# Schools Districts Finding Their Stride in Getting to Zero

*Amy Cortese, New Buildings Institute*
*Nik Kaestner, San Francisco Unified School District*
*Reilly Loveland, New Buildings Institute,*
*Jeff Medwetz, Boulder Valley School District*
*Aaron Presberg, Portland Public Schools*

## ABSTRACT

Schools are an early adopter in achieving zero energy. According to a 2019 list of zero energy buildings, the education sector leads, with 211 kindergarten through twelfth grade (K-12) facilities representing 34% of the total verified or emerging zero net energy buildings. (NBI 2019).

Demonstrated examples and technical guidance like the 2018 ASHRAE Zero Energy Advanced Energy Design Guide for K-12 Schools prove that simple solutions and a common palate of measures can achieve zero for little, if any, incremental cost in new construction. However, no zero energy school retrofit has yet been verified, and many districts are not building new. Districts struggle with deferred maintenance and how to get to zero across their portfolio.

This paper presents experience of three school districts who are actively working to overcome these challenges and eventually get to zero in all their facilities. Boulder Valley School District, San Francisco Unified School District, and Portland Public Schools are developing and implementing comprehensive, strategic approaches that utilize energy efficiency goals and targets to influence policies, plans and projects.

This paper explains how these schools have used efficiency as the core of their plans to achieve a clean energy future. It builds on real world experience, national research, and participation in programs like the U.S. Department of Energy's Zero Energy Accelerator Program and California's Proposition 39 ZNE School Retrofit Pilot program. It will add to the body of knowledge in this sector by providing a blueprint that can be emulated by energy efficiency programs and school districts alike.

## Introduction

The United States has over 98,000 public school buildings, representing 7.5 billion gross square feet of floor space, where over 50 million primary and secondary students attend school (NCES 2017). Decisions about facilities are made at the local level, by school boards and district staff of over 13,600 different public school districts (Ibid). School districts spend $8 billion / year on utility costs, according to the U.S. Department of Energy (U.S. EPA 2017). This represents about 3% of the annual operating budget and represents the second largest line item, behind only staff salaries.

Since the beginning of the U.S. Green Building Council's Leadership in Energy and Environmental Design program, the education sector has been at the forefront of the green building movement. Yet, even in California, LEED schools make up only 20% of school new construction, and represent just 2% of the total education building stock (Pande, et al. 2019, 63). This is despite decades of research showing that sustainable, high performance schools have many benefits including higher student test scores, reduced operating cost, increased attendance, enhanced

teacher performance and satisfaction, reduced environmental impact, increased building life and reduced liability for school district. (CHPS 2006, 2-10).

## Status of Zero Energy in Schools

Leadership in the education sector continues on the path to zero energy in school buildings. A zero net energy building, sometimes called a zero energy or net zero energy building, is an energy efficient building that produces as much energy as it consumes over the course of a year. This can be zero when measured at either the "site" or "source," meaning that the energy consumption is defined at the site boundary or at the source which takes transmission and distribution losses into account (Torcellini et al., 2006). Energy efficiency is an important way to manage first costs in a zero energy building. (ASHRAE 2018, 26).

Education buildings make up 34% (211 buildings) of the total number of buildings in the largest dataset of buildings verified or striving to operate at zero energy (NBI 2019). A number of efforts have supported this early market development, including programs like the U.S. Department of Energy's Zero Energy School Accelerator program and the Proposition 39 Zero Net Energy (Prop 39 ZNE) School Retrofit Pilot Program administered by the California investor owned utilities. However, these programs focused on individual zero energy building projects, rather than a systematic approach to improve energy performance in the overall district portfolio.

## Districts on the Path to Zero

At least three school districts are actively working to surpass goals at the building-level and get to zero net energy (ZNE) across their entire portfolio. This paper represents their experience. Boulder Valley School District (BVSD), San Francisco Unified School District (SFUSD), and Portland Public Schools (PPS) are three districts that are developing and implementing plans to get to zero over time in their school operations, although they are at different phases in the process.

Located in the foothills of the Rocky Mountains, Boulder Valley School District stretches more than 500 square miles from the Continental Divide to the Denver suburbs. The district operates 63 buildings of over 4.8 million square feet to support more than 31,000 students. BVSD is building on three decades of environmental stewardship and continues to embrace and integrate environmental sustainability. The district hired a Sustainability Coordinator in 2008 and a Project Manager of Energy Systems in 2009 to manage sustainability and energy. That same year, BVSD began their journey toward better energy management with their first Sustainability Management System Plan (SMS) that outlined energy goals (BVSD 2009). The SMS is a comprehensive approach for identifying and coordinating existing efforts, establishing baselines, defining sustainability for BVSD, and creating plans to integrate sustainability into operations and curriculum. BVSD developed the Sustainable Energy Plan in 2013 to address energy consumption in more detail because energy significantly impacts the district's environmental footprint and budget (BVSD 2013). The energy plan set a long-term goal to be ZNE-capable by the year 2050. In 2015, BVSD released the updated SMS to reflect new 5-year goals and updated visions and this was formally incorporated into Board Policy (BVSD 2015). BVSD will be further updating the SMS and celebrating the 10-year anniversary of their work in 2020.

SFUSD embarked on the path to ZNE after attending in-person workshops hosted by the California investor owned utilities as part of their Prop 39 ZNE School Retrofit Pilot Program and

by the California State Architect as part of the 7x7x7: Design/Energy/Water challenge, which identified strategies for retrofitting existing buildings to meet ZNE goals (GTZ 2020, M. Ross 2016). Since then, SFUSD has completely transformed the process by which it designs, constructs, and modernizes its campuses. New buildings are designed to be ZNE-ready, building modernizations are aligned with future energy goals, and all facilities and deferred maintenance projects must adhere to a strict set of sustainability guidelines. As laid out in its 2017 Carbon Neutral Schools resolution, SFUSD's goal is to go beyond ZNE to achieve carbon neutrality by the year 2040. As of March 2020, the District has completed the first of five new ZNE-ready buildings.

PPS, located in Portland, Oregon, has been requiring LEED certification for school construction and major modernization projects since 2012. PPS has 98 school sites and operates 254 buildings (178 permanent and 76 modular buildings). The average age of permanent buildings is 68 years. The 2011 Long Range Facilities Plan evaluated the adequacy of existing educational facilities, plan for future capital facilities spending and address how the student population will be housed over the next 10 years. (PPS 2011). It also identified a $1.6 billion deferred maintenance backlog (Ibid, I-2). Since then efforts have been focused on addressing immediate needs and use of bond funding for modernization of high schools, many of which have operated for over 100 years. One new middle school is on the Path to Net Zero through a program with the Energy Trust of Oregon, and this has encouraged the district to take another look at how building construction, renovation and repairs are conducted and encouraging the district go even further (ETO 2020).

These districts recognize that getting to zero will take a long-term, concerted effort with regular and ongoing tracking of energy performance. This paper summarizes the barriers, approaches, lessons learned and experiences of these districts as experienced by staff in their efforts to overcome common challenges and develop solutions on the path to zero.

## Barriers in Getting to Zero

K-12 school districts face a number of barriers to improving the energy performance in their portfolio and advancing the district portfolio to ZNE. Past research has categorized these as: (1) lack of awareness surrounding getting to zero, (2) lack of process to consider energy, and (3) lack of financing for efficiency (Cortese et al. 2018)

(1) *Lack of Awareness.* Lack of awareness about getting to zero energy is a primary barrier to shifting the education market to zero energy emissions. The lack of awareness barrier is the result of a number of factors. First, the school market has many decision makers and influencers in each of the districts across the country. These decision makers include school boards members, administrators, business officials, facilities staff, design and construction professionals, principals, teachers etc. (Torcellini et al. 2019). Not surprisingly, the primary focus of these decision makers is on educating students, not on energy, and most of these market actors remain unfamiliar with the benefits of getting to zero (such as improved health and productivity). In general, most school district are barely tracking energy performance, let alone demanding zero energy. This same lack of awareness exists among many design and construction professionals, who do not know how to achieve zero on a conventional project budget (Ibid). Even in early adopter school districts, maintenance staff may feel uncomfortable with newer systems technology where there is often a mismatch between staff skills and those needed to operate newer equipment.

(2) *Lack of Process*. Another barrier to zero energy in the school sector is that few districts have a process to incorporate energy into decision making. In the Boulder Valley, San Francisco Unified and Portland Public school districts, the focus during construction projects is meeting

schedules and minimizing capital (i.e. first) cost to complete the project, not the ongoing costs that would be paid out of the general operating budget.

While many districts are benchmarking energy performance, educational concerns guide actions, not energy. In fact, energy is often not considered, or not considered early enough in conventional district practices. For example, energy is rarely considered in facilities assessments which are often seen as a first step to building improvements. This lack of consideration of energy tends to drive districts toward a like-for-like replacement rather than investigating opportunities for efficiency improvements.

Most districts do not have policies or plans in place that would guide construction, retrofits, or equipment replacement toward more efficient solutions. In addition, tight construction schedules create additional complications since construction can only be scheduled around school breaks when students and teachers are away from the building. This even presents challenges when applying for and receiving energy efficiency incentive dollars from local programs.

(3) *Lack of Dedicated Funds*. School district financing for facilities is complicated and varies by state. Generally, it consists of general fund dollars for routine operations and maintenance (O&M) and capital dollars, often from bond funding, for repairs, renovations and/or new construction. These separate sources of funding cannot be commingled.

Another challenge is that many schools are in disrepair after years of underfunding O&M, which means that the cost of upgrading schools can be significant. In fact, the American Society for Civil Engineers give America's schools a "D+" on their school infrastructure report card, and report that 53% of schools need improvements to reach "good" condition. (ASCE 2017) In addition, the Center for Cities and Schools at the University of California Berkeley has found that most schools do not meet industry benchmarks for funding school O&M, and that this can contribute to deteriorating facility conditions, shortened facility useful life, and poor student educational outcomes (Vincent and Brown 2015).

## Getting to Zero Over Time

In private commercial building portfolios, Rocky Mountain Institute outlines a six step process for zero over time that leverages major life-cycle events as trigger events for energy upgrades, when incremental costs are lowest (Carmichal et al 2018). While RMI approach focuses on return on investment, a metric common in commercial buildings but not in schools, the framework of zero over time holds true in school districts who also aim for zero over time. The six-step process includes: (1) setting goals, (2) establishing a baseline, (3) planning efficiency projects, (4) analyzing renewables, (5) implementing projects and (6) tracking progress Below we examine steps in the approach, as well as how this applies to our three school districts.

(1) *Set goals*. School district goals are established by board policy. An energy champion, often an energy or sustainability manager, is key to success in developing the policy. They must first gain stakeholder support by recognizing that different stakeholders have different drivers so messages can be tailored to the interests of any particular stakeholder (Torcellini et al. 2019, 14). Goals are set at various levels, for example at the overall portfolio, individual building level and for particular life-cycle events. In public school districts, overarching goals are supported by plans and policy guidance documents that outline how these goals will be achieved. The policy sets the minimum performance required in bond construction and policy guidance documents help district staff implement the policy.

SFUSD's goals are to reduce energy usage 50% by 2030, eliminate combustion of natural gas by 2040, and generate 100% of their own power needs by 2050 (SFUSD 2017). BVSD's goals are outlined in their SMS plan, first written in 2009 and updated in 2015. The SMS strives toward net zero energy buildings with an average EUI of 30 kBtu/square foot-year, and an 80% reduction in greenhouse gas emissions, and climate neutrality by 2050 (BVSD 2015). PPS is currently in the process of setting formal goals which aim to achieve an average site EUI of 30 kBtu/ square foot-year by 2040 across their entire portfolio from a 2018-2019 baseline of 55 kBtu/square foot-year.

In addition to these overarching goals, all three districts have established site Energy Use Intensity (EUI) targets for "triggers" such as new construction and major modernization. This is seen as a way to track improvements over time, and to compare design predictions to actual performance outcomes. The ASHRAE Advanced Energy Design Guide (AEDG) for new K-12 Schools provides a table of EUI targets for primary and secondary schools in various climate zones. The site EUI targets range from 17 - 25 kBtu/square foot-year depending on type of school and its location (ASHRAE 2018, 34).

(2) *Establish a baseline*. Energy benchmarking is the primary method to establish a baseline in school districts. As they say, you cannot improve what you don't measure, therefore all three districts are actively tracking the energy performance of their buildings. This provides insights into building performance, allows districts to compare buildings across their portfolio, and understand how any particular building is performing over time. While site EUI is the most commonly tracked energy metric, these districts have learned that weather normalization of data is needed to account for variations in temperatures and to account properly for cold winters. While kilowatt hours and therms are important, utility costs –and avoided utility costs – is of critical of importance to particular stakeholders, including school business officials and the school board.

(3) *Planning efficiency projects*. Districts rely on the various policy guidance documents previously outlined when planning for efficiency projects. Given the focus on education rather than energy outcomes, as well as the reality of massive deferred maintenance in all of the districts, opportunities to improve efficiency must piggyback on existing bond projects, rather than running a parallel and separate process for efficiency projects. These districts have learned to find synergies within the existing project pipeline to overlay efficiency. Each life-cycle trigger has its own process to ensure that energy efficiency is achieved.

Building assessments play an important part in project planning by outlining opportunities within individual school facilities. Level 2 ASHRAE audits form the basis for any renovation or major system replacement to achieve aggressive energy reduction goals. However, they have learned that conventional building assessments often do not go far enough to get to zero. Typical assessment looks only at like-for-like replacement, but in these districts, a deeper level of opportunities are explored. In addition to audits covering routine HVAC and lighting systems, they also search for opportunities to caulk and seal the building envelope and install solar on the roof. This is consistent with findings from the Prop 39 Zero Net Energy Pilot program by California investor owned utilities (GTZ 2020).

To support project planning, SFUSD conducted energy modeling to investigate particular measures that would result in efficiency upgrades. After a number of models on different schools, a pattern of common measures was identified. Now these measures are incorporated in the tech spec and OPRs, reducing the need for ongoing energy modeling in the district.

(4) *Analyzing renewables*. While the feasibility of solar is increasing, most school districts are far from producing as much energy as they consume with onsite renewables. Often, these districts are simply trying to address massive deferred maintenance challenges, and have a limited

budget for solar. However, SFUSD wanted to gain experience with maintaining a solar system, and photovoltaics have been incorporated into new construction and major renovation projects in SFUSD (Willie Brown Middle School). Power purchase agreements are another option that has been employed in BVSD, where they have a 100 kilowatts of solar on 14 schools.

Oregon state law requires that public entities, including school districts, spend 1.5% of public building construction costs on green energy technology (Oregon 2013). While this used to be devoted entirely to renewables, the rule was recently expanded to include investment in passive approaches, energy efficiency and geothermal systems (ODOE 2020). Now PPS has some flexibility on how to invest these funds, and they can use energy modeling to determine the most cost effective ways to save energy. Their first school on the path to net zero is the Kellogg Middle School which is currently under construction.

(5) *Implementing projects*. A number of policy guidance documents support the goals and policy during implementation. Owners Project Requirements (OPRs) and Energy and Sustainability Standards outline school district expectations when procuring a new building or major modernization. EUI targets, along with other sustainability goals such as water conservation, are explicitly written into a districtwide OPRs and Energy Standards. These documents also clarify expectations regarding important aspects of the integrated design process (such as energy modeling and system and envelope commissioning).

Another important guidance document for school districts to get to zero are Facility Assessments and Master Plans which center on improving the learning environment and providing better schools. On the path to zero, these plans are slightly different than conventional assessments. Assessments on the path to zero align every retrofit opportunity with energy efficiency goals. Zero energy assessments prioritize load reduction, typically with building envelope first (sealing/caulking, insulating, shading, windows) as well as reduction of lighting and plug loads. The next step is to optimize mechanical design and serve it with efficient mechanical equipment before adding photovoltaics as a last step (Resource Refocus 2020, 122). BVSD has found that evolving these plans past a like-for-like equipment replacement is critical in efforts of continual improvement toward aggressive energy goals (BVSD 2013).

Technical specifications ("tech specs") are a third important energy policy guidance document. Based on standardized formats, tech specs organize written information regarding building construction into "Divisions", many of which influence building energy use. Tech specs set minimum performance standards for building characteristics and particular equipment, and they further clarify requirements expected by the district regarding the design and construction process. Essentially, when updated with equipment that supports low energy use intensity goals they can outline a prescriptive approach to get to zero.

The project implementation approach depends on the particular life-cycle trigger. In new construction and major modernization, energy goals are incorporated into the overall project goals and expectations as defined by the OPR. Energy considerations can also be mentioned in requests for proposals and asked about during interviews. This makes the prospective design teams consider how they will achieve the goals, and encourages them to go back to other projects to see how well those are performing. According to our school districts, asking potential teams about their experience and success with regard to efficiency and renewable systems during the interview process can increase the likelihood that their selected team is supportive and knowledgeable about how to achieve deep energy reductions within a limited budget.

While guidance documents like OPRs and tech specs are necessary in new construction and modernization projects, they are not sufficient to ensure that energy goals are achieved in

actual performance. The district must have an adequate process to ensure that these goals are considered throughout design and construction. The energy champion, along with energy and commissioning consultants, should be included in early design meetings, and regularly throughout the design and construction process. Moreover, the energy champion is often the staff responsible for double-checking that the design team is complying with details as outlined in the tech specs. The energy champion works to review the outcomes of the energy modeling and ensures that the commissioning agent is onboard and part of the team during the design phase. In summary, new construction and modernization projects require an internal process flow that loops in the energy champion as a key part of the design and construction process.

In school districts with dozens of schools, system replacement and end-of-life equipment replacement can present special challenges for energy efficiency. This is because there are many different individuals involved in the implementation of these projects and they happen very quickly. In this case, the role of the energy champion is to ensure that all project managers in charge of these projects are using the technical specs appropriately, so that efficiency continues to be part of every project moving forward.

(6) *Tracking progress*. Regular energy benchmarking tracks progress that is reported back to school boards and other stakeholders. Reviewing benchmarking data has revealed important insights into energy performance and the success of programs.

BVSD reports energy performance and cost savings annually to the school board. BVSD was able to detect a 19% reduction in energy in general renovation and retro-commissioning projects, a 34% average improvement from deep energy retrofits, and a 44% reduction over code in new construction projects. Moreover, benchmarking data has allowed the Energy Manager at BVSD to share data showing that the 2006 bond, before the plan, resulted in a 16% decrease of energy usage, while the 2014 bond has achieved a 26% improvement to date. Figure 1 shows a graph of weather normalized historical average EUIs for BVSD.

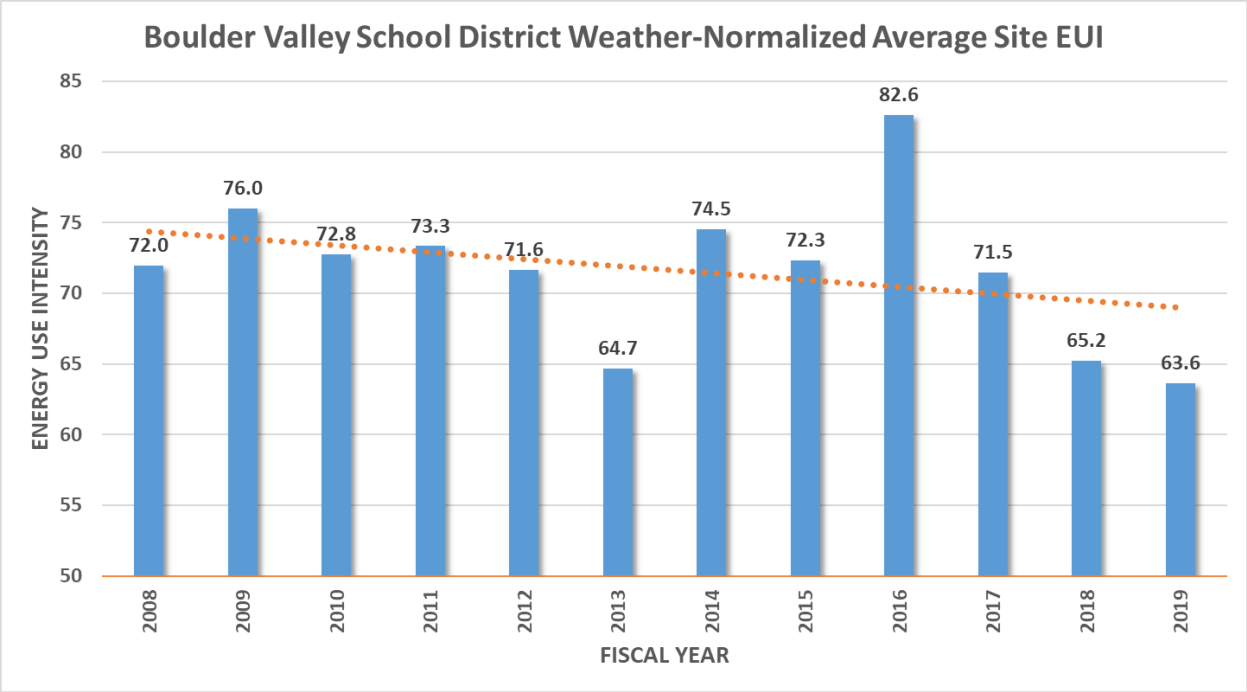


Figure 1: BVSD Weather-Normalized Average Site EUI

In SFUSD, progress toward energy goals is reported at the annual budget meeting. SFUSD has learned that their newest buildings were not always their most energy efficient by benchmarking against others in their district. PPS is still working on an appropriate format to report progress in energy improvements over time to school stakeholders and decision makers. All three districts have developed an online benchmarking dashboard to summarize energy consumption and solar production across their portfolio (BVSD 2020, SFUSD 2020, PPS 2020).

## From Energy to Carbon

A zero carbon building is one that produces zero carbon emissions and includes zero combustion on site (V. Burrows, 2018). Getting to zero carbon requires considerations beyond energy efficiency including the carbon content of electricity as well as on-site gas combustion. Specifically, it requires consideration of the fuel type used in building systems. Many facilities maintenance staff are not familiar with all-electric equipment. Some have expressed dissatisfaction with variable refrigerant flow (VRF) systems because of refrigerant lines running through occupied spaces which present challenges when they need to service the equipment. Overall, districts have found a mismatch between the skills of staff and the skills needed to maintain unfamiliar equipment.

When striving for zero carbon, kitchen staff are also important stakeholders, especially if they are accustomed to working in a gas kitchen. Special outreach might be necessary to convince them to go all-electric. SFUSD has identified many benefits of electrification in kitchens, including the health of the food (specifically due to the removal of gas fryers) as well as the improved air quality and temperature management in electric kitchens (Seals and Krasner 2020).

Each of the districts is addressing gas combustion in its own way. SFUSD has laid out its strategy for replacing natural gas building systems with all-electric equipment and procuring electric and renewably-fueled vehicles in a Carbon Reduction Plan (SFUSD 2017). Generally, SFUSD is not buying new gas equipment, and gas infrastructure is banned in new construction. They are actively investigating electric replacement equipment, although staff admits this is a challenge with old steam boilers. Currently, SFUSD is considering switching to an air to water heat pump system where the heat transfer medium is water for ease of maintenance. As of March 2020, SFUSD has completed the first of six fuel-switching projects.

In BVSD the next iteration of the SMS may consider fuel type selection in future district projects. PPS is still considering how to address gas in their portfolio, but a current zero energy new construction project eliminated gas and saved $800,000 in first costs with this decision.

## Lessons Learned

The school district staff authors offer the following lessons learned to others and on their path to zero:

- Process is critically important on the path to zero. This includes the process of getting an overarching strategic energy plan and goals in place, as well as the process employed during the design and construction process on individual building projects. While guidance documents like OPRs and tech specs are important, they are not enough if staff is not actively double

checking against them. This means that energy or sustainability staff needs to be part of the design, construction and retrofit process.

- These early adopter districts all report that the process of gaining trust and internal buy in with facilities staff and other internal stakeholders can be a challenge. It takes time to develop trust with the internal teams who are ultimately responsible for making sure that schools function and are energy efficient. It is critical to listen and understand their concerns in order to move beyond the "us and them" mentality that can effectively stymie projects and progress toward goals. The energy champion must understand why the maintenance staff may be reluctant to change their typical behavior so that their needs can be adequately addressed.
- The energy champion should connect energy and sustainability goals to the district's mission/vision and align it with goals that support a positive learning environment for students and staff, including healthy buildings and good indoor air quality.
- Commissioning agents are worth the money from both system performance and maintenance standpoint. Commissioning agents add value through their ability to catch a number of details that would not have been identified without them.
- Schools must get beyond like-for-like replacements and that this must start with doing building assessments differently, in a way that prioritizes considerations of energy.
- BVSD suggests that districts look for low-hanging fruit to build momentum for their sustainability program. In their district, an early review of the building energy management system uncovered disparities between building operating schedules, which were set between 6:00 a.m. and 6:00 p.m., and actual occupancy patterns. This allowed them to quickly and inexpensively save energy with scheduling adjustments.
- BVSD suggests that board energy policy is key because it gives clear guidance and rationale that steps toward efficiency must be taken because there is a board policy that demands it. SFUSD had a slightly different approach where the Sustainability Director worked behind the scenes to gain support from internal stakeholders before the board policy was passed.
- SFUSD has found that the district does not need perfection to advance energy and carbon goals. They have learned to be realistic with the resources at hand and decide how to build systems that are easily maintained (e.g., opting for all-electric heat pump systems over VRF).
- Regular reporting to the school board and school business officials ensure that the plan is progressing toward its stated goals.

## Conclusion and Next Steps

Getting to zero energy in schools takes a long-term, strategic effort across an entire portfolio. Most projects in the existing pipeline can be leveraged to incorporate deep energy reductions and possibly renewable energy sources. However, the public nature of schools and the many stakeholders involved can make this difficult. An energy champion is helpful to spearhead a planning and implementation process on the path to zero. This person can help set overarching goals, and develop policy guidance documents that dictate efficient choices in building design and construction. However, having the policy is not enough. The champion must also ensure that the prescriptive approaches are used and low-energy, zero energy and zero carbon outcomes are achieved through routine benchmarking. Regular reporting to the school board and business officials ensures that the plan is progressing toward its stated goals.

Each of the three districts has clear next steps on their ongoing path to zero. BVSD will be updating their Sustainability Management System which includes a status update and the evolution

of goals. SFUSD is taking lessons learned from their process to date to refine requirements on upcoming bond projects. They will be closely monitoring their first zero net energy projects, the first of which has been occupied since September 2019. PPS is working diligently to update their tech specs and OPRs in advance of a vote on a bond measure expected to take place in November 2020, so the requirements will be mandatory for all construction projects going forward.

Building off the success of these and other districts, NBI is working to get more districts committed to zero over time through the creation and facilitation of regional cohorts of school districts that are interested in working together to share experiences and develop their own program for getting to zero. This is based on the model from the U.S. Department of Energy's Zero Energy School Accelerator project, only this effort will expand beyond individual buildings to overall portfolio level improvement.

With the successful start of these three districts on the path to zero energy and carbon plus additional efforts to transform the market, the goal is to get more school districts to adopt goals, policies and practices to get to zero energy and zero carbon emissions over time and to use these facilities themselves to educate the next generation of environmental leaders.

## References


ASCE (American Society for Civil Engineers). 2017. *2017 Infrastructure Report Card*. Reston, VA: ASCE Foundation.

ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers). 2018. Achieving Zero Energy: Advanced Energy Design Guide for K-12 School Buildings. Atlanta, GA.: ASHRAE.

BVSD (Boulder Valley School District). 2009. Sustainable Management System Document. Boulder Valley, CO.: Brendle Group.

BVSD (Boulder Valley School District). 2013. Sustainable Energy Plan. Boulder Valley, CO.: Boulder Valley School District Department of Operational Services.

BVSD (Boulder Valley School District). 2015. Sustainable Management System: Five Year Update. Boulder Valley, CO.: Boulder Valley School District Department of Operational Services.

BVSD (Boulder Valley School District). 2020. Live Energy Data for BVSD Schools. https://www.bvsd.org/departments/operational-services/sustainability/sustainability-management-system

C. Carmichael, M. Jungclaus, A. Peterson. 2018 Guide: Best Practices for Achieving Zero Over Time for Building Portfolios, Rocky Mountain Institute. https://rmi.org/insight/zero-over-time-for-building-portfolios

CHPS (Collaborative for High Performance Schools). 2006. *Best Practices Manual Volume 1: Planning*. Sacramento, CA: CHPS, Inc.

Cortese, A., M. Lyles, R. Loveland, M. Sutter. 2018. "Zeroing in on Energy Performance in New and Existing Schools." In Proceedings of the ACEEE 2018 Summer Study on Energy Efficiency in Buildings, 10: Net Zero: Moving Beyond 1%. Washington, D.C.: American Council for an Energy-Efficient Economy.

CPUC (California Public Utilities Commission). 2017. *California K-12 and Community College Zero Net Energy Retrofit Readiness Study*. San Francisco, CA: California Public Utilities Commission Energy Division.

ETO (Energy Trust of Oregon). 2020. Path to Net Zero Energy. https://energytrust.org/pathtonetzero/. Portland, OR.: Energy Trust of Oregon.

GTZ (Getting to Zero). 2020. Proposition 39 Zero Net Energy School Retrofit Pilot. https://gettingtozeroforum.org/prop39-zne-schools/. Portland, Oregon.: New Buildings Institute.

Burrows, V. 2018. The Pathways to Zero Net Carbon Buildings. https://www.worldgbc.org/advancing-net-zero/what-net-zero. London, UK.: World Green Building Council.

NBI (New Buildings Institute). 2019. *2019 Getting to Zero Status Update and List*. Portland, OR: New Buildings Institute. https://newbuildings.org/resource/2019-getting-to-zero-project-list/

NCES (National Center for Education Statistics). 2017. *Fast Facts: back to School Statistics*. Washington, DC: Institute of Education Sciences. https://nces.ed.gov/fastfacts/display.asp?id=372

——— . 2017a. *Number of public elementary and secondary education agencies, by type of agency and state or jurisdiction: 2013-14 and 2014-15*. Washington, DC: Institute of Education Sciences. nces.ed.gov/programs/digest/d16/tables/dt16_214.30.asp?current=yes

——— . 2017b. *Number and enrollment of public elementary and secondary schools, by school level, type, and charter and magnet status: Selected years, 1990-91 through 2014-15*. Washington, DC: Institute of Education Sciences. nces.ed.gov/programs/digest/d16/tables/dt16_216.20.asp?current=yes

Oregon (1.5 % for Green Energy Technology in Public Building Construction Contracts). 2013. Oregon Administrative Code. Chapter 330. Div. 135. § 330-135-0010 (passed Dec 23).

ODOE (Oregon Department of Energy). 2020. 1.5% Green Energy Technology HB 2496 Program Updates. https://www.oregon.gov/energy/energy-oregon/Documents/GET-2020-Updates-Summary.pdf. Salem, Oregon.: Oregon Department of Energy.

A. Pande, M. Goebes, S. McCabe, R. Singla, M. Nakajima, J. Loomis, N. Albers, M. McRae, A. Cortese, W. Bowles, J. Arent, S. Taylor. 2019. *Commercial ZNE Market*

*Characterization – Final Report*. Oakland, CA: Pacific Gas & Electric and Joint Investor Owned Utilities. http://www.calmac.org/publications/IOU_-_TRC_Comm_ZNE_Mkt_Char_Final.pdf

PPS (Portland Public Schools). 2012. Long Range Facilities Master Plan. Portland, OR.: Portland Public Schools.

PPS (Portland Public Schools). 2020. Energy and Utility Dashboard. https://app.powerbi.com/view?r=eyJrIjoiYzFhM2VlNjctMjc1YS00ZTU1LTkwODQtOGI0ZWQyNmQzN2U0IiwidCI6IjRjYTJkNDI0LTBlMmYtNDM3My04MGQwLTdiZjMwNWQwYmRiOCIsImMiOjZ9. Portland, Oregon.: Portland Public Schools.

Ross, M. 2016. "California's 7x7x7 Program Explores How Its Schools Can Be More Sustainable." *The Architect's Newspaper*. May 10.

Resource Refocus. 2020. *Zero Net Energy Pilot for Local Educational Agencies and Community Colleges Final Statewide Report*. Oakland, CA: Pacific Gas & Electric. https://www.etcc-ca.com/reports/zero-net-energy-pilot-local-educational-agencies-and-community-colleges?dl=1584245074

B. Seals and A. Krasner. 2020. Gas Stoves: Health and Air Quality Impacts and Solutions, Rocky Mountain Institute. https://rmi.org/insight/gas-stoves-pollution-health/

SFUSD (San Francisco Unified School District). 2017. Resolution in Support of Carbon Neutral Schools. Sept. 26. San Francisco, CA.: San Francisco School Board.

SFUSD (San Francisco Unified School District). 2020. Earth Day Every Day Dashboard. https://www.earthdayeverydaysf.com/district-goals

P. Torcellini, S. Pless, and M. Deru. 2006. *Zero Energy Buildings: A Critical Look at the Definition*, National Renewable Energy Lab. https://www.nrel.gov/docs/fy06osti/39833.pdf

P. Torcellini, K. Trenbath, N. Allen, M. Mcintyre. 2019. A Guide to Zero Energy and Zero Energy Ready K–12 Schools, National Renewable Energy Lab. https://www.nrel.gov/docs/fy19osti/72847.pdf

U.S. EPA (United States Environmental Protection Agency). 2017. *Energy Efficiency Programs in K-12 Schools: A Guide to Developing and Implementing Greenhouse Gas Reduction Programs*. Washington, DC: United States Environmental Protection Agency. www.epa.gov/sites/production/files/2017-06/documents/k-12_guide.pdf

Vincent, J. and L. Brown. 2015. *Going it Alone Can California's K-12 School Districts Adequately and Equitably Fund School Facilities? Policy Research Working Paper.* Berkeley, CA: University of California Berkeley Center for Cities + Schools.