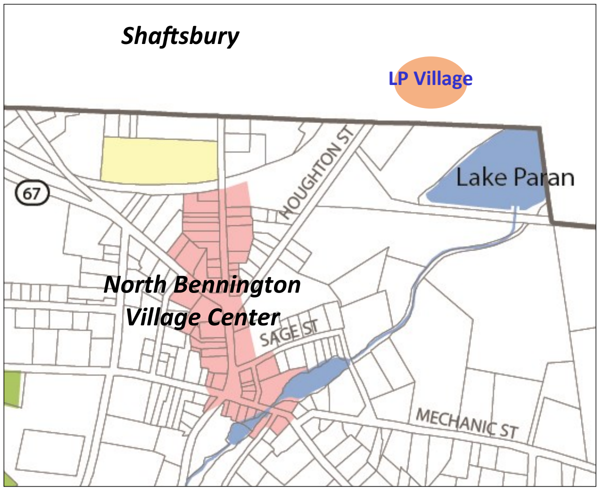
Case Study in Energy Efficient Building Technologies
Lake Paran Village Housing Development

Goldstone Architecture + MSK Engineering and Design + Naylor and Breen Builders

Shires Housing
Southwest Vermont

Overview and Location

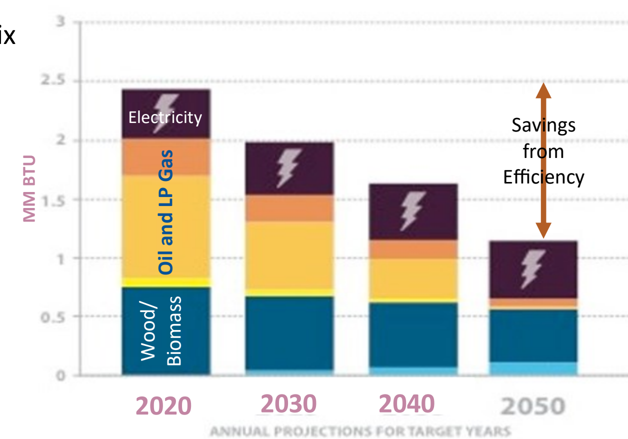


Lake Paran Village is a new development of the regional nonprofit organization, Shires Housing. The project has been thoughtfully designed to be efficient, comfortable, and sustainable for both its residents and the surrounding community. The development is composed of 22 apartments in four buildings located along the Shaftsbury/North Bennington border and is designed and built to a level of energy efficiency that meets or exceeds all Energy Star and Vermont energy standards for buildings.

Location is a crucial energy efficiency consideration. Siting can save energy and reduce pollution by reducing the distances people have to drive and by making it easier to walk, bike, or take public transit to common destinations. Lake Paran Village is located immediately adjacent to historic North Bennington Village Center with its school, library, stores, restaurants, and recreational facilities.

Meeting our Energy Goals

This graph illustrates fuels used in the residential sector in our region—primarily for space and water heating—and how the mix of fuels must change over time to meet Vermont's goal of having 90% of all energy use derive from renewables by 2050. Oil and propane are the main sources of residential heating fuel, but their use must be reduced to a tiny fraction of current levels by 2050. Energy efficiency measures, including construction techniques, will be relied upon to cut total energy demand. The use of electricity, generated from renewable sources such as hydroelectric, solar, and wind, will grow to become the largest source of residential heating. New building construction and renovation projects must include aggressive weatherization measures and utilize renewable fuel sources or we will fail to meet our energy and greenhouse gas emission goals.



Envelope Sealing Results:

BEFORE SERVICE

412.2 CFM of Leakage, equivalent to a
49.6 Square Inch Hole or
2.33 Air Changes per Hour

(for your 1253 square-foot structure enclosing a volume of 10624 cubic feet)

AFTER SERVICE

12.6 CFM of Leakage, equivalent to a
1.5 Square Inch Hole or
0.07 Air Changes per Hour

This corresponds to a
96.9% Reduction
in Envelope Leakage

NOTE: Envelope leakage and air-change results are calculated at a standard pressure of 50 Pa.

Air Sealing and Insulation

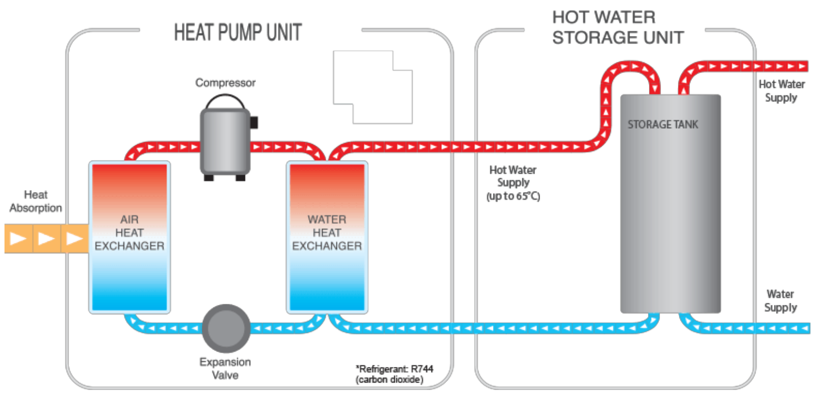
Construction at Lake Paran Village used AeroBarrier sealing, a system that disperses an aerosolized sealant in a pressurized space to fill cracks and holes, many of which would not be caught by the human eye. Original plans, which did not include the use of AeroBarrier, were designed to meet the standard of the Residential Stretch Energy Code of 2.0 air changes per hour at 50 Pascals pressure (ACH 50). The AeroBarrier sealing far surpassed this goal. Blower door tests revealed a remarkable average of 0.1 ACH 50, with one apartment testing at 0.07 ACH 50.

Buildings feature dense-packed cellulose insulation in wall cavities, R-60 loose-fill cellulose insulation in attics, R-15 continuous rigid insulation at foundation walls, and an additional 2" of R-10 rigid insulation under the entire slab, as well as zip-sheathing water barriers. Each building will use only 7 BTU per square foot at peak heat load (typical construction is between 20 and 30 BTU per square foot).

Heating Systems

The original plan for the Lake Paran Village development called for the installation of one propane tank per building with low-pressure fired LP boilers. Shires Housing was determined, however, to explore any alternative that would eliminate fossil fuels in favor of heating systems based entirely on renewable fuels. The use of new air-sealing technology and high levels of insulation lowered energy demand to the point that inexpensive electric resistance baseboard units could be utilized for space heating. Even though electric resistance heating is not as efficient as some other systems, such as electric heat pumps, the buildings require so little heating that the additional operating cost is minimal and offset by lower installation and maintenance costs. The electric resistance heaters also do not require any backup on extremely cold days. Cost-savings also will allow for installation of a rooftop photovoltaic (solar) system that is anticipated to offset between 50% and 75% of the year-round space heating and domestic hot water costs.

Domestic hot water is produced by 83-gallon air-to-water split heat pump systems (Sanden SANCO2) – two each in three of the buildings and one in the fourth building. Additional resistance water tanks are provided in each building as water storage and redundant back-up.



The heat pump systems use a small amount of electrical energy to move heat from one location to another. Heat in the air is absorbed by a natural refrigerant, CO_2, which is ozone friendly and a far less damaging greenhouse gas than other refrigerants commonly used in similar systems. The warm gaseous refrigerant is circulated in the system via a compressor. As it passes through the compressor, its pressure rises, as does its temperature. This hot refrigerant then passes through a heat exchanger to heat the water, which is then pumped to the storage tank.

Other Considerations

Because the buildings are so air-tight, *energy recovery ventilation (ERV) systems* with ducted supplies and returns are incorporated in each apartment. The ERV systems provide continuous fresh air (with a bathroom operated boost) to the living spaces while capturing the heat (or cool) and the moisture in the exhausted air .

Another innovative construction technique incorporated in the project design is the use of *frost protected shallow foundations*. By insulating the foundations from frost, the volume of concrete needed for construction was significantly reduced, an important energy-saving measure because of the high level of embodied energy (the energy that goes into production and installation) in concrete.

For additional information:

- Vermont Residential and Commercial Building Energy Standards: https://publicservice.vermont.gov/content/building-energy-standards-update
- AeroBarrier Building Envelope Sealing: https://aerobarrier.net/
- Air to Water Split Heat Pump System: https://www.sandenwaterheater.com/
- Bennington County Regional Energy Plan: http://www.bcrcvt.org/energy-plan.html

Probes inserted below frost protected shallow foundations were used to monitor ground temperatures through the fall and winter. Temperatures never fell below freezing allaying concerns of potential frost heaving.

Forms for the frost protected shallow foundation (FPSF) before the installation of crushed stone, vapor barrier and insulation.

Forms in place for the installation of the FPSF. The slabs are 4” thick and have a perimeter haunch of 24”. The maximum depth of the slab is 18” below grade – far less than the code required 5’-0” for a standard footing and wall foundation. The orange blanket is a heater to keep subtrade from freezing before the installation of the sub-slab insulation.

Vapor barrier installed and taped under FPSF

FPSF slab has been poured and slab edge insulation is installed. The vapor barrier protruding above the slab will be taped to the sheathing to maintain continuity of air barrier.

FPSF with insulation “wing” installed to extend frost protection to the soils under the slab edge.

Densepacked cellulose insulation installed in exterior and demising walls. The pink fiberglass batts provide sound insulation in floor/ceiling assemblies.

3” of EPS (expanded polystyrene) continuous insulation installed to the exteriors of the buildings and strapped for siding installation. EPS was selected for the relatively low GWP of the blowing agent used for its manufacture.

Aero Barrier emitters prepared for spraying acrylic aerosol caulk. Horizontal surfaces are protected from caulk that will settle from air.

Aerobarrier sealing in progress. The red “door” is the “blower door” sealed in the door opening with a fan which pressurizes the building (apartment) during installation.