

Smart Energy Audit: Office

Ramapo Energy Project

*A Project of Ramapo College of New Jersey
and the New Jersey Board of Public Utilities*



Office Basics

- ***Small Business Offices are good buildings to look at when trying to save energy and money.***
 - Millions of small business operate in the USA. With an average electricity use of 16.5 kWh/sq. ft./year, the potential for environmental and financial benefits from energy savings are huge.
 - The average small business office could achieve energy savings of 20-50% from just modifying lights and lighting habits. Simple and low or no-cost changes in ventilation, heating and cooling will also produce substantial savings, with no reduction in comfort.
 - Energy reductions from the use of computers and electronic equipment (computers, monitors, scanners, printers, copiers) are simple to achieve.
 - Legislation passed in 1996 has allowed businesses to deduct expenditures for equipment upgrades from their taxes.
- Source: *Putting Energy into Profits* (EPA ENERGY STAR, 20001, at <http://www.energystar.gov/ia/partners/publications/pubdocs/energyintoprofits%202001.pdf>)

Building Basics

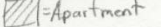
- 2 connected buildings, constructed in the 1940's or 1950's.
- Combination one and two-story building with utility basements and rented apartments upstairs.
- Approximately 2900 sq. ft. total utilized space.
- Main roof is flat, with a small overhanging roof over the entrance (which faces SW).
- The front of the building facing SW) has lots of windows, but the large overhang eliminates most solar gain throughout the year.
- Building generally in operation Monday through Friday, 9 – 5. There is occasional evening and weekend use.

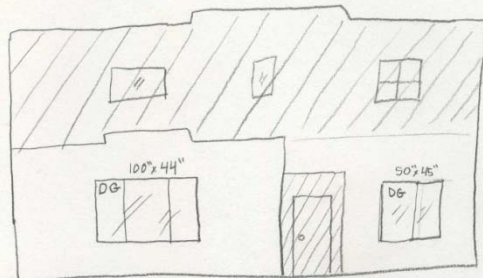
Building Energy Use

- Heating: 775 therms/year
- Cooling: approx. 14,500 kWh
- Other electricity (office equipment, lighting): 24,000 kWh
- H (heating index): 8.1 Btu/sq. ft./DD (degree day)
- Natural gas for heating and cooling; fuel oil for hot water.

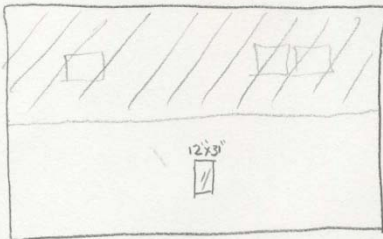
Façade Sketches

Orientation of Building (Include window and door location as well as vegetation and shading; indicate outdoor lighting fixtures):
North View of Building:

DG = New double Glazed
 = Apartment




East View of Building:
South West



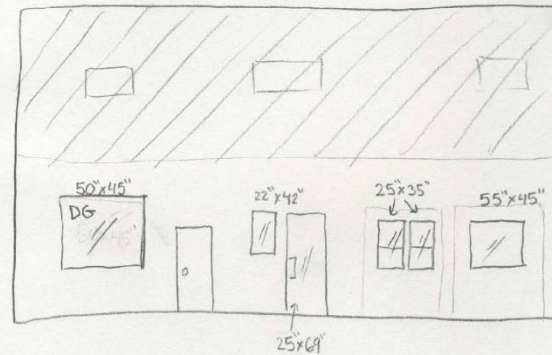
South View of Building (Pay particular attention to potential south facing roof space, tilt angle, shading, type of roofing, uninterrupted space on walls, places for attached sunspace or GH):

South East

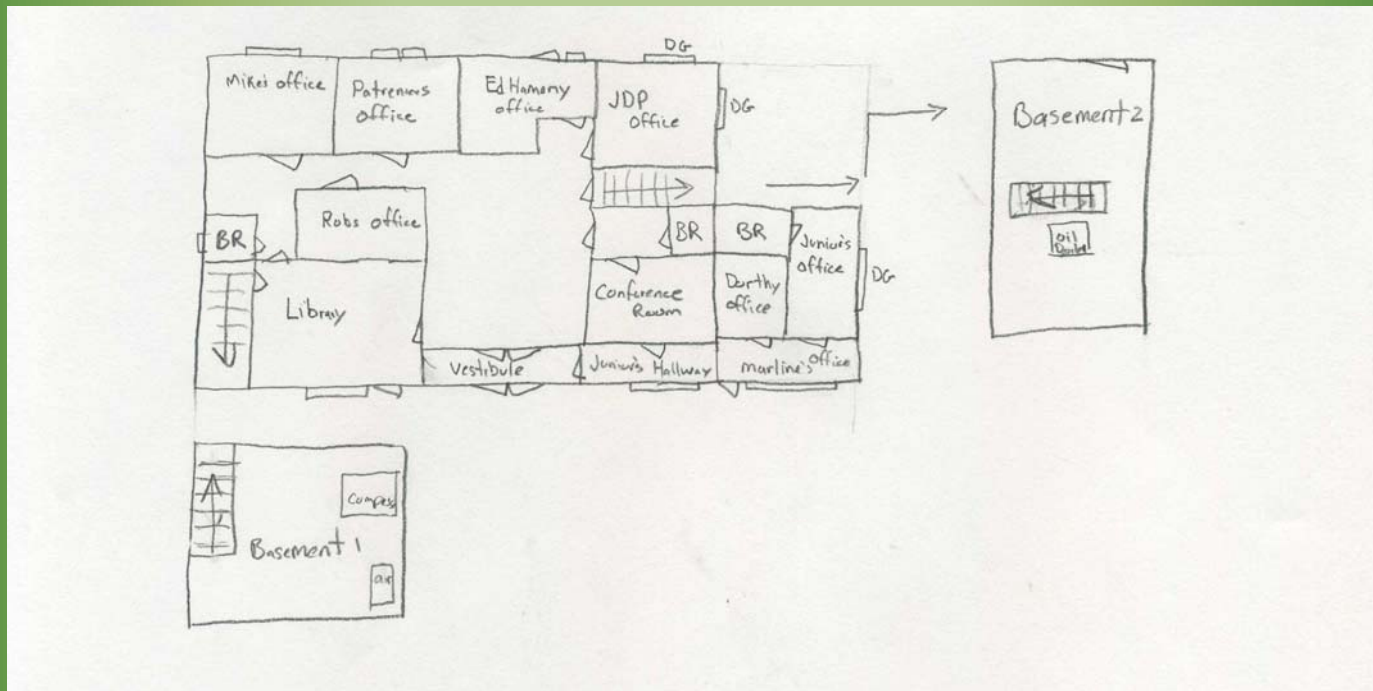
 = Apartment



North West View of Building:



Floor Plan Sketch



More on Façade/Envelope

- There is no vestibule; as a consequence, the waiting room, which connects through the entrance door to the outside, is often cold in winter. There is potential for a vestibule.
- Some of the windows were replaced with double-pane windows but the majority are single-pane.
- Weather stripping around some doors is poor and should be replaced.
- The building has no insulation; it is wood paneling and paint over drywall. The walls are made out of tapestry brick and stucco cement. This building was constructed in the 1940's or 1950's.
- Heat losses occur mostly through the roof, the single-glazed windows, the doors, and infiltration when the entry door opens.

The Roof

- There is no solar blockage of the building roof (flat) and the overhang roof across the front of the building.



HVAC Info

- **HEATING (air and water):** Ultra oil boiler Model # POBT-4 is located in single story basement. The water temperature is set to 190 degrees F and has a power rating of 143,500 Btu/hr (hot water for the entire building plus heating for one apartment). There is also a GE forced hot air, natural gas heating system with un-insulated duct work in the two story basement. This is tied into a compressor for cooling (law library and apartment). Natural gas fired unit on the roof is the primary HVAC for the law office (the entire first floor).
- **VENTILATION:** There is one fan in the woman's bathroom that turns on when the light in the bathroom is turned on. The HVAC unit on the roof mixes ventilation air into the ductwork.
- **AIR CONDITIONING:** HVAC compressor on roof. Also, compressor tied into natural gas furnace system.
- **DISTRIBUTION:** Warm and cool air distributed via ductwork in the law office. Baseboard heating in one apartment with window AC. Conditioned air distribution in the other apartment.

HVAC Info



Oil-fired heating unit for apartment on the SE side, providing both hot water and baseboard heat. This is located in the basement in the one story building. Hot water for the bathrooms in the law offices is also obtained from this unit. There is very little hot water use by the law office.



Heating and cooling gas-fired system is for both the law office library, and one apartment located in the 2nd floor. This unit is located in the basement below the 2nd story building.

HVAC Info



Compressor unit is located next to the furnace in the previous picture. There is a heat exchanger in the ductwork associated with this unit.



Ductwork from the natural gas fired heating and cooling unit in the basement below the two story part of the building. It is not insulated.

Temperature Control

- The thermostat is located behind a desk in the main office. Temperature is adjusted by staff members for comfort level. They attempt to keep the temperature set on 70 degrees F year round.



Lighting



Type of Light		Operating Hours
12 incandescent bulbs		Mostly occasional use (basement and desk lamps); 2 are on timers from 4:30 – 11 PM every day
3 candelabra incandescent bulbs		Occasional use (in a bathroom)
Desk lamp with 4 fluorescent bulbs		Occasional use
23 individual CFL bulbs		18 used during office hours 5 on timers from 4:30 – 11 PM every day
48 fluorescent fixtures w/4 bulbs each	34 W	Mostly office hours; occasional evening/weekend use 2 fixtures are only used 1 – 2 days a week

Appliances/Electronics

Appliance	Hours of Operation
2 space heaters	Used occasionally
1 copy machine	Used mainly during office hours
1 water cooler	Constant
1 microwave oven	Used occasionally
1 fax machine	Used mainly during office hours
1 Traulsen industrial refrigerator Model # ADT232NUT (4.2 amps)	Constnat
1 computer	Used 1 -2 days per week
10 computers	Used daily mainly during office hours
2 fax machines	
1 postage machine	Used occasionally
2 typewriters	Used occasinally
1 printer	Used 1 – 2 days per week.
9 printers	Used mainly during office hours

Audit Results – Likely Energy Savings!

Thermostats

- The programmable thermostats should be set during the heating season to drop to 60 degrees F when the office is closed, and to 68 degrees during hours of operation.
- In the warm weather, the thermostat should be set to 78 degrees F during occupied hours. HVAC units should be set to go on about 2 hours before a space is occupied, and go off an hour before it closes. These times can be adjusted if needed.
- Compared to a constant 72 degrees (current operation), the above action can save around 8-10% of the heating and cooling energy.
- This is a no-cost option since the programmable thermostats are already installed.

Audit Results – Likely Energy Savings!

Insulation

- A major problem for the building is that ***it has in essence no insulation***, which results in substantial heating and cooling loss. The walls have wood paneling over drywall. If the walls are ever replaced, 2" x 4" studs can be added with foam insulation. However, the walls are presently in good condition so this is not an immediate recommendation.
- The single-story lower roof of the office is in relatively poor condition and will need to be replaced or repaired in the near future. When it is replaced, you might consider adding insulation to the top of the existing roof, and then covering it with the new roof. Or it also might be possible to install foam insulation under the existing roof, but it may require some removal of existing materials. We suggest getting contractor estimates of feasibility and cost for this action.
- The upper roof above the apartments is in relatively good shape. Although we were unable to visually inspect from below, foamed-in-place insulation could likely be installed under this roof, with considerable energy savings for both heating and cooling. We again suggest getting contractor estimates of costs and savings for this action. For this upper roof, there are additional options that could include adding PV on top of the roof, or adding a white reflecting material that would reduce heat gain from the sun during the warm weather (see below for more on these options).

Audit Results – Likely Energy Savings!

Insulation

- The GE forced hot air, natural gas heating system has un-insulated duct work in the basement. This duct work should be insulated. The duct tape which seals the duct work together is old and should be replaced with mastic or aluminized tape. There are also some small holes present in this duct work which should be sealed with the mastic as well. These are relatively low-cost one time actions.
- The hot and cold pipes on the hot-water tank should be insulated. The tank should be wrapped with additional insulation, taking care not to interfere with the burner and necessary air flow.



Audit Results – Likely Energy Savings!

Insulation/Weather Stripping

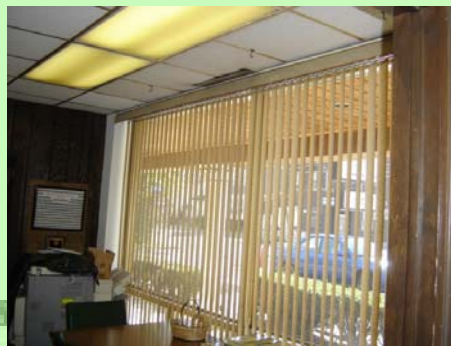
- In an adjacent little-used office, the door has poor weather-stripping and lots of air leakage. All doors should have effective weather-stripping
- Until double-glazed windows are installed, a few options can reduce heat loss in the winter. Windows should be checked for drafts, and new caulking applied to prevent the air leakage. You also can add another glazing to the single glazed windows, either glass or solid plastic, or add a low-E window film on the inside to reduce losses. Heavy curtains and/or cellular shades may also reduce heat loss, but at substantially greater expense.



Audit Results – Likely Energy Savings!

Windows

- There are a large number of windows that are single-glazed, particularly facing the main street, causing a large heat loss during winter months, and a large heat gain during summer months. The most cost-effective way to reduce these losses is to replace the existing, single-glazed windows with gas-filled, double or triple pane windows with a low-E coating. Also (see below) , creating a sunspace/vestibule on the front of the building can reduce heat loss and also provide solar heating.



Audit Results – Likely Energy Savings!

Vestibule

- There is no vestibule at the entrance of the building which allows the cold air from the entry door to blow directly into the client waiting area and surrounding offices, significantly lowering staff and client comfort, as well as causing a significant heating (and cooling) energy loss.
- This problem can be solved by adding a small glass-based or plastic-based vestibule to the front of the building entrance which would mitigate cold air entry as well as gain useful solar energy in the winter to help keep itself warm. By keeping its construction back two feet from the existing overhang, the vestibule will be shaded in summer to avoid overheating.



Audit Results – Likely Energy Savings!

Vestibule Alternative—Sunspace

- A possible single fix to the single-glazed window heat loss, the lack of a vestibule, and to provide additional heating, would be to enclose the entire area on the front of the building with mostly transparent material (essentially creating a large sunspace).
- With over 300 ft² or more of “window” area, the space would gain the equivalent of about 250 million Btu over the heating season, but also be shaded by the 2 foot overhang in warmer weather.
- A few small fans activated by thermostats can bring the warm air into the building whenever the temperature is greater than 78 degrees F. Openable vents at the top and bottom of the front of the sunspace or a temperature-operated fan can be used for venting during the summer, as needed.



Audit Results – Likely Energy Savings!

Lighting

- Multiple light bulbs throughout the office are out and need to be replaced. These bulbs should be replaced with energy-efficient fluorescent light or CFL bulbs where possible.
- Where fixtures are replaced, maximum savings can be achieved by replacing with more efficient T8 or T5 fluorescent lights. We suggest getting an estimate from a lighting contractor that would include:
 - measuring existing foot candle levels on working surfaces to see if intensities could be lowered somewhat, and
 - providing estimates of cost and payback times for replacing existing fixtures with T8 and/or T5 fluorescent bulb fixtures.

Audit Results – Likely Energy Savings!

Lighting

- The conference room and library are used on and off throughout the day depending on scheduling. A conscious effort should be made to turn these lights off when the rooms are not in use, or to put them on a heat or movement sensor control.
- Outside lighting can be put on a light-sensor control rather than a timer, and the most efficient bulbs can be installed.
- Inefficient lighting not only increases power usage, but the waste heat generated increases air conditioning loads in the warmer weather when prices for electricity are the highest. Improvements in this area thus provide multiple and substantial energy savings.



Audit Results – Likely Energy Savings!

HVAC

- The existing oil boiler for heat and hot water is likely very inefficient, particular when only used to provide hot water in the warmer weather. The aquastat setting should be reduced from 190 degrees F to a lower, but still acceptable ,setting.
- A solar hot water heater, coupled with an electrical backup, might be a possible alternative for hot water production (see below).



Audit Results – Likely Energy Savings!

Computers

- Computers should be shut down fully when the library is closed. This can simply be done by putting them on power strips which are turned off when the library closes.
- To avoid unneeded power use, computers can also be put in a “sleep” mode when not performing tasks. Simple options in the computer’s Control Panel activate this feature.
- Isolated printers can be put on a separate power strip and turned on only when used.
- Computers not only use power, but they increase the air conditioning loads in warm weather.



Audit Results – Likely Energy Savings!

Solar Hot Water

- The upper-level flat roof has good solar access for solar hot water. Since the office owner is also the owner of the apartments above the office, this is an option the owner should consider.
- For the two apartments and the office hot water needs, a solar hot water system consisting of 2-3 panels and an 80-120 gallon storage tank would likely suffice. This system would produce about 75% of the hot water needs over the year. .
- There are state and federal tax credits and deductions that significantly reduce the cost of this option. (See the Smart Energy Audits website for links to up-to-date information on credits, rebates and subsidies)
- Payback times are typically 6-10 years depending on the existing energy source and the hot water price.



Audit Results – Likely Energy Savings!

Solar Photovoltaics

- The upper-level flat roof and the lower roof have good solar access, and photovoltaic solar panels for electricity could be installed on part of the roof, either in flat configuration or in a tilted configuration.
- While initial cost for installation are high, there are financial incentives such as subsidies and tax credits from the state of New Jersey and from the federal government that can reduce costs. Moreover, generating solar electricity generates yearly income (in the form of an SREC, a Solar Renewable Energy Certificate). Additional financing options exist, some of which require no money down with monthly payments based on the productivity of the solar energy equipment.
- We recommend that most other items listed should be considered first since their payback times are likely to be a lot shorter.
- ***A detailed photovoltaic analysis follows.*** PV, it should be noted, can be installed over time, with a small array to start that is augmented later.



Audit Results – Likely Energy Savings!

PV Analysis -- Site Information:

Inspection Date: December 2007

Usable Roof Area:

Roof A: Height: 18', Width: 28'

Roof B: Height: 17', Width: 20'

Roof Pitch: Flat

Array Direction: South West

Roof Obstacles: none

Array Shading Analysis: No shading issues

Proposed System Information:

Panel Recommendation: Evergreen 190 watt panels, Width: 38", Height: 62"

System Size/Configuration:

Roof A & B:

-15° tilt

-panels in landscape mode

- mounting system: low profile rack with penetrations into roof support structure

Audit Results – Likely Energy Savings!

Roof A:

- 20 panels, totaling 3800 watts (190 watts * 20 panels)
- estimated output: 4300 kWh/year
- estimated Carbon Dioxide Reduction: 6100 lbs in first year

Estimated Electric Rate (kWh) \$0.14

Estimated Electric Savings (per year) \$607.18

Estimated SRECs (per year)* 4

Estimated SREC Value* \$500

Estimated SREC Income (per year)* \$2,000

Estimated First Year Savings \$2,607.18

Estimated System Cost (per watt): \$9.00

Estimated Total System Cost: \$34,200.00

Federal Tax Credit %** 0.30

Federal Tax Credit Value** \$10,260

Post Incentive Cost** : \$23,940

** SREC values and length of time that systems may accrue SRECs are subject to the New Jersey Board of Public Utilities and the NJ Clean Energy Program*

See <http://www.NJCEP.com>

***See below and Smart Energy Audits Website for info on Federal incentives and tax credits.*

Audit Results – Likely Energy Savings!

Roof B:

- 12 panels, totaling 2280 watts (190 watts * 12 panels)
- estimated output: 2675 kWh/year
- estimated Carbon Dioxide Reduction: 3836 lbs (first year)

Estimated Electric Rate (kWh)* \$0.14

Estimated Electric Savings (per year) \$374.50

Estimated SRECs (per year)* 3

Estimated SREC Value* \$500

Estimated SREC Income (per year)* \$1,500

Estimated First Year Savings \$1,874.50

Estimated System Cost (per watt): \$9.00

Estimated Total System Cost: \$20,520.00

Federal Tax Credit %** 0.30

Federal Tax Credit Value** \$6,156

Post Incentive Cost** : \$14,364

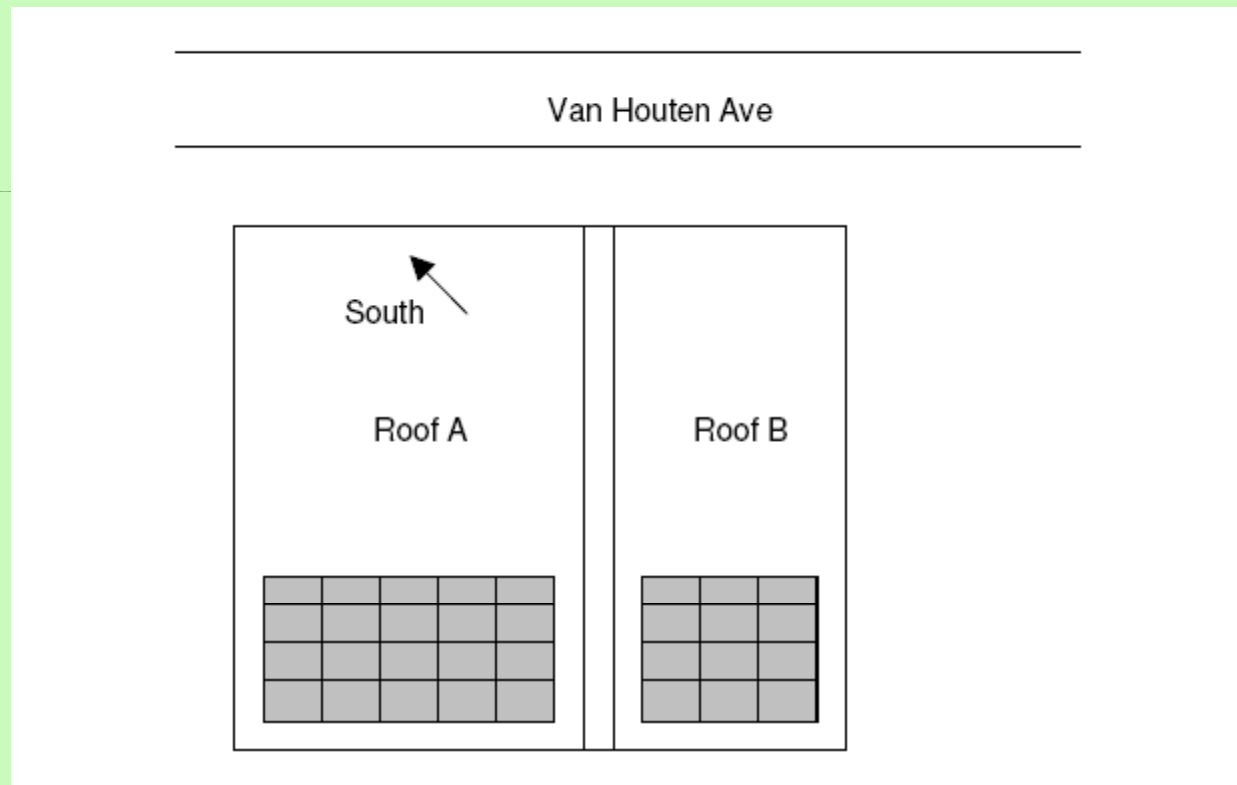
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Audit Results – Likely Energy Savings!

Schematic Diagram



Audit Results – Likely Energy Savings!

Photovoltaic Analysis – Financial Incentives and Benefits

- New Jersey Clean Energy Program Website: <http://www.NJCEP.com>. Offers detailed information on incentives, rebates and financial benefits that New Jersey's Clean Energy Program offers to New Jersey residents for purchasing renewable energy. Detailed and up-to-date information is available on Solar Renewable Energy Credits, a major financial asset for producers of solar energy.
- Federal Tax Incentives: The Energy Act of 2005 includes tax incentives for PV systems. Photovoltaic systems may be eligible for a federal tax credit of up to 30%. Please contact your tax professional to determine your eligibility for this credit. A detailed document, titled, "Guide to Federal Tax Incentives for Solar Energy" has been compiled by the Solar Energy Industries Association (SEIA). This guide can be obtained at <http://www.seia.org/manualdownload.php>.
- The Smart Energy Audit website offers detailed resources on both renewable energy and energy efficiency – visit TK.

Audit Results – Likely Energy Savings!

Roof

- If solar photovoltaics are not installed, the building owner should consider placing a light-colored reflective roof coating on the roof, when the roof needs to be resurfaced. This will reduce summer cooling loads.



The End...

- The Smart Energy Audit team hopes you found this detailed audit helpful!
- If viewing this on the Smart Energy Audit Website , please use the links at left to obtain more information.
- Detailed Photovoltaic Audit performed by SEA Audit team member:
 - Charles Virga
 - *Choose Green Energy LLC*
 - 100 Manhattan Ave #611
 - Union City, NJ 07087
- Detailed audit performed by SEA audit team members Danielle Ersalesi, Nicholas DeCristofaro, and William Makofske, Ph. D.