Sustainable Construction in Indian Country

Energy Evaluation and Recommendations

Elder Housing Sunrise Acres

November 27, 2012

Akwesasne Housing Authority Hogansburg, NY

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Executive Summary

St. Regis Tribal and housing authority leadership believes that an energy efficient, healthy home is the foundation of society and that a quality home provides a pathway to achieving an enriched lifestyle. Sunrise Acres Phase Two illustrates the Tribe and the housing authority's leadership role in the successful design and development of a sustainable neighborhood. Sunrise Acres-Phase 1 illustrates the Tribe's commitment to updating an existing neighborhood to a green, sustainable neighborhood.

There are 116 million residential households currently in the United States with an average of 500,000 new homes built annually. This accounts for 21.5% of the national energy consumption and CO_2 emissions, and about 38% of the nation's electricity use. About 85% of the housing stock was constructed prior to 2000. Older buildings generally have less stringent energy codes, are poorly insulated, suffer from excessive air leakage, and have inefficient mechanical, and lighting systems. This report is an energy evaluation which provides a comparison and analysis of the 20 older residential units to the 20 newer residential units at the Sunrise Acres Development. The report also provides strategies to upgrade the older residential units making them more energy efficient.

The Akwesasne Housing Authority which is located on the St. Regis Indian Reservation in Hogansburg, New York, manages the Sunrise Acres elderly housing development. It was constructed in two phases. The Phase 1 Sunrise Acres project cost $1,089,035 and was built beginning in 1998 with 1937 ACT funding. The Phase 2 project, built in 2011, cost approximately $7 million, of which $4 million was built with Recovery Act funds and $3 million was NAHASDA funding.

This report provides an energy and cost comparison analysis between Phase 1 and Phase 2 buildings, includes strategies to reduce the annual operation cost for the Phase 1 buildings through load reduction and energy efficiency improvements, and highlights the green construction features incorporated into the Phase 2 buildings.

1. Site Description: Sunrise Acres

The Phase 1 development was built in 1998 using HUD 1937 Act Funds and was designed by Architectural & Engineering Design Associates. The total project cost was $1,089,035. It included six apartment buildings, an administration building, and a warehouse. Each 3,497 ft^2 one-story building has its own mechanical room and is divided into four 2-bedroom apartments, comprising a total of 20 units. The Phase 1 buildings were built with traditional 2x6 wood frame construction with a primary heating source provided through a radiant floor system fueled by kerosene. National Grid provides the electricity and the kerosene is provided by #9 Fuels.

Figure 1: Ariel view of Sunrise Acres with 1998 buildings (Phase 1) on the right and 2011 buildings (Phase 2) to the left.

The Phase 2 development was completed in the summer of 2011. The total project cost was $7 million of which $4 million was built with Recovery Act funds and $3 million was NAHASDA funding. The Sunrise Acres Expansion Project was completed just southwest of the original complex. This second phase was designed by Beardsley Design Associates and provided five additional apartment buildings, a community center, parking area and pavilion on 28 acres of tribal land. Each 4,050ft^2 one-story multi-family building also has its own mechanical room and is divided into four 2-bedroom apartments, comprising a total of 20 units. These new units were built with a 6" insulating concrete form (ICF) wall system and utilize a geothermal system as their primary heating and cooling source. Each building has one meter for the 4 units which registers the building's electricity consumption. Electricity use is partially supplemented by six solar photovoltaic arrays where each array produces 5.04 kW. The Phase 2 units are part of the National Grid's net-metering program.

2. Phase 1: Building Description

The development is comprised of a total of six one-story buildings each approximately 3,497 ft^2; two of the six buildings have two apartments, while the others have four apartments for a total of 20 units. Figure 2 is an illustration of a Phase 1 elder housing building with four units.

2.1 Building Envelope

Figure 2: Phase 1 Elder Housing

Walls: Each unit is separated by a 1-hour fire rated wall. The typical wall construction from the inside to outside is 1/2" gypsum board, 2x6 wood frame construction with a thermal resistance rating (R-value) of R-19 batt insulation, and exterior siding over Tyvek house wrap over 7/16" oriented strand board (OSB) sheathing. It is estimated that the wall assembly is an R-20.

Roof: The roof is hipped with a 3.5:12 slope. It is constructed with wood trusses, is covered in dark brown asphalt shingles, and has R-38 insulation above the ceiling.

Floor: The ground floor is a 4" reinforced concrete slab on grade with 1" polystyrene rigid insulation under the slab. The main living areas of the apartments have carpet while the kitchen, bath, and laundry room have sheet vinyl flooring.

Windows: Since the window schedule was missing from the building plans provided, during the site visit the team observed that the windows are Andersen windows with double-pane glass and a vinyl frame.

2.2 HVAC

Heating: The primary heating source for each apartment unit is a cast-iron boiler in each building, which heats a radiant floor slab system, Figure 3. Most of the boilers are a Weil Mclain Gold Oil Model P-WTGO-3 with an Annual Fuel Utilization Efficiency (AFUE) of 85% and provides roughly 100,000 British thermal unit (Btu), although some of the boilers have been replaced over the last 10 years. Figure 4 shows the fuel tank outside of each building which connects to the cast-iron boiler and can hold approximately 250 gallons of kerosene. Additional heating is also supplied by space heaters used by the residents in the winter months.

Figure 3 & 4: Boiler & Kerosene Oil tank for a Phase 1 building.

Cooling: The primary cooling source for each apartment is a window air conditioning unit which the resident purchases and the housing authority installs. Each apartment has roughly one AC unit with an estimated cooling efficiency, or Energy Efficiency Ratio (EER) of 8.5.

Ventilation: Ventilation air is provided by building infiltration and the residents opening windows. Each bathroom has an exhaust fan originally rated at 70 CFM, but is estimated to be performing at 35-50 CFM. According to the building plans for the six Phase 1 Sunrise Acres buildings, bathroom exhaust fans and the dryer vents are located in the attic.

2.3 Domestic Hot Water

Each apartment has a Reliance 40-gallon electric domestic water heater with model number 5-40-2DRT4-Z. It is estimated that each heater has a 53-gallon first hour rating and uses approximately 4,773 kWh per year, Figure 5.

Figure 5: DHW tank for a Phase 1 building.

2.4 Lighting

When day-lighting from the windows is insufficient, lighting in the building is provided by a 2'x4' fluorescent light in the kitchen and light fixtures throughout the apartment. The Akwesasne Housing Authority is currently retrofitting the 60-Watt (60W) incandescent lamps with compact fluorescent lamps (CFLs) and the T12 fluorescent lamps with T8s. Since each of the Phase 1 apartments are the same size it was assumed that each unit uses the lighting described in Table 1.

Location	Fixture Type	Watts	Operating Hours	kWh Usage
2 Bedrooms	2-lamp 60W Inc.	240	1,460	350
Kitchen	2-lamp 34W 4' T12	72	2,190	158
Kitchen sink	2-lamp 20W 2' T12	50	730	37
Living room	3-lamp 60W Inc.	180	2,920	526
Bathroom	1-lamp 60W Inc.	60	365	22
Bathroom sink	2-lamp 60W Inc.	120	365	44
Laundry	1-lamp 60W Inc.	60	365	22
Hallway/stair	1-lamp 60W Inc.	60	365	22
Exterior	1-lamp 60W Inc.	60	1,095	66
Total Watts per Unit		**902**	**9,855**	**1,245**
1,245 kWh * 16 cents = $199.20		$199.20 - $74.76 = **$124.44 over Phase 2 costs**		

Table 1: Phase 1 Unit Lighting

2.5 Additional Plug Loads

Additional plug loads in the building include typical residential appliances: TVs, washer/dryer, refrigerators, stoves, microwaves, and task lighting. Although the housing authority is currently replacing, refrigerators, microwaves, and washers with ENERGY STAR appliances, for the project base model it was assumed that the Phase 1 units had non-ENERGY STAR appliances.

3. Phase 2: Building Description

There are a total of five one-story apartment buildings each approximately 4,050 ft^2 with an identical floor plan as the Phase 1 buildings consisting of four apartments for a total of 20 units, Figure 6. The expansion project also included a training center, parking area, outdoor pavilion, and outdoor light-emitting diode (LED) lighting.

Figure 6: Phase 2 Elderly Housing

3.1 Building Envelope

Walls: Each unit is separated by a 2-hour fire rated wall. The typical wall construction from the inside to outside is 5/8" gypsum board over a Buildblock 6" ICF wall system, over 1/2" OSB sheathing with exterior siding. It is estimated that the wall assembly is an R-20.

Roof: The roof is hipped with an 8:12 slope. It is constructed with wood trusses, is covered in a standing seam metal roof system, and has 6" of blown in cellulose insulation over 6" R-21 fiberglass batt insulation above the ceiling for a combined insulation value of R-46.

Floor: The ground floor is a 4" reinforced concrete slab on grade with 2" polystyrene rigid insulation under the slab. The main living areas of the apartments have carpet while the kitchen, bath, and laundry room have sheet vinyl flooring.

Windows: According to the architectural drawings, the windows are Andersen tilt-wash double hung 400 series windows with low-e glazing. Vertical blinds were also installed for all windows.

3.2 HVAC

The Phase 2 Sunrise Acres buildings feature a number of sustainable/renewable energy features.

Heating/Cooling: The primary heating and cooling source for each apartment unit is the geothermal system, which heats a radiant floor slab system, Figure 7. The system includes a total of 35 wells which serve the housing units and 9 wells which serve the training center. To learn about geothermal systems, see 10.2.

Figure 7: Geothermal system for the Phase 2 buildings.

Ventilation: Ventilation air is provided by heat recovery ventilators (HRVs), Figure 8. As recently constructed houses incorporate tighter energy efficient features, HRVs are used to remove indoor air pollutants that once escaped through cracks around windows and doors. Without this HRV system, the indoor air pollutants will become trapped inside the home creating an unhealthy interior environment. The HRVs provide constant air exchange to the bathrooms and from the hallway outside the bedrooms.

Figure 8: HRV system for the Phase 2 buildings.

3.3 Solar Domestic Hot Water

Each apartment building is provided domestic hot water (DHW) from a solar tube system, Figure 9. Each building's mechanical room contains two tanks with a holding capacity of 80 gallons; one tank heated by the solar system, and one conventional electric hot water tank. Water from the solar holding tank flows into the electric tank as needed. This provides a 50% savings compared to the Phase 1 buildings.

Figure 9: Solar DHW for a Phase 2 building (left) and electric DHW tank (right).

3.4 Lighting

Natural lighting is provided by windows and solar tube lighting in each apartment, Figure 10. When day-lighting from the windows is insufficient, lighting in the building is provided by a 2'x4' fluorescent light in the kitchen and light fixtures with CFL bulbs throughout the apartment. Since each of the Phase 2 apartments are the same size it was assumed that each unit uses the lighting described in Table 2.

Figure 10: Solar tube lighting for a Phase 2 building outside (left) and inside the unit (right).

Location	Fixture Type	Watts	Operating Hours	kWh Usage
Living room	(5) 1-lamp 13W CFL	65	1,460	95
Kitchen	2-4', 1-42", and 2-12" T8	130	2,190	285
Hallway	(2) 2-lamp 13W CFL	52	730	38
Laundry	1-2' T8 fixture	13	2,920	38
Bathroom	1-lamp & 3-lamp 13W CFL	52	365	19
3 Closets	1-lamp 34W 2' T8	34	365	12
Bedroom 1	2-lamp 13W CFL	26	365	9
Bedroom 2	2-lamp 13W CFL	26	365	9
2 Exterior	1-lamp 13W CFL	26	1,095	28
Total Watts per Unit		**424**	**9,855**	**534**
534 kWh * 14 cents = $74.76		$199.20 - $74.76 = **$124.44 savings over Phase 1**		

Table 2: Phase 2 Unit Lighting

3.5 Additional Plug Loads

Additional plug loads in the building include typical residential appliances: TVs, washer/dryer, refrigerators, stoves, microwaves, and task lighting. All appliances installed (refrigerators, microwaves, and washers) were ENERGY STAR rated.

4. Energy Analysis Approach

A comprehensive energy analysis was conducted on two sites. The approach involved several steps. First, initial information was collected from the tribal housing authority about each building's design, occupancy data, energy consumption, and energy costs. This included the following:

- Building plans
- Utility consumption data for the last 12 months
- Geographical location and climate data
- Details about unit occupancy, mechanical equipment, HVAC systems, and lighting fixtures from interviews with tribal housing authority staff and during a site visit

Second, utility consumption was then compared with annual heating and cooling degree day data to determine any correlation between energy usage and climate conditions; the results were examined for anomalies. Third, during a site field visit from July 31 - August 1, 2012, data, observations, and photos were recorded.

Fourth, a baseline energy model was constructed in computer modeling software that performs building energy simulations. The HVAC load design and analysis software e-Quest version 3.64 was used to model the building. This modeled data was calibrated to match the actual building energy usage from the utility bills. This baseline was then used for evaluating the energy cost reduction measures (ECRMs). The software program uses these measures to calculate the energy consumption and energy costs the building is expected to use over an entire typical weather year if the ECRMs are implemented. The weather file for e-Quest was taken from the Massena, New York, weather station. Model inputs are taken from information collected during the site visit and information provided by the client. Assumptions made for the e-Quest model include:

- Because these units are for elders, the residents spend most of their time at home. Therefore, it is estimated that the tenants will primarily be in the units 80% of the time during the week (approximately 134 hours/week) and 20% of their time outside of the home.

- Temperature settings of 72 degrees (F) during the winter; 75 degrees (F) in the summer.

- 0.5 air changes per hour (ACH).

- Although the housing authority is currently replacing, refrigerators, microwaves, and washers with ENERGY STAR appliances, for the base model it was assumed that the Phase 1 units had non-ENERGY STAR appliances.

- Lighting power density of approximately 0.90 Watts per square foot for each unit.

- Bathroom exhaust fans originally rated at 70 CFM.

Subsequently, computer analyses of the ECRMs were performed. The baseline model was then adjusted to reflect the implementation of these ECRMs and the computer model generated the expected energy consumption and utility costs. When necessary, some ECRMs are evaluated outside of the modeling software using spreadsheet calculations.

Finally, the estimated savings and additional costs of implementing ECRMs are evaluated in a life cycle cost analysis. This analysis assumes a 20-year life cycle and calculates the internal rate of return (IRR) and the net present value (NPV) of each ECRM and a package of ECRMs. IRR is essentially the annual yield on an equivalent investment. A project is a good investment if its IRR is greater than the rate of return that could be earned by an alternative investment (other projects, bonds, bank accounts, etc.). For this project 5% as the minimum acceptable rate of return is assumed. The NPV calculation uses a discount rate to find the present value of savings occurring at a future date. The discount rate is your minimum acceptable rate of return, or your time value of money. Again, 5% is assumed. Investments have a positive NPV when the IRR is greater than the discount rate. Therefore projects with IRR greater than the discount rate and a positive NPV are considered to be good investments and are recommended.

5. Energy Consumption and Analysis

5.1 Utility Rates

Utility data was provided for the 12-month period of June 2011-May 2012. The Phase 1 Sunrise Acres units have five meters per building (one for each unit) and receive electricity through National Grid. The buildings are classified at a residential rate and are delivered electricity at an average rate of $0.16 per kWh. The buildings receive kerosene from #9 Fuels at an average rate of $3.90 per gallon. These rates include meter fees, delivery fees, and taxes. After modeling the baseline in e-Quest, Table 2 indicates that the average annual energy use intensity (EUI) of a Phase 1 (4 unit) building is approximately 70 kBtu/ft^2 and the average annual energy cost intensity (ECI) is approximately $2.34/ft^2. These two values are used to benchmark the energy performance of the Phase 1 buildings as seen in Table 3.[1]

Average Annual Consumption			Annual Costs		Average Unit Cost	
Electricity	18,520	kWh	$ 2,948	36%	$ 0.16	$/kWh
Kerosene	1,340	gallons delivered	$ 5,229	64%	$ 3.90	$/gal delivered
		Total:	**$ 8,176**	x 4 buildings = $32,705 total		
Total Facilities Area	3,497	ft^2				
Electricity Use Intensity	5	kWh/ft^2/yr	**Kerosene Use Intensity**		0.38	Gallons/ft^2/yr
Energy Use Intensity	**70**	**kBtu/ft^2/yr**	**Energy Cost Intensity**		**$ 2.34**	ft^2/yr
Electricity is provided by National Grid and kerosene is supplied by #9 Fuels						

Table 3: Average Annual Utility Consumption for Phase 1 Elderly Housing

The Phase 2 units have one meter per building and receive electricity through National Grid. These buildings are classified at a commercial rate and are delivered electricity at an average rate of $0.14 per kWh. The Phase 2 units are partially supplemented by six solar photovoltaic arrays (one per building) and each produces 5.04 kW (30.24 kW total). The Phase 2 buildings are part of the National Grid's net-metering program which provides credit for electricity produced. The Akwesasne Housing Authority may receive credit for any excess electricity that is produced. The buildings are heated by a geothermal system and do not consume any kerosene. When modeled in e-Quest, Table 3 indicates that the average annual EUI of a Phase 2 (4 unit) building is approximately 25 kBtu/ft^2 and the average annual ECI is approximately $1.01/ft^2.

Average Annual Consumption			Annual Costs		Average Unit Cost	
Electricity	30,181	kWh	$ 4,110	100%	$ 0.14	$/kWh
Kerosene	0	gallons delivered	$ 0	0%	$ 0.00	$/gal delivered
		Total:	**$ 4,110**	x 5 buildings = $20,552 total		
Total Facilities Area	4,050	ft^2				
Electricity Use Intensity	7	kWh/ft^2/yr	**Kerosene Use Intensity**		0	Gallons/ft^2/yr
Energy Use Intensity	**25**	**kBtu/ft^2/yr**	**Energy Cost Intensity**		**$ 1.01**	ft^2/yr
Electricity is provided by National Grid and kerosene is supplied by #9 Fuels						

Table 4: Average Annual Utility Consumption for a Phase 2 Elderly Housing

Comparing Table 3 and 4 indicates an approximate 58% annual utility savings and a 50% annual cost savings between the Phase 1 buildings and the Phase 2 buildings.

[1] The Energy Use Intensity (EUI) is measured in kBtu which is a common energy unit used in benchmarking and allows for comparing different fuel sources. The higher the EUI, the less efficient the building is.

5.2 Energy Consumption Profiles

Twelve months of electric and kerosene data provided by the Akwesasne Housing Authority was analyzed.[2] The utility data covers the months from June 2011 through May 2012. For this period the closest weather station, Massena, New York, recorded 6,588 heating degree days and 574 cooling degree days.[3] Degree days are indicative of the duration and intensity of the heating and cooling seasons and are used in this analysis to track how electricity and gas usage correspond to seasonal weather changes.

Figure 11 compares the Phase 1 Sunrise Acres buildings' average electricity usage with cooling degree days and the billed electricity usage. Electricity is used for lighting, cooling, domestic hot water, plug loads, fans, and pumps. The base electrical load for the building is approximately 1,400 kWh per month. The graph shows that additional electricity use corresponds with the cooling degree days except for the additional use in October which could be attributed to a delayed change in seasons. The higher usage in the winter months up through April could be from space heaters used by the residents in the winter months. This implies that the apartments could be drafty and therefore implementing weatherization strategies would help create a tighter building envelope reducing the need for additional space heating.

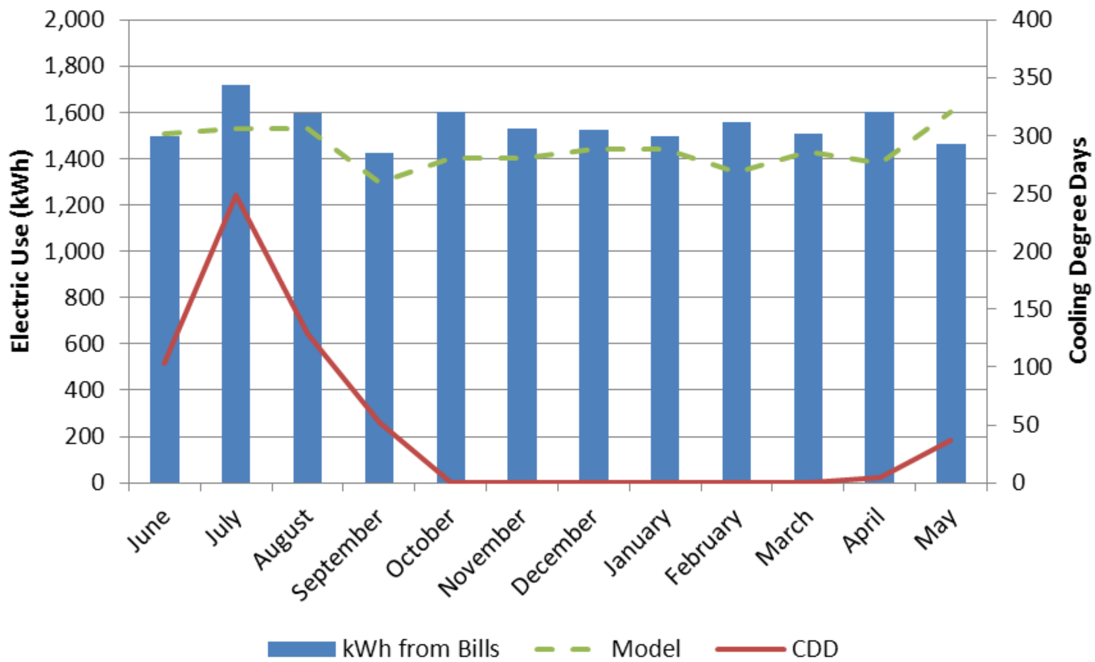

Figure 11: Average Annual Electricity Consumption for Phase 1 buildings vs. Cooling Degree Days

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[2] The IHA pays all utility bills for elder residents.
[3] This climate data came from: http://www.weatherdatadepot.com/

Figure 12 compares the gallons of kerosene delivered to the Phase 1 Sunrise Acres buildings with heating degree days. Kerosene is used to power the boiler which provides heating for the units. The graph shows that kerosene was not delivered in the summer months and some winter months had considerably low amounts of kerosene delivered. This is most likely because there was leftover kerosene in the 250 gallon tank to carry over into the following month.

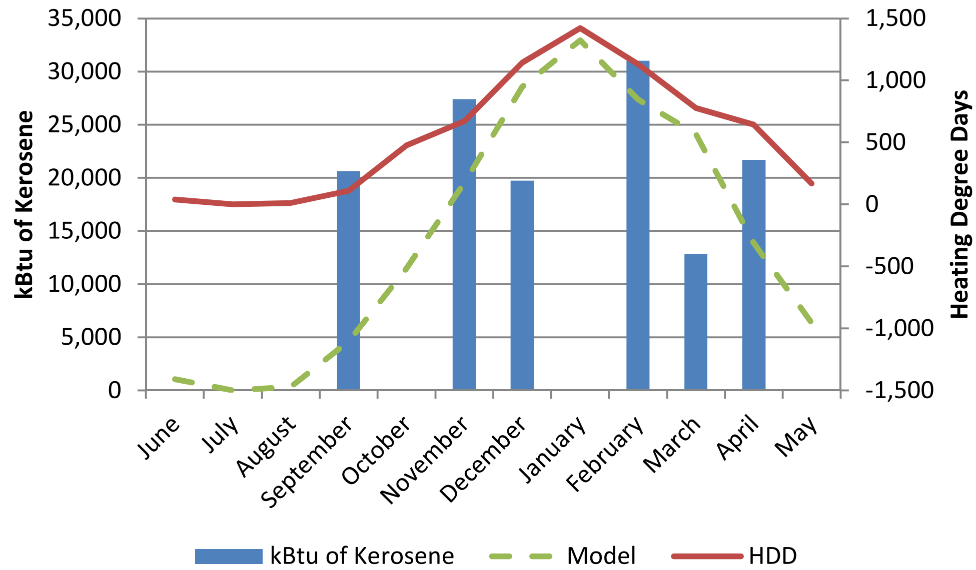

Figure 12: Average Annual Kerosene Delivered for Phase 1 buildings vs. Heating Degree Days

The Phase 2 Sunrise Acres buildings have a geothermal heating system and only consume electricity. Their electricty comes from the Natiional Grid and a supplementary grid-tied photovoltaic panel system. Figure 13 compares the Phase 2 Sunrise Acres buildings' electricity usage with heating and cooling degree days. The low electricity use in February was a result of a billing error by National Grid.

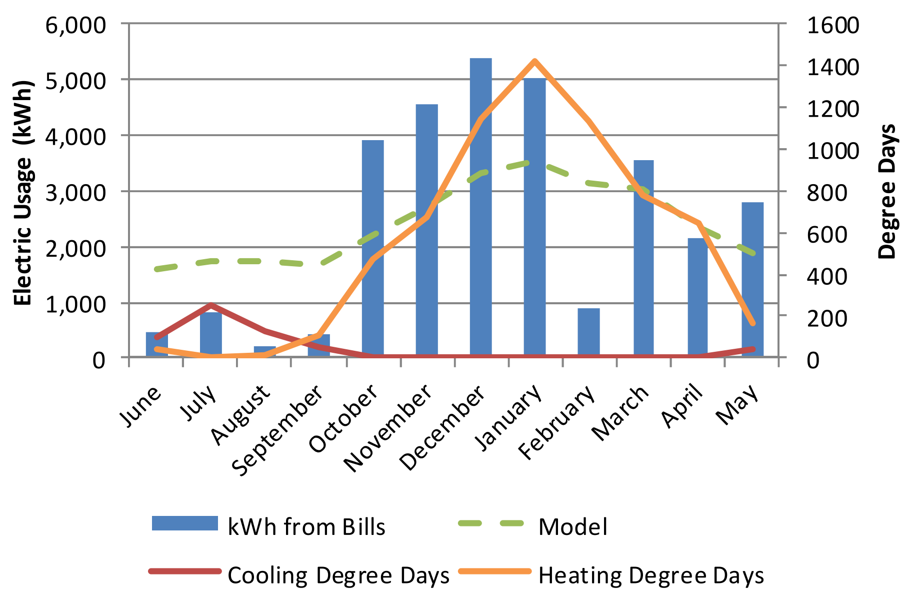

Figure 13: Average Annual Electricity Consumption for Phase 2 buildings vs. Degree Days

5.3 Breakdown of Energy Consumption & Costs

Using the eQUEST modeled energy data, an energy consumption profile was created for the Phase 1 Sunrise Acres 20 units. Figure 14 shows the estimated energy consumption breakdown for a typical 4 unit apartment building. The largest category of energy usage is space heating (74%), the second largest is plug loads (9%), and the third largest is lighting (8%).

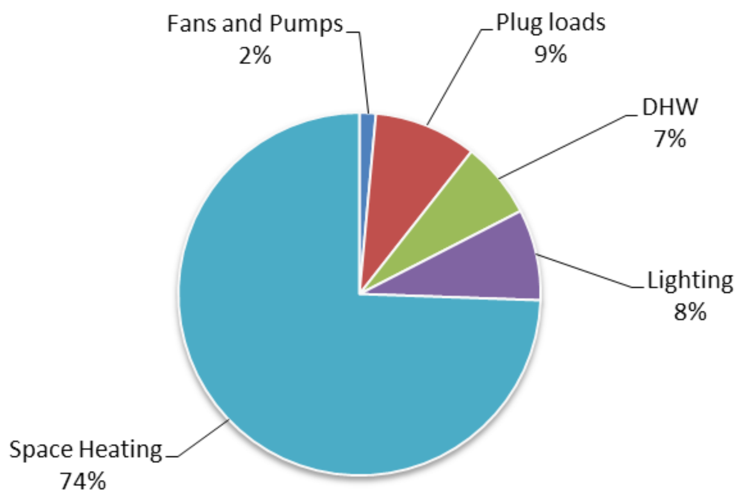

Figure 14: Average Annual Energy Consumption for a Phase 1 4 unit building

The energy cost breakdown is illustrated in Figure 15.[4] When energy consumption is converted to cost, the most costly operational categories are: space heating ($6,668), plug loads ($979), and lighting ($869). These are the first areas that should be targeted for energy savings.

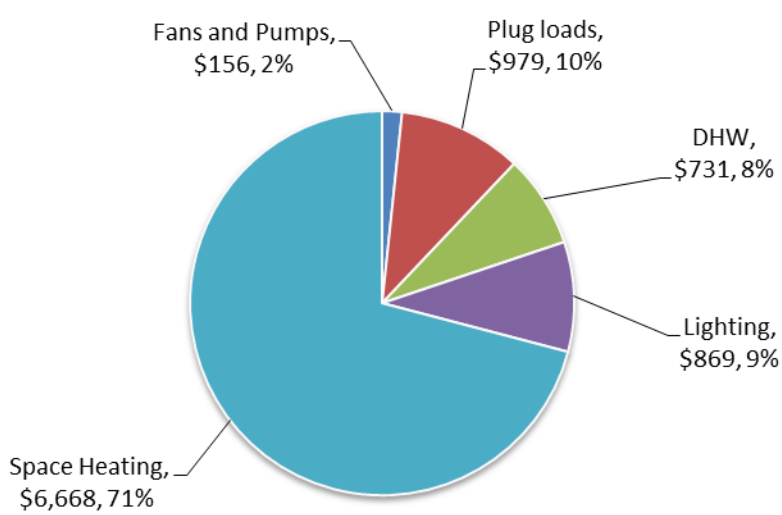

Figure 15: Average Annual Energy Cost Breakdown for a Phase 1 Sunrise Acres building

[4] The difference in percentages between the consumption and cost charts is due to the use of two different energy sources, kerosene and electricity, and the difference in cost between the two.

Using the eQUEST modeled energy data, an energy consumption profile was created for the Phase 2 Sunrise Acres 20 units. Figure 16 shows the estimated energy consumption and cost breakdown for a typical 4 unit apartment building.[5] The largest category of energy usage is space heating (28%) costing $1,111, the second largest is plug loads (21%) costing $805, and the third largest is DHW (20%) costing $782. These are the first areas that should be targeted for energy savings.

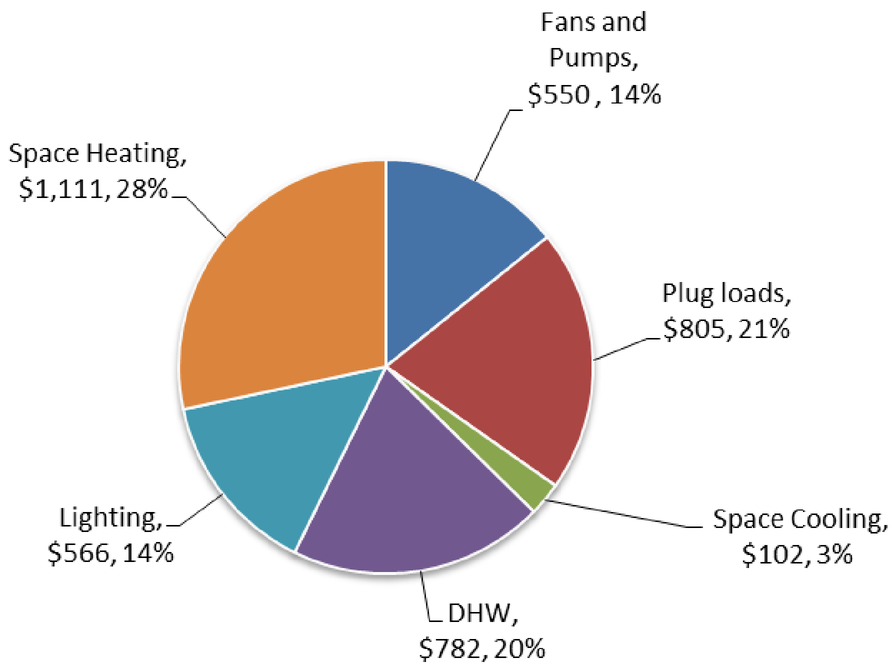

Figure 16: Average Annual Energy Consumption & Costs for a Phase 2 (4 unit) building

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[5] Since there is only one energy source used, electricity, there is not a difference in the consumption and cost percentage breakdowns.

6. Load Reduction and Efficiency Improvements Measures

Energy conservation is best achieved through a multifaceted approach that involves load reduction, efficiency improvements, and renewable generation. Addressing any of these strategies will save energy.

Load reduction, whether no cost or low cost, should be the first step. Load reduction involves managing energy consumption by simply turning things off when not needed or implementing control systems to help manage unnecessary energy use. Examples of load reduction include using nighttime thermostat setbacks or turning off lights in well-lit areas on sunny days to reduce lighting loads. Envelope upgrades such as adding insulation or window shades can result in load reduction but usually require large capital expenditures.

Energy efficiency improvements should be considered next. While typically more expensive than load reduction, energy efficiency improvements are more cost effective than implementing renewable energy generation. Efficiency improvements involve replacing old or failing systems with modern technologies which perform the same function while consuming less energy. Examples of energy efficiency improvements include installing boilers with greater heating efficiency, installing lighting with increased luminous efficacy, or installing ENERGY STAR appliances.

The final step is energy generation. This step offsets a portion of the remaining energy consumption with onsite energy generation. Onsite energy generation is purposefully recommended after load reduction and efficiency improvements. Accomplishing the first two steps makes it possible to install lower capacity, therefore less expensive, generation systems, such as:

- A solar photovoltaic array system
- A solar domestic hot water system
- A geothermal system

The following sections of the report address load reduction and efficiency improvements and compares their annual energy and cost savings.

6.1 ECRM 1: Lighting Upgrade

Research shows that an average household dedicates about 6% of its energy budget to lighting.[6] Switching to energy-efficient lighting is one of the fastest ways to cut energy bills. CFLs last about 10 times longer and use about 75% less energy than traditional incandescent bulbs. A typical CFL can pay for itself in energy savings in less than 9 months and can continue to cut down energy costs each month. Furthermore, incandescent bulbs are slowly being phased out and in a few years will no longer be produced.

The electrical plans for Phase 1 were provided and indicated that there are a total of 68 lamps in the building. As mentioned earlier, lighting in each apartment is provided by a 2 lamp 4' 34W T12 florescent fixture and a 2 lamp 2' 20W T12 (over the sink) in the kitchen and from the ceiling fixtures in the living room and bedrooms. In the baseline model for e-Quest, it was assumed that each light fixture would have a 60W incandescent lamp providing a total average of 1.03 W/sq. ft. for the whole building. The baseline in e-Quest was then compared to replacing the 60W incandescent lamps with 13W CFLs, decreasing the lighting intensity to 0.32 W/sq. ft. Table 5 shows that this lighting upgrade would save the building an estimated 4% in annual energy consumption and an estimated $591 in annual utilities. While the building would be saving 3,696 kWh annually for lighting and cooling the building, more energy would be required for space heating (30 gallons of Kerosene) since CFLs generate less heat than incandescents, therefore requiring the HVAC system to work more to heat the rooms.

[6] http://www.energysavers.gov/tips/indoor_lighting.cfm

ECRM 1: CFL Lighting[7]						
Annual Energy Savings				Economic Analysis		
kWh	Gallons of Kerosene	Cost[8]	% Energy	Investment	IRR	NPV
3,696	-30	$591	4%	$69	860%	$4,283

Table 5: Lighting Upgrade Energy Savings

The investment cost is based on replacing the 60W incandescent lamps with CFL lamps (a total of 52 CFL lamps in the building) at an estimated rate of $1.72 per CFL[9] and replacing the T12 with T8 fixtures (a total of 16 lamps). The IRR and NPV analysis are based on a 10 year study period and indicates that such a lighting upgrade will prove to be economical and cost-effective. Therefore this initiative is highly recommended.

6.2 ECRM 2: Replace Old Refrigerators

Refrigerators consume the most energy of all household appliances due to the 24 hour a day/ 7 day a week operational schedule. With recent improvements in insulation and compressor technology, new refrigerators use much less energy than older models. ENERGY STAR qualified refrigerators are in fact required by the U.S. Department of Energy to use 20% less energy than models not labeled with the ENERGY STAR logo. The refrigerator currently in use in each of the four units of the building is a 1989 Westinghouse RT143GCDA which costs $206 annually to run, whereas an equivalent new ENERGY STAR model would only cost $39 annually to run. Table 5 shows the savings for upgrading to ENERGY STAR refrigerators in a Phase 1 (4 unit) building.

ECRM 2: ENERGY STAR Refrigerator Replacement					
Annual Energy Savings			Economic Analysis		
kWh	Cost	% Energy	Investment	IRR	NPV
2,992	$479	4%	$1,600	27%	$1,997

Table 6: Energy Star Refrigerator Replacement

6.3 Install Low Flow Fixtures

Although stormwater and domestic water management was not addressed as part of the building energy analysis, a large amount of energy savings can be achieved by reducing the amount of hot water used on a daily basis. Research shows that along with energy, access to fresh, clean water is also becoming a dwindling resource and shortages in certain areas of the United States are already causing water to be the next leading concern. Reducing water consumption will not only save water, but it will reduce energy to heat hot water.

Low-flow showerheads and aerators are inexpensive, simple to install, and save hot water heating costs. We recommend low flow showerheads (1.6 GPM or less), faucet aerators (1.0 GPM or less) and kitchen sink aerators (1.8 GPM or less). Some faucet aerators will reduce flow to 0.5 GPM.

6.3.1 ECRM 3: Install Low-flow Showerheads

The United States Environmental Protection Agency (EPA) has developed a WaterSense™ label to identify water efficient products such as showerheads, aerators, and toilets. Similar to the ENERGY STAR label, all WaterSense labeled products are certified to be at least a certain percentage more efficient than standard models while still achieving an equal or better performance as standard models. For instance, WaterSense labeled showerheads must use at least 20% less water than standard showerheads and perform as well or better than standard showerheads. Standard showerheads

[7] Each measure table calculates savings for one building.
[8] The cost savings of each measure does not reflect the investment.
[9] Price of CFLs was taken from: http://www.easywebcalculators.com/cf.htm

typically consume 2.5 gallons per minute (gpm) of water while WaterSense showerheads must use no more than 2.0 gpm.[10]

The 4 units of each building have standard showerheads. Switching to 4 low flow units will save approximately 1,219 kWh and 10,950 gallons of water annually. Figuring $0.16 per kWh, this will save $195 on annual water heating costs and $41 on water usage costs (at $3.70/1000 gallons) totaling $236 in savings as shown in Table 7.

ECRM 3: Low-Flow Showerheads						
Annual Energy Savings				Economic Analysis		
kWh	Gallons of Water	Cost	% Energy	Investment	IRR	NPV
1,219	10,950	$236	2%	$200	118%	$2,605

Table 7: Low-Flow Showerhead Replacement

6.3.2 ECRM 4: Install Low-flow Sink Aerators

WaterSense labeled faucets and aerators must use at least 30% less water that standard units and perform as well or better than standard units. Standard faucets typically consume 2.2 gpm of water while WaterSense units must use no more than 1.5 gpm.[11] According to the Water Systems Council (WSC), the typical U.S. household consumes 10.9 gallons per day per person for everyday faucet use.[12] Hence, significant water savings can be achieved from upgrading conventional units. In addition to water savings, some energy savings can be achieved as low-flow fixtures also reduce the total hot water demand.

All of the units' sinks have standard aerators. Switching to 8 low flow units will save approximately 697 kWh and 8,760 gallons of water annually. Figuring $0.16 per kWh, this will save $112 on annual water heating costs and $32 on water usage costs (at $3.70/1000 gallons) totaling $144 in savings as shown in Table 8.

ECRM 4: Low-Flow Aerators						
Annual Energy Savings				Economic Analysis		
kWh	Gallons of Water	Cost	% Energy	Investment	IRR	NPV
697	8,760	$144	1%	$160	90%	$1,556

Table 8: Low-Flow Sink Aerator Replacement

[10] http://www.epa.gov/watersense/docs/showerhead_factsheet508.pdf
[11] http://www.epa.gov/watersense/docs/ws_bathroom_faucets508.pdf
[12] http://www.watersystemscouncil.org/VAiWebDocs/WSCDocs/2026952INSERT_CONSERV.pdf

6.3.3 ECRM 5: Install Low-flow Toilets

WaterSense labeled toilets must use at least 20% less water that standard toilets and perform as well or better than standard toilets. Standard toilets typically consume 3-5 gallons per flush (gpf) of water or more while WaterSense toilets must use no more than 1.28 gpf.[13]

Toilets should be replaced with high efficiency units using ≤ 1.28 gallons per flush. Switching to 4 low flow units will save approximately 13,105 gallons of water annually. Figuring $3.70 per 1,000 gallons, this will save $48 on annual water usage costs as shown in Table 9.

ECRM 5: Low-Flow Toilets						
Annual Energy Savings				Economic Analysis		
kWh	Gallons of Water	Cost	% Energy	Investment	IRR	NPV
	13,105	$48	<1%	$1,200	78%	$11,344

Table 9: Water-Saver Toilet Replacement

6.4 ECRM 6: Boiler Upgrade

The boiler system currently in use in each of the four units of the building is a Weil Mclain Gold Oil Model P-WTGO-3 with an Annual Fuel Utilization Efficiency (AFUE) of 85% and provides roughly 100,000 Btu. If this system was replaced with an ENERGY STAR rated system with a 3.6 Coefficient of Performance (COP), 140 gallons of kerosene may be saved annually resulting in an annual cost savings of $547. The lifespan of boiler is calculated at 20 years. This upgrade will pay back within its lifespan (15 years), therefore implementation of this measure is recommended.

ECRM 6: Boiler Upgrade					
Annual Energy Savings			Economic Analysis		
Gallons of Kerosene	Cost	% Energy	Investment	IRR	NPV
140	$547	8%	$8,000	3%	-$1,128

Table 10: Boiler Upgrade Energy Savings

[13] http://www.epa.gov/WaterSense/docs/ws_het508.pdf

7. Renewable Energy Related Measures

7.1 ECRM 7: Geothermal

The primary heating source for each apartment unit is provided by a radiant floor slab system powered by a cast-iron boiler in each. Cooling is provided by the resident's individual window air conditioning units which have an estimated EER of 8.5. If the current kerosene boiler system is replaced with a geothermal heat pump system with a 14.5 Seasonal Energy Efficiency Ratio (SEER) for cooling and a 3.6 COP for heating, 1.262 gallons of kerosene may be saved annually resulting in an annual cost savings of $2,346. The lifespan of the geothermal system is calculated at 20 years. This upgrade will pay back in just under its lifespan (19 years) if the tax credit is utilized, therefore implementation of this measure is recommended. While the cost/savings nearly zeros out, there are environmental savings from not using coal fired electricity.

ECRM 7: Geothermal Upgrade						
Annual Energy Savings				Economic Analysis		
kWh	Gallons of Kerosene	Cost	% Energy	Investment	IRR	NPV
-16,090	1,262	$2,346	50%	$45,000	0%	-$15,014
With 30% Tax Credit:				$31,500	4%	-$2,156

Table 11: Geothermal Upgrade Energy Savings

7.2 ECRM 8: Solar Thermal Domestic Hot Water Upgrade

A Phase 1 building currently uses around 4,600 kWh to heat water per year. Evacuated-tube solar collectors could offset most of the electricity used for heating hot water. Panels are available capable of producing 14,700 Btu/day in the Northern New York region. The panel size is around 41ft² (varies by manufacturer) and the building would need two panels to produce all of the building's hot water needs. It is estimated that the panels would have a first cost of nearly $2,000. The economics of this are favorable with a 4 year payback before incentives. If the 30% federal tax credit is taken advantage of, the cost would be reduced to $1,400 and would pay back in 3 years. Despite the economics, the space required for installation is considerable. A storage tank may also be necessary for the hot water loop. Consulting with a system designer to establish the best setup for the building is recommended. Table 12 summarizes the analysis of this measure.

ECRM 8: Solar Thermal DHW Upgrade					
Annual Energy Savings			Economic Analysis		
kWh	Cost	% Energy	Investment	IRR	NPV
3,214	$514	5%	$2,000	25%	$4,199
With 30% Tax Credit:			$1,400	37%	$4,770

Table 12: Solar Thermal DHW Upgrade Energy Savings

7.3 ECRM 9: Photovoltaic Array

The purpose of a photovoltaic array is to reduce the use of traditional energy sources and create renewable energy. This system captures solar energy and converts it to electricity for use in the home which cuts down on the amount of energy that must be purchased from the utility company. When analyzed using the PV Watts calculator,[14] the following results indicate that a 5.0 kW array in the Massena, NY, area will produce 5,814 kWh annually. The investment cost is calculated with the $9,000 federal/state tax credit. This measure is recommended for implementation only if the tax credit is utilized. The calculator shows that this array, with the tax credit, would pay back within the photovoltaic 25 year lifespan (23 years).

ECRM 9: Photovoltaic Array					
Annual Energy Savings			**Economic Analysis**		
kWh	**Cost**	**% Energy**	**Investment**	**IRR**	**NPV**
5,814	$930	9%	$30,000	-2%	-$16,085
With 30% Tax Credit:			$21,000	1%	-$7,514

Table 13: Photovoltaic Array Energy Savings

[14] The PV Watts calculator can be found at: http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/

7.4 ECRM Recommendation Summary

The purpose of the table below is to combine the ECRMs recommended for implementation, and calculate the combined energy savings for these measures. Package 1 includes CFL, refrigerator, low-flow measures, boiler, solar thermal DHW, and photovoltaic array upgrades. Package 2 includes CFL, refrigerator, low-flow measures, geothermal, solar thermal DHW, and photovoltaic array upgrades. When analyzed in the e-Quest model, the following results indicate these measures should be implemented as the package of ECRMs will pay off well within the lifetime of the photovoltaic array and solar thermal (25 years).

ECRM		Savings					Economic Analysis			
		kWh	Gallons of Kerosene	Gallons of Water	Cost	% Energy	Investment	IRR	NPV	SP[15]
ECRM 1	CFL upgrades	3,696			$591	5%	$69	860%	$4,283	0
ECRM 2	ENERGY STAR Refrigerators	2,992			$479	4%	$1,600	27%	$1,997	3
ECRM 3	Low-Flow Showerheads	1,219		10,950	$236	2%	$200	118%	$2,605	1
ECRM 4	Low-Flow Aerators	697		8,760	$144	1%	$160	90%	$1,556	1
ECRM 5	Low-Flow Toilets			13,105	$48	<1%	$1,200	78%	$11,344	25
ECRM 6	Boiler Upgrade		140		$547	8%	$8,000	3%	-$1,128	15
ECRM 7	Geothermal	-16,090	1,262		$2,346	50%	$45,000	0%	-$15,014	19
	With Incentives						$31,500	4%	-$2,156	13
ECRM 8	Solar Thermal DHW	3,214			$514	5%	$2,000	25%	$4,199	4
	With Incentives						$1,400	37%	$4,770	3
ECRM 9	Photovoltaic Array	5,814			$930	9%	$30,000	-2%	-$16,085	32
	With Incentives						$21,000	1%	-$7,514	23
Package 1	All Recommend ECRMs - Boiler Upgrade	17,632	140		$3,489	34%	$43,229	5%	$245	12
	With Incentives						$22,400	15%	$20,082	6
Package 2	All Recommend ECRMs - Geothermal	1,542	1,262		$5,288	77%	$80,229	3%	-$13,640	15
	With Incentives						$53,900	8%	$11,435	10

Table 14: ECRM Recommendation Summary

15 Simple Payback in years.

7.5 Additional Energy Reduction Measures

Triple Pane Low-E Window Upgrade

The current windows of the building are typical double pane windows with clear glazing. By replacing them with triple pane window that have low emissivity, 30 kWh and 167 gallons of kerosene may be saved annually resulting in an annual cost savings of $655. The lifespan of windows is calculated at 20 years. The window replacement with triple pane windows will not pay back in the lifespan of the windows (24 years), therefore implementation of this measure is not recommended.

Triple Pane Low-E Window Upgrade						
Annual Energy Savings				Economic Analysis		
kWh	Gallons of Kerosene	Cost	% Energy	Investment	IRR	NPV
30	167	$655	10%	$16,000	-2%	-$7,463

Table 15: Triple Pane Low-E Window Upgrade Energy Savings

8. Educational Outreach

A twelve month utility data analysis showed that although the occupancy levels for each apartment was generally only one person, the electricity consumption for each apartment greatly varied. This may be a factor due to individual lifestyles and personal habits. It may therefore be extremely beneficial for the Akwesasne Housing Authority to create educational outreach programs and seminars on sustainable living habits and practices. Energy education programs not only will help the housing authority save money on utilities, but help elders develop the habit of saving energy. Projects directly involving the elders help them to learn about energy resources and take an active role in teaching others, particularly younger generations, the importance of using energy efficiently.

Figure 17: Protect the Earth for future generations.

As table 16 illustrates, there is a wide range of electrical consumption by the individual units. In the Phase 1 buildings the highest usage is 7,116 kWh by apartment 15 in building 5. The lowest usage is 2,136 kWh by unit 2 in building 1. Phase 1 buildings 1-6 are electric with combined kerosene for heating. In addition, each unit is individually metered. The residents pay an average of 0.16 cents per kWh. The average kWh consumption per building (4 units) is 18,520.

In the phase 2 buildings, the highest usage is averaged at 10,555 kWh and the lowest is 8,510 kWh. These kWh usages are higher because of the geothermal system and the five buildings being all electric. Each of the five buildings has their own meters servicing four units in each building. The residents pay an average of 0.14 cents per kWh. The average kWh consumption per building (4 units) is 36,909.

The individual meter service delivery fees and taxes reflect the additional 0.02 cents costs for the residents residing in the phase 1 building.

Annual Electricity Use By Apartment										
Phase 1						Phase 2				
Bldg #	Unit #	# of Occupants	Kerosene Use (Gallons)	Electricity Use (kWh)	Total Use in kBtu	Bldg #	Unit #	# of Occupants	Electricity Use (kWh)	Total Use in kBtu
	1	1		2.924			21	1	9.431	
	2	1		2.136			22	1	9.431	
	3	1		4.049			23	1	9.431	
1	4	1	1419	4.560	238,224	9	24	1	9.431	128,714
	5	1		3.049			25	1	8.770	
2	6	1	1150	4.216	179,977		26	1	8.770	
	7	1		4.001			27	1	8.770	
	8	1		6.798		10	28	1	8.770	119,693
	9	2		4.098			29	1	8.870	
3	10	1	1213	6.872	238,024		30	1	8.870	
	15	1		7.116			31	1	8.870	
	16	1		4.291		11	32	1	8.870	121,058
	17	1		3.520			33	1	8.510	
5	18	1	1226	3.227	227,391		34	1	8.510	
	19	2		3.289			35	1	8.510	
6	20	1	945	2.175	146,272	12	36	1	8.510	116,144
	11	1		5.498			37	1	10.555	
	12	1		3.853			38	1	10.555	
	13	1		6.776			39	1	10.555	
7	14	1	1501	4.362	272,584	13	40	1	10.555	144,058

Table 16: Annual Electricity Use by Apartment

9. Rebates & Tax Credits

As mentioned earlier, electricity for the Phase 1 Sunrise Acres development is provided by National Grid and kerosene is supplied by #9 Fuel. In order to help fund some of the upgrades and ECRMs outlined in this report, it may prove useful to investigate different funding opportunities. National Grid residential electric customers in Upstate New York are eligible for several incentives. Rebates are available for properly recycling inefficient refrigerators, freezers, and for the improvements of multi-family residential units through the Energy Wise Multi-Family Program. This program will offer the following incentives to the Akwesasne Housing Authority:

Type	Amount
Evaluation to assess energy usage and increase energy efficiency	FREE
Installation of up to ten compact fluorescent bulbs per dwelling unit	FREE
Installation of low flow showerheads & aerators	FREE
Installation of hot water pipe & tank wrap	FREE
Rebate towards refrigerator replacement costs	$300
The following are offered by the National Grid Non-Residential Program:	
Fluorescent Lighting	$15-$50/fixture
LED	$15-$50/fixture
Lighting Sensors	$20-$60
Refrigerator/Freezer Recycling	$30/unit

Additional rebates and savings may be found through different manufacturers of the appliances installed in the new buildings and through state and federal rebates and tax credits. For example, GE Appliances offers two rebates up to $150 for domestic hot water heaters that are ENERGY STAR certified.[16]

While tax-exempt entities, including Indian tribal governments, may not take advantage of federal tax credits, tribes also often operate taxable entities or may structure financing to allow the trade or sale of tax credits. Tribes should seek legal advice regarding tax credits and financing options. Also, the following federal tax credit information may be found at the ENERGY STAR website: http://www.energystar.gov/index.cfm?c=tax_credits.tx_index.

Tax Credit:	30% of cost with no upper limit
Expires:	Saturday, December 31, 2016
Details:	Existing homes & new construction qualify. Both principal residences and second homes qualify.
Includes:	**Geothermal Heat Pumps** **Small Wind Turbines (Residential)** **Solar Energy Systems**

For more information on state and federal rebates and tax credits, visit DSIRE's website at: http://www.dsireusa.org/incentives/index.cfm?re=0&ee=0&spv=0&st=0&srp=1&state=NY

[16] Visit http://www.geappliances.com/rebates_promotions/available-rebates.htm?ecrzip=49047&ecrproducttype for more information.

10. Green Features/Sustainable Development

Successful sustainable tribal communities begin with strong leadership and planning. Sustainable developments represent a change in direction in how tribal communities have been designed and developed. The Phase 2 20 units and training center have incorporated the integration of walkable areas, high performance buildings using ICF construction, LED outdoor lighting, and renewable energy sources. This subdivision transformed traditional stick built housing into housing that will be physically and financially viable over the long-term. The new subdivision also illustrates how the design of place influences lifestyle choices and quality of life issues by providing infrastructure for positive outcomes for residents through the Diabetes Center for Excellence Program housed in the training center, LED outdoor lighting for safety, walkable pathways and landscaped grounds.

The green design elements, renewable energy features, and costs included in the Phase 2 20 elder units, training center, outdoor infrastructure, and pavilion are featured in this section. The total project cost was $7 million of which $4 million was ARRA funds and $3 million was NAHASDA funds.

10.1 Renewable Energy Sources

Renewable energy sources to either supplement or create complete energy independence is not inexpensive. The housing authority, to decrease high utility bills and still ensure healthy indoor comfort, provided geo-thermal heating (heating and cooling was also provided at the training center), solar domestic hot water, a grid-tied solar pv panel system, and solar tube lighting in the buildings' interior. The total project cost was $1,400,000. Renewable energy summary costs are listed below:

Total Renewable Energy Costs

1. Geo-thermal ground loop control system @ $820,000 for HVAC-radiant floor heat
2. Geo-thermal @ $320,000 for 53 wells and piping (44: housing buildings; 9 training center)
3. 6 Solar PV Panels and DHW Systems @ $260,000
4. Grand Total = $1,400,000

10.2 Geo-Thermal Energy

A geothermal or ground source heat pump system transfers heat stored in the earth and pumps it into the indoor air delivery system in the winter. In the summer, the ground acts as a heat sink, and the heat is transferred from the interior through the heat exchanger back to the ground. The energy produced is concentrated naturally existing heat which is clean and sustainable. The system relies on the ground beneath the surface being warmer than the air above it in the winter and cooler in the summer. [17] Figure 19 illustrates a closed loop geo-thermal system. The Sunrise Acres Phase 2 Development has a total of 53 geo-thermal wells. Each apartment building has 7 wells and the training center has 9 wells. An extensive HVAC system and mechanical system is located in each building for system operation, temperature controls, monitoring and maintenance (Figure 18).

Figure 18: Mechanical Room

Each system is daily monitored electronically through a lap top computer software system. Temperature controls, system failures and adjustments are handled through this software system.

Figure 20: Computer Monitoring System

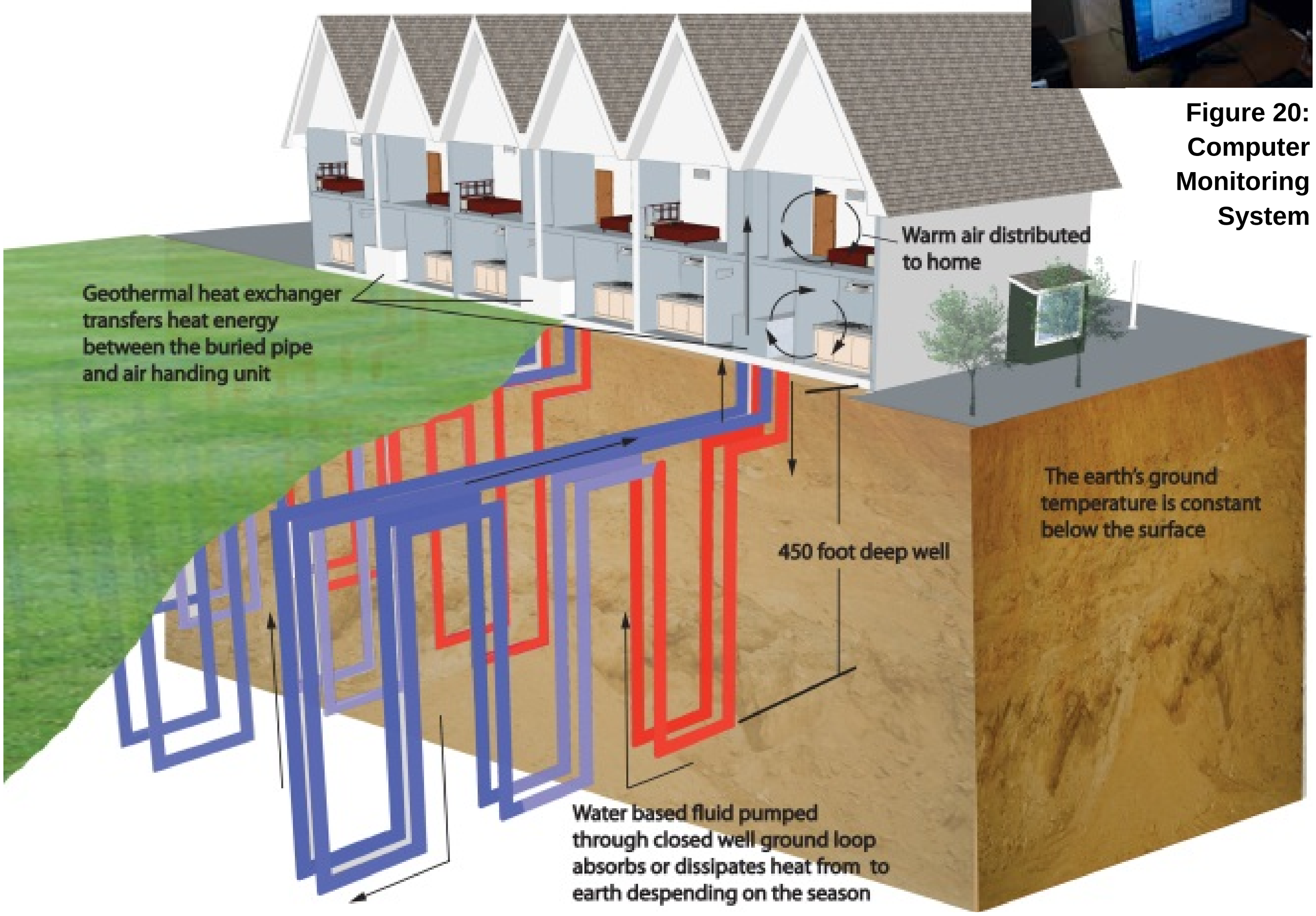

Figure 19: Closed Loop Geo-Thermal System

[17] More information about geothermal heat pumps may be found at the U.S. Department of Energy's website: http://www1.eere.energy.gov/geothermal/heatpumps.html

10.3 Optimum Solar Harvesting

The climate of the region plays a significant role in the design and production of the renewable energy sources. Building and solar photovoltaic system orientation are critical to a solar energy system. Key factors that influence harvesting are the number of degrees east or west of true south and the amount of shading from trees. The subdivision was designed with optimum solar harvesting in mind. Decisions for buildings and PV panel systems site locations for optimum sun light harvesting were incorporated into the subdivision design.

10.4 Solar Domestic Hot Water Systems

As section 3.3 outlines, each apartment building is provided domestic hot water from a solar tube system. Inside each building's mechanical room there are two tanks with a holding capacity of 80 gallons. One tank holds water heated by the solar system and other is an electric hot water tank. Water from the solar holding tank is stored in the electric tank.

10.5 Solar Tube Indoor Lighting

Sunlight brings a room and a home to life. Using the sun to light indoor spaces, known as day lighting decreases the use of electrical lights, energy consumption, and costs. An example of the solar tube lighting used in the Phase 2 buildings is shown in Figure 21.

Figure 21: Solar Tube Lighting

10.6 Solar Photovoltaic (PV) Panel System and Net- Metering

Tribal elders spend a large percentage of their time at home. They expect their homes will support their lifestyle choices. Energy consumption is essential for maintaining their lifestyles. Electric is required for heating, cooling, cooking, entertaining, and a host of other daily lifestyle activities. Decreasing and supplementing electric costs was a key objective of the new development. A solar Photovoltaic System tied into the utility grid through net-metering was designed and implemented.

The solar panel system chosen was two strings: 2 x 12 (24 Kyocera KD210) = 5040 watts DC. The Phase 2 buildings are completely electric and receive electricity from National Grid and are supplemented by a Photovoltaic System, as seen in Figure 22. There are a total of six arrays and each 240V array is connected to one building. An array is a group of photovoltaic modules connected together.

Figure 22: Inverter (left) and photovoltaic system for Phase 2 buildings (right)

Calculating the project electric kWh production is shown in Table 13 based on the system size and location. The reservation is located in a cold humid climate zone. The region has high heating needs, medium cooling needs, and annual precipitation of more than 20 inches. The winters are cold with warm humid summers. The closest climate data for calculating estimated monthly electricity production for a fixed tilt 5.04 kW solar PV array tilted at 44.9^{o} is Massena, New York. This is the same size as the system used for the Phase 2 Sunrise Acres buildings. The chart comes from to the National Renewable Energy Laboratory (NREL)'s website PVWatts.com, and indicates each array should produce 5,814 kWh/year, and can save an estimated $813.96 per year on utility bills.[18] Table 17 provides estimated monthly electricity production for one PV array.

Month	Solar Radiation (kWh/m2/day)	AC Energy (kWh)	Energy Value ($)
1	3.13	401	56.14
2	4.28	484	67.76
3	4.97	608	85.12
4	5.12	574	80.36
5	5.02	558	78.12
6	5.55	578	80.92
7	5.55	593	83.02
8	5.23	554	77.56
9	4.44	476	66.64
10	3.67	423	59.22
11	2.44	277	38.78
12	2.32	287	40.18
Year:	**4.31**	**5,814**	**813.96**

Table 17: Expected monthly electricity production from one PV array

[18] http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/US/code/pvwattsv1.cgi

During a site visit on July 30, 2012, information was collected from each PV inverter inside each building to record how much electricity was produced by each array. This information was recorded in Table 18. As compared to the expected monthly production of a PV array, the results indicate that the PV system has been in operation for roughly fourteen months. When compared to the average annual utility data for a New Sunrise Acres building, these PV panels are producing roughly 1/6 or 20% of what a new Sunrise Acres building is consuming. Table 15 provides information on the estimation of kWh produced by each PV array.

Building # Array	kWh Produced	Hours of Operation	Lbs. of CO2 Saved	Estimated Cost Savings
9	7,285	4,670	12,280	$1,019.90
10	6,951	4,680	11,817	$973.14
11	7,276	4,680	12,369	$1,018.64
12	5,945	3,997	10,107	$832.30
13	7,402	4,666	12,584	$1,036.28
14 (Training Center)[19]	7,322	4,661	12,448	$1,025.08
TOTAL	**42,181**	**22,693**	**71,605**	**$4,880.26**

Table 18: kWh Produced by each Photovoltaic Array for New Sunrise Acres buildings

10.7 Local Utility Company and Net-Metering Policies

Figure 23: Meter

National Grid is the utility company serving the reservation. National Grid provides electric services to upstate New York customers. The utility also has a net metering policy that allows customers to connect their renewable energy source to the electric grid and save money by off-setting electrical costs or contributing excess production to the grid. Net metering is the practice of using a single meter (Figure 23) to measure consumption and generation of electricity by a small generation facility (such as a house with a wind or solar photovoltaic system). The net energy produced or consumed is purchased from or sold to the power provider.

When analyzing the utility bills for Phase 2 buildings over the last year, it was only during the months of September and October that the buildings received credit for generating more kWh than was used. During the rest of the year the new buildings consumed more electricity than was produced by the PV system.

10.8 Sustainable Neighborhood Development

Sustainable neighborhoods create healthy and safe lifestyle choices. Walkable communities provide their residents with the healthy benefits of exercise. Research has shown that the rise in obesity in the United States has coincided with decades of development patterns that have made walking difficult or impossible. According to the Centers for Disease Control and Prevention (CDC) and the National Center for Health Statistics, 30% of U.S. adults 20 years of age and older (over 60 million people) are obese. Being overweight or obese puts people at risk for cardiovascular disease, diabetes, hypertension, high cholesterol, stroke, cancer, and higher rates of anxiety and depression. Even

[19] This report focuses only accounts for the residential units. Therefore the Training Center was not included in the energy analysis.

people who are not overweight suffer declines in physical and mental health if they are sedentary. The direct medical costs of physical inactivity were estimated by the CDC to total more than $76 billion in 2000.

The Surgeon General advises that 30 minutes of walking 5 days a week will significantly reduce the risks to adults for the aforementioned health conditions while contributing to healthy bones, muscles, and joints. Walkable communities are a critical element in encouraging and supporting healthy lifestyles. [20]

The Tribe has created opportunities for healthy lifestyle choices. The new subdivision has outdoor LED lighting to ensure safety in evening activities. Attractive outdoor landscape and walking paths ensure participation in physical activities. In addition, the training center houses the Diabetes Center for Excellence Program, a program that works with tribal residents to decrease diabetes through education, diet, healthy cooking classes, and exercise.

Figure 24: LED Outdoor Lighting, Training Center, Walking Paths, and Landscaping

[20] Healthy & Walkable Communities, July 2007: http://putnam.lib.udel.edu:8080/dspace/bitstream/handle/19716/2851/HealthyWalkable.pdf?sequence=1

10.9 Insulating Concrete Forms (ICFs)

The Sunrise Acres Phase 2 buildings make use of an alternative building material, insulating concrete forms, (ICFs).[21] ICFs are walls and roofs constructed of concrete but the forms are left in place to serve as a continuous insulation and sound barrier to reduce energy loss and infiltration. With this construction, the major features are:

- Superior insulation
- High thermal mass
- Low infiltration

With the use of ICF's, there is an estimated 25% to 50% energy savings as compared with that of wood or steel framed homes.

As Figure 25 shows, 35% of a building's energy loss occurs through the walls, 25% through the roof, 20% through leaks around windows and doors, and 15% under the floor. ICFs were used to reduce these areas of energy loss by creating tighter buildings and therefore increasing energy efficiency.

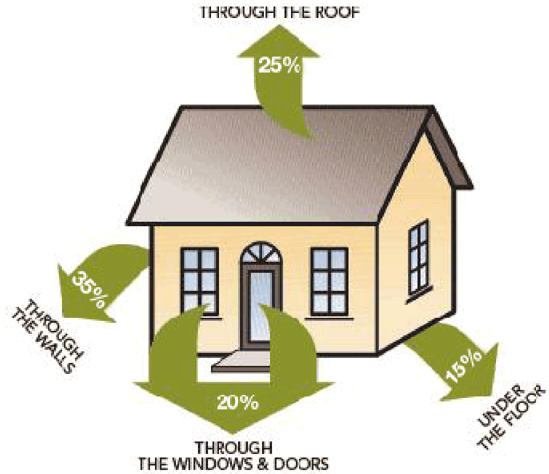

Figure 25: A diagram showing where energy loss occurs in a residential building.

[21] For more information on ICFs: http://www.toolbase.org/Technology-Inventory/walls/Insulating-Concrete-Forms

11. Overview of Phase 1 & Phase 2 Energy Consumption

St. Regis Phase 1 Units

Sunrise Acres, Hogansburg, NY

Built in 1998
875 sq. ft.
2 Bedrooms
Stick Built

Residential utility rate
4 meters/unit and 1 meter for entire building totaling 5 meters/building

Average Annual kWh Cost: 0.16 cents

Average Annual kWh Cost per Building: $7,190

Average Annual kWh Cost per Unit: $1,798 (57% difference from new units)

Energy Use Intensity: 62 kBtu/SF/yr

Energy Cost Intensity: $2.06/SF/yr

Lighting:

Location	Fixture Type	Watts	Operating Hours	kWh Usage
2 Bedrooms	2-lamp 60W Inc.	240	1,460	350
Kitchen	2-lamp 34W 4' T12	72	2,190	158
Kitchen sink	2-lamp 20W 2' T12	50	730	37
Living room	3-lamp 60W Inc.	180	2,920	526
Bathroom	1-lamp 60W Inc.	60	365	22
Bathroom sink	2-lamp 60W Inc.	120	365	44
Laundry	1-lamp 60W Inc.	60	365	22
Hallway/stair	1-lamp 60W Inc.	60	365	22
Exterior	1-lamp 60W Inc.	60	1,095	66
Total Watts per Unit		**902**	**9,855**	**1,245**
1,245 kWh * 16 cents = $199.20		$199.20 - $74.76 = **$124.44 over Phase 2 costs**		

Plug Loads:

Refrigerator: Westinghouse Model # RT143GCDA, Manufactured 8/1989, Annual kWh Usage: 1,285, Annual Cost at $0.16/kWh: $205.60

Domestic Hot Water:

Electric, each building has 4 DWH totaling 160 gallons

HVAC:

Heating: Kerosene
Cooling: Window Air Conditioning Units

Building Envelope:

Attic Insulation: R-38
Wall Insualtion: R-19 Batt Insulation, Total wall R-20

St. Regis Phase 2 Units
Sunrise Acres, Hogansburg, NY

Built in 2011
1,000 sq. ft.
2 Bedrooms
6" ICF Wall System

(Insulated Concrete Form)

Commercial utility rate
1 meter per building serving 4 units

Average Annual kWh Cost: 0.14 cents

Average Annual kWh Cost per Building: $4,110

Average Annual kWh Cost per Unit: $1,028 (57% difference from old units)

Energy Use Intensity: 25 kBtu/SF/yr

Energy Cost Intensity: $1.01/SF/yr

Lighting:

Location	Fixture Type	Watts	Operating Hours	kWh Usage
Living room	(5) 1-lamp 13W CFL	65	1,460	95
Kitchen	2-4', 1-42", and 2-12" T8	130	2,190	285
Hallway	(2) 2-lamp 13W CFL	52	730	38
Laundry	1-2' T8 fixture	13	2,920	38
Bathroom	1-lamp & 3-lamp 13W CFL	52	365	19
3 Closets	1-lamp 34W 2' T8	34	365	12
Bedroom 1	2-lamp 13W CFL	26	365	9
Bedroom 2	2-lamp 13W CFL	26	365	9
2 Exterior	1-lamp 13W CFL	26	1,095	28
Total Watts per Unit		**424**	**9,855**	**534**
534 kWh * 14 cents = $74.76		$199.20 - $74.76 = **$124.44 savings over Phase 1**		

Plug Loads:
Refrigerator: ENERGY STAR Whirlpool, Annual kWh Usage: 537, Annual Cost at $0.14/kWh: $75.18

Domestic Hot Water:
Solar DHW System, 1 building = 4 units/80 gallons

HVAC:
Heating: Geo-thermal: Electric
Cooling: ENERGY STAR Window Air Conditioning Unit

Building Envelope:
Attic Insulation: 6" Blown in cellulose insulation and R-21 Fiberglass batt insulation equalling R-46
Wall Insualtion: 4" Extruded Polystyrene (2" on both sides of wall)