SWEEP Workshop on Zero Energy Homes in Utah:
Introduction to High Performance Homes

Rob Hammon, Ph.D.

What is Building America (BA)?

• National Department of Energy program
  – Marketable, cost-effective net-Zero Energy Homes (ZEHs) by 2020
• Today’s near-Zero Energy Homes
  – Advanced energy efficiency
  – Solar energy technologies
  – Utility bill reductions >50%
  – Goal: 40%-70% energy efficiency savings plus savings from solar
What is BIRA?

• Building Industry Research Alliance
  – Collaborative team; over 100 industry partners
  – Led by ConSol
• One of six Building America teams
  – Only West Coast team
  – Only team that is part of the building industry

Building America Research Process

House designs are compared to the “BA Benchmark” to predict savings level
Benefits of Building ZEHs with BA

• Monetary benefits
  – Cost savings from making the best materials and equipment choices
  – Reduced risks, increased productivity, and fewer callbacks
  – Sells faster than competition

• Additional benefits
  – Competitive advantage in the marketplace
  – Customer satisfaction and referrals
  – Beneficial to the environment

Salt Lake City, Utah – Building America’s Cold Climate Zone
### Some Homes Exceeding Code by 30%

<table>
<thead>
<tr>
<th>Building Features</th>
<th>Appliance Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Insulation</td>
<td>Refrigerator</td>
</tr>
<tr>
<td>R13 batts, 2x4, 16&quot;o.c.</td>
<td>Energy Star</td>
</tr>
<tr>
<td>Ceiling Insulation</td>
<td>Cooking Range</td>
</tr>
<tr>
<td>R40 fiberglass</td>
<td>Gas</td>
</tr>
<tr>
<td>Infiltration</td>
<td>Dishwasher</td>
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<tr>
<td>6.0 ACH50</td>
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</tr>
<tr>
<td>Foundation</td>
<td>Clothes Dryer</td>
</tr>
<tr>
<td>8 ft basement, R15 exterior</td>
<td>Gas</td>
</tr>
<tr>
<td>Window Type</td>
<td>Clothes Washer</td>
</tr>
<tr>
<td>0.325 U-value, 0.425 SHGC</td>
<td>Energy Star</td>
</tr>
<tr>
<td>Air Conditioner</td>
<td>Hardwired Lighting</td>
</tr>
<tr>
<td>SEER 13</td>
<td>100% CFL</td>
</tr>
<tr>
<td>Furnace</td>
<td></td>
</tr>
<tr>
<td>AFUE 90%</td>
<td></td>
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<tr>
<td>Water Heater</td>
<td></td>
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<tr>
<td>Gas standard (59%)</td>
<td></td>
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<tr>
<td>Ducts</td>
<td></td>
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<tr>
<td>Buried in attic</td>
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### Current Practices Achieve 30% Savings

- **Building America Benchmark:**
  - 240.7 MBtu Source Energy Use (MBtu/yr)
  - 30.1% Annual Source Energy Savings

- **Standard Practice (30%)**
  - 168.3 MBtu Source Energy Use (MBtu/yr)

Next Building America goal: 40% energy efficiency savings
What can be done to improve efficiency?

- Increased insulation (walls, ceiling)
- Better sealing for a tighter envelope
- Improved windows (U-value, SHGC)
- High efficiency heating and cooling systems
- Improved water heater
- Moving ducts into conditioned space

### 30% → 40% Features Comparison

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<th>Feature</th>
<th>Standard Practice (30%)</th>
<th>40% Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Insulation</td>
<td>R13 batts, 2x4, 16&quot;o.c.</td>
<td>R21 batts, 2x6, 16&quot;o.c.</td>
</tr>
<tr>
<td>Ceiling Insulation</td>
<td>R40 fiberglass</td>
<td>R50 fiberglass</td>
</tr>
<tr>
<td>Infiltration</td>
<td>6.0 ACH50</td>
<td>5.4 ACH50</td>
</tr>
<tr>
<td>Foundation</td>
<td>8 ft basement, R15 exterior</td>
<td>8 ft basement, R15 exterior</td>
</tr>
<tr>
<td>Window Type</td>
<td>0.325 U-value, 0.425 SHGC</td>
<td>0.318 U-value, 0.302 SHGC</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>Energy Star</td>
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<td>SEER 13</td>
<td>SEER 15</td>
</tr>
<tr>
<td>Furnace</td>
<td>AFUE 90%</td>
<td>AFUE 92.5%</td>
</tr>
<tr>
<td>Water Heater</td>
<td>Gas standard (59%)</td>
<td>Gas tankless (80%)</td>
</tr>
<tr>
<td>Ducts</td>
<td>Buried in attic</td>
<td>Inside conditioned space</td>
</tr>
</tbody>
</table>
Future Savings Levels at 40%

- Additional opportunities for savings in both heating and cooling
- Salt Lake City: 5,603 HDDs; 1,168 CDDs

Peak Reduction from EE & PV

No East, Eleven South, And Seven West

- New Avg Net Grid Load (E2W,W,S)
- Previous Avg Net Grid Load (E,S,W)
- Average of Non-ZEH Net Grid Load (kW)
- Avg of PV Pwr (W,S)
- Avg Gross loads (Kw)

- 2.9 kW: 19%
- 1.6 kW: 55%
- 0.86 kW: 67%
- 0.3 kW: 119%
Options to Improve Savings beyond 40%

- OVE/External Insulation/SIP walls
- MELs Reduction
- Geothermal heat pump
  - Trench/bore system
  - Water main system
- Solar
  - Passive heating
  - Hot water
  - Photovoltaics (PV)
  - PVT

OVE Walls (Optimum Value Engineered)

Uses engineering principles to minimize material usage while meeting model building code structural performance requirements.

Less framing provides room for more insulation.
External Foam Insulation

- Provides more R-value per inch than batts
- Acts as a thermal break between studs and outside air

SIPs (Structural Insulated Panels)
MELs Reduction (Misc. Electric Loads)

- Feedback display
- “Green switch”
- “Smart strip”
- Efficient electronic devices (TVs, etc.)

Geothermal Heat Pump

- Bore (vertical) system
- Trench (horizontal) system
**Benefits**

- Heat & cool savings up to 70%
- Lower install costs
- Lower maintenance costs
- Reduced pumping
- Reduces mechanical space
- No roof penetrations
- No combustion
- Longer system life
- Provides source of revenue
- Flexible & easily expandable
- Uses GeoExchange technology

**Potential Financial Benefits**

- **WaterGrid** utility owned, installed and maintained
- No first cost to developer/owner
- No water supply system costs
- No wastewater system costs
- No HVAC/DHW system costs
- Lower user energy costs
- Secondary treatment for use on-site and off-site (parks, etc.)
- Owner/user pays metered water use rate or a flat fee to utility
Passive Solar Heating/Cooling

- Window orientation
- Overhangs
- Shading
  - Landscaping
  - Exterior
  - Interior
- Mass
- Controls (night cooling)

SDHW (Solar Domestic Hot Water)

Can be implemented in cold climates using an indirect system with propylene glycol
PV Panels (Photovoltaic)

BIPV (Building Integrated) shown here

May not be cost effective for the homeowner unless combined with efficiency measures

PVT (PV-Thermal)

Utilizes previously wasted heat generated by PV system
PVT (PV-Thermal)

Includes:
- SIPs walls
- Geothermal heat pump
- PVT
- 25% reduction in MELs

5.5 kW PV system offsets most remaining energy needs; however, such a large system is not currently cost effective.

Includes:
- SIPs walls
- Geothermal heat pump
- PVT
- 25% reduction in MELs
ZEH Cost Effectiveness

• 40% efficiency measures
  – Currently developing cost effective strategies with builders in Utah

• PV/PVT Systems
  – Can be cost effective when combined with efficiency measures and available incentives

• Other advanced systems
  – May not be cost effective currently but will be soon as energy costs continue to rise and mature market costs develop

Thank You!

Questions?

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