ALLEY HOUSE
Using Phius Certification to Steer Student Design Decisions in Solar Decathlon Build Challenge

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Phius Conference 2023 | Houston, Texas
November 8-11, 2023
First & Foremost, Alley House...

Is a local affordable housing solution to a global climate crisis, which disproportionately impacts the poor, vulnerable, and disenfranchised.

Employs high-performance building design to ensure the comfort, health, & well-being of low-income residents who often struggle to find quality affordable housing in the area & are being displaced due to gentrification pressure from market-rate urban development.

Uses onsite renewable energy production & other resource conservation measures to dramatically reduce monthly utility bills for residents, which can be a significant portion of their monthly income.

Acts as a catalyst for sustainable urban infill housing in an area struggling from decades of disinvestment, vacancy, & property abandonment to enhance quality of place & community interactions.
Solar Decathlon 2023: Build Locally

Build Challenge

**RESIDENTIAL**

Build Locally

Compete Nationally

10 CONTESTS

Architecture

Market Analysis

Embodied Environmental Impact

Occupant Experience

Energy Performance

Engineering

Durability and Resilience

Integrated Performance

Comfort and Environmental Quality

Presentation
PASSIVE BUILDING PRINCIPLES

Phius Prescriptive Path

phius CORE Prescriptive 2021 Snapshot

1. GENERAL
1.1.2 ICFA divided by Number of Bedrooms
(Calculated Value based on Inputs)

3. COMPACTNESS
3.1 Maximum Envelope Area
(Maximum Envelope to Floor Area Ratio)

4. SOLAR PROTECTION
4.1.1 Maximum Whole Window SHGC

4.4.1 Projection Factor for Fixed Overhangs

5. HEAT TRANSMISSION
5.1.1a Fenestration/Openings
Minimum Effective R-Value

5.1.1c Roof, Ceilings

5.1.1d Whole Slab Foundations & Below-Grade Walls and Floors of Conditioned Basements and Crawl Spaces
Minimum Effective R-Value
# Phius Prescriptive Path

## Project Information

**Phius Project Number:** 2650  
**Project Name:** The Alley House  
**Date:** 4/15/21

### 0.3 Climate Information

**State / Province:** INDIANA  
**City:** INDIANAPOLIS IN/IL/I7  
**Climate Zone:** A

### 0.4 Project Location

- **City:** Indianapolis  
- **Street Address:** 201 N Temple  
- **Zip Code:** 62601

### 0.5 Project Team

- **Submitter/CPC Name:** Walter Grondzik  
- **Phius Number:** 1234  
- **Builder Name:** Stan Ponzol  
- **Phius Number:** 1235  
- **Owner Name:** Bill Raper  
- **Phius Number:** 1236

### 0.6 Project Specifications

- **Primary Construction:** Duplex - New Construction  
- **Interior Conditioned Floor Area (ICFA) (sq ft):** 1,980
- **Number of Stories:** 2
- **Number of Bedrooms:** 3

## 1 General

### 1.1 Scope

- **The proposed building is a single-family detached or attached residence (one dwelling unit) where the occupants are primarily permanent in nature.**
- **The CTA (minus excluded floor levels) divided by the number of bedrooms < 900 (sq ft). Excluded Floor Levels are floor levels without gross windward floors.**

### 1.2 Co-Required

- **EnerStar STAR Certified Homes**
- **DOE Zero Energy Ready Homes**
- **LEED Indoor airPLUS**

## 2 Air-Tightness

### 2.1 Measured building air tightness @ 50 / 0.04 cm H2O enclosure area.

### 2.2 Testing agent identified for preliminary blower door test.

### 2.3 Airtightness detail drawings must be comprehensible and show a continuous uninterrupted air barrier that forms from different materials and components at all junctures.

## 3 Compactness

### 3.1 Building Enclosure Area

### 3.2 Does not exceed the calculated maximum (sq ft)

## 4 Solar Protection

### 4.1 Glimm Fenestration Solar Heat Gain Coefficient (SHGC)

### 4.2 Glimm Fenestration Area

### 4.2.1 The overall window-to-wall (W/W) area ratio ≤ 18%

### 4.2.1.1 Orientation (within 90°)

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**Windows Area (sq ft):** 78  
**Aluminum clad Wall Area (sq ft):** 803

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**Consistency and Compliance:**

- **Consistency:**  
  - **Consistent:** Yes
  - **Non-Consistent:** No
  - **NA:** Submittal

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**Design Verifier:**

- **Signature:**  
- **Title:**  
- **Institution:**  
- **NA:** Submittal

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**Building Location:**

- **Date:** November 8-11, 2023
ALLEY HOUSE OVERVIEW
Sustainability: Equity – Economy - Environment

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Engaged Student Involvement

The student engagement and community partnership over this two-year design build process has been transformative. Our community brought invaluable feedback to the team. We held open houses, exhibit displays, community participation sessions and work days, workshops with professional consultants, groundbreaking and ribbon cutting ceremonies, and a two-week public exhibit with over 1000 attendees to the Alley House. Students were engaged in every aspect of this project from design to construction to performance testing.

Open House to solicit feedback on design Fall 2021
- “Advance to Build” Team Presentation Spring 2022
- Groundbreaking Ceremony Summer 2022
- Full-scale layout of house and educational centers
- DayStar children full-scale mockup of play space
- House Occupancy Testing Spring 2023
- Grand Opening to give thanks to over 200 partners
- Ribbon cutting with all having part of the ribbon
- Public exhibit student led tours Spring 2023
- Performance testing of the Alley House continues
Engaged Community Partner: Englewood

Livability
Promoting authentic and unique aspects of the area, utilizing PR Mallory as a central green space, providing a walkable environment for all ages, and improving basic infrastructure.

Opportunity
Encourage new development being walkable and attractive, promoting urban food growing and production, encouraging small businesses, and building off of the areas strengths.

Vitality
Supporting current neighbors while reducing vacancy. Welcoming new residential housing types to add density.

Education
Enhancing existing offerings, providing a community-focused local school, and providing education opportunities for all ages and to those who have fallen behind.
THE ALLEY HOUSE

201 N TEMPLE AVE., INDIANAPOLIS, IN 46202

Just east of downtown Indianapolis is the lively neighborhood of Englewood, a multi-cultural, multi-generational place to live, work, worship, learn, and play. Like many post-industrial communities in the Midwest, Englewood has experienced population decline, reduced rates of educational attainment, decreasing median household incomes, and high vacancy rates. The recent affordable housing crisis and deteriorating existing building stock have made this neighborhood a target for outside developers who are building at a fast pace using low-quality construction materials and are contributing to rising property values. Higher property values bring a positive impact such as an influx of capital into the area and increased beautification efforts in the neighborhood; however, they also negatively impact residents in the displacement of original households and by changing the social character of the neighborhood. Although affordable housing has been developed in the Near Eastside (NES) of Indianapolis, this has not effectively addressed the shortage of affordable housing for families.

Research indicates that vacant and abandoned properties in the Near Eastside neighborhood continue to disturb the communities’ economy, health, welfare, and safety. Indianapolis is not sheltered from these harsh realities. Yet, communities often respond to difficulties by finding opportunities. One such opportunity is the plan of Cardinal Studio and Englewood Community Development Corporation (ECD) to re-engage this neglected community by constructing multiple family housing units on vacant lots (owned by Englewood CDC).
Urban Design

The Alley House is an affordable housing solution to a global climate crisis which disproportionately impacts the poor, vulnerable, and disenfranchised. Students designed a high-performance building to ensure comfort, health, and well-being of low-income residents who struggle to find quality affordable housing and are being displaced due to gentrification pressure of market-rate development. The two-family Alley House is a prototype for urban infill along an east-west running alley where there are over 70% vacancies.
Form Development

**INITIAL VOLUME**
Long south face toward alley

**CREATE TWO UNITS**
Short demising wall between units

**EXTEND STAIR CORE & ACTIVATE THE ALLEY**
Elevate stair angled wall for view to alley

**DEFINING ENTRANCES & SECOND FLOOR SPACES**
Porch placement and secondary entries

**ROOF PITCH STUDY & ADDITION OF EAST AND WEST PORCHES**
Addition of PV array on 4/12 pitch facing south roof

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**Initial Volume**
East-west elongated simple rectangle shape limited surface area and optimal solar orientation.

**Create Two Units**
Dividing the volume into two units, but giving both access to the south and the alley.

**Stair Core & Alley Activation**
Simple formal changes to create architectural interest, to address the alley/corner site, and provide for natural ventilation.

**Defining Entrances & Spaces**
Giving each unit a porch for transitional space and community interaction.

**Roof Pitch Study & Addition of East and West Porches**
Mono pitch to the south for optimal solar array orientation and area. Addition of pergola with the porches for creating enclosure for the connecting spaces.
Detail and Materiality

Angled walls on the corners frame alley views and create an inviting, welcoming presence. Sage green cement board and thermally-modified poplar blend Alley House with its environment. The biophilic design educates the community about green buildings; passersby can see the solar array on the roof, rain gardens, bioswales, shading devices, native plantings, and the corner stair towers for ventilation.
Equitable Community Design

Our neighborhood community development corporation began 25 years ago to help revitalize Near Eastside Indianapolis guided by principles of livability, opportunity, vitality, and education. The team embraced these principles in the design of the Alley House, addressing a sense of place, facilitating educational opportunities, incorporating sustainable site/building strategies, providing resilience and durability, addressing needs of residents at different life stages, and fostering equity and inclusion.

Asset-based community design approach
Site design promotes walkability/access to school Visibility of “green features” fosters education Arrangement of units promotes equity in access Alleyway as preferred neighborhood connector Provide east and west porches and gardens Design for a diversity of family types Consider how family will change over time 15-year rent-to-own leased at 30% and 50% AMI

Variety of Family Types
The Alley House achieves the priorities of Architecture, Affordability, and Equity set by the community and Englewood CDC where the median household income is $32,500 providing:
- Affordable & affordable housing
- Environmentally conscious designs

FAMILY 1
A family with couple and young children

FAMILY 2
A family with young children and single parent

FAMILY 3
A family with elderly member

FAMILY 4
A family with special needs member
Ball State Team: Six Design Goals

- Enhancing Sense of Place
- Building Resilience in the Home
- Facilitating Educational Opportunities
- Providing for Intergenerational Adaptability + Life Cycle Change
- Creating a Sustainable Site & High-Performance Building Design
- Fostering Equity and Inclusion
Equal Access to Green Space

Equal Southern Solar Access

Equal Access to Porches

Equal Access to the Alleyway System

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Contextual & Ecosystem Design

Englewood Village Great Places 2020 Plan
Infill Housing Guidelines for Compact Context
Consider massing, height, architectural features
Sustainable Sites framework for landscape
Employ variety of water management strategies
Promote gardening sustainable food production
Landscape with low-maintenance native plants
Provide bioswale + rain garden in SE corner

Analysis of the alley and potential for a pedestrian natural habitat corridor
Affordability & Funding Sources

From day-one, the student team used the LIHTC requirements given to the owner/community partner to structure and inform the design approach and process in the design studio courses. Every decision was made regarding first/construction costs tied to the budget and long-term costs tied to operations and maintenance by the owner and cost of utilities and maintenance by the tenants.

- LIHTC funding as part of a larger scattered site housing project
- CDBG funding from the City of Indianapolis
- Grant funding from US DOE and State Farm Insurance
- Product donations and discounts
- Cost-saving student design and building activities
- Community partner will rent units at 30% or 50% AMI
- Tenants will be part of a rent-to-own program for up to 15 years
Economic and Market Viability

- **Employment**: Self Employees 10.6%, Private Companies 74.14%, Governmental Workers 7.51%, Not for Profit Companies 7.75%
- **Marital Status**: Never Married 51.07%, Married 33.22%, Separated 2.36%, Widowed 3.62%, Divorced 12.09%
- **Occupied**: Owner Occupied 41.45%, Renter Occupied 58.55%
- **Education**: No High School 8.18%, Some High School 52.38%, Some College 18.57%, Associate Degree 4.25%, Bachelor’s Degree 11.68%, Graduate Degree 4.95%
- **Households**: Households w/ Children 23.47%, Households w/out Children 76.53%

90% Adults prefer the idea of aging-in-place.

38% Job growth within the next 10 years in Indianapolis, Indiana.

12% Indianapolis’ population are the age of 65 or older.

30% Indianapolis’ population are the age of 18 or younger.

$23k Average annual income of a community member
Affordable Duplex on Alleyway Vacant Lots

- 3 bedrooms per unit
- 2 units
- 1 lot

Vacant Lot - Part of Englewood
CDC’s Infill Project
Vacant Lot

Alley House Site
East-West Alley
Existing Buildings
Roadways
Lots

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PASSIVE DESIGN CONSIDERATIONS

Lofty spaces of staircase gives the provision of Stack Ventilation

PV array Exposure to the summer sun

Summer Sun (Blocked by roof & pergola)

Warm air through Cross-Ventilation and Stack-Ventilation

Releasing Warm air

Internal Heat Gain from Concrete floor by Winter sun

Cool Breeze

Winter sun (Passive strategy for internal passive heat gain)

PASSIVE ELEMENTS

STAIR TOWER

INTERNAL HEAT GAIN

OPERABLE WINDOWS

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• Envelope
• Passive Heating
• Passive Cooling
• Daylighting
• Storm Water Management
Potential Occupants

This family is interested in renting the Alley House. Tina is the grandmother, living with her adult daughter and granddaughter in the neighborhood.

This is Kim. She has an adult son living with her who has physical disabilities. Here, she and her friend are discussing her family renting the house.
Health & Well-Being Design

Biophilic design using natural materials and connecting the inside with the outside informs the project. Transitional spaces are reinforced in the duplex’s porches connected to the sun shading pergola, planting beds and boxes, rain gardens, and a bioswale. We leveraged the Passive House principles to address occupant’s health and comfort with continuous insulation, radiation control, airtight construction, balanced ventilation, and minimized mechanical.

- Views to natural landscaping from gathering spaces
- Use of natural hardwoods in cabinetry/built ins/stairway
- Energy recovery ventilator provides constant fresh air
- Haven IAQ monitor measures particulates, VOCs, humidity
- Optimized windows with radiation control and shading pergola
- Airtight construction value of .06 ACH50 air change/hour
- Continuous insulation with 5 inches of mineral wool
Biophilic Design Promotes Health + Well Being

JUNE 9, 2023

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Design for Water

There is a lack of environmentally responsive and community-conscious design in this neighborhood. The Alley House serves as an example of what not only through its impact on the community, but also with its building practices (following PHIUS's prescribed path) and landscape design (following Sustainable Sites certification), that the divide between sustainable building design and affordable housing criteria can be lessened. The Alley House designed for water carefully considering how all water could be harvested and used in rain gardens, bioswales, and for productive and flowering gardening. Two 100-gallon rain barrels are used on the south side and two more 80-gallon barrels on the north side. A large bioswale and rain garden in the southeast corner of the lot prevents water from draining to the alley, which every other house in the area does, creating a muddy mess. The Alley House designed the landscape utilizing Sustainable Sites as a framework, carefully calculating the rainfall and total volume of water to be managed in the vegetated space.

For domestic hot water we utilize a heat pump water heater because it is 2-3 times more efficient than a conventional electric resistance water heater. The water heater has a user interface module that allows real-time monitoring and control features such as hybrid or efficiency use and vacation time setback. The heat pump water heater will extract ambient heat from the interior of the home as part of the efficient vapor compression refrigeration cycle. It is also powered by the solar array and backup battery during weather emergencies. All the sink and lavatory faucets, water closets, and shower/tub faucets are low flow, water saving, and energy efficient.

Total Vegetated SqFt = 2,077.61 ft²
Total Rain Barrel Capacity = 1,056 Gallons
Water to Be Managed in Vegetated Space = 952.4 ft² or 7,142.2 Gallons

60th Percentile Event: 0.34 in²

Total Unvegetated SqFt = 3,216 ft²
Total Rainfall on Unvegetated Surfaces = 13,121.28 in²
Total Gallons of Rainfall = 8,179.2
Collaboration with Landscape Architecture
THE RAIN COLLECTED BY THE ROOF IS LED THROUGH THE GUTTERS TO THE RAIN CHAINS.

THE RAIN CHAINS FEED INTO THE FOUR RAIN BARRELS FOR USE BY RESIDENTS, ANY OVERFLOW GOES INTO THE BIOSWALE SYSTEM AND THE DRY WELL.

PRECIPITATION FALLS ON SITE AND ROOF.

THE RAIN THAT FALLS ON SITE IS DETAINED INTO THE RAIN GARDENS AND MOVES THROUGH THE BIOSWALE.

THE RAIN GARDENS ALL DRAIN TO THE BIOSWALE ON THE SOUTH SIDE OF THE SITE AND ANY LEFTOVER IS DETAINED IN THE DRY WELL IN THE SE CORNER OF THE SITE.

ON SITE WATER CYCLING

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Adaptable & Flexible Design

The student team designed the Alley House as a two-family home that responds to the changing needs of a family life cycle. Flexible, multi-use, and accessible spaces with adaptable furnishings suit families with children, empty nesters, and elders who wish to age in place.

- Major living areas on 1st floor
- Ground floor bedroom
- Ground floor, ADA accessible full bathroom
- Zero-step entries
- Modular built-ins and moveable furnishings for storage and seating
- Flex space on the 2nd floor could be a playroom, office, or den
- Small footprint but a variety of spaces for occupants to get away

Second Floor Flex Space

First Floor Flex Space

3rd bedroom located on the ground floor can be used flexibly as – guest room, or in-law suite, or older youth, or aging in place
Major Gathering Areas on First Floor

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Media Wall & Study Space Installation

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Family Centered Quality & Adaptability

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Integrated Design

The Integrated Design Studio (ARCH 600–400) allowed student teams to develop the Alley House with focus on a layered consideration of systems integration guided by sixteen weekly assignments, topical presentations, participatory community engagement sessions, and design workshops.

- Site, context and neighborhood analysis, structural, environmental and building systems, accessibility and life safety, environmental stewardship, and technical documentation were all synthesized in the design build project. An integrated evaluation and decision-making process across all systems informed the process.

- PV array designed net-positive with battery back-up
- Rainwater harvesting in rain barrels and landscaping
- Stormwater retention bioswales and rain gardens
- South façade shading pergola protects summer sun/allows winter frost-protected shallow foundation reduces concrete used
- Passive strategies of cross & stack ventilation and thermal mass
- Super-insulated building envelope
**Frost Protected Shallow Foundation**

**Insulated Floating Slab**
Frost protected shallow foundation (FPSF)

**Facts:**
- Does not use traditional concrete footers or stem walls
- Saves energy, time and construction cost by reducing material quantities, site preparation time, and slab construction
- 6” of EPS foam beneath the slab sits on a compacted gravel base providing R-21.6 of insulation
- EPS slab edge form-work stays in place after concrete pour for thermal control

**KEY**
- Engineered insulation skirt (Type II + mesh)
- Type II Sheets of rigid insulation

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**Diagram:**
- a] Exterior Mineral Wool Insulation
- b] “J” Bolt Anchor
- c] 1/2” EPS Insulation
- d] Earth Infill
- e] Legalett Slab Edge
- f] Blown-in Insulation
- g] Rigid Insulation Skirt
- h] 8” Concrete Slab (3500 psi)
- j] #4 Rebar
- k] Min. 6” EPS Rigid Insulation
- l] Compacted Gravel

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**Site Preparation**
- Compacted Gravel
- Concrete Pour Over Rigid Insulation
High Performance Enclosure System

Indoor Air Film / Finish Surface [R-0.68]
5/8" Gypsum Sheathing [R-0.50]

2"x6" Stud Wall 24" O.C.
5.5" High Density Cellulose [R-22.00]

5" Rigid Mineral Wool Insulation [R-19.00]

4'x8' 7/16" ZIP Sheathing,
All Seams Taped [R-0.62]

Vertical Furring Strips [R-0.00]

Horizontal Fiber Cement Lap Siding / Outside Air Film [R-1.17]
Advanced Framing Construction

**ADVANCED FRAMING FEATURES**

- Double top plate
- Minimal header, made of 2x6 studs to form a "C" shape where the header is on the interior and filled with top floorboard insulation
- Properly sized headers with foam on interior
- Stacked framing with TJI's transfer loads directly to studs below
- The rim joints act as bonders, transferring loads across studs below
- ZIP sheathing, applied with 5" of mineral wool in the West Unit, to improve thermal performance
- Place windows and doors on end layout to minimize studs in jams
- 2x6 studs at 24" O.C.
- Single stud at rough openings due to stud alignment
- No cripples under ends of window sills
- Legpilot concrete slab form edge pieces. Advanced framing on
- Two stud corners will not compress insulation and reduce thermal bridging

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**Optimal Value Engineering + TJI Benefits**

- Studs are generally spaced 24" on center instead of 16" saving lumber
- Framing method uses less wood in headers, sills, and jambs of windows and doors
- Framing method + 24" O.C. TJI selection allows for minimal wood in overall framing
- Less lumber to install = less labor cost + faster framing time
- Less lumber also decreases the heat loss from thermal bridging + more insulation

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Framing and Sheathing

First Floor Framing
**Truss Joist I-Joist (TJI)**
Pre-manufactured wooden truss joist

**Facts:**
- TJIs directly align with the advanced framing wood studs below to carry the load
- TJIs enabled a long span with less depth eliminating interior baring walls
- TJIs consist of a top and bottom flange of solid lumber held together with an oriented strand board (OSB) web and resembles a traditional wide-flange steel member
- TJIs use approximately 50% less wood than traditional joists and are pre-manufactured, resulting in high accuracy, consistency, and quality
- Made of engineered wood, they shrink less than traditional lumber and have greater resistance to twisting and warping
Engineered Roof Trusses

Lumber:
- Value Set: 13B (Effective 6/1/2013)
- Top chord: 2x4 SP #1
- Bot chord: 2x4 SP #1
- Webs: 2x4 SP #3; W1, W7 2x6 SP #1
- Lumber value set *13B* uses design values approved 1/30/2013 by ALSI

Loading:
- Truss designed for unbalanced snow loads.
- Wind loads based on MWFRS with additional C&C
- Truss designed for unbalanced snow loads.
- End verticals not exposed to wind pressure.

Roof Truss facts
- The south roof slope is 4:12 pitch, and the north slope is 8:12 pitch
- The trusses are spaced 24” on-center to align with the advanced wood stud framing below
- The roof slopes facilitate rainwater and snow melt runoff where gutters, downspouts, and rain barrels will collect it for irrigation use
- Asymmetrical gabled roof design also allows for the small mono-pitch section of the roof over the stair towers to work structurally and create more roof square footage on the south orientation to accommodate a larger solar PV array
- An innovative aspect of the Alley House's cold roof system (non-conditioned attic space) is the design of its control layers, which use taped sheathing at the 2nd floor ceiling.
- The floor of the attic is then filled with approximately 26” of loose-fill cellulose to achieve a thermal performance of R-92

Roof Truss Layout

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Framing “Topping Off” Celebration

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Window Selection: U factor and SHGC

Window facts
- The window openings in the Alley House are strategically located as part of the 24" advanced framing module.
- Pella triple-pane insulated glazing units (IGUs) in fiberglass frames filled with Krypton gas between glass panes and have low-e coating.
- The windows will achieve the following energy performance ratings:
  - U-factor 0.16-0.18
  - Solar Heat Gain Coefficient (SHGC) 0.24 - 0.27
  - Visible Transmittance (Tvis) 0.43 - 0.50
- Energy Star-certified windows are 50% better than energy code compliant windows in Indiana and meet the PHIUS Core Prescriptive standards.
- The windows are a combination of fixed, operable casements, and operable awnings.
- Fiberglass was chosen for its strength, durability, and lower carbon footprint compared with vinyl frames and were lower cost and required less maintenance over time compared with metal clad wood frames.

Window Operations

Window Installation

Window Aligned with ZIP Sheathing

Window Elevation

Triple Pane Window Section

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WE OFFER 3 KINDS OF SERVICES

GOOD • CHEAP • FAST

BUT YOU CAN PICK ONLY TWO

GOOD & CHEAP WON’T BE FAST

FAST & GOOD WON’T BE CHEAP

CHEAP & FAST WON’T BE GOOD
U.S. CEMENT SHORTAGE VS. INFRASTRUCTURE
Exterior – taped layer of ZIP sheathing and 2 layers of Rockwool mineral wool continuous insulation 5” total

Exterior – furring strips installed for cladding, allowing moisture to escape

Interior – 2 x 6 advanced framing wall cavities filled with Greenfiber Sanctuary dense packed blown-in cellulose

Students helping with cellulose installation

Installation of two layers of Rockwool

Cladding installation
Alley House Elevations

West Elevation  |  South Elevation

North Elevation  |  East Elevation
Mechanical System: Split System Heat Pump

**FCU + ERV INTEGRATION PLANS**

- **Second Floor**
  - FCU System
  - Fresh Air Supply
  - Exhaust Air

- **First Floor**
  - FCU System
  - Fresh Air Supply
  - Exhaust Air

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**Fan Coil Unit (FCU)**
Mitsubishi multi-zone, short ducted heat pump system

**Facts:**
- Split zoning of first and second floor allow for smaller mechanical units to be hidden in dropped ceiling saving mechanical room space.
- Zone splitting allows for saving in energy usage by supplying heating or cooling where it is needed.
- Integrating an ERV with the FCU provides fresh preconditioned outside air throughout the home.
- Performance characteristics of the system:
  - SEER: 17.3
  - EER: 13
  - HSPF: 9.8
  - COP Heating (47°F): 3.10
  - COP Cooling: 4.82
  - Indoor Acoustics: 23-30 dB (A)
Ventilation System: Energy Recovery Ventilator

**ERV INTEGRATION**

**ERV Second Floor chases**

**ERV in mechanical room**

**Energy Recovery Ventilation (ERV)**
Greenheck Sync 180 energy recovery ventilator

**Facts:**
- The ERV, fitted with a MERV-13 filter, supplies air to “clean” spaces such as the living area, bedrooms, and flex space via 6” hard ductwork.

- Contaminated air is pulled from the kitchen and bathrooms continuously. Bathrooms are fitted with a boost mode switch to temporarily increase the air flow rate (supply and exhaust) after a high-moisture event like a shower.

- Fresh, dehumidified air supplied via the ERV is then used by the multi-zone heating/cooling system, which does not supply any fresh outside air. The ERV has a sensible recovery efficiency of 84%.

- Exhaust and supply air streams do not cross but run through a heat and moisture exchanger for energy recovery.

- Meets ASHRAE 62.2 standards.
Heat Pump Water Heater

- Heat pump water heaters are 2-3 times more efficient than conventional electric resistance hot water heaters.
- A.O. Smith water heater includes a user interface module (UIM) that allows real-time monitoring and control features such as vacation setbacks.
- This heat pump water heater will extract ambient heat from the interior air in the home as part of the efficient vapor compression refrigeration cycle.
- The tank also has 4" of insulation to prevent heat loss from the tank to the interior.

PLUMBING SYMBOLS
- COLD WATER SUPPLY LINE
- HOT WATER SUPPLY LINE
- WASTE LINE
- VENT PIPE
- HOSE Bib
- Water Heater

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PV Array Electrical System

Solar Array facts
- The Alley House provides onsite renewable energy generation via an 8.8kW solar photovoltaic (PV) system composed of 22 Panasonic Evervolt 400W PV modules mounted on a rack to the south facing roof.

- Helioscope software suggests that the array can provide 12,181 kWh of renewable energy per year. With a 25-year warranty, their expected module yield at the end of the warranty period is 92%.

- The PV array collects energy in the form of direct current (DC). The energy is then moved through an inverter in the mechanical room to become the alternating current (AC) used by the appliances, outlets, and other equipment in the home.

- The electrical system connects to an outdoor electric vehicle (EV) charging station for use by occupants with an electric vehicle.

- Two EcoFlow modular, portable batteries can be charged during the daytime when occupants are using less solar energy and used in the event of a power failure or for load shedding.
Sustainable Materials & Embodied Energy Design

Informed material selection was critical in our design process, selecting sustainable, durable, safe, and healthy materials using Tally to consider Global Warming Potential. We chose a shallow frost-protected slab with R22, building envelope advanced framing + Cl for R47, cold roof with wood fiber insulation R92, thermally modified wood stair tower cladding, wood fiber cellulose insulation -3kgCO2e/m2, reclaimed and recycled wood and limestone, fiber cement cladding used for durability.
A: Thermally Modified Wood
B: Hemp Wood Flooring
C: Volcanic Ash Marmoleum
D: Birch Veneer Cabinets
Collaboration with Partners

Students, faculty advisors, partners, community members, industry reps, and contractors and sub-contractors together are tackling the question, how can we take sustainable building design practices and technology and bridge the gap to meet affordable housing criteria for Englewood? Collaboration with the community and our partners provided immense opportunities for students to apply new and innovative techniques in the design and build and to challenge the status quo on high-performance building in Indiana. We celebrated each victory from ground breaking, to tree “topping off,” to ribbon cutting ceremony with our partners!
Cedar Street Builders
Dan Porzel, Manager
Cedar Street Builders focuses on building high quality, high performance homes. Dan Porzel acts as a general contractor and consults with the team on high performance Cedar Street Builders will be building the home.

KP Meiring
Kemper Meiring
KP Meiring offers development, design-build, pre-construction, and construction services. KP Meiring is working with Englewood CDC on the other homes being constructed and is working with Cedar Street Builders on the Alley House.

Jefferson Electric
Joel Wltsman, PV Consultant
Jefferson Electric is a fast-growing small business in Indianapolis that has provided donated consultation time to assist the team in solar array calculations, product selection and will potentially aid in the installation of the solar array to the unit. Jefferson provided a discount on the solar array and is providing us with a smart electrical panel box.

Greenheck
Tony Rossi
Greenheck has consulted the team in our system requirements for comfort and environmental quality. The company is also graciously donating an ERV.

McComb Window Company
Paul Spacco, Sales Rep. & Angelo A. Zarvas, VP of Arch.Sales
McComb is a distributor for Pella. Pella Corporate gave us a big discount on the windows. McComb helped us choose the windows to meet the design specs—specifically the PHIUS certification requirements.

Nu-wool
Paul Spacco, Sales Rep. & Angelo A. Zarvas, VP of Arch.Sales
McComb is a distributor for Pella. Pella Corporate gave us a big discount on the windows. McComb helped us choose the windows to meet the design specs—specifically the PHIUS certification requirements.

Thermafiber Owens Corning
Todd Shear, US Manager
Eric Aubrey, Indiana Sales Manager
Thermafiber is a potential provider of insulation material. The team is currently in discussion with the company.

Legalett Frost Proof Foundation
Ken Williams, VP of Sales
Mike Reynolds, Operations Director
Legalett have been contracted to provide the slab system and have provided a discount on the engineering services necessary to get the foundation through city permitting. The slab is called a frost-protected shallow foundation and Legalett is a proprietary system for this kind of foundation.

Mitsubishi
Mark Giganti, Sales
Mitsubishi is a potential provider of components of the HVAC system. The team is currently in discussion with the company.

Rock Wool
Nolan Szalmasagi, Territory Manager Indiana
Rock Wool is a potential provider of insulation material. The team is currently in discussion with the company.

Irving Materials Concrete
Trent Shannon, Sales
Thermafiber is a potential provider of insulation material. The team is currently in discussion with the company.

Green Fiber Cellulose
Rob Walker, Regional Manager
The team is currently in discussion with the company and they have tentatively said they would supply cellulose material.
Industry Partners & Products On Site

- EcoVantage Wood
- Rockwool Mineral Wool
- Greenfiber Cellulose
- AeroBarrier
- Greenheck ERV
- Pella Windows
- Jefferson Electric Solar
- Quartz Countertops
- Mitsubishi Heat Pump
# Contest Structure

## 10 Total Contests

<table>
<thead>
<tr>
<th>Contest No.</th>
<th>Contest Name</th>
<th>Contest Type</th>
<th>Points</th>
<th>Subcontest Name</th>
<th>Subcontest Points</th>
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<tbody>
<tr>
<td>1</td>
<td>Architecture</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>Market Analysis</td>
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<td>4</td>
<td>Durability and Resilience</td>
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<td>None</td>
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<td>Embodied Environmental Impact</td>
<td>Juried</td>
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<tr>
<td>6</td>
<td>Integrated Performance</td>
<td>Measured</td>
<td>100</td>
<td>Hot Water</td>
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<tr>
<td></td>
<td></td>
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<td>Interior Light Levels</td>
<td>20</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Internally Generated Noise</td>
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<td>7</td>
<td>Occupant Experience</td>
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<td>Airtightness</td>
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<td></td>
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<td>Passive Performance</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Kitchen Appliances</td>
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<td></td>
<td></td>
<td></td>
<td>Clothes Drying</td>
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<td></td>
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<td>Electric Vehicle Charging</td>
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<td>Humidity Control</td>
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<td>Indoor Air Quality</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Comfort Gradient</td>
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<td></td>
<td>Exterior Noise Infiltration</td>
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<td>Energy Efficiency</td>
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<td></td>
<td></td>
<td></td>
<td>Energy Production</td>
<td>20</td>
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<td></td>
<td></td>
<td></td>
<td>Net Zero Energy</td>
<td>30</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Solar Energy Utilization</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>Presentation</td>
<td>Juried</td>
<td>100</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>

- **Highest final score out of 1,000 points wins**
- **Teams must do well across all contests to win!**
Instructions: Drag and drop each of the 9 measured contest events onto the calendar (the boxes are sized according to the number of days the event takes) and send back to the Organizers by March 15th, 2023 at sdbuild@nrel.gov. Below is some additional information and conditions to keep in mind when making your team’s schedule:

- For contests that involve automated data collection (Continuous Monitoring Period, Interior Light Levels, Solar Energy Utilization, Passive Performance, Energy Production), the scored period will begin at midnight (local time zone) on the first day, and end at midnight on the last day outlined on your schedule. These contests may occur on weekends, as no Organizer presence is necessary.
- The EV charging event requires team members and Organizers to be present at the start and end of the 24-hour period. Neither the start nor end of this event may occur on a weekend.
- The Measured Contest Day may not occur on a weekend, as this involves Organizers to be present via Zoom.
- The Blower Door Test and HERS Rating likely cannot occur on a weekend, unless the third-party vendor allows. The Organizers will create an introduction for you to the vendor. It is not recommended to overlap this event with others, as it will take most of the day and could interfere with ongoing measurements. Teams must work with the vendor to determine a date for this event.
- The Net Zero Energy subcontest is not included in the schedule because it will be completed virtually by a third party.
- The Passive Performance subcontest cannot overlap with any other events.
- The House Occupancy subcontest must occur during the Continuous Monitoring Period.
- Besides the two conditions immediately above, all other contests can be overlapped in any way that teams decide.
- Starting March 20, teams will be subject to a 1 point penalty per day until any one of the 9 subcontests has started.
- Once a team submits their Measured Contest Schedule to the Organizer Team by March 15th, the schedule cannot be changed unless there are extenuating circumstances, as determined by the Organizers.

Please submit this powerpoint to the Organizers by March 15th, 2023, and include the local time zone for your team’s house in the email. The Organizers will check your team’s schedule and approve it within 24 hours of the submission as long as it follows the above guidelines.

### Continuous Monitoring Period
#### 5 Days
- **Interior Light Levels**
  - 3 Days
- **Solar Energy Utilization**
  - 3 Days
- **Passive Performance**
  - 2 Days
- **Energy Production**
  - 1 Day
- **House Occupancy**
  - 1 Day
- **Measured Contest Day**
  - 1 Day

### Net Zero Energy/Effic Virtual
#### Continuous Monitoring Period
#### 5 Days

### Other Events
- **EV Charging**
  - 1 Day
- **Blower Door/HERS**
  - 1 Day
- **Grand Opening**
  - 4-8 pm
- **AIA Day Talk/Tour**
  - 4-6 pm
- **CAP Alumni**
  - 4-8 pm

### Schedule

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td></td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td></td>
<td>Passive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Days FRI 5pm</td>
</tr>
</tbody>
</table>

| 26     | 27     | 28      | 29        | 30       | 31     | 1        |
|        |        |         | House  |        |        |          |
|        |        |         | Occupancy |        |        |          |
|        |        |         | 1 Day   |        |        |          |

| Passive | Interior | Solar |
| SUN 5 pm| Light Levels | Energy Utilization |
|         | 3 Days | 3 Days |

| 2       | 3       | 4       | 5        | 6        | 7       | 8        |
|         |         |         | House  | Grand Opening | Measured  | AIA Day |
|         |         |         | Occupancy | 4-8 pm | Contest | Talk/Tour |
|         |         |         | 1 Day   |          | 1 Day   | 4-6 pm  |

| 6      | 7      | 8      |
|        |        |        |
| Energy Production | Continuous Monitoring Period | Net Zero Energy Efficiency (Virtual) |
| 1 Day | 5 Days |          |

| D.8 DUE | Energy Production | 5 pm | Continuous Monitoring Period |
| 5 pm | 1 Day |          | 5 Days |

<p>| 4-8 pm | 4-6 pm | 4-6 pm |
| CAP Alumni | AIA Day Talk/Tour | CAP Alumni |
| 4-8 pm | 4-6 pm | 4-8 pm |</p>
<table>
<thead>
<tr>
<th>BUILDING DESIGN ELEMENT</th>
<th>ZERO ENERGY READY HOME TARGET</th>
<th>PHIUS PRESCRIPTIVE TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof R-value</td>
<td>2021 IECC Prescriptive U-factor = 0.024 (R-42)</td>
<td>R = 66 effective</td>
</tr>
<tr>
<td>Wall R-value</td>
<td>2021 IECC Prescriptive U-factor = 0.045 (R-23)</td>
<td>R = 35 effective</td>
</tr>
<tr>
<td>Window U-factor</td>
<td>0.30</td>
<td>0.17</td>
</tr>
<tr>
<td>Window SHGC</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Airtightness</td>
<td>ACH50 = 3.0</td>
<td>0.04 cfm/ft² enclosure</td>
</tr>
<tr>
<td>Water heater EF</td>
<td>UEF = 2.57</td>
<td>UEF ≥ 3.0</td>
</tr>
<tr>
<td>Whole-house mechanical ventilation</td>
<td>2.9 cfm/W; heat exchange not required</td>
<td>1.2 cfm/W; heat exchange required</td>
</tr>
<tr>
<td>Lighting efficacy</td>
<td>100% Energy Star varies from 33 to 60 lm/W</td>
<td>≥ 83 lm/W</td>
</tr>
</tbody>
</table>
Net-positive Energy Design

The Alley House is all electric, eliminating dependence on fossil fuels while improving building performance and occupant comfort. Students optimized energy use resulting in an Energy Use Intensity (EUI) of 21.64 kBTU/ft²/yr (calculated with COVE Tool). Preliminary analysis of EUI was 48.95 kBTU/ft²/yr. Through design development, we effectively reduced EUI value by 55.8%. West Unit is net positive energy using 8.6kWh/yr PV system composed of 22 Panasonic Evervolt 400-watt modules. This array produces 21,181 kWh/yr (calculated with Helioscope), a 38% energy surplus.

- Passive heating concrete thermal mass storage offsets active system
- Passive cooling cross + stack ventilation offsets active system in shoulder season
- Daylighting reduces daytime electric load
- Mitsubishi low ambient, split system heat pump heating/cooling is 1.5 ton
- Heating/cooling uses ducted, soft mounted air handlers
- Two-zones allow upper + lower floor control of heating/cooling
- AO Smith heat pump water heater provides real-time monitoring and control use
- Condensing dryer extracts ambient heat/discharges dehumidified cooler air
- All appliances are Energy Star rated
- Appliances powered by solar PV + backup battery during weather emergencies

Solar Edge is inverter/panel optimizer with app. that gives real-time solar production

Solar Edge Calculations

<table>
<thead>
<tr>
<th>Energy Produced</th>
<th>3,393 kWh/yr</th>
<th>8,788 kWh/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Produced</td>
<td>12,181 kWh/yr</td>
<td>8,788 kWh/yr</td>
</tr>
<tr>
<td>Energy Needed</td>
<td>12,181 kWh/yr</td>
<td>8,788 kWh/yr</td>
</tr>
</tbody>
</table>
**Measured Contest: Energy Performance**

### Solar Array Calculations

**Energy Need**

\[ \text{EUI (21.64) x Total SF (1,386)} = 29,993 \text{ btus/yr} \]

\[ 29,993 \text{ btus/yr} \times \text{Conversion Value (0.293)} = 8,788 \text{ kWh/yr} \]

**Energy Produced**

8.8kW PV system composed of 22 Panasonic EverVolt 400w PV modules

\[ \approx 12,181 \text{ kWh/yr} \text{ (Estimated using Helioscope software)} \]

\[ 12,181 \text{ kWh/yr} - 8,788 \text{ kWh/yr} = 3,393 \text{ kWh/yr} \]

**38% Energy Surplus**

---

**PV Array Specifications**

**Panasonic EverVolt**

410W/400W

Mono-crystalline cells with 21.6% efficiency

**Solar Edge Inverter & Power Optimizers**

Maximizes individual production in partially shaded conditions

---

Phius Conference 2023 | Houston, Texas

November 8-11, 2023
Daylighting limits need for lighting

System Performance

- Current Power: 330.24 W
- Energy today: 34.26 kWh
- Energy this month: 138.67 kWh
- Lifetime energy: 4.58 MWh

Power and Energy

Energy in the past 7 days

<table>
<thead>
<tr>
<th>Date</th>
<th>Wh</th>
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<tbody>
<tr>
<td>10/29/2023</td>
<td>5000</td>
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<tr>
<td>10/30/2023</td>
<td>12000</td>
</tr>
<tr>
<td>10/31/2023</td>
<td>20000</td>
</tr>
<tr>
<td>11/01/2023</td>
<td>30000</td>
</tr>
<tr>
<td>11/02/2023</td>
<td>38000</td>
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<tr>
<td>11/03/2023</td>
<td>30000</td>
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<tr>
<td>11/04/2023</td>
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</table>

Last update: 11/04/2023 6:10 PM
Energy Performance

This Contest evaluates whole-building energy consumption and how it is offset by renewable energy systems.

<table>
<thead>
<tr>
<th>University</th>
<th>Score</th>
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<tbody>
<tr>
<td>Ball State</td>
<td>100.00</td>
</tr>
<tr>
<td>Kansas</td>
<td>100.00</td>
</tr>
<tr>
<td>Wyoming</td>
<td>100.00</td>
</tr>
<tr>
<td>IIT Bombay</td>
<td>79.00</td>
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<tr>
<td>Illinois</td>
<td>60.00</td>
</tr>
<tr>
<td>Texas A&amp;M</td>
<td>54.00</td>
</tr>
<tr>
<td>Woodbury</td>
<td>54.00</td>
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<tr>
<td>Waterloo</td>
<td>53.060</td>
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<td>BYU</td>
<td>52.180</td>
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<td>British Columbia</td>
<td>40.00</td>
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<tr>
<td>CU Boulder</td>
<td>34.50</td>
</tr>
</tbody>
</table>
Light sensors in kitchen & study

**COMFORT**

**LIGHT & WATER**

**LIGHTING**
- Turn lights ON at night
- Turn lights OFF during the day
- Windows bring in sunlight during the day
- Light from windows saves energy
- Light from windows saves money
- Light from windows keeps you healthy & helps your body maintain a natural circadian rhythm (day/night cycle)

**HOT WATER**
- The hot water tank is in the mechanical closet
- Hot water uses A LOT of energy
- Making hot water costs you money
- Do not adjust the temperature on the hot water tank (for safety)
- Push the VACATION button if you will be away
- TURN OFF the vacation setting when you get back
- The tank is different than typical ones. It may be louder and it may make the closet cold.
- Tank can be adjusted. Ask Englewood CDC to help
Integrated Performance

This Contest evaluates the interdependencies of building design elements to achieve optimized whole building performance. In a truly integrated design, when any element is altered or removed from the building, overall building performance is diminished.

Integrated Performance Contest Scores

<table>
<thead>
<tr>
<th>Institution</th>
<th>Score</th>
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<tbody>
<tr>
<td>IIT Bombay</td>
<td>94.540</td>
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<tr>
<td>Ball State</td>
<td>89.880</td>
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<tr>
<td>British Columbia</td>
<td>87.280</td>
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<tr>
<td>Wyoming</td>
<td>76.840</td>
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<td>Kansas</td>
<td>73.570</td>
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<td>BYU</td>
<td>71.440</td>
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<td>25.110</td>
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<td>Texas A&amp;M</td>
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<tr>
<td>Waterloo</td>
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Points
<table>
<thead>
<tr>
<th>SOLAR DECATHLON CHALLENGE</th>
<th>SUPPORTING PHIUS ELEMENTS</th>
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</thead>
<tbody>
<tr>
<td><strong>Integrated Performance: Airtightness Subcontest</strong>— All available points are earned for a measured air tightness of less than or equal to 0.05 cfm50/ft²</td>
<td>Exceptionally low infiltration; quality assurance protocols that involved multiple blower door tests</td>
</tr>
<tr>
<td><strong>Integrated Performance: Passive Performance Subcontest</strong>— The home’s ability to retain interior thermal comfort over a 48-hour period without the use of active heating or active cooling</td>
<td>Exceptionally low infiltration; triple paned windows; high-R enclosure; verified solar control; reduced interior loads resulting from lighting and appliance efficiency</td>
</tr>
<tr>
<td><strong>Integrated Performance: Lighting Illuminance Subcontest</strong>— 300-1,500 lx monitored over 3 days</td>
<td>Excellent daylighting offer little use of electric lighting during daytime; verified lighting efficacy &gt; 83 lm/W in light fixtures</td>
</tr>
</tbody>
</table>
Measured: Comfort & Environmental Quality
• April 3rd House Occupancy Dinner with 6 guests, 2 from Ball State, 2 from the Community and 2 from the Building Industry with 4 students and faculty.

• April 5th was Alumni Day and One Ball State Day of Giving. 98 past students, now Alumni, came out to see the Alley House.

• April 15th was Ball State Open House Day at the Alley House. Tours and food were enjoyed by 238 attendees, which included the president of Ball State University, the dean of the College of Architecture and Planning, the chair of the architecture department, student and faculty co-leads, and the director of sustainability whom all spoke a few words about the project.
Comfort & Environmental Quality

This Contest evaluates the building's capability to deliver intended comfort and indoor environmental quality.

**Comfort & Environmental Quality Contest Scores**

<table>
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<tr>
<td>British Columbia</td>
<td>91.000</td>
</tr>
<tr>
<td>Ball State</td>
<td>90.000</td>
</tr>
<tr>
<td>Kansas</td>
<td>89.450</td>
</tr>
<tr>
<td>IIT Bombay</td>
<td>66.680</td>
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<tr>
<td>Woodbury</td>
<td>54.840</td>
</tr>
<tr>
<td>BYU</td>
<td>54.050</td>
</tr>
<tr>
<td>Illinois</td>
<td>40.000</td>
</tr>
<tr>
<td>CU Boulder</td>
<td>0.000</td>
</tr>
<tr>
<td>Texas A&amp;M</td>
<td>0.000</td>
</tr>
<tr>
<td>Waterloo</td>
<td>0.000</td>
</tr>
</tbody>
</table>
### Comfort and Environmental Quality: Temperature and Humidity Control Subcontest
All available points are earned for maintaining a time-averaged interior dry-bulb temperature between 68°F and 74°F and a time-averaged relative humidity between 35% and 50%.

- Exceptionally low infiltration; triple paned windows; high-R enclosure; verified solar control

### Comfort and Environmental Quality: Indoor Air Quality Subcontest
All available points are earned for a time-averaged interior CO2 level below 1,000 PPM following occupancy of at least 8 individuals for 1 hour.

- Balanced ventilation using an ERV; compliance with the EPA’s IndoorAir PLUS program
<table>
<thead>
<tr>
<th>SOLAR DECA THLON CHALLENGE</th>
<th>SUPPORTING PHIUS ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comfort and Environmental Quality: Comfort Gradient Subcontes</strong>t—All available points are earned for achieving a maximum delta of time-averaged interior dry-bulb temperatures of 3°F across all measurement locations.</td>
<td>Exceptionally low infiltration; triple paned windows; high-R enclosure; verified solar control; concern for air distribution</td>
</tr>
</tbody>
</table>
| **Comfort and Environmental Quality: Exterior Noise Infiltration Subcontest**—All available points are earned for a measured sound pressure level from outside noise intrusion less than or equal to 35 dBA based on peak hour sound level equivalents of 90 dBA. | Exceptionally low infiltration; triple paned windows; high-R enclosure

*Oddly the Alley House did not do well in this subcontest—despite the above design moves* |
COMFORT

FRESH AIR

SYSTEM
• Fresh air keeps you happy & healthy
• The ventilation system runs all the time
• The system brings in fresh air
• The system gets rid of stale air
• You don’t need to adjust it at all
• Equipment is in the mechanical room

BOOST
• TIMER SWITCHES behind the stove and in the bathrooms
• USE when there is a lot of steam from cooking
• USE when there is a lot of steam from showers
• It turns the exhaust up for a few minutes

CEILING FANS
• TURN ON Ceiling fans in each room
• Fans will make you feel cooler
• Fans use very little electricity
• Fans make a house feel less stuffy
• Fans let you set thermostats higher to save energy

COMFORT

HEAT & AC

HEAT
• On thermostat, select Mode and then Heat
• Set the thermostats to:
  • 67-70 degrees WHEN YOU ARE HOME
  • 61 degrees WHEN SLEEPING OR AWAY
• Thermostats can be programmed. Ask Englewood CDC to help

AIR-CONDITIONING (AC)
• On thermostat, select Mode and then Cool
• Set the thermostats to:
  • 77-78 degrees WHEN YOU ARE HOME
  • 77-78 degrees WHEN SLEEPING
  • 84 degrees WHEN AWAY
• 80-82 degrees IF USING CEILING FANS
• Pull blinds in summer to keep sun out
• Thermostats can be programmed. Ask Englewood CDC to help

WASTING ENERGY
• Keeping the heat too high in winter or the AC too low in summer wastes energy.
• Energy is expensive
• Turning thermostats down or up when not home or sleeping saves you money

SYSTEM
• Equipment is hidden in the drop down ceilings in the kitchen and upstairs flex space
• Thermostats are near downstairs bathroom & upstairs bedroom doors
• Upstairs has one thermostat
• Downstairs has one thermostat
• Outdoor unit will blow warm air
Occupant Experience

This Contest evaluates how the building design prioritizes occupant experience, productivity, and quality of life.

**Occupant Experience Contest Scores**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Points</th>
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<tbody>
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<tr>
<td>Texas A&amp;M</td>
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</tbody>
</table>

Points
Locally Sourced Materials
- Thermally modified wood used on exterior and interior details
- Reclaimed limestone slabs for walkway set in gravel
- Reclaimed walnut wood for built-ins
- Cement board siding with rainscreen for moisture control and durability

Design & Construction Detail
- Well-detailed continuous control layers and rain screen

Manufacturers’ Warranties
- Reduce maintenance burden for occupants
- Improve building longevity
- Resident Guide for use of the Alley House explaining passive design strategies and active systems
EcoFlow Delta Pro 2

- Portable and expandable backup system
- Outlet to plug into when power outage to utilize battery backup
- Interlock in electrical panel can easily be toggled by the homeowner during power outages
- Two batteries – 7200W, 240V output
- 7.2 kWh capacity total

Weathering an Outage

During an outage, it is estimated that the EcoFlow Delta Pro 2 system can power the following critical functions:

- Refrigerator: 4 days
- Lighting: 8 days
- Air conditioner: 7 hours
### SOLAR DECATHLON CHALLENGE

**Durability and Resilience:**

**Durability**—
The ability of the building envelope to maintain long-term performance despite routine environmental conditions

**Resilience**—
The ability of the building to maintain critical operations during disruptions and quickly restore normal operations.

### SUPPORTING PHIUS ELEMENTS

- Continuous control layers that were well-articulated, well-detailed, and site inspected; substantively reduced infiltration
- Battery backup system with substantially reduced heating and cooling loads that extend the life of battery backup during outages

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**Phius Conference 2023 | Houston, Texas**

**November 8-11, 2023**
# Juried Contest Areas Results

## Architecture
This Contest evaluates the building's architecture for creativity in matching form with function, overall integration of systems, and ability to deliver both outstanding aesthetics and functionality.

### Architecture Contest Scores

<table>
<thead>
<tr>
<th>Location</th>
<th>Score</th>
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</thead>
<tbody>
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## Market Analysis
This Contest evaluates the building's appeal, affordability, and attainability to the stated target market. This includes addressing specific market needs, such as affordability and financial feasibility, and socioeconomic barriers to increase likelihood of adoption by intended occupants and the construction industry for impactful, cost-effective design.

### Market Analysis Contest Scores

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### Schedule

**FRIDAY 4/21/2023**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Architecture</th>
<th>Engineering</th>
<th>Market Analysis</th>
<th>Durability &amp; Resilience</th>
<th>Embodied Environmental Impact</th>
<th>Presentation</th>
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</tbody>
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**Phius Conference 2023 | Houston, Texas**

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Juried Contest Areas Comments

Engineering:
- Very well thought out design that goes above and beyond
- Materials selection allowed HVAC to be smaller than typical home of this size
- Aggressive heating and cooling setpoints (e.g. heating setpoint of 68°) could lead to problems meeting space temperature requirements
- Decision to incorporate ERV was bold but necessary
- Very polished, professional-grade documentation and construction drawings
- Appreciated well thought out enclosure based around interesting slab insulation system
- Continuous mineral wool and thorough ceiling insulation
- Liked utilization of Passive House framework in pursuit of certification

Market Analysis:
- Responsible design for surrounding community
- Liked partnership with ECDC; created specific context and attainable goals
- Easily adaptable for multiple generations
- Average rent payment $1669 but target market has a median income of 25k
- Impressive, scalable financing plan focused on affordable housing
- Real and sustained community engagement

Presentation:
- Detailed, well-considered plan that required serious commitment to see through to completion
- Detailed evaluation of site opportunities and neighborhood gave clear rationale behind design decisions
- Excellent graphic design throughout materials, cohesive articulation of concept and design
- Commendable local news segment
- Admirable plan, proposal, and execution of this project
- Inspires community and end users of home
- Very well planned community exhibition
- Liked how the team worked with university's marketing and communications department
- A lot of information provided, could have been a little more succinct
- Main presenters were all virtual and reading very fast; students in the room looked a little bored and not utilized well during the presentation
- Initial submission was "phenomenal", but energies of written materials provided and the live presentation did not match up
- Felt like you could see the house by the way it was well documented

2023 Build Challenge Juried Contest Feedback:
Ball State University

Architecture:
- Very thorough presentation; successful approach, coherence, and implementation
- Could be more innovation in design
- Liked mimimization of hallways through flex space and other strategies, and pergola and planters along the alley
- Thoughtful use of materials
- Good idea to separate the building east-west to ensure equal solar access and minimize sound transition between units
- Loved the stair railing feature but not articulated well enough in presentation
- Great drawings and documentation
- Cool custom light fixture
- Functional floor plan maximizes quality out of constrained space, great use of built-in furniture
- Slight angle at south corners adds construction cost but not sure how much value is added
- Good answers during presentation
- Created a beautiful home that contributes positively to the community and people who will live there
Student-Directed Design and Led Tours

Phius Conference 2023 | Houston, Texas
November 8-11, 2023
Thank you

Pam Harwood, AIA, NCARB
Professor of Architecture
Ball State University

Emily Rheinheimer
Graduate Architect
Ball State University

Dan Porzel, CPHB, Leed AP
Owner / Builder
Cedar Street Builders

Walter Grondzik, PE, CPHC
Emeriti Professor of Architecture
Ball State University