High Performance Homes

What I will cover

- Design Features
- Financial and Technical Assistance
- Marketing and Selling
- When to Incorporate Solar and Distributed Generation
Design Features

- **Envelope Performance First**

- **Systems Approach**
  - Health
  - Safety
  - Affordability
  - Comfort
  - Durability

- **Lowest Cost Greatest Benefit**
  - Air Flow
  - Moisture Flow
  - Heat Flow
  - Pressure Management

- **Design Features**

- **Maximize Dollars Already Spent**
  - Framing
  - Windows
  - Air Sealing
  - Insulation
  - HVAC
  - Duct Systems

- **Further Improve Performance**
  - Pressure Management
  - Moisture Management

- **Additional Cost to Builder**
Design Features

- Inspect and Test
  - Framing Inspection
  - Duct Leakage Test
  - Insulation Inspection
  - Pressure Test
  - Air Leakage Test

Inspect
Inspect

Misalignment

No Air Barrier

Voids

Similar Detail with Infra-Red

7/27/05 11:33:20 e=0.98
Pressure Management

- **Extremely Important**
  - Health and Safety
  - Energy Use
  - Comfort

- **3 Primary Reasons**
  - Duct Leakage
  - Door Closures
  - Exhaust Devices
Manage Pressures – Duct Leakage

Impact of Duct Leakage On House Pressures

Supply Leaks

Return Leaks

Eliminate Duct Leaks

No mastic between the sheet metal collar and the flex duct beneath the strap.

The return duct to plenum is not sealed at all. The strap did not catch the interior flex duct.
Pressures from Door Closures

Control Pressures
Exhaust Devices

1. Exhaust Fans and Exhaust Ventilation
2. Dryers
3. Cooktop/Stove Exhaust
4. Central Vacuums
5. Power Venting

Install and Filter Fresh Air
Test During Construction

Test When Complete
Financial & Technical

- **Builder – Financial Assistance**
  - Average $400.00 per home cash incentive
  - Print, Radio, TV Advertising
  - On-site promotional items

- **Builder – Technical Assistance**
  - HVAC Load Calculations
  - Inspections and Testing
  - Training for Sub-contractors, Sales Agents, Etc.

Marketing and Selling

- Guaranteed Comfort
- Specially Designed Electric Rate
- Personal Attention on problems
Distributed Generation
Guarantee with PV@ Armory Park

NearNet Zero
Long Term Goal - Near NetZero

They Work Together

For More Information:
Linda Douglas - Worthey
ldouglas@tep.com
Or visit website
www.tep.com
Financial Assistance - Distributed Generation

- **Distributed Generation (2008)**
  - $3.00 per DC watt up-front incentive
  - $2,000 maximum Federal Tax Credit
  - $1,000 maximum State Tax Credit

Financial Assistance 2008
Residential Solar Hot Water

- **Solar Water Heating (with 10 year warranty)**
  - $750 plus
  - 25¢ per kWh based on 1st year kWh (max $1750)

- **Solar Water Heating (with 5-10 year warranty)**
  - PBI at 5.7¢/kWh for 10 Years
  - PBI at 5.2¢/kWh for 15 Years
  - PBI at 5.1¢/kWh for 20 Years
Financial Risk of Guarantee?

- Average Dollars Exceeding Guarantee:
  $5,800.00/Year (10 year average)

- Percentage Exceeding Guarantee:
  10% (10 year average)

Average air change & duct leaks

The baseline Guarantee Home DOE-2 model was developed using test data, specification and program standards provided by TEP. Table 2.0 provides a summary description of the baseline Guarantee Home DOE-2 model that was validated against TEP provided utility data. Some of the parameters in Table 2.0 are slightly superior to the Guarantee Home specification, such as infiltration rates and duct leakage. Each Guarantee Home is tested for infiltration and duct leakage using a blower door test method and with a Duct Buster®; respectively. The test data provided by TEP shows that on average the infiltration rate for an approximate 1850-square-foot Guarantee Home is 0.22 air-change per hour (ACH), and the average duct leakage is about 2%. These numbers were used as the DOE-2 model inputs. Infiltration was modeled only when the HVAC...
## Enovity Analysis

### Table 3.9
Model Home DOE-2 Annual Simulation Results

<table>
<thead>
<tr>
<th>DOE-2 Model Home</th>
<th>HVAC</th>
<th>Total Energy</th>
<th>Total Utility Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating (kWh)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling (kWh)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (kWh)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer (kWh)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric: TOE (electric)</td>
<td></td>
<td>(electric)</td>
<td>(electric)</td>
</tr>
<tr>
<td>Electric: TOE (fuel)</td>
<td></td>
<td>(fuel)</td>
<td>(fuel)</td>
</tr>
<tr>
<td>Total Utility Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HVAC Efficiency Options</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Guarantee Home</td>
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<td>1.94</td>
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<td>IECO Standards:</td>
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<tr>
<td>Electric Heat &amp; DW</td>
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<tr>
<td>Guarantee Home Savings</td>
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<td>776</td>
<td>1.774</td>
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<td>IECO Standards:</td>
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</tr>
<tr>
<td>Electric Heat &amp; DW</td>
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<td>3.34</td>
<td>N/A</td>
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<tr>
<td>Guarantee Home Savings</td>
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<td>776</td>
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<td>EnergyStar Homes:</td>
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<tr>
<td>Electric Heat &amp; DW</td>
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<tr>
<td>Guarantee Home Savings</td>
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<td>776</td>
</tr>
</tbody>
</table>

### Footnote:
- Support the data in these tables using validation procedures and models for electric and gas savings using home data from DOE 2006.
- TOE = total energy use.
- **IECO** = IECO standards.
- **EnergyStar** = EnergyStar standards.
- **Guarantee Home Savings** = Savings from the DOE-2 simulations.
- **HVAC Efficiency Options** = Efficiency options for HVAC systems.

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## High-Efficiency Options

### Table 4.1
Additional DOE-2 Annual Simulation Results: Guarantee Home with Higher Efficiency (SEER), Heat Pumps

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<td>Electric: TOE (fuel)</td>
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<tr>
<td>Total Utility Costs</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HVAC Efficiency Options</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guarantee Home 14 SEER, Electric Heat &amp; DW</td>
<td>N/A</td>
<td>874</td>
<td>4.023</td>
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<tr>
<td>Guarantee Home 16 SEER, Electric Heat &amp; DW</td>
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<tr>
<td>Guarantee Home 16 SEER, Electric Heat &amp; DW</td>
<td>N/A</td>
<td>774</td>
<td>3.353</td>
</tr>
</tbody>
</table>

### Footnote:
- **IECDO** = IECDO standards.
- **IEC20** = IEC20 standards.
- **IECO Standards** = IECO standards.
- **Guarantee Home Savings** = Savings from the DOE-2 simulations.
- **HVAC Efficiency Options** = Efficiency options for HVAC systems.
Does The Guarantee Work

Guarantee vs Actual Heat/Cool Cost
New World Homes - All Projects
Anniversaries through March 2003

Cost per Day

Individual Homes

Guaranteed Amt
Actual Amt

Does The Guarantee Work

Guarantee vs Actual Heat/Cool Cost
Kaufman & Broad - All Projects
Anniversaries Through March 2003

Cost per Day

Individual Homes

Guaranteed Amt
Actual Amt
House Facts

- 1860 ft$^2$
- All Electric
- 12 SEER, 3-ton heat pump
- Solar water heating with electric back-up
- Heydon Building System

Energy Costs - Year 1

- Total Energy Cost = $652
- $54.30 per month
- Heating & Cooling = $198
- $16.50 per month
- 56¢ per day avg. (356 days)
Energy Costs - Year 2

- Total Energy Cost = $799
- $66.57 per month
- Heating & Cooling = $244
- $20.32 per month
- 67¢ per day avg. (364 days)

Energy Costs - Year 3

- Total Energy Cost = $768
- $64.00 per month
- Heating & Cooling = $221
- $18.39 per month
- 61¢ per day avg. (364 days)
Pressure Balance

- Master Bedroom to Main Body of house = +2.8 pa.
- Bedroom 2 to Main Body = +0.8 pa.
- Bedroom 3 to Main Body = +1.8 pa.

Pressure Balance

- House to Outdoor with heat pump on = +0.6 pa.
- Master Bedroom closed with heat pump on = +0.3 pa.
- All doors closed with heat pump on = 0.0 pa.
Duct Leak Test

- 26 CFM25 - This Guarantee House
- 411 CFM25 – Average Code Built House

Blower Door Test
Average Code Built Home

- 2162 ft$^2$
- 2623 CFM50
- 7.4 ACH50
- 0.34 ACH
Blower Door Test
This Guarantee Home

- 1860 ft$^2$
- 1540 CFM50
- 5.0 ACH50
- 0.23 ACH