New York State Energy Research and Development Authority

Residential Technical Assistance Program

<u>ENERGY USE ASSESSMENT</u>

HIGH RISE APARTMENT BUILDING
UPPER WEST SIDE, NYC

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New York Energy Smart
Public Service Commission
NYSERDA

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Executive Summary

This report presents the results of an energy use assessment performed for
residential cooperative building located on Manhattan's Upper West Side. The purpose of the assessment is to investigate and identify cost effective energy conservation measures and to make recommendations for their implementation. The Scope of Work of this report includes only measures which are cost effective on the basis of simple payback and savings to investment ratio (SIR), and which will result in substantial reductions in the building's energy use. The costs and savings described herein are estimates, and as discussed in our disclaimer, are subject to uncertainties that are difficult to quantify.

The building is a cooperative, and shareholders are responsible for the interiors of their apartments and all appliances. Accordingly, implementation of in-apartment measures must be considered voluntary. We have presented such measures in the body of the report where appropriate, in addition to common area measures, but recognize that their implementation may be problematic. The presence of these recommended measures in this audit imposes no restrictions on but simply indicates available, cost-effective options. Clearly, if they are not implemented, total savings will be less than projected below.

The comprehensive list of energy efficiency measures for the facility developed by CEC is presented below in a Scope of Work and a table of Expected Costs and Savings for each measure. Important components include:

- A gas-fired condensing boiler for domestic hot water,
- Energy Management System & Thermostatic Radiator Valves,
- Occupancy Sensors on lighting, and
- Closure of building air leaks.

The results summarized in the following table include only the energy efficiency measures with SIR greater than 1; they are projected to lower fuel use by 24% and electric use by 4%.

We also examined solar hot water, and photovoltaic production of electric power. Neither were cost effective, even including available subsidies and tax credits, and we do not recommend them at this time. Discussion with building representatives led to the omission of a cogeneration system in favor of the domestic hot water project.

Project Summary- 250 West 94th Street

Total Investment:	$270,318	Payback Period:	6.7 years
Annual Savings:*	$40,269	Savings to Investment Ratio:	1.68
	5,170 million Btu	Net Life Cycle Savings:	$184,565
Summer Peak	55,362 kWh	Discounted at 3.0% over	14 years
Demand Reduction:	1.6 kW		
New Gas:	-1,704 million Btu	(New purchases for DHW conversion)	

* "Annual savings" figure includes all interactive effects, but excludes "new gas" consumption of proposed DHW conversion

Proposed Scope of Work

	Measure	Details	Estimated Installed Cost
Measures to be undertaken by building, savings accrue to building:			
1	**Energy Management System**	TREAT	
	Provide better control of heating system		$ 25,700
2	**Thermostatic Radiator Valves** Control local heating imbalances	TREAT	$ 30,000
3	**Low Flow Showers & Faucets** Reduce usage with high quality fixtures	TREAT	$ 7,350
4	**Seal Elevator Penthouses** Eliminate drafts due to current openings	TREAT	$ 12,000
5	**Weatherstrip doors** Reduce infiltration of outdoor air	TREAT	$ 250
6	**Bilevel Lighting in Common Areas** Occupancy sensors in halls, stairwells, & elevators	TREAT	$ 19,800
7	**Bilevel Lighting in Basement** Occupancy sensors in hall, laundry, work areas	TREAT	$ 7,200
8	**Light Switch Improvement** Move switches to accessible locations	TREAT	$ 300
9	**Upgrade Exit Lights** Replace old fixtures with LED-based signs	TREAT	$ 1,800
10	**Upgrade Washing Machines** Energy Star units where applicable	TREAT	$ 6,300
11	**Condensing gas fired DHW** Separate domestic hot water system	Text, estimate	$ 109,010
Measures where savings accrue to residents:			
12	**None Included** Implementation very unlikely	TREAT	$ -
	Estimated Construction Cost		$ 219,710
	Contingency @	15%	$ 32,957
	Construction Management @	8.03%	$ 17,652
	Total Estimated Project Cost:	....	$ 270,318

Installed Cost and Annual Savings

	Measure	Installed Cost	Energy Savings		Demand Savings	Cost Savings	Pay Back	SIR	Life Cycle Savings	Life
			mmBtu	kWh	kW		years			years
Measures to be undertaken by building; savings accrue to building:										
1	Energy Management System	$25,700	1,094	137	-	$10,549	2.4	4.9	$100,233	15
2	Thermostatic Radiator Valves	$30,000	469	59	-	$4,521	6.6	1.8	$23,971	15
3	Low Flow Showers & Faucets	$7,350	403	51	-	$3,886	1.9	4.5	$25,798	10
4	Seal Elevator Penthouses	$12,000	216	25	-	$2,081	5.8	2.6	$18,960	20
5	Weatherstrip doors	$250	29	6	-	$279	0.9	9.5	$2,130	10
6	Bilevel Lighting in Common Areas	$19,800	-77	37,191	1.27	$5,024	3.9	2.2	$23,056	10
7	Bilevel Lighting in Basement	$7,200	-31	14,706	0.17	$1,985	3.6	2.4	$9,732	10
8	Light Switch Improvement	$300	-3	1,347	0.12	$182	1.6	9.0	$2,408	20
9	Upgrade Exit Lights	$1,800	-4	1,815	-	$245	7.3	1.2	$290	10
10	Upgrade Washing Machines	$6,300	222	26	0.00	$2,136	2.9	4.0	$19,199	15
11	Condensing gas fired DHW	$109,010	2,851 (oil) -1,704 (Gas)	0	-	$9,381	11.6	1.0	$2,981	15
Measures where savings accrue to residents:										
	None Included									

Notes on Installed Costs and Energy Savings

1) All cost estimates are based on contractor installations unless otherwise noted. Installed costs may be reduced if the owner implements any of these measures in-house.

2) Most of the energy savings presented in this table are part of the package calculated by TREAT and they are cumulative and include interactive effects. For measures studied outside of TREAT (e.g., cogeneration), interactive effects have been included on a case-by-case basis.

3) The lighting upgrade savings do not include bulb savings.

4) For this analysis the average cost of natural gas is $1.48/gallon ($9.62/million Btu) and the average cost of electricity is $0.155/kWh; these rates are what the owner paid in 2006.

5) The SIR is the Savings-to-Investment Ratio, equal to discounted savings over the analysis period divided by the capital investment for that measure.

6) The calculation of the SIR and Life Cycle Savings assume a constant dollar discount rate of 3.0%; this corresponds roughly to a discount rate of 6% in inflating dollars.

Building Description

is a residential building with 147 apartment units on fourteen full floors, one half floor (the remainder being below grade at the east end) and a penthouse covering approximately one-half of the roof. The building was built in 1924 and has a total floor area of approximately 280,800 square feet (SF), of which 276,900 SF are residential and 3900 SF are used by retail space on Broadway. The building is located in Manhattan, with Block Number and Lot Numbe 2. The lot dimensions are 100.67 by 225 feet, with an area of 22,660 square feet. The Dept. of Taxation lists it as Class D4, an elevator coop.

The building has a E-shape configuration open to the south with its three wings, east, central, and west, enclosing two interior courtyards. The basement extends under the courtyards. Each wing has a central hallway on each floor, served by a passenger elevator, a service elevator, and an internal fire stair. The building has no studio apartments, but is comprised of a mix of one, two, and three bedroom apartments as well as larger units. Perhaps because of combination of separate apartments into larger units, the exact breakdown by unit size is not currently available. The basement houses the boiler room, laundry, a meeting room, offices, a gym, a two-story storage room, and elevator and meter rooms.

The building façades are face brick. The exterior wall system appears to be in good condition, with some repair work evident, but no current flaws. Most apartments have double pane windows. A more detailed discussion of shell follows in the “Building Envelope” section.

The apartments are heated by steam generated in oil-fired boilers and distributed to radiators located in apartments and common areas. The same boilers provide domestic hot water (DHW).

Street is master metered for electric service, with submeters for each apartment and for the common areas. Common area electricity consumption is paid by the building management. The building is master metered for cooking gas.

Mechanical Systems

Heating System

The boiler plant consists of two large steam boilers, each large enough to meet all demands including hot water. The newer one (Eastmond) normally supplies both heat and hot water in the winter, and the older is fired in the summer to provide hot water alone

The details of the boilers and their combustion test results follow. The tests were carried out with a recently calibrated Bacharach Fyrite Pro electronic instrument.

Boilers -

Boiler 1	Boiler 2
Make: Eastmond	Make: Rockmills
Model: FST-350 SN: 7685	Model: MP350 SN: 4592
Input: 14,700 mBtu/hr	Input: 14,700 mBtu/hr
Output: 11,716 mBtu/hr	Output: 11,716 mBtu/hr
HX Area: 37,901 steam sq. ft.	
Burner: Industrial Combustión	Burner: Industrial Combustión
Model: DEG 145-P	Model: DEG 145-P
Fuel: #6 oil (gas startup)	Fuel: #6 oil (gas startup)
Year: Unknown	Year: unknown; older than Boiler 1

Combustion Test Results

Boiler 1	Boiler 2
Fuel: #6 oil Stack Temp.: 472°F Boiler Room Temp: 67°F Net Stack Temp: 405°F Oxygen: 5.2% CO_2: 12.4 % CO: 0 ppm Efficiency: 84.6 %	Boiler shut down for winter; test not possible.

These results are very good for a boiler of this type and age, and indicate that it is receiving excellent maintenance.

The boiler room is supplied with outside air by a fan mounted in a louvered window, and electrically coupled to the burner. There was no easy way to measure the air flow during firing, but it felt generous, and the reading of zero CO in the flue indicates that the air supply is adequate.

The steam generated by the boilers is distributed to apartment and common area radiators through a two-pipe system with a condensate pump but no vacuum system. All visible pipes in the boiler room were well insulated, and radiators appeared to be in good shape from a visual inspection (handles in place, no evidence of leaks, etc.) of a few apartments. The entire building operates as a single zone. The superintendent reports that thermostatic radiator valves have been installed in a few apartments in response to complaints of overheating.

The boiler is controlled by a Heat Timer MPC Platinum unit, which provides an hourly run-time that varies with outdoor temperature on a schedule selected when the device is programmed. It is currently set to provide heat during the day only when the outdoor temperature is below 55°F, and increases the run time each hour as the outdoor temperature drops below that set point. There are no indoor temperature sensors at this time.

Improvements to the Heating System

Although the boilers and distribution system are well-cared for and in good condition, there are several steps that can be taken to lower the fuel used to heat [illegible].

Measure 1: Energy Management System

An energy management system (EMS) is a computer that controls and monitors the operation of the boiler. The most important improvement over the Heat Timer currently installed is that it will monitor indoor temperature at about twenty different points in the building, using in-apartment sensors that are either hard-wired or radio-coupled to the EMS. Use of these temperature readings to help control boiler firing prevents overheating in the spring and fall shoulder months, when heat is needed at low levels. In addition, the EMS monitors condensate return temperature, boiler stack temperature, burner operation, and similar variables, and can be programmed to telephone for help in the event of malfunction. It also allows boiler operation to be monitored and adjusted remotely. The savings estimates found in TREAT and presented in the tables are conservative; many manufacturers guarantee 10% savings in heating fuel and we have assumed 7%.

Recommendation: Install an Energy Management System to control the boilers. The system shall have at least twenty internal temperature sensors, shall monitor critical boiler and burner functions, and shall be equipped to permit remote access via modem and phone line or direct Internet connection if the building has a network.

Measure 2: Thermostatic Radiator Valves

Thermostatic radiator valves (TRVs) turn individual radiators on and off on the basis of a temperature set by the occupant. Some have already been installed in response to overheating complaints. More can be included, to provide btter control, after the EMS has been operated for a couple of months to ensure it is optimally adjusted.

Recommendation: Install thermostatic radiator valves as needed in apartments and rooms where overheating is observed. Treat in Appendix C and the Installed Costs&Savings (ICAS) table show the savings achieved by the implementation of this measure, and its economic analysis. We have assumed that a total of 100 additional valves (out of a total of approximately 800 radiators) will be adequate to control overheating, and will result in a 3% savings in heating fuel. The details are presented in Appendix C, TREAT output. We used a cost of $300 per valve, since in-house staff can perform the replacements. The installations should be done incrementally, in response to complaints, and it may not be necessary to install the full 100 valves assumed here. If there are no complaints, it is not likely that installation of the valves will result in savings.

Domestic Hot Water (DHW) System

Hot water is supplied from a coil in the boiler, tempered to 135°F by a Holby mixing valve (F3898). There is no storage tank, and pumps circulate hot water throughout the building to keep the supply hot at all points. This is a common system in multifamily buildings. The older (Rockmills) boiler is used to supply DHW in the summer, when there is no heating demand.

Less commonly, the hot water recirculation is controlled by an aquastat, which turns on whenever the return water temperature drops below 110°F. This is a very cost-effective installation, which we would have recommended were it not already present.

The pipes in the boiler room and basement hallways all appeared to be well-insulated and in good condition.

Several measures, of increasing complexity, are available to reduce fuel use for domestic hot water:

Measure 3: Flow control in fixtures
The inspected apartments were not equipped with low flow shower heads and faucet aerators. We include the installation of appropriate flow restrictors in the Scope of Work and as Measure 4 just below. We realize that implementation of this measure can be difficult or impossible in a coop, where residents will normally maintain and refurbish their own bathrooms and kitchens, but nevertheless include it to make the potential savings clear. It would be within the power of the Board to require that all fixtures meet these standards, but that might prove to be a difficult position to maintain politically. Since hot water is not metered, the building as a whole carries the cost of excessive use of hot water.

Recommendation: Install 1.5 gallon per minute (gpm) flow restricting faucet aerators heads in all bathrooms and kitchen sinks and 2.25 gpm tamper-resistant shower heads in all bathrooms. The expected fuel savings are shown in the tables. In addition to fuel savings there are water consumption savings. Cost savings for this measure which are not included here and make the measure even more cost effective.

Condensing gas boiler for DHW

The large steam boilers are an inefficient way to produce hot water, especially in summer, when 40-50% of the energy content of the fuel can escape up the chimney. Condensing gas boilers, properly plumbed, can achieve efficiencies of 95% when making hot water, and gas purchased on an "interruptible" tariff costs about the same as #6 fuel oil, resulting in substantial savings. The "interruptible" gas must be turned off when Con Edison requests, normally only in the coldest weather, but at such times the existing system can be used. The energy savings calculations for this measure are reported in Appendix B-1.

Measure 11: Install an one (or an integrated array of) condensing boilers with an output capacity of 1.0 million Btu per hour (sizing to be verified by the design engineer) and a 1500 gallon storage tank-heat exchanger (sizing also to be confirmed by the design engineer) to supply DHW. Additionally, a DHW piping arrangement connecting the storage tank-heat exchanger return water line to the heating water return line, as suggested by TEKMAR (Esp. Fig 16, E002.pdf at http://www.tekmarcontrols.com/literature.html), will lower the return water temperature to the condensing boilers and improve their efficiency as a result.

If the design follows the approach outlined above, the condensing boiler will work at high efficiency almost all of the time. The details of our sizing and cost estimate are shown Appendix B-1. The total estimated cost of the system is $114,100. We have assumed that this compact boiler and the storage tank can be fitted into unused space in the boiler room. If this is not practical, it may prove difficult to find other space in the basement. We do *not* recommend removing the existing Rockmills steam boiler to make room, as it provides valuable redundancy.

The system would require construction of an additional (but much smaller) flue next to the existing one. It is possible that the much of this flue could be constructed of polymer tube, but we have assumed a stainless steel stack for pricing purposes. A careful design must be prepared by an engineer familiar with condensing boilers. The engineering design fee is included in the cost estimate.

Our modeling determined that the annual savings would come to 1150 million Btu worth $9380. Economic payback for this measure was adequate, with a simple payback of about 11 years and a savings to investment ratio (SIR) over 1.0. This calculation was performed assuming natural gas could be purchased for 110% the cost of #6 oil, which is conservative since interruptible gas is usually priced to compete with #6 oil. Our estimate of system costs is also conservative and should not be shown to potential bidders.

This measure provides several less tangible benefits, including an end to dark clouds of smoke during startup and a reduction in CO_2 emissions of about 180 tons per year if used six months per year.

Below we consider a cogeneration system based on either microturbines or reciprocating engines. Should the Coop decide to implement that option, it will supply the bulk of the building's hot water, and this condensing boiler would be redundant and should not be implemented under any circumstances. Our understanding is that the coop prefers this measure.

Solar Thermal Hot Water

We analyzed the option of generating DHW by a Solar Water heater; we used the RETScreen computer model as presented in Appendix B. The entire penthouse roof has good southern exposure; an area of about 7860 sq.ft. is available on the penthouse roof. The estimated cost of an array of fifteen 21% SF (solar fraction) evacuated tube solar collectors is $89,000 and its annual fuel savings are about 1,381 therms. Approximately 900 kWh per year will be needed for pumping. This measure is not cost-effective, and its SIR is approximately 0.3. Accordingly, we did not include this measure in the recommended Scope of Work.

Building Envelope

Windows: Apartment windows are for the most part double-pane, double-hung units. They do not merit replacement at this time, and since they are already double-pane, their replacement will never be economically justified by prospective energy savings.

Recommendation: If individual owners wish to replace their windows for reasons of esthetics or convenience, we recommend that the Coop require that the replacement windows be argon filled with low emissivity coatings and a "whole window U-value" of 0.50 or less. The additional cost ($20-50) will be paid back in fuel savings in five to eight years, although there may be an issue if the incremental cost is born by the owner, since the coop as a whole will benefit from the reduced fuel bills. Window suppliers can be referred to the National Fenestration Ratings council (http://www.nfrc.org/) for more information. (We do not call for Energy Star windows because these are not available in the commercial window grades required for New York City high rise buildings.) Since there is no recommended scope for the windows, it is not included as a "measure" with estimated savings.

Measure 4: Vents in Elevator Penthouses:

There are openings in the roofs of the three elevator pulley penthouses that create substantial air infiltration and heat loss due to stack effect through the elevator shaft. This situation creates excessive draft in the hoistway which can be reduced by closing the openings and installing smoke/thermostat driven dampers to prevent air flow unless a fire condition occurs, which will minimize the draft while complying with code requirements. The savings estimates presented in the tables were developed in TREAT as presented in Appendix C.

Recommendation: Close the openings in the roofs of the in the building's elevator hoistway penthouses and install electrically-controlled dampers rated for low air leakage which will open in response to a signal from the building's fire alarm, increased temperature or upon smoke detection.

Measure 5: Weatherstrip exterior doors

In addition to the main entrance and the storefront doors, we saw two access doors at ground level and three doors from public hallways onto the roof. (There were also doors from the penthouses onto the roof, but we did not get access to these.) Although the doors were in good condition, sealing them more tightly would decrease stack effect infiltration and lower the heating load. The savings are developed in TREAT and presented in the ICAS table.

Recommendation: Install high quality, screw-attached weatherstripping to ground floor and roof service doors. The estimated cost for this measure is $250. (based on five doors; all doors should be done if we missed any.)

Roof Insulation

The roof has two areas: the penthouse roof, which is accessed only for maintenance, and the roof of the main building around the penthouse, which is used for recreation by residents. The penthouse roof has an area of approximately 8000 square feet, and the remaining roof also has an area of about 8000 square feet. (These rough estimates should not be used for pricing purposes.) The penthouse roof is in good condition, but the level of insulation is not known. Two methods can be used to increase the thermal integrity of the penthouse roof to a useful value, say R-23:

1. Get access to and blow cellulose into the roof cavity. R-23 corresponds to about six inches of cellulose in place. The cavity may not be deep enough to allow this.
2. Alternatively (if the cavity is inaccessible or not large enough), include an inverted roof membrane (IRMA) system, or equivalent. In these systems, the waterproof membrane is laid down first, and then foam insulation topped with paving material that acts as ballast is laid on top of it. The foam insulation and ballast then protect the membrane, extending its life, while providing thermal insulation. Information is available on-line.[1]

It is also possible, but more difficult, to increase the insulation under the portions of the roof used for recreation. An IRMA system can be used, with the ballast pavers used as the walking surface, but this will raise the level of the roof, so it can create the possibility of snow or ice dams that might direct melt water into penthouses or hallways under their roof access doors. A careful assessment should be carried out by a professional before an IRMA installation is attempted. It may also be possible to blow insulation into the roof cavity below the recreational portions of the roof, but we could not determine the depth of that cavity or gain access to it.

Because of the lack of urgency, the fact that roof replacement is not cost-effective on an energy-savings basis, and the many uncertainties involved in the recreational part of the roof, we do not include a recommendation for roof work at this time. When the roof needs replacement, we strongly urge that an IRMA system be considered and insulation blown in if possible.

Lighting

In a coop, the in-apartment lighting is the responsibility of the residents, and experience indicates the building will have little success trying to coerce the use of efficient lighting. Since the residents pay their own bills, they already have some incentive for efficiency, and we make no

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[1] www.buildings.com/Newsletters/roofing/february03roofing.asp; www.advanced-roofing.com/prodsvs.htm, click on "IRMA"

specific recommendations for in-apartment lighting. The coop could point out to residents that the use of compact fluorescent bulbs and/or fluorescent fixtures for lamps that are on for more than two hours per day is both very cost-effective and a meaningful step to lower carbon emissions. On the other hand, there is no point in replacing lamps that are, for example, in closets and rarely used.

Common area lighting occurs in several areas: the lobby, the hallways, the stairwells, the elevators, and the basement. We will consider these in turn.

The lobby is lit by decorative incandescent bulbs in designer sconces. Knowing that strong esthetic objections would be raised to any change, we make no recommendation here.

Measure 6: Convert hallway, stairwell, and elevator lighting to occupancy sensors

There are three central hallways on each of fourteen floors, one for each wing. The ceiling fixtures and lamps are reportedly managed by the residents on that floor, but seemed to have two 100W incandescent bulbs in the majority of the floors we visited. The three service stairs connecting the hallways had one 22W fluorescent fixture per floor. Installation of high efficiency fixtures with occupancy sensors will reduce electric loads substantially. The fixtures should be sized to provide fairly bright illumination (12-15 foot candles) when the sensors detect motion, and to drop back to a code-minimum level (4 foot-candles) after ten minutes of vacancy. Four foot-candles is completely adequate for seeing people or furniture, but some people will find reading difficult at that level. However, the only way residents can see the low level is through their peepholes, if the hallway is empty. The fixtures are designed to default to the "high" setting if the sensor fails.

The stairwells are currently equipped with 22-Watt fluorescent fixtures. Although these are not "energy hogs", the fact that much of the stairwell is visited very infrequently means that occupancy sensors can be valuable in this context as well. The elevators were illuminated by fluorescent lamps whose wattage we could not determine, but they appeared to stay on at all times. (There may have been a manual switch in the service elevators.)

We have budgeted $250 per fixture for these replacements. This is generous for the stairwell fixtures, but the Coop may wish to spend more for more ornamental fixtures in the hallways. A cut sheet for a typical fixture is included in Appendix B.

Recommendation: Replace the hallway fixtures with decorative fixtures providing 5000 lumens on the high setting (to provide an increase in lighting levels) and equipped with ultrasonic occupancy sensors. We assumed one fixture per hallway for a total of forty-two fixtures. Data provided by H. Hinkle indicates the "C" hallways have two fixtures, and the total is sixty-three. Until it is determined whether the two fixtures should be replaced by one or two new fixtures, we will leave the estimate as it is. Increasing the number simple increases the cost-effectiveness of the measure.

Second, replace the forty-two stairway fixtures with utilitarian fixtures equipped with ultrasonic occupancy sensors, providing 2000 lumens on the "high" setting and ensuring four foot candles on the "low" setting. All six elevators should be equipped with occupancy sensors governing the existing lamps. Selection of appropriate fixtures should be made in consultation with a reputable vendor. For the "bilevel" feature to operate correctly, save energy, and not burn out bulbs, IT IS ESSENTIAL THAT THE SENSITIVITY OF THE SENSORS AND DURATION OF THE "ON" TIME BE CORRECTLY SET DURING INSTALLATION. Thirty to ninety minutes of battery operation may be added to some or all fixtures for about $50 each, and is a good idea, but is not included in our price estimate.

Measure 7: Upgrade basement hallway lighting

The basement hallway, laundry, and employee space are equipped with T-12 fluorescent lamps with (inefficient) magnetic ballasts. There were also four 60 W incandescent lamps in the employee area. These areas are grouped together because they all seemed to be open, with the lamps in use, on the same schedule (most of the day). We counted twenty-eight fixtures of varying sizes, adding up to about 2800 watts. (They are labeled "b" in the TREAT tables.)

Recommendation: All the T-12 fluorescent fixtures and incandescent lamps in the basement hallways, laundry room, and employee space should be upgraded to new fixtures with efficient T-8 lamps with electronic ballasts and occupancy sensors to provide bi-level operation. The laundry room switch should be left operable, so the lights can be shut down completely when the room is locked at night (if it is locked). The decision as to whether to install fixtures with individual sensors or to use separate sensors to control multiple fixtures should be made after consultation with a reputable lighting designer or vendor. The savings are calculated in TREAT.

Measure 8: Rewire switches in basement rooms for adequate control

Several rooms in the basement had lights on switches that were off when we visited, indicating that they are generally turned off by occupants as they leave. In this case, it is not worth converting to automatic operation. A timer in the lower half of the storage space seemed useful, and could be replicated in the upper half, but it is not clear how much saving would ensue. However, in two of these rooms, the gym and the bike storage room, there were light switches that were relatively inaccessible, and which were therefore left on most of the time.

Recommendation: The lighting in the gym and bike storage room should be re-wired so that all lights are governed by the single switch near the operable door. The savings are calculated in Appendix B.

Hints on fluorescent lamp specification:

A local manufacturer and vendor of bi-level ("OccuSmart") fixtures is Lamar Lighting (www.lamarlighting.com), but their fixtures may be a bit "industrial" in appearance for the public hallways in [illegible] A cut sheet for one of their many sensor-based products is included in Appendix B. Many other lighting consultants and installers can provide sensor-based equipment, but it should be made clear from the beginning that sensors are a requirement.

The "color rendition index" or CRI indicates how well color will be replicated when illuminated by the lamp. The sun or an incandescent lamp have CRI= 100. A CRI of 80 or greater will be adequate for most people, but "visual" people will be happier with a CRI of 85 or greater.

The "color temperature" indicates the overall color range of the lamp. The lower values, about 3000K for a fluorescent lamp, will be "warmer" and redder, while higher values 4000K and 5000K will be bluer and "cooler". The color temperature of the sun is 5700K at noon, and that of a standard incandescent bulb is 2700K.

All replacement lighting shall have a color rendition index (CRI) of 80 or higher. Wherever possible, replacement lamps shall meet the US EPA Toxic Characteristic Leaching Procedure (TCLP) criteria for mercury release, as do Philips Alto lamps. (E.g., a 4-ft T-8 lamp should release less than 6 mg of mercury on disposal.)

Measure 9: Upgrade Exit Lights
We found a total of nine exit lights around the basement, all illuminated by either 15 Watt CFLs or low-wattage incandescent bulbs. They did not appear to have battery back-up.

Recommendation: Replace all exit signs in the building with units based on light emitting diodes (LEDs) drawing less than two watts and equipped with batteries to provide 90 minutes of unpowered operation. Our calculations are based on the nine signs we are aware of, but there may be many more, since we could not survey the entire building.

Building Ventilation

The building has no mechanical ventilation (other than the boiler room supply fan), due to its age and construction with windows in every bath and kitchen. Elevator shaft way ventilation was discussed above.

Elevators

The building has three fully automatic passenger elevators and three service elevators that are manually operated. The three passenger elevators are moved by 20 HP DC hoist-motors, each of which is supplied with DC power by a 15 kW motor-generator (MG) set. The MG sets run on timers, so they are turned off after a few minutes of inactivity, and do not consume power until the next call occurs. This is a relatively efficient system, and because of the substantial cost, replacement cannot be justified based on energy savings.

The three service elevators are also moved by 20 hp DC motors, but these are supplied with DC power by a single 75kW rectifier. This is more efficient than the MG sets, since there are no standby losses, but older units like this sometimes provide a slightly jerky ride.

The passenger elevator drives could be upgraded by replacing the MG set with modern silicon control rectifiers (SCR) on the DC hoist-motor (old, rebuilt, or new); The energy savings of these two options range from 15 % to 25% of the power used by the elevator, but because the motor operation has already been made more efficient through the "spin down" option, this improvement would not pay for itself in further savings.

Recommendation: Should even one of the motor-generator sets break down, the Coop should either convert all three passenger elevator power supplies to a rectifier system, or proceed to the AC option discussed below.

All six elevators are controlled by old control racks equipped with dozens of relays. As long as these controllers continue to function or can be repaired by replacing one or two relays, all is well. However, when they begin to suffer frequent breakdowns, it's a sign that replacement will soon be required.

Recommendation: When faced with expensive replacements of old equipment, the entire MG-DC drive system should be replaced with with high efficiency AC controllers and motors. This can provide more significant savings than those achieved by upgrading the control system, since the idling period is completely eliminated, and the variable frequency drive control on the newer high efficiency AC motors would allow for additional savings. Often, the elevator speed can also be doubled. However, the installation costs of AC controls and motors are high, in part because of further design costs for grounding and noise insulation required for this type of system.

Hint on elevator work:
Undertaking any major work on an elevator can lead to inspections and requirements that, for example, the cab be upgraded to meet the standards of the Americans with Disabilities Act (ADA). For this reason, and because the interests of an elevator service company may not coincide with those of the building, it is essential that a qualified ELEVATOR CONSULTANT be retained to provide guidance on the best way to move forward. The consultant should not be associated with any elevator service company, but should serve as the building's representative negotiating with the service company.

Health and Safety Measures

The public spaces and boiler rooms are equipped with smoke and CO detectors. Because it is now New York City law that all apartments be equipped with both smoke and CO detectors, we do not specifically check for this, although we note deficiencies if we see them. None were observed.

Appliances

Appliances in the apartments are owned by residents and since electricity is individually metered, the building has no direct interest in forcing the use of efficient appliances. It would still be a good practice to recommend the use of Energy Star refrigerators, which are available in almost all sizes and styles. Again, residents can be reminded that a "greener" New York is up to them. Gas dryers have almost no variation in efficiency, so if they are permitted in apartments, there is no efficiency factor in deciding which to install. Hybrid stoves with gas burners and electrically heated ovens will create a much smaller cooling load in the summer, but again, this is on the resident's electric bill. (Gas ovens must be vented to provide air for the flame, while the heat can be sealed inside an electric oven quite effectively.)

Measure 10: Replace Laundry Room Washing Machines

The laundry room was equipped with one front loading Energy Star washer and nine Maytag MAT12PRDAW top loading washers. These are standard, low-efficiency models. Replacement by Energy Star front-loading machines can cut overall hot and cold water usage in half. Because the machines are owned by the vendor of laundry services, the building cannot make this change immediately. However, the building can request that the machines be swapped out immediately, and if the vendor is not willing to do so, make it a condition of any renewal contract.

Recommendation: Replace nine top-loading washing machines in the laundry room with front-loading Energy Star machines. The machines should be installed on stands at least eighteen inches high to minimize stooping when the machines are used. We used a cost of $700 per machine to show the economic viability; the actual cost to the Coop may be zero.

There is little variation among gas dryers, and the seven units that were installed present no significant savings opportunities.

Four pumps lift water to the storage tank on the roof and circulate hot water through the building. Both of these systems are well-controlled and neither offers substantial savings opportunities, but when the motors fail they should be replaced by the highest efficiency models then available.

Recommendation: Determine now what high efficiency motors will best replace the existing water pump motors when they reach end-of-life, and keep this plan in a safe and obvious place, so that poor decision don't get made under the pressure of time at the occurrence of failure.

Three refrigerators were found in the basement, all operating. One was empty. The purpose of these units should be assessed, and only those actually needed should be in operation. Since they are probably discards from apartments, they may be regarded as "free", but the electricity they consume is not free, and since they are probably not efficient, their use should be minimized.

Electric Power Issues

already has the optimal electric distribution system, with a master meter allowing the building to purchase power from suppliers for delivery by Con Edison at the attractive RA-8 tariff, with submeters ensuring that each resident is billed for their actual usage. The common areas receive power through the building's submeter. The storefronts all have their own, independent accounts with Con Edison.

This situation makes the installation of cogeneration (also called combined heat and power, or "CHP") an attractive option, since all the power produced in the building can be used in the building to lower its purchases. In addition, the building could install photovoltaic panels on the roof to produce electricity from sunlight. We examined both options, and find that a CHP installation could be quite cost-effective, while photovoltaics remain to expensive to be economically attractive. We were told that one penthouse resident planned to install his or her own photovoltaic system, but received no details about the installation.

Recommendation: A private photovoltaic installation could have a significant impact on the ability of the building to install its own CHP system and should only be permitted after careful analysis of the interactions of the two systems.

Combined Heat and Power

The installation of a small, gas-fired cogeneration system in the boiler room would provide substantial benefits to the building, while helping the environment. As a result of fundamental physical constraints governing electric generation, approximately two-thirds of the energy content of the fuel is released as heat and normally discarded to the atmosphere or a nearby river. When the generator is located in a building, much of that discarded heat can be used to produce hot water, essentially doubling the efficiency of resource use from 33% to 66%. Two sorts of generators are in use, piston engines derived from automobile engines and microturbines, derived from jet engines. Both are available in useful sizes from 25 to 250 kilowatts (kW). The piston engines are somewhat more efficient, but the choice of driver should only be made after a detailed feasibility study can be carried out. Here we present the results of a screening study, designed to show that the likelihood of success is sufficient to justify the detailed analysis. Substantial financial assistance may be available from NYSERDA for either the detailed feasibility study or the installation.

The primary analysis was carried out using the "Multicogen" model recently prepared for NYSERDA by Steven Winter Associates. This is a "beta" version of the model, which has not yet been officially released. The analysis is presented in Appendix B, and found that the installation would indeed be cost effective. We re-analyzed their results, and in order to err on the side of caution, reduced the estimates of expected savings. This gave an SIR of 2.0. A table summarizing our analysis is also included in Appendix B, A check using the RetScreen model also found that the project could be cost effective, although less so (SIR of 1.3). Even under more conservative assumptions, it appears that cogeneration is a feasible option, if the space we believe is available in the boiler room can in fact be used. Should the Coop decide to proceed, the first step would be a more detailed study:

Option: should proceed with a detailed feasibility study of a cogeneration system in the 50 – 100 kW size range. The system should be designed to follow the hot water load, as modulated by a storage tank of two to four thousand gallons. The tank itself will be at the low pressure of the cogenerator's cooling system, but will contain a coil of pressurized DHW to be pre-heated prior to entering the boiler. The tank will be well insulated, designed for maximum stratification, and plumbed to operate in counter flow, for maximum efficiency and utilization. There will be no cooling tower (there being no place for one), and the system will shut down when the storage tank becomes completely charged with thermal energy. The feasibility study would cost in the range of $7-15,000, and would produce a detailed proposed system, firm costs, and rigorous savings estimates.

We included a discussion of a condensing hot water heater earlier in this report. The water heater and the CHP system are mutually exclusionary. Either one will render the other not cost effective. The coop should choose to pursue one or the other (or neither) of these options.

Discussion of this project with a coop representative (H. Hinkle) has led to the conclusion that the coop does not wish to proceed with this CHP project for a variety of reasons. If they proceed with the condensing hot water heater (which they are leaning toward), this CHP option will become non-viable.

Solar Photovoltaics

In addition to solar domestic hot water, we considered the use of photovoltaic panels on the roof to produce electricity for consumption in the building. We did not verify that the roof has room for both installations, since it turns out that neither is close enough to cost-effective to be a reasonable recommendation. For photovoltaics, we examined a 2.0 kW array, which would occupy about fifteen square meters or 160 ft^2. The system turned up not at all cost-effective, even counting available subsidies, ending up with an SIR of 0.5 – 0.6. We have therefore not loaded this report down with the details. They are available on request from CEC.

Disclaimer

The energy conservation opportunities contained in this report have been reviewed for technical accuracy. However, because energy savings ultimately depend on behavioral factors, the weather, and many other factors outside its control, Community Environmental Center does not guarantee the cost savings estimated in this report. Community Environmental Center shall in no event be liable should the actual energy savings vary from the savings estimated herein.

Estimated installation costs are based on a variety of sources, including our own experience at similar facilities, our own pricing research using local contractors and vendors, and cost handbooks such as those by RS Means. The cost estimates represent the best judgment of the auditors for the proposed action. The Owner is encouraged to confirm these cost estimates independently.

Since actual installed costs can vary widely for a particular installation, and for conditions which can not be known prior to in-depth investigation and design, Community Environmental Center does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein.

Community Environmental Center will not benefit from any decision by the Owner to select a particular contractor, vendor or manufacturer to supply or install any materials described or recommended in this survey.

Funding Opportunities

The New York State Research & Development Authority (NYSERDA) offers different types of funding opportunities to promote the implementation of energy conservation measures in all types of facilities throughout the state. CEC has conducted an agency review to identify potential funding opportunities that may be applicable for The following programs were identified:

- **Multifamily Performance Program**

  This new program for residential buildings is similar to ResTech but offers significant incentives to buildings that undertake recommended improvements. Details are available at http://www.getenergysmart.org/buildingowners/existingmultifamily/overview.asp.

- **New York Energy $mart Loan Fund**

  This program seeks applications from potential borrowers for interest rate reductions of up to 650 basis points (6.5%) in Con Edison territory on loans and leases for energy efficiency improvements. The maximum loan term is ten years. Loans must be from participating lenders, although new lenders are encouraged to apply under the program. Based upon a conventional interest rate of 6.5%, the net present value of the interest rate buy down is approximately $36,258 per $100,000 of loan – that is, the loan becomes essentially interest-free. More information and a savings calculator are available at http://www.nyserda.org/loanfund/default.asp.

Recommendation:
CEC recommends that consider these programs to defray some of the costs of implementing the measures identified in the project work scope. For more information, visit http://www.getenergysmart.org and click on the "Building Owners" link.

Appendix A: Analysis of Electricity and Fuel Bills

The energy analysis of on the following two pages reveals a fairly efficient building; however, substantial energy savings can still be achieved by implementing cost-effective energy conservation measures.

Electricity

The annual electrical consumption of (including both apartment and common area use, but not that of the storefronts) from October 2005 through October 2006 was 1,357,200 kWh, and cost $193,339. Electricity consumption over a two year period works out to 9642 kWh/apartment, which somewhat above the 7500 kWh/apt. average for comparable master-metered buildings. Especially in the common areas, this electrical consumption can be further reduced through the recommended measures.

Heating

The computation of the normalized heating energy factor in Btu/sq.ft./HDD allows comparison of the energy consumption of different buildings under different weather conditions. The normalized heating energy factor is equal to the yearly fuel consumption of the building in Btu's divided by the heated square footage of the building and divided again by the yearly Heating Degree Days for the year during which the fuel was consumed.

The building uses approximately 7.3 Btu/sq.ft./HDD of fuel oil. 66% of New York City multifamily buildings range with fossil fuel heat range from 8.8 to 19 Btu/sq.ft./HDD, putting this building in the lowest 16%. The national average is 15 Btu/sq.ft./HDD. The heating energy factor of is lower than the national average and at the low end of the spectrum of comparable buildings (masonry shells with fossil fuel heat). Nevertheless, substantial energy can still be conserved by implementing the proposed energy savings measures.

ELECTRIC USE ANALYSIS

Building Name:			
Building Address:			
Number of Units:		147	
Fuel Type:	**Electricity**	Fuel Units:	kWh
Fuel Heat Content:		3,414	Btu/kWh
Heating Degree Days:		4,193	HDD
Total Heated Area:		280,809	sq. ft.
Metering covers:		Entire building	
Billing Period Analyzed:		Dec-04	thru Oct-06
Utility:	Con Edison	Tariff:	Rate RA8 - Resid. Redist
		Account #:	494021407800001

MONTH	Energy kWh	Demand kW	Cost	mmBtu
12/3/2004	108,400	216	$16,787	370
1/4/2005	111,200	228	$16,145	380
2/3/2005	110,000	240	$16,948	376
3/7/2005	109,600	220	$15,942	374
4/5/2005	94,400	228	$13,519	322
5/4/2005	88,400	204	$14,002	302
6/3/2005	90,000	200	$15,303	307
7/5/2005	136,400	340	$25,455	466
8/3/2005	134,400	328	$25,961	459
9/1/2005	132,000	296	$23,479	451
10/3/2005	122,400	324	$26,140	418
11/1/2005	94,800	216	$19,919	324
12/5/2005	110,800	220	$25,971	378
1/4/2006	104,800	220	$19,809	358
2/3/2006	100,400	220	$21,276	343
3/7/2006	108,800	228	$15,221	371
4/5/2006	92,800	212	$14,216	317
5/3/2006	83,600	196	$12,155	285
6/2/2006	94,000	248	$15,529	321
7/3/2006	117,200	280	$24,251	400
8/2/2006	144,000	332	$6,982	492
8/31/2006	116,800	324	$7,447	399
10/2/2006	99,200	216	$5,416	339
10/31/2006	90,000	196	$5,147	307
TOTALS	2,594,400	340	$403,020	8,857

Yearly Consumption:	1,358,617	kWh =	8,857 mmBtu
All-Inclusive Average Cost of Electricity:	$0.155 /	kWh	
Actual Average Use for this meter:	9,242	kWh / apartment	
	4.84	kWh / sq. ft.	
Compare to:			
Average use by Con Edison customers:	3,408	kWh / apartment	
National average residential use:	4.9	kWh / sq. ft.	

HEATING FUEL ANALYSIS

Building Name:			
Building Address:			
Number of Units: 147			
Fuel Type: #6 Oil	units: gal		
Fuel Heat Content:	153,600 Btu / gal		
Heating Degree Days:	4,721 HDD		
Total Heated Area:	280,809 sq. ft.		
Billing Period Analyzed:	1/1/2005 thru 12/31/2000		
Utility/Supplier: Stuyvesant	Tariff: NA		
Hess	Account #: NA		

Delivery Date	gal	Cost	mmBtu
January-2005	10,426	$17,055	1,601
February-2005	17,073	$20,164	2,622
March-2005	16,379	$20,754	2,516
April-2005	5,459	$7,078	**839**
May-2005	5,066	$6,385	778
June-2005	5,397	$7,616	829
July-2005	0	$0	0
August-2005	0	$0	0
September-2005	3,756	$6,872	577
October-2005	5,372	$9,655	**825**
November-2005	4,390	$6,611	674
December-2005	21,199	$34,058	3,256
January-2006	10,919	$17,281	1,677
February-2006	15,048	$22,816	2,311
March-2006	17,111	$25,820	**2,628**
April-2006	3,918	$6,249	602
May-2006	5,142	$7,771	**790**
June-2006	0	$0	**0**
July-2006	0	$0	**0**
August-2006	4,945	$8,311	**760**
September-2006	0	$0	**0**
October-2006	5,930	$8,836	**911**
November-2006	4,941	$7,228	**759**
December-2006	14,529	$21,106	**2,232**
Total:	**177,000**	**$261,666**	**27,187**

Gross Usage:			
Yearly Consumption:	92,425 gal =	14,196	mmBtu
Average Cost of Fuel:	$1.48 / gal =	$9.62	/mmBtu
Average Use per apartment:	629 gal	/ apartment	
Average use by area:	50,556 Btu/sq. ft.		
Non-Heat Usage:			
Baseload Consumption:	29,167 gal/year =	4480	mmBtu/yr
Heating Usage:			
Heating Normalized Consumption:	34,601 Btu/sq. ft.		
Heating Energy Factor	2,058,119 Btu/HDD		
Normalized Htg. Energy Factor:	**7.3 Btu/HDD/sq. ft.**		
NYC Two-pipe multi-family 66% range:	11 - 19 Btu/HDD/sq. ft.		
National Multi-family Average:	15.0 Btu/HDD/sq. ft.		

Appendix B: Calculations for Recommended Energy Conservation Measures

1. Condensing Boiler for Domestic Hot Water
2. Solar Thermal Hot Water
3. Combined Heat and Power

B-1 Condensing Boiler for Domestic Hot Water

Fuel analysis (Appendix A) shows the baseload is 4480 mmBtu/year of fuel oil, which corresponds to 3136 mmBtu of DHW at 70% efficiency. This gives an average load of 358 mBtu/hr. For initial sizing, propose a boiler capable of three times the average, or 1.0 mmBtu/hr, and provide a storage tank capable of holding two hours of DHW. With a temperature rise from 55 to 140oF, 305 gals/hour of storage is needed, so the price assumes a 1500 gal tank for two hours storage. This is a conservative estimate; bids should come in well below this, *but do not let potential contractors see this table!*

Condensing DHW Boiler Cost Estimate at

Item		Item cost	
Cond. Boiler (1.0 mmBtu/hr)		$	27,000
Stack		$	6,400
Boiler electrical wiring		$	2,500
Mechanical & electrical installation		$	9,500
1500 gal DHW Heat exchanger storage tanks with valves, piping, controls, & pumps		$	7,000
Gas line		$	7,400
Removal/demolition		$	5,000
Rigging		$	5,000
Piping/pumps/valves		$	13,000
Breeching		$	7,500
Insulation		$	3,800
Permitting		$	5,000
Design & engineering fee at	10%	$	9,910
	Job Total:	**$**	**109,010**

TREAT can be used to calculate savings for this measure, but is not accurate, since it cannot represent the real situation, where the condensing boiler may only be used in the summer months. The calculation displayed just below displays an estimate that results in a ten-year payback, and is incorporated into our tables.

Condensing Boiler Savings Estimate at ;

Average DHW use:			3136	mBtu DHW/yr
6	month's usage=		1,568	mmBtu
Base case	Fuel oil use=		2,851	mmBtu (#6 oil)
	at		55%	efficiency
	Equivalent to:		19,006	gallons
	Costing:	$	28,129	
Proposed:	Gas use=		1,704	mmBtu (gas)
	at		92%	efficiency
	Equivalent to:		17,043	Therms
	Costing:	$	18,748	
	With gas price of	$	1.10	/Therm
Annual savings:		**$**	**9,381**	

B-2 Solar Water Heater - Measure Analyzed But Not Recommended

RETScreen® Energy Model - Solar Water Heating Project — Training & Support

Site Conditions		Estimate	Notes/Range
Project name		DHW @ :	See Online Manual
Project location		New York NY	
Nearest location for weather data		New York City, NY	Complete SR&HL sheet
Annual solar radiation (tilted surface)	MWh/m²	1.63	
Annual average temperature	°C	12.3	-20.0 to 30.0
Annual average wind speed	m/s	5.4	
Desired load temperature	°C	60	
Hot water use	L/d	93,700	
Number of months analysed	month	12.00	
Energy demand for months analysed	MWh	1,904.21	

System Characteristics		Estimate	Notes/Range
Application type		Service hot water (with storage)	
Base Case Water Heating System			
Heating fuel type	-	#6 oil - gal	
Water heating system seasonal efficiency	%	70%	50% to 190%
Solar Collector			
Collector type	-	Evacuated	See Technical Note 1
Solar water heating collector manufacturer		Thermomax	See Product Database
Solar water heating collector model		Mazdon 30 - TMA 600S	
Gross area of one collector	m²	4.47	1.00 to 5.00
Aperture area of one collector	m²	3.22	1.00 to 5.00
Fr (tau alpha) coefficient	-	0.54	0.40 to 0.80
Fr UL coefficient	(W/m²)/°C	1.27	0.30 to 3.00
Temperature coefficient for Fr UL	(W/(m·°C)²)	0.00	0.000 to 0.010
Suggested number of collectors		383	
Number of collectors		100	
Total gross collector area	m²	447.0	
Storage			
Ratio of storage capacity to coll. area	L/m²	45.9	37.5 to 100.0
Storage capacity	L	14,780	
Balance of System			
Heat exchanger/antifreeze protection	yes/no	No	
Suggested pipe diameter	mm	N/A	8 to 25 or PVC 35 to 50
Pipe diameter	mm	38	8 to 25 or PVC 35 to 50
Pumping power per collector area	W/m²	0	3 to 22, or 0
Piping and solar tank losses	%	1%	1% to 10%
Losses due to snow and/or dirt	%	3%	2% to 10%
Horz. dist. from mech. room to collector	m	5	5 to 20
# of floors from mech. room to collector	-	14	0 to 20

Annual Energy Production (12.00 months analysed)		Estimate	Notes/Range
SWH system capacity	kWth	225	
	MWth	0.225	
Pumping energy (electricity)	MWh	**0.00**	
Specific yield	kWh/m²	704	
System efficiency	%	43%	
Solar fraction	%	17%	
Renewable energy delivered	MWh	**314.47**	
	GJ	1,132.08	
			Complete Cost Analysis sheet

Version 3.1 NRCan/CETC - Varennes

RETScreen® Solar Resource and Heating Load Calculation - Solar Water Heating Project

Site Latitude and Collector Orientation		Estimate	Notes/Range
Nearest location for weather data		New York City, NY	See Weather Database
Latitude of project location	°N	40.8	-90.0 to 90.0
Slope of solar collector	°	25.0	0.0 to 90.0
Azimuth of solar collector	°	0.0	0.0 to 180.0

Monthly Inputs

(Note: 1. Cells in grey are not used for energy calculations; 2. Revisit this table to check that all required inputs are filled if you change system type or solar collector type or pool type, or method for calculating cold water temperature).

Month	Fraction of month used (0 - 1)	Monthly average daily radiation on horizontal surface (kWh/m²/d)	Monthly average temperature (°C)	Monthly average relative humidity (%)	Monthly average wind speed (m/s)	Monthly average daily radiation in plane of solar collector (kWh/m²/d)
January	1.00	1.92	-0.3	61.1	6.0	2.92
February	1.00	2.74	0.6	60.3	6.1	3.70
March	1.00	3.85	5.1	59.5	6.0	4.53
April	1.00	4.93	10.5	59.3	5.7	5.19
May	1.00	5.70	16.3	63.9	5.1	5.56
June	1.00	6.13	21.5	64.6	4.8	5.79
July	1.00	6.02	24.4	64.8	4.6	5.77
August	1.00	5.38	23.8	67.0	4.6	5.48
September	1.00	4.34	20.0	67.3	4.9	4.89
October	1.00	3.18	14.1	65.1	5.1	4.08
November	1.00	2.04	8.5	64.2	5.7	2.97
December	1.00	1.62	2.5	63.5	5.9	2.51

		Annual	Season of Use
Solar radiation (horizontal)	MWh/m²	1.46	1.46
Solar radiation (tilted surface)	MWh/m²	1.63	1.63
Average temperature	°C	12.3	12.3
Average wind speed	m/s	5.4	5.4

Water Heating Load Calculation		Estimate	Notes/Range
Application type	-	Service hot water	
System configuration	-	With storage	
Building or load type	-	Apartment	
Number of units	Unit	147	
Rate of occupancy	%	100%	50% to 100%
Estimated hot water use (at ~60 °C)	L/d	20,096	
Hot water use	L/d	93,700	
Desired water temperature	°C	60	
Days per week system is used	d	7	1 to 7
Cold water temperature	-	Auto	
Minimum	°C	7.9	1.0 to 10.0
Maximum	°C	16.5	5.0 to 15.0
Months SWH system in use	month	12.00	
Energy demand for months analysed	MWh	1,904.21	
	GJ	6,855.14	

Return to Energy Model sheet

RETScreen® Cost Analysis - Solar Water Heating Project

Type of project: Pre-feasibility | Currency: $

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs
Feasibility Study					
Other - Feasibility study	Cost	1	$ 5,000	$ 5,000	
Sub-total :				**$ 5,000**	7.0%
Development					
Other - Development	Cost	0	$ -	$ -	
Sub-total :				**$ -**	0.0%
Engineering					
Other - Engineering	Cost	1	$ 10,000	$ 10,000	
Sub-total :				**$ 10,000**	14.0%
Energy Equipment					
Solar collector	m²	447.0	$ 65	$ 29,055	
Solar storage tank	L	14,780	$ 1.00	$ 14,780	
Solar loop piping materials	m	114	$ 6.00	$ 687	
Circulating pump(s)	W	0	$ 1,000.00	$ -	
Heat exchanger	kW	0.0	$ -	$ -	
Transportation	project	1	$ 100	$ 100	
Other - Energy equipment	Cost	0	$ -	$ -	
Sub-total :				**$ 44,622**	62.4%
Balance of System					
Collector support structure	m²	447.0	$ -	$ -	
Plumbing and control	project	1	$ 300	$ 300	
Collector installation	m²	447.0	$ 10	$ 4,470	
Solar loop installation	m	114	$ 2.00	$ 229	
Auxiliary equipment installation	project	1	$ 50	$ 50	
Transportation	project	1	$ 50	$ 50	
Other - Balance of system	Cost	0	$ -	$ -	
Sub-total :				**$ 5,099**	7.1%
Miscellaneous					
Training	p-h	4	$ 60	$ 240	
Contingencies	%	10%	$ 64,961	$ 6,496	
Sub-total :				**$ 6,736**	9.4%
Initial Costs - Total				**$ 71,457**	100.0%

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs
O&M					
Property taxes/Insurance	project	0	$ -	$ -	
O&M labour	project	1	$ 15	$ 15	
Other - O&M	Cost	0	$ -	$ -	
Contingencies	%	10%	$ 15	$ 2	
Sub-total :				**$ 17**	100.0%
Electricity	kWh	0	**$ -**	**$ -**	0.0%
Annual Costs - Total				$ 17	100.0%

Periodic Costs (Credits)		Period	Unit Cost	Amount
Valves and fittings	Cost	10 yr	$ 250	**$ 250**
				$ -
				$ -
End of project life		-		**$ -**

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RETScreen® Financial Summary - Solar Water Heating Project

Annual Energy Balance

Project name	DHW @		Electricity required	MWh	-
Project location		New York NY			
Renewable energy delivered	MWh	314.47			
Heating fuel displaced	-	#6 oil - gal			

Financial Parameters

Avoided cost of heating energy	$/gal	0.060	Debt ratio	%	0.0%
			Income tax analysis?	yes/no	No
Retail price of electricity	$/kWh	-			
Energy cost escalation rate	%	3.0%			
Inflation	%	2.0%			
Discount rate	%	3.0%			
Project life	yr	25			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	7.0%	$	5,000	O&M	$	17
Development	0.0%	$	-	Electricity	$	-
Engineering	14.0%	$	10,000			
Energy equipment	62.4%	$	44,622	**Annual Costs and Debt - Total**	**$**	**17**
Balance of system	7.1%	$	5,099			
Miscellaneous	9.4%	$	6,736	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$**	**71,457**	Heating energy savings/income	$	633
Incentives/Grants		$	500			
				Annual Savings - Total	**$**	**633**
Periodic Costs (Credits)						
Valves and fittings		$	250	Schedule yr # 10,20		
		$	-			
		$	-			
End of project life -		$	-			

Financial Feasibility

Pre-tax IRR and ROI	%	-6.8%			
After-tax IRR and ROI	%	-6.8%			
Simple Payback	yr	115.1	Project equity	$	71,457
Year-to-positive cash flow	yr	more than 25			
Net Present Value - NPV	$	(55,935)			
Annual Life Cycle Savings	$	(3,212)			
Benefit-Cost (B-C) ratio	-	0.22			

Version 3.1

B-3 Evaluate Cogeneration

The following pages show the results of an analysis of cogeneration using a "beta" version of the Multicogen analysis program, developed by Steven Winter Associates for NYSERDA. Because this model has not yet been officially released, we have actually scaled back the savings from its estimates, and used the following calculations for our estimates.

Extract savings from Multicogen analysis:					
Capacity:	80	kW			
Hours operation:	8,000				
Electric efficiency:	25%				
Thermal efficiency:	55%				
Oil savings	8,431	mmBtu @	$9.62	/mmBtu =	$81,103
@ Boiler efficiency:	57%				
Electric Savings	640,000	kWh @	$0.155	/kWh =	$99,200
Gas Expense	-87,373	Therms @	$1.51	/therm =	-$131,933
Maintenance contract			$0.02	/kWh =	-$12,800
			Net annual savings:		**$35,570**

We validated this analysis by also preparing an analysis using the RetScreen CHP model. This model accepts inputs similar to Multicogen, but its computational process and intermediate results are more available to the analyst, leading to greater confidence in the results. The results were not as optimistic as those projected by Multicogen, and gave net annual savings of $22,000. However, our capital cost estimate was slightly below that of Multicogen, $200,676, and the result was an SIR of 1.31 compared to Multicogen's of 2.0 (both evaluated over a 15 year life at a 3% constant dollar discount rate.) The RetScreen analysis is available on request; we saw no reason to further burden the report with it.

Beta Version 1.1

Screening status:

OK

Data Entry

Multicogen

Combined Heat and Power Screening Tool for Multifamily Buildings

ENTER Building Name or Reference

State: New York

City: NYC-Manhattan

Electric Utility: Consolidated Edison Company of New York

Gas Utility: Consolidated Edison Company of New York

Natural gas availability	Building is connected to natural gas utility
Import data from energy audit software	N/A (import) (Reset)
How is Domestic Hot Water generated?	Centrally (in a mechanical room)
Total number of apartments	147
Total number of detached buildings	1 ☐ I don't know
	Validate
Electric metering	Master meter
Energy bills	Monthly energy records are available (entry)
Where is heat generated?	Centrally (boiler room)
Heating distribution system	Steam
Cooling system	Window air conditioners

Building parameters

☐ I don't have the requested information below

	Width	Length	Height
Available space for CHP unit and storage tanks	30 (ft)	20 (ft)	15 (ft)
Distance between projected CHP and roof top	100 (ft)		

Distances between equipment (ft)

Projected CHP location

- Domestic Hot Water Equipment: 30 (ft)
- Boilers: 30 (ft)
- Electric Meter: 70 (ft)
- Chiller: (ft)

Monthly Energy Bill Data

important note before entering data :

Billing data to be entered for master or common area meter account <u>only</u>. If each apartment is individually metered, do not add kWh usage together.

Electric bills

	On-Peak or General		Off-Peak (*)	
	Demand	Usage	Demand	Usage
	Kw	kWh	Kw	kWh
January	104800	220		
February	100400	220		
March	108800	228		
April	92800	212		
May	83600	196		
June	94000	248		
July	117200	280		
August	144000	332		
September	116800	324		
October	99200	216		
November	90000	196		
December				

(*) Enter Off-Peak data only if the building is currently at this rate.

Natural Gas

	Therms
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

Oil

#6 oil

	gallons
January	10919
February	15048
March	17111
April	3918
May	5142
June	
July	
August	4945
September	
October	5930
November	4941
December	14529

Screening Report - Page 1/3

Multicogen
Combined Heat and Power Screening Tool for Multifamily Buildings

Utility district:
NYC-Manhattan

Combined Heat and Power Analysis

Criteria	Results	passed	failed	?	Comments
Spark spread analysis	48.3 $/MMBTU	V			
Gas on-site availability		V			
Building size		V			
Domestic Hot Water configuration		V			
Displaceable Domestic Hot Water load	2668 MMBTU	V			
Electric metering configuration		V			
Electric baseload usage	587828 kWh	V			
Minimal electric peak demand	83600 kW	V			
Available space for CHP	720 sqft	V			
Optimal CHP electric output	85 kW	V			
Economics (S.I.R)	2.2	V			
Candidate for CHP ?	**YES**	V			Detailed Analysis

Details	Results	Comments
Energy conservation software used for analysis	N/A	
Energy records used for analysis	Monthly	
Building parameters data entry completion	100%	
Estimated DHW Storage capacity to be connected to CHP (gallons)	4285	Based on data entered, available footprint would accept CHP storage tank

Combined Heat and Power Economics (*)

Recommended technology	IC Engine	
Media	Hot water	
	Recommended size range	
Output capacity (kW)	60	80
Capital cost	$ 173,870	$ 213,870
First year energy savings	$ 43,238	$ 55,134
Simple payback - years	4.0	3.9
S.I.R	**2.1**	**2.2**

Energy pricing assumptions

1.51 $/therm natural gas price
14.3 $/kW electric demand
0.18 $/kWh electric usage

A Savings-to-Investment-Ratio (**S.I.R**) above 1.0 shows a favorable investment over the life cycle of the measure.

(*) Figures are estimates and should not be considered contractual

Job Name	
Catalog Number	
Notes	Type

V O SERIES
CUSTOM LUMINAIRES
VOYAGER

features

- A unique bi-level luminaire controlled by an integral ultra-sonic motion sensor, designed to provide safe, dependable illumination while conserving energy. Suitable for ceiling or wall mounting
- Bi-level fixtures operate at a low standby light level, offering safety and security with full light output instantly upon occupancy with areas fully lit only as needed
- Ideal for stairwells, restrooms, laundry rooms and other areas where maximum light levels are not required on a constant basis
- The ultra-sonic sensor features enhanced sensitivity and alamp conditioning circuit (patented) that keeps new lamps on for 100 hours to assure long lamp life and proper operation
- For safety and compliance purposes in areas designated as emergency egress, we recommend choosing a standby light level that will provide minimum code compliant light levels while in the standby mode. In most municipalities, this is 1 FC average (2 FC in NYC). See back for options

construction

- Housings are die-formed of 20 gauge steel, with riveted socket supports
- Quality construction throughout for long-term dependable service
- New York City Department of Buildings calendar number #43525
- Ends are die formed for a clean, smooth look
- Ample knockouts are provided for convenient mounting with recessed or surface power feeds
- All fixtures are U.L. listed and IBEW union made

diffuser

- One-piece extruded linear ribbed clear, light stabilized acrylic is standard, 100% DR acrylic available
- Features a linear refractive pattern for even illumination
- Grooved formation on the edges allow for a tight, no light leak attachment to the body
- Optional white powder coated perforated steel diffuser

All units are U.L. listed as emergency power and lighting equipment (U.L.-924) when equipped with optional battery back-up and meet requirements of the life safety code/NFPA101, NEC/OSHA and most state and local codes.

electrical

- All electrical components are U.L. listed
- Ballasts are class P, thermally protected T8 Electronic
- Optional battery backup available for one or two light emergency operation at various output levels. Please consult factory for your specific emergency pack requirements

finish

- Prior to painting, all metal parts are treated with a multi-stage phosphate bonding process to ensure adhesion and inhibit rusting
- Painted with a lighting grade baked white enamel, having a reflectance factor exceeding 87% for premium quality and durability

sensor

- High frequency, extremely sensitive ultra-sonic, internally mounted
- LED status indicator light
- Exclusive lamp conditioning circuit (patented)
- Fail-safe feature switches light level to high (100%) if sensor is physically damaged
- 5 minute walk-test feature, easy-set time and sensitivity controls, compact design

ordering guide

NOTE: SOME ORDERING OPTIONS APPEAR ON PRODUCT LINE. FOR OTHER OPTIONS, SEE LIST AT RIGHT.

SAMPLE ORDER NUMBER

VO – 2 – 32 – [ ] – E8 – 1 – PA – AS – EM

SERIES · NO. LAMPS · WATTAGE · TANDEM · BALLAST TYPE · VOLTAGE · LENS OPTION · LIGHTING OPTION · OPTION · DIMENSIONS · LAMP TYPE

T-8 ORDERING GUIDE										
VO	1	31U		E8	1, 7, U	PA,PF	FO, AS		8″ x 24″	FB31T8
VO	1	17		E8	1, 7, U	PA, PF	FO, AS, ES		8″ x 24″	F17T8
VO	1	25		E8	1, 7, U	PA, PF	FO, AS, ES		8″ x 36″	F25T8
VO	1	25	T	E8	1, 7, U	PA, PF	2C, FO, AS, ES		8″ x 72″	F25T8
VO	1	32		E8	1, 7, U	PA, PF	FO, AS, ES		8″ x 48″	F32T8
VO	1	32	T	E8	1, 7, U	PA, PF	2C, FO, AS		8″ x 96″	F32T8
VO	2	17		E8	1, 7, U	PA, PF	2C, FO, AS, ES		8″ x 24″	F17T8
VO	2	25		E8	1, 7, U	PA, PF	2C, FO, AS, ES		8″ x 36″	F25T8
VO	2	25	T	E8	1, 7, U	PA, PF	2C, FO, AS, ES		8″ x 36″	F25T8
VO	2	32		E8	1, 7, U	PA, PF	2C, FO, AS		8″ x 48″	F32T8
VO	2	32	T	E8	1, 7, U	PA, PF	2C, FO, AS		8″ x 96″	F32T8

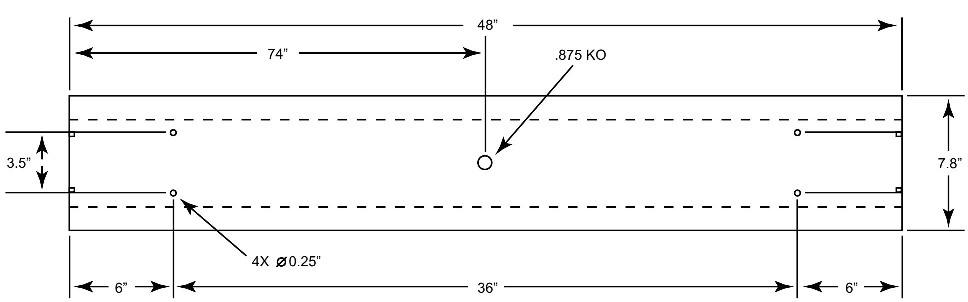
NOTE: TANDEM UNITS CONTAIN DOUBLE THE AMOUNT OF LAMPS SHOWN

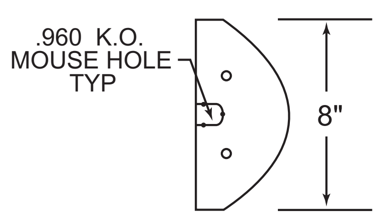
NOTE: STANDBY OPTIONS 4 AND 8 ARE UNIVERSAL VOLTAGE STANDARD

dimensional data

NOTE: SPECIFICATIONS AND DIMENSIONAL DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE.

cross sections





occu-smart® technology

Revised 10/06

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V O SERIES

VOYAGER

options

OPTIONS: INSERT APPROPRIATE CODE FOR CUSTOMIZED ORDERING

BALLAST
E8 Electronic T8
Program rapid start ballasts are used for lamps that are cycled on/off or dimmed

VOLTAGE
1 120V
7 277V
U Universal 120-277V

DIFFUSER OPTIONS
PA Clear ribbed acrylic
DR 100% DR Acrylic (consult factory)
PF Perforated metal - white

LIGHTING OPTIONS
2C 1 lamp on constantly/1 lamp sensored
FO All lamps on/off, All lamps sensored on
AS User selectable standby options 5, 10, 20 & 30% Nominal Light Output
ES 20% standby 120V only - Energy Star ballast 2 yr. warranty

GENERAL OPTIONS
EM Emergency pack, 1 lamp 90 min. up to 500 lu.

Consult Factory for higher lumen battery pack availability and additional options not shown or listed

accessories

LAMP OPTIONS
12 T8 741K
15 T8 735K
10 T8 730K
13 T8 841K
16 T8 835K
11 T8 830K

BEFORE INSTALLATION, PLEASE CONSULT YOUR LOCAL ORDINANCES AND BUILDING CODES FOR COMPLIANCE

ASK ABOUT ENERGY STAR

LaMar Lighting Company Inc. — Where Service and Technology Unite

Appendix C TREAT Calculations for ResTech Proposed Improvements

CEC used the TREAT computer model to assess the suitability of a number of energy efficiency options. TREAT is short for "Targeted Residential Energy Analysis Tools" and is a whole building simulation model developed under contract to NYSERDA. More information is available at www.treatsoftware.com.

TREAT accepts extensive data describing the building under analysis and the energy efficiency measures (ECM's) to be analyzed, and then assesses the potential energy savings associated with each ECM and package of ECM's. The following pages are a record of the TREAT run used to assess the building under study.

TREAT output is presented on the following pages. Due to idiosyncrasies in TREAT, the page numbers restart at "one" several times.

BUILDING DESCRIPTION

Project:

For:

By:

Date: 3/30/2007

General Project Information:

Building Address:

Year Built: 1925

Number of Occupants: 333

House Type: Detached

Contact Person: Richard Wolf

Phone: (516) 349-0540 ext 226

Directions: Supt. Al Estrada
(212) 866- 1418

General Building Information:

Long term weather site: NEW_YORK_CITY NY

Daily weather site: NEW_YORK_CITY NY

Shielding Class: 5 - Typical downtown: Large obstructions surrounding perimeter within 30ft

Number of Stories: 16

Number of Units: 147

Wall Color: Light

Roof Color: Dark

Total Heated Area: 280809 sq.ft

Spaces in the Building

Space Type	Space Name	Ceiling Height (Ft)	Floor Area (sq.ft)	Elevation (ft)	Conditioned (either heated or cooled)	Used (Hours/ Day)	Persons
Whole Building	Whole Building1	10	280809	160.70	Yes	24	333

Exterior Walls/Floors/Ceilings/Roofs

Space Name	Construction	Exposure	Length (Ft)	Height or width (Ft)	Elevation (Ft)	Tilt	Over hang Depth (Ft)
Whole Building1	0.75" Plaster/Lath, 1" Air, 8" Block, 4" Brick, R-4	South	220	155	0	90	NA
Whole Building1	0.75" Plaster/Lath, 1" Air, 8" Block, 4" Brick, R-4	West	242	163	0	90	NA
Whole Building1	0.75" Plaster/Lath, 1" Air, 8" Block, 4" Brick, R-4	North	220	155	0	90	0
Whole Building1	0.75" Plaster/Lath, 1" Air, 8" Block, 4" Brick, R-4	East	228	156	0	90	NA
Whole Building1	4" Concrete, 2" Rigid XPS, 0.5" Wood, Asphalt Roofing, R-11	NA	65	60	10	0	0
Whole Building1	4" Concrete, 2" Rigid XPS, 0.5" Wood, Asphalt Roofing, R-11	NA	173	103	10	0	0

Walls/Floors Adjacent to Ground

Space Name	Construction	Length (Ft)	Width or Height (Ft)	Type
Whole Building1	8" Block, R-2	893	12	Wall
Whole Building1	8" Concrete, R-1	150	145	Slab below grade

Exterior Doors

Description	Height Ft	Width Ft	Door U-Value	Qty	Location	Expo-sure
Polyurethane core without thermal break (24 gage residential steel)	7	4	0.29	1	Whole Building1	North
Polyurethane core without thermal break (24 gage residential steel)	7	6	0.29	1	Whole Building1	North
Solid urethane foam core without thermal break	7	6	0.40	2	Whole Building1	North
Polyurethane core without thermal break (24 gage residential steel)	6	3.50	0.29	3	Whole Building1	North

Polyurethane core without thermal break (24 gage residential steel)	6.70	3	0.29	1	Whole Building1	West
Polyurethane core without thermal break (24 gage residential steel)	6	3.50	0.29	3	Whole Building1	South
Solid urethane foam core without thermal break	6.70	2.50	0.40	6	Whole Building1	East

Windows

Glazing	Frame	Width Ft	Height Ft	Shad-ing Factor	Height above floor	Qty	Location	Expo-sure
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	3.50	5.50	1	2	168	Whole Building1	North
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	6.50	5.50	1	2	152	Whole Building1	North
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	1.30	4.50	1	3	29	Whole Building1	North
1/8" single glass, clear, with fully closed	Aluminum with 3/8" thermal break, Curtainwall	8	7	1	3.80	2	Whole Building1	North
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	3.50	5.50	1	2	152	Whole Building1	West
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	6.50	5.50	1	2	3	Whole Building1	West
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	1.30	4.50	1	3	48	Whole Building1	West
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	8.50	5.50	1	2	60	Whole Building1	West
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	3.50	5.50	1	2	87	Whole Building1	South
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	6.50	5.50	1	2	5	Whole Building1	South
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	1.30	4.50	1	3	16	Whole Building1	South
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	8.50	5.50	1	2	45	Whole Building1	South
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	3.50	5.50	1	2	127	Whole Building1	East
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	6.50	5.50	1	2	113	Whole Building1	East
1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	1.30	4.50	1	3	73	Whole Building1	East

1/2" double glass, 0.25" air space, clear	Aluminum with 3/8" thermal break, Curtainwall	8.50	5.50	1	2.70	30	Whole Building1	East
1/8" single glass, clear, with partly open	Aluminum with 3/8" thermal break, Curtainwall	8	10	1	2.70	5	Whole Building1	East

Infiltration

Total Infiltration of Heated Area : ACH = 0.74

Infiltration of Unheated Spaces:

Unheated Space Name	Infiltration ACH

Holes in the Building:

Space Name	Surface Adjacent To	Leakage Area (Sq.Inch)
Whole Building1	Outdoors	1152

Central Heating System :

Primary Heat Plant

Heat Plant Type	Boiler, Steam
Fuel	Oil #6
Input capacity, Btu/Hr	14700000
Annual Efficiency, %	85
Location	Whole Building1
Year	1990
Is there Reset Control	No
Design Supply Temperature, F	210
Design Return Temperature, F	190

Primary Distribution

	Supply	Return
Insulation R-Value	0	0
Total Area of Piping, SqFt	5503.86	5503.86

Percent of Total Pipe area in each space:

Space Name	% Supply	% Return
Whole Building1	100	100

Estimated total distribution efficiency: 85%

Thermostats:

Is Thermo-stat program-mable	Spaces Served by the thermostat	Heating				Cooling			
		Is Area Heat-ed	Temperature (F)		Hours per day unoccu-pied	Is Area Cool-ed	Temperature (F)		Hours per day unoccu-pied
			Occu-pied period	Un-occupied Period			Occu-pied period	Un-occupied Period	
No	whole building: Whole Building1	Yes	76	NA	NA	No	NA	NA	NA

Mechanical Ventilation:

Fan Name:

Hours per Day Fan is On:

Heat Recovery Effectiveness:

Ventilation Rate:

Space Name	Ventilation Rate	
	CFM	ACH
	0	0
Total for the fan	0	0

Domestic Hot Water

Hot Water Heater:

Type	Space-heating boiler w/tankless coil
Fuel	Oil #6
Rated Volume, gallons	5
Rated Input Capacity, Btu/Hr	14700000
Design Supply Water Temperature, F	130
Additional Insulation R- value	0.0
Location	Whole Building1
Number of Identical Water Heaters	1
Solar Fraction of Energy Input	0.00
Year	1990
Thermal (Recovery) Efficiency, %	85
Energy Factor (heating season)	0.7
Energy Factor (non-heating season)	0.4

Hot Water Demand:

Usage Adjustment Multiplier	0.95
Are Dishes Handwashed	Yes

Fixture Details:

Regular Shower Flow Rate, GPM	3.40
Low-flow Shower Heads Max. Rated Flow, GPM	2.50
Fraction of Showers with Low-flow Shower Heads	0.00
Regular Faucet Flow Rate, GPM	3.40
Low-flow Faucet Aerator Max. Rated Flow, GPM	2.20
Fraction of Faucets with Low Flow Aerators	0.00

Hot Water Piping:

Total Piping Area, Sq.Ft	2246
Insulation R-value	2
Recirculating System	Yes
Recirculate When Water Temperature F Falls Below	120
Hours per Day Recirculation is On	24.00
Circulating Pump HP	1/12

Percent of piping running through each space:

Space Name	% Piping
Whole Building1	100

Lighting

Description	Watts per Fixture	Daily Hours On (Hr/Day)	Count	Location
a 1-100 w. incand. - - in hallways	100	24	42	Whole Building1
a 1-18 w. flour. - - in stairwells	22	24	42	Whole Building1
1 48" t-12 40w. fl. -- in apt. kitch, &	52	3.5	294	Whole Building1
5-100 w. incand. chandl.- dining rm.	500	2.5	147	Whole Building1
1-100w. incand. - in bathrms.	100	2	412	Whole Building1

1-100w. incand. - in living rooms	100	3	960	Whole Building1
1-100w incand. - in bedrooms	100	1	1056	Whole Building1
1-100w. incand. - in dining rms	100	2.5	320	Whole Building1
1-100w. incand. - foyers, pantry, galley	100	4	603	Whole Building1
b 2-48" 40w. t-12- in basement	96	24	8	Whole Building1
b 1-48" t-12, 40w. fl. -in basement	52	24	1	Whole Building1
b 2-48" t-12 34w. fl. - in basement	84	24	1	Whole Building1
b 2-96" t-12 75w -in basement	168	24	2	Whole Building1
b 2-20w fl. t-12,bsmt. hall	54	24	3	Whole Building1
d 2-7.5w incand. exit sign _ in bsmt. ha	25	24	2	Whole Building1
4-36" t-12 30w-in common room	168	8	6	Whole Building1
c 4-36" t-12 30w. fl. in gym	168	8	11	Whole Building1
4-36" t-12 30w. fl- in confr/library	168	4	4	Whole Building1
b 1-100w. incand. -in employee space	100	16	4	Whole Building1
b 2-96" t-12 75 w. fl- in employee spac	168	16	1	Whole Building1
b 1-96" t-12 75w. fl. - in employee spac	89	16	1	Whole Building1
b 2-48" t-12 40w. fl. - in laundry room	96	15	6	Whole Building1
b 2-96" t-12 fl. 75w. - in laundry room	168	15	1	Whole Building1
c 2-96" t-12 75w. fl. _ in bicycle room	168	24	1	Whole Building1
1-96" t-12 75w. fl. - in bicycle room	89	2	1	Whole Building1

2-96' t-12 75w fl. - in storage area	169	3	12	Whole Building1
1-96" 1-12 75w. fl. in storage area	89	3	1	Whole Building1
d 2-7.5w. incand. - exit signs in stor.	25	24	7	Whole Building1
a 2-18 W fluorescent in elevators	36	24	6	Whole Building1

Appliances

Appliance Name	Electri-city Usage, (kWh/ year)	Electri-city Demand Watts	Second Fuel (Not includ-ing Hot Water fuel)	Annual Second Fuel Usage	Second Fuel Units	Hot Water Usage (gal/ year)	Location	% Heat Loss to Space	Quan tity
Laundry Room Dryer, NG	288	0	Natural gas	274.5	Therm	0	Whole Building1	20	7
In-Apt Dryer, NG	96	0	Natural gas	91.5	Therm	0	Whole Building1	20	39
Refrigerator-auto def top freezer,	884	0	None	NA	NA	0	Whole Building1	100	147
Color TV, typical usage	110	0	None	NA	NA	0	Whole Building1	100	151
Computer, typical usage	130	0	None	NA	NA	0	Whole Building1	100	147
room air conditioner	1266	0	None	NA	NA	0	Whole Building1	0	147
In-Apt Clothes washer, hot-hot	156	0	None	NA	NA	7188	Whole Building1	100	39
Excersise machine	95	0	None	NA	NA	0	Whole Building1	100	5
Water tank pump-20hp	81	0	None	NA	NA	0	Whole Building1	100	1
water pump- 13.9a.	25509	0	None	NA	NA	0	Whole Building1	100	1
Elevator motor-pass/serv	13748	0	None	NA	NA	0	Whole Building1	100	6
Laundry Room washer, hot-hot	468	0	None	NA	NA	43680	Whole Building1	100	9

Laundry Room ES washer, hot-hot	468	0	None	NA	NA	21840	Whole Building1	100	1

DESIGN HEATING AND COOLING LOADS FOR BASE BUILDING

3/30/2007
Project Name:

Date:

Primary Heating System:

Space Name	Load, Btu/Hr	Load, per SF Btu/(Hr-SqFt)	Distribution	
			GPM	Ft of baseboard
Whole Building1	5273451	19	599.5	10089

Required Heating Equipment Output Capacity: 5800795 Btu/hr

Available Heating Equipment Output Capacity: 12495000 Btu/hr

Total flow: 580.2 GPM

Baseboard Capacity: 575 Btu/Hr-Ft

Heating Equipment Efficiency: 85 %

Calculated Distribution Efficiency: 100 %

Supply Water Temperature: 210 F

Temperature Drop: 20 F

Heating Safety Factor: 1.10

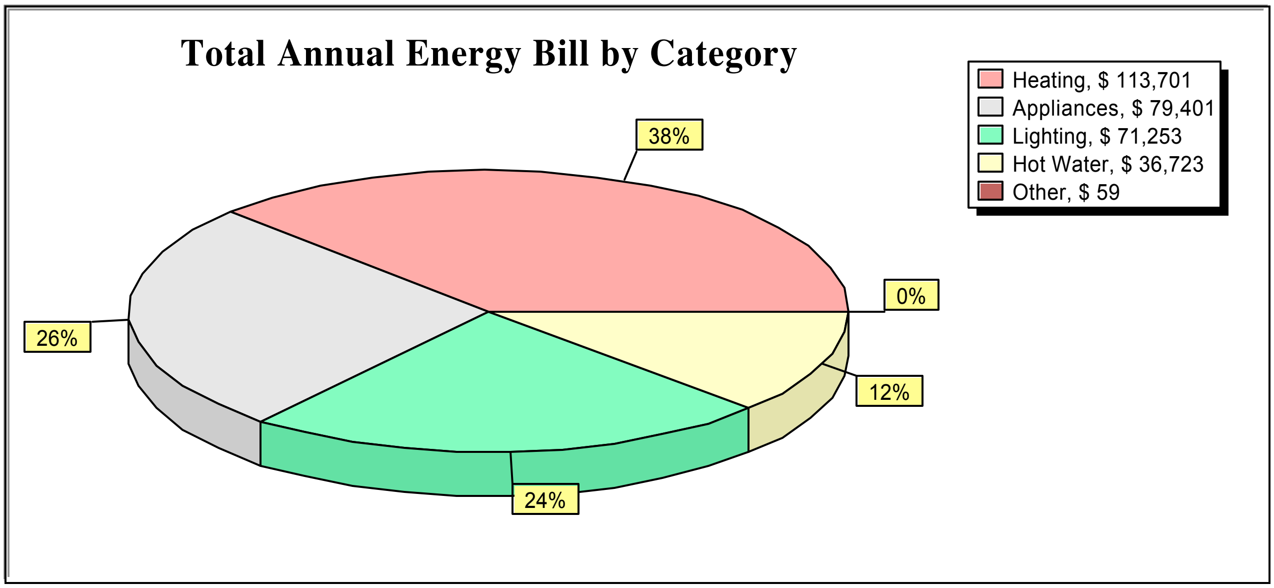
Distribution Safety Factor: 1.10

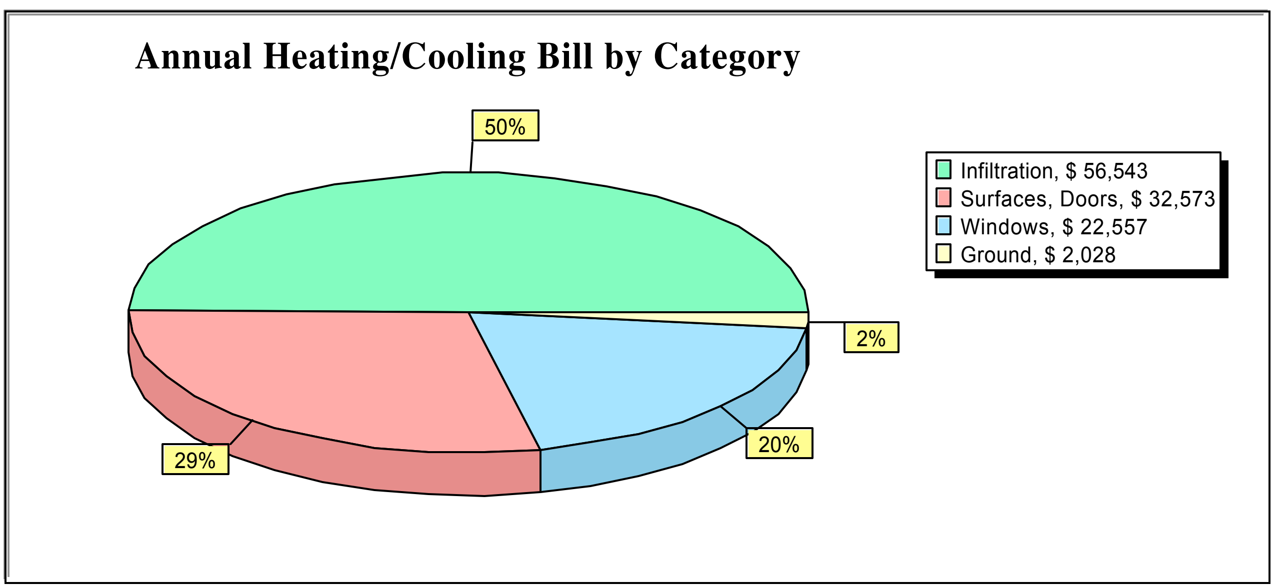
Notes:

1. The room heating/cooling loads do not include the equipment and distribution safety factor and distribution losses
2. The room distribution includes distribution safety factor.
3. The load on the room is the peak load for this room in a year.
4. Available equipment output capacity includes equipment efficiency.
5. Required equipment output capacity includes diversity, distribution losses and equipment safety factor.
6. Overall distribution CFM/GPM for heating/cooling includes equipment safety factor, distribution losses and diversity.

MODEL ENERGY REPORT FOR BASE BUILDING

Date: 3/30/2007





Note: Due to rounding, the sum of percentages may not be equal to 100.

Base Load Report

Customer Information

Customer Name:

Address:

Billing Period: 10/2005 - 10/2006

Auditor Information

Technician Name: Richard Leigh, CEC

Company:

Phone Number: 718-784-1444

Date: 3/30/2007

Model to Actual Comparison of Base Usage Per Year

	Oil #6		Electricity		Natural gas	
	Gallon	$	kWh	$	Therm	$
Base Building	24,813	36,723	936,922	145,223	5,490	5,490
BillingPeriod	23,140	35,980	1,277,060	238,886	0	0
% Difference	-7	-2	27	39	NA	NA

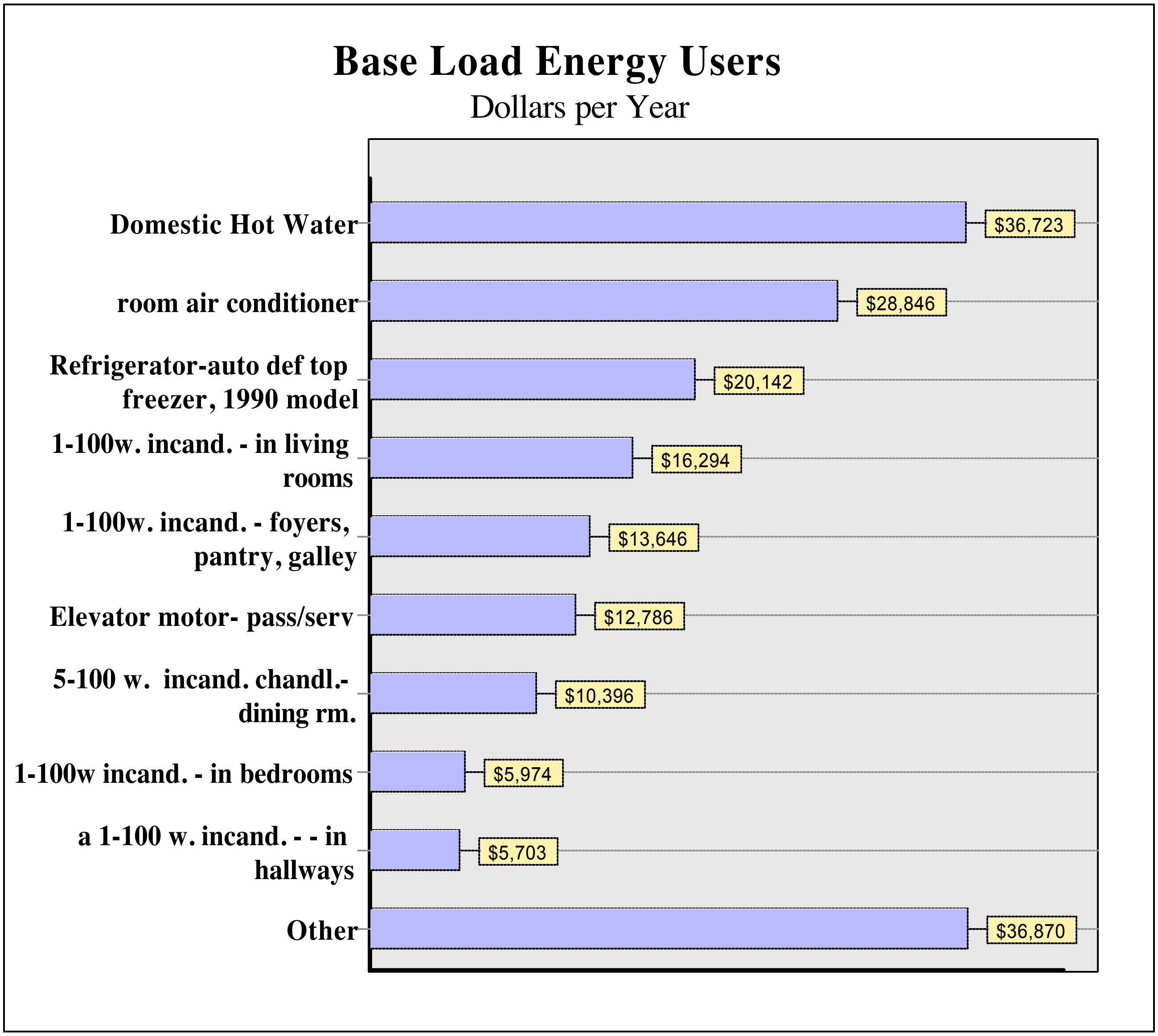
Base Building						
BillingPeriod						
% Difference						

Note: Actual billing data is adjusted to reflect a full year's usage.

Annual Use of Domestic Hot Water, Appliances, and Lighting

	Oil #6 $1.48 per Gallon		Electricity $0.16 per kWh		Natural gas $1.00 per Therm		Total
	gallons	$	kWh	$	therms	$	$
1. Domestic Hot Water	24,813	36,723	0	0	0	0	36,723
2. room air conditioner	0	0	186,102	28,846	0	0	28,846
3. Refrigerator-auto def top freezer, 1990	0	0	129,948	20,142	0	0	20,142
4. 1-100w. incand. - in living rooms	0	0	105,120	16,294	0	0	16,294
5. 1-100w. incand. - foyers, pantry, galley	0	0	88,038	13,646	0	0	13,646
6. Elevator motor-pass/serv	0	0	82,488	12,786	0	0	12,786
7. 5-100 w. incand. chandl.- dining rm.	0	0	67,069	10,396	0	0	10,396
8. 1-100w incand. - in bedrooms	0	0	38,544	5,974	0	0	5,974
9. a 1-100 w. incand. - - in hallways	0	0	36,792	5,703	0	0	5,703
10. Other	0	0	202,440	31,380	5,490	5,490	36,870
TOTAL	24,813	36,723	936,541	145,167	5,490	5,490	187,380

							Total
							$
1. Domestic Hot Water							36,723
2. room air conditioner							28,846
3. Refrigerator-auto def top freezer, 1990							20,142
4. 1-100w. incand. - in living rooms							16,294
5. 1-100w. incand. - foyers, pantry, galley							13,646
6. Elevator motor-pass/serv							12,786
7. 5-100 w. incand. chandl.- dining rm.							10,396
8. 1-100w incand. - in bedrooms							5,974
9. a 1-100 w. incand. - - in hallways							5,703
10. Other							36,870
TOTAL							187,380


Base Load Energy Users
Dollars per Year
Domestic Hot Water
$36,723
room air conditioner
$28,846
Refrigerator-auto def top freezer, 1990 model
$20,142
1-100w. incand. - in living rooms
$16,294
1-100w. incand. - foyers, pantry, galley
$13,646
Elevator motor- pass/serv
$12,786
5-100 w. incand. chandl.- dining rm.
$10,396
1-100w incand. - in bedrooms
$5,974
a 1-100 w. incand. - - in hallways
$5,703
Other
$36,870

PERCENTAGE IMPROVEMENT REPORT

Project Name:

For:

By:

Date: 3/30/2007

Package Name	Annual Energy Use of All Fuels, MMBtu	Percentage
Base Building	19357.37	100.0
Proposed Improvements wo CHP	16849.56	87.0

IMPROVEMENT PACKAGES

Date: 3/30/2007

Evaluated Packages:

Package Name	Cost $	Annual Savings, MMBtu	Annual Savings, $	Payback years	Cashflow $/year	SIR
Proposed Improvements wo CHP	110,700	2,507.81	30,888	3.58	21,141	3.31

Package Description:

1. Proposed Improvements wo CHP

Improvement Name	Cost ($)	Annual Savings MMBtu	Annual Savings ($)	Payback (years)	Cashflow ($/year)	Improvement Life (Years)	SIR in Package
M6 Lights: Stairwells	8,400	8.40	845	9.9	105	10	0.86
M9 Lights: Exit lights to LEDs	1,800	2.42	245	7.4	86	10	1.16
M7 Lights: Basement 2-20W T-12 Bilevel	750	1.24	124	6.1	58	10	1.41
M4: Seal elevator penthouses	12,000	216.00	2,081	5.8	1,025	20	2.58
M6 Lights: Elevator sensors	900	1.58	160	5.6	80	10	1.51
M7 Lights: Basement 1-48" T-12 Bilevel	250	0.45	46	5.4	24	10	1.58
M7 Lights: Basement 1-96" T-12 Bilevel	250	0.47	48	5.3	26	10	1.62
M7 Lights: Basement incandescents Bilevel	1,000	2.09	214	4.7	126	10	1.83
M1/2: Energy Management System/TRVs	55,700	1564.04	15,070	3.7	10,166	15	3.23

M7 Lights: Basement 48" T-12 Bilevel	3,750	10.82	1,094	3.4	764	10	2.49
Me10: Laundry Room Washers	6,300	221.71	2,136	2.9	1,582	15	4.05
M7 Lights: Basement 96" T-12 Bilevel	1,200	4.53	459	2.6	353	10	3.26
M6 Lights: Main hallways	10,500	40.01	4,019	2.6	3,095	10	3.27
M3: Low Flow shower heads, aerators	7,350	403.30	3,886	1.9	3,239	10	4.51
M8 Lights: Switches in gym, bike room	300	1.81	182	1.6	156	20	9.05
M5: Weatherstrip five or more exterior doors	250	28.92	279	0.9	257	10	9.51
Total for Package	110,700	2,507.81	30,888	3.58	21,141	N/A	3.31

Non-Energy Benefits:

1. M6 Lights: Stairwells: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
2. M9 Lights: Exit lights to LEDs: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
3. M7 Lights: Basement 2-20W T-12 Bilevel: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
4. M4: Seal elevator penthouses: Reduce drafts.
5. M6 Lights: Elevator sensors: Improve safety and security by automatically turning on outdoor lighting.
6. M7 Lights: Basement 1-48" T-12 Bilevel: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
7. M7 Lights: Basement 1-96" T-12 Bilevel: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
8. M7 Lights: Basement incandescents Bilevel: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
9. M1/2: Energy Management System/TRVs: Improve comfort, improve convenience.
10. M7 Lights: Basement 48" T-12 Bilevel: Reduce maintenance, reduce replacement cost

(fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).

11. Me10: Laundry Room Washers: Increase value of building, reduce environmental risk due to old ozone-depleting refrigerants.
12. M7 Lights: Basement 96" T-12 Bilevel: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
13. M6 Lights: Main hallways: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
14. M3: Low Flow shower heads, aerators: Reduce water use.
15. M8 Lights: Switches in gym, bike room: Reduce maintenance, reduce replacement cost (fluorescent bulbs last 10,000 hours whereas incandescent bulbs typically last less than 1,000 hours).
16. M5: Weatherstrip five or more exterior doors: Reduce drafts.

NORMALIZED MODEL TO BILLING COMPARISON

Date: 3/30/2007

Billing Period Name: BillingPeriod

Model Package Name: Base Building

Natural gas

	Model		Billing Data	
	Consumption Therm	Cost $	Consumption Therm	Cost $
January	466.27	466	0.00	0
February	421.15	421	0.00	0
March	466.27	466	0.00	0
April	451.23	451	0.00	0
May	466.27	466	0.00	0
June	451.23	451	0.00	0
July	466.27	466	0.00	0
August	466.27	466	0.00	0
September	451.23	451	0.00	0
October	466.27	466	0.00	0
November	451.23	451	0.00	0
December	466.27	466	0.00	0
Total	5490.00	5490	0.00	0
Daily Base Load	15.04	15	0.00	0

Electricity

	Model		Billing Data	
	Consumption kWh	Cost $	Consumption kWh	Cost $
January	79574.20	12817	108462.60	17295

February	71873.47	11624	97966.22	15668
March	79574.20	12817	108462.60	17295
April	77007.29	12419	104963.81	16753
May	79574.20	12817	108462.60	17295
June	77007.29	12419	104963.81	16753
July	79574.20	12817	108462.60	17295
August	79574.20	12817	108462.60	17295
September	77007.29	12419	104963.81	16753
October	79574.20	12817	108462.60	17295
November	77007.29	12419	104963.81	16753
December	79574.20	12817	108462.60	17295
Total	936921.98	151021	1277059.69	203743
Daily Base Load	2566.91	398	3498.79	542

Oil #6

	Model		Billing Data	
	Consumption Gallon	Cost $	Consumption Gallon	Cost $
January	20023.98	29635	18959.05	28059
February	15555.10	23022	15301.04	22646
March	13054.31	19320	13433.57	19882
April	8271.65	12242	9355.56	13846
May	2107.39	3119	1965.32	2909
June	2039.41	3018	1901.92	2815
July	2107.39	3119	1965.32	2909
August	2107.39	3119	1965.32	2909
September	2358.86	3491	1901.92	2815
October	6144.55	9094	6656.22	9851
November	11448.57	16944	10952.77	16210
December	16419.43	24301	15433.67	22842
Total	101638.00	150424	99791.69	147692
Daily Base Load	67.98	101	63.40	94

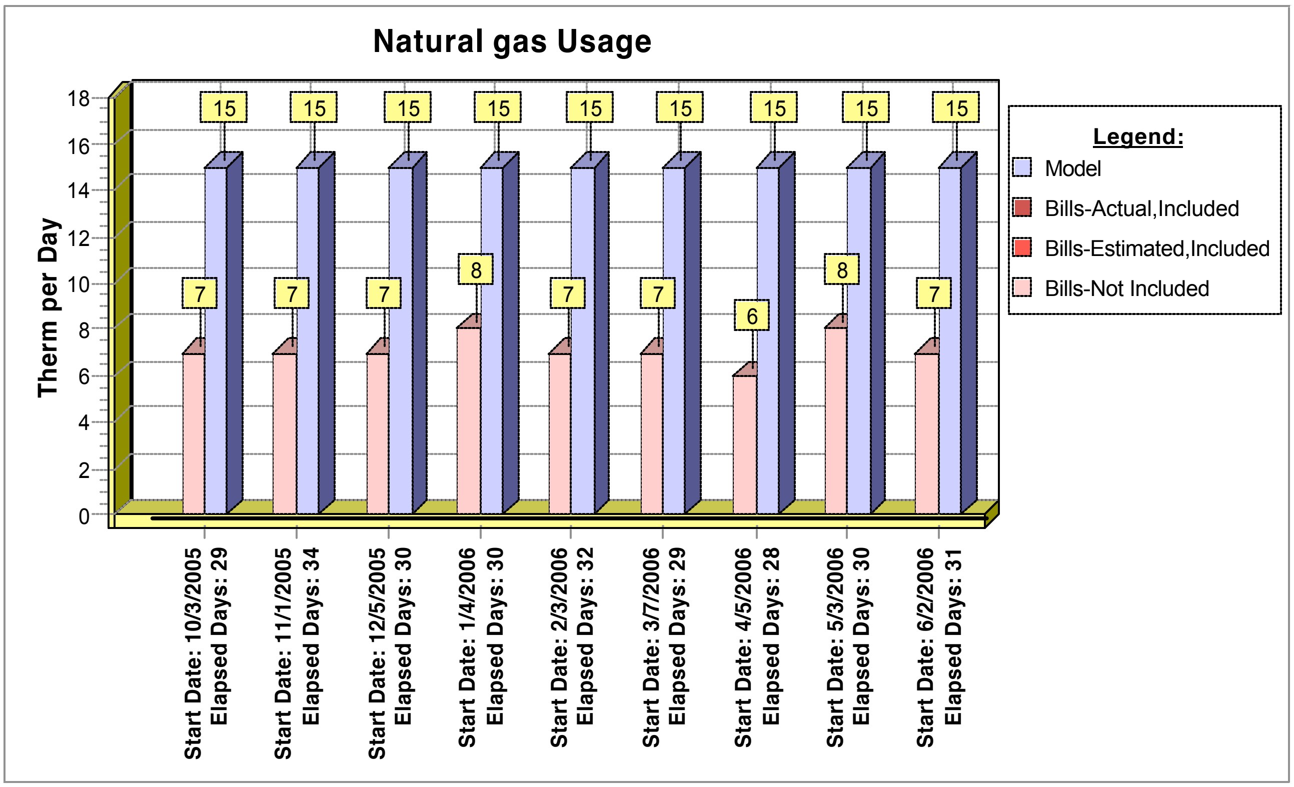
Notes:

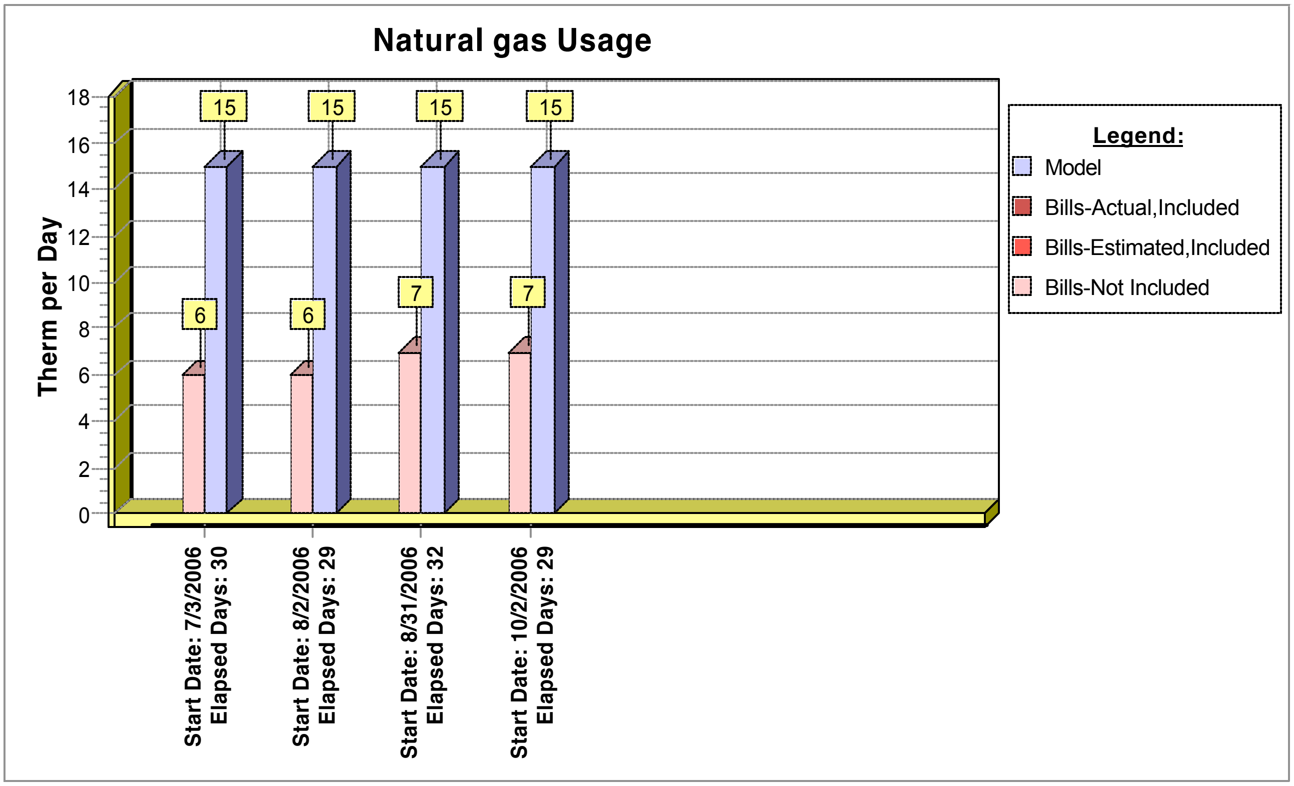
1. The report compares model energy consumption with the consumption calculated using the billing analysis slope and reference temperature. The usage is for normalized thirty year average weather conditions.
2. Monthly fuel cost includes heating, cooling and base load usage and monthly flat meter fee entered on Fuels/Rates screen.

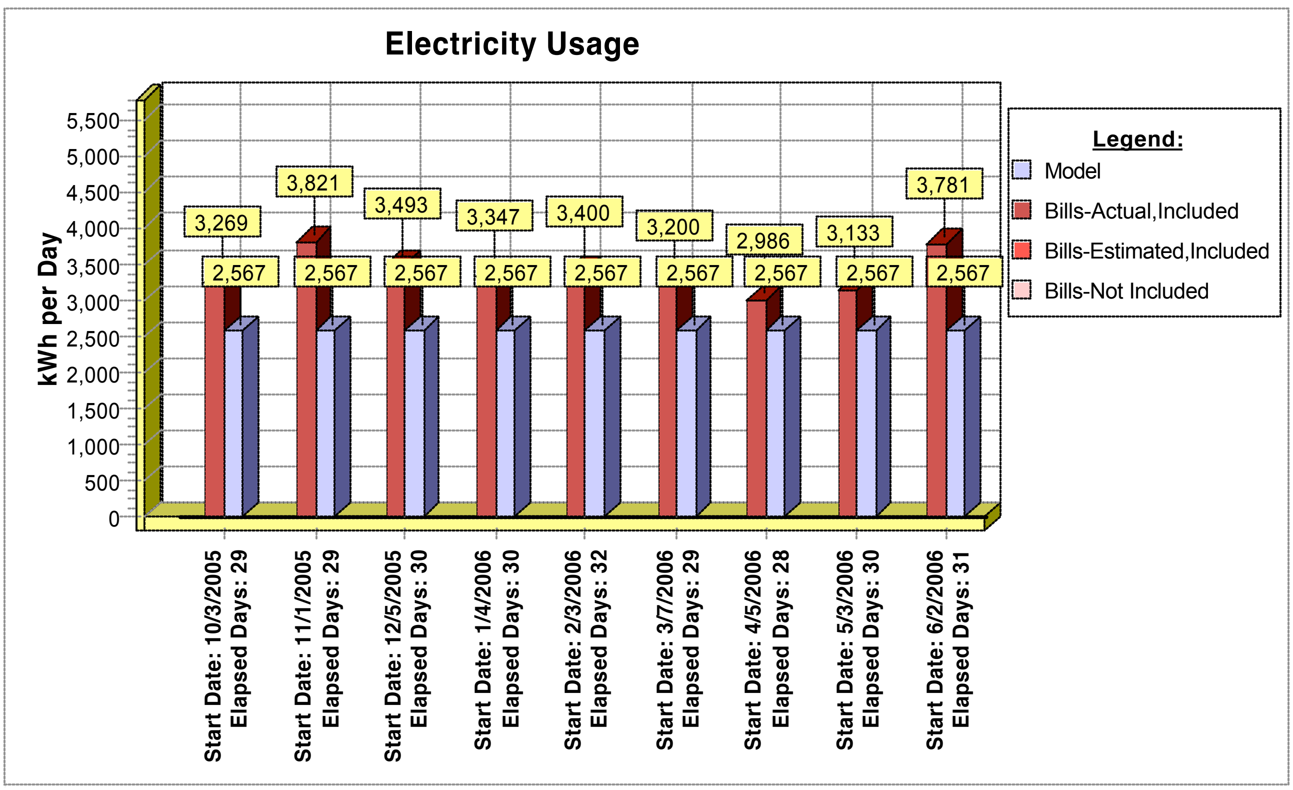
ACTUAL BILLING TO MODEL COMPARISON REPORT

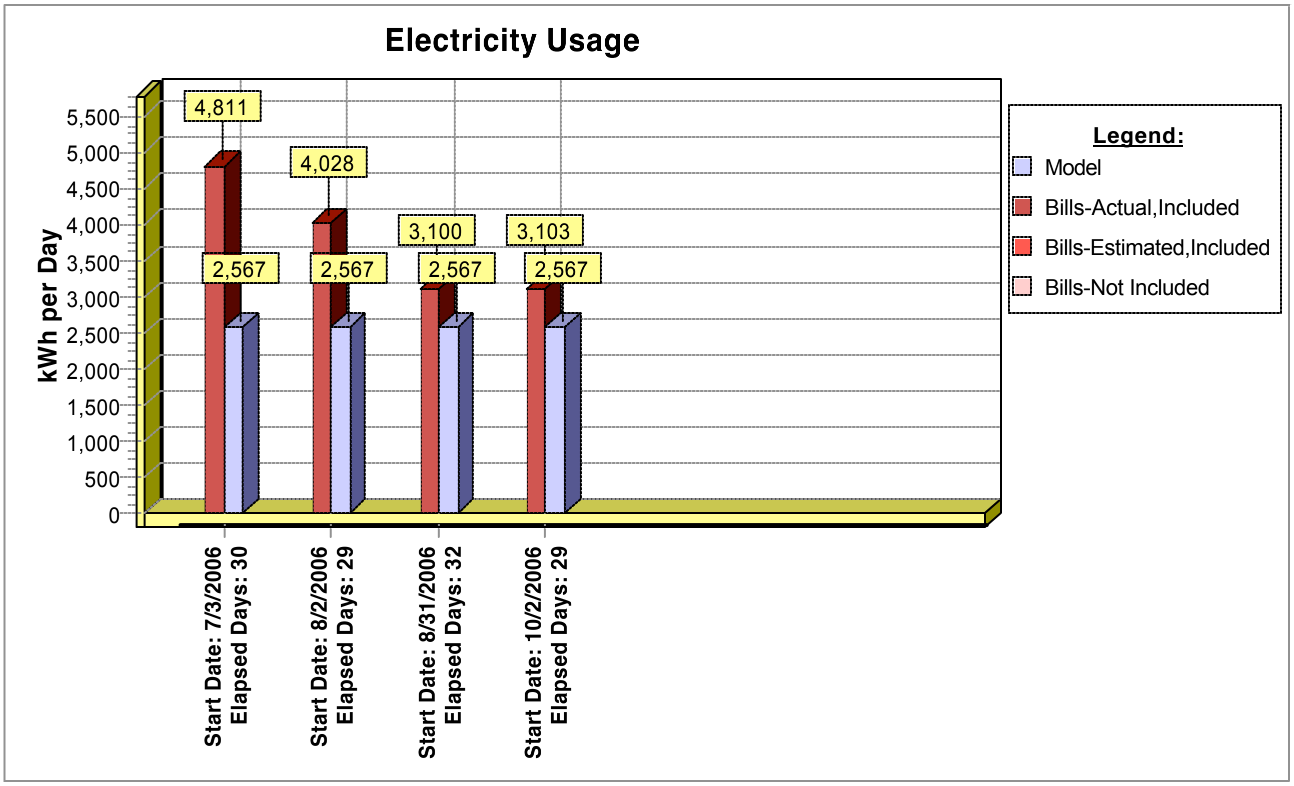
Date: 3/30/2007

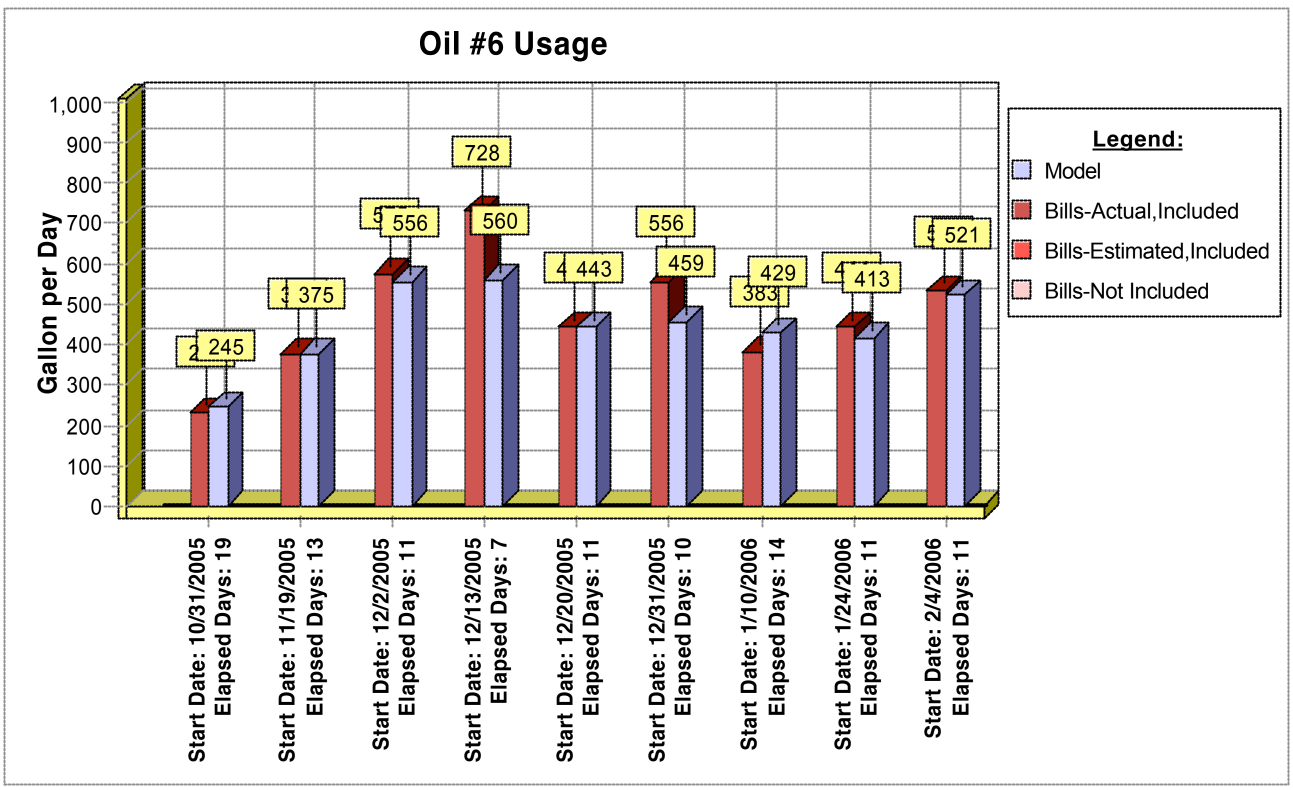
Billing Period Name: BillingPeriod
Model Package Name: Base Building

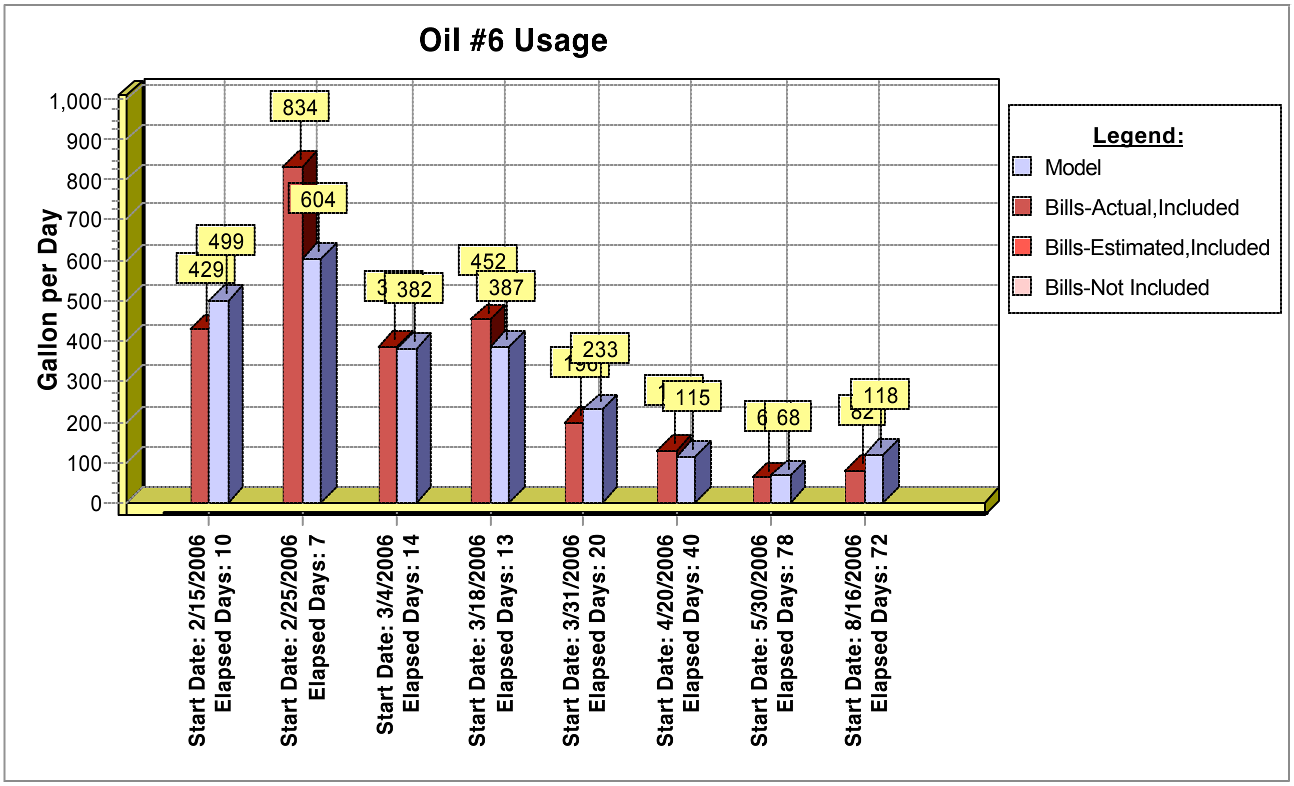



Natural gas Usage
Therm per Day
18
16
14
12
10
8
6
4
2
0
15
15
15
15
6
6
7
7
Start Date: 7/3/2006
Elapsed Days: 30
Start Date: 8/2/2006
Elapsed Days: 29
Start Date: 8/31/2006
Elapsed Days: 32
Start Date: 10/2/2006
Elapsed Days: 29
Legend:
Model
Bills-Actual,Included
Bills-Estimated,Included
Bills-Not Included


Electricity Usage
kWh per Day
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
3,269
3,821
3,493
3,347
3,400
3,200
2,986
3,133
3,781
2,567
2,567
2,567
2,567
2,567
2,567
2,567
2,567
2,567
Start Date: 10/3/2005
Elapsed Days: 29
Start Date: 11/1/2005
Elapsed Days: 29
Start Date: 12/5/2005
Elapsed Days: 30
Start Date: 1/4/2006
Elapsed Days: 30
Start Date: 2/3/2006
Elapsed Days: 32
Start Date: 3/7/2006
Elapsed Days: 29
Start Date: 4/5/2006
Elapsed Days: 28
Start Date: 5/3/2006
Elapsed Days: 30
Start Date: 6/2/2006
Elapsed Days: 31
Legend:
Model
Bills-Actual,Included
Bills-Estimated,Included
Bills-Not Included


Electricity Usage
kWh per Day
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
4,811
4,028
3,100
3,103
2,567
2,567
2,567
2,567
Start Date: 7/3/2006 Elapsed Days: 30
Start Date: 8/2/2006 Elapsed Days: 29
Start Date: 8/31/2006 Elapsed Days: 32
Start Date: 10/2/2006 Elapsed Days: 29
Legend:
Model
Bills-Actual,Included
Bills-Estimated,Included
Bills-Not Included


Oil #6 Usage
Gallon per Day
1,000
900
800
700
600
500
400
300
200
100
0
245
375
556
728
560
443
556
459
383
429
413
521
Start Date: 10/31/2005 Elapsed Days: 19
Start Date: 11/19/2005 Elapsed Days: 13
Start Date: 12/2/2005 Elapsed Days: 11
Start Date: 12/13/2005 Elapsed Days: 7
Start Date: 12/20/2005 Elapsed Days: 11
Start Date: 12/31/2005 Elapsed Days: 10
Start Date: 1/10/2006 Elapsed Days: 14
Start Date: 1/24/2006 Elapsed Days: 11
Start Date: 2/4/2006 Elapsed Days: 11
Legend:
Model
Bills-Actual,Included
Bills-Estimated,Included
Bills-Not Included



Notes:
1. Only bills that are completely within the analysis period are included in the report.
2. Bills for the "Whole building" metered space are included in the report.
3. If there are multiple metered spaces for the fuel, then only the usage for the dates for which utility bills are available for ALL metered spaces is included in the report. The start date and elapsed days of all such bills must be exactly the same. The restriction allows TREAT to calculate the total building energy consumption for the time period.
4. The billing bar is color-coded as Not Included if utility bill for at least one individually metered space for the time period was entered as not to be included in the Billing Analysis (Include the Bill in Analyais field was set to No on the Utility Bills screen for this bill).
5. The billing bar is color-coded as Estimated if there is at least one estimated utility bill for at least one individually metered space for the time period (Bill Type field is set to Estimated on the Utility Bills screen for this bill) and all the bills for the time period are included in the billing analysis.
6. The billing bar is color-coded as Actual if utility bill for all individually metered spaces for the time period are actual.
7. Model data is only shown if the billing period is compared to the model with valid calculation results.
8. Model heating and cooling usage is calculated using model heating/cooling slope and reference temperature and weather data available in Daily Weather Data library for the period covered by utility bill.