Managing HVAC in High Performance Buildings
• High Performance Custom Builder since 2010
  • New Construction, Renovations, & Additions
  • Recipient of more than 10 housing awards
• ENERGY Raters since 2009
  • LEED, EarthCraft, DOE Zero Energy Ready, Enterprise Green Communities, Energy Star, NGBS to name a few...
  • Certified more than 1,200 units
• Air Sealing Professionals
  • Launched AeroBarrier with supplemental services
• Developers
  • Q2 break ground on Eco-Village, 66 Acre TND +88 plus homes
LEARNING OBJECTIVES

• Understand how building design and construction affects HVAC equipment design and capacity

• Define and describe what is meant by the terms “high performance home” & “low load home”

• Identify differences between traditional and high performance residential HVAC system components

• Understand how to control humidity in high performance homes and the benefits to occupants and builders
CASE STUDY 1:
Green Shortz Green House

PROJECT DATA
- **Layout:** 3 bdrm, 2.5 bath, 2 fl + bsmt, 2,389 ft²
- **Climate:** IECC 3A, mixed-humid

**SQUARE FOOTAGE:**
- **LOWER LEVEL**................. 544 SQ.FT.
- **MAIN LEVEL**.................. 1,475 SQ.FT.
- **UPPER LEVEL**................ 698 SQ.FT.
- **TOTAL**........................ 2,389 SQ.FT.
- **BONUS ROOM**..................
- **GARAGE**......................
- **PORCHES & DECKS**........... 382 SQ.FT.
CASE STUDY 1:

Green Shortz Green House

KEY FEATURES

- **Walls:** 2x6 24” o.c., advanced framed; R-23 blown-in fiberglass; R-6 insulated coated taped sheathing; rain screen; fiber cement siding.
- **Roof:** 29-gauge reflective metal roof over furring strips, 15-lb felt; coated roof deck.
- **Attic:** Unvented attic, R-21 open-cell spray foam.
- **Foundation:** Split level with basement and slab on grade; R-5 rigid fiberglass on exterior; R-7 on interior and under slab.
- **Windows:** Double-pane, low-e+, argon-filled, vinyl frames; U=0.26, SHGC=0.19.
- **Air Sealing:** 1.6 ACH 50.
- **Ventilation:** ERV + in-line fan into attic.
- **HVAC:** 16.5 SEER, 9.5 HSPF mini-split heat pumps: 2 ducted air handlers and 2 ductless air handlers connected to one exterior compressor unit.
- **Hot Water:** Heat pump water heater, EF 3.39; manifold plumbing; insulated piping.
- **Lighting:** Interior 90% LED; exterior 100% LED.
- **Appliances:** ENERGY STAR refrigerator, dishwasher, clothes washer.
- **Solar:** Solar ready.
- **Water Conservation:** Followed EPA WaterSense recommendations.
- **Energy Management System:** Smart thermostat.
- **Other:** EPA Indoor AirPLUS, EarthCraft Sustainable Program.
CASE STUDY 1: Green Shortz Green House

Four Zones - Ducted + Ductless

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**Project Summary**

*Energy Vanguard*

**Entire House**

*Energy Vanguard*

**Project Information**

*Job: Mills Res., 617 Bruce Wa.*

*Date: 02/10/2017*

*By: Andy Bell*

*Plan: Rev5*

**Notes:**

- ERV ventilation, R-19+R6.6 cont, BG-R-5 cont ext + R-7 closed cell, R-5 under slab

**Design Information**

*Weather: Dekalb Peachtree, GA, US*

**Winter Design Conditions**

- Outside db: 25 °F
- Inside db: 70 °F
- Design TD: 45 °F

**Summer Design Conditions**

- Outside db: 91 °F
- Inside db: 75 °F
- Design TD: 16 °F
- Daily range: M
- Relative humidity: 50 %
- Moisture difference: 33 g/ft²

**Heating Summary**

- Structure: 21645 Btuh
- Ducts: 1363 Btuh
- Central vent (54 cfm): 903 Btuh
- Humidification: 0 Btuh
- Piping: 0 Btuh
- Equipment load: 23900 Btuh

**Infiltration**

- Method: Simplified
- Construction quality: Semi-tight
- Fireplaces: 1 (Tight)

**Sensible Cooling Equipment Load Sizing**

- Structure: 13939 Btuh
- Ducts: 1027 Btuh
- Central vent (54 cfm): 329 Btuh
- Blower: 0 Btuh
- Use manufacturer's data: n
- Rate/swing multiplier: 0.96
- Equipment sensible load: 14745 Btuh

**Latent Cooling Equipment Load Sizing**

- Structure: 1913 Btuh
- Ducts: 171 Btuh
- Central vent (54 cfm): 766 Btuh
- Equipment latent load: 2084 Btuh
- Equipment total load: 16829 Btuh
- Req. total capacity at 0.75 SHR: 1.6 ton

**Outdoor Units Heads**

- 4
CASE STUDY 1: Green Shortz Green House

<table>
<thead>
<tr>
<th>PANASONIC MODEL#</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-E9SD3UAW</td>
<td>Indoor 9K BTU Low Profile Duct</td>
</tr>
<tr>
<td>CS-E12SD3UAW</td>
<td>Indoor 12K BTU Low Profile Duct</td>
</tr>
<tr>
<td>CS-ME7RKUA</td>
<td>FLEXI HP I/D WALL MOUNT 7 KBTU</td>
</tr>
<tr>
<td>CU-5E36QBU</td>
<td>5 ZONE MULTI HP O/D 36 KBTU</td>
</tr>
</tbody>
</table>
CASE STUDY 1: Green Shortz Green House

Ductless (Basement + Master Bed)

Ducted (Main + 2nd Floor)

Walking into a trap!?  
• Jumper ducts  
• Transfer grills  
Let us see...
CASE STUDY 1:
Green Shortz Green House

**Bath Exhaust & Transfer**
WhisperValue with Condensation Control

**Make Up AIR (hood & supplement)**

- **FV-04WS2**
  - 20 CFM/40 CFM/Off switch
  - 6” Duct

**SPOT ERV**

- **FV-04VE1**
  - 40/20 CFM or 20/10 CFM
  - Two 4” Ducts

- What’s missing?
CASE STUDY 1: Green Shortz Green House

The industry's most complete line of whole house ventilating dehumidifiers and accessories.

How did the house perform?
CASE STUDY 1:

Green Shortz Green House

2nd FLOOR
- Average %HR 67
- Thermostat Set
- Homeowner 78 F
- 1 week sampled
CASE STUDY 1: Green Shortz Green House

MAIN FLOOR
- Average %HR 62
- Thermostat Set Homeowner @ 78 F
- 1 week sampled
CASE STUDY 1:

Green Shortz Green House

• What was driving this high RH in home?
  – Low tolerance to cool temp by homeowners, thermostat set above design condition 74 F (78 F)
  – VERY long showers by teenagers
  – Upgraded Huber Zip Sheathing from R-3 to R-6
    • HVAC ran ONLY 21 minutes in one week (August in Atlanta, GA)

• Solutions:
  – Adjusted Thermostat to 74 F, problem stabilized but then added permanently an OFF THE SHELVES dehumidifier on unvented attic

BUT AT THE END...
CASE STUDY 1:
Green Shortz Green House

Home Energy Rating Certificate
Final Report

HERS® Index Score: 39
Annual Savings: $1,722
*$Relative to an average U.S. home

Your Home's Estimated Energy Use:

<table>
<thead>
<tr>
<th>Use [MBtu]</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>$243</td>
</tr>
<tr>
<td>Cooling</td>
<td>$64</td>
</tr>
<tr>
<td>Hot Water</td>
<td>$38</td>
</tr>
<tr>
<td>Lights/Appliances</td>
<td>$493</td>
</tr>
<tr>
<td>Service Charges</td>
<td>$60</td>
</tr>
<tr>
<td>Generation (e.g. Solar)</td>
<td>-0</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>$898</strong></td>
</tr>
</tbody>
</table>

This home meets or exceeds the criteria of the following:
- Energy Star v3
- Energy Star v3.1
- 2009 International Energy Conservation Code
- 2012 International Energy Conservation Code

Rating Completed by:
- **Energy Rater:** Carl Seville
  - RESNET ID: 9857492
- **Rating Company:** SK Collaborative
  - 333 Adams St, Decatur, GA 30030
  - 404-480-4500
- **Rating Provider:** Energy Vanguard
  - 533 W Howard, Suite E, Decatur, GA 30030
  - 678-662-4332

Carl Seville, Certified Energy Rater
Date: 6/15/18 at 1:49 PM
CASE STUDY 2: Kuntz Mitsubishi Residence

IMERY HOMES
Healthy · Durable · Efficient

SQUARE FOOTAGE:

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>SQUARE FOOTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOWER LEVEL</td>
<td>1025 SQ.FT.</td>
</tr>
<tr>
<td>MAIN LEVEL</td>
<td>642 SQ.FT.</td>
</tr>
<tr>
<td>UPPER LEVEL</td>
<td>248 SQ.FT.</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1915 SQ.FT.</td>
</tr>
</tbody>
</table>

BONUS ROOM: 638 SQ.FT. (EXISTING)
GARAGE: 450 SQ.FT.
PORCHES & DECKS: 400 SQ.FT.

FRONT ELEVATION

Note: ATTIC VENTILATION PER LOCAL CODES AND REQUIREMENTS.
CASE STUDY 2: Kuntz Mitsubishi Residence

KEY FEATURES

• **Walls**: 2x6 plates with 2x4 staggered studs 24” OC, R-19 blown-in cellulose, R-3 Zip R-board
• **Roof**: 26- gauge reflective standing seem roof.
• **Attic**: Vented, with R-50 blow-in cellulose
• **Foundation**: Above grade insulated slab R-10
• **Windows**: 3 pane, low-e, argon filled, vinyl frames U=.19, SHGC=0.23
• **Air Sealing**: 2.69 ACH50
• **Ventilation**: ERV – balanced
• **HVAC**: 20 SEER, 10 HSPF mini-split heat pumps, 3 ductless, and 1 dusted connected two 2 outdoor units
• **Hot Water**: Prototype Split Heat Pump water heater, EF 2.3; manifold plumbing, insulated piping
• **Lighting**: 100% LED
• **Appliances**: ENERGY STAR refrigerator, dishwasher, clothes washer
• **Solar**: 2 strings of 15 panels - 8.1 Kw
• **Water Conservation**: Followed EPA WaterSense
• **Energy Management**: 2 energy monitoring systems
• **Other**: EPA IndoorAirPlus, EarthCraft House
CASE STUDY 2: Kuntz Mitsubishi Residence

<table>
<thead>
<tr>
<th>Area</th>
<th>Htg Load</th>
<th>Clg Load</th>
<th>Minisplit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Bed</td>
<td>4,670</td>
<td>1,524</td>
<td>½ Ton ductless</td>
</tr>
<tr>
<td>Bed 2</td>
<td>1,539</td>
<td>1,056</td>
<td>½ Ton ductless</td>
</tr>
<tr>
<td>Bed 3</td>
<td>2,822</td>
<td>1,978</td>
<td>½ Ton ductless</td>
</tr>
<tr>
<td>Main</td>
<td>13,758</td>
<td>10,021</td>
<td>1 ½ ton ducted</td>
</tr>
<tr>
<td></td>
<td>20,789</td>
<td>14,579</td>
<td></td>
</tr>
</tbody>
</table>
CASE STUDY 2: Kuntz Mitsubishi Residence
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CASE STUDY 2: Kuntz Mitsubishi Residence

Mitsubishi Electric Equipment Installed
- (3) MSZ-FH Wall-Mounted Indoor Units
- (1) MXZ-3C24NAHZ2 Multi-zone Outdoor Unit
- (1) PEAD-A18AA7 Horizontal-Ducted Indoor Unit
- (3) PAC-USWHES002-WF-1 Wireless Interfaces
- (1) PUZ-PW30NHA Hot Water Heat Pump and Space Conditioning Outdoor Unit Prototype

Ductless:
Master Bedroom
2nd & 3rd Bedroom

Ducted:
Rest of House

Outdoor Units:
CASE STUDY 2: Kuntz Mitsubishi Residence

Bath Exhaust & Transfer
WhisperValue with Condensation Control
WhisperValue with Condensation Control

ERV BROAN ERVS100S (%RH sensor)

MD33 l
CASE STUDY 2: Kuntz Mitsubishi Residence

Home Energy Rating Certificate
Final Report

HERS® Index Score: -13
Your home's HERS score is a relative performance score. The lower the number, the more energy efficient the home. To learn more, visit

Annual Savings: $2,837
*Relative to an average U.S. home

Home: 2376 Troy Smith Rd
30656
Builder: Imery Group

This home meets or criteria of the following:
- Energy Star v3
- Energy Star v3.1
- 2012 International Energy Conservation Code
- 2009 International Energy Conservation Code

This home is considering:
- 1½ ton ductless
- 1 ton ducted
- 1½ ton ductless
- 3/4 ton ducted

Final Energy Use:

<table>
<thead>
<tr>
<th>Use [MBtu]</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>$196</td>
</tr>
<tr>
<td>Cooling</td>
<td>$65</td>
</tr>
<tr>
<td>Hot Water</td>
<td>$122</td>
</tr>
<tr>
<td>Lights/Appliances</td>
<td>$735</td>
</tr>
<tr>
<td>Service Charges</td>
<td>$120</td>
</tr>
<tr>
<td>Generation (e.g. Solar)</td>
<td>-$1,118</td>
</tr>
<tr>
<td>Total</td>
<td>$120</td>
</tr>
</tbody>
</table>

Home Feature Summary:
- Home Type: Single family detached
- Conditioned Floor Area: 1,963 sq. ft.
- Number of Bedrooms: 3
- Primary Heating System: Custom, Electric, 10 HSPF
- Primary Cooling System: Custom, Electric, 20 SEER
- Primary Water Heating: Custom, Electric, 2.3 Energy Factor
- House Tightness: 0.33 CEMF50 (2.69ACH50)
- Ventilation: 970 CFM, 100% Outdoor Air
- Duct Leakage to Outside: 14 CEM25
- Above Grade Walls: R-29
- Attic: R-52
- Window Type: U-Value: 0.31, SHGC: 0.23
- Foundation Walls: N/A

Rating Completed by:
- Energy Rater: Brian Young
- RESNET ID: 5078000
- Rating Company: Southface Energy Rated Homes
- 241 Pine St NE
- 404-604-3637

Digitally signed: 12/6/18 at 8:55 AM
CASE STUDY 2:
Kuntz Mitsubishi Residence

Energy production peaked at 5.1 kW. The little energy usage spike is the hot water heater.

Here’s one from the weekend showing me charging my EV. Almost a perfect match of production and consumption – free fuel!