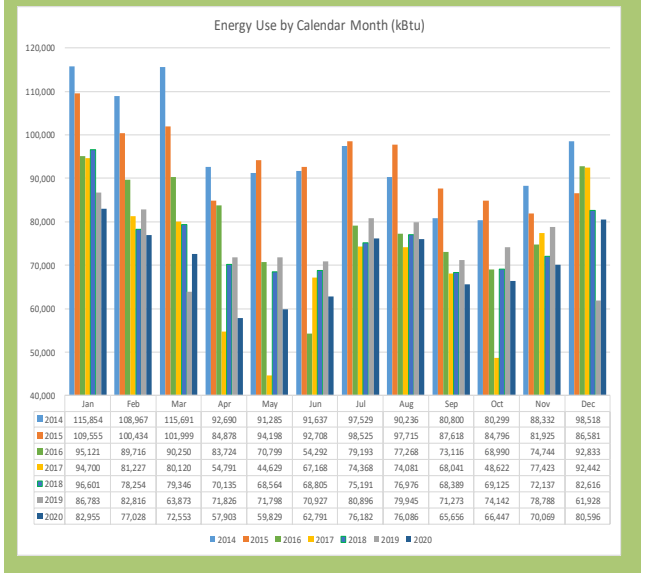
We had completed extensive energy efficiency improvements to the library and needed to replace an old, inefficient, oil-powered HVAC system. The town had appropriated funds to replace the library's boiler and cooling tower and to design and install a new heat pump system.

The engineers provided options for the replacement system, including installing a newer version of the oil-fired system and changing to a geothermal system. The rate of return (ROI) analysis performed by the engineering firm indicated that a geothermal HVAC system design for the library would have the most favorable ROI (12 years) and be the least invasive to the building.

The project was funded through the combined financial support of the Governor and Executive Council's award of a NH Public Utilities Commission Renewable Energy Fund grant and an Energy Efficiency Services Rebate from Eversource Energy, in combination with Town funds. This funding combination made it possible to install a state of the art closed loop geothermal thermal system at the Library.

A touch screen monitor highlighting the project is on view for the public to learn about our geothermal system.

Project cost:	$880,000
NH Public Utilities Commission Renewable Energy Fund grant:	$387,842
Eversource Energy Efficiency Services rebate:	$50,000



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	115,854	108,967	115,691	92,690	91,285	91,637	97,529	90,236	80,800	80,299	88,332	98,518
2015	109,555	100,434	101,999	84,878	94,198	92,708	98,525	97,715	87,618	84,796	81,925	86,581
2016	95,121	89,716	90,250	83,724	70,799	54,292	79,193	77,268	73,116	68,990	74,744	92,833
2017	94,700	81,227	80,120	54,791	44,629	67,168	74,368	74,081	68,041	48,622	77,423	92,442
2018	96,601	78,254	79,346	70,135	68,564	68,805	75,191	76,976	68,389	69,125	72,137	82,616
2019	86,783	82,816	63,873	71,826	71,798	70,927	80,896	79,945	71,273	74,142	78,788	61,928
2020	82,955	77,028	72,553	57,903	59,829	62,791	76,182	76,086	65,656	66,447	70,069	80,596

Timeline:

⇒ 2013: Facilities Study identified HVAC in need of replacement
⇒ 7/2014: Engineering Study completed
⇒ 9/2014: REF Grant submitted
⇒ 6/2015: Executive Council approved grant
⇒ 9/2015: Test pits dug
⇒ 10/2015: RFQ issued
⇒ 12/2015: Town Council approved additional funds & awarded contract
⇒ 2/2016: Surveying and tree cutting completed
⇒ 3/2016: Well drilling began
⇒ 4/2016: Ductwork cleaned
⇒ 5/2016: Borings covered and trench connecting to building completed
⇒ 5/2016: Lower level units replaced
⇒ 6/2016: Upper level units replaced
⇒ 6/2016: Lower level units operational
⇒ 8/2016: Upper level units operational

Revised 03/2021

Geothermal Heating & Cooling

This Library uses geothermal heat pumps to cool and heat the building.

Bedford Public Library
3 Meetinghouse Road
Bedford, NH 03110
Phone: (603) 472-2300
www.bedfordnhlibrary.org

What is geothermal heating and cooling?

- The geothermal system uses the stored energy of the earth for heating and cooling inside the building.
- Below 4 to 6 feet, the earth maintains a relative constant temperature year round, this is used to heat the water in the winter, and cool it during the summer.
- A typical geothermal system will consist of indoor heat pumps, a system of buried pipes and vertical bore holes.

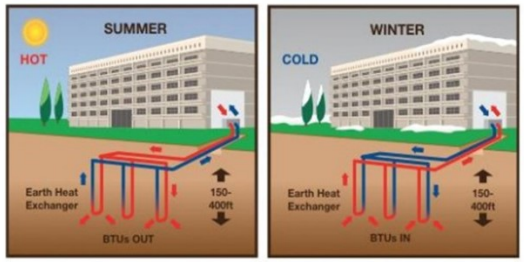


Fig.1: Overview of geothermal system operation in summer and winter.

What are the benefits of a geothermal system?

- The system has less mechanical components compared to a conventional system, which typically means less maintenance.
- It lowers peak electrical load on the electric system, freeing up power on the grid to be used for other purposes.
- The system does not use combustion for heating, thus it doesn't create any greenhouse gases in its operation.
- Compared to a hot water boiler, geothermal systems are much more efficient. The best boilers can get 95% efficiency. This means for 1 unit of energy that is input into the boiler, we can convert it to 0.95 units of energy for heating. With geothermal, we can get 400% efficiency, meaning for 1 unit of energy we input (the electricity needed to run the system) we can transfer 4 units of energy for heating.

History of Geothermal Heating and Cooling

- In 1904 the Italian scientist Piero Ginori Conti invented the first geothermal electric power plant, which used steam to generate power.
- In 1946 the first geothermal heat pump was installed at the Commonwealth Building in Portland, Oregon.
- In 1960 Pacific Gas & Electric opened the first large scale geothermal power plant (11 MW) near San Francisco, California.
- After the 1973 oil crisis, renewable energy sources gained a new importance and by the 1980's geothermal heat pumps had increased in popularity.
- In 2012 US geothermal energy produced 17 million MWh of electricity, almost enough to power the state of New Hampshire.

Previous HVAC system at the Bedford Public Library

- Water sourced heat pumps (WSHP) located throughout building.
- Heating provided by oil fired hot water boiler.
- Cooling provided by water cooling tower.

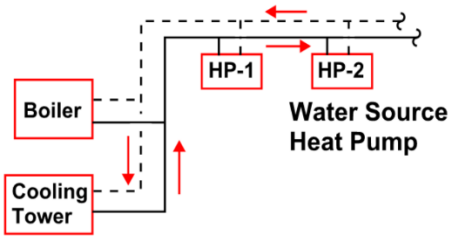


Fig.2: Simple diagram of previous HVAC system.

New HVAC system at the Bedford Public Library

- The existing cooling tower, boiler and heat pumps have been removed.
- 20 bore holes were drilled to a depth of 500 feet beneath the existing field adjacent to the parking lot.
- New geothermal water source heat pumps were installed.
- Emergency back-up heat will be provided by an oil fired hot water boiler should the geothermal system encounter a problem.

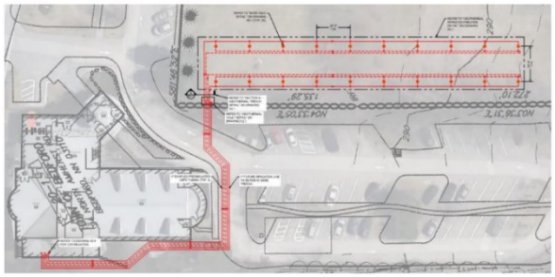


Fig.3: Layout of water piping going to wells.

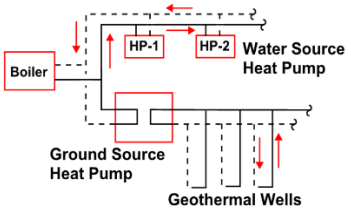


Fig.4: Simple diagram of the new HVAC system. The ground source heat pump (GSHP) separates the water loop of the water source heat pumps and the geothermal wells. In the GSHP, heat is transferred between the two loops.

How does a water source heat pump work?

- All heat pumps use the basic refrigeration cycle, which consists of 4 major components: the compressor, condenser, expansion valve and evaporator.
- In this cycle, a special liquid, called the refrigerant, changes phases from liquid to gas and vice versa.
- When the refrigerant changes from liquid to gas, it takes in heat, meaning it provides cooling. This occurs in the evaporator.
- When the refrigerant changes from gas to liquid, it gives out heat, meaning it provides heating. This occurs in the condenser.
- The main idea behind the heat pump is that it can switch between being an evaporator and being a condenser.
- For the heat pump to work properly it has to release heat energy in the summer and absorb heat energy in the winter. This is where the water comes into play.
- The water in a water source heat pump will absorb or release the heat energy, depending on the mode of operation.

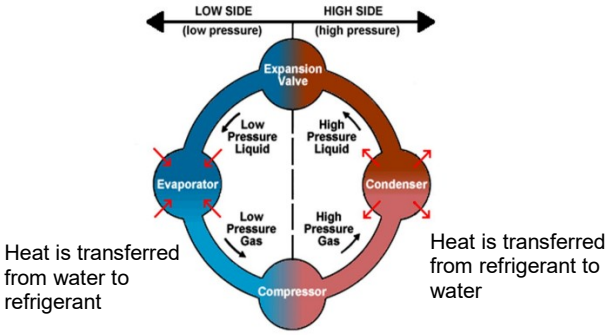


Fig.5: Simple diagram of the refrigeration cycle. This is what would be inside HP-1,2 as seen on Fig. 4 and 2. When in cooling mode, water would be receiving heat from the condenser, and when in heating mode, water would be releasing heat from the evaporator.

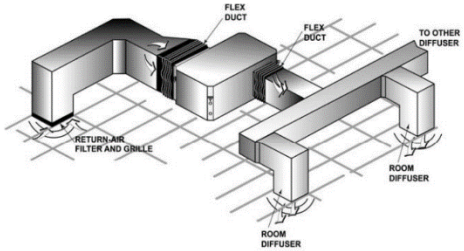


Fig.6: How an installed water source heat pump with supply & return ductwork may look.

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