Stockbridge-Munsee Health & Wellness Center & Family Center

Renewable Energy Feasibility Study.

Stockbridge-Munsee
Tribal Overview

- A Band of Mohican Indians
- From the Algonquin language group of Tribes.

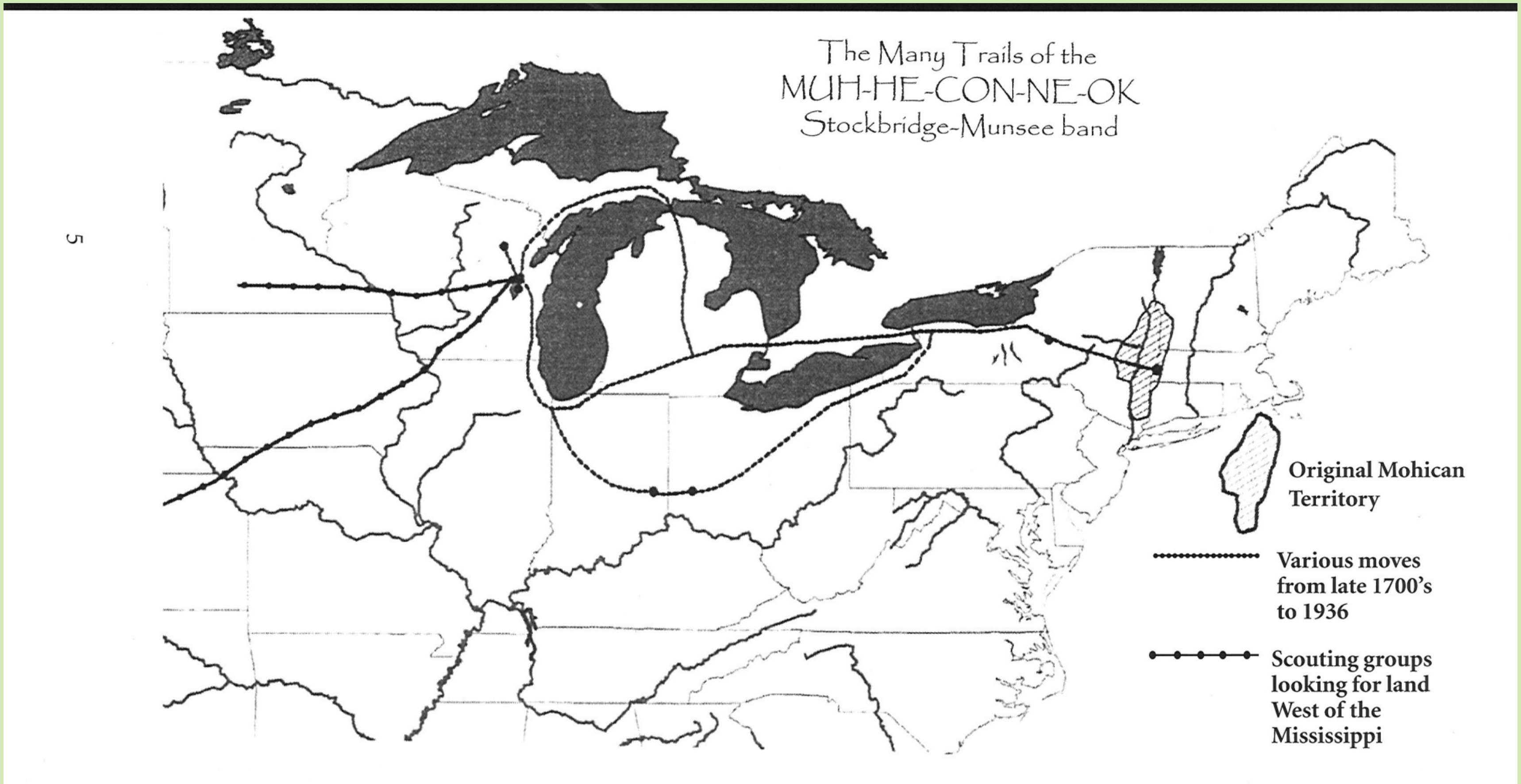
Papscanee Village Site

Painting follows archeological reports & accurately depicts pre European village.

Tribal History

- The tribe lived along the Muh-he-con-ne-ok River, “where the waters are never still”. (now the Hudson River)
- The Stockbridge name came from the town of Stockbridge in the Housatonic Valley of Massachusetts.
- The Munsee Delaware, another Algonquin-speaking band, joined the westward movement of the Stockbridge Mohicans.

Many Trails to Present Day Location



Continuing Traditions

Water & Forestry Resources

Wildlife Resources – Bear Study

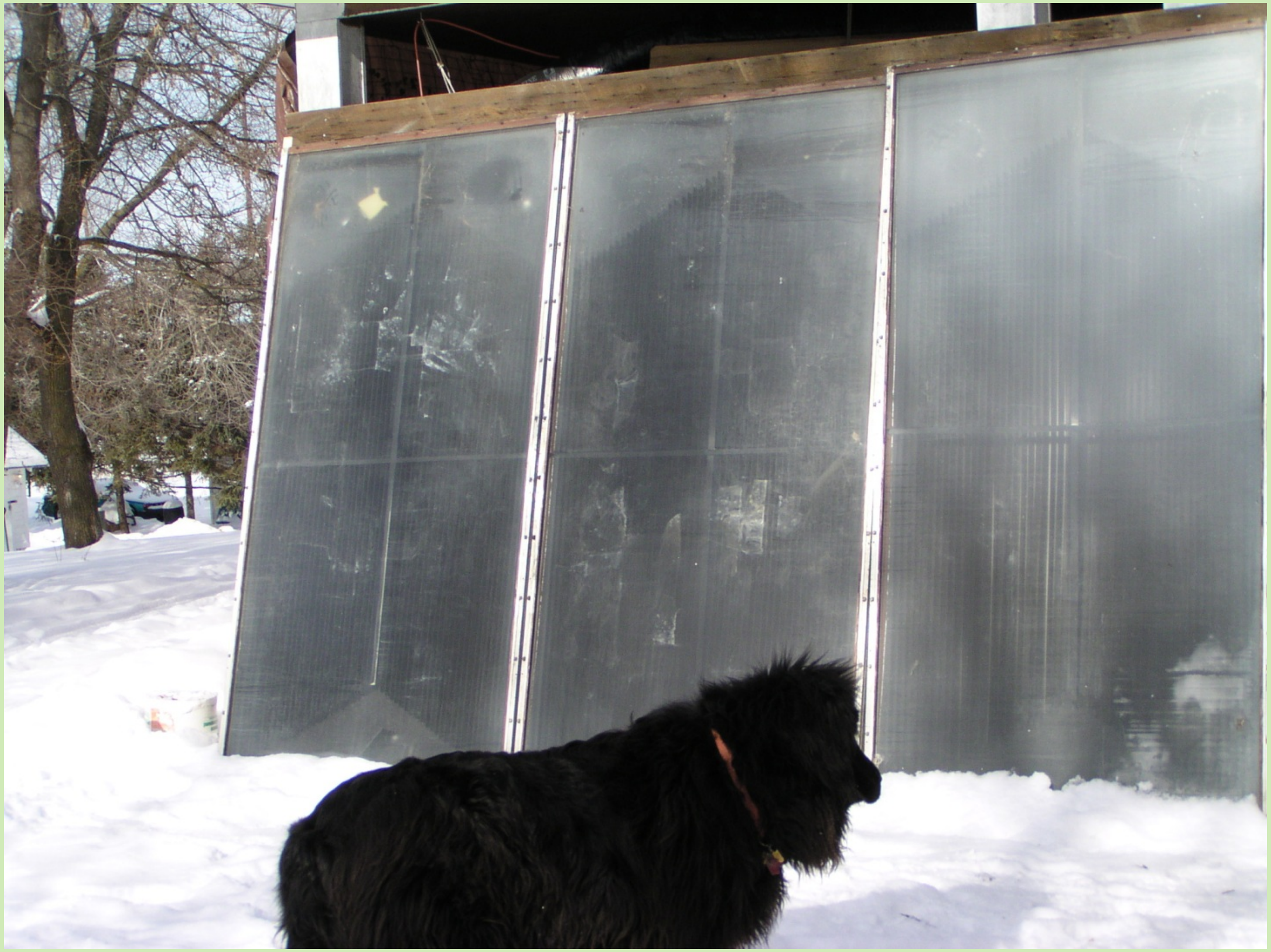
Cultural Symbols

Various Views of Alternative Energy

- Some view on-grid electric as “modern” and only reliable energy.
- Hardships of not having electric and ready supply of fuel still within memory of elders.
- Difficulty in accepting end of fossil-fuel age when many remember horse & buggy, firewood heating & finally getting electricity.

Alternative Energy Beginnings

Solar Heating



Solar DHW on Tribal Apartments.

Project Objectives:

Study feasibility of installing the following energies to provide 30% of the needs for the Health &Wellness Center (HWC) & the Mohican Family Center

- Photovoltaic power for electrical needs.
- Heat pump for heating & cooling.
- Solar thermal for space heating or hot water.
- Wood fiber biomass for heating.

Stockbridge-Munsee
Health & Wellness Center

Main Entrance of the Health & Wellness Center.

Air View of the Health & Wellness Center.

Mohican Family Center

Main Entrance of Family Center

Gym in Family Center

Progress

- A request for proposals (RFP) was drafted using the grant objectives as the work statement.
- The tribe accepted a proposal from Sustainable Engineering Group LLC of Madison WI.
- The HWC site visit was on January 22-23, 2013.
- The final study for the HWC completed 10-17-2013.
- Grant extensions, amendments & approvals; contract negotiations, approvals, & signing, add family center.
- The family center site visit was on January 17, 2014.
- Draft of the family center study delivered 3-3-2014

Results of the Study to Date.

- The HWC is a good building, but improvements are needed.

(January 21, 2013 outdoor temp was 0^{o} F to -15^{o} F)

Before Adding Renewable Energy, Make it Energy Efficient!

The buildings energy performance measured by EPA ENERGY STAR Portfolio Manager®.

- ✓ The HWC rated poorly, earning an 8/100.
- ✓ The Family Center was very good, earning an 80/100. (>75% = ENERGY STAR rating)

Some of the difference can be attributed to different assumptions & building types, & 50% of the family center is not air conditioned.

Measuring Energy Consumption: Source vs Site Energy

The EPA's definition is:

- Source energy is a measure that accounts for the energy consumed on site in addition to the energy consumed during generation and transmission in supplying the energy to your site.
- Site energy is the amount of energy measured at the point of consumption – i.e. what is on the utility bill.

Life Cycle Assessments of Energy Technologies

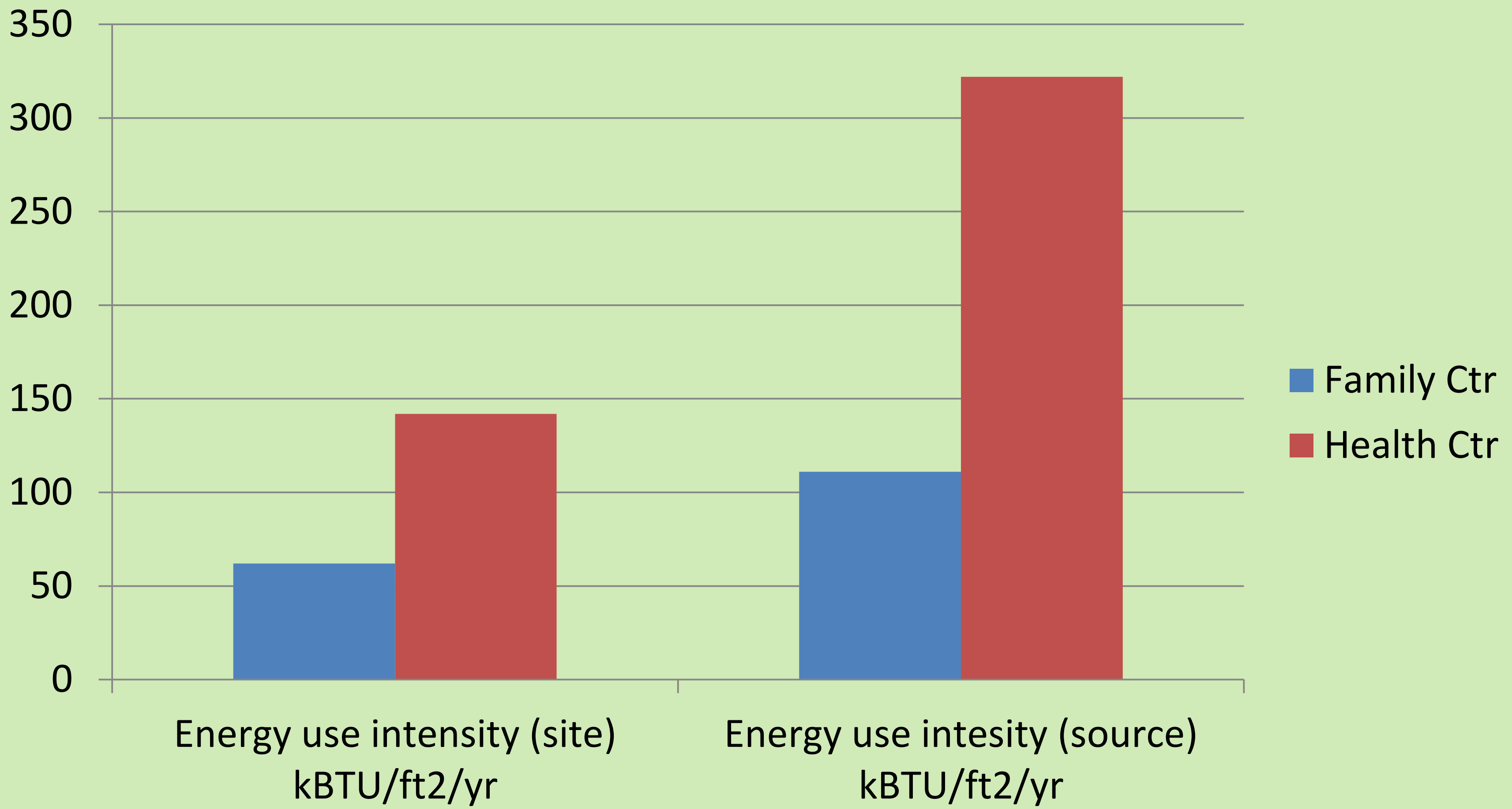
- Life cycle assessment is a standardized technique that tracks all material, energy, and pollutant flows of a system—from raw material extraction, manufacturing, transport, and construction to operation and end-of-life disposal. Life cycle assessment can help determine environmental burdens from "cradle to grave" and facilitate comparisons of energy technologies. http://www.nrel.gov/analysis/sustain_lca_about.html

EPA Recommends Using Source Energy When Evaluating Buildings.

EPA has determined that *source energy* is the most equitable unit of evaluation. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses.

Building Energy Usage.

In kBTUs per square foot per year



Buildings Energy Metrics

Metric	Result
Energy Star Score – HWC	8 of 100
Energy Star Score – Family Center	80 of 100
Cost per square foot - HWC	$\$3.56/ft^2/yr$
Cost per square foot – Family Center	$\$1.61/ft^2/yr$
Energy Use Intensity (site) - HWC	142 $kBTU/ft^2/yr$
Energy Use Intensity (site) – Family Center	$62/kBTU/ft^2/yr$
Energy Use Intensity (source) - HWC	$322/kBTU/ft^2/yr$
Energy Use Intensity (source) – Family Center	$111/kBTU/ft^2/yr$
Total Annual Cost – HWC	$107,000
Total Annual Cost – Family Center	$24,000

Energy Conservation Measures (ECMs)
To Increase Building Efficiency.

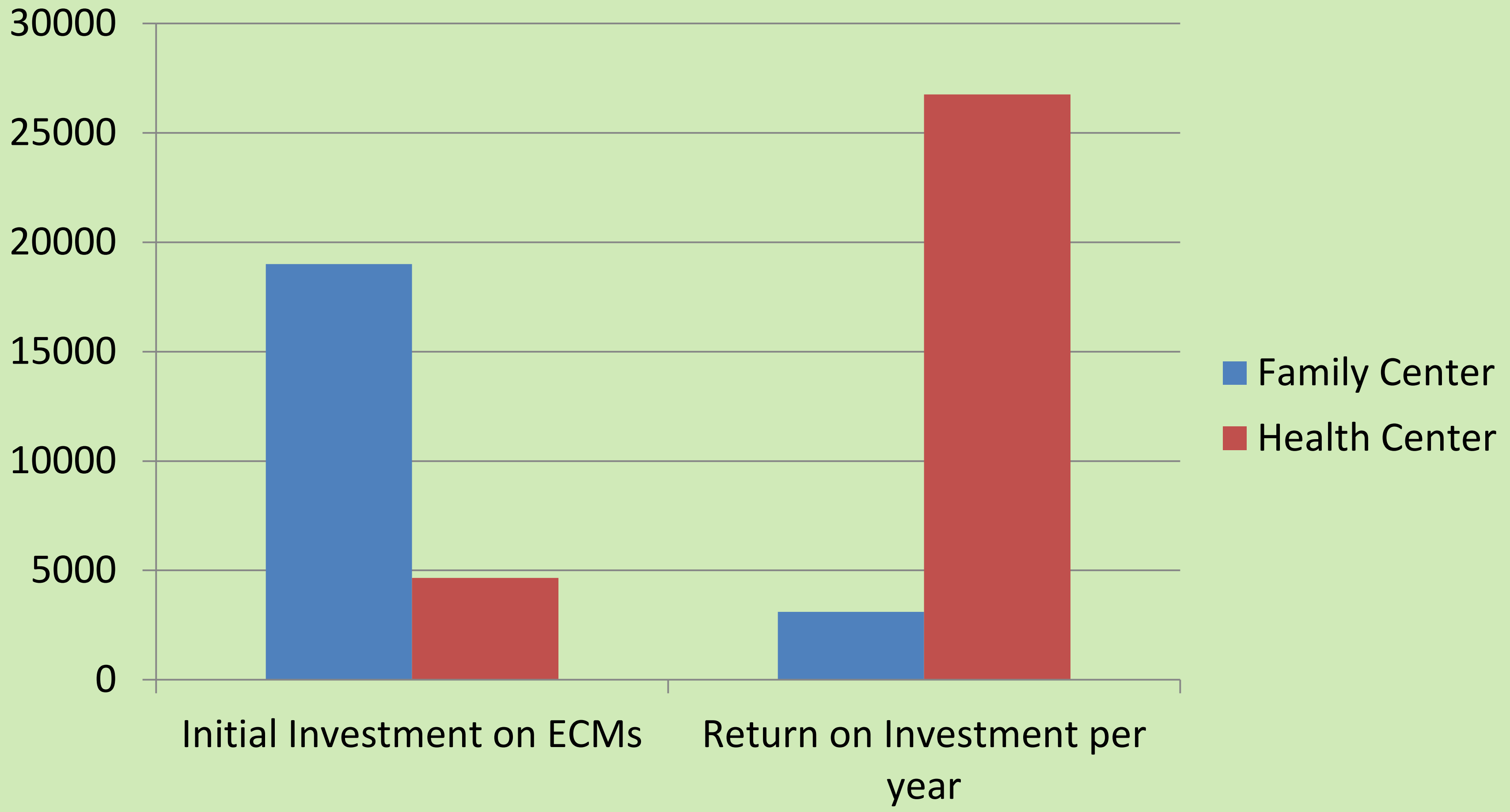
- There are 14 - ECMs for the HWC that have an estimated cost of $4,650, a return on investment (ROI) from 0.2 to 5 years. The energy savings would be approximately 25% a year or $26,762.

Some of these are as simple as matching the ventilation schedule to the occupancy schedule.

Energy Conservations Measures

- The ECMs recommended for the family center involve an estimated cost of $19,000, with a ROI of about 6 years. This would be approximately13% energy savings, or about $3,100/year.

Return on Investments per Year



Alternative Energy Sized to Meet 30% to 100% of Buildings Needs

- To reduce the required size and enhance the economic feasibility of the proposed renewable energy systems, the total site energy loads are based on the predicted amount of energy needed after the ECMs are implemented.
- Current total – ECM savings = future need.

Renewable Energy Technologies

The following renewable energy sources were considered to provide power for the buildings.

1. Photovoltaic power for electrical needs.
2. Solar thermal for space heating or hot water.
3. Heat pump for heating & cooling.
4. Wood fiber biomass for heating.

Photovoltaic.

A roof structure prime for PV panels.

30% of the Electric Need Would Require the Addition of Ground Array.

Pictured below is the HWC with good potential for ground mounted PV systems nearby.

Estimated production, costs & economics of a 240-kW PV system

Production	
PV system's rated module capacity	240 kW (DC)
Estimated system output	295,200 kWh/yr
Estimated system output (site energy)	1,007,000 kBTU/yr
Percentage of total building's energy	33 %
Costs & Economics	
Installed cost	$ 1,000,000
Incentives	$ 100,000
Final cost after possible incentives	$ 900,000
ROI, 25-yr average	0.0 %
Simple payback period	25 yrs
Environmental Impact	
CO2 emission reduction	192 tons/yr

Solar Thermal

1. Solar thermal for space heating. The building is not a good application for winter space heating due to the roof orientation and the heating load, which is small compared to the cooling load. The ROI would be "through the roof".
2. Solar thermal for water heating. The relatively small domestic hot water load of the building would be well served by a thermal system.

Aerial view of HWC

Showing roof area for possible solar water heating.

Estimated Production, Costs & Economics of Solar Thermal.

Production	
Solar thermal system's size	64 ft2 / 80 gallons
Estimated propane offset	110 gallons/yr
Estimated propane offset (site energy)	10,000 kBTU/yr
Percentage of total building's energy	0.3 %
Cost and Economics	
Installed cost	\$ 12,000
Incentives	\$ 0
Final cost after possible incentives	\$ 12,000
ROI, 25-yr average	0.0 %
Simple payback period	25 yrs
Environmental Impact	
CO2 emission reduction:	1 ton/yr

Geothermal

Current & Proposed System

- Currently the HWC has water-source heat pumps.
- Conversion to ground-source heat pumps needed.
- 40 boreholes, 300’ deep would be to be drilled.
- Existing cooling towers & boilers would be removed.
- Ventilation heat pump added to the system.
- Pipe insulated to conserve energy & prevent condensation which leads to mold, etc.
- Additional electric costs with proposed system.

Estimated Production, Costs & Economics of Geothermal Heating & Cooling.

Production	
Geothermal system’s size	40 bores, 300 ft deep
Estimated propane offset	14,500 gallons/yr
Estimated electricity increase	100,000 kWh/yr
Estimated total site energy offset	1,000,000 kBTU/yr
Percentage of total building’s energy	30 %
Cost and Economics	
Installed cost	$ 240,000
Incentives	$ 30,000
Final cost after possible incentives	$ 210,000
ROI, 25-yr average	17 %
Simple payback period	10 yrs
Environmental Impact	
CO2 emission reduction	34 ton/yr

Biomass Energy Systems

- Two types considered:
  1. Wood pellet system.
  2. Wood chip system.
- In this study, both of these are paired with a typical gasification wood boiler.

A Wealth of Forestry Resources.

Wood Pellets vs Wood Chips.

1. Pellets are denser & have greater energy per unit of volume.
2. Pellets would require far less storage space.
3. Due to irregular size the wood chips are more difficult to process as a fuel.
4. Wood chips require more robust handling equipment & a different, more expensive, combustion chamber.

An Example of Wood Chips.

Size and shape differ requiring machine handling equipment, such as augers, to be constructed very robust, therefore more expensive.

An Example of Wood Pellets.

Pellets are uniform and dense, providing more heat per square foot & ease of handling = less expensive.

Considerations for Community Produced Wood Products.

- Do we use logging residuals or full logs which would take money from logging sales.
- Gathering the material would be expensive.
- What type and what volume of wood fuel would we produce?

Chipping or densification (pellets) facilities are very expensive, & to be economical, we would need to heat about 100 buildings, therefore for this study we assume the purchase of fuel.

Estimated Production, Costs & Economics of Wood Fired Energy

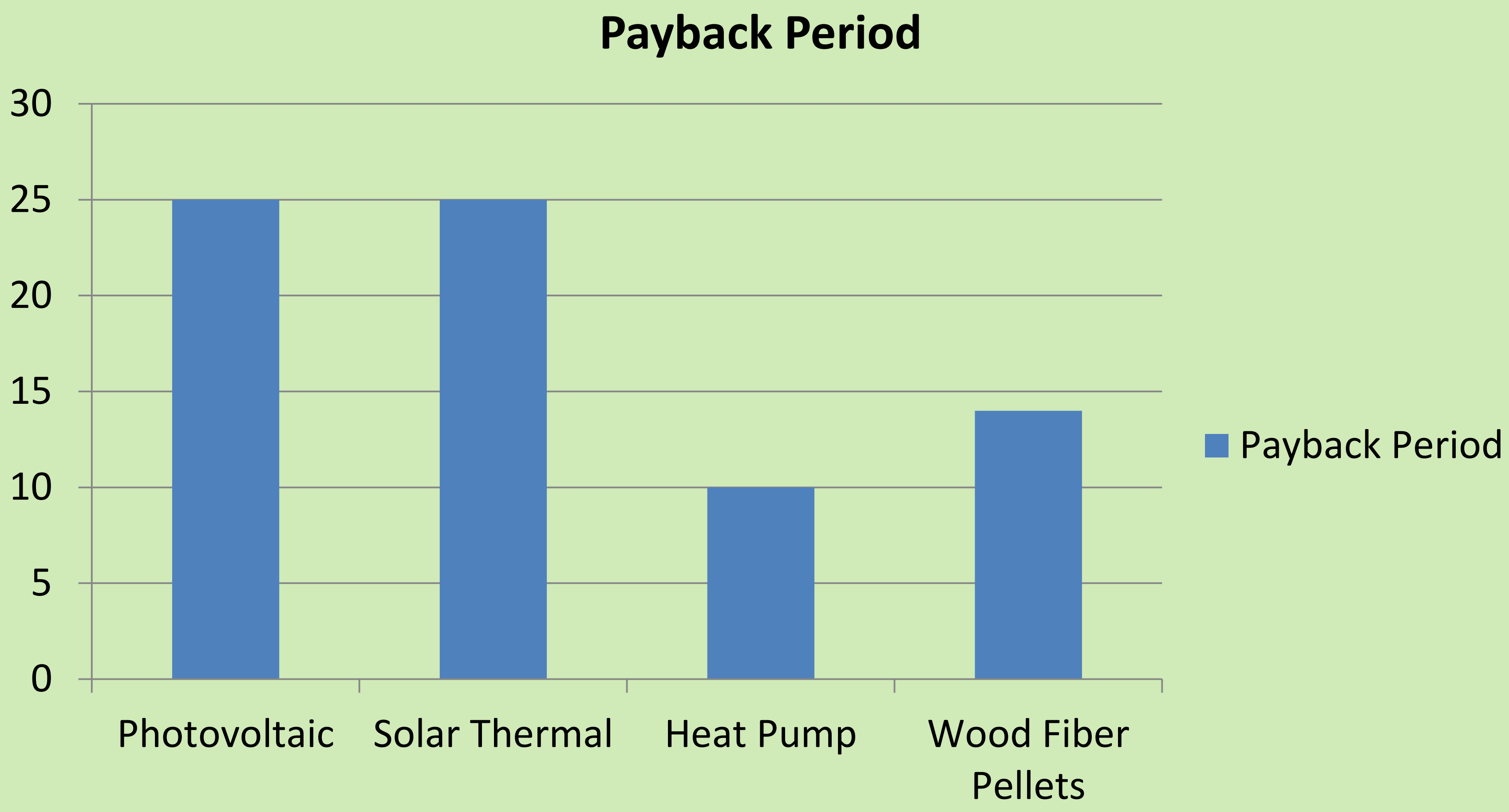
Production

Biomass system type	*Wood Pellet*	*Wood Chip*
System size	625 MBH	625 MBH
Estimated propane offset	10,800 gallons/yr	10,800 gallons/yr
Estimated total site energy offset	990,000 kBTU/yr	990,000 kBTU/yr
% of total building's energy	30 %	30 %
Cost and Economics		
Installed cost	$ 205,000	$ 510,000
Incentives	$ 0	$ 0
Final cost after possible incentives	$ 205,000	$ 510,000
ROI, 25-yr average	8.1 %	4.5 %
Simple payback period	14 yrs	18 yrs
Environmental Impact		
CO2 emission reduction	67 ton/yr	67 ton/yr

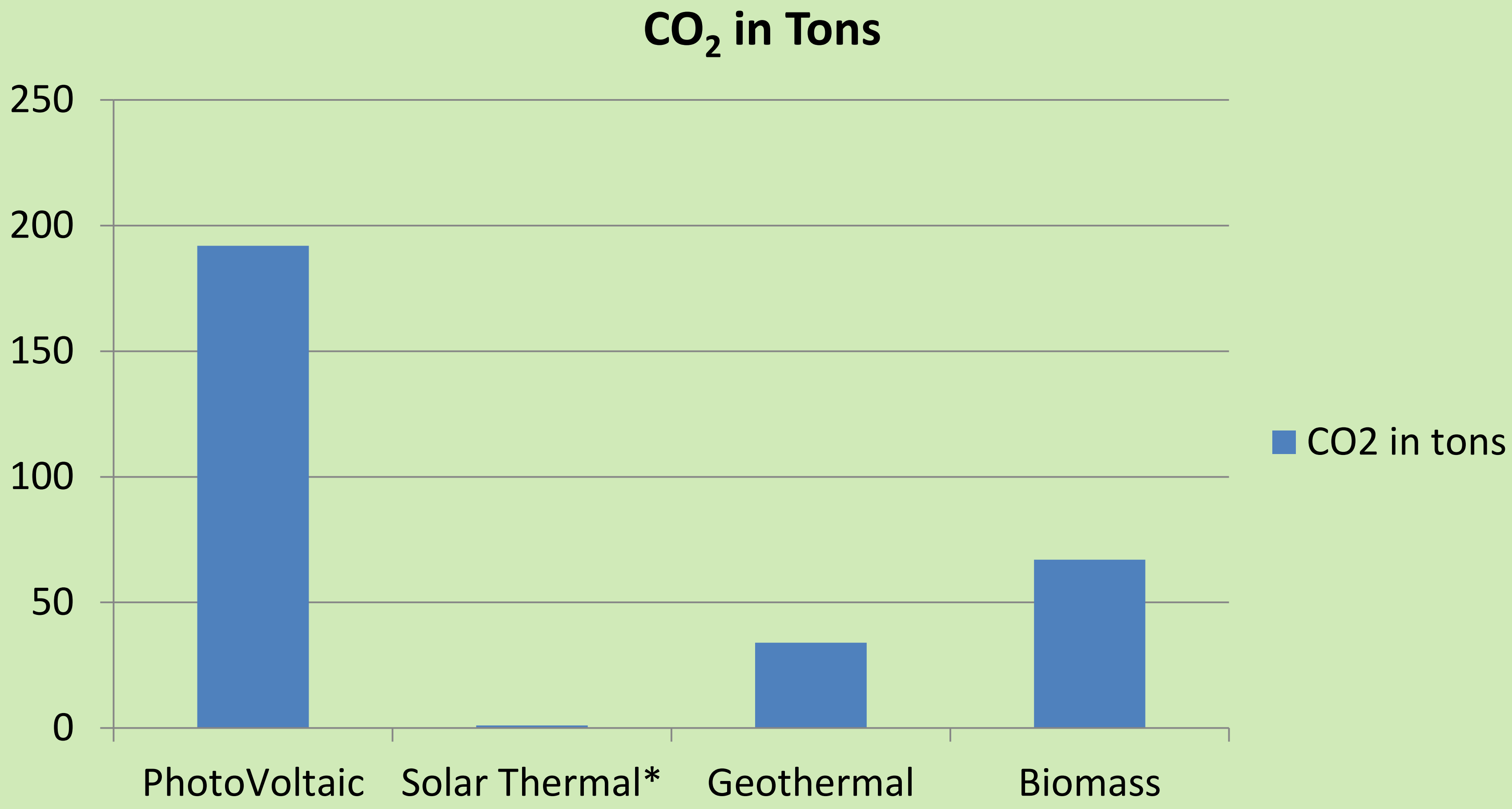
Conclusions

- Energy conservation measures number one!
- Initially the "oblivious alternative" (i.e. huge biomass resource, therefore biomass = most economical) is not always the case.
- Viable renewable energy measures are available to retrofit the HWC.
- Heat pump technologies greatest payback.
- Heat pump greatest CO_2 emissions reduction.

Payback


Payback Period
30
25
20
15
10
5
0
Photovoltaic
Solar Thermal
Heat Pump
Wood Fiber Pellets
Payback Period

CO_2 Emission Reductions



Future Activities

- Encourage implementation on the ECMs.
- Use this for community education.
- Promote inclusion of renewable energies in new construction.
- Use source energy as opposed to site energy in measuring a buildings efficiency.
- Encourage the establishment of a tribal energy & sustainability department.

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