Lessons Learned

Two Passive House Case Studies for New and Retrofit Affordable Senior Housing in Pittsburgh
Laura Nettleton • Rebecca Griffith
LESSONS FROM PITTSBURGH

Two Passive House Retrofits

$170/SF

Morningside Crossing

$185/SF

Glassport Retirement Residence
THREE BUILDINGS IN ONE

Morningside Crossing

New Wing
1897 School
1929 Addition
Standardize design detailing and components.
THREE BUILDINGS IN ONE

Morningside Crossing

New Wing
MORNING SIDE CROSSING

Walls

Morningside Crossing: Three Walls

1897

1929

2018
MORNINGSIDE CROSSING

Walls

1897 Wall

- GYPSUM BOARD
- METAL STUDS
- 5" SPRAY FOAM & AIR BARRIER
- EXISTING WALL

INSIDE

AIRSPACE

EXISTING WALL

OUTSIDE
Walls

1929 Wall

INSIDE

OUTSIDE

GYPSUM BOARD

6” METAL STUDS

ZIP SHEATHING

& AIR BARRIER

4” POLYISO

FURRING

EXT. CLADDING
Indoor pollution control outdoor contaminants
TWO BUILDINGS IN ONE

Glassport Retirement Residence
WE NEED A SITREP
WE NEED A GLASSPORT SITE PLAN HERE
GLASSPORT GYM AREA WALL

Need for New Wall

1. Contractor wanted plumb surface for insulation attachment.
2. Contractor concerned about air sealing uneven wall surface.
3. Existing wall contained holes and protrusions.
4. Two plaster walls not in same plane.
GLASSPORT GYM AREA WALL

Demolition
GLASSPORT GYM AREA WALL

Demolition
GLASSPORT GYM AREA WALL

Demolition
Evolution: Original Concept

GLASSPORT GYM AREA WALL

E6
EXTERIOR WALL CLADDING OVER EXISTING WALL W/ INSUL.

- CLADDING PER ELEVATIONS
- 1/4 TREATED WOOD FURRING (FASTEN THRU TO NAILER)
  AT EXPOSED FASTENER CLADDING, PROVIDE SECOND
  (PERPENDICULAR) LAYER OF FURRING
- 6" TYPE II EXPANDED POLYSTYRENE RIGID INSULATION (EPS)
  R-4.2 PER INCH (R-25.5 MIN.) INSTALLED IN OVERLAPPING LAYERS
- 2x4 TREATED WOOD NAILER ATTACHED TO EXISTING WALL
- SELF-ADHERED WATER-RESISTIVE BARRIER (AIR BARRIER, VAPOR PENE TRABLE)
- EXISTING CONSTRUCTION

Assembly no. 01u6
Building assembly description E6 (Existing Wall w/ 6" Ext. Insulation)

<table>
<thead>
<tr>
<th>Orientation of building element</th>
<th>R per inch</th>
<th>R per inch</th>
<th>R per inch</th>
<th>R per inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall</td>
<td>4.20</td>
<td>4.20</td>
<td>1.20</td>
<td>4.50</td>
</tr>
<tr>
<td>Outdoor air</td>
<td>0.21</td>
<td></td>
<td></td>
<td>1.50</td>
</tr>
<tr>
<td>Existing Masonry</td>
<td></td>
<td>2x4 Nailer 16&quot; o.c.</td>
<td>16.00</td>
<td></td>
</tr>
</tbody>
</table>

Percentage of sec. 1 79%  Percentage of sec. 2 22%  Percentage of sec. 3 8%  Total 22.00

R-value: 27.9 hr-ft²·°F/ BTU
GLASSPORT GYM AREA WALL

Evolution: New Concept

- GLADDING PER ELEVATIONS
- 14 TREATED WOOD FURRING (FASTEN TO NAILED)
- AT EXPOSED FASTENER, GLADDING, PROVIDE SECOND (PERPENDICULAR) LAYER OF FURRING
- TYPE II EXPANDED POLYSTYRENE RIGID INSULATION (EPS)
- R-4.2 PER INCH (R-26 MIN.) INSTALLED IN OVERLAPPING LAYERS
- SELF-ADHERED WATER-RESISTIVE BARRIER (AIR-BARRIER, VAPOR-PERMEABLE)
- 1/2" EXTERIOR SHEATHING
- 2X4 WOOD STUDS @ 16" O.C. (BRACE TO EXISTING WALL @ 48" VERT/HORIZ.)
- 3-1/2" MINERAL WOOL BATT INSULATION
- R-4.2 PER INCH (R-15 MIN.)
- AIR GAP FROM EXISTING WALL CONSTRUCTION AS NECESSARY TO ALLOW VERTICAL/PLUMB WALL
GLASSPORT GYM AREA WALL

New Wall
GLASSPORT GYM AREA WALL

New Wall
GLASSPORT GYM AREA WALL

New Wall
Existing Conditions
MORNINGSIDE INTERSECTING WALLS

New Plan
MORNINGSIDE INTERSECTING WALLS

Ideal Conditions
Our Approach

MORNINGSIDE INTERSECTING WALLS

1897 Wall

<table>
<thead>
<tr>
<th>INSIDE</th>
<th>AIRSPACE</th>
<th>EXISTING WALL</th>
<th>OUTSIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• GYPSUM BOARD</td>
<td>• METAL STUDS</td>
<td>• 5&quot; SPRAY FOAM &amp; AIR BARRIER</td>
<td>• EXISTING WALL</td>
</tr>
</tbody>
</table>
MORNINGSIDE INTERSECTING WALLS

Our Approach

1. ‘Sleeve’ insulation and air barrier on either side of existing masonry bearing walls.
MORNINGSIDE INTERSECTING WALLS

Solutions: Exterior Walls
MORNINGSIDE INTERSECTING WALLS

Our Approach

1. BASE OF EXTERIOR WALL
   SCALE: 1/2" = 1'-0"
MORNINGSIDE INTERSECTING WALLS

Existing Conditions
MORNINGSIDE INTERSECTING WALLS

Solutions: Underslab
MORNINGSIDE INTERSECTING WALLS

Solutions: Underslab
Our Approach

- **Set stud wall on subfloor on sleepers to provide thermal break.**
- **Exist masonry wall.**
- **Air barrier (HFO CC SPF).**
- **Exist concrete floor.**
- **Exist concrete joist on curved STL strongback.**
- **Extend air barrier (HFO CC SPF) 5' along floor underside, encapsulate joists and STL strongbacks.**
- **Thermally broken support as required - no MTL stud connection to slab or masonry wall.**
- **Patch existing plaster and lath ceiling as required after SPF installation on floor structure above.**

**WALL AT INTERMEDIATE FLOOR**

Scale: 1 1/2" = 1'-0"
MORNINGSIDE INTERSECTING WALLS

Existing Conditions
MORNINGSIDE INTERSECTING WALLS

Solutions: Wall to Ceiling
MORNINGSIDE INTERSECTING WALLS

Solutions: Wall to Ceiling
MORNINGSIDE INTERSECTING WALLS

Solutions: Wall to Ceiling
MORNINGSIDE INTERSECTING WALLS

Our Approach

- **NEW ROOFING AND SHEATHING OVER EXISTING ROOF STRUCTURE**
- **BLOWN IN ATTIC INSULATION**
- **2” SPRAY FOAM INSULATION IN ATTIC ABOVE EXISTING MASONRY WALLS**
- **EXISTING MASONRY WALLS IN ATTIC**
- **EXISTING MASONRY WALLS IN ATTIC**
- **EXISTING SHEATHING ON EXISTING STEEL FURRING**
- **NEW ASPHALT SHINGLE ROOF**
- **EXISTING STEEL STRUCTURE**
- **NEW GUTTER STRUCTURE AND REPAIR/REPLACE PATCH AND REPAINT CORNICE**
- **EXTERIOR**
- **AIR BARRIER (HDF 00 SPF)**
- **EXISTING MASONRY WALL**
- **EXIST PLASTER AND LATH CEILING**

**Typical:**
- **EXTEND EXTERIOR ASSEMBLY TO UNDERSIDE OF EXISTING STRUCTURE, REMOVE/FILL PLASTER CEILING, REmOVED FOR ACCESS & EXTEND AND SEALS END JAMB, LAY-AWAY OPENING ALONG FACE OF EXISTING FLOOR STRUCTURE (MIN 48”)**

- **EXTEND INTERIOR ASSEMBLY & DAMAGE REPAIR (AS NECESSARY)**
- **EXISTING FOUNDATION WALL**
- **EXIST MASONRY WALL**
- **EXIST RASH AND LATH CEILING**

**3**

**Scale: 1'0" X 1'0"**
MORNINGSIDE THERMAL BREAK

Steel to Steel
MORNINGSIDE THERMAL BREAK

Steel to Steel
MORNINGSIDE WINDOW ADVENTURE

Our 1st Solution

4 SILL: WINDOW AT EXIST MASONRY (INT INSUL)

SCALE: 3" = 1'-0"
MORNINGSIDE WINDOW ADVENTURE

A Wake Up Call
MORNINGSIDE WINDOW ADVENTURE

A Wake Up Call
MORNINGSIDE WINDOW ADVENTURE

A Wake Up Call
MORNINGSIDE WINDOW ADVENTURE

The Evolution
MORNINGSIDE WINDOW ADVENTURE

The Evolution

\[ T_{\text{ext}} = 48.3 \, ^\circ\text{F} \]
\[ T_{\text{air-inlet}} = 48.7 \, ^\circ\text{F} \]
\[ T_{\text{air-100\% dew-point}} = 42.8 \, ^\circ\text{F} \]
\[ f_{\text{air}} = 0.687 \]
\[ f_{\text{air/Rh100\% dew-point}} = 0.599 \]
\[ T_{\text{f}} = 68.0 \, ^\circ\text{F} \quad \text{Rh}_f = 40 \% \]
\[ T_{\text{w}} = 5.2 \, ^\circ\text{F} \quad \text{Rh}_w = 50 \% \]

\[ M_{\text{in}} = 67.1 \, ^\circ\text{F} \]
MORNINGSIDE WINDOW ADVENTURE

The Evolution

\[ T_{\text{air}} = 48.3 \, ^\circ \text{F} \]
\[ T_{\text{RH} 50\% \text{ (moist)}} = 48.7 \, ^\circ \text{F} \]
\[ T_{\text{RH} 100\% \text{ (dry-powd)}} = 42.8 \, ^\circ \text{F} \]
\[ f_{\text{ref}} = 0.687 \]
\[ f_{\text{ref} 100\% \text{ (dry-powd)}} = 0.599 \]
\[ T_e = 68.0 \, ^\circ \text{F} \quad \text{RH}_e = 40\% \]
\[ T_{we} = 5.2 \, ^\circ \text{F} \quad \text{RH}_{we} = 50\% \]

\[ T_{\text{air}} = 67.1 \, ^\circ \text{F} \]
MORNINGSIDE WINDOW ADVENTURE

The Evolution

\[ T_{max} = 48.3^\circ F \]
\[ T_{min} (\text{drybulb}) = 48.7^\circ F \]
\[ T_{min} (\text{dew-point}) = 42.8^\circ F \]
\[ f_{eu} = 0.687 \]
\[ f_{eq, \text{RH}100\% (\text{dew-point})} = 0.599 \]
\[ T_1 = 68.0^\circ F \text{ RH}_1 = 40\% \]
\[ T_2 = 5.2^\circ F \text{ RH}_2 = 50\% \]

\[ T_{air} = 67.1^\circ F \]
MORNINGSIDE WINDOW ADVENTURE

The Evolution
MORNINGSIDE WINDOW ADVENTURE

The Evolution
MORNINGSIDE WINDOW ADVENTURE

The Evolution
MORNINGSIDE WINDOW ADVENTURE

The Evolution
<table>
<thead>
<tr>
<th>C.S.I. Description</th>
<th>PH Upgrade Cost</th>
<th>PH % Delta</th>
<th>Cost per SF</th>
<th>46 Cost per Unit</th>
<th>Comments</th>
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<tbody>
<tr>
<td>02 Existing Conditions</td>
<td>$ -</td>
<td>No Change</td>
<td>$ -</td>
<td>$ -</td>
<td>-</td>
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<tr>
<td>03 Concrete</td>
<td>$ 91,054</td>
<td>+19.2%</td>
<td>$ 1.55</td>
<td>$ 1,979.42</td>
<td>4&quot; insul + 3&quot; SOG overlay</td>
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<td>04 Masonry</td>
<td>$ -</td>
<td>No Change</td>
<td>$ -</td>
<td>$ -</td>
<td>-</td>
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<tr>
<td>05 Metals</td>
<td>$ 11,300</td>
<td>+3.8%</td>
<td>$ 0.19</td>
<td>$ 245.65</td>
<td>Thermal break steel connections, Additional flooring overlay, window bucks, ZIP VB premium</td>
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<tr>
<td>06 Wood, Plastics, and Composites</td>
<td>$ 44,144</td>
<td>+5.0%</td>
<td>$ 0.75</td>
<td>$ 959.65</td>
<td>Roof Insulation 70, Podium Insulation 40, Spray insulation @ attic ceilings 20, Spray at building walls ILO fiberglass 42, Exterior Additon 2&quot; - 24; misc caulking/sealing 12</td>
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<tr>
<td>07 Thermal and Moisture Protection</td>
<td>$ 218,432</td>
<td>+26.7%</td>
<td>$ 3.71</td>
<td>$ 4,748.52</td>
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<td>08 Openings</td>
<td>$ 57,118</td>
<td>+10.1%</td>
<td>$ 0.97</td>
<td>$ 1,241.70</td>
<td>PH windows premium</td>
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<td>09 Finishes</td>
<td>$ -</td>
<td>No Change</td>
<td>$ -</td>
<td>$ -</td>
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<td>10 Specialties</td>
<td>$ -</td>
<td>No Change</td>
<td>$ -</td>
<td>$ -</td>
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<td>11 Equipment</td>
<td>$ -</td>
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<td>12 Furnishings</td>
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<td>13 Special Construction</td>
<td>$ -</td>
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<td>14 Conveying Equipment</td>
<td>$ -</td>
<td>No Change</td>
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<td>21 Fire Suppression</td>
<td>$ -</td>
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<td>$ -</td>
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<td>22 Plumbing</td>
<td>$ -</td>
<td>No Change</td>
<td>$ -</td>
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<td>23 Heating Ventilating and Air Conditioning</td>
<td>$ (110,000)</td>
<td>(15.3%)</td>
<td>$ (1.87)</td>
<td>$ (2,391.30)</td>
<td>Ballpark</td>
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<tr>
<td>25 Internet/Control Automation</td>
<td>$ -</td>
<td>No Change</td>
<td>$ -</td>
<td>$ -</td>
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</tr>
<tr>
<td></td>
<td>Description</td>
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<tr>
<td>30</td>
<td>Integrated Automation</td>
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<td>No Change</td>
<td>$</td>
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<tr>
<td>31</td>
<td>Electrical</td>
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<td>32</td>
<td>Earthwork</td>
<td>$</td>
<td>-</td>
<td>No Change</td>
<td>$</td>
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<tr>
<td>33</td>
<td>Exterior Improvements</td>
<td>$</td>
<td>-</td>
<td>No Change</td>
<td>$</td>
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<tr>
<td>34</td>
<td>Utilities</td>
<td>$</td>
<td>-</td>
<td>No Change</td>
<td>$</td>
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<td>35</td>
<td></td>
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<tr>
<td>36</td>
<td>Subtotal Trades Cost</td>
<td>$312,048</td>
<td>3.6%</td>
<td>$5.30</td>
<td>$6,783.65</td>
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<td>37</td>
<td></td>
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<tr>
<td>38</td>
<td>Fabreeka Pads</td>
<td>$9,481</td>
<td>N/A</td>
<td>$0.16</td>
<td>$206.12</td>
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<td>39</td>
<td>Added Sealing Existing Building</td>
<td>$16,839</td>
<td>N/A</td>
<td>$0.29</td>
<td>$366.06</td>
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<tr>
<td>40</td>
<td>Polysio @ Specific Walls</td>
<td>$16,225</td>
<td>N/A</td>
<td>$0.28</td>
<td>$352.72</td>
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<tr>
<td>41</td>
<td>Ceiling Modifications @ Existing</td>
<td>$8,640</td>
<td>N/A</td>
<td>$0.15</td>
<td>$187.83</td>
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<tr>
<td>42</td>
<td>Insulated Headers</td>
<td>$3,870</td>
<td>N/A</td>
<td>$0.07</td>
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<tr>
<td>43</td>
<td>2 pass spray foam</td>
<td>$8,727</td>
<td>N/A</td>
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<tr>
<td>44</td>
<td>Added Liquid Flashing</td>
<td>$12,840</td>
<td>N/A</td>
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<td>45</td>
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<tr>
<td>46</td>
<td>Subtotal Cost</td>
<td>$76,622</td>
<td>0.9%</td>
<td>$1.30</td>
<td>$1,665.70</td>
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<tr>
<td>47</td>
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<td>48</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>49</td>
<td>Total Cost</td>
<td>$388,670</td>
<td>4.5%</td>
<td>$6.60</td>
<td>$8,449.35</td>
</tr>
</tbody>
</table>
Policy Context: PHFA

Pennsylvania Housing Finance Agency

Passive House confers advantage in competition for LIHTCs (Low Income Housing Tax Credits).

PHFA’s LIHTCs are highly competitive: only 1 in 4 project proposals are awarded LIHTCs.

Projects that pursue Passive House earn 10 bonus points out of a total of 130 possible points.

59 of 179 projects pursued Passive House during first two years of PHFA’s new policy.

Competition spurred innovation. Innovation cut costs.
PENNSYLVANIA

Policy Context


Projected Construction Cost

Data Source: Pennsylvania Housing Finance Agency via Onion Flats
Policy Context


The Market Is Changing...
The Market Is Changing...
The Market Is Changing...
Lessons Learned

Two Passive House Case Studies for New and Retrofit Affordable Senior Housing in Pittsburgh

Laura Nettleton • Rebecca Griffith

lnet@thoughtfulbalance.com • rebeccag@nkarch.com