Orchards at Orenco: Phase I vs. Phase II

More Units...Less Cost...Still Passive

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.

Michael Bonn
Ankrom Moisan Architects

Woodworks
March 2022
Outline

• Orchards at Orenco – Background & Context

• Orchards Ph. I vs. Orchards Ph. II
  – Design
  – Passive House Process
  – Construction
  – Feedback / Monitoring / Measured Performance
  – Challenges and Lessons Learned
  – Costs

• Orchards at Orenco – Proof of Concept?
Learning Objectives

• Demonstrate how the Passive House standard has been applied successfully to affordable housing development, serving as a model for future developments in North America, and serving as a primary path to achieving net zero energy affordable housing
• Describe the key design measures incorporated in the overall building design, enclosure and mechanical systems to achieve Passive House certification
• Describe the integrated teamwork / process used by the project team in the design, construction and operation of high performance affordable housing
• Demonstrate how efficient design and cost optimization can be used to reduce the overall development and operating costs of affordable housing
The Orchards at Orenco

• Affordable housing community in Hillsboro, OR
  – Phase I: 57 units of workforce housing
    (completed 6/2015)
  – Phase II: 58 units of workforce housing
    (completed 7/2016)
  – Phase III: 52 units of family sized workforce housing
    (completed 2018)

• Developer/Owner:
  REACH Community Development
REACH Community Development

- REACH’s goal is to provide Healthy, Safe and Affordable living

- Affordability not only includes low rents but also close proximity to work and schools, and low monthly utility bills

- REACH set a goal in their 2010 Strategic Plan to have a Passive House project in their portfolio by 2015
Why Passive House?

• Most rigorous building energy efficiency standard in world

• Achieve significant reductions of utility costs to residents, while improving comfort and durability

• The right path to net zero...
Orchards at Orenco - Background

• Site history
• Suburban location
• Growing community
• High-tech employer base
• Light rail TOD
Phase I Basics

- 57 units of affordable workforce housing
- 57,750 square feet
- 3-story, wood frame construction on concrete slab-on-grade foundation
Design Overview

Photo Credit: Casey Braunger
Aerial View from South

REACH COMMUNITY DEVELOPMENT | ANKROM MOISAN ARCHITECTS | WALSH CONSTRUCTION CO.
First Floor Plan
**Typical Roof Assembly: R-81**
- 80 mil TPO roof membrane (fully adhered, white)
- 1/2” coverboard
- 12” polyisocyanurate insulation
- Self-adhered rubberized asphalt membrane vapor barrier (serves also as temp. roof)
- 3/4” plywood
- Prefabricated wood truss framing (trusses @ 24” o.c.)
- 5/8” gypsum wall board (2 layers)

**Typical Exterior Wall Assembly: R-39**
- Fiber cement siding w/ treated 1x wood furring @ 24” o.c.
- 1-1/2” rigid mineral wool insulation (8 lb. density)
- Spun-bonded polyolefin sheet water-resistive barrier
- 1/2” plywood with air sealing tape at all seams
- 2x10 wood framing (studs at 24” o.c.)
- 9 1/4” blown fiberglass insulation at all framing cavities
- Polyamide sheet vapor barrier
- 5/8” gypsum wall board

**Typical Slab Assembly: R-19**
- 4” concrete slab
- 15 mil polymer sheet vapor barrier
- 4” Type II expanded polystyrene insulation
- Gravel base with radon mitigation system piping

---

**Enclosure Assemblies**
HVAC Design

Highly iterative process
- Design work → modeling work → costing analysis → constructability review → Repeat...

Bidding / procurement
- Coordinating the work...

REACH COMMUNITY DEVELOPMENT       |        ANKROM MOISAN ARCHITECTS       |        WALSH CONSTRUCTION CO.
HVAC Design

• Highly iterative process – Design work → modeling work → costing analysis → constructability review → Repeat…

• Bidding / procurement

Mechanical Penthouse
HVAC Design

- 3 HRV Zones
- Cook ERV serves each zone
HVAC Design

- Continuous 50cfm supply air per bedroom
- Continuous exhaust at kitchen and bath
- Electric cove heater in living room for user control & backup heat
  - Estimated at 20% of building heating load
- No active cooling at apartments

Image courtesy of PAE Consulting Engineers
Preliminary Airtightness Test Result: 0.0875 ACH$_{50}$
Final Airtightness Test Result: 0.133 ACH$_{50}$
Phase I - Lessons Learned

- Owner vision - and commitment - is pivotal
Phase I - Lessons Learned

• Owner vision - and commitment - is pivotal

• It takes a team...working collaboratively, with everyone pulling in the same direction
Phase I - Lessons Learned

• Owner vision - and commitment - is pivotal

• It takes a team...working collaboratively, with everyone pulling in the same direction

• Early team integration pays off
Phase I - Lessons Learned

• Owner vision - and commitment - is pivotal

• It takes a team...working collaboratively, with everyone pulling in the same direction

• Early team integration pays off

• Proactive coordination and QC is essential
Phase I - Lessons Learned

• Owner vision - and commitment - is pivotal

• It takes a team...working collaboratively, with everyone pulling in the same direction

• Early team integration pays off

• Proactive coordination and QC is essential

• Keep it simple
Measured Performance

Orchards Phase I Energy Use: Measured vs Modeled (PHPP)

- Modeled EU: 22.5 kBTU/sf.yr (Plug loads per US norms)
- Measured (extrapolated): 21.6 kBTU/sf.yr (4% under Model)
- Large Commons Elec Use

Graph courtesy of REACH Community Development / Housing Development Center
Measured Performance

- Apartments energy use lower than modeled
- Common area electricity use much higher than modeled
  - Causes have been investigated
  - Fan at 3rd floor storage room that should be on timer is running continuously
  - Elevator usage higher than anticipated
  - Thermostats at freeze protection heaters in stairwells had been set at 70 degrees, have now been set to 45 degrees
  - DAS system added late during construction was not in original model (increasing site EUI slightly: approx. 0.2 kBTU/sf/yr)
## Cost Premium & Financing

### Uses

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental Soft Costs</td>
<td>$148,580</td>
</tr>
<tr>
<td>Incremental Hard Costs</td>
<td>$910,520</td>
</tr>
<tr>
<td>Total incremental Cost</td>
<td>$1,059,100</td>
</tr>
<tr>
<td>Premium over &quot;typical Orenco&quot;</td>
<td>11.0%</td>
</tr>
</tbody>
</table>

### Sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>REACH Equity</td>
<td>$300,000</td>
</tr>
<tr>
<td>Meyer Memorial Trust grant</td>
<td>$500,000</td>
</tr>
<tr>
<td>Neighborworks grant</td>
<td>$260,000</td>
</tr>
<tr>
<td>OHCS Weatherization</td>
<td>$100,000</td>
</tr>
<tr>
<td>Energy Trust of Oregon</td>
<td>$65,000</td>
</tr>
<tr>
<td>Enterprise charrette grant</td>
<td>$4,000</td>
</tr>
<tr>
<td><strong>Total additional Sources</strong></td>
<td>$1,229,000</td>
</tr>
</tbody>
</table>

Analysis courtesy of Housing Development Center
Would We Do It Again?
Innovation Towards Replication

- Best Overall Project and Best Affordable Project, 2015, PHIUS
- Sustainable Project of the Year, 2015, Portland Business Journal
- Golden Hammer Award for Best Project, 2015, Oregon Opportunity Network
- Energy Efficiency Project of the Year & People’s Choice Award, 2016, Daily Journal of Commerce
- Best Green Project, 2016, Affordable Housing Finance Magazine’s Reader’s Choice Award
- Featured in Dwell, Portland Monthly, Politico, Alaska Airlines’ in-flight magazine, and local newspapers
## Orchards Phase I vs. Phase II

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(PHIUS+ Certified)</td>
<td>(Passive House Inspired)</td>
</tr>
<tr>
<td>• Innovate to meet REACH strategic goal of building Passive House</td>
<td>• Reduce costs to meet OHCS cost containment limits</td>
</tr>
<tr>
<td>• REACH brought significant private investment for this innovation</td>
<td>• Additional private resources not available</td>
</tr>
<tr>
<td></td>
<td>• Take lessons learned &amp; best practices from Phase I</td>
</tr>
</tbody>
</table>
Design Response to Cost Containment

**Phase II (original design)**
- L-shaped building with 46 parking stalls
- 57 units in 57,750 SF
- Shallow units to increase daylight
- Community room, office

**Phase II (after design revisions)**
- Bar building with 77 parking stalls
- 58 units in 49,900 SF
- Deeper, narrower units
- Reduced number of balconies
- Reduced amenity space
First Floor Plan
Wide and Shallow…

Narrow and Deep…

Phase I Typ. 1 BR

Phase II Typ. 1 BR
Orchards Phase I & II

**Phase I**  
*(PHIUS+ Certified)*

- Envelope
  - Fully insulated slab & footings
  - 2x10 walls with 1 ½” exterior insulation
  - Triple-glazed windows
  - Low-slope roof with R-81 insulation
- Whole building ERV with heat pump
- Spaces outside conditioned envelope = very expensive doors & detailing
- Ultra airtight: 0.13 ACH50
- Extended sequencing / duration

**Phase II**  
*(pursuing PHIUS+ Certification)*

- Envelope
  - Insulated slab. No insulation under footings
  - 2x8 walls with 1” exterior insulation
  - Triple-glazed windows
  - Steep-slope roof with R-60 insulation
  - Vented attic
- Reduced vertical envelope area
  - 35,000 SF → 27,700 SF
- Same HVAC as Phase I, but with better zoning due to orientation of building
- All spaces inside conditioned envelope
Phase I – Areas Outside PH Envelope

Phase II – All Areas Inside PH Envelope
Phase I Foundation  

Phase II Foundation
Phase I Ext. Wall

1 ½” Exterior Insulation
2 x 10 Wall Framing

Phase II Ext. Wall

1” Exterior Insulation
2 x 8 Wall Framing
Phase II - Performance

• Modeled Performance: EUI = 22.2
Phase II - Lessons Learned

• Airtightness
  – A major challenge at steep slope roof with vented attic...

• Cost premium to achieve Passive House certification can be effectively reduced through more inherently efficient design

• Construction cost: $173/ SF, $147k/unit)
  – 8% cost/unit reduction from Phase I
  – 15%+ cost reduction if factoring in market escalation...
Passive Measures - Incremental Costs

- Foundation insulation
- Wall framing
- Exterior insulation at cladding
- Triple-glazed windows (if required)
- Heat recovery at ventilation system
- Materials and labor to achieve airtightness
- Traction elevator
- Certification
- Quality assurance / verification
Orchards Phase I & II - Costs

**Phase I**
(PhilUS+ Certified)
- TDC of $14.5M
- $255K/unit
- Construction cost: $9,093,040
- $158/SF
- $159,527/unit
- Energy performance:
  - 5 energy models
  - 31-71% better than code

**Phase II**
(PhilUS+ Certified)
- TDC of $13.6M
- $234K/unit
- Construction cost: $8,531,624
- $173/SF
- $147,097/unit
- Energy performance:
  - 3 energy models
  - 29-67% better than code
Orchards Phase I & II - Costs

**Phase I**
(PHIUS+ Certified)

- TDC of $14.5M
- $255K/unit
- **Construction cost: $9,093,040**
- $158/SF
- $159,527/unit
- Energy performance:
  - 5 energy models
  - 31-71% better than code
  - Actual data available now

**Phase II**
(pursuing PHIUS+ Certification)

- TDC of $13.6M
- $234K/unit
- **Construction cost: $8,531,624**
- $173/SF
- $147,097/unit
- Energy performance:
  - 3 energy models
  - 29-67% better than code
  - Actual data available in 2017
Orchards at Orenco - Proof of Concept

• When implemented with knowledge and skill, passive building measures are cost effective AND provide substantial benefits:
  – Enhanced comfort, health and durability
  – Energy use reduction, leading to operational cost savings

• Orchards at Orenco demonstrates that passive building measures can be implemented at multifamily housing for little additional first cost

• Life cycle cost & quality benefits likely to far exceed the additional investment at project inception
More Information & Insights

• REACH Community Development:

• Housing Development Center:

• Ankrom Moisan Architects:
  – https://www.youtube.com/watch?v=ewJUCWl6dqM

• PHIUS Case Study:

• BEST 4 Conference Paper:

• Guest Blog on Green Building Advisor:
Q & A

Michael Bonn
Ankrom Moisan Architects
michaelb@ankrommoison.com

This concludes The American Institute of Architects Continuing Education Systems Course