

# 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



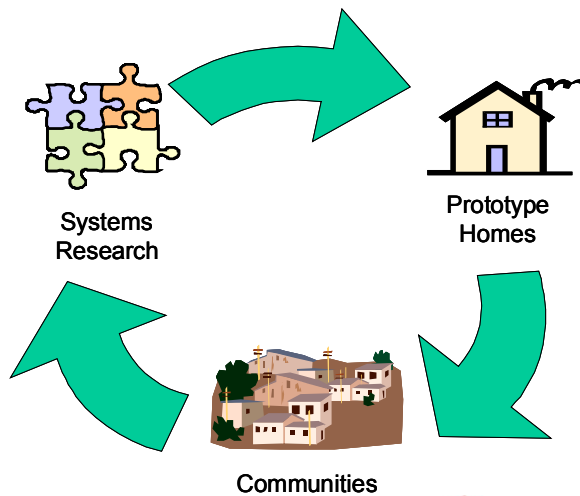
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## Building America Research Process



House designs are compared to the "BA Benchmark" to predict savings level



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## Benefits of Building ZEHs with BA



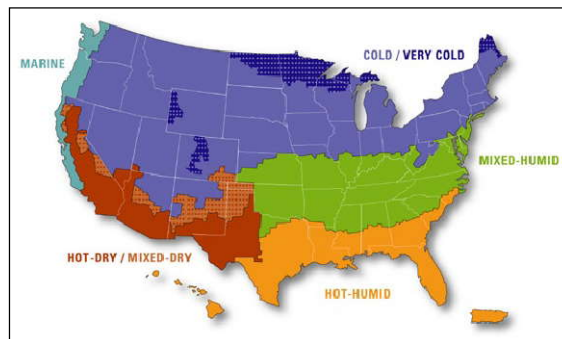
- Monetary benefits
  - Cost savings from making the best materials and equipment choices
  - Reduced risks, increased productivity, and fewer callbacks
  - Sells faster than competition
- Additional benefits
  - Competitive advantage in the marketplace
  - Customer satisfaction and referrals
  - Beneficial to the environment



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## Phoenix, Arizona – Building America's Hot Dry Climate Zone



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## What features are currently being used?\*



\*based on 2006 IECC standards

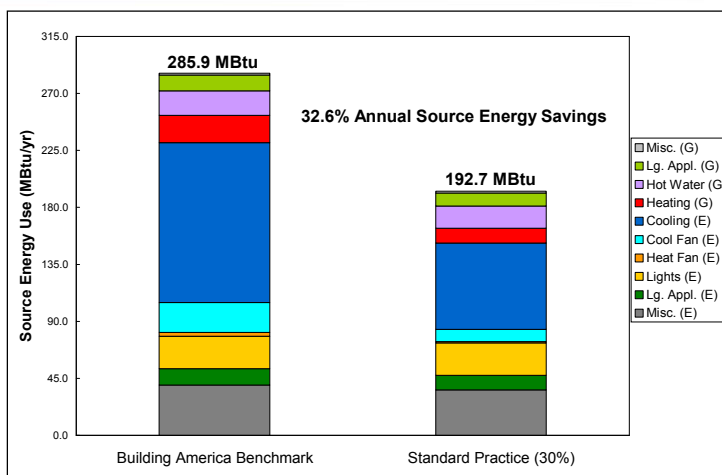
Building Features		Appliance Features	
Wall Insulation	R13 batts, 2x4, 16"o.c.	Refrigerator	Standard
Ceiling Insulation	R30 fiberglass	Cooking Range	Gas
Infiltration	6.0 ACH50	Dishwasher	Standard
Foundation	Slab, uninsulated	Clothes Dryer	Gas
Window Type	0.39 U-value, 0.39 SHGC	Clothes Washer	Standard
Air Conditioner	SEER 13	Hardwired Lighting	0% CFL
Furnace	AFUE 80%		
Water Heater	Gas standard (59%)		
Ducts	Typical, R4.2		



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## 2006 IECC Achieves 30% Savings



Current Building America goal: 50% energy efficiency savings



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## 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



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



Feature	Standard Practice (30%)	40% Savings
Wall Insulation	R13 batts, 2x4, 16"o.c.	R13 batts, 2x4, 16"o.c.
Ceiling Insulation	R30 fiberglass	R40 fiberglass
Raidiant Barrier	None	None
Infiltration	6.0 ACH50	6.0 ACH50
Foundation	Slab, uninsulated	Slab, uninsulated
Window Type	0.39 U-value, 0.39 SHGC	0.35 U-value, 0.35 SHGC
Refrigerator	Standard	Energy Star
Cooking Range	Gas	Gas
Dishwasher	Standard	Energy Star
Clothes Dryer	Gas	Gas
Clothes Washer	Standard	Energy Star
Hardwired Lighting	0% CFL	50% CFL
Air Conditioner	SEER 13	SEER 14
Furnace	AFUE 80%	AFUE 80%
Water Heater	Gas standard (59%)	Gas standard (59%)
Ducts	Typical, R4.2	Improved, R8



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## Standard (30%) → 50% Features Comparison



Feature	Standard Practice (30%)	50% Savings
Wall Insulation	R13 batts, 2x4, 16"o.c.	R13 batts, 2x4, 16"o.c.
Ceiling Insulation	R30 fiberglass	R40 fiberglass
Raidiant Barrier	None	Radiant Barrier
Infiltration	6.0 ACH50	3.0 ACH50
Foundation	Slab, uninsulated	Slab, uninsulated
Window Type	0.39 U-value, 0.39 SHGC	0.35 U-value, 0.35 SHGC
Refrigerator	Standard	Energy Star
Cooking Range	Gas	Gas
Dishwasher	Standard	Energy Star
Clothes Dryer	Gas	Gas
Clothes Washer	Standard	Energy Star
Hardwired Lighting	0% CFL	100% CFL
Air Conditioner	SEER 13	SEER 14
Furnace	AFUE 80%	AFUE 92.5%
Water Heater	Gas standard (59%)	Gas tankless (80%)
Ducts	Typical, R4.2	Inside conditioned space

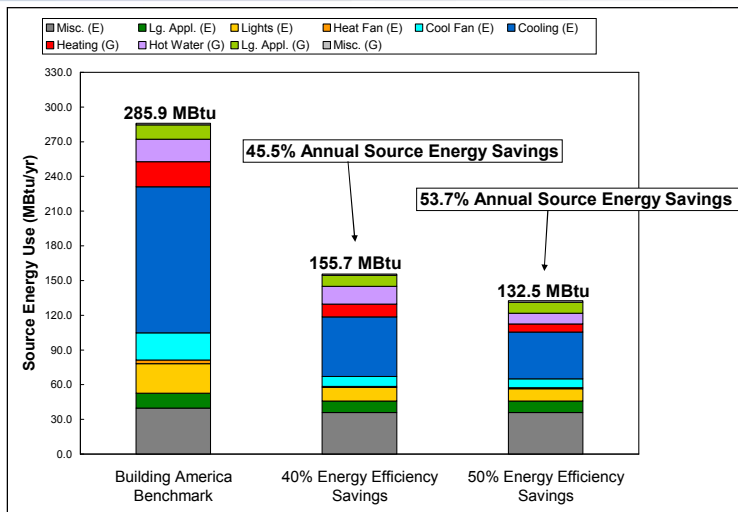


█ Features necessary to reach 40%  
█ Features necessary to reach 50%

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## Savings Levels at 40% and 50%



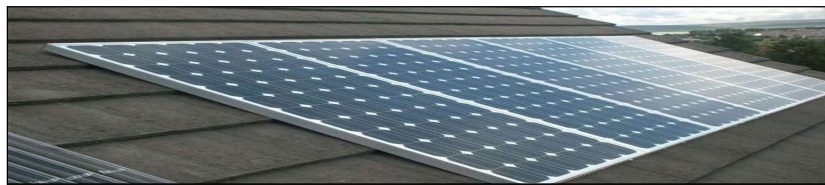
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## Options to Further Improve Savings



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



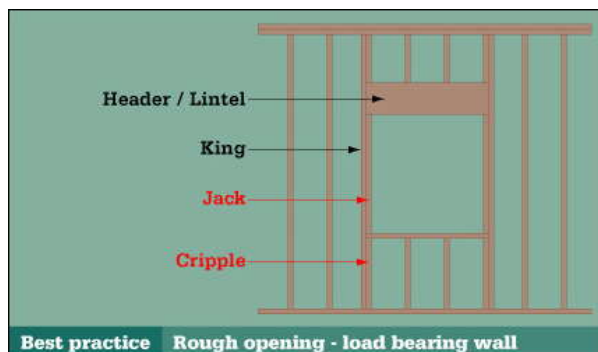
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## OVE Walls (Optimum Value Engineered)



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



Less framing provides room for more insulation



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## External Foam Insulation



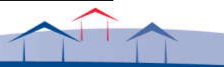
- Provides more R-value per inch than batts
- Acts as a thermal break between studs and outside air



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## SIPs (Structural Insulated Panels)



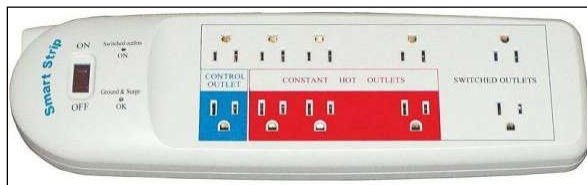
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## MELs Reduction (Misc. Electric Loads)



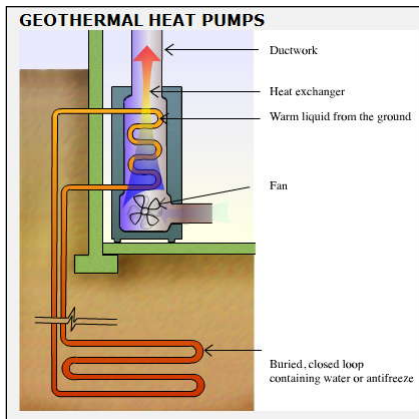
- Feedback display
- “Green switch”
- “Smart strip”
- Efficient electronic devices (TVs, etc.)



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## Geothermal Heat Pump



Trench (horizontal) system

Bore (vertical) system



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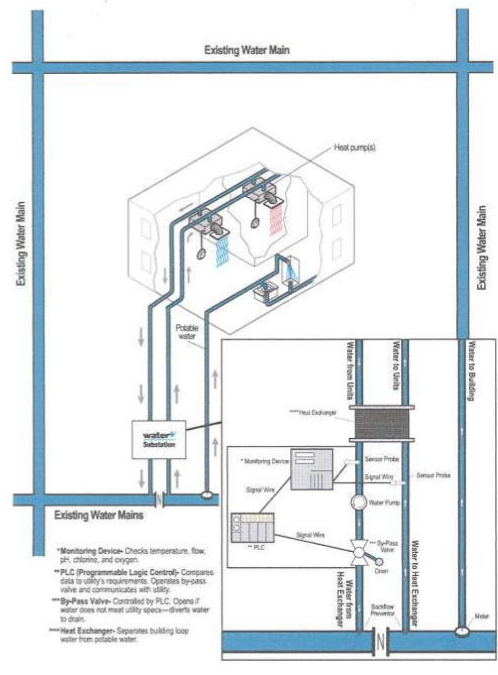
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**Benefits**

- 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

**water+ Installation with Heat Exchanger**



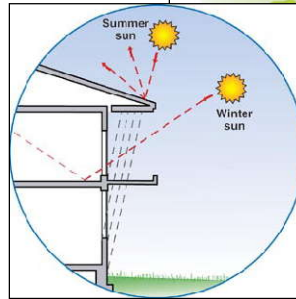
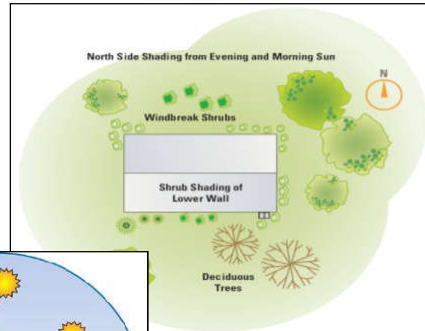
**Financial Benefits**

- **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)



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## SDHW (Solar Domestic Hot Water)



Can be implemented in hot climates using a direct or indirect system



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## PV Panels (Photovoltaic)



BIPV (Building Integrated) shown here

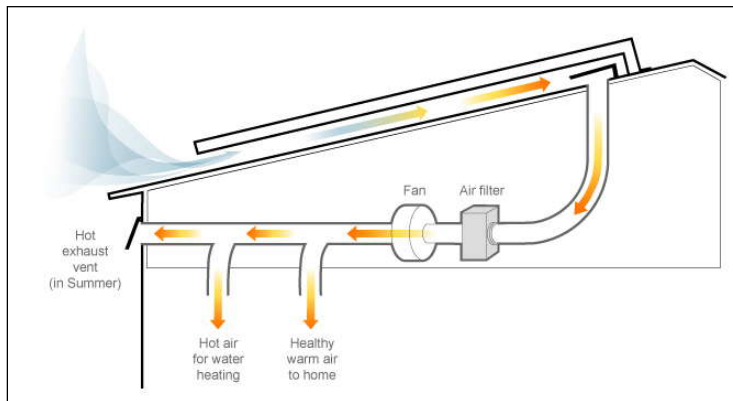
May not be cost effective for the homeowner unless combined with efficiency measures



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## PVT (PV-Thermal)



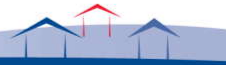
Utilizes previously wasted heat generated by PV system



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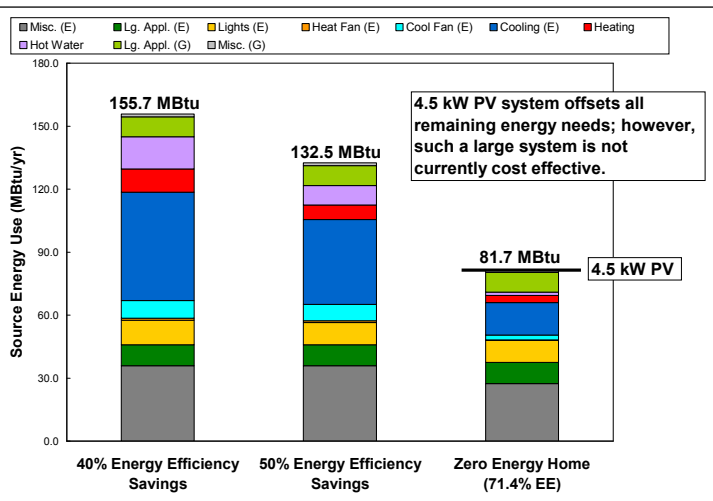
# PVT (PV-Thermal)



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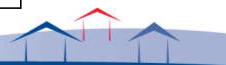
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# ZEH Example



Includes:

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



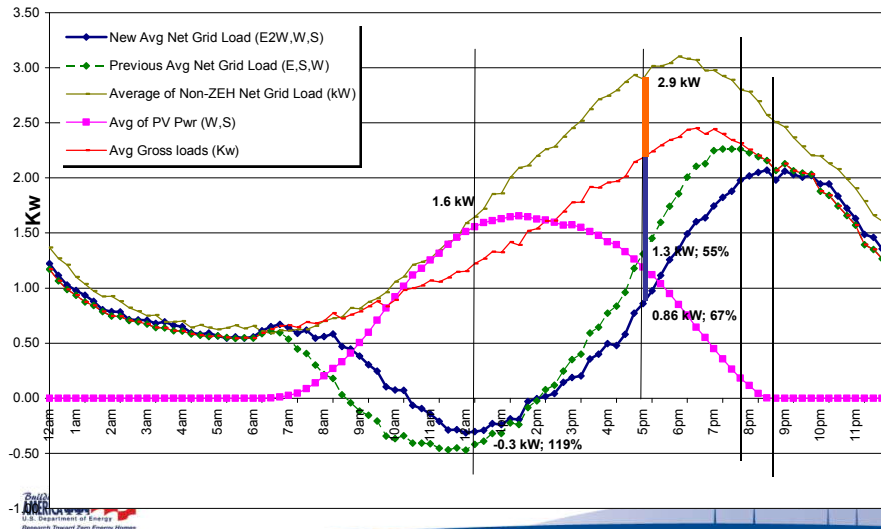
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## Peak Reduction from EE & PV



No East, Eleven South, And Seven West



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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



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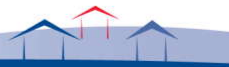


Thank You!



Questions?

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