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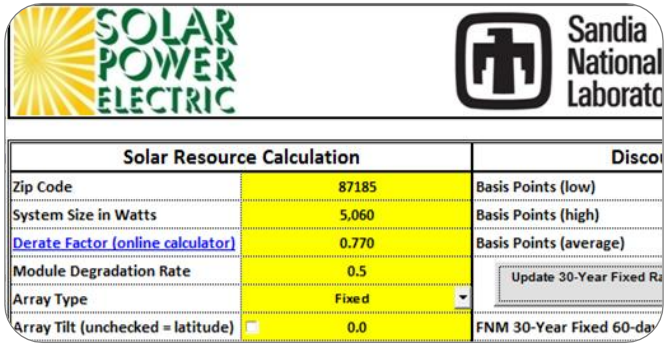

Photovoltaic System Valuation Model – PV Value™

Presentation to the Solar Instructor Training Network

Geoff T. Klise & Jamie L. Johnson

April 18, 2012

SAND 2012-XXXXX

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Today's Presentation

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- Background
- Importance of Valuing Energy Production
- Approach
  - Appraisal Methodology
  - Link to Appraisal Institute Green Addendum
  - Current Limitations
- Model Demonstration
- Installers/Integrator Discussion
- Potential Market Value and Installed Cost - 2010
- Questions

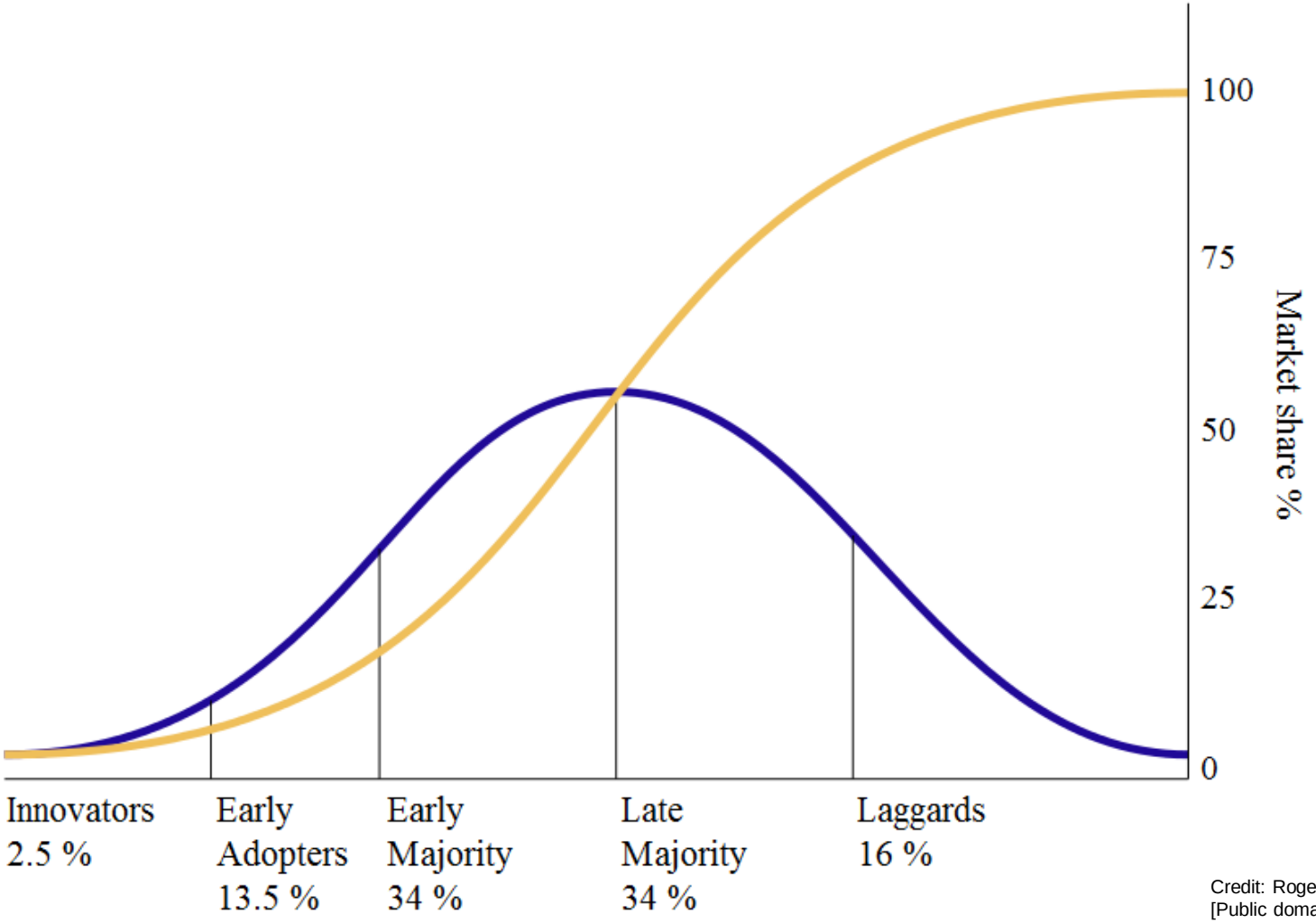
Background

- Separate projects led to a coordinated effort to develop photovoltaic valuation model
  - Geoff Klise focused on Kennecott Land – Daybreak Development in Utah
  - Jamie Johnson from Solar Power Electric focused on Florida for Appraisal Institute
- Reviewed for financial accuracy by licensed appraisers
- Released on January 31, 2012 at http://pv.sandia.gov/pvvalue
- FY 12 funding to study valuation of PV systems, validate model and make improvements

Importance

- Value of PV system may or may not be included in the sale price of a property
  - Comparable properties – Limited or none
  - Cost and incentives change and are sometimes unknown to appraiser
  - Knowledge of appraiser
- If home or business owner is not compensated for investment, depressed demand may result
- Realistic value = ‘bankability’

Rogers Bell Curve – Diffusion of Innovations



Credit: Rogers Everett [Public domain], via Wikimedia Commons

Appraisal Methodology

- This model uses the **Income Capitalization Approach**

  The present value of the PV system is equal to the capitalized value of the net income stream that the PV system can generate

- One of three appraisal approaches, cost and comparable sales are the other two

- For PV, the value of the income stream is related to:
  1. energy production
  2. existing electricity rate
  3. utility escalation rate
  4. discount rate
  5. O&M expenses over its remaining useful lifetime

AI Reports®
Form 820.03*

Client File #:		Appraisal File #:	

Residential Green and Energy Efficient Addendum

Client:		
Subject Property:		
City:	State:	Zip:

Additional resources to aid in the valuation of green properties and the completion of this form can be found at
http://www.appraisalinstitute.org/education/green_energy_addendum.aspx

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Client:		Client File #:	
Subject Property:		Appraisal File #:	

ENERGY EFFICIENT ITEMS

The following items are considered within the appraised value of the subject property:

Insulation	☐ Fiberglass Blown-In ☐ Foam Insulation ☐ Cellulose ☐ Fiberglass Batt Insulation ☐ Other (Describe): ☐ Basement Insulation (Describe): ☐ Floor Insulation (Describe):					R-Value: ☐ Walls ☐ Ceiling ☐ Floor
Water Efficiency	☐ Reclaimed Water System (Explain): ☐ Rain Barrels - #:		☐ Cistern - Size: Gallons ☐ Rain Barrels Provide Irrigation			Location:
Windows	☐ ENERGY STAR®	☐ Low E	☐ High Impact	☐ Storm	☐ Double Pane ☐ Triple Pane	☐ Tinted ☐ Solar Shades
Day Lighting	☐ Skylights – #:	☐ Solar Tubes - #:	☐ ENERGY STAR Light Fixtures		☐ Other (Explain):	
Appliances	ENERGY STAR Appliances: ☐ Range/Top ☐ Dishwasher ☐ Refrigerator ☐ Other:		Water Heater: ☐ Solar ☐ Tankless (On Demand) Size: Gal.		Appliance Energy Source: ☐ Propane ☐ Electric ☐ Natural Gas ☐ Other (Describe):	
HVAC (Describe in Comments Area)	☐ High Efficiency HVAC – SEER: ☐ Programmable Thermostat		☐ Heat Pump ☐ Wind		☐ Thermostat/Controllers ☐ Radiant Floor Heat	☐ Passive Solar ☐ Geothermal
Energy Rating	☐ ENERGY STAR Home ☐ HPwES (Home Performance with ENERGY STAR) ☐ Other (Describe):				☐ Indoor Air PLUS Package ☐ Energy Recovery Ventilator Unit ☐ Certification Attached	
HERS Information	Rating:	Date Rated:	Monthly Energy Savings on Rating: $			
Utility Costs	Average Utility Cost: $ per month based on:				☐ Dashboards - #:	
Energy Audit	Has an energy audit/rating been performed on the subject property? ☐ Yes ☐ No ☐ Unknown If yes, comment on work completed as result of audit.					
Comments						

Solar Panels

The following items are considered within the appraised value of the subject property:

Description	Array #1	Array #2	Array #3	Array #4
KW				
Age of Panels				
Energy Production Kwh per Array				
Source for Production				
Location (Roof, Ground, Etc.)				
If Roof/Slope for Array				
Azimuth per Array				
Age of Inverter(s)				
Name of Utility Company:		Cost per Kwh charged by Company: $ /Kwh		
Comments (Discuss incentives available for new panels, condition of current panels, and any maintenance issues)				

*NOTICE: The Appraisal Institute publishes this form for use by appraisers where the appraiser deems use of the form appropriate. Depending on the assignment, the appraiser may need to provide additional data, analysis and work product not called for in this form. The Appraisal Institute plays no role in completing the form and disclaims any responsibility for the data, analysis or any other work product provided by the individual appraiser(s).
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Client File #: | Appraisal File #:

Residential Green and Energy Efficient Addendum

Client:
Subject Property:
City: | State: | Zip:

Additional resources

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Solar Panels

The following items are considered within the appraised value of the subject property:

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Name of Utility Company:		Cost per Kwh charged by Company: $ /Kwh		
Comments (Discuss incentives available for new panels, condition of current panels, and any maintenance issues)				

ENERGY EFFICIENT ITEMS

The following items are consid

Insulation
Water Efficiency
Windows
Day Lighting
Appliances
HVAC (Describe in Comments Area)
Energy Rating
HERS Information
Utility Costs
Energy Audit
Comments

Array #4

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PV System Specifications

- Can you figure out the size of this array from looking at it?
- What is the month and year of installation?
- Is there a custom derate factor for this system that takes into account the shading?

- Do you know how long the module warranty period is for?
- How about the azimuth direction the modules are facing and the slope of the modules?

Current PV Value Limitations

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- Needs internet access to work
- Currently works in Excel 2007 and 2010 for Windows
- Only valid for grid-tied PV systems with net metering
- Applies to residential and commercial properties
- Tax liability is not addressed
- Commercial depreciation is not addressed
- Does not address aesthetic and 'green cache' value
- Does not include SREC's, REC's, net differentials, FIT's, above and beyond net metering
- Only for leased systems when determining fair market value for lease-to-purchase

PV Value Demonstration

Benefits to Installers/Integrators

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- Additional financial metric beyond simple payback
- Allows for comparison between purchasing or leasing
- New service 'opportunity' if more detailed analysis is needed by appraiser
  - Compare measured and modeled system performance
    - Determine current derate factor
  - E.g., shading after 10 years, impacts to performance
  - PV system not working properly

How Installers/Integrators Can Help

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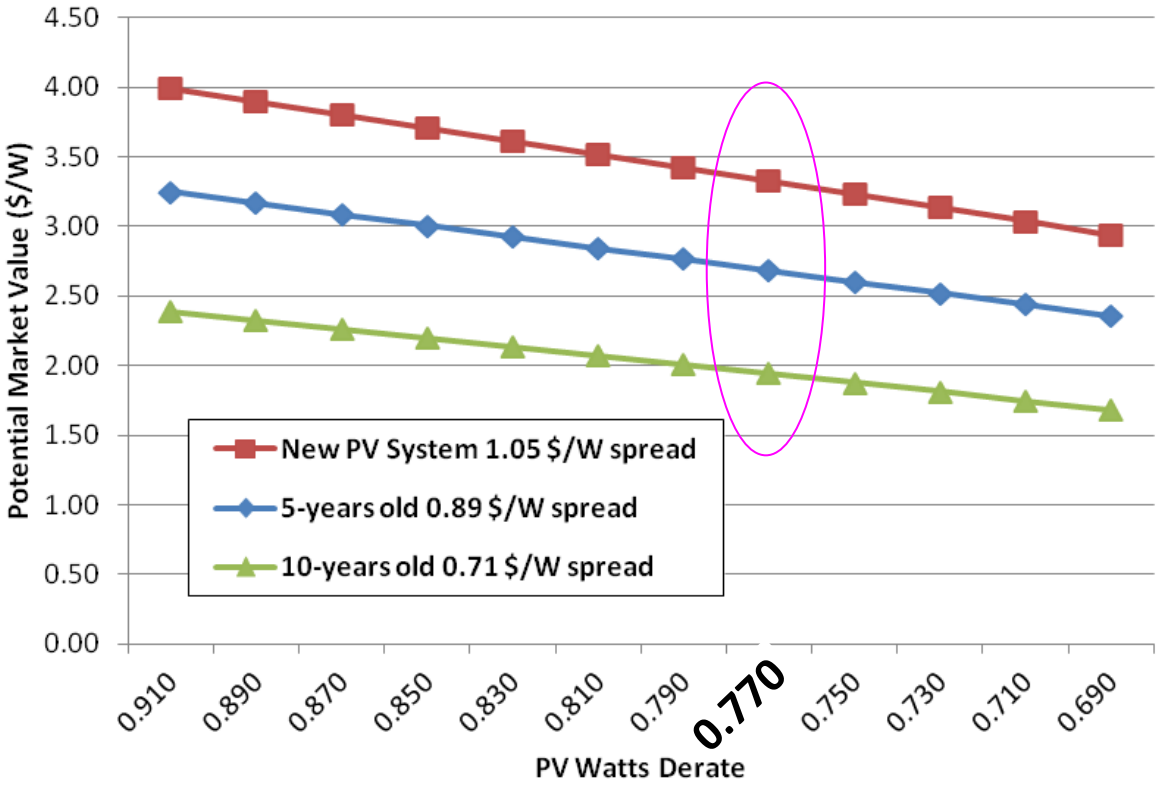
- Permanent Documentation – Beyond NEC 690
  - STC DC and AC in kW
  - Initial detailed derate factor used in commissioning report
    - What SolarPro October/November 2009 “PV System Commissioning” article defines as $\mathbf{K_s}$
    - Percent of outperformance (if system is underperforming $\mathbf{K_s}$ then $\mathbf{K_s}$ may not be correct)
  - Derate used for PVWatts
    - $\mathbf{K_s}$ along with additional derate factors adjusting for ac wiring, soiling & system availability
  - Shading analysis report with shading expressed as a derate factor using the 4 corner average method

Example of derate sensitivity

- Derate sensitivity decreases as PV system ages. Spread is lower
- For a new 5kW system, example shows around a $5,000 difference for this hypothetical market



How Installers/Integrators Can Help

- Permanent Documentation – Beyond NEC 690 (continued)
  - Orientation (tilt & azimuth)
  - Inverter model number
  - Module model number
  - Installation date
- Respond to appraiser inquiries about installed cost
  - Appraiser uses cost, income and sales comparison approach to make value determination

Potential Market Value - Research

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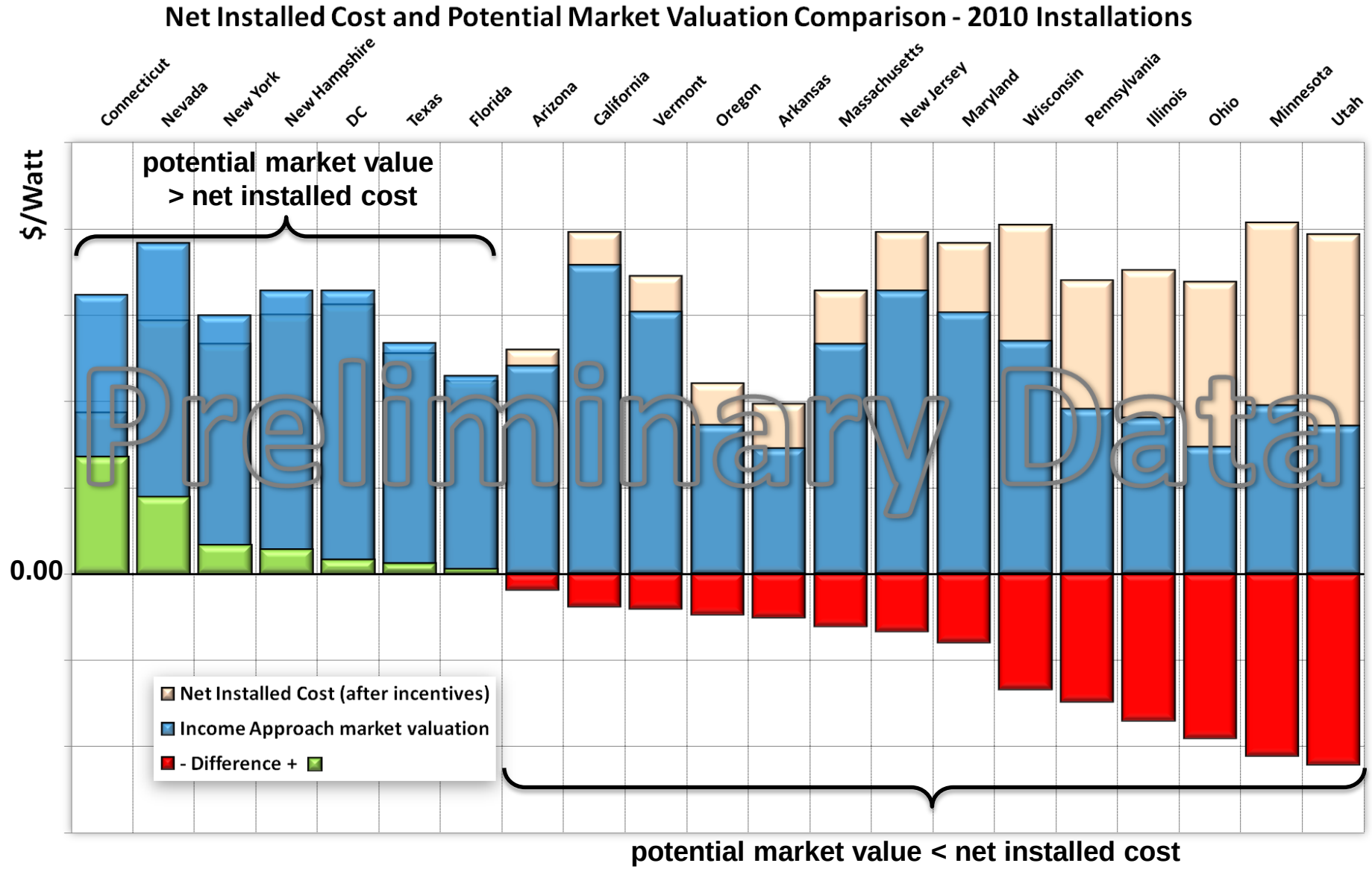
- Utilizing 2010 data:
  - IREC – U.S. Solar Market Trends 2010
    - Capacity and number of installations in residential and commercial sectors
  - LBNL Tracking the Sun IV
    - Net installed cost for 21 states
  - Open PV Project - http://openpv.nrel.gov/
    - Filling in gaps for specific states
  - PV Value™ 25-year value analysis:
    - New 1kW PV system
    - Average annual utility rates
    - 20-year utility escalation
    - Average annual 1st year energy production by state – Parametric Analysis in SAM for all TMY2 stations in U.S.

Residential Market



States shown are those used in Barbose et al. (2011) "Tracking the Sun IV" for installed cost comparison

Implied Relationship between Installed Cost & Potential Market Value

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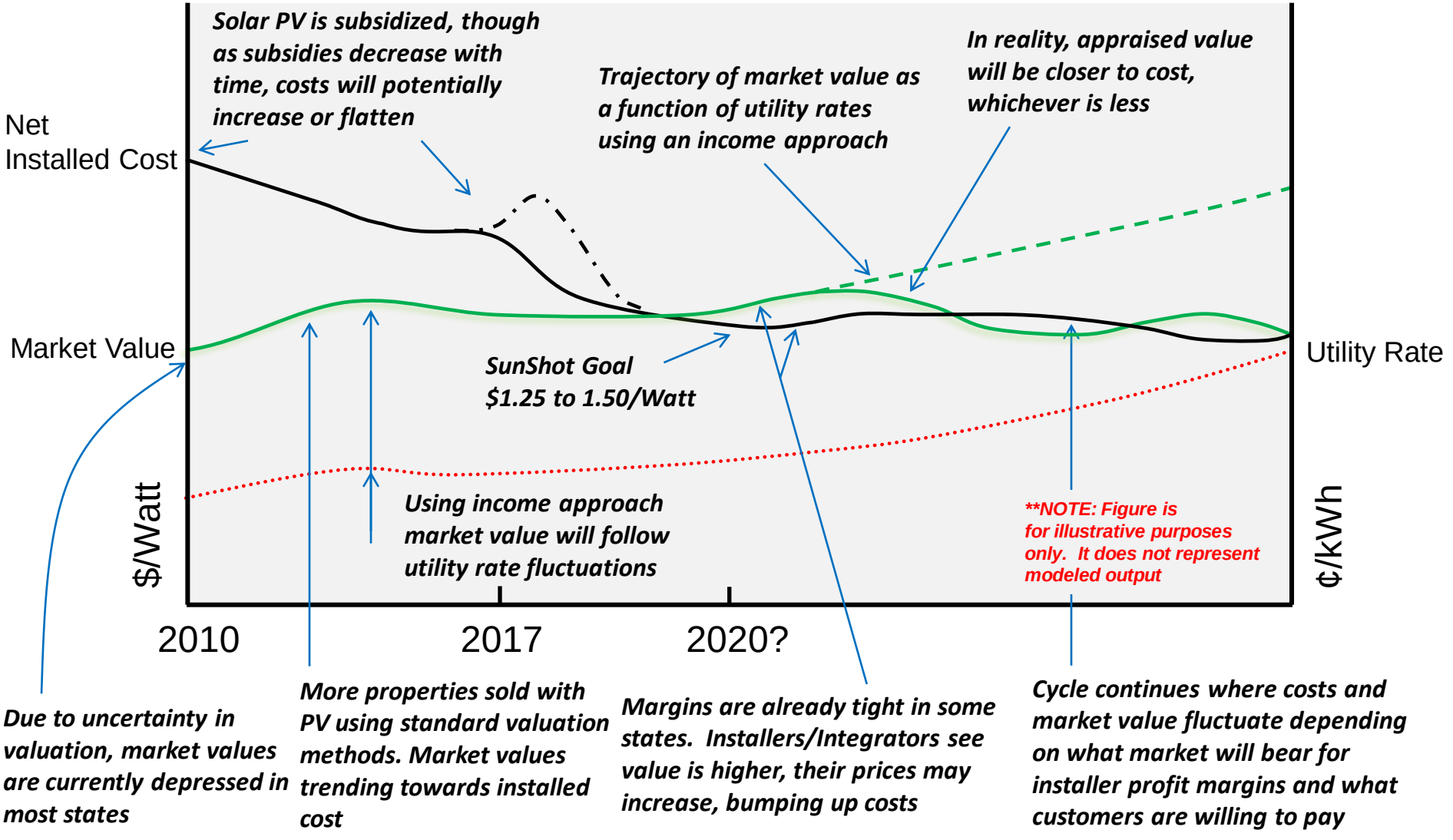

Current & Future Work

- Education and valuation research. Partnering with Lawrence Berkeley Natl. Lab, Solar Power Electric™, Appraisal Institute, national mortgage lenders
- Incorporate additional interest rates
- Incorporate microinverter costs & thin film data
- Allow option to allow utility escalation rate to follow remaining lifetime
- Utilize current year REC income, or long-term if fixed
- Feed-In-Tarrif analysis option
- Add in cost basis for comparison

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Thank you for Attending

Questions?

Geoff Klise – gklise@sandia.gov
Jamie Johnson – jjohnson@spefl.com