SWEEP Workshop on Zero Energy Homes in Arizona: 
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

- Systems Research
- Prototype Homes
- Communities
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

Phoenix, Arizona – Building America’s Hot Dry Climate Zone
What features are currently being used?*

*based on 2006 IECC standards

<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>Standard</td>
</tr>
<tr>
<td>Ceiling Insulation</td>
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<td>R30 fiberglass</td>
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<tr>
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</tr>
<tr>
<td>Slab, uninsulated</td>
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<tr>
<td>Window Type</td>
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</tr>
<tr>
<td>0.39 U-value, 0.39 SHGC</td>
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<tr>
<td>Air Conditioner</td>
<td>Hardwired Lighting</td>
</tr>
<tr>
<td>SEER T3</td>
<td>0% CFL</td>
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<tr>
<td>Furnace</td>
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<tr>
<td>AFUE 80%</td>
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<tr>
<td>Water Heater</td>
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<tr>
<td>Gas standard (59%)</td>
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<tr>
<td>Ducts</td>
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<td>Typical, R4.2</td>
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2006 IECC Achieves 30% Savings

Current Building America goal: 50% energy efficiency savings
What can be done to improve efficiency?

- Increased ceiling insulation
- Adding a radiant barrier
- Better sealing for a tighter envelope
- Improved windows (U-value & SHGC)
- Energy Star appliances
- Fluorescent lighting
- High efficiency heating and cooling systems
- Improved water heater
- Improved duct insulation & location

### Standard (30%) → 40% Features Comparison

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<td>0% CFL</td>
<td>50% CFL</td>
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<tr>
<td>Air Conditioner</td>
<td>SEER 13</td>
<td>SEER 14</td>
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<td>SEER 13</td>
<td>SEER 14</td>
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<tr>
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<td>Gas standard (59%)</td>
<td>Gas tankless (80%)</td>
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<tr>
<td>Ducts</td>
<td>Typical, R4.2</td>
<td>Inside conditioned space</td>
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Features necessary to reach 40%
Features necessary to reach 50%

Savings Levels at 40% and 50%

- **45.5% Annual Source Energy Savings** (40% Energy Efficiency Savings)
- **53.7% Annual Source Energy Savings** (50% Energy Efficiency Savings)
Options to Further Improve Savings

- 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

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 hot climates using a direct or indirect system
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

4.5 kW PV system offsets all remaining energy needs; however, such a large system is not currently cost effective.
Peak Reduction from EE & PV

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)

No East, Eleven South, And Seven West

1.6 kW; 55%
0.86 kW; 67%
1.3 kW; 55%
0.66 kW; 67%
-0.3 kW; 119%
3.9 kW
20:45
19:45
18:45
17:45
16:45
15:45
14:45
13:45
12:45
11:45
10:45
9:45
8:45
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ZEH Cost Effectiveness

• 50% efficiency measures
  – Currently developing cost effective strategies with builders in the Hot Dry Climate Zone

• 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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