

Smart Energy Audit: House of Worship

Ramapo Energy Project

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



House of Worship Basics

- ***Houses of worship are good buildings to look at when trying to save energy and money.***
- According to the U.S. Department of Energy, if each of the nation's approximately 307,000 religious worship buildings cut its energy use and costs 25%:
 - More than 13,500,000,000 kWh of electricity would be available with no new power plants.
 - More than 5 million tons of CO₂ emissions would be prevented.
 - AND, congregations would save nearly \$500,000,000 to spend on other priorities.
- Source: *Stewarding energy in your house of worship* (2000), at <http://www.greenfaith.org/programs/stewardship/energy-HouseofWorship.pdf>

Building Basics

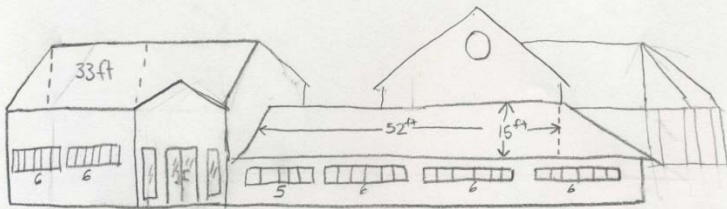
- 3 connected buildings: main building built in the 1960's, two wings built late 1990's
- One-story building, with some high ceilings
- 5500 sq. ft., total
- Angled roofs (25° – 35°), covered in shingles
- 20,320 kWh per year
- 7,863 therms of natural gas per year (786 million Btu)

Building Basics

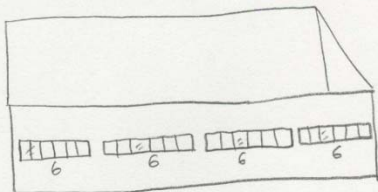
- Main entrance faces east; school entrance faces north
- Hours of Operation:
 - Monday –Friday: 9 AM – 5 PM
 - Sat: 8 AM – 2 PM
 - Sunday: 8 AM – 1 PM
 - *Classrooms are only used Sunday - Tuesday*
 - *Maintenance personnel use building M – F, 6 – 9 AM*

Façade Sketches

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):



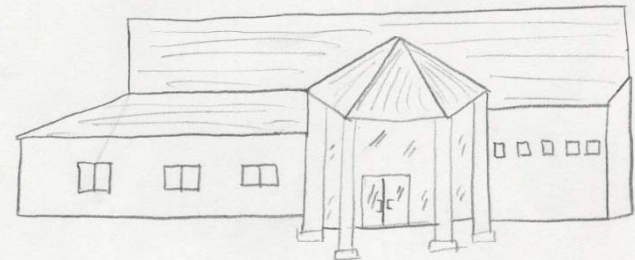
West View of Building:



North View of Building:



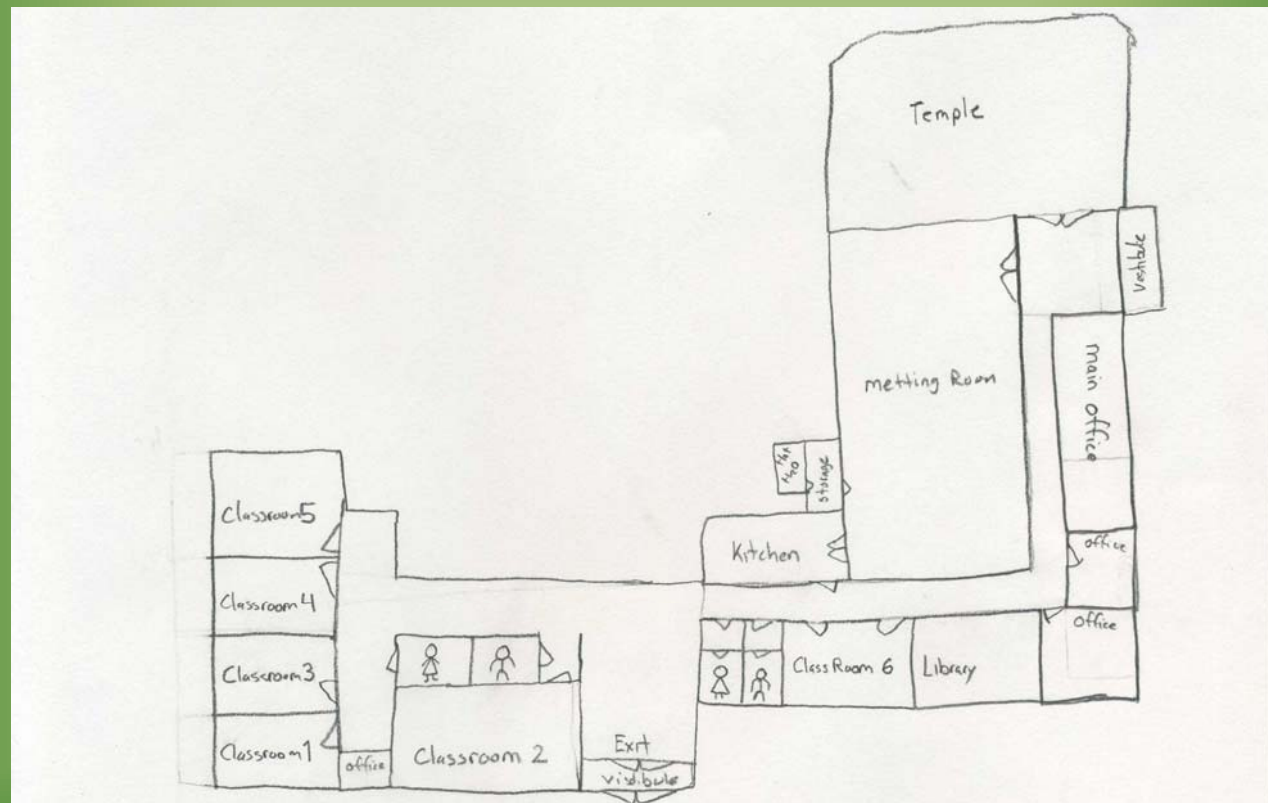
East View of Building:



More on Façade

- There are two vestibules: one connecting the “Old Building” wing to the new “School” wing and one at the main entrance to the temple on the east side. The vestibule that connects the “Old Building” wing to the “School” wing has a large gap underneath the doors.
- Windows on N, S, E and W exposures.

Floor Plan



The Roof

- Roofs are angled (25° – 35°) and shingled
- South-facing roofs on Old and School wings



HVAC Info

- **HEATING:** Gas-fired HVAC unit on roof, and two Lennox pulse heaters in the utility room above the janitor's closet.
- **VENTILATION:** Commercial ventilation fan above the large gas-fired kitchen stove. Presumably, HVAC system circulates air with heating and cooling air.
- **AIR CONDITIONING:** HVAC roof units, installed 8 years ago so likely pretty good.
- **DISTRIBUTION:** The building has an air distribution system with duct work that circulates both warm and cool air. All duct work appears to be insulated but leakiness not tested or observed.

Water Heating

- Natural gas
- 67-gallon tank, Ruud Model # RFD67-120-1 (Recovery: 109.1 GPH)
- Note: Although they have this hot water heating system, none of the checked hot water temperatures at faucets appear to be different from the cold settings. ***The system appears to be not working.***

Temperature Control

- The office staff informed us that the three sections of the building all have their own zones. These are set and not changed unless there is a clear emergency.
- The thermostat is set by the HVAC maintenance man and goes down at night. No one touches these settings throughout the normal work day.

Building Envelope and Insulation

- Façade is brick. There is no evidence of any insulation in the walls but there could be some between block and brick (unlikely).
- Windows and doors appear to be new and in good condition.
- The windows are Anderson KW double glazed casement windows; model # NFRC001-002 high pressure.

Building Envelope and Insulation

- The roof in the school wing appears to have fiberglass insulation present right above the suspended ceiling. The vapor barrier is facing down and it appears to be installed tightly. The ductwork in the school wing is insulated.

- It would appear that the Old Building has a **broken air barrier** that negates the value of the insulation and is very leaky. The two newer wings connect to this part of the building, both in the lived-in spaces, and above the ceiling. **The new wing's insulation is being bypassed by the air flow and is mostly ineffective. The suspended ceiling is the only barrier to the outside and it leaks air as well.**
- **Repairing this is the top priority for the building.**



very leaky. this part of spaces, and **insulation is and is mostly ceiling is the it leaks air**



Lighting



Type of Light		Operating Hours
36 sodium single bulb fixtures		On timer from
2 fluorescent box lights		On timer from
2 circular lights		On timer from
21 fluorescent fixtures w/2 bulbs each	32 W	Infrequently
20 fixtures with 1 small incandescent bulb and 1 large bulb each		Sun, Mon, and Tues
20 fluorescent fixtures w/3 bulbs each	32 W	Sun, Mon, and Tues
3 fluorescent fixtures with 2 u-shaped bulbs each		Sun, Mon, and Tues
36 fluorescent fixtures w/4 bulbs each	32 W	7 days a week
1 fluorescent fixture w/2 short bulbs		7 days a week (On motion sensor)

Appliances/Electronics

Appliance	Hours of Operation
1 computer	Sun, Mon, and Tues
1 copy machine	Sun, Mon, and Tues
1 desk lamp	Sun, Mon, and Tues
1 electric stapler	Sun, Mon, and Tues
1 industrial stove	Used periodically on Sat. by caterers
1 Traulsen industrial refrigerator Model # ADT232NUT (4.2 amps)	Used daily
1 Sharp Microwave Model # R55TS	Used daily
1 water cooler	Used daily
3 computers	Used daily
2 fax machines	
1 postage machine	
1 typewriter	
1 T.V.	
2 printers	Used daily

Audit Results – Likely Energy Savings!

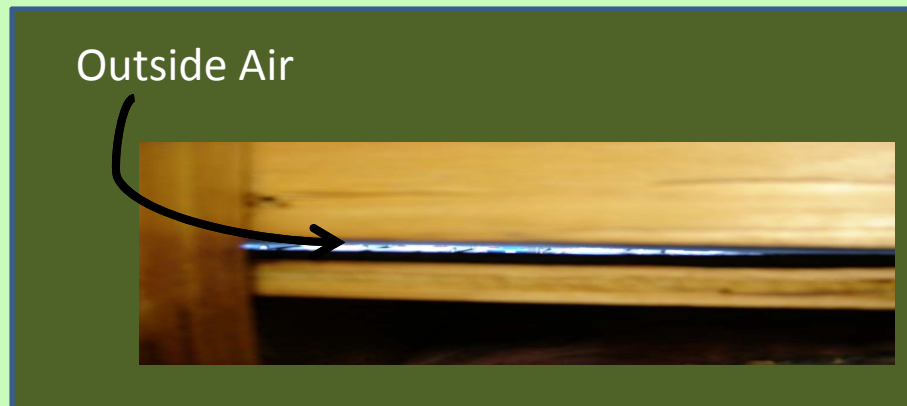
Thermostats

- The programmable thermostats should be set during the heating season to drop to 60 degrees F when the synagogue 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 found in the HVAC equipment room in the old building above the janitor closet. That space has many leakage areas directly to the outside, and there are many large connections to the inside of the building. ***The air leakage means that all the insulation is being bypassed as the warm air leaks through the suspended ceiling and other exit paths, around the the outside.*** out pulls other areas
- From what it appears and temple wings of the building have adequate thermal and air barriers. ***However, since all three parts of the building are connected through both the occupied areas and above the ceilings, the lack of a well defined air and thermal barrier in the old building is compromising the thermal integrity of the rest of the building.***



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Warm air leaking cold air in from of the building.

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Audit Results – Likely Energy Savings!

Insulation

- We suggest that you have a HVAC contractor examine the existing situation, and make recommendations for sealing and re-insulating as needed above the old building, and that the existing HVAC room above the janitor closet be isolated from the building, with outside air being brought in for combustion as needed.
- ***This is a high-priority and cost-effective action.***

Audit Results – Likely Energy Savings!

Lighting

- Newer lighting fixtures and bulbs are quite a bit more efficient than older ones. In particular, T8 and T5 fixtures and bulbs are currently recommended for both new and retrofit lighting.
- 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 bulbs.
- 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. This usually makes lighting upgrades a smart choice for energy upgrades.



Audit Results – Likely Energy Savings!

Hot Water Heater

- The gas-fired hot water heater appeared to be not working when we visited. Unit can be repaired and put on a timer.
- The hot and cold pipes on the tank should be insulated. The tank should be wrapped with additional insulation, taking care not to interfere with the burner and necessary air flow.
- Thermostat setting should be no higher than 120 degrees F.
- Insulation savings should be about 10%.
- Relatively low-cost one-time actions.



Audit Results – Likely Energy Savings!

Exit Signs

- The exit signs should be replaced with LED lights and fixtures.
- Typical paybacks for this are 1-2 years depending on whether you are currently using incandescent or fluorescent lights.
- EPA Fact Sheet:
http://www.energystar.gov/ia/business/small_business/LED_exit_sign_tech.doc



Audit Results – Likely Energy Savings!

Computers

- Computers should be shut down fully when the building is closed. This can simply be done by putting them on power strips which are turned off when the building closes.
- To avoid unnecessary power use, computers can also be put in a “sleep” mode when not in use. 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. Thus, reducing unneeded computer power consumption brings substantial energy savings.



Audit Results – Likely Energy Savings!

Refrigerator/Freezer

- The commercial refrigerator/freezer is a large user of electricity. As it approaches 10-15 years of operation, or should it break down, you should investigate the energy and dollar savings from a new model, replacing it at the first opportunity with an Energy Star rated refrigerator.



Audit Results – Likely Energy Savings!

HVAC

- While we did not examine the HVAC rooftop units, they appeared to be relatively new (< 10 years old). As part of the yearly maintenance, we recommend that the service contractor measure their efficiency. When they reach their useful lifetime, new HVAC units are likely to be much more efficient.
- Also, ***by fixing the thermal barrier problem in the roof of the old building, it is likely that a smaller unit will be able to service the building.***

Audit Results – Likely Energy Savings!

Roof/Photovoltaics

- The existing roof appears to be in good condition.
- ***The orientation and angle of part of the roof is excellent for adding photovoltaics. There is essentially no shading on the almost south-facing roof surfaces.***
- 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 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: 19', Width: 40'

Roof B: Height: 19', Width: 55'

Roof Pitch:

Roof A: 25 degrees

Roof B: 15 degrees

Array Direction: South East

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:

- panels in portrait mode
- mounting system: flush mount

Audit Results – Likely Energy Savings!

Roof A:

- 36 panels, totaling 6840 watts (190 watts * 36 panels)
- 12 columns, 3 rows
- estimated output: 8664 kWh/year
- estimated Carbon Dioxide Reduction: 12,427 lbs in first year

Estimated Electric Rate (kWh) \$0.11

Estimated Electric Savings (per year) \$953.04

Estimated SRECs (per year)* 8

Estimated SREC Value* \$500

Estimated SREC Income (per year)* \$4000

Estimated First Year Savings \$4,953.04

Estimated System Cost (per watt): \$8.25

Estimated Total System Cost: \$56,430

** 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>*



Audit Results – Likely Energy Savings!

Roof B:

- 51 panels, totaling 9690 watts (190 watts * 51 panels)
- 17 columns, 3 rows
- estimated output: 12,003 kWh/year
- estimated Carbon Dioxide Reduction: 17,215 lbs (first year)

Estimated Electric Rate (kWh)* \$0.11

Estimated Electric Savings (per year) \$1320.33

Estimated SRECs (per year)* 12

Estimated SREC Value* \$500

Estimated SREC Income (per year)* \$6000

Estimated First Year Savings \$7,320.33

Estimated System Cost (per watt): \$8.00

Estimated Total System Cost: \$77,520

** SREC values and length of time that may accrue SRECs are subject to the New Jersey Board of Public Utilities NJ Clean Energy Program
See <http://www.NJCEP.com>*



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 SolarEnergy" has been compiled by the Solar Energy Industries Association (SEIA). This guide can be obtained at <http://www.seia.org/manualdownload.php>.
- Our Smart Energy Audit website offers detailed resources on both renewable energy and energy efficiency.

Audit Results – Likely Energy Savings!

Last Words...

- The roof has good solar access for solar hot water. However, given the minimal use of hot water in the synagogue, this is not recommended at the present time.
- There are gaps around the doors that allow air leakage in the vestibules. Weather-stripping may be added to reduce this air leakage. This is typically highly effective and cost-efficient.

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.