

Solar Water Heater at the Chanhassen License Center



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License Center Background

- 3 story facility; 14,000 sq ft
- Houses community social services and health clinic
- Annual water usage ~110,000 gal (~9,500 gal monthly)
- Traditional water heater in place



South facing roof



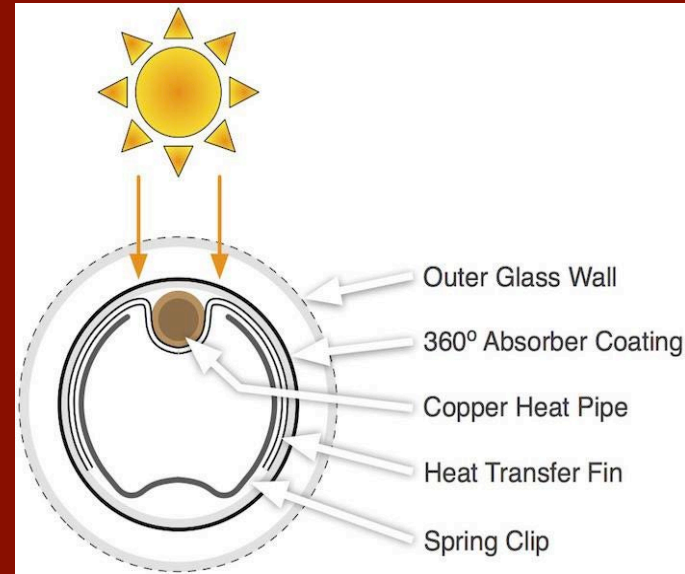
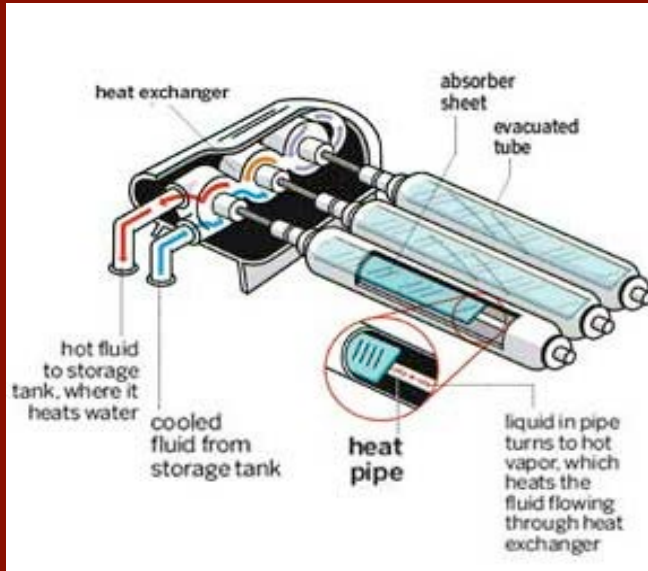
Upper level roof

Objective

- Explore the feasibility of using a solar powered heater to heat water at the facility
- Research various types of solar heaters and determine the most viable option
- Explore any grant or lottery options to partially fund the solar heater

Evacuated Tube Theory

- Light hits the tubes
- Energy is transferred to liquid in the “Heat Pipe”
- Hot vapors travel up the tube
- Heat is transferred from the vapor to the fluid



Why Evacuated Tube Style?

- Vacuum tubes act as superior insulation
 - Performs better in winter months than alternative options
 - Performs better in cloudy conditions
 - Allows for a higher hot water temperature
- Liquid mixture in Heat Pipes will not freeze overnight

Evacuated Solar Heater Options

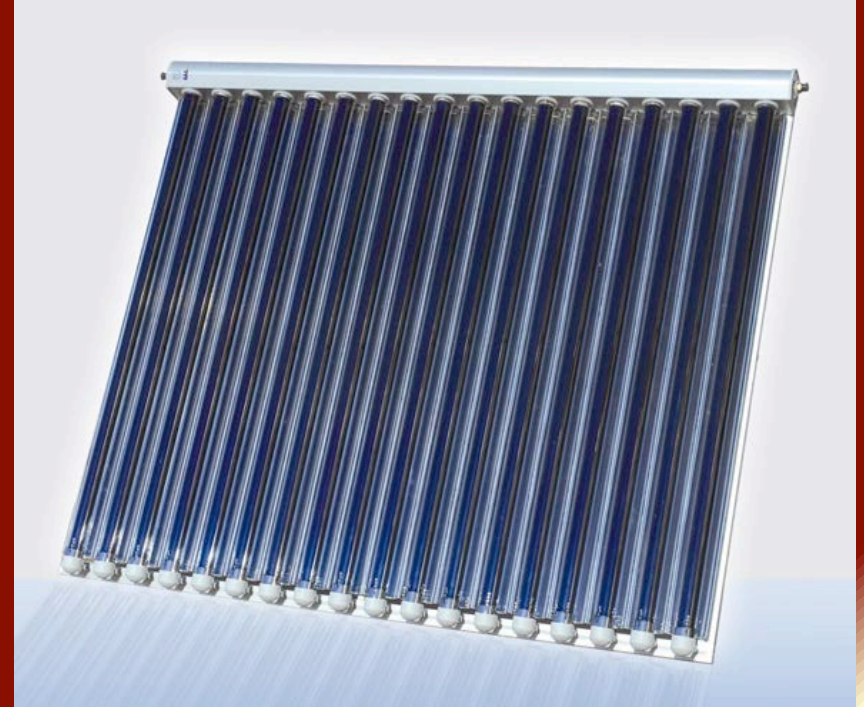
SunMaxx Solar Water Heater VTS30NP

- Infeasible due to the fact that the water in the tank will freeze



Evacuated Solar Heater Options

- Apricus ETC-30 Solar Collector
- Thermopower VHP 30 Solar Collector
- Silicon Solar 30 Evacuated Tube Collector V1
- SPP-30A Evacuated Tube Collector



Most Viable Option

- Apricus ETC-30 Solar Collector
 - Total Cost per panel: \$850.00
 - Installation cost ~\$60.00 per sq ft
 - Antifreeze: Propylene Glycol
 - Collectors are freeze protected

Government Assistance

- SolarSense Program
 - Lottery Based
 - Pay up to 25% or 25,000, whichever is less
 - Need a traditional water heater as a backup

Made in Minnesota Solar Thermal Program

- Similar to the SolarSense Program
 - Up to 25% of the cost or 25,000
 - Very small chance of getting selected
 - Only 5 commercial projects supported
- All materials must be made in Minnesota

Tax Breaks

- Sales Tax
 - Minnesota will refund the sales tax of everything associated with the project (even on components like panels, pumps, racks, wiring, and pipes)
- SolarSense program also offers a 30% Federal Investment Tax Credit (ITC) to help reduce installation costs

Amount of Energy From the Sun

- Place on roof (prevent sunblock)
- Surface Azimuth: 0 degrees (facing South)
- Data Collected
 - Solar Altitude
 - Solar Azimuth
 - Direct Normal Radiation
 - Diffuse Radiation Factor

Calculating Energy From the Sun

$$\text{Radiation} = IDN * \cos(\theta) + Ids + Idg$$

$$\cos(\theta) = \cos(\beta) * \cos(\gamma) * \sin(\Sigma) + \sin(\beta) * \cos(\Sigma)$$

$$Ids = C * IDN * \frac{(1 + \cos(\Sigma))}{2}$$

$$Idg = IDN * (C + \sin(\beta)) * \frac{(1 - \cos(\Sigma))}{2}$$

Final Values for December

- Calculated radiation for each hour of sun on the 21st and estimated it to be the same for each day
- Tilt Angle
 - 50: 3.37 BTU/day = 104.6 BTU/month
 - 70: 1.91 BTU/day = 59.3 BTU/month
 - 90: 0.26 BTU/day = 7.91 BTU/month

Years to Pay It Off

- Ranges from 7-10 million BTU/month - 102/year
- Receive 32336 BTU/day = 11.8 million BTU/yr
- Natural Gas: \$6/million BTU
- \$1200/panel

$(\$6/\text{million BTU}) \cdot (102 \text{ million BTU/yr}) \cdot n =$

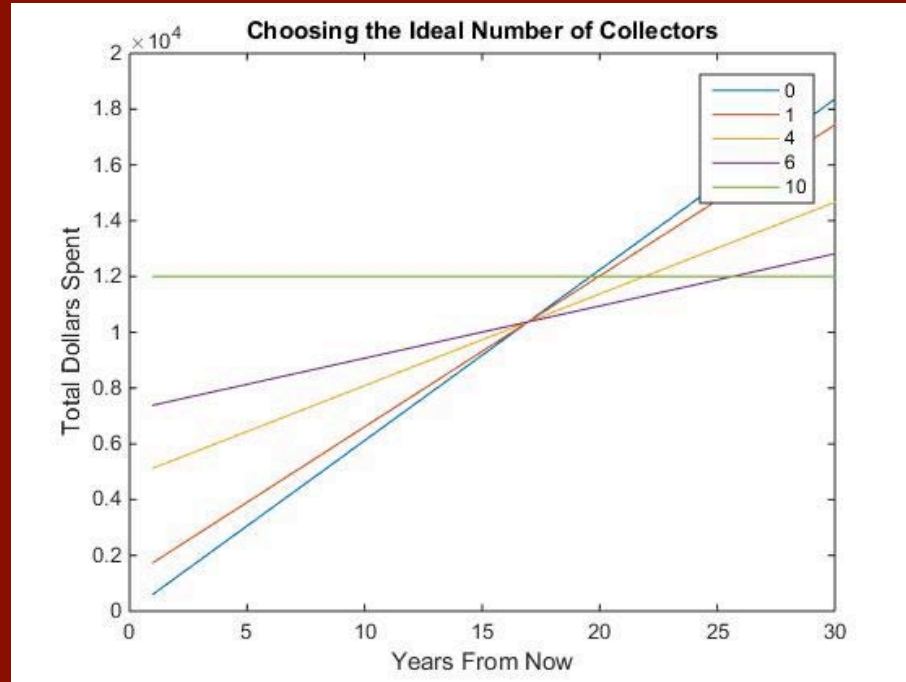
$\$1200 + (\$6/\text{million BTU}) \cdot (102 \text{ million BTU/yr} - 11.8 \text{ million BTU/yr}) \cdot n$

- 16.95 years

Amount of Collectors Needed

- Average natural gas usage at site
 - 7-10 Million BTU's per month
 - 230,000-330,000 BTU's per day
- Number of Collectors needed:
 - ~32,000 BTU's per day per panel
 - ~6-10 panels required to provide total heat

Amount of Collectors Needed

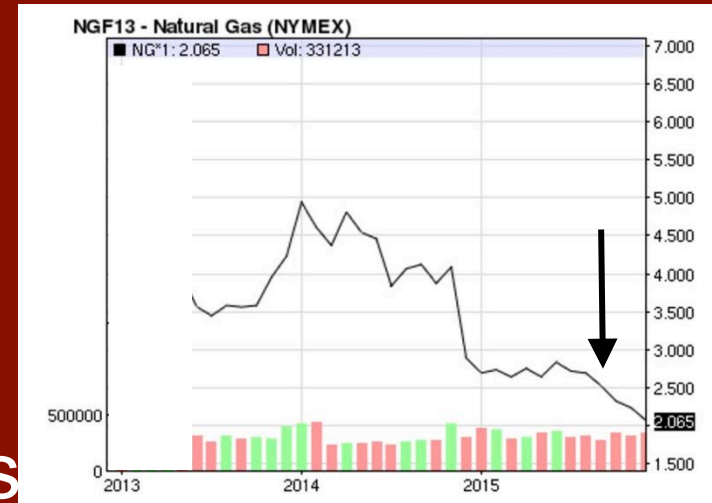
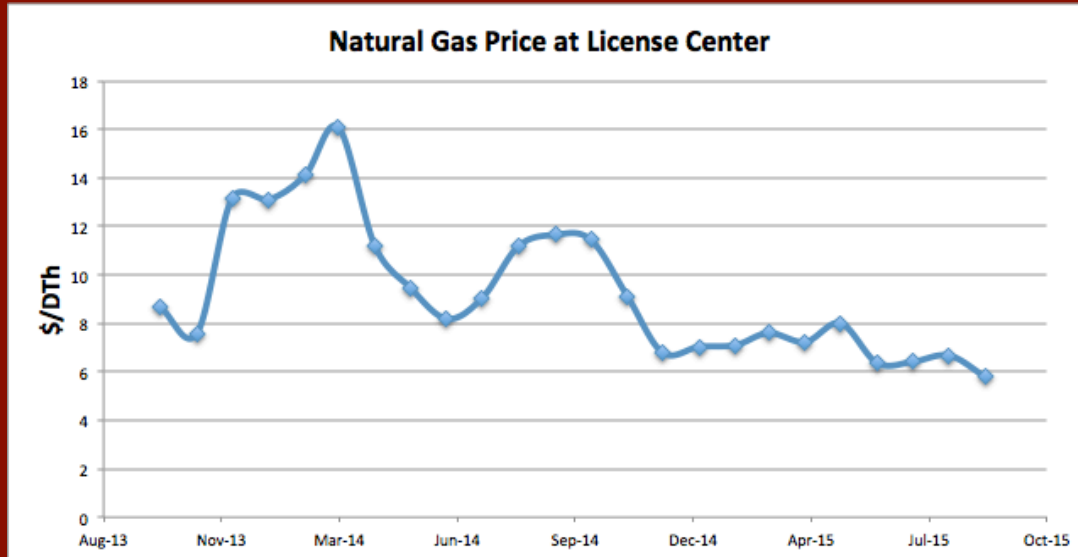


Amount of Collectors Needed

- Don't want to have collectors going to waste in summer months
- Use less than 6 collectors
- Calculations will be done using 4

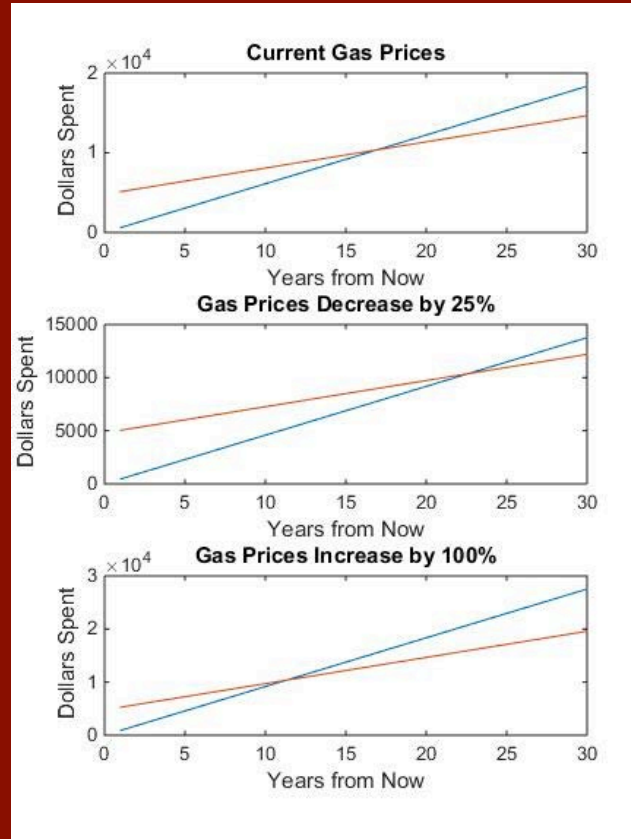
Payback Time for Varying Gas Prices

- Gas Prices fluctuate monthly

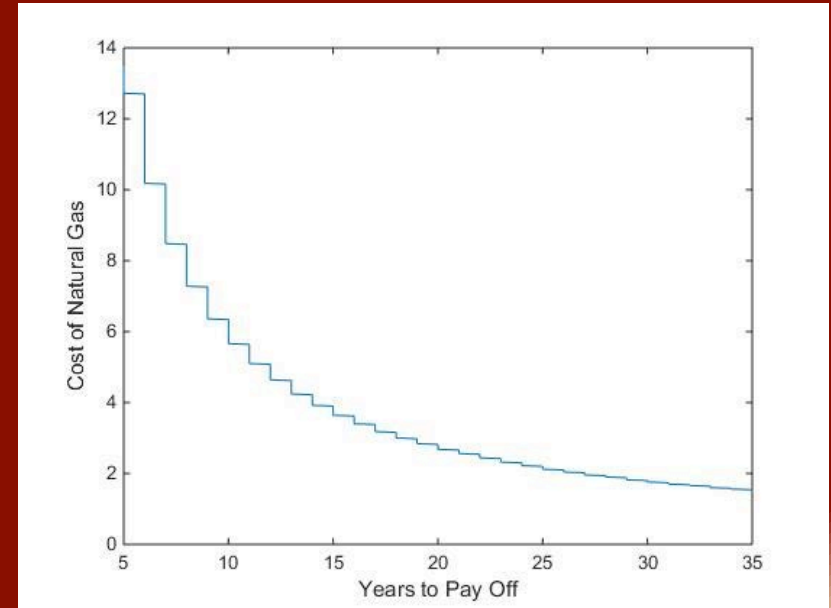
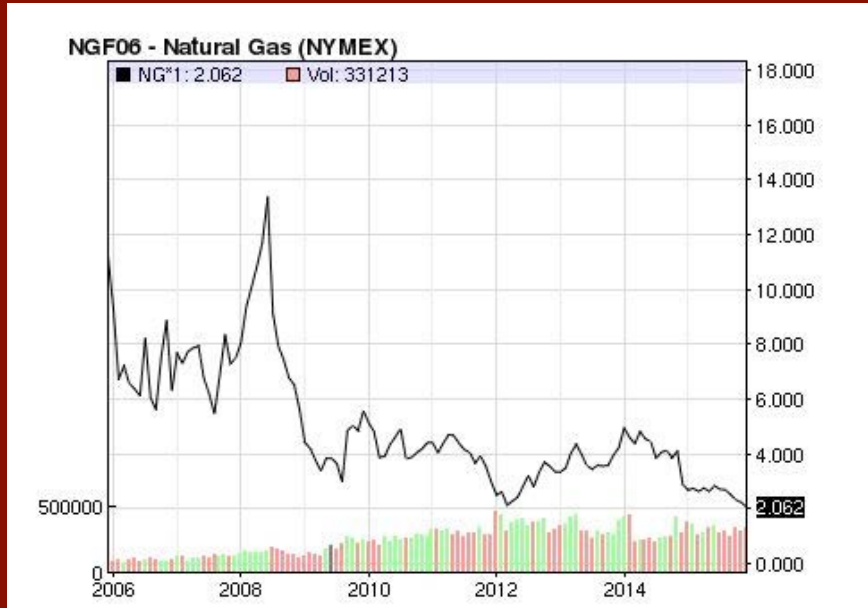


Payback Time as a function of Gas Prices

- Payback time is dependent on gas prices



Payback Time as a function of Gas Prices



Conclusions

- At current gas prices
 - Payback time of ~17 years
- For a payback time of 10 years, Gas prices must increase to ~\$6 from the current \$2
- Not currently recommended

References

1. <http://www.co.carver.mn.us/departments/prts/chan.asp>
2. http://www.apricus.com/html/solar_collector.htm#.Vmi2or91Bpk
3. www.sustainability.vic.gov.au