# Renewable Energy Financing

## Maryland Smart Energy Communities

Maryland Energy ADMINISTRATION
*Powering Maryland's Future*

Doug Hinrichs, MEA Solar &
Geothermal Program Manager

# Preliminary Assessment of PV

PVWatts

Click on the site where you want to use PVWATTS to calculate the electrical energy produced. Choose the site nearest to your location that has similar topography. If near a state border, you may wish to review site locations in the adjacent state.

## Maryland


http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/US/Maryland/Baltimore.html

# Preliminary Assessment of PV

PVWatts

Click on **Calculate** if default values are acceptable, or after selecting your system specifications. Click on **Help** for information about system specifications. To use a DC to AC derate factor other than the default, click on **Derate Factor Help** for information.

**Station Identification:**

| | |
|---|---|
| WBAN Number: | 93721 |
| City: | Baltimore |
| State: | Maryland |

**PV System Specifications:**

| | | |
|---|---|---|
| DC Rating (kW): | 500.0 | |
| DC to AC Derate Factor: | 0.785 | Derate Factor Help |
| Array Type: | Fixed Tilt | |
| Fixed Tilt or 1-Axis Tracking System: | | |
| Array Tilt (degrees): | 39.2 | (Default = Latitude) |
| Array Azimuth (degrees): | 180.0 | (Default = South) |

**Energy Data:**

| | |
|---|---|
| Cost of Electricity (cents/kWh): | Default = State Average |

PVWatts

**AC Energy & Cost Savings**

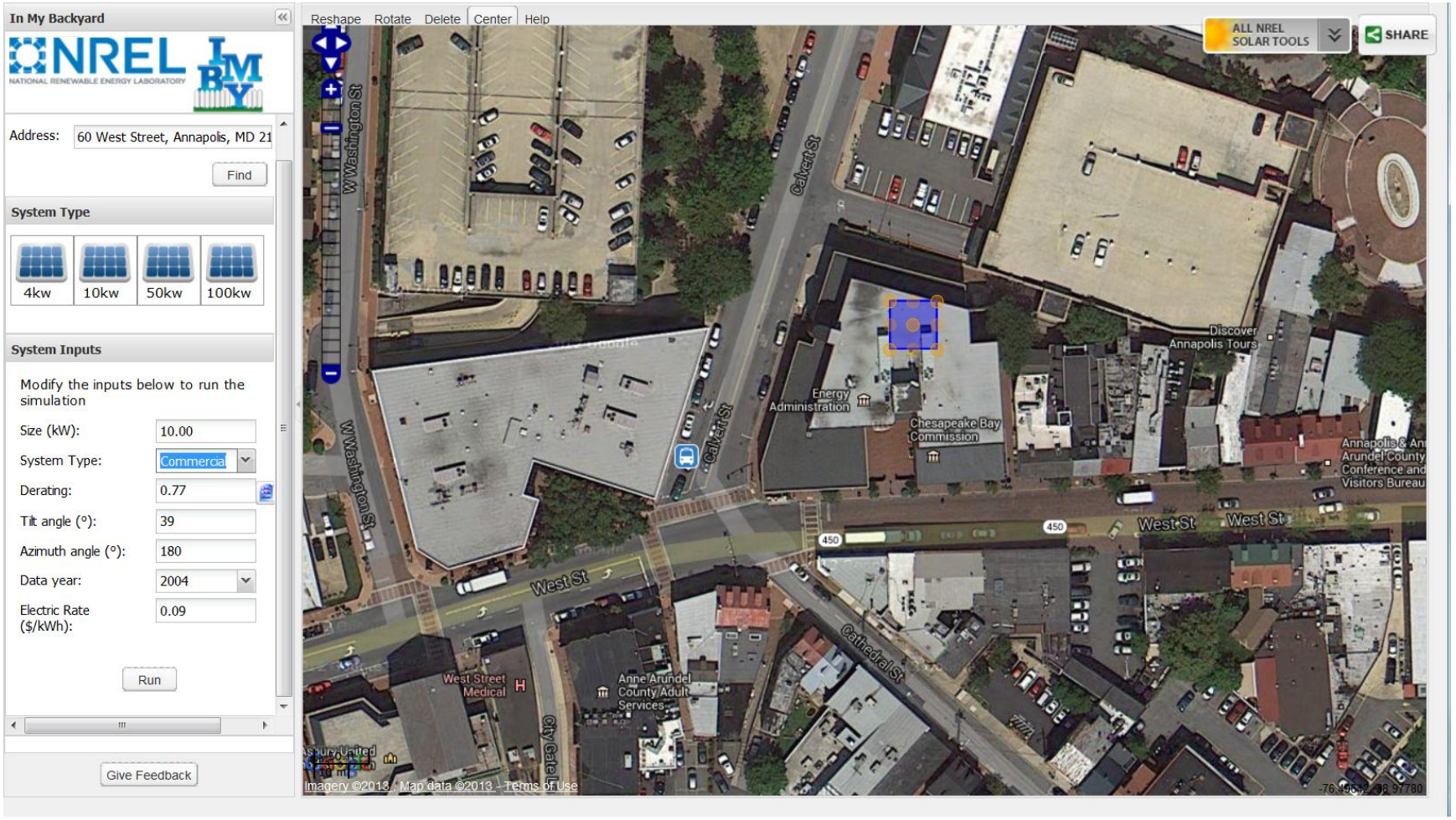
Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 80 characters.)

| Station Identification | |
|---|---|
| City: | Baltimore |
| State: | Maryland |
| Latitude: | 39.18° N |
| Longitude: | 76.67° W |
| Elevation: | 47 m |
| **PV System Specifications** | |
| DC Rating: | 500.0 kW |
| DC to AC Derate Factor: | 0.785 |
| AC Rating: | 392.5 kW |
| Array Type: | Fixed Tilt |
| Array Tilt: | 39.2° |
| Array Azimuth: | 180.0° |
| **Energy Specifications** | |
| Cost of Electricity: | 7.8 ¢/kWh |

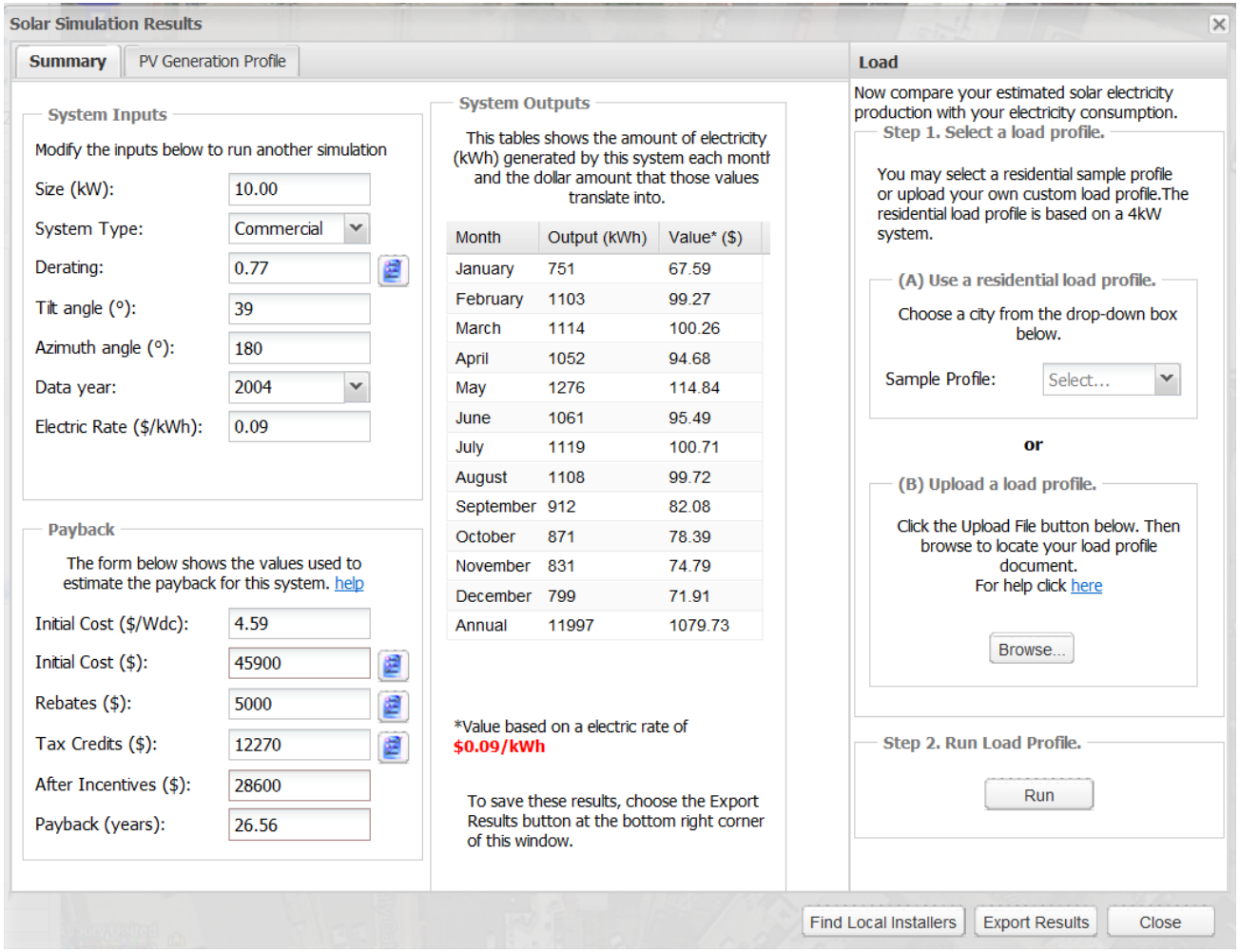
| Results | | | |
|---|---|---|---|
| Month | Solar Radiation (kWh/m²/day) | AC Energy (kWh) | Energy Value ($) |
| 1 | 3.47 | 43222 | 3371.32 |
| 2 | 4.40 | 49234 | 3840.25 |
| 3 | 4.79 | 56973 | 4443.89 |
| 4 | 5.12 | 57625 | 4494.75 |
| 5 | 5.28 | 59049 | 4605.82 |
| 6 | 5.70 | 59278 | 4623.68 |
| 7 | 5.61 | 60128 | 4689.98 |
| 8 | 5.28 | 56587 | 4413.79 |
| 9 | 4.95 | 52224 | 4073.47 |
| 10 | 4.90 | 56095 | 4375.41 |
| 11 | 3.58 | 41344 | 3224.83 |
| 12 | 2.85 | 34497 | 2690.77 |
| Year | 4.66 | 626255 | 48847.89 |

# Space Required for PV - Rooftop

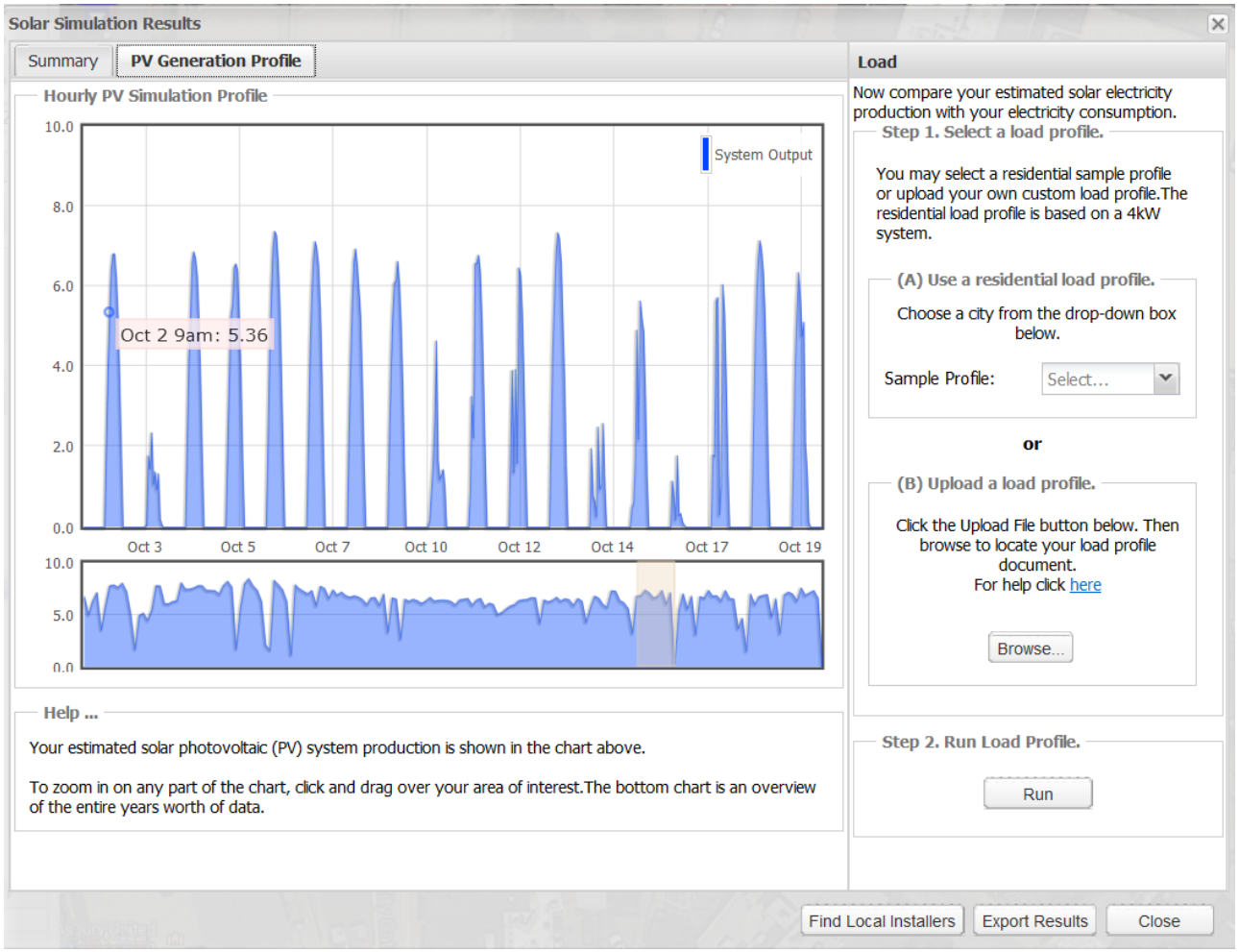



http://maps.nrel.gov/imby

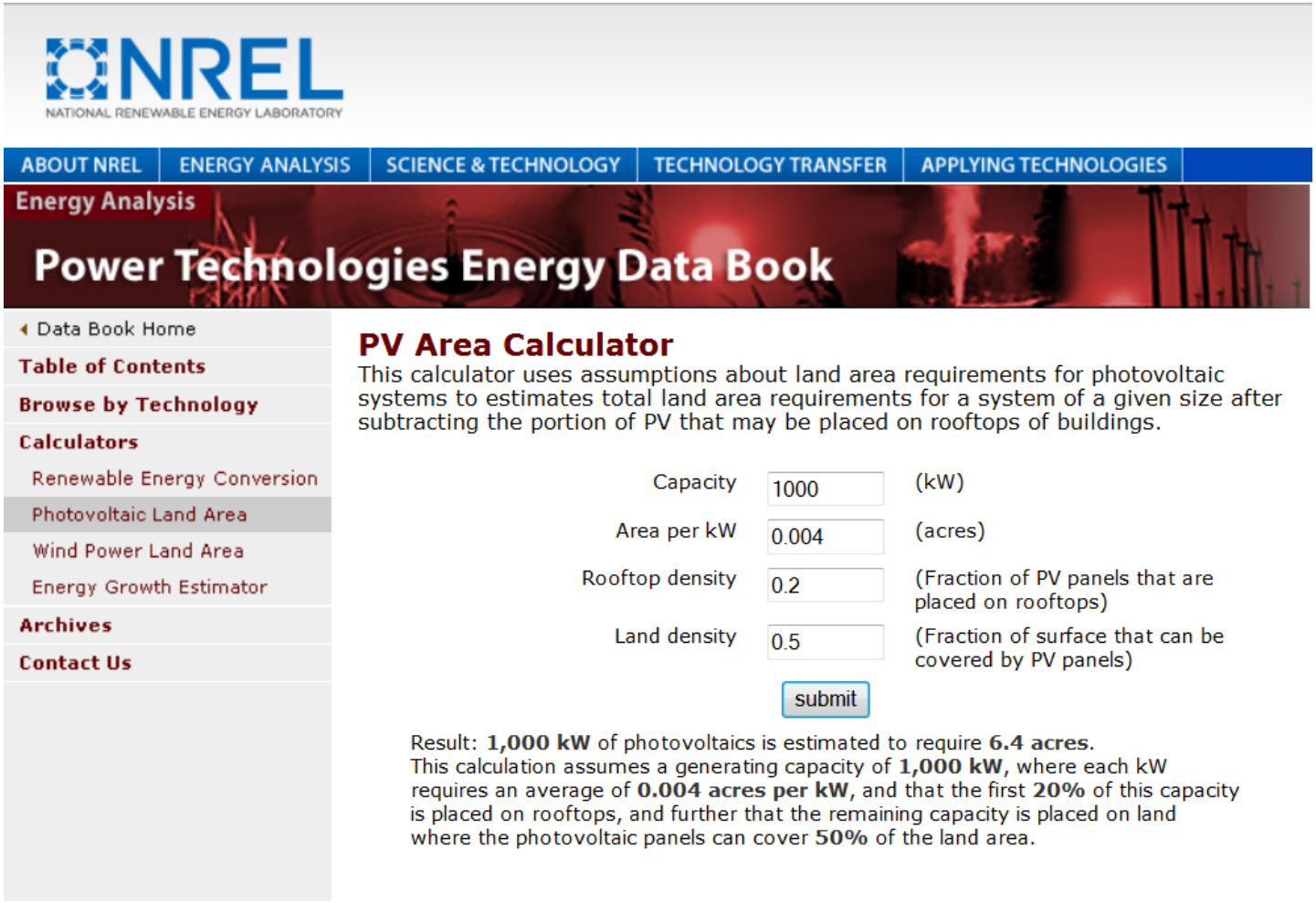
# Space Required for PV - Rooftop



# Space Required for PV - Rooftop



# Space Required for PV - Open Land




http://www.nrel.gov/analysis/power_databook/calc_pv.php

# Net Metering

*Your bi-directional meter will continue to be read once each month. The meter measures the energy generated by your solar system and the energy consumed by you over a month's time, and will display the net difference. Over a year, your energy usage totals may look something like the example below.*

**Relevant Period:** August to July

| **Month 1** (Aug) | **Month 2** (Sept) | **Month 3** (Oct) | **Month 4** (Nov) | **Month 5** (Dec) | **Month 6** (Jan) | **Month 7** (Feb) | **Month 8** (Mar) | **Month 9** (Apr) | **Month 10** (May) | **Month 11** (June) | **Month 12** (July) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Generated* 550 kWh | *Generated* 520 kWh | *Generated* 420 kWh | *Generated* 200 kWh | *Generated* 155 kWh | *Generated* 190 kWh | *Generated* 185 kWh | *Generated* 215 kWh | *Generated* 395 kWh | *Generated* 410 kWh | *Generated* 465 kWh | *Generated* 550 kWh |
| *Consumed* 500 kWh | *Consumed* 510 kWh | *Consumed* 500 kWh | *Consumed* 400 kWh | *Consumed* 475 kWh | *Consumed* 415 kWh | *Consumed* 395 kWh | *Consumed* 405 kWh | *Consumed* 420 kWh | *Consumed* 405 kWh | *Consumed* 410 kWh | *Consumed* 525 kWh |
| Energy Charges = **–50 kWh** (energy usage credit) | Energy Charges = **–10 kWh** (energy usage credit) | Energy Charges = **80 kWh** (energy usage charge) | Energy Charges = **200 kWh** (energy usage charge) | Energy Charges = **320 kWh** (energy usage charge) | Energy Charges = **225 kWh** (energy usage charge) | Energy Charges = **210 kWh** (energy usage charge) | Energy Charges = **190 kWh** (energy usage charge) | Energy Charges = **25 kWh** (energy usage charge) | Energy Charges = **–5 kWh** (energy usage credit) | Energy Charges = **–55 kWh** (energy usage credit) | Energy Charges = **–25 kWh** (energy usage credit) |

This customer's **annual energy bill** will be tallied as follows= (50) + (10) + 80 + 200 + 320 + 225 + 210 + 190 + 25 + (5 ) + (55) + (25) x Domestic Energy Rate per kWh

- 2 MW cap for PV system
- PV energy offsets grid power, at full retail electricity rates
- In some months, a PV generator may produce more electricity than building can use, creating "net excess generation" (NEG)
- Compensation for NEG remaining in a customer's account after a 12-month period ending in April of each year is paid to the customer at the commodity energy supply rate, which is perhaps 1/3$^{rd}$ lower than retail rates

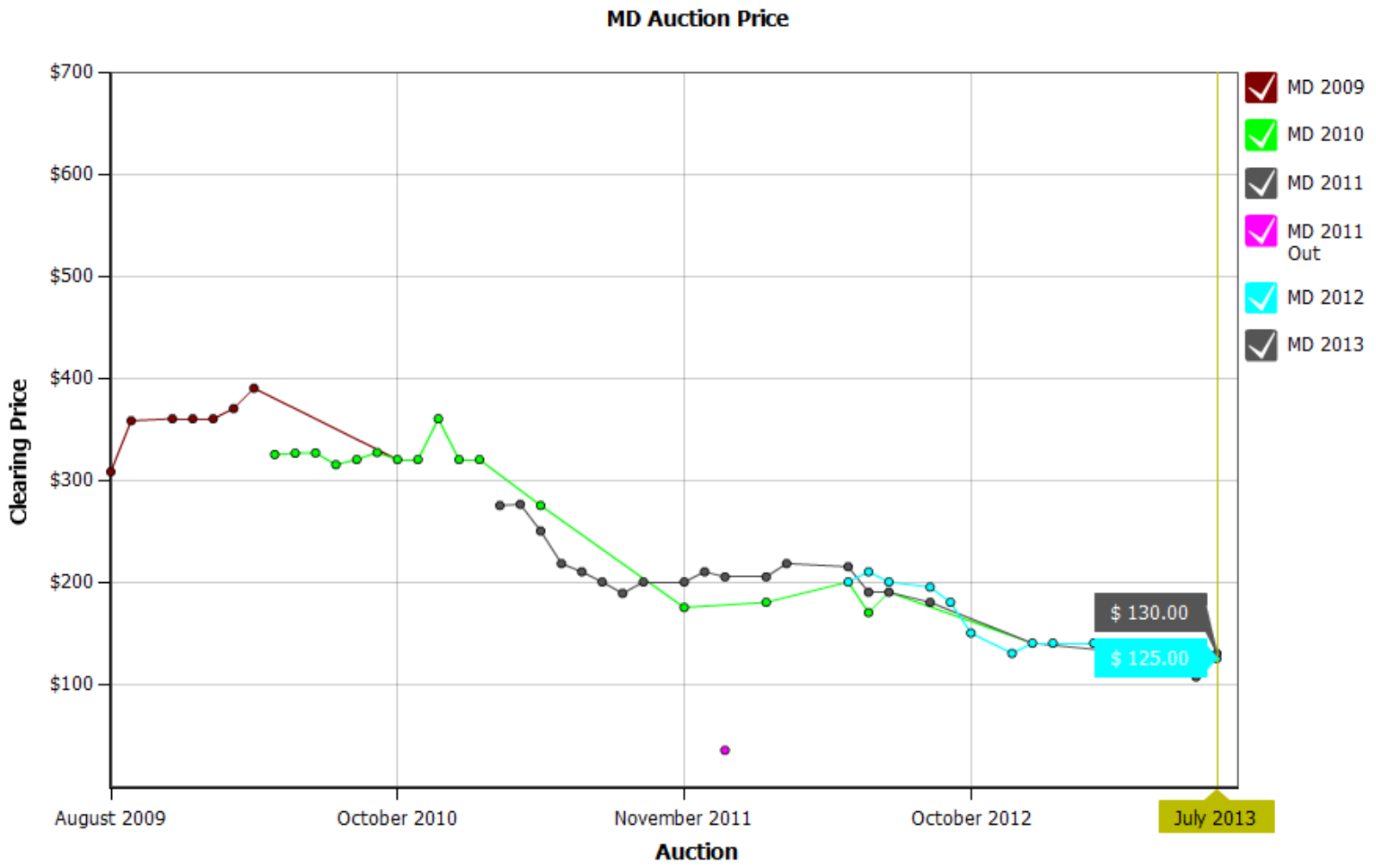
# Costs, Incentives, Revenues

- Costs
  - $2,200-2,600/kW (total installed cost)
  - 250 kW x $2,400/kW (avg.) = $600,000
  - Land/rooftop lease?
- Incentives
  - Federal Investment Tax Credit (30%)
  - Federal MACRS (advanced depreciation)
  - MEA Clean Energy Grant of $30/kW (cap of 200 kW)
  - MEA Clean Energy Production Tax Credit of 0.85 cents/kWh
  - County? Utility?
    - (Check http://www.dsireusa.org/incentives/index.cfm?state=md)
- Revenues
  - Sale of solar energy
    - If net metered, full retail offset of, e.g., 8-12 cents/kWh
  - MD SRECs
    - Currently, 34% of SACP

# Costs, Incentives, Revenues

| Energy Year | RPS Solar Requirement | Projected SRECs Required (MWh) | Projected Capacity Required (MW) | SACP |
|---|---|---|---|---|
| 2009 | 0.01% | 6,259 | 5.2 | $400 |
| 2010 | 0.025% | 16,334 | 13.6 | $400 |
| 2011 | 0.05% | 31,800 | 26.5 | $400 |
| 2012 | 0.10% | 64,554 | 53.8 | $400 |
| 2013 | 0.25% | 163,805 | 136.5 | $400 |
| 2014 | 0.35% | 232,767 | 194.0 | $400 |
| 2015 | 0.50% | 337,512 | 281.3 | $350 |
| 2016 | 0.70% | 479,605 | 399.7 | $350 |
| 2017 | 0.95% | 660,655 | 550.5 | $200 |
| 2018 | 1.40% | 988,201 | 823.5 | $200 |
| 2019 | 1.75% | 1,253,781 | 1,044.8 | $150 |
| 2020 | 2.00% | 1,454,385 | 1,212.0 | $150 |
| 2021 | 2.00% | 1,476,201 | 1,230.2 | $100 |
| 2022 | 2.00% | 1,498,344 | 1,248.6 | $100 |
| 2023 | 2.00% | 1,520,819 | 1,267.3 | $50 |

# Costs, Incentives, Revenues



# PV Cash Flow & Payback

**Solar Project Assumptions**

| | | |
|---|---|---|
| Total System Size: | 100 | kW DC |
| Installation Type: | Ground Mount | *See costs at right* |
| Total Project Cost: | $3.00 | $/Watt |
| Estimated System Production: | 132,000 | kWh/Year |
| Federal Tax Rate: | 35.0% | |
| State Tax Rate: | 5.5% | |
| Land Cost: | $0 | |
| Land Lease Cost: | $0 | $ / Year |
| O&M, Asset Management, Insurance Cost | $24 | $ / kW DC / Year |
| O&M, Asset Managment, Insurance Escalator | 3.0% | |
| Inverter Reserve / Soft Cost Contingency | $12 | $ / kW DC / Year |
| System Degredation Factor | 0.5% | |
| System Installation Year | 2013 | |
| Electricity Offset Rate / PPA Rate | $0.095 | $/kWh |
| Electricity Escalator | 1.0% | |
| SREC % ACP | 30.0% | |
| Investment Tax Credit: | 30.0% | |
| Total Project Basis for Depreciation: | $255,000 | |
| Total Cash Benefit From Depeciation: | $103,275 | |

| kW Installed | 100 | 2,000 | Final Cost |
|---|---|---|---|
| Ground Mount | $3.00 | $2.55 | $3.00 |
| Roof Mount | $3.10 | $2.65 | $3.10 |
| Parking Canopy | $3.50 | $3.00 | $3.50 |

# PV Cash Flow & Payback

| Electric Rate with Escalator | Year | Annual Electricity Generation (kWh) |
|---|---|---|
| $0.0950 | 2013 | 132,000 |
| $0.0960 | 2014 | 131,340 |
| $0.0969 | 2015 | 130,683 |
| $0.0979 | 2016 | 130,030 |
| $0.0989 | 2017 | 129,380 |
| $0.0998 | 2018 | 128,733 |
| $0.1008 | 2019 | 128,089 |
| $0.1019 | 2020 | 127,449 |
| $0.1029 | 2021 | 126,811 |
| $0.1039 | 2022 | 126,177 |
| $0.1049 | 2023 | 125,547 |
| $0.1060 | 2024 | 124,919 |
| $0.1070 | 2025 | 124,294 |
| $0.1081 | 2026 | 123,673 |
| $0.1092 | 2027 | 123,054 |
| $0.1103 | 2028 | 122,439 |
| $0.1114 | 2029 | 121,827 |
| $0.1125 | 2030 | 121,218 |
| $0.1136 | 2031 | 120,612 |
| $0.1148 | 2032 | 120,009 |
| $0.1159 | 2033 | 119,409 |
| $0.1171 | 2034 | 118,812 |
| $0.1182 | 2035 | 118,218 |
| $0.1194 | 2036 | 117,626 |
| $0.1206 | 2037 | 117,038 |
| $0.1218 | 2038 | 116,453 |

**Annual Cash Flow**

| System Revenues | | | | | | | | System Costs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity Revenue | SACP Schedule | SACP % | SRECS Revenues | MEA Clean Energy | MEA Production Tax Credit | Federal ITC Cash Benefit | Federal MACRS Depreciation | O&M, Asset Mgt, Insurance | Inverter Reserve, Soft Costs | Land / Lease Expense | Total Annual Cash Flow |
| $12,540 | $400 | 30.0% | $15,840 | $13,500 | $1,122 | $90,000 | $36,146 | ($2,400) | ($1,200) | $0 | **$165,949** |
| $12,602 | $400 | 30.0% | $15,761 | | $1,116 | | $26,852 | ($2,472) | ($1,200) | $0 | **$53,059** |
| $12,664 | $350 | 30.0% | $13,722 | | $1,111 | | $16,111 | ($2,546) | ($1,200) | $0 | **$40,212** |
| $12,727 | $350 | 30.0% | $13,653 | | $1,105 | | $11,371 | ($2,623) | ($1,200) | $0 | **$35,384** |
| $12,790 | $200 | 30.0% | $7,763 | | $1,100 | | $11,371 | ($2,701) | ($1,200) | $0 | **$29,322** |
| $12,853 | $200 | 30.0% | $7,724 | | | | $1,425 | ($2,782) | ($1,200) | $0 | **$18,221** |
| $12,917 | $150 | 30.0% | $5,764 | | | | | ($2,866) | ($1,200) | $0 | **$14,766** |
| $12,981 | $150 | 30.0% | $5,735 | | | | | ($2,952) | ($1,200) | $0 | **$14,715** |
| $13,045 | $100 | 30.0% | $3,804 | | | | | ($3,040) | ($1,200) | $0 | **$12,710** |
| $13,110 | $100 | 30.0% | $3,785 | | | | | ($3,131) | ($1,200) | $0 | **$12,664** |
| $13,175 | $50 | 30.0% | $1,883 | | | | | ($3,225) | ($1,200) | $0 | **$10,683** |
| $13,240 | $50 | 30.0% | $1,874 | | | | | ($3,322) | ($1,200) | $0 | **$10,642** |
| $13,305 | $50 | 30.0% | $1,864 | | | | | ($3,422) | ($1,200) | $0 | **$10,598** |
| $13,371 | $50 | 30.0% | $1,855 | | | | | ($3,524) | ($1,200) | $0 | **$10,552** |
| $13,438 | $50 | 30.0% | $1,846 | | | | | ($3,630) | ($1,200) | $0 | **$10,503** |
| $13,504 | $50 | 30.0% | $1,837 | | | | | ($3,739) | ($1,200) | $0 | **$10,452** |
| $13,571 | $50 | 30.0% | $1,827 | | | | | ($3,851) | ($1,200) | $0 | **$10,397** |
| $13,638 | $50 | 30.0% | $1,818 | | | | | ($3,967) | ($1,200) | $0 | **$10,340** |
| $13,706 | $50 | 30.0% | $1,809 | | | | | ($4,086) | ($1,200) | $0 | **$10,279** |
| $13,773 | $50 | 30.0% | $1,800 | | | | | ($4,208) | ($1,200) | $0 | **$10,215** |
| $13,842 | $50 | 30.0% | $1,791 | | | | | ($4,335) | ($1,200) | $0 | **$10,148** |
| $13,910 | $50 | 30.0% | $1,782 | | | | | ($4,465) | ($1,200) | $0 | **$10,078** |
| $13,979 | $50 | 30.0% | $1,773 | | | | | ($4,599) | ($1,200) | $0 | **$10,004** |
| $14,048 | $50 | 30.0% | $1,764 | | | | | ($4,737) | ($1,200) | $0 | **$9,926** |
| $14,118 | $50 | 30.0% | $1,756 | | | | | ($4,879) | ($1,200) | $0 | **$9,845** |
| $14,188 | $50 | 30.0% | $1,747 | | | | | ($5,025) | ($1,200) | $0 | **$9,760** |

| Total Investment | | | $300,000 |
|---|---|---|---|
| Federal Tax Paid | State Tax Paid | Total Annual Cash Flow | Cumulative Cash Flow (Post |
| ($13,791) | ($1,363) | $150,795 | $150,795 |
| ($9,033) | ($1,358) | $42,669 | $193,463 |
| ($8,313) | ($1,245) | $30,654 | $224,118 |
| ($8,282) | ($1,241) | $25,861 | $249,979 |
| ($6,213) | ($916) | $22,193 | $272,172 |
| ($5,808) | ($913) | $11,500 | $283,672 |
| ($5,115) | ($804) | $8,846 | $292,518 |
| ($5,098) | ($801) | $8,816 | $301,334 |
| ($4,413) | ($694) | $7,603 | $308,937 |
| ($4,397) | ($691) | $7,576 | $316,513 |
| ($3,721) | ($585) | $6,377 | $322,890 |
| ($3,707) | ($583) | $6,352 | $329,242 |
| ($3,692) | ($580) | $6,326 | $335,568 |
| ($3,676) | ($578) | $6,299 | $341,867 |
| ($3,659) | ($575) | $6,270 | $348,137 |
| ($3,641) | ($572) | $6,239 | $354,376 |
| ($3,621) | ($569) | $6,207 | $360,583 |
| ($3,601) | ($566) | $6,173 | $366,756 |
| ($3,580) | ($563) | $6,137 | $372,892 |
| ($3,558) | ($559) | $6,099 | $378,991 |
| ($3,534) | ($555) | $6,059 | $385,049 |
| ($3,510) | ($552) | $6,017 | $391,066 |
| ($3,484) | ($547) | $5,973 | $397,039 |
| ($3,457) | ($543) | $5,926 | $402,965 |
| ($3,428) | ($539) | $5,878 | $408,843 |
| ($3,398) | ($534) | $5,827 | $414,671 |

**NOTES:**

Variables are noted with blue text and highlighted

Costs do not include cost of capital.

SREC prices are only estimates.

Model does not include cost for decommissioning at end of life

Federal Tax is paid on Electricity, SREC, State Grants/Incentives, State Tax is paid on Electricity, SREC

***This entire spreadsheet is for educational purposes only. MEA cannot be held responsible for any assumptions, calculations, or estimates.***

# Power Purchase Agreements

- Purpose
  - Allows local governments (which don't pay taxes) to partner with solar developers to take advantage of tax credits, reduce risk, etc.
- Benefits
  - Can take advantage of Federal ITC (30%)
  - No upfront capital cost
  - No system performance or operating risk
  - Predictable energy pricing
  - Net metering allowed if PV serves local load
    - If net metered, full retail electric rate offset
      - Some demand charges (in kW) will remain under T&D chargers
    - Ideally at lower costs than conventional grid power
  - Solar developer or building owners can sell SRECs

# MEA's Work with PPAs

- Sunburst I Program
  - Incentives offered (no longer offered)
  - Mainstreamed PPAs
  - 16 State and local government partners
  - Brought 8.9 MW of PV online

# MEA's Work with PPAs

*NMWDA – Installation of Racks for Ballasted Rooftop Mounts*

*George Carver Washington ES - Pole Mount*

*Talbot County Community Center – Ground Mount*

*Coppin State University – Ballasted Rooftop Mount*

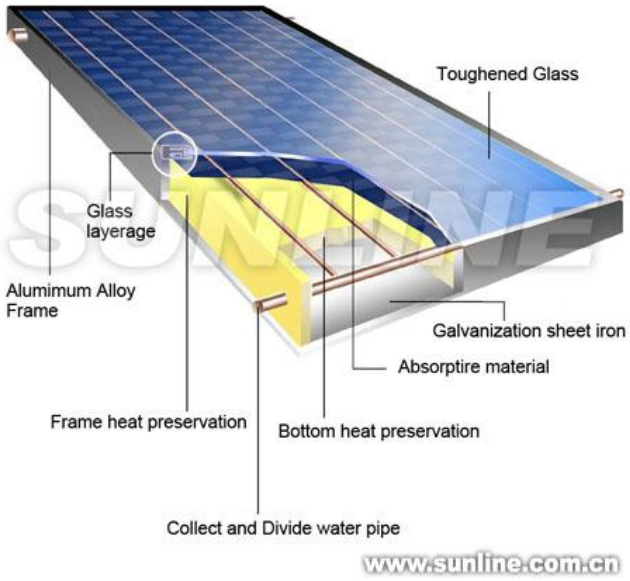
*Back River WWTP – Screw-type Ground Mount*

*Frederick County Oakdale High School – Ballasted Rooftop Mount*

# MEA's Work with PPAs

| Sunburst I Project | PV Capacity (kW) | Procurement Vehicle |
|---|---|---|
| 1. MPA Shed 10 + Cruise Terminal, Baltimore | 750 kW | Energy performance contract |
| 2. Back River Wastewater Treatment Plant, Baltimore | 900 kW | Energy performance contract |
| 3. MTA Bus Facility, Baltimore | 500 kW | Energy performance contract |
| 4. MAA, BWI's Daily Parking Garage Roof | 500 kW | PPA |
| 5. Town of Hancock Facility | 104 kW | PPA |
| 6. Prince George County Facility | 384 kW | PPA |
| 7. NE MD Waste Disposal Authority - Howard Co. | 462 kW | PPA |
| 8. NE MD Waste Disposal Authority - Montgomery Co. | 281 kW | PPA |
| 9. AAC Combined Support Services Complex, Millersville | 750 kW | PPA |
| 10. George Washington Carver Elem. School, Lexington Park | 500 kW | PPA |
| 11. Frederick County Oakdale High School, Ijamsville | 499 kW | PPA |
| 12. Talbot County Community Center, Easton | 550 kW | PPA |
| 13. Anne Arundel Community College | 750 kW | PPA |
| 14. Coppin State University, Baltimore | 500 kW | PPA |
| 15. Harford County Public School, Bel Air | 752 kW | PPA |
| 16. University MD at College Park Severn Building, Beltsville | 630 kW | PPA |

# Solar Water Heating




Flat plate collectors


Evacuated tube collectors

# Solar Water Heating

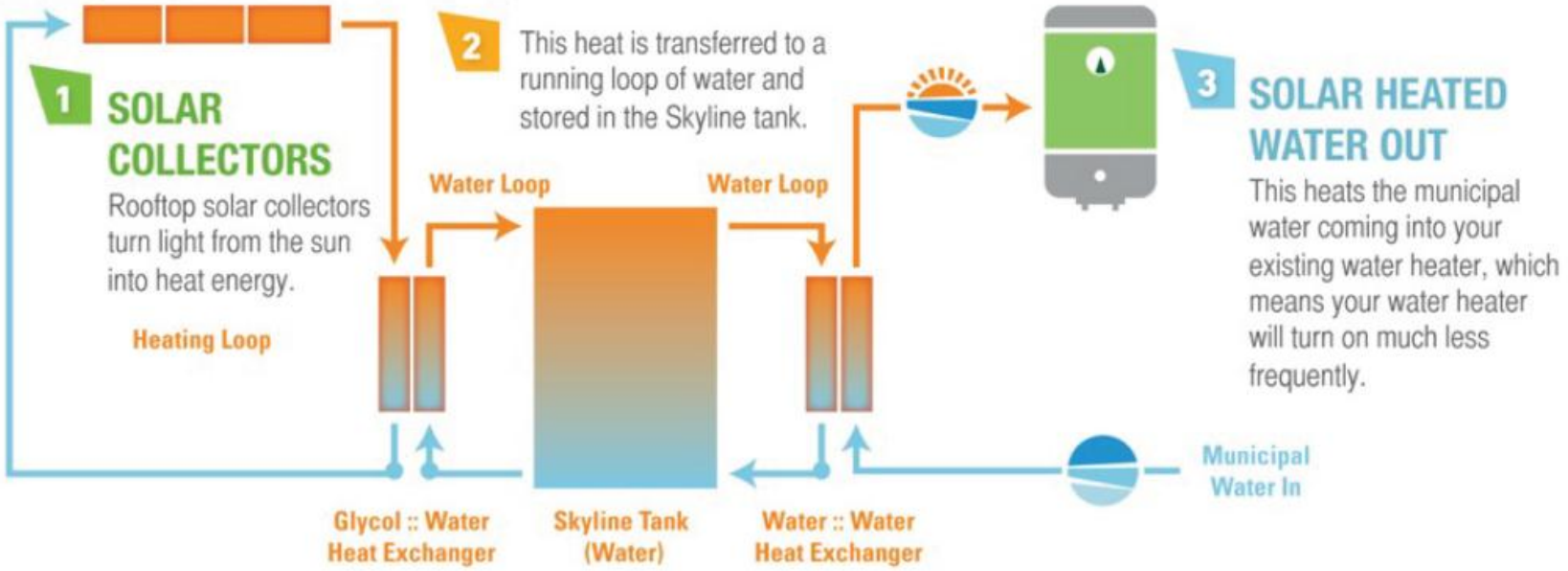
- Game Changer Award
  - Glazed polymeric collectors
    - “1/2 the cost, ¾ the performance” of flat plates
    - Low per square foot weight load
    - Rapid un-installation and re-installation
    - Seemingly ideal for multi-family housing

  - Awardee will test performance of flat plates, evacuated tubes, and glazed polymerics

# Solar Water Heating

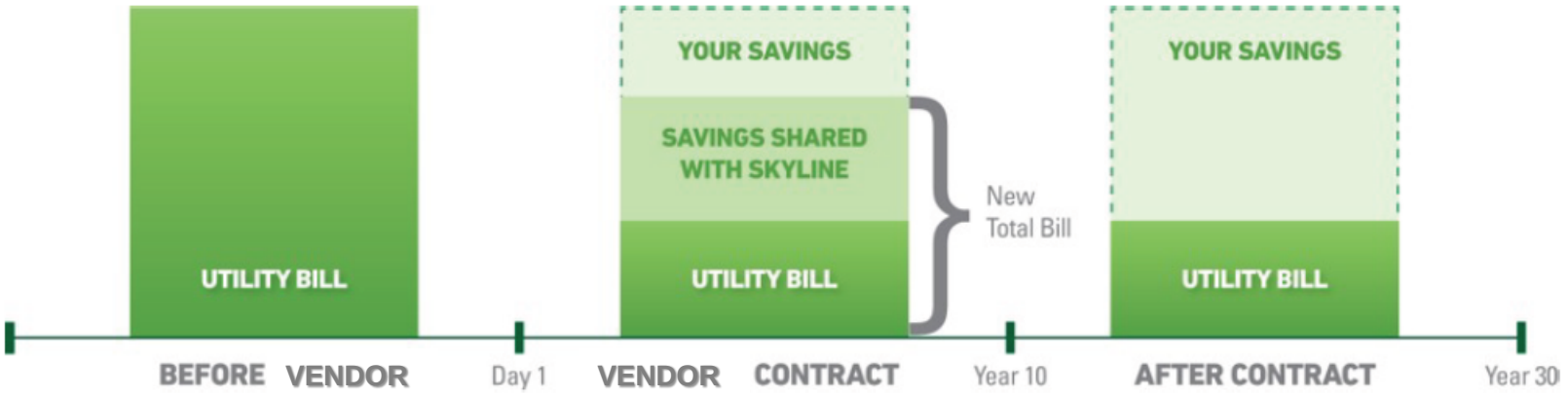
- Target Markets
  - Attributes
    - High population density
    - High hot water use
    - Year-round hot water use
  - Markets
    - Detention centers
    - Multifamily
    - Hospitals
    - Laundry, e.g. with elderly housing, assisted living
    - Facilities that can use HW + solar thermal absorption cooling
    - (Schools are not ideal unless they operate in summer)

# Solar Water Heating




- Solar thermal system equipment configuration based on proven technology (OG-100 certified and SRCC-rated equipment) with utility-grade metering and monitoring points across the system
- Ongoing measurement, reporting and optimization of energy savings delivery
- Internal billing software for delivery of price-indexed energy

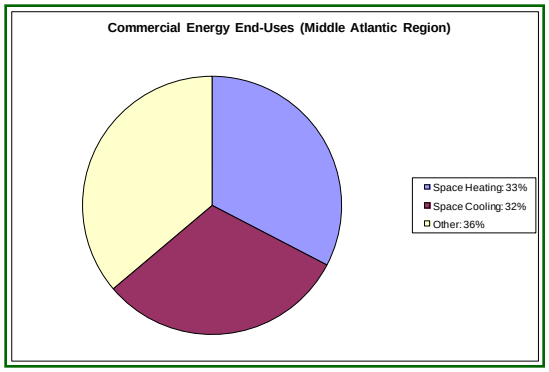
# Solar Water Heating

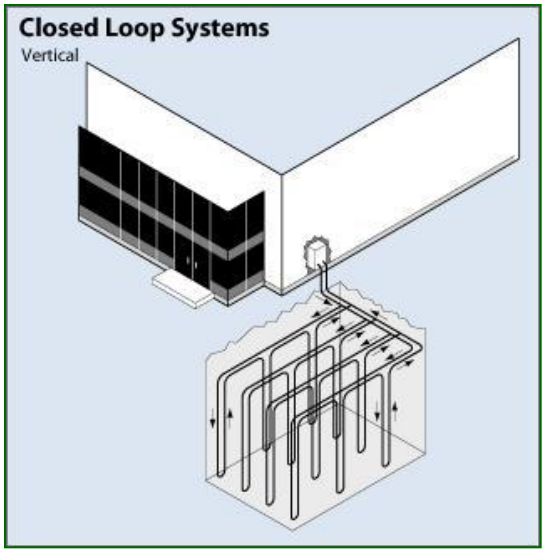



- Solar hot water priced at fixed discount (indexed) to utility rate
- No upfront cost to customer
- 10 year contract term
- Monitoring and maintenance included
- Opportunity to take ownership of system at end of contract and keep 100% of savings

# Geothermal Heating & Cooling

- In the RPS, counts for MSEC
- Eco-friendly heating and cooling
  - 2/3rd of a building's energy consumption
- Energy savings of 25-50%
- Vertical fields act as efficient heat exchanger with earth
- Heat pump uses 55ºF thermal energy to:
  - Cool during summer
  - Heat during winter
  - Heat water year-round



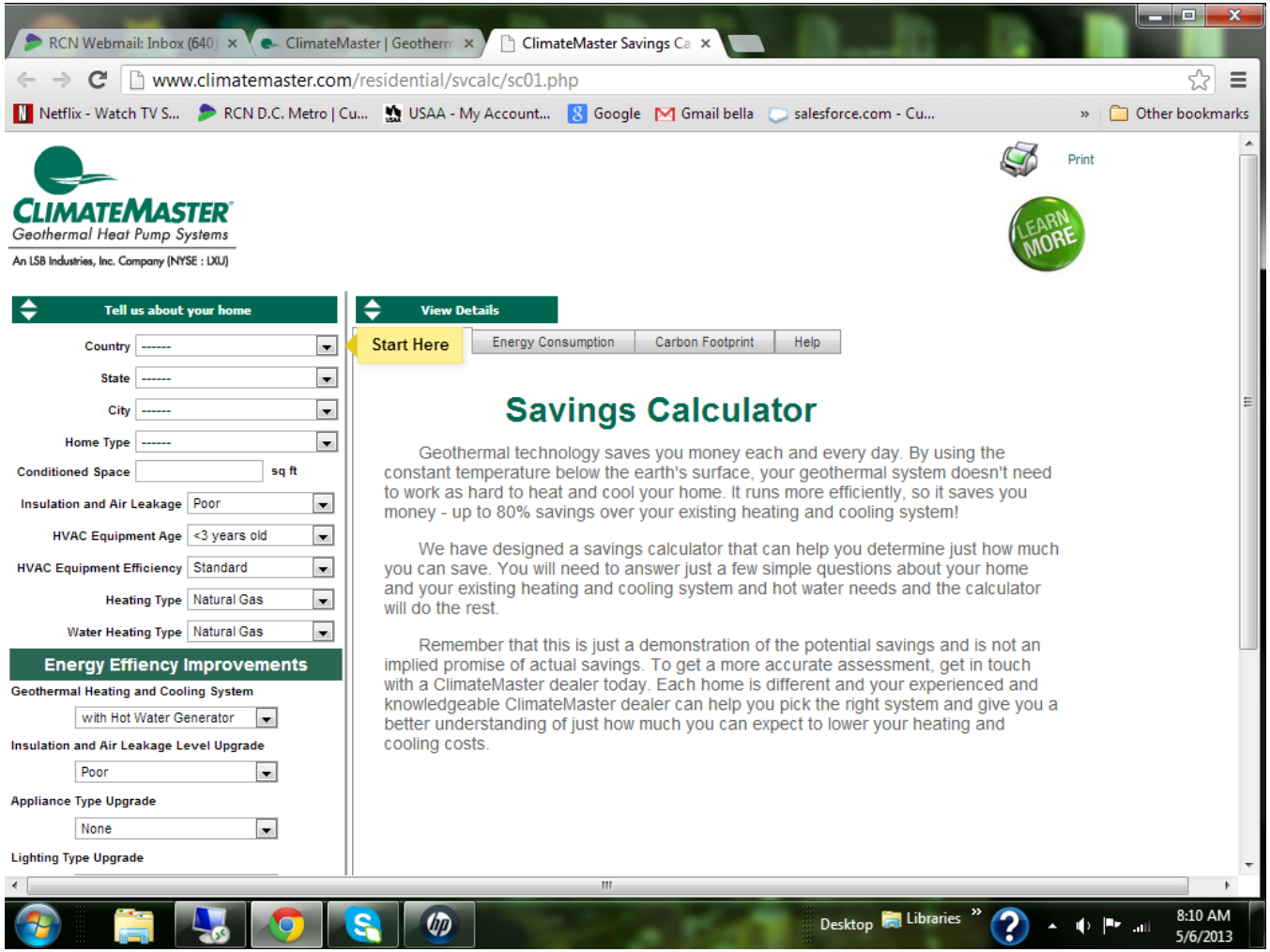
# Geothermal Heating & Cooling

- Proven technology
- ~14,000 tons installed in MD
  - Aberdeen Proving Ground (APG)
    - 634 wells/heat pumps
    - 2,853 tons
    - ESCO model = no upfront $ from APG
    - $600k/yr savings
  - Allegany College
  - McDaniels College
  - Annapolis Market House

# Geothermal Heating & Cooling

| 2012 GHC | Sector | Number of Grants | Award Amount | Total Project Cost | Tons | $/Ton |
|---|---|---|---|---|---|---|
| | Commercial | 4 | $17,000.00 | $204,501.00 | 37.25 | $5,489.96 |
| | Residential | 630 | $1,064,250.00 | $21,237,894.25 | 3,110.70 | $6,827.37 |
| **Grand Totals** | | **634** | **$1,081,250.00** | **$21,442,395.25** | **3,147.95** | **$6,811.54** |
| | | | | | | |
| 2011 GHC | Sector | Number of Grants | Award Amount | Total Project Cost | Capacity | $/Ton |
| | Commercial | 5 | $23,500.00 | $321,066.00 | 101 | $3,178.87 |
| | Residential | 600 | $1,117,250.00 | $19,281,499.38 | 2,836.60 | $6,797.40 |
| **Grand Totals** | | **605** | **$1,140,750.00** | **$19,602,565.38** | **2,937.60** | **$6,672.99** |
| | | | | | | |
| 2010 GHC | Sector | Number of Grants | Award Amount | Total Project Cost | Capacity | $/Ton |
| | Commercial | 2 | $3,500.00 | $31,417.35 | 7 | $4,488.19 |
| | Residential | 634 | $1,413,875.00 | $19,569,010.94 | 3,055.25 | $6,405.04 |
| **Grand Totals** | | **636** | **$1,417,375.00** | **$19,600,428.29** | **3,062.25** | **$6,400.66** |

# Geothermal Heating & Cooling

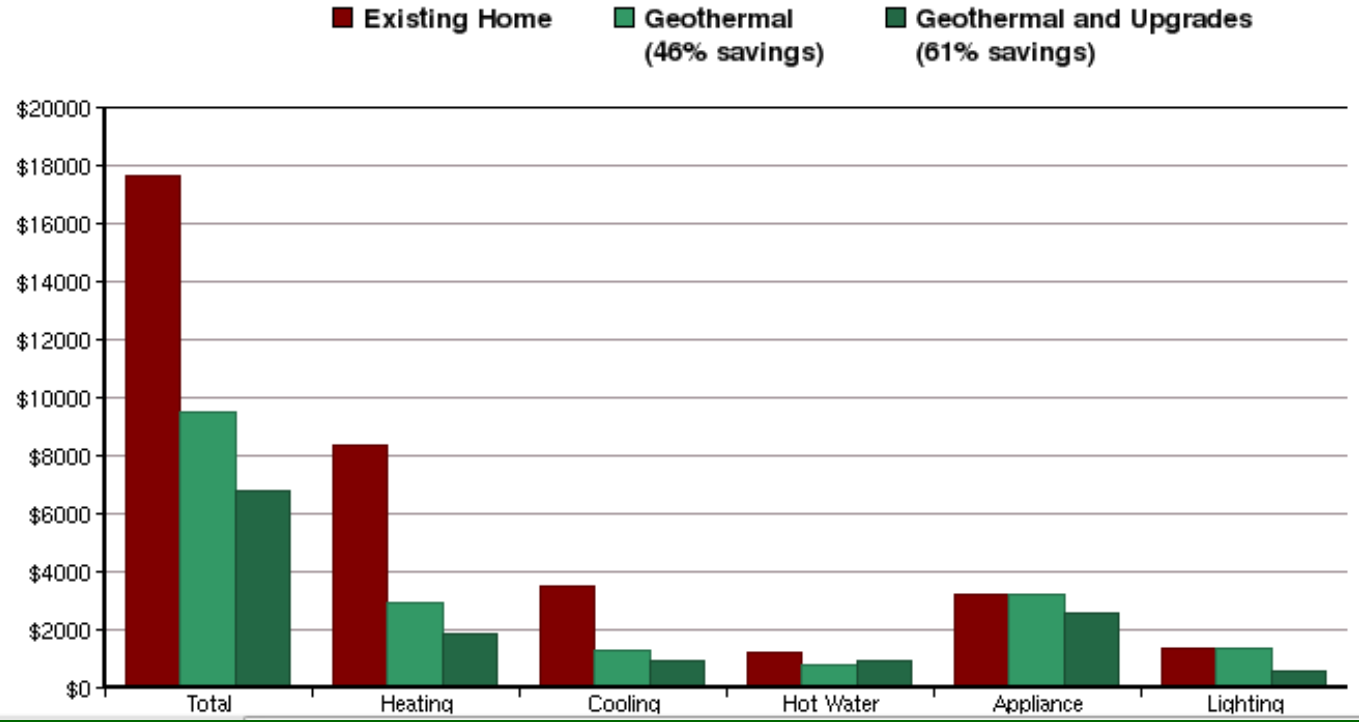



http://www.climatemaster.com/residential/svcalc/sc01.php

# Geothermal Heating & Cooling

## Annual Energy Costs

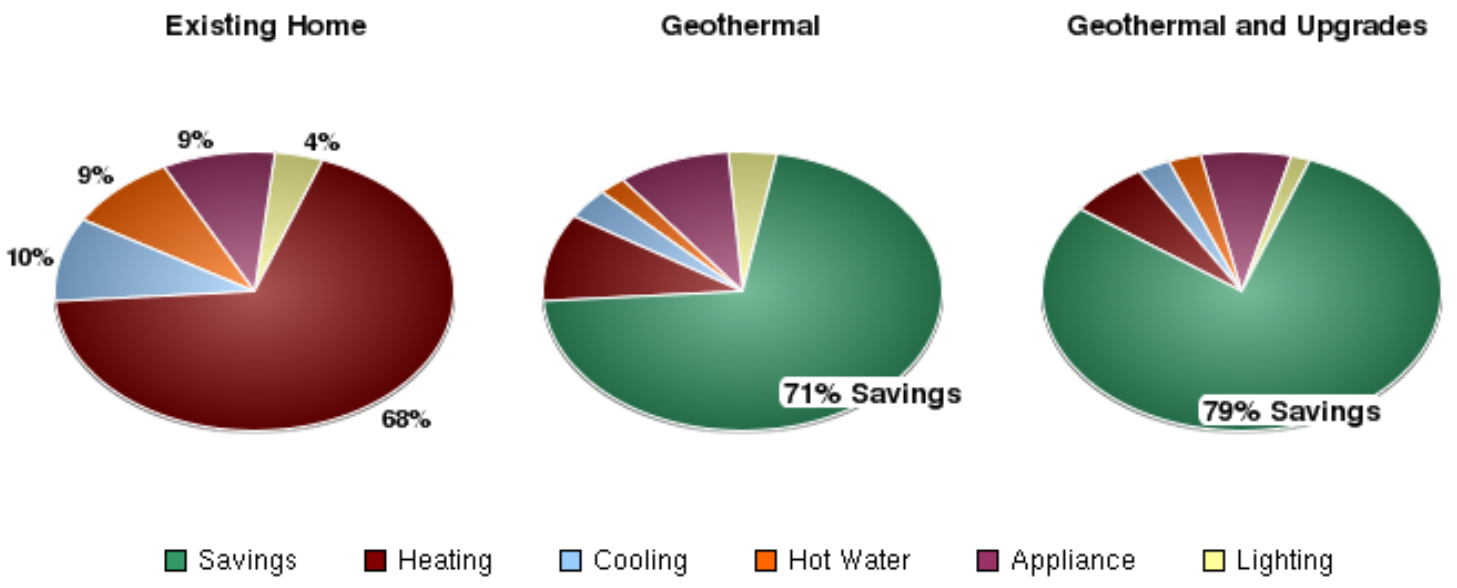
| | Total | Heating | Cooling | Hot Water | Appliance | Lighting |
|---|---|---|---|---|---|---|
| **Existing Home** | $17,653 | $8,346 | $3,520 | $1,228 | $3,192 | $1,367 |
| **Geothermal System** | $9,505 | $2,906 | $1,286 | $755 | $3,192 | $1,367 |
| **Geothermal System and Selected Upgrades** | $6,811 | $1,830 | $955 | $926 | $2,553 | $547 |



# Geothermal Heating & Cooling

## Annual Energy Consumption (Million Btu)

| | Total | Heating | Cooling | Hot Water | Appliance | Lighting |
|---|---|---|---|---|---|---|
| **Existing Home** | 836 | 571 | 81 | 75 | 76 | 33 |
| **Geothermal System** | 242 | 85 | 30 | 18 | 76 | 33 |
| **Geothermal System and Selected Upgrades** | 172 | 53 | 22 | 22 | 61 | 13 |



# Solar + Geothermal


- Richardsville (KY) Elementary
  - Nation's first Net Zero Energy School
  - Used green design, solar PV, geothermal heating & cooling
  - Exports excess electricity to the grid on annual basis

# Solar + Geothermal