Pre-Fabricated Building Envelope Systems in Passive House New Construction

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Who is this guy?

- Karan Gupta
  - pronounced KUH-run
  - you can call me KG
  - Energy Efficient Design Specialist for Build SMART
    - based in Lawrence, KS
    - manufacturer of high-performance, pre-fabricated building envelope systems
  - Certified Passive House Consultant
  - PHIUS Certified Builder
Why Pre-Fabricated?
Why Pre-Fabricated? (continued)
Wall System

Framing:
2x4 to 2x12 engineered lumber framed in a jig system to guarantee precision and stability; allows for cavity insulation for varying climates; familiarity to trades

Air barrier:
Factory sealed OSB joints; fastened to meet shear wall requirements

Insulation:
3.5” to 11.5” termite treated EPS according to climate requirements; factory laminated to OSB

Exterior sheathing:
OSB with integrated weather membrane factory laminated to EPS - no need for house wrap and ready to accept all standard exterior finishes

Flashed window buck:
All the window panels come with a sloped sill and liquid applied flashing around the rough opening to provide a watertight and airtight installation

Super efficient windows:
Triple-paned filled with inert gas. The windows and doors are factory installed and sealed to guarantee weather tightness
Framing
Preinstalled Windows & Doors
Not SIPs, Not Modular
Panel Types
Slab Insulation System

- Top and exterior face of EPS foam coated with Dryvit
- Cast-in-place concrete slab
- Plastic rebar chairs
- Pre-fabricated 3.0# termite treated EPS slab form
- 1.5#, 2" thick termite treated EPS, total thickness varies per climate
- Pressure treated plate sealed to vapor/air barrier and slab with high-performance liquid sealant
- Continuous air/vapor barrier supplied and installed in field
Benefits of Pre-fabrication

- A stick-framed house creates nearly 30x more jobsite waste than a component-framed house.

- **2.5x faster.** A crew can frame two and half homes with structural building components in the time it takes to stick-frame one house.

- It takes 75% more lumber wood product to stick frame a structure than to frame it with components.
Airtightness
## Blower Door Results

| Gross Envelope Area | 63641 ft² | \( \text{dry-in (9/26/2017)} \) | 3550 CFM\(_{50} \) = 0.056 CFM\(_{50} / \text{ft}^2 \) gross envelope area | \( \text{completion (4/17/2017)} \) | 2996 CFM\(_{50} \) = 0.047 CFM\(_{50} / \text{ft}^2 \) gross envelope area |
What about cost?
## Cost Comparison

<table>
<thead>
<tr>
<th></th>
<th>Pre-2012 code</th>
<th>Field install Passive House</th>
<th>Pre-fabricated wall panels Passive House</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Window &amp; Door Materials Cost</td>
<td>$144,220</td>
<td>$292,660</td>
<td>$220,000</td>
</tr>
<tr>
<td>2-Wall Materials Cost</td>
<td>$40,652</td>
<td>$221,336</td>
<td>$267,070</td>
</tr>
<tr>
<td>3-Window Door Wall Cost</td>
<td>$184,872</td>
<td>$513,996</td>
<td>$487,070</td>
</tr>
<tr>
<td>4-Cost per Floor Sq Ft</td>
<td>$3.50</td>
<td>9.74</td>
<td>$9.22</td>
</tr>
<tr>
<td>5-Wall, Window &amp; Exterior Door Labor Cost</td>
<td>$144,350</td>
<td>$214,125</td>
<td>$99,025</td>
</tr>
<tr>
<td>6-Total Wall, Window &amp; Exterior Door Labor &amp; Materials Cost</td>
<td>$329,222</td>
<td>$728,121</td>
<td>$586,095</td>
</tr>
<tr>
<td>7-Cost per Floor Sq Ft</td>
<td>$6.24</td>
<td>13.80</td>
<td>$11.10</td>
</tr>
</tbody>
</table>
Impact of Lower Utility Costs on Underwriting

- **Total Tenant Payment Must Be Less than or Equal to the Max Tax Credit Rent or FMR**
- **Total Tenant Payment = Rent + Utilities**
- **Rent = Total Tenant Payment – Utilities**. Utilities Often Underwritten using Housing Authority Allowances
- We had Qualified Expert Calculate the difference between typical Housing Authority Allowances and Passive House projected utility allowances

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**/utility_analysis: passive house makes us money!!**
## Impact of Utility Costs on Borrowing Capacity

<table>
<thead>
<tr>
<th></th>
<th>Housing Authority Allowances</th>
<th>Calculated Passive House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Operating Income</td>
<td>$99,116</td>
<td>$136,292</td>
</tr>
<tr>
<td>Debt Coverage Ratio*</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Payment (NOI/DCR)</td>
<td>$55,064</td>
<td>$75,718</td>
</tr>
<tr>
<td>Max Mortgage (30 yrs @ 5.5%)</td>
<td>$800,000</td>
<td>$1,100,000</td>
</tr>
</tbody>
</table>

*1.07 in Year 15

**CHIP:** “Passive House lets you borrow/leverage more money to build more housing.”
## Impact of Utility Costs on Developer Fee

<table>
<thead>
<tr>
<th></th>
<th>Housing Authority Allowances</th>
<th>Calculated Passive House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Development Cost</td>
<td>$12,750,000</td>
<td>$12,750,000</td>
</tr>
<tr>
<td>LIHTC Equity</td>
<td>$11,000,000</td>
<td>$11,000,000</td>
</tr>
<tr>
<td>Soft Debt/Grants</td>
<td>$450,000</td>
<td>$450,000</td>
</tr>
<tr>
<td><strong>Mortgage</strong></td>
<td><strong>$800,000</strong></td>
<td><strong>$1,100,000</strong></td>
</tr>
<tr>
<td>Total</td>
<td><strong>$12,250,000</strong></td>
<td><strong>$12,550,000</strong></td>
</tr>
<tr>
<td>Deferred Fee Required</td>
<td>$500,000</td>
<td>$200,000</td>
</tr>
<tr>
<td>Gross Fee</td>
<td>$1,500,000</td>
<td>$1,500,000</td>
</tr>
<tr>
<td><strong>Net Fee</strong></td>
<td><strong>$1,000,000</strong></td>
<td><strong>$1,300,000</strong></td>
</tr>
</tbody>
</table>

**CHIP:** “We’re a nonprofit, which means we don’t put the net fee in our pockets. We put that money into new developments. Higher net fees mean we can house more people.”

UTILITY ANALYSIS: PASSIVE HOUSE MAKES US MONEY!
missionfirsthousing.org

“WOULD WE DO IT AGAIN?”

1. We built it within the budget we proposed
2. Significant savings on utilities allows us to leverage fees to build more housing
3. No major screw-ups during construction (related to Passive House)
4. Healthier, more comfortable environment for our tenants