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ZERO ENERGY HOME PROJECT
Project Overview

- Cheap
- Easy to manufacture
- Sacrifice
- Simplicity
- Mass Produce
- Basic Needs
- Location (city, state): Pottstown (General Area), PA
- House size (floor area in square feet): 2100 sqft
- Number of floors: 1 plus attic, no basement
- Number of occupants: 4
- Number of bedrooms: 3 bedrooms, 2 full baths
- Type of heating system: Geothermal, Dual System
- Main heating fuel: Geothermal, Electric Backup
- Solar water heater (yes or no): Yes
- Ventilation air heat recovery (yes or no): Yes
Pictures-North Face
Pictures-South Face
Pictures- East Face
Pictures- West Face
Pictures- Inside Top View
Pictures-21\textsuperscript{st} December
Pictures- 21st September
Pictures-21$^{st}$ of June
Pictures-21st of September
Research Summary

- Design - our house
- Create - a simplistic design and models
- Combine - various systems to work together
- Simplify - do not bring complex components into the plan
- Study - ZEH research, looking at other models
- Collaborate - work as a team
Analysis of Key Decisions

- Basic Design- Rectangle, seventy feet by thirty feet- designed house first, then rooms inside
- Three bedrooms, two bathrooms
- Open floor plan for aeration when wind permits
- Laundry room combined with Utility room
- Kitchen, dining room, office, bar
- Total Square Footage= 2100 sq. ft.
Appliances

- Selection Process for each appliance:
  - James Washing Machine
    - Zero energy
    - Minimal water usage
  - Kenmore Refrigerator
  - Vizio LCD TV
  - Whirlpool Dishwasher
Envelope and Behaviors

- Five Surfaces to consider
- Opted to have no basement, there was really no need for one
- Thus, four walls, one ceiling
- Designed to be very tight, with minimal amount of spaces that could leak air.

- Minimal water usage:
  - Low flow shower heads
  - Hands free faucets
  - Laminar Flow Faucet Aerator

- Save on energy costs:
  - Clothes line
  - Manual Clothes Washer
  - Power Strips
## ZEH Spreadsheet

### Penn State Center for Sustainability

<table>
<thead>
<tr>
<th>General Info</th>
<th>Zero Energy Home Calculator</th>
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</thead>
<tbody>
<tr>
<td>Location</td>
<td>Philadelphia</td>
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<tr>
<td>Electricity cost ($/kwh)</td>
<td>0.1</td>
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<tr>
<td>Conditioned floor area (sq.ft.)</td>
<td>1152</td>
</tr>
<tr>
<td>Number of bedrooms</td>
<td>3</td>
</tr>
<tr>
<td><strong>Envelope Details</strong></td>
<td><strong>Behavior</strong></td>
</tr>
<tr>
<td>Wall construction</td>
<td>Double 2x4 with 10' foam</td>
</tr>
<tr>
<td>Ceiling Insulation</td>
<td>R60</td>
</tr>
<tr>
<td>Window type</td>
<td>Triple low-e</td>
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<tr>
<td>Upper floor ceiling area (sq.ft.)</td>
<td>2100</td>
</tr>
<tr>
<td>North wall area (gross) (sq.ft.)</td>
<td>630</td>
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<tr>
<td>East wall area (sq.ft.)</td>
<td>270</td>
</tr>
<tr>
<td>South wall area (sq.ft.)</td>
<td>630</td>
</tr>
<tr>
<td>West wall area (sq.ft.)</td>
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</tr>
<tr>
<td>North window area (sq.ft.)</td>
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<td>East window area (sq.ft.)</td>
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<td>South window area (sq.ft.)</td>
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<td>West window area (sq.ft.)</td>
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<tr>
<td>Air tightness</td>
<td>Tight with heat recovery</td>
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<tr>
<td>Major Appliances</td>
<td>Refrigerator: Best</td>
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<tr>
<td></td>
<td>Clothes Washer: Best</td>
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<tr>
<td></td>
<td>Dishwasher: Best</td>
</tr>
</tbody>
</table>

### Heating & Cooling

- Type of heating & cooling system: Electric heat pump
- Solar Technologies:
  - Size of PV system (kw): 5.3
  - Solar water heater: Yes

### Envelope Heat Transmission

<table>
<thead>
<tr>
<th>Component</th>
<th>Transmission Percentage</th>
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</thead>
<tbody>
<tr>
<td>Floor</td>
<td>17%</td>
</tr>
<tr>
<td>Walls</td>
<td>17%</td>
</tr>
<tr>
<td>Windows</td>
<td>32%</td>
</tr>
<tr>
<td>Roof</td>
<td>17%</td>
</tr>
</tbody>
</table>

### Annual Cost ($)

- **Lights**: $77
- **Major appliances**: $162
- **Misc electric loads**: $287
- **Hot water**: $89
- **Heating**: $97
- **Cooling**: $75
- **TOTAL**: $76
HVAC

- No dedicated air conditioning system (built into geothermal)
- Mostly a Geothermal based heat pump system
  - System lasts for 25 to 50 years, thus very practical
  - Very high efficiencies (300-600%) achieved on very cold nights
  - Dual source heat pump provides even greater savings
  - Original cost returned through electrical savings in five to ten years.
Solar Technologies

- Photovoltaic Panels for Electricity Generation
- Solar Water heating panels
  - First hand account- Tyrus-Little to no maintenance, last a very long time
  - Very little maintenance, cost returned to you many times over.
  - Original cost returned in estimated four to ten years, has a much longer life span
  - If designed well, backup heater will only experience minimal usage
Summary of Design

- Simplicity
- Integrated Designs
- Greatest Challenges - Designing the physical model, coming up with a floorplan, working with rough materials when building physical models
Summary of Design

- Team Members favorite parts:
  - Ian - Designing and working on Physical model, lack of complex variables
  - Tyrus - floorplan
  - Christian - Sketchup model, Simplistic design
  - Josh - Open Floorplan design, working on physical model
Goals and Conclusions

- Main goal: simplistic house that combined various systems, including HVAC and Solar Energies, in an integrated design that was easily obtainable.

- Obtained, as shown by previous slides, through collaboration, study of previous designs, and simplistic variables.