



**ThirdSun**  
solar & wind power, ltd.



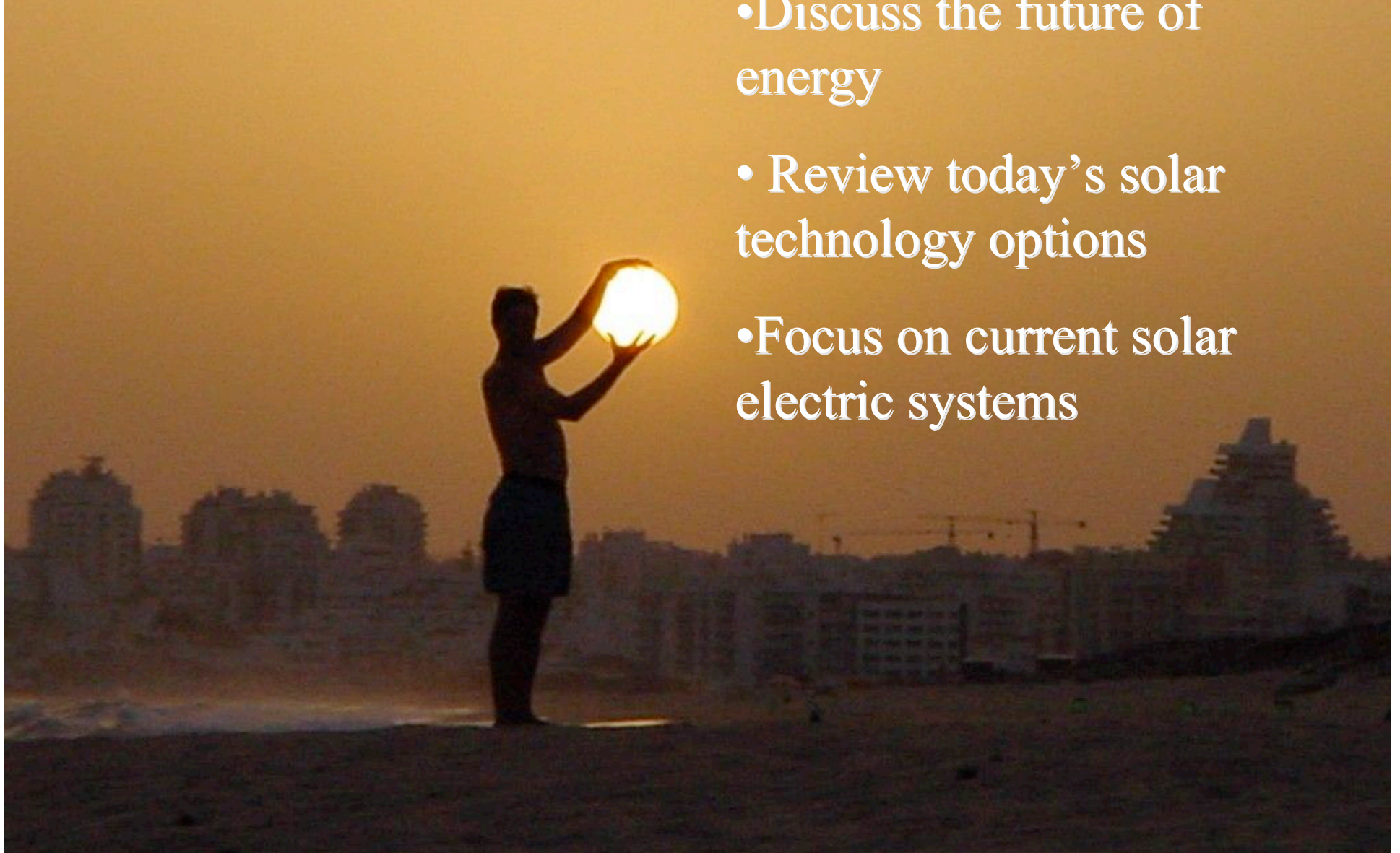
## **Solar Electricity Today**

Presented by John Fanselow

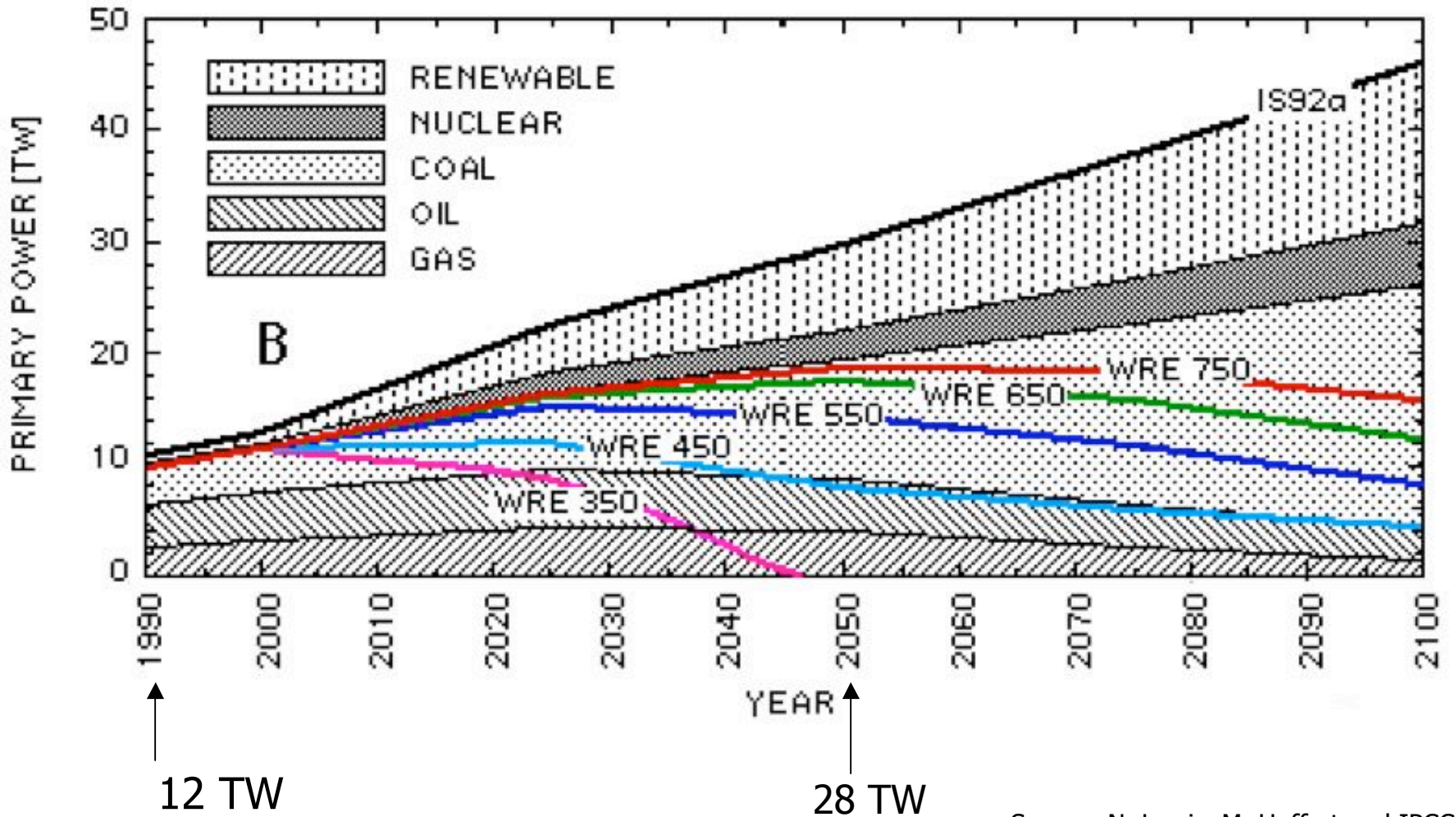


Today we will:

- Discuss the future of energy
- Review today's solar technology options
- Focus on current solar electric systems



# Total Primary Power vs Year



Source: N. Lewis, M. Hoffert and IPCC

# Solar Energy Potential

- Theoretical:  $1.2 \times 10^5$  TW solar energy potential  
( $1.76 \times 10^5$  TW striking Earth; 0.30 Global mean albedo)
  - Energy in 1 hr of sunlight = 14 TW x 8700 hours
- Practical: ~ 600 TW solar energy potential  
(50 TW - 1500 TW depending on land fraction etc.; WEA 2000)  
Onshore electricity generation potential of ~60 TW  
(10% conversion efficiency):
- 3 TW (total US power demand in 2000) requires 1.7% of US land area



# Solar Energy

## Passive Solar

Direct Heating from Sunlight

Cooling from shade & Natural ventilation

## Active Solar

Photovoltaic (PV): sunlight -> electricity

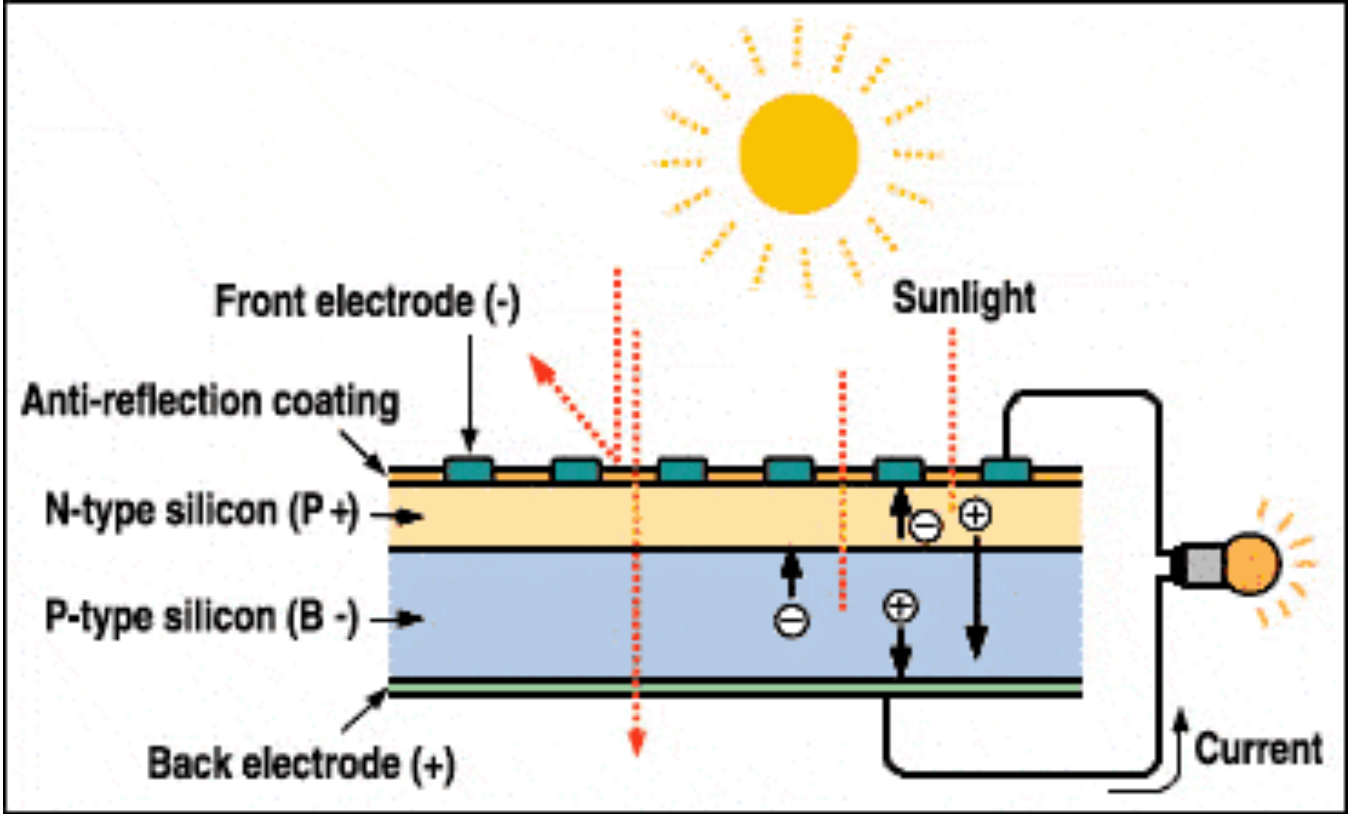
Solar Thermal: sunlight -> heat

New technologies:

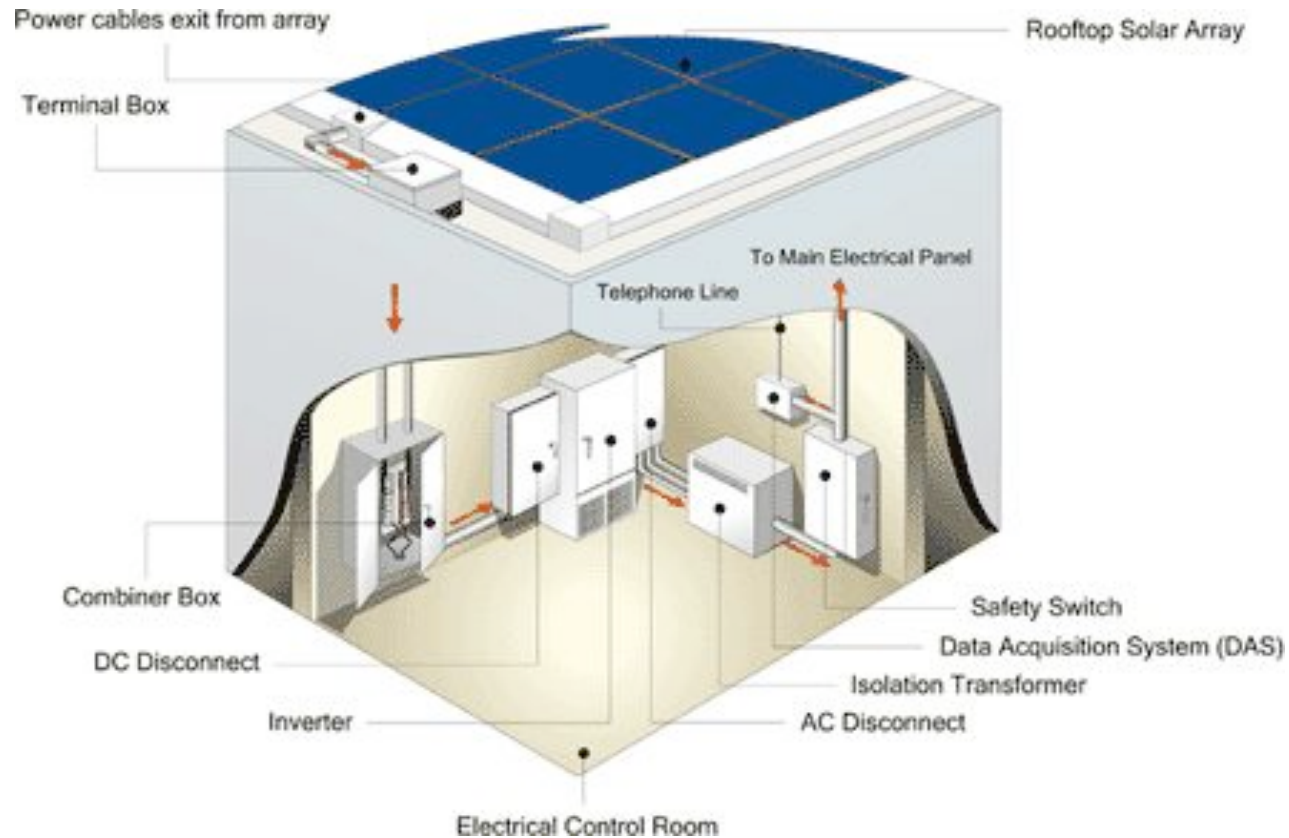
Sunlight -> liquid fuels, synthetic photosynthesis



# Solar Electric Basics



# Photovoltaic (PV) System Basics



# PV Energy Production

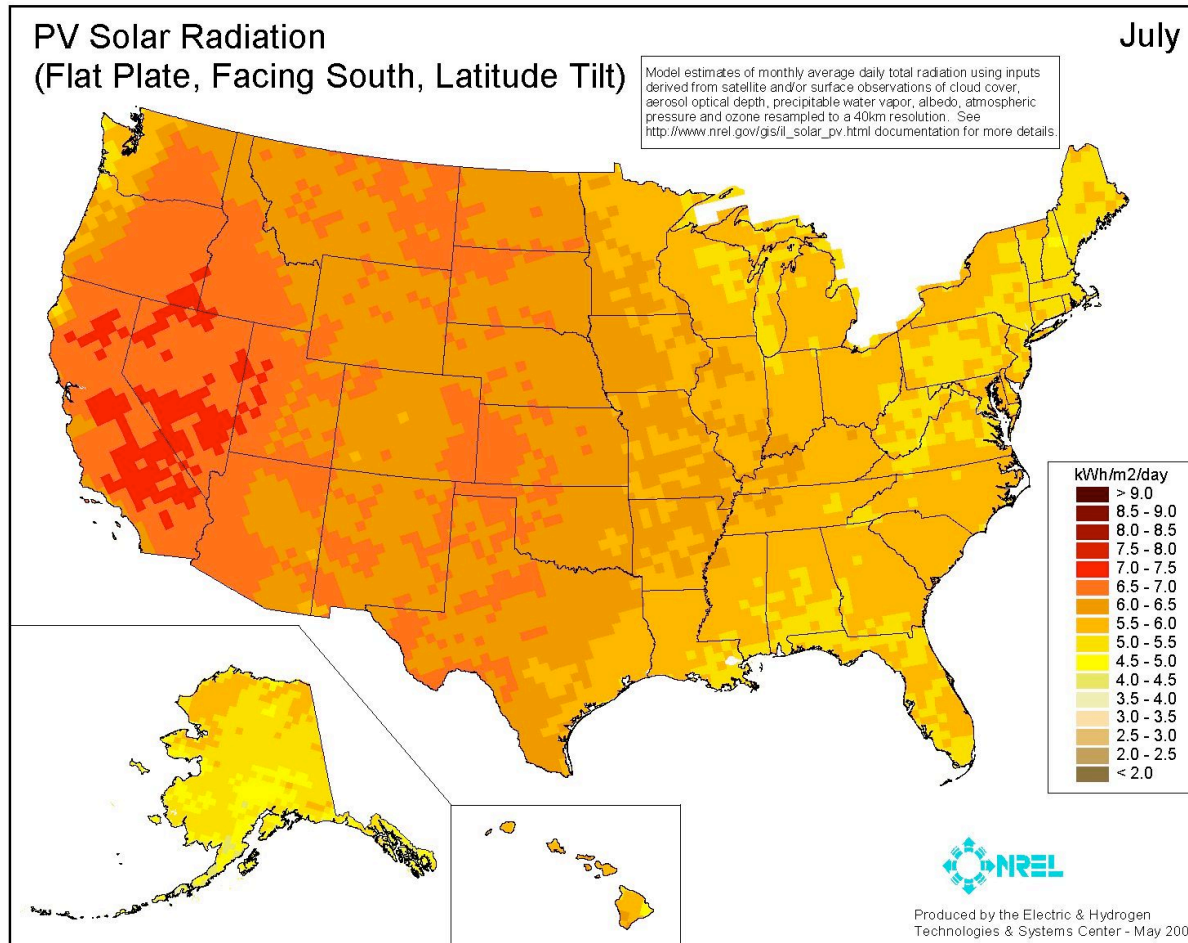
DC System size - based on nameplate ratings of modules under STC

Actual AC power output in peak sun ~ 75% of the DC STC rating

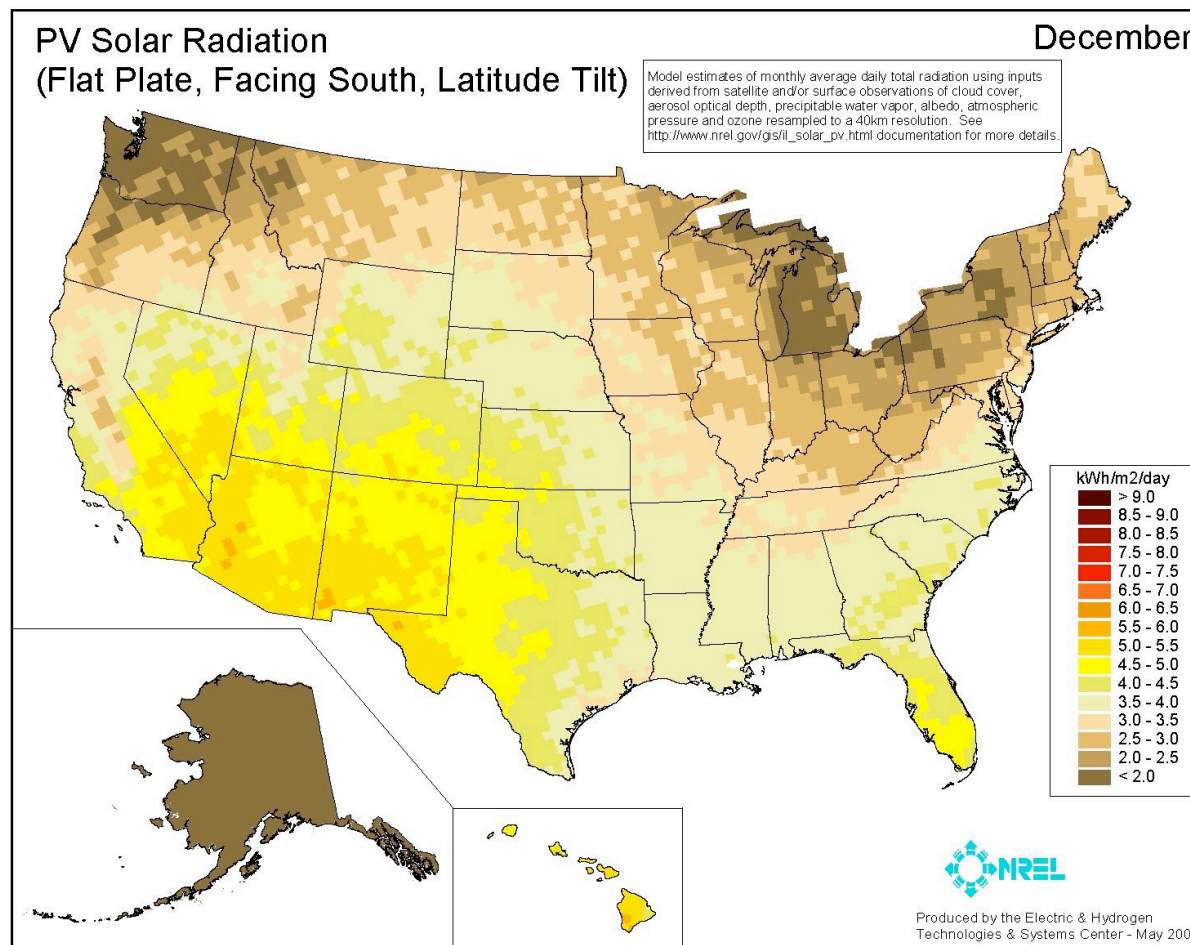
System Output Derating Factors:	Typical	Range
Manufacturer nameplate variance	.95	.8 - 1.05
Module current mismatch	.98	.97 - .995
DC wiring	.98	.97 - .99
AC wiring	.99	.97 - .99
Dirt and dust on module	.95	.3 - .995
Inverter efficiency	.92	.88 - .96
Diodes and connections	.995	.99 - .997
System Availability	.98	0 - .995
Ageing	1.0	.7 - 1.0
Module heating	.89	.83 - .92
Overall DC-AC derate factor	.69	



# Solar Energy - July Seasonal Performance



# Solar Energy - December Seasonal Performance



## Typical design steps:

- Clarify and understand client's motivation and goals. This often includes client education (as well as countering misinformation and out of date assumptions).
- There are typically three design drivers:
  - Available un-shaded roof space
  - Power production goals (kWh, LEED%, modeling)
  - Budget (after subsidies, may be driven by projected tax appetite) .
- Start with the roof and shrink (or expand onto the ground) if needed.



## Sizing rules of thumb:

- 1 kw DC of solar = 60-100 sq. ft.  
(panel efficiency and racking type)
- 1 kw DC of solar = (Gross) \$9,000-\$6,500  
or (net) \$2,500-\$1,000.
- 1 kw DC of solar = 1,200 kwh/year  
(1 x 75% x 4.4 hrs/day x 365)
- Model with PVwatts (shade, axis, pitch)



# The Solar Array



- Roof, ground, wall or integrated mounting.
- No shade allowed!
- Pointed South (mostly)
- Variety of colors, styles and shapes – can be invisible or a design element
- Typically requires 1 SF per 10 watts of panel.
- Weight ~ 4 lbs per SF.





Can be integrated into parking shades, entrance canopies, pergolas, awnings or other design elements.





- Flat roof applications
- Non-penetrating mounting systems
- Ballast and aerodynamic design
  - > 120 mph winds
- Easy install, easy removal
- Lowest cost per watt
- Protect underlying roof
- Add insulating value





## Flat Roof Installations:

Ballasted non penetrating mounting systems

Require:

Slope < 1/12

Functional air barrier

Adequate drainage

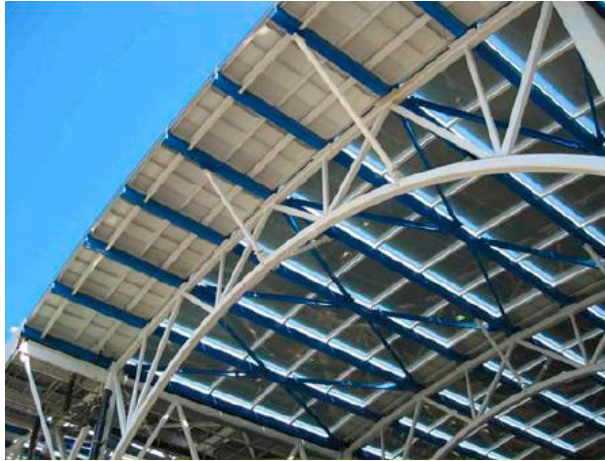


## PV can be an architectural feature



high visibility  
project has  
enhanced  
company  
image

# Building Integrated Photovoltaics (BIPV)

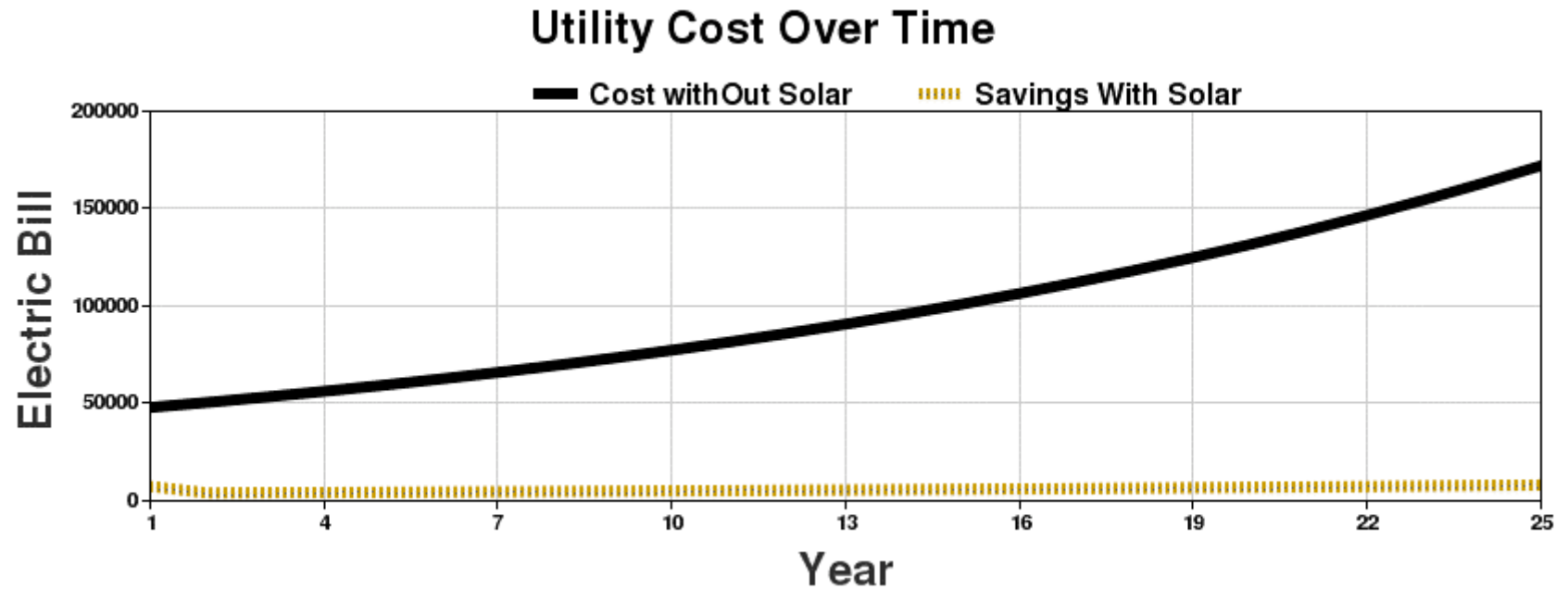


Architectural Element

Custom product  
-specify color,  
transparency, shape,  
etc..

Cost per watt:  
2 - 4 x standard PV

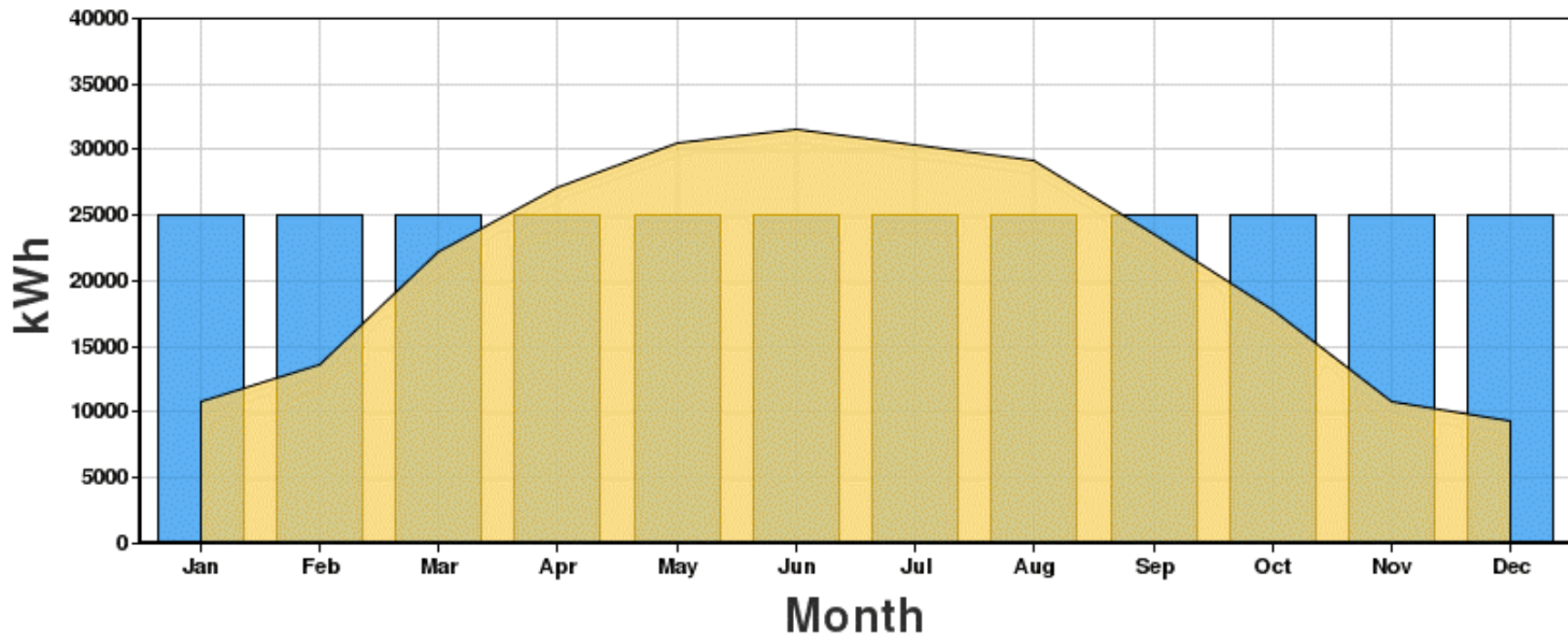
Lock in stable energy prices!



## Monthly Electricity Use and Amount Supplied by Solar

■ PV Supply   ■ Energy Use

**86% of Electric Usage Supplied by Solar**



## Federal Tax Credit

- 30% of actual project costs.
- Accelerated depreciation schedule (MACRS). Worth another 20-35% depending on tax situation? (non-res only)
- Can span 2 years (useful depending on tax “appetite”)
- You need to consult with your tax expert etc etc...
- Schools/non-profits etc use PPA model to access...



Flat roof = power plant



## State of OH grant program

- Must be served by an IOU Utility
- \$150,000 cap for non-residential (up to \$200,000 for PPA).
- Residential PV: on hold for new rules (Oct?) Was \$3.50/DC watt
- Commercial PV:
  - \$3.50/DC watt
  - 10 kW minimum size
  - 43 kW “sweet spot” (57kW for PPA)

*Must use NABCEP certified installer*



## SB 221 and Ohio's Advanced Energy Portfolio Standard

- Mandates Utility include 12.5% Renewable Energy by 2025
- Solar “carve out” of .5%
- Non-compliance payments and annual milestones will create a market for SRECs (Solar Renewable Energy Credits). This separates electrons and environmental attributes, allowing an income stream from both
- Rulemaking and pricing still ongoing – will have a tremendous effect on project finances.
- Major financial impact (NJ).
- Design carefully (environmental claims)

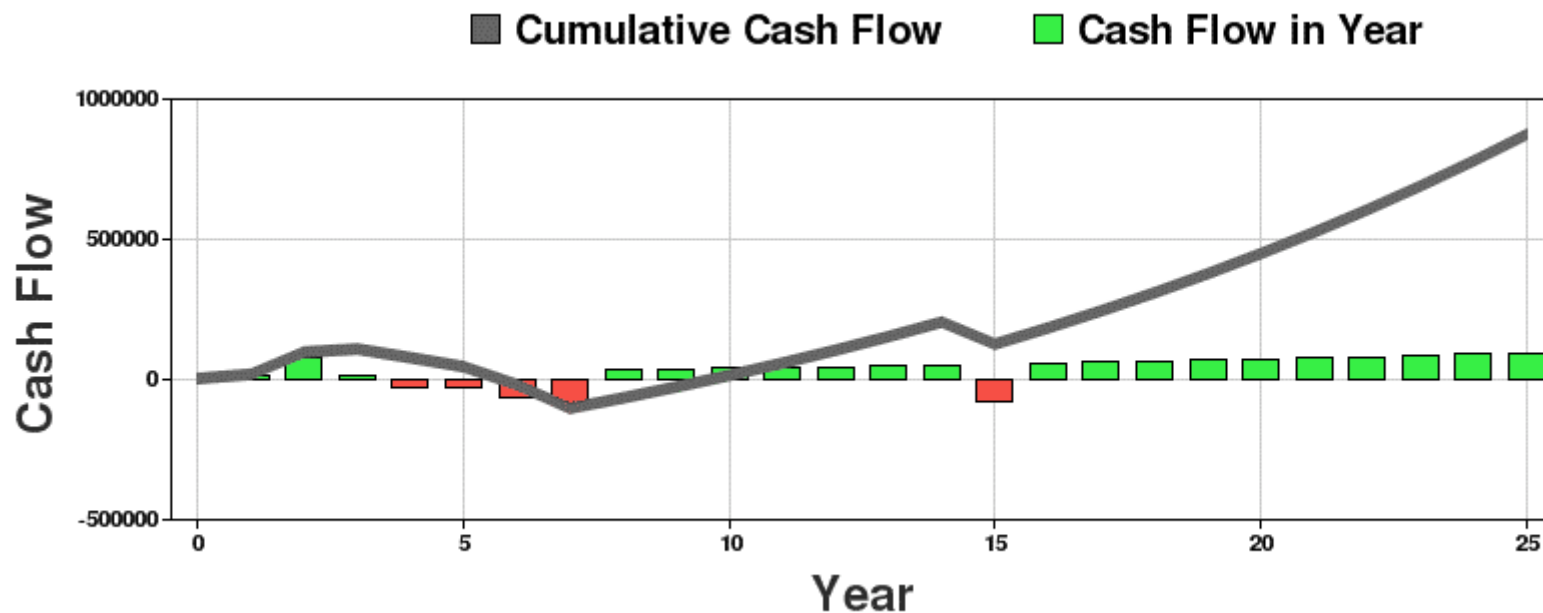


## PPA – Power Purchase Agreements

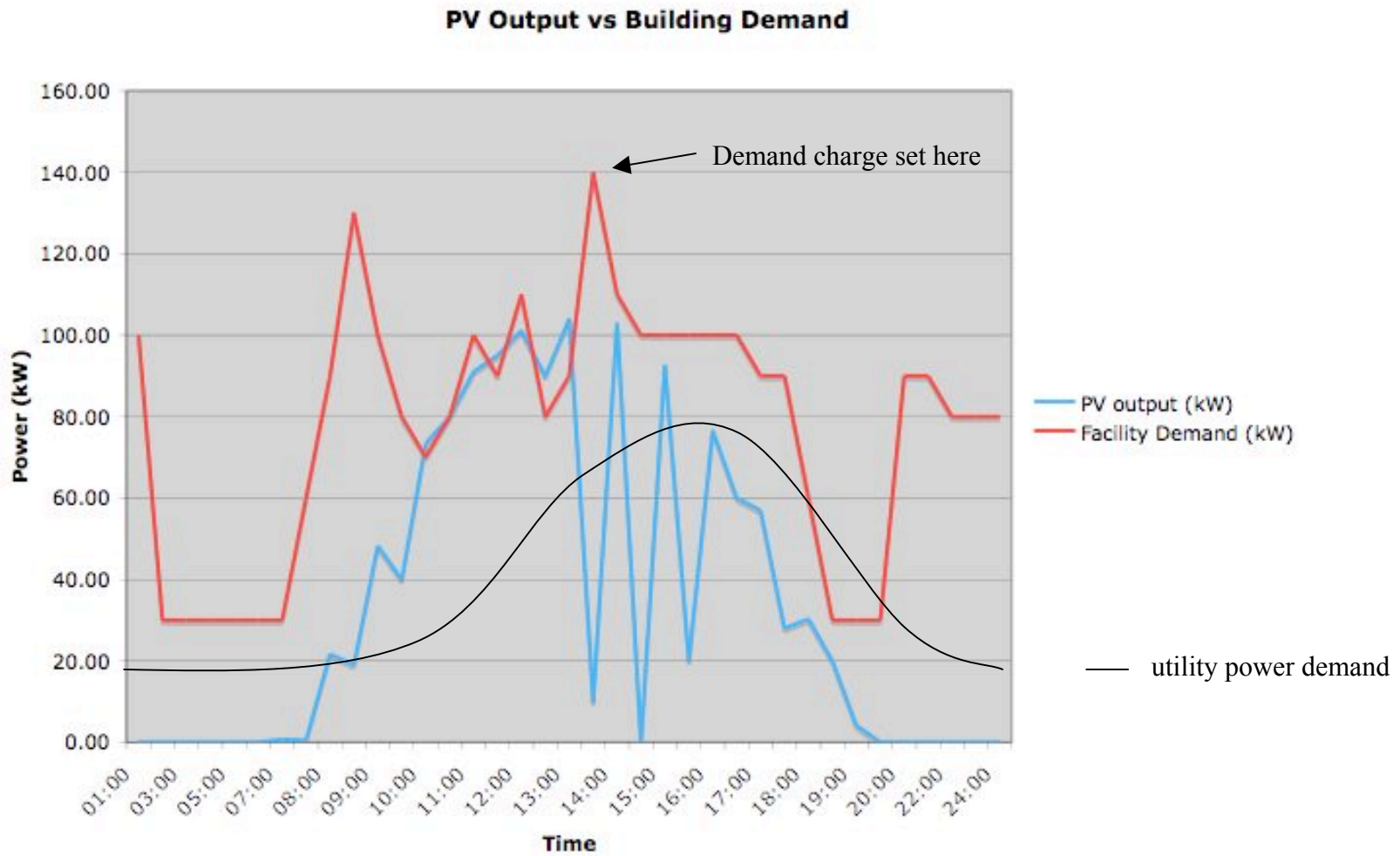
- A new model for solar deployment – “Solar as a service”. More than ½ of CA projects based on PPA approach.
- Project developed and owned by third party – energy metered and sold to building customer at agreed upon rate (typically at current market price plus 1-3% escalator).
- O+M risk borne by developer (along with grant, ITC, MACRS and SRECs)
- Very popular for public projects with no tax appetite
- High transaction (legal) costs limit model to large projects.
- None in OH (yet) due to “low” electric cost (This is changing).



Financial analysis is project and customer specific. Projects can be cash flow positive in year one, but typically have a 6-9 year payback (at conservative energy inflation assumptions and without SRECs).



# PV may not affect Demand Charges





*In our choices today lay our future*

*Thank you*

