Net Zero Energy Pathway Plan

[SCHOOL NAME]

[DATE]

midwest renewable energy association

MIDWEST RENEWABLE ENERGY ASSOCIATION

The Midwest Renewable Energy Association (MREA) is a 501(c)(3) non-profit organization incorporated in Wisconsin in 1990 with a mission to promote renewable energy, energy efficiency, and sustainable living through education and demonstration in the Midwest region. Together with partners around the Midwest, the MREA works to expand renewable energy adoption through innovative programs, renewable energy training, and educational events.

This work was made possible through grant funding from the Wisconsin Public Service Commission (PSC) and Wisconsin Office of Energy Innovation (OEI) through the Energy Innovation Grant Program (EIGP). For more information on this project, contact info@midwestrenew.org.

EXECUTIVE SUMMARY

Welcome to the net zero energy pathway plan for *[INSERT SCHOOL].* The Midwest Renewable Energy Association, in partnership with GDS Associates, Inc., created this plan to pave the way towards Net Zero Energy use at these target schools.

[INSERT BACKGROUND INFORMATION ABOUT THE SCHOOL].

This plan provides the school/district with current energy performance benchmarks and ideas to achieve net zero energy consumption. The schools' current Energy Star Portfolio Manager Scores, which rank each school on a 0-100 scale of energy efficiency performance, illustrate the districts' effort in practicing energy efficient operations.

[INSERT ENERGY STAR PORTFOLIO MANAGER SCORE(S)]

Implementation of actions in this plan will continue to increase the schools' energy performance. This plan includes energy efficiency recommendations and resources to reduce your school's energy use, ideas to replace on-site fossil fuel consumption with electricity, and recommendations to achieve 100% renewable energy consumption. The top ranked opportunities include:

- *[INSERT TOP RANKED OPPORTUNITIES]*

Your schools' current energy use, utility rates, and current energy-using equipment are inventoried in this plan to aid in net zero pathway planning. Organizations and energy expert resources are provided to help progress your school's path to Net Zero Energy. Use pieces of the written narratives in this document to communicate about net zero energy projects, develop financing assistance through grants and referendums, as well as language to assist in the development of requests for bids/proposals (RFB's/RFP's) for installing energy-saving improvements at your school.

Put this plan to use! Share the ideas in this plan with school staff, students, and community leaders who are passionate about helping your schools to be more energy efficient. Involve the community, students, and teachers to strategize and solidify your school's net zero pathway plan. Engage with the Wisconsin-based, free consultation offered through Focus on Energy, your utility, the MREA's Solar on Schools program, the Wisconsin K12 Energy Education Program (KEEP), the CREATE Center, WPS SolarWise, and the other resources listed throughout this plan.

1. WHAT IS A NET ZERO ENERGY SCHOOL?

A Net Zero Energy School…

- Produces as much energy as it consumes over the course of a year. In other words, the total amount of energy used by the school building (for heating, cooling, lighting, computers, etc.) is balanced by the amount of energy it generates, typically through renewable sources such as solar panels and geothermal systems.

- Is highly energy efficient, with optimized insulation, windows, HVAC systems, lighting, appliances, and plug-in electronics to minimize energy consumption and power demand.

- Is most often all- or nearly all-electric in operation or utilizes renewable natural gas for equipment that cannot be electrified. Electrification strategies displace any fossil fuels used such as natural gas for kitchen appliances and space and water heating. Electricity consumed is from local renewable electricity production.

- Generates its own energy on-site, usually through renewable sources like solar photovoltaic (PV) panels, wind, or geothermal systems. This energy production offsets the school building's energy consumption.

The term “net” in Net Zero Energy means that, over the course of a year, the building produces enough energy to cover its total energy needs. While the energy demand may fluctuate daily (higher during winter heating or summer cooling), the idea is that the school building's energy consumption and generation will balance out over the year.

Net Zero Energy school buildings may still be connected to the electrical grid to draw power when renewable energy production is low (such as at night) or to export renewable energy production back into the grid when the building is producing more energy than it needs. However, the goal is for the building to be net-zero on an annual basis, meaning it doesn’t consume more energy than it generates over the year.

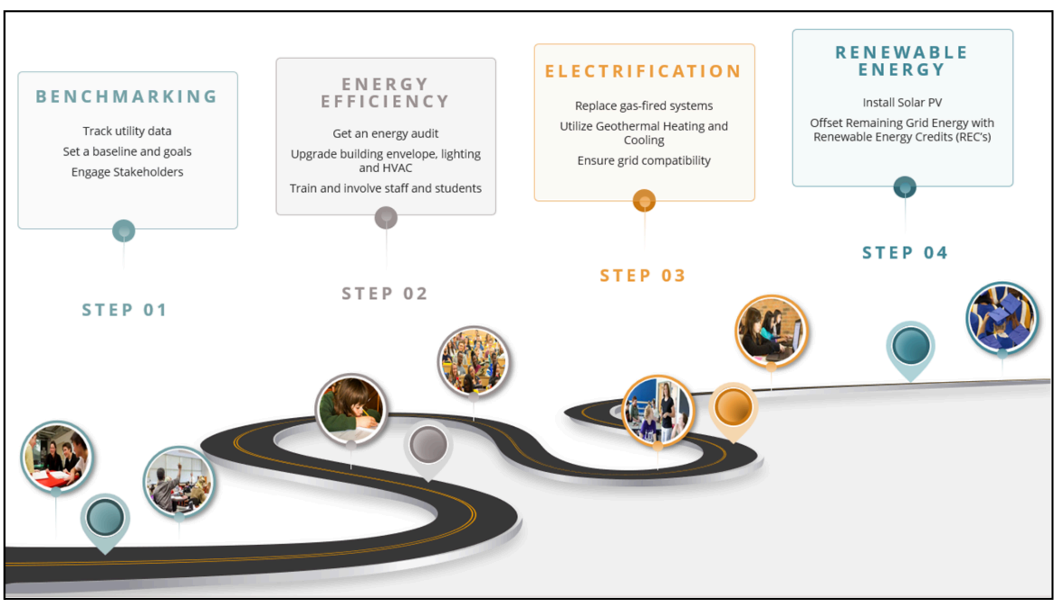
The benefits of a Net Zero Energy school building include:

- Lower operating costs due to on-site renewable energy generation and energy-efficient systems. While there are significant upfront costs in electrification and renewable energy systems, long-term savings on energy bills often outweigh investment in Net Zero Energy school building systems.
- Predictable energy expenses because of on-site renewable energy generation. Net Zero Energy schools are less prone to the impact of rising energy costs.
- A lower carbon footprint from the offset of fossil fuel consumption.
- Improved air quality from no or low levels of on-site fossil fuel combustion.
- Hands on learning through real-world lessons on renewable energy and energy efficiency.
- Community leadership and engagement. Net Zero Energy schools may help to educate the community about electrification, renewable energy, and decarbonization.

Looking for some inspiration? Wisconsin is home to several net-zero energy schools that generate as much energy as they consume. Forest Edge Elementary School in Fitchburg, part of the Oregon School District, is the state's first net-zero energy school, utilizing 1,700 solar panels and 90 geothermal wells to meet its energy needs since its opening in 2020. Maplewood Middle School in Menasha, currently under construction, is designed to achieve net-zero energy status through a combination of solar power and a microgrid system, aiming to serve approximately 1,000 students upon completion. Higher education buildings can also serve as examples of Net Zero Energy school buildings. Madison College's Fort Atkinson campus has achieved net-zero electrical status with a 150-kilowatt solar photovoltaic system that generates as much electricity as the campus consumes. Similarly, Northeast Wisconsin Technical College's Great Lakes Energy Education Center in Green Bay is designed to be net-zero energy capable, featuring geothermal systems and has a variety of student-installed solar arrays totaling over 260 kW of in capacity.

OVERVIEW OF THE PLAN

The pathway to a Net Zero Energy school involves these four steps: Benchmarking, Energy Efficiency, Electrification, and Renewable Energy. All along the pathway are students, teachers, staff and community involvement. This Net Zero Energy plan provides a summary of your school building's current energy consumption and current building envelope, lighting, HVAC, and electrical capacity features. This plan provides recommendations for making the school building more energy efficient and provides further resources for each energy efficiency topic. The plan also provides steps to electrify building systems and replace energy use with on-site renewable energy. While the plan concentrates on the school building, it also makes some recommendations to address school bus use. Financial incentives as well as community and school engagement strategies in the Net Zero Energy pathway process are also discussed.



BENCHMARKING

Goal: Understand current energy use and identify areas of improvement.

Actions:

- Collect Utility Data: Gather 12–24 months of electric, gas, and water bills. This plan includes at least 12 months of electricity and gas usage for your school.
- Benchmark and Track School Building Energy Use: Use ENERGY STAR Portfolio Manager to see the impacts of energy-saving project implementation and overall building performance. An initial benchmark using this tool was set for your school.
- Set a Baseline: Establish a baseline for total energy use intensity (EUI), typically measured in kBtu/square foot/year. The 2018 national average EUI for education buildings including K12 buildings and adult education facilities is 62.7 kBtu/square foot/year according to the Energy Information Administration's 2018 Commercial Building Energy Use Survey (CBECS).
- Identify Peers & Set Goals: Compare the school's performance to similar facilities. Set achievable short- and long-term energy reduction goals.
- Engage Stakeholders: Share results with district leadership, staff, and the community.

ENERGY EFFICIENCY

Goal: Reduce energy demand through building improvements and behavior changes.

Actions:

- Take action to reduce energy inefficiencies. This report provides some general energy efficiency recommendations for lighting, HVAC, insulation, and plug loads. The plan also recommends the school have an energy audit to further identify energy-saving projects.
- Improve Building Envelope: Enhance insulation, seal leaks, and upgrade windows and doors for better thermal performance.
- Upgrade Lighting: Replace fluorescent and incandescent lighting with LED fixtures and install daylighting and occupancy sensors. Replace LED's that are over ten years old in high use areas.
- Optimize HVAC: Implement smart controls that run ventilation, heating and cooling only as needed and utilize heating and cooling systems with high energy efficiency ratings. Transition the school's fossil fuel heating systems to electric heating for use with on-site renewable electricity production. Consider renewable natural gas (RNG) for gas systems that are not feasible to electrify.
- Train & Involve Staff and Students: Consider energy-reporting dashboards that promote energy-saving habits like turning off computers and unplugging appliances. Resources to evaluate, monitor and display energy use and solar production at Wisconsin schools are available through the Focus on Energy Renew Our Schools program, UW-Stevens Point's K-12 Energy Education Program (KEEP), the CREATE Energy Center, and WPS SolarWise.

ELECTRIFICATION

Goal: Transition from fossil fuels to electric-powered systems to enable clean energy use.

Actions:

- Ensure Grid Compatibility: Work with local utility to ensure infrastructure supports added electric load.
- Replace Gas-Fired Systems: Transition boilers, furnaces, and water heaters to electric heat pumps where possible.
- Electric Cooking: In cafeteria/kitchen areas, replace gas stoves with induction or electric equipment where possible.
- Electric School Buses: This plan explains actions to take with electrification of school buildings with some discussion on electrifying school bus transportation.

RENEWABLE ENERGY

Goal: Generate clean energy on-site or procure off-site to meet or exceed remaining energy needs.

Actions:

- Install Solar PV: Install rooftop or ground-mounted solar panels. Consider canopies over parking lots for dual-use.
- Battery Storage: Add battery systems to store solar energy and support demand management.
- Offset with RECs: For any remaining electricity, purchase Renewable Energy Certificates (RECs) to reach net zero. This may include sourcing renewable natural gas (RNG) in place of fossil fuel natural gas.

ONGOING MONITORING AND ENGAGEMENT

- Continuously monitor energy performance via dashboards.
- Celebrate milestones and educate students and staff about energy literacy.
- Reassess goals annually and refine strategies to maintain Net Zero Energy performance.

2. CURRENT BENCHMARK & ENERGY USE SUMMARY

ENERGY STAR PORTFOLIO MANAGER

Tracking energy usage is a key step in saving energy. Tracking energy use with numbers and graph visualization helps schools understand where and how energy is being consumed. Data can be used to identify anomalies in energy use and reduce energy waste. Tracking energy also allows schools to set energy-saving goals and monitor progress towards those goals. Seeing how energy efficiency and renewable energy installations make a difference in numbers provides motivation to continue energy reduction efforts.

Figure. Past and Present ENERGY STAR Portfolio Manager Scores:

ENERGY STAR® PortfolioManager®

[INSERT SCORES]

Thanks to your school providing at least twelve months of electricity and gas utility bills, energy use was benchmarked using the ENERGY STAR PORTFOLIO MANAGER free online platform. The ENERGY STAR PORTFOLIO MANAGER score is a 1-100 scale that benchmarks a building's energy performance relative to similar buildings nationwide, with a score of 50 representing average performance and 75 or higher indicating a top-performing building.

[INSERT NOTE ON SCHOOL SCORE]

The ENERGY STAR PORTFOLIO MANAGER platform provides both the source and the site Energy Use Intensity (EUI) number, with the site being the actual thousand Btu of energy per square foot (kBtu/ft^2) and the source EUI including the energy losses of transporting electric and natural gas energy to the site.

Figure. Past and Present EUI

[INSERT EUI GRAPH]

If your school installs solar renewable energy systems, it is important to track the amount of renewable energy generated. Much of a school's renewable energy will be consumed directly and not show up on utility bills. Therefore, it is important to have a renewable energy system that creates energy production reports. The Value of Tracking Solar Production section, found later in this report, provides illustrative examples of tracking solar production for a building. In addition, ENERGY STAR PORTFOLIO MANAGER provides instructions on how to track renewable energy in Portfolio Manager at https://www.energystar.gov/buildings/tools-and-resources/how-benchmark-onsite-renewable-energy-portfolio-manager.

ENERGY STAR PORTFOLIO MANAGER does not have a scoring system for net zero energy buildings. The tool can be used to track EUI, which is a measure of a school's progress towards net zero energy. A net zero energy school will have an EUI of zero or a negative EUI, indicating the production of renewable energy exceeds the school's energy consumption.

UTILITY RATES AND ENERGY COSTS

The school uses electricity and natural gas energy supplied by the utility. *[INSERT SOLAR GENERATION INFORMATION IF APPLICABLE]. [INSERT WHETHER SCHOOL USES MORE ELECTRICITY OR NATURAL GAS]*. A breakdown of the buildings' energy resource consumption is provided in the pie chart.

Figure. Energy Resource Breakdown

[INSERT GRAPH]

Electricity is provided by *[INSERT UTILITY COMPANY]* to the school. A state executive order has been established for all Wisconsin utilities to provide 100% carbon-free electricity by 2050. At this time WPS's electricity has a carbon emissions rate of 1,142 lbs CO2e per megawatt-hour (MWh). The utility generates electricity from coal, natural gas, and a mix of renewables including 8.1% of its electricity from hydroelectric dams, 0.5% from biofuels, 4.4% from wind and 3.6% from solar. A pie chart illustrates the electricity utility energy mix for *[INSERT UTILITY COMPANY]* electricity.

Figure. [INSERT UTILITY COMPANY] Electricity Resource Mix

[INSERT PIE CHART]

Each of the schools are billed through *[INSERT UTILITY COMPANY AND BILLING RATE STRUCTURE]*. Each of the utility rates are broken down below.

It is important to understand the school's utility rate to gauge the cost impacts of energy efficiency and renewable energy projects. Your utility representative is an excellent resource for answering questions and helping to anticipate the operating cost of building improvements. The school's electricity rate includes kilowatt (kW) demand charges, which is a cost based on the peak power consumption during the billing period. Demand charges are often a sizable portion of annual utility costs, as one month of high demand can impact the next year of utility costs.

Figure. [INSERT UTILITY COMPANY ELECTRICITY RATE STRUCTURE]

[INSERT CHART]

Figure. [INSERT UTILITY COMPANY NATURAL GAS RATE STRUCTURE]

[INSERT CHART]

Figure. UTILITY COSTS FOR THE SCHOOL(S)

	Annual Electricity Consumption	Annual Electricity Cost	Annual Natural Gas Consumption	Annual Natural Gas Cost	Average Cost per kWh*	Average Cost per Therm*
[SCHOOL / BUILDING NAME]						

*Total bill charge minus annual customer electric charges divided by annual kWh or therms.

ENERGY BENCHMARKING RESOURCES

There is a saying, "**you can't manage what you don't measure**." Continue to track your ENERGY STAR PORTFOLIO MANAGER score and Energy Utilization Intensity (EUI). The school district has ENERGY STAR PORTFOLIO MANAGER accounts for all of its schools and should consider annual utility data uploads to PORTFOLIO MANAGER for continued energy tracking.

WORK WITH FOCUS ON ENERGY

At the time this plan was written, Focus on Energy had an offer called *Utility Bill Energy Savings* to support continued energy tracking and incentivize non-capital investment-related energy reductions. This program recently saved Wauwatosa School District 100,667 kWh and 11,701 therms in annual energy consumption, and the school received a $9,439 Focus on Energy incentive for their efforts. Contact your school's energy advisor, *[INSERT SCHOOL ENERGY ADVISOR & CONTACT INFORMATION]* to learn how continued energy tracking may lead to energy savings and potential financial incentives!

ENERGY BENCHMARKING RESOURCES

- Energy Star Portfolio Manager, https://www.energystar.gov/buildings/benchmark
- Focus on Energy Advisor, https://focusonenergy.com/energy-advisor-map?program=schoolGovernmentCustomers
- Focus on Energy Utility Bill Energy Savings Program, https://focusonenergy.com/business/special-offerings;
    a. Wauwatosa School District Case Study https://assets.focusonenergy.com/production/inline-files/2025/Focus-on-Energy_Wauwatosa-SD-Success-Study_2025.pdf
- Wisconsin Public Service EPA Greenhouse Gas Reporting and Emission Rates, https://www.wisconsinpublicservice.com/company/epa-greenhouse

3. ENERGY EFFICIENCY STRATEGIES

The following provides a high-level overview of the existing conditions of your school's building as well as energy-saving and electrification actions recommended for a pathway to net zero energy. It is highly recommended that your school utilize the free resources offered through the Wisconsin Focus on Energy program and your local utility representative for determining what energy-saving steps make sense for your school. Share this plan with Focus on Energy and your local utility representative and use it as a springboard to take energy-saving action!

GET AN ENERGY AUDIT

Focus on Energy and your local utility representative can provide a wealth of resources about how to save energy in the school buildings. Deeper energy savings analysis can also be achieved by having an energy audit. An energy audit of the school building will be worth the time and money to help prioritize major investment decisions. Consider at least an ASHRAE level 2 energy audit that provides an on-site inspection of HVAC, lighting, building envelope, and other school systems. The Level 2 audit will provide energy savings analysis calculations and prioritize energy-saving measures with a financial analysis such as simple payback. For detailed, capital-intensive planning, it is recommended that the school have an ASHRAE Level 3 audit performed. A level 3 energy audit builds upon a Level 2 audit with an engineering analysis of the school's energy-using systems. A level 3 audit also includes data logging and monitoring, which may or may not include a blower-door test for assessing a building's leakiness, energy modeling, and financial analysis such as life cycle cost and return on investment metrics. Qualified energy auditors may have one or more of the following certifications: P.E., CEM® , BECxP, BPI® BA MF, LEED® AP.

Focus on Energy and your utility can help you find a qualified energy audit provider. At the time this plan was written, Focus on Energy was offering a program for a no-cost 123 Energy Audit, https://focusonenergy.com/business/special-offerings. Energy auditors can be hired for a fee to provide independent energy analysis, not tied to the sale of a specific product. Alternatively, Energy Service Companies (ESCO's) also provide energy audits without upfront costs. Instead of paying upfront costs for an energy audit and energy-saving upgrades, ESCO's enter an Energy Performance Contract with schools/entities. The energy performance contract guarantees energy savings that will pay for the energy audit and energy-saving investments over time, usually 10 to 20 years. On top of the energy audit, ESCO's can provide installations of energy-saving lighting, HVAC, building automation systems, insulation, and air sealing, as well as solar photovoltaic (PV) systems. There are risks to schools when entering an energy performance contract: The school must rely on the ESCO's anticipated energy savings and potential challenges if guaranteed savings are not achieved and the ESCO does not cover the shortfall. A third-party independent evaluation of ESCO guaranteed savings is a good way to mitigate the risks involved in an ESCO contract.

OPTIMIZE YOUR SCHOOL'S BUILDING ENVELOPES

Your schools' building envelopes are their enclosure: the roof, walls, windows, and doors that keep warm air inside during the winter and heat out of the building during summer months. The roof structure is also important for supporting renewable energy systems like solar photovoltaic (PV) arrays. The following discusses your school building's current building envelope and makes recommendations for saving energy through building envelope upgrades.

YOUR SCHOOL'S CURRENT BUILDING ENVELOPES

[INSERT DETAILS OF SCHOOL BUILDING MATERIALS, CONSTRUCTION, AND UPGRADES]. The exact condition of each school's building envelope was not observed for this report, but the district provides continuous maintenance of its school buildings. The following table lists the year of construction and upgrades for each school.

Figure. Year Built and Renovated for each School Building

	Year Built	Year(s) Renovated
[SCHOOL / BUILDING NAME]		

If the school does not already own an infrared camera, it is recommended to have one on hand to visually observe opportunities for air sealing. Infrared cameras are available for less than $200, and when temperature differentials are greater than 18 degrees Fahrenheit between the indoors and outdoors, air infiltration is usually visible with an infrared camera.

[INSERT INFORMATION ON THE TYPES OF WINDOWS USED, U-VALUES, AND IF IT'S WITHIN ENERGY STAR'S RECOMMENDED PERFORMANCE]

GET A BLOWER DOOR TEST WITH INFRARED IMAGING

A blower door is a diagnostic tool used to measure how airtight the building is. During the test, a series of powerful fans are temporarily mounted in an exterior doorway to pull air out of the building, creating a pressure difference between the inside and outside. (Home energy auditors can do this with one fan, but blower door tests on larger buildings like schools requires a number of fans operated by a technician experienced in assessing air leakage of large buildings). When the building is depressurized, infrared imaging is used to highlight areas of the building with the most leaks. Technicians typically identify air leaks around windows, doors, walls, and other openings. A professional building envelope inspection will also help to prioritize building insulation and upgrade improvements. Is it more cost-effective for your school to have roof insulation or new windows and doors installed? Consult with a professional energy auditor and/or building envelope technician to help prioritize projects. A well-insulated, well-sealed school enhances indoor comfort and lowers heating and cooling costs.

INSTALL HIGH-PERFORMANCE INSULATION AND AIR SEALING

Building leaks can be found with a blower door test and infrared imaging or simply be noticed by visual inspection and building occupant complaints. Pinpoint building leaks and improve air sealing with caulk and insulation, to reduce energy loss. When it comes to repairing building leaks and adding insulation, it is recommended to work with a qualified commercial building insulation provider to ensure that insulation upgrades are done safely, effectively, and in compliance with building codes.

ENERGY-EFFICIENT WINDOWS AND DOORS

High-performance windows and doors are designed to reduce heat loss in the winter and minimize heat gain in the summer, leading to more stable indoor temperatures and reduced strain on HVAC systems. Features like double or triple glazing, low-emissivity (Low-E) coatings, and insulated frames help improve thermal performance and block UV rays, protecting classrooms and equipment. Promote the closure of window shades as a no-cost way to reduce solar heat gain on warm sunny days.

COOL OR GREEN ROOFING

Cool and green roofs may provide schools environmental and financial benefits. Cool roofs, made with reflective materials, reduce heat absorption and lower indoor temperatures, cutting cooling costs and improving comfort during hot months. Cool roofing can also enhance the performance of bifacial solar photovoltaic (PV) panels. Green roofs, which are covered with vegetation, provide natural insulation, absorb rainwater, reduce stormwater runoff, and help mitigate the urban heat island effect. Both types can extend roof lifespan, reduce HVAC strain, and support sustainability education by turning the roof into a living lab for students.

BUILDING ENVELOPE OPTIMIZATION RESOURCES

- Focus on Energy – Trade Ally Search. Search for Business – Insulation to find Focus on Energy Insulation Trade Allies. https://focusonenergy.com/trade-allies
- Focus on Energy – Specialty Program: 123 Energy Audit: https://focusonenergy.com/business/special-offerings
- Commercial Building Insulation: Installation Considerations, Insulation Institute. https://insulationinstitute.org/im-a-building-or-facility-professional/commercial/installation-guidance/installation-preparation/
- Technical Specialty Spotlight: Torrence Kramer, Wisconsin-based commercial blower door tester assisted Reedsburg Schools with taking down ceiling tiles and either spray the roof deck or create an air barrier with foam board and perimeter sealing to conjoin batted insulation and provide wall and perimeter vapor barriers. Torrence has also provided advice and installation for newer buildings to improve air sealing of roof to wall junctures, roof curbs, vestibules, and more.

INSTALL HIGH EFFICIENCY LIGHTING AND APPLIANCES

YOUR SCHOOL'S CURRENT LIGHTING

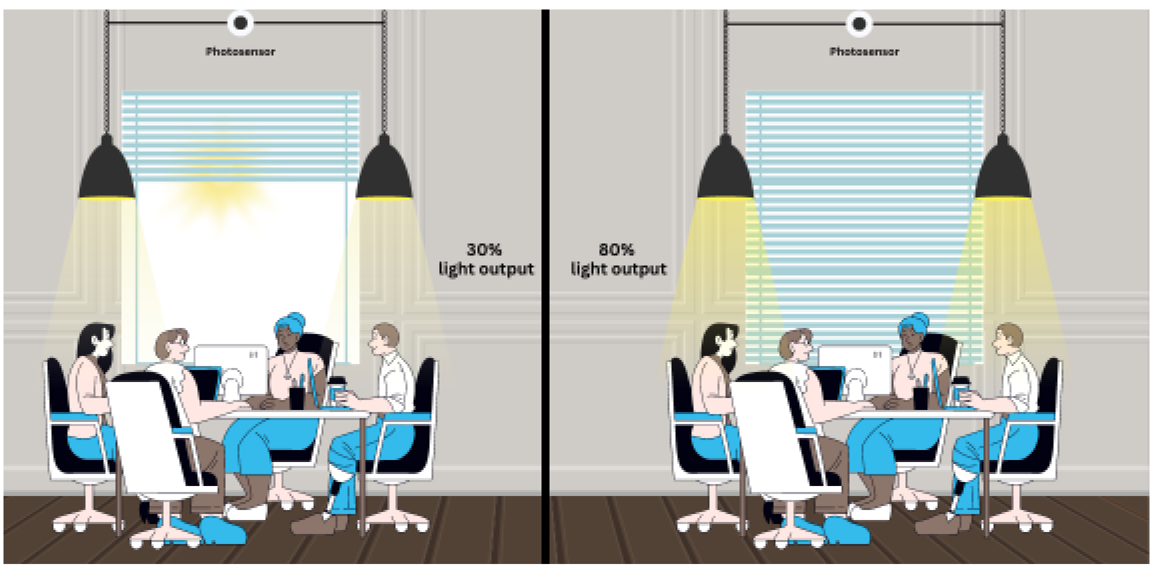
[INSERT INFORMATION REGARDING THE SCHOOL'S CURRENT LIGHTING TECHNOLOGIES AND WHEN THEY WERE INSTALLED AND/OR LAST UPDATED]

LED LIGHTING WITH OCCUPANCY, DIMMING AND DAYLIGHT SENSORS

LED lighting continues to be the most energy efficient lighting technology widely available today. It is recommended to pair LED lighting with occupancy sensors wherever possible to avoid unnecessary runtime.

Daylight Sensors can be used to save lighting runtime and energy by automatically adjusting the lighting based on the amount of natural light available in a space. When daylight levels are sufficient, the sensor dims or turns off the lights, ensuring that artificial lighting is only used when necessary. This helps to reduce overall energy consumption by minimizing the time lights are on, while maintaining appropriate illumination levels. In environments like classrooms or hallways, where natural light can vary throughout the day, daylight sensors optimize energy use and extend the lifespan of the light fixtures.

Figure. Example Daylight Control Strategy From TECHNOLEDLIGHTS.COM



Consider a dimming strategy to save light energy, while maintaining illumination levels required for educational settings (light levels in schools range around 30 to 50 footcandles). Utilize a light meter, which costs about $30-$40 to measure light levels and dim lighting to save energy and prevent over-lighting. Setting light levels using this method is often called "high-end trim." In addition, LED lighting experiences lumen depreciation over time, meaning the amount of light it emits gradually decreases as the fixture ages. Unlike traditional bulbs that often fail suddenly, LEDs typically continue working but become dimmer. Older LED lights drop to 95% of their initial light output after operating about 50,000 hours. Therefore, an energy-saving strategy is to dim brand-new LED lighting by 5% for the first 50,000 hours and then tune the lighting to 100% of power after the new ran for 50,000 hours. Dimming LED lighting to 95% of the fixtures' full rated watts for most of their lifespan saves your school building energy and power and extends the lifetime of your LED lighting.

ENERGY-EFFICIENT APPLIANCES AND EQUIPMENT

Figure . Energy Star Logo

Consider creating a purchase policy that recommends the purchase of ENERGY STAR certified appliances such as refrigerators, dishwashers, computers, and vending machines. ENERGY STAR certified products meet strict efficiency standards without compromising performance. ENERGY STAR appliances save between 10% and 50% more energy than standard appliances. ENERGY STAR certifies products including refrigerators, freezers, heating and cooling equipment, lighting, commercial food service equipment, computers, monitors, data center equipment, electric vehicle chargers, vending machines, and more.

SUBMETERING AND DEMAND

Submetering typically involves installation of current transducers on individual electric power circuits. Submeters can report data to a building automation system or even a visible dashboard for building occupants to view. Providing a visible graph of how power and energy is being consumed in the building promotes energy consumption awareness and may provide insight into low- and no-cost ways to save energy.

Figure . eGauge energy monitoring system from egauge.net

If the building does not monitor overall demand, consider installing a current transducer to monitor overall demand. This can provide both significant electric demand (kW) cost savings for buildings and help to optimally size and design a solar array.

Enroll your school in Focus on Energy's *Renew Our Schools* challenge to receive an eGauge energy monitoring system! The *Renew Our Schools* Challenge focuses on empowering students to become energy leaders by engaging them in hands-on energy conservation and efficiency activities within their schools. Through real-time energy monitoring, audits, and behavior-based strategies, students work together to reduce energy use and promote sustainability.

HIGH EFFICIENCY LIGHTING AND APPLIANCES RESOURCES

- Lighting Specification Guidance for Schools, https://www.energy.gov/sites/default/files/2024-12/lighting-spec-guidance-school_nov24.pdf
- Renew Our Schools offers schools sub-metering equipment (eGauge-brand) to monitor and track electricity use to discover no-cost energy and power demand savings opportunities. https://focusonenergy.com/renewourschools
- Take Control of Demand: Green Bay Area Public School District Reduces kW Charges, Saves Money https://www3.uwsp.edu/cnr-ap/KEEP/Documents/Publications/School%20Building/TakeControlGreenBay.pdf
- Submeter Guide - Better Buildings Solution Center https://betterbuildingssolutioncenter.energy.gov/sites/default/files/tools/submeter-guide.pdf
- Focus on Energy offers retrocommissioning and Whole Building Tune-Up information and incentives, https://focusonenergy.com/business/building-optimization.

INSTALL HIGH EFFICIENCY HVAC SYSTEMS

It is not uncommon for a school's heating, ventilation, and cooling (HVAC) system to use over 65% of the school's consumption. HVAC is also crucial to student, teacher, and staff comfort. The following provides an inventory of your school's equipment and recommends HVAC energy-saving and electrification actions for the pathway to net zero energy use.

YOUR SCHOOL'S CURRENT HVAC SYSTEMS

[INSERT DETAILED DESCRIPTION OF SCHOOL'S CURRENT HVAC SYSTEMS, INCLUDING AIR HEATING, AIR COOLING, WATER HEATING, VENTILATION, AND MORE.]

SUB-METER BOILER AND AIR CONDITIONER OPERATION

Install an energy tracking system such as a current transducer linked to the boiler combustion fan and chiller as well as an outdoor temperature sensor to estimate the peak heating loads and part-load operation levels of the school's heating and cooling system. This information can help to right-size future heat pump capacity. An energy and power monitoring system can be installed for less than $1,500.

PIPE INSULATION

Most schools have pipe insulation on hot water pipes, boilers, and chiller hydronic lines but it might be worth the time to assess that all hydronic pipes and joints are insulated. Low-cost pipe insulation helps maintain desired water temperatures, allowing water heaters, boilers, and chillers to work less and conserve energy. It also reduces wait times for hot water at fixtures, improving convenience and comfort. Additionally, insulated pipes lower the risk of condensation and pipe freezing in colder areas of the building.

BUILDING AUTOMATION CONTROLS: DEMAND-CONTROLLED VENTILATION

Supply and return fans in HVAC air handlers are typically running constantly during the school day. Variable frequency drives are commonly employed to speed up and slow down fans according to the occupancy programmed into the school's building automation system. For example, fans may run at nearly full speed when the building is fully occupied and run at half the speed, saving energy and power, when the building may be half-occupied during special events or teacher-only school days.

> Use occupancy controls to set back the temperature and reduce ventilation rates, reducing equipment runtime when spaces are not occupied.

Go beyond scheduling and link occupied HVAC settings with lighting or CO_2 occupancy sensors. Lighting occupancy sensors detect motion (like people walking or moving) using technologies such as infrared or ultrasonic and turn lights on or off based on detection of movement. In contrast, fine-tuning ventilation rates and fan speeds can be done using CO_2 occupancy sensors. CO_2 occupancy sensors estimate the actual number of occupants by measuring carbon dioxide levels in the air, which build up as people exhale.

Look to see how your school's kitchen ventilation system operates. Consider implementing smart controls for kitchen hood fans that adjust fan speed based on real-time heat, smoke, or vapor levels, operating the fan only as needed.

BUILDING AUTOMATION CONTROLS - FACILITY MANAGER SUPPORT

Facility managers are usually the unspoken heroes of saving their schools' energy. Facility managers utilize manual and automated controls to shut off lighting, ventilation, heating, and cooling when it is not needed to operate. Creative solutions are shared among facility managers through the Wisconsin Association of School Business Officials (WASBO), which offers an annual spring conference. Check with Focus on Energy to see if scholarships are available to offset the cost of attending this conference. More information about WASBO and their annual spring conference can be found at https://www.wasbo.com/WASBO/WASBO/Professional_Development/Conference/Spring_Conference.aspx.

INSTALL ENERGY RECOVERY VENTILATION (ERV)

Ventilation is nearly constantly running in occupied school buildings to exhaust air from the building and bring in fresh outdoor air. Energy recovery ventilation (ERV) systems save energy by transferring heat and moisture between outgoing (exhaust) air and incoming (fresh) air. This means that in winter, warm exhaust air preheats cold incoming air and in summer, cooler exhaust air precools and dehumidifies warm incoming air.

ERV can be retrofit into existing air handling units (AHU's) or added as a standalone ERV unit up or downstream of the AHU. The types of ERV's include rotary wheels, plate heat exchangers, or run-around coils.

Consider if there is enough physical space to retrofit existing air handlers with ERV units. An ERV retrofit into existing AHU's will add extra resistance to airflow and airflow requirements and balance of supply and return airflow will need to be considered with ERV retrofits.

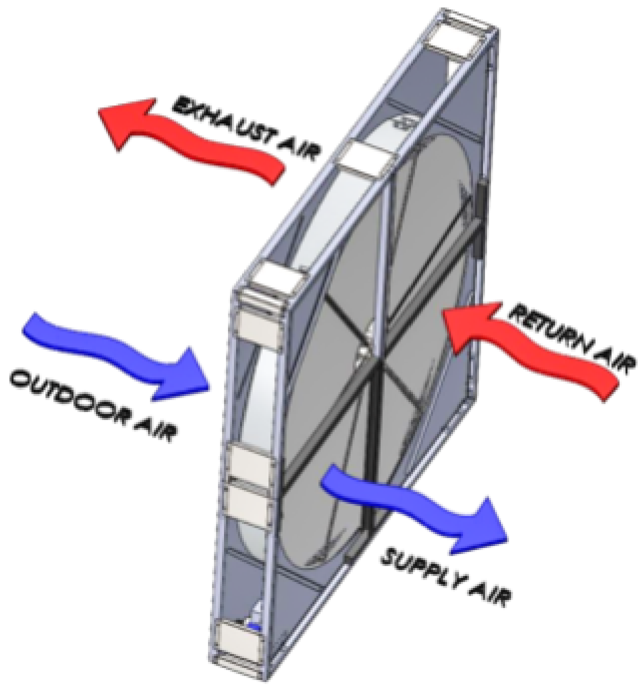


FIGURE . ENERGY RECOVERY WHEEL FROM AIROTOR.COM

HIGH EFFICIENCY HVAC RESOURCES

- Focus on Energy Schools and Government Program, https://focusonenergy.com/blog/categories/schools-government
- Focus on Energy offers retrocommissioning and Whole Building Tune-Up information and incentives, https://focusonenergy.com/business/building-optimization.
- Integrating Lighting and HVAC Controls: Solutions for High Performance Buildings https://slipstreaminc.org/research/integrating-lighting-and-hvac-controls-solutions-high-performance-buildings
- EPA Heating, Ventilation and Air-Conditioning Systems, Part of Indoor Air Quality Design Tools for Schools, https://www.epa.gov/iaq-schools/heating-ventilation-and-air-conditioning-systems-part-indoor-air-quality-design-tools

4. ELECTRIFY HEATING AND COOKING EQUIPMENT

Electrifying the current gas heating and cooking systems is crucial on the path to net-zero energy because it allows for a significant reduction in greenhouse gas emissions by transitioning from fossil fuels to electricity, which can be sourced from renewable energy sources. If electricity is used, it is important to consider the cost of heating with electricity versus gas-fueled heating.

When considering electrification of HVAC equipment, assess the capacity of the existing electrical infrastructure. Check the main breaker ampacity (amperes, “amps” of power) and panel capacity (spaces or breaker slots for additional circuits). Also check to see if the building has subpanels and their available capacity. Alternatively, if electrification is not an option, consider purchasing renewable natural gas (RNG) to offset natural gas use.

YOUR SCHOOL’S CURRENT ELECTRICAL CAPACITY

Surveys of the electrical panels for the schools and found the following information regarding available electrical capacities at the school. More detailed data can be found in the appendix.

Figure. Current Electrical Capacity

	Main Service Amerage	Main Service Voltage	Breaker Spaces Available
[BUILDING NAME]			

ELECTRIFY SPACE HEATING EQUIPMENT

There are a variety of ways schools can heat their spaces and provide hot water needs with electricity. The most efficient ways to heat with electricity use heat pump technology. Heat pumps operate on electricity as well as a separate source of energy, which can be the ambient, outdoor air (air source heat pumps) or the ground (geothermal heat pumps).

Many net zero school buildings in Wisconsin were built brand new with geothermal heating and cooling systems. It offers Wisconsin schools’ high efficiency year-round operation and does not require any fossil fuel back-up systems, although they have a much higher up-front cost than air source heat pump systems. In addition, air source heat pumps cannot be solely relied upon as a heat source in Wisconsin winters because they lose efficiency and heating function at extremely cold outdoor temperatures. For schools with longer-term (20–30-year planning) and access to grants or bonds, ground source, geothermal heating may make more financial sense than air source heat pumps. That said, some schools may want to weigh the option of installing air source heat pumps because of their relatively lower up-front costs, especially if they can provide heat for most of the heating season, and if they are powered with on-site renewable energy. For schools that do not have air conditioning, adding air source heat pumps offers an opportunity to both cool school spaces and heat with electricity during mild winter temperatures, using the existing gas boiler for heating when temperatures are below about 35°F.

AIR VERSUS GEOTHERMAL HEAT PUMPS

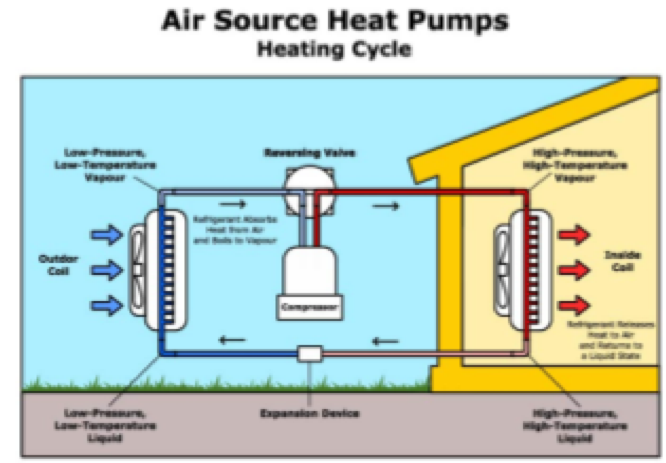


FIGURE . HEAT PUMP IN HEATING MODE FROM THE DEPARTMENT OF ENERGY

An air source heat pump (ASHP) works by transferring heat between the indoor and outdoor air. In heating mode, it extracts heat from the outside air (even in cold weather) and pumps it inside to warm the building. The diagram shows the main components of an air source heat pump system in heating mode. Following the diagram from left to right, the outdoor heat exchanger absorbs heat energy from the outdoors and routes this energy to a compressor. The compressor circulates the refrigerant, and in the case of heating, squeezes the refrigerant generating heat in the process. The hot refrigerant in the compressor is then routed to an inside coil where it can be released to the building. In cooling mode, a reversing valve reverses the process, absorbing heat from inside the building and releasing it outdoors. This process uses air as a resource and refrigerant to absorb and release heat, making the system energy-efficient and versatile for both heating and cooling.

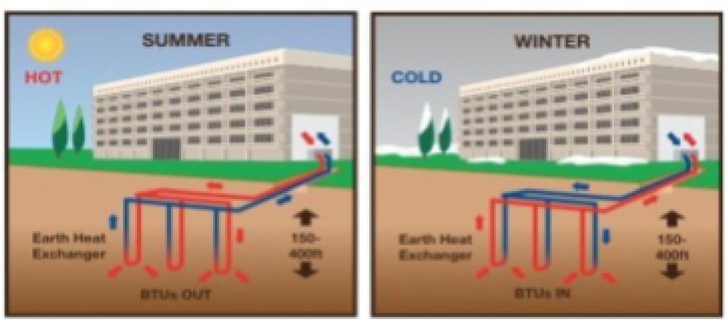


FIGURE . GEOTHERMAL SEASONAL OPERATION FROM ADVANCEAIR.NET

As outdoor temperatures decrease, the efficiency of air source heat pumps to provide heat decreases. It is recommended to install cold climate heat pumps, which are specifically designed to operate efficiently in colder temperatures, often down to -5°F to -15°F or lower. Geothermal systems work by using the stable temperature of the earth beneath the surface to heat and cool buildings. The average year-round ground temperature in Wisconsin typically ranges from about 45°F to 55°F. A geothermal heat pump system consists of a loop of pipes buried in the ground, through which a fluid circulates to exchange heat with the earth. In a vertical loop system, deep boreholes (150 feet-450 feet deep) are drilled into the ground, with pipes extending vertically to access the constant temperature of the earth at greater depths. In a horizontal loop system, pipes are laid out in trenches near the surface, typically covering a larger area. Both systems transfer heat from the ground to the building during winter and can reverse the process to cool the building in summer using a heat pump system. Just like an air source heat pump, this includes a compressor that reverses its cycle from heating to cooling season. In the case of geothermal heating, a glycol-water mix circulating in and out of the ground exchanges heat with an indoor refrigerant loop, making geothermal systems an energy-efficient and environmentally friendly option for heating and cooling.

HEAT PUMP PERFORMANCE STANDARDS

Heat pumps for commercial buildings may be rated in terms of their Energy Efficiency Ratio (EER), Coefficient of Performance (COP), Seasonal Energy Efficiency Ratio (SEER2), and Heating Seasonal Performance Factor (HSPF2). In all cases, a higher number is better in terms of energy efficiency. Packaged systems may come with a rating in their specifications whereas larger, complex systems that require engineering may have individual component specifications but not a comprehensive system performance rating. Work with Focus on Energy and other incentive programs to ensure the equipment installed meets incentive/grant efficiency requirements.

Figure. Recommended Commercial Heat Pump Efficiency Ratings Electrical Capacity

Metric	Applies To	Recommended Values	Rating Measures
EER	Geothermal & Air Source	Geothermal: ≥ 17.1 (closed loop), ≥ 21.1 (open loop). Air Source: ≥ 12	Measures cooling efficiency (steady-state).
COP	Geothermal & Air Source	Geothermal: ≥ 3.6 (closed loop), ≥ 4.1 (open loop). Air Source: ≥ 3.0-3.5	Measures heating efficiency (steady-state).
SEER2	Air Source	≥ 13.4 (minimum), ≥ 16 (recommended)	Measures average cooling efficiency across a season.
HSPF2	Air Source	≥ 7.5 (minimum), ≥ 9.0 (recommended)	Measures average heating efficiency across a season.

WHAT'S INVOLVED WITH A GEOTHERMAL CAPACITY STUDY

A geothermal heating and cooling system for a school will involve considerable length of geothermal piping, used horizontally or vertically. Geothermal system designs consider the conductivity of the soil when designing geothermal loops. The design needs to meet the school's current and anticipated heating and cooling needs.

CHOOSE A QUALIFIED GEOTHERMAL SYSTEM DESIGNER

A qualified geothermal system installer possesses specialized knowledge and experience in the technology, including certifications, extensive installation experience, and adherence to industry standards and local regulations. They understand the nuances of different system types (vertical, horizontal, etc.) and can assess site conditions to determine the most suitable installation method. They may hold certifications like the Certified GeoExchange Designer (CGD) or Certified GeoExchange Installer (CGI) from the International Ground Source Heat Pump Association (IGSHPA). Work with a geothermal installer that will support your project through the design, installation, and operation of the system. Geothermal and heat pump systems are new to most building operators, and it will be important to have professional support during the start-up and operation of a new geothermal heating and cooling system.

ENERGY LOAD CALCULATIONS

Heat pump system designers will consider the annual heating and cooling needs of your school to right-size the heat pump. Designers can do this using building modeling software, and valuable information can also be provided by having data from the school's existing HVAC systems.

BOREHOLE AND THERMAL CONDUCTIVITY TEST

To help size the system and determine how well the ground conducts heat at the school site, a 100ft – 200ft deep borehole is drilled and a soil and rock profile is created. Besides conductivity, this test also considers the presence of bedrock, aquifers, and other geological conditions. This step also evaluates if there is enough land space to locate the geothermal loop system.

GEOTHERMAL LOOP AND HEAT PUMP SYSTEM DESIGN

Using the information gathered in the initial steps of energy load calculations and ground condition testing, a geothermal designer determines the vertical or horizontal geothermal loop and heat pump design that will meet the heating and cooling requirements of the school. They determine how heat will be distributed and absorbed throughout the school, with options such as ductwork, radiant floors, fan coils, and variable refrigerant flow systems. This is also the point at which electrical requirements of the geothermal system are assessed, ensuring that the school has enough electrical capacity to handle the all-electric geothermal heating and cooling system.

BUILDING AND ENVIRONMENTAL PERMITTING

Geothermal systems will be subject to mechanical, electrical, and plumbing (MEP) permitting through city and county codes and ordinances. The Wisconsin Department of Natural Resources (WI-DNR) approval is required for systems with 10 or more drilled bore holes, bore holes deeper than 400 feet, or for geothermal systems within 400 feet of a municipal well.

INSTALLATION, COMMISSIONING, AND SYSTEM VISUALIZATION

After the geothermal system is designed and approved the bore holes (geothermal wells) are drilled on the exterior of the building. On the building interior, heat pumps, piping, and heat distribution systems such as ductwork, fan coils, and variable refrigerant flow piping are installed. The system is then commissioned for use by starting it up and fine-tuning the system controls. Work with your geothermal installer to ensure that building operators have the support they need to continuously monitor and support efficient operation of the geothermal system. Also consider signage and visualization of the system components to support student learning about geothermal technologies. This may include open ceilings with labeled ductwork and piping, glass-walled mechanical rooms with labels on mechanical components, as well as kiosk screens to display real-time geothermal system operation.

TYPES OF HEAT PUMPS AND MODES OF HEAT DISTRIBUTION

1. Split-Style Air Source Heat Pumps

Figure . Outdoor Units of a Split-System Air Source Heat Pump from Popularmechanics.com

Consists of two main components: an outdoor condenser unit and one or more indoor air handling units (AHUs) or fan coil units. These range in size from 3 – 140 tons. The outdoor unit contains the compressor, condenser coil, and expansion device, and is responsible for extracting or rejecting heat to the outside air, depending on whether the system is in heating or cooling mode. The indoor units typically house the evaporator coil, blower fan, and controls, and are connected to the building's ductwork or used in ductless configurations. Refrigerant lines run between the indoor and outdoor units, allowing the system to transfer thermal energy efficiently. Larger systems may also include variable-speed compressors, inverter technology, and zoning controls for optimized comfort and efficiency across different parts of a school building, such as classrooms, offices, or multipurpose spaces.

2. Ductless Heat Distribution-Variable Refrigerant Flow

One classroom may be occupied by students and overheated while another building space is not occupied and needs heat. It is possible to move heat from the occupied warm room to the unoccupied cooler room with variable refrigerant flow heat distribution. Variable Refrigerant Flow (VRF) systems work by circulating only the amount of refrigerant needed to meet the cooling or heating demands of different zones within a building. They use a single outdoor condenser unit connected to multiple indoor units, each of which can be individually controlled. The system adjusts the flow of refrigerant using inverter-driven compressors and electronic expansion valves, allowing for precise temperature control and high energy efficiency. VRF systems can be paired with fan coil units to distribute and absorb heat through ductwork.

3. Dual Fuel Heat Pump System Option - Air to Water Heat Pumps

Figure . heating Coil from Grainger.com

Air source heat pumps can be paired with existing gas-fired heating systems, which are considered a dual-fuel heat pump system. Dual-fuel heat pump systems combine the energy efficiency of a heat pump with the reliability of a gas boiler, automatically switching primary heating between the two based on outdoor temperature. During milder temperatures, the heat pump efficiently heats the building and when outdoor temperatures drop below the threshold of efficient heat pump operation, perhaps below 35°F, the natural gas heating system kicks in. Utilizing dual fuel systems may also help to optimize heating costs, especially if the school is primarily dependent on utility-supplied electricity.

An air-to-water heat pump can be added to an existing boiler plant with a heating coil retrofit. An air-to-water heat pump and boiler plant can be run as a dual-fuel system, utilizing the heat pump in mild weather and boiler in cool weather. Or the air-to-water heat pump alone can provide most of the heating needs for a school building. An air-to-water heat pump provides 110-140°F temperature water during the heating season. Heating coils used with this type of system require a larger surface area and higher airflow to transfer enough heat versus heating coils used with boiler plants. (Boilers provide water temperatures typically around 150-180°F). When replacing coils and ductwork, consider oversizing the coils and ductwork as a strategic move to transition to electrification of the heating system. Oversized coils can function well during part-load performance in spring and fall seasons, which may also reduce boiler on-off cycling and increase system efficiency.

Figure . Outdoor Unit of Air to Water Heat Pump System

Using an air-to-water heat pump as an interim step before transitioning to a geothermal heat pump system can be a flexible approach to electrification of heating. The air-to-water heat pump can serve as the initial source for heating and cooling through a hydronic distribution system, like fan coil units or radiant loops, allowing the school to electrify HVAC operations sooner than geothermal systems. This staged strategy is especially useful when budget, permitting, or site constraints delay the geothermal phase. If the system is designed with future compatibility in mind (e.g., low-temp hydronic loops, space for additional equipment, and flexible piping), the ASHP can be later replaced or supplemented by a GSHP with minimal disruption.

For a smooth transition from an air source heat pump to a ground source heat pump it is important to design the mechanical and electrical systems to accommodate both technologies. That means sizing panels for future loads, using programmable controls that can integrate multiple heat sources, and leaving space for geothermal units in the plant room. A hybrid system—where the air and ground heat pumps work together—is also possible, balancing efficiency and resilience. While air source heat pumps may be less efficient in very cold climates and could increase peak electrical demand, they provide a potential intermediate step toward decarbonization and can reduce the up-front investment required to move fully to geothermal.

4. Dual Fuel System Option - Packaged Rooftop Unit (RTU) ASHP

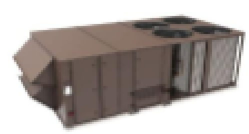


Figure . Packaged Air Source Heat Pump Rooftop Unit (RTU) from jonsoncontrols.com

Packaged rooftop units (RTU's) contain the evaporator and condenser components of an air source heat pump system all within the RTU. Natural gas-fueled RTU's can be retrofit with a heat pump system if there is enough electrical capacity, ductwork, and structural support can accommodate the pump system. Heat Pump RTU's can range in size from 2 to over 50 tons. Roof improvements may be needed with dual-fuel heat pump RTU's, including potential new curbing due to the increased size of heat pump RTU's versus standard gas-fire units. Heat pump RTU's will also weigh more than standard gas-fired RTU's.

5. Mini Split Air Source Heat Pump

Mini-split air source heat pumps typically come in a 1 to 5-ton capacity, making them appropriate for a relatively small part of the school building. Mini-split systems have a separate indoor versus outdoor coil, and air is distributed using a wall-mounted cassette style fan.

6. Packaged Thermal Heat Pumps

Packaged terminal heat pumps (often called a PTAC, Packaged Terminal Air Conditioner) are mounted through walls and may be a good electrification option for replacing wall-mounted cabinet unit heaters.

7. Heat Pump Water Heaters

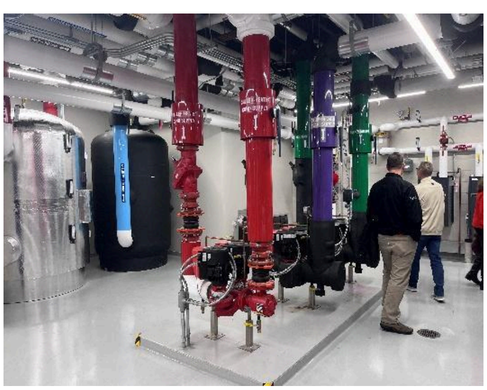
Commercial grade air source and ground source water heaters are available to serve kitchen, bathroom, and other domestic hot water needs of a school. As an example, larger heat pump water heaters can provide as much as ~340,000 Btu/hour of water heating needs.

Figure . mini-split air source heat pump from fujitsugeneral.com

Figure . Packaged Terminal Heat Pump from Wikimedia Commons

Figure . Heat Pump Water Heater from hotwater.com

THERMAL ENERGY STORAGE



Thermal energy storage systems can play a key role in the electrification of a school building by shifting heating and cooling loads to off-peak hours, reducing peak electricity demand and easing the strain on electrical infrastructure. By storing thermal energy—such as chilled water or hot water—during times when electricity is cheaper or more readily available (like at night or when solar production is high), schools can use that stored energy during the day to condition classrooms without relying on active equipment. This makes it easier to integrate heat pumps and electric chillers, lowers operating costs, and supports grid-friendly electrification.

CONSIDER ELECTRIC VERSUS GAS HEATING OPERATING COSTS

If the electricity required to heat the building is produced by on-site solar energy, such as solar PV panels, there is *no electric fuel cost* and *no air emissions* produced in the building heating process. In addition, heat pump systems are generally 200% or more efficient than gas combustion heating equipment. If utility electricity is required to electrify the heating system, a fuel cost with system efficiency analysis is recommended.

A high-efficiency boiler is over 90% thermally efficient, which means that for every therm (a therm contains about 100,000 Btu's of energy), 0.90 therm (90,000 Btu's of energy) of heat energy is provided to the space. Natural gas is combusted at the site, which is relatively clean burning, but also produces some local air emissions in the process. At the time this report was written, natural gas costs about $0.60/therm, meaning the boiler heat energy provided in this scenario costs about $0.0000061/Btu.

An all-electric geothermal heat pump system may be about 300% efficient, meaning that for every 1 kWh (a kWh contains about 3,412 Btu of energy) consumed by the heat pump system, 3 kWh (10,236 Btu's) of heat energy is provided to the space. No on-site air emissions are produced in this process, and if the electricity consumed is produced by on-site renewables, no emissions are released overall in the heating process. If utility electricity is consumed in the process, air emissions could be produced at fossil fuel power plant sites. Wisconsin utilities are mandated to provide all electricity from carbon-free sources by 2050. At the time this report was written, school electricity costs about $0.13/kWh, meaning the heat pump heat energy provided in this scenario costs about $0.0000127/Btu, about 52% more than natural gas costs.

Fuel prices fluctuate and it is advised to evaluate electrification of heating costs using true energy prices. A True Cost of Energy Comparison Microsoft Excel tool is available through the Penn State Extension (image of the tool is shown below). In addition, heating system designers, utility companies and Focus on Energy may be able to help you evaluate Fuel Cost Consideration.

A fuel price comparison will help your school anticipate electric energy costs, but do not forget about electric demand charges. Electricity for your school is billed with kW demand charges, and adding additional kW demand could significantly impact year-round utility costs. With careful planning your school may be able to offset the electric energy (kWh) and some demand (kW) costs with solar PV production.

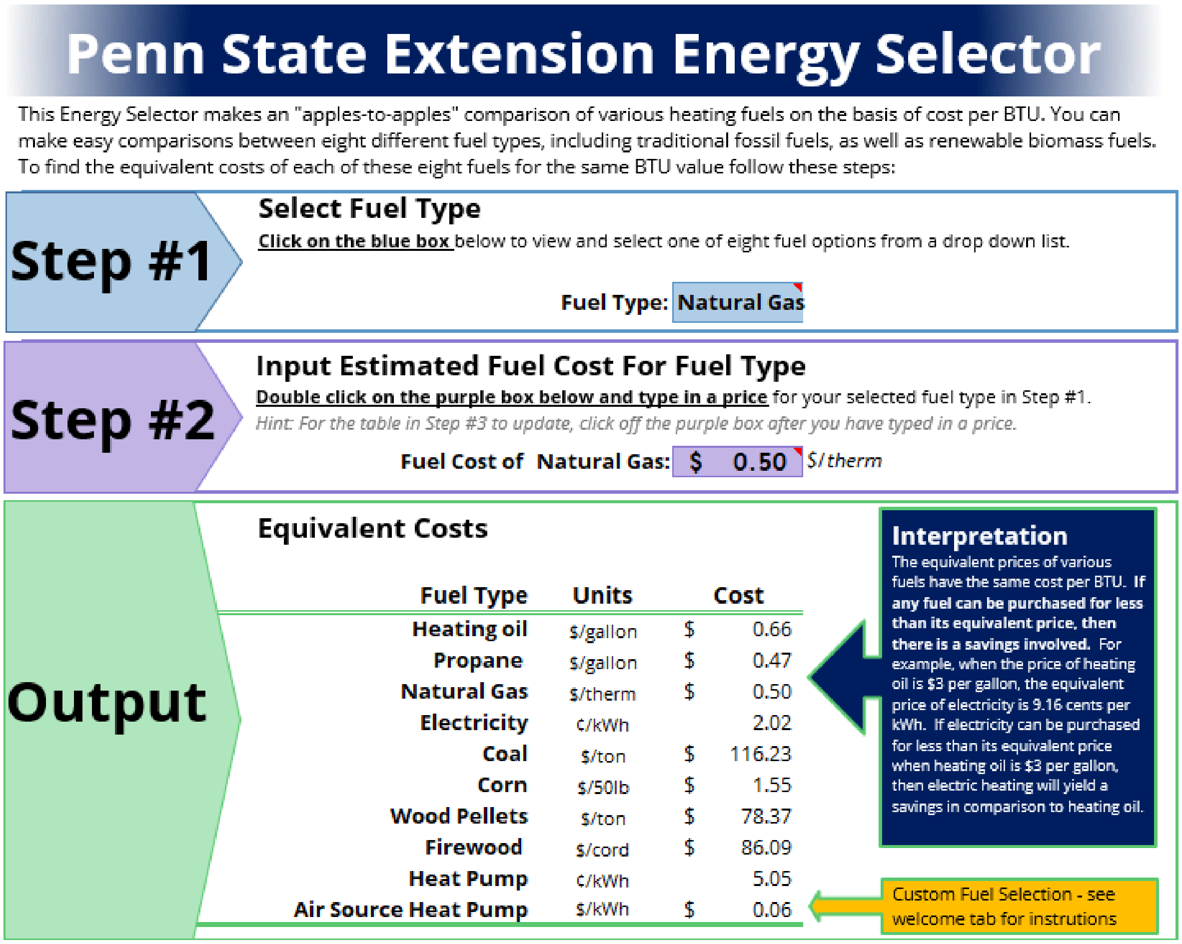


FIGURE 4-13. ENERGY COMPARISON TOOL AVAILABLE AT EXTENSION.OKSTATE.EDU

ELECTRIFICATION OF HEATING RESOURCES

- Commercial Heat Pumps video, Slipstream, https://www.youtube.com/watch?v=pF2B03kXCmE&list=PL-mtgGdh8bvj2VBzoYogabVeBvG7qtVNp&index=29&t=129s
- Modeled Retrofit Package Performance for Schools, Lawrence Berkley National Laboratory, https://www.energy.gov/sites/default/files/2024-05/Modeled%20Retrofit%20Package%20Performance%20for%20Schools-2024.pdf
- Trane® Thermal Energy Storage https://www.trane.com/content/dam/Trane/Commercial/north-america/products-systems/thermal-energy-storage/IB-SLB001-EN_12012020.pdf
- True Cost of Energy Comparison tool, https://extension.okstate.edu/fact-sheets/true-cost-of-energy-comparisons-apples-to-apples.html#:~:text=Access%20our%20online%20energy%20cost,for%20the%20types%20of%20energy.

ELECTRIFY COOKING EQUIPMENT

Electrification of school kitchen equipment eliminates carbon emissions and local air emissions when operating the equipment on clean renewable electricity, but cost of operation as well as staff training should be considered. The cost to operate electric versus gas heating was discussed previously in *4.2.6 Consider Electric versus Gas Heating Operating Costs?* section of this report. Optimally, there should be no cost of using electric appliances if paired with the production of on-site solar electricity. Consider the school's capacity to handle an additional electrical load. Commercial-grade electric kitchen equipment usually requires 240-volt circuits for operation and may require new kitchen wiring, electrical panels, or transformers to be installed. Lastly, kitchen staff may need training when transitioning to new technology that heats and cooks differently than gas appliances. The following are strategies to electrify kitchen equipment.

REPLACE GAS STOVETOPS WITH INDUCTION COOKTOPS

Induction cooktops offer faster heating and precise temperature control and are an energy efficient electric cooking option. Gas-fired cooktops have an open flame which can be hazardous and produce in-kitchen air emissions.

REPLACE GAS OVENS WITH ELECTRIC OVENS

There are a variety of commercial electric ovens available including convection, combination steam/convection and conventional electric ovens. No local gas combustion means no kitchen air emissions and risks associated with open flames.

USE ELECTRIC GRIDDLES, FRYERS, AND FOOD WARMERS

Electric griddles are considered easier to clean than gas griddles, and electric versions of commercial fryers and food warmers are available to replace gas versions.

USE ENERGY STAR DISHWASHERS

Dishwashers in school kitchens are typically electrically heated and operated, but it is recommended that ENERGY STAR dishwashers are used.

5. RENEWABLE ENERGY INTEGRATION

Solar and wind systems help decarbonize buildings by generating clean, renewable electricity on-site, reducing reliance on fossil fuel-based grid power. Geothermal energy can eliminate the need to use fossil fuel-based heating and cooling systems. These renewable energy systems, paired with an electrified building system, significantly lower school building carbon emissions. When paired with energy storage, solar and wind systems can also supply power during non-solar hours, further minimizing carbon-intensive electricity use. By reducing peak demand and exporting clean energy into the grid, solar and wind support broader grid decarbonization efforts.

Teachers and staff can engage students in renewable energy production from solar, wind, and geothermal systems at their schools by incorporating hands-on learning and real-time monitoring into the curriculum. Students can track the school's energy production through dashboard displays or data apps, analyze energy savings, and explore how different weather conditions impact solar energy generation. Schools can also organize projects like building small solar or wind models, conducting geothermal experiments, or creating awareness campaigns. Field trips to local renewable installations or inviting guest speakers can further connect classroom learning with real-world sustainability efforts, inspiring students to become active participants in the clean energy future. There are fantastic, Wisconsin-based resources for engaging students, staff, and the community in renewable energy production at schools through the following resources:

- Focus on Energy, Renew Our Schools Challenge: offers K-12 schools eGuage technology and hands-on learning opportunities. https://focusonenergy.com/renewourschools
- UW-Steven's Point's K-12 Energy Education Program (KEEP): lessons and professional development opportunities to support energy education for Wisconsin K-12 schools. https://focusonenergy.com/renewourschools
- CREATE Energy Center: faculty workshops, instructional materials, energy career resources, program and curriculum development and industry partnerships. https://createenergy.org/
- Wisconsin Public Service SolarWise: hand-on renewable energy curriculum and teacher training, along with an annual Solar Olympics student competition of renewable energy projects. https://www.wisconsinpublicservice.com/environment/solarwise/
- Solar on Schools Program: provides in-kind solar panel grants and technical assistance to Wisconsin K-12 schools and colleges pursuing solar PV systems.

This section covers the recommendations, design and interconnection process for Solar PV systems, and discusses the benefits and characteristics of solar thermal heating systems. Solar photovoltaic (PV) systems help decarbonize buildings by generating clean, renewable electricity on-site, reducing reliance on fossil fuel-based grid power. This clean energy can power electrified systems like heat pumps and induction cooktops, significantly lowering emissions from heating, cooling, and appliances. When paired with energy storage, solar PV can also supply power during non-solar hours, further minimizing carbon-intensive electricity use. Additionally, by reducing peak demand and feeding clean energy into the grid, solar PV supports broader grid decarbonization efforts.

YOUR SCHOOL'S SOLAR GENERATION POTENTIAL

[INSERT INFORMATION REGARDING THE SOLAR GENERATION POTENTIAL OF THE SCHOOL]

Figure. Solar Arrays Specificed

	Location	kWdc	kWac	Annual KWh Production	% Electricity Offset Based on Consumption	Estimated % Electricity Offset

Figure. Solar Arrays Estimated Cost and Payback

	Location	kWdc	Annual KWh Production	Estimated Cost at $3 per Watt Installed	Average Cost per kWh	Value of Solar (Offset of the Building's Consumption)	Simple Payback at Full Cost	Simple Payback with Incentives

CASH FLOW OF SOLAR INVESTMENTS AT YOUR SCHOOL

At the time of this report, it is estimated that installed solar may cost about $3 per installed watt. Incentives for solar at this time include Solar on Schools panel grants (grants that donate solar modules/panels), Focus on Energy incentives at $50/kW installed up to $25,000, as well as 30% Direct Pay Credits from the federal government. The following cash flow diagrams consider these incentives, current average kWh cost for the school, and a 3% annual utility electricity cost increase. Please note that the average cost blends together kWh and demand rate charges. The schools' utility rate is between [INSERT RATE] with kW demand charges. Each cash flow diagram also considers a $30,000 investment in year fifteen for new inverters and potential maintenance costs.

[INSERT CASH FLOW PROJECTIONS]

SOLAR'S OFFSET OF OVERALL ENERGY CONSUMPTION

The solar arrays specified for each school are not sized to offset the schools' overall energy consumption. The following pie charts illustrate the potential of the current solar specifications to offset each school's overall annual energy consumption.

[INSERT PIE CHARTS]

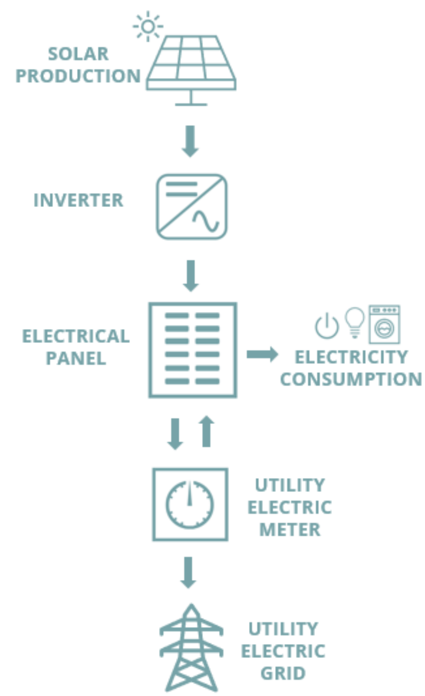
Reduce heating energy use and electrify heating equipment. When schools switch to electric heating using heat pumps, they can use half as much energy or even less. That's because heat pumps are very efficient—they provide 2 to 4 times more heat than the amount of electricity they use. However, electricity usually costs more than natural gas, so heating bills could still go up even though energy use goes down. That's why it's a good idea to install solar panels to help cover the electricity costs of running the heat pumps.

Size the solar array so that all the electricity it produces can be used at the building. This helps offset the higher cost of buying electricity from the utility. Schools pay around $0.13 per kilowatt-hour (kWh) as a blended energy and demand rate for electricity they buy from the utility, but they only get about $0.035 per kWh for any excess solar energy they send back to the grid.

The carbon emissions of the electric grid are expected to decrease. Wisconsin has a goal to use 100% carbon-free electricity by 2050, according to its Clean Energy Plan. This means that even if a school's solar panels don't cover all of its energy needs, the electricity it buys from the utility will become cleaner and produce less carbon over time.

COMPONENTS OF A SOLAR PV ARRAY

A typical PV system includes several key components: solar PV panels mounted on the roof to capture sunlight and convert it into electricity, an inverter that transforms the direct current (DC) produced by the panels into usable alternating current (AC), and an electrical panel to distribute the electricity throughout the building. Note: the conversion of DC to AC electricity is not 100% efficient and it is realistic to consider the kW-DC rating will be reduced by 15%-30% because of soiling, snow, line losses and inverter efficiencies. AC electricity from solar arrays may be connected to the utility grid, allowing the school to feed excess electricity back into the grid or draw from it when needed. Some systems also include monitoring equipment and optional battery storage for increased energy resilience. **The image provided of the grid-connected solar PV system is adapted from Solar PV Balance of System and System Design lesson, available from the CREATE Energy Center at https://createenergy.org/. This website has excellent teaching resources!**



Not all solar PV panels are the same. Bifacial solar panels produce more electricity than standard PV panels by capturing sunlight on both the front and back sides of the panel. While the front side absorbs direct sunlight like traditional panels, the back side collects reflected light from surfaces such as rooftops or the ground. This dual-sided design can increase energy output by 10–30% depending on the installation environment, white "cool" roof colors are optimal, making bifacial panels a more efficient option for maximizing solar energy production.

ROOF AND GROUND-MOUNTED SOLAR PV

FIGURE . BALLASTED SOLAR PV ARRAY

Because most schools have a flat roof, solar panels racking is typically ballast-mounted on the roof. Ballast systems secure solar panel racking using concrete bricks to weigh the racking down to the roof, avoiding the need to pierce the roof. Ballasted systems are often tilted at a 10-degree tilt from horizontal, which means the solar panels will not produce as much electricity as they could at a 35-45-degree tilt in Wisconsin. The 10-degree tilt is used so that the solar panels do not act like a wind sail, catching wind and dragging their racking and ballast systems across the roof, potentially causing damage to both the solar array and roof. While sunlight can easily melt snow that accumulates on solar panels on sunny winter days, snow tends to melt slower and may not easily shed on panels at a 10-degree tilt angle versus panels at a 35–45-degree angle.

FIGURE . CARPORT SOLAR FROM GREENLANCER.COM

Ground-mounted solar PV systems, including carport types installed over parking lots, offer schools a flexible and efficient way to generate renewable energy without using rooftop space. Traditional ground mounts can be placed in open fields or unused land near the school, while parking lot-mounted systems—often called solar canopies or carports—provide the added benefit of shaded parking for vehicles. Both options allow for easy maintenance and optimal panel tilt orientation for maximum energy production. These installations are especially valuable for schools with limited roof space or aging buildings unsuitable for rooftop arrays but also consider that a snowplow might need to work around carport arrays.

SOLAR SYSTEM DESIGN AND INTERCONNECTION

The solar design and interconnection process can take up to one year to complete. The following provides a general outline of the steps involved in solar design and interconnection.

1. Research Local Regulations and Incentives: Each utility company has specific rules and policies regarding solar interconnection, including grid capacity, equipment standards, and procedures. Look into federal, state, or local incentives like rebates or tax credits, and net metering policies. Work with Focus on Energy, the school's electric utility representative, and a qualified solar installer early in the process to take advantage of any available incentives and grants.

2. Choose a Qualified Solar Installer: It's important to hire a certified solar installer who can navigate the technical and regulatory requirements of the installation. The installer will be responsible for ensuring the system meets local codes and utility company requirements.

3. Design the System: The installer will assess your energy needs, roof space, roof structure, and other factors to design a solar system that fits your school. Like with electrification of HVAC, when considering a solar PV system, assess the capacity of the school building's existing electrical infrastructure. Determine the size (in amperes, or "amps") of the building's main electrical service panel. The panel must be able to accommodate both the existing load and the additional load from the solar PV system. Typical school building electrical panels range from 200 to 1200 amps, depending on the building's size. A solar PV array with ballasts, which are concrete bricks that hold down the racking to the roof, weighs about five or more pounds per square foot of roof area. A structural analysis is needed to ensure your school's roof can handle the load of a solar PV array. A qualified solar designer will design the size of the PV array according to load calculations that assess the building's current energy demands. The school's utility bill kW demand readings will also be considered when sizing the PV array.

4. Submit Interconnection Application to the Utility: The school will need to apply to the electric utility company for permission to connect your solar system to the grid. This includes submitting system design, technical specifications, and details of the components (inverters, panels, etc.). The utility determines if the local electric lines have enough capacity to receive solar production, and also ensures the system is designed safely, including automatic disconnection from the local power lines if the local electric grid loses power. Utilities require solar arrays to disconnect from the grid if the local power grid is down to prevent power line workers from potential harm. Some utilities charge a fee for processing the application and inspecting the installation.

5. Obtain Necessary Permits: Schools will need to obtain the necessary permits from your local government before installing a system. This often includes electrical permits and zoning permits, depending on your location. The solar installer often handles this on their customers' behalf.

6. Install the System: The solar panels, inverter(s), and electrical components are installed on the school's property. The installer will also ensure that the system meets the necessary electrical codes and utility company requirements. The installer will ensure that the system includes safety mechanisms like anti-islanding protection, which ensures the solar system shuts off in case of a power outage to protect utility workers.

7. Inspection by the Utility and Local Authorities: After installation, the utility company and/or local authorities will usually inspect the system to verify that it meets all code and safety standards. This may involve a visit to ensure everything is properly set up.

8. Sign Interconnection Agreement: Once the inspection is complete and the system is approved, you will need to sign an interconnection agreement with the utility company. This agreement formalizes the connection to the grid and outlines details like net metering terms and any charges for grid access.

9. Activate the System: After receiving approval from the utility and the interconnection agreement is signed, the solar system can be activated. Activation means that disconnect switches can be flipped to connect the solar system to the grid, and the system begins generating power.

10. Ongoing Maintenance and Monitoring: Regular maintenance will be required to keep the system operating efficiently. Clean solar panels produce more energy than dirty solar panels. Many solar systems have monitoring tools that allow you to track performance.Set aside a budget for solar system maintenance. Solar inverters have a lifespan of about 15 years while solar panels can produce electricity for over 30 years. Your utility company may also provide periodic monitoring to ensure that your system continues to operate safely and within agreed parameters.

Solar inverters have a lifespan of about 15 years while solar panels can produce electricity for over 30 years.

VALUE OF TRACKING SOLAR PRODUCTION

Solar photovoltaic (PV) systems in Wisconsin are typically sized to meet the needs of a building's energy consumption without much extra solar energy production. The reasoning for sizing the PV system so that most of its energy is consumed on site is because the price most utility companies pay for solar exported from a building to the grid is half or one-third the cost per kilowatt-hour (kWh) that buildings are billed for each kWh. The table below provides and example of a ~30,000 square foot Wisconsin education building's July and December bills and the value of the 238 kWdc PV system's kWh production.

Figure. Example Value of Solar Noting What is Not Shown on Utility Bills

	July	December
kWh Solar Produced on Site (from solar inverter, not shown on utility bill)	20,515	686
Solar kWh consumed on site (difference between kWh solar produced and kWh sold to the utility, not shown on the utility bill)	7,687	53
kWh purchased from the utility (shown on utility bill)	6,952	16,938
kWh sold to the utility (shown on the utility bill)	12,828	633
Value of Solar kWh Consumed on Site (at $0.09/kWh)	$1,846	$62
Value of Solar Sold to the Utility (at $0.04/kWh)	$513	$25

Notice in the above example that the solar kWh consumed on the site is not metered by most utilities. Most utilities only meter the energy consumed from the grid and energy exported from the building to the grid (*excess* solar production). When tracking energy production and consumption of solar energy, it is important to track the true solar production, often obtained from solar inverter data or sub-metering of the solar array, as well as the utility bill purchased kWh and exported kWh. The following kWh tracking graph was created using data from the same building that produced the above kWh data. The solar production line is from inverter data, and the solar purchased from the utility and solar sold data is from the building's utility bills. This building has geothermal primary heating with some natural gas-fueled back-up heating, as well as a 238 kWdc rooftop solar array that was snow-covered in the winter months. (natural gas consumption is not included in the graph).

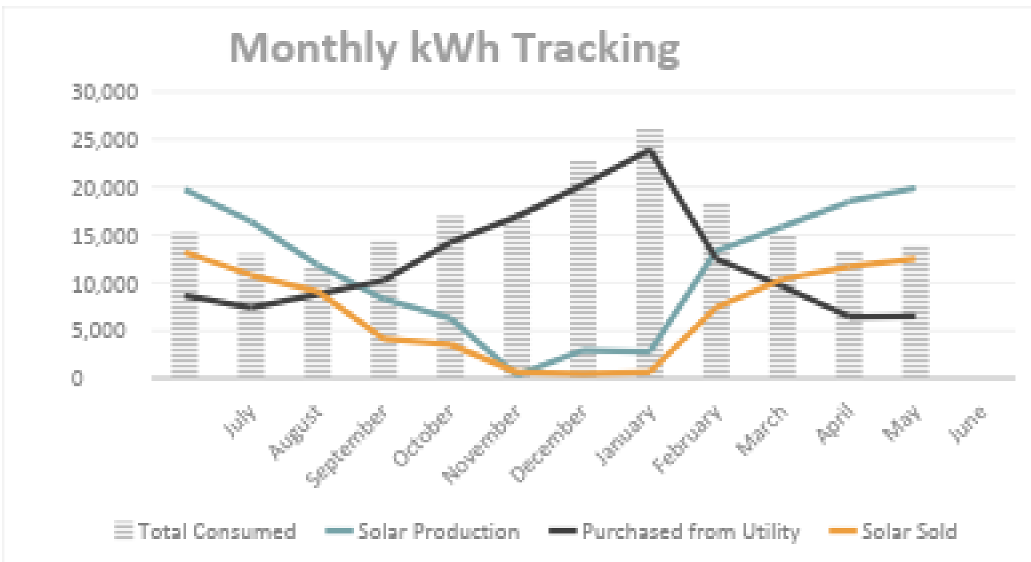


FIGURE 5-6. MONTHLY KWH TRACKING FOR A WISCONSIN EDUCATION BUILDING

BATTERY STORAGE FOR ENERGY RESILIENCE

The installation of battery energy storage to solar PV installations comes with a significant financial cost, but some schools may want to consider battery storage to strategically avoid electricity demand charges and/or to use the school building as a resilient shelter to the local community during power outages. The larger the battery capacity (measured in kilowatt-hours or kWh), the higher the cost. A 10kWh battery might cost around $9,000, while a 15kWh battery could cost $12,000 or more. Weigh this cost against your school's *daily* kWh use to get an idea of how much battery storage may cost your school (most battery storage systems are sized for one day of discharge/autonomy). Work with a qualified solar installer to size batteries to support critical power loads of the school. Most batteries paired with solar PV installations are lithium-ion, offering high energy density, efficiency, and longevity, but other types like lead-acid, nickel-cadmium, and flow batteries also exist.

CAN SOLAR PANELS AND BATTERIES BE RECYCLED?

Solar photovoltaic (PV) panels can be recycled into new solar panels. The aluminum frames, glass, copper wire, polymer layers, back sheet, silicon solar cells and plastic junction box can be separated. Most of these components can be recycled. The solar panel recycling process is explained at this U.S. Environmental Protection Agency Solar Panel Recycling website, https://www.epa.gov/hw/solar-panel-recycling#:~:text=Recycling%20Process,through%20chemical%20and%20electrical%20techniques.

SOLAR THERMAL ENERGY

Different from a solar PV system, solar thermal systems use sunlight to heat water for domestic use, such as in kitchens, restrooms, and locker room showers. Solar thermal systems can be used to supplement traditional gas or electric water heaters, providing as much as 70% of water heating needs in a Wisconsin climate. Solar thermal systems can also be paired with heat pump systems to reduce energy consumption during the heating season.

A solar thermal heating system typically includes solar collectors, heat transfer fluid, a storage tank, and a control system. The solar collectors look quite different than a PV panel and are usually mounted on a roof, absorbing sunlight and converting it into heat. A solar thermal collection array weighs six to eight pounds per square foot, so it is important to consider if the school's roof structure can handle the load. Solar heat in thermal heating systems is transferred by a fluid—often water or a water-glycol mix—circulating through the system. The heated fluid is then stored in an insulated tank for later use, such as providing hot water or space heating. A control system manages flow and temperature to ensure efficient and safe operation.

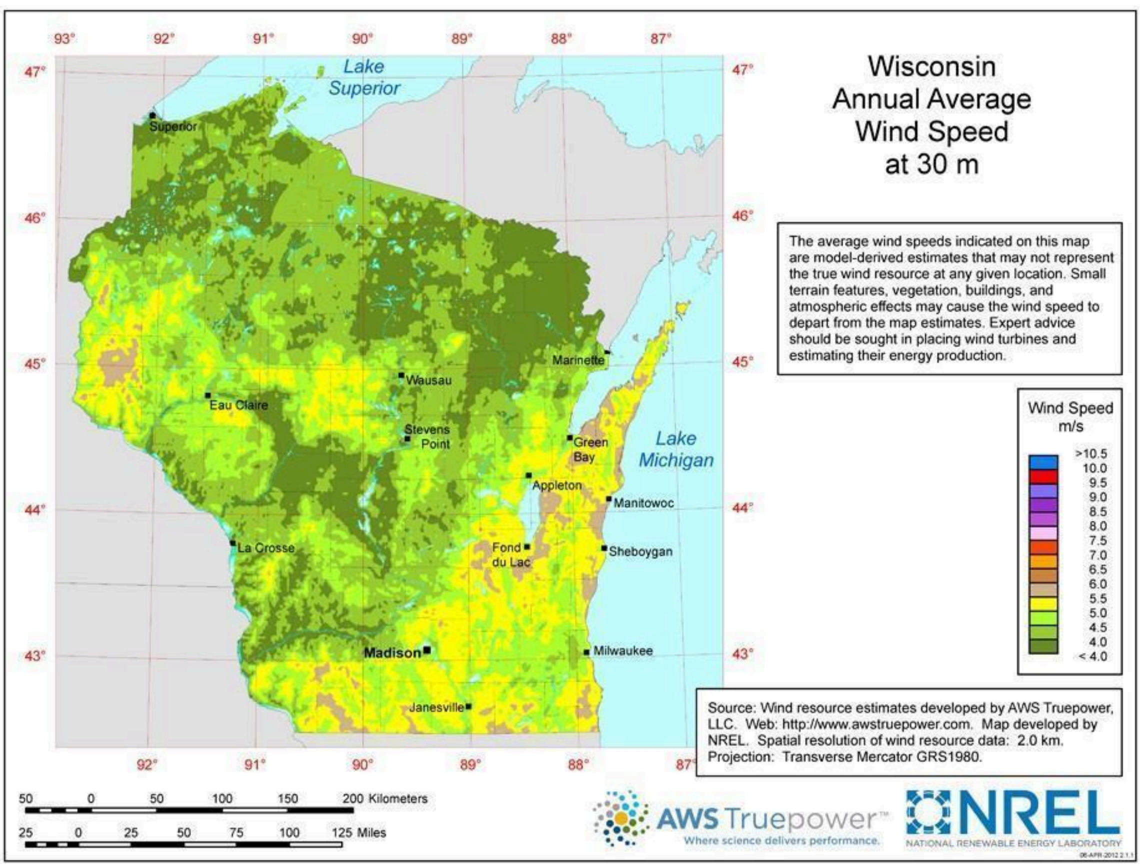
SOLAR ENERGY RESOURCES

- Solar Energy Industries Association (SEIA) – Solar for Schools, Offers policy updates, case studies, and market data on solar adoption in K-12 schools across the U.S., https://www.seia.org
- Generation180 – Solar Schools Program, Provides an interactive map of schools with solar, downloadable reports, and tools to help districts explore solar options, https://generation180.org/solar-schools/
- National Renewable Energy Laboratory (NREL) – Solar Energy in Schools, Features research, data, and technical assistance on solar implementation in schools and other public buildings, https://www.nrel.gov
- U.S. Department of Energy – Energy Saver: Solar for Schools, Includes information on solar technologies, funding opportunities, and benefits for educational institutions, https://www.energy.gov/energysaver

WIND ENERGY - A BRIEF DISCUSSION

Wind turbines can produce a significant amount of power and electricity in small spaces. Wind turbines have not been favored over solar PV electricity production at Wisconsin schools and businesses in recent years. Wind turbines require at least annual maintenance, including lubrication of the turbine's gears and generators. This means that each year a maintenance technician either needs to scale the wind turbine tower or the turbine must be somehow accessible on the ground, using systems like tilt-up tower structures. In addition, permitting large-scale wind turbines is generally more difficult than permitting a solar array. That said, wind turbines are a viable renewable energy source in Wisconsin, particularly in open rural areas and along the Great Lakes, where average wind speeds of at least 12–14 miles per hour are sufficient for effective electricity production. Utilities operate over 430 wind turbines in Wisconsin, providing enough annual energy to power over 170,000 homes.

Wind turbines generate electricity by converting the kinetic energy of wind into electrical power. When the wind blows, it turns the blades of the turbine, which are connected to a rotor that spins a shaft connected to a generator, producing electricity. Modern wind turbines are equipped with sensors and control systems that adjust the blade angle and orientation to capture the most energy efficiently. This energy can then be used on-site or fed into the electric grid.



RENEWABLE NATURAL GAS (RNG)

FIGURE . ANAEROBIC DIGESTERS ON A WISCONSIN FARM

Renewable Natural Gas (RNG) is a clean, pipeline-quality gas derived from organic waste sources such as landfills, livestock manure, food waste, and wastewater treatment plants. Unlike conventional natural gas, RNG is produced by capturing and upgrading methane emissions from decomposing organic materials, making it a low-carbon or even carbon-negative fuel. RNG can be sourced directly from local biogas production facilities, through utilities offering RNG supply programs, or by purchasing Renewable Thermal Certificates (RTCs) or environmental attributes linked to RNG use. These options allow schools to reduce their carbon footprint while utilizing existing gas infrastructure.

The carbon intensity (CI) of RNG is significantly lower than that of fossil fuel natural gas. While conventional natural gas has a CI of around 70–100 gCO_2e/MJ, RNG can have a CI as low as 0 or even negative values, especially when derived from sources like dairy manure or food waste, which prevent methane from escaping into the atmosphere. This means RNG can not only reduce greenhouse gas emissions but also help offset other carbon-intensive activities.

Work with your local utility and wholesale natural gas suppliers to learn what the true feasibility and costs are for RNG. The table below considers a 72,000 square foot school, and makes an apples–to-apples energy comparison, considering heating energy input in MMBtu for both a natural gas boiler and geothermal (electric) heating system. Estimated efficiency of heating is also factored in, with natural gas boilers being about 90% efficient and geothermal about 360% efficient (Coefficient of Performance, COP, of 3.6). The table also considers electricity at $0.16 per kWh, natural gas at $0.60 per therm, and RNG at a cost of $20 per MMBtu ($2 per therm).

The table below does not consider several important factors such as the inflation of natural gas and RNG. Schools that invest in solar take inflation of electricity costs out of the equation—the cost of solar electricity is $0 per kWh once the solar is installed. That said, schools that are limited in their ability to upgrade heating, ventilation, and air conditioning (HVAC) infrastructure and/or are limited in their ability to install enough solar PV capacity to offset their HVAC, RNG may be considered as a no- or negative-carbon energy source. Schools can utilize existing boiler infrastructure and utilize RNG. This quick analysis shows it would cost an additional $30,832 annually to use RNG in place of utility natural gas. A school could heat its building for over 100 years with RNG using the same amount of money, $3.75 million, it may cost to install both solar and geothermal infrastructure on a school.

Figure. Comparison of Heating Costs with Natural Gas, RNG, and Geothermal

	Natural Gas Boiler Efficiency 90%	RNG Boiler Efficiency 90%	Geothermal Efficiency 360%
MMBtu Energy Input	2,202	2,202	551
Annual Heating Cost	$13,214	$44,045	$0-$25,818
Geothermal Infrastructure Upgrade Cost	$0	$0	$3,000,000
Solar PV Cost to Displace 250,000 kWh of Geothermal Heating	-	-	$750,000
Total Infrastructure Upgrade Cost	$0	$0	$3,750,000
Value of Solar Sold to Utility (4¢/kWh)	$513	$25	

*The $25,818 annual heating cost with geothermal considers purchasing all electricity from the utility. On a pathway to net zero energy, it is recommended to offset geothermal heating consumption with solar energy, which would cost $0 once the solar is installed.

RENEWABLE ENERGY CERTIFICATE (REC) OFFSETS

If physical infrastructure areas limit the size of on-site solar production, schools may offset electricity consumed from the grid by purchasing Renewable Energy Certificates (RECs). It allows you to support renewable energy projects elsewhere and claim the environmental benefits. Each REC represents one megawatt-hour of electricity generated from a renewable source. REC prices vary depending on supply and demand, volume of purchase, and other factors. Prices for Wisconsin were not available at the time this plan was written, but online resources show a range in REC prices from $1 to over $5 per megawatt-hour. For example, Omaha Public Power District's website reads that RECs can be purchased for $3.34 per megawatt-hour, and that means for every 100,000 kWh the school consumes in RECs, it would cost the school $334.

[INSERT INFORMATION ON PROGRAMS THOUGH THE SCHOOL'S ELECTRIC UTILITY]

6. STRATEGIZE SCHOOL TRANSPORTATION

Electric vehicles (EV's) and electric school buses have zero tailpipe emissions and may have lower operating costs than standard gasoline and diesel vehicles. If considering EV and electric school bus infrastructure, start analyzing your school's electrical capacity early in the process. The electrical capacity requirements for EV and electric school bus charging at schools are significantly higher than for typical building operations, especially when multiple vehicles are charged simultaneously. Electric buses require high-power chargers, often 60 kW or more per bus, which can strain existing electrical infrastructure. Schools may need to upgrade transformers, panels, and service connections to support the increased load. Plan for these upgrades to ensure reliable charging, avoid peak demand charges, and allow for future.

ELECTRIC VEHICLE CHARGING

Beyond the school building and installing renewable energy, net zero energy pathways for many schools involve installation of electric vehicle (EV) charging stations and the use of electric school buses. EV charging infrastructure supports a school's path to net-zero energy by enabling the integration of electric vehicles, like buses and staff vehicles, into a clean energy ecosystem. When paired with on-site renewable energy sources—such as solar arrays—EV chargers can be powered by clean electricity, reducing reliance on fossil fuels and further cutting greenhouse gas emissions. Additionally, with smart charging technology and vehicle-to-grid (V2G) systems, electric vehicles can store excess energy and feed it back into the school's energy system during peak demand times. This not only enhances energy efficiency and grid resilience but also maximizes the use of renewable energy, pushing schools closer to their net-zero energy goals.

ELECTRIC SCHOOL BUSES

Electric school buses produce zero tailpipe emissions, eliminating pollutants like nitrogen oxides and particulate matter that are prevalent in diesel exhaust. This transition not only contributes to decarbonization efforts but also improves the health and well-being of students by reducing their exposure to harmful emissions during daily commutes. Financially, while electric buses have higher upfront costs compared to diesel counterparts, they offer significant long-term savings. Reduced fuel and maintenance expenses can lead to savings over the lifespan of an electric bus.

7. ENGAGE THE COMMUNITY

Teacher, student, staff, and community engagement is essential in net-zero energy school initiatives to build support and find contributors to champion sustainable, long-term solutions. Consider the following ideas as choices your school can make as next steps towards a net zero energy school.

Continue Clean Energy Advisory Committee Work. The energy advisory committee can build from this plan to set and achieve strategic goals towards a net zero energy school. Continue to include administrators, facilities staff, teachers, parents, students, and local energy or sustainability experts.

Make Energy Awareness a District Initiative. "Low-hanging fruit" energy savings may have been reaped based on the energy performance benchmark achieved at each school. This is the perfect time to involve building occupants—students, teachers, and staff—in understanding how each of their buildings use energy. Awareness is a great way to initiate energy savings from human behavior, and to educate each person for their own benefit in household energy management.

Integrate Energy Awareness into School Curriculum. Integrating energy awareness into the school curriculum can be achieved through hands-on projects, interdisciplinary lessons, and real-time data from the school's energy systems to help students connect classroom learning with real-world sustainability practices. Your school is highly encouraged to check out the free resources provided by the following local organizations:

- Focus on Energy, Renew Our Schools Challenge, which offers K-12 schools eGuage technology and hands-on learning opportunities. https://focusonenergy.com/renewourschools
- UW-Steven's Point's K-12 Energy Education Program (KEEP), which provides lessons and professional development opportunities to support energy education for Wisconsin K-12 schools. https://focusonenergy.com/renewourschools
- CREATE Energy Center. CREATE provides faculty workshops, instructional materials, energy career resources, program and curriculum development and industry partnerships. https://createenergy.org/
- Wisconsin Public Service SolarWise program provides hand-on renewable energy curriculum and teacher training, along with an annual Solar Olympics student competition of renewable energy projects. https://www.wisconsinpublicservice.com/environment/solarwise/

Public Awareness Campaigns and Community Partnerships. Share this plan with your community to inspire action and gain support. Use surveys, community meetings, and other forms of public input to help guide your school's path to net zero energy.

Student-Led Awareness Campaigns. Students can effectively market school sustainability goals and efforts through creative campaigns such as social media outreach, posters, school announcements, events, and peer-led presentations that engage and inspire the wider school community.

Consider Sponsorship. Many school sports complexes and other facilities are sponsored by local businesses. Sponsorship may also be an opportunity to fund energy efficiency and renewable energy efforts for your school.

APPENDIX

PROJECT FINANCE RESOURCES

Focus on Energy offers a variety of incentives for energy-saving projects. Work with your school's FOE advisor, explore the Utility Bill Energy Savings Program, and no-cost 123 Energy Audit, along with retrocommissioning and Whole Building Tune-Up information and incentives, and incentives on a variety of technologies and energy-saving improvements

- Renew Our Schools offers schools sub-metering equipment (eGauge-brand) to monitor and track electricity use to discover no-cost energy and power demand savings opportunities. https://focusonenergy.com/renewourschools

CREATE Energy Center offers no-cost educator training faculty workshops, instructional materials, energy career resources, program and curriculum development and industry partnerships. (https://createenergy.org/)

UW-Steven's Point's K-12 Energy Education Program (KEEP), provides lessons and professional development opportunities to support energy education for Wisconsin K-12 schools. (https://www.uwsp.edu/wcee/wcee/keep/#:~:text=KEEP%2C%20Wisconsin's%20K%2D12%20Energy,activities%2C%20and%20school%20site%20resources).

RENEW Wisconsin Solar on Schools program provides in-kind solar panel grants and technical assistance to Wisconsin K-12 schools and colleges pursuing solar PV systems.

Wisconsin Public Service SolarWise program provides hand-on renewable energy curriculum and teacher training, and annual student competition of renewable energy projects. (https://www.wisconsinpublicservice.com/environment/solarwise/)

Under the Inflation Reduction Act (IRA), public schools can benefit from the Investment Tax Credit (ITC) through a mechanism known as **Direct Pay** (also referred to as **Elective Pay**). This provision allows tax-exempt entities to receive a cash payment from the IRS equivalent to the value of the tax credit for qualifying clean energy projects, such as solar installations. This enables schools to access federal clean energy incentives, making renewable energy projects more financially feasible. (https://www.cleanegroup.org/publication/itc-direct-pay-guide-for-nonprofits/?utm)

National Association of Energy Service Companies provides a national listing of Energy Service Companies (ESCO's) that can provide energy services with no-upfront costs that are financed by energy savings. (https://www.naesco.org/)

[INSERT TABLE ON ELECTRICAL PANEL INFORMATION]

[INSERT TABLE ON ENERGY IMPROVEMENT COST ESTIMATES]