PARTNERSHIP FOR ADVANCING TECHNOLOGY IN HOUSING

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Eaton Row: Efficiency and Affordability

An Infill Development in New Haven, Connecticut

TECHNOLOGY HIGHLIGHTS

- Modular Hybrid Construction
- Smart-Growth Principles
- Energy Modeling and ENERGY STAR Homes
- High-Efficiency Gas Furnace
- Compact Duct Layout
- Durable Materials
- Recycled-Content Materials

The city of New Haven, Connecticut is home to a new development that blends affordable housing with innovative building practices. The Eaton Row HOPE IV revitalization project is located in an emerging neighborhood that was once one of the poorest in the city. New market-rate and low-income rental properties have already been constructed in this neighborhood adjacent to Yale University. The third and final phase of the project features 27 affordable homes that incorporate a number of best-practice building technologies. The two-story, single-family homes have full basements. Traditional architecture was used to relate to the existing neighborhood. The houses are factory-built, four-box modular construction; garages, porches, and decks were built on site by the contractor. Modular construction was selected to speed construction and increase jobsite security, among other advantages. The site-constructed elements add unique character to each home.

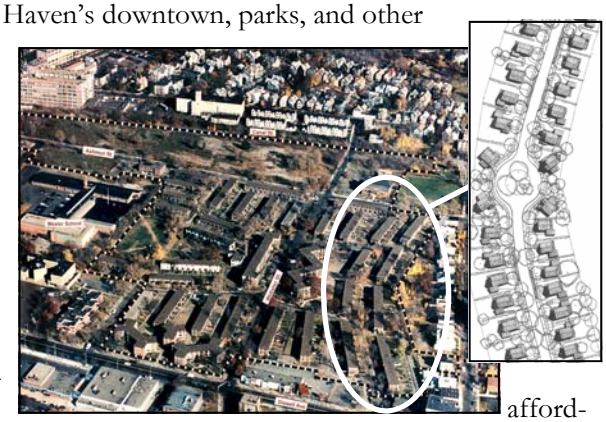
Eaton Row developer Jonathon Rose Companies, LLC has experience building traditional communities and is recognized nationally for sustainable development. The company was eager to incorporate the same principles of smart growth, energy efficiency, and environmental stewardship at Eaton Row, but was limited in its usual approaches by affordable cost targets. The Partnership for Advancing Technology in Housing (PATH) worked with the developer to promote the demonstration site as a model for energy-efficient affordable homebuilding in New Haven and similar climate regions. Steven Winter Associates, Inc. (SWA), through PATH, provided technical advice on the use of technologies to meet project goals within the defined cost parameters. Homes will be sold to first-time homebuyers at both affordable and market rates.

Advanced Technologies

It is the goal of the U.S. Department of Housing and Urban Development's PATH program to accelerate the development and use of technologies that radically improve the quality, durability, energy efficiency, environmental performance, and affordability of America's housing market. Eaton Row features several of these technologies, carefully planned and implemented to yield performance and cost benefits to both the builder and the homeowner. Highlighted in this case study are the PATH technologies used in this project.

Smart-Growth Principles

Smart-Growth Principles of preventing sprawl and protecting land resources are at the heart of Eaton Row Homes. This new infill development utilizes an existing urban infrastructure by siting the neighborhood and homes near public transportation, schools, churches, and parks. As a result, New Haven's downtown, parks, and other institutions reduce dependence on personal automobiles and parking requirements. Throughout the development, elements of Traditional Neighborhood Design include front porches, garages set back from the street, and efficient use of space. This helps to create walkable communities within a traditional setting. Another Smart-Growth Principle used was constructing a mixed-income community so that high-quality homes were affordable to a variety of homeowners rather than a single economic class.



Modular Hybrid Construction

To increase the quality, speed, and control of the construction process, a modular hybrid building system was selected for Eaton Row Homes. Modular hybrid construction combines factory-made house sections with site-constructed features. These hybrid elements (such as site-built garages and porches) help give each home a unique personality. PATH technical advisors recommended modular construction for the following reasons:

- Controlled factory environments allows for better quality control;
- Air infiltration is reduced through tight construction;
- Faster construction speeds are possible;
- Weather-related construction delays are minimized;
- Waste is minimized in the factory and jobsite waste is drastically reduced (a PATH priority), saving both landfill space and hauling costs;
- Jobsite security increases with modular home construction.

The Eaton Row homes were made of four modular boxes or sections that were placed on top of the foundation by crane and fastened together to form the house structure. Foundation and modular units were placed at a rate of two homes per week. Different porch and garage configurations built onsite plus a varying color scheme mitigate the "cookie cutter" look sometimes associated with modular housing. A modular housing manufacturer had been selected early in the process, but the PATH consultants helped choose a replacement supplier after site construction had begun because the limited capacity of the first plant would have delayed overall construction.

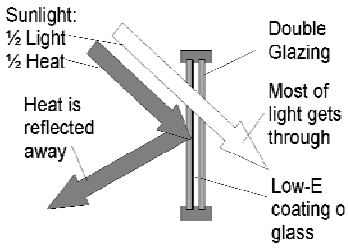
Money Isn't All You're Saving

Tight Building Envelope

Because factory control tolerances are smaller than those achievable in the field, straight, precise modular construction is one aspect contributing to a tighter building envelope at Eaton Row Homes. All of the single-family units will meet ENERGY STAR® Home standards with a HERS score of 89 or better. The project team selected strategies with affordable first cost that will also offer homeowners substantial savings on energy bills.

Energy Modeling—Modeling performed by PATH engineers was used to pre-

dict and optimize efficiency. When budget constraints are a primary concern, modeling can identify which energy saving technologies have greatest impact.



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Low-E Double-Glazed Windows—Generous windows let in daylight and reduce lighting loads, but poor quality windows result in heat and cooling losses. Low-e coating and double glazing minimize energy losses while maximizing daylighting (1). Building systems consultants have found that low-e coating with insulated glass is one of the most effective energy upgrades.

Building Insulation—The builder added R-38 roof insulation and R-19 wall and floor insulation to improve the building envelope. PATH technical advisors recommended insulating the basement walls in order to locate mechanical equipment in conditioned space, which improves operating efficiency of the HVAC system, but the builder elected to insulate the floor only because of cost.

Air Sealing—Applying urethane foam around windows, doors, and other breaks in framing helps prevent leakage of conditioned air to the outside.

Efficient HVAC Design

Consulting engineers designed the HVAC system and made recommendations regarding equipment and sizing to achieve maximum efficiency for project conditions. HVAC engineering also improves thermal comfort, eliminating hot and cold spots throughout the house. Testing verified that the design goals for efficiency were being met.

2

Manual J Design—Engineers calculated room-by-room loads and air flow requirements for the first model home, providing comments on duct layout and zoning. Heating and cooling equipment was appropriately sized using ACCA Manual J guidelines to maximize efficiency.

AFUE 92% Efficient Furnace—The gas-fueled direct vent condensing furnace is very efficient (2). This is particularly important in the Northeast climate, where cold winters often mean high utility bills. Eaton Row homeowners can expect long-term savings with this furnace.

SEER 13 Air Conditioner—The condensing unit with a high SEER 13 rating achieves superior energy performance. Air conditioners with this level of rating also qualify for energy rebates in many areas, including New Haven.

Programmable Thermostat—When used properly, programmable thermostats save heating and cooling energy when the house is unoccupied.

3

Compact Duct Layout—In a compact duct layout design, registers are located on interior corners of rooms close to the air handler. Eliminating long runs of ductwork has two benefits: energy efficiency increases and initial construction cost decreases.

Mastic-Sealed Ducts—Air leakage from duct joints and connections causes significant energy losses and affects pressurization, air distribution, and indoor air quality. Mastic is a putty-like sealant (3) used to fill cracks and crevices that does not harden and crack but rather remains flexible over time, resulting in a much better air seal than traditional duct tape.

Other Energy Savers

Eaton Row Homes have ENERGY STAR® appliances including refrigerators and dishwashers. The homes use compact fluorescent bulbs to save 70% on lighting costs. Technical advisors recommended Rinnai gas-fueled tankless water heaters, which heat domestic water instantly to eliminate standby losses and conserve a third of the gas used by conventional tank heaters. The builder elected not to install the units due to cost.

Superior Indoor Air Quality

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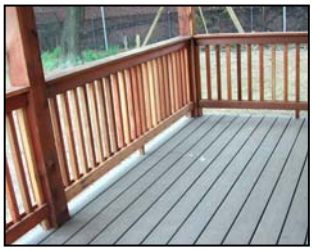
Most pollutants come from sources inside the home, including building materials. Eaton Row Homes use less toxic materials and finishes, including low-VOC paints and ceramic tile in place of vinyl. Air sealing techniques restrict air infiltration and also limit the introduction of outside pollutants to the home environment.

Durable Materials

A common problem with affordable housing is the use of low-quality materials that do not stand up over time. Durable materials used at Eaton Row do not need to be replaced as often, reducing solid waste, saving money, and spreading environmental impacts of product manufacturing over a longer time period. Ceramic floor tile (4) lasts far longer than the vinyl flooring that is typically used in affordable housing, and ceramic is inherently low toxic and waterproof. Fiber cement siding (or Hardiplank® lap siding) has the look of wood and the easy maintenance of vinyl, but the fiber-cement product has superior resistance to rooting, cracking, rain, or hail damage, and fire, and is backed by a 50-year warranty. PEX plumbing tubing (cross linked polyethylene piping) is more resistant to chemical damage than copper and requires fewer joints, where leaks often start.



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Recycled Content Materials

Using recycled content lessens the environmental impacts associated with extracting, harvesting, and manufacturing virgin raw materials. Recycled content is also diverted from the waste stream. At Eaton Row, recycled content building materials were incorporated at no or low additional cost. Composite decking (5) contains recycled plastic trash bags and waste wood fibers. This product is weatherproof without adding toxic chemicals used in conventional treated lumber. PET carpet (6) contains recycled polyethylene terephthalate. Commonly called "Pop Bottle Carpet," it often outperforms virgin nylon carpet.

6

Accessibility and "Visit-Ability"

From door hardware to kitchen layouts, architects working with PATH focused on providing building access and interior design that promotes accessibility and "visit-ability" for individuals with a wide range of mobility.

Conclusion

The Eaton Row project team possessed a commitment to more sustainable building with a desire to create affordable homes. PATH support to this project included architectural design, energy efficiency consultation, specification, and implementation training and media outreach. Technical advisors worked with Jonathan Rose to analyze their standard practices and identify areas for PATH innovations. The homes incorporate modular hybrid construction, high-efficiency mechanical equipment, and greener, more durable design and materials, plus a site design guided by Smart-Growth Principles. High performance building innovations implemented under the PATH banner resulted in durable, comfortable, and high-performing homes in a mixed-income urban setting.