174 Barberry — HVAC Systems Overview

Energy Strategy

Because electricity is significantly more expensive than natural gas, the home's HVAC design prioritizes minimizing electrical consumption and offsetting electrical usage with solar generation. Air conditioning must be powered by electricity; therefore, the most cost-effective cooling option is the water-to-water geothermal heat pump, which delivers the highest efficiency per kilowatt.

For heating, natural gas provides the lowest operating cost. Although the geothermal system can produce heat, its electricity demand makes it more expensive to operate than natural gas equipment. As a result, the home's heating strategy is built around natural-gas-based systems, with geothermal heat available only as supplemental or backup heat.

Heating, Ventilation & Air Conditioning Overview

The House includes two connected structures—the **FarmHouse Module** and the **One Floor Living Module**—which share return-air pathways and work together to provide whole-home conditioning.

One Floor Living Module

- Equipped with a **4-ton water-to-water geothermal system** that heats or cools a **50-gallon buffer tank**.
- Conditioned water from the tank feeds the module's central air handler to supply heating or cooling.
- Controlled by the **Dining Room thermostat** (smart-enabled).

FarmHouse Module

- Recently upgraded with a **2.5-ton conventional heat pump** paired with a natural-gas furnace for backup heat and air conditioning.
- Controlled by the **hallway thermostat** outside the Media Room (smart-enabled).

Shared Return Air

Both structures share return-air pathways. This design allows:

- Closing off unused bedrooms in the FarmHouse Module to reduce conditioning load.
- Using thermostat setbacks for additional energy savings.
- More even distribution and improved comfort compared to conventional isolated HVAC zones.

Air Conditioning Operation

- The **4-ton geothermal unit** chills water in the buffer tank, which is then circulated to the One Floor Living air handler.
- The FarmHouse Module cools via its **conventional heat pump**.
- Both systems run under independent smart thermostats, located in the Dining Room and FarmHouse hallway

One Floor Living Module — Heating Operation

The heating system is intentionally staged to maximize natural-gas efficiency while minimizing electric use.

Stage 1 — Primary Heat: Vermont Castings Gas Stove

- Located in the basement directly beneath the main living area.
- Controlled by its own wall thermostat.
- Positioned in the main return-air path, allowing conditioned air to be carried naturally toward the air handler and circulated throughout the home.
- Typically set to **70°F** and left operating throughout the winter.

Stage 2 — Natural Gas Hot Water Heater (Primary Air-Handler Heat)

- A **50-gallon natural-gas water heater** circulates hot water through a tank-integrated heat exchanger to maintain approximately **105°F** buffer tank temperature.
- This hot water supplies the air handler, controlled by the **Dining Room thermostat**.
- Acts as the main forced-air heating source.

Stage 3 — Geothermal Heat Pump (Standby/Backup)

- Provides additional hydronic heat if required.
- Kept powered on but idle because it is more expensive to operate with electricity than natural gas.

Stage 4 — Gas Fireplace (Supplemental/Finishing Heat)

- Located in the Dining/Living area.
- Intended for supplemental comfort, not continuous operation.
- Operated locally via its on/off control.

Stage 5 — In-Floor Hydronic Heating (Basement Slab)

- Hydronic tubing and pumps are installed throughout the basement floor.
- Testing showed that heating the concrete slab requires significantly more energy than heating the air volume above it—**an order of magnitude more**—so this system is not used for regular heating.

FarmHouse Module — Heating Operation

- Heated by the **2.5-ton conventional heat pump**, with a **natural-gas furnace** providing auxiliary and backup heat.
- Controlled by the smart thermostat in the hallway near the Media Room.

Ventilation

Natural Ventilation Strategy

The home is designed to take advantage of passive, natural ventilation whenever outdoor conditions allow. Operable clerestory windows in the Living Room and Kitchen, along with screened windows throughout the house, allow warm air to escape upward and be replaced by cooler incoming air.

A typical operating pattern is:

- **Open windows** when the outdoor temperature is lower than the indoor temperature (often overnight and early morning).

- **Close windows** as the outdoor temperature rises to match the indoor temperature, trapping the cool morning air inside until evening.

- **Reopen windows at sunset**, when outside temperatures drop again, to re-establish natural ventilation.

Ceiling Fans and Air Circulation

Most rooms, including all bedrooms, are equipped with ceiling fans. These are used extensively during natural ventilation periods to enhance air movement and improve comfort without relying on air conditioning.

During these ventilation periods, both HVAC systems—the FarmHouse Module and the One Floor Living Module—should be set to the **"Circulate"** or **fan-only** mode. This keeps air moving throughout the interconnected spaces and assists in distributing cooler air collected overnight.

Humidity Management

When outside air becomes humid, especially during late spring and summer, the **basement dehumidifier** should be used to remove excess moisture from the home. This technique is effective until conditions require mechanical air conditioning—typically during stretches when both temperature and humidity remain high overnight.

BARN HVAC Systems

The PA Bank barn is equipped with a 2 ton Geothermal Water to Water system similar to the house with a 25 gal buffer tank that provides hot and cold water to the 2 ton air handler and ductwork system. Additionally, the barn is equipped with in-floor heat in its concrete floor slab provided by the buffer tank. An instantaneous natural gas water heater provides hot water to the buffer tank which is able to be circulated to either the in-floor heat or the air handler.

Primary heat is provided by a 120,000 BTU torpedo heater fueled by home heating fuel controlled by its thermostat. This method of providing heat to the utility building keeps the barn from freezing and is able to warm the building to 70 degrees at the lowest possible energy cost.