SECOND AND DELAWARE
SCALING PASSIVE HOUSE

Creating Lasting Value through Sustainable Real Estate

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Changes in Demographics and Housing Preferences

Sustainable Development Opportunity

<table>
<thead>
<tr>
<th>DISTRIBUTION OF HOUSEHOLDS WITH AND WITHOUT CHILDREN, AND SINGLE-PERSON HOUSEHOLDS, 1960, 2000, AND 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Type</td>
</tr>
<tr>
<td>Households with Children</td>
</tr>
<tr>
<td>Households without Children</td>
</tr>
<tr>
<td>Single-Person Households</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUMMARY OF HOUSING PREFERENCE SURVEYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing Type</td>
</tr>
<tr>
<td>Attached</td>
</tr>
<tr>
<td>Apartment</td>
</tr>
<tr>
<td>Townhouse</td>
</tr>
<tr>
<td>Condominium/Cooperative</td>
</tr>
<tr>
<td>Detached</td>
</tr>
<tr>
<td>Small Lot</td>
</tr>
<tr>
<td>Large Lot</td>
</tr>
<tr>
<td>Total “new urbanity” preference (attached + small lot detached)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROJECTED HOUSING DEMAND COMPARED TO CURRENT SUPPLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attacheds all types</td>
</tr>
<tr>
<td>Small lot</td>
</tr>
<tr>
<td>Large lot</td>
</tr>
<tr>
<td>Detached total</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

In 2030, only 27% of U.S. Households will have Children

75% of U.S. Households prefer to live where they could walk to more destinations.

44.5 million new attached and small lot detached units will need to be built between now and 2020 to meet the demand.
How should we build the next generation of housing?
Last Generation Development Model

Wood Frame Construction:

- Not Adaptable - Cannot easily move walls.
- Poorly insulated and energy inefficient.
- OSB absorbs moisture and is prone to mold.
- Costly to maintain buildings over time.

While stick-built construction offers a low cost alternative to concrete construction, over time the structure becomes susceptible to mold.
Belnord Hotel - Concrete courtyard typology.
The Belnord Apartments—Floor Plan—Second, Fifth, Seventh and Tenth Floors
About the Arnold Development Group

Long Term Investment Philosophy

- Build high performance real assets that outperform the current model financially, socially and environmentally.
- Combine best practices in building science, transportation, and urban food production to increase competitive

CORE COMPONENTS TO ADG DEVELOPMENTS

Concrete Structures
Making long lasting and adaptable buildings.

Super Insulated Envelopes
Passive House Certified buildings, reducing energy costs by 70-90%

Livable Density
Making density attractive, secure and desirable.

Urban Gardens
Producing food and strengthening communities.
About the Arnold Development Group

Investment Philosophy

People + Profit + Planet

Certified

the change we seek™
Primary Challenges

Climate Change

“Climate change is the challenge of our time.”

Henry Paulson
Former Treasury Secretary

How we respond to this challenge will largely determine the kind of world we leave our children and grandchildren.

Buildings account for 40-70% of carbon emissions. We need to change the way we build.

2 or 4 degree rise in temperature?
Primary Challenges

Income Inequality

Stagnant wages are eroding the middle class.

(Limiting who can afford market rate housing.)
The Future We Want

Jonathan Arnold and Bill Becker co-founded the project then partnered with the United Nations.

A 5-year initiative to fill the “vision vacuum” in the sustainability space.

A replicable model for envisioning sustainable communities around the world.

“We need everyone — Government Ministers and policymakers, business and civil society leaders, and young people — to work together to create a future worth choosing, a future we want.”

- Secretary General Ban Ki-Moon
Conclusions after working with the United Nations

- We have all the technologies we need to create long lasting economically resilient environments.

- We need profitable models for smart growth developments that can be easily replicated.
Siloed Thinking addresses issues as distinct “Problems” to be solved individually.

Systems Thinking considers the interdependence of objects and their attributes.
The New Development Model

Goal: Reduce HH Expenditures through Sustainable Design

Replicable model to reduce these household expenditures.

Living in transit oriented neighborhoods can reduce transportation costs by 70%.

- Conventional Development: $598.25 per month
- Transit Oriented Development: $192.60 per month
## The New Development Model

### Workforce Housing

20% of Units Reserved for 50% AMI

Reserving units for workforce housing increases social equity

<table>
<thead>
<tr>
<th>Unit Mix</th>
<th># of Units</th>
<th>Ave. Sq. Ft.</th>
<th>Total Sq. Ft.</th>
<th>Current Appraisal</th>
<th>Annual Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit I - Studio</td>
<td>44</td>
<td>550</td>
<td>24,200</td>
<td>$930 $1.69</td>
<td>$40,920 $491,040</td>
</tr>
<tr>
<td>Unit IA - Studio 50%</td>
<td>14</td>
<td>550</td>
<td>7,700</td>
<td>$531 $0.97</td>
<td>$7,434 $89,208</td>
</tr>
<tr>
<td>Unit H1 - 1 Bed / 1 Bath</td>
<td>29</td>
<td>644</td>
<td>18,676</td>
<td>$1035 $1.61</td>
<td>$30,015 $360,180</td>
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<tr>
<td>Unit H1A - 1 Bed / 1 Bath 50%</td>
<td>7</td>
<td>644</td>
<td>4,508</td>
<td>$557 $0.86</td>
<td>$3,899 $46,788</td>
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<tr>
<td>Unit H2 - 1 Bed / 1 Bath</td>
<td>10</td>
<td>700</td>
<td>7,000</td>
<td>$1075 $1.54</td>
<td>$10,750 $129,000</td>
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<tr>
<td>Unit H2A - 1 Bed/ 1 Bath 50%</td>
<td>3</td>
<td>700</td>
<td>2,100</td>
<td>$557 $0.80</td>
<td>$1,671 $20,052</td>
</tr>
<tr>
<td>Unit H3 - 1 Bed / 1 Bath</td>
<td>57</td>
<td>850</td>
<td>48,450</td>
<td>$1200 $1.41</td>
<td>$68,400 $820,800</td>
</tr>
<tr>
<td>Unit H3A - 1 Bed / 1 Bath 50%</td>
<td>11</td>
<td>850</td>
<td>9,350</td>
<td>$557 $0.66</td>
<td>$6,127 $73,524</td>
</tr>
<tr>
<td>Unit G - 2 Bed / 2 Bath</td>
<td>13</td>
<td>850</td>
<td>11,050</td>
<td>$1300 $1.53</td>
<td>$16,900 $202,800</td>
</tr>
<tr>
<td>Unit GA - 2 Bed / 2 Bath 50%</td>
<td>3</td>
<td>850</td>
<td>2,550</td>
<td>$668 $0.79</td>
<td>$2,004 $24,048</td>
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<tr>
<td>Unit E - 2 Bed / 2 Bath</td>
<td>24</td>
<td>1,050</td>
<td>25,200</td>
<td>$1400 $1.33</td>
<td>$33,600 $403,200</td>
</tr>
<tr>
<td>Unit EA - 2 Bed / 2 Bath 50%</td>
<td>6</td>
<td>1,050</td>
<td>6,300</td>
<td>$668 $0.64</td>
<td>$4,008 $48,096</td>
</tr>
<tr>
<td>Unit D - 2 Bed / 2 Bath</td>
<td>29</td>
<td>1,150</td>
<td>33,350</td>
<td>$1510 $1.31</td>
<td>$43,790 $525,480</td>
</tr>
<tr>
<td>Unit DA - 2 Bed / 2 Bath 50%</td>
<td>7</td>
<td>1,150</td>
<td>8,050</td>
<td>$668 $0.58</td>
<td>$4,676 $56,112</td>
</tr>
<tr>
<td>Unit B - 2 Bed / 2 Bath</td>
<td>14</td>
<td>1,300</td>
<td>18,200</td>
<td>$1650 $1.27</td>
<td>$23,100 $277,200</td>
</tr>
<tr>
<td>Unit BA - 2 Bed / 2 Bath 50%</td>
<td>4</td>
<td>1,300</td>
<td>5,200</td>
<td>$668 $0.51</td>
<td>$2,672 $32,064</td>
</tr>
<tr>
<td><strong>Total / Average</strong></td>
<td><strong>275</strong></td>
<td><strong>843</strong></td>
<td><strong>231,884</strong></td>
<td><strong>1,091 $1.28</strong></td>
<td><strong>$299,966 $3,567,528</strong></td>
</tr>
</tbody>
</table>

$1,269 per month (Market Rate)

$654 per month (Workforce Housing)
Passive House Construction

Current Development Model uses poorly insulated walls and oversized mechanical systems to compensate for the thermal losses.

Passive House Model calls for super insulated building envelopes and require 70-90% less energy to heat and cool the building.

5” Walls

16” Walls

$119.00 per month

$26.47 per month

Passive House Buildings have 70-90% lower utility bills.
The New Development Model

Second & Delaware

- 276 Unit Multifamily Project
- Transit Oriented
- Passive House Certified
- 20% Workforce Housing
Environmental Benefits

**Kansas City High Rise**
- Building Size: 277,512 SF
- Site Energy: 40,703,323 kBtu/yr

**Second and Delaware (Passive House)**
- Building Size: 321,096 SF
- Site Energy: 5,054,051 kBtu/yr
Additional Environmental Benefits

Natural Gas Combined Heat and Power

CHP CAPTURES ENERGY THAT WOULD NORMALLY BE LOST in power generation and uses it to provide heating and cooling, making CHP **75-80 PERCENT EFFICIENT** at using fuels.

**82 GW**
The current installed capacity of CHP - about 8 percent of U.S. generating capacity.

**40 GW**
The national goal for added CHP capacity, signed in an August 2012 Executive Order by President Obama.

Meeting this goal would:

- Save American manufacturers and companies $10 billion each year
- Spur $40 to $80 billion in new capital investments in plants and facilities
- Save 1 percent of all energy use in the U.S. (one quadrillion Btus of energy)
- Reduce emissions by the equivalent of taking 25 million cars off the road
Environmental Benefits

Primary Energy Comparison

<table>
<thead>
<tr>
<th>Conditioned Space (sf)</th>
<th>Total Energy Consumption kBtu/yr</th>
<th>Source Energy (kBtu/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Light Tower</td>
<td>40,703,695</td>
<td>145,370,339</td>
</tr>
<tr>
<td>Second and Delaware</td>
<td>4,519,743</td>
<td>11,292,706</td>
</tr>
</tbody>
</table>

90% Reduction in Primary Energy

2015 High-Rise
122,177,964 kBtu/yr

Second and Delaware
12,591,648 kBtu/yr
FORMWORK CYCLE

1. Steel & Utilities - Walls and Columns
   - Erect and Place Reinforcing Steel
   - Install Rough-In Electrical Conduits and Plumbing

2. Forming Part 1
   - Form Interior Walls and Columns
   - Form Interior Beams & Elevated Slabs

3. Steel & Utilities - Elevated Slab
   - Erect and Place Reinforcing Steel
   - Install Rough-In Electrical Conduits and Plumbing

4. Forming Part 2
   - Place Thermomass XPS in Wall Cavity
   - Form Exterior Wall – One Side

5. Pour & Finish Concrete
6” Non-Post Tensioned Concrete Slab
QUADRANT 1
Northwest

POUR 1 – 240.21 Cubic Yards

6 STOREY TOWER
(FORM SET -1A)

5 STOREY TOWER
(FORM SET-1B)

POUR 2 – 264.15 Cubic Yards
QUADRANT COMPLETE – 1 QUADRANT

QUADRANT 1
Northwest

POUR QTY

POUR 10 – 283.99 CY
POUR 8 – 263.59 CY
POUR 6 – 263.96 CY
POUR 4 – 264.80 CY
POUR 2 – 264.15 CY

POUR 11 – 313.66 CY
POUR 9 – 239.37 CY
POUR 7 – 239.37 CY
POUR 5 – 240.39 CY
POUR 3 – 239.92 CY
POUR 1 – 240.21 CY

6 STOREY TOWER (FORM SET -1A)

5 STOREY TOWER (FORM SET-1B)
HALF COMPLEX – 2 QUADRANTS

QUADRANT 1
Northwest

QUADRANT 2
Southwest
Lean Construction & IPD

Between 50% and 75% of on-site labor does not produce value.

Lean Construction and Integrated Project Delivery (IPD) lowers waste by 10%-40%

**Best Practices Key to Keeping Costs in Line:**

- Last Planner System
- Honored Commitments
- 6 Week Look Aheads
- Planning for Flow
Efficient Systems (ie. Doka)

- Fewer shore posts
- No nails
- Less labor
Lean Construction Best Practices

Efficient Systems (ie. Doka)
Lean Construction Best Practices

EZ Scaffold

- Twin Mast
- Single Mast
Lean Construction Best Practices

Synchro Modeling

• Placed based scheduling
• Optimize crew size
• Identify constraints
• Communicate expectations
• Best practice in industry
7/1/2016
Week: 4

Daily Activities
Place + Pour Columns D (West)
Elevator Pit Sleeves D
Install (B)ranch Lines (A)
Column Pads G (South Ramp)
7/8/2016
Week: 5

Daily Activities

Install Lateral (B)branch Lines
Vent D
Place + Pour Columns A (North)
Edge Form (A)
Under Slab Water Ground
Conduit (A)
Under Slab (B)branch Circuit (A)
Strip Footing C (West)

Appearance P...
- Place (Rebar + Form)
- Pour (Generic)
- Pour (Monolithic)
- Prep (Edge Form)
- Prep (General)
- Prep (Rock + VB)
- Strip + Clean
7/15/2016
Week: 6

Daily Activities
Place + Pour Columns
Column Pads C (North)
Strip Footing C (North)
Daily Activities
Form Prep C
Elevator Pad B + Pad
Ramp Columns G (South)
7/29/2016
Week: 8

Daily Activities
Pour Walls + Slab D

Appearance P...
- Place (Rebar + Form)
- Pour (Generic)
- Pour (Monolithic)
- Prep (Edge Form)
- Prep (General)
- Prep (Rock + VB)
- Strip + Clean
8/5/2016
Week: 9

Daily Activities
Backfill South East
Set Wall Forms for Ramp
Place + Pour Columns E (South)
Pour Walls + Slab (A)

Appearance P...
- Place (Rebar + Form)
- Pour (Generic)
- Pour (Monolythic)
- Prep (Edge Form)
- Prep (General)
- Prep (Rock + VB)
- Strip + Clean
Daily Activities
Backfill North East
Pour Walls + Slab C
Pour Slab G (South)
Pour Slab G

Appearance Percentages
- Place (Rebar + Form)
- Pour (Generic)
- Pour (Monolithic)
- Prep (Edge Form)
- Prep (General)
- Prep (Rock + VB)
- Strip + Clean
8/19/2016
Week: 11

Daily Activities
Backfill South West
Strip Footing B (North)
Column Pads B (North)
Strip Footing B (South)
Strip Ramp
Column Pads F (North)
Place Rebar + Form Slab F (South)

Appearance P...
- Place (Rebar + Form)
- Pour (Generic)
- Pour (Monolithic)
- Prep (Edge Form)
- Prep (General)
- Prep (Rock + VB)
- Strip + Clean
8/26/2016
Week: 12

Daily Activities
Place Rebar + Forms Wall B
Pour Columns G

Appearance P...
- Place (Rebar + Forms)
- Pour (Generic)
- Pour (Monolithic)
- Prep (Edge Form)
- Prep (General)
- Prep (Rock + VB)
- Strip + Clean
Continuous Improvement

B) Training workers on the benefits of standardized work practices, the continuous improvement of work practices and the negative impact upon the Project of failing to achieve commitments;

C) Using mockups, first run studies, early completion of standard work units, and similar efforts to demonstrate and document agreed-upon levels of quality;
TUESDAY
7:00 AM - 10:00 AM STRIP & CLEAN WALL & COLUMN FORMS ON FLOOR BELOW (22)
10:00 PM - 2:00 PM SET COLUMN STEEL & COLUMN FORMS (22)
2:00 - 4:00 PM PREP WALL STEEL, FOAM and WALL FORMS ON EZ SCAFFOLD FOR NEXT DAY (22)
WEDNESDAY
8:00 AM INSTALL PRE-TIED INSIDE WALL STEEL, INSPECT AND BEGIN WALL FORMS (22)
WEDNESDAY
9:00 AM INSIDE WALL FORMS (22)
WEDNESDAY
10:00 AM INSERT WALL FOAM and THERMOMASS TIES (22)
WEDNESDAY
11:00 PM - 12:00 PM INSERT PRE-TIED OUTSIDE WALL STEEL & INSPECT OUTSIDE STEEL (22)
WEDNESDAY
12:30 PM - 2:00 PM SET OUTSIDE WALL and WINDOW FORMS.
2:00 PM - 4:00 PM BREAK DOWN BEAM SHORING & FORMS AND CLEAN BEAM FORMS (22)
THURSDAY
7:00 AM - 8:00 AM SET UP SHORING & CONTINUE TO TAKE DOWN DECK FORMS ON DECK BELOW (27)
THURSDAY
9:00 AM SET UP SHORING (10) & TAKE DOWN, CLEAN & OIL DECK FORMS ON DECK BELOW (17)
THURSDAY
10:00 AM SET UP SHORING (10) & TAKE DOWN DECK FORMS ON DECK BELOW (17)
THURSDAY
11:00 AM COMPLETE SHORING (10) & CLEAN AND MOVE DECK FORMS FROM BELOW and START PLACING DECK FORMS (17)
THURSDAY
10:00 AM BEGIN TO SET DECK FORMS (20)
THURSDAY
10:00 AM - 5:00 PM SET DECK FORMS (20) & LOCATE AND PLACE SLEEVES & FLY IN BEAMS (7)
THURSDAY
7:00 PM COMPLETE SLEEVES & FLYING IN BEAMS (10)
FRIDAY
7:00 AM - 3:00 PM COMPLETE TIE DECK STEEL (20) & INSPECTION
KLEARWALL WINDOW

1/2" AIRDAM SEALANT

1" RIDGID INSULATION

BREAKMETAL

COVER

TAPERS PLYWOOD SILL EMBEDDED IN FAST FLASH

BREAKMETAL SILL COVER

SILICON CAULK W/ WEEP HOLES ON BOTTOM

KLEARWALL WINDOW

1/2" AIRDAM SEALANT
- KLEARWALL TILT AND TURN WINDOW ON 1/2" SHIMS
- 3/4" PLYWOOD EMBEDDED AND COATED IN FAST FLASH
- 1/2" AIRDAM SEALANT
- 1" RIDgid INSULATION
- PREFABRICATED BREAKMETAL COVER
# Contractor's and/or Mortgagor's Cost Breakdown

## Schedule of Values

### Second + Delaware Apartments Gross SF: 550,000

<table>
<thead>
<tr>
<th>Item</th>
<th>ADG Model</th>
<th>Stick</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concrete</strong></td>
<td>$14,289,502</td>
<td>$4,256,002</td>
</tr>
<tr>
<td><strong>Masonry</strong></td>
<td>$899,800</td>
<td></td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td>$1,423,506</td>
<td></td>
</tr>
<tr>
<td><strong>Rough Carpentry</strong></td>
<td>$377,280</td>
<td></td>
</tr>
<tr>
<td><strong>Finish Carpentry</strong></td>
<td>$686,830</td>
<td></td>
</tr>
<tr>
<td><strong>Waterproofing</strong></td>
<td>$380,002</td>
<td></td>
</tr>
<tr>
<td><strong>Insulation</strong></td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>Roofing</strong></td>
<td>$1,352,451</td>
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<tr>
<td><strong>Sheetmetal</strong></td>
<td>$54,277</td>
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<tr>
<td><strong>Doors</strong></td>
<td>$587,361</td>
<td></td>
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<tr>
<td><strong>Windows</strong></td>
<td>$1,743,247</td>
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<tr>
<td><strong>Glass</strong></td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>Lath and Plaster</strong></td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td><strong>Drywall</strong></td>
<td>$3,290,604</td>
<td></td>
</tr>
<tr>
<td><strong>Painting and Decorating</strong></td>
<td>$813,231</td>
<td></td>
</tr>
<tr>
<td><strong>Specialties</strong></td>
<td>$108,388</td>
<td></td>
</tr>
<tr>
<td><strong>Special Equipment</strong></td>
<td>$15,000</td>
<td></td>
</tr>
<tr>
<td><strong>Cabinets</strong></td>
<td>$893,875</td>
<td></td>
</tr>
<tr>
<td><strong>Appliances</strong></td>
<td>$963,841</td>
<td></td>
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<tr>
<td><strong>Blinds and Shades, Artwork</strong></td>
<td>$136,836</td>
<td></td>
</tr>
<tr>
<td><strong>Carpets</strong></td>
<td>$229,790</td>
<td></td>
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<tr>
<td><strong>Special Construction</strong></td>
<td>$1,721,503</td>
<td></td>
</tr>
<tr>
<td><strong>Elevators</strong></td>
<td>$536,560</td>
<td></td>
</tr>
<tr>
<td><strong>Plumbing and Hot Water</strong></td>
<td>$2,732,365</td>
<td></td>
</tr>
<tr>
<td><strong>Heat and Ventilation</strong></td>
<td>$2,602,679</td>
<td></td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td>$4,209,080</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (Structures)</strong></td>
<td><strong>$40,048,008</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Structure Cost Per Square Foot:**

- **ADG Model:** $80.55
- **Stick:** $84.68

**Land Cost ADG Model:** $7.74
**Land Cost Stick:** $10.06
### Total Life-cycle Cost

<table>
<thead>
<tr>
<th></th>
<th>ADG Model</th>
<th>Stick</th>
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</thead>
<tbody>
<tr>
<td>Land and Structures Cost</td>
<td>$80.55</td>
<td>$84.68</td>
</tr>
<tr>
<td>First Cost Savings</td>
<td>$4.12</td>
<td>-</td>
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<tr>
<td><strong>Operating Expenses Savings</strong></td>
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<tr>
<td>Painting at Turnover (50%)</td>
<td>$0.04</td>
<td>-</td>
</tr>
<tr>
<td>General Maintenance (50%)</td>
<td>$0.04</td>
<td>-</td>
</tr>
<tr>
<td>Utilities (76% Less)</td>
<td>$0.34</td>
<td>-</td>
</tr>
<tr>
<td>Insurance (15% Less)</td>
<td>$0.02</td>
<td>-</td>
</tr>
<tr>
<td>Vacancy (1% less)</td>
<td>$0.09</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>$0.53</td>
<td>-</td>
</tr>
<tr>
<td>Value at 5% Cap Rate</td>
<td>$10.59</td>
<td>-</td>
</tr>
<tr>
<td>20% of NPV of Years 50-100</td>
<td>$1.170</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Life-cycle Cost</strong></td>
<td>$68.79</td>
<td>$84.68</td>
</tr>
</tbody>
</table>

New Model is 19% Lower in Life-cycle Costs.
The New Development Model

ADG Model Summary

• Efficient flexible structures
• Efficient Land Use
• 90% Energy Savings
• 5% Lower First Cost
• 19% Lower life-cycle costs
Financing Team

**Ameritas - Bond Underwriting**

Ameritas is a highly experienced public finance team of bankers and administrators with knowledge and expertise in preparing for public bond issuance. They structure bond financing for public infrastructure and tax credit components of our projects.

**Oppenheimer Multifamily Housing & Healthcare Finance, Inc.**

Oppenheimer Multifamily Housing & Healthcare Finance, Inc. is a wholly-owned subsidiary of the same Oppenheimer and Co. that provides investors with the necessary expertise and insight to meet their financial challenges. Oppenheimer Multifamily Housing & Healthcare Finance will be the lender for the construction and permanent financing for the project.

**Berkshire Hathaway AHP**

Berkshire Hathaway's Affordable Housing Partners is direct investor in historic and affordable housing developments. Affordable Housing is a subsidiary of Warren Buffett’s holding company, Berkshire Hathaway Inc., which had total revenue of $143.7 billion in 2011.
Strategic Plan

From Buildings to Urban Villages

**Second and Delaware**

275 unit Passive-house Certified development in Kansas City, MO.

Funded with HUD 221(d)4 loan guarantee, Low Income Housing Tax Credits and Equity.

**Cost:** $60 million  
**Affordable Units:** 58  
**Start Construction:** September - 2015

**Urban Villages**

4,000 residential units, 500,000 sf commercial space, parks, and schools in transit oriented urban core locations.

**Cost:** $1.1 billion  
**Equity Required:** $50 million  
**Return on Equity:** 11-14%
Bridging East and West with Sustainable Development

Infill Development

New Transit Line
Thank you.

For more information visit:
ArnoldDevelopmentGroup.com

or send an email to:
jarnold@ArnoldDevelopmentGroup.com
2nd and Delaware

Galen Staengl, PE CPHC

Arnold Imaging
2nd and Delaware

• 276 Unit apartment building in Kansas City, Mo.
• Project is using Integrated Project Delivery and Lean Construction to deliver a concrete constructed, Passive House building for market rate costs: ~$140 / sqft.
• Project is currently in the end stages of design, and construction will begin this year.
• Developer: Arnold Development Group.
Kansas City Weather is Hot and Humid
- Requires Cooling & Dehumidification
2nd and Delaware

Peak Load Driven by Cooking (Dinner Hour)
Peak load diversity allows 150% of indoor unit capacity connected per outdoor unit capacity. Units are connected to 16 ton outdoor units to maximize unit cost efficiency, and to keep system refrigeration charge within safe limits.
Peak load diversity allows 150% of indoor unit capacity connected per outdoor unit capacity. 
~30 indoor units are connected to each 16 ton outdoor units to maximize unit cost efficiency, and to keep system refrigeration charge within safe limits.
2nd and Delaware

1 and 2 Bedroom Units
Centralized (per floor) ERV allows dehumidification of ventilation air:

- Conditioned air delivered to rooms handles cooling load for low load situations (~20% of cooling hours).
- VRF terminals provide “re-heat” if required.
- Combo Supply/Outdoor air terminals in units
  - save installation costs and complexity
  - allow constant outside air delivery
• VRF takes advantage of diversity
• Dedicated Ventilation System
• High Efficiency ERVs per floor with Dehumidification (No Stack Effect Issues)
2\textsuperscript{nd} and Delaware

150 kW Rooftop PV Array

Shared Roof Space with Gardens
2\textsuperscript{nd} and Delaware

Centralized HW system allows use of combined heat and power micro-turbine to generate power and domestic hot water.

• Design is optimized to keep turbine running maximum hours.

• Will offset \sim 8\% of building electricity use while making hot water.
2nd and Delaware

2nd and Delaware Site Energy Use and Production

- Estimated Annual Apartment Electricity Use: 22.7 kBTU/GSQFT
- Annual Apartment DHW Gas Use: 17.94 kBTU/GSQFT

Micro-Turbine Power Production: 22.7 kBTU/GSQFT
Annual Apartment Electricity: 17.94 kBTU/GSQFT
Solar Array Electricity Production
2nd and Delaware

2nd and Delaware Site Energy Use and Production

Estimated Annual Energy Use [kBTU/yr]

Average Multi-Family Energy Consumption [kBTU/yr]

Building Energy Use Less Generation [kBTU/yr]

77.8 kBTU/GSQFT

17.94 kBTU/GSQFT

77% Less Energy Use Than an Average Multi-
Questions?

Galen Staengl, PE, LEED BD+C, CPHC - gstaengl@staenglengineering.com
2nd + Delaware

276 Unit PHIUS+ Multifamily
Prudence Ferreira, CPHC
Passiv Science Team: Do what you love

4 CPHC Partners
- Prudence Ferreira
- Adam Cohen
- Galen Staengl
- Russell Richman

Lean Project Delivery

Visionary Developer
Success

What people think it looks like

Success

What it really looks like
Lean Project Delivery: Work Smarter

- **Eliminate Waste**
  - Don’t produce anything before you have to
  - Make the profit collaborative through IPD contract

- **Maximize Efficiency**
  - Make decisions as you need to and have all information
  - Systematize repetitive tasks
  - Streamline hand-offs

- **Optimize Results**
  - Rely on your experts, trust your team
  - Communicate with ALL Tm’s even those who aren’t directly involved may have valuable insight
Challenge: Complexity

Image: C.J. Burton
6 Exterior Walls Avg R-25
R-52 Roof (12-16in foam w/taper) | R17 Floor (4in foam)
4 in exterior
6 in foam
6 in interior
Balcony Slab

Typical Stair

Guardrail @ Roof Parapet

Stair Below Grade

Roof Curb

Stair @ Ground

Curb@ Greenhouse

1st Floor Column@ Garage

Ext Wall @ 1st Floor Garage

9 Thermal Bridges
6 window installation details: 12 psi install factors, fluid applied window air sealing
160,548 ICFA x 2 towers
650+ window groups per tower
39 psi install conditions
14 overhangs types
100+ varied reveal depths and distances
Workflow Solutions:

- Weekly meeting with entire team
- Slack + Share File + ProCore
- Creation and continual improvement of ‘standard work’ templates for Passiv Science/SE team to eliminate waste + optimize hand-off’s
  - Thermal Bridge Analysis + Reporting
  - WUFI Passive Mechanical Inputs
  - Utility Estimates
  - Natural Gas Cogen Calculator
  - Frequent standardized peer review and alignment between mechanical and passive energy models
Challenge 1: Complexity

Alignment/comparison of mechanical and passive models: (IES VE + WUFI Passive)

- Share sketchup file for geolocation and shading
- Enclosure and shading
- Appliances
- Occupancy (+schedules)
- Plug loads (+ schedules)
- DHW load (+ schedules)
- WUFI Passive – Compliance
- IES VE – Loads and Utilities
Lessons Learned:

- Design team shouldn’t get ahead of construction pricing team
  - Because of HUD deadlines more drawings were done earlier than should have been
  - Pricing couldn’t keep up with the mad dash on drawings, so there has to be a lot of rework to get pricing in line
  - Without artificial deadline, real-time costing could have been employed. This is the approach we advocate - real-time continuous cost model
Lessons Learned:

- **Thermal Bridging Calcs**
  - Dated and organized iterations of each detail in question is key
  - Single point of contact between the detail designer and the thermal bridge simulator
  - Finalize material properties before you simulate
  - Agree on a set of design strategies when attempting to improve details (stick to that set of strategies…rather than guessing)
  - It is always good to discuss improvement options with all team members
Lessons Learned:

**Complex Shading**
- Georeferenced SketchUp or other 3D model with color-coded windows is extremely helpful to refer to during modeling.
- Detailed window modeling to allow yourself and certifiers to check entries against label works best.
- **W1-5a FX@Conc Wall A-701/1 Zone 1 - 1001 - 32.15@26.59**
  - W1 - Façade
  - 5a – Floor + position for overhang/head reveal
  - FX - fixed window type
  - @Conc Wall A-701/1 installation detail for base reveal depth
- **Zone 1** – if multi-zone model
- **1001** – install code
- **32.15@26.59** – distance @ height of horizontal obstruction

Update!! WUFI Updates will simplify.
Fixed
Tilt-turn
Muntins
Glazed Doors
The Year’s Best of ENERGY STAR for Energy Efficiency and Innovation

WHEN ONLY THE BEST WILL DO.

Looking for the ENERGY STAR label is a simple way to save you money and protect the environment. Now EPA introduces ENERGY STAR Most Efficient 2016, a new distinction that recognizes products that deliver cutting edge energy efficiency along with the latest in technological innovation. It is an award that truly represents the best of ENERGY STAR.

AS GOOD AS IT GETS…FOR NOW

Dishwasher: Bosch - SHE9ER5*UC 0.93 kWh/use
Washer: Speed Queen - LFNE5BJP113+ 0.17 kWh/use
Dryer: Whirlpool WED99HED HP Dryer 2.03 kWh/use
Fridge/freezer: Frigidaire FFHT1814Q* 1.1 kWh/day
Challenge: Lighting Efficiency

Where do you go beyond 100% LED lighting?
Challenge: Elevator Efficiency

(Source: http://www.otisworldwide.com)
Challenge sum(a:c): Monster Internal Gains
Project started using Passivhaus Criteria, then transitioned to PHIUS+ 2015

March 2014
First Energy Model: Passivhaus Criteria

Design Development ensues for the next 11+ months

PHIUS+ 2015 Criteria introduced

Feb 2015 Model updated to PHIUS+ Protocols

Comparison of PHIUS+ model to earlier Passivhaus model
Challenge 3: Efficiency of Internal Loads

Solutions & Lessons Learned: Model These on 1st Pass!

- **CPHC-driven appliance performance spec to meet PE**
  - Do your homework, know energy star baseline and most efficient for each appliance type
  - Don’t use defaults! Model with ES baseline first, then adjust to optimize

- **ALWAYS calculate actual lighting energy**
  - PHPP 100% high efficacy @2900hr/P severely underestimates (11%) PHIUS+ can be 30% greater than LPD 0.75 W/ft2 for common areas
  - At start of project use PHIUS+ calc or a conservative LPD as a placeholder

- **Don’t forget the elevator(s)**
  - Min 1900 kWh/yr as placeholder. Look for low standby energy
  - Calculate trips per year to determine kWh use

Count on IHG of at least 1 Btu/hr.ft²
PHIUS+ LIGHTcomm @100% high efficacy ≈ 30% higher than actual with LED. PHIUS+ LIGHTdwell @100% high efficacy ≈ actual lighting.

### Lighting Reality Check: PHIUS+ vs Actual

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Fixture Label</th>
<th>Quantity</th>
<th>LED Wattage per Fixture</th>
<th>Total Watts per Fixture per Space</th>
<th>Total Watts per Space</th>
<th>Area (ft²)</th>
<th>Watts per Tower</th>
<th>Hours/yr</th>
<th>kWh/yr</th>
<th>W/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Floor Corridor</strong></td>
<td>R1</td>
<td>66</td>
<td>15</td>
<td>990</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>R2</td>
<td>18</td>
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<td>810</td>
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<tr>
<td></td>
<td>R3</td>
<td>46</td>
<td>10</td>
<td>460</td>
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<tr>
<td></td>
<td>R5</td>
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<td>10</td>
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<td></td>
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<tr>
<td></td>
<td>P2</td>
<td>8</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Typical Floor Corridor</strong></td>
<td>R1</td>
<td>68</td>
<td>15</td>
<td>1,020</td>
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<td></td>
<td>R2</td>
<td>16</td>
<td>45</td>
<td>720</td>
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<td></td>
<td>R3</td>
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<td><strong>Fifth Floor Corridor</strong></td>
<td>R1</td>
<td>36</td>
<td>15</td>
<td>540</td>
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<tr>
<td></td>
<td>R2</td>
<td>8</td>
<td>45</td>
<td>360</td>
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<tr>
<td></td>
<td>R3</td>
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<td>10</td>
<td>300</td>
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<tr>
<td><strong>Fifth Floor Rooftop</strong></td>
<td>SA</td>
<td>7</td>
<td>16</td>
<td>112</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>SB</td>
<td>31</td>
<td>3</td>
<td>93</td>
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<td><strong>Sixth Floor Corridor</strong></td>
<td>R1</td>
<td>16</td>
<td>15</td>
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<tr>
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<td>R2</td>
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<td>45</td>
<td>990</td>
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<td>R3</td>
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<tr>
<td><strong>Sixth Floor Rooftop</strong></td>
<td>SA</td>
<td>6</td>
<td>16</td>
<td>95</td>
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<td>SB</td>
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<td></td>
<td>SD</td>
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<td>108</td>
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<td><strong>Rooftop Elevator Lobby</strong></td>
<td>P6</td>
<td>2</td>
<td>36</td>
<td>72</td>
<td></td>
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<tr>
<td></td>
<td>W2</td>
<td>2</td>
<td>29</td>
<td>58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>W3</td>
<td>2</td>
<td>15</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>W2</td>
<td>1</td>
<td>29</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**PHPP @100% high efficacy = Only 11% of actual lighting energy - BEWARE!**
### Plug Load Reality Check: PHIUS+ vs Actual

<table>
<thead>
<tr>
<th>Room</th>
<th>Area (ft²)</th>
<th>Loads</th>
<th>Load Consumption</th>
<th>UOM</th>
<th>ASHRAE Heat Gain (btuh)</th>
<th>Rated</th>
<th>Standby</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>Kitchen / LR</td>
<td>700</td>
<td>Refrigerator</td>
<td>295 watts/hr</td>
<td></td>
<td>1008</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Dishwasher</td>
<td>32 watts/hr</td>
<td></td>
<td>1302</td>
<td>0</td>
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<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Electric Oven</td>
<td>55 watts/hr</td>
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<td>8189</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Range - Induction</td>
<td>112 watts/hr</td>
<td></td>
<td>9167</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Microwave</td>
<td>67 watts/hr</td>
<td></td>
<td>10900</td>
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<td>0</td>
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<td></td>
<td></td>
<td>Toaster</td>
<td>33 watts/hr</td>
<td></td>
<td>18080</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Coffee Maker</td>
<td>4 watts/hr</td>
<td></td>
<td>3413</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Range Hood Fan</td>
<td>4 watts/hr</td>
<td></td>
<td>341</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Computer</td>
<td>15 watts/hr</td>
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<td>222</td>
<td>15</td>
<td>0</td>
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<td></td>
<td></td>
<td>Printer</td>
<td>4 watts/hr</td>
<td></td>
<td>61</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td>Monitor</td>
<td>5 watts/hr</td>
<td></td>
<td>92</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Modem\Router\DVR</td>
<td>40 watts/hr</td>
<td></td>
<td>0</td>
<td>136</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TV</td>
<td>8 watts/hr</td>
<td></td>
<td>92</td>
<td>10</td>
<td>0</td>
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<tr>
<td>Max Load</td>
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<td>2.90 w/sqft</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>12</td>
<td>12</td>
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<td></td>
</tr>
</tbody>
</table>

| Max Load    | 2.03      | kW                  | Schedule %       | 0.6%    | 0.6%                  | 0.6%  |

PHPP ‘Plug Load + Small App’ Defaults = Only 57% of estimated actual -BEWARE!!
NOW All internal gains are in the model. I made it comply.....but I did not like the required measures.

<table>
<thead>
<tr>
<th></th>
<th>PHIUS+ 2015 Criteria</th>
<th>PHIUS+ Upgraded, 0.12 SHGC, No Cogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>6200</td>
<td>5887</td>
</tr>
<tr>
<td>PE</td>
<td>39.93</td>
<td>37.91</td>
</tr>
<tr>
<td>Heat Demand</td>
<td>4.7</td>
<td>2.47</td>
</tr>
<tr>
<td>Cool Demand</td>
<td>6.9</td>
<td>6.9</td>
</tr>
<tr>
<td>Heat Load</td>
<td>4.8</td>
<td>3.14</td>
</tr>
<tr>
<td>Cool Load</td>
<td>5.2</td>
<td>2.45</td>
</tr>
</tbody>
</table>
Challenge: The right glazing /shading
Challenge: The right glazing /shading

Progression and Lessons Learned:

1- PHPP defaults for internal loads placeholder (BAD IDEA)
   - 0.37 SHGC was best fit with summer screens, but caused severe overheating once accurate lighting and plug loads were modeled

2- Transition to PHIUS+ was a wake-up call
   - Holy internal gains! 0.17 SHGC with 83% solar reflective bug screen was only way to meet PHIUS+ ACD criteria. (=0.12 SHGC) TOO DARK!
   - 0.17 SHGC AVAILABLE, BUT NOT IDEAL!
Subject: HELP!!

Lighting can’t get more efficient. All LED!

Appliances can literally not get more efficient. Best Energy Star has for 2016…

We’ve got 193 kWh of PV production and no budget for more…

ERV efficiency and humidity recovery is as high as we can find…

The internal gains are the issue, not the solar gains, but if I go to 0.12 SHGC, we can comply, but…

0.12 is too LOW! No daylight. We really need to look at this issue.

Dynamic effects of thermal mass aren’t reflected in static model, actual peaks will be lower, thus demand lower

Final Glazing Spec: U-0.09, 0.33 SHGC, Tvis 50%+ (no screens, no film, no fins)

BEWARE! Modeled result to meet criteria does not necessarily equate to good design
PERFORMANCE + COMPARISONS
PHIUS+ Multifamily

2nd + DE

30+ cases
Final Modeled Results

- PE below without cogen
- With cogen PE = lower
PV Utilization [i.e. credit claimed in model]

<table>
<thead>
<tr>
<th>PV Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site electricity (kWh/yr)</td>
</tr>
<tr>
<td>Output from PV Watts (kWh/yr)</td>
</tr>
<tr>
<td>Annual PV Output/Annual Electricity Demand</td>
</tr>
<tr>
<td>Utilization fraction from utilization curve</td>
</tr>
</tbody>
</table>
If we didn’t have solar, PE would be blown and no room to move SHGC upwards for better Tvis

<table>
<thead>
<tr>
<th></th>
<th>PHIUS+ 2015 Criteria</th>
<th>Current PHIUS+</th>
<th>Current PHIUS+ No PV</th>
</tr>
</thead>
<tbody>
<tr>
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How to meet Passivhaus PE Criteria (38 kBtu/ft²/yr)?

Optimization 1
1. Lower DHW to 6.6
2. Summer shutters
3. Eliminate:
   - Washers
   - Dryers
   - Dishwashers
   - Elevators
   - Ext lighting
   - Garage lighting

Optimization 2
1. Undo above
2. Reduce lighting kWh by 90% by using PHPP lighting@11 W setting

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PHPP 7 cooling algorithm
COOLER CLIMATES
PHFA PROJECTS

52 UNITS

48 UNITS

43 UNITS

47 UNITS

36 UNITS – MIXED USE
Pennsylvania Multifamily Comparison

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- Heat Demand
- Cool Demand
- Heat Load
- Cool Load
- PE
CONCLUSIONS
In Summary…

**LEAN and IPD** can help minimize waste associated with complexity… not just for construction folk

Harmonization of passive compliance and dynamic HVAC models is imperative.

Accurate accounting of internal gains in multifamily is critical for comfort and utility estimates.

MF is more difficult in mixed humid and humid climates.
More Info on 2+D and Multifamily

http://multifamily.phi.us.org/case-study/second-and-delaware
KEEP EXPLORING!

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