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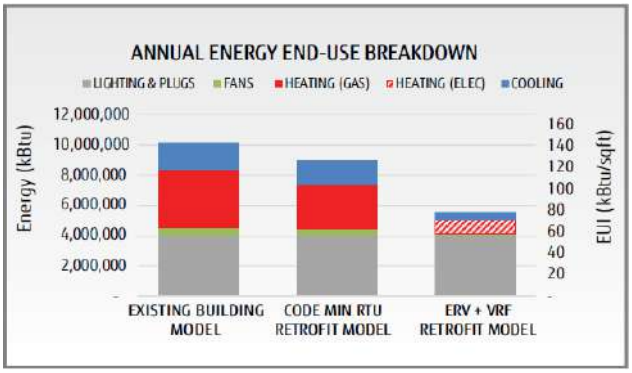
COMMERCIAL HEATSMART: CASE STUDIES

Tarrytown, NY Case Study: Property Management Headquarters

71,000 sq. ft
Installer: Blend Air Mechanical Corp
Manufacturer: Fujitsu
System: Air Source VRF heat pump combined with a high-efficiency ERV system
Project Timeline: Phase One commissioned in March 2019
Phase Two completion in late 2019



Fujitsu's air-source VRF (Variable Refrigerant Flow) heat pump system was selected to replace the building's 47-year-old natural gas-fired rooftop units that are inefficient by today's standards. The VRF system provides simultaneous heating and cooling throughout the building while the ERV (Enthalpy Recovery Ventilation) system recovers energy from exhaust air and transfers it to the incoming fresh air. By the end of Phase Two, the building will have 109 heating and cooling zones compared to 48 zones in the previous system.
The new heat pump system will provide annual electricity and natural gas savings over the original system of 224,000 kWh and 38,800 therms respectively. This leads to a $62,000 annual cost reduction. The cost to upgrade the original system to a heat pump system versus a standard code minimum system is 9.6% higher. As a result, the simple payback for upgrading from a code minimum system to heat pumps is just 3 years. Based on the results of the analysis, the project was fast-tracked by the customer.

Mamaroneck, NY Case Study: Mamaroneck Self Storage

40,000 sq. ft.
Use: 30,000 sq. ft. of storage and 250 mixed units
Installer: Daikin
System: Air source heat pump, new construction

In 2008, Chris and Sean Murphy, owners of Murphy Brothers Contracting in Mamaroneck, started the design and build of a multi-story self-storage facility that would meet the increased demand for storage space in their community. The main goal of the project was energy efficiency and sustainability in order to meet the rigorous standards of NYSERDA's New Construction Program (NCP).

Today, Mamaroneck Self Storage is a 40,000 sq. ft.self- storage facility with nearly 30,000 sq. ft. of rentable storage space and 250 mixed units throughout four-stories. The construction boasts energy-saving features that include: high-performance spray foam insulation; high-efficiency HVAC equipment with variable frequency flow heat pumps for heating/cooling and a 65% efficient energy recovery ventilation system; interior and exterior LED light on motion sensors and an 8 kW solar shingle system. According to NYSERDA, these features make Mamaroneck Self Storage 52% more energy efficient of standard baseline construction, with an annual operating cost savings of $35,000. The energy-saving measures also earned a $45,000 rebate from NYSERDA and a sales tax incentive from Westchester County.

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White Plains, NY Case Study:
White Plains High School
12,000 sq. ft. for The B-Wing
Installer: Daikin
System: Air source heat pump, retrofit

Daikin Unit Ventilator and VRV Solutions Provide Design Flexibility

At White Plains High School, the B-Wing is one of two original structures on campus constructed in the 1950s. Exterior structural beams were a common architectural design method and a way of ensuring the integrity of the building. However, this original design posed challenges when it came time to update the HVAC systems. The exterior structural beams were blocking the free-air space for the new, more efficient compressorized unit ventilator designs, which required higher condenser airflow than older models.

Daikin Applied unit ventilators, which come with factory-installed electronic expansion valves (EEVs), utilized remote Daikin VRV IV heat pump condensing units to eliminate the need for condenser airflow. The VRV condensers were placed outside on the ground level where there is ample space and airflow to reject heat in cooling mode. The unit ventilators were also able to use the existing hot water heating system during the cold New York winters.

The design included demand control ventilation, a feature which increased operating efficiency and budgetary savings for the District. EEVs in the system modulate the precise amount of refrigerant to each zone, meeting the requested set point in a more efficient manner. The demand control ventilation feature is continuously monitoring CO2 levels in the classrooms and bringing in fresh air accordingly, optimizing the volume of outside air supplied to the classroom. The single air filter in each unit removes particulate from the outside air before it is conditioned and supplied to the classrooms. The students and faculty now enjoy individual zone control, lower sound levels with the absence of ductwork and better indoor air quality.

Buffalo, NY Case Study:
Siano Building
Use: 11 apartments and retail, mixed-use
12,600 sq. ft.
Installer: Buffalo Geothermal Heating (BGH)
System: Ground Source heat pumps
Project Timeline: Completed in 2017

The Siano Building is a $2.3 million project that converted a vacant lot into a 12,600 sq. ft mixed-use building featuring retail space and 11 apartments. The building exclusively uses geothermal heat pumps for heating, cooling, as well as domestic hot water. Based on cost analysis by Buffalo Geothermal Heating, the project is a cheaper alternative to traditional natural gas heating systems. Since boilers and cooling towers are not required, the operational and maintenance costs are also significantly reduced.

Geothermal System Costs (heating, cooling, hot water)	$195,000
Conventional System Cost	$129,000
Cost Difference	-$66,000
Saved Infrastructure Costs (No gas lines)	+$12,000
10% federal tax credit	+$19,500
NYSERDA Rebates	+$38,000
Money Saved compared to conventional system	+$3,500

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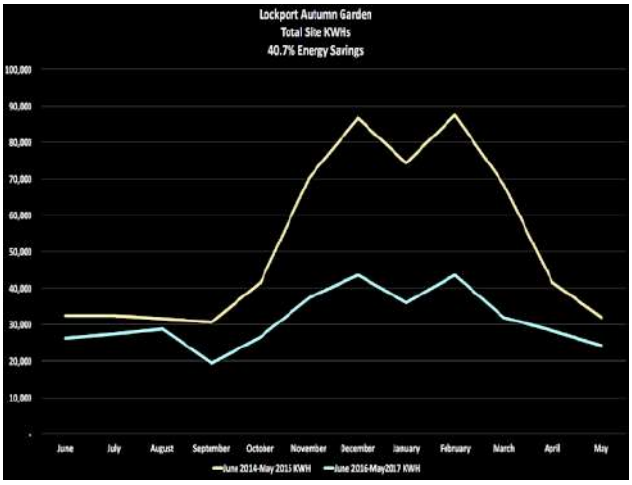
Lockport, NY Case Study: Autumn Gardens Housing Complex

Use: 9-building, low-income, housing complex
Installer: Buffalo Geothermal Heating
Manufacturer: WaterFurnace
System: Ground Source Heat Pumps
Project Timeline: Completed in 2016

The Autumn Gardens Housing Complex consists of 72 housing units, and its old electricity-powered heating system was converted to a geothermal system between September 2015 and May 2016. A total of 171 heat pumps were installed in the complex by Buffalo Geothermal Heating, and the geothermal portion of the project cost $600,000. NYSERDA provided a $68,400 grant upon project completion, plus an additional $25,200 after the system delivered 40.7% energy savings during its first year.

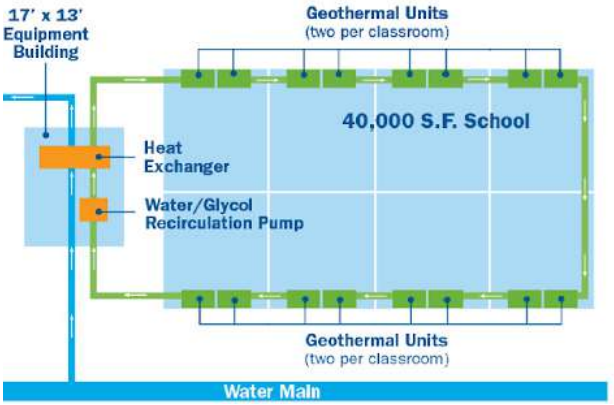
Based on Buffalo Geothermal's projections, the system will save $35,000 annually and $1.6 million over a 30-year period.



Valley Stream, NY Case Study: William L. Buck Elementary School

40,000 sq. ft,
Installer(s): American Water, Image Engineering, Bancker Construction Corp.
System: Geothermal heat pumps, uses utility's water instead of wells for heat transfer
Project Timeline: Completed in 2015

The William L. Buck Elementary School's old heating system was replaced with a geothermal heating and cooling system. The system is unique compared to traditional geothermal systems because it uses water from the utility's main distribution system to transfer heat, which eliminated the need to drill over a hundred boreholes. This alone procured $600,000 in savings compared to traditional geothermal.



The utility water is sampled with an analyzer and diverted into a diffusion well to ensure that there is no change in water quality, leading to virtually zero water waste. Thanks to the geothermal system, for the first time ever, the school can be cooled during the summer. The system saves the school district more than $40,000 per year in heating costs or 41,000 BTU/sq. ft./year. The savings to heat the building and the addition of air conditioning provided climate comfort and cost savings to the District. Two oil boilers remain in the school building as a backup for emergencies.

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Toronto, ON Case Study:
WestWood Gardens
Use: 2 buildings each 16 stories, 420 units, common parkade, and main floor retail
330,000 sq ft.
Installer: Diverso Energy
System: Geothermal, new construction

"Diverso partnered with Eolectric in Montreal in order to introduce a unique proposition that unlocks the potential of geothermal to be more widely adopted," says Maurice Wager, President of Collecdev development company. Eolectric has a background in renewables, financing expertise and access to capital.

With Eolectric's backing, Diverso developed a utility model under which they build, own, maintain and operate a building's geothermal system for 30 years, after which the condo owners can choose to buy it. This reduces capital costs, eliminates the developer's budget and technical challenges, and also helps the condo owners corporation manage their annual budget.

By law, condo owner corporations must use owner maintenance fees to pay operating costs and also carry reserves for long-term capital upgrades. This can be problematic with gas heating. Gas is traded on the global commodities market and prices can be volatile, often spiking when the economy weakens and employment becomes unstable.
Buyers liked the clean energy system, electric car chargers, biking facilities, and nearby trails. Westwood meets the Toronto Green Standard Tier Two (equivalent to LEED Gold).

(https://www.diversoenergy.com/news-media/2018/10/4/geothermal-finance-model-for-toronto-condos-helps-first-time-buyers)

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Ontario, Canada Case Study:
Lillian Park
Use: 26-story apartment rental
500,000 sq. ft
Installer: Diverso Energy
Manufacturer: Diverso Energy
System: Ground Source heat pumps
Project Timeline: Completion in late 2019

For commercial and multi-family buildings, the third-party utility model provides a low-risk heating and cooling solution for real estate developers.

Diverso Energy, an Ontario-based geothermal utility company uses such a model; it designs, builds, pays for, owns, and operates the geo-thermal system. One of their ongoing projects is the installation of a geothermal system in Lillian Park, a 26-story, 600-unit property which is scheduled to open in Fall 2019.

The project has net construction savings of $250,000 since the need for HVAC equipment such as cooling towers and boilers is eliminated. In addition, the geothermal system leads to operational cost savings of $36,000 from Year 1, based on Diverso's financial projections. Over a 30-year period, the system will result in net savings of $4.4 million.

Financial Details		
Annual Energy (Electricity & Gas) Avoided Cost	$	140,000
Annual Water Avoided Cost	$	33,000
Annual Capital Reserve Avoided Cost	$	50,000
Annual Maintenance & Repairs Avoided Cost	$	25,000
Annual Chemicals Avoided Cost	$	18,000
Total Expected Avoided Costs	$	266,000
Annual Diverso Energy Charge	$	230,000
Year 1 Net Savings to Condo Corporation	$	36,000

Operational Cost Savings for Condo Corporation

Year	Energy & Gas Avoided Costs	Water & Chemicals Avoided Costs	Maintenance & Capital Reserve Avoided Costs	Diverso Energy Charge	Annual Net Savings
1	$ 140,000	$ 51,000	$ 75,000	$ (230,000)	$ 36,000
5	$ 163,780	$ 59,663	$ 85,522	$ (253,877)	$ 55,088
10	$ 199,264	$ 72,589	$ 100,821	$ (287,238)	$ 85,436
20	$ 294,959	$ 107,449	$ 140,347	$ (367,690)	$ 175,065
30	$ 436,611	$ 159,051	$ 195,795	$ (470,674)	$ 320,783
TOTAL	$ 7,851,891	$ 2,860,332	$ 3,780,894	$ (10,097,622)	$ 4,395,496

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Vancouver, BC Case Study:
Wall Centre Central Park
Use: Mixed-use residential development
System: Sharc Energy System and Piranha T10
Project Timeline: Phase One completed in 2017
Phase Two completed in 2018

Wall Centre Central Park (Wall Centre) is a mixed-use residential development in Vancouver, British Columbia. Phase 1 contains 728 units and was opened to the public in 2017, while Phase 2 contains 332 units and was opened in 2018.

Each phase incorporates a wastewater heat recovery system from SHARC Energy Systems, sized to provide approximately 30% of the water heating load at high efficiencies. This case study aims to provide an overview of the system at Phase 2 of the project, based on data collected between Jan. 1st, 2019 and Oct. 31st, 2019 and prorated across a full year.

Wall Centre Phase 2 implements a Piranha system, commissioned in July 2018. It consists of two Piranha T10 modules operating in parallel, for 20 tons' total heat output. Each module houses a specialized heat pump, serving as a batch-reactor type wastewater heat recovery unit. Each pass of domestic water through the heat pump is designed to increase its temperature by 9°F.

The table below summarizes the performance of the Piranha system.

Parameter	Value
Total heat pump output (tons)	20
Runtime (hr/day)	21.4
Average COP	5.9
Average water temperature entering Piranha (°F)	81.7
Average water temperature leaving Piranha (°F)	93.0
Heat output (GJ/yr)	1,980
Natural gas use reduction (therm/yr)*	23,400
CO_2 reduction (tonnes CO_2e/yr)	126
Trees-planted equivalent**	5,520

* Estimate assumes an 80%-efficient natural gas boiler
** Estimate assumes the average tree can uptake 22.8 kg CO_2e/yr

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Philadelphia, PA Case Study: Kensington High School for the Creative and Performing Arts

LEED™ Platinum Project
90,000 sq. ft.

This new construction high school has a Geothermal Water Source Heat Pump, which is a high performance (EER >30.0) and low maintenance system. There is no boiler system nor any of the mechanical components that accompany older HVAC systems. There are also no outdoor components on the roof. This is a modular operation, meaning that systems run only in rooms that are occupied. Temperature and humidity control are improved implementing these "green technology."

The ventilation system is a CO2 demand-based, air-to-air heat recovery system. It recovers 70% of heating/cooling from the exhaust. The energy management system monitors room temperatures via a web-based system that is easy to view and control. Other factors that helped this construction gain LEED™ Platinum status are the energy-efficient lighting, including daylight harvesting, rainwater collection and a greywater system, and green roofs.

Maintenance costs for geothermal systems are lower than conventional systems due to no boiler, cooling tower or centrifugal chiller. All equipment is within the thermal envelope of the building.

Some amazing things have occurred since the building opened. First, the developers who came into the project with zero knowledge of sustainable design bought into what the plan said it would deliver and came out converts of sustainable design. The school faculty has embraced the building's sustainability, using it not only as a "teaching tool" for science classes but also for art, photography, broadcasting, and performance.

Lansing, MI Case Study: Michigan State University Fraternity House

Installer: Bogden Plumbing and Heating
System: Air source heat pumps as part of building renovation
Project Timeline: Completed in 2017

As part of a massive building renovation, the Sigma Alpha Epsilon fraternity house was more than doubled in size to accommodate 36 dorm rooms from 16 dorm rooms previously. Fujitsu air source heat pumps were installed to provide heating and cooling to the entire building as some parts of the building did not have air conditioning previously. A total of 61 indoor units were installed and, despite the building square footage more than doubling, the annual utility costs decreased by 50%.

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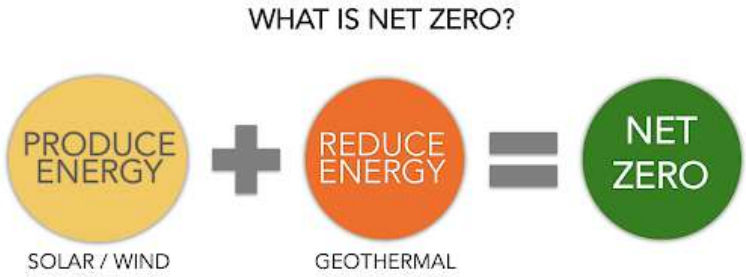
Irving, Tx Case Study:
Lady Bird Johnson Middle School
Net Zero School
Certified LEED™ Gold

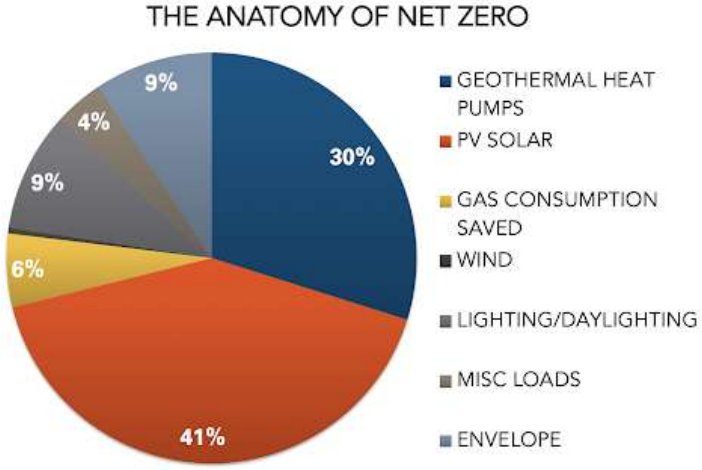
The addition to Lady Bird Johnson Middle School was a thoughtfully designed building that produces as much energy as it consumes through energy-efficient construction and renewable energy systems.

By producing and reducing more energy than this facility has reduced the utility bill to almost no cost at all. This is considered a NET ZERO facility. Systems are designed so that over the course of a year, the energy consumed will equal the energy produced; thus net zero.



The Geothermal Heat Pump alone is responsible for 30% of energy use reduction in the building. The project drilled 468 Geothermal Bores approximately 250 feet deep.

Other sustainable systems in the design and construction of this middle school include a solar array, north clerestory, solar shading, wind energy, recycling, light shelves, a water cistern, and LED lighting. Educating the students about these systems was visibly built into the design to create a learning opportunity.



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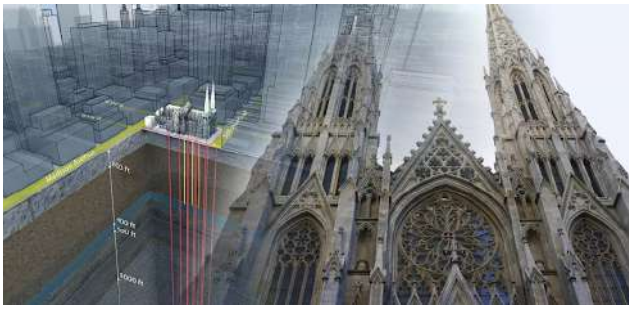
Kitchener, ON Case Study:
Garment Street
Use: Condo & Office, 26 stories, mixed-use
300,000 sq. ft.
Installer: Diverso Energy
System: Geothermal, new construction

New York City, NY Case Study:
Location: Millennium Tower
Use: 35 story, 234-unit condominium building
400,000 sq. ft
Manufacturer: Climate Master
System: 932 water-to-air heat pumps, closed-loop system
Project Timeline: Completed in 2007

Real estate developers, Millennium Partners, chose to install water source heat pumps in their 35-story condominium building. This system played a large part in the Millennium Tower obtaining LEED™ Gold Certification. The manufacturers, Climate Master, use a non-ozone-depleting refrigerant for their heat pumps, making them an environmentally friendly option. The system led to a 22% reduction in annual energy consumption, compared to a baseline condominium building.

New York City, NY Case Study:
St. Patrick's Cathedral
Installer: PW Grosser
System: Geothermal, retrofit



PW Grosser designed a state-of-the-art geothermal heating and cooling system for St. Patrick's Cathedral in New York City, the largest Gothic Catholic cathedral in the country. Engineered as part of the $177 million restoration project of this 138-year-old landmark, the system replaces a more conventional HVAC system that dated to the 1980s. The geothermal plant will reduce the building's energy consumption by more than 30 percent and reduce CO2 emissions by approximately 94,000 kilograms.
Early feasibility studies that were performed as part of the renovation determined that installing a conventional system would have posed many challenges for preserving the integrity of this historic building. Plans required substantial excavation and rock removal which would have impacted the building's architecture. The geothermal system, however, is ecologically sound, takes up just 40% of the space of a conventional HVAC system, and uses the building's existing structure.
The St. Patrick's project highlights the tremendous utility of geothermal systems for restoration projects. Aside from the long-term financial and environmental gains, the systems are able to be built out of sight, without interfering with visual aesthetics that are crucial to preservation projects. https://pwgrosser.com/blog/geothermal-system-st-patricks-cathedral/

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New Paltz, NY Case Study:
Zero Place
Use: 42 apartments, 6 commercial spaces, mixed-use 15,000 sq. ft.
Installer: Buffalo Geothermal, Matrix New World
System: Geothermal, new construction
Project timeline: Fall 2019

Rockaways, NY Case Study:
Beach Green Dunes II
Use: 127 units
Installer: ZBF Geothermal
System: Geothermal, new construction

The system was projected to have a return on investment of less than one year due to the cost savings of not installing other mechanical equipment. The operating costs are estimated to be 10% less than natural gas for heating and a one-bedroom apartment is estimated to use $15 of electricity to cool the apartment over the summer. The project was also awarded a $100,000 PSEG Long Island rebate.