GOING SOLAR IN AMERICA: TECHNICAL APPENDIX

Analytical Approach and Data Sources

For our analysis, we drew on several data sources to build our System Advisor Model "cases" for each city.

The System Advisor Model (SAM), National Renewable Energy Laboratory (NREL)

- We used the publicly-available System Advisor Model (SAM) platform created and maintained by the National Renewable Energy Laboratory (NREL). SAM uses a simulation engine that uses weather data from around the United States to determine the amount of solar energy that common types of PV systems can generate (called PVWatts), as well as the financial and savings impacts for the customer.
    - For more information about the simulated load data, simulated "typical meteorological year" and other assumptions built into that model, please visit sam.nrel.gov.
- We assumed that, in line with the findings of the Lawrence Berkeley National Laboratory (Hoen, et al. *Exploring California Home Premiums.* Lawrence Berkeley National Laboratory, December 2013. Available at: http://emp.lbl.gov/sites/all/files/lbnl-6484e.pdf) that customers with solar PV had houses that corresponded most closely with homes with that "base" electricity usage characteristics. According to background information posted on OpenEI, the size of the average home of a customer adopting solar PV in California was a close match in all jurisdictions to a standard-sized, "base" electricity using home. Thus, we assumed that the average home adopting solar PV was a "base" usage home.
- As a first simplifying assumption (and because of the broad diversity of terms and conditions associated with third-party lease and PPA options) we chose only to explicitly model ***customer ownership options***. We believe that without a more robust dataset of third-party lease and PPA options by state and locality, representing third-party PPA options (or even the size of lease payments under customer ownership options) could provide customers with an inaccurate view of how much they may pay per month to finance their solar PV system.
    - **However, the System Advisor Model's net present value outputs for the "100% financing" case *fully reflect the value of investing in solar net of the cost of financing*.**
- As a second simplifying assumption (and given the diversity of incomes of people considering solar PV), we assumed that the customer had a sufficient federal tax liability to be able to claim a credit of approximately $6,000 for a 5 kW system.
    - However, this does not necessarily mean that other available incentives and credits are not considered taxable income – **we encourage all customers considering solar PV to consult with a tax professional before contacting a solar PV installer.**
- As a third simplifying assumption (given a lack of data related to the value of homes nationwide that invested in solar PV and the oft-challenging applications of local property taxes to solar PV) our analysis did not attempt to add property taxes to the cost of the system.
    - We believe this assumption was appropriate, given that the vast majority of states containing America's largest cities exempt PV systems (either wholly or partially) from property tax.
- Given the prevalence of microinverters, the Center's engineering team recommended use of a 0.84 derate factor, rather than the 0.77 PVWatts standard derate factor. This is due to the increasing commonality of higher-efficiency modules, as well as microinverters. Our engineers based this recommendation on data extracted from technical product briefs from SolarWorld and Enphase Energy.
- The following are two tables containing the uniform set of engineering and financial parameters related to the "typical" sized solar PV system input into SAM, regardless of the city.

Uniform Engineering & Physical System Parameters		
Parameter Type	*Parameter*	*SAM Default Parameter?*
System Nameplate Capacity (DC)	5,000 Watts (5 kW)	No (was informed (and rounded) based on SEIA/GTM data referenced below)
DC-to-AC Derate Factor	0.84	No
Panel Output Degradation Rate	0.5%/year	Yes
System Expected Useful Life (EUL)	25 Years	Yes
System Tilt	Tilt forced to city's latitude	Yes, SAM-supplied option

Uniform Financing & Discount Rate Terms & Parameters		
Parameter Type	*Parameter*	*SAM Default Parameter?*
Discount Rate (Real/ Adjusted For Inflation)	6.61%*	No (represents the 25-Year annualized inflation-adjusted (& dividend-reinvested) return of the Standard and Poors (S&P) 500, and thus represent the value of investing in stocks as an alternative to solar PV).
Inflation Rate	2.7%	Yes
Discount Rate (Nominal)	9.31%	No (reflects S&P annualization)
Financing Terms (For Financing Case)	5% Interest for 25 years	Yes
Financing Terms (For Upfront Purchase Case)	No financing terms	Yes
Marginal (& Effective) Federal Tax Rate for Analysis	28%	Yes (is also effective tax rate for federal/state tax credit interaction described below, given SAM has no built-in income parameters).
Marginal (& Effective) State Tax Rate for Analysis	4%	Yes

U.S. Energy Information Administration (EIA) 2014 Annual Energy Outlook

When evaluating a solar PV investment, a key piece of information for the analysis is the rate at which utility rates are expected to grow over the life of the system. To do so, we utilized the EIA's 2014 Annual Energy Outlook, which provided sufficient raw data to calculate the annualized rate growth through 2040, the end of a PV system's 25-year economic life. The information by reliability region and subregion (and applied to the cities & utilities within each subregion) is below.

Reliability Region & Subregion	*EIA Forecasted 2012-2040 Annual Residential Rate Growth (From AEO 2014)*
Texas Regional Entity (ERCT)	2.60%
Florida Reliability Coordinating Council (FRCC)	2.40%
Midwest Reliability Council East (MROE)	2.30%
Midwest Reliability Council West (MROW)	2.00%
Northeast Power Coordinating Council Northeast (NEWE)	2.30%
Northeast Power Coordinating Council NYC-Westchester (NYCW)	3.30%
Northeast Power Coordinating Council Long Island (NYLI)	2.50%
Northeast Power Coordinating Council Upstate NY (NYUP)	3.40%
Reliability First Corporation West (RFCW)	2.70%
Reliability First Corporation Michigan (RFCM)	1.90%
Reliability First Corporation East (RFCE)	2.30%
SERC Reliability Corporation Delta (SRMV)	3.10%
SERC Reliability Corporation Gateway (SRMW)	2.30%
SERC Reliability Corporation Southeastern (SRSO)	1.70%
SERC Reliability Corporation Central (SRTV)	1.30%
SERC Reliability Corporation Virginia Carolinas (SRVC)	2.00%
Southwest Power Pool South (SPNO)	1.90%
Southwest Power Pool South (SPSO)	2.50%
WECC Southwest (AZNM)	2.70%
WECC California (CAMX)	1.80%
WECC Northwest Power Pool (NWPP)	2.10%
WECC Rockies (RMPA)	2.40%

The Utility Rate Database (URDB), EIA Form 826 & Individual Utility Tariffs

- Except for when it was unavailable (or when a "buy-all, sell-all" tariff was economically more attractive), we used net metering as the standard method by which solar PV customers could realize savings associated with their systems.
- As a way to streamline the analysis, we utilized the URDB (available on OpenEI) to locate the most standard residential rate each utility had, and loaded its parameters into SAM.
- However, we made some exception in certain cases.

- When the most recent records from the URDB 1) had not been updated within the past year and/or 2) were not at least a rough match (within a few cents/kWh) used it when checked against the data from U.S. Energy Information Administration (EIA) Form 826 for June 2014 for each utility's residential rates. In that situation, we would manually enter the information from the utility's individual tariff.

Compensation for Net Excess Generation

- "Net excess generation" is the amount of net energy a customer produces relative to what they consume, and may (or may not) be carried over month-to-month. The authors ensured, via several rounds of quality assurance and quality control (QA/QC) that the behavior of net excess generation rollover month-to-month in each state and utility service territory was properly reflected in the analysis.
- However, in the case of states and utilities that had carryover provisions that required end-of-year compensation not at the retail rate, we utilized appropriate compensation rates as supplied by those utilities. Those rates tend to be referred to as "net surplus compensation" rates, "avoided cost" rates, or by other names that identified them as being for the purpose of compensation customers for their net excess generation.
- Since our analysis was limited to only one single calendar year of simulated load data (given that it is based only on a "typical meteorological year"), if state or utility policy gave customers a choice of whether or not to continue rolling over their net excess generation or to be compensated, we chose for that customer to be compensated. We made this simplifying assumption because our dataset limited us to only a single year of load information, and does not reflect inter-year variation that can (and does) occur).
- The manner in which net excess generation is credited is based solely on the net metering policy entries in the Database of State Incentives for Renewables and Efficiency (DSIRE), or, if unavailable there, from the utility's own net metering tariff.

Database of State Incentives for Renewables and Efficiency (DSIRE)

- We utilized the DSIRE database, given that all of the members of the Center's Energy Policy team maintain the database. Each analyst used data from their states to populate the incentives page of the System Advisor Model (SAM), and also to ensure that the net metering policies applicable to each city were incorporated as well. The information they drew on, to maintain consistency in the data, came from the information in the database as of September 2014. Any alterations or changes to rates, policies or incentives since that time are not reflected in the results for each city.

SEIA/GTM Research Data for Module/Inverter Costs

- Our analysis also utilized data from the Solar Energy Industry Association & GTM Research's U.S. Solar Market Insight report for the second quarter (Q2) of 2014, which we used a nationwide estimate for current costs of modules and inverters.

Sales Tax Data

- We also obtained data on current sales tax rates from sale-tax.com, which we included (as appropriate) for each city located within states that do not exempt solar PV from state and local sales taxes.

Deviations or Alterations to Our Standard Approach

There are three key ways in which certain circumstances required us to deviate from using SAM in the ways outlined above. Those three situations include:

- Cities in which system owners can claim state and federal income tax credits (and the state credit must be treated as income);
- Cities in which a buy-all, sell-all tariff is the only option (or is more economically attractive than net metering); and
- Cities within states that have in-state solar renewable energy certificate (SREC) markets.

State/Federal Tax Credit Interactions (Per DSIRE)

- It is common for state tax credits to effectively be considered "income" for the purposes of calculating the federal investment tax credit, because in general, the amount of state tax you pay is deducted from your federal income taxes. Thus, when modeling financial outcomes in SAM without a customer's income and tax rate inputted, it is necessary to trim the "effective" federal ITC (which, given the SAM default tax rate is 28%, which must be used since it has no income parameters, is also 28%) by the amount that a customer would receive. These adjustments were made for the following cities in the following amounts.

State	Cities	Effective Federal ITC %	Effective State ITC %	Total State & Federal ITC Combined
AZ	Phoenix, Tucson, Mesa	29%	5%	34%
KY	Louisville	29%	3%	32%
MD	Baltimore	23%	25%	48%
MA	Boston	29%	5%	34%
NY	New York	23%	25%	48%
NM	Albuquerque	29.8%	25%	55%
NC	Charlotte, Raleigh	20%	35%	55%
OR	Portland	28%	8%	35%
WI	Milwaukee	23%	25%	48%

Cities In Which Standard Offer Retail Net Metering Was Not Utilized in Analysis

In certain places (specifically Austin, TX and in Memphis and Nashville, TN), it is not possible for customers to benefit from net metering, but they can benefit from specifically structured utility "buy-all, sell-all" programs. Two groups of cities in Texas (including Dallas/Fort Worth/Arlington, TX and Houston, TX) are in a restructured electricity market with no standard offer net metering (but options through retail electric providers separate from their distribution utilities). Since these buy-all, sell-all tariffs do not lock in a long-term rate, we assumed that the value of the tariffs would escalate with natural gas prices, which the Annual Energy Outlook showed increasing nationally at slightly more than a 1% rate through 2040. Finally, in Atlanta, GA, Georgia Power offers the Georgia Power Advanced Solar Initiative (GPASI), which is currently a better deal for consumers than their standard-offer net metering.

City	Name of Alternative Tariff or Program to Net Metering	Reason For Use*
Atlanta, GA	Georgia Power Advanced Solar Initiative (GPASI)	Offers a more significant customer return profile than standard offer net metering.
Austin, TX	Austin Energy Value of Solar Tariff (VOST)	No standard offer net metering is available.
Memphis, TN	Tennessee Valley Authority (Green Power Partners 2014 Program)	No standard offer net metering is available.
Nashville, TN	Tennessee Valley Authority (Green Power Partners 2014 Program)	No standard offer net metering is available.
Dallas/Fort Worth/Arlington, TX	Green Mountain Energy (Renewable Rewards Buyback program)	No standard offer net metering is available (but is available under certain terms and conditions from a retail electric provider).
Houston, TX	Green Mountain Energy (Renewable Rewards Buyback program)	No standard offer net metering is available (but is available under certain terms and conditions from a retail electric provider).
**Note that we used the terms of these programs as they were available in 2014 up until September of 2014.*		

Publicly-Available Solar Renewable Energy Certificate (SREC) Pricing Data from SRECTrade

We also deviated from (and expanded upon) our standard approach of using DSIRE for all incentive information in the case of cities in states with active in-state SREC markets. We utilized publicly-available data from SRECTrade to price the cost of the longest-term spot SREC contracts available at auction in September 2014. Thus in these situations, we did not rely on the DSIRE database for all of our incentive and policy information.

Pricing of SRECs Assumed in Going Solar America Analysis					
City	Assumed SREC Market for Analysis	Spot Price (2014)	Spot Price (2015)	Spot Price (2016)	Max. Term of Spot Contract (Years)
Baltimore, MD	MD	$120/MWh ($0.12/kWh)	$120/MWh ($0.12/kWh)	$120/MWh ($0.12/kWh)	3
Boston, MA	MA (SREC II only)	$300/MWh	$300/MWh	N/A	2
Cleveland, OH	PA (due to SB 310)	$30/MWh ($0.03/kWh)	$35/MWh ($0.035/kWh)	N/A	2
Columbus, OH	PA (due to SB 310)	$30/MWh ($0.03/kWh)	$35/MWh ($0.035/kWh)	N/A	2
Philadelphia, PA	PA (due to SB 310)	$30/MWh ($0.03/kWh)	$35/MWh ($0.035/kWh)	N/A	2
Washington, DC	DC	$430/MWh ($0.43/kWh)	$430/MWh ($0.43/kWh)	$430/MWh ($0.43/kWh)	3
*Spot prices were assumed to be what the customer could obtain, given that this data was the only data available to the public – long-term SREC contract terms are not uniformly available in all states. Spot prices are based on the September 2014 SREC auctions in each state. All prices represent the market-clearing bid price for the longest-term spot contract available. We assumed that Ohio customers would buy Pennsylvania SRECs given that recent Ohio legislation (SB 310) froze its Renewable Portfolio Standard for two years, and permitted utilities to procure all RECs from out-of-state sources.					