



Solar Solutions Workshop



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Kirsch Center, Cupertino

Slides at

www.acterra.org/programs/greenathome/outreachmaterials.html



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ACTION FOR A
SUSTAINABLE EARTH

Solar Solutions Workshop

Objectives

1. **Why buy solar systems**
2. **Basic components of a solar electric system and making choices**
3. **System price and payback examples based on monthly electric bill**
4. **Purchasing tips from the information sheet**



Additional information in slides

1. A new solar electric technology to consider
2. Solar hot water heating options

Reasons To Install Solar?

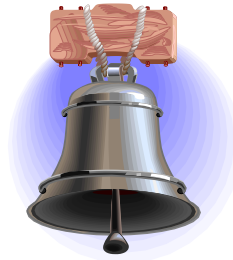
1) Economics



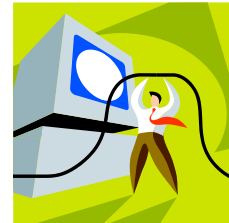
2) Environmental Benefits



3) Independence



4) Technology Interest



Knowing why you want to go solar
will help you make choices and keep the big picture in mind



- Solar Electric

- 3kW system = 6000 pounds/yr of CO2 reduced
~\$14,600 after rebates



- Solar Hot Water

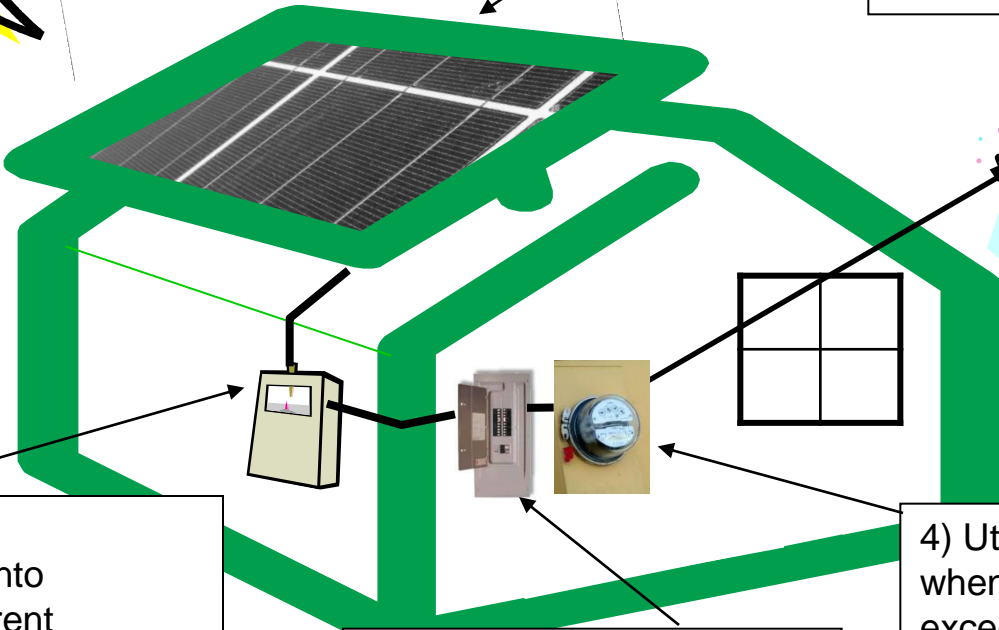
- Typical system 3,500 pounds/yr of CO2 reduced
\$3,000 - \$6000 after federal 30% tax credit &
after CA rebate up to \$1875

Solar Electric System Basics



1) Solar panels convert sunlight into direct current (DC) electricity

5) Power from the utility is automatically provided at night and during the day when your demand exceeds your solar production



2) Inverter converts direct current (DC) into alternating (AC) current for electricity use in the home and keeps track on solar output
Place **inverter in cool shady location** for efficiency and maximum service life

3) Existing electrical panel distributes solar electricity to the house
An separate shut off switch may also be required

4) Utility meter spins backward when solar power production exceeds the house demand and power is sold back to the utility
Option: A new meter is required for Time Of Use (TOU) metering

Considerations in Selecting Solar PV (aesthetics, efficiency/space, track record)

Monocrystalline
(Single)



75 Watts

Polycrystalline
(Multi)



80 Watts

Amorphous
(Thin-Film)



43 Watts

← 12-22% efficient →
50 year track record

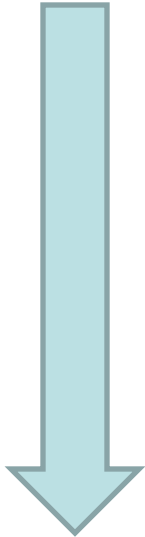
5 – 10% efficient
New to market
Less sensitive to heat

Roof Condition and Type

Roof should be in good condition

- **15 – 20 year life remaining**
- **Ideal to install solar on new roof**

**More
Expensive
to
Install
Solar**



- Composite shingle
- Standing seam metal roof
- Shake if new and not brittle
- Tar and gravel flat (not including tilting)
- Cement tile
- Spanish tile
- Shake if old and brittle

Many contractors will not install on:

- Slate
- Hardie shake



Solar- what size will fit my roof

~ using www.roofray.com ~

1 Create Solar Array

2 Current Electric Costs

3 Financial Analysis

4 Free Estimate

Next >



Name:

Save

How-to Create Your First Array

1. Locate Your Property

- > Use the Address Search above
- > Then drag the map and zoom in/out until you're above the property

2. Click Corners of Roof

- > Click a point to create the first corner.
- > Continue to click other corners to form your array
- > When finished, re-click the first corner to close it off.



3. Determine Orientation

- > Drag the end of the red slope line to the bottom of the roof. (For flat roofs - leave at due south)

4. Select Roof Pitch or Tilt

- > Guesstimate your pitch using the slider - mid 20 degrees in typical

20

Make a mistake? No problem...

Remove Last Point

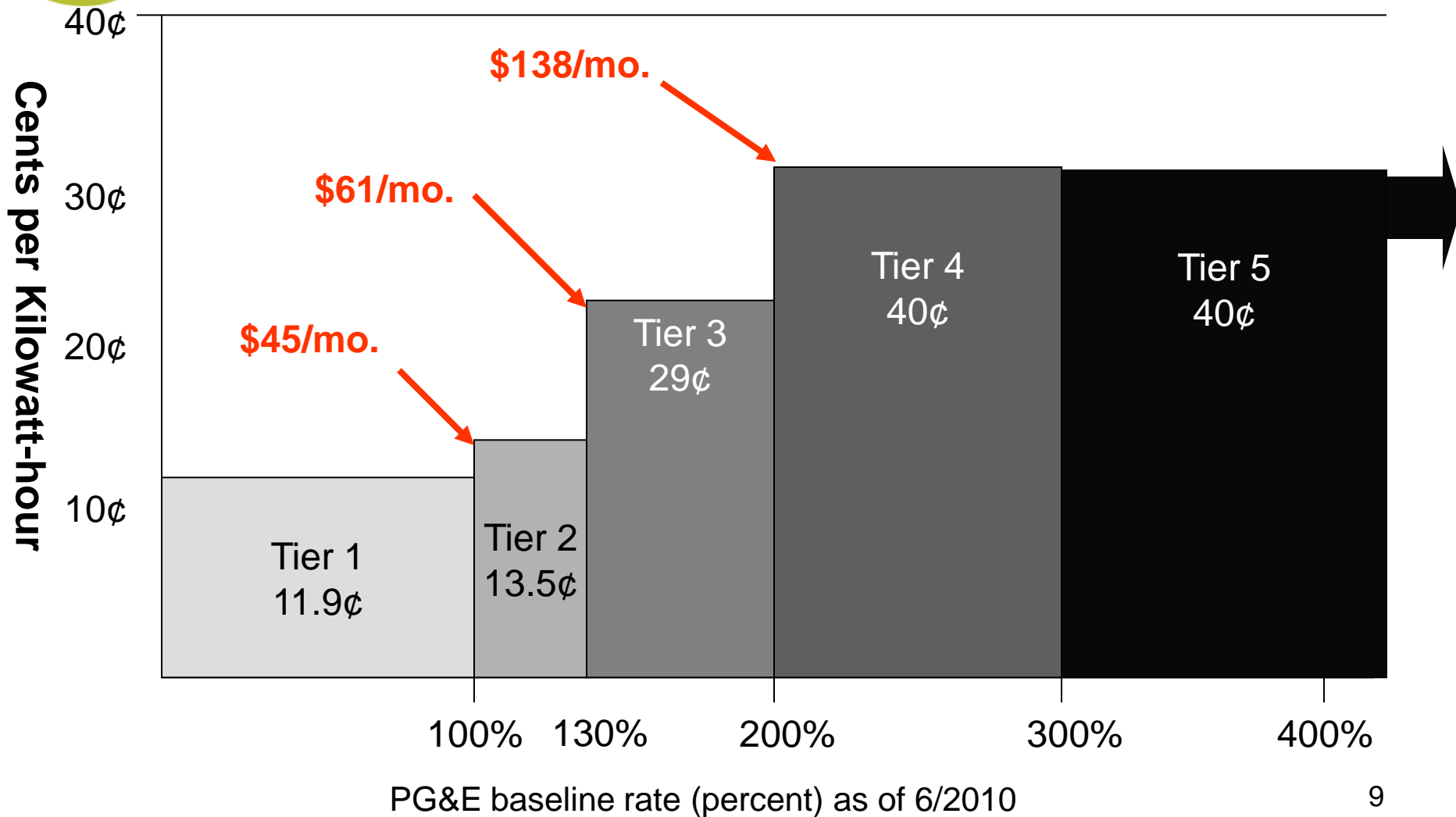
Start Over

Next >

Segment	Potential	Power per Sq. Ft.	Area	Orientation	Total Peak Power	Delete	Calculate
	65%	8.46 Watts DC	218 Sq. Ft	271.2° (W)	1849.1 Watts DC		<input checked="" type="checkbox"/>



5-TIERED RESIDENTIAL PRICING USE LESS > PAY LESS

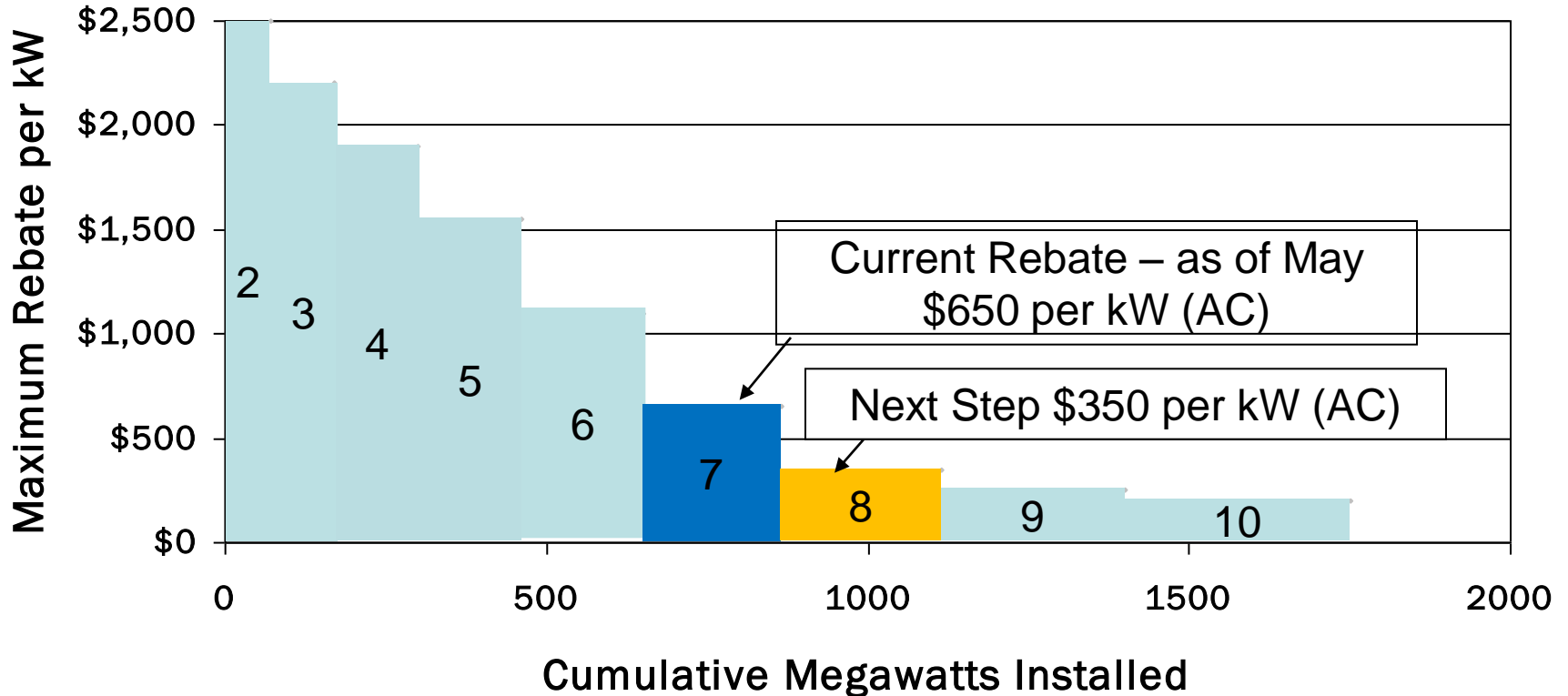




- Federal tax credit
 - 30% of system cost – no limit in 2009 through 2016
 - Home owner submits information on federal tax return
 - Must have taxes owed to put credit toward
- State rebate (PG&E)
 - \$650 per kW AC - shrinks over time
 - Installer manages; locked in when paperwork submitted
 - Last step took ~8 months before reduced
- Increase in property value – over 100% of net cost
 - Up to 20 times the annual energy savings,
based on Appraisal Journal 1998



STATE SOLAR REBATES SHRINK AS MORE SOLAR IS INSTALLED



Rebate based on peak AC watt output of total system
Installer submits paperwork
For current rebate status: <http://www.csi-trigger.com/>



Financial Examples

Solar System Financial Examples

Ave. monthly electric bill	System size kW AC*	Cost after rebate & tax credit	First year savings \$ per year	% of Electricity generated by solar	Payback in years	Tax Free Rate of Return over 30 years
\$100	2	\$9,660	\$700	45%	14	12%
\$100	3	\$14,490	\$914	68%	16	10%
\$100	4	\$19,460	\$1121	91%	11	10%
\$150	2	\$9,660	\$980	37%	10	16%
\$150	3	\$14,490	\$1254	55%	12	14%
\$150	4	\$19,460	\$1487	73%	13	13%

Based on Clean Power Estimator; www.consumerenergycenter.org

* Note, this is for kW AC (many installers quote in kW DC which is higher)



Financial Examples

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	3	\$14,490	\$1254	55%	12	14%
	4	\$19,460	\$1487	73%	13	13%
	5	\$24,150	\$1746	94%	14	12%

Zero Out Electric Bill

BETTER ROI

Based on Clean Power Estimator; www.consumerenergycenter.org

* Note, this is for kW AC (many installers quote in kW DC which is higher)

Financial Assumptions

- **Cost of the system**
 - \$7000 to \$8000 per kW AC (\$7,500 used in example)
 - Warranties; Prorated (get it in writing)
 - 25 years on solar panels
 - 10 years on inverter
 - 5 years on installation
 - **Savings from electricity production**
 - including future price increases (6.7% / yr since 1971)
 - 5% used in examples
 - Tier 4 increased 7% in Jan. 2010
 - Tier 1 & 2 increased 3% in Jan. 2010
- **Solar allows you to lock in the price of energy today**



Change in Utility Bill (PG&E)

- Two statements
 - Gas and electric bill monthly (bill with blue header)
(electric connection charge paid monthly ~ \$6)
 - Monthly report on electric energy charges
 - Shows cumulative energy charges
 - Summer time cumulative bill is usually negative
 - Only pay energy charges once a year (True up bill)
- PG&E will write you a check if the electricity produced is more than your electricity usage over a full year.
 - clock starts in 2010 for payment in 2011
 - 8.1 cents/kWhr PG&E proposal
 - if select Time of Use pricing - not likely to get check because based on electricity usage not cost of energy

Highlight key items from info sheet

- Get three bids
- Don't give more than \$1000 before panels arrive
- Ask for California Energy Commission AC output for your system
 - This is what the state rebate is based on
- Consider Time of Use pricing if you don't use AC
- solar-estimate.org & Yelp.com – local installer info
- www.californiasolarstatistics.ca.gov for searchable installs by location including size, price, installer, panel model etc.

A yellow starburst graphic with a blue outline, containing the text 'Local Prices' in bold black font.

**Local
Prices**

More Purchasing Tips

- 1BOG.org (1 Block off the Grid)
\$5.24/watt DC ~ \$6.5/watt AC 5/2010
 - Sign up for group purchase discount; no obligation
 - No significant geography restrictions
- Check if the installer offers a discount for your company
 - Example, discounts for HP and Google employees
- Check contractor license and BBB rating
- Keep the big picture in mind – why am I doing this 😊

A yellow starburst graphic with a black outline, containing the text 'Great Deal' in black, bold, sans-serif font.

Great
Deal

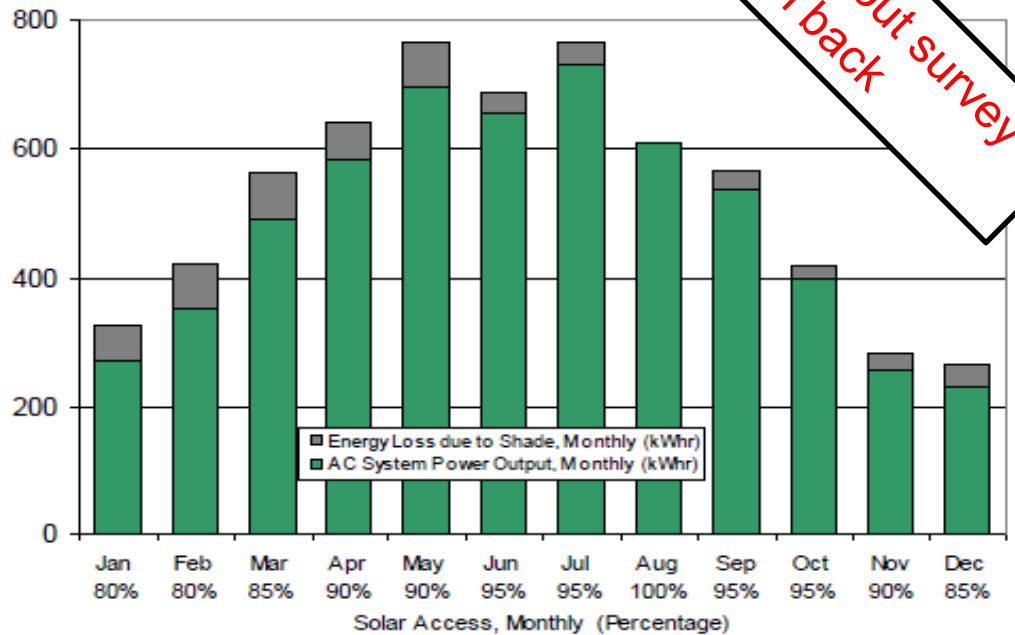
Solar Energy Estimate

Please fill out survey on back

Estimate Provider

5,311 kWh (AC)
First year estimated energy

107,892 kWh (AC)
25 year estimated energy



Estimate Date: March 17th, 2010

Version: Alpha-One

Location: **1290 Parkmoor Avenue, San Jose, CA**

Reference Zip Code: 92867

Panels: Evergreen Solar ES-200-RL

Quantity 20

Inverters: SMA America SB4000US (240V)

Quantity 1

Tilt 18⁰ Azimuth 180⁰ Shading Correction? YES Tracking: FIXED > 6-in Standoff? YES

EPBB derating includes:

PV module DC rating = 95%

Mismatch = 98%

Diodes and connections = 99.5%

DC wiring = 98%

AC wiring = 99%

Soiling = 95%

System availability = 98%

Overall standard derate = 83.7%

Additional Estimate Provider Information

Estimate based on CPUC Solar Estimator Model using SolarTech Solar Energy Estimate (SEE) standard. For more information, visit www.solartech.org/SEE.





Solar Water Heating

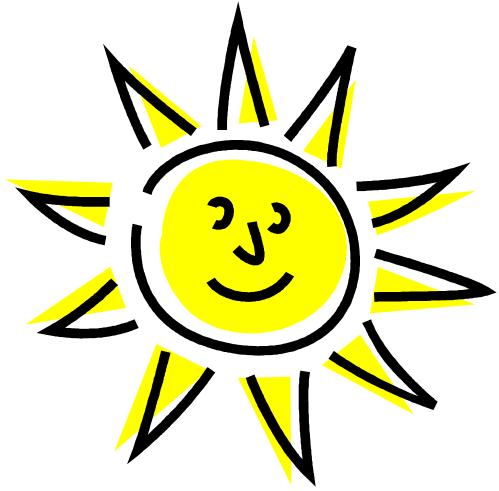
Financial Incentives!

Unlimited \$ 30% US tax credit through 2016
for **solar heaters** supplying at least 50%
of domestic hot water

CA rebate up to \$1875 - NEW!

- based on energy saved (contractor calculates)
 - \$12.82 per therm saved
- lower rebate for electric water heater
 - \$.37 per kWh capped at \$1262
- rebates decline over time





The Big Picture

***"THE SUPPLY OF SOLAR ENERGY IS BOTH
WITHOUT LIMIT AND COST;***

***SOLAR ENERGY WILL POUR DOWN ON US LONG
AFTER WE RUN OUT OF FOSSIL FUELS."***

CHARLES FRITTS, 1886

INVENTOR OF THE FIRST SELENIUM SOLAR PANEL

THANK YOU

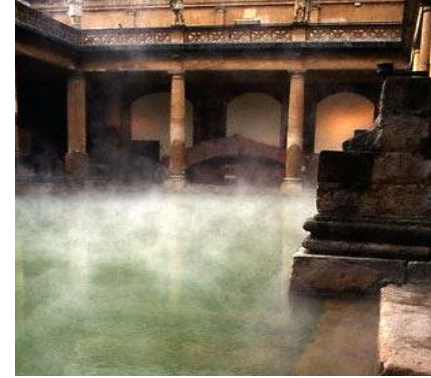


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ADDITIONAL MATERIAL

*Solar Thermal
Used by Romans!*



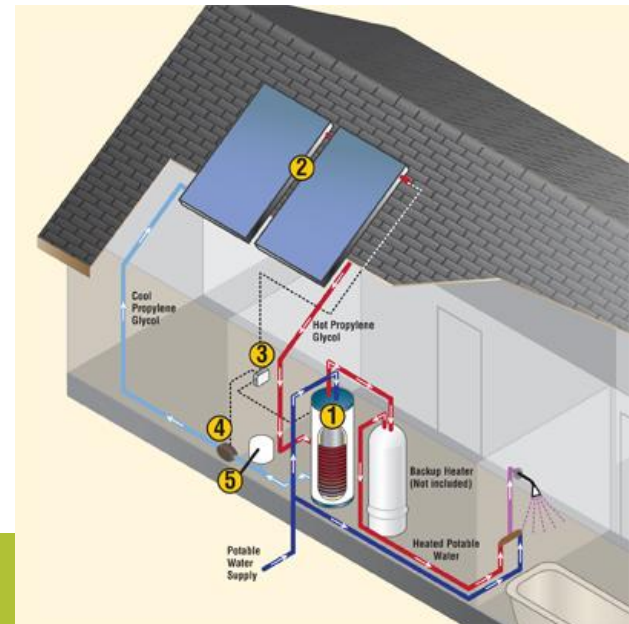
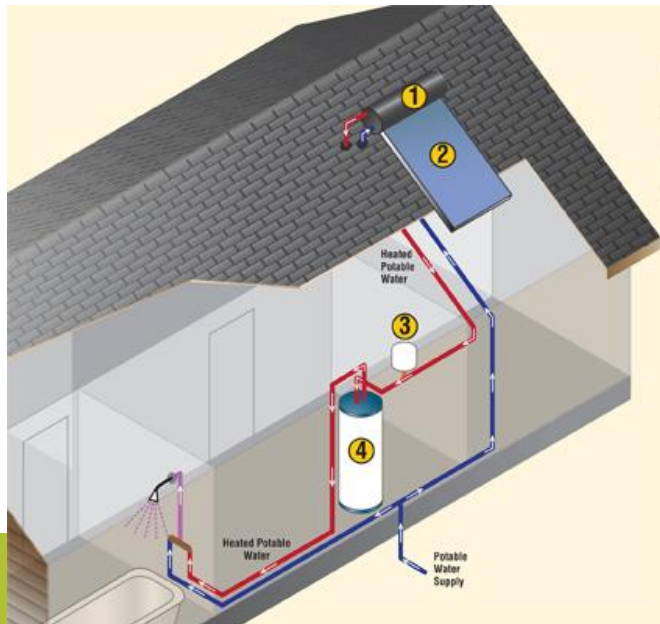
- Direct use of sun's energy
- Lower cost than PV
- Good environmental payback
- Tax credits & new CA rebate

Solar Water Heating

Two Basic System Types

Passive

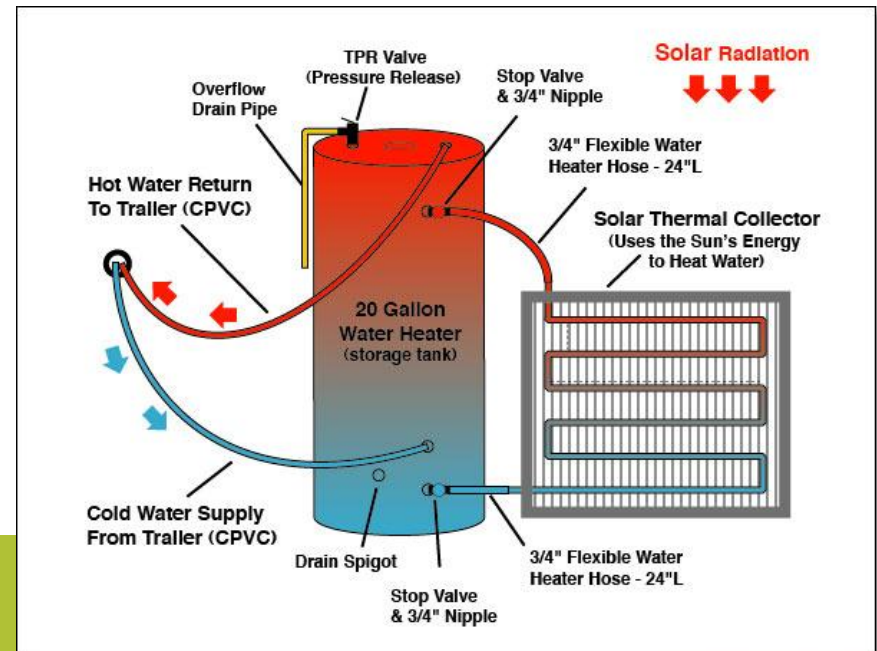
Active





Passive Solar Hot Water System

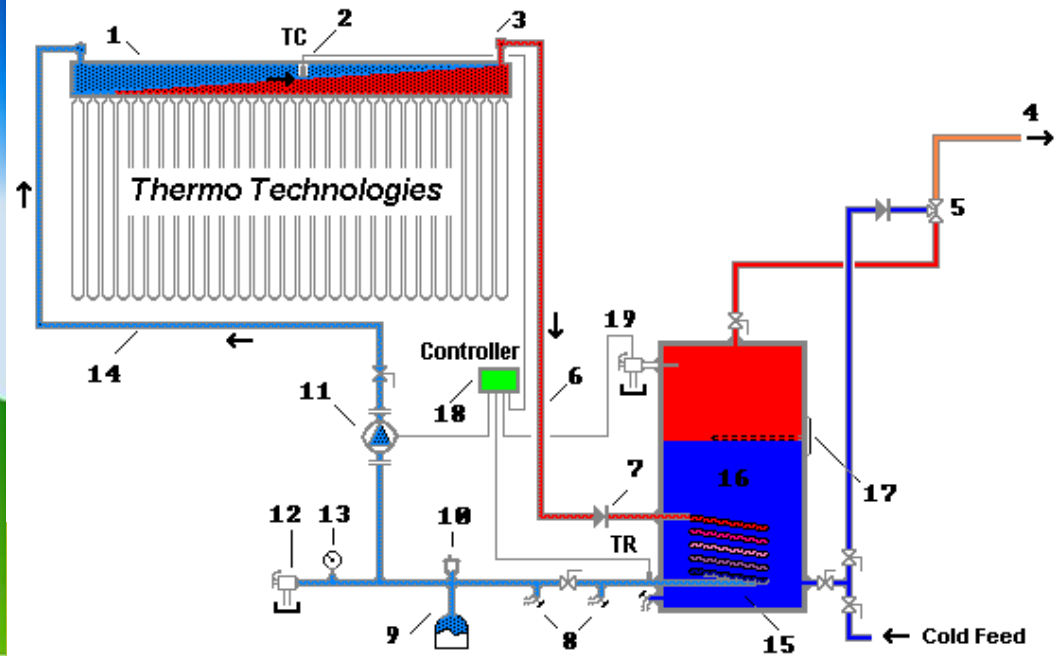
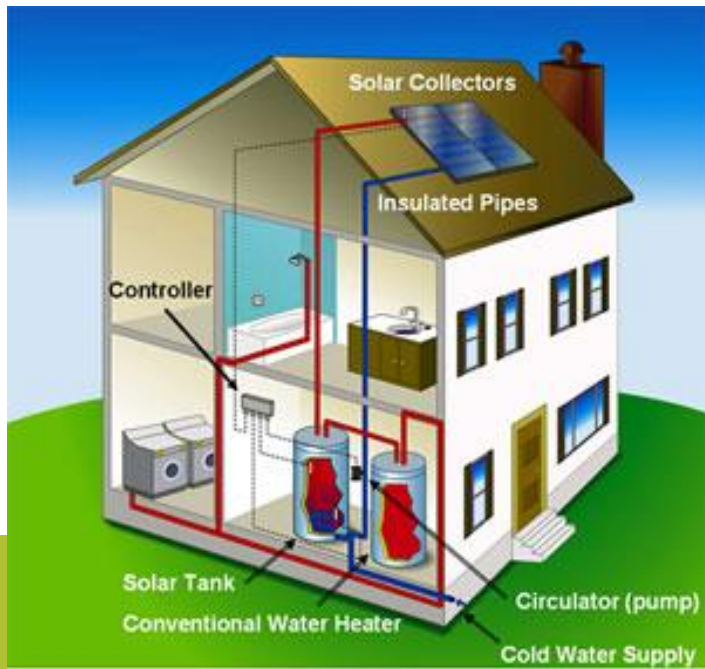
*Heats water directly, simple plumbing,
less expensive (\$3,000 to \$6,000)*





Active Solar Hot Water System

Uses heat transfer fluid, actively pumped, more efficient (\$6,000 to \$11,000)



Types of Solar Thermal Collectors

Flat Plate



Evacuated Tube



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ACTION FOR A
SUSTAINABLE EARTH



More Solar PV information

-



Shading is Critical Issue for Solar

- Get solar shading measurement from installer, from your roof where panels will be located
(X percent shading over the year)
- Shading trees may be in neighbors yard
- Consider tree growth for next 20+ years
- Close persistent shade can disproportionately effect output as much as 3 to 23X shaded area
- If shade is an issue ask about micro inverters or panel maximizers (later slide)





Effect of Direction & Tilt on Energy Output (% less than optimal - 30 deg, S)

	<u>Flat (0)</u>	<u>15 deg</u>	<u>30 deg</u>	<u>45 deg</u>	<u>60 deg</u>
S	-11%	-3%	0%	-3%	-10%
SW*	-11%	-5%	-4%*	-8%*	-15%*
SE	-11%	-7%	-7%	-11%	-19%
W*	-11%	-12%*	-17%*	-24%*	-32%*
E	-11%	-15%	-21%	-28%	-37%

* More output in afternoon;
financially better with Time of Use rate schedule

Low Maintenance



- Only wash panels when they are not hot (early morning or evening)

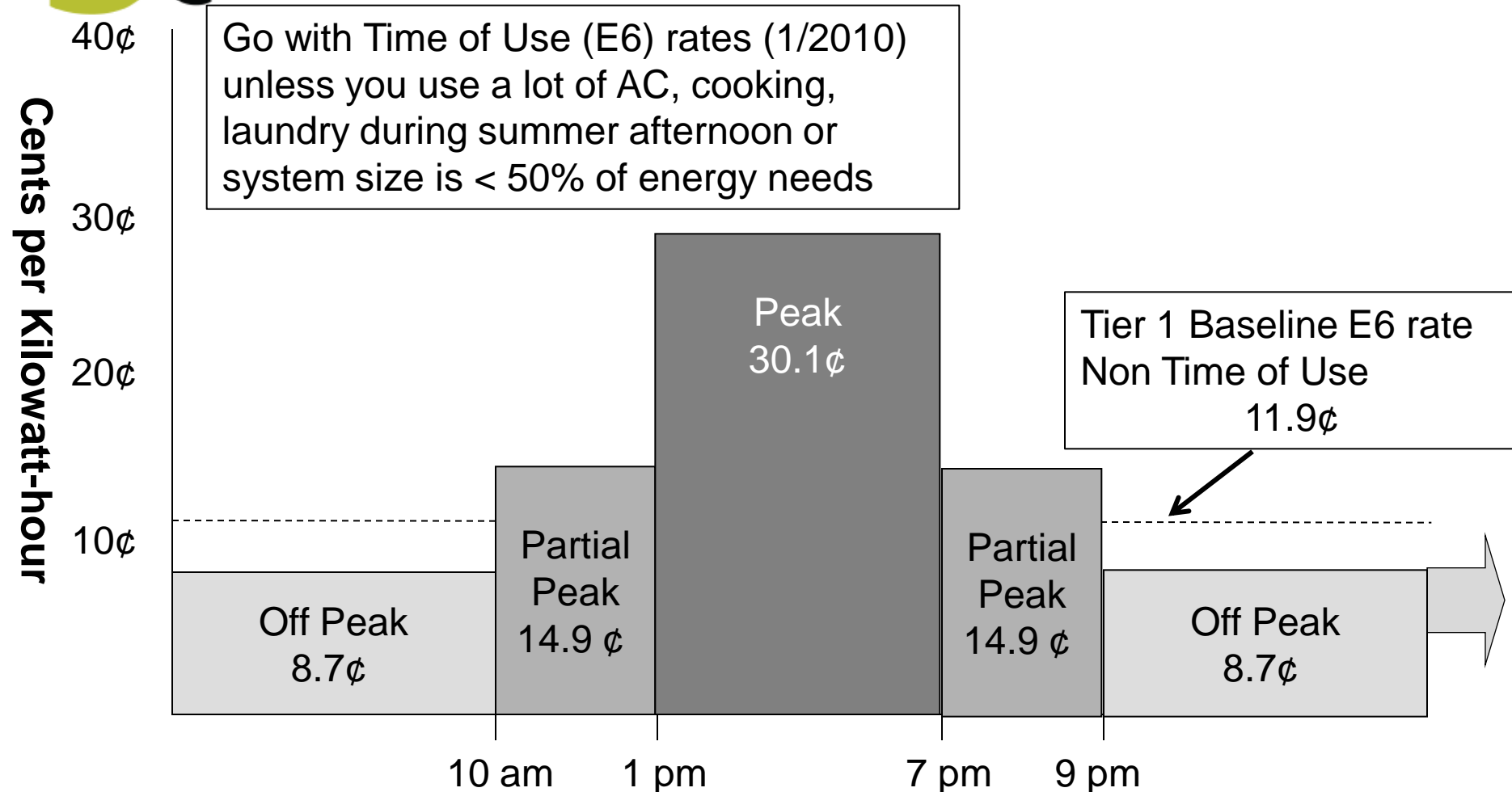
- Be careful with powerful hose, stay perpendicular to panel
- Garden hose from the ground is fine



Source: DOE National Renewable Energy Laboratory

- Wash once per year (~4% loss over ideal)
(best time to wash is early in summer, when TOU rates increase)
- Never wash (~7% loss over ideal)

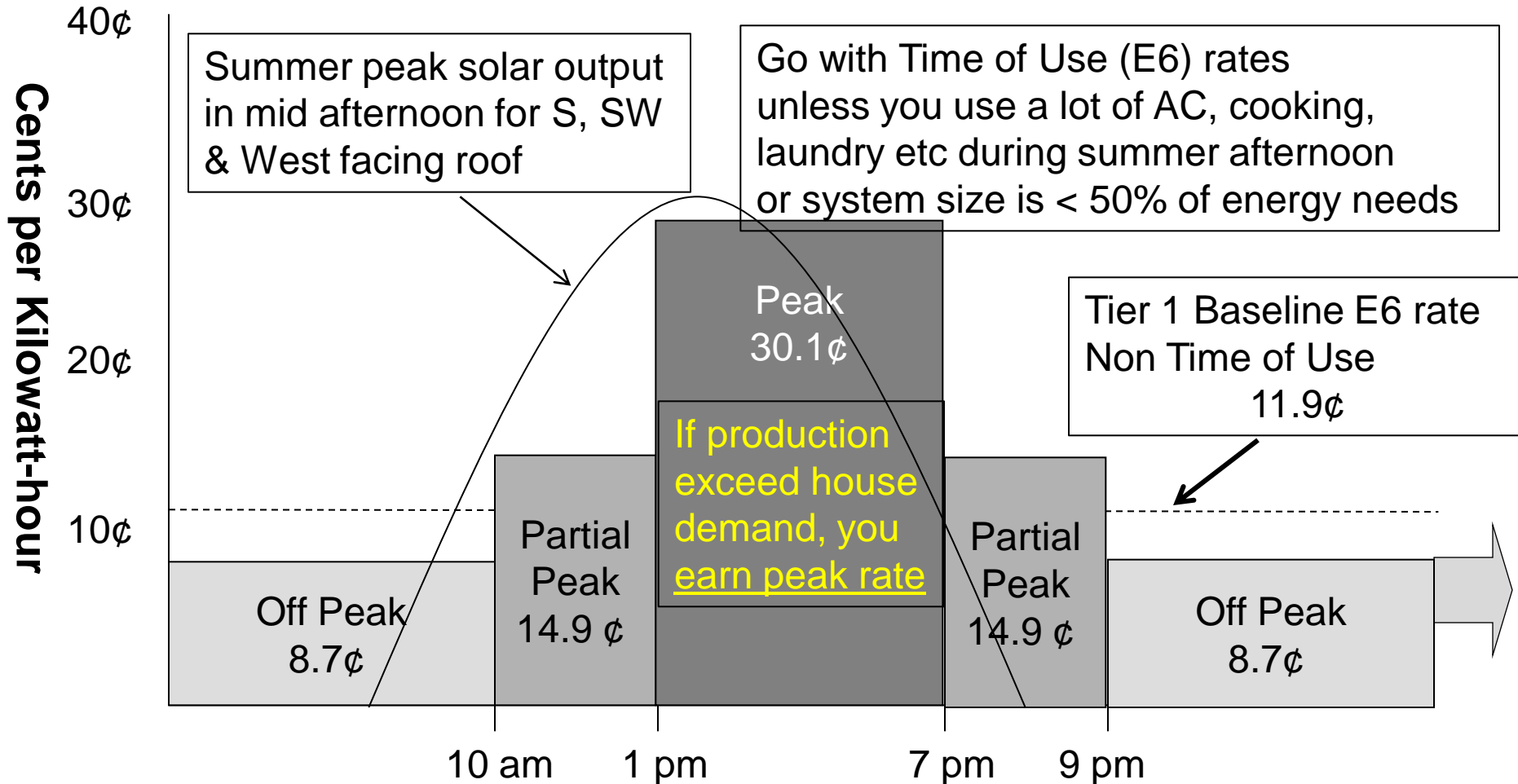
Time of Use Metering



Summer Tier 1 Baseline E6 rates (May 1 to Oct 31)
 (Sat., Sun. and holidays are off peak)



Option: Time of Use Pricing



Summer Tier 1 Baseline E6 rates (May 1 to Oct 31, 2010)
(Sat., Sun. and holidays are off peak)



California FIRST – Financing Energy Conservation and Solar

- Project cost repaid on your property tax bill
- Payments fixed for up to 20 years (7% estimated interest rate)
- Payments transfer to new owners when property sold
- Based on value of property and status of property tax payments, not on personal credit
- Application fee – estimated between \$400 and \$800
- Energy efficiency may be required before solar
- May not happen because of issues with ability for new owner to get a mortgage (originally called PACE Program)



Example – Poor Location

(West, 20% shade, \$500/kW more to install)

Solar System Financial Examples

Ave. monthly electric bill	System size kW AC*	Cost after rebate & tax credit	First year savings \$ per year	% of Electricity generated by solar	Payback in years	Tax Free Rate of Return over 30 years
\$250						
Good Site	5	\$24,150	\$2475	70%	10	16%
Poor Site	5	\$26,600	\$2150	46%	14	12%
Poor Site w/TOU rates	5	\$26,600	\$2410	46%	12	13%

Based on Clean Power Estimator; www.consumerenergycenter.org

* Note, this is for kW AC (many installers quote in kW DC which is higher)

For people willing to be on the leading edge

The benefits are real, however:

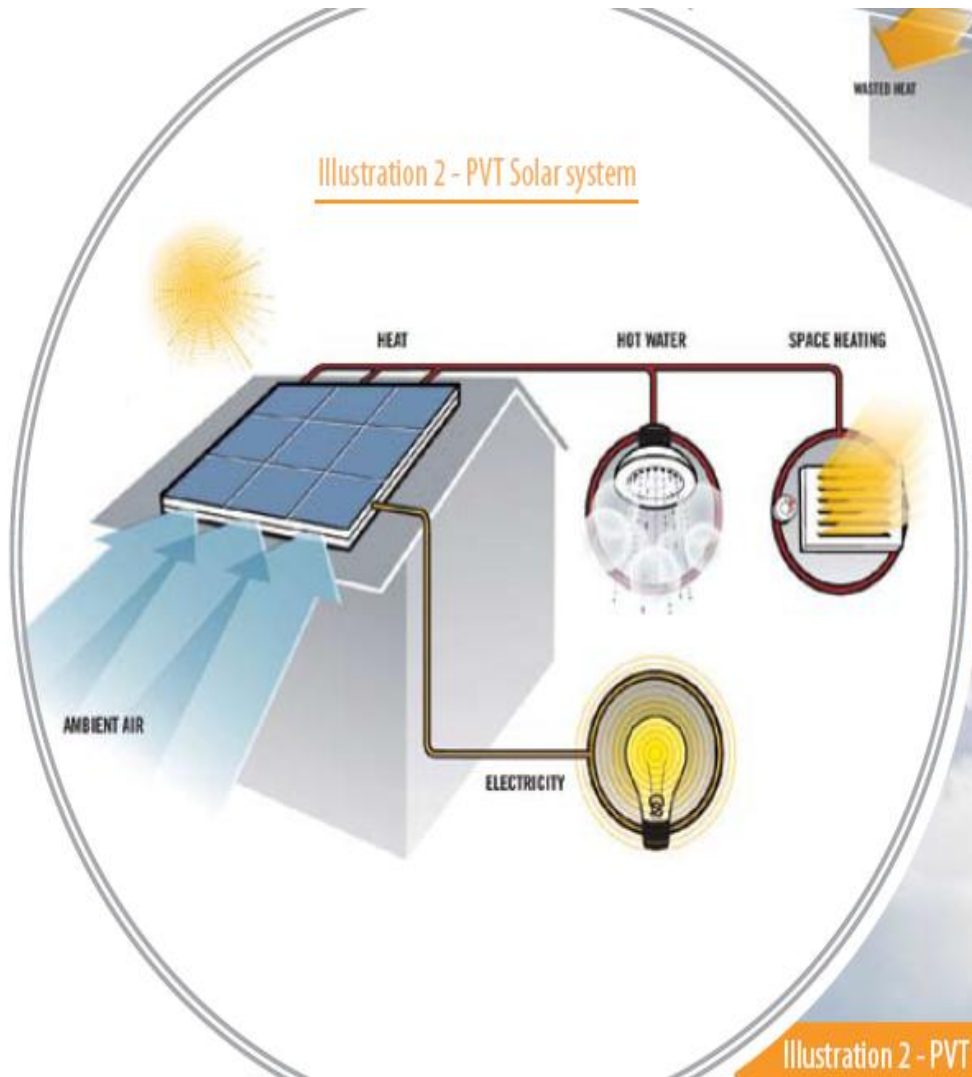
- Fewer installers offer
- Less experience installing
- Less data on reliability and performance
- Inspectors have less experience
- May not add value in all situations

Ask for them if you have shade issues and even if not

- Inverters/Optimizer with each panel
 - Much better for optimizing with shade up to 25% more
 - Optimizes each panel even with no shade issues
 - Enables multiple roof angles without multiple central inverters
 - Most track output of each panel separately
 - Easier to determine panel problems for warranty issues
- Manufacturers
 - Akeena Andalay PV Panels with integrated Inverter
 - Enphase – Micro Inverter
 - National Semiconductor - Solar Magic DC-DC
 - Tigo DC-DC

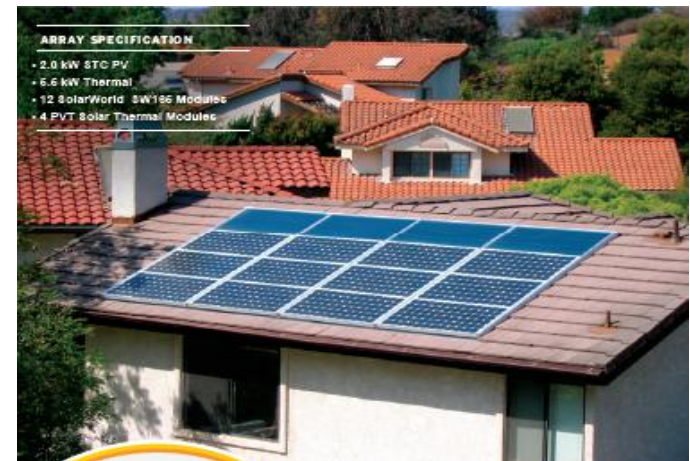


Maximum Energy Capture Combines PV, Hot Water and Hot Air



Regular PV installation

- Captures hot air
 - used for hot water
 - forced air heating
- 2 X to 3X total energy capture
- ~25% more cost than just PV
- PVTSolar.com

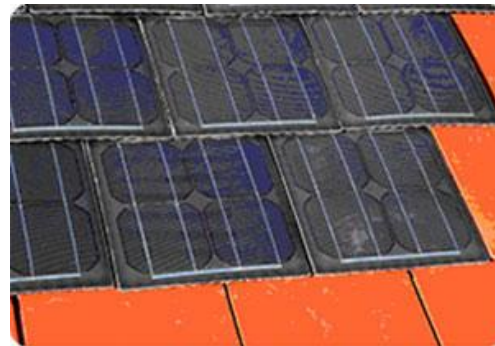


Solar Integrated Roof

(Known as Building Integrated PV, BIPV)



Dow
PowerHouse Solar Tile
– just announced



- **Improved aesthetics**
- **Cost can be similar to roof plus solar**
- **Can increase heat in attic**
- **Lack of experienced installers**
- **Tempting to put solar all over even in shade & reducing output**
- **Often use low efficiency cells**

Redwood Renewables
- High efficiency design
- local start up



Sole' Power Tile
- Solar integrated tile

Roof Space

1.2 kW *Crystalline Silicon*

90-150 sq ft per kW

Thin-film needs about twice as much space for the same-size system, but the total cost is about the same.

1.2 kW *Thin-Film*

170-300 sq ft per kW





Financial Examples

Solar System Financial Examples

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\$300	4	\$19,320	\$2510	51%	7.7	20%
	5	\$24,150	\$2840	64%	8.5	19%
	6	\$28,980	\$3120	76%	9.3	17%
	7	\$33,810	\$3370	89%	10	16%
	8	\$38,640	\$3550	100%	10.9	15%

Based on Clean Power Estimator; www.consumerenergycenter.org

* Note, this is for kW AC (many installers quote in kW DC which is higher)



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	8	\$38,640	\$3550	100%	10.9	15%

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Zero Out Electric Bill

Based on Clean Power Estimator; www.consumerenergycenter.org

* Note, this is for kW AC (many installers quote in kW DC which is higher)



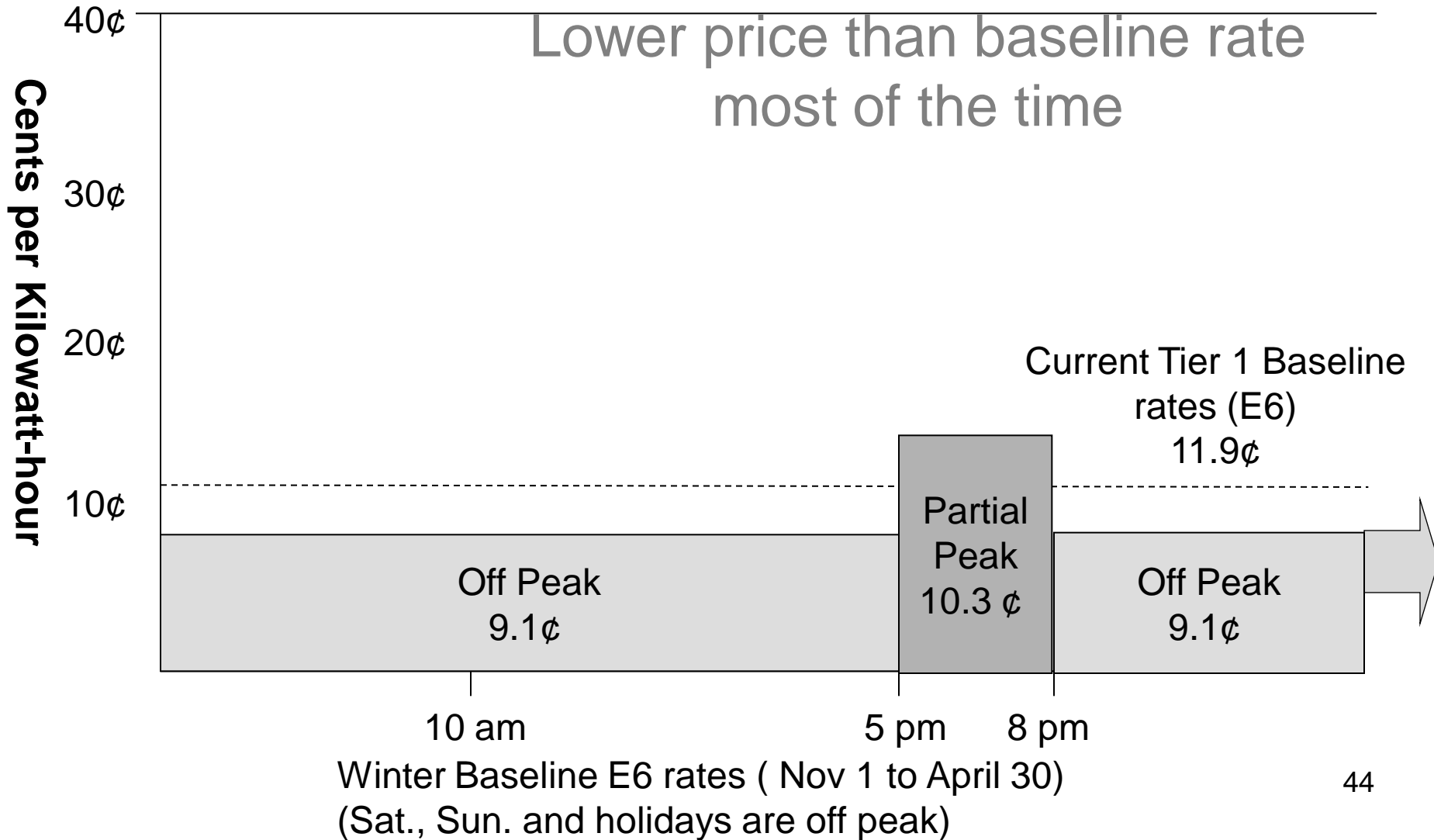
Reduction in Energy Output Has Modest Impact on Overall Payback

% Reduction in Energy Output	Payback	ROI (over 30 years)
0%	8.5 yr	19%
10%	9.0 yr	18%
20%	9.6 yr	17%
30%	10 yr	16%

Assumes \$300/mo bill; 5kW AC system



Time of Use Pricing Can Be Great In The Winter Too





Solar– what size will fit my roof ~ using www.roofray.com ~

- Type street address, city and state into roofray.com
- Choose the roof facing S, SW, SE or West in that order with unobstructed exposure
- Follow instructions to locate solar panel area on roof image provided by googlemaps
- Drag red line to show direction of roof
- Estimate slope of roof – typical roof is 24 degrees
(flat is 0: 60 would be a very steep roof)
- Roofray provides
 - Array size, peak output and system performance
 - Financial payback based on utility rate and the monthly bill
(can compare PG&E E1 rate or with older E7 Time Of Use rate)