U.S. DEPARTMENT OF ENERGY SOLAR DECATHLON

VIRGINIA TECH

ecologic treeHAUS

PROJECT SUMMARY

The TreeHAUS is a net-positive, regenerative attached housing project inspired by the way trees collect and distribute resources in the forest. The goal of the project is to strengthen the surrounding environment and Blacksburg municipality by imagining the house as a cooperative constituent of its contextual ecology. The TreeHAUS harnesses energy from the sun, harvests water from the rain, and cycles resources and information throughout its community in the same way that plants and trees do in nature. Our design is the first residential building in a proposed Live/Work/Learn village at the Virginia Tech Corporate Research Center (VTCRC).

According to the recently released Campus Master Plan, Virginia Tech will drastically increase enrollment and add seven million gross square feet (GSF) to its campus by 2047 (including over one million GSF in the next five years). This has caused widespread speculation in Blacksburg, skyrocketing real estate prices, and a local affordability crisis - especially for under-paid graduate students lacking outside financial assistance. The aim of our project is to provide the burgeoning graduate student population an affordable, sustainable home where they can grow into future faculty and industry leaders.

FIGURE 1.1 | EXTERIOR RENDERING

FIGURE 1.2 | INTERIOR RENDERING

Floor Area: 15,504 SF, 12 Units
Occupancy Type: R-2 | **Current Zoning**: R&D
Zoning Overlay: Airport Safety Zone
Construction: Type V-B
Process: Planned Residential Development (PRD)

TABLE 1.1 | ZONING OVERVIEW

DESIGN STRATEGY

Our design approach involves prefabricated modules that comprise scalable housing complexes. This strategy can reduce construction waste by up to 80%, as well as minimize site disturbance in sensitive areas, and reduce costs through standardization and economy of scale. Constructing entire housing units in advance also reduces construction timelines to a matter of days rather than months, and facilitates more efficient recycling of construction materials and byproducts through streamlined factory processes.

On-site, the building incorporates an interconnected smart grid of shared energy, resources, and data powered by blockchain. This network is inspired by mycorrhizal networks in nature, emulating a cohesive and cooperative ecosystem. Each housing unit contributes to the same cyclical energy market through such processes as anaerobic digestion, shared solar PV, and backup combined heat and power (CHP) fueled by biogas.

Considerations of embodied energy and full life cycle costs ensure we not only minimize but reverse our carbon footprint and environmental impact. Additionally, each housing development considers its unique ecological context and is carefully integrated into a productive agroforestry landscape that provides both strategic seasonal shading and edible harvests for community residents. It is our hope that these food forests long outlive the building itself and continue to nurture the environment and provide ecosystem services to the area for centuries to come.

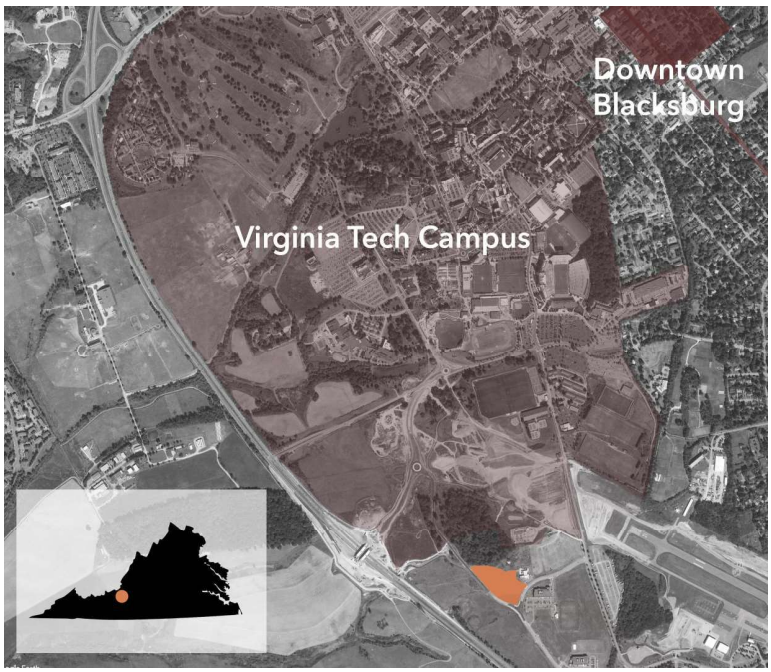


FIGURE 2.1 | CONTEXT MAP

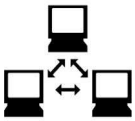
- **Project Type**: Attached Housing (AH)
- **Location**: Blacksburg, Virginia
- **Climate Zone**: 4A (Mixed-humid)
- **Unit Sizes**: 640-1920SF
- **HERS Index**: 34 (without PV)
- **Lot size**: 36,000SF / 12 Units: (3) 1BR, 1BA
  (3) 2BR, 1.5BA
  (3) 3BR, 2.5BA
  (3) 4BR, 2BA

TABLE 2.1 | PROJECT DATA

- **Envelope**: R37 wall, R14 foundation, R55 roof
- **Windows**: R4 day / R14 night
- **HVAC specs**: SEER 15, 16, 24
- **HVAC type**: Zoned DFHP / gas HWH-backup
- **Ventilation**: Energy recovery ventilation (ERV)
  Hydroponic phytoremediation
- **Energy**: 50 kW PV array for net-positive power

TABLE 2.2 | TECHNICAL SPECIFICATIONS

PROJECT HIGHLIGHTS



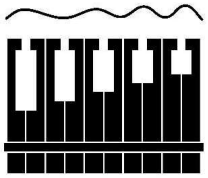
1. *Mycorrho-grid local blockchain energy exchange*
   - TreeHAUS is designed as one node in a proposed Live/Work/Learn network
   - Smart contracts execute energy transactions and incentivize less consumption
   - System interfaces with nearby utility sub-station as a virtual power plant (VPP)

2. *Modular design and smart construction*
   - One, two, three, and four-bedroom modules pre-fabricated off-site
   - Significant cost reduction with decreased construction waste and assembly time

3. *Agroforestry landscaping for smart shading and food production*
   - Edible landscape provides food for occupants in case of supply chain disruption
   - Collected rainwater and HVAC condensate irrigates plants
   - Deciduous agroforests provide shading in the summer and direct light/heat in the winter
   - Phytoremediative green wall connected to HVAC reduces indoor ventilation loads

4. *Integrated application for building control and behavioral learning*
   - Artificially intelligent back-end monitors conditions and learns user behavior
   - Blockchain provides cyber-security for home control and energy transactions
   - Automated building controls with manual overrides

5. *Wooden Envelope and Stomatal Windows*
   - Wooden wall section naturally modulates moisture flow
   - Wood fiber insulation and fiberboard help reclaim post-production waste
   - Dowel Laminated Timber (DLT) removes the need for metal & adhesives
   - Operable screens insulate the windows, increasing net thermal performance



6. *Innovative Acoustics*
   - Helmholtz cavities in DLT wall panels attenuate target auditory frequencies
   - Mass timber ceilings, and cork insulation offer additional acoustic control