Penn State's MorningStar House

MorningStar designed by Penn State's Solar Decathlon Team for 2007 Build Challenge

House is settled into Sustainability Experience Center

PV Panels recalled, outdated mechanical and energy systems

Sustainability Institute asks 2022 Design Team to retrofit the house
Stakeholders

Site visit of the house with the Sustainability Institute

Feedback from the Sustainability Institute

What is your favorite part of the Morningstar House?

What is your least favorite part of the Morningstar House?

Stakeholders involved with the MorningStar House
Retrofit Concepts

Design Goals

- Honoring History and Legacy
- Staying on the Cutting Edge of Technology
- Settling into Existing Site
- Site and Building Performance
- Materials and Waste
- User Experience
Why Retrofit?

• A retrofit has **89%** less global warming potential of a new construction for the same purpose.
Envelope – South Facade

- PV Panels
- PV Support Frame
- Single Ply Membrane Roof
- Plywood
- Roof Scupper
- Taped-Seam ZIP Sheathing panels
- Low Roof - 0' - 0”
- 1½” Padding For Stone Floor
- 1½” Warm Board Flooring
- Galv. Steel Flashing
- Anchor Bolts - Level 1 - 0' - 0”
- Outdoor Slate Pavers
- Steel Support Structure
- Taped-Seam ZIP Sheathing panels
- S 1/2” Mineral Wool Insulation
- Reinforcing Bar
- Basement - 10' - 0”

Architecture
Engineering
Durability & Resilience
Embodied Environmental Impact
Integrated Performance
Occupant Experience
Comfort & Environmental Quality
Energy Performance
Presentation
**Envelope – Air Sealing**

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Durability &amp; Resilience</th>
<th>Integrated Performance</th>
<th>Comfort &amp; Environmental Quality</th>
<th>Energy Performance</th>
<th>Presentation</th>
</tr>
</thead>
</table>

![Image of Envelope – Air Sealing](image)

- Spot: 70.3 °F
- Spot: 62.9 °F
- Spot: 67.0 °F
- Spot: 87.9 °F

- New windows/doors
- Roof perimeter
- Floor perimeter
- Addition of caulk and spray foam to create an air-tight seal
Envelope – Windows/Doors
Mechanical Upgrades

Rheem ProTerra
- 3.75 EF
- 40 Gallon Capacity

Zehnder ComfoAir 550
- 324 CFM
- 95% efficiency
- 10-350W Power
Energy Demand

Air Leakage
Energy Demand

Air Leakage

Site EUI: 22.03 reduced to 13.95
Energy Production and Storage

2.5 kW increased to 11 kW total solar

47 kWh battery

3 MWh increased to 13.4 MWh estimated annual production with just over 7 MWh energy demand

Solar Production (kWh) Corresponding Value ($)
Energy Production and Demand

Energy Generation vs Demand - January

Energy Generation vs Demand - July
Market Analysis

Tier 1:
- Air sealing
- Insulation
- ERV
- Solar Panels
- Battery
- Windows & Doors
- Handicap-Accessible Sidewalk

Tier 2:
- No-mow lawn
- Swale & Raingarden
- Pollinator Garden
- Meadow & Sculpture Garden
- Audubon Garden
- Orchard

Material Costs

Total Cost of Retrofit: $170,640
Architecture Updates

Exterior

- Wood Panel Canopy for Shelter, Occupant Comfort, Bulk Water Deflection
- Colored Milk Bottle Wall to Create Beautiful Environment for Visitors, Reduce Waste from Retrofit
- Informational Sign to Welcome/Educate Visitors
Architecture Updates
Exterior

Audubon Garden

Sculpture Garden/Exhibition

Meadow & Sculpture Garden

Handicap-Accessible Pathway
Architecture Updates

Interior

- White Finishes Reflect Light
- Updated Appliance(s)
- Triple Pane Glass Fixed/Hinged Door
Architecture - Basement

Informational Signage

Live Data Monitoring & Lecture Screen

Interactive Elements & Material Displays
Architecture - Pathing

- Intentional direction and flow through site
- Handicap-accessible for everyone to enjoy
- Community connections

Existing Sidewalk Along Porter Rd.
Handicap-Accessible Access to Basement/Patio Space

New Green Concrete Sidewalk Along Existing Parking Lots
Architecture - Landscaping
Celebrating 20 Years of Sustainable Design Excellence