8440 HVAC Lifecycle and Cost

1.1 HVAC Lifecycle Cost

A. As an essential component of modern school buildings, HVAC systems play a pivotal role in ensuring indoor comfort, energy efficiency, and environmental sustainability. Understanding of the different HVAC system types available, as well as the significance of analyzing their lifecycle costs can help to make informed decisions about their selection and long-term operational viability.

B. When it comes to HVAC systems, there is a wide range of options available, each with its own set of features, benefits, and considerations. Common types include central air conditioning systems, heat pumps, rooftop units, chillers, boilers, and packaged units, to name a few. Each system type offers distinct advantages in terms of capacity, efficiency, flexibility, and environmental impact. By gaining an understanding of these various HVAC system types, stakeholders can evaluate their suitability based on specific project requirements, building size, location, and anticipated occupancy patterns.

C. An essential aspect that often goes overlooked in the decision-making process is the lifecycle cost analysis. While upfront costs are a crucial factor, considering the long-term expenses associated with owning and operating an HVAC system is equally important. Lifecycle cost analysis involves evaluating the total cost of owning, operating, and maintaining an HVAC system over its anticipated lifespan. This holistic approach takes into account factors such as initial installation costs, energy consumption, maintenance and repair expenses, system reliability, and potential replacement costs. By conducting a thorough lifecycle cost analysis, stakeholders can make informed choices that align with their budgetary constraints, sustainability goals, and desire for optimal system performance.

D. Understanding the various HVAC system types and conducting a comprehensive lifecycle cost analysis are fundamental steps in making informed decisions about heating, ventilation, and air conditioning solutions for buildings. By considering the unique characteristics and benefits of each system type, along with the long-term financial implications, stakeholders can select the most suitable HVAC system that meets their specific requirements while optimizing energy efficiency, occupant comfort, and environmental sustainability.

The table on the following page (Figure 8-1) provides a high-level comparison of features in common HVAC systems.

- The lifespan of different components of each system varies so the number in the table above is an average. The compressors in heat pumps have a median lifespan ASHRAE states is around 15 years. The ground piping loop in a geothermal system is typically 50+ years.

- All of the systems are capable of being fully electric systems, however electric resistance heat and electric boilers are not recommended. The VRV systems and Heat Pump systems are more apt to be all electric systems. However, it is likely most cost effective to still utilize natural gas for DOAS systems and supplemental heat when required in a condensing loop.

- Air distribution strategies as described in Chapter 8 such as traditional variable air volume (VAV), fan powered VAV, displacement ventilation, underfloor ventilation, dual duct VAV can be applied to systems with central air handling systems These variations in air distribution strategies can also have impacts on all of the variables that impact the lifecycle costs of the system.

- Water source VRV systems are not included in this analysis, but could be considered as viable systems for schools if their first cost decreases and their usage becomes more common that it currently is.

Figure 8-1 HVAC System Comparison and Lifecycle Costs

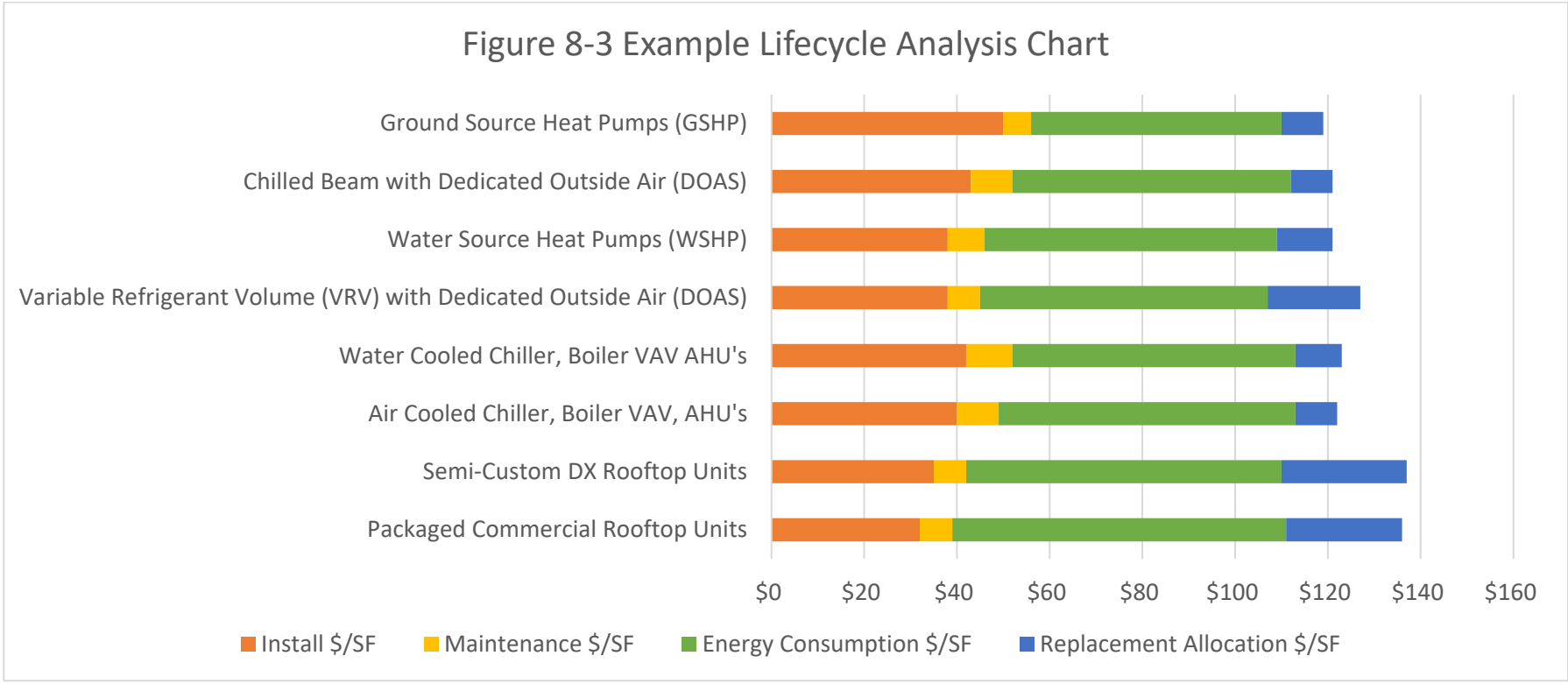
	Packaged Commercial Rooftop Units	Semi-Custom DX Rooftop Units	Air Cooled Chiller, Boiler VAV, AHU's	Water Cooled Chiller, Boiler VAV AHU's	Variable Refrigerant Volume (VRV) with Dedicated Outside Air (DOAS)	Water Source Heat Pumps (WSHP)	Chilled Beam with Dedicated Outside Air (DOAS)	Ground Source Heat Pumps (GSHP)
Approved System in OSDM	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Lifespan (years)	15	15-20	20-25	20-25	15-20	15-20	20-25	15-25
Efficiency	Low	Medium	High	High	High	Medium-High	Very High	Very High
Installed Cost	Lowest	Low	Medium-High	High	Medium-High	Medium	Very High	Very High
Maintenance Cost	Medium	Medium	Medium-High	High	Medium-High	Medium-High	Medium	Medium
Rebates Available	Unlikely	Unlikely	Possible	Possible	Often	Possible	Possible	Often

Figure 8-2 is an example of categories and associated probable costs that should be evaluated in a lifecycle cost analysis. These probable numbers are based on current information in 2023 and will vary based on utility rates, region, material availability, and escalation.

Figure 8-2 Example 30 Year Lifecycle Costs for Various HVAC Systems

Probable Costs (2023)	Packaged Commercial Rooftop Units	Semi-Custom DX Rooftop Units	Air Cooled Chiller, Boiler VAV, AHU's	Water Cooled Chiller, Boiler VAV AHU's	Variable Refrigerant Volume (VRV) with Dedicated Outside Air (DOAS)	Water Source Heat Pumps (WSHP)	Chilled Beam with Dedicated Outside Air (DOAS)	Ground Source Heat Pumps (GSHP)
Install $/SF	$32	$35	$40	$42	$38	$38	$43	$50
Maintenance $/SF	$7	$7	$9	$10	$7	$8	$9	$6
Energy Consumption $/SF	$72	$68	$64	$61	$62	$63	$60	$54
Replacement Allocation $/SF	$25	$27	$9	$10	$20	$12	$9	$9

Figure 8-3 is an example of a total lifecycle cost graph of various HVAC systems.
These probable numbers will vary based on utility rates, region, material availability, and escalation.



1.2 HVAC Maintenance Costs

A. ***HVAC systems in new Ohio schools are generally more complex than what school districts and their maintenance staff are used to maintaining. This is true for all of the approved OSDM HVAC systems that can achieve the minimum energy efficiency required by OFCC's high-performance baseline. All of the HVAC system options generally require a centralized DDC Control system which requires annual maintenance to perform in the manner it was designed. Control sensors, devices, communication that fail or loose calibration over time can cost districts significantly in operating costs.***

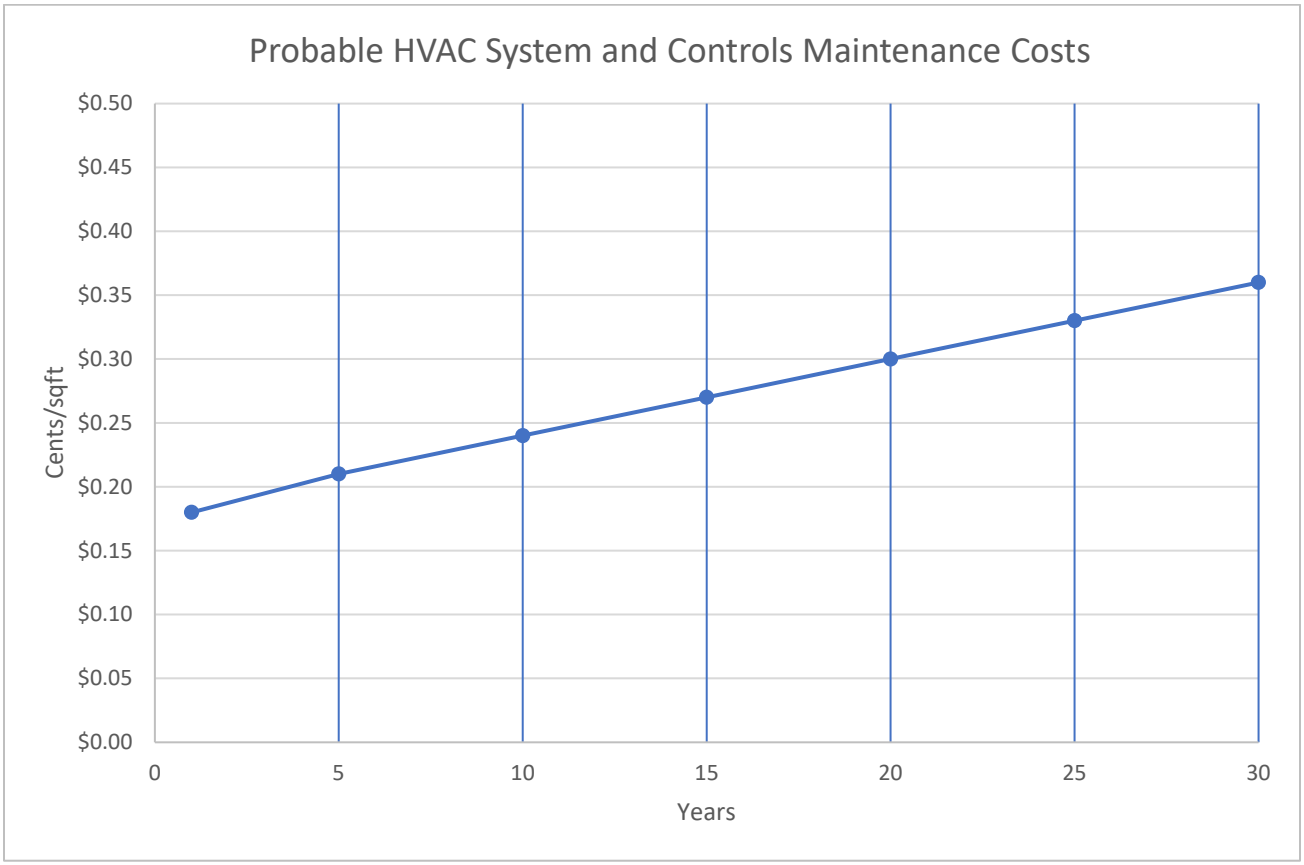
B. The most common HVAC equipment in schools whether it be chillers, condensing boilers, air handlers, energy wheels, heat pumps, VRV systems are complex pieces of equipment that require annual service and preventative maintenance that the districts own staff can likely not provide.

C. Districts should have a realistic expectations for annual HVAC system maintenance. Based on current data the costs range from $15,000 to $23,000 annually on average over a 30 year time period for a 70,000 sq ft school. The costs in the initial 5-10 years will typically be less than average and costs as the equipment ages and requires more repair and upkeep will likely be more than average. Based on the size of the school those probable costs would increase or decrease proportionally based on the building square footage which correlates closely to the quantity of equipment and control points. Based on the HVAC system type the costs will also vary.

Year	Maintenance (Cost/sqft)
1	$0.18
5	$0.21
10	$0.24
15	$0.27
20	$0.30
25	$0.33
30	$0.36

D. The below chart is an approximate representation for HVAC maintenance on average for the 2023 year for a new school. This is assuming one of the higher efficiency HVAC system types with full DDC controls, moderately complex sequences of operation, and associated sensors, devices and equipment. The chart represents the annual cost in terms of cents per sq ft of the building over time.

E. The below chart is a representation of the relationship between the probable aggregated repair, service, and corrective maintenance costs versus the age of the HVAC system. This is based on 2023 data and a High Efficiency Moderately Complex HVAC System (equivalent to $8/sqft over 30 years)



END OF SECTION