PROJECT SUMMARY

How can attached housing play a role in revitalizing a cyclically traumatized culture and neighborhood, while also designing a solution for gridlocked unsustainable city infrastructure? This project aims to answer that question by creating two prototypes for net zero energy row homes-an infill model and a renovation model-in order to establish a new standard for urban renewal and development. The designs are sited in Sharswood, Philadelphia, which is a historically abused, impoverished neighborhood. By combining these models across a block scale to create a mixed-income community, the design encourages low-income home ownership, creates public space, and increases financial stability in the neighborhood. Due to the nature of row homes, the individual designs will be applicable on sites all over Philadelphia.

Figure 1.1 Elevation of Both Models

The 3-bedroom infill model is designed for the scenario with the toughest constraints, fitting into the smallest lot (14' wide) that could exist between existing row homes, thus allowing it to be adapted to fit into any lot. Filling in a vacant lot between row homes supports its neighbors not only structurally and thermally, but also financially through excess energy production and rainwater collection, treatment, and distribution.

We are partnered with the Lower North Philadelphia CDC to perform a renovation on a vacant row home at 1423 N 29th St. It was donated to the CDC by the Philadelphia Housing Authority and we have worked with these community partners to develop a net-zero energy design which will begin construction this year and be sold at a low-income rate. The CDC project is a typical row home size, 16' wide x 50' deep. Thus, the renovation we complete will be applicable to row homes all over the city. In addition to the pilot project on 29th St, we are envisioning the renovation model existing in conjunction with the infill on our chosen site in Sharswood.

Both models seek to evolve the capabilities of the residents of Sharswood by supporting home ownership in a neighborhood that has been reduced to mostly renters due to property tax increases and a centralization of public housing. We seek to bolster the existing community by eliminating energy bills and designing a business model where profit from market rate housing helps finance low-income housing.

DESIGN STRATEGY

Each model is designed to be energy independent and play a role in offering low income housing. Both models reduce energy needs through passive means before implementing active systems, and also offer rainwater collection and reuse strategies. The potential for larger scale impact increases when both models are implemented in all 4 cardinal directions at the block scale. This allows the excess energy generated from solar panels as well as the excess water collected to be utilized to support shared services for the community.

The renovation model focuses on solar efficiency, thermal comfort, and occupant health and stability in order to maximize potential in this under-resourced neighborhood. Architecturally, the plan supports a variety of occupant needs through the implementation of a flex space. This can be an office space for an entrepreneur, a play space for children, or transformed into a separate bedroom with a full ADA bathroom. Thus, the home is able to adapt to accommodate either small or large families with potential for generational growth.

The infill model uses an innovative filtration system to capture rainwater from the roof, exceeding the water needs of the household while eliminating runoff into the combined sewer system. This is accomplished through a backyard bioswale that doubles as a source of coolth for a solar chimney in the summer. This solar chimney is placed over the staircase, reducing artificial lighting and ventilation needs. When integrated with renovations in a 12-unit block intervention, the design suggests that whole blocks could share a backyard to increase social resilience, manage and utilize street rainwater, and provide passive cooling benefits for the whole block.

RENOVATION	PROJECT DATA	INFILL
1423 N 29th St, Philadelphia, PA, 19121.		Philadelphia, PA, 19121. Climate Zone 4
Climate Zone 4[3]		14'x60' lot, 3-Story Duplex, 1,890 sq.ft.
16x64' lot, 2-stories, 2,000 sq.ft.		Unit 1: 1 bed, 1 ADA bath, 1-2 occupants
EUI target: 12 kBtu/ft2/year before solar		Unit 2: 2 bed, 1.5 bath, 2-3 occupants
Estimated monthly utility cost: $55 for water[4]		EUI target: 12 kBtu/ft2/year before solar
Zoning: RSA-5: max height of 38', 25% lot open[5]		Estimated monthly utility cost: $0
		Zoning: RM-1: Max height of 38', 25% lot open[8]
TECHNICAL SPECIFICATIONS		
Wall: R-45		Wall: R-45
Foundation: Separated from the 1st floor by an R-30 floor		Foundation: R-30
Roof: R-50		Roof: R-50
HVAC:Minotair Compact Air Treatment Unit[6]		HVAC: Solar chimney for passive ventilation, Minotair Compact Air Treatment Unit
Solar: Sonali Solar 320-225 Series[7]		Solar: Sonali Solar 320-225 Series
		Other Tech: Rainwater collection & filtration

ENERGY PERFORMANCE
Philadelphia is a heating-dominated climate. By insulating to Passive House standards we are able to reduce our renovation EUI to 13.52 kBtu/ft2/yr with a surplus energy production of 5400.225kwh/year after solar. The infill model uses a solar chimney to further reduce energy loads, providing a passive ventilation strategy that is supplemented by an ERV with a hot water heat pump loop. The infill EUI is 11.39 kBtu/ft2/yr with a surplus energy production of 6,371.065kwh/year after solar. The CDC can sell this energy back to the grid using net metering to help pay off solar panel debt. This number doesn't even factor in the energy savings that come from our model for rainwater capture and reuse, which must be considered for a building to be truly net-zero.

ENGINEERING
Row homes are all about efficiency - of structure, systems, and space. In both the infill and the renovation models, the space is planned so that plumbing is stacked and square footage is maximized for occupiable spaces. Both models use super insulated assemblies, but special attention is paid to building enclosure in the renovation because the wall assembly lies inside the existing brick. The primary air barrier is placed to the inside of the bulk of the insulation, allowing it to breathe and blocking moisture from entering the building.

FINANCIAL FEASIBILITY & AFFORDABILITY
With the Lower North Philadelphia CDC as our real client on the pilot renovation project, and assuming they will be for future infill and renovation projects, our goal is to promote home ownership through our business model. A portion of the profit from the infill property offsets the cost of construction for the renovation. This allows the CDC to sell the renovation at a low-income rate. In a one-off renovation such as the pilot project, Reinvestment Fund offers a lower interest rate for sustainable elements - many of which overlap with existing scope such as windows and insulation - which makes the project more affordable. The CDC will also own the solar panels, becoming an energy company which provides them a steady source of revenue. At the block scale, affordability increases through buying in bulk as well as shared resources such as cisterns and filters.

RESILIENCE
Other than the economic resilience we have already mentioned as a key focus, the largest resilience challenge in the city of Philadelphia is flooding and water damage. A combined sewer and stormwater system frequently overflows into the river and the streets. We are addressing this problem by considering not only the envelope of the building, but also controlling how water is managed at the block scale. An interconnected backyard bioswale system offers a solution for rainwater collection and runoff management. Filtration systems allow the buildings to be entirely off the grid for water and reduces energy use as well. By using this method, we are proposing a new system for how the city of Philadelphia can manage water.

ARCHITECTURE
In the renovation model an emphasis is placed on accessible design. Many active members of the community are seniors, and have expressed a need for accessibility and aging in place. By including ADA compliant entrances and bathrooms on the ground floor of the renovation we can accommodate those with disabilities. Flexible spaces in both models encourage occupants to cater to their own needs and provide opportunities for multi-generational living conditions.

OPERATIONS
In the renovation project, the solar panels are owned and maintained by the LNPCDC, which will receive a check from PECO each month for energy sold back to the grid. This relieves the residents of the pressure to maintain the system and offsets the cost of the solar panels, making the construction cost more feasible for the CDC. Both models will feature LED lighting and Energy Star appliances. In the infill model, sensors detect temperature and automatically open window panels in the solar chimney for passive ventilation.

MARKET POTENTIAL
In Sharswood alone the infill model could be placed on 228 vacant lots between existing buildings and 245 existing vacant properties could be renovated to provide net-zero energy low-income housing. Implementing our models across Sharswood would produce an excess of over 900,000 kwH/year, or an extra $150,000 that the LNPCDC could invest back into the community. Row homes make up almost 60% of housing in Philadelphia, and that percentage accounts only for what is already constructed. Imagine the impact both the infill and renovation models could have on energy, water and urban density if adopted by other CDCs and constructed across the city - or even nationwide.

COMFORT & ENVIRONMENTAL QUALITY
Philadelphia experiences hot, humid summers and cold, dry winters.[9] Thick insulation in both models mitigates the effects of outside temperature on indoor air and a Minotair air unit functions like an ERV with combined functions for heating and cooling. Air and water quality is also an issue in Philadelphia, where industrial factories pollute the air, water, and soil. By implementing a backyard bioswale, water and air are naturally filtered in order to create a healthy outdoor environment as well as a source of coolth for natural ventilation.

INNOVATION
By designing systems at the individual project scale as well as at the block scale, we aim to re-imagine development standards and impact how energy and water are managed all over the city of Philadelphia. Implementation of this backyard filtration system by the Philadelphia Water Department would take the pressure off the aging existing infrastructure and provide potable water for the city through on-site, natural filtration systems. Storage for excess on-site renewable energy would power this system as well as generate revenue for the residents through shared infrastructure.