


# Green Needham Collaborative



## Solar 101



### Solar 101 – An Introduction for Homeowners

March 20, 2013

Presented by the  
**The Green Needham Collaborative,**  
in collaboration with  
**Needham Community Education**



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### About Green Needham

**Green Needham Collaborative**

- Volunteer group founded in 2006
- Bring together people and organizations to build a much more sustainable community through collaborative efforts on energy and the environment
- 501(c)3 Green Needham Foundation- larger projects, fiscal agency

**How we work**

- Collaborative and inclusive by design
  - Municipal & schools involvement
  - Business outreach and engagement
  - People in individual and social contexts
  - Community organizations – clubs, service organizations, houses of worship, colleges
- Champion and lead projects
- Foster, support, connect and partner with other organizations
- **We leverage relationships and networks**

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### Green Needham Projects

**Needham Community Solar Challenge**

- Community donations to NE Wind Fund → \$21,000 for municipal projects & 2kW Solar PV array for High Rock School

**10% Challenge – Needham 1,000**

- Easy-to-use online tool to identify ways to save 10% on energy use
- Over 900 households (and selected businesses) participated
- Plaque presentation to Town of Needham October 2012

**Community Summit on Energy and the Environment**

- Community conversation on Needham in 2020 in the context of the Massachusetts 2020 Clean Energy & Climate Plan
- Over 150 residents, students, elected officials & staff participated

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# Green Needham Collaborative

## Solar 101



### Green Needham Projects (continued)

**NStar Community Energy Challenge**

- Promoting home energy assessments & follow-up actions
- Significantly overachieved kWh reduction targets but much opportunity remains

**Home Energy Savings Team**

- Build on success of Community Energy Challenge to help more homeowners reduce energy use and save money

**RTS Solar PV**

- Working to have Needham install a 2 MW solar PV system on top of the closed landfill at the RTS

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### Solar 101 Workshop Goals and Agenda

- Learn the fundamentals of solar PV (photovoltaic) and solar thermal systems
- What makes a house a good candidate for solar
- Questions to consider before proceeding
- Building code considerations, with Needham Building Inspector David Roche
- Financial options and issues
- Preview of Solarize Needham

Meet and Greet with neighbors and their installers

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### Why are we here?



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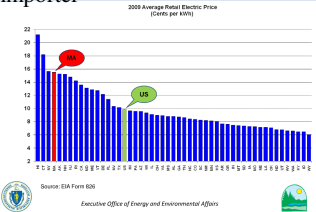
## Solar 101



### Energy Issues in New England

- We're at the end of the pipeline for traditional energy resources
- Prices are volatile and will be rising.
- Mass. is an energy importer

Mass electric cost is 27% above the US avg.



Source: EIA Form 861  
Executive Office of Energy and Environmental Affairs

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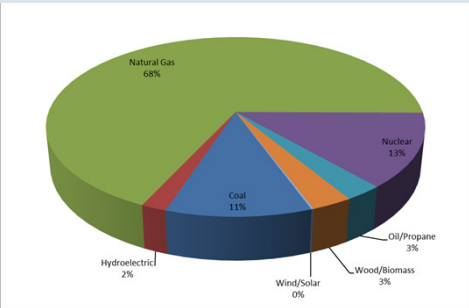
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### Massachusetts Electricity Sources in 2011




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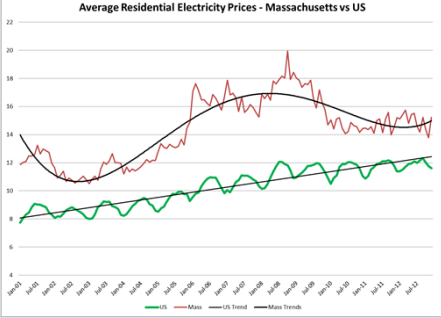
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### Energy Price Trends




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## Solar 101



### Solar Myth & Reality

**It's not "pie in the sky"**  
— Solar is proven (>30 years), reliable technology

**It's not exorbitantly expensive**  
— Hardware prices have dropped significantly  
— Installation costs are slowly coming down  
— Significant incentives are available

**It won't save the earth or allow you to go "off the grid"**  
— But you will reduce greenhouse gas emissions

**It's not too cold, snowy or cloudy here**  
— Germany has far more solar PV - and cloudy weather - than New England!

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### It's Not Magic – It's a Construction Project!

**Design & plan – making choices**  
— Evaluate your design options  
— Choose your design/build team

**Financing**  
— Now that you have a plan, how do you pay for it?

**Contracts and agreements**

**Doing the work**  
— Permits & Approvals

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### Why Choose Solar?

**Reduce your carbon footprint with a clean, renewable source of energy**  
— Proven technology with long warranties  
— Low maintenance

**Financially attractive**  
— Flexible options - purchase or pay for power (no upfront cash)  
— Federal and state incentives  
— Reduce or eliminate impact of electric price increases over 10 – 20 years

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## Solar 101



### Massachusetts is a Leader

Comprehensive, long-term commitment from the Administration and the Legislature has made Massachusetts a national leader

- Global Warming Solutions Act
- Green Communities Act (2009)
- Massachusetts 2020 Climate and Energy Plan
- Administration's commitment and plan to install 400 MW of solar PV in Massachusetts
  - Over 200 MW as of January 2013
  - Public meetings being held now to plan beyond 400 MW
- 2012 Act "Relative to Electricity Pricing"
  - Modifications/enhancements to Green Communities Act
- The administration, its executive agencies (DoER) and the legislature have been generally responsive and pro-active in addressing issues that arise.

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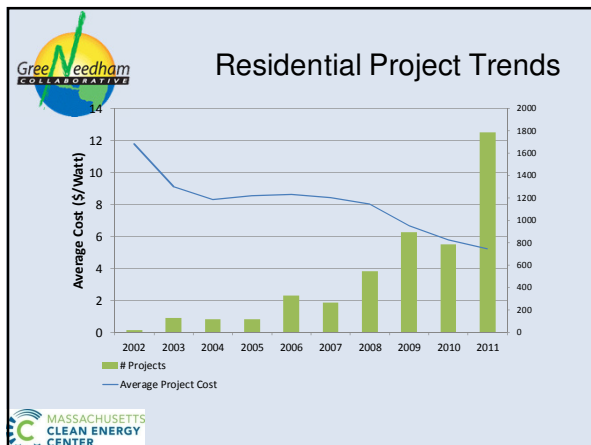
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### Solar PV in area towns

Town	Installed	Avg cost/W	Smallest	Average kW	Largest
Acton	21	\$5.51	4.6	6.9	13.3
Bedford	14	\$5.54	2.2	7.0	17.2
Concord	29	\$5.74	1.8	5.5	9.9
Dedham	5	\$6.56	3.4	5.2	8.4
Dover	5	\$5.98	2.9	10.0	18.5
Framingham	39	\$5.39	1.9	6.0	13.0
Lexington	25	\$5.56	2.7	5.8	8.5
Lincoln	16	\$5.07	1.9	6.6	10.5
Medfield	5	\$5.81	2.2	6.0	8.4
Natick	40	\$5.78	2.3	5.6	14.7
Needham	21	\$5.93	2.9	5.7	9.2
Newton	61	\$5.70	1.3	5.4	12.9
Sherborn	5	\$6.18	3.7	4.7	5.9
Wayland	47	\$4.62	3.2	8.0	19.6
Wellesley	3	\$5.26	2.2	3.5	5.1
Weston	10	\$5.39	2.7	7.8	11.4
Westwood	10	\$5.99	4.5	6.5	9.5

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## Solar 101



### Solar Power Basics

#### Common Terms:

**Photovoltaic** – using the sun’s energy (light) to produce electricity

**Solar Thermal** – using the sun’s energy to produce heat

**Net Metering** – selling electricity back to utility

**SRECs** – selling “green” attribute of solar energy

**PPA** – a third-party owns the solar project and sells you the electricity

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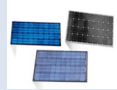
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### How Does Solar PV Work?

- The molecular structure of the silicon crystals within the solar cells get excited by sunlight
  - Various types of panels available, but focus on power production (Watts/SF) and cost (\$/Watt)
- Excited crystals produce electric energy
- More solar panels – more electricity
- Electricity produced is DC - like batteries
- The DC is converted to AC by an inverter for use in your house



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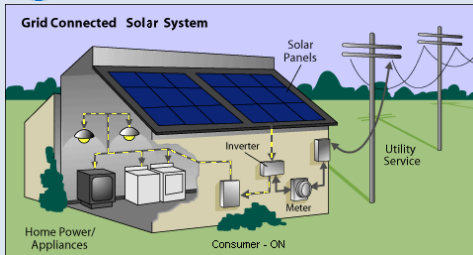
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### How Solar PV Works



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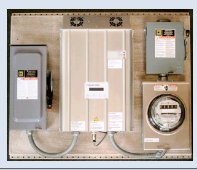

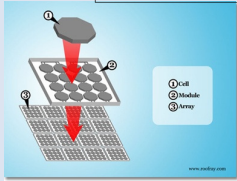
## Solar 101

 **Solar PV System Components**

**Arrays** made of  
**Panels** made of  
**Modules** made of  
**Cells**

**Racking** holds the panels

**Inverter** turns DC power to AC power; connects to **meter, monitoring system**



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 **System Considerations**

**Panels**

- Typically warranted for 20-25 years
- Quality, sourcing considerations?

**Racking**

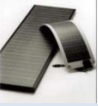
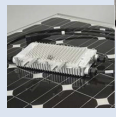
- Typically warranted for 10-15 years

**Inverters**

- Large Inverters vs. Micro-Inverters
- Typically warranted for 10 years – extended warranties available
- Typical 12-15 year life expectancy.
- Replacement cost approx. \$3-\$5,000.

**Utility Interconnect**

- Your system is interconnected to NStar's distribution system (the grid)



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 **Is my Home a Good Candidate for Solar?**

**Orientation of the roof**

- South-facing (or near south-facing)

**Obstructions from trees and structures**

- As many hours of sun as possible to maximize production

**Condition and expected life of your roof**

- Solar PV has 20 – 25+ year life – **make sure your roof is in good shape!**

**Your home's electrical system**

- “Modern” – 100 Amp or greater; circuit breakers

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## Solar 101



- Not always on the front of your house.
- Not always on your house!



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### What makes a Good Site?

#### South(-ish) Facing Roof Surface

Headings: 247.82 degrees

Orientation

☐ Mouse Navigation

Save Clear



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### What Makes a Good Site?

#### Minimal Shading



Significant shading on the south facing portion of the roof

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## Solar 101



### Optimal Site Example



Doesn't have to be due south

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### Solar Thermal Systems

- In solar thermal systems, the sun's energy heats fluids (water, glycol, etc.) in roof-mounted panels
- Those heated fluids are circulated to heat water in the home for:
  - Domestic hot water (most common)
  - Baseboard heating
  - Swimming pools

Not the focus of this program, but:

- Incentives are available (not as large as for PV)
- Massachusetts is studying installations to determine whether to do more



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### Solar Thermal

Typical single-family installation

- Installation cost (median) - \$9,900
  - Mass Rebate (median) - \$1,895
- 80 – 100 gallon hot water tank
- 55 – 70 gallons/day hot water use
  - 70% of usage offset (provided) by solar thermal
- Physical size: 55 – 65 sq. ft. (on roof)
- Estimated payback – 7 years

Source: Analysis of MassCEC installation data

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### Solar Thermal Considerations

#### Good candidates for Solar Thermal

- Roof and site prerequisites similar to solar PV
- Electric hot water
- High hot water usage
- Additional needs – swimming pools

#### Considerations

- Will use roof space that could otherwise be used for Solar PV
- Have you maximized the efficiency of your existing installation (much of which will still apply)?
  - Wrapping hot water tank with insulation
  - Insulate hot water pipes with long runs
  - Set appropriate hot water temperature
- Plumbing work and cost depends on your home's existing systems
- Financial incentives are not as large for solar thermal
- Most families spend much less on hot water than on electricity

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### Building Code Considerations

#### The Building Inspector is a Resource

#### Building Permit Required

- Structural report evaluates impact of added snow, wind & other loads on roof

#### Wiring Inspection Needed

#### Treated as a Quick Permit

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### Bids & Contracts

#### Things to Look for

- Installer training & certifications
  - No state licensing, but NABCEP certification is good
- Bids and quotes need to be “apples to apples”
- Equipment details specified:
  - Manufacturer, Model #'s, Quantity
- Warranty Language
- Don't sign anything you don't understand
- Work Schedule/Description of Work
- Price/Payment Schedule

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## Solar 101



### Comparing Bids

	Company A	Company B
Panel Quantity, Make, Model # & Size	12 Brand X #123 Panels @ 220 Watts	13 Brand Y #567 Panels @ 200 Watts
Inverter Quantity, Make, Model & efficiency	1 Acme Inverter XYZ (94% efficiency)	1 Acme Inverter JKF (97% efficiency)
System DC Rating	2640 Watts DC	2600 Watts DC
System AC Rating	2218 Watts AC	2254 Watts AC
System Output – kWh/year	2550 kWh/year	2700 kWh/year
Total Cost	\$11,203	\$18,200
Cost per Watt – DC	\$5.38/Watt (AC)	\$7.00/Watt (AC)
Cost per Watt - AC	\$6.40/Watt (AC)	\$8.07/Watt (AC)

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### The Average Massachusetts Home

**Avg. for Massachusetts:**

- 2,472 square feet
- 2.34 residents
- 6967 kWh per year
- \$1,131 per year electricity cost @ 16 cent/kWh

**5 kW Solar PV system**

- Produces 5,913 kWh per year
- 85% of avg. total usage
- Cost \$20,000 - \$30,000 (before incentives)
- \$960 annual electricity savings
- \$1,050 SREC value per year @ most recent prices

Source: US Energy Information Administration

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### Solar in Massachusetts

**High electricity prices + Reduced Solar PV Costs + Numerous Incentives = Economical solar projects**

**Incentives**

- Tax Incentives:
  - Federal (30%)
  - State (15% up to \$1,000)
- Rebates from MassCEC
- Net Metering
- SREC Sales
- Low/No money down options



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# Green Needham Collaborative

## Solar 101



### Two basic options: Purchase and PPA

#### Purchase

- Buy and own the solar PV system
- Substantial up-front cost (investment)
- “Own” all the financial benefits, along with the risks and uncertainties

#### Enter into a Power Purchase Agreement (PPA)

- Pay for the electricity the system generates
- A 3<sup>rd</sup> party owns the system on your roof
- Little or no up-front cost
- Smaller financial benefit, but fewer risks and uncertainties

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### Key Drivers of Financial Return

Where the value comes from

#### Initial cost of system

- Built-in to PPA – invisible to homeowner
- Homeowners purchasing systems should consider options more carefully

#### The future price of electricity

- Estimates (by you and your vendor) are central to the level of financial benefit projected for either PPA or Purchase

#### Net Metering

- Maximizes the value of all the electricity produced, whether used or provided to the grid
- Important to the financial return (unless you use all of the electricity on site)
- Availability of net metering can currently be safely assumed

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### Key Drivers of Financial Return

Where the value comes from

#### Solar Renewable Energy Certificates (SRECs)

- Important component of total financial return for purchase
- Real, but volatile with significant uncertainties
- Built-in (conservatively) to PPA

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## Solar 101



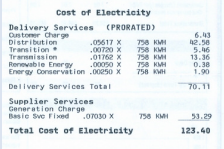
### Understanding electricity prices

Electric industry restructuring:

- Utilities no longer generate power, they just deliver it
- The **supply** cost is set in the market
- The **delivery** cost is still regulated
- Different drivers of future costs

Electricity price trends:

- **3%** yearly inflation in MA retail electric rates since 1990
- Since 2008:
  - Supply cost – **down 38%** (9%/yr)
  - Delivery cost – **up 41%** (7%/yr)



Cost of Electricity		
Delivery Services (PRORATED)		
Customer Charge		6.33
Distribution	.0617 X 758 kWh	46.58
Transmission	.00703 X 758 kWh	5.36
Transmission	.01762 X 758 kWh	13.36
Renewable Energy	.00500 X 758 kWh	3.83
Energy Conservation	.00250 X 758 kWh	1.90
<b>Delivery Services Total</b>		<b>76.36</b>
Supplier Services		
Generation Charge		53.09
Basic Svc Fixed	.07030 X 758 kWh	53.09
<b>Total Cost of Electricity</b>		<b>123.40</b>

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### Trends in electricity prices

**Peak Load / Peak Demand**

- Electricity is most expensive when it's most in demand
- Reducing peak load reduces the need to build expensive new power generation plants
  - Distributed generation (like Solar PV) and Energy Efficiency reduce demand

**Recent Trends**

- Cost of fuel – commodity volatility
- Historically low natural gas price – shale gas & fracking

**Future Trends**

- Growing cost of delivery as grid is upgraded
  - Replacement of aging infrastructure, deployment of "smart grid"
  - New and additional long-distance transmission & pipelines
  - Improving resilience of distribution system – impacts from climate change
- Variable or time-of-day pricing

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### How does Net Metering work?

**The utility grid is a two-way street:**

Authorized by the Green Communities Act (2009)  
—Enhanced in 2012

Solar electricity used in your home offsets electricity provided through your utility

Net metering puts unused electricity back on the grid  
—Your utility credits you at (almost) full retail cost



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### Solar Renewable Energy Certificates SRECs

- All qualified solar PV systems generate 1 SREC for each MWh of electricity generated.
  - SRECs can be bought and sold
- Solar Carve-Out** program requires each utility ("load serving entity") to generate a small percentage of its total load from solar PV.
  - Utilities must obtain and deliver SRECs representing that amount each year.
  - If they cannot obtain enough, they must make an "alternative compliance payment" instead. That payment is currently **\$550** per SREC.
- The targets for the carve-out program adjust based on the supply of SRECs.
  - If there are too many SRECs, the target goes up faster.
  - If there are not enough SRECs, the target goes up more slowly

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### Solar Renewable Energy Certificates SRECs

- The Commonwealth will hold a **fixed-price auction** once a year if there are unsold SRECs.
  - The auction is designed to provide a floor for SREC prices
  - Owners of SRECs receive \$285 per SREC from the proceeds of the auction
  - So far, there hasn't been a need to hold this auction, so there is uncertainty about how well it will work.
- The system is well thought-out and should, in theory, ensure a robust market and price for SRECs.
- So far, the prices aren't reflecting that
  - Recent open auction price of \$210
- Why? Short answer – this is a new, small, opaque market that doesn't (yet) have the conditions to operate effectively
  - Solar Finance 201. or perhaps 301, for a (much longer) answer
- Those with patience likely to be rewarded

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### Power Purchase Agreement How it works

You enter into a contract to buy the electricity generated by the system over an extended period

- No initial payment (usually)
- 10 – 20 year term is typical
- The rate (\$/kWh) is less than you are currently paying
- Financial benefit is the savings each year from that difference
- As electric rates go up, your savings increase
- The 3<sup>rd</sup> party owner is responsible for ensuring the system works

Years	10	15	20	25
Discount rate	3.00%			
PPA Savings, undiscounted	\$2,962	\$5,596	\$9,115	\$13,622
PPA Savings, discounted	\$2,467	\$4,256	\$6,318	\$8,597
Initial PPA rate	\$0.13 per kWh	0% Inflation rate		
Initial Utility rate	\$0.16 per kWh	3% Inflation rate		

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## Solar 101



### Power Purchase Agreement

Considerations / Questions to ask

- What is the initial difference between the PPA rate and the current rate you are paying?
  - Typically, PPA providers claim 5-15% savings.
  - As long as it is below the utility rate (and stays there), you will save money.
- Is your cost over the life of the PPA flat? Or is there an escalator?
  - For the same PPA rate, an escalator will reduce your benefit.
  - Some installers will offer a lower PPA rate with an escalator – analysis is required for comparison.

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### Power Purchase Agreement

Considerations / Questions to ask

- The more electricity prices rise, the greater the financial benefit
  - The “projected savings” you are shown is based on an assumed yearly increase in future electricity prices. Ask what it is.
  - That percentage is a major driver of total “projected savings”.
  - You can’t compare projected total savings between PPAs without knowing it.
- What is your estimate of future electricity price increases?
  - Not as critical for PPA as for a purchase, but worth thinking about.

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### Power Purchase Agreement

Considerations / Questions to ask

- What are your options at the end of the PPA term?
  - Extension/Renewal: what would the new PPA rate be?
  - Upgrade: option to replace with new technology and enter into a new PPA.
  - Purchase: opportunity to purchase the system at specified amount or “fair value”.
  - Removal: system removed from your roof and the roof returned to “as before” condition.
- Understand your obligations and rights under the contract you sign.
  - You are allowing a 3<sup>rd</sup> party to install their property on your home. They will need and be granted access to it.

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# Green Needham Collaborative

## Solar 101



### Power Purchase Agreement

Variant – Prepaid PPA

A “prepaid PPA” is a variant of the PPA model

- Make an upfront payment in exchange for:
  - A lower PPA rate
  - Some of the benefits of ownership (e.g. rebates & SRECs)
- May be structured more like an equipment lease
- An “in-between” model – homeowner accepts more risk & uncertainty than in a standard PPA for additional potential financial benefit

Using the previous example, these options have a similar 20-year “return” (net present value, NPV):

- \$0.13 PPA rate with no up-front payment
- \$0.085 PPA rate with a \$5,000 up-front payment

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### PV System Purchase

How it works

You buy and own a solar PV system

- Substantial up-front cost
- But tax incentives and rebates reduce that cost significantly

	Example	Details
System Cost	\$25,000	• 5,000 watt solar PV installed at 5.00/watt
Federal Residential Renewable Energy Tax Credit	(\$7,500)	• 30% of the installed cost of the system
Massachusetts Income Tax Credit	(\$1,000)	• 15% of the installed cost of the system, not to exceed \$1,000
Massachusetts Clean Energy Center Commonwealth Solar Rebate	(\$2,000)	• \$0.40/watt on first 5kW • Additional \$0.40/watt for: • moderate income (family income < \$92,750) • moderate home value (Needham < \$400,000)
Net cost after incentives	\$14,500	

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### PV System Purchase

How it works

- All the electricity you generate and use is “free”
  - Replaces, dollar for dollar, what you would have paid your utility
- You receive a net metering credit from your utility for the all the electricity you generate but don’t use
  - Receive a credit on your bill from your utility
  - Rate is “almost” retail – excludes renewable energy and energy efficiency charges (about 2% of total currently)
- You benefit from selling the SRECs your system generates
  - Significant but highly variable and uncertain values
  - A real, but opaque and inefficient, market
- You are responsible for system maintenance beyond warranty coverage

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# Green Needham Collaborative

## Solar 101



### PV System Purchase

Considerations/Questions to ask

You should be more involved in the choice and specification of system components

- Those choices affect the initial system cost, total output and long-term reliability

System prices have improved

- \$5.00/watt is not uncommon
- Trend likely to continue, but more slowly

Maximize incentives and rebates

- Ensure you obtain everything you're qualified for

Ask about system maintenance

- Warranty coverage details and length
- Options for extended warranty and post-warranty maintenance
- Reputation, size and financial condition of providers

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### PV System Purchase

Considerations/Questions to ask

Explore your options for selling SRECs

- An **aggregator** manages the SREC process for most owners
  - The aggregator files the paperwork, tracks the SRECs generated and maintains an account for the owner.
- Larger installers are often aggregators themselves
- Most smaller installers work with one (or more) aggregators and will offer those services to their customers
- MA DoER maintains a list
  - Only a handful work directly with retail customers
  - SRECTrade, Knollwood Energy and SolSystems are three that do

Most common options

- Auction Account** – you enter SRECs into the regular auctions that are held and receive the proceeds. The aggregator manages this process
- Upfront payment** - certainty has a high cost - offers to pay you upfront for your SRECs will demand a very steep discount

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### PV System Purchase

Considerations/Questions to ask

Consider various scenarios for key financial drivers as you make your decision

- Look at the impact of different levels of inflation for future electricity prices (e.g. 3%, 6%)
- Consider several different levels for SREC prices (e.g. \$150, \$200, \$250 and perhaps more)

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# Green Needham Collaborative

## Solar 101



### PV System Purchase

Variant: Purchase with financing

A homeowner can obtain financing for all or part of the system cost instead of paying for the system upfront

- An option for homeowners who do not have the cash on hand or do not wish to liquidate investments to pay for a solar PV system
- Cost of financing is the key element to consider when evaluating this option
- Options include
  - Seller-provided financing - available from some installers
  - Home equity loans can be a low-cost source of funds
  - "Liquid" assets earning low/no return - e.g. money market funds
  - Investment assets - weigh the return and risk profile of the investment versus that of a solar PV system

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### Solarize Needham

Solarize Massachusetts is a hugely successful program piloted by the Massachusetts DoER to accelerate the adoption of residential solar PV.





2011 - Initial pilot in 4 Green Communities  
 2012 - Follow-on programs in 17 Communities  
 2013 - Two rounds - February & September  
 — Targeting September round for Needham

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### Goals of Solarize Massachusetts

- Increase education through community outreach
- Introduce model to simplify process
- Reduce installation costs
- Reduce time to contract

**Drive down costs for all**

Average	Solarize Mass
Installation	Installation
Sales	"Soft" Costs
"Soft" Costs	"Soft" Costs
Equipment Costs	Equipment Costs




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# Green Needham Collaborative

## Solar 101



### How Solarize Works

**Municipality**

- Issues RFP
- Assembles committee to review responses and select vendor

**Mass Clean Energy Center**

- Vets participants (installers)
- Provides contractual structures, program oversight

**Community Organization**

- Does community outreach and education through “solar coaches”

**Selected installer**

- Provides volume-based tiered pricing
- Installs systems for homeowner

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### An opportunity, not a reason for delay

The Solarize program is an opportunity to significantly increase solar PV in Needham

Possible participation in the fall is not a reason to delay taking action on installing solar PV now

- Installations through a Solarize program would take place early next year

Needham’s active interest in Solarize – and programs like this session – attract solar providers to our community

- Communities participating in Solarize have found that other installers are attracted to the community and compete aggressively for business

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### Questions? Ideas?

The presentation slides and much more information available at  
[www.greeneedham.org](http://www.greeneedham.org)

Or contact one of us directly:  
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