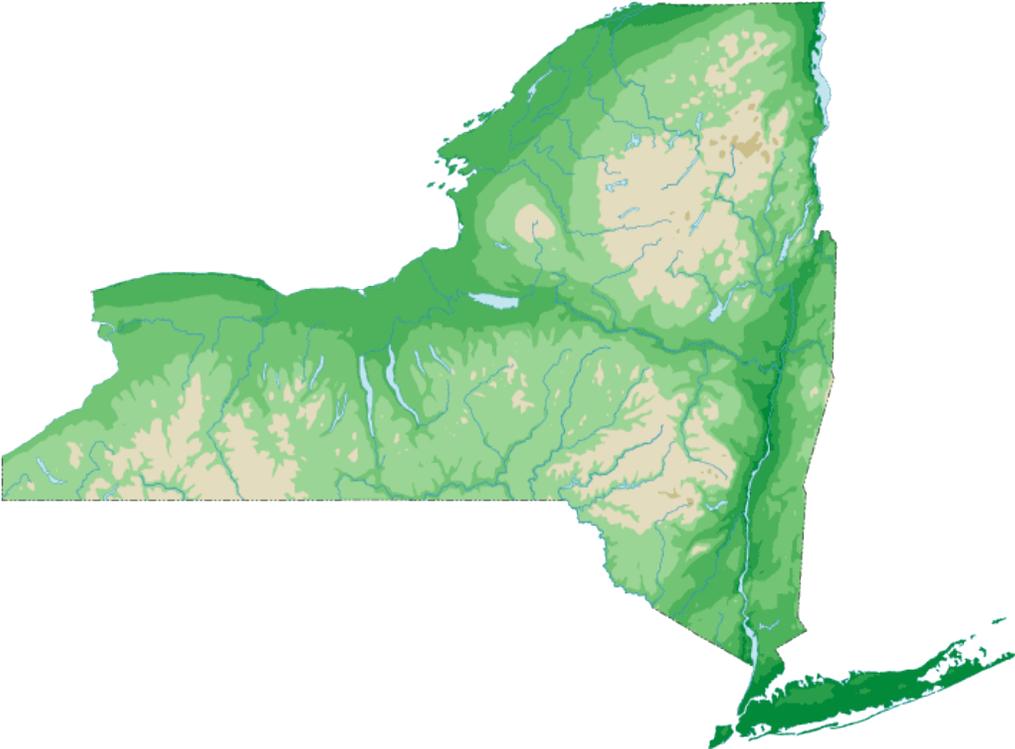


# Clean Heating and Cooling Screenings for Pre-Kindergarten to 12<sup>th</sup> Grade Schools

## Report for Discovery School District, Challenger Elementary School



<b>Region:</b>	West Finger Lakes
<b>Address:</b>	101 Education Avenue, My City, New York, Zip
<b>Building Type:</b>	P-12 / <b>Academic</b> / High School
<b>Conditioned Area:</b>	160,000 square feet
<b>Systems Evaluated:</b>	Ground source heat pump (GSHP) , air source heat pump (ASHP), and variable refrigerant flow (VRF) systems for an existing building that requires no significant interior modifications.
<b>Cooling Capacity Modeled:</b>	157 tons
<b>Heating Capacity Modeled:</b>	4.2 MMBtu/hr

## Notice

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# Summary

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Clean Heating and Cooling (CHC) technologies provide schools with an opportunity to reduce energy costs, while at the same time creating cleaner and healthier learning environments for students. This screening report provides results from the analysis of up to three CHC technologies that could be implemented at your school. The technologies evaluated include ground source heat pump (GSHP), air source heat pump (ASHP),<sup>1</sup> and variable refrigerant flow (VRF) systems.<sup>2</sup>

## S.1 Screening Summary

Table 1 presents a summary of key results, including the estimated impact of CHC technologies on first-year energy consumption (fossil fuel and electricity use) and energy cost savings. The table shows installed capital costs (a range) and avoided costs. The table also shows investment payback periods that can be expected for CHC technologies.

**Table 1. Summary of Key Modeling Results Compared to Existing HVAC**

Description	Technology		
	GSHP	ASHP	VRF
Fossil Fuel Reduction (MMBtu/year)	11,416	11,416	11,416
Electricity Increase (MWh/year)	637	1,075	863
First Year Energy and O&MSavings (\$/year)	\$172,397	\$45,217	\$80,107
Installed Capital Cost	\$1,394,162 - \$1,617,228	\$588,751 - \$682,951	\$942,001 - \$1,092,721
Avoided Capital Cost (\$)	\$462,091	\$462,091	\$462,091
Investment Payback Time (years)	4.3 - 5.3	2.6 - 4.3	5.3 - 6.7

NYSERDA incentives are not currently available for GSHP, ASHP, or VRF installations. However, check with your local utility as they may offer incentives for these technologies.

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<sup>1</sup> Screening assessment based on cold climate ASHP technology.

<sup>2</sup> The findings presented in this report are indicative and should not be used as the sole basis for investment decisions.

# 1 Environmental Impacts

Table 2 shows greenhouse gas (GHG) reductions expressed in terms of equivalent carbon dioxide emissions (CO<sub>2</sub>e) for each CHC alternative. The CO<sub>2</sub>e emissions reductions can be converted to everyday terms using the equivalency values shown in Figure 1.

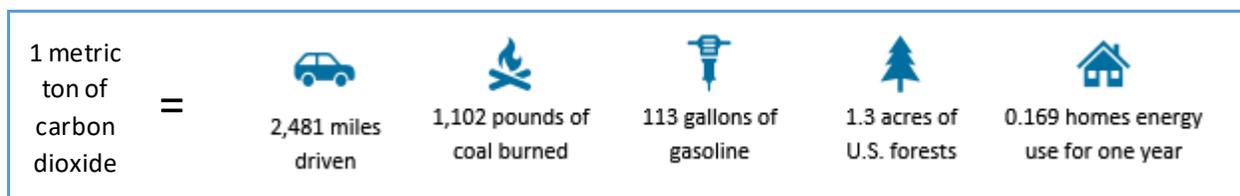
**Table 2. Reduced GHG Emissions Compared to Existing HVAC**

Description	Technology		
	GSHP	ASHP	VRF
Reduced CO <sub>2</sub> e Emissions (1 <sup>st</sup> year value, metric tons/year)	512	282	393
Reduced CO <sub>2</sub> e Emissions Over 30 Years (metric tons) <sup>a</sup>	15,368	8,457	11,794

<sup>a</sup> A 30-year period is used to compare lifetime CO<sub>2</sub>e emissions, which is consistent with the assumed asset life for in-building mechanical components for GSHP, ASHP, and/or VRF technologies. The loop field in GSHP installations has a longer life, and this longer life is considered in this report's economic analysis.

**Figure 1. CO<sub>2</sub>e Equivalency Values**

Overall CO<sub>2</sub>e reduction equivalents can be determined by multiplying the CO<sub>2</sub>e reduction by the desired metric.



While not considered in the financial calculations for this screening report, GHG emissions are often discussed in monetary terms. Estimates for the value of reduced GHG emissions from the CHC technologies are shown in Table 3. These results are calculated over the expected CHC system lifetime and shown in nominal dollars.

**Table 3. Societal Value of Reduced Carbon Emissions Compared to Existing HVAC (over 30 years)<sup>3</sup>**

GSHP	ASHP	VRF
\$444,277	\$244,499	\$340,950

<sup>3</sup> Data in this table are based on the social cost of carbon (SCC) multiplied by annual GHG changes in fossil fuel and electricity consumption from the adoption of CHC technologies calculated for this report. SCC per metric ton are from the U.S. Government's Interagency Working Group on Social Cost of Greenhouse Gases and are adjusted for electricity by forecasted prices for the Regional Greenhouse Gas Initiative. Note that the value of carbon emissions may not be monetizable by the applicant, but rather reflects the overall value to society provided by reduced carbon emissions. The value is not used as a factor in the economic analysis in this report. However, the benefits to society can be substantial, particularly when buildings consuming fossil fuels such as fuel oil, propane, or natural gas switch to CHC technologies.

## 2 Energy Consumption and Energy Costs

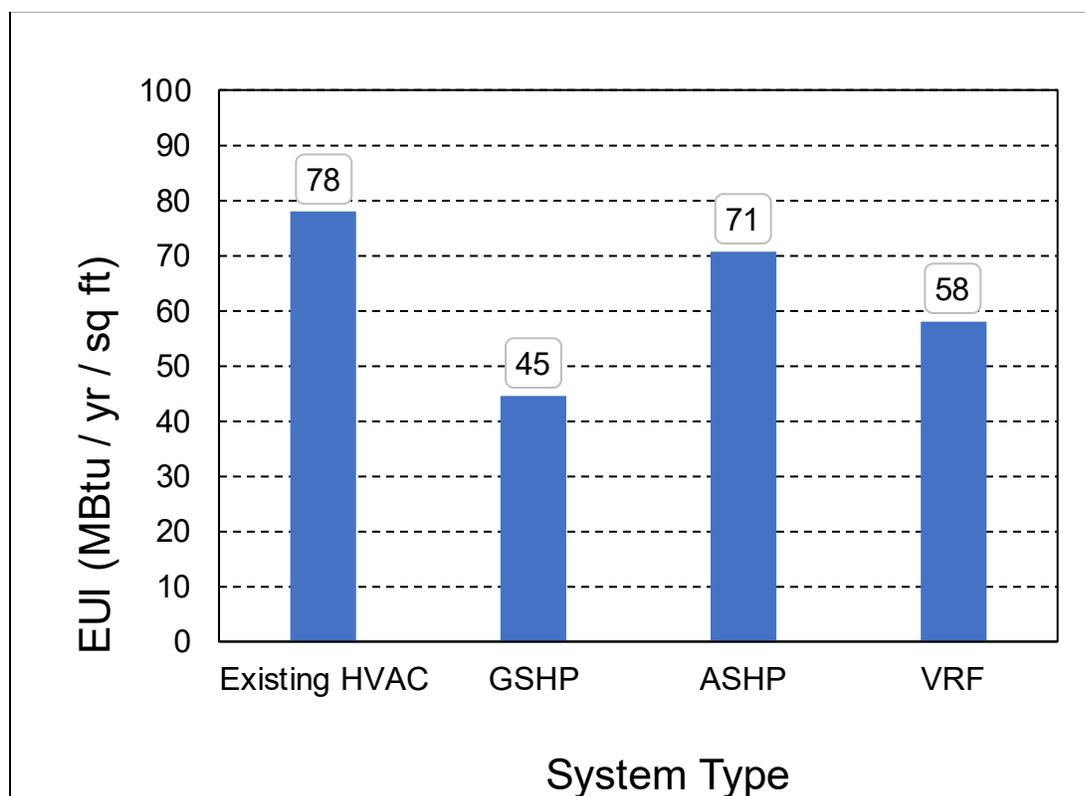
Table 4 shows first-year energy consumption impacts for the CHC technologies. Figure 2 converts these consumption impacts into an energy use intensity (EUI) metric. EUI results are displayed for the CHC alternatives along with your building as currently configured (existing HVAC).

**Table 4. Annual Energy Consumption Impacts Compared to Existing HVAC**

Energy Type	Technology		
	GSHP	ASHP <sup>a</sup>	VRF
Fuel Oil Decrease (gallons/year)	82,428	82,428	82,428
Fuel Oil Decrease (MMBtu/year)	11,416	11,416	11,416
Electricity Increase (MWh/year)	637	1,075	863

<sup>a</sup> As applicable, ASHP cost and performance assumes inclusion of backup resistance heating units, if necessary, to allow the system to maintain the desired interior building temperature during the coldest hours of the year.

**Figure 2. Source Energy Use Intensity (EUI) Comparison<sup>4</sup>**



<sup>4</sup> The EUI defined as “Existing HVAC” accounts only for the energy usage corresponding to the HVAC system. This EUI does not incorporate energy use from non-HVAC loads, such as lighting and plug loads, and is intended for comparison to the GSHP, ASHP, and VRF EUI values.

Table 5 shows how the CHC alternatives impact energy costs in project year 1.

**Table 5. Annual Energy Costs Compared to Existing HVAC**

Totals may differ slightly due to rounding.

Energy Type	Technology		
	GSHP	ASHP	VRF
Fuel Oil Decrease (\$/year)	\$222,555	\$222,555	\$222,555
Electricity Increase (\$/year)	\$105,070	\$177,338	\$142,448
<b>Total Decrease (\$/year)</b>	<b>\$117,485</b>	<b>\$45,217</b>	<b>\$80,107</b>

### 3 Operations, Maintenance, and Energy Savings

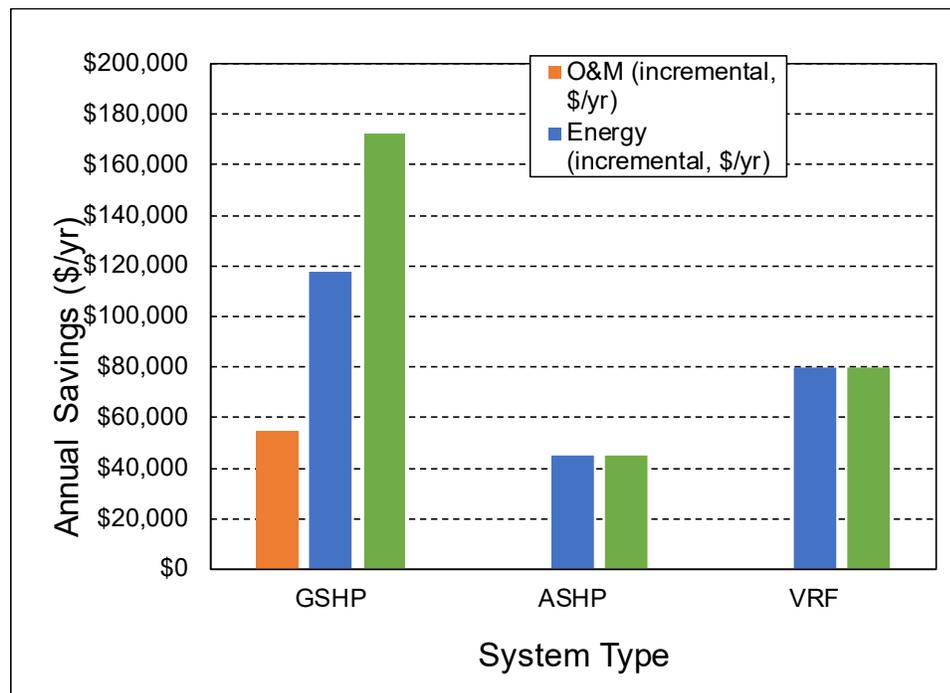
Table 6 shows estimated operations and maintenance (O&M) costs for CHC technologies. The costs are expressed as reductions relative to the incumbent HVAC system. Annual energy savings are also shown along with total annual savings (O&M plus energy).

**Table 6. Annual Reduced Operations, Maintenance and Energy Savings Compared to Existing HVAC (in project year 1)<sup>5</sup>**

Description	GSHP	ASHP	VRF
O&M Savings (\$/year)	\$54,912	\$0	\$0
Energy Savings (\$/year)	\$117,485	\$45,217	\$80,107
<b>Total Annual Savings (\$/year)</b>	<b>\$172,397</b>	<b>\$45,217</b>	<b>\$80,107</b>

Figure 3 shows energy, O&M, and total savings (energy plus O&M) for the first year of operation for GSHP, ASHP, and/or VRF systems. Savings are escalated after the first year based on assumptions for annual changes in fuel and electricity costs, annual changes in O&M costs, and changes in the efficiency of the existing HVAC system after replacement.

**Figure 3. Summary of Cost Savings Compared to Existing HVAC (in project year 1)**



<sup>5</sup> O&M cost savings in the first year of CHC technology operation are based on the difference between (1) actual annual O&M costs provided by the building's present HVAC systems, if available, or default HVAC O&M costs if actual data are not provided by the building and (2) annual O&M costs for the CHC technology as provided by credible external sources such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). The first year O&M value is escalated in real dollars by 1.5% for each remaining year of the 30-year investment.

## 4 Capital Costs

Table 7 shows high and low estimates of the installed cost of each CHC system, the avoided cost of replacing the existing system with traditional HVAC equipment, and the year that replacement is expected to occur. If the existing HVAC equipment is at the end of its useful life, the avoided cost occurs at project year 0. As noted previously, NYSERDA does not currently offer incentives for GSHP, ASHP or VRF installations; however, your local utility may have incentives applicable to all three technologies.

**Table 7. Capital Costs and Incentives**

Description	Technology		
	GSHP	ASHP	VRF
Installed Capital Cost Range (\$) <sup>a</sup>	\$1,394,162 - \$1,617,228	\$588,751 - \$682,951	\$942,001 - \$1,092,721
Avoided Capital Cost for Heating (\$) <sup>b</sup>	\$124,541	\$124,541	\$124,541
Avoided Capital Cost for Cooling (\$) <sup>b</sup>	\$337,550	\$337,550	\$337,550
Avoided Cost Investment Year for Heating	0	0	0
Avoided Cost Investment Year for Cooling	0	0	0

a Estimated capital costs reflect an expected range based on similar projects, but costs may differ based on site specific factors.

b Avoided capital costs reflect the costs, if any, of investments in traditional HVAC systems needed by the building to maintain heating and cooling for 30 years in the absence of a GSHP, ASHP, or VRF system investment. These costs are expressed in 2020 dollars.

## 5 Financial Metrics

Table 8 shows estimated payback and net present value (NPV) for the CHC technologies at your building compared to your incumbent HVAC system over a 30-year investment horizon. There is a range of results because two capital cost estimates were considered in the analysis.

**Table 8. Financial Metrics**

Description	Technology		
	GSHP	ASHP	VRF
Investment Payback (years) <sup>a</sup>	4.3 - 5.3	5.0 - 6.0	2.6 - 4.3
NPV (\$) <sup>b</sup>	\$1,574,327 - \$1,373,568	\$1,434,911 - \$1,211,845	\$675,307 - \$581,107

- a The investment payback period is calculated separately for each of the analyzed CHC technologies (GSHP, ASHP, and/or VRF). It is the number of years required to recoup the capital cost outlay, without discounting future year cash flows. The formula is: - capital cost of CHC technology + annual operating cash flows (comprised of energy cost savings + O&M cost savings) + avoided cost of traditional HVAC system. The year in which this formula turns positive is the payback period. If the payback period is greater than 50 years, it is shown as >50. If savings are negative and payback does not occur, it is shown as N/A.
- b Net present value (NPV) is calculated based on a 10% nominal discount rate and a 2.04% 30-year average annual inflation rate.

## 6 Next Steps

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In addition to this report, applicants participating in the CHC Screenings for P-12 Buildings have an opportunity to schedule a free, one-hour phone briefing for themselves and their building engineering experts to discuss the report analysis, results, and eligibility for potential follow-on support from NYSERDA. Potential follow-on support from NYSERDA includes cost-sharing for energy studies on load reduction or conversion to carbon-free fuels (e.g., CHC and similar technologies); potential cost sharing on CHC design development; and direct incentives for CHC projects.

To schedule a free follow-up briefing, please contact [P12Screenings@icf.com](mailto:P12Screenings@icf.com) within two weeks from receipt of this report. Visit <https://www.nysерda.ny.gov/All-Programs/Programs/P-12-Initiative> for more information on NYSERDA's CHC technology screenings and follow-on support, or contact NYSERDA at [P12Schools@nysерda.ny.gov](mailto:P12Schools@nysерda.ny.gov).