THE

THE RED DEVON RESTAURANT

BANGALL, NEW YORK

PROJECT OVERVIEW

NOMAD ARCHITECTURE

51-02 21st Street

Long Island City, NY 11101

PROJECT SUMMARY

The Red Devon Restaurant is the vision of Julia and Nigel Widdowson. Their goal was to create a restaurant that featured locally produced organic foods (including Red Devon beef raised on their own farm in Millbrook, NY) and showcased sustainable design. The restaurant includes a 75-seat dining room, a bar and an outdoor dining terrace. The adjacent bakery features prepared foods, local produce and baked goods.

The Widdowsons purchased the former Stage Stop Inn in Bangall, NY in 2005. The original Victorian house had been built in the 1880's. Over the years the building had grown through half a dozen additions to a rambling 8,300 sq. ft. This project retained as much of the original structure as possible. However, extensive structural repairs were required at a number of locations. The restaurant opened for business in June, 2008.

SITE DESIGN

1. Green roof: The 400 sq. ft. addition incorporates a landscaped green roof. This intensive-type green roof provides 10" of soil capable of supporting a broad range of plant types.

The green roof

2. Indigenous landscaping: Areas that were formerly a grass yard or asphalt paving have been replaced by extensive landscaping, including indigenous trees and plantings, as well as organic gardens that produce foodstuffs for use in the restaurant.
3. Reduced area of impervious surfaces: The total area of impervious paved surfaces was reduced by 20% from 27,000 to 22,600 square feet by removing a portion of the existing asphalt paving. The building and impervious paved areas total 28,900 square feet, leaving 82% of the site area as pervious surfaces, thus minimizing storm water run-off. The removed paving was ground up and reused as a base course under paving elsewhere on site. The existing gravel surface was retained for the parking surfaces.
4. Site lighting: Site lighting is not provided at the parking areas. Bollard-type path lights are provided at pedestrian walkways and designed to provide a low light level of 0.2 foot [remove foot, right?] candles per square foot. This approach reduces light pollution while also minimizing electrical consumption.

WATER EFFICIENCY

Estimated water consumption is reduced by up to 219,000 gallons per year compared to that of a code-compliant conventional design. Water-saving features include:

1. Rainwater harvesting to provide water for site irrigation: The roof-rainwater-harvesting system can collect and displace the consumption of up to 117,000 gallons of potable water per year. Roof rainwater is collected via downspouts and below-grade piping and stored in a decorative pond cistern in the front yard.
2. Ultra-low-flush toilets: The use of pressure-assisted 1.1-gallon-per-flush ultra-low-flush toilets and waterless urinals will save approximately 23,000 gallons per year compared to conventional 1.6-gallon-per-flush low-flush fixtures (assumes 46,000 flushes per year.)
3. Dishwashing pre-rinse spray valves: Use of a 1.6-gallon-per-minute pre-rinse spray valve at the dishwashing station can save 52,000 gallons of water and 346 therms of hot water per year compared to the standard 3.2-gallon-per-minute sprayers (assumes ninety minutes per day of operation for 360 days per year.)
4. Clothes washer: Use of a horizontal-axis clothes washer to wash table linens, etc. will save 27,000 gallons of water per year and 1,743 KwH per year of electricity compared to a conventional vertical-axis clothes washer (assuming three loads per day for 360 days per year times twenty-five gallons.)

ENERGY AND ATMOSPHERE

Initial energy modeling indicates energy-efficient features incorporated into the Red Devon will reduce energy consumption to an estimated 57% below the already stringent requirements of the Energy Conservation Construction Code of New York. This leads to an estimated annual savings of $27,300 in energy costs and 197 tons of CO^2 production. Energy-efficient features include:

1. Added insulation: Insulation was added in excess of the minimum required by the energy code. Walls are insulated to R25 with 6" of salvaged existing fiberglass batt insulation in the 2x6 wall cavity and 1" of isocyanurate board insulation sheathing. The roof is insulated to R = 38 using spray foam insulation on the underside and 1" isocyanurate board insulation on top of the roof deck. The spray foam insulation also provides a more airtight seal than conventional batt insulation, improving thermal performance by reducing air-infiltration heat losses.
2. Sealed envelope: To reduce air-infiltration heat losses through the exterior envelope, all gaps around windows, sill plates, etc., were sealed with flashing tape, sealant or foam sealant. Gaskets were installed at all doors and at all electrical outlets in exterior walls. Taped gypsum board was added at the underside of the floor framing to minimize air and water vapor infiltration from the cellar.
3. High-performance windows: All existing windows were replaced with Marvin Integrity fiberglass sash windows with low-e coated, argon-filled insulated glass with a whole window U factor of 0.30. This is estimated to save 10,000 btus per year as compared to windows that met the minimum performance requirements of the Energy Conservation Construction Code of New York. (u = 0.30 provided verses u = 0.50 min. per code.)
4. Heat pumps: All space heating and air conditioning is provided by a twenty-ton-capacity ground-source heat pump. The system includes eleven 400-foot-deep wells placed in the front yard and five individually-zoned fan coil units located in the cellar. This extremely efficient system will use 37,500 kw/hr less electricity than a conventional air-to- air heat pump and save approximately $3,300 per year in energy costs.
5. Variable-volume kitchen hood: Whereas a conventional hood runs full-speed all day long, this variable-air-volume kitchen exhaust hood uses smoke and heat sensors to

sense the cooking load and adjust the exhaust and make up air fan speeds. This unit can reduce the quantity of air exhausted from the kitchen from an average of 3,800 CFM to only 2,300 CFM, a 39% reduction compared to a conventional constant-volume hood. Using a conservative $2 per cfm per year energy cost, this translates into an 87,200 MBtu and $5,172 annual energy savings. (A combination of reduced fan operation and reduced heating of the make-up air. Assumes 16 hours a day operation.)

6. Heat recovery ventilators: Two 1000-cfm heat recovery ventilators provide ventilation to the public areas. These recover up to 58% of the heat from the exhaust air steam to preheat the incoming make-up air, heat that would be wasted by a conventional ventilation system. The ventilators also work in reverse in the summer, using the already-conditioned exhaust air to pre-cool the hot incoming air.
7. Natural ventilation: Extensive operable windows and a skylight with operable clearstory windows in the dining room provide natural ventilation as well as day lighting. On some temperate days in the spring and fall, air conditioning will not be required.
8. Heat-recovery drain line: This device placed on the dishwasher drain uses heat from the hot drain water to preheat the well water supplying the hot water storage tank. The dishwasher heats wash water to 180 degrees. This device can reclaim much of that heat, an estimated 6,446 kw/hr per year in heat that would otherwise go down the drain.
9. Efficient lighting: Most lighting uses fluorescent and compact fluorescent bulbs which will consume roughly 20% of the electricity of conventional incandescent bulbs. LED-type bulbs are used at the exterior since they perform better than compact fluorescents in cold weather. Low-voltage halogen incandescent down lights are used as accent lighting in the dining room. The proposed lighting design saves an estimated 52,000 kw/hrs and $4,680 per year in electrical consumption compared to an all-incandescent lighting system.
10. Fireplace with outside air intake: The existing fireplace was modified by adding a glass screen and outside air intakes at the fire box for combustion make-up air. Conventional fireplaces that are open to the room typically draw more heat out of the room and up the chimney then they add to the room. Adding the glass doors eliminates this heat loss.
11. A reflective standing seam galvalum roof: This Energy Star rated roof will reflect up to 90% of the solar energy that strikes it, reducing the building's summer cooling load.
12. Efficient kitchen cooking equipment: New high-efficiency cooking and refrigeration equipment can use less than half the energy consumed by older, conventional equipment. All reach-in refrigerators and freezers use remote compressors located in the cellar to avoid dumping their heat into the kitchen. Water used to cool these compressors is then used to preheat the incoming well water supplied to the domestic hot water tanks.

The water cooled compressors the heat recovery drain line

In addition, much of the energy consumed is produced by on site renewable resources. Renewable energy systems include:

1. Photovoltaics: A 7.2 KVA grid-tied, battery-less photovoltaic electric system that will generate 8,400 kw/hr of electricity per year directly from sunlight. This system includes 35 205 watt peak capacity PV panels mounted on the southern roof. The system will save $750 in electrical costs as well as offset the production of 8,000 lbs of carbon annually.
2. Solar hot water: An evacuated-tube solar hot water system that can generate 26,000 kw/hr of hot water per year, roughly 49% of the restaurant's total hot water load. The system is sized to produce 100% of the hot water demand on a typical summer weekday. (A larger system, capable of producing 100% of a weekend day's load, would produce too much heat on other lower-demand days, heat that would be wasted.) The system includes ninety-six evacuated tube type collectors mounted on the roof and two 125- gallon storage tanks located in the cellar. These evacuated tube type collectors perform much better than conventional flat-plate collectors in this relatively cold climate. Back-up water heating for times when the solar system cannot provide the entire hot water load is provided by an LP gas-fired instantaneous water heater.

The solar water heaters

3. Passive solar: A large south-facing window provides passive heating in the function room. The room's colored concrete floor acts as a heat sink, slowly absorbing, then re-releasing the heat from the sun that passes through the windows. Overhangs block out the summer sun. Insulated blinds drawn at night reduce the heat loss back out through the glass.

MATERIALS

By reusing existing components and incorporating salvaged components or those with a high recycled content, this project eliminated 21,800 lbs of materials from the waste stream and avoided the consumption of 21,800 lbs of new materials.

1. The project kept demolition and new material consumption to a minimum by reusing the entire existing shell and as much of the interior of the former Stage Stop Inn as possible. Some reused features include:
2. All 2,842 square feet of the existing oak flooring were retained and refinished. This kept 9,095 lbs of wood out of the waste stream and also avoided the consumption of an equal amount of virgin wood.
3. The existing bar, including its solid walnut countertop, was retained and refinished. This avoided the consumption of 6.2 cubic feet of wood.
4. The three insulated boxes for the existing walk-in coolers were retained and refitted with new refrigeration equipment. This kept 260 cubic feet out of the waste stream and avoided the consumption of 2500 lbs of steel.
5. The contractor developed a construction waste management plan to minimize the amount of waste generated by demolition and construction. Salvaged studs and other materials not reused on site were donated.

Materials with a high proportion of recycled content were used throughout. Some recycled content materials include:

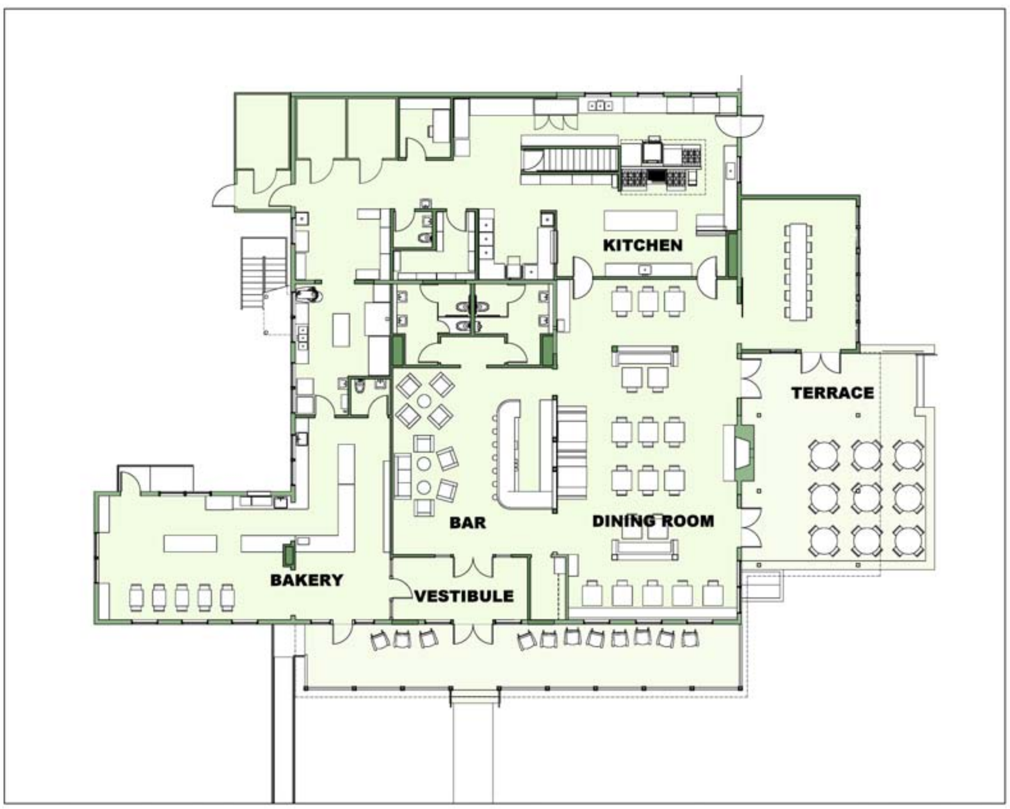
1. Wheel stops: The seventy parking lot wheel stops and four roof downspout splash blocks are manufactured from recycled tire. They eliminate 3,220 lbs of discarded tires from the waste stream, approximately 140 tires.
2. Walk off mat: The walk off mat at the entrance is manufactured from recycled tires. It eliminates 333 lbs of tires from the waste stream.
3. Toilet partitions: The toilet partitions are manufactured from 100% post-consumer recycled plastic. These partitions eliminate 4,368 plastic milk jugs from the waste stream and avoid the production of 546 pounds of virgin plastic.
4. Remilled wood trim: All standing and running trim is manufactured from yellow pine remilled from heavy timbers salvaged from demolished buildings. The 1,900 board feet of salvaged lumber installed avoided the consumption of 5,900 lbs of virgin lumber.
5. Wheatcore millwork: In the public areas, all interior doors and millwork cabinetry are made from wheatcore particle board that is manufactured from agricultural waste.
6. Lay-in ceiling: The 400 sq. ft. of lay-in acoustic ceiling in the function room is fabricated from 61% recycled content materials. This eliminates 256 lbs from the waste stream.
7. Metal roof: The standing seam metal roof is made in part from recycled steel, is fully recyclable and will last far longer than typical asphalt shingles. We estimate that during its fifty-year-projected lifespan, the metal roof will keep 10 tons of asphalt shingles out of the waste stream (avoiding 3 replacement shingle roofs.)

8. Salvaged concrete: Crushed concrete from on-site demolition was used for below-slab granular fill in lieu of crushed gravel.

INDOOR AIR QUALITY

1. VOC-free paints and finishes: All paints are water-based latex and 100% volatile organic compound-free. All wood floor and trim finishes are natural linseed oil-based penetrating sealer with carnauba wax top coat.
2. Plywood: all plywood and particle board products are urea formaldehyde-free.
3. A walk-off mat at the entrance vestibule helps reduce the amount of dust and pollutants tracked in from the outside.
4. Natural and mechanical ventilation maintains ventilation rates in excess of those specified by ASHRAE 62 – 1999.
5. Daylighting: A skylight and added windows provide natural daylighting in public spaces. During the day artificial lighting is not required in the dining room.

Although the design team did not apply for USGBC LEED certification for this project, we have completed a LEED V2.2 certification spreadsheet to see how the design would rate. Our calculations indicate a LEED score of 39 points, sufficient to obtain a LEED Gold rating.



Floor Plan

SUPPLIERS

(In order that items are listed above.)

Ultra-low flush toilets: Kohler Highline 1.1 gpf. www.kohler.com

Spray foam insulation: Selection 500 by demilec USA LLC; www.sealectiom500.com. Supplied and installed by Foam Rite, Inc., Monroe, NY. (845) 928 9609.

High-performance windows: Marvin Integrity Wood Fiberglass windows. www.integritywindows.com. Supplied by Williams Lumber, Hopewell Junction, NY (845) 221 4333.

Ground source heat pumps: Water Furnace International, E series. www.waterfurnace.com. Supplied by Buckley Associates, Albany, NY (518) 438 7423.

Variable-volume kitchen exhaust hood: The exhaust hood was manufactured by Cadexair, Quebec. The variable-speed fan controls are by Melink Corporation, www.melinkcorp.com.

Heat recovery ventilators: Life Breath Indoor Air Systems by Nutech Brands Inc. www.lifebreath.com. Supplied by Buckley Associates, Albany, NY (518) 438 7423.

Heat recovery drain line: A GFX Model G3-40 manufactured by GFX technology. www.gfxtechnology.com. Supplied by the manufacturer.

Photovoltaics: The photovoltaic system includes thirty-five panels manufactured by Sunpower Corporation and two inverters also manufactured by Sunpower. The system was supplied and installed by Hudson Valley Clean Energy, Rhinebeck, NY (845) 876 3767. www.hvce.com.

Solar hot water: Sunda Seido 1 system, www.sssolar.com. The system was supplied by Phoenix Energy Supplies, Auburn, NY. (315) 253 3720.

The wheel stops and downspout splash blocks: Locally manufactured by Enviroform Recycled Products in Geneva, New York. (315) 789-1810. www.enviroform.com.

Walk off mat: Made from Fluff Cord strip tiles manufactured by Musson Rubber Company. (330) 773 7651. www.mussonrubber.com.

Toilet partitions: "Origins" panels manufactured by Yemm and Hart Ltd. (573) 783 5434. www.yemmhart.com.

Wood trim: the salvaged lumber used at interior trim is antique yellow pine locally produced by Antique and Vintage Woods of America in Pine Plains, NY (518) 398 0049. www.antiqueandvintagewoods.com.

Interior wood doors: the Wheatcore doors are manufactured by Humabuilt Healthy Building Systems in Ashland Oregon. (541) 488 0931. www.humabuilt.com.

Interior paint: Prep and Prime odor-less primer and Du lux Lifemaster interior latex by ICI Paints. www.icipaintsstores.com. Supplied by Sun Wallpaper and Paint, Poughkeepsie, NY. (845) 471 2880.

Floor and wood trim finishes: Hard oil #9 and wax finish #39 by Biosheild paints and finishes. www.bioshieldpaint.com.

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SUMMARY REPORT

BY: C. W. Callahan, PE (CT#23000)
DATE: 2 January 2006
CLIENT: Nomad Architecture – Brooklyn, NY
PROJECT: Red Devon Restaurant – Bangall, NY

TOPIC: Overall Building Energy Model and Assessment of Design Features

SUMMARY

An energy model of a planned restaurant building was used to determine the benefit of certain design features over minimum New York State Energy Conservation Code (NYSEC) requirements[1,2]. The simulation results for the most aggressive planned design (10 kVA PV, etc) predict the following savings:

- ENERGY: 303 million watt hours annually, all in electricity
    - 57% overall savings vs. code minimum model
        - 47% savings from energy efficiency measures
        - 10% from onsite production and heat recovery
    - 59% overall savings vs. national restaurant average[3]
- FINANCIAL: $27,300 annually in energy expenses
- ENVIRONMENTAL: 197 tons of CO_2 emissions annually
    - Analogous to removing 45 cars from the nation's roads, or
    - Planting 152 acres of CO_2 absorbing forest

The predicted benefit of various individual design features are summarized as follows, with greater detail provided later in this report.

- Ventilation of the cooking areas in a restaurant is an energy intense activity. A variable volume range hood (VVRH) is included in the renovated design. This device allows for a much lower nominal ventilation rate and a peak ventilation rate which is dramatically lower than the standard code sizing. The inclusion of a VVRH in this design results in 62% of the overall energy savings.
- The use of a clearstory for day-lighting, energy efficient lighting fixtures and controls provide 13% of the overall energy savings.
- The heating, ventilation and air conditioning (HVAC) energy load is the single greatest load in the building. For this reason a design decision to install a high efficiency ground source heat pump (GSHP) for space conditioning results in a 6% reduction in overall energy consumption and 10% reduction in HVAC related energy consumption.
- A GSHP design which integrates the restaurant's refrigerators results in 11% overall energy savings.
- The installation of enhanced windows and doors results in 4% overall energy savings.
- The building's existing insulation is already above the code minimum. The proposed renovations related to insulation are relatively minor and result in 2% overall energy savings.
- Including an evacuated tube solar hotwater heater (SHW) results in 48% of the onsite power production and displaces 9% of conventional energy consumption.
- Including a 10kVA solar photovoltaic (PV) system results in 34% of the onsite power production and displaces 6% of conventional energy consumption.
- Using heat recovery devices (conditioned air and dishwasher water) results in 17% of the onsite "production". The recovery of this energy displaces 3% of conventional energy consumption.

BACKGROUND

A series of renovations are planned for a ~5789 ft^2 restaurant in Bangall, NY. The owners of the building seek significant sustainable energy efficiency performance. The schematic design for these renovations has been completed by Nomad Architecture and included a "Green Matrix" of sustainable building options. The analysis summarized in this report has been completed to determine performance of the building design relative to New York State Energy Code (NYSEC) and also national average performance for restaurants. Additionally, the performance of individual Green Matrix design features has been assessed to aid in the design process. A projection of the renovated building's energy performance has been summarized in this report based on the final schematic integration of these Green Matrix options.

METHODS

The software program Energy10 was employed in performing this analysis. Energy10 is a commercially available building modeling program which is intended to compare different conceptual designs with respect to energy efficiency performance. A NYSEC compliance software program, COMCheck, was also employed to determine minimum compliance in this early stage of design. Accurate inputs and reasonable assumptions are critical for these programs to provide useful results. Every effort has been made to arrive at such inputs and assumptions through review of plans and research into energy technologies and the relevant code. However, the specific predicted performance may not completely agree with actual future performance. The relative performance, and relative contribution of each design feature, however, should be very close to relative future performance.

Not all design features could be easily or completely simulated using this program. Therefore, some design features were assessed using engineering calculations[4] external to the Energy10 model, and were then used to supplement the Energy10 results. The predicted performance summarized in Table 3 provides the most complete and integrated results.

The general approach to this analysis was to (1) determine the main energy factors of the specific design, (2) determine the NYSEC minimum design for such a building, (3) model both NYSEC Minimum and Nomad Designs (including Green Matrix items), and (4) compare the results.

ASSUMPTIONS and MODEL INPUTS

The planned renovations will be performed on a building in Dutchess County, NY which is climate Zone 13a according to reference 1[*] (Heating Degree Days: 6391, Cooling Degree Days: 593). The building design includes approximately 23% glazed exterior surface area. Building surface areas assumed in this model are summarized in Table 1. The building location and the glazed surface area determine the applicability of Table 802.2(4) of the NYSEC in conjunction with the rest of the code as summarized in Table 2 under the heading "NYSEC Minimum for Zone 13a".

[*] *This reference (the NYSEC) includes an error which relates directly to this project. Dutchess County is listed as Zone 13a in Table 302.1, but is listed as Zone 14a in Figure 302.1. The NYS Code Division was contacted regarding this discrepancy and indicated Zone 13a is correct both verbally and through published clarification in reference 2.*

Table 1 - Building Surface Area Assumptions (ft^2 unless otherwise noted)

	North	East	South	West	Total
Walls	729	1008	729	1008	3474
Windows	167	50	117	217	551
Doors	48	24	72	96	240
Roof	762 @ 26° 1012 @ 6°	731 @ 26° 1519 @ 6°	762 @ 26° 1012 @ 6°	731 @ 26° 1519 @ 6°	8048
Basement (perim)					5879 (416 ft)
Total	2718	3332	2692	3571	18192

The occupancy schedule of the building was assumed to peak at 80 people on Friday and Saturday nights, with a lower occupancy during the week peaking at 50 people. The mid-day peak is assumed to be 50% of the evening peak in each case. The thermostat settings correlate with occupancy and assume a normal set point of 68 degrees F with a setback of 60 degrees F (heating) and 72 degrees F with a setup of 80 degrees F (cooling).

Nomad Architecture and the building owners have determined that the renovated building will also include design features that are note directly addressed by the NYSEC. These features have either been included in the Energy10 model of the building or their benefit was estimated external to the model and included in the summary of results if significant:

- Reflective roof to reduce solar loading in summer
- Trombe wall on south side of community room for passive solar heating[5]
- Variable volume range hood to reduced kitchen ventilation load[6,7]
- Heat recovery devices in air ventilation and dishwashing systems[8]
- Hot water heating by evacuated tube solar collector[9]
- Onsite electrical power production by grid-tied photovoltaic solar panels
- Lighting efficiency improvement by means of a clearstory in the dining area
- Inclusion of the refrigerators on the GSHP loop
- Infiltration control beyond the code minimum performance

Table 2 - Comparison of NYSEC Minimum Design Requirements to Nomad Design Features

Design Item	NYSEC Minimum for Zone 13a	Nomad Design	Comments
Slab or below grade wall	R-0	R-0	No below grade insulation enhancements are planned.
Floors over unconditioned space	R-19	R-25	All-wood joist/truss assumed
Above grade walls	R-11	R-19	
Roof assemblies	R-25	R-40	
Windows and glass doors	U-factor $\leq$ 0.6 SHGC $\geq$ 0.6 < 25% glazed surface	U-factor = 0.33 SHGC = 0.32 ~23% glazed surface	Projection factor <0.25
Air Infiltration	- Windows and doors meeting AAMA/ WDMA 101 / I.S.2. - Sealed envelope - Dampers - Vestibules - IC or equivalent recessed fixtures if used. - Vapor retarder installed	- All planned	
Interior Lighting	< 12,634 Watts (Total Building Method) or < 13,447 Watts (Building Portion Method) (effectively 2.3 W/ft^2)	Model: 1,499 Watts (0.25 W/ft^2) Budget: 13,447 Watts	- NYSEC indicates < 12,634 Watts based on whole building 5879 ft^2 at 1.7 W/ft^2 as a Restaurant space and additional decorative lighting in the 2640 ft^2 restaurant section at 1.0 W/ft2. - 13,447 Watt budget assumes Restaurant section is 2640 ft^2 at 1.7 W/ft^2 plus 1.0 W/ft^2 decorative, Retail Space is 1114 ft^2 @ 2.1 W/ft^2 and Kitchen is 1809 ft^2 @ 2.2 W/ft^2.
Exterior Lighting	> 45 Lumens / Watt	80 Lumens / Watt	Assume compact fluorescent in Nomad design.
Lighting Controls	- Minimum of one independent manual switch or occupancy sensor for each space where no activity takes place (storage, etc). - Multiple in other spaces. - Tandem wiring - Exceed minimum transformer efficiencies.	- All planned	
Heating & Cooling	> 13.4 EER and 3.1 COP	20 EER and 4.0 COP	
HVAC Design	- Load calculations based on 1997 ASHRAE Fundamentals - Equipment no greater than to meet load. - Hot water pipe insulation per code - Economizer required on AC system	- All planned	
Hot Water	Per NAECA, Energy factor > 0.62	- Planned	

RESULTS

Both the NYSEC minimum and the Nomad Architecture designs were modeled using Energy10. The results are summarized in Table 3 below along with benchmark performance for similarly sized restaurants in the USA. These results are depicted graphically in various forms on the following pages.

Table 3 - Energy Modeling Results

Energy Breakdown, kWhr/yr	**Average Restaurant**	**NY Code Minimum**	**Nomad Design**		**Nomad Design 2kVA PV**	**Nomad Design 10kVA PV**	
Lights	36771	44613	13269	5%	13098	12418	
HVAC	325465	287488	174114	61%	170442	161511	
Hot Water	67786	66130	66130	23%	33125	29733	
Other	134292	135718	31105	11%	29268	27672	
Onsite Production / Recovery					-38684	-53284	
Total Grid Energy Consumption, kWhr/yr	**564314**	**533949**	**284618**		**245934**	**231334**	
Savings vs. Code Minimum Model, kWhr/yr			*249331*		*288015*	*302615*	
%			*47%*		*54%*	*57%*	
Cost, $/yr @ 0.09 $/kWhr	**50788**	**48055**	**25616**		**22134**	**20820**	
Savings vs. Code Minimum Model			*22440*		*25921*	*27235*	
CO2, lbs/yr @ 1.3 lbs CO2/kWhr	**733608**	**694133**	**370003**		**319714**	**300734**	
tons/yr	367	347	185		160	150	
Savings vs. Code Minimum Model, lbs/yr			*324130*		*374419*	*393399*	
tons/yr			*162*		*187*	*197*	
cars/yr			*37*		*43*	*45*	
acres/yr			*126*		*145*	*152*	
Savings by Design Feature, kWhr/yr			**249331**		**288015**	**302615**	
Consumption / Energy Efficiency			**249331**		**249331**	**249331**	
Variable Volume Range Hood			154674		154674	154674	62%
Lighting Eff 1.7 to 0.25, Clearstory			31344		31344	31344	13%
Refrigeration on GSHP			27276		27276	27276	11%
GSHP 20 EER / 4.0 COP			16062		16062	16062	6%
Windows and Doors			9611		9611	9611	4%
Insulation Beyond Code			5511		5511	5511	2%
Reflective Roof (0.7 to 0.2)			2938		2938	2938	1%
Infiltration 300 to 200			1914		1914	1914	1%
Production / Recovery					**38684**	**53284**	
Solar Hot Water					25711	25711	66% / 48%
Photovoltaic					3650	18250	9% / 34%
Water Heat Recovery					6446	6446	17% / 12%
Air Heat Recovery					2877	2877	7% / 5%

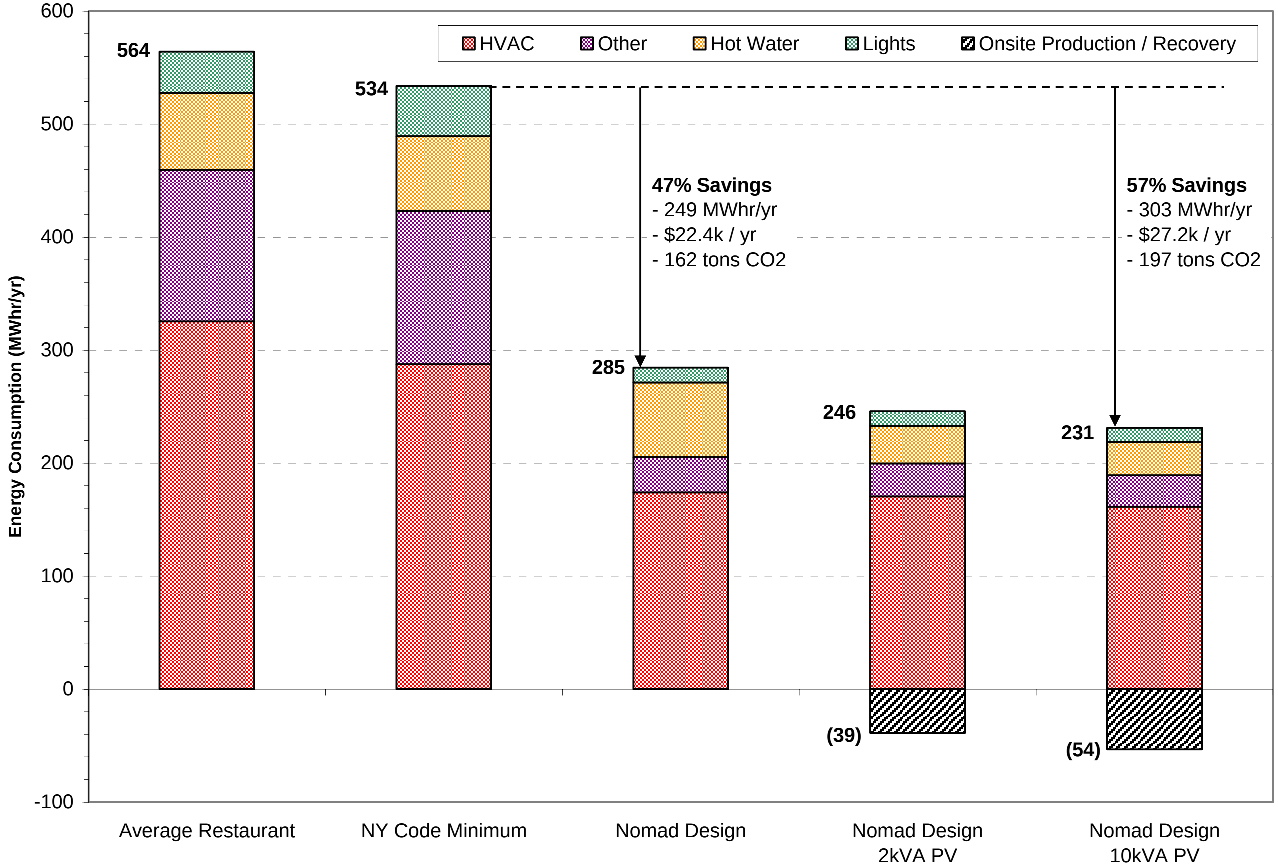

Figure 1 - Overall Energy Savings by Category of Use. Units: MWhr/yr; millions of watt-hours per year. The overall, annual energy savings due to the Nomad Architecture design is 303 million watt hours (equivalent to 576 standard 60 watt incandescent light bulbs left on all year long.) This corresponds to approximately $27,200 per year in energy related expenses. Additionally, the Nomad Architecture design avoids the emission of 197 tons of CO_2. This is analogous to 152 acres of forest or 45 cars on the road at national average mileage (11904 miles) and fuel economy (21.4 mpg). “HVAC” includes all space heating, cooling and ventilation. “Other” includes plug loads and appliances. “Lights” accounts for both interior and exterior lighting. “Onsite production / recovery” includes solar hot water, solar photovoltaic and heat recovery.

Figure 2 – Breakdown of Onsite Energy Production and Energy Recovery Measures. Units: MWhr/yr; millions of watt-hours per year. Two cases are shown; the left assumes a minimal solar photovoltaic installation and the right assumes a larger installation.

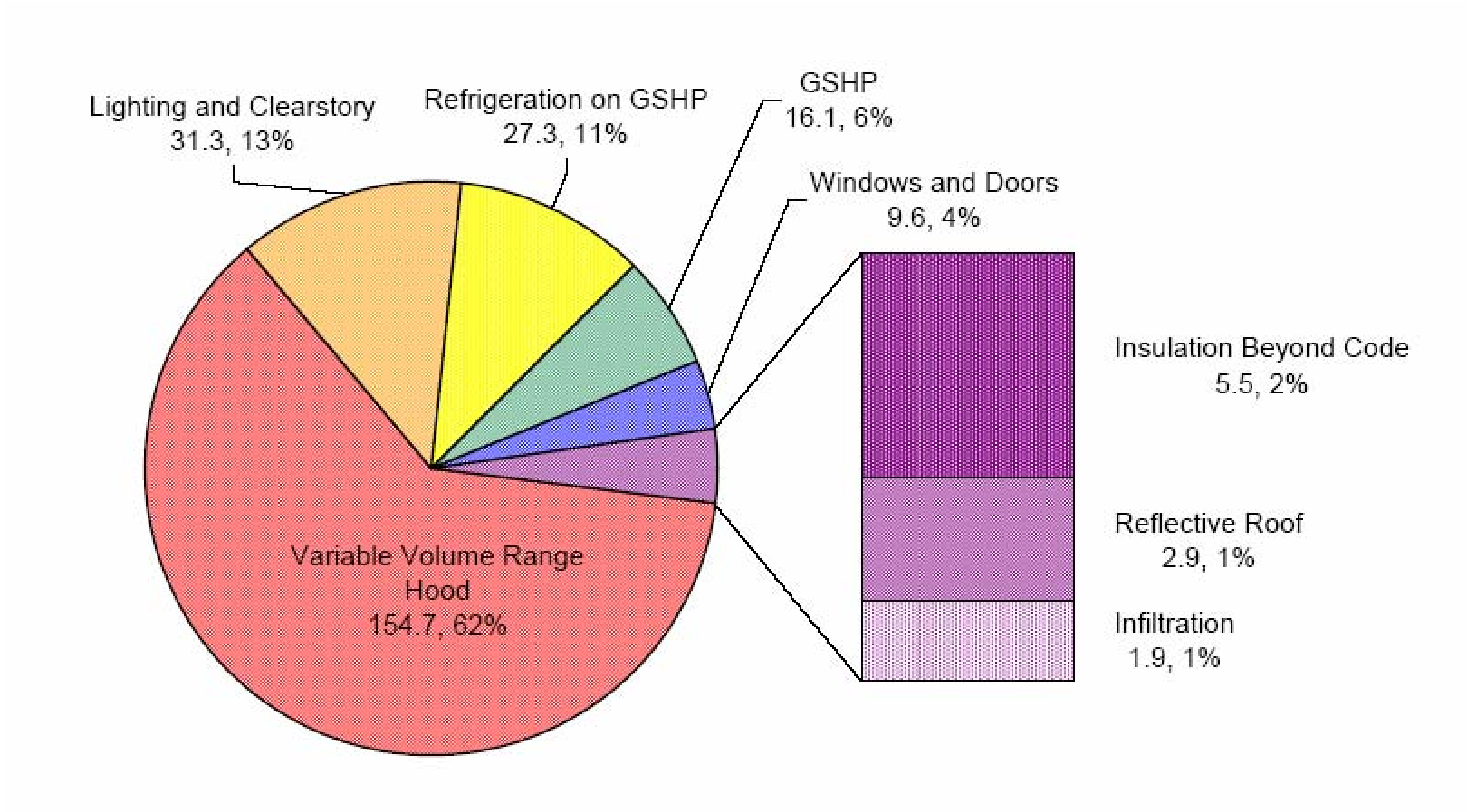

Figure 3 -Energy Savings due to Individual Design Features. Units: MWhr/yr; millions of watt-hours per year and percent of total consumption savings. The single greatest energy savings is due to the inclusion of a variable volume range hood.