ASES | SOLAR2016

Design Schools as Drivers for Sustainable & Affordable Housing

Speaker: Christopher Hazel

coauthored with Lisa D. Iulo,
professor of architecture at Penn State

chrisjhazel@gmail.com

The Pennsylvania State University

Christopher Hazel is an M.Arch student at the Pennsylvania State University. He graduated from the University of Pittsburgh in 2014 with a B.A. in Architectural Studies and a certificate in Civil and Environmental Engineering. Over the past year he has been working with Professor Lisa Iulo to develop a set of design and research drawings for a net-zero energy ready duplex to be built in State College, PA. Previously he was an English editor for the multi-lingual architecture theory journal "Cloud-Cuckoo-Land," and he worked professionally at Renaissance 3 Architects in Pittsburgh, PA (2013-2014) and with David Albright AIA in Altoona, PA (2015).

Introduction

EEHR

SCCLT

DOE's Race to Zero Competition

Heritage Homes

Community Engagement

Design Process

National Renewable Energy Laboratory

Design Development

Conclusions

The Energy Efficient Housing Research Group

The Energy Efficient Housing Research Group (EEHR) is a multidisciplinary organization at Penn State with the objective of reflecting upon past housing projects undertaken by the university while also researching new ways to design, construct, and monitor energy-efficient and affordable homes

MorningStar PA - 2007

MorningStar MT - 2007

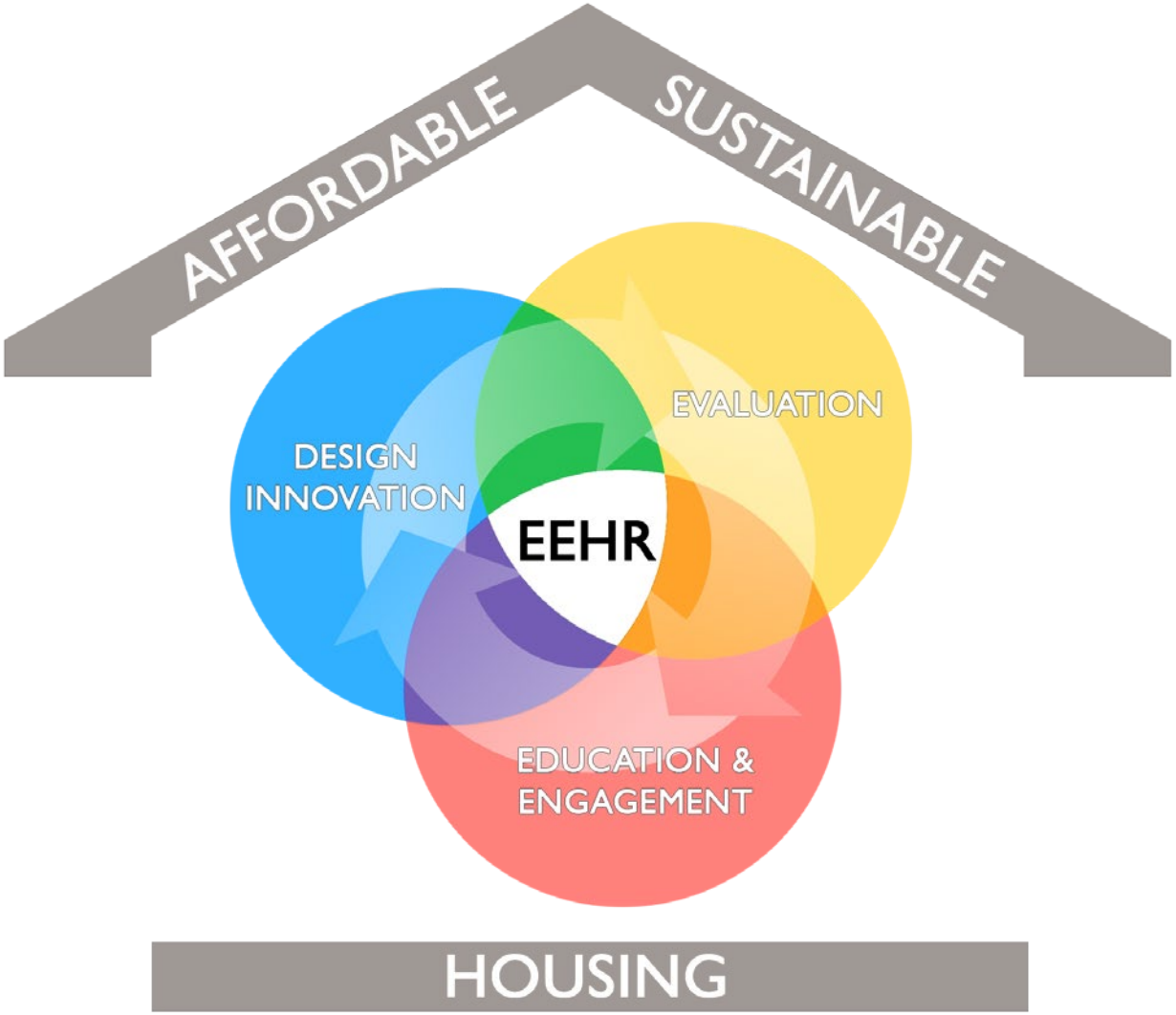
Natural Fusion - 2009

GridStar (retrofits) - 2012

UCHA - 2012

The Energy Efficient Housing Research Group

EEHR examines projects through three lenses, design, evaluation, and education so that a project does not conclude after a set of drawings is submitted or a house is built.



The State College Community Land Trust

The State College Community Land Trust is a local non-profit (part of over 200 land trust organizations) that buys and sells homes to qualified first-time homebuyers at reduced costs.

SCCLT

State College Community Land Trust

Private, non-profit, community-based organization.

Focus is on buying, rehabilitating, and selling houses.

Acquires properties through donation or purchase.

Formed in 1996 at the request of the State College Borough.

Has worked with over 30 households.

Separates ownership of the land from the home.

The State College Community Land Trust

For this project, the SCCLT wanted two connected homes (a duplex) for a moderate income family. They wanted the duplex to also serve as a beacon of sustainability in the community.

SCCLT

> "What is the point of buying your own home, if you cant afford to live in it?"
> –Peg Hambrick Board Member of SCCLT

Design and build a moderately priced, owner-occupied duplex utilizing advanced and long-term cost-effective green technology.

Develop a sustainable project "using best practices to create lasting environmental, economic, community and organizational vitality."

The Duplex:

2 Units, 3 Bedrooms, 1.5 baths with approximately 1250 square feet of living space in each unit.

Union County Housing Authority
Energy Efficient Housng Program - 2012
Street View

Union County Housing Authority
Energy Efficient Housng Program - 2012
Kitchen View

EEHR HAMER CENTER PennState Institutes of Energy and the Environment PHRC

The State College Community Land Trust

The SCCLT buys the land and leases it to the future homeowner to assure that the property remains available to the SCCLT while also reducing mortgage costs for the homeowner.

SCCLT

The SCCLT signs a long-term lease with the new owner of the house assuring them that the property will remain available to them.

The new homeowner only purchases the improvements to the land.

The SCCLT purchased the land for a total of $150,000.

Accordingly, each homeowner of the duplex saves $75,000 towards the sales price of their home.

DOE Race to Zero Competition

The Department of Energy's Race to Zero competition is an open student design competition that challenges students to fully design and document a net-zero energy ready home that is also affordable.

RACE TO ZERO
U.S. DEPARTMENT OF ENERGY
2015 STUDENT DESIGN COMPETITION

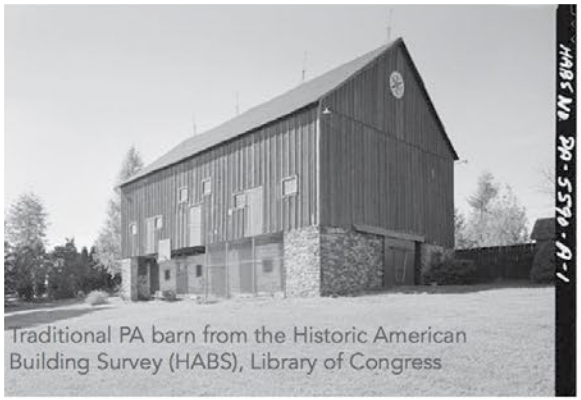
R2Z

Heritage Homes

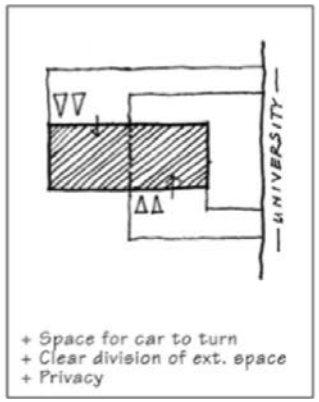
The Penn State team was named Heritage Homes with the goal of connecting with the history of State College and agriculture in State College while progressively looking forward at new sustainable technologies.

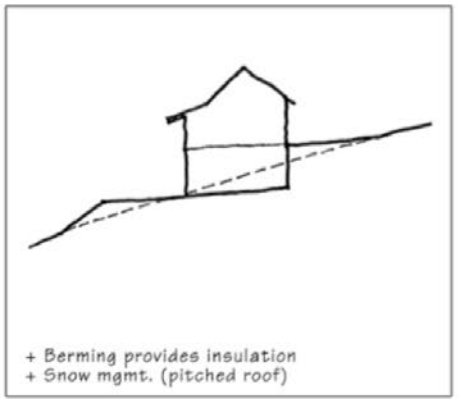
Heritage Homes

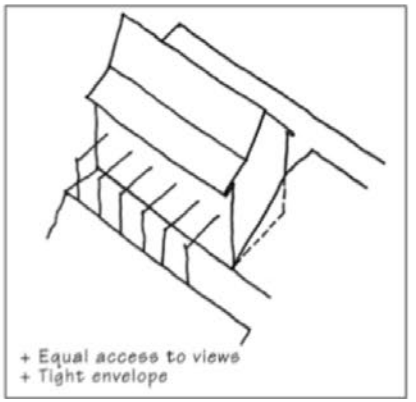
Two building typologies that best capture the history and heritage of State College are the Pennsylvania bankbarn and the farmhouse.



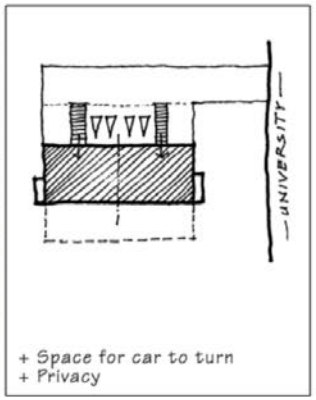
Traditional PA barn from the Historic American Building Survey (HABS), Library of Congress

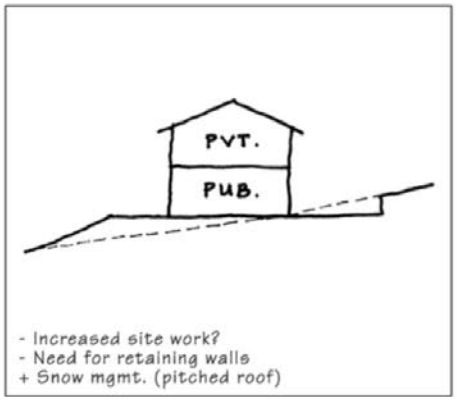


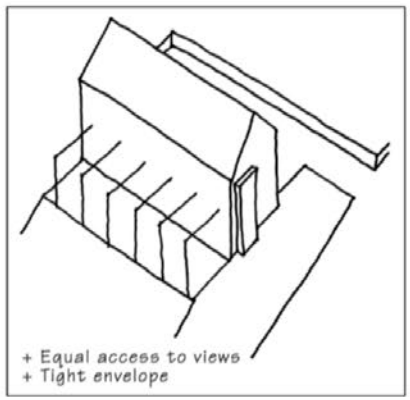




Pennsylvania Bankbarn



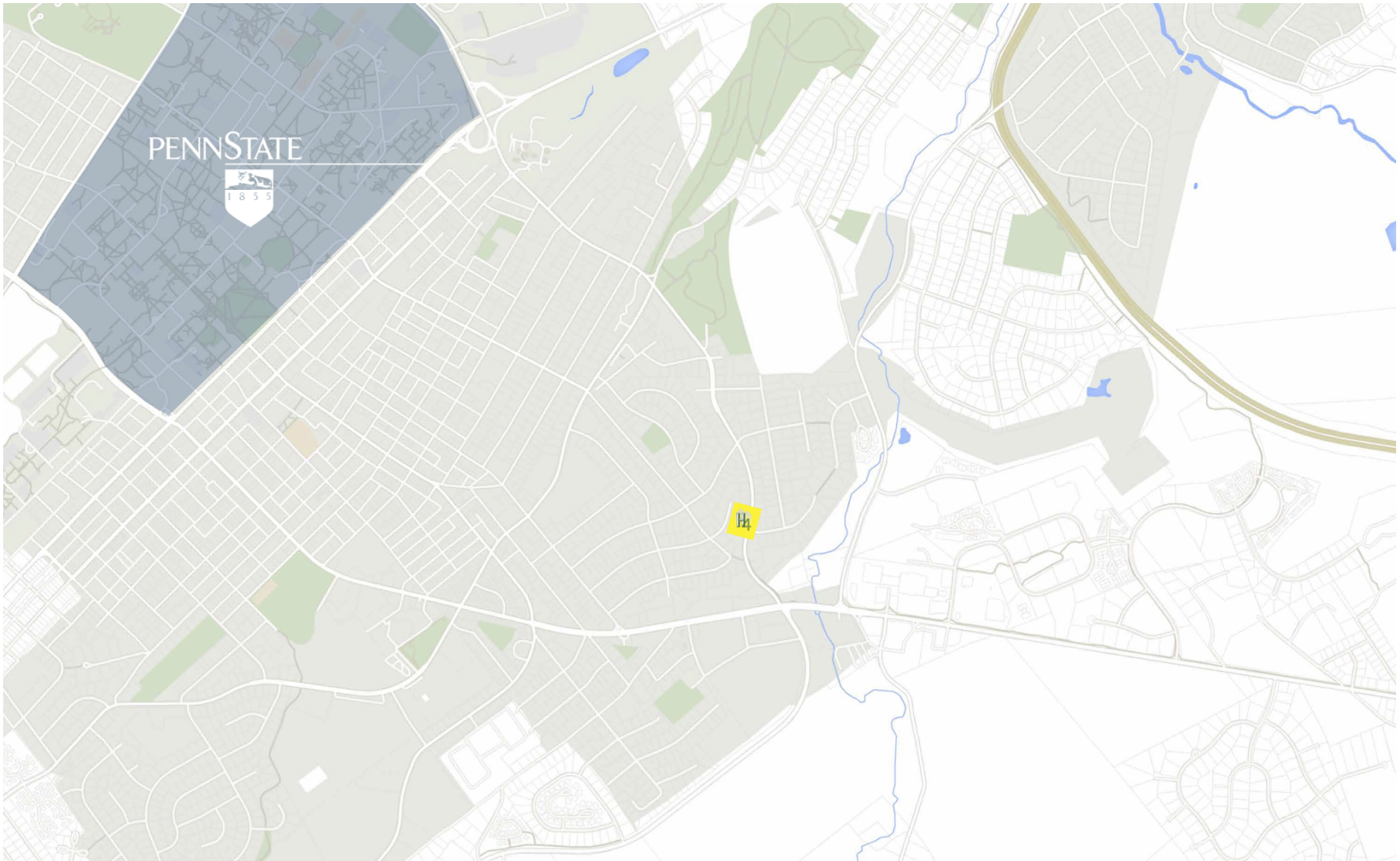




Pennsylvania Farmhouse

Heritage Homes

The site is located ~1.5 miles southeast of the Penn State campus on one of the very few unbuilt plots of land left in the State College Borough.



H4

Heritage Homes

The site has a gentle southward slope with a view of the Appalachian mountains and very generous opportunities for solar gain.

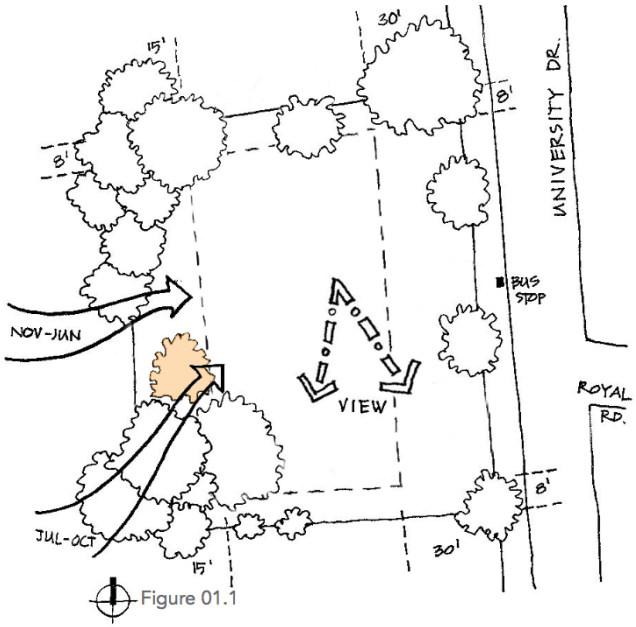


Figure 01.1

H4

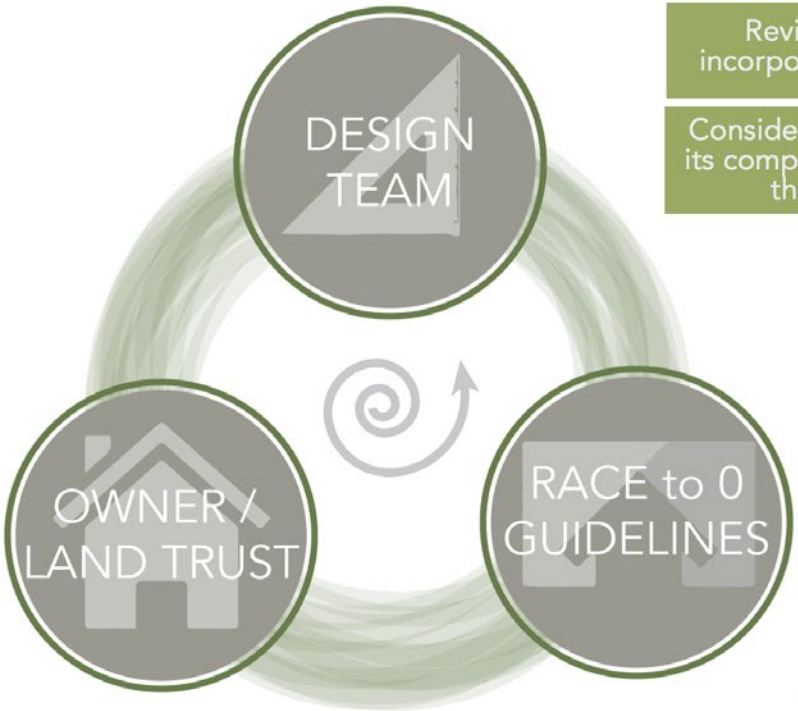
Community Engagement

The Race to Zero team strived to connect with the community throughout the entire process including multiple design charrettes where SCCLT members, PSU faculty & staff, and community members could actively influence the design.

Engage

Community Engagement

From the beginning of the competition, the competition team distinguished a Triad of Interests so that they could determine and organize the desires of each of the stakeholder groups.



- Revitalize local architecture, incorporating heritage and history.
- Consider the life of the building and its components, their initial cost, and the energy implications.
- Sensitivity to budget; long–term affordable housing, not only looking at initial cost.
- Design a duplex that fits the SCCLT's unique financial agreement structure.
- Create a landmark for the State College Community, a symbol of what affordable housing can be.
- Communicate individuality and identity for each of the homes.
- Passive solar design to reduce heating loads in the home.
- Option for solar PV in the design for future net zero energy home.
- Meet the DOE Zero Energy Ready home technical guidelines.

> "Engage Everybody Early on Everything"[1]

[1]7-groupand B. Reed, The Integrative Design Guide to Green Building: Redefining the Practiceof Sustainability, Hoboken, NJ: John Wiley & Sons, 2009.

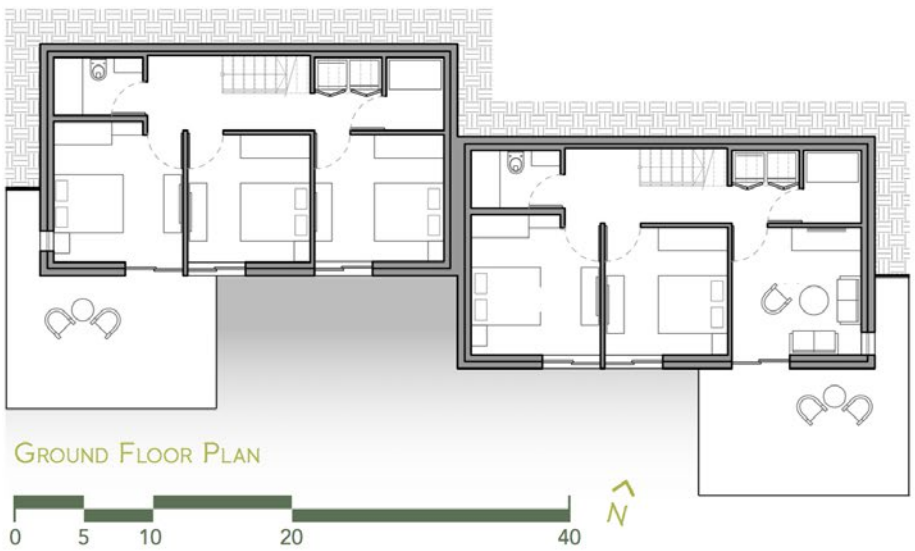
Engage

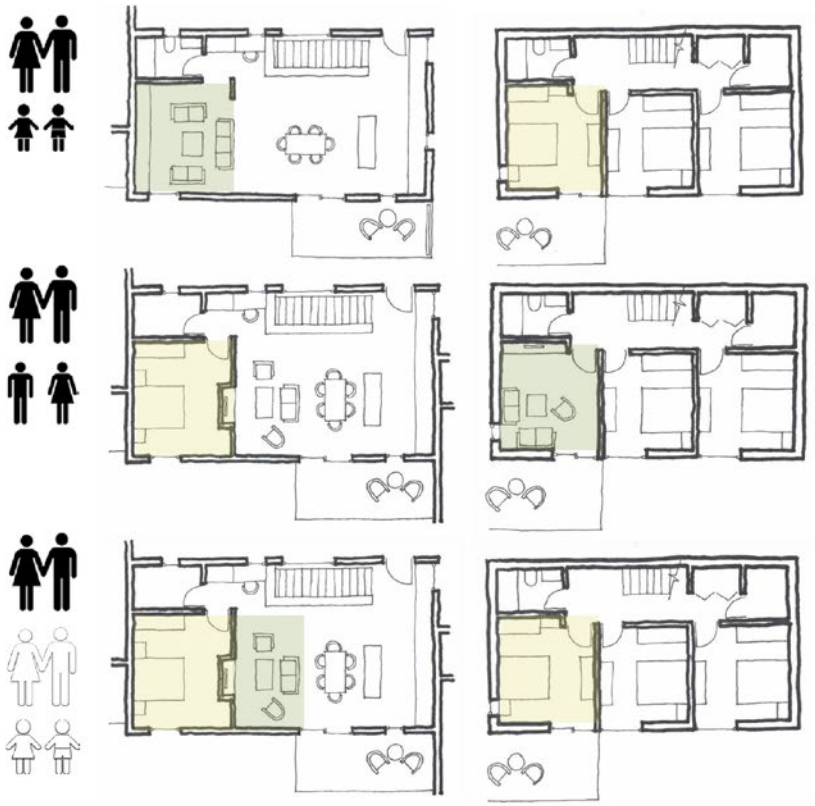
Community Engagement

The design charrettes included visual surveys to determine how people responded to different aesthetics of exterior, interior, and materiality.

Design: Heritage, Sustainability & Community

The floor plans were designed to respond and adapt to the changing needs of a growing family so that the house remains useful for a lifetime.

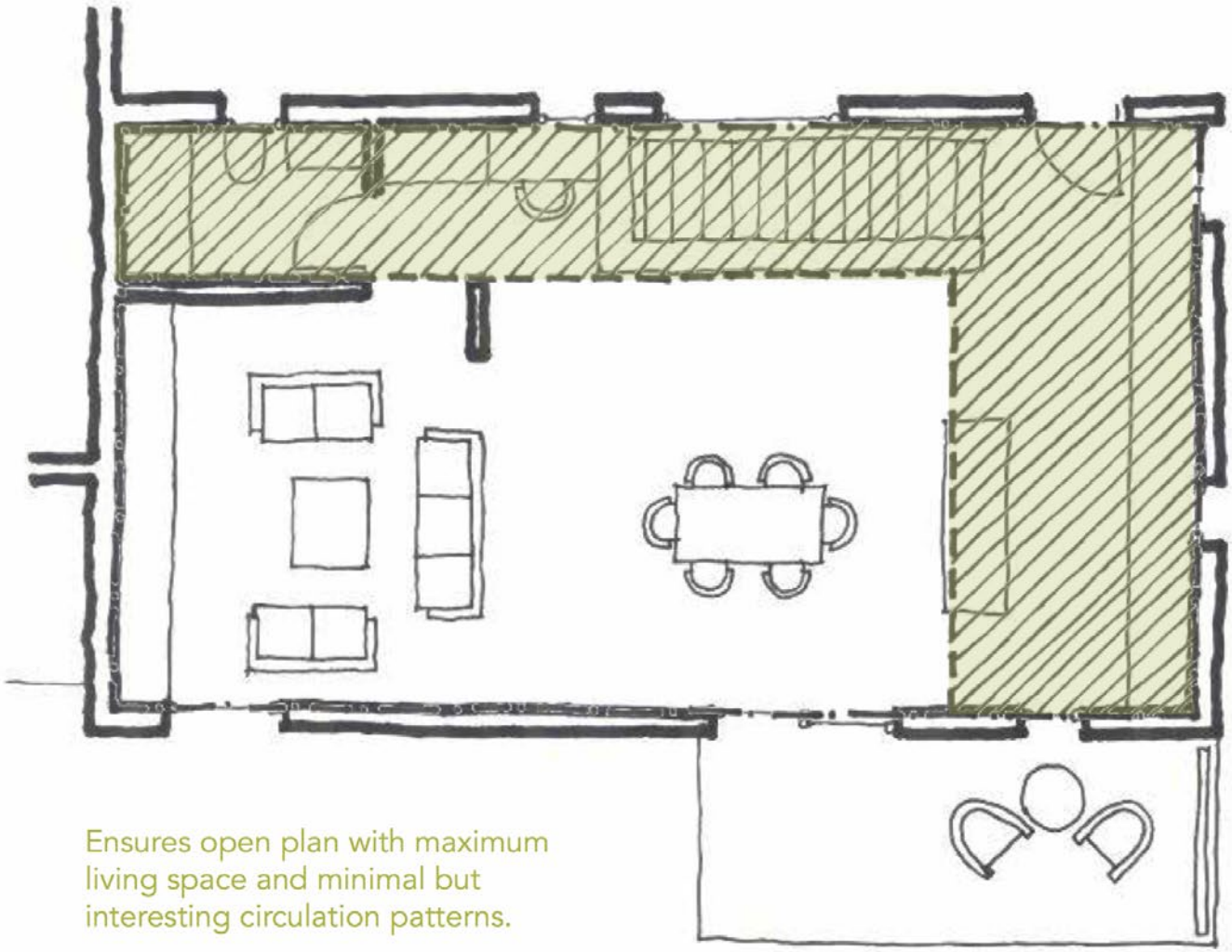




Space Flexibility for Changing Needs:
Space on both the first floor and the ground floor can be converted from living space to an additional bedroom or vise-versa. This flexibility allows for satisfaction of any growing family's needs from small children to aging in place.

Design: Heritage, Sustainability & Community

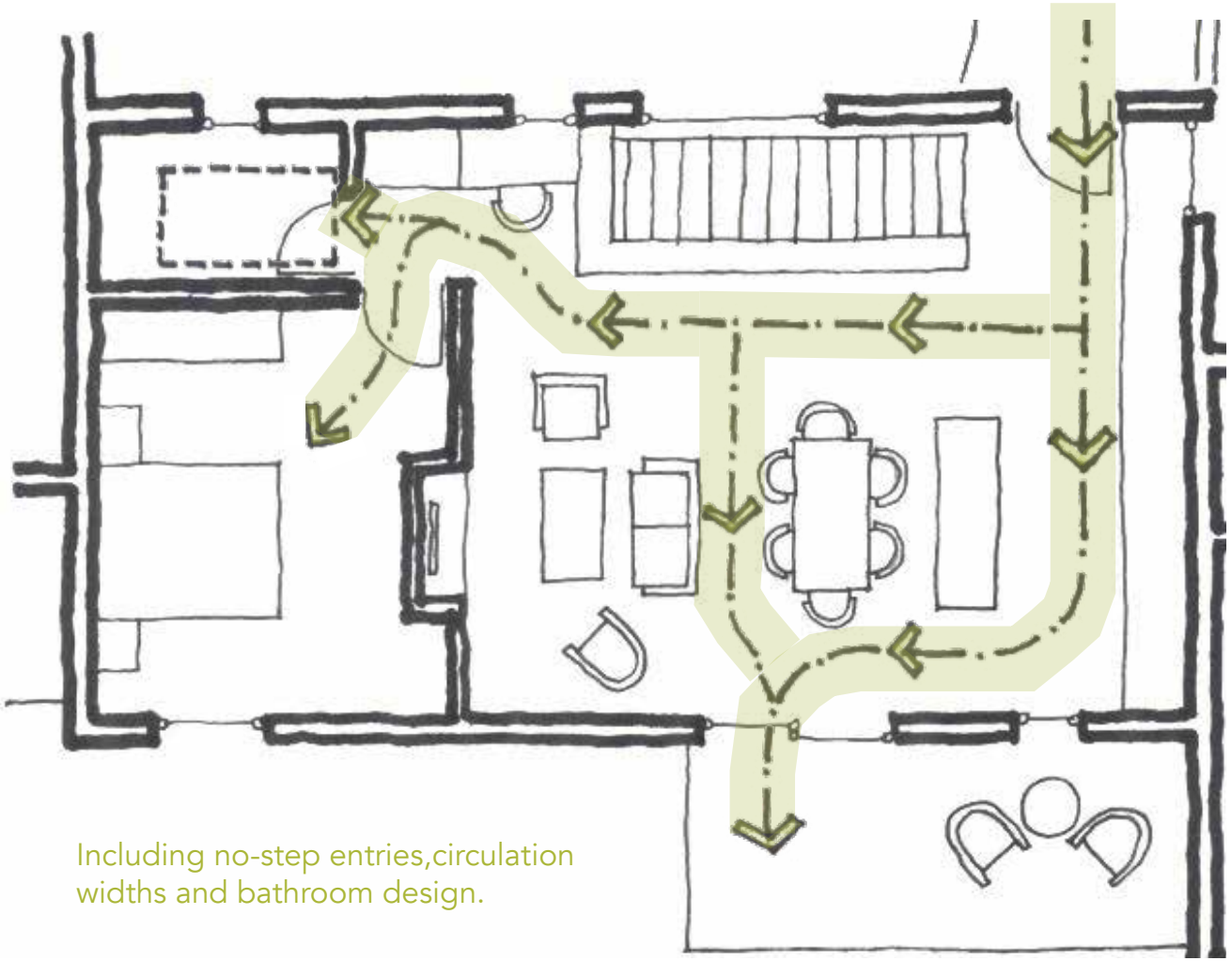
The floor plan was divided as a living/served space, and a functional/service space.



Ensures open plan with maximum living space and minimal but interesting circulation patterns.

Design: Heritage, Sustainability & Community

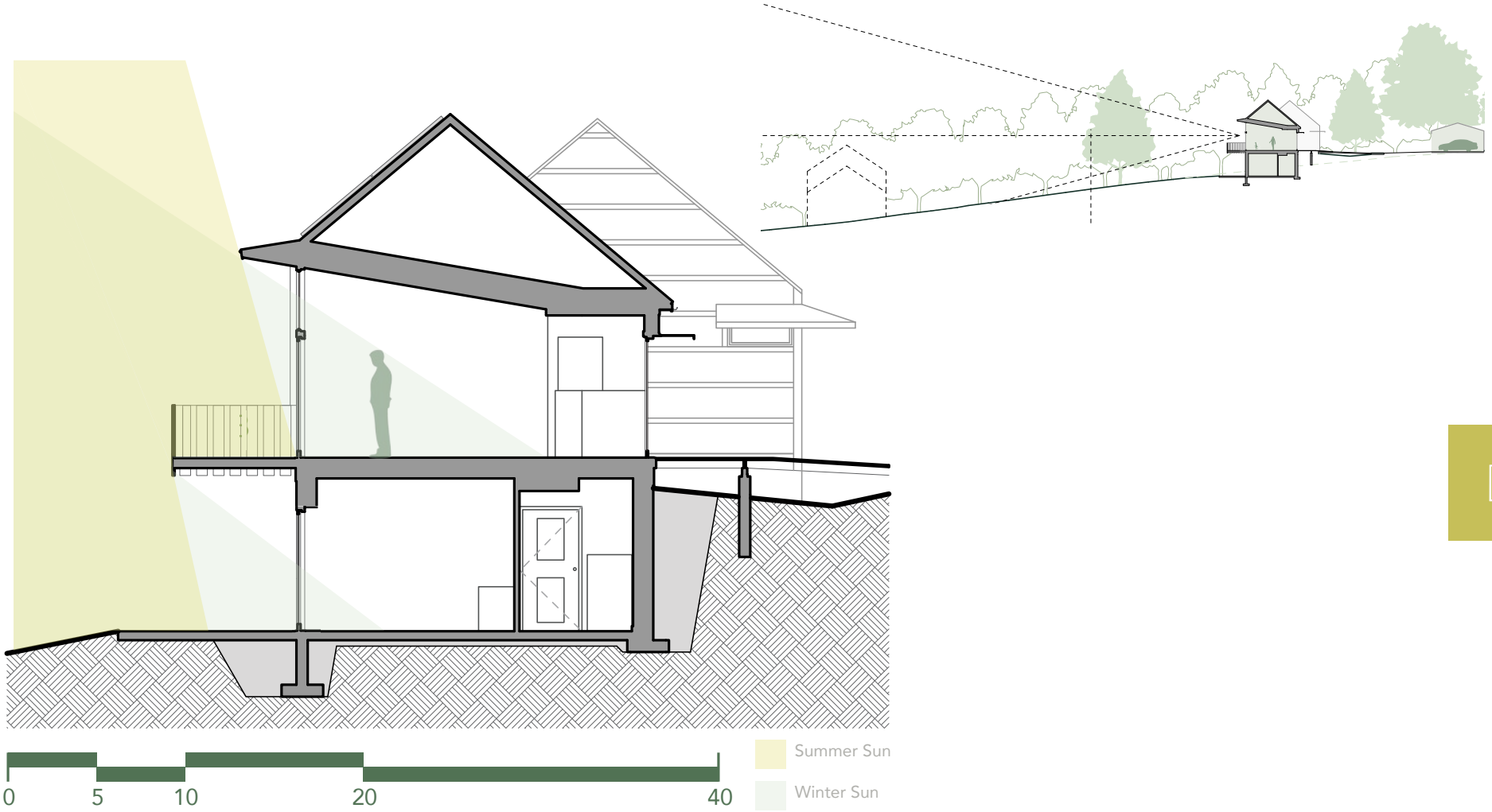
The floor plan emphasized visitability to minimize the potential need for future construction.



Including no-step entries,circulation widths and bathroom design.

Design: Heritage, Sustainability & Community

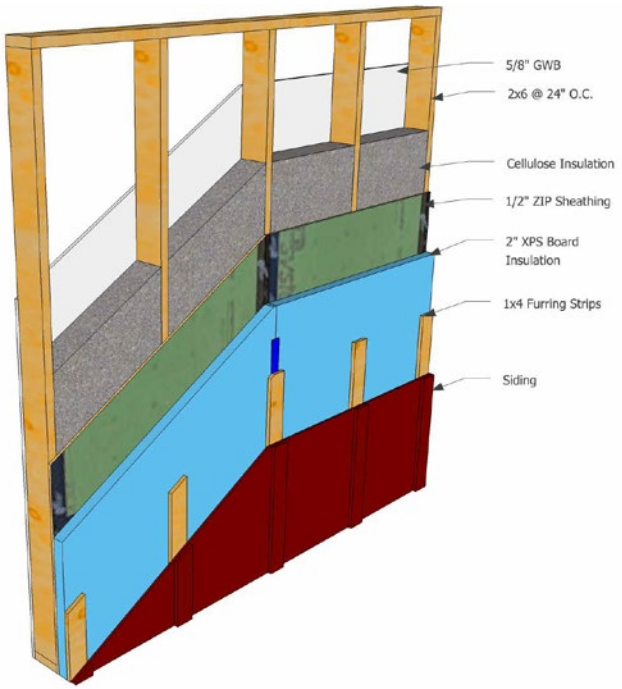
The building section maximized views toward the south and passive solar heating during the winter and shading during the summer.

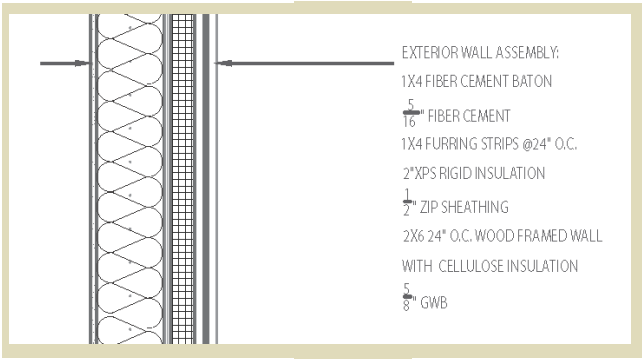


Design

Design: Heritage, Sustainability & Community

The building envelope was the most heavily researched area, combining contemporary, leading research and best practices provided by industry mentors.





Wall Section Detail

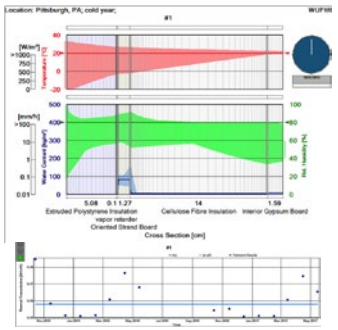
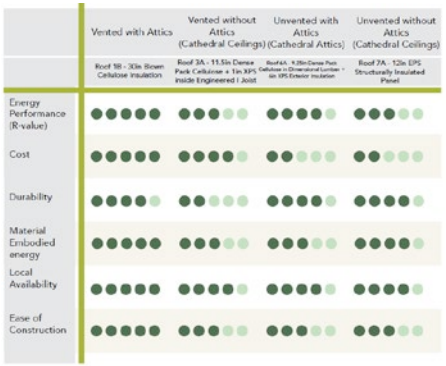
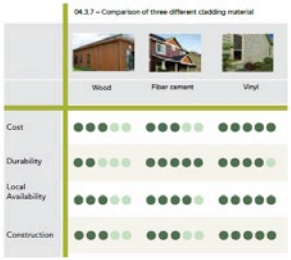
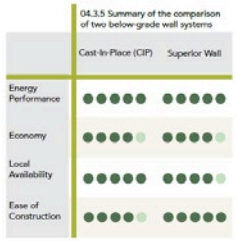


Figure 04.1.2 - WUFI analysis







Design

Design: Heritage, Sustainability & Community

Both houses use the same building footprint with similar exterior openings, but are differentiated by a slight stagger and material/ siding changes.

Competition Presentation and Results

In April 2015, two team leaders presented the design to industry experts at the National Renewable Energy Laboratory in Golden, CO.

NREL

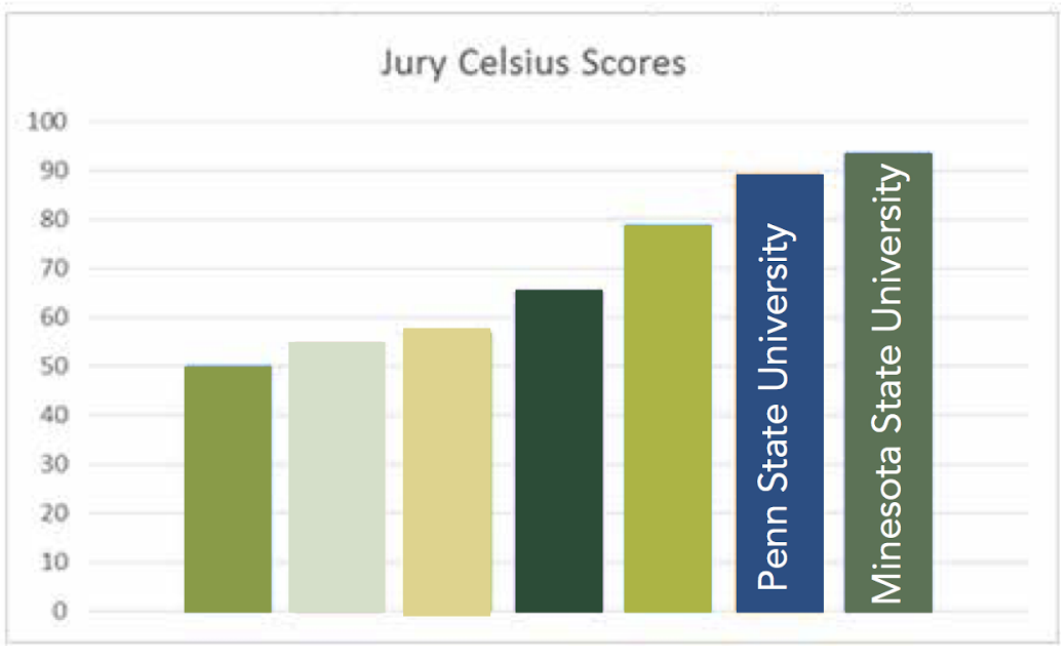
Competition Presentation and Results

In April 2015, two team leaders presented the design to industry experts at the National Renewable Energy Laboratory in Golden, CO.

NREL

Competition Presentation and Results

The team scored very well including a perfect score in building envelope design.

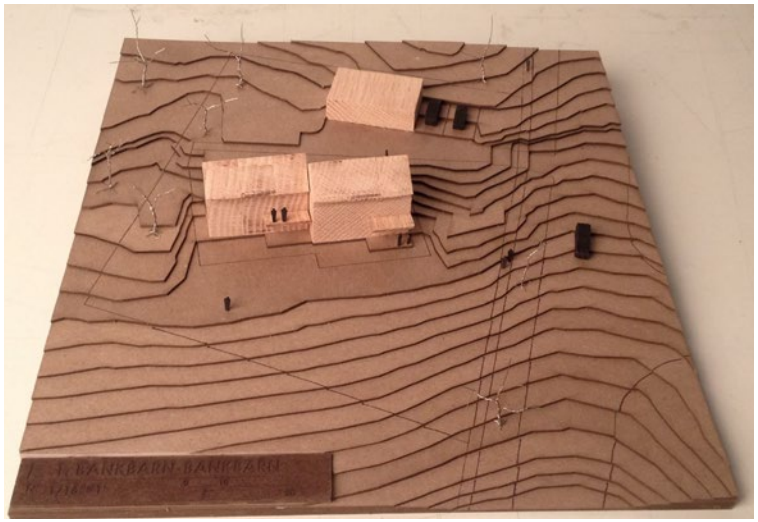


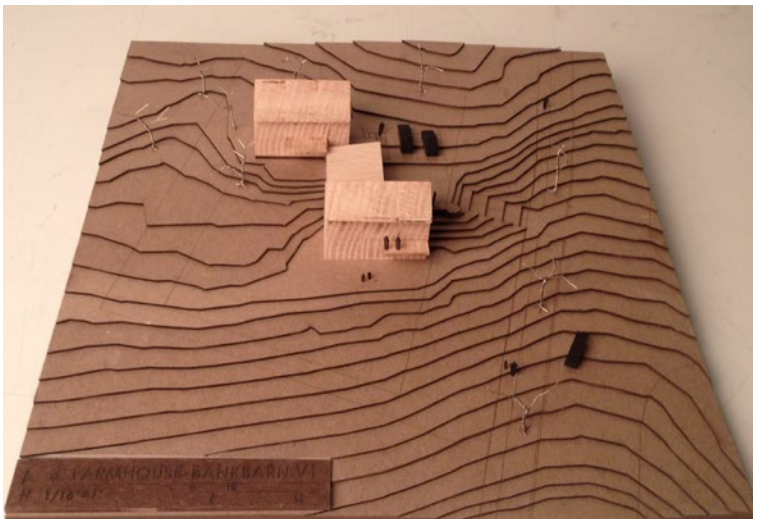
^ GRADING ROOM SCORES

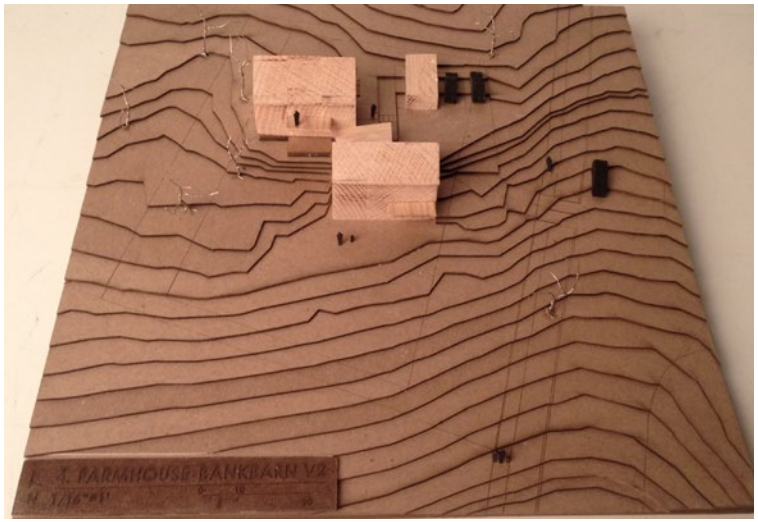
NREL

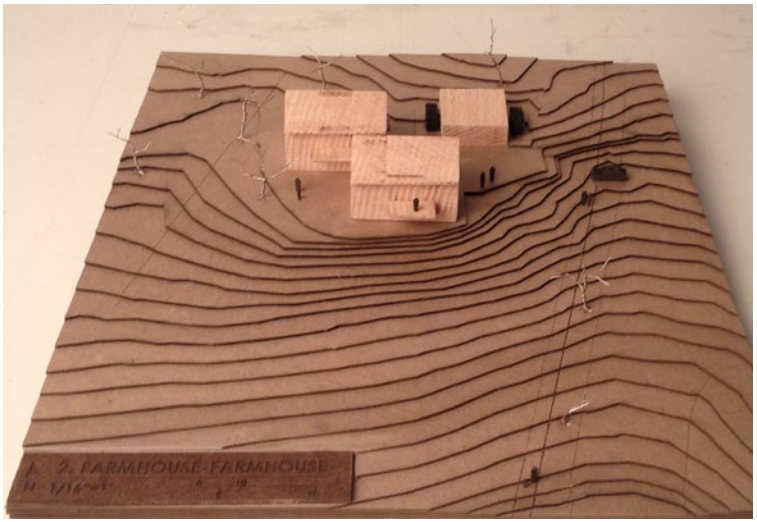
Design Development with the SCCLT

Following the competition, the design was expanded to show four slightly different massing options for the SCCLT.





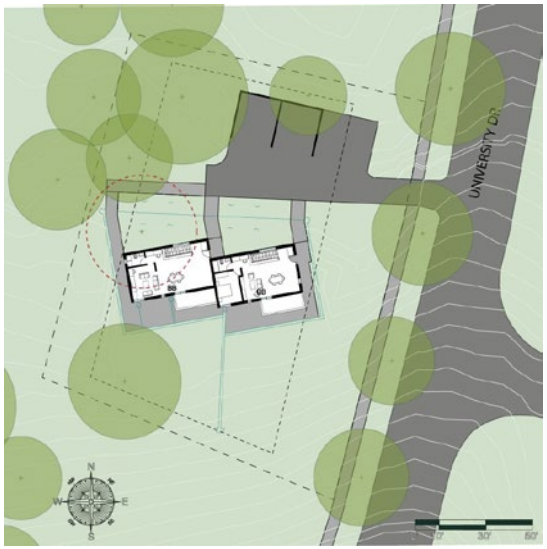


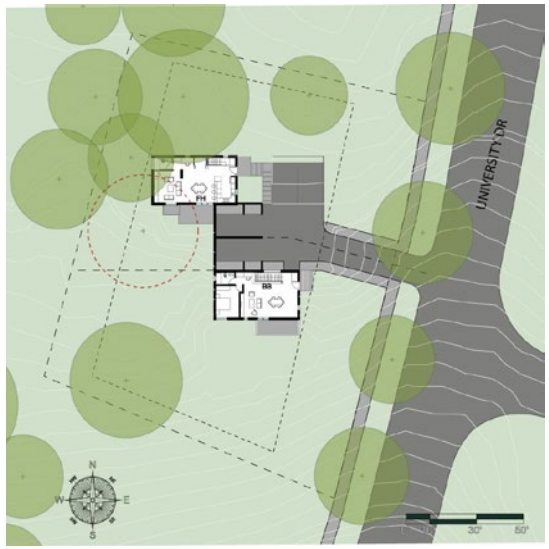


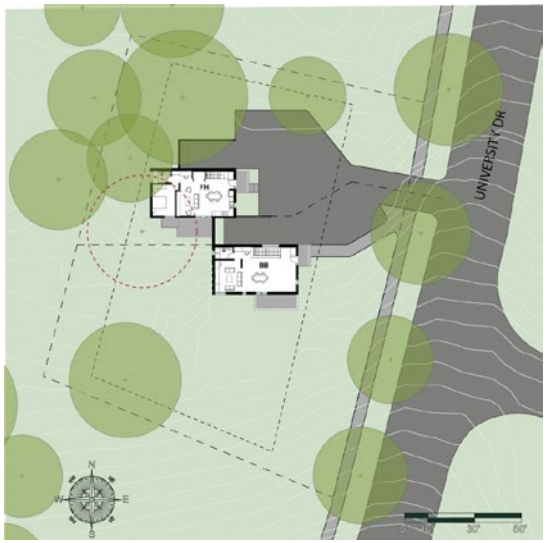
Develop

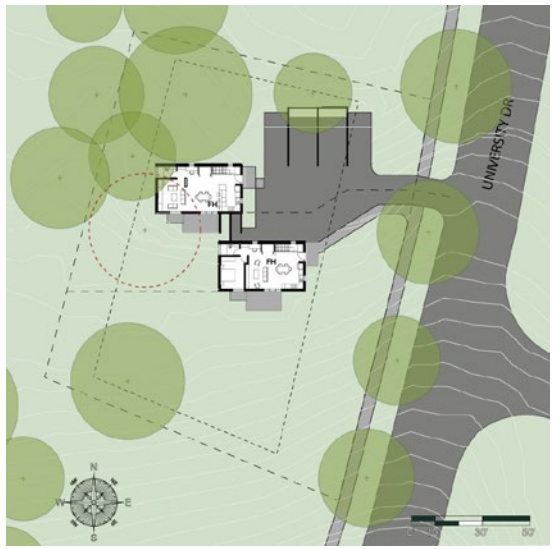
Design Development with the SCCLT

While floor plans and technical design remained fairly consistent with the competition design, the site design changed to better respond to the needs for individuality of the future homeowners.









Develop

Design Development with the SCCLT

In early Fall 2015, the EEHR team met with the SCCLT at the site to determine a final design scheme.

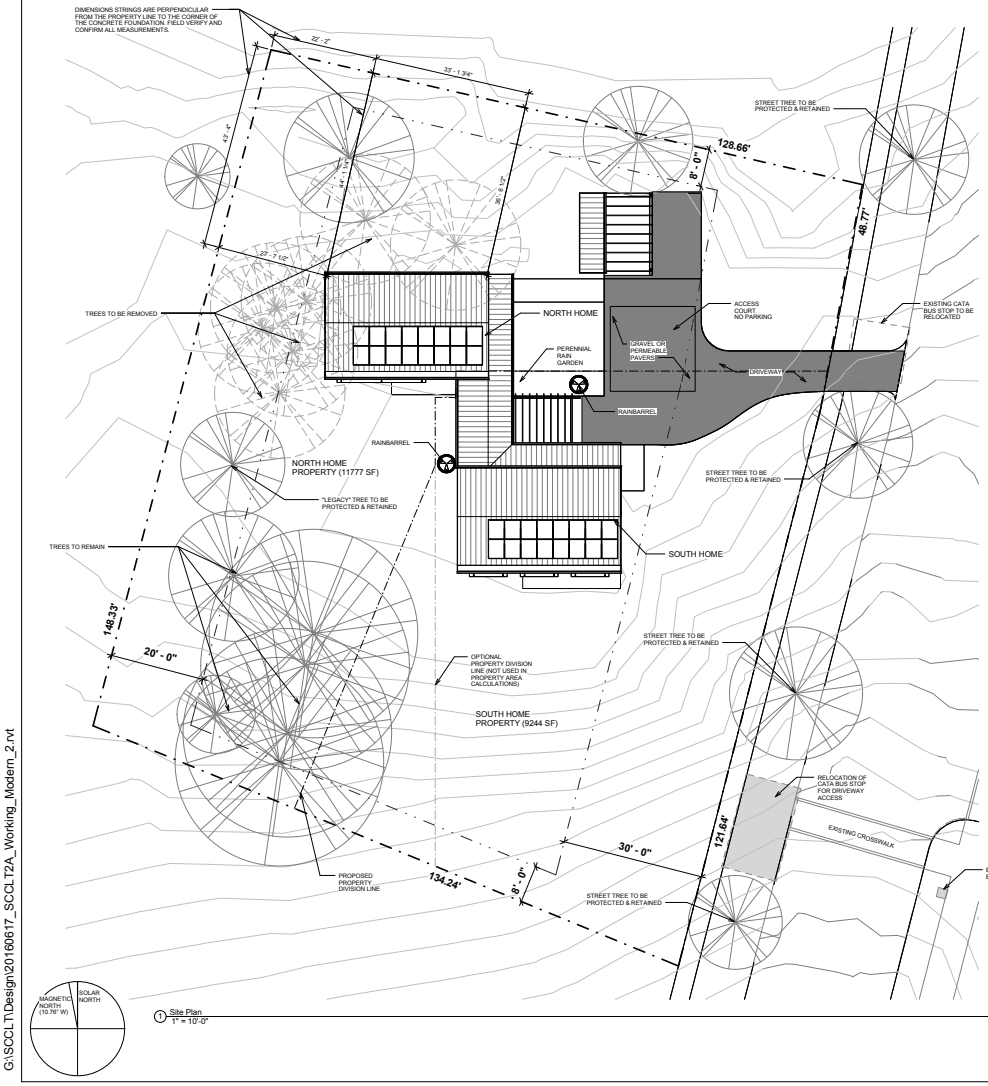
Develop

Design Development with the SCCLT

Over the past year the design changed to better account for homeowner needs and site constraints.

Develop

Design Development with the SCCLT



ADDRESS:	1394 UNIVERSITY DRIVE, STATE COLLEGE PA 16801
ZONING INFORMATION:	
MUNICIPALITY:	STATE COLLEGE BOROUGH
ZONING DISTRICT:	RESIDENCE 2 (R2)
MINIMUM LOT SIZE:	20,000 SF
ACTUAL LOT SIZE:	21,021 SF
MINIMUM LOT WIDTH:	125 FT
ACTUAL LOT WIDTH:	128.66 FT
LOT COVERAGE: 1. BUILDING FOOTPRINT: i. MAXIMUM ii. PROPOSED (*MAIN BLDG*) iii. PROPOSED (*ACC. BLDGS. INCLUDING COVERED CARPORTS*) iv. PROPOSED (*TOTAL*)	 4,500 SF + 5%*(21,021 SF - 15,000 SF) = 4,800 SF 1584 SF 579 SF 2163 SF
2. DRIVEWAY & PARKING: i. MAXIMUM: ii. PROPOSED (*GRAY AREA, EXCLUDING COVERED CARPORTS & WALKWAYS*):	 (>20,000 SF) 8% = 1,680 SF 1425 SF
YARD SETBACKS: i. FRONT YARD: ii. SIDE YARD: iii. READ YARD:	 30 FT 8 FT 99'-7" * 20% = 20 FT
MAXIMUM HEIGHT:	25 FT
PROPOSED HEIGHT (*TO MIDPOINT OF ROOF SLOPE*):	23 FT

Notes:

- FIELD VERIFY ALL SITE AND SOIL/BEARING CONDITIONS.
- PROVIDE TEMPORARY EROSION CONTROL AND SILTATION FENCE WHERE NECESSARY.
- TREE REMOVAL: ANY TREES OUTSIDE OF BUILDING PERIMETER SHALL BE APPROVED FOR REMOVAL BY THE CLIENT. TRIM EXISTING TREES AND VEGETATION AS ACCEPTABLE TO CLIENT.
- PROTECT ALL EXISTING STREET TREES AND ALL TREES INDICATED ON THE DRAWING TO REMAIN.

DRAWING FOR RESEARCH & EDUCATIONAL PURPOSES ONLY.

NOT FOR CONSTRUCTION

S·C·C·L·T GreenBuild

THE STATE COLLEGE COMMUNITY LAND TRUST

1315 S. ALLEN STREET
STATE COLLEGE, PA 16801

CONTACT: RON QUINN
(814) 867-0656

EEHR

105 STUCKEMAN FAMILY BUILDING

CONTACT: LISA IULO
(814)) 865-3852

SCCLT Duplex
1394 University Dr.

SITE PLAN

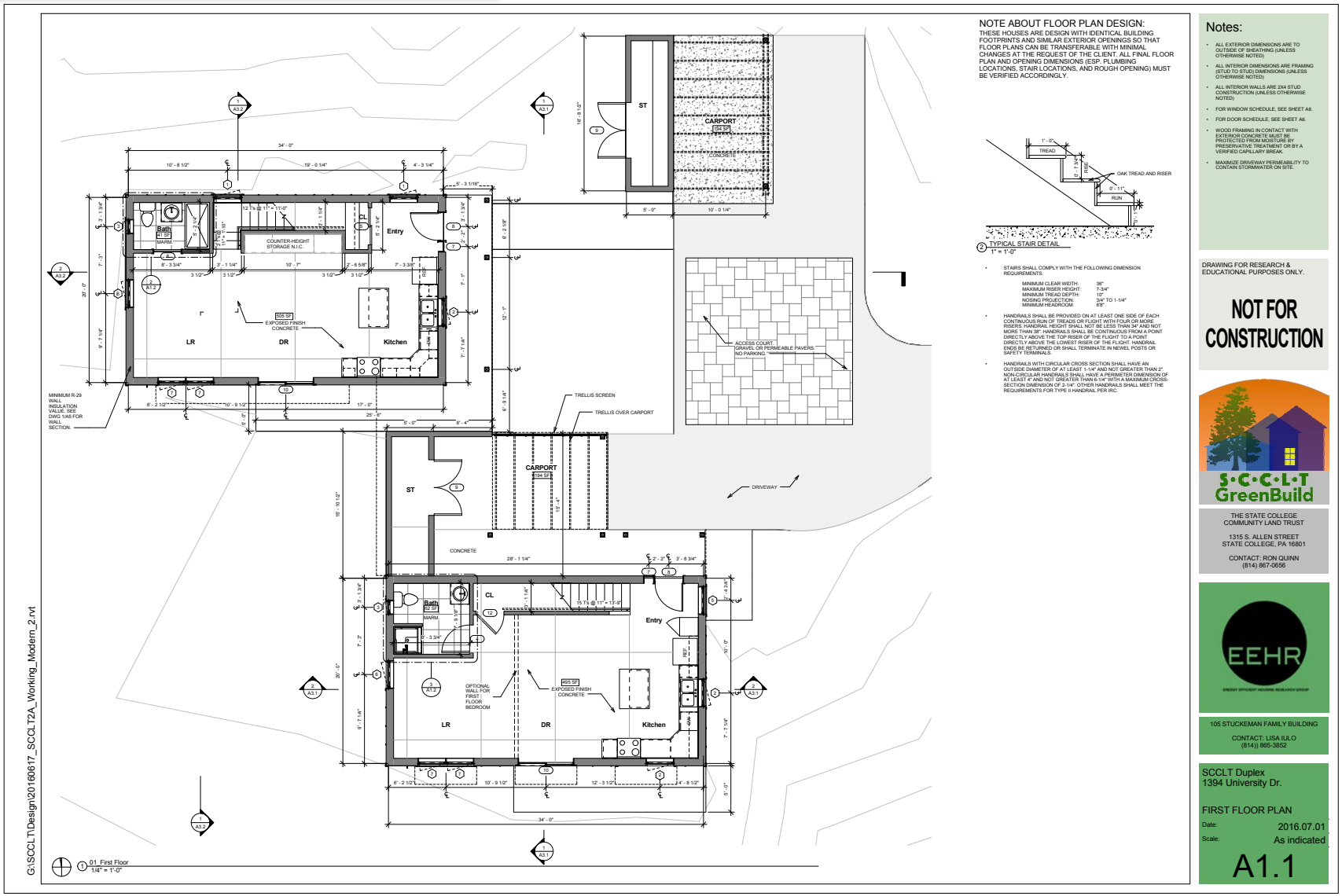
Date: 2016.07.01
Scale: 1" = 10'-0"

C1

G:\SCCLT\Design\20160617_SCCLT2A_Working_Modern_2.rvt

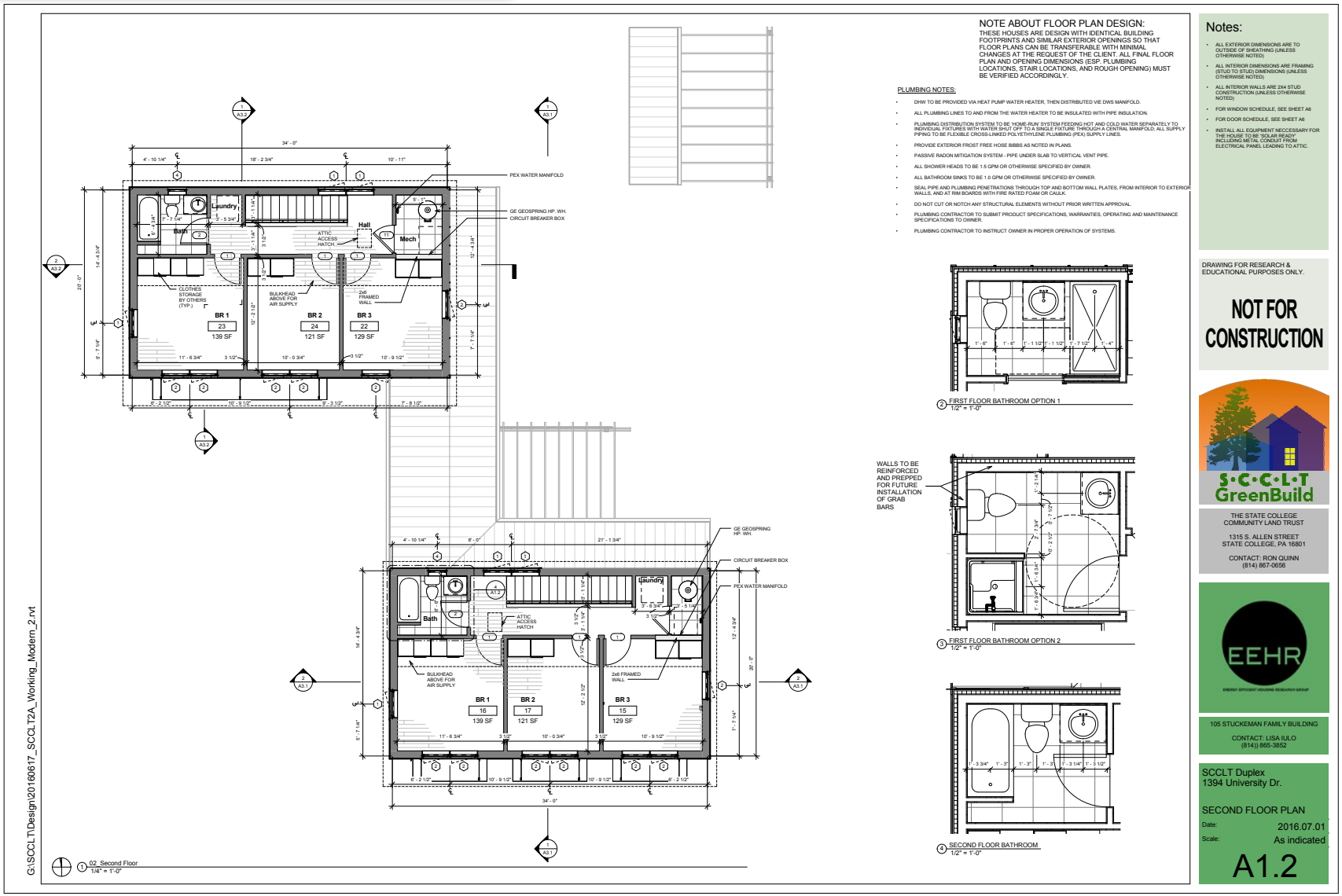
Develop

Design Development with the SCCLT



Develop

Design Development with the SCCLT



Develop

Design Development with the SCCLT

Notes:

- ALL APPLIANCES ARE TO BE ENERGY STAR CERTIFIED.
- VENT RANGE HOOD TO OUTSIDE.

DRAWING FOR RESEARCH & EDUCATIONAL PURPOSES ONLY.

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SCCLT Duplex
1394 University Dr.

BUILDING SECTIONS

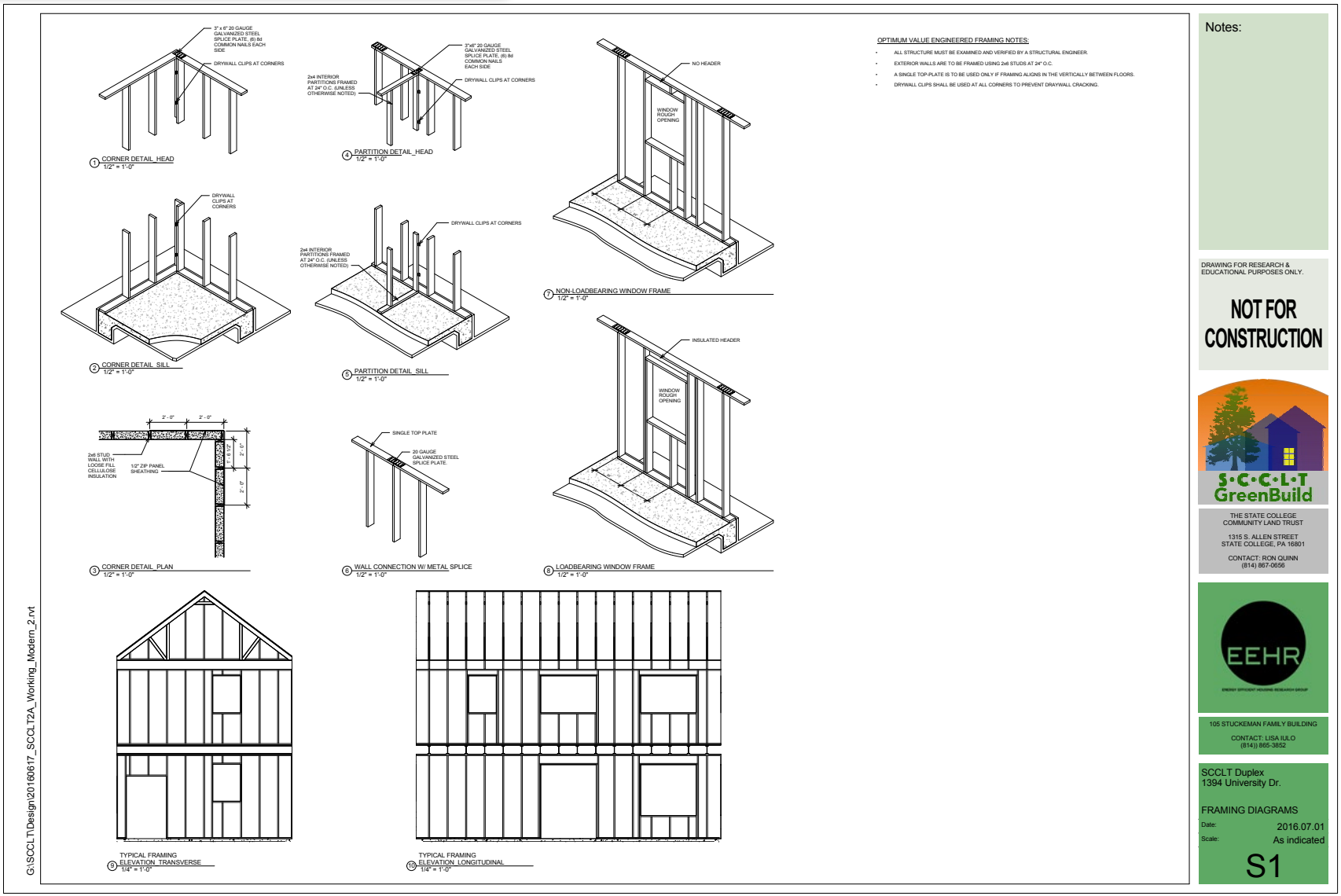
Date: 2016.07.01
Scale: As indicated

A3.1

Develop

EEHR | HAMER CENTER | PennState Institutes of Energy and the Environment | PHRC

Design Development with the SCCLT



Develop

Design Performance Summary

Christopher Hazel
chrisjhazel@gmail.com
Pennsylvania State University
Energy Efficient Housing Research Group

Project Data

- Location: 1394 University Drive, State College, PA 16801
- Climate Zone: 5
- Square Footage: 1,440 ft2 per duplex (2,880 ft2 total)
- Number of bedrooms: 3 per duplex
- Number of bathrooms: 2 full bathrooms per duplex
- Number of stories: 1 story with full basement per duplex
- HERS score without PV: 39
- HERS score with PV: -3
- Estimated monthly energy cost without PV: $78.96 @ $0.12 per kWh
  Estimated monthly energy cost with PV: - $1.70 @ $0.12 per kWh

Technical Specifications

- Walls Effective R-value =29
- Foundation Wall Effective R-value = 23
- Slab Insulation = R-10
- Roof Insulation = R-60
- Window Performance
  - South & East Windows:
    U=0.29, SHGC = 0.500
  - North & West Windows:
    U=0.24, SHGC = 0.260
- HVAC specifications
  - Heating/Cooling/Ventilation:
    - Basement and First Floor Bedroom: (1) ¾ ton, 24 SEER, 13 HSPF ducted Mini Split Heat Pump,
    - First Floor Main Space: (1) ¾ ton, 33 SEER, 14.2 HSPF wall mounted Mini Split Heat Pump
  - Water Heating: 50 gallon heat pump water heater

H4

HERITAGE HOMES

H4: High Performance Living in Harmony with Community

Summary