ENERGY
AND
SUSTAINABILITY
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Chesapeake College

Energy and Water Use Reduction Concepts and Ideas

Presented by:

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Energy Fundamentals

- How is electricity billed for a typical building?
- For most Maryland utilities you pay for Energy in

  KW-h = Kilowatt-Hours, where:

$$1\,\text{Watt} = \frac{1\,\text{Joule}}{\text{sec}}\,(\text{Power})$$

$$1\,\text{Kilowatt} = 1{,}000\,\text{Watts}\,(\text{Power})$$

$$1\,\text{Kilowatt-hour} = 1{,}000\,\text{Watts-hour}\,(\text{Energy})$$

Energy Fundamentals

- In a Home you are charged for Energy (Watts x Time), not Power (Watts)
- In a commercial/institutional building you pay for energy and power.
- Therefore, a 100 watt light bulb operating for 10 hours would equal:

$$\frac{100\,\text{Watts} \times 10\,\text{hours}}{1{,}000\,\text{watts}/\text{KW}} = 1\,\text{KW-h}$$

- Typical Residential Rate is about 12 Cents/KW-h
- So, the cost = 1 KW-h x (12 Cents/KW-h) = 12 Cents

Energy Fundamentals

What is Efficiency?

$$\eta = \text{Efficiency} = \frac{\text{What you get}}{\text{What is cost you}}$$

Typical Efficiency for Various Fuels

Fuel	Efficiency
No. 2 Fuel Oil	.80
Natural Gas	.85
Propane Gas	.85
Electric	1.0
Air Side Heat Pump	2.25
Water Cooled Heat Pump	5.00

Energy Fundamentals

Typical Fuel Heat Content

Fuel	Heat Content
No. 2 Fuel Oil	140,000 BTU/Gallon
Natural Gas	100,000 BTU/Therm
Propane Gas	92,000 BTU/Gallon
Electric	3,413 BTU/KW
Air Side Heat Pump	3,413 BTU/KW
Water Cooled Heat Pump	3,413 BTU/KW

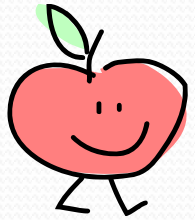
Energy Fundamentals

Typical Cost Per Unit

Fuel	Cost
No. 2 Fuel Oil	$2.25/Gallon
Natural Gas	$1.60/Therm
Propane Gas	$2.25/Gallon
Electric	$0.12/KW-h
Air Side Heat Pump	$0.12/KW-h
Water Cooled Heat Pump	$0.12/KW-h

Energy Fundamentals

- To make an "Apples-to-Apples" comparison we must take the ***cost per unit*** of the fuel ($/Gallon) and divide by the ***heat content*** (BTU/Gallon), then multiply by 100,000.
- For Example, for No. 2 Fuel oil:



$$\frac{\text{Cost}/\text{Unit}}{\text{Heat Content}} = \frac{\$2.25/\text{Gallon}}{140{,}000\,\text{BTU}/\text{Gallon}} \times 100{,}000 = \$1.607/100{,}000\,\text{BTU}$$

Energy Fundamentals

- We then divide by efficiency to obtain the true $/100,000 BTU.
- For Example: For No. 2 Fuel Oil:

$$\frac{\$1.60 \,/\, 100{,}000\,\text{BTU}}{.80\,(\text{Efficiency})} = \$2.00 \,/\, 100{,}000\,\text{BTU}$$

Energy Fundamentals

- The following Table summarizes the results for all fuel types:

Fuel	True Cost in $ per 100,000 BTU (corrected for efficiency)
No. 2 Fuel Oil	$2.00
Natural Gas	$1.88
Propane Gas	$3.22
Electric	$3.52
Air Side Heat Pump	$1.56
Water Cooled Heat Pump	$0.70

Energy Fundamentals

Monitoring

"Be thou diligent to know the state of thy flocks, and look well to thy herds." – Proverbs 27:23

- Learn how to read your Main Meter and Trend for a couple of months.
- For commercial/institutional projects submeter buildings so you can identify problems.

Energy Fundamentals

- Purchase a Kill-a-Watt meter (From Amazon.com) for about $23.00.
- Will allow you to monitor actual energy use in KW-h over a period of time so you can determine where the KW-h's are going.
- Also allows you to compare power use of products in a store and will read:

- ✓ Voltage (Volts)
- ✓ Current (Amps)
- ✓ Watts (Power)
- ✓ Frequency (Hertz)
- ✓ Power Factor
- ✓ Elapsed Time

Energy Fundamentals

- Now we know how to calculate and compare Fuels, Read our Meter, and Monitor Appliances.
- We can now review some Energy and Water Use Reduction products.

Simple Payback / Return on Investment (ROI)

$$\text{Simple Payback} = \frac{\text{Cost of Improvement}}{\text{Savings} \,/\, \text{Year}} \text{ (years)}$$

$$\text{Return on Investment} = \frac{\text{Annual Cost Savings}}{\text{Installed Cost of the Appliance}} \times 100 \text{ (\%)}$$

Note: These are quick simple calculations. They do not take into consideration taxes, depreciation, salvage costs, maintenance costs, pollution costs, etc…

Lighting

Painted Trim & Reflector White
(original was black)

- Compact Fluorescent
- Dimmable Compact Fluorescent
- LED (for night lights)
- LED (mixed with standard CFL's)

Where to purchase:

- Any Hardware store or lighting supply house.

Simple Payback: 1.14 years

Return on Investment: 87.5% (Tax Free)

Additional Thoughts: Minimize the use of recessed lighting where the same is utilized in attic ceilings or use I.C. rated fixtures to reduce heat loss/gain.

Water Heating

- First Step is to Reduce Load
- Try Low Flow Shower Heads and Low Flow Aerators.

1.0 GPM at
30 psig pressure

.375 GPM at
30 psig pressure

Water Heating

- Next, Insulate all pipes…

- Finally, wrap your water heater with a Radiant Barrier product such as Prodex…

Water Heating – Shower Heads

Where to Purchase

- Shower Heads: www.bricor.com

Simple Payback: 2.6 months

ROI: 453% !! (Tax Free)

Additional Thoughts

Low Flow Shower Heads also save on Sewer Cost, domestic water costs, well pump costs (Rural areas) and Septic Tank Pump Costs (Rural areas)

Water Heating – Heater Wrap

Where to Purchase

- Radiant Barrier Wrap: www.insulation4less.com

Simple Payback: 6 months

ROI: 189% !! (Tax Free)

Domestic Re-Circulation

- One of the largest Energy and Water Losses in a home or business is when users turn on the water waiting for hot water.

OR…

- If the facility has a continuous Domestic Re-circulation loop which results in increasing costs of heating the water all the time. (Basically acts as a large radiator!)

Domestic Re-Circulation

- The Solution
- To Install an “On-Demand” domestic re-circulation pump kit under the most used vanity.

Domestic Re-Circulation

Where to Purchase

- N.H. Yates & Company – www.nhyates.com
- Cummings Wagner – www.cummins-wagner.com

Simple Payback: 3.24 years

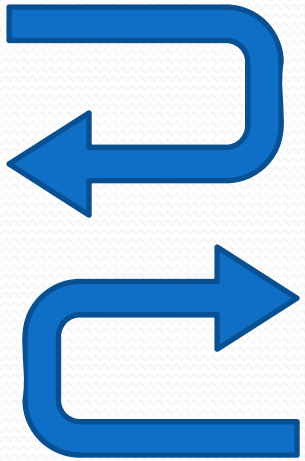
ROI: 30.8% (Tax Free)

Additional Thoughts

- Runs only when activated
- Saves energy in heating hot water and saves water and sewer costs (not included in the savings calcs)
- Can be coupled with an infrared remote for activating from more than one location.

Plug Loads

- All of us pay for electricity and heat in our homes on many items that do not even provide us with a benefit.
- Many of these items use electricity all of the time through wasteful Transformers.



- The solution is to use Smart Strips.

Plug Loads

Where to Purchase

- Amazon – www.amazon.com

Cost: $20.00

Simple Payback: 1.26 years

ROI: 78.8% (Tax Free)

Additional Thoughts

- Reduces Cooling load in summer.
- Also provides surge protection.
- Allows chosen outlets to remain “hot” or energized all the time.
- Prolongs life of equipment

Solar Photovoltaic System

24 – 180 watt panels

DC to AC Inverter

- The remaining items are not “low hanging fruit”, but should be at least investigated.
- Our Solar Photovoltaic system has so far been a wonderful experience.

Solar Photovoltaic System

- At my house, my electrical bills for April, May, June and July were $6.00…
- AND THAT IS WITH A POOL!!!!

Where to Purchase:

Chesapeake Solar, Green Energy Design, Solar City

First Cost: $30,000

Simple Payback: 5.72 years

ROI: 17.45% (Tax Free)

Solar Photovoltaic System

Additional Thoughts

- Check Maryland Energy Administration Website and DSIRE website (www.disreusa.org) for Federal and State Incentives.
- Maryland State Incentive has decreased from $10,000 for a 4 KW Solar System to $2,000 due to demand.

Solar Domestic Hot Water Heating System

Notice all pipes/panels are sloped ¼ inch per foot

Solar Thermal Drain Back Tank & Piping

Solar Thermal Flat Plate Collectors

Coefficient of Performance (Actual Measured) = 24.5

- Completely amazed at Performance
- First Cost including estimate for Labor = $6,250
- Simple Payback = 5 years
- Return on Investment = 20% Tax Free
- Where to Purchase: Solar Heat Exchange Manuf.
- Green Energy Design

Solar Hot Water Heating System

- Monitoring is very valuable
- Hoffman House Actual Consumption:
  - From 3/9/10 to 3/16/10 Total gallons = 145
  - Hot Water Use per person per day = 5.17 gallons/person/day
  - Compare with National Average which = 20 gallons/person/day
  - As of January 11, 2011 our usage is 8 gallons/person/day!

Variable Speed Pumping

- Due to Pump Affinity Laws, pump energy savings can be dramatic.

$$BHP_2 = BHP_1 \times \left(\frac{\text{Flow Rate}_2}{\text{Flow Rate}_1} \right)^3$$

- Since this is a cubed function, the following will result:
  - 10% Reduction in Flow = 27% Reduction in Power
  - 50% Reduction in Flow = 87% Reduction in Power

Variable Speed Pumping

- If you don't have a flow meter, install one to determine your base line flow rate.

- A variable speed pump can then be dialed into any flow desired using the flow meter and control panel.

Variable Speed Pumping

Where to Purchase

- American best Pool Supply, Sparkle Pools, Aqua Pools

First Cost: $800.00

Simple Payback (Max): 5.5years

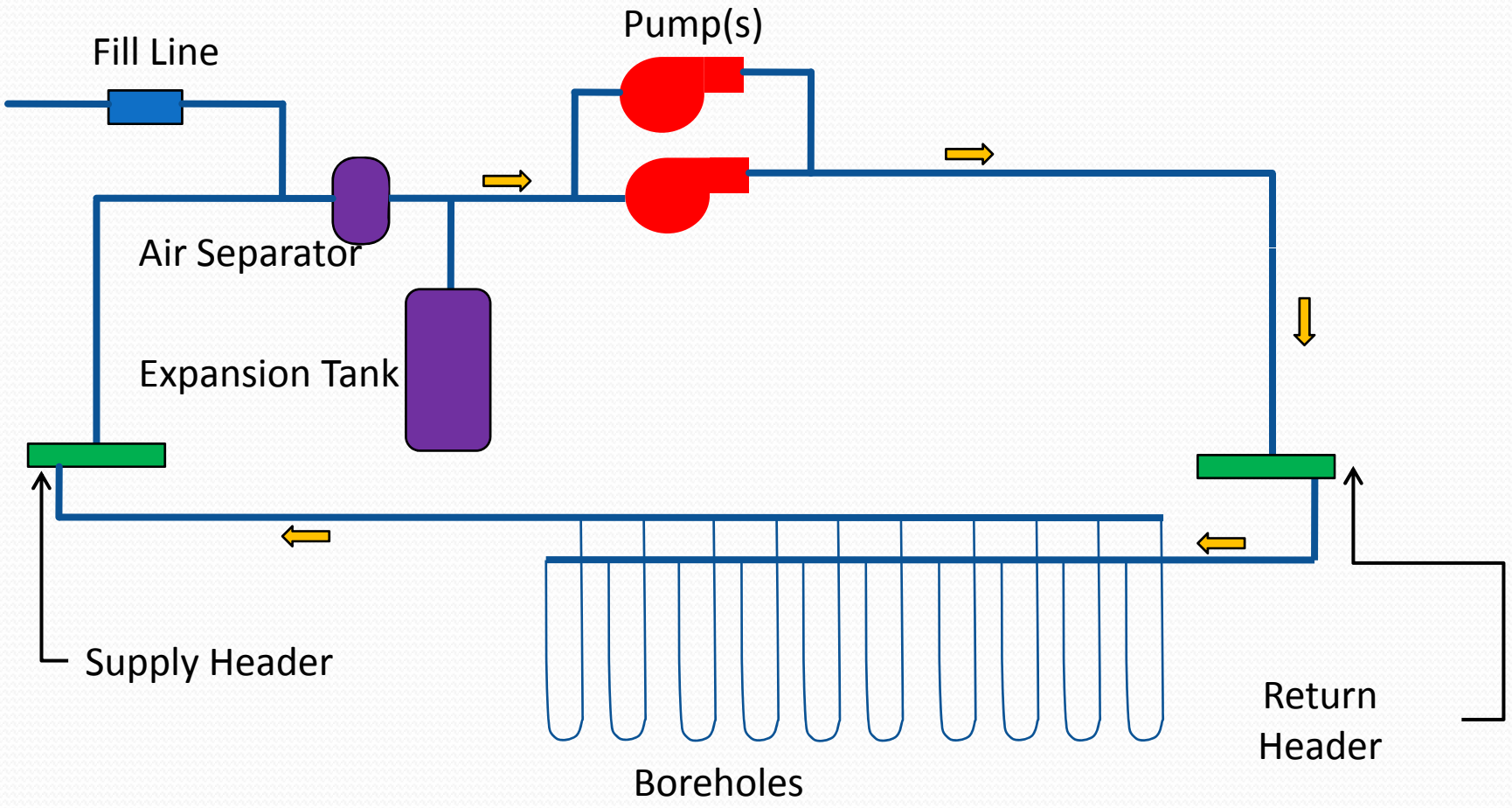
Simple Payback (Min): 4.7years

ROI (Max): 21% (Tax Free)

ROI (Min): 18% (Tax Free)

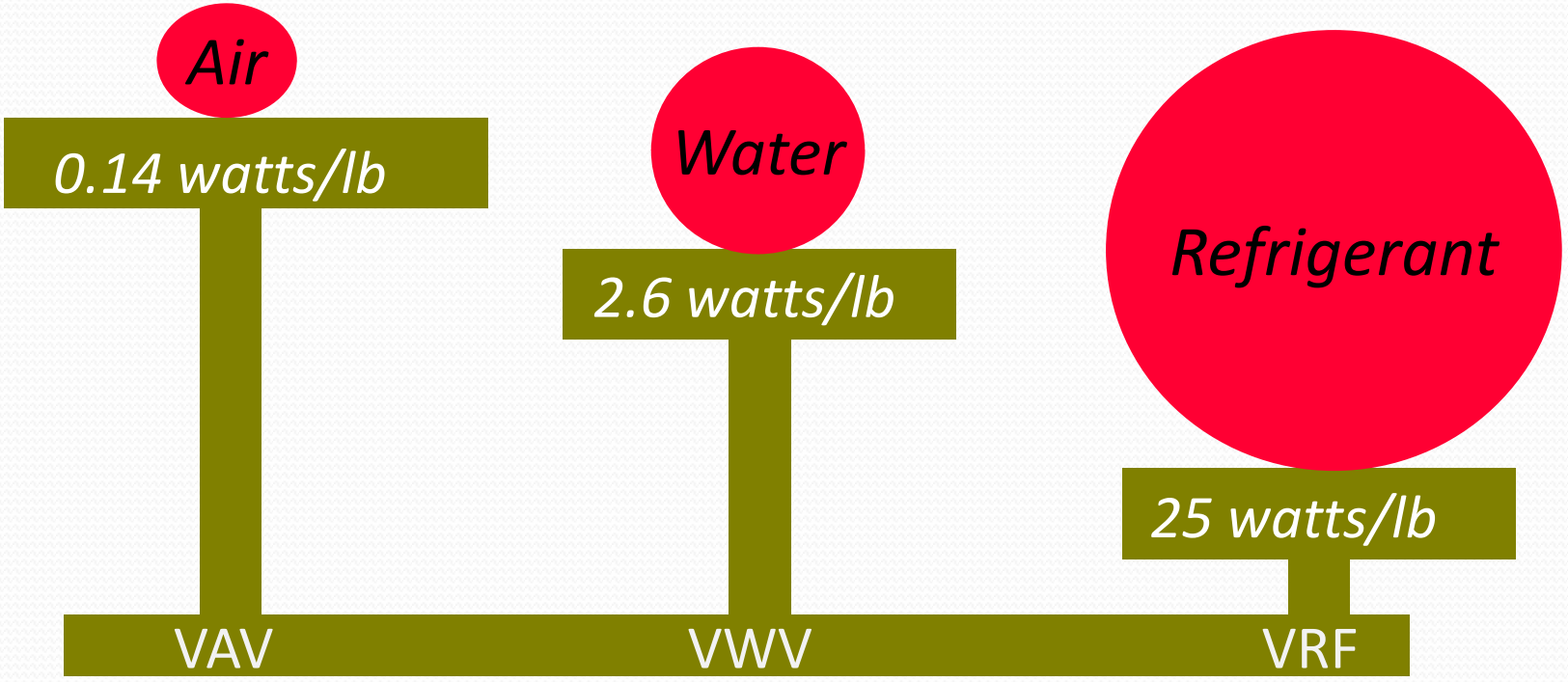
COMMERCIAL SYSTEM

Geothermal System Flow Diagram



Heat Transfer Media

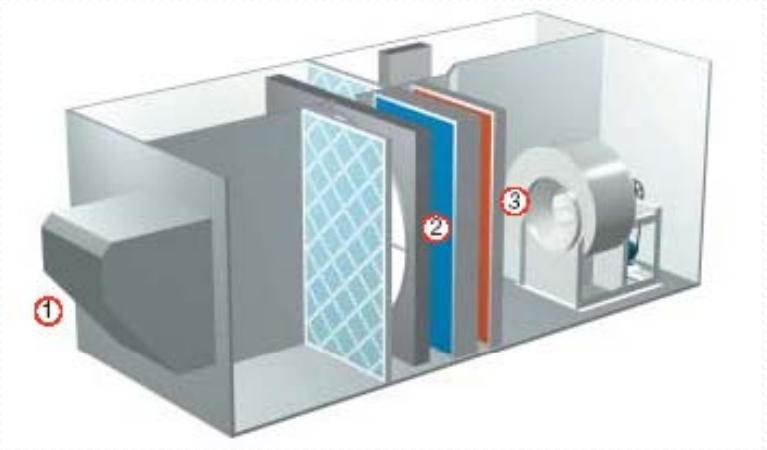
- The Commonly Used Methods of Heat Transfer in Air Conditioning Solutions Each Exercise Different Operational Characteristics By Adding or Removing Heat Energy to a Conditioned Space:

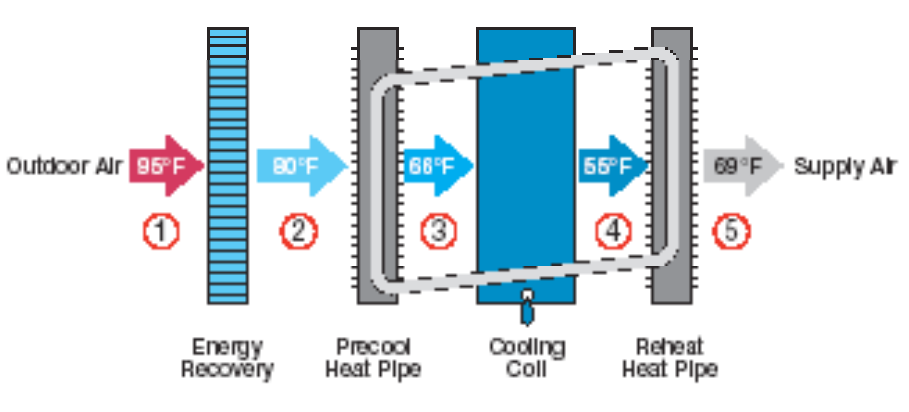


- Energy Transfer Possible per LB of Media

Energy Recovery Technology

- Variable speed control on Supply & Exhaust Fan
  Fan Laws can be utilized to reduce Energy Consumption
  10% Reduction in Airflow results in 27% fan energy reduction.
  50% Reduction in Airflow results in 88% fan energy reduction
- CO2 Monitoring
- Dedicated Outside Air Tempering Control
- Heat Pipe Technology
- Outdoor Air Reset





Summary (In descending order from Best Return to Lowest Return on Investment)

System	First Cost	Simple Payback	Return on Investment
Water Heating – Shower	$118.00	2.6 months	453%
Water Heating – Wrap	$19.98	6 months	189%
Clothes Drying – Hanger	$53.00	0.9 years	110%
Insulate Garage Door	$36.00/sq.ft. (128 sq.ft.)	0.9 years	110%
Lighting	$16.00	1.14 years	87.5%
Plug Loads	$20.00	1.26 years	78.8%
Dom. Re-circulation	$167.00	3.24 years	30.8%
Clothes Drying – Dryer	$500.00	4.3 years	23.2%
Var. Speed Pump – Pool	$800.00	4.7 years (Min.)	21% (Max)
Energy Star – Refrigerator	$800.00	4.76 years	21%
Solar Domestic Water Heating	$6,250	5.0 years	20%
Solar Photovoltaic System	$30,000	5.72 years	17.45%
Spray Foam Insulation	$7,000	13.6 years	7.3%

Delmarva Power Versus Energy Purchasing Cooperative

- Go to: https://coop.cqiassociates.com
- Maryland has been deregulated since 2004.
- Cooperatives now exist to allow purchasing energy from competitors.
- As of August 2010 Energy can be purchased at 9.1 cents per kwh, versus 11 to 14 cents per kwh from Delmarva Power.
- Only apply to supply portion of electric bill not distribution portion.
- Does not cost anything. Guards against increases in future energy costs.

The End…

Questions/Answers