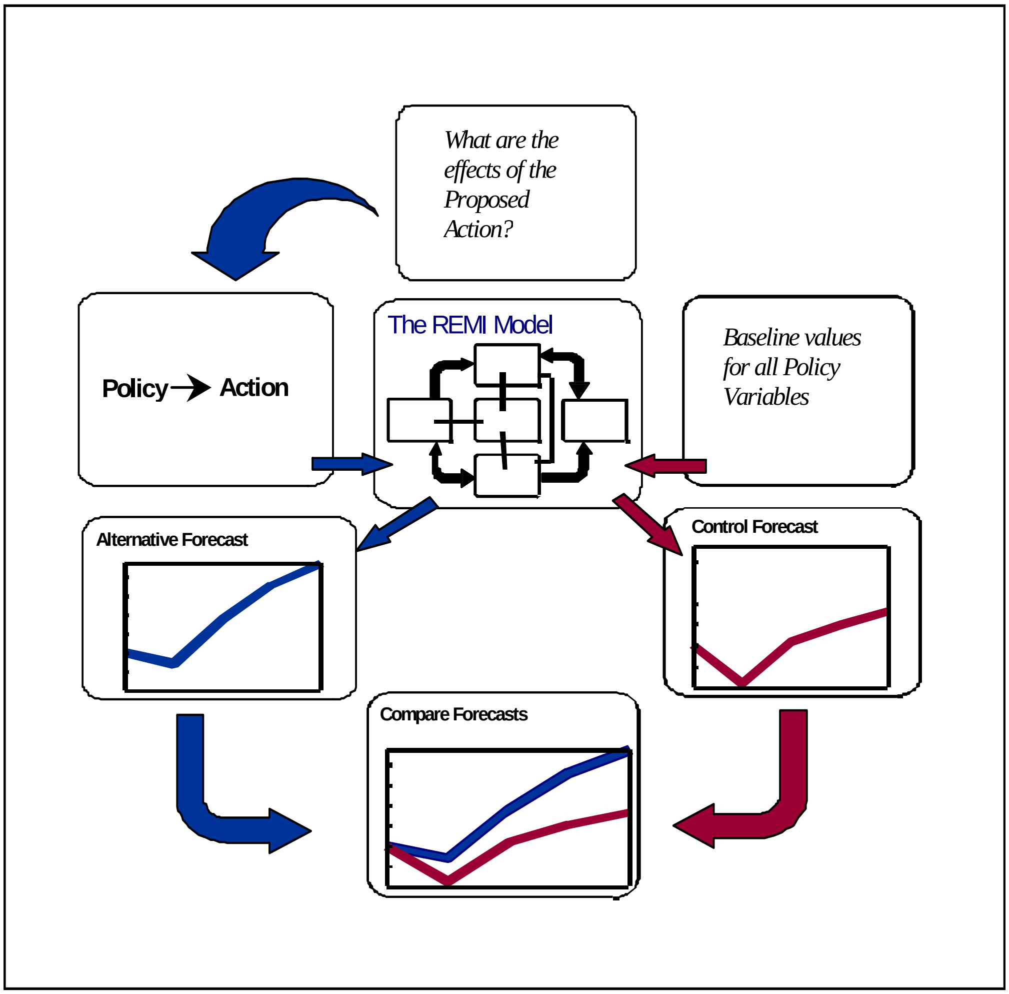
A REMI model (Regional Economic Modeling, Inc.) of the Connecticut economy is used to calculate the economic effects (the "*spin-off*" benefit as may be) from proposed scenarios to promulgate solar installations on the state's economy by tracking the flow of dollars, changes in purchasing and sales patterns, and impacts on prices and costs resulting from solar initiatives (more discussion on the rationale for leveraging economic models to energy policy is contained in Appendix A). 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 2-4.

**Figure 2-4**
**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 2-5 depicts this.

**Figure 2-5**
**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.

The "spin-off" economic effect associated with a scenario is measured with the REMI model. The resulting impact in terms of $ of gross state product (GSP or value-added) is incorporated as part of the benefits (the numerator) of the BC tests.

# 3. Description of Existing CT Solar Energy Programs

Under full funding, the CCEF receives approximately $28 million per year from the systems benefit charge found on the UI and CL&P utility bills. This funding covers all of the CCEF's programs including residential and commercial rebate programs, the technology development program, all of its community programs as well as research, studies and evaluations.

CCEF implemented its first installed capacity program, the On Site Renewable Distributed Generation Program, in 2005, to encourage commercial, industrial, and institutional organizations to install distributed generation systems producing clean electricity. With Connecticut serving as the home of the major pioneering fuel cell technology companies, this first program was immediately successful in providing grants to several fuel cell projects in the state.

In 2004, a broader strategic vision was set forth in a series of three program goals. The goals were included in CCEF's *Strategic Focus 2004-2007*. The first of those goals, Program Goal 1, was for the installation of distributed generation resources. Program Goal 1 states that "Connecticut ratepayers will have access to a diverse supply of installed clean energy resources through the implementation of Project 100 (later renamed Project 150) and on-site distributed generation (5MW)." Project 100 referred to a 2003 legislative mandate to have 100 MW of Class 1 (as defined by C.G.S. § 16-1(26)) clean energy distributed generation projects installed in Connecticut. Project 150 expanded the mandate to 150 MW. The other goals included:

- Program Goal 2 – supporting operational demonstration projects to encourage commercial viability of renewable energy technologies
- Program Goal 3 – educational activities to encourage adoption of alternative or renewable energy within Connecticut communities

The Solar PV Rebate program, formulated in 2004 and launched in January 2005 was designed to complement the On Site Renewable Distributed Generation Program by focusing on residential PV installations.

This section provides brief additional background on the installed capacity programs, the Project 150 initiative, and efforts Connecticut has made to invest in the development of renewable energy companies in-state.

More information on the installed capacity programs, including a benefit/cost analysis, will be available in KEMA's pending report to CCEF on the Monitoring and Evaluation of Installed Capacity Programs.

## 3.1 Solar PV Rebate Program

Established in January 2005, this program provided rebates for the installation of solar photovoltaic (PV) systems 10 kW or less, primarily targeted for residential installations. Since 2004, the Small Solar program has contributed energy, demand and peak capacity to Connecticut's energy supply mix. Participation in the program has steadily increased since its inception, and has accounted for the great majority of participants in all CT solar programs. Participation for 2008 will again show a large increase, possibly doubling participation of 2007. However, in 2008 the significantly increased demand exhausted the funds that were to be available to the program through June 2010, and currently CCEF is no longer accepting applications to this program.

The program offered a maximum of \$5.00/$kW_{PTC}$ for the first five kilowatts and \$4.30/$kW_{PTC}$ for the next five kilowatts of installed capacity. These incentives were reduced based on the efficiency of the installed system relative to an optimal system.

Program satisfaction is very high among participants and installers. Installers see the program as essential to the PV market in Connecticut and believe that it continues to be necessary.

## 3.2 OSDG Program

The On Site Renewable Distributed Generation Program (OSDG) is offered to all for-profit commercial (including multi-family), industrial, and institutional buildings, and to non-profit organizations and government agencies installing systems larger than 10 kW. The OSDG program is a \$32.75 million flexible, integrated-technology financial support program designed to stimulate demand for behind-the-meter installations of renewable energy generators at Commercial, Industrial and Institutional (CI&I) buildings in Connecticut. Applications for this program are accepted on an ongoing basis. The current OSDG program began in FY2005 and was preceded by an RFP-based program.

Through the On Site Renewable OSDG Program, CCEF offers grants to buy down the cost of renewable energy generating equipment. Renewable energy must be generated by a Renewable Energy electric generating resource within the scope of CCEF's authorization as defined by Conn. Gen. Stat. § 16-245n(a)., and includes fuel cells, solar PV, biomass, and small hydropower. To date, the OSDG program has only provided incentives to PV, fuel cell projects and a small number of wind projects.

The level of support for individual grant awards varied based on the specific economics of the installation. Additionally, the OSDG program offered grants of up to $50,000 per installation to support site-specific technical and financial feasibility studies.

In response to the overwhelming market demand in 2008 for the OSDG Solar Programs, the CCEF reduced the incentive levels and system size limits in April 2008, and again in June 2008. However, in the first five months of FY ’09, the CCEF approved incentives of $22,858,000, equivalent to an annual rate of $54,859,000. Because of the unprecedented response to the CCEF’s programs, the CCEF is not accepting any new Commercial For-Profit and Government/Not-For-Profit solar PV pre-applications and applications until further notice.

## 3.3 Solar Lease Program

To address low and moderate-income customers for whom the upfront cost of solar PV, even with rebates, is a significant barrier, CT Solar Leasing, LLC, a specialty leasing company, now offers the CT Solar Lease program in partnership with the Connecticut Clean Energy Fund, AFC First Financial Corporation, Gemstone Lease Management, LLC and US Bank. The goal of the CT Solar Lease Program is to provide leases for the purchase and installation of approximately 1,000 solar systems in a three-year period. This program was fully launched in November 2008.

The CT Solar Lease program combines CCEF's Solar Rebate program with a leasing arrangement to create opportunities for qualifying homeowner customers of CL&P and UI to add solar energy to their homes without any upfront costs. The CCEF Solar Rebate is utilized by CT Solar Leasing to reduce the monthly cost of the lease. And, because the leasing company owns the solar energy system, it can take advantage of expanded business tax incentives. The value of these extra incentives further reduces the monthly cost of the lease to the homeowner.

Through the leasing agreement, customers lock in a fixed monthly payment for a period of 15 years. As electric prices are expected to continue rising, the monthly payment stays the same thus increasing the savings on the customer’s electric bill.

As with the Solar PV Rebate program, approved solar installers are the primary point of contact with the customer, and have the responsibility to explain the leasing program to potential buyers.

The CT Solar Lease Program is for Connecticut homeowner customers of CL&P and UI who:

- Install qualifying Solar PV systems
- Reside in their 1 to 4 family owner-occupied homes
- Have a household income of 200% or less of their area's median income
- Meet the credit and debt to income qualifications of the program

While the customer assumes responsibility for all costs associated with operation and maintenance of the system, an innovative Solar Dividends™ program, funded through a portion of the value the leasing company can achieve from the sale of Renewable Energy Credits (RECs), is intended to create a reserve for future operating costs of the system such as inverter replacement and out of warranty repairs.

CCEF has allocated more than $23 million for the leasing rebates, and is encouraging approved solar installers and their customers to participate while funds for the other incentive programs are exhausted. Thus far, only a very small amount of this funding has been committed. Due to the complexity of having to explain multiple programs, installers may have difficulty in fully developing the potential from both the residential rebate and solar lease programs. Below, we have recommended that the solar lease program be continued, on a pilot basis, for 3 years, and then evaluated as to whether it is likely to be a successful long term program.

## 3.4 Education and Training

In response to the solar PV market that has been jumpstarted in Connecticut, and the increased demand for solar installers, in 2007, The Center for a Sustainable Future at Gateway Community College began offering non-credit certificate programs in solar PV.

The Center is a new proactive and unique programming initiative to meet the leadership challenge of providing education and training for a technology-ready workforce for a sustainable society. The Center is committed to taking an integral role in the sustainable economic development of the State of Connecticut, facilitating the transition to renewable energy resources, sustainable building development, energy efficiency programs, alternative transportation technologies, water management, and numerous other public and private initiatives. The Center has worked closely with Connecticut Innovations, the Connecticut Clean Energy Fund, and Solar Connecticut, the professional association representing solar installation companies in Connecticut. This program enables students to complete a certificate that includes the skills and knowledge needed to satisfy the North American Board of Certified Energy Professionals (NABCEP) requirements for entry-level work. Program graduates will take the NABCEP Certificate of Knowledge exam. Experience working on two solar installations over the course of a year can complete the requirements for NABCEP certification. The Center is seeking approval of this certification as one of the licensing requirement options for work in this field by the State of Connecticut.

The Center's PV Solar Energy Installer program has to date trained 78 installers, and has been expanded into a certificate program that trains students to be employed as entry-level PV solar installers in one of the existing 60 plus and rapidly increasing number of solar installation companies in Connecticut.

The program is based on the content and skill recommendations published by NABCEP. Instruction covers technically appropriate estimating, sizing, and installation procedures, understanding electrical systems and requirements, as well as switching, metering, and connecting alternatively-fueled and grid-tied electrical generation systems. Training is holistic in nature, teaching shop safety, human and environmental health standards, along with contextualized academics.

## 3.5 Clean Tech Fund

Capturing the economic activity associated with manufacturing and installing renewable energy systems contributes significantly to the overall benefits of any combination of incentive programs. Connecticut has supported such economic development consistently, and CCEF, through Program Goals 2 and 3, has recognized that supporting clean tech entrepreneurs through the funding of demonstration projects and conducting broad education initiatives are critical components of its mission.

In November, 2008, Connecticut Innovations (CI), the state's quasi-public authority responsible for technology investing and innovation development, announced that it will administer a new $9 million "Connecticut Clean Tech Fund" which will make investments in seed- and early-stage companies focused on innovations that conserve energy and resources, protect the environment or eliminate harmful waste.

The goal of the Clean Tech Fund is to position Connecticut as the preferred location to grow clean technology jobs.

The Connecticut Clean Tech Fund was formed through a partnership between Connecticut Innovations (CI), the Department of Economic and Community Development (DECD) and the Connecticut Clean Energy Fund (CCEF). CI and DECD have each made an initial commitment of $3 million to launch the fund. CCEF has pledged an additional $3 million for investments into companies that meet its criteria.

In addition to Connecticut companies that meet the fund's eligibility requirements, businesses interested in establishing a significant presence in the state now have the opportunity to receive investment capital from the Connecticut Clean Tech Fund. Some of the examples of the technologies eligible for funding include:

- Renewable Energy Generation Technologies (such as solar PV, wind, low impact hydro, biomass and fuel cell technologies)
- Energy Efficiency Technologies (such as solar thermal, geothermal, high efficiency lighting, advanced motor, energy storage, electric grid and load management technologies)
- Environmental Remediation Technologies (such as emissions control, microbial/algal water clean up and hazardous waste remediation technologies)
- Clean Water Technologies
- Renewable Fuel Technologies

In addition to these areas, other technologies deemed appropriate after consideration by the fund may be eligible for investment.

# 4. Proposed Residential Incentives

## 4.1 Residential Rebate Programs

### 4.1.1 Description

The Connecticut Clean Energy Fund has been running the Solar PV Rebate Program since October 2004. This segment addresses residential and/or non-profit sectors up to the maximum systems size of 10 kW. Incentives offered were \$5 $kW_{ptc}$ up to 5 kW, \$4.30/ $kW_{ptc}$ 5-10 kW. Incentives are adjusted based on predicted performance of the PV system relative to “optimal” system performance. This accounts for shading, tilt angle, and other factors that affect performance.

### 4.1.2 Other Jurisdictions

Many other states offer solar incentives to residential customers, typically in \$ per kW rebates, either performance-based or capacity based. States such as Massachusetts, New Jersey and New Mexico also include adders for in-state manufacturing products. Capturing a greater percentage of manufacturing and installation activity in-state would serve to improve the benefit/cost factors for all incentive programs. However, in terms of manufacturing, we note that other states, like Massachusetts, have included the in-state adders as a way to retain existing solar manufacturers. Connecticut does not currently have any in-state solar manufacturers.

### 4.1.3 Proposed Offering

The proposed offering is a version of the existing program that includes performance based incentives, but offers declining initiatives over time. The funding for this market segment/program would come from the System Benefits Charge.

As presented, the incentives decrease on an annual basis. The risk in this type of approach is that the program could be annually budget limited, and incentives could routinely run out in the middle of a year, creating a “boom and bust” situation for installers. Another model to be considered is to tie incentives to installed MW. For example, the residential rebate begins at \$2/Watt, but instead of being reduced at the end of 2009, it is only reduced when 0.5 MW of solar has been approved for installation by the program. That way, if market forces determine that \$2/Watt is too low to incentivize residential solar at the expected rate, the incentive remains at \$2/Watt beyond a year, until the goal is met. The incentive could also be raised if installations were well below the expected rate. Conversely, if installations outpace expectations, the incentives are automatically reduced when the goal is fulfilled. The advantage of this method is that the State knows exactly how much will be spent for each “block” of MW. The disadvantage, from an annual budgeting perspective, is that it is unclear when in a given year the incentives would be reduced. This decision will ultimately be made by the administrator of the program.

### 4.1.4 MW Goal and Incentives

As shown in the table below, we propose declining $/Watt incentives over a 10 year period, starting with a rebate amount of $2.00/Watt and regressing $0.10 per year (or potentially per MW block). The initial rebate level was determined based on recent experiences of other states that have been successfully providing residential solar rebates in that range (e.g. Vermont $1.75/Watt, Wisconsin $2.17/Watt, California $2.84/Watt). The goal was to initially target 25% to 30% of system costs, with declining incentives over time. In 2024 incentives would total just 12% of projected system costs. Initial projections of resulting installed MW are based on lower participation, based on the lower incentives, than was observed in 2008.

This program would be targeted at residential and potentially small commercial or non-profit customers. We would recommend limiting system size to 10 kW, and no greater than the expected on-site load. As in the current Solar PV Rebate program, the owner of the system would also own the RECs associated with the system’s production. Measurement and verification would be conducted by the program administrator, which is presumed to be CCEF.

**Table 4-1**
**Proposed Residential Incentives and Estimated Installations**

| | Estimated System Cost ($/Watt) | Proposed Incentive ($/Watt) | Incentives as % of System Cost | Estimated Installations (MW) | Incentive Budget |
|---|---|---|---|---|---|
| **2009** | $8.40 | $2.00 | 24% | 0.5 | $1,000,000 |
| **2010** | $8.06 | $1.90 | 24% | 1.1 | $2,042,500 |
| **2011** | $7.74 | $1.80 | 23% | 1.2 | $2,080,125 |
| **2012** | $7.43 | $1.70 | 23% | 1.2 | $2,111,905 |
| **2013** | $7.13 | $1.60 | 22% | 1.3 | $2,136,751 |
| **2014** | $6.85 | $1.50 | 22% | 1.4 | $2,153,444 |
| **2015** | $6.58 | $1.40 | 21% | 1.5 | $2,160,622 |
| **2016** | $6.31 | $1.30 | 21% | 1.7 | $2,156,764 |
| **2017** | $6.06 | $1.20 | 20% | 1.8 | $2,140,173 |
| **2018** | $5.82 | $1.10 | 19% | 1.9 | $2,108,963 |
| **2019** | $5.58 | $1.00 | 18% | 2.1 | $2,061,032 |
| **2020** | $5.36 | $0.90 | 17% | 2.2 | $1,994,048 |
| **2021** | $5.15 | $0.80 | 16% | 2.4 | $1,905,424 |
| **2022** | $4.94 | $0.70 | 14% | 2.6 | $1,792,289 |
| **2023** | $4.74 | $0.60 | 13% | 2.8 | $1,651,466 |
| **2024** | $4.55 | $0.50 | 11% | 3.0 | $1,479,439 |
| **2025 Total** | | | | 28.6 | $30,974,944 |

### 4.1.5 Residential Rebate BC Analysis

The results of the  BC analysis indicate that such a rebate program would be effective. The table below summarizes the results of the BC analysis.

**Table 4-2**
**Summary of BC Analysis for Residential Incentives**

| | | | | | |
|---|---|---|---|---|---|
| **Residential Rebate** | 2009 to 2048 | Total *Societal* Benefits | **$641,612,934** | Total *Societal* Costs | **$160,112,467** |
| | | *Avoided energy costs* | $498,707,612 | Project cost to HH | $160,112,467 |
| | | *emission benefits* | $7,952,659 | | |
| | | *Federal ITC* | $38,441,257 | | |
| | | *import substitution* | $34,428,728 | | |
| | | *economic spin-off ($ GSP)* | $62,082,679 | | |
| *Discount Rate* | 3% | **Present Value_Benefits** | **$364,747,128** | **Present Value_Costs** | **$126,938,917** |
| | | | | | |
| | | Benefit:Cost ratio | 2.87 | | |

## 4.2 Low Income Programs

To complement the residential incentive offering and specifically target the low-income sector that faces additional barriers to funding development of solar energy systems, we recommend implementation of separate low-income incentive program.

### 4.2.1 Program Description

CCEF currently has two programs that address the low income housing sector: the Affordable Housing Initiative, and the CT Solar Lease Program, which is also intended to serve moderate-income customers.  The Affordable Housing Initiative is a CCEF program that provides developers of low income housing a financial incentive to include clean energy in their affordable housing designs. Small residential rebates are capped at $60,000, while larger commercial developments can receive up to $850,000. Program data is not currently available for the Solar Lease Program. The program's financial benefits also spill over to the affordable housing residents, who incur reduced electricity bills as a result of the clean energy installations. Eligible participants must be affordable housing developers, management companies that own or manage affordable housing, or third party energy service providers; and projects must occur in the Connecticut Light & Power (CL&P) or United Illuminating (UL) service territories.  The program provides performance based financial incentives for PV installations in both small residential developments, and larger commercial housing developments. Performance based incentives are based on several factors, including inverter efficiency, system orientation, panel tilt, and shading.

The CT Solar Lease Program, described previously in Section 3.3, uses leasing to address the lack of capital barrier, by removing high initial PV system costs and offering residents access to clean energy at a low monthly rate. Currently, the CT Solar Lease Program is the only state-sponsored leasing program available in the United States. The goal of the lease program is to be able to offer a 5 kW system at a lease of about $120 per month, only slightly higher than the typical household electricity bill.

### 4.2.2 Other Jurisdictions

Many low-income clean energy programs have been developed at both the state and municipal level in other jurisdictions. Many states also offer rebates for solar hot water heating systems, however, only a few of these programs offer special rebate terms for low-income participants, including Vermont, California, and Florida. Those programs are further described below.

***Vermont:*** The Vermont Small Scale Renewable Energy Incentive Program, established in 2003, provides capacity-based rebates to low-income multi-family projects for solar PV systems, solar hot water collectors, and small wind systems. The program is overseen by the Vermont Energy Investment Corporation, on behalf of the Vermont Department of Public Service. Incentives are capped at the lesser of $35,000 or 50% of the total system cost for solar PV systems and solar hot water collectors, and $12,500 for wind systems (The Vermont Department of Public Service, 2009). Vermont's program extends to individuals, businesses, schools, farms, and local/state governments, but sets higher solar PV and solar water heater incentive limits for low-income multi-family projects. Currently the program only supports multi-family low-income projects and does not include single-family projects. Incentive levels for low-income multi-family wind systems do not differ from the standard levels set for other program participants.

According to Gabrielle Stebbins, Program Administrator for the Vermont Small Scale Renewable Energy Incentive Program, it is important to be extremely clear regarding program eligibility requirements both from the outset and during the course of the program. The program has received several questions regarding eligibility of retrofits, particularly in the case of towns and municipalities. In order to maintain consistency in their response to such inquiries, they have developed a tracking system to record eligibility decisions (G. Stebbins, personal communication, February 4, 2009).

The Vermont program does not currently require any documentation to prove low-income status (G. Stebbins, personal communication, February 4, 2009). Although this hasn't yet presented any major challenges for the Vermont program, it could create problems in the differing context of another state or municipality. Documentation of income-based eligibility, if deemed appropriate, should be clearly outlined in program eligibility requirements.

Vermont's program operates on a reservation system; after an application is received, funding for that particular project is guaranteed. Unfortunately, rebate funds have been exhausted on more than one occasion during the program's lifetime. As a result, the program has had to occasionally put applications on hold until new funds come in (G. Stebbins, personal communication, February 4, 2009). The program has supported the installation of over 345 renewable energy systems, awarding approximately $1,373,920 in incentives between 2003 and 2006 (The Vermont Department of Public Service, 2009). As of February 2009, low income participation has accounted for 12 of the renewable energy systems installed by the program, including 11 solar hot water systems and 1 solar PV system, totaling approximately $117,880 in incentives (G. Stebbins, personal communication, February 20, 2009).

Vermont's program offers incentives based on installed capacity, while CCEF's solar incentives under the Affordable Housing Initiative are performance based. Vermont's program also differs from CCEF's programs in that it offers incentives to developers, homeowners, schools, governments, and farms under the same incentive structure; CCEF offers developers incentives through the Affordable Housing Initiative and separate incentives tailored for homeowners through the Solar Lease program. Finally, Vermont's program offers a solar hot water heating incentive not currently offered by CCEF programs.

***California:*** The California Solar Initiative (CSI) Low-Income Incentive Programs are aimed at low-income single family and multi-family projects. The CSI Single-Family Low Income Incentive Program, provides incentives which fully subsidize 1kW solar PV systems for low-income residents meeting the lowest income criteria, and $/watt incentives to highly subsidize solar PV systems for other low-income residents. The CSI Multi-family Affordable Solar Housing (MASH) Program provides two types of incentives, a fixed, capacity-based incentive for solar systems that offset common area loads, and higher incentives for projects that can quantify savings that are shared with tenants (California Public Utilities Commission, 2008).

The California Energy Commission also launched the New Solar Homes Partnership (NSHP) in 2007, which offers performance based incentives for affordable housing developments that are higher than those for standard market rate housing projects. The program also includes a unique monitoring and maintenance component, which requires applicants to submit maintenance and monitoring plan to the building manager, outlining the maintenance and monitoring tasks required for the system to achieve maximum output over its lifetime (California

Energy Commission, 2007a). The program has committed 36 MW of its overall 400 MW goal over ten years to affordable housing projects (California Energy Commission, 2007b).

In 2008, the CSI authorized $1.5 million to be used for their Solar Hot Water Heating Pilot Program (SWHPP) (Center for Sustainable Energy California, 2008). The pilot program is only available to residential, commercial, and industrial customers of San Diego Gas & Electric. While the program does not specifically provide additional incentives for low-income participants or developers of low-income housing, the relative affordability of solar thermal water heating systems compared to PV systems could make this type of program particularly attractive to the low-income sector. Residential systems can receive up to $1500, while larger systems can receive up to $75,000 (Center for Sustainable Energy California, 2008). To date, the pilot program has successfully installed 109 heating systems, representing a total of $157,199 in incentives (Center for Sustainable Energy, 2008).

Both California and CCEF offer performance based incentives for affordable housing developments, but California also provides a unique structure to provide increased incentive levels, including a fully subsidized 1kW solar system, for very low income residents. California has also developed a solar hot water heating incentive.

***San Francisco:*** In 2008, the City and County of San Francisco launched the GoSolarSF program which includes special incentives for low-income and non-profit organizations. The program offers fixed residential incentives ranging from $2,000-$4,000, with low-income residents potentially qualifying for an additional $7,000 rebate[5], because low-income residents are not likely to benefit from the increased federal tax credit (San Francisco Public Utilities Commission, 2009). The GoSolarSF program has a total budget of $2,850,000 for incentives. A total of 23 low-income residential applications, representing $115,000, were received by the program as of November, 2008 (San Francisco Public Utilities Commission, 2009).

San Francisco's program offers capacity based incentives, while CCEF offers performance based incentives. San Francisco also takes a different approach by offering incentives to both low income residents and non-profit organizations. The program also differs in structure, with low income incentives offered through an existing rebate program, rather than through a separate program specifically aimed at low-income residents.

[5] New incentive level for 2009, pending approval by the San Francisco Board of Supervisors.

***Florida:*** In 2003, Florida's Front Porch Sunshine program began installing solar hot water heating systems in low-income, weatherized homes (Florida Department of Energy, 2003). The program evolved through a unique partnership between the Florida Solar Energy Research and Education Foundation, the Florida Energy Office, the Florida Solar Energy Center and Front Porch Florida, a program initiated in 1999 to revitalize 20 low income communities throughout the state (Florida Department of Energy, 2009). The program set out to install 150 solar hot water heating systems in Front Porch Communities, with the goal of reducing energy use, monthly energy bills, and thus improving quality of life for low-income residents in Florida (Florida Solar Energy Research and Education Foundation, 2009).

Florida's program is unique from other jurisdictions because it is designed to work in conjunction with an existing state program aimed a community revitalization. This strategy targets known low-income participants, while CCEFs programs are offered through an application process.

### 4.2.3 Proposed Offering

KEMA recommends that CCEF continue with both the CT Solar Lease and Affordable Housing Initiative programs, provided they are viewed as being successful. Particularly with the CT Solar Lease program, however, we note that the burden on installers of having to explain a variety of residential incentive programs adds complexity, with the result being that installers may come to favor one program over another. For that reason, we have modeled the Solar Lease Program as a 3-year pilot program, though based on its success it could be extended. Table 4-3 presents the estimated costs and installations of the Solar Lease Program.

**Table 4-3**
**Proposed Solar Lease Program Installations and Grants**

| Year | Estimated Installations (MW) | Equipment Grants ($/kW) | Total Budget |
|---|---|---|---|
| **2009** | 0.25 | $3,909 | $977,347 |
| **2010** | 0.25 | $3,753 | $938,253 |
| **2011** | 0.5 | $3,603 | $1,801,446 |
| **Total** | 1.0 | | $3,717,047 |

The Affordable Housing Initiative program was not modeled in the BC analysis, for two reasons. First, low income programs are primarily focused on providing equity to disadvantaged populations, and are unlikely and not designed to pass BC tests that are expected of other programs.

The CCEF's programs generally appear to reflect best practices and emerging trends in other jurisdictions. CCEF's Affordable Housing Initiative provides for performance-based incentives, which distinguishes the program from many others that only offer incentives based only on installed capacity. However, several other programs have developed solar hot water heating components, and CCEF's low-income initiatives do not yet offer this incentive. Solar thermal water heating systems likely represent a particularly affordable option in comparison to other clean energy technologies, making them well-suited for low-income residents.

### 4.2.4 Solar Lease BC Analysis

The results of the BC analysis indicate that the Solar Lease pilot will be cost effective. The table below summarizes the results of the BC analysis.

**Table 4-4**
**Summary of BC Analysis for Solar Lease Program**

| | | | | | |
|---|---|---|---|---|---|
| **Solar Lease** | 2009 to 2037 | Total *Societal* Benefits | **$25,466,294** | Total *Societal* Costs | **$9,434,049** |
| | | *Avoided energy costs* | $16,524,122 | Project cost developer | $7,434,098 |
| | | *emission benefits* | $243,893 | HH *net* Lease cost | $1,999,951 |
| | | *Federal ITC & Depr. Deduction* | $2,663,265 | | |
| | | *import substitution* | $1,137,751 | | |
| | | *economic spin-off ($ GSP)* | 4897262.005 | | |
| *Discount Rate* | 7.5% | **Present Value_Benefits** | **$11,940,866** | **Present Value_Costs** | **$6,234,338** |
| | | | | | |
| | | Benefit:Cost ratio | 1.92 | | |

### 4.2.5 Low Income Solar Hot Water Heating

KEMA recommends that the CCEF develop and incorporate a solar hot water heating incentive into its existing Affordable Housing Initiative, in partnership with the CEEF and the Fuel Oil Conservation Fund to provide Solar Thermal Domestic Hot Water STDHW incentives to electric, gas, oil and new construction systems. System malfunction was reported to be a problem during the early solar hot water programs in California in the 1980s, thus many programs have included warranties or monitoring components into their eligibility requirements (Center for Sustainable Energy California, 2008). For example, the Vermont program requires a five-year warranty on all system parts, and has found that this has worked well. Only two out of 200 contractors in Vermont decided not to work with the program based on this requirement (G. Stebbins, personal communication, February 4, 2009). California's SWHPP provided training to contractors/ customers on a monthly basis during the first three month's of the program and on a bi-monthly basis thereafter. The program also requires a 10 year warranty on the solar collector, 1-5 year warranties on other system parts, and a 1 year warranty on installation labor and workmanship (Center for Sustainable Energy California, 2008). KEMA also recommends that eligibility requirements for solar hot water system rebates include a requirement that the solar collectors be certified by the Solar Rating Certification Corporation (SRCC) or an equivalent organization. This is a common eligibility requirement in similar programs throughout the country, including California and Vermont. Similar programs also generally do not allow pool and spa heating systems to qualify. Finally, documentation of income-based eligibility, if deemed appropriate, should be clearly outlined in program eligibility requirements. KEMA suggests this be a joint pilot with other efficiency funds with funding in part coming from the energy efficiency funds.

#### 4.2.5.1 Track Low-Income Participation

Despite the wide variety of existing low income solar incentive programs, data on program results and metrics, particularly regarding low-income participation, is sometimes lacking. Low-income program offerings are often a subset of standard program offerings, and thus do not necessarily get tracked separately. KEMA therefore recommends that CCEF assess low income participation in the solar lease program. The CT Solar Lease Program targets residents of varying income levels; assessing low income participation will reveal the extent to which the program is truly benefiting low income residents.

#### 4.2.5.2 Monitor System Performance

The Affordable Housing Initiative currently requires the same revenue quality, metering, and reporting requirements as the Solar Rebate program after installation. Under the CT Solar Lease program, residents are responsible for maintenance costs during the lease period. Although CCEF program incentives are performance-based, it is not guaranteed that systems will perform optimally over time. Vermont Program Administrator recommended maintaining a continual dialog with contractors and installers to gauge actual system performance in the field. Minnesota's residential Solar Hot Water Rebate Program also includes a requirement to ensure system performance over time, referred to as a consumer education requirement. This requirement states that installers provide an owner's manual specific to the system, a maintenance schedule, and guidance on how to determine if their solar hot water system is functioning correctly to the system owner (Minnesota Office of Energy Security, 2009). CCEF should also consider including a consumer education component, or a monitoring and maintenance plan requirement, similar to that required by the California NSHP program (described above), in their eligibility requirements. An education/maintenance component won't require CT to make a long-term commitment to track system performance, but rather empowers building operators and system owners the tools they need to maintain a solar PV or solar thermal system for optimum performance.

## 4.3 Zero Net Energy (ZNE) Homes

Zero Net Energy Homes programs target new construction and are an additional way to develop interest in and demand for solar energy systems. Not to mention, the most effective and efficient way to implement an alternative energy technology into a development is during the planning stages.

Beginning in March 2009, the Connecticut Energy Efficiency Fund, in partnership with the CCEF, issued a Zero Energy Challenge to identify, encourage and promote builders and developers of super high efficiency (near *zero energy*) homes in Connecticut in order to demonstrate that building to this level of efficiency is achievable today and to become better informed about what it takes to get there. The Challenge is a design and build competition for single and multi-family homes in Connecticut completed between April 17, 2009 and December 1, 2010.

### 4.3.1 Program Description

In the United States, residential buildings consume twenty-two percent of the primary energy used in the country (Federal Research and Development Agenda). One proposed initiative that will reduce the energy consumption and subsequent greenhouse gas footprint of the residential sector is the promotion of zero net energy homes. According to the U.S. Department of Energy, a zero net energy home is a residential "building with greatly reduced needs for energy through efficiency gains, with the balance of energy needs supplied by renewable technologies." The home is still connected to the grid and receives energy from a utility when necessary, but ultimately produces and returns that same amount of energy to the utility over the course of a year through on-site renewable generation sources.

The overall need for energy in the home is reduced through efficient building design and equipment. Zero net energy homes will have thick insulation to reduce HVAC loads and better placed windows to increase natural light and ventilation. Appliances and other in home equipment should be energy star or above in order to use as little energy as possible. The home is also fitted with on-site renewable energy sources such as a solar hot water heating system and rooftop photovoltaic cells that generate electricity that can be consumed or sold back to the grid.

## 4.3.2 Other Jurisdictions

California has proposed as one of the "big bold energy efficiency strategies" in their Long Term Energy Efficiency Strategic Plan, that all new homes must be zero net energy homes in 2020. While this proposal is aggressive, the California Energy Commission hopes to advance technological innovation, increase building standards and codes, and initiate pilot projects to advance the development of zero net energy homes throughout the state (California Long Term Energy Efficiency Strategic Plan). The Sacramento Municipal Utility District has launched a pilot program that will guide their promotion of zero energy homes. The utility had teamed up with developers like Premier Homes and GE, and has helped fund 127 Premier and Treasure homes between 2004 and 2007. These homes had an average of forty percent energy savings, and the municipal utility gave $1.5 million in solar incentives for the projects (General Electric's Solar Systems). Because of the success of these projects, SMUD has created two new pilot projects that will further their goal of creating zero net energy homes in the future (Parks, "Heading to Net-Zero by 2020"). They plan to build a zero energy home with eighty percent energy savings in order to demonstrate the features of a zero energy home to the public. They have also teamed up with PIER and San Diego Gas and Electric to build two zero energy home subdivisions as a pilot program.

Some progress towards advancing zero net energy homes has already occurred in Connecticut. A nonprofit home developer, the SAND Corporation, has committed to building six zero energy homes in inner-city Hartford (Holladay, Near Zero Energy Homes in Inner City Hartford). Steven Winter and Associates, located in Norwalk, Connecticut, has already started to assist in the development of zero net energy homes in other states. Funded by the Building America program, a Department of Energy Initiative that funds builders and developers to help them find ways to get homes closer to zero energy, this company has seen little interest so far in Connecticut. They feel many people do not know about zero net energy homes and have only been contacted by one or two people looking for ways to get their homes closer to zero energy. They have been in contact with Connecticut Light and Power about creating an incentive or rewards program for highly efficient homes through the Connecticut Energy Efficiency Fund. According to the representative interviewed at Steven Winter and Associates, the company would like to deploy the program within a year but no firm plans have been made.

### 4.3.3 Barriers

Currently, zero net energy homes are not economically competitive with conventional homes but are technically feasible. Though not yet economically competitive, ZNE homes would serve a useful purpose as demonstration and education projects to residential builders in Connecticut.

Also, other, non-financial barriers must be considered concerning zero net energy homes in Connecticut. Builders must be trained to construct a zero net energy home, and likewise, homeowners need to be educated on what a zero net energy home is and how it can save them money in the long run to increase interest in the program.

### 4.3.4 Proposed Offering

In addition to the recently announced Zero Energy Challenge, we propose that CCEF work with the Connecticut Energy Efficiency Fund and Oil Conservation Fund to develop a net zero energy component in the existing new construction program as a pilot offering. This pilot program should then be evaluated and reviewed so more aggressive new home standards will be developed over time that will support the movement toward new zero net energy homes. As a pilot program, and in recognition that net zero energy homes are in the development phase, we recommend paying elevated rebates to the initially piloted homes. Table 4-5 summarizes the recommended program offering.

**Table 4-5**
**Proposed Zero Net Energy Homes Program Incentives and Estimated Installations**

| Year | Estimated Installations (MW) | Proposed Incentive ($/Watt) | Total Budget |
|---|---|---|---|
| **2009** | 0.03 | $4.00 | $120,000 |
| **2010** | 0.06 | $4.00 | $240,000 |
| **2011** | 0.12 | $4.00 | $480,000 |
| **Total** | 0.21 | | $840,000 |

California has already established standards for new homes and a framework for getting there that increases building standards every few years. Connecticut should also establish aggressive standards after fully evaluating their pilot program in order to spur innovation among developers and encourage participation and assistance from the utilities.

Immediate action can speed the market penetration of zero net energy home technologies because there is more research needed to get a home to be completely zero net energy. With the advancement of zero net energy homes in Connecticut will come more opportunities for jobs, education and energy conservation. Developers and homebuilders will benefit from more jobs as consumers look to build more zero net energy homes in the state.

### 4.3.5 Zero Net Energy Homes BC Analysis

The results of the BC analysis indicate that the rebates for the Zero Net Energy Homes program would be cost effective. The table below summarizes the results of the BC analysis.

**Table 4-6**

**Summary of BC Analysis for Zero Net Energy Homes Program**

| | | | | | |
|---|---|---|---|---|---|
| **Homes** | 2009 to 2048 | Total *Societal* Benefits | **$4,372,873** | Total *Societal* Costs | **$1,549,620** |
| | | *Avoided energy costs* | $3,483,888 | Project cost to HH | $1,549,620 |
| | | *emission benefits* | $51,471 | | e |
| | | *Federal ITC* | $241,920 | | |
| | | *import substitution* | $239,532 | | |
| | | *economic spin-off ($ GSP)* | $356,063 | | |
| *Discount Rate* | 3% | **Present Value_Benefits** | $3,170,558 | **Present Value_Costs** | $1,486,866 |
| | | | | | |
| | | Benefit:Cost ratio | 2.13 | | |

# 5. Proposed Programs for Government Facilities

## 5.1 State Government Facilities

### 5.1.1 Description

In the past few years, third-party ownership with a Power Purchase Agreement (PPA) is emerging as a dominant model for financing PV. Third-party ownership of PV systems grew from 10% in 2006 to 50% in 2007 for commercial and industrial sectors, according to GreenTech Media. A similar model can be applied to government buildings whereby the government or other public-sector buildings are developed as locations for PV by third-party owners and operators. The public sector host signs a long-term power purchase agreement (PPA) with a third party which owns the system. This third party benefits from any tax incentives and passes the benefit on to the public sector host in the PPA contract. In return, the PPA will provide a stable and predictable facility electricity budget.

### 5.1.2 Other Jurisdictions

While third party ownership of PV systems is common in commercial and industrial facilities, there are limited government examples. Some of these include:

- Denver International Airport, CO–25-year contract for 2 MW of solar PV–Option to buy the system in year 6 (at market value)
- Port of Oakland, CA–756 kW ground-mounted system–Driver: “clean and predictably priced electricity”
- San Diego Alvarado Water Treatment Plant–1 MW of solar PV–Covers 20% of plant’s power needs

### 5.1.3 Proposed Offering

Following legislation required to implement this policy initiative, the Connecticut Clean Energy Fund and the Department of Administrative Services would develop and issue a Request for Proposals to install solar PV at facilities owned or managed by the State of Connecticut. Any towns, municipalities or others that receive state funds would also be able to opt-in to this RFP process. A technical consultant, hired by CCEF and DAS, would pre-screen and rank projects for technical viability.

State bonding would potentially be used to reduce the up-front costs of solar, and would enable the State to secure a long-term PPA at electricity rates below the current market rates. These savings would in turn benefit all citizens due to the reduced cost of government services and may subsequently reduce the need to raise taxes or curtail services. Additionally, long term PPAs secure and stabilize electricity prices for the duration of the contract, and third-party owners are responsible for operation and maintenance of the solar installations. This model is intended to shift these risks away from the government entity to the project developer. Importantly, this model also enables the state to leverage the 30% Federal Investment Tax Credit otherwise unavailable to solar system owners with no federal tax obligation.

### 5.1.4 MW Goals and Costs

The proposed budget for the State Government Building Program is based on a gradual increase in installed MW over the course of 5 years, beginning in 2010. This program does assume that the state is in the appropriate financial position to issue bonds to buy down the up front costs of the PV systems and secure favorable PPA pricing.

Recently, President Obama has committed to using a portion of federal economic stimulus funds to jumpstart a “green” economy, including installations of renewable energy as well as required upgrades to transmission and distribution systems to allow for greater integration of renewables onto the electric grid. Because of the limited time frame for the use of any such funds, which are primarily designed to stimulate economic activity, we don’t consider such funds to be part of a sustainable strategy for Connecticut. However, we note that there may be an opportunity for federal economic stimulus funds to accelerate the installation of renewable energy systems, such as those on state government facilities, in the short term which could accelerate employment growth for in-state solar installers and large installations from such an effort could expand the scale at which solar is considered for development in Connecticut. We have not modeled such a “burst” of installations in this study, and in order to preserve an ongoing incentive for solar development in Connecticut, we would recommend that the total MW of any such “stimulus” installations not be eligible to count against the solar RPS carveout, or that the solar RPS goals be adjusted upward to account for them.

KEMA used a conservative estimate of the growth of retail electric rates (1.5%), which is in line with predictions by the federal Energy Information Administration and the most recent avoided electricity cost projections for New England, conducted by Synapse in 2007. Higher growth in electricity rates would increase the savings available to the State, and we note that an annual growth rate of between 4% and 5% would result in an overall cost savings for this program by 2030. KEMA used a starting point for electricity prices of $161/MWh in 2010 , based on the most recent pricing data from the Energy Information Administration, and a 2010 starting price for assumed 15-year PPAs of $110/MWh, escalating at 2% per year. The table below summarizes the estimated installed MW, energy cost savings, debt service costs, and overall costs of such a program.

**Table 5-1**
**Proposed Government Building Program Installations and Funding**

| Year | Installed MW | Annual MWh | Energy Cost Savings | Debt Service Costs for State Bonds | Total Cost |
|---|---|---|---|---|---|
| 2009 | | | | | |
| 2010 | 1 | 1,174 | $59,866 | $157,231 | $97,365 |
| 2011 | 2 | 2,348 | $180,355 | $459,113 | $278,759 |
| 2012 | 3 | 3,522 | $362,169 | $893,825 | $531,656 |
| 2013 | 3 | 3,522 | $545,357 | $1,311,147 | $765,791 |
| 2014 | 3 | 3,522 | $729,828 | $1,711,777 | $981,949 |
| 2015 | | | $732,389 | $1,711,777 | $979,388 |
| 2016 | | | $734,821 | $1,711,777 | $976,956 |
| 2017 | | | $737,119 | $1,711,777 | $974,658 |
| 2018 | | | $739,277 | $1,711,777 | $972,501 |
| 2019 | | | $741,288 | $1,711,777 | $970,489 |
| 2020 | | | $743,149 | $1,711,777 | $968,628 |
| 2021 | | | $744,852 | $1,711,777 | $966,925 |
| 2022 | | | $746,392 | $1,711,777 | $965,385 |
| 2023 | | | $747,763 | $1,711,777 | $964,015 |
| 2024 | | | $748,957 | $1,711,777 | $962,820 |
| 2025 | | | $687,471 | $1,554,547 | $867,075 |
| 2026 | | | $563,094 | $1,252,664 | $689,570 |
| 2027 | | | $375,709 | $817,953 | $442,244 |
| 2028 | | | $187,960 | $400,630 | $212,670 |
| | 12 | 14,086 | $11,107,816 | $25,676,658 | $14,568,842 |

### 5.1.5 State Government Building PPA Program BC Analysis

The results of the BC analysis indicate that the state government PPA program would be cost effective. The table below summarizes the results of the BC analysis.

**Table 5-2**
**Summary of BC Analysis for Government Building Program**

| | | | | | |
|---|---|---|---|---|---|
| **State Facilities (PPA)** | 2009 to 2038 | Total *Societal* Benefits | **$349,871,031** | Total *Societal* Costs | **$110,734,788** |
| | | *Avoided energy costs & Retail Elec. Purchase savings* | $216,332,325 | Project cost to Developer | $85,058,130 |
| | | *emission benefits* | $3,016,896 | Bond payments | $25,676,658 |
| | | *Federal ITC & Depr. Deduction* | $43,230,795 | | |
| | | *import substitution* | $13,848,052 | | |
| | | *state bonds* | $17,767,662 | | |
| | | *economic spin-off ($ GSP)* | $55,675,302 | | |
| *Discount Rate* | 7.5% | **Present Value_Benefits** | **$162,923,930** | **Present Value_Costs** | **$85,818,096** |
| | | | | | |
| | | Benefit:Cost ratio | 1.90 | | |

## 5.2 Municipal: Community Solar

### 5.2.1 Description

Community solar projects allow multiple users to purchase a portion of their electricity from a solar facility, which is typically connected to the grid but not "behind the meter" at each user's location. Modifications to current state laws may be necessary to enable this type of model. Alternatively, there may be an opportunity for the utility to own and operate such facilities and to ratebase such investments. Under this model, participants receive solar power without having to pay upfront costs or handle installation challenges and it allows efficiency of scale in design, construction and monitoring costs. Customers drawing this power often lack the proper on-site solar resource or fiscal capacity or building ownership rights themselves. Community solar typically allows increased power output per unit installed because the arrays can be placed on the sunniest sites and at the optimum geometrical orientation.

### 5.2.2 Other Jurisdictions

Community Solar programs exist in pockets throughout the U.S. and in different types of programs. However, many are focused on educational facilities as these are growing most rapidly. Limited data exists on results and metrics to measure and evaluate these programs. Specific examples include:

- A cluster of installations in a community (Martha's Vineyard, MA; Block Island, RI)
- Solar co-op as part of a green power program, such as the NW Solar Cooperative, Chelan PUD SNAP Program, and the City of Ellensburg Community Solar Electric.
- Solar on public or non-profit agencies that serve the community, funded via a specific green power program (Seattle City Light, SMUD Community Solar, City of Ashland). Under SMUD's community solar program, called SolarShare, private developers are able to take advantage of the federal tax incentives to build, own and operate systems of 1 MW in size and enter into 20-year fixed price contracts to sell all of the output to SMUD, which then retails this power to participating customers

### 5.2.3 Proposed Offering

Under a Community Solar program, proposed legislation would authorize the development of community solar projects to serve residential, non-profit as well as local municipal governments. Also included would be other entities that receive funding by the state that choose to enter into the program. Utilities should be included as partners in managing such projects, and potentially in implementing and funding them as well.

The CCEF would provide project grants for community solar projects serving residential consumers. Consumers enrolling in community solar projects would receive the full retail offset of their proportional interest in the community solar facility.

### 5.2.4 MW Goals and Costs

KEMA considers the budget for Community Solar projects to be from the same pool as that for Residential rebates previously discussed, or from Solar RECs which are discussed below. Similarly, we consider the MW Goals for Community Solar projects to be included in the goals for those other programs. The key to the success of Community Solar projects would be the development of Virtual Net Metering legislation (further discussed in Section 7.2) which would be the mechanism under which customer accounts that are not located "behind the meter" would be able to offset retail-priced electricity from the production of a centralized PV system.

# 6. Proposed Commercial Incentives

## 6.1 Solar RECs

### 6.1.1 Description

Solar Renewable Energy Certificates (SRECs) work similar to RECs, as tradable certificates in the clean power markets. Each SREC contains the attributes of 1 MWh of solar power instead of a broader array of renewable energy attributes. SRECs provide a revenue stream to solar producers that help displace the cost of solar production which helps it compete with other technologies (such as fossil fuels). Several states have set up provisions in their RPS which apply specifically to solar power. In addition, these states set a special, usually much higher, non-compliance fee for the solar portion of their RPS. While SRECs trade below these non-compliance fees, they do tend to be worth substantially more than other RECs.

Established in 1998 and subsequently revised several times, Connecticut's renewable portfolio standard (RPS) requires each electric supplier and each electric distribution company wholesale supplier to obtain an annually increasing share of its retail load from renewable energy. Connecticut's RPS does not currently have a separate provision specifically for solar, but does stipulate that the majority of the RPS must be met by "Class I" sources, which include solar, wind, fuel cells,, wind and bio-gas. Connecticut's non-compliance fee is currently set at $55/MWh ($0.055/kWh).

### 6.1.2 Other Jurisdictions

New Jersey has an aggressive RPS with a specific provision for developing 2.12% of their in-state electricity from solar by 2021. New Jersey's solar non-compliance fee (known as the solar alternative compliance payment (SACP)) is set at a declining rate schedule beginning at about $700/MWh for fiscal year 2009. The SACP is intended to be above the highest monthly market clearing price for SRECs. Thus, load serving entities are encouraged to purchase SRECs from the market rather than pay the fee, and the fee is essentially a ceiling on the price of SRECs. SRECS typically trade well below this price, with a weighted average price in December 2008 of $418/MWh in New Jersey.

New Jersey has an SREC Administrator who tracks production from individual generators, issues SRECs, and records the sale (or other transfer of ownership) of SRECs from generators to other account holders. For 10 kW or less systems, the SREC Administrator provides an annual engineering review that estimates the monthly production from the system. Larger systems are directly metered. This information is uploaded to an online trading system maintained by the SREC Administrator. Once a generator has produced 1 MWh of energy, they are awarded an SREC, which they can then trade using the online system. Quantities less than 1 MWh can be carried over year-to-year. Load-serving entities pass the cost of SRECs onto ratepayers, and New Jersey has instituted a 2% cap on rate increases due to the cost of SRECs.

New Jersey recently decided to transition from a system that included solar rebates to one that uses exclusively SRECs to grow its solar industry. New Jersey's rebate program was aggressive, but the program periodically ran out of funds. This caused boom and bust cycles in New Jersey's solar industry. New Jersey hopes that a system based on SRECs will alleviate this problem. New Jersey plans to phase out the rebate program gradually, such that by 2012, they will rely completely on SRECs. To help compensate for the phasing out of the rebate program, New Jersey encourages load-serving entities to sign long term (15 year) contracts to purchase SRECs from solar generators. This will provide the generators with a predictable revenue stream, which should help them secure financing for the initial installation costs.

Maryland has established a special RPS for solar which starts small and increases each year. The RPS gradually increases from 0.005% energy from solar in 2008 up to 2% by 2022. The non-compliance fee in Maryland starts at $450/MWh in 2008, and decreases by $50/MWh per year. Utilities recoup costs via a generation surcharge on all customers, but Maryland caps the maximum surcharge. To help compensate utilities for the rate increase cap, if a utility's SREC costs are greater than 1% of its total sales, it can apply for a 1 year delay on its solar RPS targets.

Maryland has recently decided to transition entirely to SRECs as well. Maryland had a modest and underutilized rebate program, so they decided to move to SRECs as a way to encourage more rapid growth in solar capacity. In order to help homeowners and other small generators (<10 kW) with the high initial cost of solar systems, Maryland requires utilities to sign 15 year contracts and pay the entire contract price up front. However, it is currently unclear whether this provision is having the intended effect.

### 6.1.3 Proposed Offering

Several qualities make SRECs an attractive option in Connecticut. First, SRECs are also a performance based system, meaning that generators are awarded based on actual energy produced, rather than installed capacity. Second, while an SREC market may be regulated by state agencies, it is not reliant on state funds or subject to often unpredictable state budget-making processes. Third, the RPS can be used to set a specific goal for the share of in-state solar electricity the state wants to produce. Fourth, SRECs leverage market forces and efficiencies to help grow solar capacity.

The ability to leverage market forces is both strength and a weakness of SRECs. Specifically, if the market price of SRECs ever exceeds the non-compliance fee, then utilities have no incentive to purchase the SRECs. Thus, the non-compliance fee is effectively a ceiling on the price of an SREC, but there is no floor price. The lack of a floor price means that more efficient producers (larger producers) have a competitive advantage in the SREC market. This is strength because the market rewards and encourages efficiency by allocating resources to the most efficient producers. But it is also a weakness, because smaller installations may fail to benefit from the SRECs due to lack of generation efficiencies. Because SRECs are market-based, they also do not provide as much investor security as other funding mechanisms (e.g. Feed-in tariffs, discussed in Section 6.3), so in the absence of long term contracting opportunities, they may not facilitate financing options to help cover the high initial cost of solar systems. New Jersey encourages and Maryland requires utilities to enter into long term SREC contracts to help compensate for both of these weaknesses. We would recommend that Connecticut require this as well. Other options also exist, including setting up a state-wide aggregator for smaller systems and exempting smaller systems from burdensome metering requirements.

KEMA does not advocate that Connecticut transition entirely to SRECs. However, by modifying its current RPS to include a specific provision for solar power, Connecticut will create a special market for SRECs apart from other Class I renewables. A special market and requirements for long term contracting for SRECs would provide a stable revenue stream for solar generators.

In summary, in implementing an SREC system, the following provisions should be considered:

1. The percentage of power generated from solar should start small and steadily increase on an annual basis. As summarized in Section 2, KEMA suggests a schedule for Connecticut which results in approximately 3.5% of estimated in-state demand be met by solar by 2025. As part of the implementation rules, Connecticut may decide whether

the SREC applies to new and/or existing developments. As presented, KEMA has assumed that existing solar installations would count toward the carveout; therefore, though the carveout required 10 MW of solar in 2009, 8.6 MW of that is met by existing installations, meaning only 1.5 MW more would need to be developed in 2009 to meet the requirement.

2. The non-compliance fee for solar should be set significantly higher than that for other Class I renewables. The fee should be set at a level above the expected market price for SRECs. Most jurisdictions set their non-compliance fees around $500/MWh. However, the New Jersey solar alternative compliance Payment (SACP) levels were established through a 2003 Board Order and subsequently modified to roughly $711 per MWh effective June 2008.

3. Load-serving entities should be required to purchase all SRECs from in-state resources to ensure the growth of solar capacity in the state. To implement, Connecticut could leverage the NEPOOL GIS system.

4. The non-compliance fee should gradually decrease on an annual basis. This will help put downward pressure on SREC prices and on the cost of solar installations.

5. Connecticut should continue policies such as the existing small solar rebate program to help small producers cover initial costs and compete in the SREC market.

6. Connecticut should require long term SREC contracts in order to help create investor security and improve the availability of private financing options.

7. Monitor and provide a mechanism to alleviate or cap utility rate increases. For example, Maryland allows utilities to apply for a one year delay in meeting RPS requirements if the cost of SRECs exceeds one percent of their annual revenues.

### 6.1.4 MW goals and Costs

The table below summarizes the expected MW installations and estimated SREC costs, and compares those costs to estimates of standard RECs under current conditions to calculate an SREC premium that represents the incremental cost of the program.

The SREC concept is relatively new, and little data exists regarding the long term impact on solar development as a result of such a system. KEMA based its estimates of initial installations (MW) as a result of the implementation of an SREC system on the recent experiences of New

Jersey, which has seen rapid growth in solar installations in the first two years after implementation of an SREC system. Over time, we anticipate that an increasing proportion of the solar carveout would be met by commercial installations incentivized by SRECs. Finally, while we attribute the anticipated commercial installations below to "SRECs", these are meant to represent commercial installations not covered by other suggested programs. We anticipate solar installations developed as a result of other programs would also be eligible to trade SRECs.

KEMA's estimate of SREC values were based on the experiences to date in New Jersey and the professional judgment of KEMA and workgroup members. As a market driven system, ultimate prices will be determined by the success of the development of solar installations to meet the goals of the RPS.

**Table 6-1**
**Proposed SREC Incentives and Estimated Installations**

| | Recommended Required Solar RPS Carve-Out (MW) | Estimated MW Installed via SREC program | Cumulative Installed MW via SREC program | Cumulative Installed SREC Program MW as % of Solar Goal | SRECS ($/MWh) | Value of 15 Year Contract |
|---|---|---|---|---|---|---|
| 2009 | 10 | 1.0 | 1.0 | 11% | $360 | $3,709,334 |
| 2010 | 24 | 3.3 | 4.3 | 18% | $320 | $11,067,903 |
| 2011 | 39 | 7.0 | 11.3 | 29% | $320 | $21,035,213 |
| 2012 | 55 | 9.8 | 21.1 | 38% | $280 | $26,228,281 |
| 2013 | 71 | 11.8 | 32.9 | 46% | $280 | $28,160,891 |
| 2014 | 88 | 12.9 | 45.8 | 52% | $240 | $27,332,630 |
| 2015 | 105 | 13.8 | 59.7 | 57% | $240 | $25,996,368 |
| 2016 | 122 | 14.7 | 74.3 | 61% | $200 | $24,111,631 |
| 2017 | 140 | 15.6 | 89.9 | 64% | $200 | $22,637,377 |
| 2018 | 159 | 16.5 | 106.4 | 67% | $160 | $20,899,411 |
| 2019 | 178 | 17.5 | 123.8 | 70% | $160 | $19,691,889 |
| 2020 | 197 | 18.5 | 142.4 | 72% | $120 | $18,264,227 |
| 2021 | 218 | 19.6 | 162.0 | 74% | $120 | $17,516,264 |
| 2022 | 238 | 20.8 | 182.8 | 77% | $80 | $16,612,793 |
| 2023 | 260 | 22.1 | 204.9 | 79% | $80 | $16,573,704 |
| 2024 | 281 | 23.4 | 228.3 | 81% | $40 | $16,470,119 |
| 2025 Total | | 228.3 | | | | $316,308,034 |

## 6.1.5 SREC Program BC Analysis

The results of the BC analysis indicate that the SREC program would be cost effective. The table below summarizes the results of the BC analysis.

**Table 6-2**
**Summary of BC Analysis for SREC Program**

| | | | | | |
|---|---|---|---|---|---|
| **Solar RECs** | 2009 to 2048 | Total *Societal* Benefits | **$6,201,537,415** | Total *Societal* Costs | **$1,228,065,351** |
| | | *Avoided energy costs* | $3,927,105,535 | Project cost to Developer | $1,228,065,351 |
| | | *emission benefits* | $62,931,494 | | |
| | | *Federal ITC & Depr. Deduction* | $624,164,215 | | |
| | | *import substitution* | $270,984,978 | | |
| | | *economic spin-off ($ GSP)* | $1,316,351,193 | | |
| *Discount Rate* | 7.5% | **Present Value_Benefits** | **$1,623,011,092** | **Present Value_Costs** | **$678,769,539** |
| | | | | | |
| | | Benefit:Cost ratio | 2.39 | | |

## 6.2 Utility Development of Solar Energy

This section considers the potential benefits of allowing utilities to develop solar energy projects and to recapture their investments through ratebased financing. Beyond the opportunity to develop solar, utilities must be directly included in any strategy to significantly expand the solar industry. Their expertise on transmission and distribution and familiarity with other forms of integrating distributed generation is critical to identifying geographic areas where the installation of solar might provide added benefits to ratepayers.

The benefits of solar to overall utility system include the following:

- With no fuel costs, solar is a price hedge against traditional fuel price increases and potentially carbon costs
- With maximum production timed to coincide with periods of peak demand, solar is already a cost-effective peak generation resource
- Distributed assets can provide a range of advantages to utilities, including cost reductions and savings around centralized generation and transmission and distribution. Solar installations can ease congestion in regions where energy demands have stressed the grid

Accordingly, the interest of utilities in developing solar is growing as their interest in all distributed resources grows, and as the cost of solar (not just at peak periods) comes down relative to traditional forms of generation. In addition, public acceptance of utility solar development is growing in reverse proportion to public resistance against nuclear power and increasingly resistance against coal. In just the past year, a number of utilities and solar companies have announced aggressive programs to deploy large-scale solar power projects, including Southern California Edison's plan to install 250 MW of distributed solar PV, Duke

Energy's stated goal of investing $100 million in rooftop solar, and Pacific Gas & Electric's announcements to invest in thousands of MW of concentrating solar power in California's deserts. Such investments will accelerate economies of scale and further drive down the price of solar energy.

A recent study assessing the role of utilities in supporting development of 10% solar power nationally by 2025, prepared by Clean Edge, Inc. and the Co-op America Foundation, reviewed the important potential role of utilities in developing solar at that scale. Interviews with industry experts suggested that "while [some] felt that solar could continue on its current path without active utility involvement, most concluded that the utility sector's active participation will be required to bring solar "to scale."

Last, utilities have experience and mechanisms to spend money on infrastructure, so the cost of solar development doesn't necessarily scare them off. They do require regulatory approval to recover their expenditures and a fair rate of return.

### 6.2.1 Other Jurisdictions

The proliferation of multi-MW solar projects undertaken by investor owned utilities and third party developers across the U.S. has been sparked by technology innovations and cost reductions, and fueled by the extension of federal investment tax benefits.

As discussed above, utility owned generation has already been attempted in several deregulated states. For example, Southern California Edison has requested approval for a 250-megawatt rooftop system. The roof space will belong to customers and will be leased to Southern California Edison for solar generation that is ultimately owned by the utility. This project, if approved, would be ten times larger than any current, similar project and will power 16,000 homes. The utility plans to cut costs by embracing the economies of scale that will come with large installations; this should make the solar generation more competitive with conventional generation sources. Other utilities in California, like Pacific Gas & Electric Company and San Diego Gas & Electric Company are also at the forefront on the national utility owned generation scene. Governor Schwarzenegger has said that "these are the kinds of big ideas we need to meet California's long-term energy and climate change goals" (Wald, "California Utility to Install Solar Panels"). It is hard to draw on the California experience for suggestions on how Connecticut should structure their potential programs however; the two states have very different generation models.

Massachusetts on the other hand has attempted to allow solar development on utility owned sites. Even though electricity in Massachusetts is deregulated, the recently passed Green Communities Act has authorized utilities to own solar electric installations on customer's roofs. The Act allows each utility to own up to fifty megawatts of solar generation by 2010 and will be evaluated by the Department of Public Utilities in 2011 ("Massachusetts Enacts Green Communities Act", McDermott Will & Emery). Pending the results of the evaluation, the program could be expanded to allow for more ownership. National Grid, a large utility in Massachusetts, has announced a proposal to build and own solar installations on four pieces of company property around Boston, with other sites under consideration. National Grid hopes to later install solar generation at other locations such as public schools and government owned buildings. They will also advance solar generation in Massachusetts by providing education and advice for their customers (Solar Plan, National Grid). While National grid believes the costs could be reasonable in the long run, based on future energy cost increases, declining costs for photovoltaic cells, and carbon legislation, many of the proposals for utility owned solar in Massachusetts to date have not been cost effective. Even though the projects would be rate based, they must still be cost effective, and the recently extended federal tax incentive of thirty percent may make more projects feasible. These are considerations Connecticut will also have to realize when they evaluate their own programs.

### 6.2.2 Barriers

The largest barrier solar developers and utilities will face in Connecticut is legislation that currently prevent utilities from owning generation.

SEPA, the Solar Electric Power Association, has found other barriers to utility owned solar generation. From a survey given to utilities around the country, they found that utilities generally do not believe that solar developers have as much knowledge as natural gas and coal generation developers (Utility Procurement Study: Solar Electricity in the Utility Market, Solar Electric Power Association). Utilities understand generation, but are newer to developing their capacities in the solar markets. Cooperation between solar developers and utilities is imperative to move the market forward.

### 6.2.3 Proposed Offering

In order to create a utility sponsored renewable energy development program in a deregulated state like Connecticut; KEMA has proposed the following three-year pilot program:

- Allow distribution utilities to develop projects greater than 250 kW, capped at 9 MW total by 2011, per the schedule below
- Allow development on utility-owned properties or other properties, such as brownfields or other locations identified for strategic placement of distributed generation
- Require utilities to file a plan of their proposed pilot activities with the DPUC
- Evaluate the effectiveness of the proposed offering.

The BC study is intended to assess whether utility development of projects is a cost effective approach that will stimulate development of solar in Connecticut. However, the REMI model doesn't encompass the full range of costs involved with ratebasing generation resources, therefore this analysis should be considered preliminary. For that reason, we have recommended a limited three year pilot program, and during and as a result of such a pilot would recommend a more complete analysis of the benefits and costs of ratebasing generation resources.

Allowing utility companies to include self-owned solar generation in their resource plans will give the utilities more baseload resources in their energy mix as well as a resource that peaks in generation when energy demand also peaks. Solar generated electricity is not susceptible to price fluctuations like fuel-based resources so there is no risk associated with price volatility (Solar Energy and Utilities, Solar Buzz). On the other hand, solar generation is associated with fewer environmental risks than conventional generation resources like coal and natural gas. This can be factored into the utilities' plans as well.

Alternatively, at any time the distribution utilities may seek to create an unregulated, competitive solar company that would ultimately compete throughout all market segments.

### 6.2.4 MW Goals and Costs

The MW goals for utility development of solar assume growth in the number of installations over the 3 year pilot program period. KEMA modeled the solar investments as utility expenses, like conservation and load management funds, though utilities may ultimately consider spreading the investment costs into the ratebase over a number of years.

**Table 6-3**
**Proposed Utility-Developed Solar Program**

| Year | Installed MW | Estimated Installed Price of Solar Commercial ($/kW) | Project Costs |
|---|---|---|---|
| 2009 | 1.0 | $7,813 | $7,812,778 |
| 2010 | 3.0 | $7,500 | $22,500,799 |
| 2011 | 5.0 | $7,200 | $36,001,279 |
| 2011 Total | 9.0 | | $66,314,856 |

### 6.2.5 Utility Developed Solar Program BC Analysis

The results of the BC analysis indicate that the Utility Developed Solar Program would be cost effective. The table below summarizes the results of the BC analysis.

**Table 6-4**
**Summary of BC Analysis for Proposed Utility-Developed Solar Program**

| | | | | | |
|---|---|---|---|---|---|
| **Utility Expensed** | 2009 to 2048 | Total *Societal* Benefits | **$225,758,524** | Total *Societal* Costs | **$60,604,320** |
| | | *Avoided energy costs* | $149,373,534 | Project cost to Utility | $60,604,320 |
| | | *emission benefits* | $2,206,967 | | |
| | | *Federal ITC & Depr. Deduction* | $30,802,146 | | |
| | | *import substitution* | $10,269,908 | | |
| | | *economic spin-off ($ GSP)* | $33,105,971 | | |
| *Discount Rate* | 7.5% | **Present Value_Benefits** | **$105,166,615** | **Present Value_Costs** | **$54,738,970** |
| | | | | | |
| | | Benefit:Cost ratio | 1.92 | | |

## 6.3 Feed In Tariffs

### 6.3.1 Introduction

Under a Feed-in Tariff (FIT) system, utilities are legally obligated to sign long term (typically 15-20 year) contracts with producers of renewable energy to buy power at above-wholesale market prices. The exact premium (or tariff) usually is (1) available to all producers, (2) varies by technology, and (3) periodically reviewed and adjusted for new contracts. FITs work either by setting a fixed price for a kWh of solar electricity, or by adding a premium to the market price of a kWh of electricity. The tariffs are considered to be “all-in” costs, and the only incentives available to project developers (i.e. developers would not also be trading SRECs) Utilities recoup the increased costs by spreading them among all ratepayers. Connecticut would likely consider an either/or scenario between FITs and SRECs. The final recommendation will be based on the BC analysis.

### 6.3.2 Other Jurisdictions

*Germany*. Since about 1990, Germany's policies towards solar energy have evolved from rebates to low-interest loans to FITs. Since moving to the FITs system, and especially after setting a high FIT for solar in 2004, Germany's solar capacity has boomed, even with relatively low insolation values, as summarized in Section 2.1.

A 2007 Washington Post article investigating the growth in solar also identified ulterior motives for the high rebates. "German officials readily acknowledged that they are embracing solar technology not just for its environmental benefits. German firms that manufacture photovoltaic panels and other components have prospered under the new energy act and now employ 40,000 people. An additional 15,000 people work for companies in the solar-thermal business, which make heating systems for homes and businesses. Matthias Machnik, an undersecretary for the German ministry of the environment, said the country can't hope to compete in the long term with perpetually sunny ones in generating solar power. But it hopes to expand its exports of solar technology and become the leader in that field as well. Last year, German exports accounted for 15 percent of worldwide sales of solar panels and other photovoltaic equipment, according to industry officials. German companies hope to double their share of the global market, which amounted to $9.5 billion last year and is growing by about 20 percent annually, said Carsten Koernig, managing director of the German Solar Industry Association, a trade and lobbying group."

Before the FIT system, Germans installed about 10 MW of solar capacity per year. After the FIT law started, new capacity jumped to about 90 MW/year. After the FITs were raised to current levels, new capacity jumped again, to around 800 MW/year. Germany sets a fixed price for solar power, ranging from $0.33/kWh to $0.57/kWh[6], depending on the size of the installation. This tariff is an "all-in" cost, and the only incentive available to project developers. The tariffs are set to automatically decrease by about 5% each year. The tariff level for a new plant remains the same for the duration of its contract (normally 20 years) but depends on the year of commissioning. The later a plant is commissioned, the lower its tariff. In addition, Germany's Ministry for the Environment, Nature Conservation and Nuclear Safety periodically reviews and occasionally adjusts the tariff levels.

[6] All currency figures converted from native currencies to $US based on exchange rates on 1-30-2009.

*Spain*. Spain has also used FITs to rapidly expand its solar capacity. Spain's FITs began in 1997 and were revised in 2004. By mid-2008, Spain's solar capacity was already almost four times its 2010 targets. This rate of growth was so fast that the Spanish government deemed it unsustainable and reduced tariff levels and instituted installation caps of about 400 MW for 2009 and 2010. Spain uses both fixed-price and market-premium FITs. Solar plants under 100 kW of capacity must take the fixed-price, which ranges from $0.42 to $0.45/kWh, depending on installation size. Larger plants (greater than 100 kW capacity) have an option of the fixed-price or market-premium model, and usually take the market-premium. In 2004, the premium over market price was about $0.25/kWh, and will probably decrease to around $0.20/kWh for 2009-2010. In Spain, the FIT tariffs adjust each year based on the Consumer Price Index, and the government also periodically reviews and adjusts the tariff levels.

*California*. In July, 2007 California enacted a solar FIT system that affects some of California's investor-owned utilities (Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric). California also has a renewable portfolio standard (RPS), and the FIT was enacted to try to facilitate rather than replace California's RPS goals. The affected utilities are required to offer FITs to renewable energy producers (including, but not limited to solar) of up to 1.5 MW capacity. Producers may enter 10, 15, or 20-year contracts. California's FIT uses a fixed-price model, but bases the exact tariff level on the wholesale market price for a combined-cycle natural gas fired baseload proxy plant. This price is adjusted based on time-of-use: upwards during peak hours and downwards during off-peak hours. For 2007, these rates range from $0.09 - $0.15/kWh, which is about the same as the retail rate for electricity. Producers who participate in the FIT program are not eligible for any of California's other incentives, including rebates and renewable energy credits (RECs, which are transferred to the utility with the power sale.) The requirement to forego other state incentives, combined with the modest FIT levels, means FITs are currently a less economically viable option for residential installations than California's rebate program.

*Florida.* Gainesville Regional Utilities (GRU) approved a FIT in Feb. 2009, pending expected Florida Public Service commission approval. Under the program, GRU customers can sign up for the feed-in-tariff as of March 1. Participants signing up during the first two years of the program will be guaranteed a fixed rate of $0.32 per kilowatt hour for 20 years. GRU estimates that investors will see a 5-percent return on investment for large-scale projects.

### 6.3.3 Proposed Analysis

Several qualities may make FITs attractive. First, FITs are a performance based incentive, meaning that producers are awarded for actual generated energy, rather than installed capacity.

Second, FITs can make prices for solar energy high enough to compete with other technologies such as fossil fuels, which encourages new and existing producers to invest in solar capacity. Third, FITs set a floor price for solar energy, and can be set to different levels for different installation sizes (in terms of capacity) to prevent market concentrations. Fourth, FITs encourage financing and investment in renewable technologies by building predictability and stability into the solar market. From the producers' perspective, FITs guarantee a price, buyer, and long-term revenue stream, and interconnection is also typically guaranteed. Finally, funding is not tied to state budgets and quantities are often uncapped. Taken together, these characteristics can help reduce producer revenue uncertainty, project risk, and associated financing concerns. Germany and Spain's experiences show that FITs can encourage rapid growth of solar capacity.

FITs also come with several risks. The total cost of FITs is often difficult to determine, despite the predetermined prices built into the contracts. This is because it is difficult to predict the quantity of generation that will result in response to the FIT. Because utilities must buy this solar power at a premium, total costs can increase rapidly. If utilities are allowed to pass all these costs on to ratepayers, electricity rates can increase at an undesirable rate; however utilities are exposed to risk if they are prevented from passing increased costs to ratepayers. FITs must be structured to allow utilities to maintain a fair rate of return to support business operations. Some jurisdictions with FIT laws (e.g., Spain) have capped quantities as a way to control total costs.

Setting the right price is another challenge for an FIT system. If the price is set too low, the FIT may not produce sufficient incentive to encourage solar development. Setting the price too high may over-stimulate the market and cause consumers to overpay. Making corrections to prices can be difficult, because of the length of the contracts and because price-stability is one of the main advantages of FITs. Thus, care must be taken to ensure that prices are set to the right levels from program inception. CCEF and the CT DPUC should have active roles in setting and monitoring FIT levels. We have modeled a FIT rate of $0.30/kWh, about 4 times higher than the recent wholesale price of electricity in Connecticut. This is similar to the level set in Gainseville.

FITs can and often are set to higher levels for smaller installations. This prevents market concentration into large installations by allowing the smaller, less efficient installations to remain competitive. Although FITs are designed to make financing easier to obtain, they do not directly help with the high initial installation costs of solar systems. These costs are often a greater barrier for smaller installations, so additional subsidies could be offered to smaller installations. Germany and Spain, for example, continue to offer low-interest loans to small (<10 kW) solar installations, in addition to FITs. Alternatively, FITs could apply only to larger projects, while smaller projects could still take advantage of other incentive programs, such as residential/small commercial rebates.

*Recommendations*. If Connecticut instituted an FIT, it would be one of the first jurisdictions in North America to do so, to date only behind California and the City of Gainesville, Florida in the United States. Connecticut would benefit from some of the lessons learned by Europe's experience with FITs:

1. FITs based on the cost of generation have been more effective at expanding solar capacity than FITs based on value. Germany's solar capacity boomed in 2004 when they moved from a value-based to cost-based model.

2. If technologies other than solar receive FITs, the FITs should vary by technology. This variance should be based on generation costs for that technology plus the degree to which Connecticut wishes to diversify its energy portfolio with various technologies.

3. Investor security is based on both price and policy certainty. Long term contracts are particularly important. In addition, Germany's system of fixed tariff levels and long-term degression schedules provides more certainty than Spain's approach of adding a premium to the market price. To date, the German system has required less policy changes than the Spanish system.

4. Germany's set degression schedule puts automatic downward pressure on renewable energy prices. Spain's market-based system may not do so.

5. Size-differentiated tariffs (higher tariffs for smaller capacities) can encourage all market segments and help prevent market concentration into larger installations.

6. FITs are the primary renewable funding mechanism for both Germany and Spain. However, both continue to offer low-interest loans to help smaller installations cover initial costs.

7. Encouraging renewables, especially solar, can be expensive. In Germany, electricity rates have increased about 5% per kWh (which covers their entire renewable portfolio, not just solar). Both Germany and Spain have experienced (and submitted to) political pressures to reduce their FIT levels.

We recommend that Connecticut continue to evaluate FITs as a possible alternative to other commercial incentive programs. Additional analysis would be required to determine the appropriate tariff level and rate impacts.

# 7. Other Proposed Initiatives

This section describes related initiatives that support the direct investment portion of this plan. These initiatives do not specifically have MW targets associated with them nor do they necessarily require additional expenditures. These initiatives are intended to assist with the removal of key barriers to the development of solar in Connecticut.

## 7.1 Education and Training

### 7.1.1 Description

Developing a sustainable solar industry requires a qualified technical workforce capable of handling PV/solar installations as well as other related qualified professionals. Connecticut, through the efforts of the Center for Sustainable Development at Gateway Community College, has already begun this effort by offering installer training and certification programs, as described previously in Section 3.3. In addition, in Connecticut support for entrepreneurs creating clean technology firms is being provided by the Clean Tech Fund, as described in Section 3.4.

### 7.1.2 Other Jurisdictions

As in Connecticut, many other states provide training to PV installers by one-day sessions and, more formally, through technical courses through trade schools or community colleges. New York in particular has developed a robust set of educational programs and initiatives. The New York State Energy Research and Development Authority (NYSERDA) has approached training and education from a variety of angles, targeting different groups. For example, NYSERDA has:

- Developed eight accredited solar training centers and continuing education programs statewide to develop and implement technical training programs for PV system installers, utility and local inspectors, and others;

- Helped train 35 installers in an accredited, hands-on, one-week PV design and installation course;

- Sponsored study assistance to 70 installers preparing to take the NABCEP exam, including an on-line refresher course;

- NYSERDA, NABCEP, and the Interstate Renewable Energy Council (IREC) developed media kits and public relations tools to help certified installers differentiate themselves from other, non-certified installers;

- Held five introductory PV workshops across the state for builders, contractors, realtors, and bankers to teach them about PV systems, the costs and benefits of owning a PV system, the impact of a PV system's value on the cost of a home, and opportunities for builders and realtors to differentiate themselves through gaining experience building and selling energy-efficient homes with PV systems.

The results are promising. In terms of PV industry growth alone, from late 2002 until the end of 2007 the workforce grew from 12 NYSERDA-approved photovoltaic installation firms to more than 125 approved firms. Since the PV incentive program was revised in early 2008, NYSERDA has approved 78 participating firms, with new firms joining monthly. These qualified installers buttress NYSERDA's New York Energy $mart PV Incentives program, generating about $86 million in PV sales statewide since the program's launch.

NYSERDA's Residential Efficiency and Affordability Program (REAP) also includes a growing portfolio of training for renewable energy professionals. To ensure high standards, NYSERDA works closely with and financially supports the industry's accreditation and certification bodies.

The Institute for Sustainable Power (ISP) develops and maintains international standards for evaluation and qualification of RE, EE and distributed-generation training providers. The North American Board of Certified Energy Practitioners is a volunteer board of renewable energy stakeholders who created a certification program for renewable energy installers, designers and inspectors. By working with ISP and NABCEP, NYSERDA is able to provide third-party-accredited training programs and to certify designers and installers of PV, small wind and other renewable and distributed-generation systems.

To meet strong demand in New York, NYSERDA initially focused on training PV system installers. Since 2002, NYSERDA has provided nearly $1 million to seven training organizations to develop ISP-accredited PV training programs. As NYSERDA partners, State University of New York (SUNY) Farmingdale, SUNY Delhi, Ulster County Boards of Cooperative Educational Services (BOCES), Alfred State College, Hudson Valley Community College, Bronx Community College and the International Brotherhood of Electrical Workers have developed nationally accredited PV training programs statewide. NYSERDA's PV training partners offer courses ranging from introductory one-week classes to credit-bearing classes and one-year certificate programs. More than 800 practitioners have been trained in PV design and installation.

Job placement is part of these initiatives. To earn ISP accreditation, NYSERDA's training partners must have job placement programs. Through internship programs, students gain real-world experience — and hosting installation companies gain access to potential employees.

### 7.1.3 Proposed Offering

Through the initiative of the Gateway Community College Center for a Sustainable Future, Connecticut has already established robust education and training programs that are preparing the in-state solar workforce of the future. This provides even more incentive to create programs that drive the solar industry in-state, so that the installers, technicians, and business owners that have been and are currently being trained are retained. In addition, the Clean Tech Program is already working to incentivize in-state renewable energy entrepreneurs. The development of a consistently growing in-state solar industry will maximize the leverage that these programs have.

To these existing programs, Connecticut should also consider partnerships with utilities to provide training on interconnection standards and guidelines.

### 7.1.4 Proposed Budget

Based on data from similar NYSERDA efforts, a budget of $1 million over 5 years resulted in training of over 800 practitioners through the community college and state university system. Based on the comparatively smaller size of Connecticut, KEMA recommends an initially smaller budget for Connecticut, $500,000 over 5 years, to potentially be funded out of CCEF's Program Goal 3. An ongoing assessment of the demand for in-state installers would be recommended to adjust this budget in the future.

## 7.2 Virtual Net Metering

### 7.2.1 Description

With standard net metering, the owners of small renewable generators receive a credit for at least some small portion of the electricity they feed into the grid which they are not consuming (i.e. meter runs backwards). One minor drawback however is that the credit given for feeding into the grid is usually significantly less than the amount saved if the electricity was consumed directly by the owner.

Virtual net metering differs from standard net metering in that all excess renewable energy produced on property owned by a consumer group or municipality goes to offset the electricity bill of an entire neighborhood/region or municipality. The excess energy flows back into the grid locally and is consumed by citizens who are beneficiaries of the virtual net metering agreement or have municipal membership. Consumers of the excess energy must share local grid infrastructure for this arrangement to be feasible.

### 7.2.2 Other Jurisdictions

Massachusetts allows for up to 2 MW of aggregated (i.e. "virtual") net metering and is considered a leader in virtual net metering policy. This provision was included in the Green Communities Act, signed by Mass. Gov. Deval Patrick in July 2008. No definitive reports have emerged as to how well virtual net metering has worked in other states

### 7.2.3 Proposed Offering

Connecticut should work with the DPUC, utilities, CCEF and other stakeholders to consider a virtual net metering proposal. The policy in Massachusetts, under the Green Communities Act of 2007, signed by Gov. Deval Patrick in 2008, could serve as a guide. For example, under this Act, solar-generated power owners may sell their excess electricity into the grid at favorable rates for installations up to 2 megawatts.

## 7.3 PV Interconnection Standards

### 7.3.1 Description

Each state individually regulates the process by which an electrical generator can connect to the grid via interconnection standards. Such standards exist to help stabilize and secure the grid. Typically these standards are streamlined for smaller systems which allows for more certainty in the budgeting and installation process. Reducing the complexity and red tape associated with interconnection will help to remove obstacles for customers interested in pursuing their own solar development.

There has been a movement towards unification of standards for small renewable interconnection. Some examples of this movement are as follows:

- The non-profit group Interstate Renewable Energy Council (IREC) has developed a set of interconnection standards that have been vetted by the IEEE.

- The Federal Energy Regulatory Commission (FERC) approved a set of interconnection standards for small generators, including solar PV in May of 2005. The rules allow simpler interconnection for systems of 2 MW or less, and even simpler procedures for systems of 10 kW or less that use inverters. However, the rules apply only to interconnections with facilities already subject to FERC jurisdiction and does not apply to local distribution facilities (i.e. may not apply to CT local utility companies).

Connecticut Light & Power and United Illuminating have both developed interconnection guidelines that are consistent with the FERC standards and have been approved by the Connecticut Department of Public Utility Control. As background, on December 5, 2007, the DPUC issued a final Decision on small generators (20 MW or less) interconnection guidelines proposed by Connecticut Light and Power and United Illuminating under Docket 03-01-15RE01. These revised guidelines were adopted in accordance with state legislation (Section 38 of Public Act 07-242). According to the Dec. 5, 2007 Decision, the DPUC "believes aligning the interconnection standards to the greatest extent possible will minimize confusion and maximize transparency of the process."

The DPUC noted that the interconnection guidelines align as closely as possible with the FERC interconnection standards, with some deviations. The following lists the Connecticut guidelines that deviate from FERC Standards.

- *Customers are required to install an external disconnect switch and an interconnection transformer.* This is not required in some jurisdictions such as New Jersey. The CT DPUC had considered and rejected this option.
- *Customers must indemnify their utility against "all causes of action," including personal injury or property damage to third parties.*
- *Customers are required to maintain liability insurance in specified amounts based on the system's capacity*. Connecticut is one of roughly 10 states to require this provision.
- *Utilities must collaboratively submit to the DPUC a status report on the research and development of area network interconnection standards*.

In addition, Table 7-1 shows Connecticut interconnection guidelines compared to those advocated by IREC. In almost every category, the Connecticut standards are also well-aligned with the IREC guidelines.

## Table 7-1
## Comparison of Connecticut and IREC Interconnection Standards

| | Year of Original Implementation | Application Cost | Separate Rules for Small DG and Renewables (1) | Breakpoint for Small Systems (Simplified Rules) | Eligible Technologies | System Size Limit | Standard Agreement | Additional Insurance | External Disconnect Switch Required | Technical Screens for Interconnection Studies | Network Interconnection Permitted | Authority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Connecticut | 2007 | Systems up to 2 MW: $500 Systems larger than 2 MW: $1,000 | Yes | 10 kW | All DG | 100 kW for net-metered systems; 20 MW non-net metered systems | Yes | Yes | Yes | Yes | Yes | CT DPUC |
| IREC Model Rules (4) | N/A | 10 kW: $20: 2MW: $50+$1kW: 10 MW non-export $100+$1.50kW; 10 MW: $2/kW | Yes | 10 kW | All DG | 10 MW | Yes | No | No | Yes | Yes | State PUC |

(1) Many states and utilities have a separate set of interconnection standards for very small renewable and DG systems. These standards often apply to net-metered systems.

### 7.3.2 Proposed Offering

The Connecticut utilities have given small generator owners more certainty in the interconnection process by closely aligning its interconnection guidelines with FERC and IREC Standards, with some minor differences, as noted in Section 7.3.1. KEMA recommends that Connecticut continue to monitor interconnection guidelines relating to solar energy and continue to consider future revisions that would both maintain and encourage safe and efficient integration of renewables onto the grid.

## 7.4 Alternative Funding Scenarios

As a complement to the suggested programs, there may be a variety of other alternative financing scenarios that Connecticut could offer or encourage that would provide additional security, confidence, or opportunities for additional segments of the customer population to develop solar projects.

Alternative scenarios that have been developed in other jurisdictions and may be applicable to Connecticut include:

- Reduced interest rate programs
- State or local loans for PV or solar thermal
- Utility-provided financing for PV or solar thermal

### 7.4.1 Reduced Interest Rate Programs

This type of program would provide reduced-interest loans through participating lenders to finance the installation of renewable energy systems.

The New York Energy $mart Loan Fund is a nearby example of such a program. It is administered by NYSERDA. Any commercial, industrial, retail, agricultural, non-profit, residential, or multifamily facility that is an electric distribution customer of one of the State's six investor-owned utilities is eligible for this interest rate reduction program.

For grid-connected photovoltaic systems, a customer must first be approved to receive incentives through NYSERDA's Power…Naturally℠ program. Once a customer has been approved to receive these incentives, they may then apply to the Loan Fund for a low-interest loan for their out-of-pocket expenses. Photovoltaic (PV) systems are included as eligible measures for all customer classes. Power...Naturally$^{SM}$ was developed as a logo or brand for all of NYSERDA's renewable energy programs. Most of NYSERDA's renewable energy initiatives are part of the New York Energy $mart$^{SM}$ program, which is designed to support certain public-benefit programs during the transition to a more competitive electricity market.

### 7.4.2 State or local loans for PV or solar thermal

In some jurisdictions, direct loans are made for the purchase and installation of renewable energy systems.

In 2008, the City of Berkeley, California developed the Financing Initiative for Renewable and Solar Technology (FIRST) that allows property owners to borrow money from the city's Sustainable Energy Financing District to install photovoltaic (PV) systems and repay the cost over 20 years through an annual special tax on property tax bills. This program is currently being conducted as a pilot.

The FIRST Program will provide financing up to $37,500 per installation for either residential or commercial properties. The effective rate was approximately 7.75% as of December 26, 2008. Payments will be made through a special tax on the participant's property tax bill. If the owner moves out of their house during the 20 year repayment period, the property tax assessment and the PV system remain with the property. This removes one key disincentive for PV.

Program participants are required to apply to the California Solar Initiative (CSI) rebate program, which will help off-set the total cost of the solar project. The FIRST program does not reduce the amount of the rebate available through the CSI program.

In Pennsylvania, the Pennsylvania Public Utility Commission created the Sustainable Development Fund (SDF) in its final order of the PECO Energy electric utility restructuring proceeding. The Reinvestment Fund, Inc. (TRF), which was formed in 1985 to build wealth and opportunity for low-wealth communities and low- and moderate-income individuals, administers the SDF.

SDF later received additional funding and responsibilities as a result of the PECO Energy/Unicom merger settlement. That settlement added funding for new wind development, for solar photovoltaics and for renewable energy education, as well as a lump-sum payment and an increase in SDF's core fund. In total, the fund has received approximately $31.8 million in income over its lifetime.

The SDF provides financial assistance to eligible projects in the form of grants, commercial loans, subordinated debt, royalty financing, and equity financing. The Sustainable Development Fund provides financial assistance for the following types of ventures:

- Companies and ventures that generate electricity using renewable energy sources;
- Manufacturers, distributors and installers of renewable energy, advanced clean energy and energy-conserving products and technologies; and,
- Companies and organizations that are end-users of renewable energy, advanced clean energy and energy-conserving products and technologies.

The specific terms of the financial support are flexible and are determined on a case-by-case basis. SDF also has a lease-financing product for large nonprofit institutions (schools and hospitals) for energy conservation improvements.

The SDF Commercial Financing Program provides flexible business loans to

- Manufacturers, wholesalers/distributors, retailers and service companies who want to finance equipment upgrades or electricity energy savings improvements to their plant/office facilities;
- End-user companies wishing to purchase advanced clean energy systems; and
- Start-ups and expansions of companies producing clean energy.

According to the 2008 Program Plan, SDF expects to award more than $5 million in equity investments, loans, and other forms or financing.

### 7.4.3 Utility-provided financing for PV or solar thermal

A number of utilities provide financing to their customers for the installation of PV and/or solar thermal systems.

In Massachusetts, MassSAVE, a residential conservation services program administered by Massachusetts electric companies, gas companies and municipal aggregators, offers no-interest financing to help residential consumers increase the energy efficiency of their homes through their HEAT Loan Program. This financing is available to all residential customers who own and reside in a one to four family residence, buy their power from one of MassSAVE's member companies, and obtain a Home Energy Assessment through the MassSAVE Program.

Customers are eligible to choose between applying for a 0% loan or obtaining applicable MassSAVE Program rebates for measures installed, which include energy efficiency measures such as insulation and high efficiency heating or hot water systems, as well as solar hot water systems. Loans are available from $2000-$10,000 with terms up to 7 years. Loans are unsecured or secured depending on the participating lender.

Home improvement measures financed by the HEAT Loan must meet or exceed the efficiency standard set forth by the program, and do-it-yourself installations are not eligible for Heat Loan financing. After all work financed with the HEAT Loan is complete, customers must notify their MassSAVE Vendor to schedule a verification inspection. More information, including a list of participating lenders, may be found on the website listed above.

Another example is the Sacramento Municipal Utility District's (SMUD) Residential Loan Program, which provides 100% financing to customers who install solar water heating or photovoltaic (PV) systems. All solar water heating systems must meet standards set by the Solar Rating and Certification Corporation (SRCC), must be installed by a SMUD-approved solar water heating contractor, and must pass inspection by SMUD representatives. PV systems must be installed by a SMUD-approved PV contractor.

# Appendix A – Rational for Employing Economic Impact Modeling Tools

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 responses to 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.

  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.

# Appendix B – Scenario Annual *non-discounted* Time-series for BC Test

## Table B1: Annual Benefits for Residential Rebate Scenario ($2008)

| Year | Gross Energy Savings | Emissions Savings | Federal ITC | Import Sub. | Economic Spin-off (GSP) | Total Benefits | Cum. Annual MW | Cum. Annual MWh |
|---|---|---|---|---|---|---|---|---|
| 2009 | $331,922 | $5,130 | $1,745,634 | $33,339 | 614,016 | **$2,730,040** | 1 | 1,174 |
| 2010 | $808,288 | $11,998 | $1,807,945 | $89,501 | 706,843 | **$3,424,574** | 2 | 2,425 |
| 2011 | $1,751,151 | $18,871 | $1,874,120 | $157,468 | 773,799 | **$4,575,408** | 3 | 3,760 |
| 2012 | $2,919,350 | $26,394 | $1,944,524 | $221,860 | 784,745 | **$5,896,873** | 4 | 5,184 |
| 2013 | $4,029,129 | $38,333 | $2,019,570 | $280,512 | 1,350,851 | **$7,718,394** | 6 | 6,705 |
| 2014 | $5,019,774 | $52,844 | $2,099,703 | $348,958 | 847,696 | **$8,368,975** | 7 | 8,330 |
| 2015 | $6,073,178 | $75,761 | $2,185,412 | $420,576 | 915,019 | **$9,669,947** | 9 | 10,067 |
| 2016 | $7,229,577 | $97,431 | $2,277,244 | $501,644 | 986,836 | **$11,092,732** | 10 | 11,924 |
| 2017 | $8,493,968 | $122,646 | $2,375,796 | $592,407 | 1,000,019 | **$12,584,835** | 12 | 13,910 |
| 2018 | $9,795,753 | $151,735 | $2,481,733 | $680,212 | 1,179,918 | **$14,289,352** | 14 | 16,035 |
| 2019 | $11,185,457 | $192,279 | $2,595,774 | $772,951 | 1,327,896 | **$16,074,357** | 16 | 18,310 |
| 2020 | $12,751,144 | $227,848 | $2,718,718 | $884,845 | 1,511,807 | **$18,094,362** | 18 | 20,746 |
| 2021 | $14,389,193 | $244,674 | $2,851,447 | $997,469 | 1,784,267 | **$20,267,050** | 21 | 23,355 |
| 2022 | $16,206,107 | $289,741 | $2,994,931 | $1,128,062 | 1,844,592 | **$22,463,432** | 23 | 26,151 |
| 2023 | $18,128,406 | $308,139 | $3,150,222 | $1,263,199 | 2,165,572 | **$25,015,537** | 26 | 29,146 |
| 2024 | $20,208,193 | $361,580 | $3,318,485 | $1,410,736 | 2,262,653 | **$27,561,645** | 29 | 32,357 |
| 2025 | $20,166,374 | $340,520 | $0 | $1,403,627 | 1,213,088 | **$23,123,608** | 29 | 32,066 |
| 2026 | $20,140,439 | $355,134 | $0 | $1,399,218 | 1,212,683 | **$23,107,473** | 29 | 31,777 |
| 2027 | $20,103,966 | $334,442 | $0 | $1,393,017 | 1,321,995 | **$23,153,420** | 29 | 31,491 |
| 2028 | $20,077,864 | $331,432 | $0 | $1,388,580 | 1,454,848 | **$23,252,724** | 29 | 31,208 |
| 2029 | $20,041,280 | $328,449 | $0 | $1,382,360 | 1,629,175 | **$23,381,265** | 29 | 30,927 |
| 2030 | $20,014,752 | $325,493 | $0 | $1,377,851 | 1,911,065 | **$23,629,161** | 29 | 30,649 |
| 2031 | $19,998,801 | $322,564 | $0 | $1,375,139 | 2,122,574 | **$23,819,078** | 29 | 30,373 |
| 2032 | $19,961,940 | $319,661 | $0 | $1,368,873 | 2,078,243 | **$23,728,716** | 29 | 30,099 |
| 2033 | $19,934,878 | $316,784 | $0 | $1,364,272 | 2,165,318 | **$23,781,252** | 29 | 29,829 |
| 2034 | $19,249,678 | $303,988 | $0 | $1,317,418 | 2,134,164 | **$23,005,249** | 28 | 28,624 |
| 2035 | $18,499,766 | $290,562 | $0 | $1,264,786 | 2,167,448 | **$22,222,562** | 27 | 27,359 |
| 2036 | $17,714,064 | $276,455 | $0 | $1,211,683 | 1,919,695 | **$21,121,896** | 26 | 26,031 |
| 2037 | $16,860,073 | $261,613 | $0 | $1,153,006 | 1,843,839 | **$20,118,531** | 25 | 24,634 |
| 2038 | $15,947,012 | $245,978 | $0 | $1,090,775 | 1,953,408 | **$19,237,173** | 23 | 23,161 |
| 2039 | $14,954,644 | $229,487 | $0 | $1,022,036 | 2,098,320 | **$18,304,488** | 22 | 21,609 |
| 2040 | $13,903,827 | $212,075 | $0 | $950,857 | 2,044,859 | **$17,111,619** | 20 | 19,969 |
| 2041 | $12,738,829 | $193,668 | $0 | $868,328 | 2,068,122 | **$15,868,946** | 19 | 18,236 |
| 2042 | $11,494,600 | $174,189 | $0 | $780,993 | 1,917,664 | **$14,367,445** | 17 | 16,402 |
| 2043 | $10,165,125 | $153,555 | $0 | $688,480 | 1,820,711 | **$12,827,871** | 15 | 14,459 |
| 2044 | $8,743,938 | $131,677 | $0 | $590,389 | 1,669,323 | **$11,135,327** | 13 | 12,399 |
| 2045 | $7,224,089 | $108,459 | $0 | $486,288 | 1,605,260 | **$9,424,096** | 11 | 10,213 |
| 2046 | $5,598,107 | $83,798 | $0 | $375,715 | 780,504 | **$6,838,123** | 8 | 7,890 |
| 2047 | $3,857,961 | $57,582 | $0 | $258,172 | 1,158,791 | **$5,332,505** | 6 | 5,422 |
| 2048 | $1,995,018 | $29,692 | $0 | $133,126 | 521,563 | **$2,679,398** | 3 | 2,796 |
| **Total** | **$498,707,612** | **$7,952,659** | **$38,441,257** | **$34,428,728** | **$60,869,188** | **$640,399,443** | | |

**Table B2: Annual Costs for Residential Rebate Scenario ($2008)**

| Year | Project Costs |
|---|---|
| 2009 | $7,818,780 |
| 2010 | $8,068,982 |
| 2011 | $8,327,191 |
| 2012 | $8,593,651 |
| 2013 | $8,868,650 |
| 2014 | $9,152,453 |
| 2015 | $9,445,329 |
| 2016 | $9,747,577 |
| 2017 | $10,059,493 |
| 2018 | $10,381,406 |
| 2019 | $10,713,613 |
| 2020 | $11,056,442 |
| 2021 | $11,410,249 |
| 2022 | $11,775,391 |
| 2023 | $12,152,206 |
| 2024 | $12,541,054 |
| 2025 | $0 |
| 2026 | $0 |
| 2027 | $0 |
| 2028 | $0 |
| 2029 | $0 |
| 2030 | $0 |
| 2031 | $0 |
| 2032 | $0 |
| 2033 | $0 |
| 2034 | $0 |
| 2035 | $0 |
| 2036 | $0 |
| 2037 | $0 |
| 2038 | $0 |
| 2039 | $0 |
| 2040 | $0 |
| 2041 | $0 |
| 2042 | $0 |
| 2043 | $0 |
| 2044 | $0 |
| 2045 | $0 |
| 2046 | $0 |
| 2047 | $0 |
| 2048 | $0 |
| **Total** | $160,112,467 |

## Table B3: Annual Benefits for Zero Net Energy Home Scenario ($2008)

| Year | Gross Energy Savings | Emissions Savings | Federal ITC | Import Sub. | Economic Spin-off (GSP) | **Total Benefits** | **Cum. Annual MW** | **Cum. Annual MWh** |
|---|---|---|---|---|---|---|---|---|
| 2009 | $9,958 | $154 | $36,619 | $1,000 | $10,138 | **$57,869** | 0.03 | 35 |
| 2010 | $35,089 | $521 | $70,309 | $3,887 | $79,483 | **$189,289** | 0.09 | 105 |
| 2011 | $114,037 | $1,231 | $134,992 | $10,271 | $99,747 | **$360,278** | 0.21 | 245 |
| 2012 | $136,970 | $1,237 | $0 | $10,401 | $27,729 | **$176,337** | 0.21 | 243 |
| 2013 | $145,283 | $1,377 | $0 | $10,076 | $45,913 | **$202,649** | 0.21 | 241 |
| 2014 | $144,829 | $1,514 | $0 | $9,999 | $26,807 | **$183,149** | 0.21 | 239 |
| 2015 | $144,143 | $1,780 | $0 | $9,882 | $8,549 | **$164,354** | 0.21 | 237 |
| 2016 | $144,024 | $1,915 | $0 | $9,862 | $43,894 | **$199,695** | 0.21 | 234 |
| 2017 | $144,209 | $2,048 | $0 | $9,893 | $94,187 | **$250,337** | 0.21 | 232 |
| 2018 | $143,456 | $2,178 | $0 | $9,765 | -$7,870 | **$147,530** | 0.21 | 230 |
| 2019 | $142,663 | $2,396 | $0 | $9,630 | -$7,338 | **$147,351** | 0.21 | 228 |
| 2020 | $142,734 | $2,483 | $0 | $9,642 | $29,420 | **$184,280** | 0.21 | 226 |
| 2021 | $142,299 | $2,347 | $0 | $9,569 | $16,692 | **$170,907** | 0.21 | 224 |
| 2022 | $142,353 | $2,460 | $0 | $9,578 | -$21,380 | **$133,010** | 0.21 | 222 |
| 2023 | $142,108 | $2,326 | $0 | $9,536 | $15,614 | **$169,585** | 0.21 | 220 |
| 2024 | $141,935 | $2,437 | $0 | $9,507 | $79,994 | **$233,873** | 0.21 | 218 |
| 2025 | $141,654 | $2,295 | $0 | $9,459 | $30,120 | **$183,527** | 0.21 | 216 |
| 2026 | $141,479 | $2,393 | $0 | $9,429 | -$38,636 | **$114,665** | 0.21 | 214 |
| 2027 | $141,233 | $2,254 | $0 | $9,387 | -$43,210 | **$109,664** | 0.21 | 212 |
| 2028 | $141,057 | $2,233 | $0 | $9,357 | -$36,843 | **$115,805** | 0.21 | 210 |
| 2029 | $140,811 | $2,213 | $0 | $9,315 | -$84,377 | **$67,963** | 0.21 | 208 |
| 2030 | $140,632 | $2,193 | $0 | $9,285 | $44,183 | **$196,293** | 0.21 | 207 |
| 2031 | $140,524 | $2,174 | $0 | $9,267 | $25,474 | **$177,439** | 0.21 | 205 |
| 2032 | $140,276 | $2,154 | $0 | $9,225 | $12,287 | **$163,942** | 0.21 | 203 |
| 2033 | $140,094 | $2,135 | $0 | $9,194 | -$34,248 | **$117,174** | 0.21 | 201 |
| 2034 | $120,052 | $1,817 | $0 | $7,875 | -$71,838 | **$57,907** | 0.18 | 171 |
| 2035 | $79,984 | $1,204 | $0 | $5,242 | $11,572 | **$98,001** | 0.12 | 113 |
| 2036 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2037 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2038 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2039 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2040 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2041 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2042 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2043 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2044 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2045 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2046 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2047 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2048 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| **Total** | **$3,483,888** | **$51,471** | **$241,920** | **$239,532** | **$356,063** | **$4,372,873** | 0.03 | 35 |

**Table B4: Annual Costs for Zero Net Energy Home Scenario ($2008)**

| Year | Project Costs |
|---|---|
| 2009 | $234,563 |
| 2010 | $450,362 |
| 2011 | $864,695 |
| 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 |
| 2028 | $0 |
| 2029 | $0 |
| 2030 | $0 |
| 2031 | $0 |
| 2032 | $0 |
| 2033 | $0 |
| 2034 | $0 |
| 2035 | $0 |
| 2036 | $0 |
| 2037 | $0 |
| 2038 | $0 |
| 2039 | $0 |
| 2040 | $0 |
| 2041 | $0 |
| 2042 | $0 |
| 2043 | $0 |
| 2044 | $0 |
| 2045 | $0 |
| 2046 | $0 |
| 2047 | $0 |
| 2048 | $0 |
| **Total** | **$1,549,620** |

## Table B5: Annual Benefits for Solar Lease Scenario ($2008)

| Year | Gross Energy Savings | Emissions Savings | Federal ITC & Dep. Deduction | Import Sub. | Economic Spin-off (GSP) | Total Benefits | Cum. Annual MW | Cum. Annual MWh |
|---|---|---|---|---|---|---|---|---|
| 2009 | $82,980 | $1,283 | $374,617 | $8,335 | $142,614 | **$609,829** | 0.3 | 293 |
| 2010 | $194,747 | $2,891 | $441,046 | $21,563 | $166,706 | **$826,953** | 0.5 | 584 |
| 2011 | $542,571 | $5,852 | $850,064 | $48,831 | $386,978 | **$1,834,296** | 1.0 | 1,166 |
| 2012 | $651,769 | $5,883 | $309,630 | $49,447 | $164,343 | **$1,181,072** | 1.0 | 1,155 |
| 2013 | $691,371 | $6,546 | $309,630 | $47,903 | $64,557 | **$1,120,007** | 1.0 | 1,145 |
| 2014 | $689,213 | $7,199 | $228,217 | $47,536 | $79,128 | **$1,051,292** | 1.0 | 1,135 |
| 2015 | $685,953 | $8,463 | $150,061 | $46,982 | $13,562 | **$905,020** | 1.0 | 1,125 |
| 2016 | $685,384 | $9,106 | $0 | $46,885 | $70,694 | **$812,069** | 1.0 | 1,114 |
| 2017 | $686,265 | $9,738 | $0 | $47,035 | $75,134 | **$818,171** | 1.0 | 1,104 |
| 2018 | $682,686 | $10,356 | $0 | $46,426 | $128,151 | **$867,619** | 1.0 | 1,094 |
| 2019 | $678,916 | $11,390 | $0 | $45,785 | $133,928 | **$870,019** | 1.0 | 1,085 |
| 2020 | $679,253 | $11,804 | $0 | $45,843 | $152,466 | **$889,366** | 1.0 | 1,075 |
| 2021 | $677,186 | $11,159 | $0 | $45,491 | $220,558 | **$954,394** | 1.0 | 1,065 |
| 2022 | $677,439 | $11,695 | $0 | $45,534 | $160,402 | **$895,071** | 1.0 | 1,056 |
| 2023 | $676,278 | $11,059 | $0 | $45,337 | $176,739 | **$909,413** | 1.0 | 1,046 |
| 2024 | $675,455 | $11,584 | $0 | $45,197 | $108,431 | **$840,668** | 1.0 | 1,037 |
| 2025 | $674,116 | $10,910 | $0 | $44,969 | $173,115 | **$903,110** | 1.0 | 1,027 |
| 2026 | $673,285 | $11,378 | $0 | $44,828 | $137,990 | **$867,480** | 1.0 | 1,018 |
| 2027 | $672,116 | $10,715 | $0 | $44,629 | $211,289 | **$938,749** | 1.0 | 1,009 |
| 2028 | $671,280 | $10,618 | $0 | $44,487 | $177,709 | **$904,094** | 1.0 | 1,000 |
| 2029 | $670,108 | $10,523 | $0 | $44,288 | $258,322 | **$983,241** | 1.0 | 991 |
| 2030 | $669,258 | $10,428 | $0 | $44,144 | $272,340 | **$996,169** | 1.0 | 982 |
| 2031 | $668,747 | $10,334 | $0 | $44,057 | $299,498 | **$1,022,636** | 1.0 | 973 |
| 2032 | $667,566 | $10,241 | $0 | $43,856 | $254,517 | **$976,180** | 1.0 | 964 |
| 2033 | $666,699 | $10,149 | $0 | $43,709 | $292,017 | **$1,012,573** | 1.0 | 956 |
| 2034 | $500,215 | $7,572 | $0 | $32,814 | $229,974 | **$770,575** | 0.8 | 713 |
| 2035 | $333,267 | $5,017 | $0 | $21,840 | $346,102 | **$706,226** | 0.5 | 472 |
| 2036 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2037 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2038 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2039 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2040 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2041 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2042 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2043 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2044 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2045 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2046 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2047 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2048 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| **Total** | **$16,524,122** | **$243,893** | **$2,663,265** | **$1,137,751** | **$4,897,262** | **$25,466,294** | | |

**Table B6: Annual Costs for Solar Lease Scenario ($2008)**

| Year | Project Costs | Net Lease Costs | **Total Costs** |
|---|---|---|---|
| 2009 | $1,954,695 | -$905,348 | **$1,049,348** |
| 2010 | $1,876,508 | -$794,254 | **$1,082,254** |
| 2011 | $3,602,895 | -$1,513,448 | **$2,089,448** |
| 2012 | $0 | $288,000 | **$288,000** |
| 2013 | $0 | $288,000 | **$288,000** |
| 2014 | $0 | $288,000 | **$288,000** |
| 2015 | $0 | $288,000 | **$288,000** |
| 2016 | $0 | $288,000 | **$288,000** |
| 2017 | $0 | $288,000 | **$288,000** |
| 2018 | $0 | $288,000 | **$288,000** |
| 2019 | $0 | $288,000 | **$288,000** |
| 2020 | $0 | $288,000 | **$288,000** |
| 2021 | $0 | $288,000 | **$288,000** |
| 2022 | $0 | $288,000 | **$288,000** |
| 2023 | $0 | $288,000 | **$288,000** |
| 2024 | $0 | $237,600 | **$237,600** |
| 2025 | $0 | $187,200 | **$187,200** |
| 2026 | $0 | $86,400 | **$86,400** |
| 2027 | $0 | $86,400 | **$86,400** |
| 2028 | $0 | $86,400 | **$86,400** |
| 2029 | $0 | $306,050 | **$306,050** |
| 2030 | $0 | $284,450 | **$284,450** |
| 2031 | $0 | $482,500 | **$482,500** |
| 2032 | $0 | $0 | **$0** |
| 2033 | $0 | $0 | **$0** |
| 2034 | $0 | $0 | **$0** |
| 2035 | $0 | $0 | **$0** |
| 2036 | $0 | $0 | **$0** |
| 2037 | $0 | $0 | **$0** |
| 2038 | $0 | $0 | **$0** |
| 2039 | $0 | $0 | **$0** |
| 2040 | $0 | $0 | **$0** |
| 2041 | $0 | $0 | **$0** |
| 2042 | $0 | $0 | **$0** |
| 2043 | $0 | $0 | **$0** |
| 2044 | $0 | $0 | **$0** |
| 2045 | $0 | $0 | **$0** |
| 2046 | $0 | $0 | **$0** |
| 2047 | $0 | $0 | **$0** |
| 2048 | $0 | $0 | **$0** |
| **Total** | **$7,434,098** | **$1,999,951** | **$9,434,049** |

## Table B7: Annual Benefits for SREC Scenario ($2008)

| Year | Gross Energy Savings | Emissions Savings | Federal ITC & Dep. Deduction | Import Sub. | Economic Spin-off (GSP) | Total Benefits | Cum. Annual MW | Cum. Annual MWh |
|---|---|---|---|---|---|---|---|---|
| 2009 | $331,922 | $5,130 | $2,669,236 | $33,339 | $83,903 | **$3,123,530** | 1 | 1,174 |
| 2010 | $1,685,279 | $25,035 | $8,832,794 | $186,757 | $567,878 | **$11,297,741** | 4 | 5,060 |
| 2011 | $6,150,111 | $66,410 | $18,582,306 | $554,167 | $1,542,433 | **$26,895,427** | 11 | 13,232 |
| 2012 | $13,819,049 | $125,325 | $26,605,149 | $1,053,454 | $2,959,552 | **$44,562,529** | 21 | 24,616 |
| 2013 | $22,867,619 | $218,382 | $32,944,317 | $1,598,051 | $4,511,197 | **$62,139,565** | 33 | 38,199 |
| 2014 | $31,835,894 | $336,475 | $37,362,164 | $2,221,920 | $6,099,307 | **$77,855,760** | 46 | 53,040 |
| 2015 | $41,345,894 | $517,861 | $40,523,039 | $2,874,831 | $7,462,933 | **$92,724,558** | 60 | 68,810 |
| 2016 | $51,582,871 | $697,943 | $42,458,384 | $3,593,501 | $8,305,497 | **$106,638,195** | 74 | 85,414 |
| 2017 | $62,593,986 | $907,308 | $43,742,628 | $4,382,477 | $8,705,948 | **$120,332,347** | 90 | 102,901 |
| 2018 | $73,841,574 | $1,148,072 | $44,670,214 | $5,146,678 | $8,487,783 | **$133,294,322** | 106 | 121,326 |
| 2019 | $85,674,670 | $1,478,014 | $45,489,380 | $5,941,543 | $8,691,274 | **$147,274,879** | 124 | 140,747 |
| 2020 | $98,760,397 | $1,770,660 | $46,289,979 | $6,876,349 | $9,264,142 | **$162,961,527** | 142 | 161,223 |
| 2021 | $112,282,676 | $1,915,257 | $47,104,729 | $7,807,983 | $10,818,276 | **$179,928,920** | 162 | 182,820 |
| 2022 | $127,049,937 | $2,278,048 | $47,933,765 | $8,869,235 | $12,726,586 | **$198,857,571** | 183 | 205,605 |
| 2023 | $142,461,868 | $2,427,917 | $48,777,402 | $9,953,130 | $15,614,801 | **$219,235,118** | 205 | 229,651 |
| 2024 | $158,899,645 | $2,849,926 | $49,635,861 | $11,119,250 | $18,933,237 | **$241,437,919** | 228 | 255,034 |
| 2025 | $158,570,036 | $2,683,935 | $16,076,916 | $11,063,217 | $22,136,550 | **$210,530,653** | 228 | 252,739 |
| 2026 | $158,365,615 | $2,799,123 | $12,162,251 | $11,028,465 | $22,719,359 | **$207,074,813** | 228 | 250,464 |
| 2027 | $158,078,138 | $2,636,033 | $8,178,688 | $10,979,594 | $24,129,564 | **$204,002,016** | 228 | 248,210 |
| 2028 | $157,872,406 | $2,612,308 | $4,125,015 | $10,944,619 | $26,589,214 | **$202,143,562** | 228 | 245,976 |
| 2029 | $157,584,056 | $2,588,798 | $0 | $10,895,600 | $29,360,157 | **$200,428,610** | 228 | 243,762 |
| 2030 | $157,374,967 | $2,565,498 | $0 | $10,860,055 | $32,390,151 | **$203,190,672** | 228 | 241,569 |
| 2031 | $157,249,241 | $2,542,409 | $0 | $10,838,681 | $36,235,183 | **$206,865,515** | 228 | 239,394 |
| 2032 | $156,958,712 | $2,519,527 | $0 | $10,789,291 | $42,715,804 | **$212,983,335** | 228 | 237,240 |
| 2033 | $156,745,411 | $2,496,852 | $0 | $10,753,030 | $47,989,430 | **$217,984,723** | 228 | 235,105 |
| 2034 | $155,908,136 | $2,464,435 | $0 | $10,680,324 | $52,550,330 | **$221,603,225** | 227 | 232,052 |
| 2035 | $153,412,089 | $2,409,240 | $0 | $10,487,169 | $56,531,432 | **$222,839,930** | 224 | 226,855 |
| 2036 | $148,616,899 | $2,317,945 | $0 | $10,159,398 | $59,729,126 | **$220,823,369** | 217 | 218,259 |
| 2037 | $141,867,759 | $2,199,628 | $0 | $9,694,421 | $62,278,961 | **$216,040,770** | 207 | 207,118 |
| 2038 | $133,835,261 | $2,062,885 | $0 | $9,147,749 | $64,268,420 | **$209,314,315** | 195 | 194,242 |
| 2039 | $124,912,288 | $1,915,677 | $0 | $8,531,581 | $65,753,158 | **$201,112,704** | 182 | 180,381 |
| 2040 | $115,496,399 | $1,760,789 | $0 | $7,894,669 | $66,021,274 | **$191,173,131** | 169 | 165,797 |
| 2041 | $105,220,815 | $1,599,037 | $0 | $7,169,437 | $66,007,312 | **$179,996,600** | 154 | 150,566 |
| 2042 | $94,392,167 | $1,429,986 | $0 | $6,411,480 | $65,327,016 | **$167,560,649** | 138 | 134,648 |
| 2043 | $82,976,702 | $1,253,177 | $0 | $5,618,739 | $63,981,050 | **$153,829,668** | 122 | 118,000 |
| 2044 | $70,938,643 | $1,068,123 | $0 | $4,789,031 | $62,554,275 | **$139,350,072** | 104 | 100,575 |
| 2045 | $58,240,075 | $874,307 | $0 | $3,920,042 | $60,148,435 | **$123,182,859** | 86 | 82,325 |
| 2046 | $44,840,809 | $671,184 | $0 | $3,009,320 | $57,376,971 | **$105,898,285** | 66 | 63,199 |
| 2047 | $30,698,255 | $458,174 | $0 | $2,054,268 | $54,311,812 | **$87,522,509** | 45 | 43,142 |
| 2048 | $15,767,267 | $234,663 | $0 | $1,052,134 | $50,471,459 | **$67,525,523** | 23 | 22,096 |
| **Total** | **$3,927,105,535** | **$62,931,494** | **$624,164,215** | **$270,984,978** | **$1,316,351,193** | **$6,201,537,415** | | |

## Table B8: Annual Costs for SREC Scenario ($2008)

| Year | Project Costs |
|---|---|
| 2009 | $7,812,780 |
| 2010 | $24,900,896 |
| 2011 | $50,401,820 |
| 2012 | $67,740,050 |
| 2013 | $78,036,538 |
| 2014 | $82,406,589 |
| 2015 | $84,647,954 |
| 2016 | $86,137,764 |
| 2017 | $87,653,876 |
| 2018 | $89,196,458 |
| 2019 | $90,766,393 |
| 2020 | $92,363,837 |
| 2021 | $93,989,574 |
| 2022 | $95,643,766 |
| 2023 | $97,327,087 |
| 2024 | $99,039,969 |
| 2025 | $0 |
| 2026 | $0 |
| 2027 | $0 |
| 2028 | $0 |
| 2029 | $0 |
| 2030 | $0 |
| 2031 | $0 |
| 2032 | $0 |
| 2033 | $0 |
| 2034 | $0 |
| 2035 | $0 |
| 2036 | $0 |
| 2037 | $0 |
| 2038 | $0 |
| 2039 | $0 |
| 2040 | $0 |
| 2041 | $0 |
| 2042 | $0 |
| 2043 | $0 |
| 2044 | $0 |
| 2045 | $0 |
| 2046 | $0 |
| 2047 | $0 |
| 2048 | $0 |
| **Total** | **$1,228,065,351** |

## Table B9: Annual Benefits for State Facilities Scenario ($2008)

| Year | Gross Energy Savings + Avoided Retail Purchases | Emissions Savings | State Bonds | Federal ITC & Dep. Deduction | Import Sub. | Economic Spin-off (GSP) | **Total Benefits** | **Cum. Annual MW** | **Cum. Annual MWh** |
|---|---|---|---|---|---|---|---|---|---|
| 2009 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 1 | 1,174 |
| 2010 | $450,508 | $5,130 | $1,632,000 | $2,669,236 | $43,321 | $98,016 | **$4,898,211** | 3 | 3,511 |
| 2011 | $1,811,303 | $17,369 | $3,133,440 | $5,450,337 | $147,044 | $680,016 | **$11,239,510** | 6 | 7,001 |
| 2012 | $4,289,950 | $35,137 | $4,512,154 | $8,330,081 | $299,602 | $947,110 | **$18,414,035** | 9 | 10,459 |
| 2013 | $6,866,180 | $53,250 | $4,331,667 | $8,934,558 | $437,566 | $1,462,350 | **$22,085,571** | 12 | 13,887 |
| 2014 | $9,249,337 | $79,390 | $4,158,401 | $9,514,855 | $581,735 | $1,741,468 | **$25,325,186** | 12 | 13,762 |
| 2015 | $9,151,613 | $87,302 | $0 | $3,217,269 | $574,953 | $1,862,196 | **$14,893,333** | 12 | 13,638 |
| 2016 | $9,147,494 | $102,638 | $0 | $2,592,496 | $573,771 | $1,432,991 | **$13,849,389** | 12 | 13,515 |
| 2017 | $9,160,946 | $110,437 | $0 | $1,692,824 | $575,602 | $859,257 | **$12,399,066** | 12 | 13,394 |
| 2018 | $9,119,669 | $118,095 | $0 | $829,138 | $568,157 | $271,853 | **$10,906,912** | 12 | 13,273 |
| 2019 | $9,075,876 | $125,598 | $0 | $0 | $560,313 | $393,340 | **$10,155,128** | 12 | 13,154 |
| 2020 | $9,082,172 | $138,129 | $0 | $0 | $561,014 | -$369,288 | **$9,412,027** | 12 | 13,035 |
| 2021 | $9,058,866 | $143,161 | $0 | $0 | $556,715 | -$99,943 | **$9,658,800** | 12 | 12,918 |
| 2022 | $9,063,760 | $135,330 | $0 | $0 | $557,241 | $551,492 | **$10,307,823** | 12 | 12,802 |
| 2023 | $9,051,144 | $141,838 | $0 | $0 | $554,825 | $1,340,991 | **$11,088,798** | 12 | 12,686 |
| 2024 | $9,042,476 | $134,123 | $0 | $0 | $553,114 | $1,728,191 | **$11,457,905** | 12 | 12,572 |
| 2025 | $8,964,764 | $140,490 | $0 | $0 | $550,327 | $2,263,575 | **$11,919,156** | 12 | 12,459 |
| 2026 | $8,830,354 | $132,308 | $0 | $0 | $548,598 | $2,522,481 | **$12,033,741** | 12 | 12,347 |
| 2027 | $8,628,774 | $137,986 | $0 | $0 | $546,167 | $2,698,102 | **$12,011,029** | 12 | 12,236 |
| 2028 | $8,368,208 | $129,946 | $0 | $0 | $544,427 | $3,031,431 | **$12,074,013** | 12 | 12,126 |
| 2029 | $8,103,251 | $128,777 | $0 | $0 | $541,989 | $2,755,784 | **$11,529,800** | 12 | 12,017 |
| 2030 | $8,092,850 | $127,618 | $0 | $0 | $540,221 | $2,847,325 | **$11,608,014** | 12 | 11,908 |
| 2031 | $8,086,596 | $126,469 | $0 | $0 | $539,158 | $3,116,789 | **$11,869,011** | 12 | 11,801 |
| 2032 | $8,072,144 | $125,331 | $0 | $0 | $536,701 | $3,147,975 | **$11,882,150** | 12 | 11,695 |
| 2033 | $8,061,533 | $124,203 | $0 | $0 | $534,897 | $3,203,129 | **$11,923,762** | 12 | 11,590 |
| 2034 | $8,052,869 | $123,085 | $0 | $0 | $533,424 | $3,227,456 | **$11,936,835** | 11 | 10,549 |
| 2035 | $7,374,123 | $112,033 | $0 | $0 | $487,668 | $3,567,453 | **$11,541,277** | 9 | 8,581 |
| 2036 | $6,035,967 | $91,136 | $0 | $0 | $399,442 | $3,451,092 | **$9,977,636** | 6 | 5,695 |
| 2037 | $4,025,556 | $60,482 | $0 | $0 | $266,563 | $3,471,444 | **$7,824,044** | 3 | 2,835 |
| 2038 | $2,014,041 | $30,104 | $0 | $0 | $133,496 | $3,471,229 | **$5,648,870** | 0 | 0 |
| 2039 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2040 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2041 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2042 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2043 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2044 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2045 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2046 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2047 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 0 | 0 |
| 2048 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** | 1 | 1,174 |
| **Total** | **$216,332,325** | **$3,016,896** | **$17,767,662** | **$43,230,795** | **$13,848,052** | **$55,675,302** | **$349,871,031** | | |

**Table B10: Annual Costs for State Facilities Scenario ($2008)**

| Year | Project Costs | Debt Payments | **Total Costs** |
|---|---|---|---|
| 2009 | $0 | $0 | **$0** |
| 2010 | $7,812,780 | $157,231 | **$7,970,011** |
| 2011 | $15,000,540 | $459,113 | **$15,459,653** |
| 2012 | $21,600,780 | $893,825 | **$22,494,605** |
| 2013 | $20,736,750 | $1,311,147 | **$22,047,897** |
| 2014 | $19,907,280 | $1,711,777 | **$21,619,057** |
| 2015 | $0 | $1,711,777 | **$1,711,777** |
| 2016 | $0 | $1,711,777 | **$1,711,777** |
| 2017 | $0 | $1,711,777 | **$1,711,777** |
| 2018 | $0 | $1,711,777 | **$1,711,777** |
| 2019 | $0 | $1,711,777 | **$1,711,777** |
| 2020 | $0 | $1,711,777 | **$1,711,777** |
| 2021 | $0 | $1,711,777 | **$1,711,777** |
| 2022 | $0 | $1,711,777 | **$1,711,777** |
| 2023 | $0 | $1,711,777 | **$1,711,777** |
| 2024 | $0 | $1,711,777 | **$1,711,777** |
| 2025 | $0 | $1,554,547 | **$1,554,547** |
| 2026 | $0 | $1,252,664 | **$1,252,664** |
| 2027 | $0 | $817,953 | **$817,953** |
| 2028 | $0 | $400,630 | **$400,630** |
| 2029 | $0 | $0 | **$0** |
| 2030 | $0 | $0 | **$0** |
| 2031 | $0 | $0 | **$0** |
| 2032 | $0 | $0 | **$0** |
| 2033 | $0 | $0 | **$0** |
| 2034 | $0 | $0 | **$0** |
| 2035 | $0 | $0 | **$0** |
| 2036 | $0 | $0 | **$0** |
| 2037 | $0 | $0 | **$0** |
| 2038 | $0 | $0 | **$0** |
| 2039 | $0 | $0 | **$0** |
| 2040 | $0 | $0 | **$0** |
| 2041 | $0 | $0 | **$0** |
| 2042 | $0 | $0 | **$0** |
| 2043 | $0 | $0 | **$0** |
| 2044 | $0 | $0 | **$0** |
| 2045 | $0 | $0 | **$0** |
| 2046 | $0 | $0 | **$0** |
| 2047 | $0 | $0 | **$0** |
| 2048 | $0 | $0 | **$0** |
| **Total** | **$85,058,130** | **$25,676,658** | **$110,734,788** |

**Table B11: Annual Benefits for Utility Expensed Scenario ($2008)**

| Year | Gross Energy Savings | Emissions Savings | Federal ITC & Dep. Deduction | Import Sub. | Economic Spin-off (GSP) | **Total Benefits** | **Cum. Annual MW** | **Cum. Annual MWh** |
|---|---|---|---|---|---|---|---|---|
| 2009 | $331,922 | $5,130 | $2,439,381 | $33,339 | $2,021,224 | **$4,830,996** | 1 | 1,174 |
| 2010 | $1,560,273 | $23,176 | $7,322,798 | $172,894 | $4,782,126 | **$13,861,267** | 2 | 2,425 |
| 2011 | $4,887,664 | $52,759 | $12,394,506 | $440,252 | $5,476,169 | **$23,251,350** | 3 | 3,760 |
| 2012 | $5,870,504 | $53,036 | $2,524,170 | $445,805 | -$7,131,431 | **$1,762,083** | 4 | 5,184 |
| 2013 | $6,226,780 | $59,019 | $2,524,170 | $431,880 | -$4,594,313 | **$4,647,535** | 6 | 6,705 |
| 2014 | $6,207,319 | $64,900 | $2,226,789 | $428,572 | -$2,612,767 | **$6,314,813** | 7 | 8,330 |
| 2015 | $6,177,930 | $76,301 | $1,370,332 | $423,575 | -$1,411,910 | **$6,636,228** | 9 | 10,067 |
| 2016 | $6,172,805 | $82,099 | $0 | $422,704 | $683,906 | **$7,361,513** | 10 | 11,924 |
| 2017 | $6,180,740 | $87,792 | $0 | $424,053 | $888,205 | **$7,580,790** | 12 | 13,910 |
| 2018 | $6,148,477 | $93,370 | $0 | $418,568 | $1,089,971 | **$7,750,387** | 14 | 16,035 |
| 2019 | $6,114,484 | $102,685 | $0 | $412,790 | $1,264,625 | **$7,894,584** | 16 | 18,310 |
| 2020 | $6,117,524 | $106,426 | $0 | $413,306 | $1,393,981 | **$8,031,238** | 18 | 20,746 |
| 2021 | $6,098,890 | $100,605 | $0 | $410,139 | $1,573,431 | **$8,183,064** | 21 | 23,355 |
| 2022 | $6,101,172 | $105,443 | $0 | $410,526 | $1,595,813 | **$8,212,954** | 23 | 26,151 |
| 2023 | $6,090,699 | $99,708 | $0 | $408,746 | $1,811,882 | **$8,411,035** | 26 | 29,146 |
| 2024 | $6,083,287 | $104,441 | $0 | $407,486 | $1,882,981 | **$8,478,195** | 29 | 32,357 |
| 2025 | $6,071,208 | $98,358 | $0 | $405,433 | $1,930,344 | **$8,505,343** | 29 | 32,066 |
| 2026 | $6,063,717 | $102,579 | $0 | $404,159 | $1,952,850 | **$8,523,305** | 29 | 31,777 |
| 2027 | $6,053,182 | $96,602 | $0 | $402,368 | $2,057,964 | **$8,610,116** | 29 | 31,491 |
| 2028 | $6,045,642 | $95,733 | $0 | $401,086 | $2,107,617 | **$8,650,079** | 29 | 31,208 |
| 2029 | $6,035,075 | $94,871 | $0 | $399,290 | $2,173,888 | **$8,703,124** | 29 | 30,927 |
| 2030 | $6,027,413 | $94,018 | $0 | $397,987 | $2,248,692 | **$8,768,110** | 29 | 30,649 |
| 2031 | $6,022,805 | $93,171 | $0 | $397,204 | $2,382,678 | **$8,895,859** | 29 | 30,373 |
| 2032 | $6,012,158 | $92,333 | $0 | $395,394 | $2,288,269 | **$8,788,154** | 29 | 30,099 |
| 2033 | $6,004,341 | $91,502 | $0 | $394,065 | $2,363,415 | **$8,853,324** | 29 | 29,829 |
| 2034 | $5,334,856 | $80,734 | $0 | $349,883 | $2,517,784 | **$8,283,257** | 28 | 28,624 |
| 2035 | $3,332,666 | $50,174 | $0 | $218,402 | $2,368,578 | **$5,969,820** | 27 | 27,359 |
| 2036 | $0 | $0 | $0 | $0 | $0 | **$0** | 26 | 26,031 |
| 2037 | $0 | $0 | $0 | $0 | $0 | **$0** | 25 | 24,634 |
| 2038 | $0 | $0 | $0 | $0 | $0 | **$0** | 23 | 23,161 |
| 2039 | $0 | $0 | $0 | $0 | $0 | **$0** | 22 | 21,609 |
| 2040 | $0 | $0 | $0 | $0 | $0 | **$0** | 20 | 19,969 |
| 2041 | $0 | $0 | $0 | $0 | $0 | **$0** | 19 | 18,236 |
| 2042 | $0 | $0 | $0 | $0 | $0 | **$0** | 17 | 16,402 |
| 2043 | $0 | $0 | $0 | $0 | $0 | **$0** | 15 | 14,459 |
| 2044 | $0 | $0 | $0 | $0 | $0 | **$0** | 13 | 12,399 |
| 2045 | $0 | $0 | $0 | $0 | $0 | **$0** | 11 | 10,213 |
| 2046 | $0 | $0 | $0 | $0 | $0 | **$0** | 8 | 7,890 |
| 2047 | $0 | $0 | $0 | $0 | $0 | **$0** | 6 | 5,422 |
| 2048 | $0 | $0 | $0 | $0 | $0 | **$0** | 3 | 2,796 |
| **Total** | **$149,373,534** | **$2,206,967** | **$30,802,146** | **$10,269,908** | **$33,105,971** | **$225,758,524** | | |

**Table B12: Annual Costs for Utility Expensed Scenario ($2008)**

| Year | Project Costs |
|---|---|
| 2009 | **$7,140,000** |
| 2010 | **$20,563,200** |
| 2011 | **$32,901,120** |
| 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** |
| 2028 | **$0** |
| 2029 | **$0** |
| 2030 | **$0** |
| 2031 | **$0** |
| 2032 | **$0** |
| 2033 | **$0** |
| 2034 | **$0** |
| 2035 | **$0** |
| 2036 | **$0** |
| 2037 | **$0** |
| 2038 | **$0** |
| 2039 | **$0** |
| 2040 | **$0** |
| 2041 | **$0** |
| 2042 | **$0** |
| 2043 | **$0** |
| 2044 | **$0** |
| 2045 | **$0** |
| 2046 | **$0** |
| 2047 | **$0** |
| 2048 | **$0** |
| **Total** | **$60,604,320** |

# Appendix C – Emission Price Forecasts for CT

| Year | Value per Ton | | |
|---|---|---|---|
| | SO2 | NOx | CO2 |
| 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 |

Forecasted prices (adjusting for inflation) for allowance permits currently traded in auctions or climate exchanges 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[7].

[7] http://www.epa.gov/cair/basic.html

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