Reviewing the E3A User Guide

www.e3a4u.info

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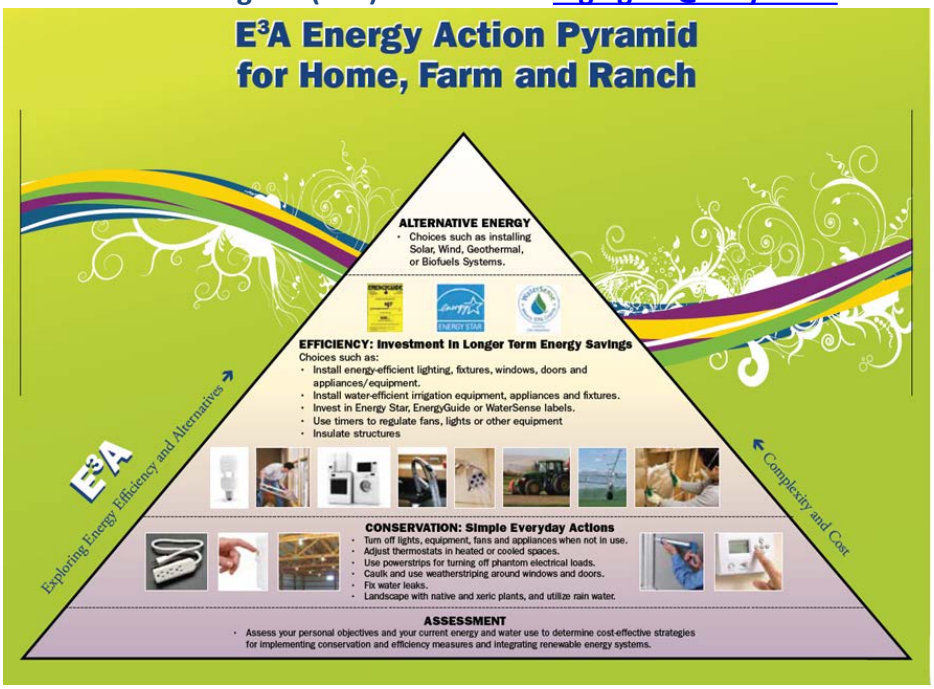

Content:

- User Guide & Programming Materials
  - Map and General Energy Info.
  - Programming Resources
  - Online Resources (PPT, Links, etc.)
- Ten Technology Folders
  - Micro-hydro
  - Small Wind
  - Solar Electric (PV)
  - Solar Hot Water
  - Biodiesel
  - Anaerobic Digesters
  - Wood heat
  - Ground Source Heat Pumps*
  - Direct Use Geothermal*
  - Solar-powered livestock watering*
- Four Energy Efficiency Folders
  - Home Energy
  - Farm Energy
  - Mobile Home Energy
  - Irrigation Efficiency*
- Two Youth Programming Modules
  - Wind
  - Solar*

Purpose:

Enhance Extension energy capacity to provide outreach & education to nations consumers, dealing with energy conservation, efficiency and small renewable energy systems for your farm, ranch or home.

Workshop Design:

- Exploratory
- Advanced
- Expert

Keys:

- Download for free or order hard copies
- Customizable!
  - In-design files available to states
- Collaborative
  - Ability to share resources among states
- Ongoing trainings:
  - Webinars: 2nd Tuesday Technical Shorts and 4th Friday "Big Picture"

All presentations available at:
www.e3a4u.info under the "Trainings" Tab

NOTES:

E³A: Exploring Energy Efficiency & Alternatives

Energy Basics and an Intro to Renewables

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Examples of Alternative Energy Sources that Address Current Energy Uses	
Current Energy Use	Alternative Energy Source
Electricity	Wind Turbine Photovoltaic Panel Micro-Hydro System Anaerobic Digester
Hot Water *(Current source may be electric, gas, or propane)*	Solar Thermal System Concentrating Solar Power Technology/Parabolic Trough Geothermal (desuperheater)
Heated Air *(Current source may be electric, gas, wood, or propane)*	Solar Air Collector Transpired Solar Collector Geothermal (Ground Source Heat Pump) Biomass Passive Solar Design
Transportation Fuel	Biofuel Renewable Electricity (for electric or hybrid vehicles)

Incentives:

www.dsireusa.org

Residential

- Federal Tax Credit (2016)
  - 30% for solar, geothermal, and wind
  - Energy efficiency expired (2013)
- State
  - Plethora in AK
- Utility
  - Numerous in AK

Commercial

- Federal Tax Credit (2016)
  - 30% for solar and wind, 10% for geothermal
- Accelerated depreciation (2016)
  - MACRS (6-year rapid) on renewable energy equipment
- USDA Rural Development Rural Energy for America Program (REAP)
  - 25% on renewable energy and energy efficiency equipment
- USDA NRCS (Ag only)
  - Environmental Quality Incentives Program (EQIP) and others

Key Terms:

Conservation vs. Efficiency – Behavior (Free or low-cost) vs. Technology (energy productivity)

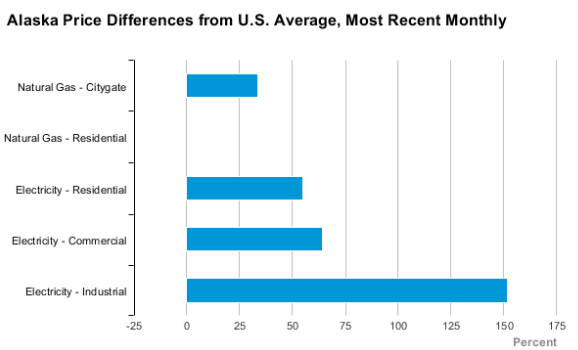
On-grid – Use the resources of a utility, typically electric, to augment renewable energy system

Off-grid – Requires energy storage (batteries) or intermittency (solar-powered livestock watering)

Small vs. Large-scale – Offset own consumption vs. generating to create revenue

Net metering & interconnection –Statute that allows electric systems under 25 kW to be connected to the grid. Also can offers a retail rate credit for extra generation utilized at a later date and purchase, at avoided cost, of excess generation.

Context:



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E³A: Exploring Energy Efficiency & Alternatives

Efficiency First

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Conservation vs. Efficiency

Conservation

Efficiency

Activity/Tools

- Windows: DOE!
  - http://efficientwindows.org/
- Refrigerators: EPA Energy Star!
  - http://www.energystar.gov/index.cfm?fuseaction=refrig.calculator
- Exit Signs: DOE!?!
  - http://www.energy.gov/eere/femp/energy-and-cost-savings-calculators-energy-efficient-products

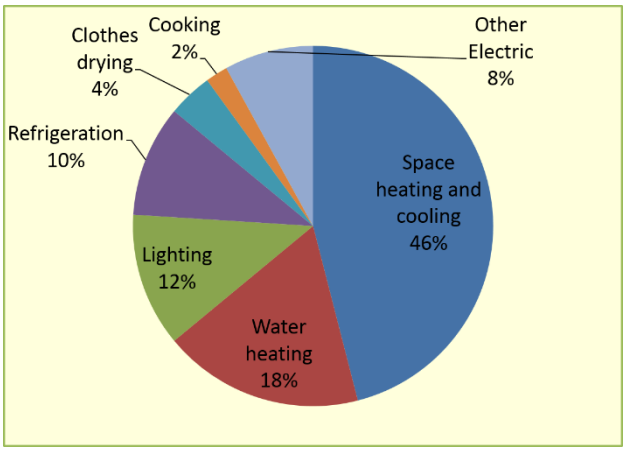
"Trunks"

- Lighting
- Insulation
- Windows

E3A Folders

- Home Energy
- Farm Energy
- Mobile Home Energy
- Irrigation Efficiency*

Context:



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Small Wind

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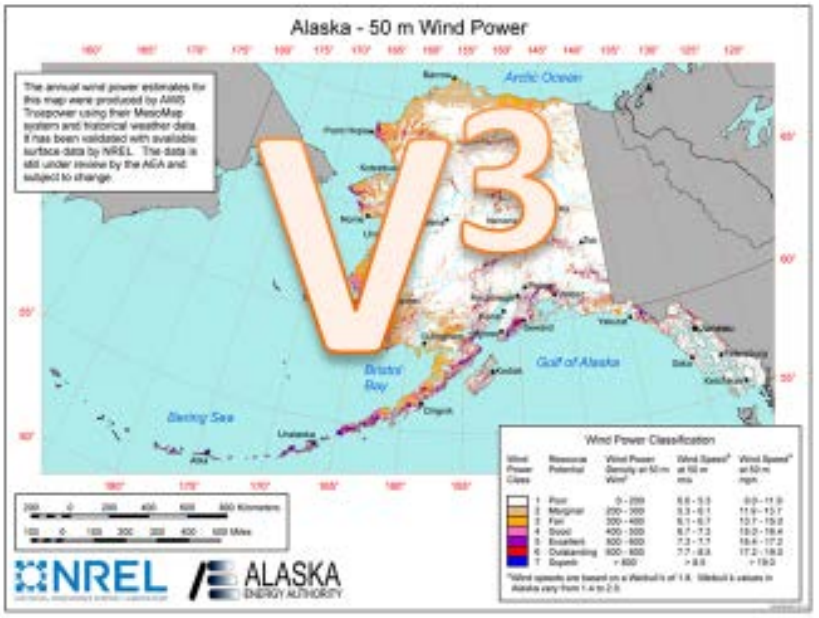

Key Questions

1. *Am I willing to learn about small wind?*
2. *Have you considered energy conservation and efficiency?*
3. *Are you comfortable with some uncertainty?*
4. *Are you willing to invest in a tall tower?*
5. *Can you finance a small wind system?*
6. *Do you have available space?*
7. *Is wind allowed in your area?*
8. *Are you willing to maintain the system?*
9. *Are you willing to live with wind?*

Wind is ENERGY

Wind is:

- Flow of air and/or gases that make up the Earth's atmosphere
- Driven by solar heating (sun) and Earth's rotation

Because air contains mass (molecules of oxygen, nitrogen, argon, carbon dioxide, etc) and possesses velocity (movement) the wind has ENERGY!

$$P = \frac{1}{2}\rho v^3 \Pi r^2$$

Power=(1/2) X (AIR DENSITY) X (VELOCITY)3 X (SWEPT AREA OF ROTOR)

Question Review

- If you answered "yes" to most of these questions, you may be a good candidate for small wind!
- If you answered "no" to:
  - Questions 3, 6, or 7, you are probably not a good candidate for small wind.
  - Questions 1, 2, 4, 5, 8, 9 or 10, you may wish to do more homework and research before you invest
- If you answered "uncertain" to most of these questions, you need to do more research before you can decide if wind is right for you.

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Micro-Hydropower

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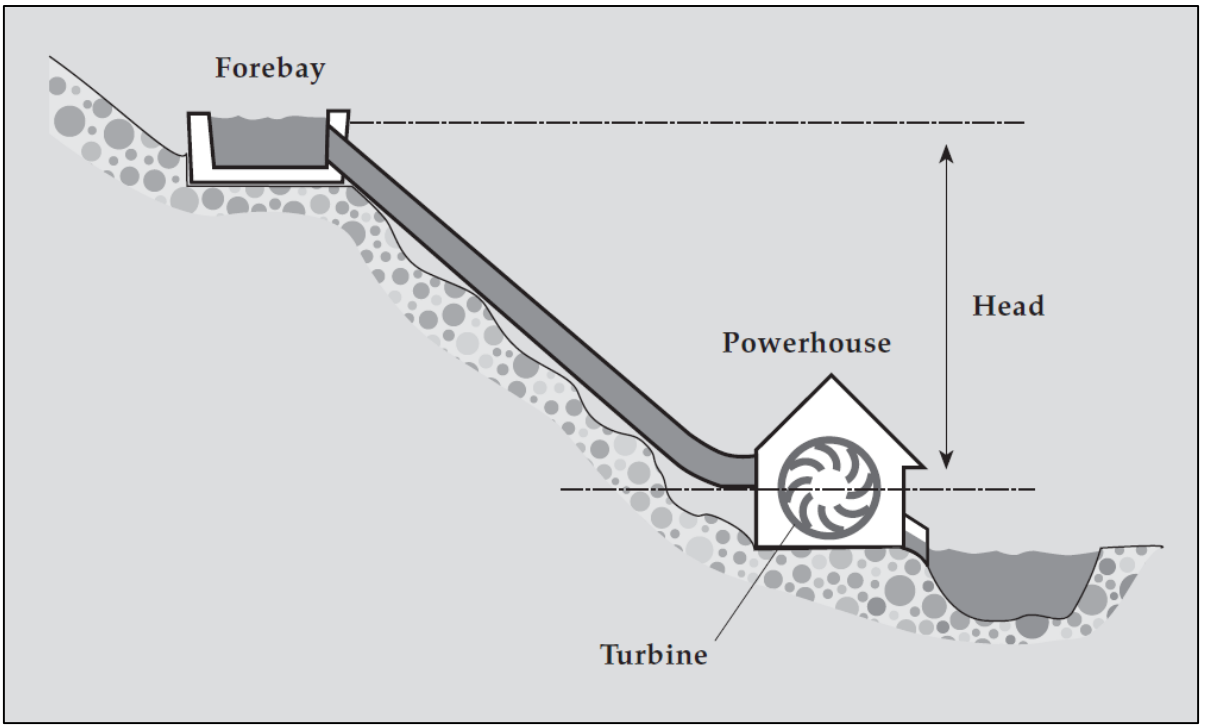

Site Assessment – Available Energy

The greater the head or flow, the more energy available!

$$Power\ (watts) = \frac{Net\ head\ (feet) x\ flow\ (gpm)}{10}$$

Power and energy are different, as energy is also a factor of time!

Equipment – Cost

- Very site specific but can be the lowest cost renewable energy system compared to wind, solar electric, etc.
- Estimates provided by National Sustainable Agriculture Information Service
  - $21,450 for a 3.5 kW system

Site Assessment – Where would be good?

- Adequate head
  - Flow can make up for lower heads, but at least 10 feet is easier to develop
- Existing civil works
  - Irrigation or other diversions, penstocks, etc.
- Proximity to load
  - Closer the better due to expense and line loss
- Minimal environmental disturbance
  - Existing heavily impacted systems
- Clearly identified water rights
  - Just because it is there does not mean it is yours…

NOTES:

E³A: Exploring Energy Efficiency & Alternatives

Solar Electric (Photovoltaic)

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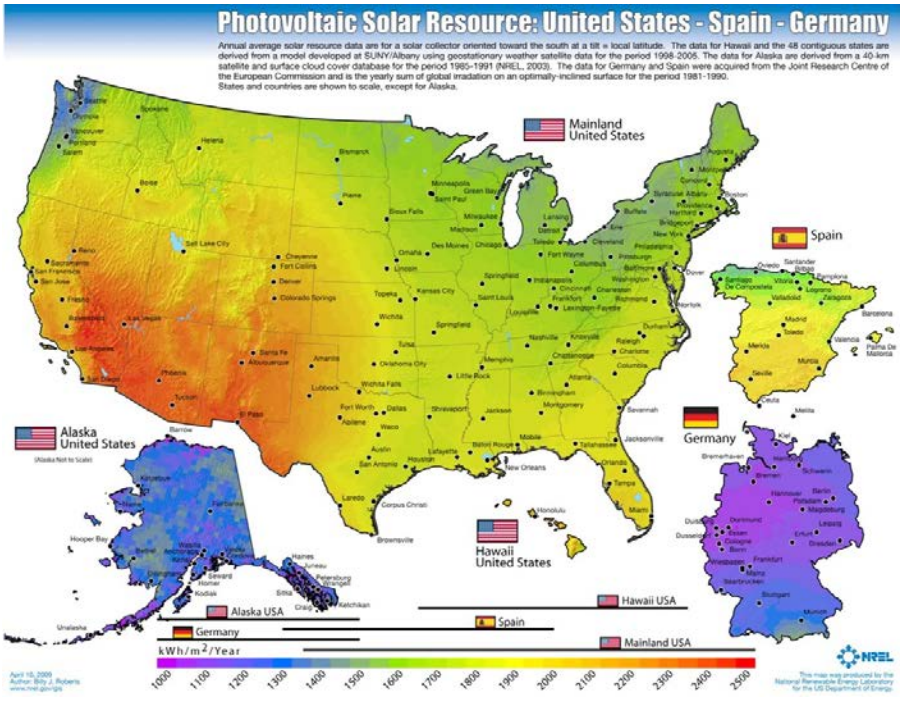

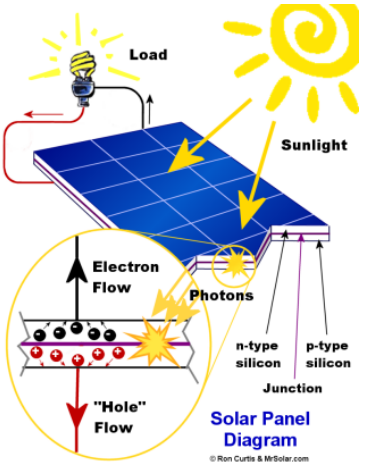

Why PV

- Reliability
  - No moving parts, long warranties
- Performance
  - Predictable production
- Scalable
  - Small technology for electric fence or utility-owned
- Rapidly declining costs

Why Not PV

- Intermittency
  - More predictable but the sun doesn't shine at night
- Cost!

Table 1 – Costs for Electric Generating Technologies

Technology Type	Mean installed cost ($/kW)	Installed cost Std. Dev. (+/- $/kW)	Fixed O&M ($/kW-yr)	Fixed O&M Std. Dev. (+/- $/kW-yr)	Variable O&M ($/kWh)	Variable O&M (+/- $/kWh)	Lifetime (yr)	Lifetime Std. Dev. (yr)	Fuel and/or water cost ($/kWh)	Fuel and/or water Std. Dev. ($/kWh)
PV <10 kW	$3,910	$921	$21	$20	n/a	n/a	33	11	n/a	n/a
PV 10–100 kW	$3,819	$888	$19	$18	n/a	n/a	33	11	n/a	n/a
PV 100–1,000 kW	$3,344	$697	$19	$15	n/a	n/a	33	11	n/a	n/a
PV 1–10 MW	$2,667	$763	$20	$10	n/a	n/a	33	9	n/a	n/a
Wind <10 kW	$7,859	$2,649	$28	$18	n/a	n/a	14	9	n/a	n/a
Wind 10–100 kW	$6,389	$2,336	$38	$12	n/a	n/a	19	5	n/a	n/a
Wind 100–1000 kW	$4,019	$803	$33	$13	n/a	n/a	16	0	n/a	n/a
Wind 1–10 MW	$2,644	$900	$36	$16	n/a	n/a	20	7	n/a	n/a
Biomass Combustion Combined Heat & Power*	$6,067	$4,000	$91	$33	$0.06	$0.02	28	8	$0.04	$0.02

NOTES:

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Solar Thermal

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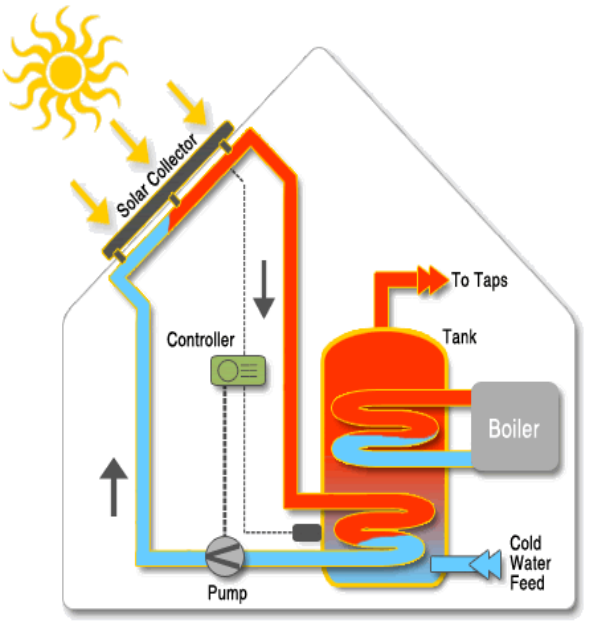

Solar Thermal – What for

- Solar hot water
  - Heat domestic or commercial hot water
- Solar heating
  - Liquid
    - Larger hot water system
  - Air
    - Dedicated heating system

Don't forget about passive sola

Flat-plate
solar hot water collectors

Evacuated tube
solar hot water collectors

Table 2 – Costs for Solar Thermal Technologies

Technology Type	Mean installed cost ($/ft2)	Installed cost range (+/- $/ft2)	O&M	Lifetime (yr)	Lifetime Std. Dev. (yr)	Fuel and/or water cost ($/ton)	Fuel and/or water Std. Dev. ($/ton)
SWH, flat plate & evacuated tube	$141	$82	0.5 to 1.0 % initial installed cost	31	14	n/a	n/a
SWH, plastic collector	$59	$15	0.5 to 1.0 %	20	10	n/a	n/a
SVP	$31	$15	n/a	25	n/a	1 Watt/ft2 fan power	
Ground Source Heat Pump	$7,518	$4,164	$109 +/- $94	38	25	$397	$392

NOTES:

Anaerobic Digester

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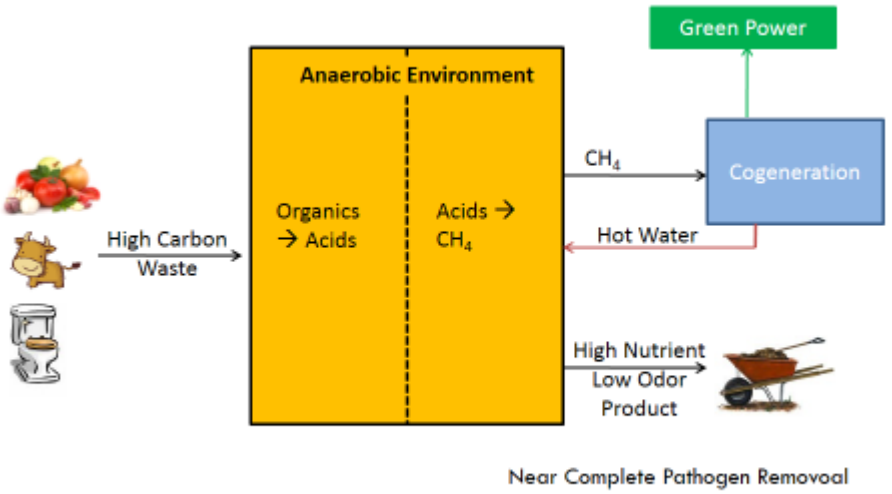

Potential Benefits of Anaerobic Digesters (Region-Dependant)

Environmental

- Production
  - Soil management
  - Manure management
  - Biogas production
- Reduces environmental pollution
  - Water
  - Green house gases
  - Ammonia

Economic and Social

- On-farm energy generation (avoid electricity purchases)
- May sell energy to utilities
- Savings on bedding
- Sale of composted solids
- Carbon credits available
- Renewable energy certificates
- Odor control
- Lawsuit mitigation

Are Ag-Related Digesters Profitable?

"Yes..."

- Several models show profitability
  - Measured in cash flows associated with the investment
- Critical to use a solids separator
  - Use the solids as a co-product
  - Bedding is a high economic use
- Larger herds lead to economies of scale: 2,000 dairy cows
- Key element to profitability: Containing costs

"Yes, But..."

- Majority of studies conducted in the East
- Profitability relies on carbon credits
  - $0.10 per metric tonne of CO_2
- "Net positive gain" may include a net gain to the environment (not necessarily a net gain to the farmer/rancher)
- Key variables identified for profitability: lawsuit mitigation, electricity prices, carbon, water prices, cost containment

NOTES:

E³A: Exploring Energy Efficiency & Alternatives

Biodiesel

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Biodiesel Facts

- What is biodiesel?
  - Fuel created from vegetable oil or animal fat
  - Can be used in traditional diesel engines
  - Biodiesel can be blended with diesel fuel
  - Biodiesel be produced in small or large quantitie

Final Products: Biodiesel Process

- Biodiesel
  - Personal Use
    - Fuel Quality is important
    - ASTM testing in not "required"
  - Off-Farm Use
    - Fuel Quality Very Important
      - ASTM Standards
    - Marketing is required

NOTES:

Wood Heat

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See Handouts!

Steps in the Wood Heat Series

1. Introduction to Wood Heat
2. Combustion Technology
3. Selection Criteria
4. All About Wood
5. Economics of Heating with Wood
6. Installation and Maintenance
7. Agricultural Wood-Burning Applications

E3A-WH
Printed April 2014

E³A: Is Heating with Wood Right for Me?

The following list may help you decide if heating with wood will work for you.

1. Have you considered the role that wood heat might play in your home? The type of heating unit, cost, and back-up heating fuel (propane, natural gas, electric, etc.) will vary according to how you intend to use wood. For example, if wood heat is the primary form of heat in your home you may purchase a larger unit and require a smaller back-up heating source than if you are looking to add wood as a part-time heat source or decorative addition to a room that will only be operated occasionally. These fact sheets will provide a general overview of wood heat, but you should be prepared to discuss your specific needs and objectives with a qualified installer.
2. Have you researched your community restrictions, home heating sources, and demands? There are many options for heating your home, especially if you are building a new house. You will be able to make a more informed decision about wood heat if you understand *what type* of energy you are currently using to heat your home, *how much energy* you are using, *how much* money you are spending, and *what* energy efficiency measures you could take to reduce your heating demand. Use the information at the end of this fact sheet to better understand your home heating consumption. Renewable energy systems, such as wood heating units, are more cost effective in markets where prices for fossil fuels are high and alternative energy sources abundant.
3. Do you have a good (legally accessible, abundant, suitable tree species, reasonable tree sizes, etc.) sustainable wood fuel resource available close by? Many factors determine the quality of a forest based-fuel resource. Transportation distance is a key consideration in the long-term economic viability of a wood heat system.
4. Are you willing to invest in a wood burning unit? A system that provides an average home's heating demand (53 Million BTU/year) will cost $5,000 or more before incentives. Some homeowners opt to reduce the total investment in the wood heat system by off-setting only a portion of their total heat needs. This reduces the system cost, but extends the economic payback period for the unit. You may have to finance the full cost as some incentives are tax credits or rebates received after installation.
5. Do you have the physical ability and time available to use wood? Unless you are considering a wood pellet system, heating with firewood takes time, resources and some hard physical labor. Research suggests that it requires about 15 hours of work to produce a standard cord of firewood (a stack of wood measuring 4ft x

NOTES:

E³A: Exploring Energy Efficiency & Alternatives

Ground source heat pumps

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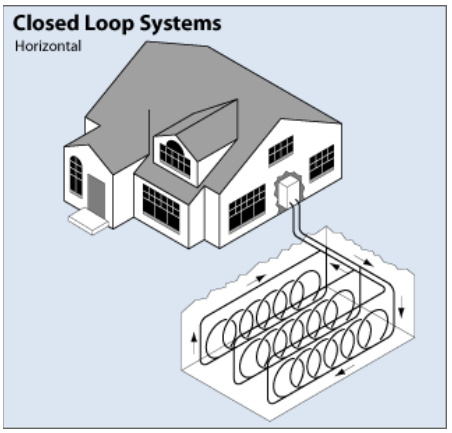
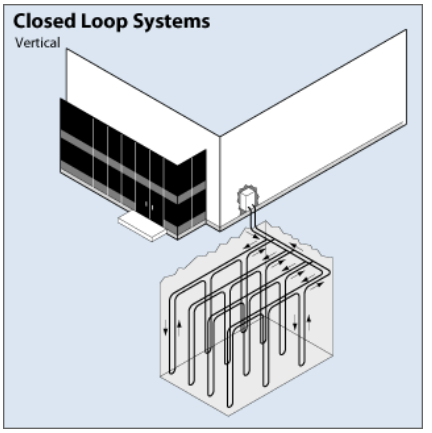
The take home – "Eat the bigger piece of the pie.": The ½ to ⅔ of household energy use that is used to heat water and condition living space.

Typical Geothermal Heat Pump (aka Ground Source or Geoexchange) Design





GSHP Details:

How

- Use relatively constant temperature of the earth
- Heat pump is like your refrigerator

What

- Heats and cools structure with the potential to heat domestic hot water

Where

- Adequate space for horizontal, pond, or vertical loop field
- Most cost effective in new construction or where expensive alternative (electric or propane) exists

Why

- Very efficient: 3-6 CoP (1 unit of electricity yields 3-6 units of heating/cooling)
- Safe, durable, and low operating cost

Why not

- High upfront cost, require ground disturbance, not suitable for all heating types (e.g. hot water boiler)

How much:

- NREL estimates $7518/ton capacity (2-3 tons for average household) with large variation ($4164 std. dev.)
- 30% federal tax credit and utility incentives (~$150-500) available

Other Options

Air source heat pumps and water heaters

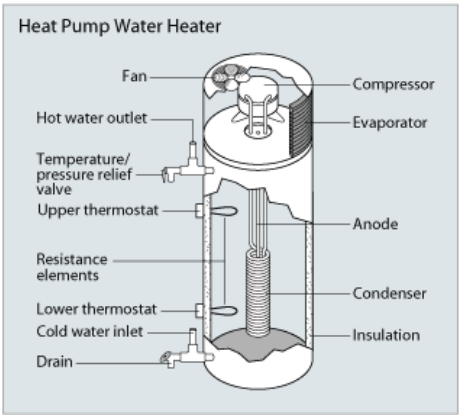


Table 5 - Useful Life

System Useful Life	Years
PV	25 to 40 yr
Wind	20 yr
Biomass Combined Heat and Power	20 to 30 yr
Biomass Heat	20 to 30 yr
SWH	10 to 25 yr
SVP	30 to 40 yr
GSHP	20 yr for interior components 100 yr for ground loop

NOTES:

Wood Heat

www.e3a4u.info

See Handouts!

The E³A (Exploring Energy Efficiency and Alternatives Youth Energy Activity Guide) is designed to help guide youth in their exploration of energy and energy technology. The guide includes hands-on experiential learning activities as well as information and resources to help lead the learning process.

TARGETED AGES

While activities can be modified to meet the needs of K-12 youth, this guide targets ages 9 to 13. More specific age recommendations are provided on each activity. Teen leaders can also be engaged to lead younger youth in the activities.

USING THE GUIDE

This guide is intended as a supplement to project leadership in topics like electricity and wind power. It is designed to provide activities and experiments for use in group meetings or camp settings to introduce key energy concepts. You may opt to use only one or two activities, or you can combine a series of activities to explore a topic in-depth.

The guide has been divided into key subject areas (wind power, solar electricity, solar thermal, etc.) Within each subject, activities are provided to teach key concepts. For some topics, multiple activities are suggested that utilize the same lesson plan—this allows you to find an activity that will work best for your group and location, as well as for available supplies.

THE LEARNING MODEL

Each lesson is built on two complimentary learning models—the Experiential Learning Model (Do, Reflect, Apply) of 4-H, and the 5E Constructivist model for science education. In these lessons, youth are involved in an activity, look back at it critically, determine what was useful or important to remember and use this information to perform another activity or modify the activity to be more successful. The lessons provide learning objectives as well as science curriculum standards addressed by each activity. Reflect and apply questions are asked in each section.

Do-Reflect-Apply model combined with 5E model.
5E model: Pfeiffer, J.W., & Jones, J.E., "Reference Guide to Handbooks and Annuals" ©1983 John Wiley & Sons, Inc. Reprinted with permission of John Wiley & Sons, Inc.

THE 5E LESSON PLAN

Engage: Each lesson begins with a brief activity to introduce the concept and get youth involved in learning. Based on their observations or experience, youth can develop a hypothesis—an assumption they will test with their experiment/activity.
Explore: Youth will explore an energy concept through an activity. Observations during the activity will help youth to test assumptions (hypothesis) and explore the concept in greater depth.
Explain: Through guided discussion, youth share their explorations and develop an understanding of the concept. Learners explore common themes and relate the key learning objectives to their experiences.
Extend: In the "extend" phase of the lesson, learners are asked to further test their assumptions and to apply the information in different ways.
Evaluate: The lesson closes with an evaluation of the concept that was explored, the activity conducted, and what was learned.

MONTANA STATE UNIVERSITY EXTENSION

NOTE! Many of these activities are designed to be conducted outdoors. In the event the weather does not cooperate, plan alternatives means of completing the activities.

NOTES:

Additional Resources

www.e3a4u.info

Selected Extension energy curriculum

- Energy Masters – Colorado State University
- Clean Energy Resource Teams– University of Minnesota
- Energize Ohio – The Ohio State University
- Energy Efficiency and Renewable Energy Resource – University of Wisconsin

Farm Energy IQ – Forthcoming: NE SARE PDP

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eXtension
more mind reach

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Farm Energy CoP
Home Energy CoP
Wood Energy CoP

NOTES: