RE-Build Black Forest

Energy and Water Efficient Construction and Financing

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Agenda

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<th>Topic</th>
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<td>9:00 - 9:50</td>
<td>The Basics of Home Energy and Water Efficiency</td>
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<td>10:00 - 10:50</td>
<td>Energy Efficient Heating and Cooling, Appliances and Lighting</td>
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<td>3</td>
<td>11:00 - 11:50</td>
<td>Renewable Energy Basics, Cost and Incentives</td>
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<td>11:50 - 1:00</td>
<td>One-on-One Q&amp;A</td>
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<td>Energy and Water Efficiency Certifications and Independent Inspections</td>
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<td>Efficient Construction Incentives and Mortgages</td>
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<td>Passive Solar and Local Case Study</td>
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<td>3:50 - 4:30</td>
<td>One-on-One Q&amp;A</td>
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Information

Slides will be posted at www.secres.org

Session 1
The Basics of Energy Efficient Construction
Session 2

Heating, Cooling & Ventilation Equipment; Appliances; Lighting

Heating Fuels and Current Costs

- Higher efficiency not always the most cost effective option
- Example for 90 MBTU annual heating requirement
  - 95% efficient gas furnace ($4500 installed): $900 fuel cost
  - 400% efficient electric ground source heat pump ($35,000 installed): $745 electricity cost
  - 197 year payback time
Selecting Heating and Cooling Equipment

- Step 1: **Always** first reduce heating and cooling requirements through passive means
- Step 2: Select balance between comfort, cost, ease of use, efficiency
- Step 3: Have equipment properly sized for actual requirements using industry standards (ACCA Manual J, Manual S)

Mechanical Heating Options

<table>
<thead>
<tr>
<th>Device</th>
<th>Cost</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Forced Air Furnace</td>
<td>$4500</td>
<td>• Efficiency up to 98%</td>
<td>• Requires ducts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reliable</td>
<td>• Volatile fuel cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cost</td>
<td>• Comfort, dust</td>
</tr>
<tr>
<td>Gas Boiler Hydronic Radiant</td>
<td>$6900</td>
<td>• Higher system efficiency than furnace</td>
<td>• No ducts for a/c</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Comfort</td>
<td>• Response time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Domestic water heat</td>
<td>• Higher cost than furnace</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Solar augmentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Easy zoning</td>
<td></td>
</tr>
<tr>
<td>Ground Source Heat Pump</td>
<td>$35000</td>
<td>• Very high efficiency</td>
<td>• Cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Water-to-air or water-to-water</td>
<td>• Misleading efficiency data:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Partial heating of domestic hot water</td>
<td>Circulation pump consumption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Heating and cooling</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ductless</td>
<td></td>
</tr>
<tr>
<td>Mini-Split Air Source Heat Heat Pump</td>
<td>$5500 (2 zones)</td>
<td>• Very high efficiency</td>
<td>• Zoning and heat distribution</td>
</tr>
</tbody>
</table>
Condensing vs. Non-Condensing Furnaces

**Condensing**
- 90+% Efficiencies
- Direct vent (Sealed Combustion)
- Eliminate combustion make-up air ducts
- Will not depressurize house (when direct vent)

**Non-Condensing**
- 80% Efficient
- Pulls combustion air from house
- Building code requirements for make-up air

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<tr>
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<th>Cons</th>
</tr>
</thead>
</table>
| Conventional Air Conditioning | $3500 to $6000 | • Reliability
• Cost
• Responsiveness | • Requires ducts
• Electrical consumption |
| Direct Evaporative Cooler   | $4500   | • 1/4th energy use of a/c
• No ducts
• Cost | • Maintenance
• Water consumption
• Increased humidity |
| Whole House Fan             | $500 to $1200 | • 1/4th energy use of a/c
• No ducts
• Cost | • Control during day
• Allows entry of pollen and allergens
• Requires homeowner action to open/close windows |
| Mini-Split Air Conditioner  | $4500   | • Very high efficiency
• No Ducts | • Zoning and distribution |
Ventilation Equipment

- “Build it tight…ventilate right”
- Indoor Air Quality: remove formaldehyde, radon, CO and CO2, VOCs
- Mechanical ventilation schemes for cold climates
  - None
  - Exhaust only: Can depressurize a tight house
  - Balanced (Energy Recovery Ventilators (ERVs); Heat Recovery Ventilators (HRVs)): Preferred option
- Standard: ASHRAE 62.2-2010
  - Supplemental Ventilation=(Total Reqmt)+(Spot Vent. Deficiencies)-(Infiltration Credit)
  - Starting point is Blower Door Test
- Approx Costs:
  - Exhaust Only: $350 to $800, No ducts required
  - ERV/HRV: $1200 to $5000, can use furnace ducts or stand-alone ducts
  - Spot ERV: $550 ea, No interior ducts reqd, Panasonic FV-04VE1 (40 cubic feet per minute, 23 Watts)

Water Heaters

- Safety
- Efficiency
  - Conventional 56-70%
  - Condensing 90-96%
  - Electric 92-98%
  - Hybrid 200-250%
- Cost $600 - $2400
- Solar Augmentation?
- Boiler Sidearm Tank?
Appliances

- Use Energy Star rated appliances
  - Search [www.energystar.gov](http://www.energystar.gov)
  - ES rating for washers and dishwashers also considers water consumption
- ES rates ceiling fans
- ES does not rate gas fireplaces
  - Select spark ignition model for 15+% increase in efficiency
  - Standing pilot lights consume $12 to $18 per month in gas
  - Great for ambiance...poor for efficient heating
- Well Pumps: High efficiency, soft start, variable speed

Appliances (Cont)

- Refrigerators
  - Select smallest ES-rated unit that meets needs
  - Larger, single refrigerator is more efficient than 2 smaller units
  - Avoid placing in unheated spaces
- Ovens & Cooktops
  - Gas ovens emit 1000+ ppm carbon monoxide during warm up (up to 10 minutes)
  - Highest efficiency electric cooktop is induction. Consider using with pressure cooker. Requires ferrous cookware
Lighting

- Conventional bulbs 10% efficient
- Highest lumens per watt per dollar is compact fluorescent bulb (CFL), but LED bulbs catching up
  - Incandescent = 14 lumens/watt
  - CFL = 63 lumens/watt
  - LED = 92 lumens/watt
- Tube Fluorescent:
  - Avoid conventional T-12 (1.5" diameter) with magnetic ballast (43 watts)
  - Install T-8 (1" diameter) with electronic ballast (28 watts)
- Consider
  - Dimming: Not all CFL bulbs are dimmable
  - Outside use: CFLs very slow to brighten in cold weather
  - Recycling: CFLs contain trace mercury. Recyclable at all Home Depot

Plumbing Fixtures

- Toilets, bathroom sink faucets, showerheads
- Search WaterSense Website: www.epa.gov/WaterSense/product_search.html
- Consider hot water recirculation: “On-demand” only, not continuous or timer
- Look for WaterSense label:
Resources

• Appliance, Furnace, Air Conditioning, Fans Search: www.energystar.gov
• Light bulb and appliance review: www.consumerreports.org
• WaterSense Product Search: www.epa.gov/WaterSense/product_search.html

Session 3

Renewable Energy: Basics and Cost
Renewable Energy Systems in 2013

• System types:
  1. Solar electric (PV)
  2. Solar Thermal
  3. Wind Energy
  4. Geothermal
  5. Combinations of the above (hybrids)

Basic “rules of energy systems”

• Every energy delivery system has 3 components:
  – Loads (requirement for energy- kwh)
  – Storage capacity (needed since generation rarely equals demand)
  – Energy production source
    • (Solar, wind, solar thermal, geothermal, biomass, etc.)
Energy Systems

Solar Electric (PV)

- Three main system categories:
  - Grid Tie Only (no batteries)
  - Grid tie with battery back up
    - Can include a back up generator
  - Off Grid system
Solar Electric (PV)

• **Grid Tie (No batteries)**
  – The utility grid acts as your storage
  – If the utility grid is down you are down (no storage component)
  – UL 1741 mandates no “islands” of power on a down grid for safety.
  – Inverter routes solar production to loads and/or grid and allows grid to provide for shortfall.
  – Local loads powered first, excess goes to grid
  – If your RE production is less than your demand, you buy shortfall from the grid.
Grid Tie System (No batteries)

- Battery based Grid Tie System
  - Battery charging is done by Charge Controller
  - Inverter takes DC from batteries and converts to AC
  - Typically only critical loads are powered by inverter and batteries.
  - Non critical loads are powered by the utility
  - Critical loads are “independent” of utility power.
  - More costly but provides independence
Solar PV GT system w/batteries

Solar Electric PV

- **Off Grid System**
  - Loads must be well defined to properly size the system (no utility to “make up the difference”)
  - Usually system owners are more aware of their energy usage
  - Systems can be quite capable if designed correctly
  - Conservation is a natural byproduct
  - Charge controller(s) charge storage media and inverter powers loads
Off Grid System

- Costs are: (residential and small commercial)
  - Grid tie (no backup): $3.50 to $5.50/watt
  - Grid tie with battery back up: $5.00 to $7.00/watt
  - Off Grid System: $4.50 to $7.00/watt

- Some cost variables are:
  - Roof mounting versus ground mounting
  - Quality of equipment
  - Market pricing of equipment
  - Distances between solar array and house
  - Code requirements, permits, fees

Solar Electric (PV)
Solar Electric (PV)

• Purchase Options:
  – Direct purchase
  – PPA (Power Purchase Agreement)
  – Equipment lease

• Other Considerations:
  – Conserve first, then size the system you need
  – Is the house design “Passive Solar”?  
  – HOAs, covenants, and the Law
  – Prepare the House; pre-wiring and plumbing pass throughs.

Solar Electric (PV)

• Return on investment:
  – Most common analysis is the payback period
    • With the Federal tax credit and typical energy rates, solar electric paybacks range from 8 to 20 years
    • On commercial installations payback is better due to tax credits and depreciation.
    • Intangibles such as energy independence, security, personal desire and lifestyle are also important.
  – Return on investment analysis is also an option:
    • What will the total return be over the lifetime of the system?
Solar Thermal Systems

• Solar Thermal Systems use the sun’s heat energy to heat a fluid medium such as water, polypropylene glycol, or a mixture of the two for use as a heat transfer solution to heat Domestic hot Water or for home heating or pools.
• Solar thermal systems use solar thermal collectors such as thermal panels or tubes to generate heat up to 300 degrees F.

Solar Thermal Systems

• Solar thermal systems have the same three segments as solar electric systems:
  – **Loads**: the domestic Hot Water tank or your home living space would be examples.
  – **Storage**: Typically there is a storage tank which acts as a thermal “battery” to store heat.
  – **Generation**: the Solar thermal panels act as the heat generation component.
Solar Thermal DHW system

Solar Thermal Systems
### Solar thermal systems

- **Payback analyses:**
  - In places where Propane is expensive ($2.00 to $2.50/gallon) these systems have excellent payback periods— as low as 5 years
  - Some utilities have rebates for solar thermal systems (Colorado Springs Utilities)
  - Federal Tax credit is available
  - Systems cost from $5,000 up to ?
  - Return on investment can be double digit.

### Wind Systems

- Wind power is a very good resource in certain parts of the country and in specific “microclimates”.
- It is a good compliment to solar energy
  - Usually, bad weather brings wind and good weather brings sun.
  - At night, winds can pick up significantly
- Care and “due diligence” is important in deciding to use wind power.
Wind Systems

• Several factors must be understood to make a good decision on wind power:
  – “General” wind resource in the area
  – Specific wind resource in your immediate area (microclimate)
  – Terrain features (terrain smoothness)
  – Trees, buildings, and other obstructions
  – Seasonal variations
Wind Systems

• Rules of thumb:
  – The wind turbine should be at least 20 feet higher than any obstruction within 300 feet.
  – Put the biggest and heaviest turbine you can afford as high as you can afford it.

  – Wind energy is a cubed function of wind speed
  – Wind harvest is a squared function of swept area

Wind Systems

• Payback periods for wind systems are generally a little longer than for solar electric systems.
  – Wind systems generally require more maintenance
  – In many situations, though, wind is a great choice for renewable energy production.
  – Wind systems are a great compliment to solar electric (Hybrid systems)
Finding a good installer

• It’s a big investment… protect yourself
  – Is the installer NABCEP certified?
    - NABCEP.org website (under certified locator tab)
    - Ask for references
    - Number of installed systems **of the type you are considering**
    - Years in business
    - Insured and licensed in local jurisdiction as an RE provider

References and materials

• NABCEP.org
• COSEIA.org
• Home Power Magazine (Homepower.com)
• Solar Energy international (Education), Carbondale, CO
• DSIREusa.org (Incentives by state and Federal)
• Colorado Energy Office (Colorado.gov under energy tab)
• RechargeColorado.com
How do I Know I’m Getting an Efficient Home?

- “Trust but Verify” with independent inspections and/or certifications
- Different Levels and Types
  - Computer Modeling
  - Home Energy Rating System (HERS) rating and certificate
  - Energy Star certification
  - Leadership in Energy and Environmental Design (LEED) Certification
  - WaterSense Certification
Finding an Independent Energy Rater or Professional Building Analyst

  - Basic design consulting
  - HERS Ratings
  - Energy Star certifications
  - Basic design consulting
  - Energy audits of existing homes

Home Energy Rating System (HERS)

- Like “EPA Mileage Sticker” for home efficiency
- Independent, third party tested (certified rater)
- Score of 100 = efficiency of 2006 energy code reference
  - Each point below 100 is 1% more efficient
- Average existing U.S. Home: HERS 130
- Compensates for climate
- Independent of homeowner behavior or family size
Interactive HERS Index

www.resnet.us/hers-index-large-scale

Energy Star Certification for New Homes

- Criteria exceeds current energy codes: Typically >25% more efficient than reference house
- Detailed inspections in 4 categories
  - Thermal enclosure: air sealing and insulation
  - Moisture management: walls, ceiling, foundation, roof, etc.
  - Heating/Cooling contractor design specifics
  - Energy Rater inspection of heating/cooling system and installer’s design criteria
- Detailed diagnostic testing and HERS rating are included
- Energy efficiency only- does not consider other sustainable features
LEED for Homes
Larry Gilland        LEED AP BD+C

What is LEED for Homes

USGBC – United States Green Building Council  www.usgbc.org
Specifics

- Is it right for you?
- Charrette
- Choose your team

Questions

- Costs
- Third party review
- How to get started
- Questions
  - Larry Gilland, LEED AP BD+C, CSI, NCBDC
  - LGA Studios - www.lgastudios.com
  - Collaborative Design Group - www.cdgteam.com
  - Rocky Mountain Plan company – www.rockymountainplan.com
  - 201 East Las Animas - Suite 113Colorado Springs, CO 80903
  - larry@lgastudios.com larrygilland@cdgteam.com
  - Cell: 719.684.5247 Office:719.635.0880
**WaterSense Certification**

- House 20% more water efficient than conventional construction
- Key fixtures: WaterSense certified
- Water-consuming appliances: Energy Star
- Irrigation and Landscaping: Designed to match climate, audited by WaterSense Partner
- Hot Water Distribution: minimized warm up time of hot water
- Don’t Forget: When on a well, water=electricity

**Resources**

- LEED for Homes Certification: [http://www.usgbc.org/leed/certification/homes](http://www.usgbc.org/leed/certification/homes)
- Interactive HERS Chart: [www.resnet.us/hers-index-large-scale](http://www.resnet.us/hers-index-large-scale)
- HERS Rating System: [http://www.resnet.us/professional/rater/what-is-a-thers](http://www.resnet.us/professional/rater/what-is-a-thers)
- Find a Home Energy Rater: [www.resnet.us/directory/search](http://www.resnet.us/directory/search)
Session 5

Incentives and Financing

Mountain View Electric

- Summary at mvea.org/documents/POLICYA012FactSheetrev2-19-13v2.pdf
- Rebates
  - High efficiency heat pumps
  - High efficiency electric water heaters
  - Energy Star refrigerator, washer, dishwasher
- Commercial Rebates
  - High efficiency motors
  - LED street, building and refrigerated case lighting
Black Hills Energy
Efficient New Construction Rebates

• Must heat the house with BHE gas
• 2 Tiers
  – Tier 1: $1500 builder rebate
  – Tier 2: $5000 builder rebate
  – Both Tiers: $300 rebate for HERS rating
• Closely mirrors Energy Star thermal envelope guidelines
• Requirements for heating system, water heating, ducts, air leakage and insulation
• Prescriptive and Performance paths
• Information at www.blackhillsenergy.com/save-money-energy/rebate-information/residential/colorado-gas-new-construction-program-builders

Colorado Energy Saving Mortgage Program

• Effective May 28, 2013 (HB 13-1105)
• Zero Net Energy (HERS 0) home: $8000 reduction in mortgage financing
• HERS 1 to 50: Partial reduction in mortgage financing
Energy Efficient Mortgage

- Credits energy efficiency in a mortgage
- Allows for higher debt-to-income ratio
  - Increase borrower’s income by monthly energy savings
- Offered through FHA, VA-- limits vary
  - VA: Applies to existing homes; $3000 to $6000 cap
  - FHA: Existing home or new construction; increase mortgage lesser of 5% of
    - The property value
    - 115% of median area price
    - 150% of conforming Freddie Mac limit
- Process:
  - RESNET rater performs formal HERS rating
  - Rater consults with buyer to determine proposed upgrades
  - Energy modeling determines annual savings and payback time
  - Report with financial analysis presented to lender

Energy Star Mortgage

ENERGY STAR Mortgage provides a permanently reduced interest rate.
- The loan proceeds must be used for improvements in Energy Efficiency.
- 1% of the loan amount is provided at closing for use as a rate reduction fee.
  Typical rate reduction from this one-time fee is 0.25% to 0.375%.

**Mortgage Savings**
$250,000 fixed rate 30 year mortgage:
- 3.875% = $1,175.00 (market rate)
- 3.625% = $1,140.00 (ESM rate)
- Saving $35.00/ month.

**Energy Savings**
- Before improvements $150.00
- After improvements $105.00
- Reduced 30% via energy efficiency improvements.
- Saving $45.00/ month

Total savings of $80.00 per month.
That can allow the borrower to finance up to $17,540.00
without increasing monthly expenses at all!

*These figures are typical, however, individual results will vary.*
Results

• Borrower improves the efficiency, comfort, and value of their home

• Even though the new mortgage is larger, due to the lower interest rate and energy savings, the borrower will spend no more paying off the loan than otherwise would have been spent.

Nothing down... Nothing a month... Nothing in the long run!

PowerSaver by Bank of Colorado

• *PowerSaver* is a new loan through HUD and the DOE providing funds to be used specifically for energy efficiency and renewable energy improvements.

• Loans up to $25,000.00
• Up to 100% of the home value.
• Loan Term of 15 years.
• Secured by 1st or 2nd Lien.
• Rate is 6.50%
• No closing costs.
Rural Development Energy Programs

- USDA Funded, Four Programs
  - Three biofuel related programs
  - Rural Energy For America Program (REAP)
- REAP
  - Renewable energy and energy efficiency loans and grants [For rural small businesses]
  - Energy Audit and Renewable Energy Development grants [For rural small businesses]
  - Feasibility Studies Grant Program

Resources

- Dept of Energy search tool for all local, state and federal efficiency and renewable energy incentives: www.dsireusa.org
- Energy Star Mortgage, PowerSaver Mortgage:
  - Stephen Ponce-Pore (970) 231-4024
  - stephen.poncepore@bankofcolorado.com
  - www.EnergySavingMortgage.com
- Energy Efficient Mortgages: www.energystar.gov/index.cfm?c=mortgages.energy_efficient_mortgages
Session 6

Net Zero Home: A Local Case Study

Jim Riggins
Southeast Colorado Renewable Energy Society

Design Philosophy

Passive House
Net Zero
All Electric
**Energy Consumption: Apr 1 2012 - Mar 31 2013**

- **Total Kilowatt-Hours:** 4001.8
- **PV Produced:** -7585.4
- **House Consumed:** -1458

Net Negative Performance: Avg 3.99 kWh/Day returned to grid.

**Overall Performance**

**Climate Zone 5**
- Monument, Colorado
- 6324 Heating Degree Days
- 149 Cooling Degree Days
- Elevation 7000’
Shell: Walls R-49 (Whole Assembly)

Shell: Roof R-67 (Whole Assembly)
Shell: Foundation R-23 Perimeter & Under

Air Sealing

Measured
- 0.02 Natural Air Changes per Hour
- Typical New House: 0.35 Natural Air Changes per Hour
Passive Solar

U=0.22, SHGC*=0.60

* SHGC = Solar Heat Gain Coefficient

Thermal Mass

Supplemental Heat

Mini-Split Air Source Heat Pump:
• Heat to -13 degrees F
• Heating at 350% efficiency
• Cooling at 2x efficiency of air conditioning
Passive Cooling

- Selective overhangs
- Thermal “chimney” at house center

Ventilation & Earth Tube
Domestic Hot Water

Lights and Appliances
Water Conservation

Sustainable Construction & Materials
Solar Photovoltaics

Substituting Sun for Gas
**Performance Snapshot**

**Temperature Data Dec 21 Through Dec 27**

- **T Outside**
- **T Inside**
- **T Earth Tube**
- **T Slab**

**Conclusions**

- “Passive House” philosophy works well
- Construction not complicated…just different focus areas
  - “Caulk is cheap”
- Cost:
  - With everything: +7.8% above conventional construction (includes solar tax credits)
  - Excluding solar PV and SHW: +2.2%
  - Excluding solar PV, SHW, Earth Tube: +0.7%
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