Solar for ME!

The solar industry in Maine and beyond

Emera Astronomy Center Presents:
January 2019 Science Lecture Series with Danny Piper, Co-Owner of Sundog Solar LLC.

Tonights Topics & Questions to Answer

- **What is the Sun's potential to meet our planet's energy needs?**
- **What has the solar industry's growth looked like over the past 5 years?**
- **Where does Maine's solar policy lie, and what does future projected policy for Maine look like?**
- **Why does solar have such a strong potential for ME?**

Danny Piper

- Co-owner at Sundog Solar LLC located in Searsport Maine.

- Danny is a **North American Board Certified Energy Practitioner (NABCEP)** Photovoltaic Professional, as well as a NABCEP certified Solar Heating Installation professional amongst other state licensing and federal certification.

- responsibilities include company wide operations, engineering, project oversight and commercial project development.

Sundog Solar LLC

- Sundog Founded in 2009
- Offers turn-key design, development, installation and service of solar energy systems throughout Maine
- Photovoltaic Systems
    - Grid Connected
    - Battery Based
- Mini Split Heat Pump Installations
- Solar Heating System Installations

What is a Sundog?

Bar Harbor Sundog

Sundog Solar Team

The Sun's Energy Potential

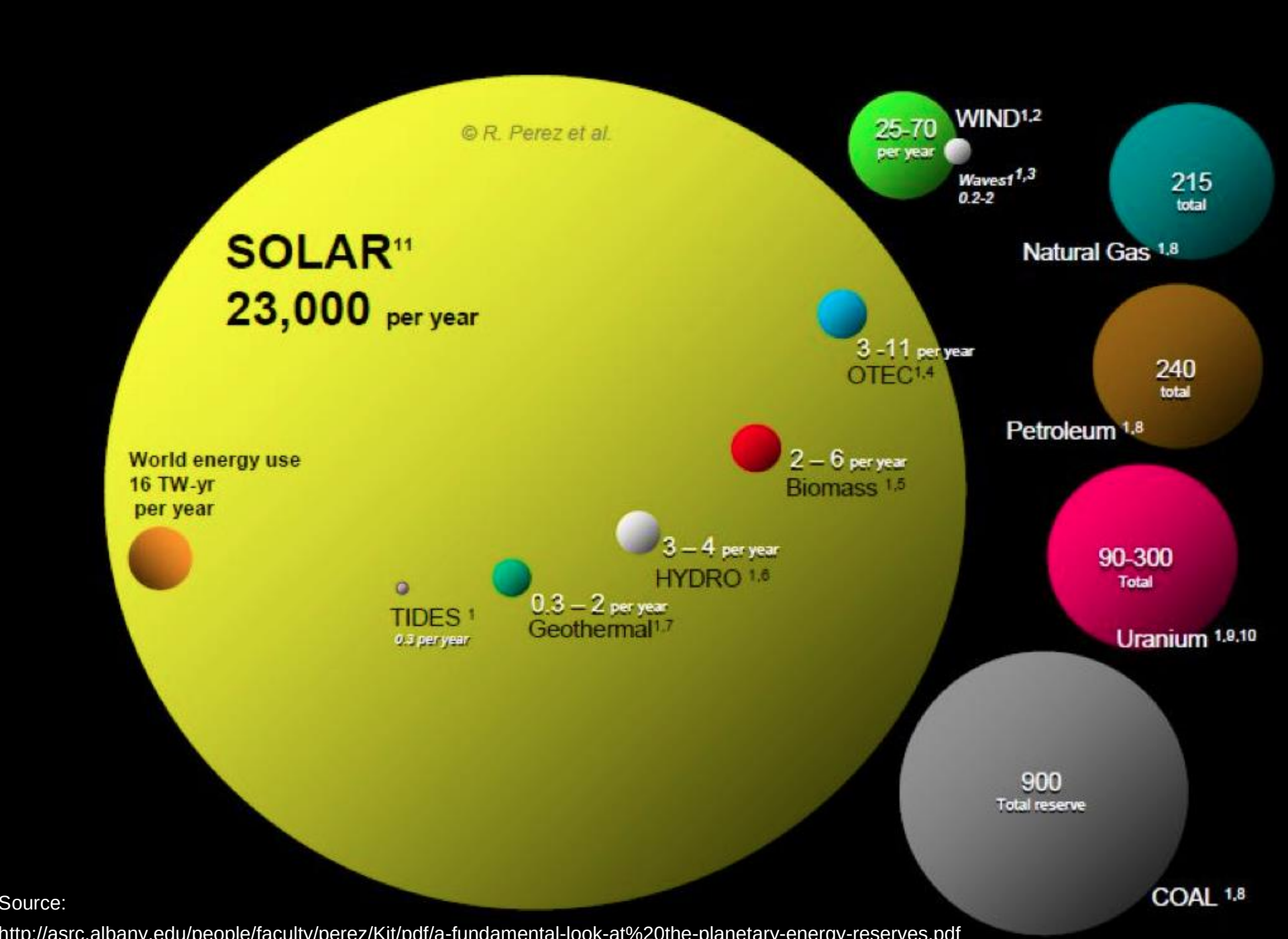
- Releases an estimated 384 yotta watts of energy in the form of light and other forms of radiation (1 yottawatt = 10^{24} watts)

- 23,000 TWy reach earth's surface annually. (1 terawatt-year, (or TWy) is equal to 8766 terawatt hours of energy.)

- Yottawatts (10^{24}), Terawatts (10^{12}), Gigawatts (10^{9}), Megawatts (10^{6}), Kilowatts (10^{3}), Watts (10^{0})

- At the upper atmosphere, the energy density of solar radiation is approximately 1,368 W/m2, and reduced to approximately 1,000 W/m2 for a perpendicular surface to the sun's rays at sea level.

Source: https://ag.tennessee.edu/solar/Pages/What%20Is%20Solar%20Energy/Sun's%20Energy.aspx , https://www.sandia.gov/~jytsao/Solar%20FAQs.pdf , http://asrc.albany.edu/people/faculty/perez/Kit/pdf/a-fundamental-look-at%20the-planetary-energy-reserves.pdf , https://en.wikipedia.org/wiki/Orders_of_magnitude_(power)



Source:
http://asrc.albany.edu/people/faculty/perez/Kit/pdf/a-fundamental-look-at%20the-planetary-energy-reserves.pdf

How much energy will the world need in the coming century?

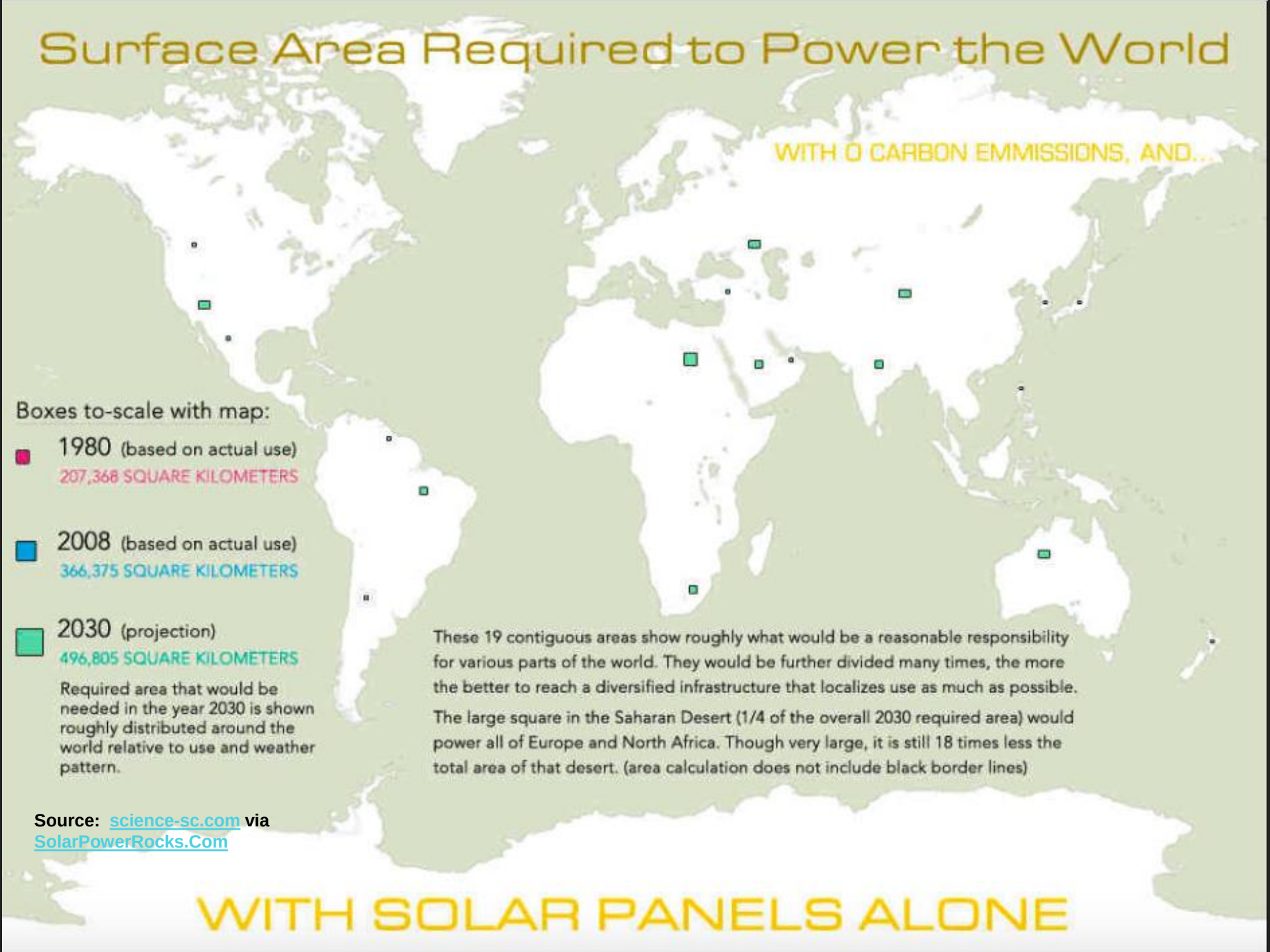
Quantity	Definition	Units	2001[1]	2050[2]	2100[3]
N	Population	B persons	6.145	9.4	10.4
GDP	Gross Domestic Product[4]	T$/yr	46	140[5]	284[6]
GDP/N	per capita Gross Domestic Product	$/(person-yr)	7,470	14,850	27,320
Ė/GDP	Energy Intensity	W/($/yr)	0.294	0.20	0.15
Ė	Energy Consumption Rate	TW	13.5	27.6	43.0
C/E	Carbon Intensity	kgC/(W·yr)	0.49	0.40	0.31
Ċ	Carbon Emission Rate	GtC/yr	6.57	11.0	13.3
Ċ	Equivalent CO_2 Emission Rate	$GtCO_2$/yr	24.07	40.3	48.8

Table 1: World Energy Statistics and Projections.

Source:
https://www.sandia.gov/~jytsao/Solar%20FAQs.pdf

Surface Area Required to Power the World

WITH 0 CARBON EMMISSIONS, AND..



Boxes to-scale with map:

1980 (based on actual use)
207,368 SQUARE KILOMETERS

2008 (based on actual use)
366,375 SQUARE KILOMETERS

2030 (projection)
496,805 SQUARE KILOMETERS

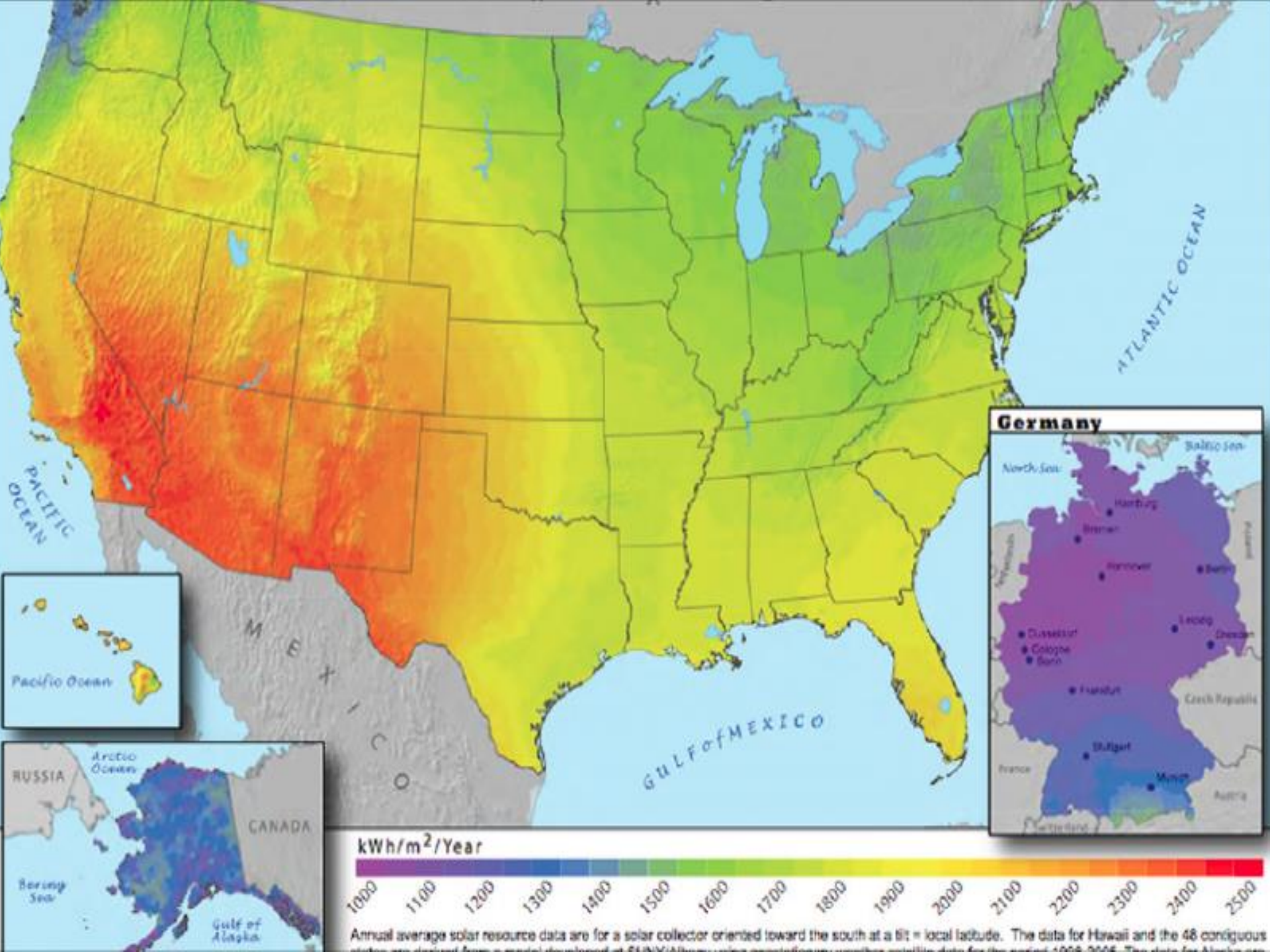
Required area that would be needed in the year 2030 is shown roughly distributed around the world relative to use and weather pattern.

These 19 contiguous areas show roughly what would be a reasonable responsibility for various parts of the world. They would be further divided many times, the more the better to reach a diversified infrastructure that localizes use as much as possible.

The large square in the Saharan Desert (1/4 of the overall 2030 required area) would power all of Europe and North Africa. Though very large, it is still 18 times less the total area of that desert. (area calculation does not include black border lines)

Source: science-sc.com **via** SolarPowerRocks.Com

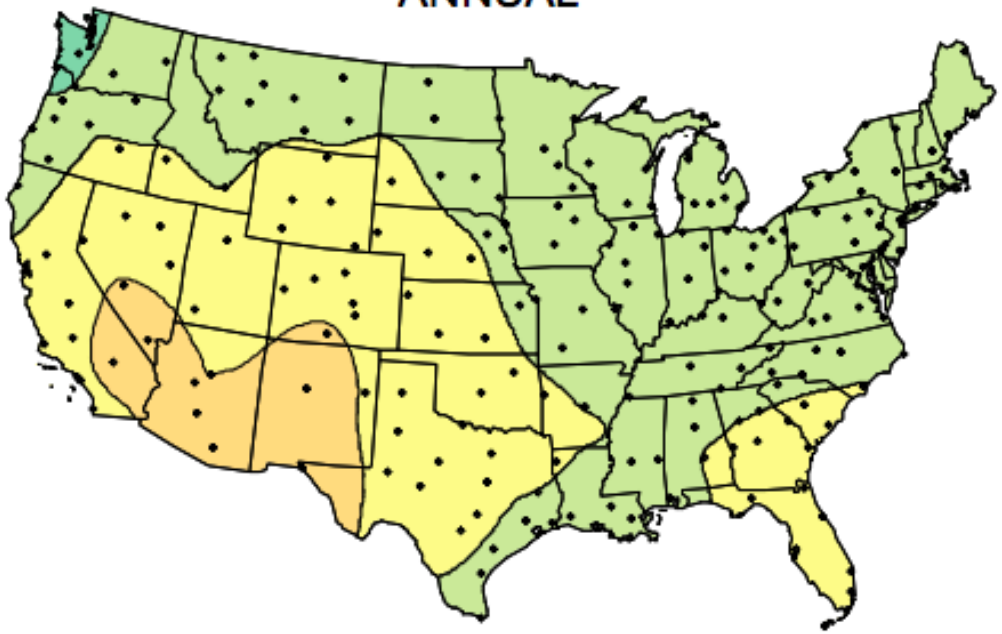
WITH SOLAR PANELS ALONE



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

Average Daily Solar Radiation Per Month

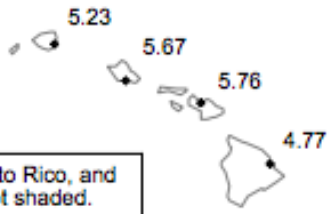
ANNUAL



Flat Plate Tilted South at Latitude

Alaska

Hawaii



Hawaii, Puerto Rico, and Guam are not shaded.

San Juan, PR

Guam, PI

Collector Orientation

Flat-plate collector facing south at fixed tilt equal to the latitude of the site: Capturing the maximum amount of solar radiation throughout the year can be achieved using a tilt angle approximately equal to the site's latitude.

This map shows the general trends in the amount of solar radiation received in the United States and its territories. It is a spatial interpolation of solar radiation values derived from the 1961-1990 National Solar Radiation Data Base (NSRDB). The dots on the map represent the 239 sites of the NSRDB.

Maps of average values are produced by averaging all 30 years of data for each site. Maps of maximum and minimum values are composites of specific months and years for which each site achieved its maximum or minimum amounts of solar radiation.

Though useful for identifying general trends, this map should be used with caution for site-specific resource evaluations because variations in solar radiation not reflected in the maps can exist, introducing uncertainty into resource estimates.

Maps are not drawn to scale.

kWh/m^2/day

	10 to 14
	8 to 10
	7 to 8
	6 to 7
	5 to 6
	4 to 5
	3 to 4
	2 to 3
	0 to 2
	none

National Renewable Energy Laboratory
Resource Assessment Program

https://www.nrel.gov/grid/solar-integration-data.html

FLATA13-208

How Much Sun does Maine Get on Average?

Augusta, ME has a average annual solar radiation value of 4.67 kilowatt hours per square meter per day (kWh/m2/day).

Baton Rouge, LA has a average annual solar radiation value of 4.94 kilowatt hours per square meter per day (kWh/m2/day).

The southern part of Germany gets on average 1200 kWh per square meter per year, the northern part less than that. This averages between 2.7 kilowatt hours per square meter to 3.29 kilowatt hours per square meter.

Germany receives comparable amounts of sunlight to Seattle and Alaska, while most of the states along the Canadian border receive 50% more sun than the Southern half of Germany.

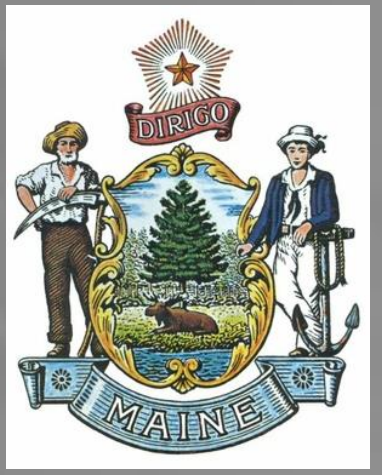
https://joewein.net/blog/2011/09/09/solar-energy-usa-vs-germany/
https://solarenergylocal.com/states/maine/augusta/

Nationwide Statistics
As of Q. 1, 2018

- 55.9 GW of solar installed nationwide
- 250,000 Americans working in the solar industry
- 1,748,000 Solar systems installed nationwide
- Average annual growth rate of 59% nation wide of the last 10 years
- Enough power generated yearly to supply 10.7 million homes
- Solar Currently generates 2% of all Electricity nationally
- Solar Prices have dropped 55% in the last 5 years, reaching grid parity for residential installs in 26 states by the end of 2017
- Solar generation offsets more than 76 million metric tons of CO_2 emissions each year, equivalent to:
    - Taking 16.2 million vehicles off the road
    - Planting nearly 2 billion trees
- In 2018, a new solar project has been installed in the U.S. every 100 seconds
- Just five years ago, the solar industry installed less than 5,000 MW of capacity annually.
- After reaching 1 million installations in 2016, 2 million should be hit in early 2019 and 4 million by 2023

Source: https://www.seia.org/solar-industry-research-data

Maine Solar Snapshot



- **Solar Installed:** 50.7 MW (19.1 MW in 2017)
- **National Ranking:** 42nd (38th in 2017)
- **State Homes Powered by Solar:** 7,000
- **Percentage of State's Electricity from Solar:** 0.08%
- **Solar Jobs and Ranking:** 713 (40th in 2017)
- **Solar Companies in State:** 69 companies total; 7 Manufacturers, 35 Installers, 27 Others
- **Total Solar Investment in State:** $ 145.57 million ($38.91 in 2017)
- **Price Declines:** 43% over the last 5 years
- **Growth Projections and Ranking:** 0 MW over the next 5 years (ranks 0th)

Source: https://www.seia.org/solar-industry-research-data

QUICK FACTS ABOUT MAINE'S ENERGY CONSUMPTION

MAINE STATE FACTS

State Overview

Population: 1.33 million (<1% total U.S.)
Housing Units: 0.72 million (1% total U.S.)
Business Establishments: 0.04 million (1% total U.S.)

Annual Energy Consumption

Electric Power: 11.6 TWh (<1% total U.S.)
Coal: 0 MSTN (0% total U.S.)
Natural Gas: 413 Bcf (2% total U.S.)
Motor Gasoline: 16,100 Mbarrels (1% total U.S.)
Distillate Fuel: 10,800 Mbarrels (1% total U.S.)

Annual Energy Production

Electric Power Generation: 14.4 TWh (<1% total U.S.)
Coal: 0 TWh, <1% [0.1 GW total capacity]
Petroleum: 0.1 TWh, <1% [1 GW total capacity]
Natural Gas: 6 TWh, 42% [1.9 GW total capacity]
Nuclear: 0 TWh, 0% [0 GW total capacity]
Hydro: 3.7 TWh, 26% [0.7 GW total capacity]
Other Renewable: 0.9 TWh, 6% [1 GW total capacity]

Coal: 0 MSTN (0% total U.S.)
Natural Gas: 0 Bcf (0% total U.S.)
Crude Oil: 0 Mbarrels (0% total U.S.)
Ethanol: 0 Mbarrels (0% total U.S.)

https://www.energy.gov/sites/prod/files/2015/05/f22/ME-Energy%20Sector%20Risk%20Profile.pdf

QUICK FACTS ABOUT MAINE'S ENERGY CONSUMPTION

- Energy consumption in the state's transportation and industrial sectors, along with strong heating needs during the frigid winters, give Maine the highest per capita energy use in New England
- Nearly two-thirds of Maine households use fuel oil as their primary energy source for home heating, a higher share than in any other state.
- Maine is one of the few states to get more electricity from petroleum than from coal.
- Maine's industrial sector primarily uses biomass, hydroelectric, and natural gas turbine power generation
- In 2017, about three-quarters of Maine's net electricity generation came from renewable energy resources, with 30% from hydroelectricity, 26% from biomass (mainly wood products), and 20% from wind. 23% Natural Gas Generation

Last Updated: June 21, 2018 , Source : (U.S. Energy Information Administration) , https://www.eia.gov/state/seds/

2018 average solar panel cost in ME

for a 5kW system

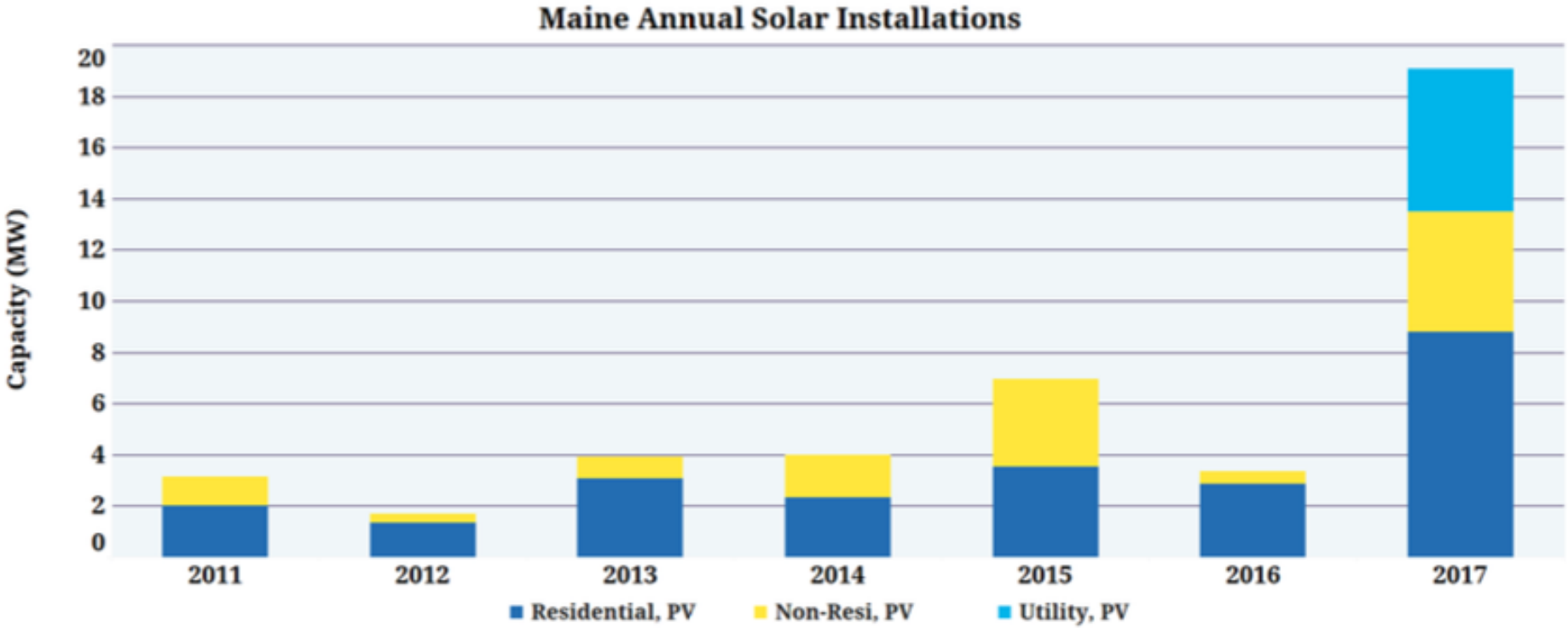
Solar installation costs do not include the 30% Federal Investment Tax Credit or local incentives. Learn more about local ME rebates and incentives.

Payback Period
10.72 Years

20-Year Savings
$15,033

Cost per Watt
$3.07

Source: https://www.seia.org/solar-industry-research-data



Source: https://www.seia.org/solar-industry-research-data

Sundog Solar Average Installed Price for a 5kW Roof Mounted PV system
$14,000 or $2.80/Watt

System Out of Pocket cost of $9,800 after 30% Federal Tax Credit and produces an average of 6,500kWh's per year

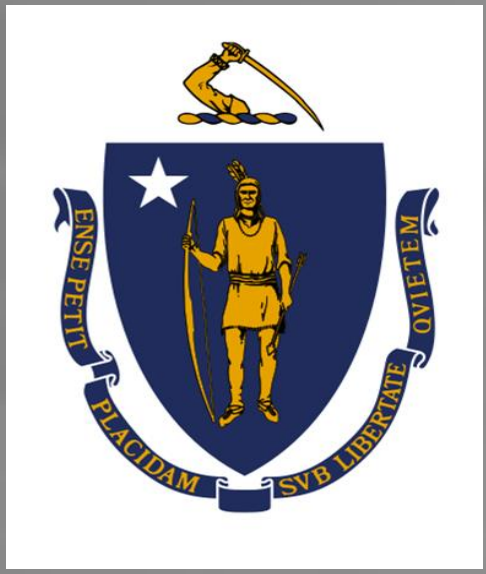
or

$1,105 per year compared to Emera Maines Standard offer electricity rates offering an 8.87 year payback on the investment

Offsetting 3.54 metric tons of Carbon Dioxide Annually

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Massachusetts Solar Snapshot



- **Solar Installed:** 2,319.2 MW (566.3 MW in 2017)
- **National Ranking:** 7th (5th in 2017)
- **State Homes Powered by Solar:** 384,000
- **Percentage of State's Electricity from Solar:** 9.80%
- **Solar Jobs and Ranking:** 11,529 (2nd in 2017)
- **Solar Companies in State:** 549 companies total; 84 Manufacturers, 210 Installers, 255 Others
- **Total Solar Investment in State:** $ 5,941.64 million ($1,000.42 in 2017)
- **Price Declines:** 43% over the last 5 years
- **Growth Projections and Ranking:** 1,726 MW over the next 5 years (ranks 13th)

Source: https://www.seia.org/solar-industry-research-data

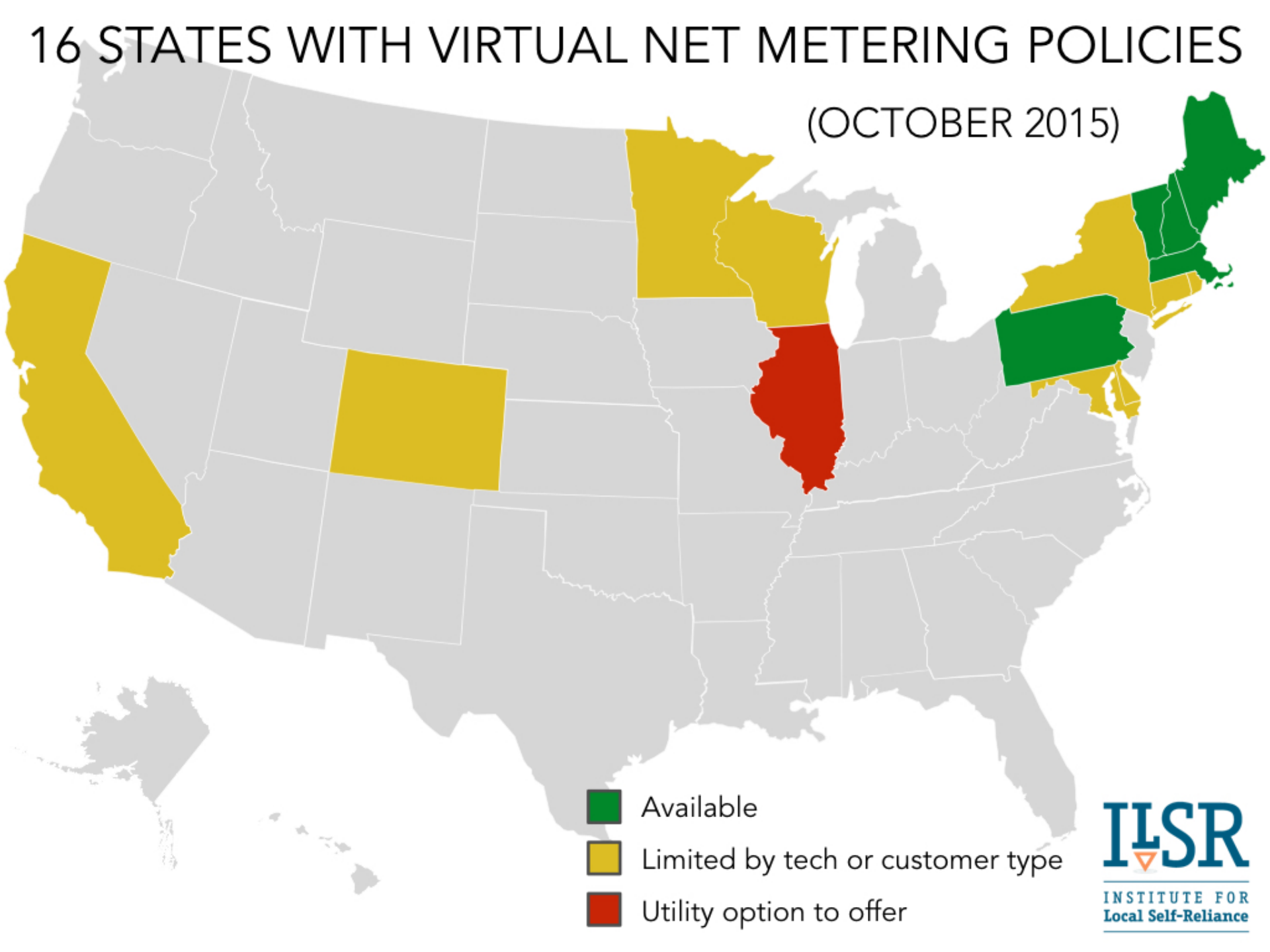
What Is Net Metering?

Net metering is a billing mechanism that credits solar energy system owners for the electricity they add to the grid. For example, if a residential customer has a PV system on the home's rooftop, it may generate more electricity than the home uses during daylight hours. If the home is net-metered, the electricity meter will run backwards to provide a credit against what electricity is consumed at night or other periods where the home's electricity use exceeds the system's output. Customers are only billed for their "net" energy use. On average, only 20-40% of a solar energy system’s output ever goes into the grid. Exported solar electricity serves nearby customers’ loads.

NET METERING

16 STATES WITH VIRTUAL NET METERING POLICIES

(OCTOBER 2015)



ILSR
INSTITUTE FOR
Local Self-Reliance

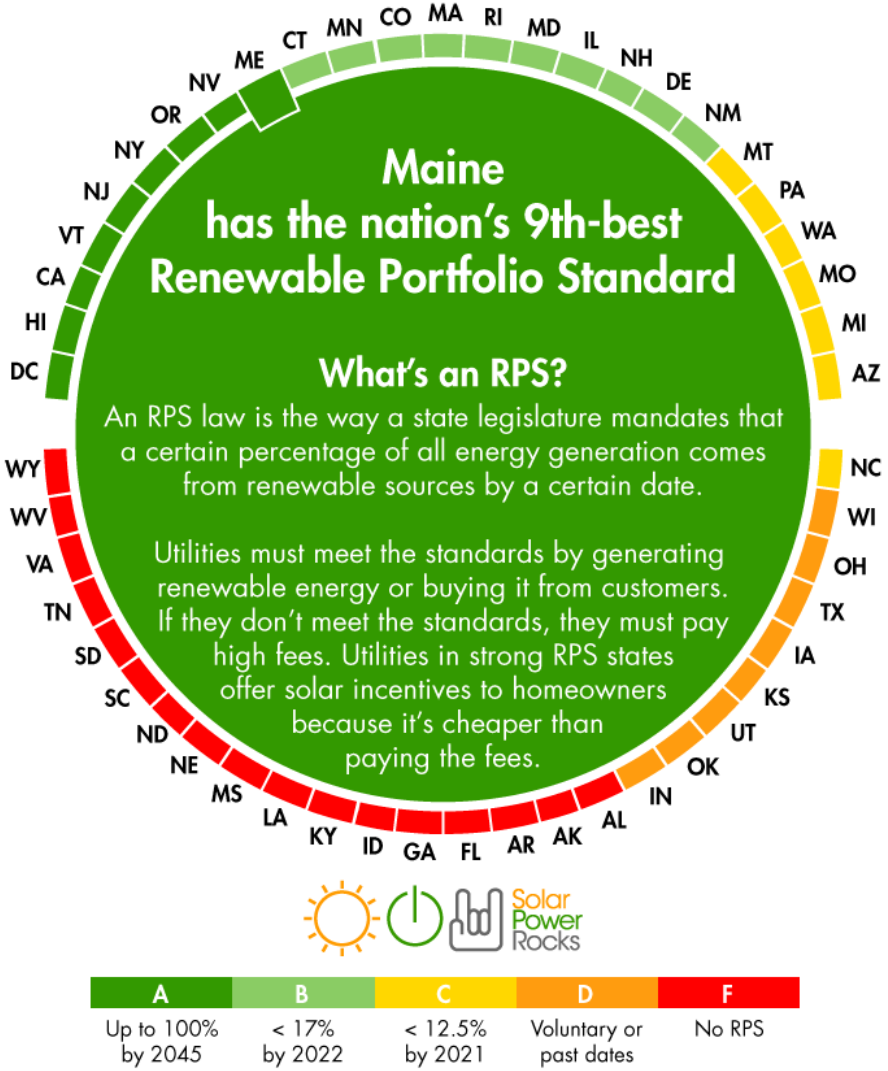
Massachusetts State Policy

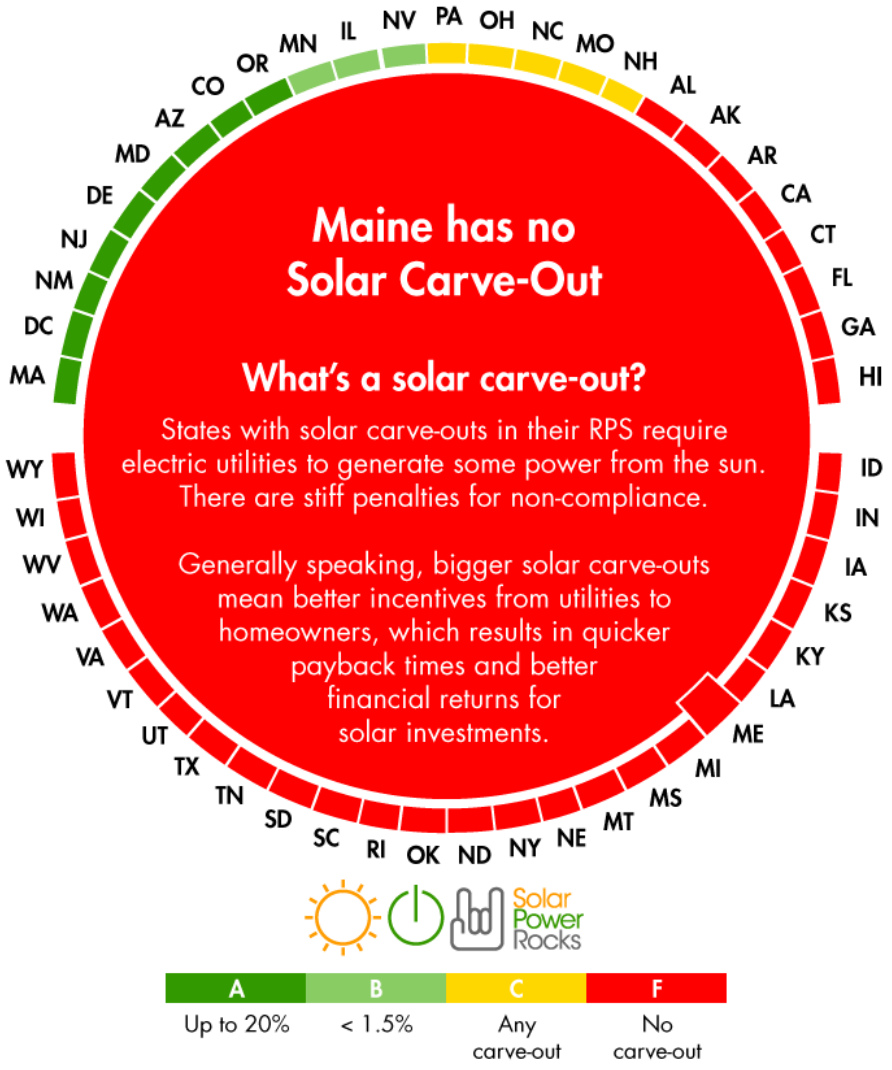
The Massachusetts market is shaped by net metering and a renewable portfolio standard with a solar goal, along with an accompanying SREC market. Net metering caps do not align with program goals, and the legislature has had to act several times to raise the net metering caps. The Massachusetts Department of Energy Resources is working on implementing a successor to the successful SREC program, and once again, net metering caps have been reached in certain utility territories.

Massachusetts State Policy Priorities

- Lift the net metering caps.
- Codify the 1.6GW solar goal and identify the most appropriate incentive regime to achieve the goal.
- Work with policymakers to improve and implement SMART program.

Current Solar Policy Q1 2019 ME





https://www.solarpowerrocks.com/maine/#taxcredits

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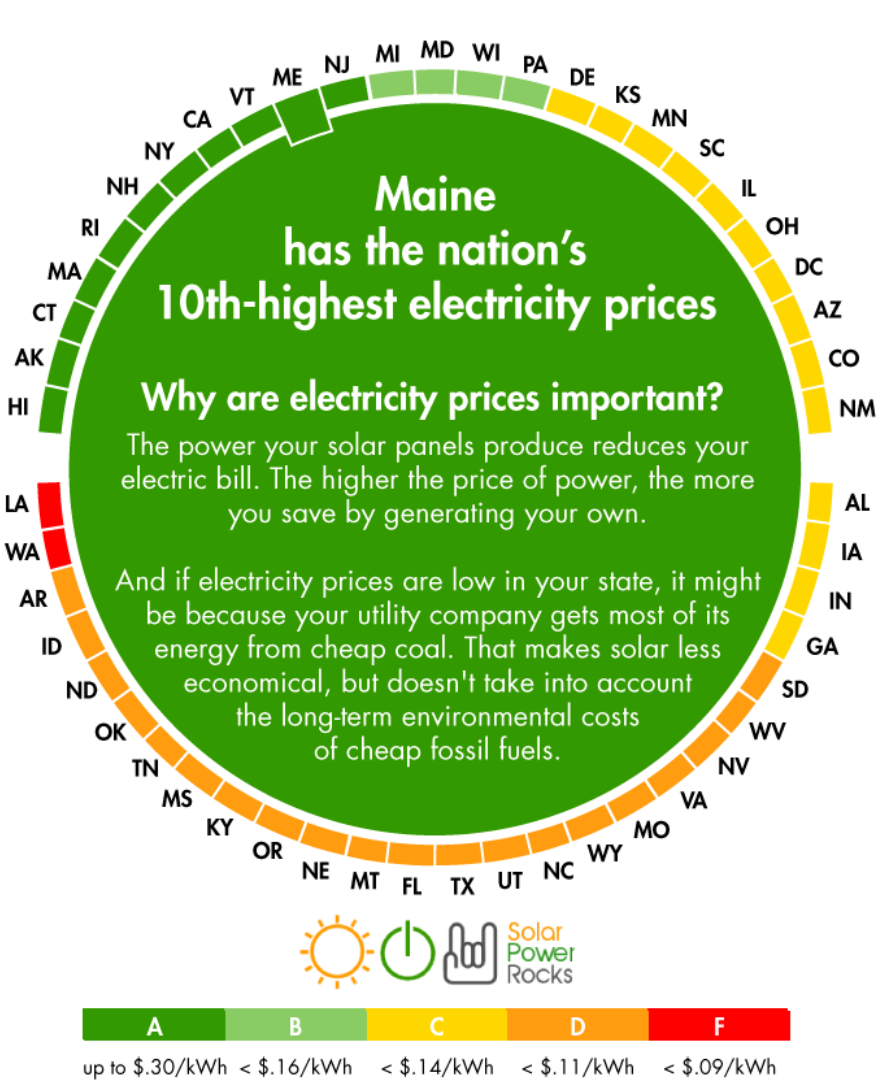

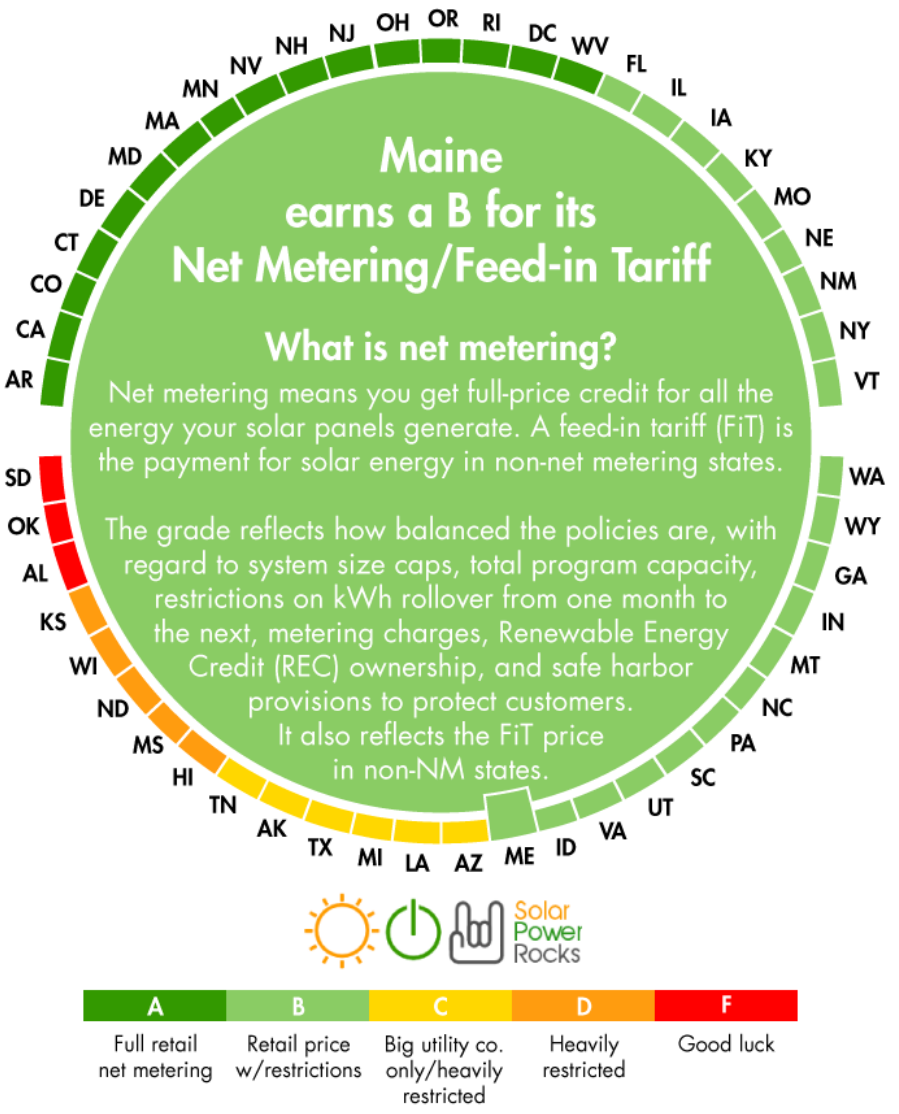

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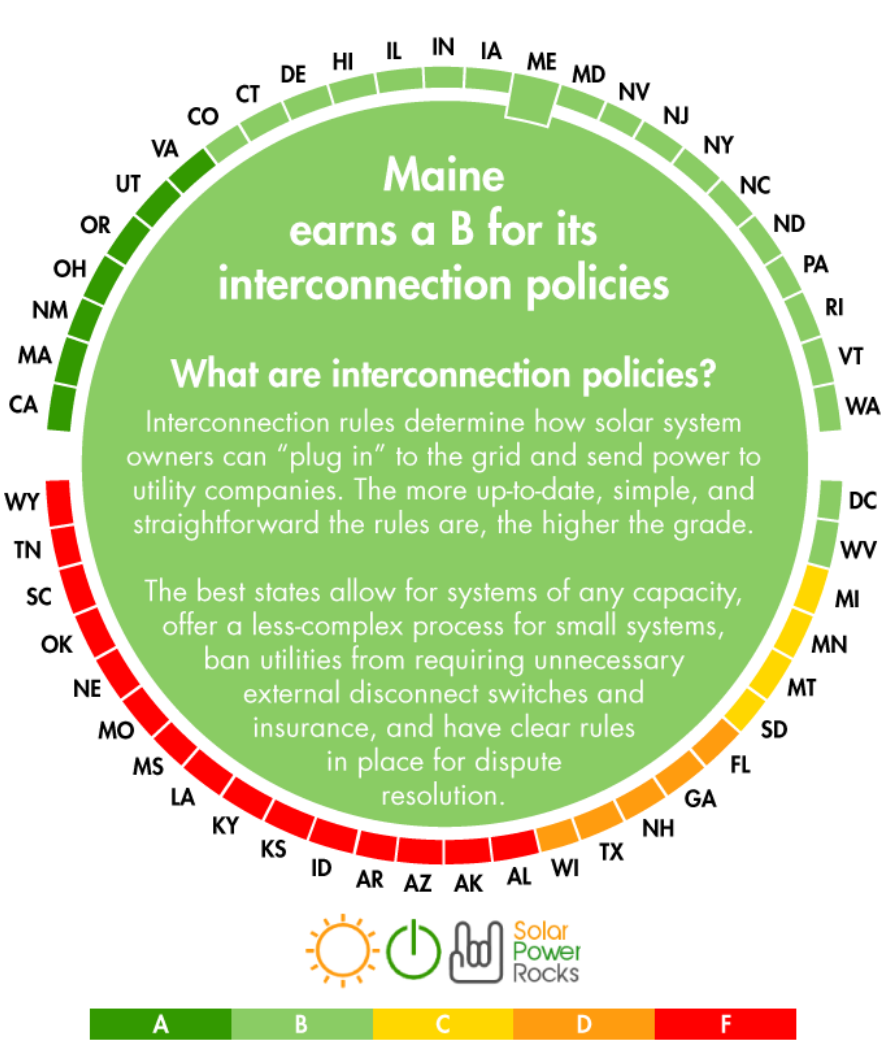

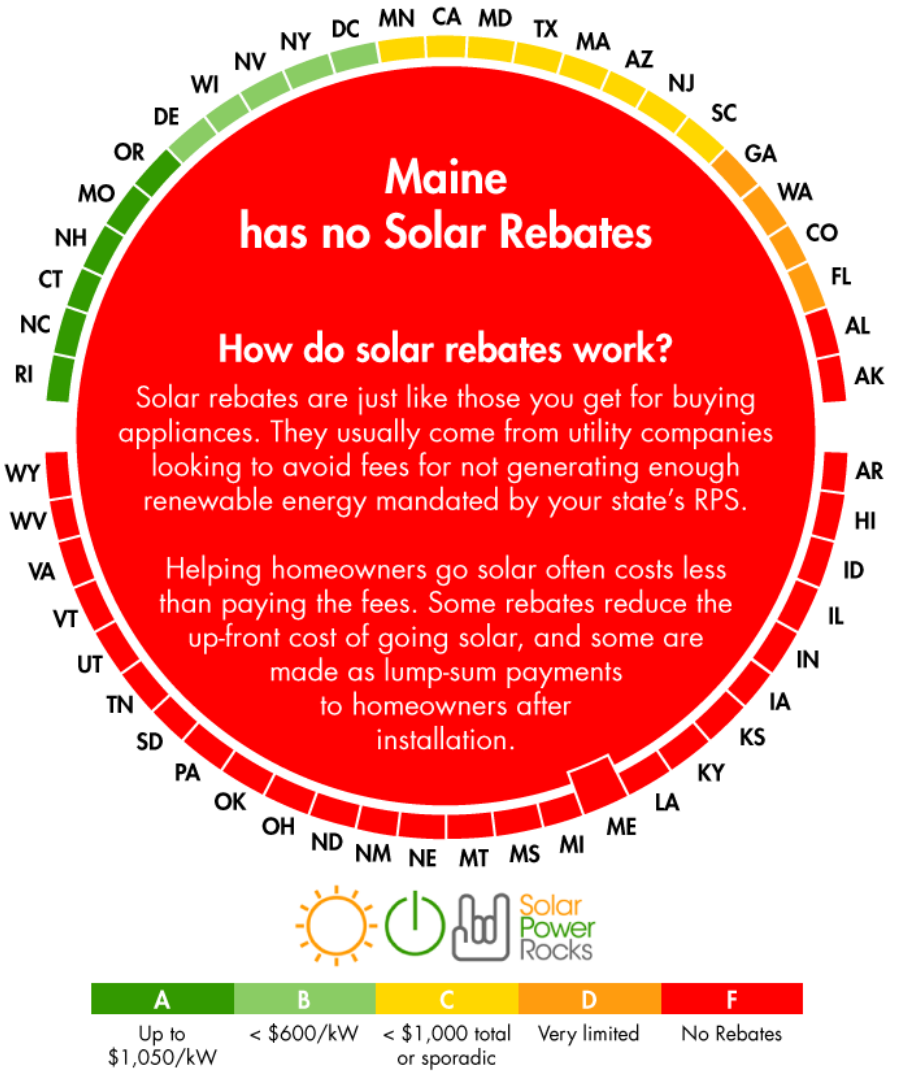

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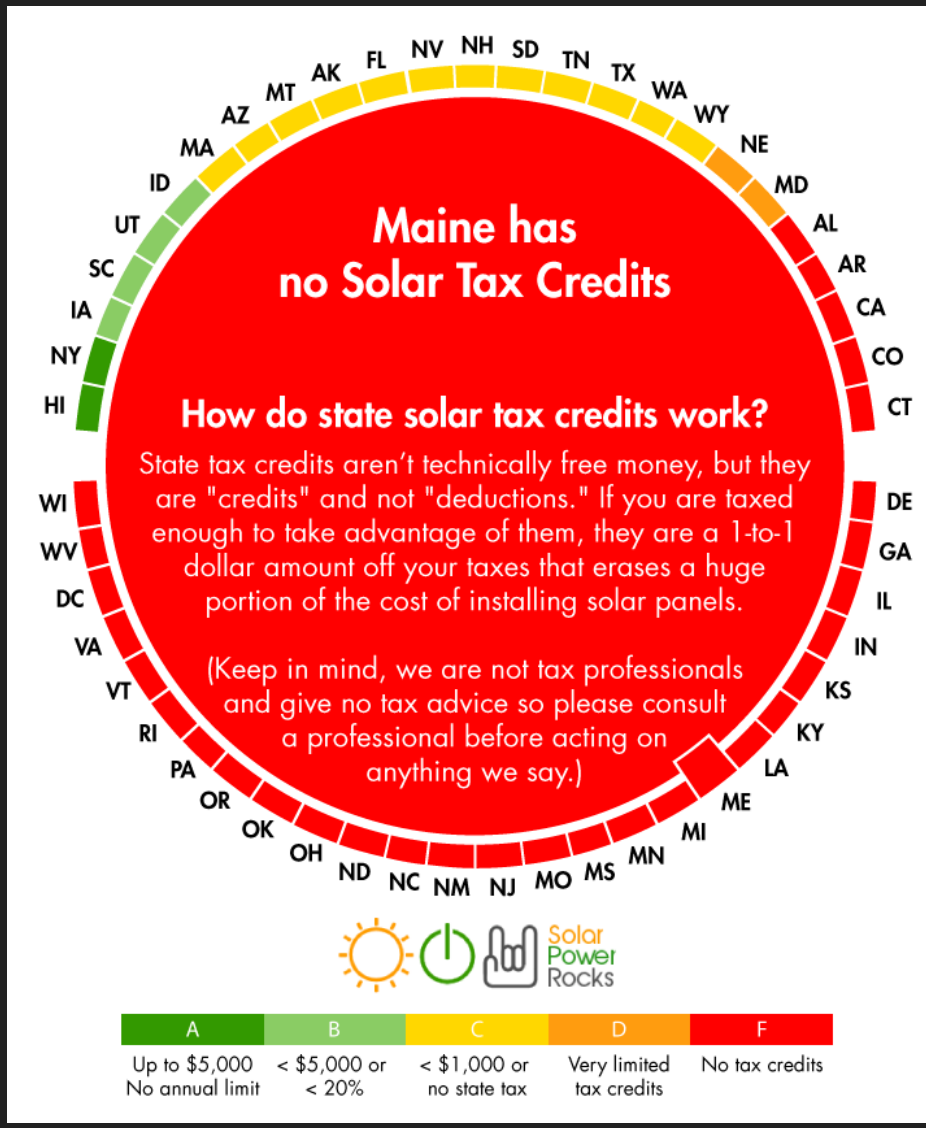

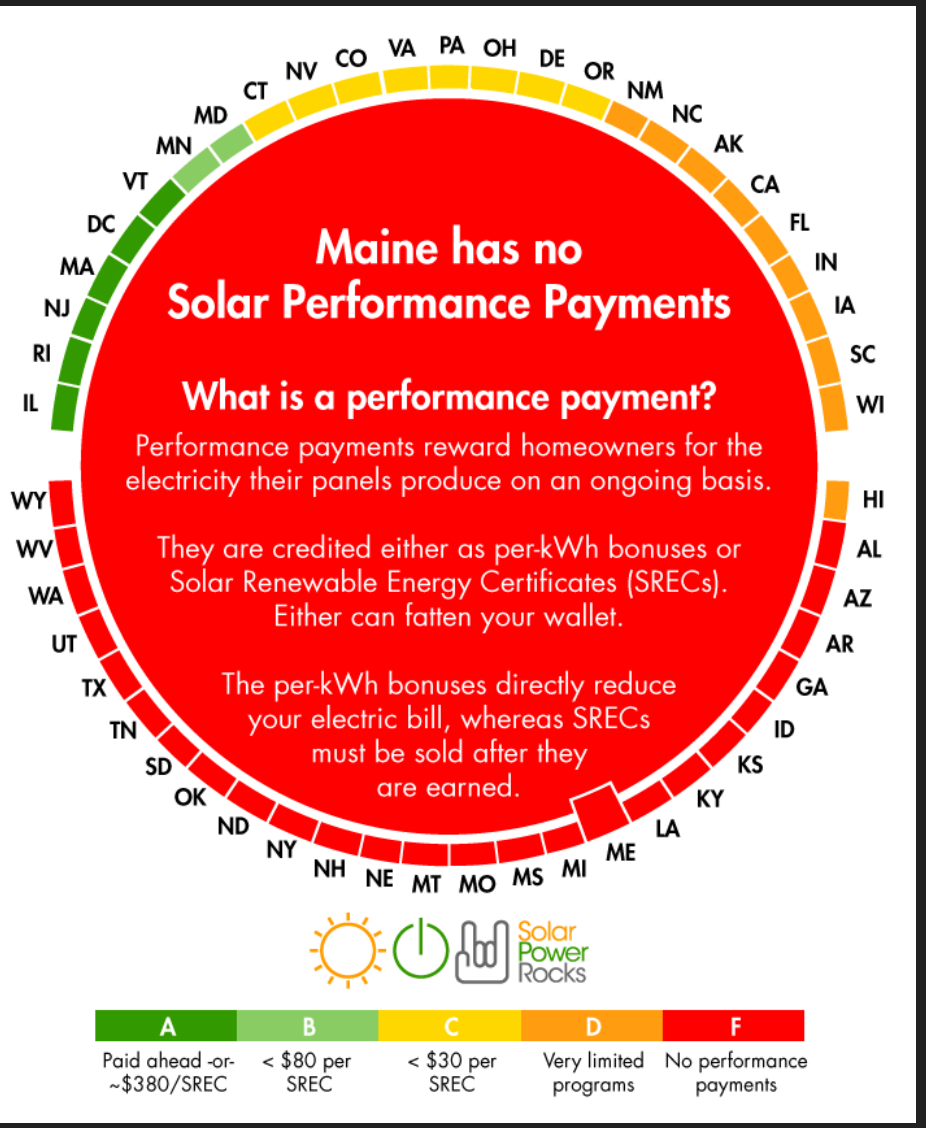

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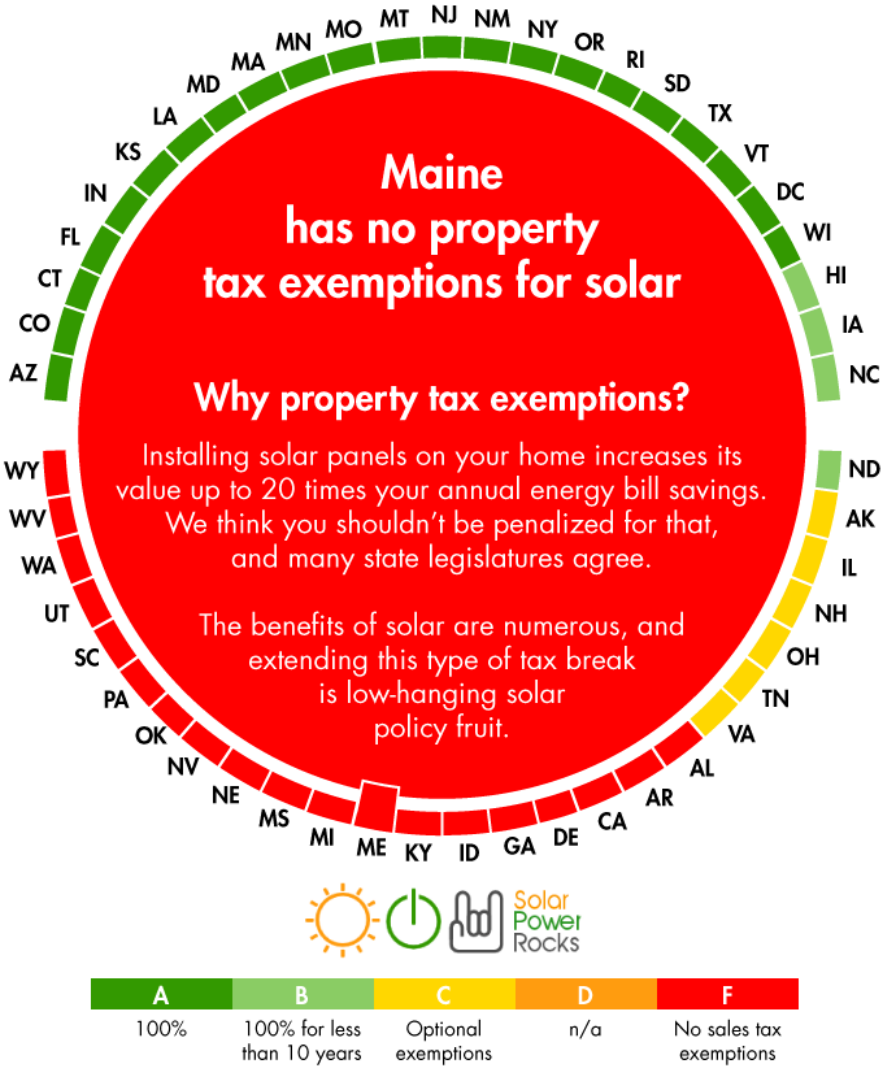

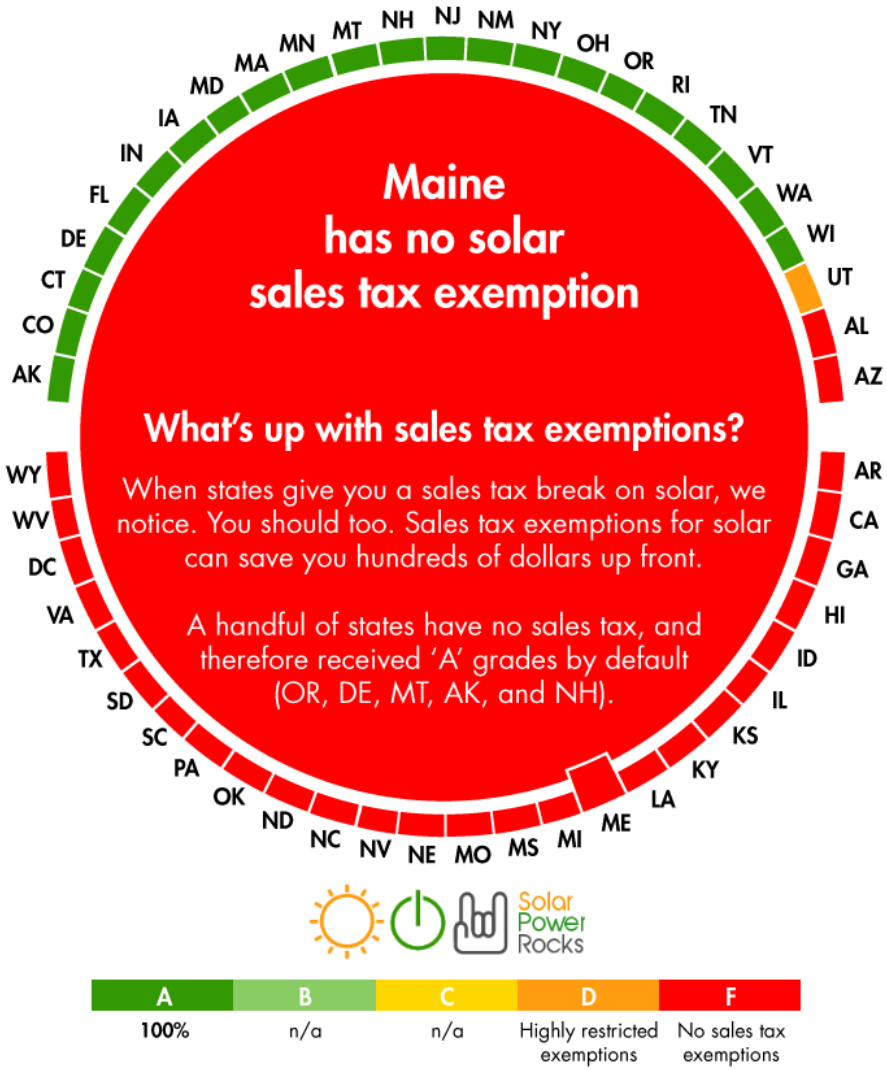

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Value of Solar Study

Figure ES- 2. CMP Distributed Value – 25 Year Levelized ($ per kWh)

25 Year Levelized

		Gross Value A ($/kWh)	×	Load Match Factor B (%)	×	Loss Savings Factor (1+C) (%)	=	Distr. PV Value D ($/kWh)	
Energy Supply	Avoided Energy Cost	$0.076				6.2%		$0.081	Avoided Market Costs
	Avoided Gen. Capacity Cost	$0.068		54.4%		9.3%		$0.040	
	Avoided Res. Gen. Capacity Cost	$0.009		54.4%		9.3%		$0.005	
	Avoided NG Pipeline Cost								
	Solar Integration Cost	($0.005)				6.2%		($0.005)	
Transmission Delivery Service	Avoided Trans. Capacity Cost	$0.063		23.9%		9.3%		$0.016	$0.138
Distribution Delivery Service	Avoided Dist. Capacity Cost								
	Voltage Regulation								
Environmental	Net Social Cost of Carbon	$0.020				6.2%		$0.021	Societal Benefits
	Net Social Cost of SO_2	$0.058				6.2%		$0.062	$0.199
	Net Social Cost of NO_x	$0.012				6.2%		$0.013	
Other	Market Price Response	$0.062				6.2%		$0.066	
	Avoided Fuel Price Uncertainty	$0.035				6.2%		$0.037	
								$0.337	

Maine Solar Policy Recap of 2017-2018 ME

- The take away from the given policy information from Q1 2019 is that Maine has no concrete goals and direction for the States Solar Policy. This is primarily due to the negative policy stance Governor Paul LePage took on solar policy in Maine throughout his 8 year career.
- The overall existing solar policy has a grade ranking around a C according to solarpowerrocks.com.
- The most negative solar policy changes took place in 2017 behind the scenes. Technical Rule changes to Net Energy Billing went into effect in May of 2018.
- The first negative rule change that occurred was the implementation of a 10% compensation step down to the T&D portion of the Net Energy Billing customers gross solar generation per year. This will be in effect until T&D compensation is eliminated.
- The second negative rule change that occurred was the implementation of the “Gross Meter”. This eliminated the potential for Net Energy Billing customers to feed power to their loads behind the meter.
- PUC Commission made additional rule changes at the end of December 2018 eliminating the need for “Gross Meter” installations on Small and Medium General Service Customers due to the realization of the high cost to ratepayers

https://www.solarpowerrocks.com/maine/#taxcredits

Maine Solar Policy Projected from 2019-2020

Maine Solar Policy is looking very good with our new state governor Janet Mills who is openly supportive of the solar industry in Maine and setting higher renewable energy goals for the state.

The First likely policy change to take effect will be to eliminate the technical rule changes that occured to Net Energy Billing in 2018

<u>Commercial, Community / Shared, & Municipal sectors</u>

Other policy measures and goals will likely include

Procurement of large scale community/shared renewables through long term contracts (150 MW)

10% of MW contracted carved out for low/moderate-income households

Subscribers receive bill credits with a $ value (not kWh)

Maine Solar Policy Projected from 2019-2020

Small/Medium-business

DG Pilot offers alternative compensation route in comparison to NEB. Long term contracts at below retail rates 50kW-2MW, require PUC reporting of Pilot after 3 years

NEB

Raise cap of 9 participants to 200 for shared ownership systems

Raise system size to 2MW

Reset cost benefit evaluation trigger to when NEB reaches 5% of load

PUC directed to initiate at least one battery pilot project