Incorporating Solar into New Construction

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

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Energy Design Conference 2017
Incorporating Solar into New Construction

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Goals

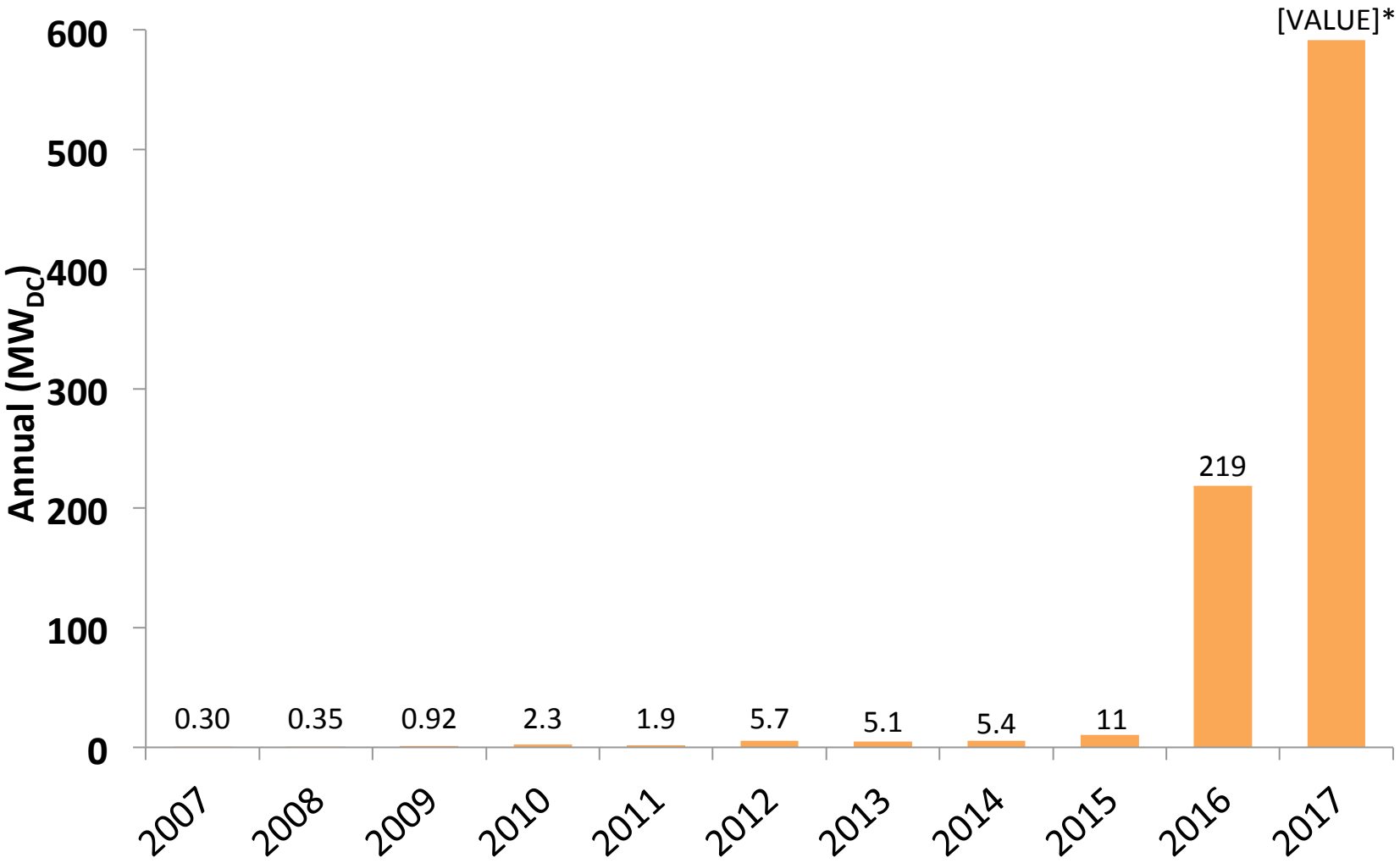
At the end of this session you will feel confident about adding solar PV to your business model.

Solar in New Construction

- Market trends
- Brief overview of technologies
- Solar ready construction
- Added value
- Selling it to your client

Minnesota's Annual Solar Installations

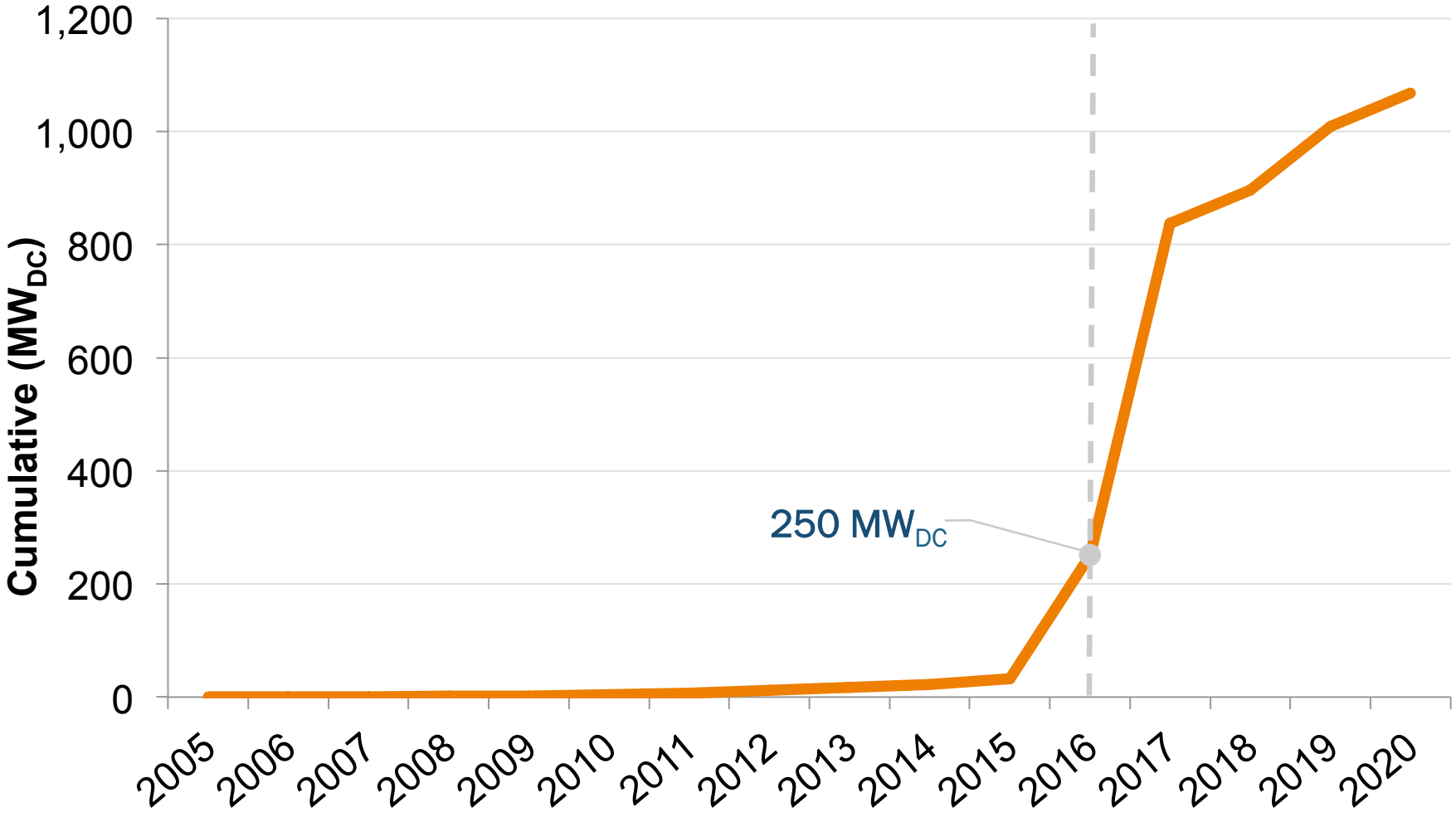
*Projected, as of January 2017



Source: MN Department of Commerce

Minnesota's Solar Capacity - Projected

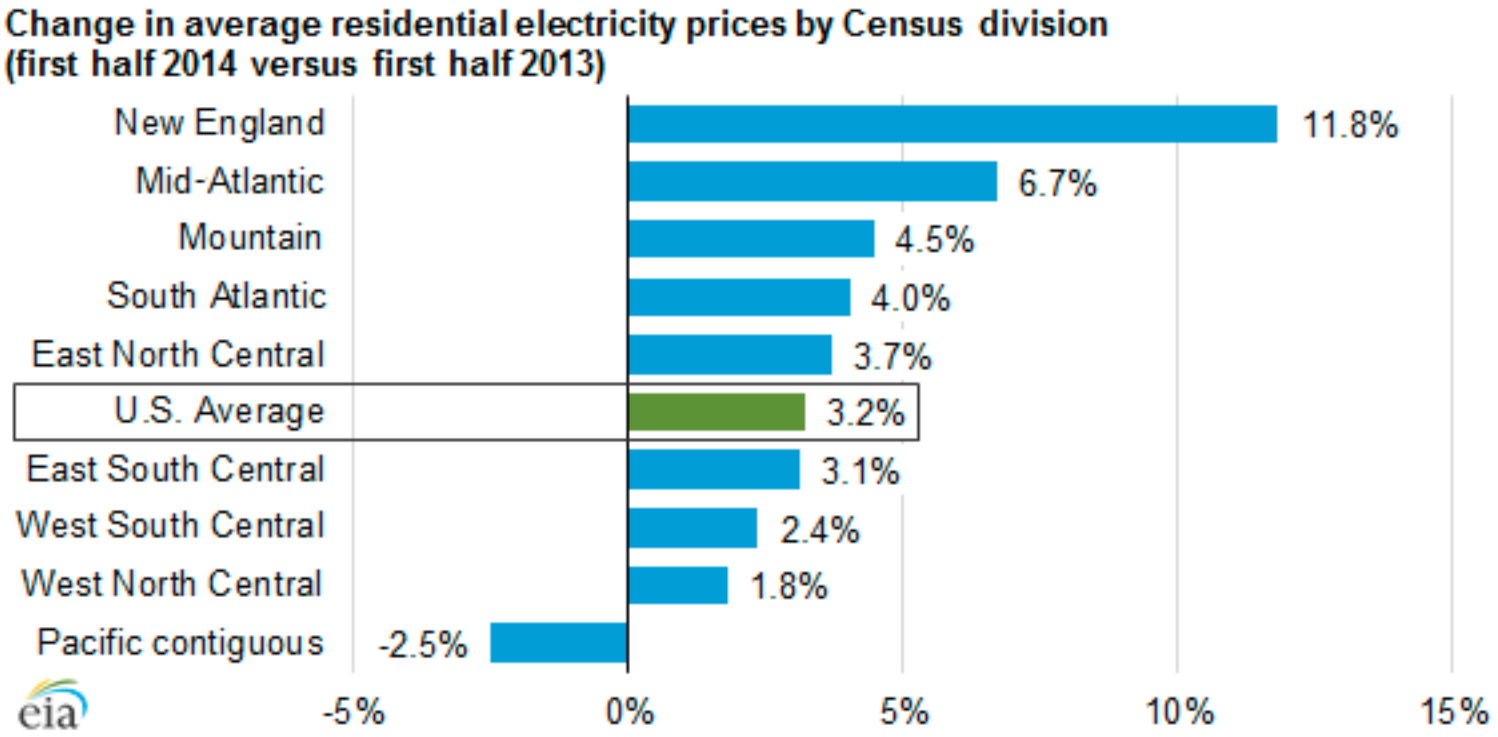
as of January 2017



Minnesota Department of Commerce

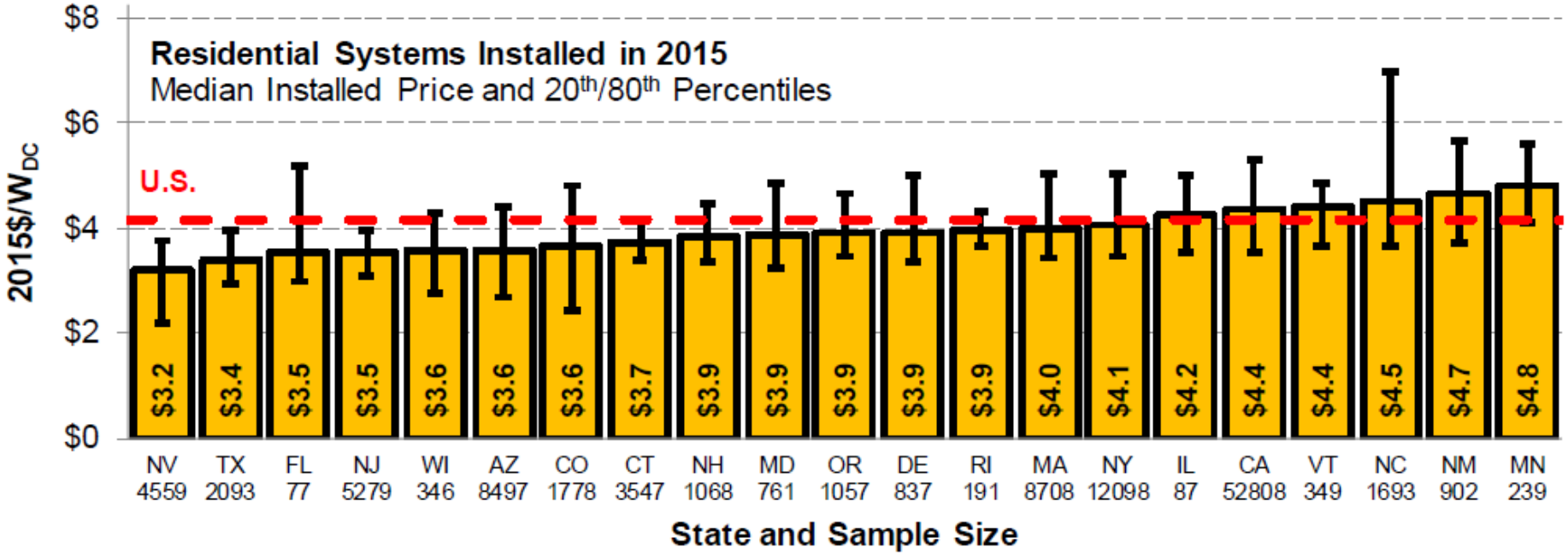
Source: MN Dept of Commerce

Residential Electricity Prices are Rising



- 3.7% residential electricity price increase for the East North Central region, which is made up of Illinois, Indiana, Michigan, Ohio, and **Wisconsin**.
- Response by utilities to decreased or sluggish electricity sales (?). Also, new rate structures are being proposed (increases in customer charges, decreases in energy charges).

Source: U.S. Energy Information Administration. Today in Energy "Residential Electricity Prices are Rising". September 2, 2014.
http://www.eia.gov/todayinenergy/detail.cfm?id=17791.



Average install cost in MN was $4.80 kW in 2015, while in WI it was $3.60.

Why such a difference from state to state?

Source: Barbose, et. al. “Tracking the Sun VI: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2012”. Lawrence Berkeley National Laboratory. LBNL-6350e. July 2013. p.25.
http://emp.lbl.gov/sites/all/files/lbnl-6350e.pdf

Solar Technologies

Two primary methods to harness energy from the sun for building use:

- Passive Solar
- Active Solar
  - Thermal Systems
  - Photovoltaic (PV) Systems

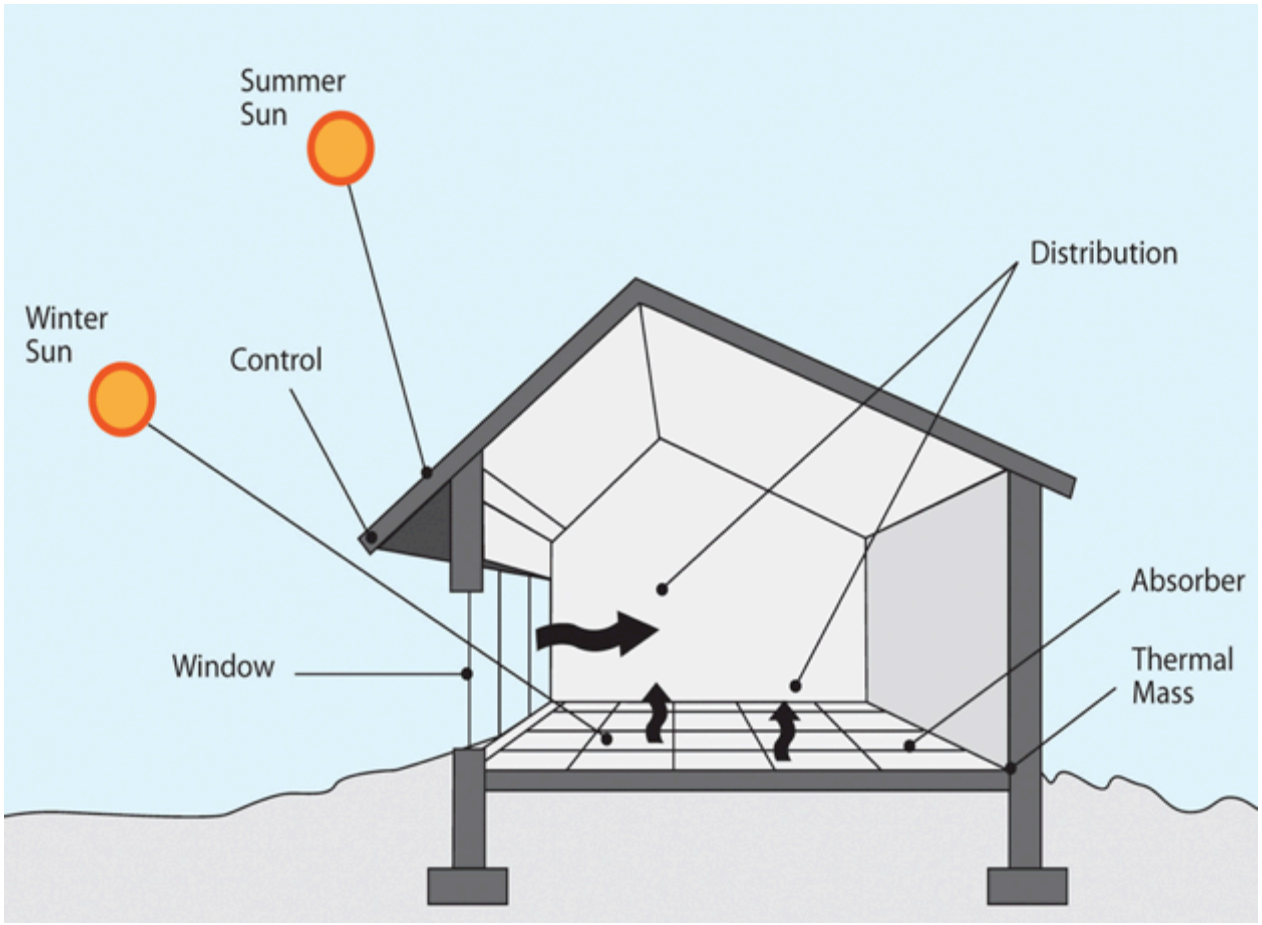
Passive Solar Design

Passive solar is incorporated into a buildings design to collect, store, and distribute solar energy as heat throughout a building.

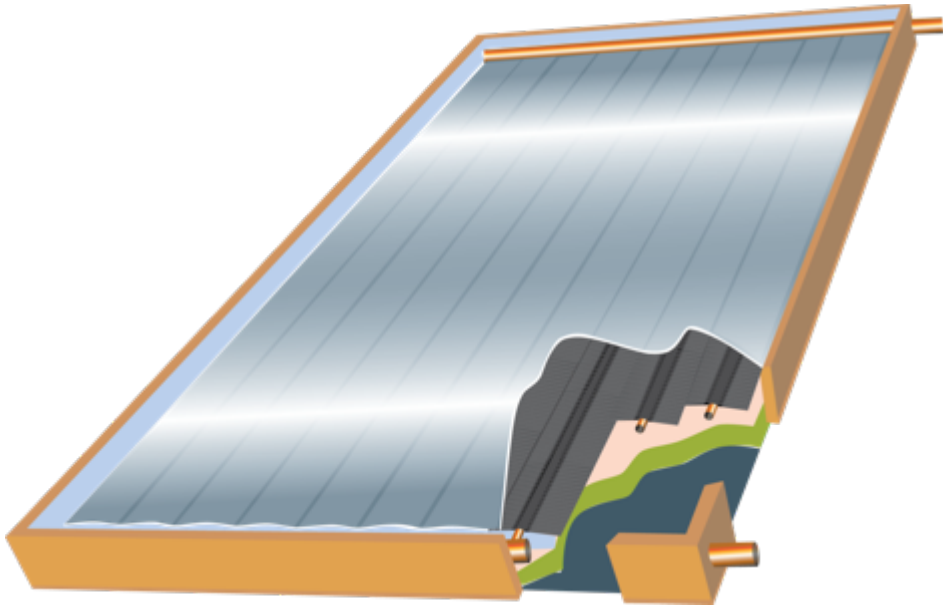
Passive Solar Design

Aperture - Control - Distribution

Absorber - Thermal Mass



Solar Thermal Systems



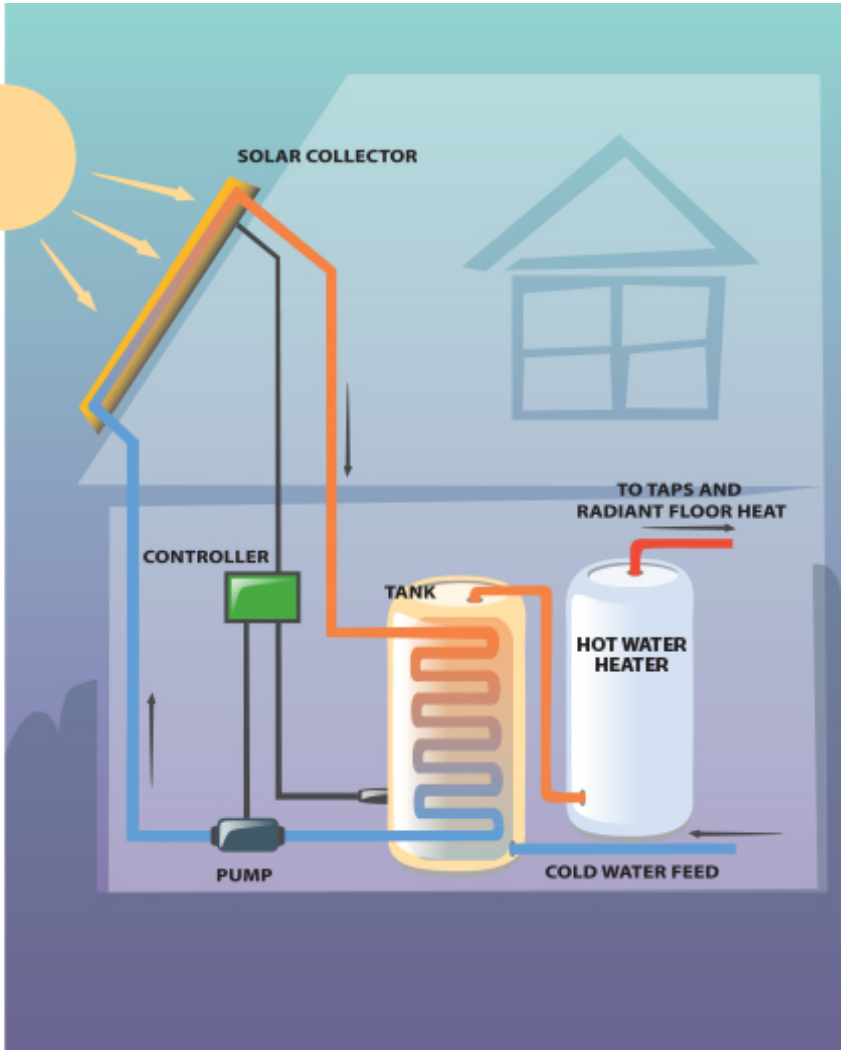
Solar Thermal harnesses solar energy to heat water or air used in a building.

Typical uses are for domestic hot water and space heating.

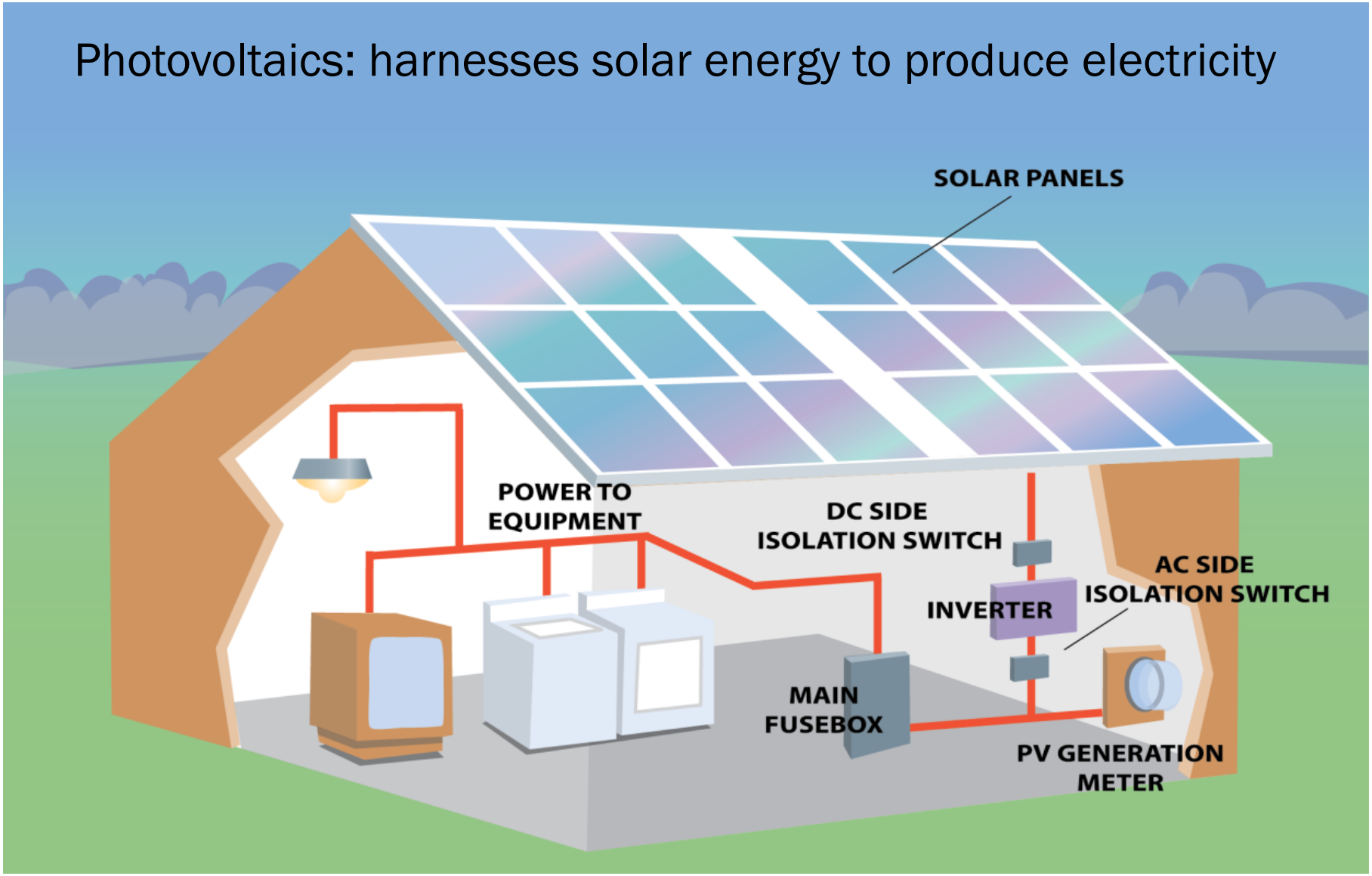
Thermal Systems

Hot Air or Hot Water Systems:

- Collector
- Storage
- Distribution



Photovoltaics: harnesses solar energy to produce electricity



Solar PV

There are four main types of solar PV systems

- Direct
- Off Grid
- Grid tied
- Grid tied w/ battery back up

Primary System Components

- PV Modules – produce electricity
  - Typically 60 or 72 cells, mono or poly crystalline.
- Inverter – converts DC to AC
  - Micro inverter
  - String or Central inverters
- Racking – secures panel to ground, roof or pole.

Balance of System Components (BOS)

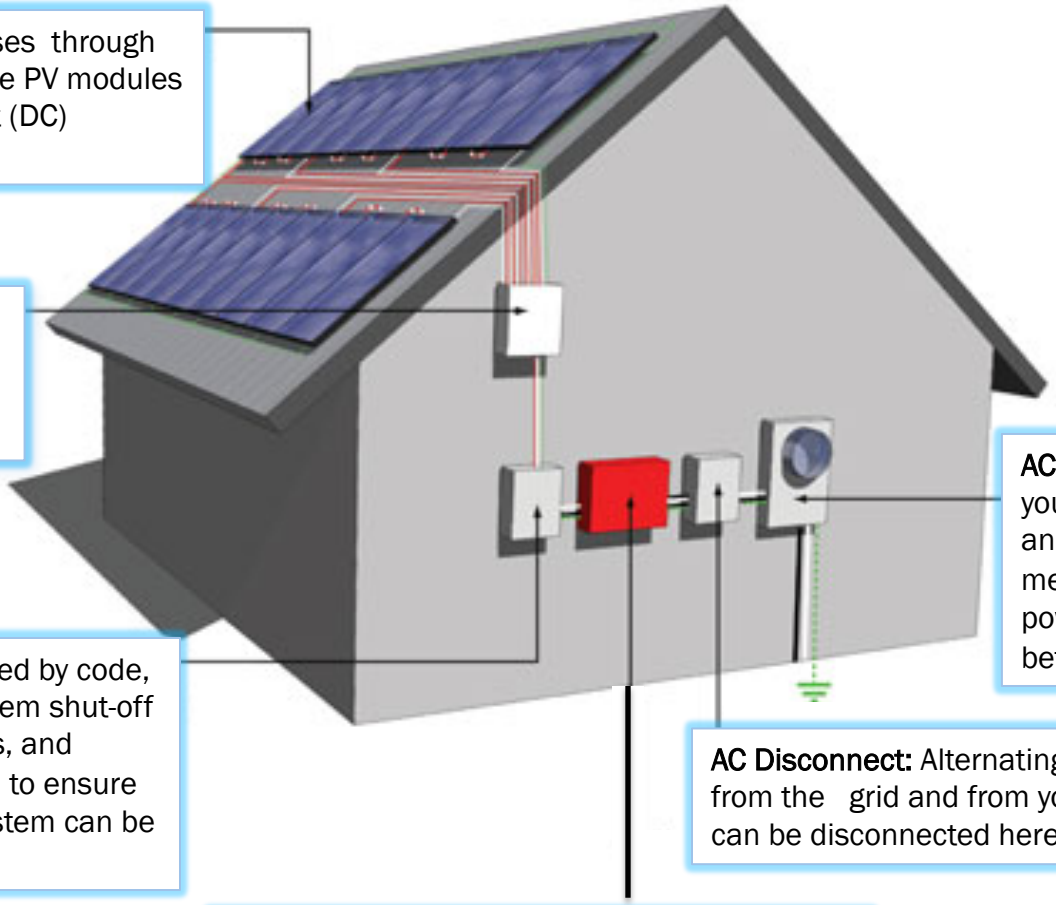
In addition to the panels, racking, and inverters a typical PV system will have:

- Grounding wires, clips, and lugs
- Combiner/junction box
- DC & AC Disconnects
- Breakers & switches
- Lighting arrestor
- Monitoring equipment
- Signage (Warning Signs)
- Metering (production meter)
- Optional Battery bank
- Optional Charge controller
- Optional Battery Monitoring

Typical Grid Tied Solar Electric System

PV Array: Sunlight passes through the silicon wafers of the PV modules creating Direct Current (DC) electricity.

Combiner Box: The PV modules are wired together in a combiner box to deliver the correct DC system voltage.



AC Main Panel & Meter: Tracks your grid energy consumption and your solar production. Net metering means you pay the power company the difference between the two.

DC Disconnect: Required by code, this box combines system shut-off switch, circuit breakers, and ground fault protection to ensure that all parts of the system can be disconnected.

AC Disconnect: Alternating Current (AC) from the grid and from your inverter can be disconnected here.

Inverter: Direct Current (DC) from you array is converted to Alternating Current (AC) to power your home or business or to sell energy back to the grid.

Transitioning to Solar

- Traditional home design
- Solar retrofits
- Concept of solar ready
  - Infrastructure
  - multi-generational investments
  - provide flexibility

- The added expense of adding solar is minimal if done during construction.

- Whereas, it can be cost prohibitive to do it on the back end.

Step one: Building Solar Ready?

The National Renewable Energy Lab (NREL) defines a solar ready building as being designed and built:

"to enable installation of solar photovoltaic and/or heating systems at some time after the building is constructed."

Three main components

1. Place to put the modules
   - Roof, ground, or pole
2. A means to get the power where you need it
   - Chase
   - Trench
3. Equipment Space
   - Utility Room
   - Garage

A designated space for collectors

- Unrestricted solar access
  - South Facing
  - Shade free
- Free of obstructions
  - Roof vents
  - Plumbing stacks
- Structurally sound
  - Weight
  - Wind loads

What does a good Solar Ready roof look like?

Getting the power to where you need it

Space within the building for equipment

Does Solar really add value?

- Lawrence Berkeley National Laboratory Study
- Over 11 years in 8 states
- The key finding: On average, homebuyers are "consistently willing to pay PV home premiums" of approximately $4 per watt of installed solar capacity.

Added Value

- Minimize install costs vs. a retro-fit
- Simpler installation process
- Built in financing, roll the cost into the mortgage

Added Value

- Solar equals faster appreciation.
- Perceived be of a higher quality.
- Higher resale value

Solar does add value to the home, but how can it add value for the builder?

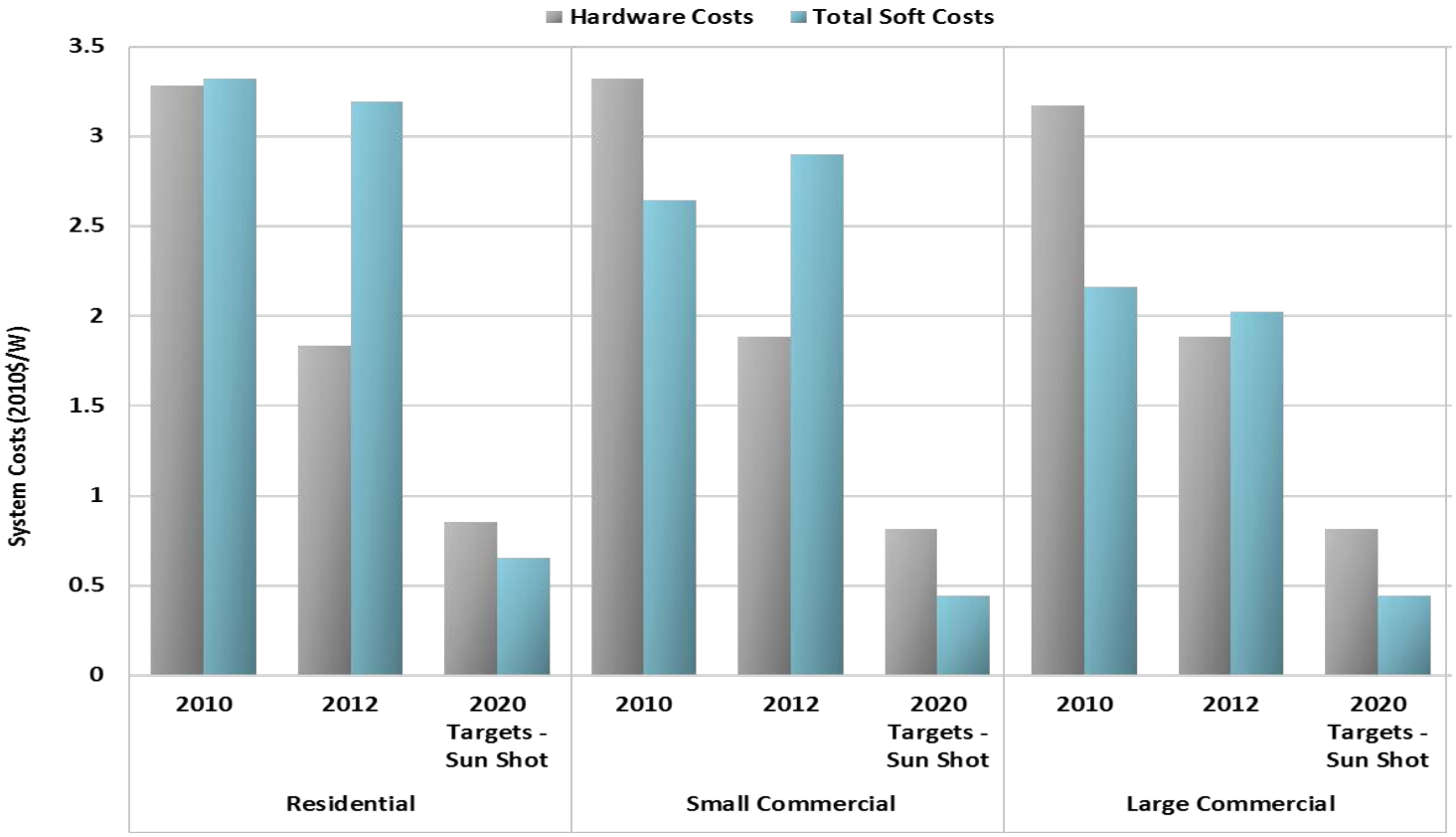
60% Savings

Table 3: Cost to Make a Building Solar Ready[5]

	During Construction			After Construction		
Measures	**Equipment**	**Labor**	**Total**	**Equipment**	**Labor**	**Total**
Increase size of electrical panel	$459	$480	$ 939	$459	$1,200	$1,659
Run conduit	$374	$416	$ 790	$374	$1,040	$1,414
Relocate vents	n/a	n/a	n/a	-	$ 300	$ 300
Install panels on multiple pitches	n/a	n/a	n/a	-	$1,000	$1,000
Total	**$833**	**$896**	**$1,729**	**$833**	**$3,540**	**$4,373**

[5] Waier, P.R., ed. Green Building Cost Data. RSMeans. 1st Annual Edition, Norwell, MA: RSMeans. 2010

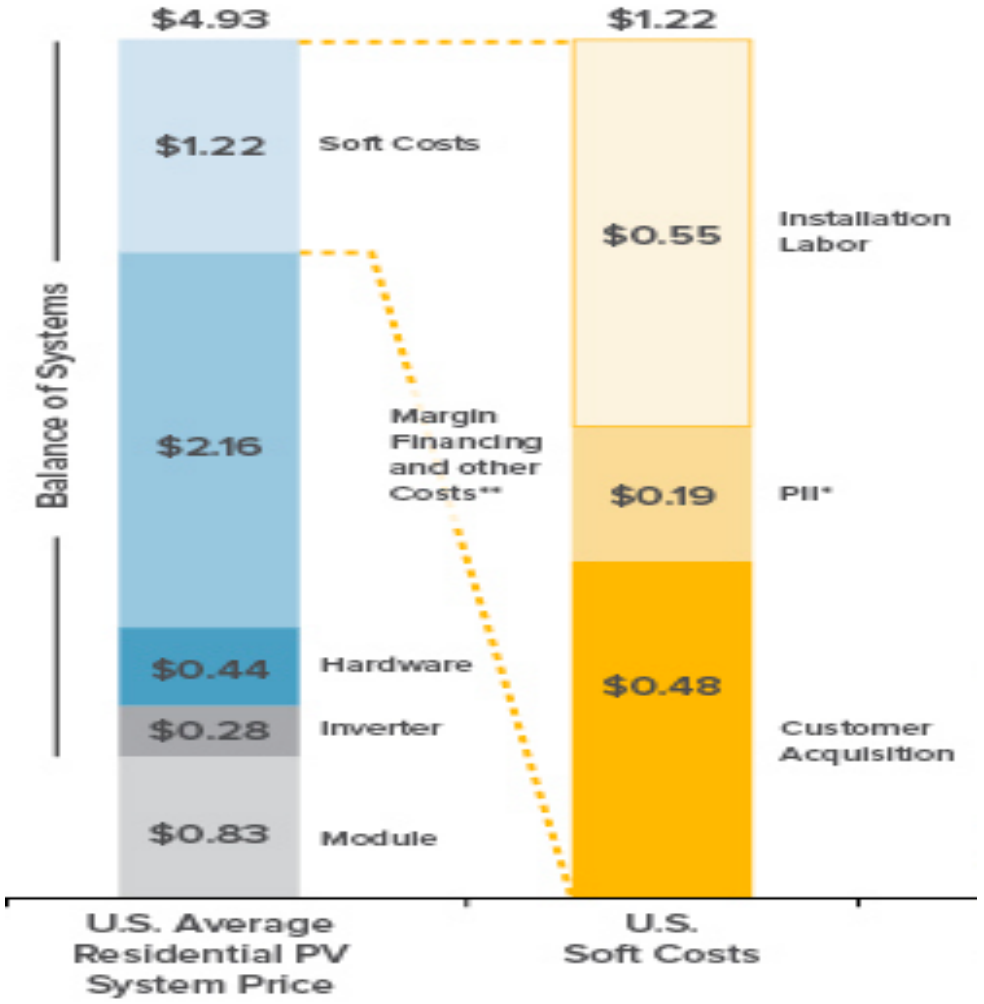
Hardware Costs Have Declined More Quickly Than Soft Costs From 2010 to 2012



- "DOE SunShot Initiative seeks to reduce PV system prices 75% over the 2010 – 2020 period."[a]

Source: Friedman, et. al. NREL. Oct. 2013. Technical Report NREL/TP-6A20-60412. p. 31. [a]Feldman, et. al. Photovoltaic System Pricing Trends: Historical, Recent, and Near-Term Projections *2013 Edition*. July 16, 2013. p. 3. http://www.nrel.gov/docs/fy13osti/60207.pdf

U.S. Average Residential PV System Costs by Components 2012 - 2013



Source: Rocky Mountain Institute. "Reducing Solar PV Soft Costs: A Focus on Installation Labor". December 2013. p.9.
http://www.rmi.org/search-category/Energy+and+Resources/Energy+and+Resources/sharepoint

Selling it to your clients

- Passive solar design
- Energy Efficiency
- Delivered fuels
- Covenants
- Codes and Ordinances

Marketing Solar

- Understand the technology
  - Study up
  - Have lunch with an installer

- Incorporate solar into presentations
  - Include on elevations
  - Include in marketing material
  - Model Homes

Know the numbers

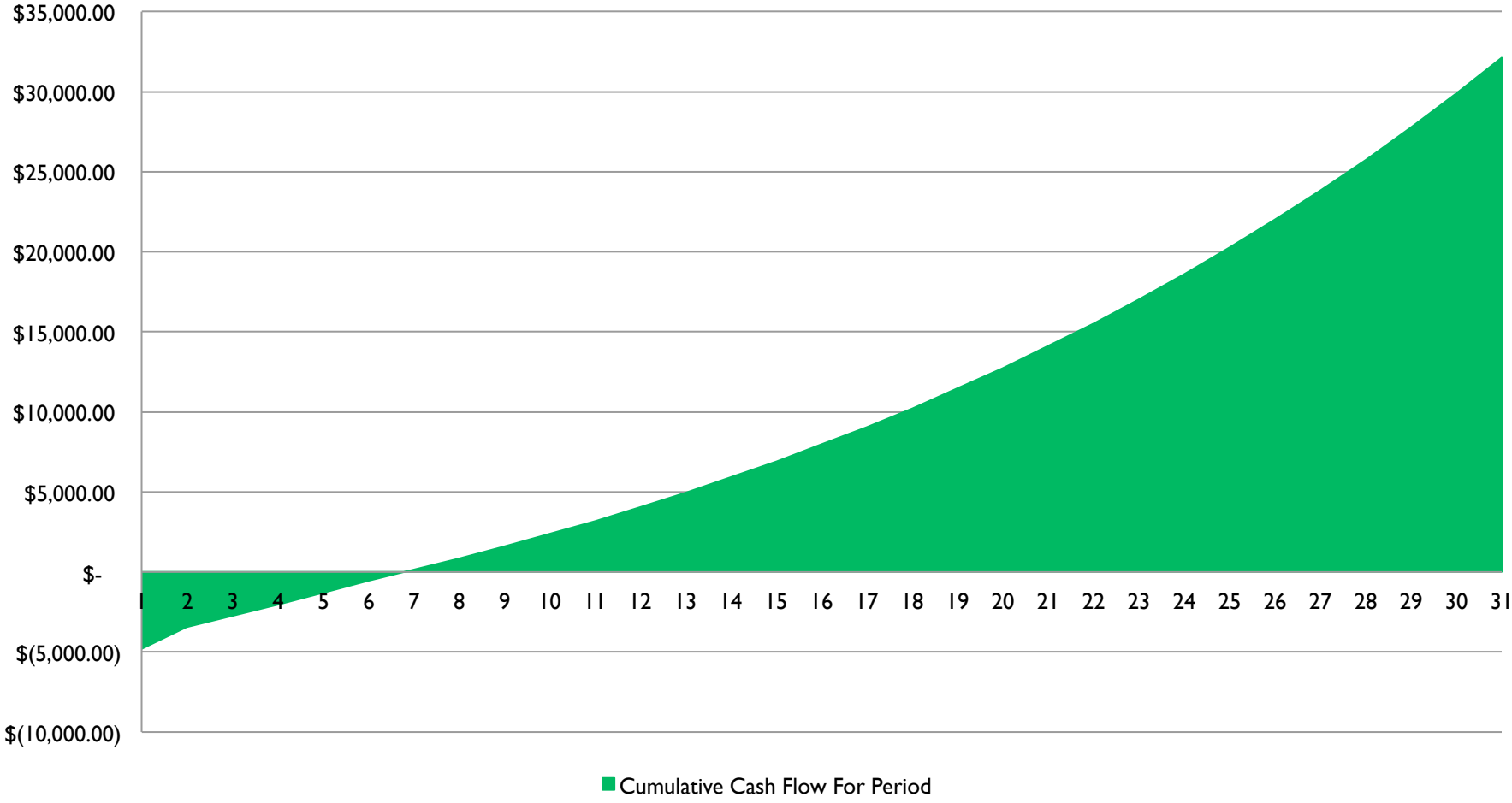
- What is the lifetime cost of solar energy vs. the upfront cost. In $'s per Watt.
  - A 4kW system after Tax Credit and Solar rewards incentive from Xcel cost about $7700.
  - At Effective rate of $0.124 per kWh from Xcel a 25 yr. IRR is 10.2%.
  - Simple payback occurs in year 9.
  - Year 25 a profit of $17,133, in year 35, $33,482 in profit in todays dollars. (calculating a 3% inflation rate).

4 kW Rooftop PV

Discount Rate Assumed	3.0%	Net Present Value	$27,617	IRR	18.8%

Demand Charges		Array Production & Usage		Net Installed Costs	
Demand Usage in kW (12 mo average)	0.0	Array Rated Capacity AC in kW	3.0 kW	System Size DC (Watts)	3920
Demand Charge per kW (12 mo average)	0	Yearly Array Power Production (kWh)	4960	Installed Costs Per Watt	$ 3.25
Demand Charges per month	$0	Monthly Array Power Production (kWh)	413	Gross Installed Costs	$12,740
Highest Demand Time		Monthly Value of Array Production	$46	Total Rebates Applied	$5,880.00
Est. Avg Array Production at Peak Demand?	0%	Monthly kWh Usage (average)	1274	Federal ITC Value	$2,058
Est Monthly Demand Reduction (%)	0.00%	Usage Electric Rate ($ per kWh)	0.1113	Net Installed Costs (Year 1)	$4,802
Est. Monthly Demand Reduction Value	$0.00	Electricity Inflation Rate	5%	Net Installed Per Watt	$1.23
O+M Cost / kW/year	$10	O+M Costs per Year $	$39.20		
Amount of Monthly Load met by Solar Array (monthly production divided by averaged monthly usage)			32.5%		

Cumulative Cash Flow For Period



By the numbers

- Warranty info
  - solar panels typically have 25 year warranties
  - micro-inverters - 25 yrs.
  - string inverters - 10 to 15 yrs.
- 1 kW of solar in Minnesota
  - 1405 kWh of electricity per year
  - 145 kWh in July and 73 kWh in November

Know the incentives

- ITC
- Made in Minnesota
- Solar Rewards – Xcel Energy
- Solar Sense – Minnesota Power
- No Sales Tax in MN
- Property Tax Exempt

Investment Tax Credit (ITC)

- Reduces cost of a PV system by 30%
- Tax credit is taken during the year the PV system was installed
- Federal tax Form 5695 (2016).

30% for systems placed in service by 12/31/2019

26% for systems placed in service after 12/31/2019 and before 01/01/2020

22% for systems placed in service after 12/31/2020 and before 01/01/2022

DSIRE www.dsireusa.org. Internal Revenue Service. www.irs.gov/

Made in Minnesota (MiM)

- Production based incentive
- Random selection process
- Modules selected must be certified as Made in Minnesota
- Located in one of the three IOU territories
  - Xcel
  - Minnesota Power
  - Otter Tail Power

MiM Residential Incentives

- Heliene $0.16/kWh
- Itek $0.18/kWh
- Silicon Energy $0.14/kWh

  – The incentive is paid on production for a period of ten years

Utility Incentives

- MP SolarSense
  - Estimated system production based on PVWatts
  - $0.94/kWh
- Xcel Solar Rewards
  - Production based incentive over ten years
  - $0.08/kWh

Selecting good partners

- Partner with a good solar installer
  - NABCEP (North American Board of Certified Energy Practitioners)
  - Let them educate you and your staff
  - They should be willing to meet with your clients to discuss the specifics
  - Make sure the architect understands the system components and how to design for it
  - Coordinate with all your subs, make sure they are willing to work with the solar team

Change your paradigm

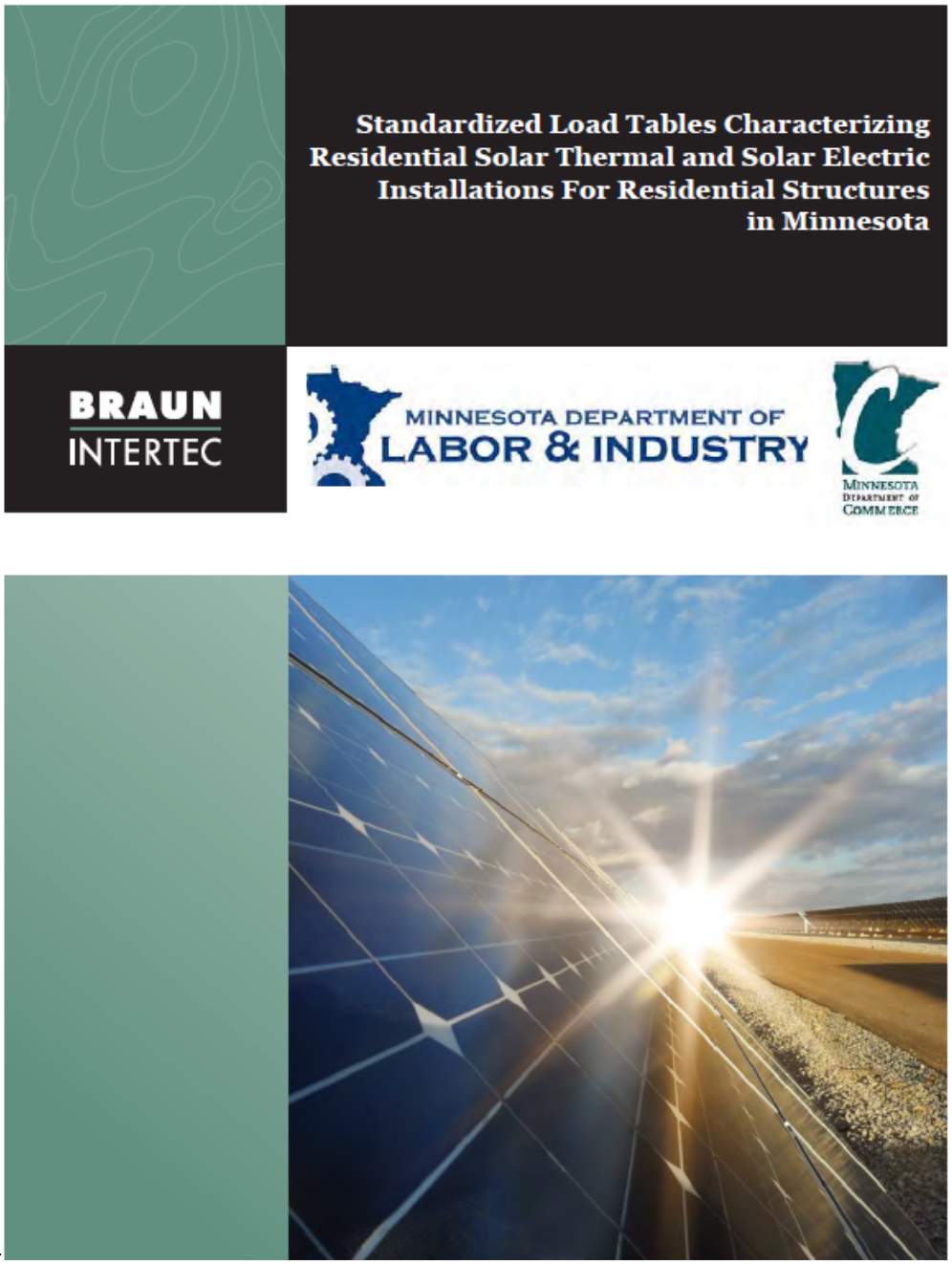
- Solar can be built and sold on new construction more competitively with higher margins than retrofit installations.
- Offered as a standard, not an add-on.
- Perceived benefits to your clients:
  - Altruistic
  - Financial
  - Hassel Free

For more information

- Midwest Renewable Energy Association: @www.midwestrenew.org/
- National Renewable Energy Laboratory: @www.nrel.gov
- Lawrence Berkeley National Laboratory:
- @www.lbl.gov
- Clean Energy Resource Teams: @cleanenergyresourceteams.org

This guide is available online at: [http:// mn.gov/commerce/energy/images/FINAL-Standardized-Load-Table-Report.pdf](http://)

Or just Google Standardized Load Tables.



Solar Ready Building Design Guidelines prepared for the Minneapolis Saint Paul Solar Cities Program by Lunning Wende Associates, Inc., coordinated by CR Planning, Inc. and funded by National Renewable Energy Laboratory (NREL).

Solar Ready Building Design Guidelines

Solar Ready Building Design Guidelines for the Twin Cities, Minnesota

Available at www.nrel.gov

Resources for Building Companies & Their Customers

- **Department of Commerce Solar Helpline**
  - (651) 539-1848
  - Solar.Help@state.mn.us

- **Solar America Communities**

National Renewable Energy Laboratory
  - (303) 275-3000
  - www.nrel.gov

- **CR Planning, Inc.**
  - (612) 558-4904
  - www.crplanning.com

Thank You

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Minnesota Department of Commerce

Division of Energy Resources

energy.mn.gov
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Site selection: Roof, Pole, or Ground Mount ?

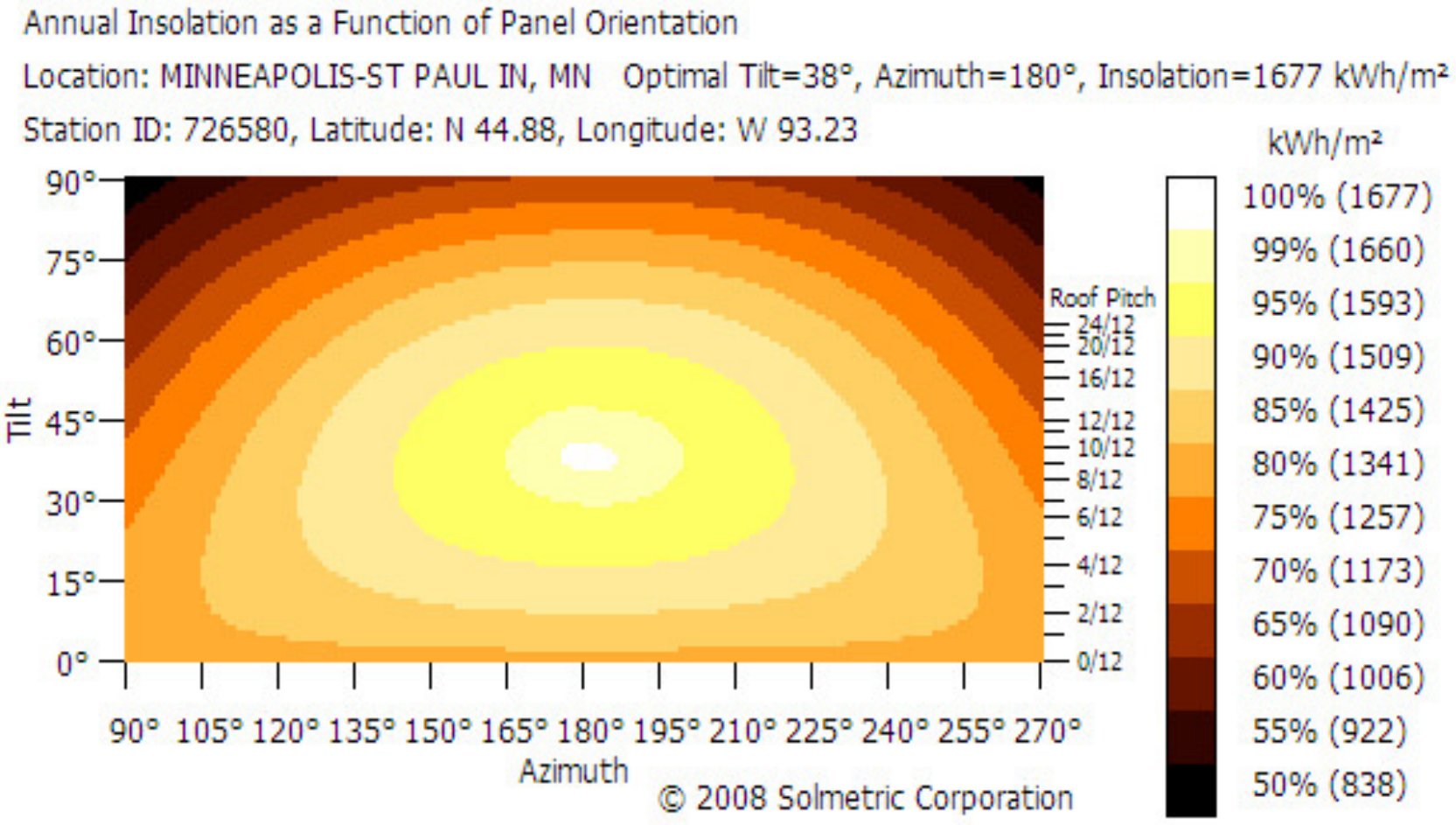
You want to put your system where it is the most aesthetically pleasing and the most productive.

Roof Vent Placement

Flat roof standoff

Thermal System

The Tilt Effect:



At Tilt: 37 º and Azimuth: 179 º, Annual Insolation: 1677 kWh/m^2 (TOF: 100.0%)

PV Equipment

PV on Exterior