

CASE STUDY: MAINE TOWNSHIP SCHOOL DISTRICT 207

Balancing energy efficiency and IAQ for **healthy and productive learning environments**

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Overhauling aging HVAC systems and controls



Mark Koscielniak, Vice President at Everest Energy & Controls Technology (left) and Dan Reynolds, owner of Everest Energy & Controls (right) examine the operations of the TC controllers.

How do you approach overhauling education infrastructure with aging HVAC systems and controls in three expansive high schools that were built decades apart? Factor in having to make those improvements without interrupting teachers and students during the school day and after-school activities. This was exactly the challenge Dave Ulm, Director of Facilities at Maine Township School District 207, faced. Even with his experience of more than 45 years as a building engineer and manager, it was a daunting challenge.

School District 207 is committed to providing high-caliber learning environments. Ulm knew this translated into improving indoor air quality (IAQ) in three institutions with different infrastructure, systems, and controls in place, while also trying to balance energy efficiency. Even before the COVID-19 pandemic, Maine Township school administrators understood the importance of air quality in relation to productivity and learning in the classroom. Post-pandemic, it became more important to understand how air quality can be affected by other particulates such as paint fumes, mold, trace metals, and formaldehyde, which can trigger students with asthma.

Team Members:

- **School District Lead:** Dave Ulm, Director of Facilities at Maine Township School District 207
- **Design:** Bob St. Mary, Senior Engineer at Elara Energy Services, Inc.
- **Install:** Dan Reynolds, LEED AP, Owner at Everest Energy & Controls Technology, LLC and Mark Koscielniak, LEED AP, Vice President at Everest Energy & Controls Technology, LLC
- **Product and Support:** Siemens Building Products Americas

About Maine Township School District 207:

Includes three high school campuses, located in the northwest suburbs of Chicago, Illinois, USA:

- Maine East, built in 1929
- Maine West, built in 1958
- Maine South, built in 1964
- 1,429,300 total square feet
- 6,200 students in grades 9 to 12 with 860 faculty and staff

To better monitor IAQ and easily maintain uptime, Ulm wanted the same building automation system and controls across all three facilities. Most importantly, it was vital to implement system-wide communication across the entire school district.



We were trying to coordinate multiple systems that were fast becoming out of date. We still had equipment that was on time clocks. We knew that operationally we really needed to get into the 21st century to work more efficiently and start reducing our utility costs.

Dave Ulm
Director of Facilities
Maine Township School District 207

Navigating a complex four-year renovation

To coordinate such a massive overhaul and bring in optimal systems and controls, Ulm turned to teams he knew he could rely on – Siemens Smart Infrastructure, Everest Energy & Control Systems, and Elara Energy Services. These long-term relationships with highly experienced teams gave him the confidence to implement this four-year

project on time and within budget. According to Ulm, “The high schools must open each year in mid-August, and we can’t miss the opening date. I chose a team with the ability to get the work done on time.”

Getting started

Kicking off the project, Ulm said, “We initially engaged Bob St. Mary, Senior Engineer at Elara Energy Services, and his firm in 2015 to give us a better overall sense of where our building systems were as far as end of life and reliability. It became apparent that we weren’t going to be able to resolve these issues by fixing one component this summer and another component next summer. We needed to invest a significant amount of money.”

To justify the funds, Ulm had to demonstrate this project’s value. Elara Energy Services and architectural firm Wight & Company led the project’s design team. To make their plan a reality, the first step was to perform an assessment. Elara completed an intensive review of the schools’ HVAC system infrastructure and Wight created conceptual drawings representing the necessary structural changes. Proposed renovations at each school were carefully reviewed with an eye toward fiscal responsibility and were scaled back substantially.

Importance of IAQ

Good IAQ includes introducing adequate outdoor air, which can help schools meet their primary goal of educating children by providing a favorable environment for students, according to the U.S. Environmental Protection Agency (EPA).¹ In addition, improving IAQ can also decrease absence rates, which is associated with higher grade point averages and academic achievement, according to the Lawrence Berkeley National Laboratory.²

¹ U.S. Environmental Protection Agency (EPA), “Why Indoor Air Quality is Important to Schools,” December 5, 2022, <https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>.

² Indoor Air Quality Scientific Findings Resource Bank, Lawrence Berkeley National Laboratory, “Ventilation with Outdoor Air in Schools,” <https://iaqscience.lbl.gov/ventilation-outdoor-air>.



Bob St. Mary, Senior Engineer at Elara Energy Services, discusses HVAC overhaul drawings with Ian Arneson, Siemens Product Manager.

From there, a community task force of students, teachers, and taxpayers convened to learn about the project. During a district-wide outreach meeting, they recommended a \$195 million bond to be put forth to voters.

On the ballot in 2015, the tax referendum for the \$195 million bond was successfully passed by a 2:1 margin. Ulm said, "It was very encouraging, knowing that the taxpayers trusted us enough to be able to take this on. And then having a great team to support us – I felt confident that we were going to be able to successfully implement this project," he added.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommended strategies to promote a healthier indoor environment:

- Control indoor temperature and humidity levels in accordance with ASHRAE guidance to reduce the risk of spreading illness among building occupants.
- Increase outdoor air, diluting the effect of any sick occupant who may be actively shedding a virus.

Implementing the solution

The dual duct system and the air handler equipment were 50 to 60 years old, and the likelihood outside air was getting into the classrooms was slim to none. "We had carte blanche to really look at the HVAC system as a whole," said Bob St. Mary, Senior Engineer at Elara Energy Services. "However, there was just one absolute mandate: to eliminate unit ventilators." He emphasized, "The challenge with unit ventilators is that they are notorious for being plugged after about five or six years."

The master plan included standardizing system types, control equipment, rooftop units, and fan coils to simplify and reduce maintenance time.

"We came up with a solution that fit all three schools," St. Mary said. At the same time, sustainability and energy savings drove decision-making. "When replacing the old pneumatic system, which wastes energy, we needed to ensure that the school district had a system that operates well and was energy efficient with good indoor air quality," he explained.



Elara's Bob St. Mary and Everest's Mark Koscielniak and Dan Reynolds pinpoint early results from HVAC and infrastructure overhaul.

Controlling costs and efficiency

The most important decision was to standardize all equipment and systems. That's why Siemens controllers to automate the HVAC system and pressure independent control valves (PICVs) were selected to both reduce overall labor costs and increase energy efficiency. According to the design and installation team, these Siemens products reduced labor costs twice over – during installation and eliminating the need for annual maintenance later.

Siemens DXR2 controllers communicate via BACnet/IP and are easy to preload and program, while the PICVs are self-balancing. Therefore, installers and maintenance staff don't need to touch the controllers or PICVs one by one when doing their work. Furthermore, the PICVs have an integrated design that eliminates the need for a separate balancing valve for rebalancing if the system is expanded, effectively eliminating labor.

Dan Reynolds, President of Everest Energy & Controls Technology, agreed.



We have installed almost 2,500 PICVs. Using the self-balancing PICVs meant we didn't need someone to touch every valve – which provides significant labor savings up front. There's also reduced water flow required and the pump motors don't have to work as hard. It all adds up to a good decision.

Dan Reynolds
President
Everest Energy & Controls Technology

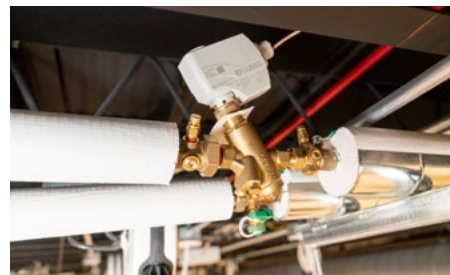
PICVs also have an automatic differential pressure regulator that automatically adjusts to pressure fluctuations in the system, maintaining consistent flow at any given control setting. The result is maximized delta-T, which significantly optimizes energy usage and cost savings by preventing an over-supply or under-supply of heating or cooling.

Siemens equipment simplified many other aspects of the project, too. Mark Koscielniak, Vice President at Everest, appreciated that he could do much of his own work readying the controllers off site instead of in the middle of construction.



Desigo DXR2 controller

Siemens DXR2 controllers and the QMX series room unit sensors also help increase staff efficiency, Koscielniak explained. "We're able to gather all of the data generated, sort it, digitize it, and react programming-wise to create the optimal classroom environments. We store all this information and make it easy for Maine Township staff to access it when needed to trend and report that the system is operating correctly as designed. If not, alarms are automatically triggered to alert staff of an issue so that they can immediately address any system errors."



PICV and electronic valve actuator

Early results

Although it's too early to have metrics on energy savings, Ulm pointed out some benefits that are already apparent with the building management system, providing transparency and intel from a single pane of glass:



I'm really happy that I can see every high school campus, as well as their systems and control equipment. That excites me and it's a great comfort. Previously, if there was an emergency, I had to go on site to troubleshoot. Now I can view all the district's school systems and data on my desktop, troubleshoot and adjust, and then marshal the resources from that point – much more efficient."

Dave Ulm
Director of Facilities
Maine Township School District 207

1. Economies of scale and rapid response:

Creating economies of scale and fast resolution to challenges by working with a single manufacturer streamlined the entire project.

- **Standardization**

- Ulm was in a recent meeting when an issue about a boiler was brought to his attention; however, the lead boiler employee was unavailable, and his assistant needed help right away. In five minutes, Koscielniak gave the lead boiler employee at another school access to the controls system through his own phone to the school in question. The employee was able to give the assistant help to solve the problem right away.
- St. Mary said that was a major goal of standardization from day one. "Any person who works at South could go work at East, could go work at West. It wouldn't matter – it's the exact same systems at each of the three schools."



New HVAC controls in place

2. Time and cost savings: Ease of installation saved time and translated directly into cost savings back to Maine Township, according to Koscielniak.

- **Controllers and Sensors**

- Siemens DXR2 and TC controllers were selected as well as the QMX series room unit sensors. "Two of the significant benefits of IP-based controllers are their reduced upload time and ability to be programmed more efficiently," Koscielniak said. "This project had 1,200 controllers – if we had to program and load each device one by one, it would take a long time and add significant costs."
- An open system, which was non-proprietary, was also specified. "Using Siemens DXR2 and TC controllers, we were able to control and view all data points to both address efficiency in addition to better IAQ," added Koscielniak.



Room unit sensor



(Time and cost savings, continued)

- **PICVs**

- Everest selected Siemens PICVs for the hydronic system. Koscielniak stated, “Once you verify the pressure is there, you know it’s providing the optimal amount with no need to rebalance the system either during installation or in subsequent years, which equals significant time and labor savings.”
- In addition, Reynolds said, “PICVs eliminate the need for a separate circuit setter, which equates to material, installation, and water balancing savings.” To date, calculations proved out a 15% to 20% upfront cost savings over installation of conventional control valves. Overall, the project’s first-cost savings were estimated at \$75,000.



TC controller

- **Complete air changes**

- At Elara’s recommendation, Ulm decided to move to a system with 100% outside air (OA) based on proven improvements in student learning abilities. And the schools are doing OA in record time thanks to the new systems. “At the time Elara Energy Services proposed moving to a 100% OA system, we averaged a complete air change at 40 minutes,” Ulm explained. “After the new systems, we are averaging 19 minutes.”



Two of the significant benefits of IP-based controllers are their reduced upload time and ability to be programmed more efficiently. This project had 1,200 controllers – if we had to program and load each device one by one, it would take a long time and add significant costs.

Mark Koscielniak, LEED AP
Vice President
Everest Energy & Controls Technology



3. Energy savings: Early results are already showing positive trends:

- **PICVs**
 - Siemens valves generate about “30% energy reduction savings on the pumps,” according to Reynolds. PICVs immediately respond to differential pressure (dP) changes signaled by dP sensors so they can prevent overflow or underflow. This eliminates wasted pumping energy: PICVs dynamically balance the system so that flow rates are maintained for proper heat transfer, providing better comfort without wasted pump energy from system changes.
- **Demand-controlled ventilation**
 - “By monitoring CO₂ levels, you can tell if a space is unoccupied and then reduce ventilation in the space,” Koscielniak said, “which decreases energy usage; then you don't need that much fan-power. This creates more of a dynamic environment, but I can say there's energy efficiency by reducing ventilation in unoccupied spaces,” he added.

Maine Township School District 207 achievements

- “Best in Class for Energy Efficiency plus Health” – 2023 U.S. Department of Energy’s Efficient and Healthy Schools Recipient
- “Most Innovative School Districts” – 2018 American Association of School Administrators

From first costs to long-term operating costs

Funding was one issue the team tackled. Typically, school districts practice funding on first costs, such as the price of all the equipment needed for a wing renovation, according to Reynolds. “Since schools are built to last 50 years, you probably should be looking at what it's going to take to operate that facility over 50 years instead of how much is it going to cost me upfront,” Reynolds said. A better practice is to keep upfront costs in mind while also considering long-term operating costs, he explained. That can affect purchasing decisions, moving them from a focus on buying the least expensive items to choosing equipment that can be maintained efficiently today and in the future.

Creating a lasting impact

The team also looked at the long-term impact of their work together for District 207. In reflecting on the magnitude of the overall infrastructure improvements, St. Mary emphasized, “It’s paramount for any school district that has multiple buildings to leverage a building control system to be able to reduce energy costs through transparency in a single pane view, as well as optimize energy savings. And I strongly believe that’s been accomplished here.”

Maine Township overhauls HVAC system district-wide

Striking the perfect balance between energy efficiency and indoor air quality for healthier schools



Higher academic achievement

Good IAQ decreases absences, supporting higher grade point averages (Lawrence Berkeley National Laboratory)



30%

Potential energy reduction from a more efficient hydronic system



\$75,000

Savings in first costs using pressure independent control valves (PICVs)



50%

Faster fresh air delivery

HVAC upgrades made across Maine Township's three high schools

2,500 PICVs

1,300 DXR2 controllers

800 room unit sensors

500 damper actuators

100 variable frequency drives

50 TC controllers

10 PXC controllers



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