EASTERN BAND OF CHEROKEE INDIANS FACILITY RETROFIT PROJECT DOE GRANT DE -EE0002499.001 FINAL REPORT

Manuel Maples, Project Coordinator
Eastern Band of Cherokee Indians
and
Bob Gilbreath, PE
Waste Reduction Partners
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I. Introduction

The Eastern Band of the Cherokee Indian (EBCI) Reservation, officially known as the Qualla Boundary, is located in western North Carolina, just south of the Great Smoke Mountains National Park. The main part of the reservation lies in eastern Swain County and northern Jackson County, but smaller non-contiguous sections are located to the southwest in Cherokee County (Cheoah community) and Graham (Snowbird community). A small part of the main reservation extends eastward into Haywood County. The total land area of these parts is 213.934 km² (82.600 sq mi), with a 2010 census resident population of over 8,000 persons.

Beginning in May 2007, the Cherokee Preservation Foundation with assistance from Waste Reduction Partners and along with grant funding from the Dept. of Energy began the effort to establish energy benchmarks for tribal buildings. The Cherokee Preservation Foundation provided the funding for the technical assessments to characterize the energy use and quantify the savings potential. This led to a $200,000 grant award by the DOE, which was leveraged with EBCI funding to implement the recommended improvements. Energy Conservation Measures (ECM's) were defined to categorize and provide a listing of potential saving opportunities for each of ten buildings. This includes:

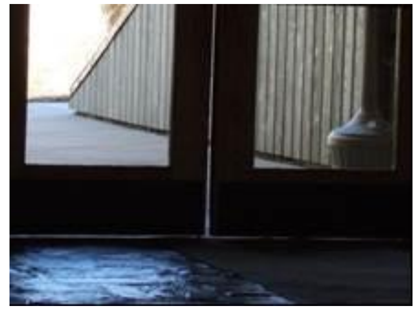
ECM 1 – ***Recommissioning*** seeks to improve how building equipment and support systems work to together; resolving problem areas and improving performance through better understanding of operations and renewed dedication to maintenance care. The energy audit process in its simplest form provides an array of benchmarks for characterizing building performance and cost effectiveness for Energy Conservation Measures. Changing energy use schedules and tempering demand via selective equipment automation are chosen considerations for improving performance.

Repairs not completed

ECM 2 – ***Lighting*** improvements include a reduction in each fixture watts for equal or better lighting output. These lighting efficacy upgrades resulted in a reduction of light power density (LPD) for a given area. Additionally, occupancy sensors were used to default to a lower LPD upon entering a room area with manual override for peak output for dual lighting circuits. Delamping was implemented in corridors and offices. Vending equipment were identified to energy use for advertisement lighting and vendors were requested to turn off all lighting for advertisement. Gym lighting 400 watt metal halides were replaced with T-5 fluorescents and individual occupancy sensors to remain off until required thus avoiding the long warm up time associated with metal halide fixtures.

ECM 3 – ***Load Reduction*** included provisions for improving the building envelope: 1) window insulating and reflective sunlight improvements, 2) up dated compliant building insulation, 3) and weather seam caulking of windows and sweeps and seal strips for doors 4) reduced plug loads. Addition credits were taken for improved efficiencies in new HVAC selections and reduced horsepower of working systems. Insulation of hot water pipe lines, especially in attic areas.

Door sweep and seals needed



Insulate hot water lines

Insulation nonexistent in many areas of this building's attic
Several buildings required additional insulation to be compliant with good practices of energy conservation.

ECM 4 – ***Air Handling*** applications were included for some buildings that had poor room distribution and required upgrading to newer more efficient HVAC equipment. Applications were implemented with cost effective technologies of a single trunk line with sock headers and outlets for large traversed single opening areas. Non-slip cog belting was utilized to improve drive efficiency with larger air handling fans and belt driven equipment.

Needs Replacing (25 years old) **SEER 8 to SEER 16**

ECM 5 – ***Heating/Cooling*** audits revealed much older units of poor efficiency and non-compliant refrigerants that are expensive to service and much more costly to operate. Life cycle analysis revealed opportunities to replace on high demand and longer consumption building occupancy schedules. Natural gas conversion from oil burners provided tighter turndown ratios and predictable excess air at lower firing rates resulting in higher combustion efficiencies for boiler heating equipment.

II. Executive Summary

The Energy Conservation Measures (ECM's) were defined by the Energy Audit for each building with savings potential summarized for each building. Annual energy cost for each of the ten buildings electricity, natural gas, propane, fuel oil and any of those combinations of energy use and cost were developed from the tribal accounting and utility records for the building. The potential savings in energy use was stipulated from the engineering computations for each application of energy saving equipment, improved automation features, time management enhancement, and reduction in power use density, and quality improvements in the building envelope. The energy savings result can be summarized as follows:

Energy Savings Results – Ten Buildings

Building	Annual Energy Cost $	Annual Energy Use (mmbtus)	Projected Annual Energy Savings $
Council House	$4,606	203	$3,653
Fire Station # 2	$5,260	235	$3,345
Finance	$19,390	943	$3,395
Qualla Arts & Crafts	$10,298	476	$1,740
Historical Association	$14,181	540	$1,446
NC Cooperative	$5,253	187	$1,208
Ceremonial & Exhibit	$18,691	745	$6,411
GLW – Library	$47,078	2,285	$8,286
GLW- Fitness	$79,633	3,574	$34,401
Hospital	$303,330	17,765	$7,583
Totals	$507,720	26,953	$71,466

Summary
Total Annual Energy Consumption and Energy Conservation Measures (ECM) Savings

Buildings	Area (SF)	Total Annual Consumption (mmbtus)	Total Energy Conservations Measures (mmbtus)	Percentage Annual Savings (%)	ECM 1 Recom-missioning	ECM 2 Lighting	ECM 3 Load Reductions	ECM 4 Fan Systems	ECM 5 Heat/Cooling
Council House	3,890	203	160.6	79.1	Audit	T8, E-Ballast	Bldg. Insulation	AHU	SEER Upgrade
Fire Station # 2	5,280	235	149.5	63.6	Audit	T8, E-Ballast, OCC Sensors	Bldg. & HWT Insulation, plug loads	-----	------
Finance	6,390	943	164.9	17.5	Audit	T8, E-Ballast	Weather Stripping, Bldg. Insulation	AHU	SEER Upgrade
Qualla Arts & Crafts	6,590	476	80.4	16.9	Audit	T8, E-Ballast, CFL	Insulation, Dbl. Pane Windows	-----	------
Historical Association	6,720	540	55.2	10.2	Audit	T8, E-Ballast, OCC Sensors, LED's	------	------	-----
NC COOP	7,200	187	43.1	23.0	Audit	T8, E-Ballast, OCC Sensors	HWT Insulation Dbl. Pane	-----	------
Ceremonial & Exhibits	12,600	745	255.5	34.3	Audit	T8, E-Ballast, OCC Sensors	HWT Insulation, plug loads	AHU	EER Upgrade
GLW Library	52,500	2,285	401.1	17.6	Audit	T8, E-Ballast, OCC Sensors	HWT Insulation	-----	------
GLW Fitness	67,000	3,574	1544.6	43.2	Audit	T5, T8, E-Ballast, OCC Sensors	Solar Thermal	-----	-----
Hospital	77,170	17,765	452	2.5	Audit	OCC. Sensors LED Security Lighting	------	Cog Belts	Oil Burners Converted to NG
Totals	245,340	26,953	3306.7	12.3					

Although the Hospital did not represent the average savings, results for the collective 9 building retrofit exceeded the 30% savings benchmark. An overall energy savings of 3,306.70 mmbtus positively reflect the EBCI's commitment to reducing our overall energy consumption.

Summary
Building Energy Conservation Measures - Savings Potential (See Appendix for breakout list)
(Expressed as mmbtus)

II. Project Overview

Buildings	Recommissioning	Lighting	Load Reduction	Fan Systems	HVAC Upgrades	Totals
Council House	8.8	28.5	57.5	In HVAC	65.8	160.6
Fire Station # 2	12.0	127.6	9.9		0	149.5
Finance	14.5	41.3	93.9	In HVAC	15.2	164.9
Qualla Arts & Crafts	0	44.0	36.4	0	0	80.4
Historical	0	55.2	0.0	0	0	55.2
NC COOP	16.4	4.8	21.9	0	0	43.1
Ceremonial & Exhibits	28.7	29.8	68.8	In HVAC	128.2	255.5
GLW Library	119.4	272.3	9.4	0	0	401.1
GLW Fitness	152.4	334.9	1057.3	0	0	1544.6
Subtotal	352.2	938.4	1355.1	0	209.2	2854.7
Hospital	314.2	0	0	137.8	0	452
Totals	666.4	938.4	1355.1	137.8	209.2	3306.9

There were several parts of the FBCI Retrofit Project that required a cooperative learning experience. Buildings, like residential homes are normally tracked and equated to monthly utility cost i.e., year-to-year electric bills. Commercial building energy use equates to a different set of parameters that must be defined accurately and consistently to be compared to other buildings of like activity functions and schedules. Although, some information was readily available, yet at times assumptions and numerical information were to be validated due to energy benchmarks that didn't appear realistic according to conditions prevailing.

Re-commissioning – energy assessment of current practices, equipment, and schedules - basement to attic, top floor to bottom, condenser to evaporator, magnetic ballast to T12 fluorescent; all were on the energy conservation radar. Energy Audit *Check Lists* were used as an initial tool for isolating potential energy conservation measures. These were organized by projects that could be accomplished for less than $250 and those that would involve much more capital to implement. This preliminary summary was compared to best practices and then elaborated in more detail in the assessment report. Then estimated cost and simple payback of capital cost was initiated based upon quantities for lighting, efficiencies for new HVAC equipment, and load reductions for building envelope expenditures. All recommendations had supportive calculations to validate preliminary recommendations. The re-commissioning credit for energy savings included control of consumption by temperature and time. In several instances there were maintenance issues – condenser coil obstructions, air filter media plugged, thermostats set for heat and cool in the same zone. Programmable thermostats were added to all buildings to take control both occupied and unoccupied schedules and building seasonal temperature adjustments. The re-commissioning energy saved was 20.1% of the total annual energy saved.

Utility Consumption Data – The investigation and evaluation of buildings energy consumption for a 12 month period required the retrieval of metered utility data that was distributed to individual and department accounts thus requiring approvals and conformation from several individuals before the raw data could be obtained. There was an educational process in utility accounting nomenclature – rate structures, quantities, energy unit definitions, for the EBCI account representative to know what to ask for and how to respond if there was reluctance to reveal the consumption data. Electricity cost was related to consumption and demand, both was necessary for evaluation of cost and applicable energy conservation measures. On occasion, other departments might be involved due to a leased building being occupied with utility account ownership and billing coming thru another department other than occupant.

Building Footprints – all gross areas of conditioned space for each building were measured. This took into account that smaller buildings could be prefabed and had seen transitions in client occupants and building additions/modifications thru the years that might not be in accord with prior drawings, if drawings were even available. Since this would be an important component of the energy use benchmark (kilobtus/square foot, kbtu/sf) it was worthwhile effort to use either a laser measurement or 100 foot tape to record the actual length and width for calculating the gross square footage of each building.

Building Orientation – even though the energy influence of building orientation to the sun was not simulated to estimate the energy consumption effect of an existing building; replacement selection of specific windows and doors could be influenced by building locations and orientations. This orientation also would influence the available building roof area for thermal solar cells that were installed for the heating of the indoor swimming pool. Renewable energy through future photovoltaic cell applications would also benefit from roof top square footage and southern sky orientation.

Data Management – WRP developed a template of audit information that would be useful for tracking building energy consumption, defining energy benchmarks, and generating background information to make a decision about investment cost and benefits. Having a common basis of evaluation proved beneficial as decisions of which investment priorities would provide the best returns and greatest savings for dollar spent.

Example - Assessment Summary Checklist for Building A and B

Low Cost/No Cost Opportunities

These recommendations include those energy conservation measures with no capital expenditure or with capital expenditure that is less than $250.

Recommendation Areas to be Considered	**Estimated Cost to Implement**		**Annual Energy Cost Savings**	
	Bldg. A	**Bldg. B**	**Bldg. A**	**Bldg. B**
Seal Doors and Windows with Weather Stripping and Caulking				
Interlock Restroom Exhaust Fan with Light Switch and Occupancy Switch				
Lights Unnecessarily On –Offices, Restrooms, Multipurpose Rooms at least 10% of the electric bill portion for lighting				
Gym Overhead Lighting on when morning/afternoon schedules empty				
Lights On during daylight hours – Parking Lot, Security Lights				
Install 0.5 gpm Aerators on Water Fixtures				
Replace Incandescent Lights with Compact Fluorescent Lamps				
Install Low Flow shower heads (See orifice flow controller, Appendix)				
Replace Exit Sign IC/Fluorescent Lighting with LED Light Kits				
Delamp Halls, Corridors, Over lit areas (foot candles exceed recommendations)				
Install Lighting Occupancy Sensors for Infrequent In/Out Use Rooms				

Ventilation Occupied/Unoccupied – Unoccupied Night Fresh Air Damper Closure				
Install Programmable Thermostats as Applicable for Temperature Setbacks				
Insulating Jacket on Hot Water Heater/Pipeline, or Reduce Temperature				
Close Ceiling to Attic Openings in Insulating Barrier (Drop Ceiling)				
Reflectance Film and/or Drapes on Southern Exposure Doors and Windows				
Thermal Windows or Storm Windows are in place or adequate				
Vending Machines Delamping or Occupancy Sensors				
Office Equipment "sleep mode" Occupied/Unoccupied				
Other Special Energy Saving Considerations • Energy Star Appliance Replacements – Future Savings • Small Building Electric Power Monitor – kwh, kw, Loading hourly tracking				
Totals				

Capital Cost Projects These recommendations include those capital expenditures in excess of $250.

Recommendation	**Estimated Cost to Implement**		**Annual Energy Cost Savings**	
	Bldg. A	**Bldg. B**	**Bldg. A**	**Bldg. B**
Repair duct leaks in HVAC supply duct work				
Solar Heating Panels for Swimming Pool				
Replace T-12's and Magnetic Ballasts with T-8's and Electronic Ballasts (cost based on immediate replacement)				
Install Variable Speed Drive on HVAC Equipment at designated locations				
Install Low Flow 1.6 gpm Toilets/1.0 gpm Urinals and/or Dual Flush Valves where designated				
Improve Building Insulation Barrier Attic/Crawl Space				
Outside Decorative Pole Lighting – Consider LED Replacements if Metered				
Replace Parking/Security Lighting with LED Cobra/Box Heads (Life Cycle)				
Combine multi-meters where Pole Transformer Proves Feasible (Single Meter)				
Totals				

After establishing annual utility consumption and cost with a measured building footprint; the frequently used energy and cost benchmarks could be established for each building.

Energy Benchmarks

Building	**Building A**	**Building B**
Building Age	2004 Last Upgrade	2004 Last Upgrade
Building Square Feet	52,500	67,000
Annual Energy Consumed mmbtus	2,285	3,574
Annual Energy Use Index kbtus/sf-yr	44	53
Annual Energy Cost Index $/sf-yr	0.90	1.19
Total Energy Cost $/yr	$47,078	$79,633
Projected Energy Saving $/yr	$7,145	$37,330
CO_2 Savings Reductions Lbs./yr	184,400	1,010,000
NO_x Savings Reductions Lbs/yr	391	2,138
SO_2 Savings Reductions Lbs/yr	144	787

Schedules – building occupancy establishes energy consumption to maintain comfort and proper ventilation. Building operating schedules also are the basis for many benchmark assessments derived from annual hours of use. It was a practice to obtain a building operating schedule from the manager in charge of each building. These schedules reflect the demand for energy based upon building occupancy.

Operating Schedules and Occupancy HVAC Service Hours

	Monday thru Friday	Friday and Saturday	Sunday	Occupancy Hours
Building A	7:45 AM to 4:30 PM	Closed Saturday	Closed	2250
Building B	6 AM to 8 PM	9 AM to 2 PM	Closed	3900

Lighting – can be represented by many acceptable choices and recently evolving technologies. An established criterion for selection was based upon: efficacies ≥ 90, rated fixture watts, lamp watts, rated life hours, initial lumens, initial lumens/watt, lumens at 40% rated life (Metal Halides) and foot candles at activity level. There were over 100 occupancy sensors installed in seven buildings to control lighting when a room was unoccupied. A majority of the lighting circuits were dual thus allowing the occupancy sensor to default to the lowest Lighting Power Density (watts/sf) of the room and requiring the occupant to override for additional lighting. Overhead high-bay lighting in gyms and fire stations have individual occupancy sensors that energize only upon sensing motion at the floor within a zone of the overhead fixture location. Lighting represented the second highest percentage of total energy savings at 30%.

Environmental Stewardship – recognizing that there is a large quantity of older magnetic ballast and fluorescent lamps eventually being disposed it was prudent to have a disposal policy. Several hazardous waste providers were identified for disposing of any potential pre-1979 PCB ballasts and/or fluorescents with high level mercury content. It was also pointed out that many older thermostats that were going to be replaced could have equivalent mercury contents of 300 fluorescent four foot lamps and that these were classified as hazardous as well. A policy was adopted for disposal and recommendations made for future purchases of low level mercury lamps that are classified as nonhazardous and can be disposed in landfills.

Load Reductions – building insulation brought to regional compliant standards, Energy Star rated windows, insulating hot water lines and water tanks, and the addition of a large thermal solar collector for an indoor swimming pool with an insulated pool cover provided the largest energy savings of the total estimated savings at 40.4%. Plug load reduction included ice merchandizing units that were leased but not necessary because of building schedules were activity driven. Vendor advertising drink boxes were delamped as well.

Fan Systems – variable speed fan drives save energy by matching load with motor torque and speed output. Rural, ice prone mountains geography serve to warn for potential hazards of three phase power during outages. It was not received as a welcomed addition due to past experience with power quality being affected by weather conditions and resultant losses of variable speed control motors. NEMA Premium motors and EPAct motors were used to replace AHU units that were purchased with new HVAC equipment. Additionally, the hospital with many large air handling fans that were v-belt driven were replaced with cog belts; this accounted for about 4% of the total annual energy saved.

Heating, Ventilating, and Air Conditioning (HVAC) – ASHRAE 90.1 -1998, 2004, 2007, and 2010 provides the minimum efficiency standard for unitary and split air conditioners and heat pumps. Each building’s existing HVAC unit(s) was checked for: physical location conditions, when manufactured, tonnage, zone/room temperature control basis, AHU filter cleanliness, and acceptable condenser coil maintenance. A visual and thermal air release check was made for the condenser units under load. Recorded model numbers and serial numbers were then searched in vendor specification sheets for efficiency both in cooling and heating modes of operation. Building benchmarks of total A/C tons/square foot were compared to norms for expectations of temperature control capacity. Life-cycle analysis was used to justify replacements, especially when much older units had low efficiencies and expected higher maintenance cost associated with phased-out, expensive refrigerants. Programmable thermostats were recommended in nearly all instances to control perimeter and zone temperatures especially when building schedules revealed predictable unoccupied times coupled with quality building insulating barriers. This added efficiency replacement of HVAC equipment accounted for 6.3% of the annual saved energy. Fairly newer units are hard to justify based on efficiency upgrades.

III. Objective

The objective of this project was to reduce overall energy consumption of a given set of buildings. The project was in accordance with the EBCI's continuing effort to define opportunities to save energy and reduce consumption of natural resources. This project focused on EBCI owned buildings located on the Qualla Boundary which is located in the DOE defined Climate Zone 4. The results of this effort provided pertinent and collective information about physical attributes of buildings, utility cost and ranking according to cost, energy consumption, and area. Additionally, it served as collective summary of all the annual utility consumption, cost and energy use intensity for all of the Qualla Boundary buildings and support infrastructure (Water and Wastewater treatment). Management had a collective vision of the total picture of utility cost and potential savings that was prioritized according to known benchmarks for comparisons to best practices. ASHRAE Standard 90.1 provided a reference of Recommendations for Building Envelope, Lighting, HVAC, and Service Water Heating that could be used as a starting point for minimum levels of performance expected in a building of a given age and what might be expected for a 30% improvement. From this starting point each building was re-commissioned with a technical energy assessment.

IV. Description of Activities Performed

Re-commissioning requires the investigation of performance i.e. how the building is operating – occupied and unoccupied. What is running, when and how it is energized and for what reason. The scoping of this basic requirement determines the path of energy conservation. In some instances, estimated savings would reveal questionable results and further investigation provided better explanation of expectations. Interviews were scheduled with building department administrative, management, and maintenance or facility mangers for initial understanding of operations and problem areas. Formal investigative processes followed that include these activities for the re-commissioning:

1. A ranking of building energy use (Energy Use Index, EUI) The Energy Star ranking via Portfolio Manager was not pursued; however, Cherokee Indian Hospital was referenced to hospitals of like size and operations to establish cost to operate at a level of an Energy Star ranked hospital.

2. Identification of energy conservation measures – estimated cost and expectations of cost recovery from savings at two levels of cost priorities 1) less than $250 and 2) greater than $250/ ECM.

3. Visual inspection and cataloging building physical parameters such as gross conditioned area, building orientation, quantifying numbers of light fixtures, windows, doors, insulating performance, identifying roof profiles and areas for future thermal or photovoltaic applications.

4. Calculating energy benchmarks and environmental reductions in greenhouse gases resulting from energy savings

5. Determining building schedules for occupancy and effective operating schedules of equipment based upon the occupancy schedules and how buildings responded to control measures during unoccupied times.

6. Breakdown of utility service rate structures – kWh, Kw, daily averages, high and low months, average monthly cost and load factor. Propane and natural gas consumption and energy cost per mmbtus.

7. Recommendations and references to best practices, providing exceptions and maintenance requirements to improve energy use and projected savings potential via implementation

8. A tabulation of lighting types, fixture quantities, lamp wattages, light power density (watts/sf), cost to replace and expectations of savings generated from lamp wattage reduction, occupancy sensors, and lighting type changes.

9. A recording of HVAC equipment by model number, Efficiency levels such as SEER, EER, COP, AFUE, HSPF, age, refrigerant type, drive system, control system, and maintenance condition.

10. Locating vending machines and ascertaining the need to provide lighting advertisement in a closed office environment. Quantifying the cost of plug in service for merchandizing equipment – bagged ice, sodas, snack food, etc

11. Identifying personal office conveniences such as fans, small heaters, refrigerators, lighting, and microwaves that consumed energy and were not authorized for use.

12. Assessment of water conservation savings in large user locations such as hospital – Quantified consumption and cost based upon number of employees, outpatient traffic and occupied bed vacancies.

13. Evaluated the potential for renewable energy applications. The energy saving benefits and cost of thermal heating hot water from solar panels were evaluated for an indoor swimming pool.

14. Define specific side studies of relevant energy assessments investigative needs, including:

- a) Cooling Tower Applications – evaporation losses at chiller tonnage demand
- b) Chiller condenser and chill water control influences and variable speed drive applications
- c) Cooling tower blowdown schedules and corrosion control strategies
- d) Submetering of cooling tower water usage and applications for building roof rainwater collection
- e) Commercial kitchens best practices and Energy Star equipment references and savings
- f) Control strategies for VAV with reheat
- g) Estimated savings with NEMA Premium Motors
- h) Life Cycle Cost for replacement of older HVAC equipment with higher efficiency rated HVAC equipment
- i) Insulation upgrades with computations of energy savings, cost, with different R values
- j) Data center benchmarks, power densities, chiller applications and cooling case studies
- k) Single pane versus double pane windows of varying "U" values and SHGC
- l) Water conservation studies to focus the cost of water usage and savings potential
- m) Faucets and showerhead replacements based upon DOE energy cost calculators
- n) Electric meter aggregation thru service line loading studies
- o) Maintenance checklists of best practices for service schedules and recommended equipment references
- p) References to technical information in support of action to be taken with case studies of result such an example included:

ANSI/ASHRAE/IESNA Standard 90.1– the fixed reference point 1999, 2004, 2007, and 2010 ***Advanced Energy Design Guide for Small Offices Buildings and Small Retail Buildings.*** This Guide includes specific recommendations for energy-efficient improvements in the following technical areas to meet 50% to 30% to 18% energy reduction goals depending upon time of building design era:

• ***Building Envelope***
- Roofs
- Walls
- Floors
- Slabs
- Doors
- Vertical Glazing

• ***Lighting***
- Daylighting
- Skylights
- Interior/Electric Lighting Efficacy Upgrades
- Controls

• ***HVAC Equipment and Systems***
- Cooling Equipment Efficiencies
- Heating Equipment Efficiencies
- Supply Fans
- Ventilation Control
- Ducts

• ***Service Water Heating***
- Equipment efficiencies
- Pipe insulation

In addition, strategies to ***improve energy efficiency*** beyond the 30% are included for:
- Exterior Façade Lighting
- Parking Lot Lighting
- Plug Load

Not all existing buildings physical attributes can be modified to the ASHRAE Standards at a reasonable cost for justification; however, there are many opportunities where buildings can readily be modified to take advantage of technologies and energy saving enhancements for significant results.

V. Conclusions and Recommendations

The Eastern Band of the Cherokee Indians continues to demonstrate a commitment to sustainability of natural resources. Blessed with a unique and beautiful place in the Smoky Mountains of North Carolina, the Tribe devotes funding, skilled tribe resources, and leadership to protect and present its Qualla Boundary in a most favorable light to the many visitors each year.

This project represents a successful endeavor to reduce energy consumption across the selected buildings. Our team comes away stronger and wiser thanks to this project experience. Based on the complexity of understanding our energy consumption, the EBCI has employed an Energy Coordinator to compile and centralize our multi-faceted energy information. We have also determined that the best use of non-renewable funds is not maintenance of some systems, as sometimes recommended, but implementation of equipment that will have long lasting returns. The use of Solar Thermal has given us insight into the orientation of our new construction projects. We must consider building layouts that account for the effects of sunlight and prepare those buildings for future expansion of solar installations. Another lesson for our team is the understanding that project experience must be shared openly. We will only slow our progress by shifting similar projects to inexperienced staff. A well-coordinated effort will allow us to take advantage of the experience with the EBCI. A coordinated effort solicits input from internal experts such as engineers, electricians, or HVAC technicians. Their experience will help develop a project that is well defined and focused on high need modifications.

In summary, we set out to reduce our energy consumption across a set of buildings owned by the Eastern Band of Cherokee located on the Qualla Boundary. Our goal was a 30% reduction through ECM's such as lighting, insulating, use of occupancy sensors, and even solar thermal for one application. We were able to hit a 31% reduction in energy use for nine buildings. This project is representative of the EBCI's continuing efforts of sustainability. Renewable energy resources provided by solar thermal and photovoltaic applications will continue to present a leadership role that will be complimentary to the energy conservation measures that have been implemented. This project has been a catalyst for change in our energy consumption and monitoring. Reducing our energy consumption protects our environment and natural resources. Energy reduction projects will continue to grow in our community as conservation is ingrained in our culture. Our goal must be sustainability through conservation.

VI. Appendix Listing

A. Summary Table – Total Annual Energy Savings Projections, 12 Months Energy Use and Percent Savings

Example Exhibits – Basis for Summary Table

- General Overview of Savings Approach – Fire Station # 2
- Lighting Occupancy Sensor and Load Reduction Basis – Ginger Lynn Welch Building
- Basis Lighting and Occupancy Sensor Building Use Hours and Applications
- Summary Building Lighting Replacements
- Swimming Pool – Thermal Heating and Pool Cover Energy Savings
- Summary Programmable Thermostat Applications
- Summary Load Reduction Basis for Energy Efficient Windows
- Summary Load Reductions Insulation Applications
- Summary Load Reductions Building Envelope – Sealing/Caulking
- Summary Load Reductions Plug Loads
- Summary Load reductions Hot Water Line Insulation Applications
- Hospital – Cog Belt Summary of Energy Reduction
- Summary HVAC Replacements and Basis for Energy Savings

B. Buildings –

- Building Profile – Building Description, Energy Conservation Measure's
- Total Annual Building Energy Consumption (mmbtus), Energy Benchmark (kbtus/sf), Energy Cost ($/sf)

1) Council House
2) Finance Building
3) Fire Station # 2
4) Historical Association
5) North Carolina COOP
6) Ceremonial and Exhibit Building
7) GLW – Library Side
8) GLW – Fitness Side
9) Qualla Arts and Crafts

Summary Table
Total Annual Energy Savings Projections, 12 Month Energy Use and Percent Savings

Buildings	Area SF	Recommissioning mmbtus	Lighting Savings mmbtus			Load Reduction mmbtus				Fan Systems		Heating/Cooling	Totals Savings	Total 12 Months	Savings Percent of Annual
			LPD	OCC Sensors	Delamping	Insulation**	HW Lines	Plug Loads	Solar	Drives	Belting	SEER/EER/HSPF Upgrade	mmbtus/yr	Utilities mmbtus	Consumption
Council House	3,890	8.8	21.3	0	7.2	57.5	0	0	0	0	0	65.8	160.6	203	79.1%
Fire Station # 2***	5,280	12	26	74.2	27.4	0	9.9	0	0	0	0	0	149.5	235	63.6%
Finance	6,390	14.5	30.5	0	10.8	93.9	0	0	0	0	0	15.2	164.9	943	17.5%
Qualla Arts & Crafts	6,590	0	36.8	0	7.2	36.4	0	0	0	0	0	0	80.4	476	16.9%
Historical Bldg.	6,720	0	48.0	0	7.2	0	0	0	0	0	0	0	55.2	540	10.2%
NC COOP	7,200	16.4	4.8	0	0	19.6	2.3	0	0	0	0	0	43.1	187	23.0%
Ceremonial	12,600	28.7	26.2	0	3.6	49.5	1.6	17.7	0	0	0	128.2	255.5	745	34.3%
GLW - Library	52,500	119.4	233.4	17.4	21.5	0	9.4	0	0	0	0	0	401.1	2285	17.6%
GLW - Fitness*	67,000	152.4	141.7	164.5	28.7	374.7	0	0	682.6	0	0	0	1544.6	3574	43.2%
Subtotal	168,170	352.2	568.5	256.1	113.6	631.6	23.18	17.7	682.6	0	0	209.2	2854.7	9188	31.1%
Hospital	77,170	314.2	0	0	0	0	0	0	0	0	137.8	0	452	17765	2.5%
Totals	245,340	666.4	568.5	256.1	113.6	631.6	23.18	17.7	682.6	0	137.8	209.2	3306.7	26953	12.3%

* OCC Sensors Turn off gym lights 2860 hours of 3900 hours gym open/yr

** Insulation, weather stripping and caulking, and window replacements

*** Removed(4) 400watt MH Fixtures from service

The basis for these projections are included as a reference to how the above summary was constructed.

Note: The Hospital received some funding for motor drive systems; however, there are some residence capacity issues with current facilities and the need for future capacity at a different location. Occupancy sensors, reduced wattage fluorescents, and exterior LED lighting are being installed presently.

Excluding the 17765/26953 x 100 **= 65.9% of the total annual energy usage of the hospital** the Energy Savings for the nine other buildings is;

Nine Buildings Energy Savings = 2854.7 mmbtus/9198 mmbtus x 100 = 31% of the total annual energy usage.

1) General Overview Lighting Energy Savings Approach –Fire Station # 2

a. Removal of (4) 400 watt MH Truck Bay Fixtures from Service
b. Occupancy sensors for all Truck bay Overhead T8 Fluorescent fixtures
c. Occupancy sensors for individual rooms
d. Reduction in lighting fluorescent watts/fixture
e. Vendor plug-in delamping
f. Programmable thermostats

Fire Station #2	Quantity	Fixture -Before Watts	Fixture - After Watts	Before Annual Energy Use kWh	After Annual Energy Use kWh	Annual Energy Savings kWh	Occupancy Sensor Application	Measured Lighting Power Density LPD watts/sf	TBD Room Area SF	Total Room Fixture Watts	Annual Hours	Time Delay Factor 5 min.	Time Delay Factor 10 min.	Occ. Sensor Savings 5 min delay (kWh)	Occ. Sensor Savings 10 min delay (kWh)
4LT12 40w to 4LT8 28w*	29	176	96	14802	8074	6728	Upstairs BR	0.87	110	96	2900	0.58	0.56	161	156
(16)400 w MH to **(12)4LT8 32w**	16 & 12	458	114	24072	2736		Upstairs BR	1.13	85	96	2900	0.58	0.56	161	156
2LT12 40w to 2LT8 28w	2	88	49	510	284	226	DownStairs BR	0.60	47	28	2900	0.6	0.54	49	44
60w IC to 11w CFL	1	60	11	174	32	142	DownStairs BR	0.60	47	28	2900	0.6	0.54	49	44
Operating Hours	**Hours**	**Areas**								Total Annual Occupancy Sensor Savings kWh				**420**	**400**
Before Hours	**4380**	**MH's Truck Bays**	**Before Metal Halides on due to warmup**												
After Hours (12 units on OCC)	**2000**	**(12) 4L T8 32w**	**After Remained on after nighttime callout**												
Before & After Hours*	**2900**	**Living Areas**													

Demand Savings MH's Removed	**4**			
Kw	**1.832**		**Square Feet**	**mmbtus**
Annual kWh removed from service	**8024**	Programmable Thermostat savings	**5280**	**12.0**
Mmbtus removed from service	**27.4**			
Vendor Delamping	**3.6**			
Total Delamping	**31.0**			
OCC Savings (Rooms)	**1.36**			
OCC Savings Truck Bay	**72.8**			
Total OCC Savings (mmbtus)	**74.2**			

Occupancy Savings Living Qtrs & Bathrooms	400
Total Electricity Savings Total kWh	7496
Annual Energy saved mmbtus	**26**

Before and After Replacement Lighting Wattages/Fixture

Reference Tables for "Before" and "After" Input Watts for a Given Lamp Wattage and Existing Fixture Configuration - Stipulated Savings Basis - *Source ASHRAE 90.1 Table 9-E, Ballast Factor 0.85 to 0.88 Normal, Guidelines only, use as needed for Efficacy ≥ 90 values

Fixture Combinations Input Watts CEE Database	T 12 Magnetic* Ballast 40w	T 12 Magnetic* Ballast 34w	T8 Electronic Ballast 32w	T8 Electronic Ballast 28w	T8 Electronic Ballast 25w
4L x 4' + Ballast	176	144	114	96	86
3L x 4' + Ballast	134	112	84	77	64
2L x 4' + Ballast	88	72	57	49	43
1L x 4' + Ballast	44	37	28	25	22

Fixture Combinations Input Watts High Output Fixtures	T12 Magnetic* Ballast 110w	T 12 Magnetic* Ballast 75w	T12 Magnetic* Ballast 60w	T8 Electronic Ballast 86w	T8 Electronic Ballast 59w
2L x 8' + Ballast	237	158	138	160	110
1L x 8' + Ballast	119	85	70	88	65
2L x 4' + Ballast	N/A	N/A	144	N/A	128

High Bay Fixtures Metal Halide, T12 to T8, T5	MH 400 w	MH 250w	T12 6F40T12	T8 6F32T8	T5 4F54T5	T5 6F54T5
Input Watts	458	289	264	220	234	351

Exit Signs	Incandescent	Fluorescents	LED
Input watts	25	17	3

Fixture Type	IC 300 Watt	IC 200 Watt	IC 150 Watt	IC 100 Watt
CFL Equivalent Watt	80	55	42	26

2) Oc Senso r and Load Reduction Basis – Ginger Lynn Welch

(Partial listing of 104 Occupancy sensors in application at Ginger Lynn Welch building)

GLW-Fitness Side Savings/Room with Occupancy Sensors Room/Type/Identifier	Room Area SF	Before Fixture 3LT1240w Input watts/fixture	After Fixture 3LT828w Input watts/fixture	Quantity Fixtures Per Room	Before Lighting Power Density (LPD) watts/sf	After Lighting Power Density (LPD) watts/sf	Average Footcandles @ "After" LPD	Lowest Fixture watts controlled by Occ. Sensor	Occ. Sensor Lighting Power Density (LPD) watts/sf	Average Footcandles @ "After" OCC. Sensor LPD	Before Annual Consumption kWh	After Annual Consumption kWh (all Lamps)	After Annual Consumption kWh 1L ea. Fixture kWh	Occ. Annual Sensor Savings 1L/Fixture 10 mins. Delay	Total Annual Savings After & OCC. Sensor kWh	Total Annual Savings Room kWh
Supv. Office	583	134	70	6	1.38	0.72	58	156	0.27	48	3136	1638	608	207	402	**2734**
Office/124/Cardio Rm	1134	134	70	15	1.77	0.93	75	390	0.34	43	7839	4095	1521	517	1004	**6835**
Office/301/Brk Rm	186	134	70	3	2.16	1.13	80	78	0.42	37	1568	819	304	70	234	**1334**
Office/305/FS	209	134	70	3	1.92	1.00	58	78	0.37	27	1568	819	304	103	201	**1367**
Office/306/Brk Rm 2L Fix	162	134	70	2	1.65	0.86	46	52	0.32	22	1045	546	203	47	156	**889**
307/Stg/Files/ 4L Fix	269	176	94	2	1.31	0.70	118	192	0.71	118	1373	733	749	255	494	**879**
Mech. Pump/Filter 2L Fix	1056	88	49	10	0.83	0.46	35	490	0.46	35	3432	1911	1911	650	1261	**2171**
										Total kWh	19960	10561	5600	**1848**	**Total kWh**	**16208**
															Total mmbtus	**55**

Occupancy Sensor Application **- Dual Circuit and Single Circuit - In default wired position the OCC Sensor turns one lamp per fixture for a dual circuit arrangement upon entering the room and for single room circuit arrangement all lamps per fixture come on. The room occupant can overiride this atutomatic "on" default for a dual circuit design by manual pushbutton of the OCC sensor upon entering the room or if more lighting is needed. Savings Computation, Blue Line above example: Before - 134 watts/fixture x 6 fixtures ÷ 1000 watts/kilowatt x 3900 hrs/yr = 3136 kWH/yr , After - 77 watts/fixture x 6 fixtures ÷ 1000 watts/kilowatt x 3900 hours/yr = 1802 kWH/yr Lighting Power Density (LPD) Before = (134 x 6) watts/583 sf = 1.38, After = (77 watts x 6)/583 = 0.79 Savings (Manual "On" - (Before - After) = 3136-1802 = 1334kWh/yr savings all lamps lit (OCC. Sensor Controlled) Dual Circuit- one lamp each fixture "on" upon entering room (156 watts/all fixtures) ÷ 1000 watts/kw x 3900 hrs = 608 kWh Then Savings will be Before = 3136 - After 608 = 2528 kWh/yr plus additional savings of a 10 minute delay and the light is automatically cut off after leaving the room which for an office is defined at 0.34 x annual consumption = 608 kwh x 0.34 = 207 kwh/yr Total Savings for dual circuit OCC sensor controlled room = Before (LPD fixture wattage) 3136 kwh/yr - (608 kwh (one lamp/fixture wattage) - unoccupied room savings 207 kwh) =3136 -(608 - 207) = 2734kwh/yr Single Circuit arrangement- receive the 0.34 savings for the time delayed "off" for an unoccupied room ex. all of the yellow grouping show the same footcandle readings indicating single circuit controlled occupancy sensor.**

Manual Switch Control **- According to B of M of lamps purchased and those occupancy sensor controlled there are additionally 2L -15 fixtures, 3L- 239 fixtures, and 4L-15 fixtures that are switch controlled at the room entrance, this equates to a reduction of 2L - 1316 kWh/yr, 3L - 30652 kwh/yr and for 4L - 2700 kWh/yr or a total of 34668 kWh/yr. 1 kWh = 3412 btus**

Total Lighting Saved kWh	**133593**
Total Lighting mmbtus	**456**

OCC Savings	
Library	17.4
Fitness	164.5

High OCC Sensor savings for Fitness due to less hours of lights being on, MH's required

GLW-Library Manual Switch Control	Before watts/fixt	After watts/fixture	Quantity	Annual Hours	Annual Savings kWh	Annual Savings mmbtus
2L	88	49	13	2250	1141	3.9
3L	134	70	17	2250	2448	8.4
4L	176	98	109	2250	19130	65.3
				Totals	**22718**	**77.5**

Summary	LPD	OCC	Totals
Library	233.4	17.4	250.8
Fitness	141.7	164.5	306.2
			557.0

Basis Lighting and Occupancy Sensor Building Use Hours and Applications

Table 1. Energy waste for the 14-day period and energy savings for the 5- and 20-minute time delay simulations.

Application	Energy waste[1]	Energy savings using the 5-min time delay[2]	Energy savings using the 20-min time delay[2]
Break Room	39%	29%	17%
Classroom	63%	58%	52%
Conference Room	57%	50%	39%
Private Office	45%	38%	28%
Restroom	68%	60%	47%

1. Maniccia and Tweed, 2000
2. Von Neida et. al., 2000

Example : Private Office Lighting - Room Area (sf) x Light Power Density (watts/sf) = watts x daily energy use (baseline), then waste (7 AM to 4 PM lights on) would be a Private Ofice of which 38% savings for a 5 minute delay in lights out or 28% for a 20 delay for lights out. Example: Private Office - 193 sf x (3 light fluorescent T8 28 watt fixture)= (3) x 77watts fixture wattage = 2 LPD = 234watts/193sf = 1.2 watts/sf Annual savings with occupancy sensor = totals area offices of 10 offices = 1,930 sf x LPD 1.2 daily hourly use (9 hours) /1000 watts/kilowatt = 20.84 kWh/day x 260 days/yr =5,419 kWh use of annual energy would give a s of 2,059 kWH for a 5 minute delay = 5,419 kWh/yr x 0.38 =2,059 kWh savings/yr.

Ginger Lyn Welch -Fitness and Library Side - Computational scope basis

Occupant Sensors applied - offices, breakrooms, conference rooms, restrooms , and assembly rooms -**total 84**
Occupant Sensors applied for Hi-Bay Gym lighting - **total 30 units**
All window side offices have daylight harvesting feature (Ambient Light Override) in Occupancy Sensor
Room Occupancy Sensor Features that contribute to savings (LevitonMdl. OSSMD-MD)
- Adaptive time out
- Walk -through Time-out (2.5 minutes then off)
- dual lighting circuit control (Auto Sensing - one lamp per fixture on, Manual for full lamp fixture on) 10 minute timeout tim of: 10,20,30, Auto Adaption options
- Ambient Light Override - 60 second delay for clouding
- Passive Infrared (PIR)
- Ultrasonic motion detection

Wattage change outs - 40w T12 to 28w T8 for four foot fluorescents
4L fixture 2 magnetic ballast replaced with one electronic

Occupancy Sensor- Percentage Savings in Daily Energy Usage per Reference					
Lights Off	**Breakroom**	**Classroom**	**Conference Room**	**Private office**	**Restroom**
5 min. Delay	0.29	0.58	0.50	0.38	0.60
10 Min. Delay	0.23	0.56	0.46	0.34	0.54
15 Min. Delay	0.19	0.54	0.42	0.31	0.50
20 Min. Delay	0.17	0.52	0.39	0.28	0.47

GE Ballasts in Use "N" O.87 BF		
GE Cat #	System Input Watts 28 w lamp	
78627	4L - 94w	3L-77w
72866	2L-43w	1L-25w
72266	2L-49w	1L-28w

	175W MH Input watts	LED 26W Input watts	Fixtures	Annual mmbtus Savings
GLW Wall Wash Lights	215	30	12	33.2

Building Operationg Hours Initial Assessment & After		
Operating Hours	**Before**	**After**
Firestation # 2	**Annual Hours**	**Annual Hours**
Truck Area	8760	1460
Living Area	2900	2900
Ginger Lynn Welch Fitness Side	3900	3900
Ginger Lynn Welch Library Side	2250	2250
NC COOP Extension	2080	2080
Ceremonial & Exhibit	2250	2250
Qualla Arts & Crafts	2433	2433
Cherokee Historical	2000	2000
EBCI Finance	2200	2200
Council House	2200	2200
Cherokee Hospital		
Office Areas	2340	2340
Outside Lighting	4380	4380
Hospital 24/7 Zones	8760	8760

Other Lighting References	**Hours**
Vending Machines	**8760**
Exit Signs	**8760**

4) Summary Building Lighting Fluorescents

Buildings Light Replacements Before & After	Quantity	Before Fixture watts	After Fixture watts	Annual Energy Savings kWh	Occupancy Sensor Storage Room	OCC Sensor Savings kWh	Total Savingsm mbtus
NC COOP Bldg.							
2LT12x 60w to 4LT8x28w	14	138	94	1281	1	113	4.76
Occupied Hours/yr	2080						
Total							**4.76**
Ceremonial & Exhibits							
MH 400w to 4LT8 32w	20	458	220	10710			36.54
2LT12 x 40w to 2LT8 x 28w	18	88	49	1580	1		5.39
4LT12 x 40w to 4LT8 x 28w	33	176	94	6089			20.77
Occupied Hours/yr	2250						
Total							**26.16**
Qualla Arts & Crafts							
2L8'T12 x 60w to 4LT8x28w	8	138	94	856	1		2.92
2LT12 x 40w to 2LT8 x 28w	23	88	43	2518			8.59
1LT12x 40w to 1LT8x 28w	22	44	25	1017			3.47
Spot IC 90w to CFL 15w	35	90	15	6387			21.79
Occupied Hours/yr	2433						
Total							**36.78**
Historical Association							
4LT12 x 40w to 4LT8 x 28w	42	176	94	6888	1		23.50
2LT12 x 40w to 2LT8 x 28w	47	88	49	3666			12.51
2LT12x40w to 2LT8x 28w	4	88	43	360			1.23
IC 90w flood to 7 watt LED	18	90	7	2988			10.20
2LT12 x 40w to 2LT8x25w	4	88	49	312			1.06
Occupied Hours/yr	2000						
Total							**48.50**
Finance Bldg							
4LT12 x 40w to 4LT8 x 28w	32	176	94	5773			19.70
2L8'T12 x 60w to 4LT8x28w	25	138	94	2420			8.26
2LT12x40w to 2LT8x 28w	4	88	43	396			1.35
1LT12 x 40w to 1LT8x25w	8	44	25	334			1.14
Occupied Hours/yr	2200						
Total							**30.45**
Council House							
2L8'T12 x 60w to 4LT8x28w	2	138	94	194			0.66
2LT12x40w to 2LT8x 28w	49	88	43	4851			16.55
2LT12x40w to 2LT8x 28w	14	88	49	1201			4.10
Occupied Hours/yr	2200						
Total							**21.31**
Lights were not installed with replacement fluorescent fixture						Less H10	**167.9**

Occupancy Sensor- Percentage Savings in Daily Energy Usage per Reference					
Lights Off	**Breakroom**	**Classroom**	**Conference Room**	**Private office**	**Restroom**
5 min. Delay	0.29	0.58	0.50	0.38	0.60
10 Min. Delay	0.23	0.56	0.46	0.34	0.54
15 Min. Delay	0.19	0.54	0.42	0.31	0.50
20 Min. Delay	0.17	0.52	0.39	0.28	0.47

Reference Tables for "Before" and "After" Input Watts for a Given Lamp Wattage and Existing Fixture Configuration - Stipulated Savings Basis - *Source ASHRAE 90.1 Table 9-E, Ballast Factor 0.85 to 0.88 Normal, Guidelines only, use as needed for Efficacy ≥ 90 values

Fixture Combinations Input Watts CEE Database	T 12 Magnetic* Ballast 40w	T 12 Magnetic* Ballast 34w	T8 Electronic Ballast 32w	T8 Electronic Ballast 28w	T8 Electronic Ballast 25w
4L x 4' + Ballast	176	144	114	96	86
3L x 4' + Ballast	134	112	84	77	64
2L x 4' + Ballast	88	72	57	49	43
1L x 4' + Ballast	44	37	28	25	22

Fixture Combinations Input Watts High Output Fixtures	T12 Magnetic* Ballast 110w	T 12 Magnetic* Ballast 75w	T12 Magnetic* Ballast 60w	T8 Electronic Ballast 86w	T8 Electronic Ballast 59w
2L x 8' + Ballast	237	158	138	160	110
1L x 8' + Ballast	119	85	70	88	65
2L x 4' + Ballast	N/A	N/A	144	N/A	128

High Bay Fixtures Metal Halide, T12 to T8, T5	MH 400 w	MH 250w	T12 6F40T12	T8 6F32T8	T5 4F54T5	T5 6F54T5
Input Watts	458	289	264	220	234	351

Exit Signs	Incandescent	Fluorescents	LED
Input watts	25	17	3

Fixture Type	IC 300 Watt	IC 200 Watt	IC 150 Watt	IC 100 Watt
CFL Equivalent Watt	80	55	42	26

GE Ballasts in Use "N" O.87 BF		
GE Cat #	**System Input Watts**	
78627	4L - 94w	3L-77w
72866	2L-43w	1L-25w
72266	2L-49w	1L-28w

Reference: Bill of Materials from Shuler & Sons Lighting Contractor for Installation12/12/2011

5) Swimming Pool - Thermal Heating and Pool Cover Energy Savings

Site Energy Available

The intensity of solar energy available is determined by latitude and longitude. Insolation Tables have been developed to define the incident irradiation (1 kWh/m^2 -day= 317.1btus/ft^2 -day) available at any given location.[2] The table shows the incident irradiation reaching the earth in a 12 month period. The long, warm days of summer as can be seen provide the sun's peak irradiation. The cold days of winter and short daily sunlight with frequent cloudy days contribute to lower collection availability. On a cold, cloudy winter day without direct sunlight the collector will contribute no heat input to the hot water system! This is why solar systems are supplemental to conventional hot water storage generated by gas or electricity.

Month	kWh/m^2 - day	btus/ft^2- day
January	2.24	710
February	2.86	907
March	3.97	1259
April	4.98	1579
May	5.42	1719
June	5.73	1817
July	5.68	1801
August	5.13	1627
September	4.59	1455
October	3.78	1199
November	2.60	824
December	2.06	653
Yearly Average	**4.09**	**1296**

Yearly Avg. Irradiation available at this location - 1296 btus/sf per panel will yield = 1296/1000 x 21,700 btus/day = 28,123 btus/day per panel x 70 panes = 1,968,624 btus/day or x 365 = for year = 718.5 mmbtus/yr from solar panels on GLW roof less a 5% heat loss average **= 682.6 mmbtus/yr**

Solar Collector Ratings

There are several types of solar collectors that are design specific in application; however, the most common in commercial hot water storage applications is the glazed, flat-plate collector. The Solar Ranking and Collector Certification (SRCC) Corporation test solar collectors for btus/sf-day output for a given net aperture square footage of panel.[3] There are five application categories and three levels of site radiation levels that are considered for each panel rating. The example shown below is for a SunEarth Empire Series Mdl EC/40-1.5

COLLECTOR THERMAL PERFORMANCE RATING — Thousands of BTU Per Panel Per Day

CATEGORY (Ti-Ta)	CLEAR DAY (2000 Btu / ft^2.day)	MILDLY CLOUDY (1500 Btu / ft^2.day)	CLOUDY DAY (1000 Btu / ft^2.day)
A (-9 °F)	51.1	38.1	25.86
B (9 °F)	46.7	34.0	21.7
C (36 °F)	39.9	27.8	15.7
D (90 °F)	26.1	14.9	4.5
E (144 °F)	12.3	3.5	0.0

A- Pool Heating (Warm Climate) **B**- Pool Heating (Cool Climate) **C**- Water Heating (Warm Climate) **D**- Water Heating (Cool Climate) **E**- Air Conditioning

Swimming Pool Covers – Energy Savers

The surface area of a swimming pool will lose heat when the air temperature is lower than the pool water surface temperature. The surface resistance to heat flow R_s (hr-ft^2-hr/btu) is affected by surface emittance, surface air velocity, and the surrounding air temperature.

***Surface Area Heat Loss - R_s (hr-ft^2-°f/btu)**

Still Air $T_s - T_a$ (°F)	R_s (hr-ft^2-°f/btu)	$U_s = 1/R_s$ = (btu/hr-ft^2-°f)
10	**0.53**	**1.89**
25	**0.52**	**1.92**
50	**0.50**	**2.0**
75	**0.48**	**2.17**
Wind Velocity (MPH)		
5	**0.35**	**2.86**
10	**0.30**	**3.33**
20	**0.24**	**4.17**

* Energy Management Handbook, 4th Edition, Turner, pg 444

The rate of heat loss is defined by $Q = U_s$ x A x ΔT where A = surface area (ft^2) of the pool and ΔT -= T_s surface water temperature of the pool °F and Ta = ambient air temperature or air inside the pool area °F.

Pool Covers Computations

Without Pool Cover - Q= (U) 1.89 x (A) 4125 sf x (ΔT) 10ºF = 77,962 btus/hr x 10 hrs /day x 365 = 284,561,300 btus/yr

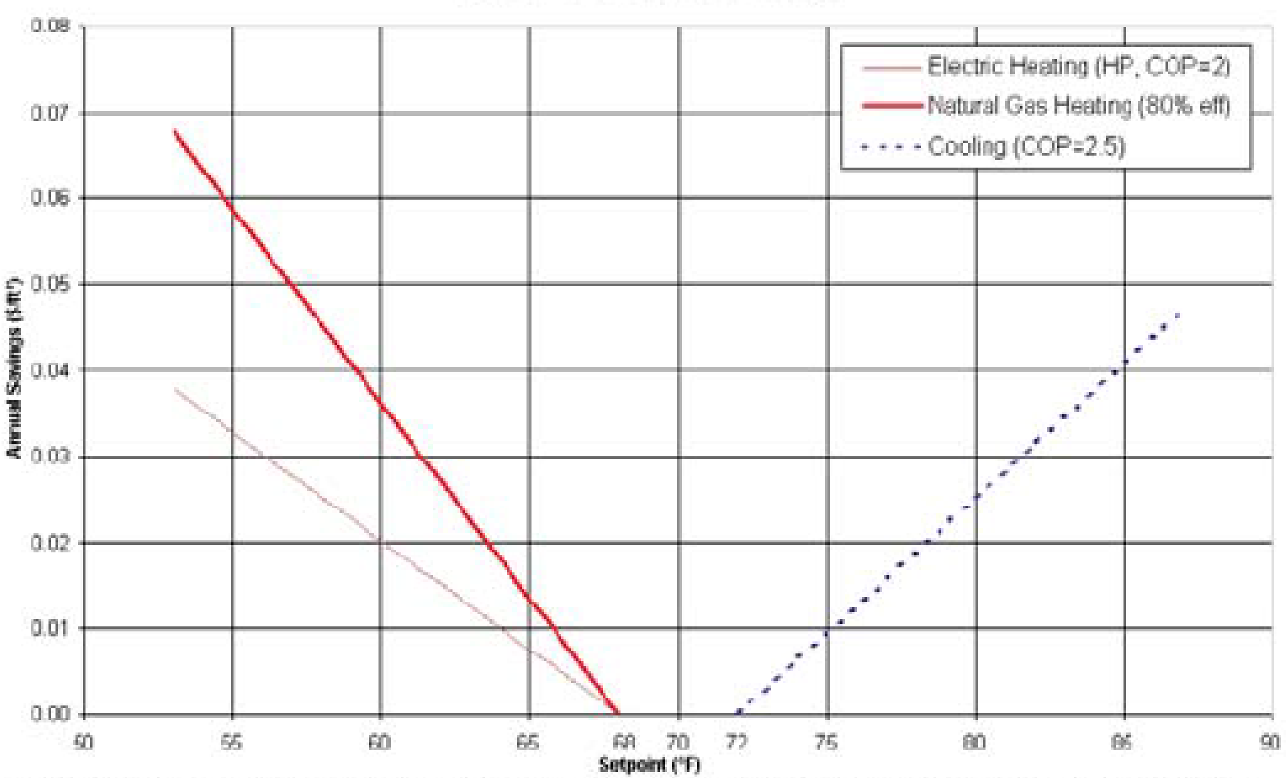
With Pool Cover - Q = 0.25 x 4125 x 10 = 10,313 btus/hr x 10 hrs/day x 365 days/yr = 37,640,625

Annual Energy Savings Pool Cover =284.6 - 37.6 = 247 mmbtus/yr

6) Summary Programmable Thermostat Applications

1) Basis - 3400 HDD, 1500 CDD , Avg. Summer Temp. 80ºF,
2) Avg. winter Temp. 40ºF, 12 hour setback per 24 hour day , weekend 48 hr setback, $0.06/kWh, $1.26/therm 2008 Prices
3) Winter - 4ºF Setback 68ºF to 64ºF $0.02/sf
4) Summer - 6ºF setforward 72ºF to 78ºF $0.02/sf
5) GLW - Library 52500 sf x $0.04/sf = $2100/$0.06/kWh = 35,000 kWh x 3412 btus/kwh = **119 .4 mmbtus**
6) GLW - Fitness 67000 sf x 0.04/sf = $2680/$0.06/kWh = 44,667 kWh x 3412 btus/kWh =**152.4 mmbtus**
7) GLW Total = 119.4 + 152.4 = **271.8 mmbtus**

Figure 1: Setback Savings



Assumptions: 12 hour setback period per day; NC climate averages: average winter temperature of 40°F, 3370 heating degree days, average summer temperature of 80°F, 1500 cooling degree days; occupied setpoints of 68°F for winter and 72°F for summer, $0.06/kWh; $1.26/therm

The estimated savings is based upon the square footage of the building and the parameters below. Simulation studies with physical building design data would provide additional arguments.

P Tstat Annual Savings Estimate According to Above Approach				
Buildings - Programmable Thermostats Applications	**Area SF**	**Annual Savings mmbtus**	**Total Annual Use mmbtus**	**Percent of Annual Use**
GLW-Fitness	67000	152.4	3574	4.26%
GLW-Library	52500	119.4	2285	5.23%
NC COOP Extension	7200	16.4	187	8.76%
Ceremonial & Exhibit	12600	28.7	745	3.85%
EBCI Finance	6390	14.5	943	1.54%
Council House	3890	8.8	203	4.36%
Total Pstats savings	149580	**340.2**	**7937**	4.29%
Annual Savings Btus/SF	**2275**			
Annual Savings % of Total	**4.29%**			

1) Basis - 3400 HDD, 1500 CDD , Avg. Summer Temp. 80°F,
2) Avg. winter Temp. 40°F, 12 hour setback per 24 hour day , weekend 48 hr setback, $0.06/kWh, $1.26/therm 2008 Prices
3) Winter - 4°F Setback 68°F to 64°F $0.02/sf
4) Summer - 6°F setforward 72°F to 78°F $0.02/sf
5) GLW - Library 52500 sf x $0.04/sf = $2100/$0.06/kWh = 35,000 kWh x 3412 btus/kwh = **119 .4 mmbtus**
6) GLW - Fitness 67000 sf x 0.04/sf = $2680/$0.06/kWh = 44,667 kWh x 3412 btus/kWh =**152.4 mmbtus**
7) GLW Total = 119.4 + 152.4 = **271.8 mmbtus**

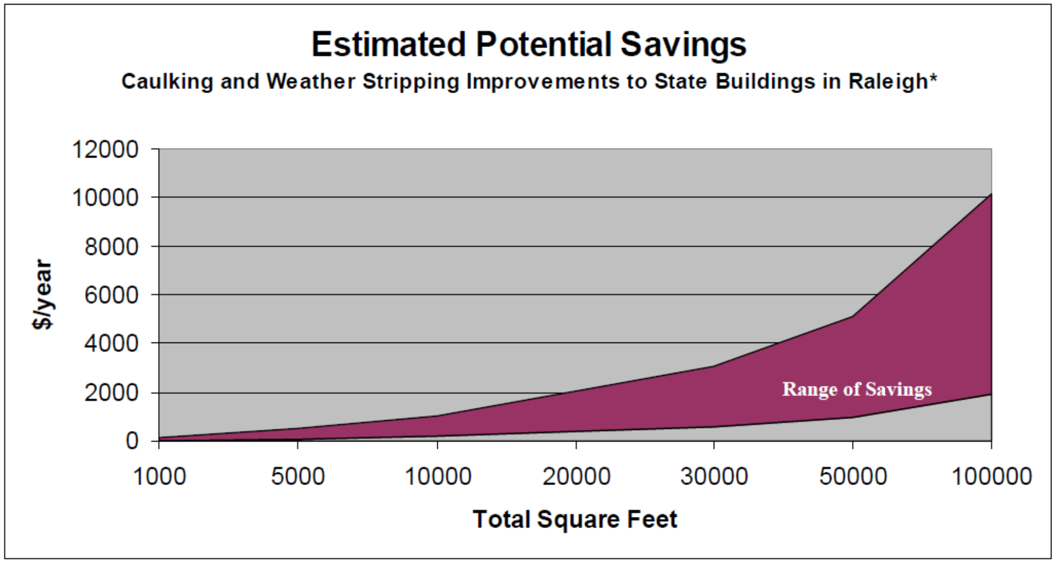
7) Summary Load Reduction Basis for Energy Efficient Windows

Month 2008	Days of the Month	Monthly Avg. Temp./24 hrs	Thermostat ºF	ΔT	Q single pane (Btu/hr)	Q Storm Window, (Btu/hr)	Dbl Pane Monthly Q Savings Btus	Slider Dbl Pane Monthly Q Savings Btus
Jan	31	**34.7**	**68**	33.3	10789	2697	6020374	1536062.4
Feb	28	**37.5**	**68**	30.5	9882	2471	4980528	1270752
Mar	31	**45**	**68**	23	7452	1863	4158216	1060944
Apr	30	**53.5**	**68**	14.5	4698	1175	2536920	647280
May	31	**61.2**	**76**	14.8	4795	1678	2318959	546155.52
Jun	30	**68**	**76**	8	2592	907	1213056	285696
Jul	31	**71.2**	**76**	4.8	1555	544	752095	177131.52
Aug	31	**70.7**	**76**	5.3	1717	601	830438	195582.72
Sep	30	**65.1**	**76**	10.9	3532	1236	1652789	389260.8
Oct	31	**54.6**	**68**	13.4	4342	1085	2422613	618115.2
Nov	30	**45.4**	**68**	22.6	7322	1831	3954096	1008864
Dec	31	**37.4**	**68**	30.6	9914	2479	5532235	1411516.8
Totals					68591	18567	36372318	9147360.96
	U Value, Winter	**U Value, Summer**				**Annual Savings mmbtus**	**36.37**	**9.15**
Single Pane	**1**	**1**						
Dbl Pane Low E-value	**0.25**	**0.35**						
Dbl Pane Slider	**0.50**	**0.60**						
	Window Area							
Window Area # 1 Dbl Pane	**324**	**Qualla A & Crafts**						
Window Area # 2 Dbl P Slider	**124**	**NCCOOP**						

8) Summary Load Reductions Insulation Applications

	Days of the Month	Monthly Avg. Temp.	Thermostat 70ºF	ΔT	Q R-6 Rock House (Btu/hr)	Q R-38, Rock House (Btu/hr)	Q Savings Total Btus Rock	Q R-6 Council House (Btu/hr)	Q R-38, Council House (Btu/hr)	Q Annual Savings Total Btu Council
Jan. 08	31	34.7	**68**	33.3	9282	1856	5524870	15484.5	3096.9	9216374.4
Feb	29	37.5	**68**	30.5	8502	1700	4733844	14182.5	2836.5	7896816
Mar	31	45	**68**	23	6411	1282	3815976	10695	2139	6365664
Apr	30	53.5	**68**	14.5	4042	808	2328120	6742.5	1348.5	3883680
May	31	61.2	**76**	14.8	4126	825	2455498	6882	1376.4	4096166.4
Jun	30	68	**76**	8	2230	446	1284480	3720	744	2142720
Jul	31	71.2	**76**	4.8	1338	268	796378	2232	446.4	1328486.4
Aug	31	70.7	**76**	5.3	1477	295	879334	2464.5	492.9	1466870.4
Sep	30	65.1	**76**	10.9	3038	608	1750104	5068.5	1013.7	2919456
Oct	31	54.6	**68**	13.4	3735	747	2223221	6231	1246.2	3708691.2
Nov	30	45.4	**68**	22.6	6300	1260	3628656	10509	2101.8	6053184
Dec	31	37.4	**68**	30.6	8530	1706	5076907	14229	2845.8	8469100.8
Totals					59011	11802	34497386	98440.5	19688.1	57547209.6
	R Value	**U Value**				**Annual $ Savings**	**$869.26**		**Annual $ Savings**	**$1,450.06**
Sheet Rock	R = 1				**Q R-6 IT/Finance (Btu/hr)**	**Q R-38, IT/Finance (Btu/hr)**	**Q Annual Savings Total Btu It/Finance**		**Annual mmbtus**	**57.5**
Half Inch Plywood	R = 1			Jan. 08	25266	5053	15038546	Kwh Savings Rock	10108	
Insulation Current	R = 6	**0.1250**		Feb	23142	4628	12885396	Kwh Savings Council	16861	
Insulation Compliant	R - 38	**0.0250**		Mar	17451	3490	10386984	Kwh Savings IT/Finance	27513	
				Apr	11002	2200	6337080	Total	**54482**	
	Area			May	11230	2246	6683798			
Rock House	2,230			Jun	6070	1214	3496320	Environmental Savings		
Council House	4,221			Jul	3642	728	2167718	SO_2	81 Lbs	
IT/Finance	6,390			Aug	4021	804	2393522	NOx	220 Lbs	
Total	12,841			Sep	8270	1654	4763736	CO_2	103,700 Lbs	
				Oct	10167	2033	6051547			
Installed Insulation Cost	$/SF = $2.00	Grant Cost	**Simple Payback**	Nov	17148	3430	9877104			
Rock House	$4,460	$2,230	**2.6**	Dec	23218	4644	13819205			
Council House	$8,442	$4,221	**2.9**	Totals	160627	32125	93900958			
IT/Finance	$12,780	$6,390	**2.7**			Annual $ Savings	**$2,366.10**			
Total Cost install	**$25,682**	**$12,841**				**Annual mmbtus**	**93.9**			
9" Loose Fill R-3.2/in										
Energy Savings	**80%**									
Total Savings	**$4,685**									

9) Summary Load Reductions Building Envelope - Sealing/Caulking



*The above estimates are based on a NIST study of air infiltration rates in two buildings using the actual total energy cost of $1.59/sf for state-owned facilities in Raleigh, NC.

Annual Energy Savings Allowance - Weather Stripping & Caulking Bldgs					
Building	**Area SF**	**Energy Cost $/sf**	**Adjusted Midrange Savings**	**$ to mmbtus Savings**	**Adjusted Savings/Total Cost**
GLW - Fitness*	67000	$1.19	$2,994	**127.7**	3.75%
NC COOP	7200	$1.29	$243	**10.4**	2.62%
Ceremonial**	12600	$1.48	$745	**31.8**	3.99%
Qualla A & C	6590	$1.56	$98	**4.2**	0.95%
Finance	6390	$3.03	$191	**8.1**	0.98%
Total or Avg.	99780	$1.71	$4,270	**182.1**	2.50%
Savings based upon $/kWH		**0.08**			

* 35 doors and windows were weather stripped and caulked
** Ceiling insulation seams were repaired, direct exposure to uninsulated roof

<u>Example of calculation basis</u>:
GLW Fitness - Midrange at building size of 67,000 sf = $4000 savings according to study, so at cost of GLW building rate would equate to $4,000 X ratio $1.19/$1.59 = $2,994 equated to kWh = $2,994/$0.08/kWh = 37,425 kWh or 37,425 x 3412 ÷1,000,000 btus/kWh = 127.7 mmbtus

10) Summary Load Reductions Plug Loads

Building	Vendor Machine Units	Total Watts	Annual kWh	Delamped Savings mmbtus	Single Sided Exit Signs Watts	Unit Number	Dual Sided Exit Signs Watts	Unit Number	Total Watts	Annual kWh	Delamped Savings mmbtus
Council House	2	240	2102.4	7.2	25	2	34	2	118	1034	**3.53**
Fire Station # 2	1	120	1051.2	3.6							
Finance	3	360	3153.6	10.8							
Qualla Arts & Crafts	2	240	2102.4	7.2							
Historical Bldg.	2	240	2102.4	7.2							
NC COOP	0	0	0	0.0							
Ceremonial	1	120	1051.2	3.6							
GLW - Library	6	720	6307.2	21.5							
GLW - Fitness	8	960	8409.6	28.7							
Hospital	0	0	0	0.0							
		Totals	26280	89.7							
Watts/Vending Lights	120										
Annual Hours	8760										

No Exit lights were upgraded for this part of the grant work

Ceremonial & Exhibit	
Outdoor Bag Ice Mechandizers	Units
	2
	Annual kWh
Load Reduction	2600
Annual Savings mmbtus	**17.7**
Removed from service	

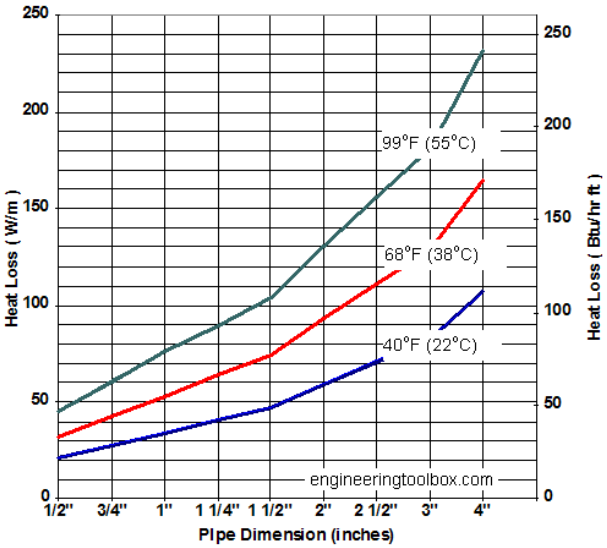
EPA suspended the ENERGY STAR Exit Sign specification effective May 1, 2008. In EPAct 2005, Congress passed a new minimum federal efficiency standard for electrically-powered, single-faced exit signs with integral light sources that are equivalent to ENERGY STAR levels for input power demand. EPAct 2005 references the ENERGY STAR Version 2.0 specification. **All exit signs manufactured on or after January 1, 2006 must have an input power demand of 5 watts or less per face.**

[Assumptions: Annual hours are 8760/yr Wattage per sign as below listed for each type in service
Single face per sign
Incandescent Wattage: 25 W [range per face 10 to 40W]
Fluorescent wattage: 17 W [range 9-25]
LED typical wattage 3
Reference
http://www.energystar.gov/index.cfm?c=exit_signs.pr_exit_signs]

11) Summary Load reductions Hot Water Line Insulation Applications

Uninsulated hot water line heat losses

Heat loss from *1/2" to 4"* copper pipes or tubes at various temperature differences between the pipe and the surrounding air, are indicated in the diagram and table below:



Nominal bore		Heat loss for the fluid inside pipe *(W/m)*			Heat loss for the fluid inside pipe *(Btu/hr ft)*		
		Temperature difference (°C)			Temperature difference (°F)		
(mm)	*(inches)*	22	38	55	60	68	99
15	1/2	21	32	45	22	34	47
22	**3/4**	28	43	60	29	**45**	64
28	1	34	53	76	36	56	79
35	1 1/4	41	64	89	43	67	93

The heat loss for a ¾" copper tubing/pipe is 45 btus/hr per linear foot of uninsulated pipe for a difference of 130 ºF water in the pipe and a 60ºF interior wall routing scheme to the use point in the building. Thus for every 100 feet of pipe there is 4500 btus/hr that are lost that must be made up at the energy source of the hot water heater to maintain temperature. That is equal to 4500 btus/hr x 8760 hrs/yr = 39,420,000 btus annually lost through the copper tubing wall for every 100 feet of pipe. This assumes that the pipe is hot, flowing full all the time; however, this is not always the case. Normally, hot water is only in the pipe when hot water is being used at the source. (Unless it has a recirculation pump system) **This is the reason that a continuous recirculation hot water system should always be insulated!** If we assume that hot water is being used at the use points in frequently then the heat loss would be less as the temperature decays in the pipe line. The frequency of use is dependent upon people having need a for hot water. Daily hours of hot water line elevated to temperature thru use :

Fire Station # 2 6 hours x 365days/yr = 2190 hrs/yr x 4500 buts/hr = 9.86
NC COOP - 2 hours x 260 = 520 hrs/yr x 4500 btus/hr = 2.34
Ceremonial - Bldg. infrequent use - 90 days/year @ 4 hours/day = 360 hrs/yr x 4500 btus/hr = 1.62
GLW - Library - 4 hrs/day x 260 days/yr = 1040 x 2 systems = 2080 hrs/yr x 4500 btus/hr = 9.36

Annual Savings Hot Water Line Insulation - Estimated Heat Losses Saved

Buildings	Service	Hrs/day	Days/yr	mmbtus/yr
Fire Station # 2	Showers	6	365	9.86
NC COOP	Lavatories	2	260	2.34
Ceremonial	Lavatories	4	90	1.62
GLW Library (2 systems)	Lavatories	4	260	9.36
Totals				23.18

Buildings	Elec. $/kWh
Fire Station # 2	0.0758
NC COOP	0.0884
Ceremonial	0.0813
GLW Library (2 system	0.0703

12) Hospital - Cog Belt Summary of Energy Reduction

Air Handling Units	Hp	Annual Cog Belt Savings kwh	Conversion to mmbtus 1 kWh = 3412 btus
# 1 Supply	20	2954	**10.1**
Return	10	1525	**5.2**
# 2 Supply	25	3659	**12.5**
Return	5	785	**2.7**
# 3 Supply	20	2954	**10.1**
Return	3	482	**1.6**
# 4 Supply	10	1525	**5.2**
Return	1.5	248	**0.8**
# 5 Supply	10	1525	**5.2**
Return	5	785	**2.7**
# 6 Supply	20	2954	**10.1**
Return	3	482	**1.6**
# 7 Supply	15	2264	**7.7**
Return	5	785	**2.7**
# 8 Supply	40	5796	**19.8**
Return	15	2264	**7.7**
Total	207.5	30984	**105.7**

To determine the kilowatt-hours saved when using synchronous or cog belt drives rather than conventional V-belt drives, the following formula is used:

KWh = (Motor HP)(Hrs/Yr)(.746)(.02) / Motor Efficiency

where constant 0.746 is the conversion factor from hp to KW, and 0.05 is the 5% energy savings gained by converting to synchronous belts (0.05) or **cog belts (0.02). Used Pre- EPACT motor Efficiency**

Size (hp)	Pre-EPAct[1]	EPAct[2]	NEMA Premium[4]
1.0	76.7	82.5	85.5
1.5	79.1	84.0	86.5
2.0	80.8	84.0	86.5
3.0	81.4	87.5	89.5
5.0	83.3	87.5	89.5
7.5	85.5	89.5	91.7
10.0	85.7	89.5	91.7
15.0	86.6	91.0	92.4
20.0	88.5	91.0	93.0
25.0	89.3	92.4	93.6
30.0	89.6	92.4	93.6
40.0	90.2	93.0	94.1
50.0	91.3	93.0	94.5
60.0	91.8	93.6	95.0
75.0	91.7	94.1	95.4
100.0	92.3	94.5	95.4
125.0	92.2	94.5	95.4
150.0	93.0	95.0	95.8
200.0	93.5	95.0	96.2

			Annual Cog Belt Savings kwh	**Conversion to mmbtus 1 kWh = 3412 btus**
Service Duty Hours	8760			
Service Duty Hours	1500			
Other Motors/Belts	**# of Units**	**Hp**		
HVAC Air Compressor	2	7.5	**2293**	**7.8**
Med. Air Compressor	2	7.5	**393**	**1.3**
Dental Air	1	4	**108**	**0.4**
Air Ventillation Draft	1	2	**324**	**1.1**
Chill/Hot Water Pumps	2	20	**5907**	**20.2**
Cooling Twr fan	1	15	**388**	**1.3**
Total this group			**9412**	**32.1**

13) Summary HVAC Replacements and Basis for Energy Savings

Existing York Split System	Replacement Carrier 38AQS018	Existing York Split System	Replacement Carrier 38ARQ008
2	2	1	1
15	15	7.5	7.5
6	9	6	10.4
2.2	3.1	2.2	3.2
920	920	920	920
2020	2020	2020	2020
76039	52,776	40554	26253
23,263		14301	
79.4			

Reference Calculator sitehttp://www1.eere.energy.gov/femp/technologies/eep_comm_heatpumps_calc.html#output

Existing Rheem Classic X Split System	Replacement AMMA Mdl ASZC16048ID
2	2
5	5
10	16
7	9.8
920	920
2020	2020
45674	26387
19287	
65.8	
Existing Rheem Classic X Split System	**Replacement AMMA Mdl ASZ13036IAD**
1	1
3	3
10	13
7	8
920	920
2020	2020
14168	9707
4461	
15.2	

Total HVAC Savings with Eff. Upgrades mmbtus
143.4

B. Buildings –

- **Building Profile - ECM's**
- **Total Annual Building Energy Consumption (mmbtus), Energy Benchmark (kbtus/sf), Energy Cost ($/sf)**

1) Council House

2) Finance Building

3) Fire Station # 2

4) Historical Association

5) North Carolina COOP

6) Ceremonial and Exhibit Building

7) GLW – Library Side

8) GLW – Fitness Side

9) Qualla Arts and Crafts

10) Cherokee Hospital

Eastern Band of Cherokee Indians — Council House

The EBCI Council House was built in the early 1950's and serves for tribal council business meetings and provides offices for administrative and executive functions of the Tribe. This 3,890 sq.ft. space is opened daily and often during periods of summer activities of the weekends. It is wired for closed circuit television broadcasting of tribal meetings thus providing a means for informing the tribal members of the business of council proceedings and general business activities. The building is somewhat paced for energy use by activities and schedules; however, operational and maintenance issues coupled with technology upgrades allowed significant energy reductions.

ECM 1 — Recommissioning: Ventilation tune-up, attic conditioned air distribution ducting was leaking, and separated at joints, and creating runtime issues with the HVAC equipment. Training was provided thru awareness to zone controls and influence. Programmable thermostats were installed for 3 building zones with training for settings. Policy for temperature settings winter and summer with setback/forward temperature values for 4 time periods and seven days f the week.

ECM 2 — Lighting: several hundred new, reduced wattage, low mercury, fluorescent lights with more efficient electronic ballast were installed through out the building. Two vending machines that had advertisement lighting were delamped from continuous use.

ECM 3 — Load Reductions: 4200 sq. ft of insulation was added to the building attic, providing a much needed tighter and more uniform insulating barrier below a conventional roof. This along with the recommissioning process of operational discovery provide significant reduction in daily heat losses in the winter and heat gains during the summer.

ECM 4— Fan Systems: HVAC included the replacement of older heat pump units with new higher efficiency units. The air handling units (AHU's) were upgraded with premium efficient motors and were programmed with thermostats to remain off for time periods when the building was unoccupied. With the tighter building envelope the run time and improved motor efficiency has shown significant results for energy use.

ECM 5— Heating and Cooling: existing HVAC equipment exceeded 15 years of operation. Additional cost for service repairs and expensive refrigerant losses over time justified on a life cycle basis the replacement of the older units. Extended use of the building beyond a normal work week schedule also promotes justifying economics.

Energy Policy— as result of a concerted effort to improve building performance of energy use, the Tribe has authorized the hiring of an Energy Coordinator for focusing on project needs, technologies, and having oversight to the ongoing evaluation of energy use within the Qualla Boundary of building properties. Protocols for area temperature setbacks, temperature guidelines for buildings occupied and unoccupied, and the approval of equipment selections based upon Energy Star ratings and certifications.

Communications— the local Tribal Newspaper has written several articles that promote the project activities and the expectations for energy savings from the application of new technologies and focused attention to the current benchmarks of energy use with in the tribal buildings.

Renewable Energy— efforts are now underway for determining best fit, locations, size, rebates, contract terms, cost, and financing opportunities for photovoltaic cell applications within the Qualla Boundary. Southern exposed roof lines, structural integrity, and influence of early and late mountain shadows are being studied for applications on several buildings.

Facility Type: Multi-Use Office and Public Assembly

Total Floorspace: 3,890 sf

Year Constructed:

Energy Intensity: 53 kbtus/sf-yr

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1— Recommissioning

- Air balance
- Maintenance Practices
- Zone Controls/ Programmable Thermostats
- Energy Policy

ECM 2— Lighting

- **Fluorescents**
  - Electronic Ballasts
  - Linear T8, 28 watt

ECM 3— Load Reductions

- Upgrade Attic Insulation
- Caulking and sealing windows and doors

ECM 4 — Fan Systems

- Premium Efficiency Motors

ECM 5— Heating and Cooling

- High Efficiency, Split Systems Replacements

ECM 6 - Other Considerations

- Low Flow Water Fixtures
- Energy Coordinator responsibility
- Renewable energy focused on applications

ANNUAL ENERGY CONSUMPTION
Council House

MONTH	YEAR	ELECTRICITY		LP GAS		
		CONSUMPTION	COST	CONSUMPTION	COST	
	2008	KWH	$	Gallons	$	
JANUARY		6510	495			
FEBRUARY		4890	372			
MARCH		4660	354			
APRIL		4640	381			
MAY		3640	319			
JUNE		5200	393			
JULY		5320	403			
AUGUST		5800	435			
SEPTEMBER		5040	406			
OCTOBER		3760	287			
NOVEMBER		4840	368			
DECEMBER		5170	393			
TOTAL		59470	$4606			
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	59470	X	3,413 BTU/KWH =		202.9	MILLION BTU'S
LP GAS	0	X	91,600 BTU/gal =			MILLION BTU'S
			TOTAL ENERGY USE =		202.9	mm BTU'S
TOTAL ENERGY INDEX MILLION KBTU/SQ. FT.					52	KBTUs/SQ.FT.
TOTAL COST INDEX = $4606/3890SQ. FT.				=	1.18	$/SQ. FT.

Eastern Band of Cherokee Indians — Finance Building

The Finance Building is a single story, vinyl sided building providing conditioned space for specialty equipment - IT Data Servers, Closed Circuit Television Equipment Transmission, and Security Systems, in addition to providing offices for financial transactions of the Tribe. It was built in the early 19??'s . Technology and building updates include: lighting replacements, higher efficiency HVAC equipment, building envelope caulking/ sealing repairs and additional insulating barrier in the building attic area.

ECM 1 — Recommissioning: several penetrations of building exterior walls were caulked and sealed. Ceiling insulation voids were created through the years as placement of additional routing wire ways for additions in security systems and large computer server systems. R-38 insulation was added to 70% of the building attic ceiling area for a uniform insulation barrier. Existing heat pumps are now being controlled by programmable thermostats according to building zoning temperatures, occupancy schedules and seasonal climate changes. These programmable thermostats were installed and set according to Energy Policy requirements for occupied and unoccupied times during winter and summer climate conditions.

ECM 2 — Lighting: several hundred new, reduced wattage, low mercury, fluorescent lights with more efficient electronic ballast were installed through out the building. The lower lighting power density along with delamping of commercial vending equipment provided 25% of the reduced energy usage for the building.

ECM 3 — Load Reductions: building walls and attic roof penetrations were caulked and sealed for a tighter building envelope. A much needed and difficult task of adding insulation to achieve a R-38 value was undertaken. Controlled use of personal plug-in equipment added to the overall load reduction of the building.

ECM 4— Fan Systems: existing air handling units were programmed with thermostats to remain off for time periods when the building was unoccupied. Centralized temperature management responsibility was defined for the building.

ECM 5— Heating and Cooling: the building heating and air conditioning is supplied by existing heat pumps and additional new ones that are rated at higher efficiency values with less expensive refrigerants in service. Diminishing annual run times of supply fan and refrigerant compressor will show energy savings. This is the case after recommissioning and programmable occupancy times and temperatures are established uniformly across perimeter and core building sections. Filter change outs and preventive maintenance schedules were revisited to compare with best practices of similar equipment and locations.

ECM 6— Energy Policy— as result of a concerted effort to improve building performance of energy use, the Tribe has authorized the hiring of an Energy Coordinator for focusing on project needs, technologies, and having oversight to the ongoing evaluation of energy use within the Qualla Boundary of building properties. Protocols for area temperature setbacks, temperature guidelines for buildings occupied and unoccupied, and the approval of equipment selections based upon Energy Star ratings and certifications.

Facility Type: Multi-Use — Offices, Specialty Equipment

Total Floorspace: 6,390 sf

Year Constructed: ????

Energy Intensity: 148 kbtus/sf-yr (large computer server area)

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1— Recommissioning
- Building repairs
- Programmable Thermostats
- Temperature Protocols

ECM 2— Lighting
- Fluorescents
  - Electronic Ballasts
  - Linear T8, 28 watt
- Delamping vendor equipment

ECM 3— Load Reductions
- Caulking and sealing building penetrations
- R-38 Insulation in attic
- Reduced wattage lighting
- Controlled personal use equipment

ECM 4 — Fan Systems
- Controlled/reduced run activity
- New more efficient heat pump

ECM 5 — Heating and Cooling
- New higher efficient heat pumps
- Recommissioning
- Maintenance schedules
- Reduced run times when unoccupied
- Defined setpoint temperatures —perimeter and core

ECM 6—Energy Policy
- Coordinator

ANNUAL ENERGY CONSUMPTION
Finance Building

MONTH	YEAR	ELECTRICITY		LP GAS		
		CONSUMPTION	COST	CONSUMPTION	COST	
	2009	KWH	$	Gallons	$	
JANUARY		28263	1994			
FEBRUARY		25363	1854			
MARCH		23163	1726			
APRIL	2008	212243	1532			
MAY		19163	1316			
JUNE		22123	1473			
JULY		23643	1551			
AUGUST		23043	1520			
SEPTEMBER		22123	1571			
OCTOBER		19203	1415			
NOVEMBER		21923	1606			
DECEMBER		27043	1832			
TOTAL		276,296	19390			
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	276,296	X	3,413 BTU/KWH =		942.9	MILLION BTU'S
LP GAS	0	X	91,600 BTU/gal =			MILLION BTU'S
			TOTAL ENERGY USE =		942.9	Mm BTU'S
TOTAL ENERGY INDEX MILLION KBTU/SQ. FT.					148	KBTUs/SQ.FT.
TOTAL COST INDEX = $19390/6390SQ. FT.				=	3.03	$/SQ. FT.

Eastern Band of Cherokee Indians — Fire Station # 2

Fire Station No. 2 is a three bay, two story, metal frame building providing conditioned space for fire trucks and specialty fire fighting equipment. It houses the largest ladder truck of the Tribe that serves the high profile buildings of the Casino. The station is occupied 24/7/365. Additionally, cooking, living, and sleeping quarters are available for four on-call firemen. Technology and building updates include: high-bay, intensive energy lighting replacements, occupancy sensors, programmable thermostats, and insulation applications for uninsulated hot water lines.

ECM 1 — Recommissioning: Existing heat pumps are now being controlled by programmable thermostats according to building zoning temperatures, occupancy schedules and seasonal climate changes. These programmable thermostats were installed and set according to Energy Policy requirements for occupied and unoccupied times during winter and summer climate conditions.

ECM 2 — Lighting: several hundred new, reduced wattage, low mercury, fluorescent lights with more efficient electronic ballast were installed through out the building. Hi-bay lighting was metal halides fixtures that required significant warm-up time for adequate lumens output. As a result these fixtures remained on most days and every night to be prepared for incoming fire response calls. These were replaced with 4-lamp T8 fluorescent fixtures and occupancy sensors for each fixture to come on when passing in a zone area of fixture lighting influence. Four metal halide fixtures were removed from service in the front of the building near the window area of the roll up doors.

ECM 3 — Load Reductions: in addition to over a hundred fluorescent lamps, most significant was the removal of 400 watt metal halides that remained on most days and nights. Replacement of all metal halides with 4 lamp fluorescent fixtures with occupancy sensor was a significant load reduction as well. Insulation was added to hot water lines that were piped through both floors of the building. Controlled use of personal plug-in equipment added to the overall load reduction of the building.

ECM 4— Fan Systems: existing air handling units were programmed with thermostats to remain off for time periods when the building was in the sleep mode of operation. Centralized temperature management responsibility was defined for the building.

ECM 5— Heating and Cooling: Diminishing annual run times of supply fan and refrigerant compressor will show energy savings. This is the case after recommissioning and programmable occupancy times and temperatures are established uniformly across perimeter and core building sections. Filter change outs and preventive maintenance schedules were revisited to compare with best practices of similar equipment and locations.

ECM 6 — Energy Policy— as result of a concerted effort to improve building performance of energy use, the Tribe has authorized the hiring of an Energy Coordinator for focusing on project needs, technologies, and having oversight to the ongoing evaluation of energy use within the Qualla Boundary of building properties. Protocols for area temperature setbacks, temperature guidelines for buildings occupied and unoccupied, and the approval of equipment selections based upon Energy Star ratings and certifications.

Facility Type: Fire Truck Garage, Firemen Resident Occupancy

Total Floorspace: 5,280 sf

Year Constructed: 2002

Energy Intensity: 45 kbtus/sf-yr

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1— Recommissioning

- Programmable Thermostats
- Temperature Protocols

ECM 2— Lighting

- Fluorescents
  - Electronic Ballasts
  - Linear T8, 28 and 32 watt
- Hi-Bay T8, HO with zone occupancy sensors for each light fixture
- Delamping vendor equipment

ECM 3— Load Reductions

- Removed (4) 400 watt MH's
- Reduced lighting wattage
- Eliminated metal halide continuous bay lighting
- Occupancy sensor driven

ECM 4 — Fan Systems

- Controlled/reduced run activity

ECM 5 — Heating and Cooling

- Recommissioning
- Maintenance schedules
- Defined setpoint temperatures —perimeter and core

ECM 6—Energy Policy

- Coordinator listed building

ANNUAL ENERGY CONSUMPTION
Fire Station # 2

MONTH	YEAR	ELECTRICITY		LP GAS		
		CONSUMPTION	COST	CONSUMPTION	COST	
	2008	KWH	$	Gallons	$	
JANUARY		6011	444	275	592.23	
FEBRUARY		4296	327	49.9	112.05	
MARCH		4384	336	99	225.06	
APRIL		4841	355	0		
MAY		3852	291	0		
JUNE		4106	306	0		
JULY		4092	305	0		
AUGUST		4098	298	0		
SEPTEMBER		3546	305	0		
OCTOBER		4200	301	0		
NOVEMBER		4224	337	95.5	179.87	
DECEMBER		4646	359	100	186.47	
TOTAL		52296	3964	620	1295.68	
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	52296	X	3,413 BTU/KWH =		178.5	MILLION BTU'S
LP GAS	620	X	91,600 BTU/gal =		56.7	MILLION BTU'S
			TOTAL ENERGY USE =		235.2	MM BTU'S
TOTAL ENERGY INDEX MILLION KBTU/5,280SQ. FT.					45	KBTUs/SQ.FT.
TOTAL COST INDEX = $5260/5280SQ. FT.				=	1.00	$/SQ. FT.

Eastern Band of Cherokee Indians — Cherokee Historical Association Building

The Cherokee Historical Association Building is a three story, metal frame and shell building serving multi-uses—business office, drama rehearsal office, and ticket office for *"Unto These Hills"* presentations during the summer. It was built in the mid 1980's with annual occupancy hours of about 2080 hours/yr. Assessment of energy users revealed HVAC units that were manufactured in 1985 with ventilation requiring control and maintenance attention. A through recommissioning was performed with several Energy Conservation Measures enacted.

ECM 1 — Recommissioning: Programmable thermostats, and replacement of 25 year old HVAC equipment provided higher efficient operation at controlled conditions of temperature during occupancy and unoccupied times of the seasons. Air handling units had maintenance issues with damper positions and operational reliability. Established maintenance policy awareness with upgrades in HVAC technologies and applications have defined new levels of reliability and energy efficiencies.

ECM 2 — Lighting: new, reduced wattage, low mercury, fluorescent lights with more efficient electronic ballast were installed through out the building. Occupancy sensor located in mail room areas where past experience had defined periods of forgetting to turn off lights after work hours and long periods of room being unoccupied. Public access lobby area of fine art work that was down lit with incandescent recessed lighting and halogen accent lighting was replaced with LED fixtures.

ECM 3 — Load Reductions: The recommissioning process identified ventilation shortfalls and needs for repairing air distribution ductwork and the need for replacement of 25 year old HVAC equipment. Fluorescent lighting was reduced in wattage for a lower power density (LPD). Additional incandescent and high out put halogen lights were replaced with LED's. Replacement of HVAC equipment and ventilation eliminated any need for personal heaters or fans for comfort.

ECM 4— Fan Systems: the new more efficient air handling units were programmed with thermostats to remain off for time periods when the building was unoccupied. Coupled with the higher efficient motors the air handling units provided reduced horsepower air distribution. Operational features of prior design functionality with existing building features were reviewed for compatibility with new HVAC equipment.

ECM 5— Heating and Cooling: the building heating and air conditioning system was 25 years old and was in much need of replacing with high efficient units. Coupled with higher efficiency equipment new programmed temperature controls that were set according to occupancy schedules. Maintenance schedules and awareness to expectations of care were emphasized to subcontracted responsibilities.

Communications— good energy saving practices often are founded in the awareness to operating equipment conditions. Deviations from the norm are expressed by personal comfort devices (heaters, fans, dehumidifiers) being used to provide the disconnect between personal comfort and building operational policy for temperature control, and subsequent energy savings. Equipment that is not working properly requires inquiry and response to comfort issues that can be the results of neglect or absence of the " squeaking wheel" approach to correction. Energy saving operational practices require awareness to maintenance issues that can benefit energy conservation measures. Structured policy is formed to make time based intervals of reporting operating conditions as a mandate.

Facility Type: Offices, Actor rehearsal offices, Ticket sales

Total Floorspace: 6,720 sf

Year Constructed: 1984

Energy Intensity: 80 kbtus/sf-yr

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1— Recommissioning
- Energy Audit/Policy
- Air Balance/Repairs
- Programmable Thermostats
- Building envelope sealing/caulking

ECM 2— Lighting
- Fluorescents
  - Electronic Ballasts
  - Linear T8, 28 watt
- Occupancy Sensors
- LED Accent Lighting

ECM 3— Load Reductions
- Modifications/Repairs ventilation system
- Removal of personal heaters/fans
- Lower wattage lighting
- Low flow water fixtures

ECM 4 — Fan Systems
- Controlled/reduced run time for unoccupied times
- New AHU's premium motors

ECM 5 — Heating and Cooling
- Recommissioning
- Higher HVAC equipment SEER, COP ratings
- Run time controlled when unoccupied
- Energy Policy defined temperatures and setbacks

ANNUAL ENERGY CONSUMPTION
Historical Association Building

MONTH	YEAR	ELECTRICITY		LP GAS		
		CONSUMPTION	COST	CONSUMPTION	COST	
		KWH	$	gallons	$	
JANUARY						
FEBRUARY						
MARCH						
APRIL						
MAY						
JUNE						
JULY						
AUGUST						
SEPTEMBER						
OCTOBER						
NOVEMBER						
DECEMBER						
TOTAL		139,372	11,986	700	2,195	
Estimated from cost		@$0.086/kwh		@$3.14/gal		
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	139,372	X	3413 BTU/KWH =		475,676,636	MILLION BTU'S
LP GAS	700	X	91,600 BTU/gal =		64,120,000	MILLION BTU'S
			TOTAL ENERGY USE =		540	MILLION BTU'S
TOTAL ENERGY INDEX MILLION BTU/SQ. FT.					80.3	KBTU/SQ.FT.
TOTAL COST INDEX = $14181/6720 SQ. FT.				=	2.11	$/SQ. FT.

Eastern Band of Cherokee Indians — North Carolina Cooperative Building

The North Carolina COOP Building is a single story, metal frame and shell building serving as an administrative office and provides educational presentation classrooms for community involvement in agricultural enterprises. It was built in the early 19??'s The annual hours of occupancy is about 2080 hours/yr. Building renovations were being made prior to the energy assessment; however, the assessment provided direction to energy saving enhancements for the planned acceptance of the new tenants—NC COOP personnel.

ECM 1 — Recommissioning: the building envelope had several leakage points and several duct seam separations that required repairs with weather stripping and caulking implemented for closure of building leak points at doors and windows. Programmable thermostats, with movement of thermostat site locations, and replacement of 25 year old HVAC equipment provided higher efficient operation at controlled conditions of temperature during occupancy and unoccupied times of the seasons. Air handling units had maintenance issues with drive components and service reliability.

ECM 2 — Lighting: new, reduced wattage, low mercury, fluorescent lights with more efficient electronic ballast were installed through out the building. Occupancy sensors were located in storage areas where past experience had defined periods of forgetting to turn off lights after community events. Delamping of corridor fixtures to reasonable levels of lighting for the intended purpose were implemented throughout the building.

ECM 3 — Load Reductions: The recommissioning process identified ventilation shortfalls and needs for repairing air distribution ductwork and the need for replacement of 25 year old HVAC equipment. The building insulation was repaired in many locations for a tighter and sealed insulation envelope. Fluorescent lighting was reduced in wattage for a lower power density (LPD). Heat losses from long runs of uninsulated hot water lines were fixed by new insulated pipe wraps. New double pane, low-e windows were installed for reducing heat losses in the winter and solar heat gain for the hotter temperatures and radiant energy in the summer months. The hot water lines from the hot water heater were exposed to the temperatures of the pipe routing locations which often times are not in insulated areas of the building.

ECM 4— Fan Systems: the new more efficient air handling units were programmed with thermostats to remain off for time periods when the building was unoccupied. Coupled with the higher efficient motors the air handling units provided reduced horsepower air distribution. Existing duct work was repaired at seams and distribution drops for a tighter network of conditioned air distribution.

ECM 5— Heating and Cooling: the building heating and air conditioning system was 25 years old and was in much need of replacing with high efficient units. Condenser coils were in need of a quality combing for damage from hail and vandals. Coupled with higher efficiency equipment new programmed temperature controls that were set according to occupancy schedules. Control strategy for large classroom educational schedules with isolation of service duty of HVAC equipment based upon schedule was developed.

Facility Type: Offices, Educational Demonstration Classrooms

Total Floorspace: 7,200 sf

Year Constructed: ????

Energy Intensity: 40.7 kbtus/sf-yr

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1— Recommissioning
- Air Balance/Repairs
- Programmable Thermostats
- Building envelope sealing/ caulking

ECM 2— Lighting
- Fluorescents
  - Electronic Ballasts
  - Linear T8, 28 watt
- Occupancy Sensors
- Delamping hallway fixtures

ECM 3— Load Reductions
- Modifications/Repairs ventilation system
- Lower wattage lighting
- Double pane windows
- Insulated HW lines
- Corridor lighting delamping
- Low flow water fixtures

ECM 4 — Fan Systems
- Controlled/reduced run time between activities
- New AHU's premium motors

ECM 5 — Heating and Cooling
- Recommissioning
- Higher EER, COP rating
- Run time controlled when unoccupied
- Energy Policy

ANNUAL ENERGY CONSUMPTION
NC COOP Extension Building

MONTH	YEAR	ELECTRICITY		Natural GAS		
		CONSUMPTION	COST	CONSUMPTION	COST	
		KWH	$	therms	$	
APRIL 2008	2008	5893	$505			
March	2008	5774	$534			
February	2008	9712	$765			
January	2008	6550	$554			
December	2007	5508	$514			
November	2007	3043	$289			
October	2007	3794	$341			
September	2007	4716	$401			
August	2007	3879	$355			
July	2007	4096	$368			
June	2007	3298	$322			
May	2007	3130	$305			
TOTAL		59,393	$5,253			
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	59,393	X	3413 BTU/KWH	=	203	MILLION BTU'S
NATURAL GAS	0	X	100,000 BTU/THERM	=		MILLION BTU'S
			TOTAL ENERGY USE	=	203	MILLION BTU'S
TOTAL ENERGY INDEX 203 MILLION BTU/SQ. FT.					40.7	kBTU/SQ.FT.
TOTAL COST INDEX = $5,253/4,896 SQ. FT.				=	$1.07	/SQ. FT.

Eastern Band of Cherokee Indians — Ceremonial and Exhibit Building

The Ceremonial and Exhibit Building is a single story, metal frame and shell building serving as a large assembly area for community activities and prescheduled events. It includes several individual offices and serves as a coordinating center for local vendors and sales of tribal food items during scheduled planned activities of the tourist seasons. It was built in the early 1980's with a single expansive area of 10,000 sf for exhibit booths and ceremonial activities. The annual hours of occupancy varies with different event schedules each year; however, several offices have individual PTAC units for conditioned spaces. Major renovations in HVAC replaced 25 year old commercial heat pump units that were past their operational prime. A lifecycle basis over the next 15 years of the replacement units provided a good basis for making a transition a much higher level of operating efficiency.

ECM 1 — Recommissioning: a main assembly room conditioned air distribution duct was upgraded to a centralized "sock " headed with better joints and fewer leakage points. The new air header for conditioned air was balanced for more uniform distribution of air over an expansive exhibit area allowing closer tolerance of temperatures via programmable thermostats on a seasonal basis. Private office PTAC's were sealed at building wall penetrations for a tighter, leak resistant fit. This allowed the building to be dominant during unscheduled activity periods and provided office personnel to be comfortable with specific equipment sized for their areas of occupancy.

ECM 2 — Lighting: new, reduced wattage, low mercury, fluorescent lights with more efficient electronic ballast were installed through out the building. Occupancy sensors were located in storage areas where past experience had defined periods of forgetting to turn off lights after community events. Vendor provided drink machine advertisement lighting was turned off. Fluorescents and metal halides both are used in the large exhibit area. Metal halides remain off except when specific programs require additional lighting beyond fluorescent lumen output. A limited number of fluorescent fixtures remain on doing the day just for moving around within the building for cleaning after events and activities.

ECM 3 — Load Reductions: The recommissioning process identified ventilation shortfalls and needs for replacement of central duct work with the purchase of higher efficient HVAC equipment. The roof insulation was repaired in many locations for a tight and sealed insulation envelope. Large ice merchandizing ice storage units were removed from the building. Fluorescent lighting was reduced in wattage for a lower power density (LPD). Heat losses from long runs of uninsulated hot water lines were fixed by new insulated pipe wraps.

ECM 4— Fan Systems: the new more efficient air handling units were programmed with thermostats to remain off for time periods when the building was unoccupied and for long periods of time between scheduled events. Additionally, the trunk line was resized for less losses and more straight line path way for conditioned air distribution. Coupled with the higher efficient motors the air handling units provided reduced horsepower air distribution.

ECM 5— Heating and Cooling: the building heating and air conditioning system was 25 years old and was in much need of replacing with high efficient units. Coupled with programmed temperature controls that were set according to event schedules on a weekly basis a much higher and more efficient HVAC system was installed for greater energy savings with less cost for refrigerant stock piling of R-22 when in need. Private office PTAC with individual controls allowed the separation of the larger HVAC units from running with a limited office heating and cooling load.

Facility Type: Multi-Use — Public Assembly, Community Functions

Total Floorspace: 12,600 sf

Year Constructed: ????

Energy Intensity: 59 kbtus/sf-yr

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1— Recommissioning
- Roof insulation seam sealing
- Air Balance/Repairs
- Programmable Thermostats
- Distribution Header Replacement

ECM 2— Lighting
- Fluorescents
  - Electronic Ballasts
  - Linear T8, 28 watt
- Occupancy Sensors
  - storage areas

ECM 3— Load Reductions
- Roof Insulation sealing
- Modifications/Repairs ventilation system
- Lower wattage lighting
- Vendor plug load removals
- Insulated HW lines

ECM 4 — Fan Systems
- Controlled/reduced run time between activities
- New AHU's premium motors
- Revised air distribution with larger trunk line and less line losses

ECM 5 — Heating and Cooling
- Recommissioning
- Higher EER, COP rating
- Run time controlled when unoccupied
- Set Temperatures — perimeter and core

ANNUAL ENERGY CONSUMPTION
Ceremonial and Exhibit Building

MONTH	YEAR	ELECTRICITY		LP GAS		
		CONSUMPTION	COST	CONSUMPTION	COST	
	2008	KWH	$	Gallons	$	
JANUARY		27742	2,262			
FEBRUARY		16005	1,305			
MARCH		17649	1,439	200	555	
APRIL		13200	927			
MAY		12600	947	255	707	
JUNE		14400	1,024			
JULY		14,800	2,061			
AUGUST		11760	819			
SEPTEMBER		8400	706	551	1894	
OCTOBER		11480	902			
NOVEMBER		20400	1,518			
DECEMBER		22760	1,625			
TOTAL		191,196	15,535	1006	3156	$3.14/gal
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	191,196	X	3,413 BTU/KWH	=	652,551,948	MILLION BTU'S
LP GAS	1006	X	91,600 BTU/gal	=	92,149,600	MILLION BTU'S
			TOTAL ENERGY USE	=	744.7	MMBTU'S
TOTAL ENERGY INDEX MILLION KBTU/SQ. FT.					59	KBTUs/SQ.FT.
TOTAL COST INDEX = $18,691/12,600 SQ. FT.				=	1.48	$/SQ. FT.

Eastern Band of Cherokee Indians — Ginger Lynn Welch Building

The Ginger Lynn Welch Building is a single story, brick veneer building serving as a major hub of Tribal business and activities. It includes several businesses and individual offices, a large library, an indoor fitness and health center with walking track and swimming pool. It was built in the early 1990's with renovations in 2004. The total building is separated by an interior partitioned wall dividing the Library and office side from the Fitness side with each side being metered for energy usage. The Library side has an annual schedule of 2250 hours of occupancy while the fitness side has an annual occupancy of 3900 hours. Common energy performance upgrading including lighting, HVAC control enhancements, and building envelope entrance and egress tightening.

ECM 1 — Recommissioning: conditioned air distribution ducting was upgraded in several locations with better joints and fewer leakage points. The DX roof top units were upgraded to be controlled by programmable thermostats according to building zoning temperatures, occupancy schedules and seasonal climate changes. These thirty programmable thermostats were installed and set according to Energy Policy requirements for occupied and unoccupied times during winter and summer climate conditions.

ECM 2 — Lighting: thousands of new, reduced wattage, low mercury, fluorescent lights with more efficient electronic ballast were installed through out the building. Over 100 occupancy sensors with dual level circuits provided offices, break rooms, conference rooms, assembly rooms, and restrooms with two levels of lighting. Upon room entry, those rooms that had windows with natural daylighting, were set to come on at the lowest level of lighting with manual override to high level if needed. A full court gymnasium was upgraded to sensor controlled high bay T-5 fluorescent fixtures along with T-5 fluorescents in the swimming pool area of the Fitness Center. Lower wattage T-8 fluorescents coupled with occupancy sensors reduced the lighting power density significantly. Security lighting of the building perimeter was replaced with LED fixtures and numerous vending machines were voided of advertisement lighting as well.

ECM 3 — Load Reductions: twenty eight doors were caulked and sealed with the addition of new floor sweeps for a tighter building envelope at entrance and egress locations. The recommissioning process identified ventilation shortfalls and needs for sealing of central duct work failures. Personal use of office plug in items were not allowed by Energy policy unless specific approval was granted by exception.

Renewable Energy — a roof mounted, solar array of flat plate thermal collectors was installed to provide 60% of the water heating requirement of the indoor swimming pool. Additionally, an insulated pool cover was used to retain the captured sun heat during extended times of non pool use.

ECM 4— Fan Systems: the roof mounted air handling units were programmed with thermostats to remain off for time periods when the building was unoccupied. Additionally, the mounting support tray for some RTU's were insufficiently sealed and required further repairs for tight mounting elevated deck seal.

ECM 5— Heating and Cooling: the building heating and air conditioning is supplied by twenty eight roof top units that have an EER rating of 9.1 to 13.1, depending upon rated tons. Smaller units (less than 5 tons) have SEER ratings of 14 or better. Diminishing annual run times of supply fan and refrigerant compressor will show energy savings. This is the case after recommissioning and programmable occupancy times and temperatures are established uniformly across perimeter and core building sections. Filter change outs and preventive maintenance schedules were revisited to compare with best practices of similar equipment and locations.

Facility Type: Multi-Use — Offices, Library, Fitness Center, and Public Assembly

Total Floorspace: Library—52,500 sf, Fitness—67,000 sf

Year Constructed: ????

Energy Intensity: Library Side—44 kbtus/sf-yr, Fitness Side— 53 kbtus/sf-yr

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1— Recommissioning
- Air Balance/Repairs
- Programmable Thermostats
- Energy Policy

ECM 2— Lighting
- Fluorescents
  - Electronic Ballasts
  - Linear T8, 28 watt
  - T5 HO eco 54watt
- Occupancy Sensors
  - dual level/default low wattage levels
  - gymnasium , offices, restrooms, assembly

ECM 3— Load Reductions
- Caulking and sealing doors
- Modifications/Repairs ducting ventilation
- Solar heated pool
- Lower wattage lighting
- Personal plug-ins removals

ECM 4 — Fan Systems
- Controlled/reduced run activity
- Sealed RTU's support

ECM 5 — Heating and Cooling
- Recommissioning
- Maintenance schedules
- Run time unoccupied
- Set Temperatures — perimeter and core

ANNUAL ENERGY CONSUMPTION
GLW Library Side

MONTH	YEAR	ELECTRICITY		LP GAS		
	2007/8	CONSUMPTION	COST	CONSUMPTION	COST	
		KWH	$	N/A		
OCTOBER 2007		56640	3678			
NOVEMBER		46400	3192			
DECEMBER		49640	3326			
JANUARY 2008		55040	3932			
FEBRUARY		91440	6436			
MARCH		58040	4078			
APRIL		43600	2858			
MAY		43580	3340			
JUNE		58560	4105			
JULY		57480	4049			
AUGUST		53440	3850			
SEPTEMBER		55600	4234			
TOTAL		669460	47078			
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	669460	X	3413 BTU/KWH	=	2284.8	MILLION BTU'S
LP GAS		X				MILLION BTU'S
			TOTAL ENERGY USE	=	2284.8	MILLION BTU'S
TOTAL ENERGY INDEX MILLION BTU/52500SQ. FT.					44	KBTU/SQ.FT.
TOTAL COST INDEX = $47078/ 52500SQ. FT.				=	0.90	$/SQ. FT.

ANNUAL ENERGY CONSUMPTION
GLW Fitness Side

MONTH	YEAR	ELECTRICITY		LP GAS		
		CONSUMPTION	COST	CONSUMPTION	COST	
	2008	KWH	$	gallons	$	
JANUARY		78320	5102			
FEBRUARY		115920	7532			
MARCH		72160	4707			
APRIL		63160	4513			
MAY		56000	4131			
JUNE		71180	4365			
JULY		69100	4124			
AUGUST		71280	4994			
SEPTEMBER		20320	1373			
OCTOBER		56000	4131			
NOVEMBER		95680	6494			
DECEMBER		90480	6229			
		859600	57695	6987@$3.14/gal	21938	
TOTAL						
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	859600	X	3413 BTU/KWH	=	2934	MILLION BTU'S
LP GAS	6987	X	91,600 BTU/gallon	=	640	MILLION BTU'S
			TOTAL ENERGY USE	=	3574	MILLION BTU'S
TOTAL ENERGY INDEX MILLION BTU/67000SQ. FT.					53	BTU/SQ.FT.
TOTAL COST INDEX = $79633/67000SQ. FT.				=	1.19	$/SQ. FT.

Eastern Band of Cherokee Indians — Qualla Arts and Crafts Building

The Qualla Arts and Crafts Building serves the general public with native American arts and crafts produced primarily by residents of the Eastern Band of Cherokee Indians. This retail store has significant glass wall areas which lends to daylight illumination on many sunny days. Technologies and building updates have been implemented, including: single pane full wall windows were changed to double pane with better insulating properties and better utilization of light transmittance. Lighting changes included: more efficient lighting fixtures with a reduction in building lighting power density (watts/sf) with conversion to higher efficacy electronic ballast fixtures, and occupancy sensors for infrequent use areas, with accent lighting changed to LED floods and spots. Programmable thermostats were installed for seasonal temperature control according to occupied building schedules. Resolution of some maintenance issues for scheduling and awareness to seasonal operating conditions requiring further attention.

ECM 1 — Recommissioning: provided an overview of temperature protocols, operational status of HVAC equipment , and maintenance issues that needed to be addressed for peak performance. Focused attention on EPA energy star benchmarks for retail businesses with histories of upgrades and successes that would provide a broad range of energy saving opportunities.

ECM 2 — Lighting: reduced wattage, low mercury, linear fluorescent lights with more efficient electronic ballast were installed through out the building. Craft accent lighting was changed to LED spots and floods. Daylighting influence awareness through lighting foot candle measurements were demonstrated for a practical guide to maintain show room illumance and conservation. Occupancy sensors have been applied to merchandise storage areas that are infrequently visited.

ECM 3 — Load Reductions: reduced wattage lighting fixtures, daylighting, HID accent lighting replaced with LED spots and floods. Occupancy sensors insured that lighting was kept off when rooms were not in use. Replacement of door seals and caulking of leakage points were initiated for all ingress/egress locations for the building. The addition of aerators and low flow restroom fixtures for reducing water usage and hot water heating for a high volume public loading.

ECM 4— Fan Systems: programmed run schedules based upon temperature, time of day, and ventilation requirements for occupancy, seasonal climate settings, and default settings. Attic ventilation fan reset for temperature control during hotter summer months. Upgraded air handling fan motor with higher SEER rated heat pumps purchased.

ECM 5— Heating and Cooling: upgraded older heat pumps and air handling units with higher efficient equipment that are controlled by programmable thermostats. Filter change outs and preventive maintenance schedules were revisited to compare with best practices of similar equipment and locations. Seasonal temperature protocols and occupancy schedules were established by Energy Coordinator.

ECM 6 — Energy Policy: as result of a concerted effort to improve building performance of energy use, the Tribe has authorized the coordination of all energy related activities, technologies, and oversight to the ongoing evaluation of energy use within the Qualla Boundary of building properties to the newly hired Energy Coordinator. Equipment selections based upon energy performance ratings and temperature protocols for operation, maintenance schedules for peak performance and ventilation for indoor air quality and comfort. ASHRAE standards are reviewed with contractors for specifying HVAC related equipment.

Facility Type: Retail Business

Total Floorspace: 6,600 sf

Year Constructed: 1960

Energy Intensity: 72.3 kbtus/sf-yr

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1 — Recommissioning

- Better Control Utilization
- Maintenance Issues
- Temperature Protocols
- Attic fan automation

ECM 2 — Lighting

- Linear Fluorescents
  - Electronic Ballasts
  - T8, 25, 28, and 32 watt
- LED accent lighting
- Daylighting
- Occupancy sensors

ECM 3 — Load Reductions

- Reduced lighting wattage
- Occupancy sensor control when rooms are unoccupied
- Door seals and caulking
- Attic fan control

ECM 4 — Fan Systems

- Delayed start schedule

ECM 5 — Heating and Cooling

- Recommissioning
- Maintenance schedules
- Higher SEER/EER heat pump
- Programmable thermostats
- Defined setpoint temperatures — perimeter and core

ECM 6 — Energy Policy

- EPA benchmarks for focusing on retail business energy saving areas
- Coordinated Energy Conservation Program
- ASHRAE Standards and Best Practices

ANNUAL ENERGY CONSUMPTION

Qualla Arts and Crafts

MONTH	YEAR	ELECTRICITY		Natural GAS		
		CONSUMPTION	COST	CONSUMPTION	COST	
		KWH	$	therms	$	
JANUARY	2007	14,960	1103			
FEBRUARY	2007	17,640	1296			
MARCH	2007	8120	658			
APRIL	2007	8040	605			
MAY	2007	7840	587			
JUNE	2007	11,720	858			
JULY	2007	13,080	947			
AUGUST	2007	14,960	1037			
SEPTEMBER	2007	11,760	844			
OCTOBER	2007	9400	689			
NOVEMBER	2007	9920	754			
DECEMBER	2007	12,000	920			
TOTAL		**139,440**	**$10,298**			
	FUEL TOTALS		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	139,440	X	3413 BTU/KWH	=	476	MILLION BTU'S
NATURAL GAS	0	X	100,000 BTU/THERM	=		MILLION BTU'S
			TOTAL ENERGY USE	=	**476**	**MILLION BTU'S**
TOTAL ENERGY INDEX 476 MILLION BTU/6592SQ. FT.					**72,209**	**BTU/SQ.FT.**
TOTAL COST INDEX = $10,298/6592SQ. FT.				=	**1.56**	**/SQ. FT**.

Eastern Band of Cherokee Indians — Hospital Building

The Cherokee Hospital Building serves the Qualla-Boundary of the Eastern Band of Cherokee Indians and is centrally located in the 82 square mile Qualla Boundary Region of Western North Carolina. The hospital continues to seek energy saving enhancements and water conservation practices that are funded internally by tribal funds and recently awarded grants. Through these funding resources new technologies and building updates have been implemented, including: better utilization of fuel options for boiler controls, building envelope tightening, a reduction in lighting power density, improvements in running efficiency for belt driven equipment, a continuation of occupancy sensor applications, motion sensed hand washing stations, and an on-going replacement of outside parking and building security lighting with LED fixtures.

ECM 1 — Recommissioning: HVAC fresh air damper controls and maintenance issues with control systems for regulation of perimeter and zone temperatures were resolved. Hot water boiler combustion efficiency for generation of VAV reheat hot water and hospital hot water were improved by dual fuel burner selections with broader range of burner management with oxygen trim regulation. Focused attention on energy benchmarks for hospitals and DOE hospital case histories of upgrades and successes proved a broad range of energy saving opportunities.

ECM 2 — Lighting: reduced wattage, low mercury, linear fluorescent lights with more efficient electronic ballast were installed through out the building. This interior lighting improvement program has evolved over 24 months of steady in-house replacements but continues to move into other areas such as exterior LED lighting fixtures for metered parking, security and walkway and loading dock recessed lighting areas as well. Occupancy sensors have been applied to offices, restrooms, conference rooms, and maintenance areas that are infrequent use.

ECM 3 — Load Reductions: in addition to the replacement of over a thousand fluorescent lamps of reduced wattage, there were 60 rooms where occupancy sensors insured that lighting was kept off when not in use. Replacement of door seals and caulking of leakage points were initiated for all ingress/egress locations for the building. The conservation of water through the use of 27 motion sensor actuated "on-off" water fixtures and the addition of aerators and low flow shower fixtures for water usage has reduced hot water heating loading for the hospital.

ECM 4— Fan Systems: several hundred v-belt driven primary movers were refitted with cog belts. Recommissioning of central control systems for damper failures and dysfunctional operation has beneficial energy saving consequences as well.

ECM 5— Heating and Cooling: Diminishing annual run times of supply fan and refrigerant compressor will show energy savings. This is the case after recommissioning and programmable occupancy times and temperatures are established uniformly across perimeter and core building sections. Filter change outs and preventive maintenance schedules were revisited to compare with best practices of similar equipment and locations.

ECM 6 — Energy Policy: the hospital has independent management of engineering project activities; however, as result of a concerted effort to improve building performance of energy use, the Tribe has authorized the coordination of all energy related activities, technologies, and oversight to the ongoing evaluation of energy use within the Qualla Boundary of building properties to the newly hired Energy Coordinator. Protocols for area temperature setbacks, temperature guidelines for buildings occupied and unoccupied, and the approval of equipment selections based upon Energy Star ratings and certifications. ASHRAE standards are reviewed with contractors for specifying HVAC related equipment.

Facility Type: General Medical and Surgical Hospital

Total Floorspace: 77,170 sf

Year Constructed: 1980

Energy Intensity: 230 kbtus/sf-yr

Contract Type: Cost Share

Financing Type: Internal Capital

Technologies Used:

ECM 1 — Recommissioning
- Better Control Utilization
- Maintenance Issues
- Temperature Protocols
- Dual Burner Management

ECM 2 — Lighting
- Linear Fluorescents
  - Electronic Ballasts
  - T8, 25, 28, and 32 watt
- Delamping vendor equipment

ECM 3 — Load Reductions
- Reduced lighting wattage
- Occupancy sensor control when rooms are unoccupied
- Hot water conservation
- Door seals and caulking

ECM 4 — Fan Systems
- V-Belt replacements with cog belting

ECM 5 — Heating and Cooling
- Recommissioning
- Maintenance schedules
- Defined setpoint temperatures — perimeter and core

ECM 6 — Energy Policy
- DOE Case History focus of hospital energy saving areas and opportunities to participate
- Coordinated Energy Conservation Program
- ASHRAE Standards and Best Practices

ANNUAL ENERGY CONSUMPTION
Cherokee Hospital

MONTH	ELECTRICITY		Fuel Oil		LP Gas	
	CONSUMPTION	COST	CONSUMPTION	COST	Consumption	Cost
2008	KWH	$	Gallons	$	Gallons	$
JANUARY	230160	13402				
FEBRUARY	187200	11275				
MARCH	213840	12580				
APRIL	257760	12714				
MAY	244080	14158				
JUNE	252980	14621				
JULY	277440	15900				
AUGUST	267600	15375				
SEPTEMBER	285120	17492				
OCTOBER	241920	15256				
NOVEMBER	200160	12983				
DECEMBER	238568	14655				
TOTAL	2,896,828	**170,412**	**56,703**	**132,918**	**275**	**886**
	Energy Totals		CONVERSION TO BTU EQUIVALENTS			
ELECTRICITY	2,896,828	X	3,413 BTU/KWH	=	9887	MILLION BTU'S
LP GAS	275	X	91,600 BTU/gal	=	25	MILLION BTU'S
Fuel Oil	56,703	X	138,500 BTU/gal	=	7853	MILLION BTUS
			TOTAL ENERGY USE	=	**17,765**	**MM BTU'S**
TOTAL ENERGY INDEX MILLION KBTU/77,170SQ. FT.					**230**	**KBTUs/SQ.FT.**
TOTAL COST INDEX = $304,215/77,170 SQ. FT.				=	**3.94**	**$/SQ. FT**.