Does Community Solar Have a Future in New England?

Cost Benefit Analysis of Community Solar in Three New England States

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University of Maine School of Economics
Why Community Solar?

• Expand access to solar
  • Only ¼ of U.S. residential buildings suitable for solar (NREL)

• Capacity in the United States projected to increase by 1.8 GW through 2020 (Green Tech Media)

Source: https://ilsr.org
Defining Community Solar

- Provides power or financial or other benefits to a group of people
  - Common local geographic area (town level or smaller)
  - Common set of interests
  - Some costs and/or benefits shared by the group

Coughlin et. al, 2012
Walker & Devine-Wright, 2008
Community Solar Database

- 5143 Community solar projects nationwide
Common Project Typologies

**Solar Farms or Gardens**

Multiple people or businesses own or purchase electricity from a single solar PV array

**Benefits of economies of scale**

This 150 kW community solar garden in Brattleboro, VT provides energy to six local residences and three businesses.

*Source:* http://soverensolar.com/

*Source:* http://energy.gov
Common Project Typologies

Solar projects at **Community Serving Institutions:**

Solar at K-12 Schools (public and private)

Solar on other Municipal Property (libraries, community centers, landfills)

Solar at Non-Profit Organizations (places of worship, charities)

Solar at Colleges and Universities

An 8.4 kW solar array at Unitarian Universalist Church West in Brookfield, WI

*Source: http://www.uucw.org/*
Common Project Typologies

**Solarize or Bulk Purchase Campaigns**

Individuals in a common geographic area purchase individual residential systems as a group

Limited time to participate

Tiered pricing structure: the more people sign up, the greater the discount on installed cost

Source: http://energy.gov
Median Project Capacity by Type

Median Project Capacity (kW)

- Solar Farms
- Municipal Solar
- Solarize
- University
- Solar Schools
- Non-Profit Solar

Massachusetts, Vermont, Maine
How Can We Evaluate the Cost-Competitiveness of Solar?

\[
\text{Net Present Value} = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0
\]

- \(C_t\) = net cash flow in year \(t\)
- \(C_0\) = initial project cost
- \(r\) = discount rate
- \(T\) = project lifetime
- \(t\) = year \(t\)

Source: http://solarpowerrocks.com
Why is Discounting Important?

Time Value of Money: money in the future is not worth as much as the same amount of money in the present

- Inflation
- Opportunity cost
- $r = 5\%$

Simple payback period does not take into account the time value of money, tends to overestimate the cost-competitiveness of solar.

Now or in 10 years?
Important Solar Incentives (All 3 States)

30% Federal Tax Credit (FTC) – Tax deduction of 30% of system cost

Reduces the upfront cost of solar
Important Solar Incentives (All 3 States)

Renewable Energy Credits (RECs)
• 1 MWh = $
• Can be sold between New England states
• Price set by supply and demand

$40/ MWh  > 50 kW

Source: http://apps3.eere.energy.gov/
Important Solar Incentives (Massachusetts)

Solar Renewable Energy Credits (SRECs)
• Similar to RECs, but solar PV only
• Can only be generated within MA
• Price set by policy
• $285/ MWh in 2015 (decreases to $180 by 2025)

State Tax Credit – Personal Tax Deduction of 15% of purchase price
Important Solar Incentives (Vermont)

Solar Adder

• Price guarantee for solar electricity
• $.20/ kWh for systems up to 15 kW
• $.19/ kWh for systems over 15 kW
• First 10 years of system operation
# State Level Assumptions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Units</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{\text{WATT}} &lt; 25$ kW</td>
<td>$$/W</td>
<td>$3.59^{1}$ Maine, $4.44^{1}$ Massachusetts, $4.44^{1}$ Vermont</td>
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<tr>
<td>$25 \leq C_{\text{WATT}} &lt; 500$ kW</td>
<td>$$/W</td>
<td>$3.20^{1}$ Maine, $4.14^{1}$ Massachusetts, $3.89^{1}$ Vermont</td>
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<td>$500 \leq C_{\text{WATT}}$</td>
<td>$$/W</td>
<td>$2.03^{1}$ Maine, $2.62^{1}$ Massachusetts, $2.47^{1}$ Vermont</td>
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<tr>
<td>$P_{\text{RETAIL}}$</td>
<td>$$/kWh</td>
<td>$0.1577^{2}$ Maine, $0.1767^{2}$ Massachusetts, $0.1775^{2}$ Vermont</td>
</tr>
<tr>
<td>Solarize Discount</td>
<td>%</td>
<td>NA, 25%, 7%</td>
</tr>
</tbody>
</table>

1. Lawrence Berkeley National Laboratory
2. Energy Information Administration
Results: NPV at 25 Years

Discount rate = 5%

Net Present Value ($/W)

Solar Farms | Municipal Solar | Solarize | University | Solar Schools | Non-Profit Solar | Individual Residential
---|---|---|---|---|---|---
Massachusetts | Vermont | Maine

No Incentives
Key Takeaways (No Incentives)

• Only large scale (>500 kw) solar PV projects are cost competitive with retail electricity

• Lower installed cost of PV in Maine means projects in the state fare better than comparable ones in Massachusetts and Vermont
Results: NPV at 25 Years

Current Incentives

<table>
<thead>
<tr>
<th>Incentive</th>
<th>MA</th>
<th>VT</th>
<th>ME</th>
</tr>
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<tbody>
<tr>
<td>FTC</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>STC</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RECs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>SRECs</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Solar Adder</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

[Diagram showing NPV at 25 years for different categories such as Solar Farms, Solarize, Municipal Solar, Individual Residential, University, Solar Schools, Non-Profit Solar, with different states represented in green (Vermont), blue (Maine), and red (Massachusetts).]
Results: Discounted Payback Period

Current Incentives

Payback Period (years)

Solarize  Solar Farms  Municipal Solar  Individual Residential  Solar Schools  University  Non-Profit Solar

Massachusetts  Vermont  Maine
Results: Simple Payback Period

Current Incentives

Payback Period (years)

- Solarize
- Solar Farms
- Municipal Solar
- Individual Residential
- Solar Schools
- University
- Non-Profit Solar

- Massachusetts
- Vermont
- Maine

Payback Period: 20
Key Takeaways (Current Incentives)

• Massachusetts most profitable for all typologies

• Projects at Community Serving Institutions, in Maine and Vermont are not cost competitive
  • In reality, projects at tax exempt organizations may be structured as PPAs

• Significant income from SREC sales means even projects at tax exempt organizations in Massachusetts achieve positive NPVs
Key Takeaways

• **Solar Farms** are the most profitable typology in all three states
  • Combine economies of scale with utilization of FTC

• **Solarize** campaigns in MA nearly as profitable as **Solar Farms**
  • Combine 30% FTC with 15% STC and discounted purchase price

• **Individual Residential** systems in ME and VT achieve positive NPVs, but only just ($0.12/W and $0.13/W, respectively)
Sensitivity Analysis

Massachusetts Solar Farms
Impact by Input

Discount Rate (A2)
Base Purchase Price (A15)
Elec. Escalation Rate (A5)
Capacity Factor (F10)
Inverter Cost (A13)
System Degredation (A9)
REC Price (F2)

Value of Solar Farms

Base Value=3.8166
Sensitivity Analysis

Maine Solar Farms
Impact by Input

Discount Rate (A2)
Base Purchase Price (A15)
Capacity Factor (H10)
Elec. Escalation Rate (A5)
Capacity for REC Income (A14)
Inverter Cost (A13)
System Degredation (A9)
REC Price (F2)

Base Value=0.7223
Changes to Maine Solar Policy

• Recent stakeholder meeting proposed changes to ME Net Metering which have the potential to influence these results if enacted

• Replaces traditional net metering with alternative model – solar PV owners compensated a flat, agreed upon rate per kWh rather than retail electric rate

• Eliminates the 10 customer cap on group net metered systems

• Sets a goal of 45 MW of installed community solar
Conclusions

• Community solar dependent financial incentives to make it cost competitive

• Current incentives make MA most profitable state for all typologies

• Alternatives to tax credits (or alternative financial structures) are needed to make non-profit typologies cost competitive

• **Solar Farms or Gardens** are the most profitable typology in all three states

• **Individual Residential** profitable in all three states
Questions
Extra Slides
## General Assumptions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Units</th>
<th>Default Value</th>
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<tbody>
<tr>
<td>$C_{\text{INV}}$</td>
<td>Cost of inverter replacement</td>
<td>$</td>
<td>9.5% of $C_{\text{SYS}}$</td>
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<tr>
<td>$d$</td>
<td>Annual system degradation</td>
<td>%</td>
<td>0.50%$^2$</td>
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<tr>
<td>None</td>
<td>Annual electricity price escalation</td>
<td>%</td>
<td>1.6%$^3$</td>
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<tr>
<td>$P_{\text{REC}}$</td>
<td>REC price in year $t$</td>
<td>$/\text{MWh}$</td>
<td>$40$</td>
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<tr>
<td>$r$</td>
<td>Discount Rate</td>
<td>%</td>
<td>5%</td>
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<tr>
<td>$T$</td>
<td>System lifetime</td>
<td>years</td>
<td>25 years</td>
</tr>
</tbody>
</table>

2. SAM
3. Energy Information Administration
NPV at 30 Years: No Incentives

Net Present Value ($/W)

No Incentives

Solar Farms, Municipal Solar, University Solarize, Solar Schools, Non-Profit Solar, Individual Residential

Massachusetts, Vermont, Maine
NPV at 40 Years: No Incentives

Net Present Value ($/W)

Solar Farms, Municipal Solar, Solarize, University, Solar Schools, Individual Residential, Non-Profit Solar

Massachusetts, Vermont, Maine
NPV at 30 Years: Current Incentives

Current Incentives

Net Present Value ($/W)

Solar Farms Solarize Municipal Solar Individual Residential University Solar Schools Non-Profit Solar

Massachusetts Vermont Maine

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NPV at 40 Years: Current Incentives

Current Incentives

<table>
<thead>
<tr>
<th></th>
<th>Massachusetts</th>
<th>Vermont</th>
<th>Maine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Farms</td>
<td></td>
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<tr>
<td>Solarize</td>
<td></td>
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<td>-1.00</td>
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<tr>
<td>Municipal Solar</td>
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<td></td>
<td>0.00</td>
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<tr>
<td>Individual Residential</td>
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<td>1.00</td>
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<tr>
<td>University</td>
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<tr>
<td>Solar Schools</td>
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<td>3.00</td>
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<tr>
<td>Non-Profit Solar</td>
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<td>4.00</td>
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</tbody>
</table>
How Can We Evaluate the Cost-Competitiveness of Solar?

Net Present Value = \( \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0 \)

- \( C_t \) = net cash flow in year t
- \( C_0 \) = initial project cost
- \( r \) = discount rate
- \( T \) = project lifetime
- \( t = year \ t \)

Source: http://solarpowerrocks.com