Solar Electric Systems 101

July 10th, 2019

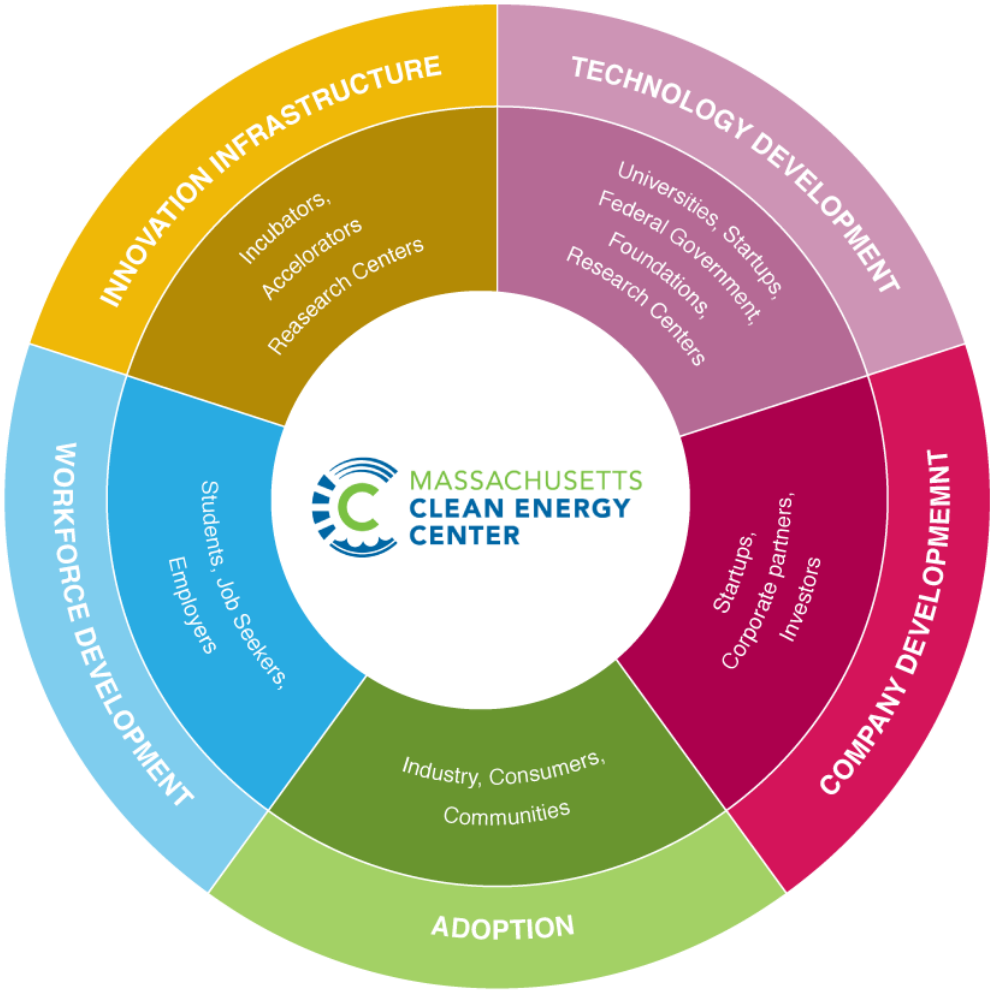
Presented By: Elizabeth Youngblood, Senior Program Manager, Massachusetts Clean Energy Center

MASSACHUSETTS CLEAN ENERGY CENTER®

Agenda

- About MassCEC
- Solar PV Basics
- Available Incentives and Programs
- Additional Resources
- Questions

MassCEC: Invest, Connect, Innovate

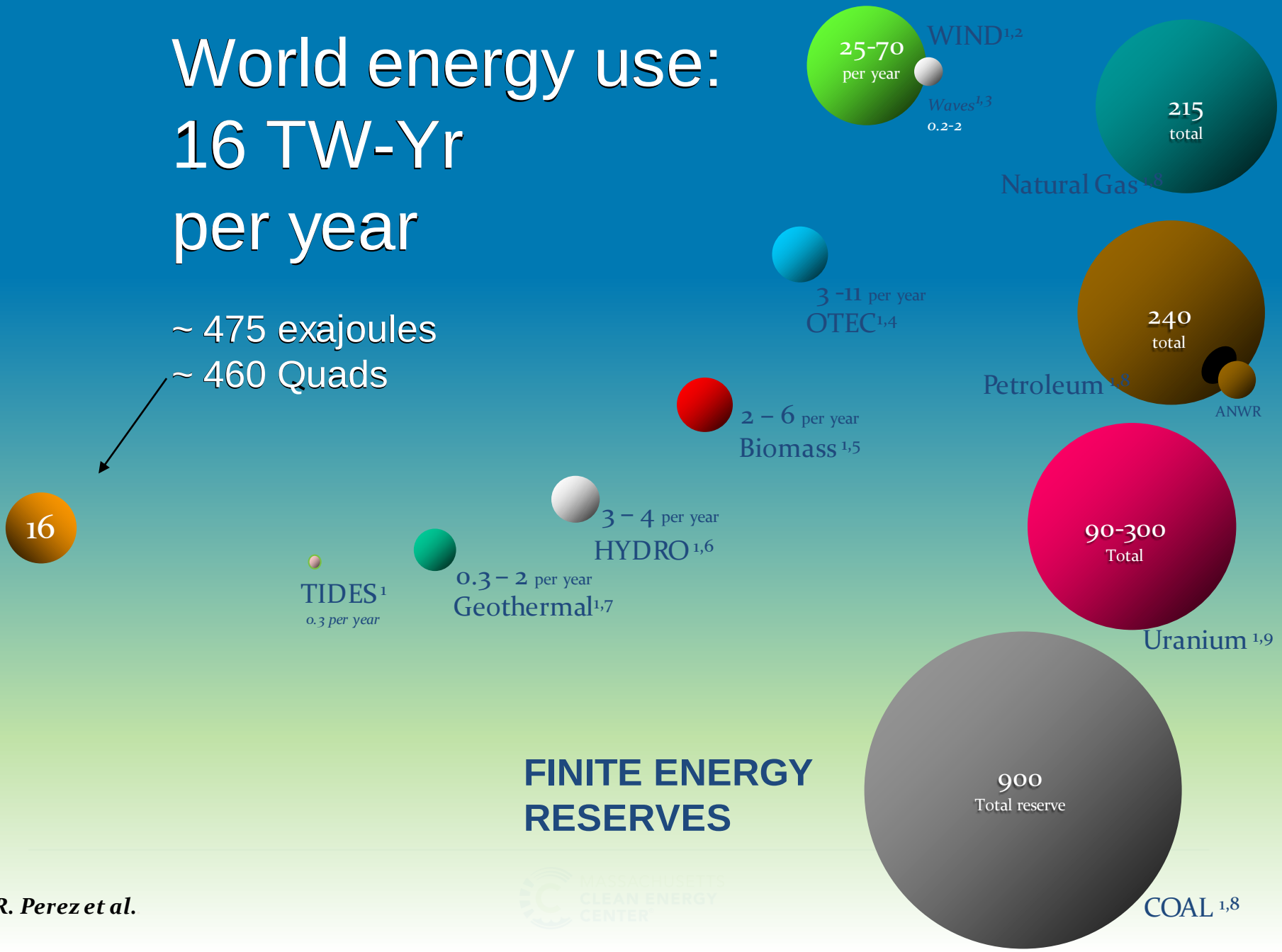


Solar PV Basics

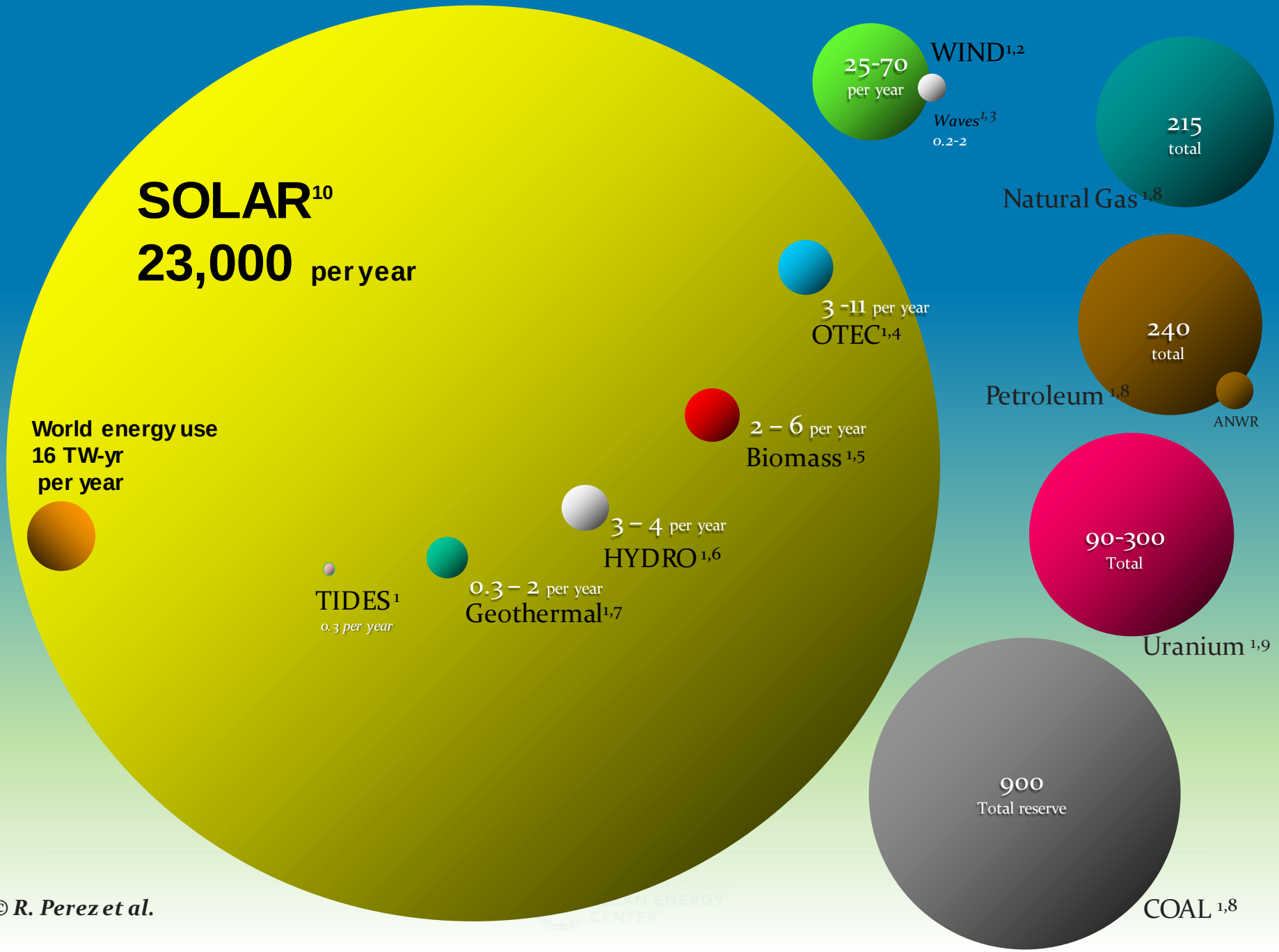
Solar Photovoltaics = Solar PV

World energy use: 16 TW-Yr per year

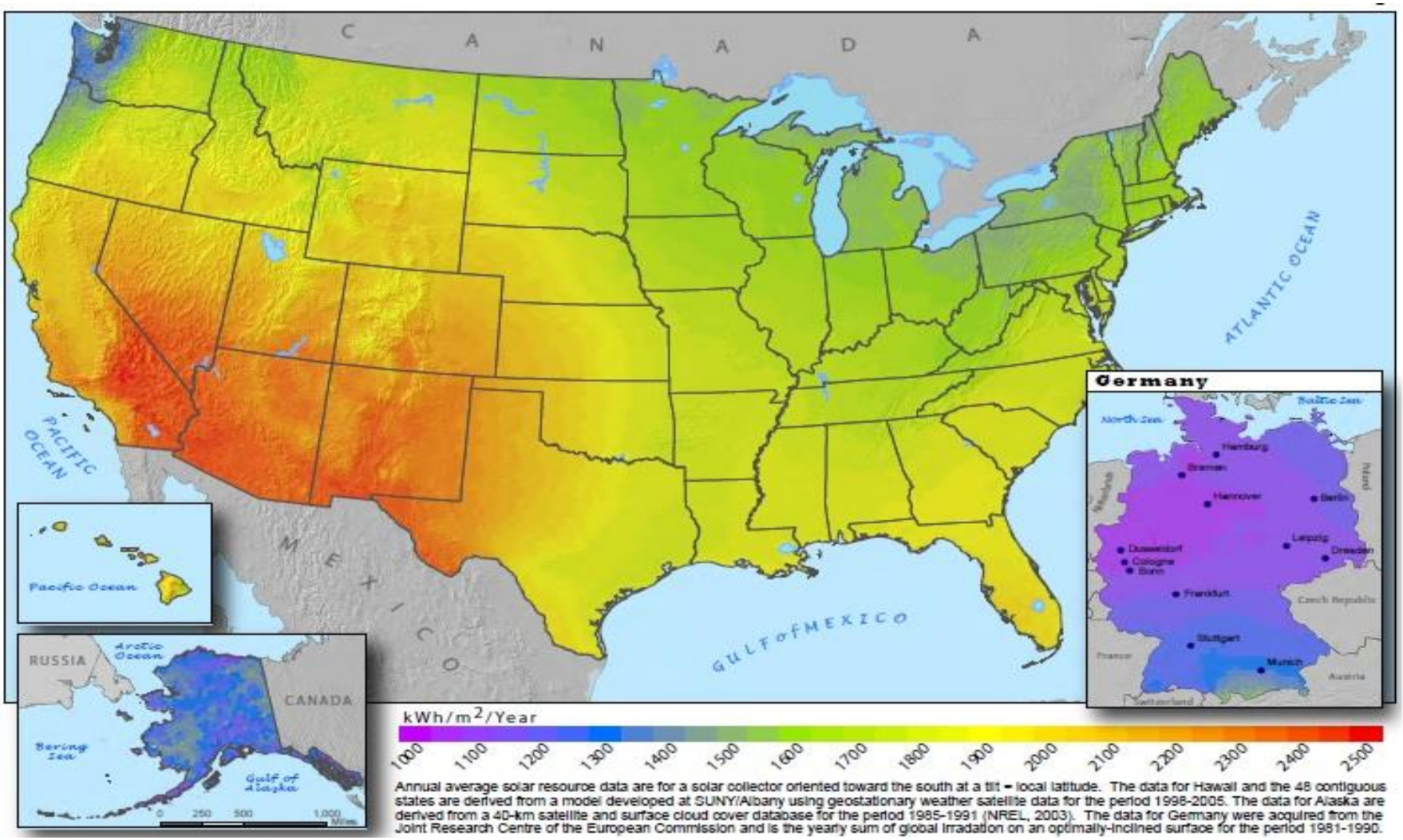
~ 475 exajoules
~ 460 Quads



FINITE ENERGY RESERVES

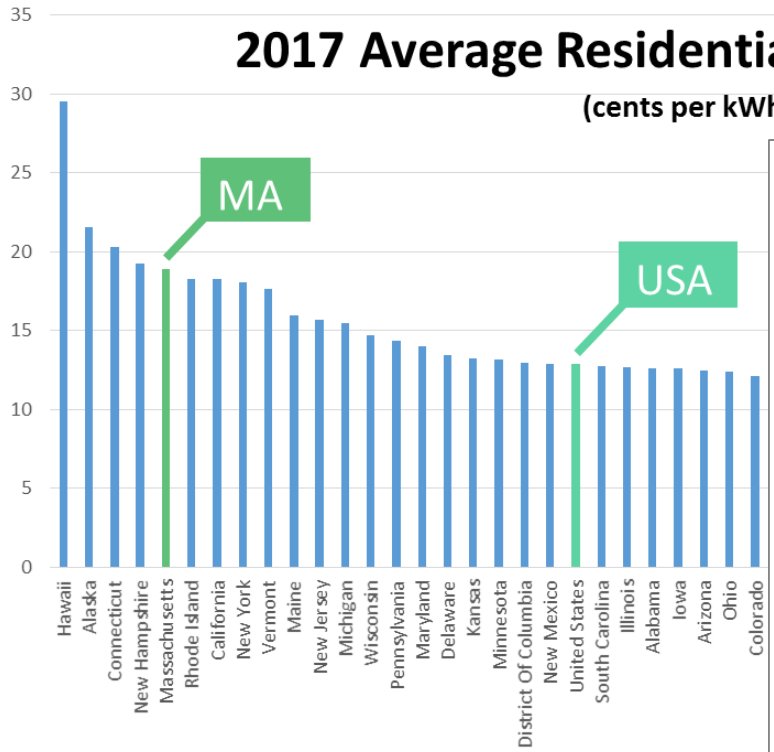

SOLAR[10]
23,000 per year
World energy use
16 TW-yr
per year
25-70
per year
WIND[1,2]
Waves[1,3]
0.2-2
215
total
Natural Gas [1,8]
3 -11 per year
OTEC[1,4]
240
total
Petroleum [1,8]
ANWR
2 – 6 per year
Biomass [1,5]
3 – 4 per year
HYDRO [1,6]
90-300
Total
Uranium [1,9]
0.3 – 2 per year
Geothermal[1,7]
TIDES [1]
0.3 per year
900
Total reserve
COAL [1,8]

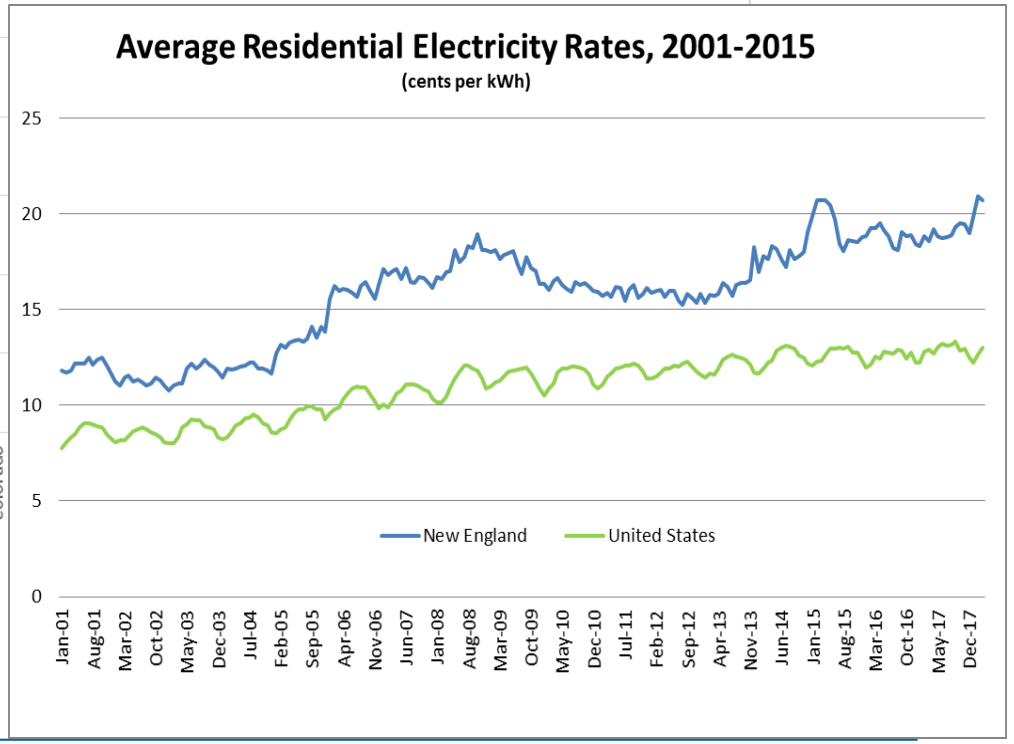
Is there enough sun in Massachusetts for solar?



Annual average solar resource data are for a solar collector oriented toward the south at a tilt = local latitude. The data for Hawaii and the 48 contiguous states are derived from a model developed at SUNY/Albany using geostationary weather satellite data for the period 1998-2005. The data for Alaska are derived from a 40-km satellite and surface cloud cover database for the period 1985-1991 (NREL, 2003). The data for Germany were acquired from the Joint Research Centre of the European Commission and is the yearly sum of global irradiation on an optimally-inclined surface for the period 1981-1990.

Massachusetts Residential Electricity Prices

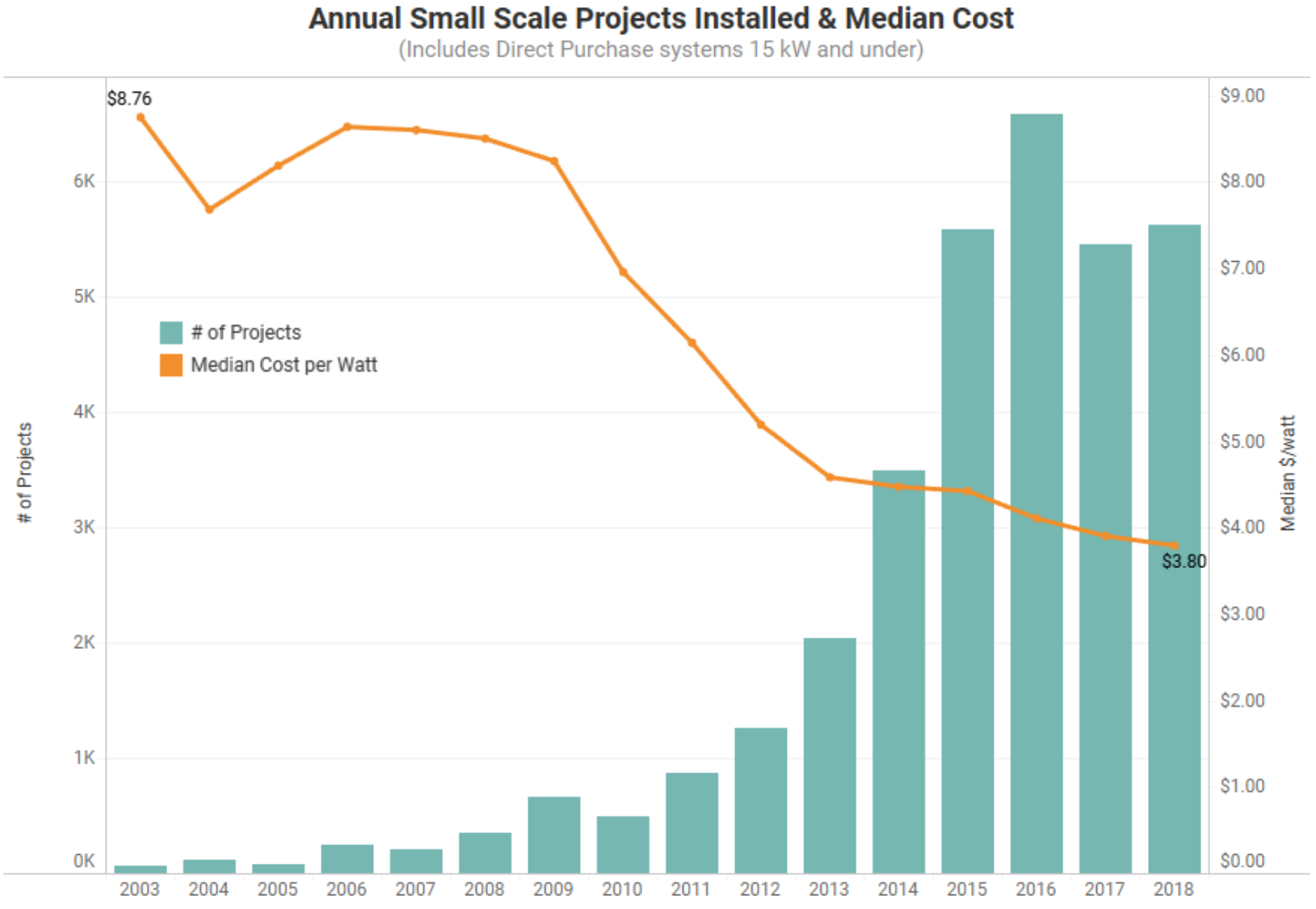




MA homeowners had the 5th highest average electricity prices in 2017.

Sources: EIA 2016-17 Data

Residential Solar PV Project Trends



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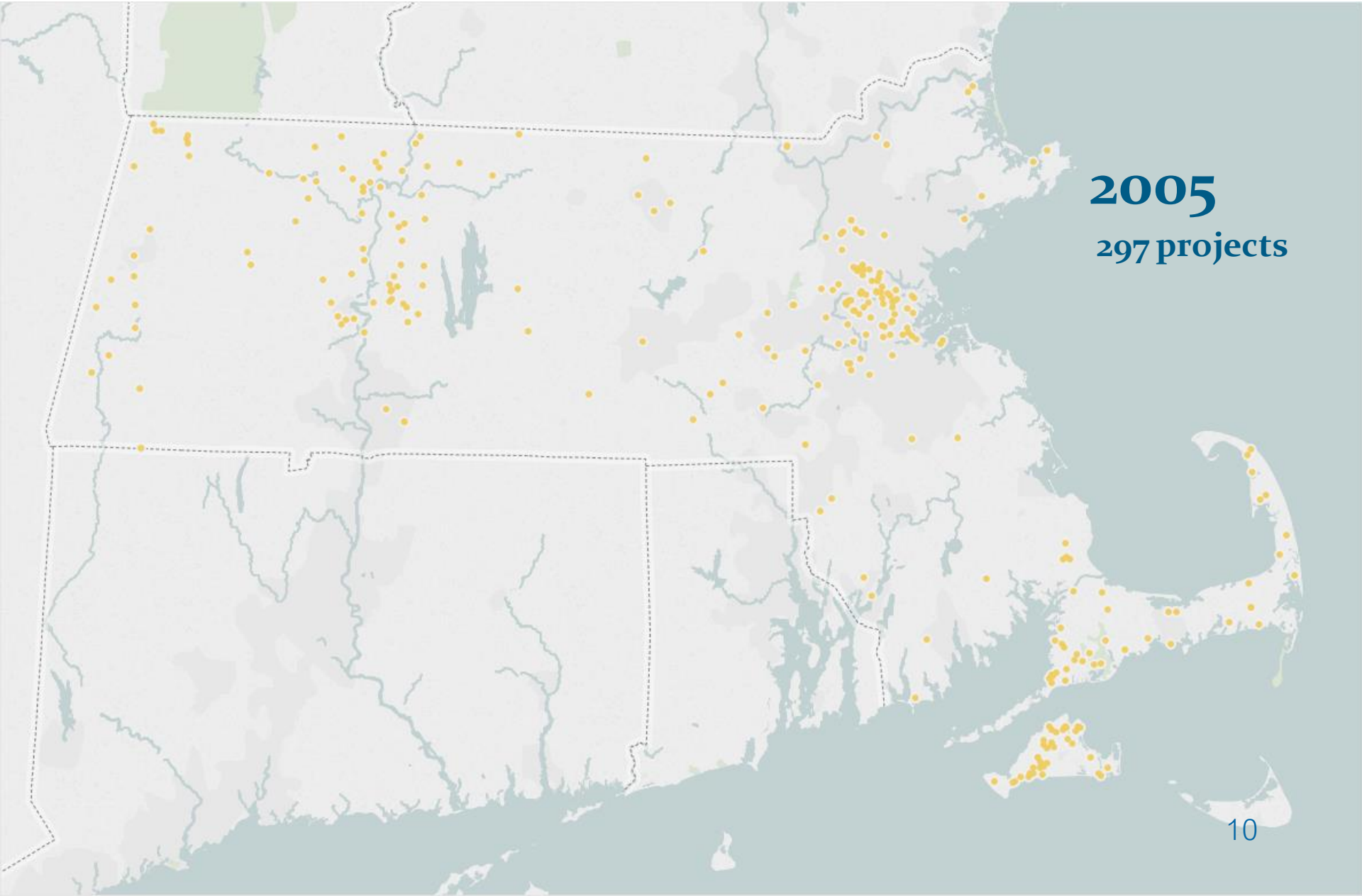
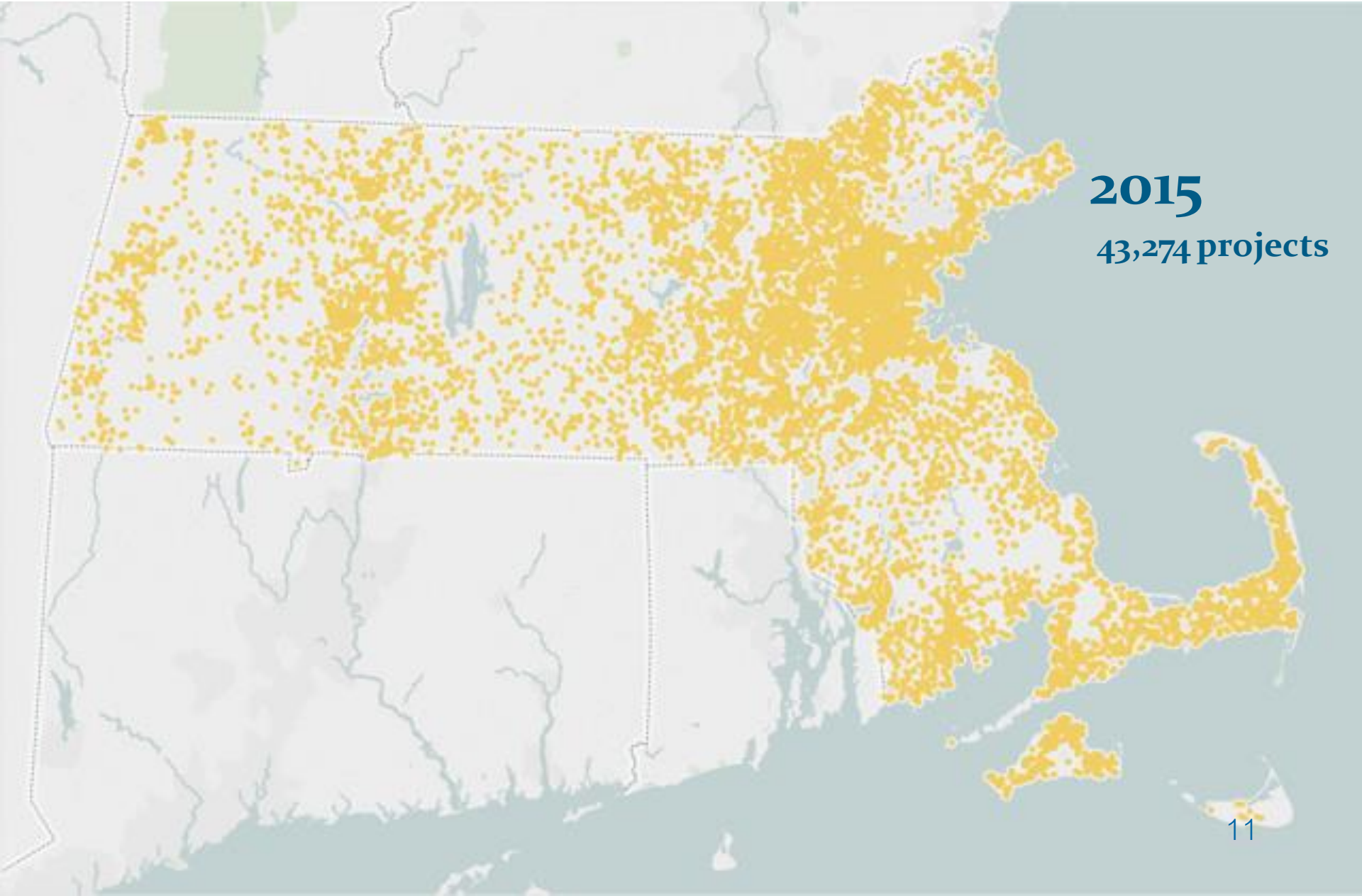
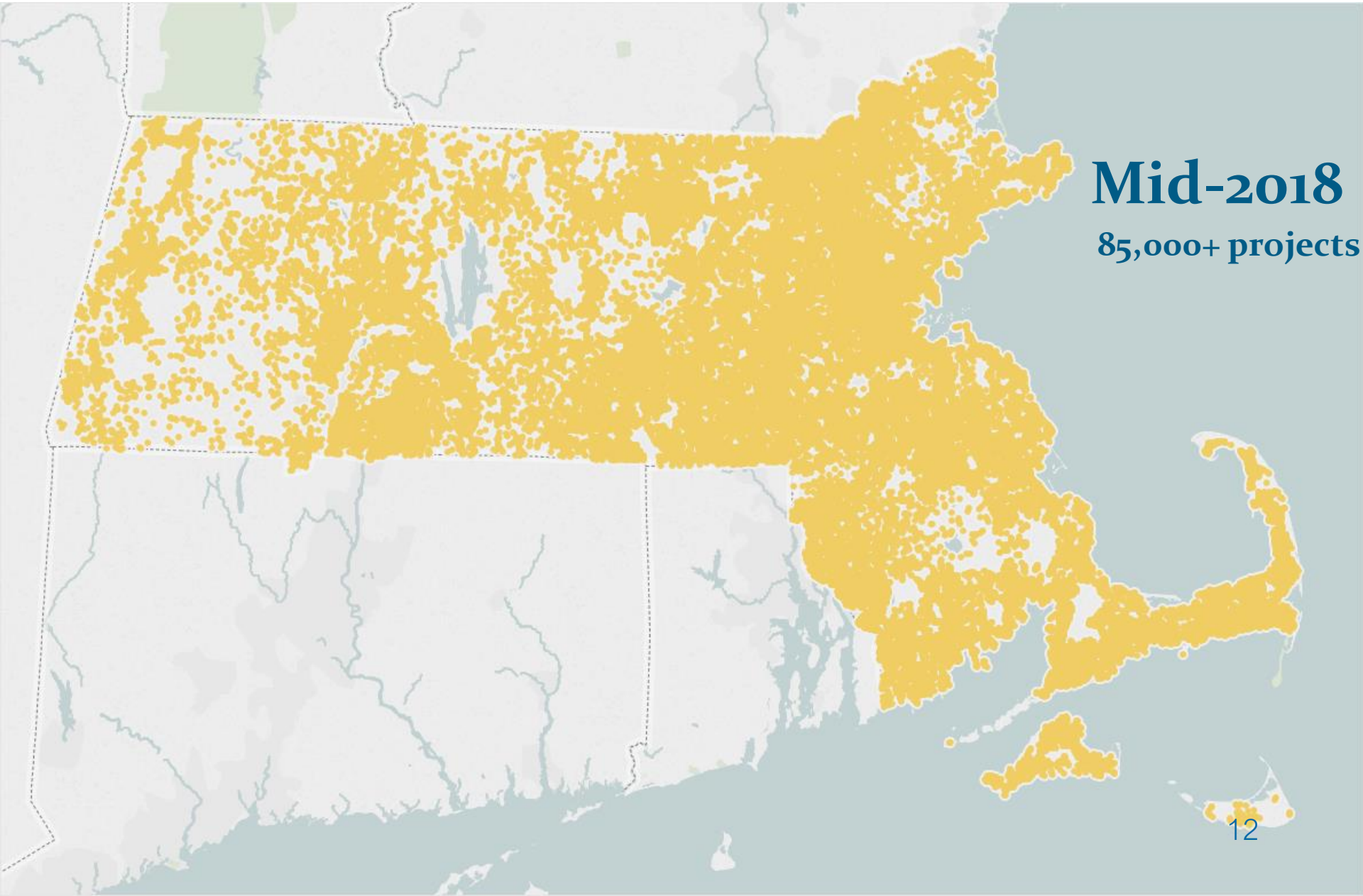
Solar PV Project Trends in Massachusetts



Solar PV Project Trends in Massachusetts

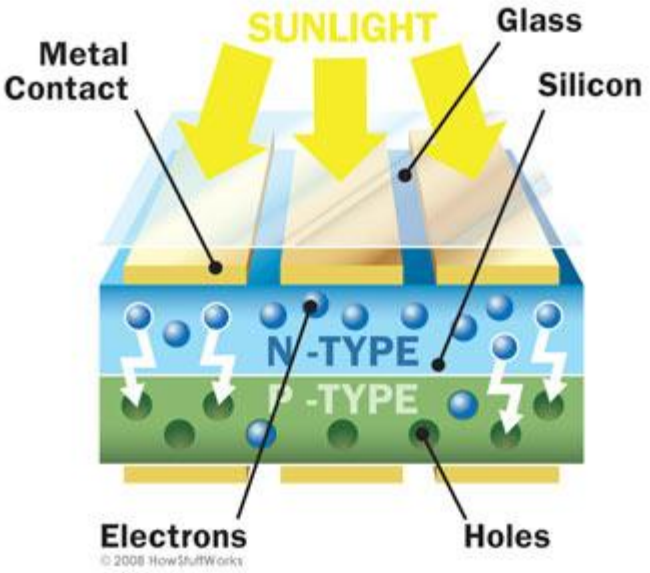


Solar PV Project Trends in Massachusetts

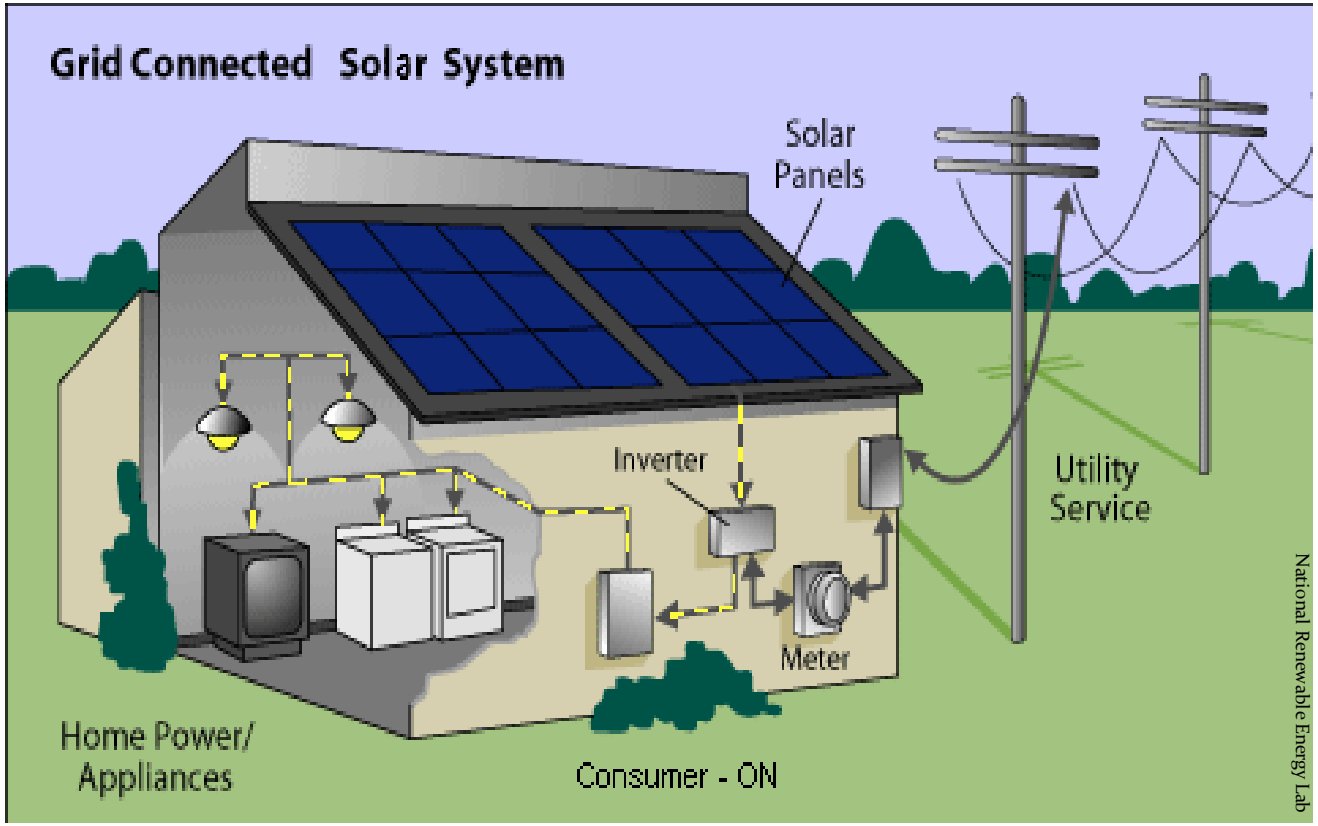


How do solar PV panels work?

- NEED DIRECT SUNLIGHT!
- Sunlight dislodges electrons in a layer of silicon
- Electrons flow to layer that needs electrons and creates a circuit



How does a solar PV system work?

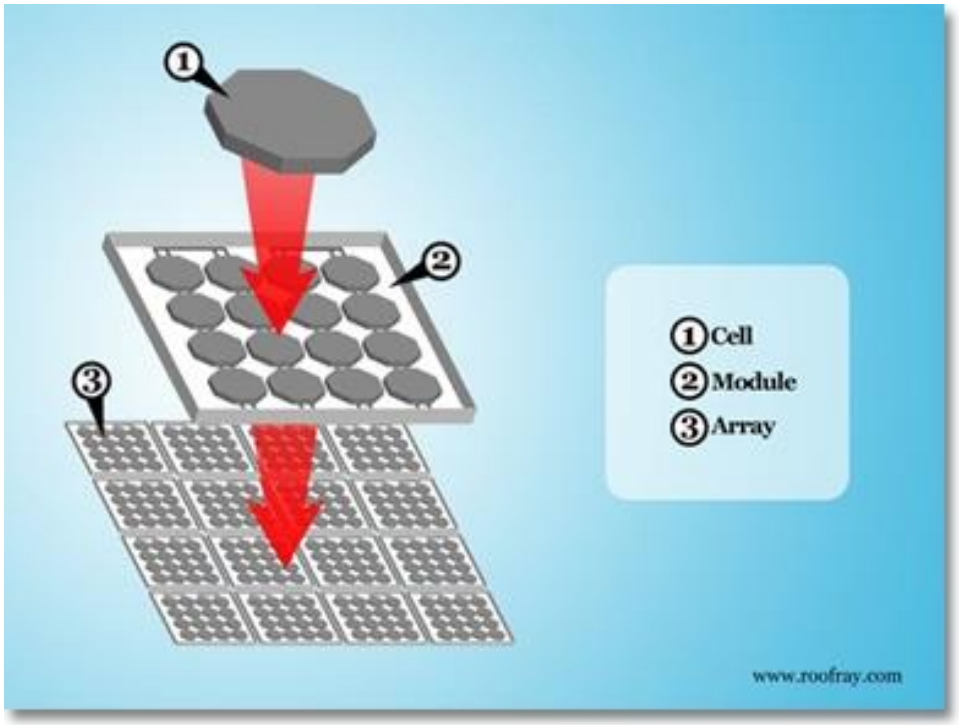


System should operates for 20+ years with minimal maintenance

Power outage: Inverter shuts down, unless a battery-back up system is installed

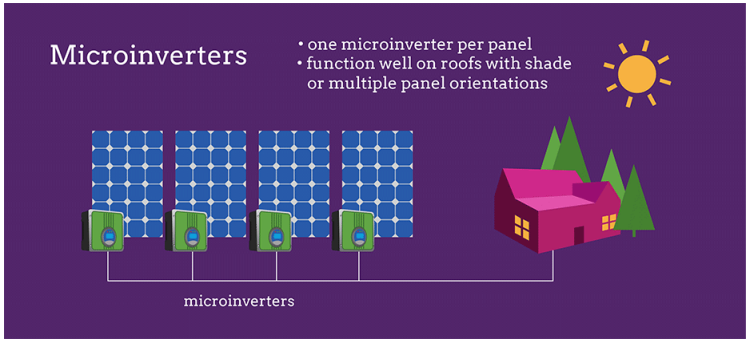
Common Solar PV Terms

Cell > Module > Array



Inverter

Central Or Microinverters



Combined = a Solar PV System

Common Solar PV Terms Continued

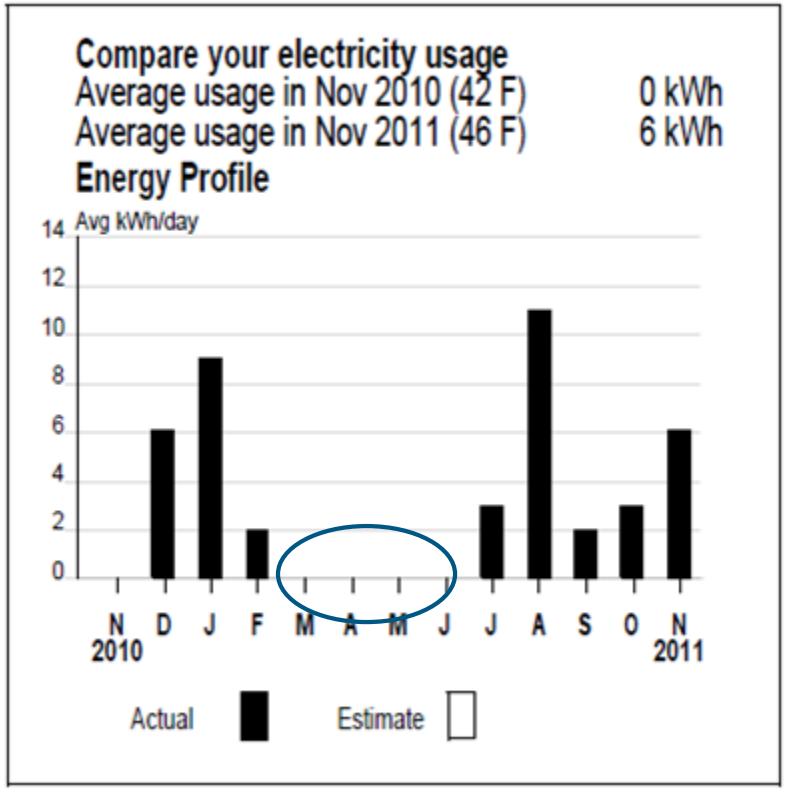
- Meters:
  - Revenue Grade Meter
  - Utility Net Meter
- External Disconnect Switch
- Batteries (Optional)

Talking about Electricity

- Solar PV system size is measured in:
  - Watt (W) < Kilowatt (kW) < Megawatt (MW)

- Electricity usage & production is measured in:
  - Watt-hour (Wh) < Kilowatt-hour (kWh) < Megawatt-hour(MWh)

Understanding Electricity Use of Building

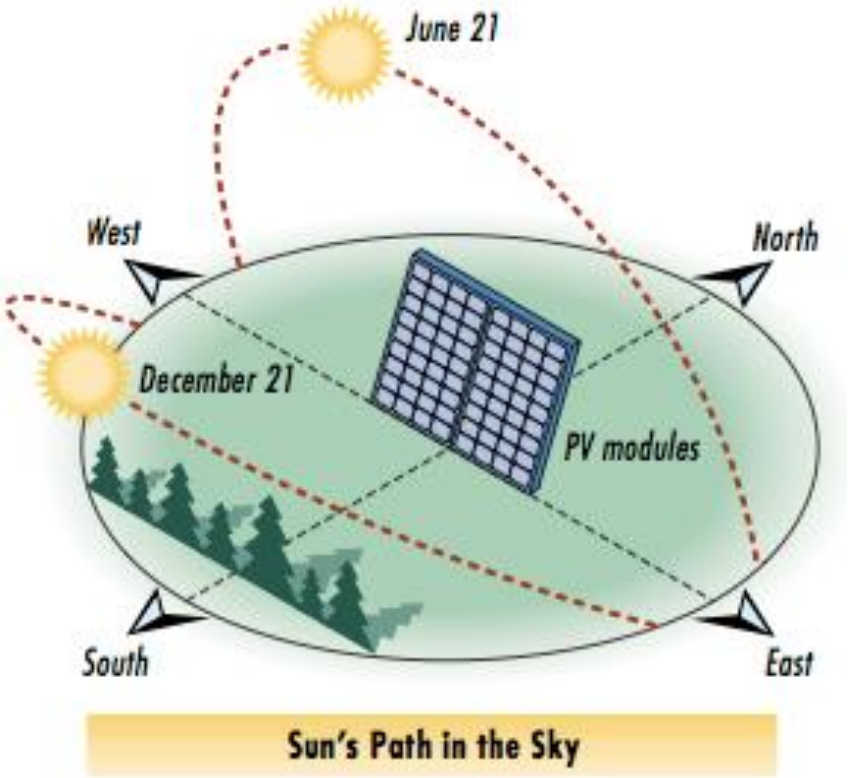


- Average MA home uses 7,500 kWh / year (EIA, 2014 state data)
- Average solar PV system in MA is about 7,000 watts or 7 kW
- Electricity bill will have summary of prior year's consumption
- Understanding site electricity use will assist installer in sizing solar PV system to best meet resident needs

Back of the Envelope Calculation: 1 kW = approximately 1,100 kWh/year

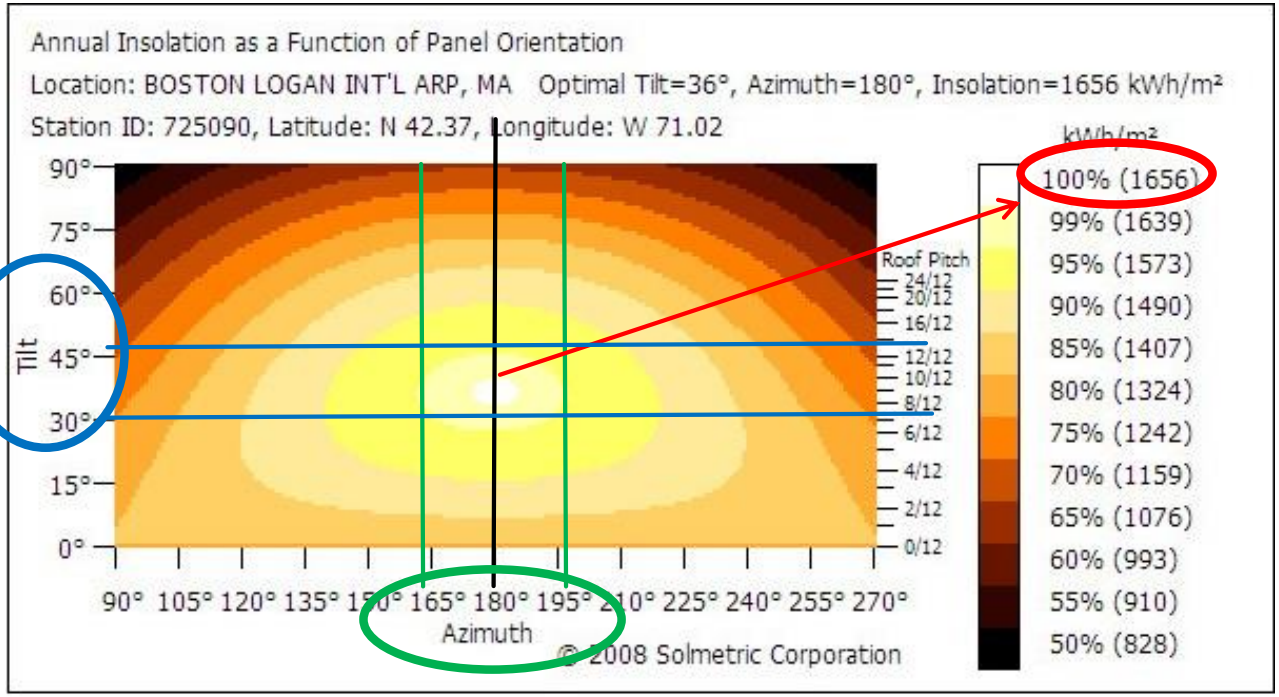
What makes a good site?

- Southern exposure
- PV panels angled 30˚ – 45˚
- At least 4-6 hours of direct sunlight
- Open roof area of ~100 sq ft per 1 kW
- Open space for a ground or pole mounted system



http://energy.ltgovernors.com/solar-energy-pv-systems-self-generation-make-your-own-power.html

Home Orientation and Roof Tilt



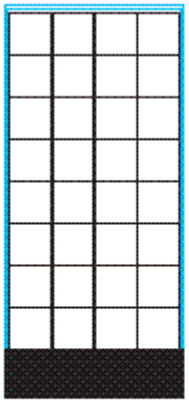
Enter panel orientation to display annual insolation and TOF

Tilt (°) 36 Azimuth (°) 180 Calculate

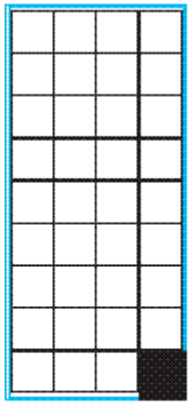
At Tilt: 36 ° and Azimuth: 180 °, Annual Insolation: 1656 kWh/m^2 (TOF: 100.0%)

Shading of Solar PV Systems

- Shading can significantly reduce the output of a panel
- Full shading of one cell within the panel can reduce electricity output by 50%, while shading of portion of cells can reduce output to zero.
- Micro-inverters may reduce some effects of shading within the entire solar array



Example of full-cell shading that can reduce PV module power to zero



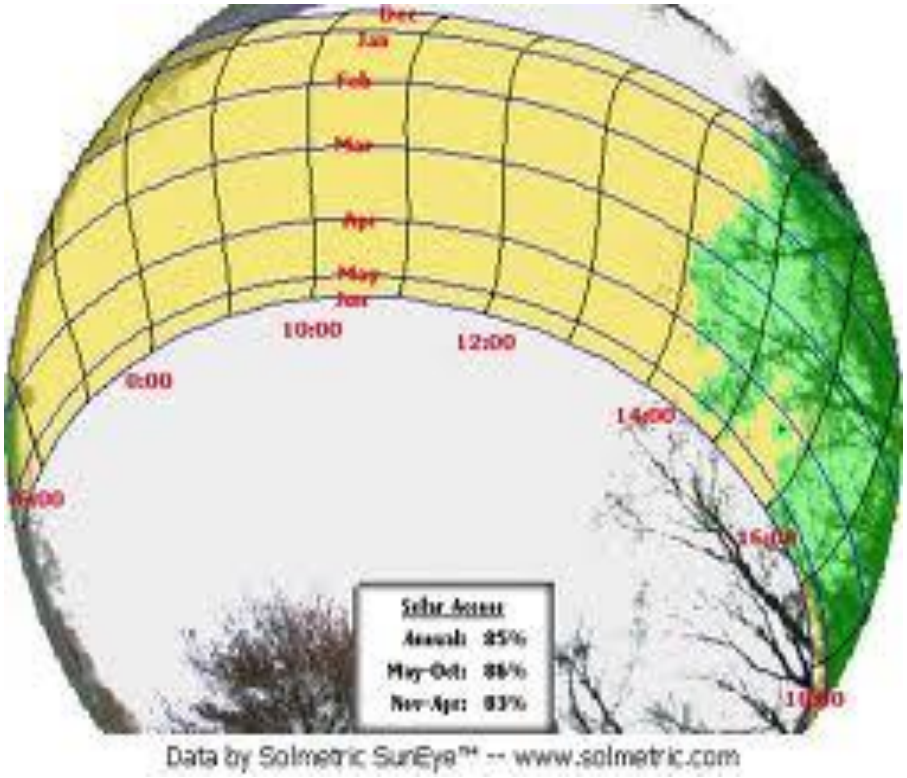
Example of full-cell shading that can reduce PV module power by ½

www.enviroharvest.ca/pv_shading.htm

Shading of Solar PV Systems

- Initial site feasibility can be determined online through aerial images, and then through online or in-person shading analysis tools

- A shading analysis should be performed for each potential project site



Understand common barriers for residents

1. Inertia (contracting can take 2+ years)
2. Aesthetics
3. Understanding incentives and payback (complexity)
4. Upfront financial cost
5. Unsure about time in residence
6. Trees, dormers, structural issues, added cost
7. Site deemed not feasible by the installer

What adds costs to an installation?

Common items that increase cost

Structural

- Reinforce Rafters
- Split Arrays/ Multi Roof
- Metal Roof
- Steep Roof

Electrical

- Service Change
- Electric Panel Upgrade

Other

- Ground-mounted System
- Data Acquisition System
- Extended Warranty
- Increased shading (TPO)

Break for Questions

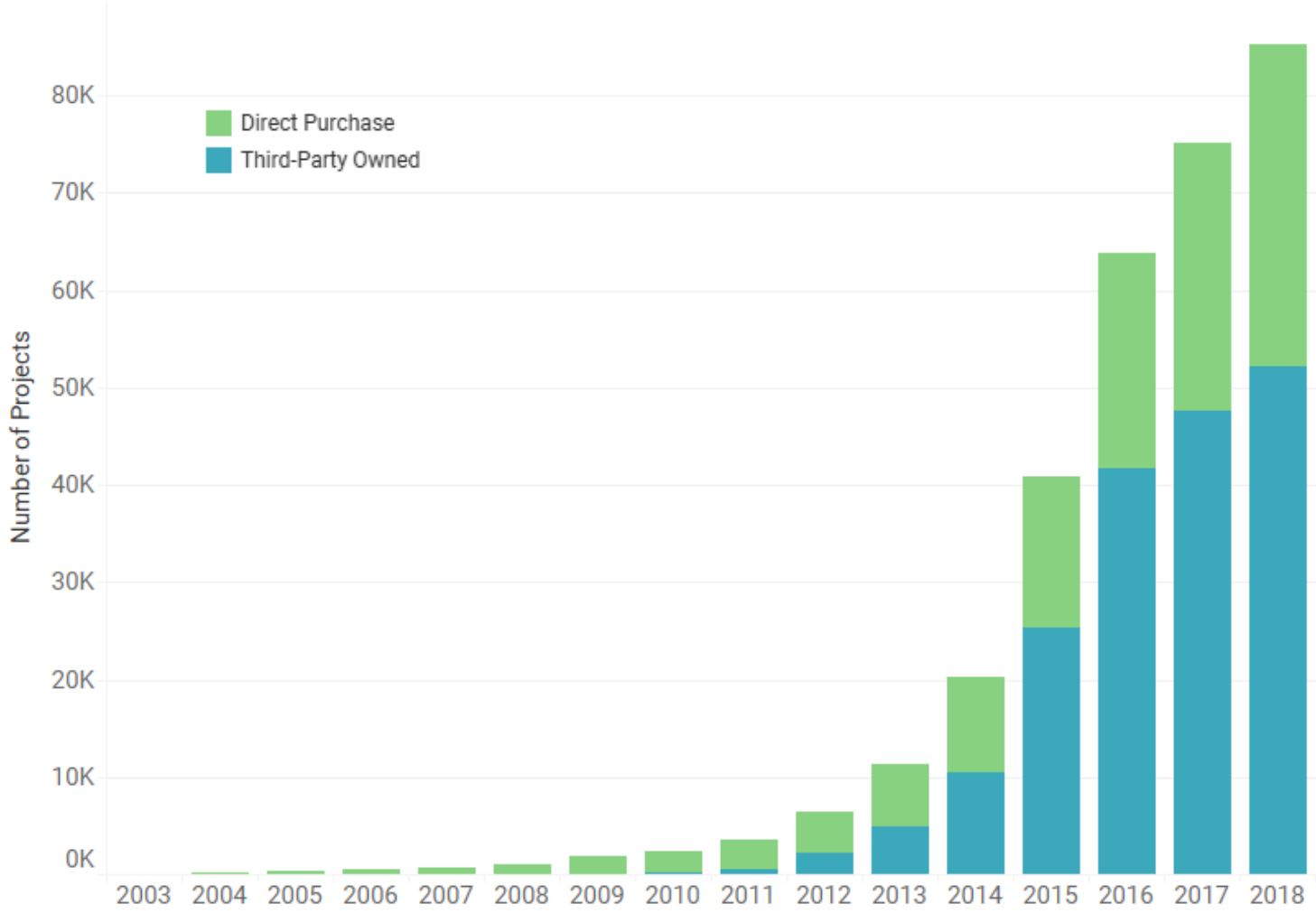
Ownership Models

- Outright purchase
- Third Party Ownership
  - Lease
  - Power Purchase Agreement




Cumulative Small-Scale Solar PV Systems Installed

(Includes systems 15 kW and smaller)

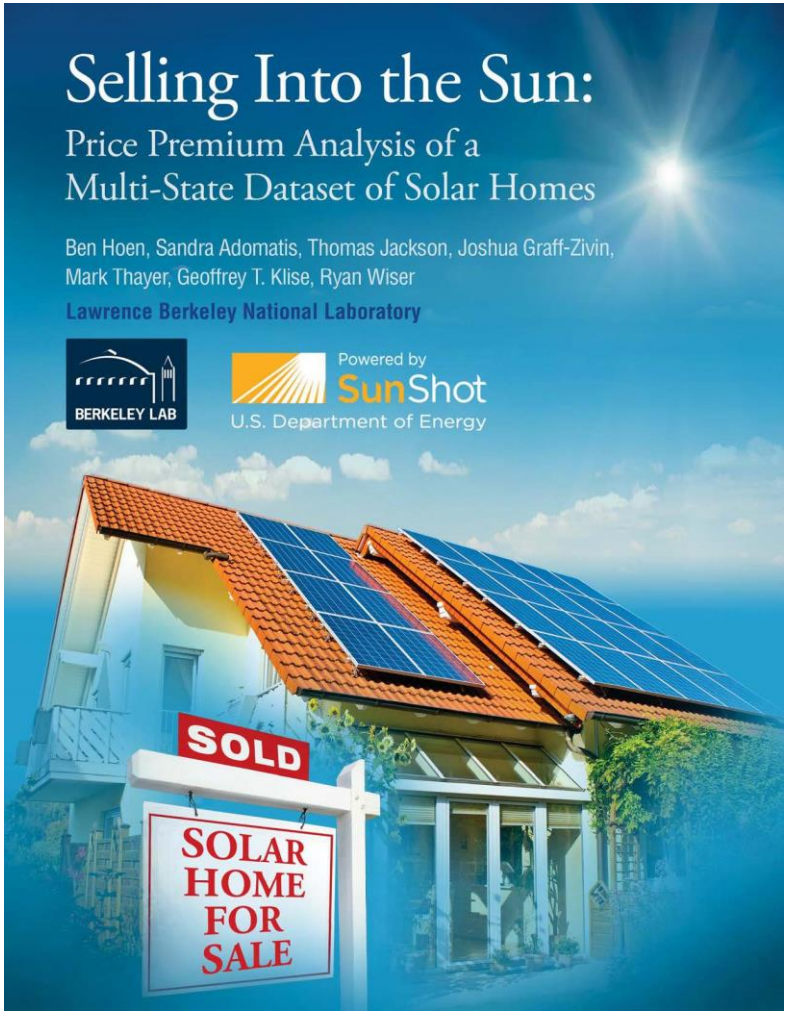


Difference Between Direct Ownership and Third Party Ownership (TPO)

	Direct Ownership	Third Party Ownership
Who buys and owns the system?	Homeowner	Third-party company
Are there any up-front costs for the homeowner?	Yes. May pay with cash or take out a home equity or solar loan	Low or no up-front cost
Who takes advantage of federal and state incentives available for solar?	Generally Homeowner	Generally third-party company
Who is responsible for maintenance and insurance?	Homeowner	Third-party company
Impact of Solar PV on Property Value	Fannie Mae guidance: **real property**. National lab studies, PV Value Tool	Fannie Mae guidance: **personal property**. LBNL study found no evidence of negative impact on value
Point of Sale: What to clarify with a realtor?	Ownership and remaining time of ongoing state incentives (SRECs / SMART incentive)*	UCC-1 subordination at refiling*

*Note that if financing a purchased solar PV system, the lender may opt to file a UCC-1.

Potential Impact on Home Value



Lawrence Berkeley National Lab "Selling into the Sun" Report, January, 2015

- National analysis of market value of solar PV homes
- Compared over 22,000 properties with and without PV
- Found high solar PV premiums for owned systems
- **Recommends using comparable sales of other PV homes,** present value of energy savings and replacement costs to predict value elsewhere.

Other Research

- *"Appraising into The Sun"* six appraisers found similar premiums as above
- *"Leasing into The Sun"* no premium found for systems owned by a third-party

Break for Questions

Available Incentives and Programs

Solar Incentives in Massachusetts

High electricity prices + reduced solar PV costs + numerous incentives = economical solar projects

Incentives
Federal and State Tax Incentives
Net Metering / Utility Bill Savings
Production Incentives (SMART program)
Mass Solar Loan program

www.house-power.com/blog/wp-content/uploads/2009/12/iStock_000009001180XSmall.jpg

Federal & State Tax Incentives

- 30% Federal tax credit through 2019
  - 2020: 26%
  - 2021: 22%
- 15% State tax credit (capped at $1,000)
- Equipment sales tax exemption
- Property tax exemption (100% for 20 years, if applicable)

Net Metering

- Allows system owners to export power to the grid
- Different export values based on system size
  - Smaller systems receive nearly full retail value of exported value (under 10 kW)
- Currently capped for each utility for large systems
- Net metering caps do not affect most residential systems

Solar Massachusetts Renewable Target (SMART) Program – Launched 11/26/18

SMART

- Program meant to support installation of 1,600 MW (AC) of new solar capacity in MA
- Available to customers in Eversource, National Grid, and Unitil (municipal utilities may participate under separate program)
- For every unit of electricity, customer receives value of electricity + additional incentive
- Provide long-term revenue certainty by providing a fixed incentive per kWh generated
  - Smaller systems will receive incentive over 10-years, larger systems will receive incentive over 20-years
- For larger-scale systems over 25 kW, compensation rate set according to project size, location, customer type as well as other project attributes
- Provides an added incentive for solar PV systems with energy storage (small and large-scale both eligible)

SMART Program Continued

- Total of 8 Incentive Blocks
  - As more systems are installed, the incentive drops for new projects applying to the program
  - Each incentive block is broken out by utility and service territory
  - Capacity set-aside for systems 25 kW and smaller under each block

- Installer will work with customer to discuss SMART incentive and will apply on behalf of customer

- To learn more about the SMART program, go to www.masmartsolar.com
  - Website will show current incentive block for each utility and service territory
  - Also see DOER SMART presentation: https://www.mass.gov/files/documents/2018/11/09/SMART Program Overview 11218.pdf

Program Features

MASS Solar Loan

- Connects customers purchasing solar PV with local lenders
- Fixed-rate loan term with capped interest rates and closing costs
- Lenders' solar loan products following their standard underwriting process
- Offers three types of loan support incentives for income-qualified customers

Income Based Loan Support (IBLS)

- Incentive paid directly to the loan principal the month following completion
- There are two qualifying income categories:

Category 1: Below 80% of State Median Income

- Eligible for a 30% principal reduction up to $10,500

Category 2: Below 120% of State Median Income

- Eligible for a 10% principal reduction up to $3,500

Interest Rate Buy Down (IRBD)

- 1.5% interest rate buy-down available for Category 1 income-qualified customers
- Paid directly to lenders so customer interest rate stays low the entire term of the loan

Loan Loss Reserve (LLR)

- Additional incentive to help those with lower credit scores obtain a loan
- Available for Category 1 or Category 2 income qualified customers

Loan Class	Credit Range	% of Loan Allocated	% of Principal Eligible for Recovery
A	720 and above	0%	0%
B	Between 681 -719	10%	80%
C	680 and Below	20%	90%

Impact on Insurance and Property Value Taxability

Massachusetts Renewable Energy Tax Exemption

- "Solar energy systems…used as a primary or auxiliary power system for the purpose of heating or otherwise supplying the energy needs of taxable property are exempt from local property tax for a 20-year period."
- See clarification from the MA Department of Revenue

Home Insurance

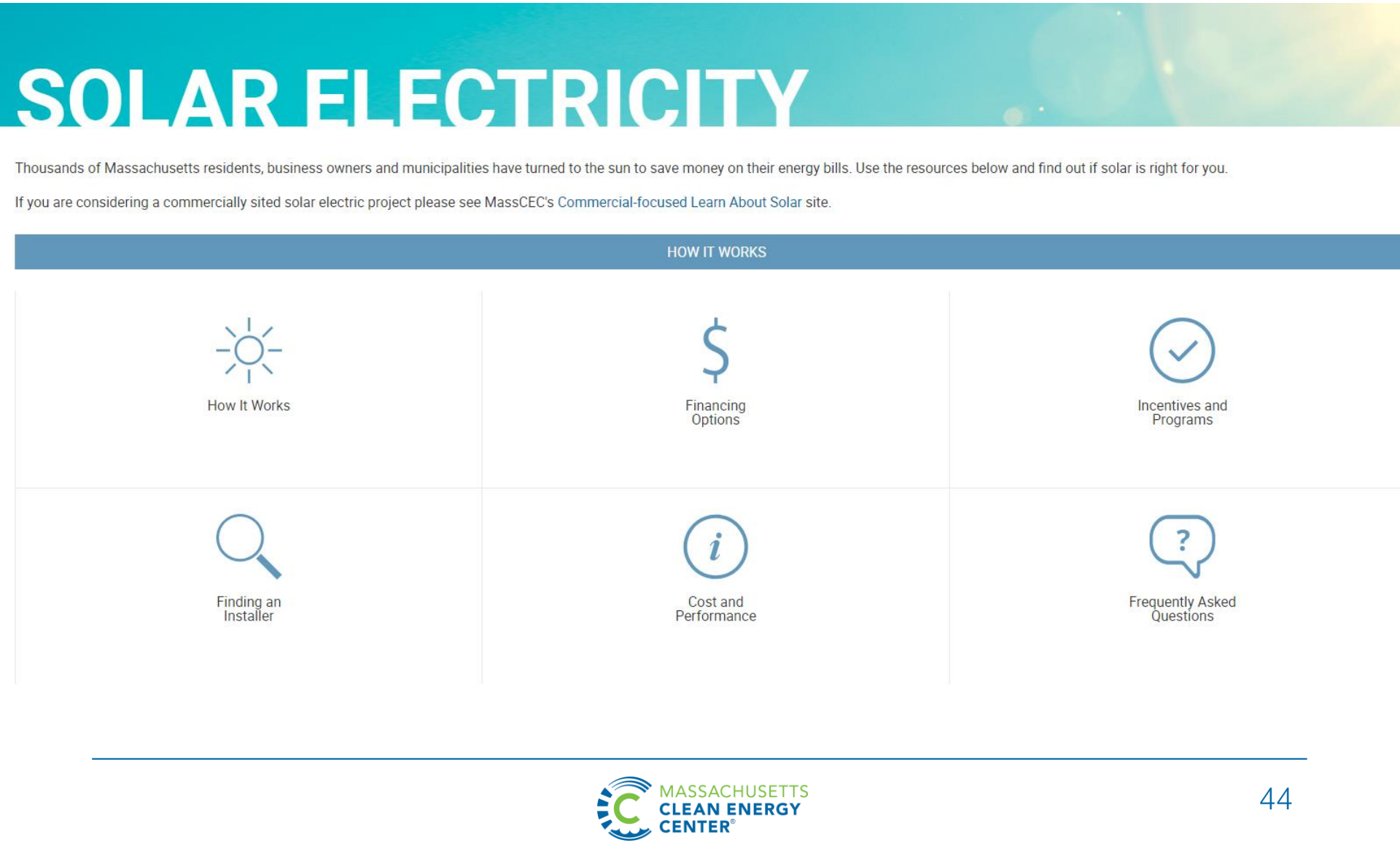
- Usually little to no increase

Break for Questions

Additional Resources

MassCEC Solar Information and Resources

MassCEC.com/Solar



MassCEC Solar Information and Resources

SOLAR ELECTRICITY

Home > Solar Electricity > Finding an Installer

Finding an Installer

As you move forward with a solar electric project, you'll want to find an installer you are comfortable working with. Use the tips below to find the right installer for your project.

The GW Solar Institute video Choosing a Solar Installer offers advice for customers in selecting a solar contractor, questions that customers should ask, and information that should be included in a solar contractor's bid.

Quick Tips

- Get bids from multiple installers
- Discuss different financing options to find the one right for you
- Ask lots of questions, such as the ones below
- Get references from others who have worked with your installer
- Check out MassCEC's solar pricing information to make sure you're getting a competitive price
- Verify that installers are properly licensed by checking the Massachusetts Home Improvement Contractor Registry and eLicensing Portal

Potential Questions for Solar Installers

Asking these questions can help determine if a contractor has the appropriate experience to install a solar system:

- Can you provide references from previous customers with similar systems?
- How many similar systems have you installed?
- When would you be able to perform the work?
- How long will the project take?
- What warranties are provided (including workmanship warranty and specific equipment warranties)?
- Have you worked with local building officials and utility representatives when installing similar systems in the past?
- Do you have a Massachusetts-licensed electrician as part of the project team?

MassCEC Solar Information and Resources

To learn more about installing solar, visit:

Residential: www.MassCEC.com/Solar
Residential Guide to Solar

Commercial: www.MassCEC.com/Commercial-Solar

Additional Resources & Clean Energy Opportunities

- Consider energy efficiency first
  - www.MassSave.com
- Consider other renewable energy technologies
  - www.masscec.com/get-clean-energy/residential
- Electric vehicles
  - https://mor-ev.org/

Questions?

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