# Best Practices for Energy Cost Savings In New York State Schools

Prepared for New York Power Authority by:
Optimal Energy, Inc.
July 31, 2013

New York Power Authority
Generating more than electricity

# Contents

**INTRODUCTION** ..... **2**
Purpose ..... 2
Study Scope ..... 2
Summary ..... 2
**BACKGROUND** ..... **5**
**STATEWIDE ENERGY EFFICIENCY AND RENEWABLE ENERGY POTENTIAL** ..... **8**
Energy Efficiency Potential ..... 8
Renewable Energy Potential ..... 14
Development of Timeframe for Energy Efficiency and Renewable Energy Deployment in Schools ..... 16
Energy Efficiency and Renewable Energy Potential Employment and Greenhouse Gas Impacts ..... 17
**BEST PRACTICE ENERGY EFFICIENCY & CLEAN ENERGY OPPORTUNITIES** ..... **20**
Methodology For Identifying Energy Efficiency and Renewable Energy Opportunities ..... 20
Technical Overviews of High-Impact Measure Opportunities ..... 25
**BEST PRACTICE PROGRAM APPROACHES** ..... **32**
Overview of Common Market Barriers ..... 32
Overview of Best Practice Program Designs ..... 36
Overview of New York State-Specific Program Considerations ..... 59
**APPENDIX A | WHERE TO FIND MORE INFORMATION** ..... **60**
Utility , Power Authority, and NYSERDA Energy Efficiency Programs ..... 60
**APPENDIX B | LIST OF ACRONYMS** ..... **62**

# INTRODUCTION

## PURPOSE

On August 17, 2012, legislation was enacted by the State of New York amending the public authorities law to require the New York Power Authority (NYPA) to produce a report detailing "best practices with regard to energy cost savings for schools." This report is intended not only to satisfy the requirements of paragraph (f) of subdivision 17 of section 1005 of the public authorities law, as amended, but also to outline key aspects of successful program designs that should be considered when developing a new initiative for schools. Paragraph (f) reads as follows:

> *The authority shall complete and submit a report… detailing best practices for energy cost savings for school districts... Such report, at a minimum, shall include cost projections and estimated timeframes for the provision of energy efficiency services, clean energy technologies to public and nonpublic elementary and secondary schools throughout the state, estimated impacts on employment, energy cost savings, greenhouse gas reductions and recommendations on how to incorporate participation in the program into science, math and technology curriculum.*

## STUDY SCOPE

This report presents several analyses related to the above requirements.

- An overview of the historic performance of NYPA's Energy Services for Schools Program
- A high-level estimate of economic and maximum achievable energy efficiency potential and an estimate of bounded technical potential from on-site photovoltaic installations, including the associated greenhouse gas reductions and impacts on employment
- Suggestions for high-impact efficiency and clean energy retrofit opportunities to pursue based on a review of energy audits conducted for New York City (NYC) schools and national guidelines
- Recommendations for best practice program approaches based on a review of leading national programs, including guidance on how such initiatives might be leveraged for educational purposes

## SUMMARY

### NYPA's Energy Services for Schools Program has delivered substantial benefits to schools and communities throughout the State

Through its continued evolution in response to the needs of schools and communities, the Energy Services for Schools Program has served nearly one-third of the state's public K-12 schools, generating annual bill savings of $37 million. Savings total 234 GWh of annual electric energy, 73 MW of electric demand, and 422 billion Btu (BBtu) of combined annual natural gas and oil. In addition, the program has installed or plans to install a total of 330 kW of photovoltaic capacity on primary and secondary schools.

### Substantial potential remains for both energy efficiency and on-site photovoltaic installations, with corresponding decreases in greenhouse gas emissions and overall positive impacts on employment.

Despite NYPA's success, the remaining potential for energy savings is many times the achievement to date. Between 500 and 1,200 GWh of additional cumulative annual[1] cost-effective electric energy efficiency potential remains at public and private schools throughout the state, along with between 1,200 and 2,500 BBtu of cumulative annual natural gas savings and an additional 1,800 to 3,900 BBtu of cumulative annual fuel oil savings. Capturing all the economic *energy efficiency* potential could create as many as 18,000 jobs[2] and reduce annual $CO_2$ emissions by as much of 1.4 million metric tons of $CO_2$ equivalent – the equivalent of taking nearly 300,000 cars off the road each year. Existing photovoltaic installations represent an even smaller portion of the likely bounded technical potential, which may exceed 3,000 MW.

### Completed audits identify several likely candidates for achieving savings in NYS Schools

School buildings and their energy consumption patterns point to several widely applicable approaches for achieving the identified potential. These approaches cover nearly all major end-uses (i.e., lighting, heating, cooling, domestic water heating); many provide additional benefits beyond energy savings, primarily increased occupant comfort and reduced O&M costs. Among those likely to represent the largest quantity of savings are replacements of boilers or boiler burners in heating systems, lighting replacements and lighting controls, and direct digital controls.

### Leading programs provide a wealth of best practices that can be implemented in New York to achieve the State's goals for school energy improvements and educational impact

While traditional approaches that involve providing financial incentives for equipment upgrades are core components of an energy savings strategy, the particular needs and characteristics of schools point to complementary strategies that address important barriers. These best practices include:

- Supporting benchmarking to raise awareness about school energy use.
- Tapping into low-cost or no-cost energy savings opportunities for schools that do not have financing available for capital improvements. By thinking beyond a project-based approach, schools can be supported with energy planning, O&M planning, and behavioral modification strategies.
- Developing and consolidating materials to help schools raise awareness about energy consumption and efficiency, including educational materials and example energy plans. This can build support from students, parents,

[1] "Cumulative annual" savings refer to the total annual savings for all measures installed during the entire implementation period. In other words, this represents the sum of the savings for each individual measure installed during the entire implementation period provided that the measure is still active on the final year of the implementation period.

[2] See page 17 for the derivation of the estimated employment impacts.

faculty, and school officials and lay the ground work for commitment and action in the future.

- Providing as much specialized support as possible that meets the needs of the individual school or district.

## BACKGROUND

The New York Power Authority has offered its Energy Efficiency Program for 25 years in collaboration with participants statewide including the City of New York through the Department of Citywide Administrative Services and with state entities such as NYS Education Department. Between 1987 and 2012, NYPA has financed and invested over $1.5 billion across 3,900 facilities within New York State. Under this Energy Efficiency Program, NYPA provides services that include developing feasibility studies, engineering design, life-cycle cost analyses, procuring equipment, contractor labor, hazardous waste disposal, managing projects/construction, and financing projects. Project measures include, but are not limited to, lighting retrofits; building envelope-related improvements; HVAC modernization including energy-efficient chillers, boilers, and controls; high-efficiency motors; variable-speed drives; energy management systems; process controls; and distributed generation. These installations, and many more, have been performed throughout the state.

The NYPA Energy Services for Schools Program (the "Program") was introduced over 20 years ago, with initial participation from only a small number of schools within New York City. The Program has since grown and expanded over the years, and has reached a cumulative project installation total cost of over $400 million. Originally known as the High Efficiency Lighting Program (HELP), participants received NYPA design, project management, and support in upgrading lighting fixtures within schools. Due to its success, it continued and expanded to include Upstate New York and Long Island. NYPA had opened the door to give public schools across the State an effective and affordable avenue to decrease their electricity costs and overall energy used through HELP.

The customers of the HELP initiative were so satisfied by the results and the realized savings that they began to ask NYPA for other energy efficiency offerings. The Program was then revised to include the recommendation to replace motors, sensors, and controls within schools. NYPA would include these recommendations as part of their standard service and, with customer approval, performed the installation of the new measures.

The next major evolution of the NYPA Energy Services for Schools Program was the inclusion of converting coal-fired furnaces to dual-fuel boilers burning No. 2 fuel oil and natural gas. As part of New York State's Clean Water/Clean Air Bond Act of 1996, NYPA took the lead to replace 86 coal-fired furnaces within the City of New York, Buffalo, and Long Island. Working together with the New York City Department of Education, New York City School Construction Authority, and the local utilities, NYPA continued to upgrade the schools' climate controls as well. The cumulative $171 million upgrade was focused in the areas of New York City with the highest rates of pediatric asthma.

The Program continues to evolve and grow as local laws and regulations increasingly promote "green" equipment and practices. More recently, with the passing of Local Law 87 (LL 87) of the City of New York, all public buildings with more than 50,000 gross square feet are required to have Level II ASHRAE Audits performed every 10 years. Retro-commissioning is no longer just encouraged; it is now mandatory and enforced by law. The NYPA Energy Services

for Schools Program now offers full retro-commissioning services and multiple levels of energy audits to help NYC schools comply with the requirements of LL 87.

Since 1991, 641 projects in 1,286 primary and secondary school facilities throughout New York State have been completed through the Energy Services for Schools Program representing nearly 30% of 4,517 public (non-charter) K-12 facilities statewide.[3] With total project costs of $404 million, these projects have yielded a cumulative estimated net bill savings of nearly $37 million annually.[4] Coupled with NYPA's unique ability to provide long-term and secure energy efficiency project financing, more and more schools are finding the Program to be of significant value in their energy portfolios. NYPA Energy Services for Schools Program has reduced an estimated 73 MW of electric demand, 234 GWh of electric energy usage, and saved 422 BBtu of combined natural gas and fuel oil. Furthermore, across New York State, the Energy Services for Schools Program has identified and installed numerous photovoltaic solar panel sites as an education tool for students, not to mention helping to meet the State's goal to meet 45% of New York's electricity through improved energy efficiency and clean renewable energy by 2015.[5] To date, NYPA has approximately 200 $kW_{DC}$ of installed photovoltaic capacity on primary and secondary schools with another 130 $kW_{DC}$ planned for installation in the near future.

Figure 1 below illustrates the level of cumulative annual energy savings by county for projects completed through NYPA's Energy Services for Schools Program. Project savings are expressed in terms of equivalent MMBtu.[6] The concentration of program activity in NYC reflects both the higher density of schools, and consequently energy sales, and NYPA's early program efforts that were limited to NYC.

---

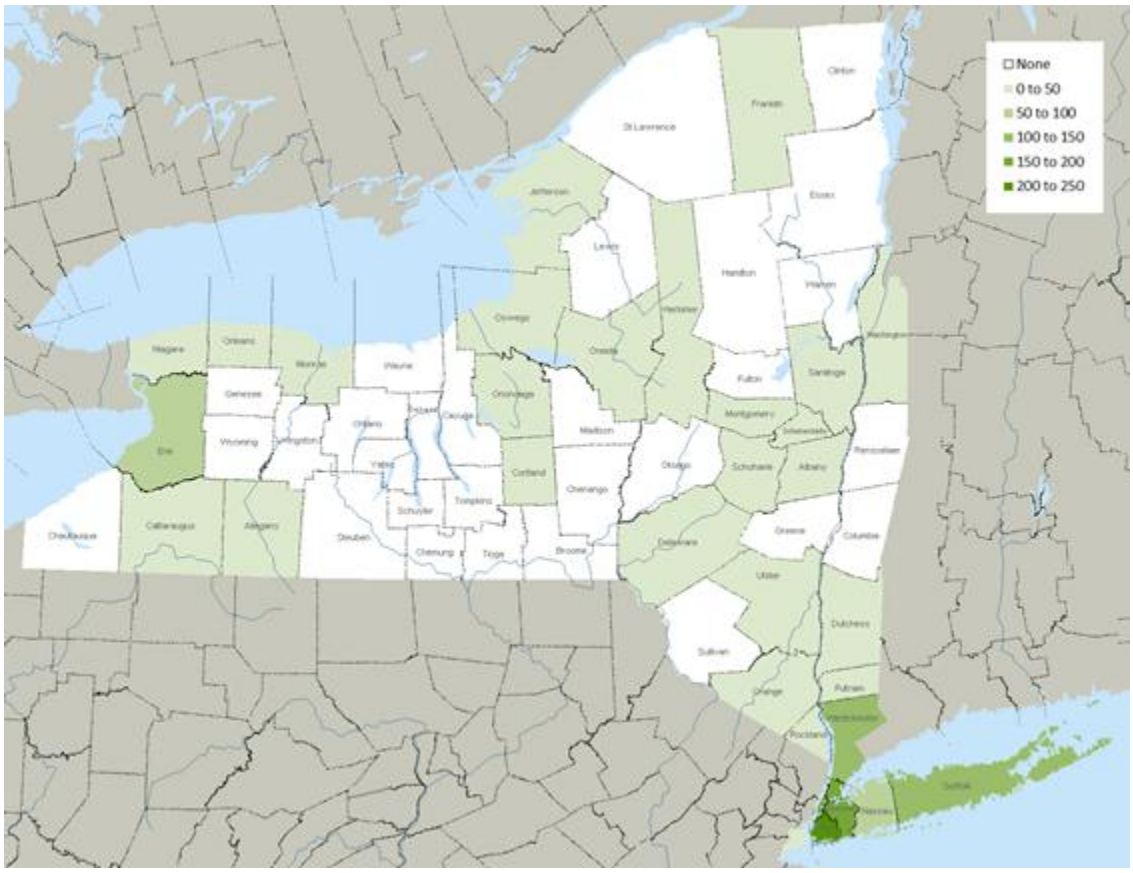
[3] New York State Education Department Information and Reporting Services, The Directory of Public and Non-Public Schools and Administrators for The State of New York, Last Updated: June 6, 2013 <http://www.nysed.gov/admin/bedsdata.html >. Note: Estimated percentage may be higher than actual due to multiple projects completed within the same facility.

[4] Note that the actual cost-effectiveness and payback for the efficiency components is much faster than implied by these costs, as some of the project investments were associated with ancillary improvements that did not directly impact energy efficiency and electric rate increases are not accounted for.

[5] State Of New York Public Service Commission, CASE 03-E-0188 - Proceeding on Motion of the Commission Regarding a Retail Renewable Portfolio Standard, Order Establishing New RPS Goal And Resolving Main Tier Issues, January 8, 2010; State Of New York Public Service Commission, CASE 07-M-0548 - Proceeding on Motion of the Commission Regarding an Energy Efficiency Portfolio Standard, Order Establishing Energy Efficiency Portfolio Standard And Approving Programs, June 23, 2008.

[6] Electric savings assume a conversion factor of 3.412 thousand Btu per kilowatt-hour. Fuel oil savings assume a conversion factor of 6.287 million Btu per barrel. U.S. EIA, State Energy Data System (SEDS), Technical Notes & Documentation (2011).

**Figure 1 | Equivalent Cumulative Annual Project Energy Savings by County for All NYPA Energy Services for Schools Program Projects Through Feb. 2013 (thousand MMBtu)**




Note: Figure includes savings contributed by projects in various states of the planning and implementation process.

NYPA's success is derived from the ability to provide program flexibility in its delivery approach as well undertaking energy saving solutions among all fuel types. This flexibility has allowed NYPA to be recognized as a leader in supporting energy efficiency and renewable energy. As a result of NYPA's extensive experience working with New York schools, they are well positioned to expand and continue to serve the school energy efficiency needs throughout the state, both public and private.

# STATEWIDE ENERGY EFFICIENCY AND RENEWABLE ENERGY POTENTIAL

## ENERGY EFFICIENCY POTENTIAL

### Methodology

#### Overview of Estimate Scope

The goal of this study is to provide a high-level overview of the economic and maximum achievable energy efficiency potential in K-12 facilities, not develop detailed savings and cost estimates at the technology or practice level.[7] The intent is to inform the scale of the necessary investments and the resulting energy cost savings to assist with the development of a statewide initiative for pursuing energy efficiency in schools. Accordingly, a "meta-analysis" of several recent potential studies conducted for customers in New York State (NYS) was performed to estimate energy cost savings and associated project costs for school facilities. A more comprehensive analysis could be conducted in the future to support a more detailed program design.

#### Development of Statewide Public and Non-Public Schools Energy Costs Consumption

The foundation for any assessment of energy efficiency potential is an estimate of total energy sales for the market segment under investigation. Unfortunately, there is no central source of energy sales and cost data available for NYS public and non-public K-12 schools. However, reasonable estimates of these values were derived using a variety of sources and cross-checked against similar estimates developed by NYSERDA.[8] There are 6,568 public and non-public K-12 schools in NYS. Table 1 below presents the distribution of schools by region.

[7] The economic potential includes all efficiency potential that is cost-effective from a specific perspective (e.g., society, utility, or participant) under the assumption that people will choose to implement all cost-effective efficiency measures without the need for efficiency programs. Maximum achievable potential refers to the energy efficiency that is economic from a specific perspective that can realistically be captured with well-designed, aggressive, fully-funded efficiency programs. Achievable potential takes into account market barriers to efficiency adoption, penetration rates of adoption, and the costs associated with program administration, including monitoring and evaluation of programs to measure and validate the savings. The economic potential is higher than the maximum achievable because the economic potential does not consider market barriers or other limitations.

[8] Interview with Matthew Brown, NYSERDA, May 2, 2013.

**Table 1 | NYS Public and Non-Public Schools by Region[9]**

| Region | Public | Non-Public | Total Public and Non-Public | Average Public and Non-Public Schools per County |
|---|---|---|---|---|
| NYC | 1,723 | 840 | 2,563 | 513 |
| Rest of State | 3,038 | 967 | 4,005 | 70 |
| **Total Statewide** | **4,761** | **1,807** | **6,568** | **106** |

Note: "public" includes charter schools.

The energy sales estimates were developed by first normalizing total energy consumption data for NYC public schools on a per student basis.[10] The analysis assumed a 4-year average of annual consumption from FY 2008-2009 to FY 2011-2012 for electricity, natural gas, and steam. The fuel oil consumption estimate assumed a 3-year average of data provided for FY2007-2008, FY2010-2011, and FY2011-2012. These average annual consumption estimates by fuel were then divided by total number of students in NYC public schools to develop the normalized values.

To extrapolate from the NYC public schools data to all statewide public and non-public K-12 schools, the normalized "per student" NYC values were multiplied by the total number of students attending public and non-public schools in NYS. The total number of students was obtained from the NYSED Information and Reporting Services.[11]

[9] New York State Education Department Information and Reporting Services, The Directory of Public and Non-Public Schools and Administrators for The State of New York, Last Updated: June 6, 2013 <http://www.nysed.gov/admin/bedsdata.html>.

[10] Energy consumption data provided directly by the NYC Department of Education.

[11] New York State Education Department, Information and Reporting Services, Public School Enrollment and Staff, Table 8. Public Enrollment by County and Level, 2009; New York State Education Department, Information and Reporting Services, Non Public School Enrollment and Staff, Table 1. Nonpublic School Enrollment by Level and Affiliation, 2010.

**Table 2 | Total Estimated Statewide School Annual Energy Consumption and Costs**

| Fuel Type | Total Annual Consumption | | % Statewide Energy Consumption | | Average Retail Rate ($Million/Unit) | Total Cost Public and Non-Public ($Million) |
|---|---|---|---|---|---|---|
| | Public | Non-Public | Public | Non-Public | | |
| Electricity Demand (MW) | 840 | 132 | 2.6% | 0.4% | N/A | N/A |
| Electricity Usage (GWh) | 2,426 | 383 | 1.5% | 0.2% | $ 0.158 | $ 443.9 |
| Natural Gas (BBtu) | 6,519 | 1,028 | 0.8% | 0.3% | $ 0.009 | $ 68.5 |
| Fuel Oil (BBtu) | 8,252 | 1,302 | 1.6% | 1.2% | $ 0.021 | $ 200.2 |
| **Total** | | | | | | $ 721.9 |

Note: Statewide electric sales reflect five-year average (2008-2012) from New York Independent System Operator, 2013 Load & Capacity Data "Gold Book," April 2013. Statewide natural gas and fuel oil sales reflect five-year average (2007-2011) from U.S. Energy Information Administration, State Energy Data System, 2011.

It should be noted that the values presented in Table 2 represent high-level estimates and actual consumption and cost values may vary considerably from these estimates. The estimates assume that statewide consumption per student is reasonably close to those values derived from NYC data. There are several factors that affect the accuracy of the statewide estimates:

- Student density for NYC (i.e., students per square foot of building area) schools may be higher than that for non-NYC schools due to higher population densities and real estate premiums.
- Annual operating hours for NYC schools may be higher than for non-NYC schools. This is due to the fact that many NYC schools often serve as community centers outside of normal school hours and hold summer sessions.
- Presence of mechanical cooling equipment may vary significantly between NYC and non-NYC schools.

While these factors may result in significant differences between NYC and non-NYC averages, it is likely that some of these issues contribute to an overestimate of energy consumption while others contribute to an underestimate thereby reducing the overall impact on estimate accuracy.

### Overview of Education Sector Potential Assessments from Relevant Studies

To develop an initial estimate of efficiency potential and project funding requirements, previous regional potential studies were referenced to determine approximate economic and maximum achievable energy efficiency potential as a percent of total energy sales. These percentages were applied to the total energy consumption estimate for schools, determined above, to yield estimates of the total economic and achievable potential. Finally, the total costs per unit energy savings to achieve this potential were applied to present a first estimate of statewide efficiency project funding requirements.

The estimates of economic and maximum achievable energy efficiency potential were estimated using the following three studies: Energy Efficiency Potential Study for Consolidated Edison Company of New York, Inc. ("ConEd 2010");[12] Statewide Energy Efficiency and Renewable Energy Potential for New York State Entities ("NYPA 2011");[13] and a recent proprietary potential analysis performed by Optimal Energy for another client in NYS ("Optimal Energy 2012").

***Economic*** **potential includes all efficiency potential that is cost-effective from a specific perspective (e.g., society, utility, or participant) under the assumption that people will choose to implement all cost-effective efficiency measures without the need for efficiency programs.**

***Maximum achievable*** **potential refers to the energy efficiency that is economic from a specific perspective that can realistically be captured with well-designed, aggressive, fully-funded efficiency programs. Maximum achievable potential takes into account market barriers to efficiency adoption, penetration rates of adoption, and the costs associated with program administration, including monitoring and evaluation of programs to measure and validate the savings. The economic potential is higher than the maximum achievable because the economic potential does not consider market barriers or other limitations.**

## Results

Because each study was concerned with a slightly different service territory and customer segment – Consolidated Edison customers, NYS Agencies and Authorities, and all statewide customers, respectively – the potential estimates summarized in Table 3 to Table 5 below represent the energy efficiency potential from each respective study as a percentage of the total forecasted energy sales in 2014. The ConEd 2010 and Optimal Energy 2012 studies provided potential estimates by building type. For the purposes of this analysis, the results for the "Education" building type were used. In both studies, this building type includes all educational facilities including K-12 schools as well as colleges and universities. The NYPA 2011 study reported potential by State Agency or Authority. This analysis assumes a cumulative savings weighted average of the results for the State University of New York and the City University of New York. While the customer segments assumed from all studies are not limited to K-12 public and private schools, all education facilities share somewhat similar end-use profiles, so the results are still instructive in the determination of the overall scale of energy efficiency potential in NYS schools.[14]

---

[12] Energy Efficiency Potential Study for Consolidated Edison Company of New York, Inc., Global Energy Partners, June 2010.

[13] Statewide Energy Efficiency and Renewable Energy Potential for New York State Entities, Optimal Energy, December 2011.

[14] It is acknowledged that college campuses have a different end-use profile for residence buildings and administrative buildings used year round; however, the referenced studies do not provide savings estimates at a level of granularity that allows explicit accounting for this issue.

### Table 3 | Economic and Maximum Electric Energy Efficiency Potential Estimates

| Reference Forecast, 2014 (MWh) | | 2,808,346 | |
|---|---|---|---|
| | **ConEd 2010** | **NYPA 2011** | **Optimal Energy 2012** |
| Economic Potential as % of Reference Forecast | 19% | 28% | 45% |
| Economic Potential Total Savings (MWh) | 544,819 | 793,415 | 1,259,824 |
| Economic Potential Cost Per First Year kWh (2013$/kWh) | N/A | N/A | $0.63 |
| Economic Potential Total Cost (Million 2013$) | N/A | N/A | $793.7 |
| Maximum Achievable Potential as % of Reference Forecast | 15% | N/A | 22% |
| Maximum Achievable Potential Total Savings (MWh) | 418,444 | N/A | 629,912 |
| Maximum Achievable Potential Cost Per First Year kWh (2013$/kWh) | N/A | N/A | $0.20 |
| Maximum Achievable Potential Total Cost (Million 2013$) | N/A | N/A | $125.2 |

### Table 4 | Economic and Maximum Natural Gas Efficiency Potential Estimates

| Reference Forecast, 2014 (MMBtu) | | 7,547,489 | |
|---|---|---|---|
| | **ConEd 2010** | **NYPA 2011** | **Optimal Energy 2012** |
| Economic Potential as % of Reference Forecast | 18% | 16% | 34% |
| Economic Potential Total Savings (MMBtu) | 1,358,548 | 1,198,057 | 2,534,106 |
| Economic Potential Cost Per First Year MMBtu (2013$/MMBtu) | N/A | N/A | $48.81 |
| Economic Potential Total Cost (Million 2013$) | N/A | N/A | $123.7 |
| Maximum Achievable Potential as % of Reference Forecast | 14% | N/A | 17% |
| Maximum Achievable Potential Total Savings (MMBtu) | 1,056,648 | N/A | 1,267,053 |
| Maximum Achievable Potential Cost Per First Year MMBtu (2013$/MMBtu) | N/A | N/A | $31.70 |
| Maximum Achievable Potential Total Cost (Million 2013$) | N/A | N/A | $40.2 |

### Table 5 | Economic and Maximum Fuel Oil Efficiency Potential Estimates

| Reference Forecast, 2014 (MMBtu) | | 9,553,191 | |
|---|---|---|---|
| | **ConEd 2010** | **NYPA 2011** | **Optimal Energy 2012** |
| Economic Potential as % of Reference Forecast | 37% | 19% | 41% |
| Economic Potential Total Savings (MMBtu) | 3,544,234 | 1,782,523 | 3,917,927 |
| Economic Potential Cost Per First Year MMBtu (2013$/MMBtu) | N/A | N/A | $47.75 |
| Economic Potential Total Cost (Million 2013$) | N/A | N/A | $187.1 |
| Maximum Achievable Potential as % of Reference Forecast | 13% | N/A | 21% |
| Maximum Achievable Potential Total Savings (MMBtu) | 1,241,915 | N/A | 1,958,964 |
| Maximum Achievable Potential Cost Per First Year MMBtu (2013$/MMBtu) | N/A | N/A | $34.87 |
| Maximum Achievable Potential Total Cost (Million 2013$) | N/A | N/A | $68.3 |

Note: NYPA 2011 assessed three different scenarios: The results for the "Material & Labor w/ Project Admin/Design Fees, No Incentives" scenario are presented in the tables above.

The studies estimate a range of economic electric energy efficiency potential of 544 to 1,260 GWh or 19% to 45% of forecasted school electric energy use in 2014. Note that in the tables above, the "Total Savings" for the respective fuels refer to the cumulative annual savings for all measures installed during the entire implementation period. Only the Optimal Energy 2012 study provides cost estimates by fuel type, so all costs presented below are adopted from that report and correspond to the maxima of the savings ranges presented. Total cost to acquire the economic potential was estimated at $794 million. The natural gas economic energy efficiency potential was estimated at between 1,198 and 2,534 billion Btu (BBtu) or 16% to 34% of forecasted school gas consumption in 2014. The studies found that the economic natural gas potential could be achieved at a cost of $124 million. Finally, the economic fuel oil energy efficiency potential was estimated between 1,783 and 3,918 BBtu or 19% to 41% of forecasted school fuel oil use in 2014. Total cost to acquire the economic fuel oil potential was estimated at $187 million. The costs to achieve the economic energy efficiency potential reflect the total costs incurred by schools to implement the efficiency measures identified. These costs do not include any necessary program costs to promote and facilitate the improvements. In other words, the economic potential costs assumed that all schools would pursue all cost-effective efficiency improvements of their own accord without any program intervention. The costs to realize the maximum achievable potential as presented in the tables above reflect the costs incurred by a hypothetical energy efficiency *program*. A typical program design that covers a portion of the incremental costs through incentive payments and requires general funding for administration, marketing, technical assistance, etc. is assumed. This is why the per unit energy costs for the maximum achievable scenario are lower than those for the economic potential. Costs to realize the maximum achievable energy efficiency would vary significantly depending on actual program design.

As demonstrated by the significant ranges in the various estimates, there are several differences between the assumptions and methodologies of the referenced studies that make direct comparisons somewhat problematic. First, it should be noted that ConEd 2010 presents a much lower estimate of economic potential than the other two studies. This study does not consider early replacement of major equipment a viable option for pursuing energy efficiency which may explain some of this difference. However, estimates of maximum achievable potential are reasonably consistent across studies.

Not all studies provided estimates of maximum achievable potential. While ConEd 2010 and Optimal Energy 2012 studies do provide maximum achievable potential estimates, the Optimal Energy study estimate is based on a simple review of other potential studies to develop upper and lower bounds for achievable potential as a percentage of economic potential. Additionally, the ConEd 2010 study does not provide an estimate of the costs associated with capturing the identified potential.

The ConEd 2010 and Optimal Energy 2012 studies present economic potential in terms of the Total Resource Cost (TRC) Test whereas the NYPA 2011 study used the Participant Test. The Total Resource Cost (TRC) Test measures the total costs of the program, including both the participants' and the utility's costs. These costs include the incremental measure costs and program costs. The benefits consist of the avoided costs of generating and supplying energy,

fuel, or other resources, operation and maintenance savings, and any non-resource benefits. The Participant Test is the measure of the quantifiable benefits and costs to the customer due to participation in a program. In short, this test considers the incremental measure costs paid by the customer, less any financial incentives received, the benefits of reduced energy costs (i.e., bill savings based on retail rates), and any changes in operation and maintenance spending.

One of the major difficulties with drawing conclusions from the different studies is that each study assumes a different implementation period: ConEd 2010 presents a nine-year period beginning in 2010, NYPA 2011 considered just 5 years beginning in 2012, and Optimal Energy 2012 covered 17 years beginning in 2013. These different analysis periods reflect different study goals such as projections for aggressive short-term initiatives vs. long-term planning.

Finally, some of the referenced studies are several years old and market conditions have changed considerably as new technologies have matured and energy codes and standards have increased. Furthermore, projections of future retail and avoided energy costs have likely changed between the publication date of some of the referenced studies and today. Some measures may not pass the cost-effectiveness screening today that did previously and vice versa.

## RENEWABLE ENERGY POTENTIAL

### Methodology

#### Overview of Estimate Scope

Similar to the energy efficiency portion of this study, the goal of the renewable energy potential assessment is to provide a high-level overview of the bounded technical renewable energy potential in K-12 facilities, not develop detailed savings and cost estimates at the site level.[15] The intent is to inform the scale of the necessary investments and the resulting energy cost savings to assist with the development of a statewide initiative for pursuing renewable energy resources in schools. Accordingly, a "meta-analysis" of several recent potential studies conducted for customers in NYS was performed to approximate energy cost savings and associated project costs for school facilities. A more comprehensive analysis could be conducted in the future to support a more detailed program design. Note that the estimate of renewable energy efficiency potential for this study is limited to on-site, rooftop photovoltaic (PV) systems – typically the renewable energy technology representing the greatest technical potential. While there are other clean energy technologies that are applicable to schools and school systems, this report focuses on photovoltaic systems because they are most amenable to a high-level

[15] Bounded technical potential for a given resource is an estimate of the total electric generation potential with consideration for the primary physical, social and technological barriers. The potential is estimated without accounting for economic factors of the costs and benefits of the required investments. The bounded technical potential also does not account for the costs and benefits from the customer's perspective, nor does it account for the market prices for the systems being installed. It is therefore important to understand that the bounded technical potential provides a base for further economic analysis – but by itself does not account for the economics.

assessment of potential in the absence of site-specific data. Determining the potential for wind turbines, for example, would require parsing detailed information about the location of the thousands of schools in the state and how that location correlates with estimates of the wind resource in that area. Similarly, biomass heating systems typically require close proximity to sources of biomass to be cost-effective, requiring information on forestry resources, biomass waste streams from agricultural or industrial sources, or other sources. Finally, schools typically do not have significant hot water consumption, so this report does not include estimates of solar thermal potential. Moreover, hot water use in the summer months, the period when solar thermal systems are most effective, is even lower greatly diminishing project cost-effectiveness. For these reasons, potential estimates for wind, biomass, and other clean energy technologies were beyond the scope of this report.

### Overview of Renewable Energy Potential Assessments from Relevant Studies

The estimates of bounded technical PV potential were developed using the following two studies: Statewide Energy Efficiency and Renewable Energy Potential for New York State Entities ("NYPA 2011") and a recent proprietary potential analysis performed by Optimal Energy for another client in NYS ("Optimal Energy 2012"). The methodology used by both studies is similar, so the more recent study was utilized as it more accurately reflects current market conditions. A simplified analysis was performed to provide an initial estimate of PV potential and project funding requirements. In short, the previous regional potential study was referenced to determine approximate bounded technical potential and the PV area necessary to provide the resource. The potential was then scaled based on an estimate of the total school rooftop area available to PV systems. Finally, the total costs per unit energy savings to achieve this potential were applied to present a first estimate of statewide project funding requirements.

It is estimated that total floor space is 214.5 million square feet for schools in NYC and 593.6 million square feet for schools in the rest of the state.[16] Consistent with the assumptions from the NYPA 2011 study, available roof space for PV installations was assumed to be 5% of total floor area for NYC and 15% of floor area for rest of the state. Finally, the total bounded technical potential from the Optimal Energy 2012 study was scaled by the ratio of the total area requirements for the bounded technical potential in NYS (approximately 135 square kilometers) to the estimate of useable rooftop area of NYS schools (approximately 100 million square feet).

Because of the dynamic PV market, cost data from the Optimal Energy 2012 study was used to develop the lower bound of the cost estimate in favor of the NYPA 2011 study, as this study reflects more recent projections. That study used costs data from the New York Solar Study[17] and updated them based on recent data from Solar Energy Industries Association. Note that these costs represent an optimistic assessment of future PV costs. Based on recent PV installations completed by NYPA, recent projects costs have ranged from $4 to $6 per installed

[16] Interview with Matthew Brown, NYSERDA, May 2, 2013.

[17] NYSERDA, New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation from Photovoltaic Devices in New York, January 2012.

watt of capacity. NYPA projects that future projects will cost between $3 and $5 per installed watt based on incentive available in NYS. This projection is used to derive the upper bound of the cost estimate to realize the bounded technical PV potential.

### Results

Following the methodology described above, New York State has the bounded technical potential to add 3,000 MW of rooftop PV at schools by 2030 which will generate cumulative annual electric energy of 3,733 GWh. The estimated total installed cost to capture this potential ranges from $5.61 to $15.0 billion dollars.

## DEVELOPMENT OF TIMEFRAME FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY DEPLOYMENT IN SCHOOLS

The three studies reviewed to develop the "meta-analysis" all present different timeframes for the deployment of all cost-effective energy efficient potential and the bounded technical renewable potential. These studies represent "resource-constrained" estimates which recognize constraints due to availability of resources such as implementation contractors and efficiency equipment. The implementation timeframes of the referenced studies range from as short as 5 years to as long as 17 years. As previously noted, these different timeframes reflect the different priorities of the individual studies and in some cases are merely hypothetical implementation schedules without a rigorous analytical basis.

There are several important barriers to the implementation of energy efficiency and renewable energy projects in school facilities that may impact the time requirements to implement all cost-effective projects. These include, but are not limited to, the permitting process of the NYSED, holding public votes to secure funding for school projects, and working around constraints of the school year, as necessary. Combined with the general barriers of limited program staffing and funding, developing projects in schools can be an uphill battle. For comparison, the NYSERDA New York Energy $mart Existing Facilities Program achieved total savings of 701.3 GWh from July 1, 2006 through December 31, 2011.[18] This corresponds to approximately 127.5 GWh saved per year. At this rate, assuming all resources were directed toward schools buildings and assuming the barriers to energy efficiency in schools are similar to those encountered in the greater population, it would take approximately ten years to capture 100% of the economic electric energy efficiency potential. Given these considerations, it is appropriate to adopt the timeframe from the Optimal Energy 2012 which suggests all cost-effective energy efficiency potential can be implemented within 17 years.

[18] NYSERDA, "New York's System Benefits Charge Programs Evaluation and Status Report, Year Ending December 31, 2011 Report to the Public Service Commission," March 2012.

## ENERGY EFFICIENCY AND RENEWABLE ENERGY POTENTIAL EMPLOYMENT AND GREENHOUSE GAS IMPACTS

### Estimated Impacts on NYS Employment

It is estimated that pursuing 100 percent of the economic energy efficiency potential, assuming the total costs from the Optimal Energy 2012 study, will result in the creation of approximately 12,800 to 18,400 jobs by 2030. The estimated lower bound of job creation potential due to energy efficiency spending was adapted from the recent NYSERDA publication New York's System Benefits Charge Programs Evaluation and Status Report.[19] This report includes a macroeconomic analysis of the net employment impact on the state's economy due to energy efficiency investments. The authors find a total of 4,077 net additional jobs created in 2010 and report $586.1 million in cumulative program spending from July 1st, 2006 through year-end 2010 – an average of $130.2 million per year. This amounts to 31.3 jobs created per million dollars of program spending, a ratio that is consistent with other recent studies on the economic impacts of efficiency investments - typically between 25 and 50 jobs per million dollars.

However, these estimates apply to efficiency program spending (incentives payments and program administration costs) and thus are not directly applicable to the investments forecasted in this report. Since the primary focus of this study is the customer economics to achieve all cost-effective energy efficiency rather than on the required program spending, the total investment represents the sum of the incremental costs of all the efficiency measures. These incremental costs are paid through the combination of program incentives (e.g., NYSERDA, LIPA, Con Edison) and customer co-funding (in this case, funding provided by schools). The total incremental costs attributable to the employment impacts in the NYSERDA report were extrapolated using NYSERDA's estimated ratio of customer co-funding to program spending (2.2) along with an assumption that 50% of program spending covers incentives. This amounts to a total of $350.2 million per year of incentive spending plus customer co-funding, which yields 11.6 jobs per million dollars.[20]

Thus, the estimate of jobs per million dollars invested in energy efficiency for this study is lower because the denominator, incremental cost spending, is a much larger sum of money. The upper bound of the job creation estimate is based on 16.7 jobs created per million dollars.[21] This is consistent with the findings of NYPA's Energy Efficiency Department.

---

[19] NYSERDA, New York's System Benefits Charge Programs Evaluation and Status Report Quarterly Report to the Public Service Commission Quarter Ending March 31, 2011, May 2011.

[20] Explicitly, this is calculated as follows: $130.2 million program spending per year x 2.19 = $285.1 million customer co-funding per year. Assuming 50% of program costs contribute to incentives, total annual incentive payments = 50% x $130.2 million program spending per year = $65.1 million. Total incentive payments plus customer co-funding per year = $65.1 million + $285.1 million = $350.2 million. 4,077 jobs divided by $350.2 million = 11.6 jobs per million dollars.

[21] IMPLAN, 2008 Current Population Survey

The recent New York Solar Study found that pursuing an aggressive goal to implement 4,585 MW of PV by 2025 would result in an economy-wide net *loss* of 3,400 jobs by 2030. While the Base PV Scenario analyzed in that study found that job impacts would be positive in the initial years due to beneficial ratepayer changes and increased demand for PV equipment and installations, the scenario ultimately resulted in a net loss of jobs due to negative ratepayer effects in the latter years. The job losses would be caused by "…a loss of discretionary income that would have supported employment in other sectors in the economy."[22] Adopting the simplifying assumption that the job losses will scale linearly with installed capacity, implementing the bounded technical potential would result in a loss of 2,200 jobs by 2030.

While the types of jobs created will depend heavily on the types of efficiency measures and renewable energy technologies installed, HVAC projects will typically create jobs for boilermakers; HVAC and refrigeration mechanics; plumbers, pipefitters, and steamfitters; sheet metal workers; electricians, cement masons, and control system technicians. Lighting projects will primarily create jobs for electricians and control system technicians, and building envelope projects will create positions for roofers, insulation workers, and glaziers. PV system installations will typically create jobs for solar photovoltaic installers, electricians, and roofers. Additionally, many projects will also drive the need for hazardous material removal workers, construction equipment operators, and design professionals such as architects, mechanical engineers, and electrical engineers.

### Estimated Reductions of Greenhouse Gas Emissions

$CO_2$ emissions reductions were calculated by applying emissions coefficients (in terms of metric tons of $CO_2$ equivalent produced per unit of energy consumed) to the estimated energy savings. The emissions coefficients assumed are consistent with those used by the U.S. Energy Information Administration as part of the Voluntary Reporting of Greenhouse Gases Program.[23] Table 6 presents the cumulative annual emissions reductions for the economic energy efficiency potential assuming the savings values developed from the Optimal Energy 2012 study and the bounded technical renewable energy potential.

---

[22] NYSERDA, New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation from Photovoltaic Devices in New York, January 2012.

[23] U.S. Energy Information Administration, "Voluntary Reporting of Greenhouse Gases Program," <http://www.eia.gov/oiaf/1605/emission_factors.html>. Accessed June 16, 2013.

**Table 6 | $CO_2$ Equivalent Emissions Reductions**

| Fuel Type | CO2e Emissions Reduction (metric tons) |
|---|---|
| Electricity | |
| EE | 999,165 |
| PV | 2,960,362 |
| Natural Gas | 134,460 |
| Fuel Oil | 297,665 |

A total annual reduction of 1.43 million metric tons of $CO_2$ equivalent will be achieved if 100 percent of the economic energy efficiency potential is implemented. A further reduction of 2.96 million metric tons of $CO_2$ will be realized if all bounded technical PV potential is captured. Combined, this is equivalent to removing over 900,000 passenger vehicles from the road annually.[24]

[24] U.S. Environmental Protection Agency, "Greenhouse Gas Equivalencies Calculator," <http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results>. Accessed June 13, 2013.

## BEST PRACTICE ENERGY EFFICIENCY & CLEAN ENERGY OPPORTUNITIES

The preceding sections of this report describe the potential for energy savings in schools; the following sections describe ways to capture that potential. Most efforts to improve school energy efficiency and renewable energy use in New York State have focused on retrofit projects involving the installation of energy efficient equipment. Specific opportunities for achieving retrofit savings are detailed in this section. While pursuing retrofit projects has and will continue to be an important element of school efficiency programs, additional strategies exist that can enhance these programs and enable schools to maximize energy saving both in the present and future. The subsequent Best Practices Program Approaches section discusses aspects of successful school retrofits from a program perspective as well as additional strategies including:

- Offer Technical Assistance
- Use Benchmarking and Auditing to Identify Opportunities for Savings
- Provide Support for Near and Long-Term Planning
- Offer Financing Options and Information
- Maximize Savings Through Education and Awareness
- Provide Educational Materials, Tools and Resources Tied to Curriculum Standards
- Engage School Personnel
- Include Strategies for Engaging the Broader Community
- Help Schools to Optimize Building Performance and Ensure Saving Persist
- Assist With Deployment of Renewable Energy Resources

### METHODOLOGY FOR IDENTIFYING ENERGY EFFICIENCY AND RENEWABLE ENERGY OPPORTUNITIES

The previous section explored the magnitude of the total energy efficiency and renewable energy, specifically photovoltaic, potential for schools in NYS. As demonstrated, the remaining potential that can be cost-effectively captured is significant, but what exactly does that potential represent "on the ground?"

Due to recent initiatives by the City of New York, there exists a strong catalog of information on the current state of NYC schools and the efficiency opportunities therein. NYPA provides the opportunity for its customers in the New York City metropolitan area to procure energy audits. The majority of the audits reviewed were requested by the City of New York as part of Mayor Michael R. Bloomberg's PlaNYC initiative and facilitated by NYPA. In December of 2009, as part of PlaNYC, the City passed Local Law 87 which mandates that the City perform Comprehensive Energy Audits for all its own facilities, to be completed within a 10 year timeframe (2013 – 2023). The body of information on NYC schools will continue to grow over this period.

A total of 68 ASHRAE Level II Comprehensive Energy Audits[25] for schools in NYC were reviewed to identify common energy efficiency and clean energy opportunities. These audits were intended to identify existing conditions and propose and qualify measures that will improve the energy efficiency of the selected sites. These audits include thorough analyses of the facilities' energy consuming systems based on detailed surveys, computerized building simulations, and recommended energy conservation opportunities.

While these audits provide valuable insights into the energy efficiency and clean energy opportunities in schools, the following caveats and limitations should be acknowledged when interpreting the summary data:

- The school buildings selected by the City of New York for analysis and were prioritized based on their relatively low benchmarking scores as determined by the EPA Portfolio Manager. Therefore, these facilities are not necessarily representative of typical NYC schools.
- Because the audits were primarily driven by New York City legislation, they are limited to NYC public schools. Typical opportunities may differ for the schools in the rest of the state, both public and private schools.
- In all cases, the audits presented measure costs in terms of the full material and labor costs of the measure, even in cases where the existing equipment was in need of replacement. Conventionally, only the incremental cost (i.e., the cost differential between high-efficiency and standard efficiency replacement equipment) is used in such cases when determining cost-effectiveness. As a result, the actual cost-effectiveness of many of these efficiency projects is likely much higher than indicated here. Accordingly, a Participant Test Benefit-Cost-Ratio of less than 1.0 does not necessarily mean that a project is not cost-effective. The rankings are intended to show the *relative opportunity* for a given measure.

To facilitate the audit review, a spreadsheet was developed documenting key attributes at the measure level including facility information (i.e., facility name, size, and county), measure description, annual energy savings (i.e., electric energy and demand, natural gas, fuel oil, steam, and high-temperature hot water) and associated energy cost savings, measure costs, and total project costs.

For purposes of comparison, total project costs including "soft costs" (e.g., construction contingency, audit and design costs, and administration costs) were distributed across measures proportional to the material and labor costs of the individual opportunities. Note that many audits included costs associated with the installation of advanced metering equipment. While these systems may, in reality, result in energy cost reductions due to increased building

[25] The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) defines three levels of audits. Level II: Energy Survey and Engineering Analysis Audits requires in-depth analysis of energy costs, energy usage, and building characteristics to identify no-cost and low-cost and capital-intensive energy savings opportunities.

intelligence, the audits do not assume any direct savings. Consequently, these measures and the associated costs have been omitted from the audit analysis.

The New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs[26] was used to determine measure lives for the purposes of estimating lifetime savings as estimates of lifetime energy savings were not explicitly provided by the audits. Energy cost savings in future years were discounted assuming a 5% discount rate. Note that this simplified analysis does not assume any escalation of energy costs.

Because the audits included dozens of unique measure opportunities, these measures were grouped into related but broader categories to enable comparison across the many audits. Finally, all measures categories identified in the audits were ranked by estimated lifetime energy cost savings, Participant Test BCR, and median first year energy cost savings per total measure cost. These metrics were then used to select the opportunities to profile in the next section of this report. Note that when selecting high-impact measures, some professional judgment was used to incorporate qualitative issues not reflected by the audit. For example, premium efficiency motors appears relatively high in both rankings, but the estimated savings for motors presented in the audits reflect the difference between code-compliant motors and the existing, inefficient motors. In most cases, these motors should be replaced anyway.

[26] New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs, New York Department of Public Service, October 15, 2010.

**Table 7 | Audit Measure Opportunities Ranked by Lifetime Energy Cost Savings**

| Rank | Measure Type | Count | Total Measure Costs | Total First Year Energy Cost Savings | Total Lifetime Energy Cost Savings | Total Lifetime Energy Savings (MMBtu) |
|---|---|---|---|---|---|---|
| 1 | Boiler/Burner Replacement | 38 | $ 55,021,231 | $ 3,326,145 | $ 43,523,675 | 2,812,906 |
| 2 | Lighting Replacement/Controls | 126 | $ 29,607,513 | $ 2,946,400 | $ 31,465,887 | 975,204 |
| 3 | Direct Digital Controls | 13 | $ 12,790,431 | $ 976,050 | $ 10,637,618 | 896,499 |
| 4 | Chiller Replacement | 7 | $ 18,866,557 | $ 656,918 | $ 8,595,983 | 238,709 |
| 5 | Domestic Hot Water Heater | 20 | $ 3,685,534 | $ 597,250 | $ 6,509,213 | 186,287 |
| 6 | HVAC Controls | 33 | $ 5,611,363 | $ 672,185 | $ 6,422,515 | 398,515 |
| 7 | Heating Dist. System Upgrades | 37 | $ 10,768,848 | $ 670,918 | $ 5,450,973 | 622,736 |
| 8 | Variable Frequency Drives | 8 | $ 1,532,120 | $ 428,763 | $ 4,672,934 | 181,549 |
| 9 | HVAC Auxiliaries | 11 | $ 4,719,904 | $ 355,837 | $ 3,858,548 | 173,144 |
| 10 | New HVAC Equipment | 2 | $ 2,879,534 | $ 138,404 | $ 1,811,061 | (22,774) |
| 11 | Chiller Controls and Auxiliaries | 5 | $ 2,108,719 | $ 132,879 | $ 1,471,537 | 107,598 |
| 12 | Premium Efficiency Motors | 26 | $ 955,460 | $ 111,869 | $ 1,219,220 | 42,491 |
| 13 | Heat Recovery | 3 | $ 1,702,186 | $ 80,820 | $ 880,828 | 101,081 |
| 14 | Boiler Controls and Auxiliaries | 6 | $ 738,680 | $ 44,132 | $ 545,064 | 168,298 |
| 15 | Rooftop Photovoltaic | 7 | $ 2,829,799 | $ 35,475 | $ 524,982 | 36,716 |
| 16 | Envelope Improvements | 8 | $ 591,698 | $ 36,572 | $ 322,543 | 27,728 |
| 17 | Other | 2 | $ 229,811 | $ 25,563 | $ 277,134 | 9,771 |
| 18 | HVAC Replacement | 4 | $ 894,263 | $ 670 | $ 3,709 | (5,810) |
| **Total** | | 356 | $ 155,533,651 | $ 11,236,850 | $ 128,193,424 | 6,950,647 |

Notes: 1) "Count" in many cases reflects more than one installation. In other words, a project containing steam trap replacements would only be counted as a single instance regardless of whether one or 100 steam traps were recommended for the replacement. 2) These tables include only measures that were recommended by the audits. Some audits include cursory analyses of measures that were ultimately not recommended.

**Table 8 | Audit Measure Opportunities Ranked by Participant Test BCR**

| Rank | Measure Type | Count | Total Measure Costs | Total Lifetime Energy Cost Savings | Participant BCR |
|---|---|---|---|---|---|
| 1 | Variable Frequency Drives | 8 | $ 1,532,120 | $ 4,672,934 | 3.05 |
| 2 | Domestic Hot Water Heater | 20 | $ 3,685,534 | $ 6,509,213 | 1.77 |
| 3 | Premium Efficiency Motors | 26 | $ 955,460 | $ 1,219,220 | 1.28 |
| 4 | Other | 2 | $ 229,811 | $ 277,134 | 1.21 |
| 5 | HVAC Controls | 33 | $ 5,611,363 | $ 6,422,515 | 1.14 |
| 6 | Lighting Replacement/Controls | 126 | $ 29,607,513 | $ 31,465,887 | 1.06 |
| 7 | Direct Digital Controls | 13 | $ 12,790,431 | $ 10,637,618 | 0.83 |
| 8 | HVAC Auxiliaries | 11 | $ 4,719,904 | $ 3,858,548 | 0.82 |
| 9 | Boiler/Burner Replacement | 38 | $ 55,021,231 | $ 43,523,675 | 0.79 |
| 10 | Boiler Controls and Auxiliaries | 6 | $ 738,680 | $ 545,064 | 0.74 |
| 11 | Chiller Controls and Auxiliaries | 5 | $ 2,108,719 | $ 1,471,537 | 0.70 |
| 12 | New HVAC Equipment | 2 | $ 2,879,534 | $ 1,811,061 | 0.63 |
| 13 | Envelope Improvements | 8 | $ 591,698 | $ 322,543 | 0.55 |
| 14 | Heat Recovery | 3 | $ 1,702,186 | $ 880,828 | 0.52 |
| 15 | Heating Dist. System Upgrades | 37 | $ 10,768,848 | $ 5,450,973 | 0.51 |
| 16 | Chiller Replacement | 7 | $ 18,866,557 | $ 8,595,983 | 0.46 |
| 17 | Rooftop Photovoltaic | 7 | $ 2,829,799 | $ 524,982 | 0.19 |
| 18 | HVAC Replacement | 4 | $ 894,263 | $ 3,709 | 0.00 |
| **Total** | | 356 | $ 155,533,651 | $ 128,193,424 | 0.82 |

**Table 9 | Audit Measure Opportunities Ranked by Median First Year Energy Cost Savings Per Total Measure Cost**

| Rank | Row Labels | Count | Total Measure Costs | Total First Year Energy Cost Savings | MEDIAN First Year Energy Cost Savings Per Total Measure Cost |
|---|---|---|---|---|---|
| 1 | Other | 2 | $ 229,811 | $ 25,563 | $ 0.295 |
| 2 | Lighting Replacement/Controls | 126 | $ 29,607,513 | $ 2,946,400 | $ 0.094 |
| 3 | Chiller Controls and Auxiliaries | 5 | $ 2,108,719 | $ 132,879 | $ 0.092 |
| 4 | Variable Frequency Drives | 8 | $ 1,532,120 | $ 428,763 | $ 0.092 |
| 5 | Direct Digital Controls | 13 | $ 12,790,431 | $ 976,050 | $ 0.087 |
| 6 | Premium Efficiency Motors | 26 | $ 955,460 | $ 111,869 | $ 0.075 |
| 7 | Heating Dist. System Upgrades | 37 | $ 10,768,848 | $ 670,918 | $ 0.064 |
| 8 | DHW Water Heater | 20 | $ 3,685,534 | $ 597,250 | $ 0.060 |
| 9 | Envelope Improvements | 8 | $ 591,698 | $ 36,572 | $ 0.059 |
| 10 | HVAC Controls | 33 | $ 5,611,363 | $ 672,185 | $ 0.056 |
| 11 | New HVAC Equipment | 2 | $ 2,879,534 | $ 138,404 | $ 0.052 |
| 12 | Heat Recovery | 3 | $ 1,702,186 | $ 80,820 | $ 0.051 |
| 13 | Boiler Controls and Auxiliaries | 6 | $ 738,680 | $ 44,132 | $ 0.040 |
| 14 | Boiler/Burner Replacement | 38 | $ 55,021,231 | $ 3,326,145 | $ 0.039 |
| 15 | HVAC Auxiliaries | 11 | $ 4,719,904 | $ 355,837 | $ 0.038 |
| 16 | Chiller Replacement | 7 | $ 18,866,557 | $ 656,918 | $ 0.036 |
| 17 | HVAC Replacement | 4 | $ 894,263 | $ 670 | $ 0.011 |
| 18 | Rooftop PV | 7 | $ 2,829,799 | $ 35,475 | $ 0.010 |
| **Total** | | 356 | $ 155,533,651 | $ 11,236,850 | N/A |

## TECHNICAL OVERVIEWS OF HIGH-IMPACT MEASURE OPPORTUNITIES

The measures below, while likely to represent the high-impact opportunities, may not be suitable for all facilities. Any investigation of opportunities should begin with an energy audit to catalog and prioritize the opportunities at a particular site.

### Domestic Hot Water Heaters

The most common system in the schools reviewed was an indirect water heater connected to the existing steam boilers. Under this system, the boilers, which often use fuel oil, heat water in a storage tank via steam heat-exchangers. This works fairly well in the winter, but it means that the boilers have to run throughout the spring, summer, and fall in order to provide hot water for the building. Furthermore, a new gas condensing boiler can transfer heat to the water tank at over 90% efficiency. Steam boilers, by contrast, have a maximum efficiency of around 80%, and there are further significant losses through the distribution system and the heat-exchanger. Finally, many of the domestic hot water storage tanks were uninsulated. Providing insulation for the existing storage tanks will provide further savings.

Costs for this measure include the equipment and labor costs associated with the condensing gas water heater, and, depending on the site, may also include the installation of a new gas line, new concrete pads, new flue vent pipes, and asbestos abatement. Total costs ranged from $17,700 to $425,103, with a median value of $32,770. This equates to a median first year savings of $0.06 per every dollar spent on the measure. The measure saves a median of 1.8% of total building energy consumption.

Currently, commercial gas-fired storage heaters need to meet a minimum efficiency of 80%. This is significantly lower than the best available condensing units, which can have a thermal efficiency as high as 95%. However, even the minimally code compliant unit will have savings over the baseline of gas or oil-fired steam boilers.

### Boiler and Burner Replacements and Fuel Conversions to Natural Gas

Many of the boilers in the schools were originally installed in the 1950s and 1960s, and are now in poor working condition. Further, they are typically steam boilers burning No. 6 or No. 4 fuel oil. This is an issue because No. 6 and No. 4 fuel oil create significantly more pollutants than natural gas, requires quarterly cleaning of the suction and discharge strainers, and is typically more expensive than gas. Thus, replacing the boiler or the boiler/burner combination with a dual-fuel natural gas and No. 2 oil boiler can save money and reduce greenhouse gas emissions. The dual-fuel burner allows the facility to use an interruptible tariff for natural gas, thus qualifying for lower rates and using No. 2 fuel oil whenever gas service is interrupted. In most cases, the existing burners are single stage, thus simply cycling between "on" and "off" and creating unnecessary heat loss as a result of heat being transferred from the steam found in the now vacated fire passages. The new burners would be fully modulating, thus eliminating the need for cycling and increasing the efficiency of the system.

Many audits evaluated two options for this measure – just replacing the burner, or replacing the whole boiler/burner combination. However, the efficiencies of steam boilers do not differ as significantly as hot water boilers, and so a new steam boiler typically will only yield slight efficiency savings. This option was only recommended when the existing boiler was well past its working life and in imminent danger of failure; however, it would also likely make sense for facilities that foresee the need for a new boiler in the medium term. The most efficient option, where feasible, would be to replace the entire steam system with a hydronic heating system. This would eliminate the loss of heated steam throughout the distribution system, and allow the boilers to reach much higher efficiencies - 90% and up compared to around 80% for steam boilers. However, this typically involves replacing all pipes and radiators and thus was usually found to be prohibitively expensive.

Calculating savings for this measure is complicated by the fact that it involves fuel switching. For example, simply switching from a modulating No. 6 fuel oil burner to a modulating No. 2 fuel oil burner may actually increase the volume of fuel needed since No. 6 fuel oil has a higher energy density. Switching from a modulating No. 6 fuel oil burner to a modulating natural gas burner may also require increased fuel but will dramatically lower energy costs and greenhouse gas emissions. However, many of the burners also increase the efficiency of the system by allowing modulation or eliminating the need for supplementary

electric heaters and in some cases primary electric steam boilers. This creates savings above and beyond a simple fuel switch. Annual energy cost savings for this measure range from $1,000 to $1.1 million, with a median of $25,631. Costs for the measure have a similarly wide range, from $145,000 to $16.8 million, with a median of $545,421. This equates to a median first year savings of $0.04 per every dollar spent on the measure.

The federal standard for steam boilers varies based on fuel type and size, but is typically around 80% thermal efficiency. For steam boilers, it is not possible to significantly increase this number, but greater efficiencies can be achieved through various controls and features, such as modulation. The more applicable law in this case regulates the use of fuel oil in boilers. Currently, just one percent of all buildings in NYC produce 86% of the total soot pollution as a result of burning No. 6 and/or No. 4 fuel oil. To address this issue, a city rule was released in April 2011 that:

- Prohibits new boiler or burner installations using No. 6 or No. 4 fuel oil.
- Existing buildings that use No. 6 fuel oil must convert to No. 4 fuel oil or cleaner before their three-year certificate of operation expires.
- By 2030 or upon boiler replacement, all buildings must convert to No. 2 fuel oil or cleaner.

Under this rule, many of the schools audited are legally required to at least convert to No. 4 fuel oil in the next two years. This forced conversion is a good time to take a more holistic look at the heating system and invest in further efficiencies.

## Direct Digital Controls (DDC)

Currently the majority of schools audited have mostly pneumatic controls or thermostats. Pneumatic thermostats respond to pressure changes (due to temperature) in the control tube to activate heating or cooling when required. However, pneumatic thermostats can be very difficult to calibrate and are not very precise compared to direct digital controls (DDC). Indeed, many of the audits found pneumatic thermostats that were not working at all or manually turned to the "on" position, resulting in overheating during the winter months. In schools, this often means that people will keep the windows open throughout the winter.

Advantages of DDC systems are that they can more easily

- Perform time scheduling controls for exhaust fans
- Ensure night setback for heating and cooling
- Provide free cooling when available
- Provide demand control ventilation
- Optimize chiller, air-handling unit, and boiler operation and sequencing
- Display real time energy consumption of key systems
- Trigger alarms when a system is malfunctioning
- Enable load management

As with all the measures in this report, costs and savings can be quite variable, depending on the size of the building, the existing HVAC configuration, and the existing HVAC controls. Costs for this measure range from $0.66 per square foot of building area to $7.19 per square foot,

with a median value of $3.07/sf, and a median of $274 per annual Btu saved. Since building management systems save electricity, oil, and gas, savings are expressed in terms of MMBtu. Total annual MMBtu savings range from $0.03 per square foot to $0.44 per square foot, with a median of $0.09 per square foot. This corresponds to a median annual cost savings of $0.09 per dollar invested.

While federal building code mandates certain control capabilities in certain building systems, there are no codes relating to centralized building energy management systems.

## Heating Distribution System Upgrades

Many of the audited schools in NY City have heating systems that have not been significantly upgraded for five to seven decades. Furthermore, in most cases, there has not been adequate attention paid to the maintenance of the facilities' steam distribution systems. This equates to some uninsulated pipes and valves and many failed steam traps and radiator valves. Steam traps are automatic valves used to remove condensate and air from the distribution system while preventing any of the steam from escaping. Blocked steam traps can create a buildup of condensate and air in the distribution system, thus reducing thermal efficiency. Steam traps that fail in the open position cause steam to travel through the radiators without condensing, which increases the amount of steam required from the boilers, as well as increasing the make-up water requirements. Failed-open pneumatic radiator control valves result in overheating of the space. Replacing these units with self-contained control valves or DDCs will allow more precise control of the space and enable more advanced control schemes such as night set back.

Heating system upgrades provide a significant increase to occupant comfort, and is one of the more cost-effective commonly recommended measures in the audit reports. Cost estimates ranged from $0.03/sf to $5.86/sf, with a median of $0.90/sf. This corresponds to savings from $0.004/sf to $0.24/sf and a median of $0.07/sf. Energy savings range from 0.0003 MMBtu/sf to 0.108 MMBtu/sf with a median of 0.005 MMBtu/sf. This corresponds to a median annual savings of $0.06 per dollar invested.

There are currently no codes or standards governing the maintenance of steam distribution systems.

## Lighting and Lighting Controls

Many of the audited schools still have many lighting fixtures using T12 lamps. This is the least efficient type of fluorescent bulb on the market; significant savings are available by retrofitting T12 fixtures to use high performance T8s, or perhaps in the near term LED technology.[27] Further, many of the schools could highly benefit from occupancy sensors, especially in rooms with highly variable occupancy patterns such as classrooms, offices,

[27] Note that older T12 magnetic ballasts also contain PCBs, which has been a concern in New York City; the EPA has identified this as a significant problem in NYC schools. Implementing very cost-effective lighting efficiency retrofits in these situations will have the added benefit of removing any remaining PCBs and reducing health risks and environmental exposure.

bathrooms, storage rooms, auditoriums, and admin spaces. Audited measures include lighting only measures, sensor only measures, and measures that include both fixtures and occupancy sensors.

This is one of the more cost-effective measures commonly identified in the audits, and was shown to save as much as 15% of total building energy consumption, including electricity, gas, and oil. Costs, however are still highly variable, ranging from $0.37 per first year kWh to $5.14 per kWh, with a median value of $1.46 per kWh. This corresponds to savings of 0.7 kWh per dollar spent, or a median cost savings of $0.09 per dollar spent on the measure.

Current regulations under the Energy Independence and Security Act (EISA) effectively prohibit the manufacture of new T12 lamps and ballasts. This likely means that most schools would have to upgrade their fixtures in the next few years anyway in order to maintain code compliance. This means that the costs quoted in the audits may overstate actual costs in the near future. It makes sense in this context to undergo a full retrofit of existing T12s, which will enable approaching the fixtures holistically and getting an extra few years of energy savings, rather than retrofitting current T12s piecemeal as units begin to fail.

### Heating, Ventilating, and Air Conditioning (HVAC) Control Upgrades

As mentioned, many of the audited schools have HVAC systems from the 1950s and 1960s that have fallen into disrepair. This means ample opportunity to replace boilers and burners, but also gives lots of room for controls on the HVAC system which provide significant extra savings. These measures include:

- **Demand Control Ventilation** – This control system reduces the amount of outside air during periods of lower than design occupancy, thus reducing the heating and cooling loads on the HVAC system.
- **Outdoor Temperature Reset** – Vary the temperature of the hot water loop based on the outdoor temperature. During warmer periods, the temperature of the water can be lowered, reducing the load on the boiler
- **Heating/Cooling Setback** – Change the indoor temperature set point during unoccupied hours to reduce the heating/cooling load.
- **HVAC Scheduling** – Ensure that AHUs, exhaust fans, boilers, and chillers only operate when needed, and have the proper sequencing.
- **Window AC Controls** – A central control system for the building's window ACs to ensure they are all turned off during unoccupied hours.

Due to the wide range of control strategies included in this measure, as well as widely different amounts of equipment to enable these strategies, costs and savings are highly variable. The cost per annual MMBtu ranges from $1/MMBtu to nearly $5,000/MMBtu, with a median of $275/MMBtu. This corresponds to 0.004 MMBtu per dollar spent, or a median cost savings of $0.06 per dollar invested.

While federal building codes require new buildings to have the ability to do certain types of control strategies (such as demand control ventilation and temperature setback) in certain building types, this does not typically apply to existing buildings.

## Rooftop Photovoltaic Systems

Photovoltaic (PV) solar power is one of the most well-known and fastest growing types of renewable energy. Driven by falling costs, awareness of the environmental impact of conventional energy sources, and supportive policies, PV installations have been growing dramatically. As New York's PV market continues to develop, costs should decrease, making more projects economically viable. Schools across the country have also begun to utilize PV as a means of both reducing the cost of energy as well as educating students.

PV systems range vastly in scale, from small to large capacity. For rooftop systems, "[r]esidential PV systems are generally 2–10 $kW_{P\ DC}$ and installed on sloped roofs, while commercial systems may be between 10$kW_{P\ DC}$ and multi-megawatts."[28] In NYS, 1-10 kW systems represent 55% of total installed PV capacity, >10-100 kW systems represent 43%, and the remaining 2% is generated by >100 kW systems.[29] For example, a typical school in NYC with a rooftop area of 60,000 square feet with 40,000 square feet suitable for solar PV installation could support the installation of a 350 $kW_{DC}$ system.[30]

For many solar installation projects, available space and capital represent major constraints. Solar panels can be installed at a fixed angle, optimized for annual output on roofs or the ground, mounted vertically or at an angle on south facing walls, or can be installed on the ground on pole-mounted trackers that move on one or two axes to follow the sun through the day.

Manufactures have gradually increased the efficiency of production PV panels, up to 20% in recent years, while R&D has pushed cell efficiency to 44% in systems that are emerging technology but not yet market ready. Efficiency here means the percentage of energy available in the sunlight falling on the surface that is converted to electricity. The prototype cell efficiency is much higher because the cell may require exotic materials and production methods that are not cost effective and because cell efficiency is always higher than panel efficiency because of the non-generating space of the panel frame. This area efficiency may or may not be a significant factor in a given application. If there is plenty of space available, high energy production per cost would be a more likely deciding factor than high energy production per unit area, given by the efficiency.

It is important to avoid shading the system during peak daylight hours, so an unobstructed view to the south is required. Trees, buildings, other sections of the roof and rooftop equipment

---

[28] Goodrich, A., Ted James, and Michael Woodhouse, "Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost-Reduction Opportunities," NREL, February 2012.

[29] NYSERDA, New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation from Photovoltaic Devices in New York, January 2012.

[30] New York City Solar Map, Sustainable CUNY, <http://nycsolarmap.com>, Accessed July 25, 2013.

all can cause shading and need to be evaluated when planning an installation. This consideration becomes increasingly important in the dense urban environment of New York City. PV system installations are less suited to schools in urban areas, such as NYC, because the school buildings tend to have smaller footprints and less rooftop area. Furthermore, the installation costs in NYC are higher due to the higher cost of labor in the region.

Roof mounted systems require a strong and durable roof. The roof and anchoring system need to be able to support the additional weight along with winter snow, and the additional wind loading created by the panels. Because a PV installation can last 30 years or more, the roof should not need to be replaced during that time to avoid having to reinstall the solar system.

NYS schools have a large amount of roof space and, in some cases, other non-roof top property that can be used to host photovoltaic systems that produce electricity. There were 24 audits which reviewed the cost savings of photovoltaic systems. The median annual cost savings of these systems was $0.01 per dollar invested. It should be noted that of the 24 audits that considered PV, only 7 ultimately recommended the measure for inclusion in the project and even those projects exhibited undesirable economics.

# BEST PRACTICE PROGRAM APPROACHES

While the previous section identified some of the most common opportunities in NYS schools, this section details some of the most common market barriers that stand in the way of pursuing such opportunities and presents best practices for program design and project implementation that provide a means of effectively addressing these barriers. These aspects of successful program design comprise a robust toolset that can be deployed to achieve significant energy cost savings in schools.

## OVERVIEW OF COMMON MARKET BARRIERS

### Lack of Project Funding

One of the most commonly cited barriers to the implementation of both energy efficiency and renewable energy projects is the lack of adequate funding to move forward.[31] For most operations, and schools districts in particular, competition is very high for internal cash. Unfortunately, expenditures on energy projects seldom receive priority when budgeting; energy efficiency is typically not part of the mission statements of NYS schools. As a result, such investments are neglected in favor of others that are more directly related to improving the quality of education provided and the learning environment. Furthermore, even if unallocated internal cash was made available, it would likely not cover the entirety of project costs.

In some cases, investments in energy efficiency and renewable energy projects may have unintended consequences. If a schools district implements an energy efficiency project that reduces energy costs, the energy budget for the following year may be reduced by an amount equal to the energy cost savings. This is effectively a disincentive to investment in energy projects.

Finally, public schools are subject to the unique requirement that capital projects, in some cases, must be to put to a public vote before implementation as most projects will require an increase in the amount of debt carried.[32] Depending on the economy, there can be real consequences to that decision as voters are ultimately responsible for repaying bonds and are unlikely to increase their own taxes without a compelling argument. Furthermore, bonds typically require an unavoidably long development time to prepare funding requests, gain voter support, and ultimately hold the vote.

### Lack of Opportunity Awareness and Technical Expertise

Pursuing energy efficiency and alternative energy requires not only an awareness of typical opportunities and financial benefits but also an understanding of the facility-specific information that would allow the appropriate prioritization and selection of those opportunities. Unfortunately, these requirements are not always met.

---

[31] Based on an informal poll of NYS school business officials conducted in June 2013.

[32] Note: A public vote is not required if the district utilizes an energy savings performance contract or implements the project with NYPA.

### Lack of Awareness of Energy Savings Opportunities

Lack of awareness of energy savings opportunities is prevalent in schools. In many school districts, administrators and facilities staff are simply unaware of opportunities for energy saving capital improvements, improved operation and maintenance practices, and clean energy installations. While staff may have a general sense of the cost benefits of capital intensive improvements such as lighting retrofits and boilers replacements, far less are aware of the low-cost and no-cost opportunities available through improved operation and maintenance practices. Furthermore, with few exceptions, facilities departments operate without direct involvement with senior district administrators. This lack of involvement from those at decision-making level presents a further barrier to the implementation of energy cost saving measures even when facilities staff are aware of the opportunities.

### Lack of Awareness of Financial Benefits

Even if school staff are aware of available energy efficiency and renewable energy opportunities, they may not possess a level of understanding of the financial benefits associated with those improvements necessary to motivate action. "[F]acilities managers and business officials do not always realize the magnitude of the impact that good energy management can have on their district's budget."[33] This lack of awareness is understandable as the impacts of efficiency investments are largely invisible unless consciously tracked. This problem is exacerbated by the fact that energy bills for the majority of school districts are handled by the central district office without any involvement by staff charged with the operation of the energy-consuming equipment. This potential disconnect between cause (i.e., energy management activities by facilities staff) and effect (i.e., reduced energy bills encountered by administrative staff) often leads to an undervaluing of energy management activities. This puts energy efficiency and renewable energy opportunities at an immediate disadvantage when competing for internal funding.

Equally as important as the ignored financial benefits of energy cost savings opportunities due to a lack of awareness are the potential financial consequences of inadequate operation and maintenance funding. Guidance from Princeton Energy Resources International shows that, "O&M spending per student is now at its lowest level in 30 years, inevitably resulting in more poorly maintained and operated facilities in many districts."[34] Administrators commonly view operation and maintenance spending cuts as a reasonable way to deal with difficult fiscal environments without fully understanding the long-term consequences on equipment performance and service life and building occupant health and comfort.

---

[33] York, Dan, M. Kushler, and P. Witte, "Compendium of Champions: Chronicling Exemplary Energy Efficiency Programs from Across the U.S." ACEEE, February 2008.

[34] Princeton Energy Resources International, "School Operations and Maintenance: Best Practices for Controlling Energy Costs," 2004.

### Lack of Technical Expertise and Building Information

While facilities or other school district staff may recognize the potential benefits of pursuing energy saving opportunities, they may not have the technical expertise to initiate the planning and implementation processes. Pursing energy performance upgrades most efficiently requires a specialized skillset to identify, analyze, prioritize, select, and manage upgrades. Facilities staff do not always have the necessary skills, possess the necessary building intelligence, or know who to work with to carry out a successful project.

As related by NYSERDA, one of the most common barriers encountered by schools is a "lack of information about what they should be doing."[35] It is difficult, if not impossible, to know where to begin without first investigating how a school building is currently operating. A lack of energy audits and benchmarking on prior energy use and costs is all too common in school districts. Finally, even if the most promising improvement opportunities are understood, selecting among the many organizations offering energy services can present further challenges.

### Lack of Adequate Time and Staff

Successful energy cost savings projects typically require an "on-the-ground" advocate at the facility to shepherd the projects to completion. However, the reality at many school districts is that facilities' staff are consumed with day-to-day operations. The majority of schools districts do not have dedicated energy managers and energy management responsibilities typically fall to normal facilities staff. Without clearly defined energy management roles and responsibilities, there may be a lack of accountability regarding energy cost control.

Generally, efficiency planning and renewable project implementation are viewed as an additional effort and are therefore not prioritized. "Personnel at both the district and individual school level are quite focused on the tasks required to keep buildings functioning. Any request for additional effort can often be perceived as interference."[36] This barrier was also cited by NYSERDA, namely "lack of internal staff to develop and manage projects."[37]

Due to significant cuts to facility operating budgets, school districts have increasingly adopted reactive maintenance practices as a perceived cost-saving measure. NYS schools experienced state aid cuts of $1.3 billion in 2011-12, $1.4 billion in 2010-11, and flat funding the year before that.[38] A recent survey of NYS school business officials found that 66% of districts planned to cut non-teaching positions and 30% planned to defer maintenance activities in attempts to balance their budgets for the 2012-2013 school year.[39] As described by Princeton Energy Resources International, "[t]his means that basic equipment and building maintenance

---

[35] Interview with Matthew Brown, NYSERDA, April 17, 2013.

[36] TRC Energy Services, "Building Performance Analysis: Energy Benchmarking of New York State Schools," Proceedings of the 2004 ACEEE Summer Study, 2004.

[37] Interview with Matthew Brown, NYSERDA, April 17, 2013.

[38] New York State School Boards Association (NYSSBA), "The New Reality for Schools: The First Budgets Under the Tax Cap," May 2012.

[39] New York State Association of School Business Officials (NYSASBO)/ New York State School Boards Association (NYSSBA) survey, April 20-27, 2012.

practices have been cut to the bone. In this climate, responding to emergencies and equipment failures has become the role of facility departments and O&M staff."[40] Given these demands on facilities staff, little time remains for proactive planning and project administration.

## Lack of Energy Policy or Objectives

As noted above, many school districts lack dedicated energy managers. Perhaps not surprisingly then, most schools also do not have a well-defined energy policy that details energy cost objectives and staff responsibilities for energy consumption. This stems from the fact that the energy component of operational costs is often not recognized as a controllable cost. Without direction from district administrators, it is unlikely that the resources necessary to develop such a policy will be made available. In the absence of a district-wide energy policy, the value of energy cost saving improvements is more likely to be overlooked.

Furthermore, the primary focus of schools, as dictated by the NYSED and local schools boards, is to provide a quality education for students. In order to meet this goal, schools must not only focus on instructors and curricula but also allocate budget for items including, but not limited to, transportation, special education, state requirements and mandates, and standardized testing. Therefore, any efforts to internally promote energy efficiency or renewable energy are a distant secondary priority.

## Project Approval and Environmental Barriers

### Barriers Due to Project Approval Requirements

In the State of New York outside of NYC, school districts are required to follow a project approval process to ensure a high level of safety and code compliance, which may impact the overall project schedule as compared to other publicly operated facilities. This more stringent approval process is due to a variety of required procedures and legislation that targets this segment only. For instance, regardless of the scope of work of a project, a comprehensive code compliance checklist must be completed for each building included in the project. This includes, but is not limited to, electrical, mechanical, and structural codes. Any code deficiencies must be identified and either corrected as part of the project, as a separate project, or formally included in the district's capital plan. The effort to conduct the necessary inspections represents an additional project cost and presents a real barrier for large buildings in addition to the barrier presented by any required remediation work. In addition, energy projects are reviewed by the same group at NYSED that is also reviewing critical school district capital projects, projects that represent hundreds of millions of dollars in investment at any one time. In order to make sure these critical projects are expedited, a lower priority is given to energy projects.

[40] Princeton Energy Resources International, "School Operations and Maintenance: Best Practices for Controlling Energy Costs," 2004.

### Barriers Due to Environmental Policies

The cost-effectiveness of lighting projects is reduced at older facilities in New York City, due to handling requirements for asbestos containing materials and PCBs specific to NYC schools.[41] In many cases, asbestos abatement must be performed on lighting wiring unless there is documentation to show that abatement is not required. Unfortunately, if it is assumed that lighting wiring contains asbestos, a complete design for abatement is required before a permit for the work can be requested. Furthermore, an approximate budget of $475 per fixture must be carried for abatement. The additional costs make lighting work, which historically supported other more costly measures, uneconomical. This represents an enormous internal barrier and greatly diminishes the cost-effectiveness of lighting measures.

## OVERVIEW OF BEST PRACTICE PROGRAM DESIGNS

Energy Efficiency programs targeted at educational facilities can help schools to save energy and cut costs. Offering effectively designed programs that reduce barriers faced by schools can help schools to implement projects that maximize energy savings. Many school efficiency programs exist that are based on traditional models of providing financial incentives to fund one-time efficiency upgrades. While these kinds of models have achieved energy savings and lowered the cost barrier for making efficiency upgrades, other models have emerged that seek to change the ways schools and school districts think about and manage energy use.[42] These additional approaches tend to promote short and long term planning, on-going monitoring and improvement efforts, and involvement of the broader school community including students, teachers, parents, and school boards. Such models may help to reduce additional barriers facing schools and help to achieve greater savings than financial incentives alone. Achieving these goals requires efficiency programs to provide schools with adequate planning support and technical assistance as well as resources and materials needed to train staff, teach students, engage the community, and ensure that energy savings persist.

The following sections describe practices and considerations that can help schools to effectively plan for and implement energy saving measures. Providing services that help to reduce barriers to improving energy efficiency can increase efficiency program participation, reduce energy consumption, and save money.

### Offer Technical Assistance

Districts with dedicated energy managers that have already received training or gained experience with similar projects may possess the necessary technical expertise to manage the implementation of energy efficiency improvements. Other school districts might have the

---

[41] PCBs (Polychlorinated Biphenyls) are a group of manmade chemicals widely used in building materials and electrical products, such as fluorescent lighting ballasts, in the past. The U.S. Environmental Protection Agency banned the manufacturing and certain uses of PCBs in 1978, but many schools may still contain PCB-containing fluorescent lighting ballasts.

[42] Thorne, J., American Council for an Energy-Efficient Economy, Report Number A005, "Approaching Commercial Sector Market Transformation by Market Segment: Opportunities in Schools." August 2000.

commitment and funding for efficiency upgrades in place, but lack the expertise to effectively undertake improvements. For these schools, the work load and expertise associated with identifying, implementing, and funding efficiency improvements may be overwhelming.

Effective program design can help reduce this barrier by providing schools (or potentially BOCES) with technical assistance (TA) to guide them through the planning and implementation process. Schools may need support from professionals for various aspects of the process from performing benchmarking and energy auditing to selecting an implementation contractor. Experts with specific technical or content knowledge are able to provide schools with information and advice about best practices to help schools maximize energy savings using the most appropriate technologies and practices.

Technical assistance is a key aspect of many school efficiency programs. For example, the California Energy Commission's Bright Schools Program[43] provides schools with technical assistance services at various stages in the efficiency planning and implementation process. These services include conducting energy audits and feasibility studies that analyze the potential for cost-effective energy efficiency and clean energy projects, reviewing existing proposals and designs, developing equipment performance specifications, and assisting with contractor and equipment bid selection. Providing these services helps to fill gaps in knowledge and experience schools may have while also involving school personnel throughout the process.

As an initial step in the program design process, program administrators may wish to determine which aspects of project implementation pose the greatest challenge to most schools. Ensuring that experts are available to support these processes can help schools to overcome the largest challenges they face during the planning and implementation phase. An additional approach may be to provide schools with technical assistance up to a certain dollar amount and allow them to choose the areas of project development and implementation for which they need the most support. For example, the California Energy Commission's Bright Schools programs provide technical assistance services up to $20,000 of a consultant's costs.[44]

NYSERDA also offers technical assistance to K-12 schools through its FlexTech Program. Schools and several other types of facilities that pay into the New York System Benefits Charge (SBC), the statewide mechanism for funding energy efficiency improvements through a surcharge on customers' electric bills, can receive support for a range of activities intended to improve energy efficiency.[45] These services include, among others, providing expert advice for purchasing efficient equipment, reviewing energy audits, and verifying proper equipment installation.

---

[43] California Energy Commission, "The Bright Schools Program." <http://www.energy.ca.gov/efficiency/brightschools>. Accessed June 13, 2013.

[44] Ibid

[45] NYSERDA, "Eligible FlexTech Projects." <http://www.nyserda.ny.gov/Energy-Efficiency-and-Renewable-Programs/Commercial-and-Industrial/CI-Programs/FlexTech-Program/Eligible-FlexTech-Projects.aspx>. Accessed June 13, 2013.

Some programs have gone a step farther to offer schools more intensive support and have established Resource Conservation Manager (RCM) programs. Through these programs, school districts hire a program sponsor-trained RCM to work with school staff to identify and implement opportunities for energy savings.[46] The cost of the RCM is typically paid for through cost savings from efficiency improvements with the guarantee that savings will fund project costs for the first few years after beginning participation in the program. If savings do not meet these expectations, program administrators often agree to fund the additional amount. For example, Puget Sound Energy's Resource Conservation Manager Program guarantees that participants' resource bills will exceed the salary of the RCM or it will pay the difference.[47] Often, the school district becomes responsible for project administration after the RCM program becomes well established.[48]

As another example, Pacific Gas & Electric's (PG&E) School Resource Program assigns a Resource Conservation Manager to school districts to guide them through developing and implementing energy efficiency projects.[49] The RCM provides support through the progression of the entire project from assessing baseline energy use and completing a benchmarking study to assisting the district with a project implementation plan. The assistance covers a range of services including informational, technical, and financial aspects of program implementation. This type of model helps schools achieve maximum savings by ensuring that every step of the process is completed properly and comprehensively. Moreover, it would enable the technical expert to develop a deep knowledge and understanding of a given district's specific constraints and goals. Such programs have been implemented in several states across the country and provide an average of 10-20% annual utility savings.[50] In 1995, a group of schools in Oregon received a U.S. DOE award for the "Best Energy Efficiency and Renewable Energy Program in the Nation" for its use of the RCM approach.[51]

Successful RCM programs improve in-house expertise and assist schools with many of the best practice activities described in this report including data collection and ongoing monitoring, training for facility operators, communicating efforts, and recognizing results. However, RCM programs they may not be cost effective for all school districts. The most successful RCM programs focus on school districts with 25 to 50 schools or a minimum of one

---

[46] Thorne, J., American Council for an Energy-Efficient Economy, Report Number A005, "Approaching Commercial Sector Market Transformation by Market Segment: Opportunities in Schools." August 2000.

[47] Puget Sound Energy, "Resource Conservation Manager Program" <http://pse.com/savingsandenergycenter/ForBusinesses/Pages/Resource-Conservation-Manager.aspx>. Accessed June 13, 2013.

[48] Thorne, J., American Council for an Energy-Efficient Economy, Report Number A005, "Approaching Commercial Sector Market Transformation by Market Segment: Opportunities in Schools." August 2000.

[49] PG&E, "School Resource Program." <http://www.pge.com/mybusiness/energysavingsrebates/tips/schools/>. Accessed June 13, 2013.

[50] Thorne, J., American Council for an Energy-Efficient Economy, Report Number A005, "Approaching Commercial Sector Market Transformation by Market Segment: Opportunities in Schools." August 2000.

[51] PG&E, "PY2004/PY2005 Energy Efficiency Program Proposal, R. 01-08-028, Local Crosscutting School Resources Program," 2003.

million square feet and using over 75,000 Btu/sf, or with a minimum utility budget of $1 million.[52] Though not unique to RCM programs, several additional factors have also been identified as aspects of successful RCM efforts in schools, including policy and goal setting, committed school administrators, supportive facilities managers, and processes for recognizing success.[53]

Some school efficiency programs provide a "turn-key" approach in which the program administrator oversees and implements the efficiency upgrade process through all phases. However, including school staff in the project can help to improve in-house expertise, lower the project budget, and ensure efficiency measures continue to save energy.

The NYPA Energy Efficiency Program provides an example of the successful turn-key approach. Developed to help program participants achieve deep energy savings, the program provides a single program implementation mechanism that takes the participant from project beginning to end. This allows the participant to focus their resources on delivering the vital services and functions they are tasked with – a critical consideration when dealing with school facilities. In effect, schools can use NYPA staff as an expert extension of their own. Under the Energy Services Program, NYPA manages the work from start to finish. NYPA integrates available rebate or incentive programs from the New York Energy and Research Development Authority (NYSERDA), the Long Island Power Authority (LIPA), and other investor-owned utilities (IOU) to help buy down the cost to the customer. The incentives are funded from collections on utility bills as established by the New York Public Services Commission and administered by NYSERDA, LIPA, and the IOU's. In this regard, NYS is unique in that it has established what is essentially an expert pool of public employees (at NYPA) able to help districts achieve energy savings, an approach that is very cost-effective, rather than replicating this talent across all public sector facilities.

While technical assistance may not be required for all schools participating in efficiency programs, making adequate TA available to schools at all steps in the efficiency upgrade process helps to maximize savings and reduce barriers schools face in improving facility energy efficiency.

### Use Benchmarking and Auditing to Identify Opportunities for Savings

In order to understand how much energy schools can expect to save and determine which approaches will be most cost effective, it is important to understand a building's current energy use. To support a proper planning process, effective school efficiency programs include benchmarking and/or energy auditing as initial steps. Depending on the program approach, schools might receive professional analyses completed by engineers or other specialists or they might receive resources for instructing and informing their own data collection and analysis process. In New York City, the importance of data collected from benchmarking and auditing

---

[52] Sacramento Municipal Utility District, "Resource Conservation Manager—Program Summary." 1999. As cited in Thorne, J., 2000.

[53] Oregon Office of Energy, "Oregon Office of Energy—Resource Conservation Management." July 2003.

has been reflected in Local Laws 84 and 87. In general, these laws require public buildings exceeding 10,000 square feet and private buildings exceeding 50,000 square feet[54] to submit annual benchmarking data and undergo an energy audit every 10 years in order to track and optimize building energy performance.[55] Incorporating similar data collection efforts into a statewide school program will align practices throughout the state that have been recognized by New York City as important strategies for reducing energy use.

### Benchmarking

Performance benchmarking is the process of comparing a building's energy use to the energy use of other similar buildings. The comparison of buildings is typically based upon a common energy index, energy use intensity, which is determined by dividing the annual total energy consumption by the area of the building in square feet. Passing legislation that requires certain buildings to be benchmarked has proven to be a successful strategy. Many school buildings in New York City have been benchmarked pursuant to Local Law 84. In 2011, benchmarking data had been collected for nearly 1,200 schools, which has helped to contribute to a better understanding of building energy use in the City.[56] California, Massachusetts, Minnesota, and Washington State have all passed legislation that requires benchmarking for buildings of various sector and sizes.[57]

In the absence of a public policy that requires school benchmarking, school efficiency programs can promote energy benchmarking as an important initial step in identifying opportunities for energy savings Comparing a school's current benchmarking "score" to that of other similar buildings provides a way for school districts to set savings goals as well as prioritize individual schools for energy audits and efficiency projects. Tracking benchmarking scores over time also provides a good way to measure progress. Program administrators such as PG&E, NYSERDA, and CenterPoint Energy provide benchmarking as a service offered through its school efficiency programs.[58]

Although many benchmarking tools are available, the U.S. Environmental Protection Agency's ENERGY STAR Portfolio Manager is widely seen as the benchmarking industry

---

[54] Explicitly, the laws requires buildings exceeding 50,000 gross square feet, two or more buildings on the same tax lot that together exceed 100,000 gross square feet, or two or more buildings held in the condominium form of ownership that are governed by the same board of managers and that together exceed 100,000 gross square feet to comply with the requirements.

[55] PlaNYC, "About LL87." <http://www.nyc.gov/html/gbee/html/plan/ll87_about.shtml>. Accessed June 13, 2013; PlaNYC, "About LL84." <http://www.nyc.gov/html/gbee/html/plan/ll84_about.shtml>. Accessed June 13, 2013.

[56] NYC Citywide Administrative Services, "Energy Benchmarking Report of New York City Municipal Buildings." November 2011.

[57] State & Local Energy Efficiency Action Network, Existing Commercial Building Working Group, "Energy Benchmarking, Rating, and Disclosure for State Governments." May 2012.

[58] PG&E, "School Resource Program." <http://www.pge.com/mybusiness/energysavingsrebates/tips/schools/>. Accessed June 13, 2013; CenterPoint Energy, "Sustainable Schools." <http://www.centerpointelectric.com/cehe/bus/efficiency/schools/>. Accessed June 13, 2013; NYSERDA, "K-12 Energy Smart Schools." <http://www.nyserda.ny.gov/Commercial-and-Industrial/Sectors/K-12-Schools.aspx>. Accessed June 13, 2013.

standard and is being used for the benchmarking efforts in New York.[59] The EPA provides several useful resources (e.g., a Benchmarking Starter Kit) to support Portfolio Manager users through the benchmarking process.[60] However, this process may still be challenging for school personnel if they lack energy management experience. NYSERDA's provides benchmarking assistance by offering a Free Energy Benchmarking Service in which the program provides both the data analysis and interpretation of results. Participants complete a Building Data Request Form and 12 months of utility bills. The program then sends the school a report evaluating the building's performance and provides recommendations for which of NYSERDA's other programs can help them to improve efficiency. To date, 1,029 schools across 236 districts have been benchmarked through NYSERDA's program.[61] An additional support strategy would be to hire a contractor to collect the data as well as analyze it and describe results to school personnel. Contractor-facilitated benchmarking may be one way to ensure that schools get benchmarked, that it is done correctly, and results are properly interpreted.

### Energy Auditing

While benchmarking provides an initial assessment of a building's energy use patterns compared to others, energy audits can enable districts to identify specific opportunities for cost effective energy efficiency improvements. Audits include a systematic inspection and analysis of energy flows in a building to identify the energy consumption of the current equipment and to recommend equipment upgrades and other energy saving practices. School efficiency programs frequently provide audits as a tool for efficiency improvement planning. The audit process aims to identify and evaluate all major energy savings opportunities. Even if current funding levels do not support the implementation of all identified opportunities, this data can be useful for long term planning.

When designing school efficiency programs, it is important to note that different types of audits exist and vary by level of detail, complexity, and implementation. As part of the program design process, program administrators should consider the appropriate level of energy audit to provide and required funding levels. ASHRAE identifies three audit levels that build on the previous level and increase in cost, thoroughness, amount of data collected, and detail included in the final report.[62] Level I Audits are walk through audits include a visual inspection and identify low and no cost efficiency measures and a high level view of possible capital upgrades.[63] Some school efficiency programs use these types of audits as an educational tool and strategy for wider school community involvement. The Alliance to Save Energy's PowerSave program has schools form teams of students to conduct walk-through surveys to

---

[59] Ibid

[60] ENERGY STAR, "ENERGY STAR Benchmarking Starter Kit." <http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager_benchmarking>. Accessed June 13, 2013.

[61] It is uncertain how many of these audits are also counted in the number audits conducted under Local Law 84.

[62] Pacific Northwest National Laboratory, Building Technologies Program. "A Guide to Energy Audits." September 25, 2011.

[63] Ibid

identify opportunities for energy savings by gathering data on current use as well as examining, the building envelope, lighting, HVAC system, electrical appliances as well as plug loads.[64] Following the audit, students identify basic changes in operations, maintenance, and behavior to reduce energy use. While this type of audit may be appropriate for identifying low- and no-cost efficiency measures, Level II Audits provide more specific energy efficiency measure recommendations based on a more detailed analysis of financial plans and engineering analysis of energy uses and costs as well as building characteristics.[65] Level III audits, considered "investment grade," include additional data collection, monitoring, and engineering analysis and provide more detailed recommendations of capital intensive improvements.[66] These more exhaustive audits are likely to be more common and help to identify additional savings opportunities. A complete understanding of energy usage and improvement options can help schools to prioritize and plan for capital improvements in addition to simpler no and low-cost measures. Level II audits are currently required under New York City Local Law 87.

School efficiency programs such as NYPA's Energy Services Program for Schools and SoCal Gas's PREPS Program do provide opportunities for these types of more comprehensive energy audits.[67] Higher level energy audits often call for a professional auditor with the experience and expertise necessary to provide detailed project cost and savings calculations. One way to ensure the quality and accuracy of energy audits is to require that audits be completed by professionals who are properly certified. For compliance with New York City's Local Law 87, for example, audits must be conducted by professionals with one of the approved certifications.[68] These included being a Certified Energy Auditor, Certified, Energy Manager, NYSERDA Approved FlexTech Consultant, as well as a few others.

## Provide Support for Near and Long-Term Planning

Early planning activities lay the groundwork for successful implementation of energy savings efforts. A clear understanding of school energy use and opportunities for reduced energy use provide districts with a realistic idea of the savings they can expect to achieve. The next step towards achieving identified savings opportunities is developing a plan that sets savings goals as well as actionable steps to achieve performance targets. This plan should act as a road map that clearly defines goals, determines the proper scope of efficiency improvements, and prioritizes investments. Project goals should also be measureable to allow for progress monitoring and determine if targets have been met.

---

[64] Alliance to Save Energy, "PowerSave Schools Program." <http://www.ase.org/programs/powersave-schools>. Accessed June 13, 2013.

[65] Pacific Northwest National Laboratory, Building Technologies Program. "A Guide to Energy Audits." September 25, 2011.

[66] Ibid

[67] PREPS, "Increasing Energy Awareness and Improving Energy Efficiency in Our Schools and Colleges." <http://prepsprogram.com/>. Accessed June 13, 2013.

[68] PlaNYC, "Local Law 87 Outreach & Training." <http://www.nyc.gov/html/gbee/html/plan/training_ll87.shtml>. Accessed June 13, 2013.

While short term project planning is essential to ensure a successful project outcome given current circumstances, long term planning can help schools achieve even greater savings in the future if end goals are not immediately feasible. Having priorities and future goals in place allow school districts to act quickly should opportunities for improvement arise. Efficiency programs should encourage schools to shift their thinking towards planning for long term energy savings. One strategy would be to help schools develop an energy policy that states future goals and intentions as well as more short-term implementation plans and action items. The Schools for Energy Efficiency program, developed by Hallberg Engineering of Minnesota, for example, helps to develop customized plans for schools that have a multi-year approach with an annual focus. The third and fourth steps of the Kentucky Energy Efficiency Program for Schools are setting performance goals and creating an energy management action plan. These processes encourage schools to set achievable energy performance goals that consider long-term energy consumption reduction targets as well as guide current and planned efforts. CenterPoint Energy's SCORE program provides schools in Texas with assistance in developing an Energy Master Plan to manage energy costs.[69]

Successful plans should not be static, but should be reviewed and revised periodically. This review process should include monitoring and tracking progress after retrofit projects have been completed to ensure that new systems are working properly and make adjustments as necessary. The review process should also seek to identify additional opportunities for energy savings as the result of new technologies, new building uses, or new goals or funding sources. An Energy Planning Guide developed by the San Diego County Office of Education recommends considering different planning horizons and setting short, medium and long term goals. While short term goals may meet immediate needs with clear steps for implementation in less than five years, longer term goals might describe the school's vision, without a specific roadmap for achieve these objectives. Successful implementation of short-term planning measured savings can help inform and gain support for more substantial future improvements.

Some school efficiency programs have demonstrated the importance of an interactive planning process by including planning activities as part of the programs' design. For example, schools participating in the Alliance to Save Energy's PowerSave Program, active in several states across the country, have student teams revisit energy saving plans mid-way through the year to assess progress and come up with new ways to save energy during the remainder of the year. Additionally, to be eligible for funding sources from Tennessee's Energy Efficient Schools Initiative, school districts must develop an energy management policy with a supporting action plan. Criteria for the program indicate that action plan should be regularly updated; often annually based on achievements, changing conditions, and any new priorities. Effective school efficiency programs can facilitate this iterative process by providing ongoing periodic review of the long-term plans.

---

[69] CenterPoint Energy, "Sustainable Schools." <http://www.centerpointelectric.com/cehe/bus/efficiency/schools/>. Accessed June 13, 2013.

### Provide Flexibility to Meet Individualized Needs

While schools share many common barriers and opportunities for energy savings, the best approach may depend on the school's savings potential, timeline, available capital, and/or savings targets. Every school has a unique set of circumstances and constraints and effective efficiency programs must provide the flexibility to meet diverse needs. For some schools, educating students and staff about ways to reduce energy consumption and encourage behavioral change may provide opportunities for savings. For others, updating and improving operation and maintenance procedures may be enough to allow schools to meet their energy savings goals. For still others, investment in cost-effective equipment retrofits may be the most desirable approach. The planning process should be individualized enough to consider each school and district's circumstances to set achievable goals and maximize savings based on diverse needs.

## Offer Financing Options and Information

In many instances, cost-effective capital investments represent significant opportunities for energy savings. Ideally, schools would have the available internal funds to pay for these projects directly, yet many schools lack the upfront capital required to make improvements. By providing schools with a variety of financing options, efficiency programs can help overcome the funding barrier and ensure that cost-effective savings are achieved. To facilitate this process, effective school efficiency programs can either provide funding directly to fund efficiency efforts or help schools to leverage funding from other sources. In some cases, programs provide schools with funding through rebates to offset project costs. For example, NIPSCO in Indiana offers a performance incentive where schools receive a rebate based on the amount of kWh that will be saved through efficiency upgrades.[70] NYSERDA's Existing Facilities Program also offers a performance-based incentive for large improvements to schools and other commercial buildings.[71] Through this program, NYSERDA also offers a prescriptive approach and provides fixed rebates to schools for making smaller qualified upgrades. These kinds of financial incentives can and have been available to both public and private schools that have reduced their energy use through efficiency measures.

School efficiency programs also offer funding options based on alternative models. For example, the Bright Schools Program administered by the California Energy Commission, provides free technical assistance services up to a certain dollar amount and then offers low interest loans to finance project implementation.[72] Additionally, Alliant Energy offers a Shared Savings financing model that allows schools to repay the initial cost of energy efficient

---

[70] NIPSCO, "School/Institution Savings."< http://www.nipsco.com/en/save-energy/schools.aspx>. Accessed June 13, 2013.

[71] NYSERDA, "Existing Facilities Program." <http://www.nyserda.ny.gov/BusinessAreas/Energy-Efficiency-and-Renewable-Programs/Commercial-and-Industrial/CI-Programs/Existing-Facilities-Program.aspx>. Accessed June 13, 2013.

[72] California Energy Commission, "The Bright Schools Program." <http://www.energy.ca.gov/efficiency/brightschools/>. Accessed June 13, 2013.

upgrades each month over a five-year contract term.[73] In New York, many of the New York Power Authority's efficiency programs provide low interest financing for efficiency projects. NYPA recovers costs by sharing the savings participants receive on their utility bills. After the loan is paid off, program participants benefit from the full savings.[74] For its Energy Services for Schools Program, NYPA, from a variety of state and federal sources has been able to apply about $150 million in grants, bonds, and incentives to reduce program participation costs to schools.

Governments, non-profits, and other organizations also offer an array of mechanisms for funding efficiency upgrades. These options may include rebates and low-interest loans as previously mentioned as well as grants, lease-purchase agreements, and on-bill financing. If school efficiency programs are unable to offer direct financial assistance, they can help schools to navigate these many different approaches and options schools might consider to obtain funding for efficiency upgrades. For example, PG&E's School Resource Program offers workshops for school financial officers and administrators about financial programs and strategies for funding energy efficiency projects.[75]

Additionally, Energizing Indiana's School Building Assessment Program helps school staff to understand what rebates may be available to them under commercial and industrial rebate programs.[76] This type of reduction in transactions costs alone may allow schools to seek out funding opportunities and obtain financing when they might not have taken the time and effort otherwise. Financial incentives alone may not be enough for an effective school efficiency program; however, providing some consideration of financing and resources for finding and evaluating resources can be a key element for school efficiency programs.

Financing options for renewable resources, namely PV systems, merit special discussion. Financing is often necessary to cover the upfront cost of a PV system even for cost effective installations. Funding for solar school installations can come from many different sources. School districts with the financial resources may buy the equipment and fund the installations themselves. Alternatively, school groups such as PTAs might undertake efforts to raise their own funding. Traditional methods of financing such as loans and bonds may be available to pay for PV systems at NYS school facilities. In addition, power purchase agreements (PPA) and leasing for PV systems are two options that have been developed to help get around the high initial cost of PV. In both of these arrangements the customer hosts the system, but does not own it, so there is little to no upfront cost. Customers pay monthly for the output of the PV system or the lease payment, plus any additional energy from the grid consumed. These

---

[73] Alliant Energy, "School Programs and Rebates." <http://www.alliantenergy.com/CommunityInvolvement/CommunityOutreach/Schools/>. Accessed June 13, 2013.

[74] NYPA, "How Our Programs Work." <http://www.nypa.gov/services/esprograms.htm>. Accessed June 13, 2013.

[75] PG&E, "School Resource Program." <http://www.pge.com/mybusiness/energysavingsrebates/tips/schools>. Accessed June 13, 2013.

[76] Energizing Indiana, "School Programs." <https://energizingindiana.com/programs/school-programs/>. Accessed June 13, 2013.

combined monthly expenses should be lower than the pre-installation electric bill, making the installation of PV cash-flow positive. At the end of the PPA or lease, the host can or must purchase the system at a previously agreed price, much lower than the installed cost.

These financial tools also allow customers that are not eligible to claim federal tax credits to buy discounted energy from a system owner who can. Being able to take advantage of federal tax credits and accelerated depreciation is critical to the economics of PV as demonstrated in the potential analysis.

One example of a PPA signed by a school district took place in Boulder, Colorado. In 2012, the Boulder Valley School District singed a 20-year PPA to install 1.4 MW of solar PV that is planned to lower the district's electricity bills by 10% over the course of the agreement.[77] Prior to taking on a large solar PV installation, the school district took incremental steps to commit to environmental sustainability efforts. In 2008, the district developed a Sustainability Management System hired a sustainability coordinator. It also gained experience with smaller solar pilots.

In other cases, utilities, nonprofits, or government agency might contribute to funding schools solar installations. Some programs such as Progress Energy's SunSense Program provide installations to qualifying schools at no cost to the school. Other programs, such as the Illinois Clean Energy Community Foundation's Solar Schools Program, provides grants up to a certain amount to support school solar PV installations. In 2011, the Manlius Pebble Hill School, a private 1-12 school in DeWitt, New York, received a $125,000 grant from NYSERDA for the installation of 117 rooftop solar panels that will produce a 25% of the school's energy and save between $6,000 and $9,000 in energy costs annually.[78] The school also a donation of the installation costs from the company installing the panels.

## Maximize Savings Through Education and Awareness

### Address Building Occupant Behavior

Improving the energy efficiency of equipment and systems in a school building can be an effective strategy for reducing energy use, but energy consumption is also a function of occupant behavior. Many schools have been able to save up to 25% of energy use by implementing behavioral and operational changes alone.[79] Simple behavioral changes such as turning off lights when rooms are unoccupied or shutting down computers at the end of the day can help schools to maximize potential savings. School efficiency programs can maximize their impact by addressing occupant behavior in addition to cost-effective capital projects.

---

[77] Borgeson, M., and Zimring, M., Lawrence Berkeley National Laboratory, "Financing Energy Upgrades for K-12 School Districts: A Guide to Tapping into Funding for Energy Efficiency and Renewable Energy Improvements. April 2013.

[78] Manlius Pebble Hill School, "Solar Panels Go Up to Bring Down Energy Bills." <http://headlines.mph.net/2011/05/solar-panels-go-up-to-bring-down-energy-bills/>. Accessed June 13, 2013.

[79] ENERGY STAR, "Energy ENERGY STAR Building Manual, Chapter 10. Facility Type: K–12 Schools." November 2006.

To achieve behavioral change savings, programs can provide schools with strategies and resources to teach students, faculty, and staff about ways behavior impacts energy use as well as steps they can take to save energy. Several nationwide and regional programs provide schools with such strategies. For example, Schools for Energy Efficiency, developed by Hallberg Engineering of Minnesota, is a comprehensive program designed for K-12 schools that seeks to reduce energy use in schools by 10% by changing behavior throughout the district. [80] The program applies a multi-year plan with training and implementation support for improving operations and raising awareness about efficiency among students and staff.

The Green Cup Challenge in New York City, sponsored by Con Edison and The Green Schools Alliance, is an example of a program designed to encourage students, teachers, and custodial staff to work together to reduce energy consumption through behavioral changes. The top performing school reduced their energy consumption by 42,324 kWh or approximately 40% from the baseline. Successful energy saving strategies included things like turned off rows of lights next to windows that already were providing natural light as well as shortening the schedule on the HVAC unit.

Additionally, the Alliance to Save Energy's PowerSave Schools Program has helped schools to reduce energy use 5-15% through basic changes in behavior as well as school operations and maintenance.[81] The program teaches students about energy efficiency and trains them to evaluate school energy use, identify opportunities for savings, and implement changes. For younger students, schools can take advantage of PowerSave's Energy Hog program. PowerSave Local Project Leaders perform at assemblies as the Alliance to Save Energy's Energy Hog character (a five foot pig) to dramatize wasteful behaviors and teaching students to be "Energy Hog Busters."[82] Providing schools with strategies for behavioral change will allow them to raise awareness about energy savings behaviors to achieve savings beyond equipment and systems improvement alone.

### Provide Educational Materials, Tools and Resources Tied to Curriculum Standards

For many schools, undertaking efforts to improve energy efficiency provide an educational opportunity for students. As schools consider ways to improve energy efficiency, they can incorporate important related science, technology, engineering, and math (STEM) concepts into their curriculum. Numerous resources exist for teachers and school districts to engage students in learning about energy. These resources include lesson plans, hands-on activities, as well as training for teachers among others. Incorporating energy education into classroom curricula also acts as a strategy for raising awareness about energy use and its impacts and encourages behavioral changes.

---

[80] Schools for Energy Efficiency, "Program Overview." <http://www.seeprograms.com/overview.htm>. Accessed June 13, 2013.

[81] Alliance to Save Energy, "PowerSave Schools Program." <http://www.ase.org/programs/powersave-schools>. Accessed June 13, 2013.

[82] Ibid

Because teachers must cover certain material dictated by curriculum standards and learning objectives, energy education that explicitly links educational programs to curriculum standards is most likely to be incorporated into the classroom. School districts, administrators, and teachers are able to justify spending instructional time devoted to energy education if it helps them work towards meeting required standards. A standards-based approach may also help to ensure that materials are grade level appropriate. Additional opportunities for student education include competitions, youth summits, conferences, and other extracurricular opportunities to gain and apply energy knowledge.

The Alliance to Save Energy's PowerSave Schools Program, is a good example of a program that seeks to create energy awareness through education. One of the programs main goals is to integrate energy into school curricula using the school building as a "learning laboratory" to connect classroom learning to real work issues.[83] Additionally, the program focuses on complementing state based standards and existing curricular goals. Although PowerSave lessons are largely STEM focused, the program is interdisciplinary and provides opportunities for including energy education in Language Arts and Social Studies. In addition to selecting program provided lesson plans, the ASE provides a place for teachers to post original lesson plans on their website to share with other teachers.

The Maine Energy Education Curriculum Project provides an example of an energy curriculum linked to specific regional standards. PowerSleuth.org, started in 2007, provides a clear set of standards-based energy-education curriculum resources for Maine students in upper elementary and middle school.[84] Resources are designed around national standards, informed by research, and associated with Maine's "Learning Results" goals. A committee of representatives from the Maine Energy Education Program, the Maine Department of Environmental Protection's (DEP) Air Quality Division, and others, advise the Maine Mathematics and Science Alliance (MMSA) on making connections to Maine's energy context and providing content.

The Wisconsin Department of Public Instruction has identified the importance of energy education and many learning objectives that relate to energy are included in the Department's Academic Science Standards. The Wisconsin K-12 Energy Education Program (KEEP) was developed to provide teachers with the education and materials necessary to address these standards and increase the energy literacy of their students.[85] The program not only provides energy curricula but also provides training for teachers about how to incorporate the material into their classrooms. Since its inception, the program has trained thousands of teachers statewide through graduate-level courses and carefully developed materials. These resources have helped the state to provide energy education to hundreds of thousands of K-12 students in Wisconsin.

---

[83] Ibid

[84] Efficiency Maine, "Maine Energy Education Curriculum Project—PowerSleuth.org." <http://www.efficiencymaine.com/education/meep>. Accessed June 13, 2013.

[85] Wisconsin KEEP, "School Energy Education." <http://www4.uwsp.edu/cnr/wcee/keep/SchoolEnergyEducation/>. Accessed June 13, 2013.

The National Energy Education Development Project (NEED) is a resource to school districts across the country that want to incorporate energy education into their curricula.[86] The NEED program utilizes a Teacher Advisory Board (TAB) to develop standards based energy curriculum and training. NEED has designed its resources to meet the National Science Education Content Standards and state standards, including New York Science Standards Correlations and New York Technology Standards Correlations. The program has a partnership with the US Energy Information Administration and's tries to provide the most energy data available, deriving many of its statistics from the EIA's Annual Energy Review. NEED has additional partnerships with many local and national energy education organizations and works to develop individualized programs that meet the specific needs and requirements of individual states, school districts, and teachers. The program provides lesson plans and activities for all grades including community colleges and universities. The program seeks to provide engaging interactive lesson plans and promotes a "Kids Teaching Kids" approach where students teach others about energy. Similar to the PowerSave Program, NEED seeks to integrate energy education across all subject areas including STEM as well as language arts and social studies.

In addition to classroom learning, educational programs such as science fairs, competitions, and conferences can encourage students to learn and think critically about energy concepts. The Ohio Energy Project, for example holds numerous daylong energy programs and special events for students at various grade levels.[87] These events, such as the Youth Energy Summit facilitate hands-on activities related of energy, energy efficiency, heat, light and sound that are aligned to New Ohio Academic Content Standards. The Summit seeks to develop student leaders who will engage their school community and homes. Competitions, such as the Florida Solar Energy Center's EnergyWhiz Olympics, also seek to encourage critical thinking and exploration of energy concepts.[88] Providing additional learning opportunities can help motivated students further their knowledge and skills and share them with the broader school community.

## Engage School Personnel

Technical assistance can help provide schools with the expertise and assistance they need to implement successful projects. However, dedicated and knowledgeable school personnel are also key aspects of successful project implementation and ensuring that savings persist once efficiency measures are in place. A couple of program design strategies that can help to engage school personnel include establishing a clear project leadership structure within the school as well as providing training for school staff.

---

[86] National Energy Education Development Project. <http://www.need.org/>. Accessed June 13, 2013

[87] Ohio Energy Project, "Energy Efficiency Programs." <http://www.ohioenergy.org/educators/efficiency>. Accessed June 13, 2013.

[88] Florida Solar Energy Center, "K-12." <http://www.fsec.ucf.edu/en/education/k-12/index.htm>. Accessed June 13, 2013.

### Develop a Project Leadership Structure

While school administrators and school board personnel play an important role in energy efficiency upgrades at a high level, they may be unlikely to engage in the day to day planning and implementation required to achieve savings goals. Therefore, it is important to identify a school staff member or team to act a liaison to contractors and program administrators during project planning, implementation, and monitoring and evaluation. For schools and districts with energy managers, these individuals are likely have the knowledge and experience to successfully take on identified projects. However, many districts lack a specified staff member with a clear energy management role. Rather, facility and maintenance staff, faculty members, or in some cases administrators often take responsibility for school energy efficiency projects or programs. A committed individual or team can help to spark interest and enthusiasm for the project and ensure that action steps developed through the planning process are initiated. [89] Additionally, they can problem solve and advocate for the project should unexpected challenges arise. Programs that require schools to establish a clear leadership structure and identify the best person or personnel to act as a point of contact can help to ensure that projects are successfully planned, supported, and implemented.

Identifying team members with the proper experience and qualifications can help ensure the project quality and achieve targeted savings. Team members with proper skills and knowledge from throughout the school district will help to ensure quality and broad support. Establishing a permanent energy committee may encourage school districts to continue revising short and long-term goals and identify new savings opportunities. Guidelines note that energy committees made up of representatives from different interest groups such as the administration, facilities staff, and teachers, can be established to provide broad support for the program and guide decision-making.[90] School efficiency programs can provide guidance about establishing a leadership team and strategies for successful management. Programs can offer schools recruitment materials, define team and individual responsibilities, as well as provide training to staff engaged in energy efficiency projects. They can also provide a template to team members for communicating efforts to the broader school community.

Additionally, some programs include student team members. Administrators and teachers may view student involvement as an educational opportunity as well as a way to improve savings through awareness and behavior modification. Student involvement is also a way to involve the broader community. The Alliance to Save Energy's PowerSave Program has schools form teams of students to perform a walk-though audit, develop an energy-savings plan as well as implement efforts to save energy and monitor results. The program aims to educate students about ways to save energy in school and spread that information to their homes and the broader community.

---

[89] Environmental Protection Agency, "Energy Efficiency Programs in K-12 Schools: A Guide to Developing and Implementing Greenhouse Gas Reduction Programs."2011.

[90] Ibid

### Provide Training for School Personnel

While technical assistance is likely to be focused on a specific site or project, training school staff, namely school building operators, can improve chances for ongoing success and continued savings. Training can help give staff a better understanding of the school's systems and equipment as well as their interactions. Through increased knowledge, training can enhance staff members' ability to identify and address problems as well as identify opportunities for improvement. Training may cover topics such as energy management, equipment maintenance and operational schedules, data collection and analysis, as well as air quality issues. Training efforts should provide staff with the skills and knowledge to ensure savings persist as well as recognize potential new opportunities for savings. Training may include classroom based workshops as well as hands on guidance.

PG&E's School Resource Program provides best practices training on operations and maintenance procedures to improved energy efficiency.[91] In New York, beginning in 2011, the NYC Division of Schools Facilities partnered with the City University of New York, the International Union of Operating Engineers, and the NYC Department of Citywide Administrative Services to provide Building Operator Certification (BOC) training nearly 1,000 public school facility managers – the largest BOC training program that has been provided to date in the US. During this 24-month initiative, a 90-hour training program provided strategies and tools to help participants reduce energy use in the schools they operate by an estimated 10-20%. NYSERDA offers High Performance Schools Design and Operations Online Training for facilities staff involved with operating a high performance school to ensure the team will keep the school functioning at maximum performance.[92] Additionally, programs may support schools in developing a training curriculum and materials that meet the school's needs. Efficiency Maine offers BOC and Certified Energy Management training for school facility operators, often at no cost to the school.[93] They also provide training on a variety of individual topics in building and equipment management for professionals in need of training in a more specific area. Providing schools with the knowledge and resources to effectively manage energy use in their buildings and raise awareness about students and teachers can helps schools to achieve continued energy savings once efficiency measures are in place.

## Include Strategies for Engaging the Broader Community

In an age where many school districts experience tight budget restrictions, funding decisions often require public buy–in and support. Opposing opinions at the community level can create barriers that prevent school boards and administrators from implementing efficiency programs. Aligning efficiency upgrades with preexisting goals may help to achieve stakeholder buy-in. Promoting the non-energy benefits associated with efficiency improvements as well as

---

[91] PG&E, "School Resource Program." <http://www.pge.com/mybusiness/energysavingsrebates/tips/schools/>. Accessed June 13, 2013.

[92] NYSERDA, "K-12 Energy Smart Schools." <http://www.nyserda.ny.gov/BusinessAreas/Energy-Efficiency-and-Renewable-Programs/Commercial-and-Industrial/Sectors/K-12-Schools.aspx>. Accessed June 13, 2013.

[93] Efficiency Maine, "Energy Efficiency Schools, Case Study." 2006.

incorporating upgrades into existing capital improvement plans, for example may help to build public consensus and support for implementation of efficiency programs.[94] As previously discussed, committed school decision makers can help promote the importance of efficiency improvements to the public and move towards planning and implementation. Benchmarking and energy audits, as discussed as a good first step can help to determine which building within a district to prioritize if funding for efficiency upgrades across the portfolio is not immediately available.

### Communication Strategies

Community awareness and support can also help schools to leverage other resources and engage partners to help increase schools' energy efficiency. Developing partnerships with other organizations, businesses, community members and governments, can improve efficiency projects by sharing expertise and information. Efficiency programs can provide resources to help develop these partnerships. For example, the EPA has a website that provides a step by step plan for leveraging and promoting energy efficiency throughout a community through ENERGY STAR.[95] Schools can use various tools for communicating information about improved efficiency and its benefits such as newsletters and website updates. The best strategy for communication will largely depend on the community and whether the school seeks to target specific groups. To achieve school decision maker buy-in, efficiency programs can help schools to consider projects from life-cycle cost perspective. Additionally, identifying non-energy benefits such as increased thermal and visual comfort can help administrators to understand that efficiency projects also help schools to reach broader goals such as improving student achievement.

### Competitions

Schools may also gain awareness through competitions with other communities or school districts. Community-wide competitions spur action and generate awareness and publicity about energy efficiency efforts. Additionally, they create public recognition and pride for those who achieve the highest levels of efficiency. As previously mentioned, The Green Cup Energy Challenge sponsored by Con Edison and The Green Schools alliance is one example of such a competition. Additionally, the Take Charge Challenge, an initiative of the Climate and Energy Project, engaged six Kansas towns in a year-long competition to reduce energy use. The nonprofit collaborated with respected community leaders to publicize the program and its benefits to various stakeholders in each town. During the year, participating towns saved over 6 million kWh.[96] An additional 7 million kWh in annual savings is expected from the installation

---

[94] For an overview of non-energy benefits for energy efficiency projects in schools (specifically commissioning activities), see Jennings, John and Lisa A. Skumatz, "Non-Energy Benefits (NEBs) from Commissioning in Schools, Prisons, and Other Public Buildings," Proceedings of the 2006 ACEEE Summer Study on Energy Efficiency in Buildings, 2006.

[95] Environmental Protection Agency, "Energy Efficiency Programs in K-12 Schools: A Guide to Developing and Implementing Greenhouse Gas Reduction Programs," 2011

[96] Fuller, M., Kunkel, M., et al. "Driving Demand for Home Energy Improvements." Lawrence Berkley National

of permanent efficiency upgrades. Efficiency programs may be able to facilitate these competitions if savings data from different communities is gathered and shared by the program administrator.

### Take Home Efficiency Kits

Some school efficiency programs have also provided students with take home efficiency measures to raise awareness and spur behavioral changes beyond schools. For example, several school efficiency programs provide students with take home materials to help spur discussion and awareness with their families. For example, the Ohio Energy Project "school to home" approach to school energy programs seeks to create community involvement by providing students with home energy efficiency kits and fostering a philosophy of "kids teaching families and communities."[97] Program administrators state that kits have saved almost 60,000 MWh and over $5.5 million on utility bills to date. Programs such as Energizing Indiana's Education Program and Alliant Energy Kids similarly provides students with savings kits for each student to implement small improvements in their homes as well as other educational materials designed to get parents engaged.[98] These activities may therefore provide a way to increase community support for school to invest in efficiency improvement efforts.

### Public Recognition of Successful Projects

Acknowledging efficiency project successes and recognizing teams or individuals within the school community can be an effective strategy for maintaining support and community enthusiasm as well as increasing participation of those involved. Schools or districts may also consider holding a celebration at the conclusion of a project to recognize accomplishments and raise awareness about the success of the program. Other school-driven forms of recognition may include holding an assembly, making a presentation at a school board meeting, and putting information about achievements on the school or district website. Additionally, external or third party recognition, such as LEED for Existing Building: Operation & Maintenance, can give schools a sense of validation for their efforts and can raise the programs visibility and encourage further participation.[99] The type of recognition can vary from a letter of congratulations to formal acknowledgement though a national award. Local media or government groups can help to raise awareness of the recognition through press releases or conferences and news coverage. Publicized awards can also help to attract additional partners from the community for future efforts.

Many school efficiency programs have processes by which they recognize success and acknowledge top performers or provide information about other awards. For example, the

---

Laboratories. 2010.

[97] Ohio Energy Project, "Energy Efficiency Programs." <http://www.ohioenergy.org/educators/efficiency>. Accessed June 13, 2013.

[98] Energizing Indiana, "School Programs." <https://energizingindiana.com/programs/school-programs/> Accessed June 13, 2013.; Alliant Energy, "School Programs and Rebates." <http://www.alliantenergy.com/CommunityInvolvement/CommunityOutreach/Schools/> Accessed June 13, 2013.

[99] U.S. Green Building Council, "Existing Buildings." < http://www.usgbc.org/ebom>. Accessed June 13. 2013.

Kentucky Energy Efficiency Program for Schools lists "Recognize Achievements" as the seventh step in its energy management process and helps school districts to focus on ways to recognize and reward program achievements.[100] They suggest that this step helps to sustain momentum and establish a sense of pride for those involved and to validate the program's goals. These also provide credibility for the program and illustrate that participants achieve expected results. For example, the Schools for Energy Efficiency program, developed by Hallberg Engineering of Minnesota, can claim that many participating schools have achieved national recognition through ENERGY STAR awards.[101] Therefore, recognizing accomplishments can be a beneficial aspect of program design for both the schools participating as well as program administrators seeking additional participants.

## Help Schools to Optimize Building Performance and Ensure Saving Persist

Installing energy efficiency measures is an important aspect of saving energy in schools; however, additional low and no cost effort represent additional opportunities for savings and can ensure that savings from efficiency measures persist. Retrocommissioning and comprehensive O&M programs are two effective strategies for achieving continued savings. School efficiency programs should include support for these efforts to maximize saving for their participants.

### Retrocommissioning

The term "commissioning," was originally associated with shipbuilding and refers to a quality assurance process by which installed equipment is tested, problems are detected and fixed, and the crew undergoes proper training.[102] Commissioning for newly constructed buildings ensures systems are tested and worked properly. For existing buildings, retrocommissioning helps to identify places where equipment or systems are operating inefficiently and provide suggestions to improve performance. [103] The process seeks to improve the way buildings systems and equipment work together by examining HVAC systems, and heating and cooling plants lighting, supplemental loads, to identify ways to improve performance.[104] Just like periodic energy auditing, New York City's Local Law 187 requires that large buildings undergo retrocommissioning every 10 years to make sure that building systems are functioning efficiently.[105] The improvements identified by retrocommissioning are implemented by making repairs to equipment and systems, and usually include

---

[100] Kentucky Pollution Prevention Center, "Kentucky Energy Efficiency Program for Schools." <https://louisville.edu/kppc/keeps>. Accessed June 13, 2013.

[101] Schools for Energy Efficiency, "Minnesota: Schools for Energy Efficiency (SEE) Energy Star Program Area: K-12 Education & Energy Conservation."

[102] Haasl, T., and K. Heinemeier. 2006. "California Commissioning Guide: New Buildings" and "California Commissioning Guide: Existing Buildings". California Commissioning Collaborative.

[103] National Renewable Energy Laboratory, prepared for the U.S. Department of Energy, "Advanced Energy Retrofit Guide—K-12 Schools." February 2013.

[104] Portland Energy Conservation, Inc., "A Retrocommissioning Guide for Building Owners." 2007.

[105] PlaNYC, "About LL87." <http://www.nyc.gov/html/gbee/html/plan/ll87_about.shtml>. Accessed June 13, 2013.

repair/replacement of the controls on equipment, such as temperature and flow controls, valves and dampers. Generally, the cost of retrocommissioning is more than regular equipment maintenance, but less than equipment retrofit/replacement.

Retrocommissioning provides opportunities to save energy and optimize building performance by improving operations and maintenance with low risk and capital required. Because many building systems are highly integrated, there are many instances where a small problem can have a big impact on performance and even well-built structures can experience decreased performance with age. Moreover, properly maintained equipment will still use more energy than necessary if it functions inefficiently. In addition to providing a useful strategy for reducing energy use, retrocommissioning can provide a number of other benefits. These benefits include reduced O&M costs and extended equipment life, improved thermal comfort and indoor environmental quality, and increased asset value.[106] Some utilities such as Connecticut Light & Power, CenterPoint Energy, and Pacific Gas and Electric have recognized that value of retrocommissioning by administering retrocommissioning programs to commercial customers. These programs include technical assistance for conducting functional tests, financial incentives, and training for building operators and facility managers.

Because retrocommissioning involves little risk and less financial resources than retrofit projects, it can be a good place to start if either a staged or whole-building retrofits are being planned.[107] Moreover, for school with limited resources or those schools that are performing fairly well compared to similar buildings, retrocommissioning may be sufficient for meeting energy savings goals. As with the overall process for achieving energy savings, the retrocommissioning process often follows a systematic approach to planning and implementation. Providing retrocommissioning as a service offered through school efficiency programs can help ensure school equipment and systems function efficiently.

### Operations and Maintenance

Operations and Maintenance (O&M) activities help to ensure that a building and its systems operate properly and continue to function optimally. Although most schools engage in O&M, procedures vary in terms of their thoroughness and frequency. While some schools only have the resources to respond to equipment failures, comprehensive O&M programs engage in continuous preventative maintenance and monitoring that can save schools energy and money while extending equipment life and improving health, comfort, and safety conditions.[108] The Federal Energy Management Program's O&M Best Practices guides suggests that O&M programs targeting efficiency can save 5% to 20% on energy bills with little cost.[109] The Alliance

---

[106] California Department of General Services, "Retro-Commissioning Fact Sheet." <http://www.documents.dgs.ca.gov/green/eeproj/retrocommfactsheet.doc>. Accessed June 13, 203.

[107] National Renewable Energy Laboratory, prepared for the U.S. Department of Energy, "Advanced Energy Retrofit Guide—K-12 Schools." February 2013.

[108] Ibid.

[109] Dept. of Energy, Federal Energy Management Program, "Operations & Maintenance Best Practices, A Guide to Achieving Operational Efficiency, Release 3.0." August 2010.

to Save Energy's PowerSave Schools program seek to do just that and help schools save energy primarily through improved operation and maintenance as well as individual behavior. The program has successfully achieved energy savings of 5 to 15% by making basic changes.[110]

Addressing operations and maintenance can also help to ensure that energy savings from efficiency upgrades persist. Although efficiency upgrades initially provide energy savings, building systems decline over time and deficiencies such as decreased light output from lumen depreciation can prevent systems and equipment for performing at well as possible.[111] Implementing an O&M program that anticipates equipment declines and tracks systems for unexpected deficiencies can help to maximize energy savings overtime.

School efficiency programs can maximize savings and ensure savings persist by reviewing school's current O&M programs. The review process can help schools identify opportunities for savings simply by adjusting O&M practices as well as planning for any changes that might need to be made once efficiency measures have been implemented. PG&E's School Resource Program, for example, incorporates operation and maintenance as one part of a broader school efficiency program.[112] Additionally, school efficiency programs can help schools to incorporate several critical for O&M programs successfully implemented. These factors, many of which are relevant to school efficiency programs in general include program visibility and progress reporting, distribution of information, program flexibility and tweaking, external support, as well as development of a detailed procedures manual.[113] Programs can also help to facilitate this process by providing technical assistance and staff training and ensuring that staff understands the building systems and equipment and how they interact. Providing training for operations and maintenance staff, as previously discussed, can be a successful aspect for achieving proper O&M procedures are enacted following school efficiency upgrades. Typical barriers to O&M programs include:

- Lack of O&M budget
- Lack of O&M skills of operations staff
- Lack of recognition of energy savings of O&M programs

### Include a Process for Evaluating Results

To assess project outcomes, recognize success, and ensure that efficiency measures are functioning properly, school efficiency programs should implement some form of measurement and evaluation for efficiency improvement projects. M&V efforts can include various methods of data collection and reporting such as metering energy consumption, conducting site surveys,

---

110 Alliance to Save Energy, "PowerSave Schools Program." <http://ase.org/programs/powersave-schools>. Accessed June 13, 2013.

111 National Renewable Energy Laboratory, prepared for the U.S. Department of Energy, "Advanced Energy Retrofit Guide—K-12 Schools." February 2013.

112 PG&E, "School Resource Program." <http://www.pge.com/mybusiness/energysavingsrebates/tips/schools/>. Accessed June 13, 2013.

113 Princeton Energy Resources International, et al.,"School Operations and Maintenance: Best Practices for Controlling Energy Costs." August 2004.

and performing engineering calculations to verify energy savings.[114] The International Performance Measurement and Verification Protocol provides guidance on different M&V approaches and standards.[115] As school efficiency programs guide schools through the initial project planning process, consideration should be given to Measurement and Verification (M&V). It is important to consider M&V up front because baseline metering or measurement may need to occur before the project is implemented. The planning phase should consider and include the scope and type of M&V efforts the school will undertake.

In addition to including M&V planning and implementation as a component of the initial planning process, school efficiency programs can help to provide guidance for completing M&V efforts. For example, as part of the services provided by The School Energy Efficiency Program, sponsored by Pacific Gas and Electric and administered by Resource Solutions Group, schools receive support developing and performing final project verifications.[116] These efforts help to ensure that efficiency measures have been installed and are functioning properly and enable schools to justify efficiency spending. M&V can be an important aspect of financing energy efficiency upgrade projects. Some efficiency funding sources, such as The Tennessee General Assembly's Energy Efficient Schools Initiative, require schools to provide information about verified savings.[117] By supporting schools through this process, efficiency programs can help persistent savings and improve the likelihood of participant satisfaction.

## Assist With Deployment of Renewable Energy Resources

In recognition of the environmental and economic benefits, programs have been developed to help schools install solar PV systems and take advantage of this renewable resource. Many of these systems are small and provide 1-2 kW of power. One example of a program for small PV systems, PG&E has provided over 120 schools with "Solar on a Stick" photovoltaic installations.[118] Schools that apply and are accepted to be Solar Schools receive a 2kW PV system that is pole-mounted on school grounds to maximum efficiency and demonstrate that solar education is taking place at the school.[119]

Some programs offer larger installations ranging from 10 kW up to 100 kW. Each year Progress Energy's SunSense Schools Program selects up to 10 K-12 public schools to receive fully installed PV systems of up to 10 kW with battery backup option.[120] The SunSense Schools

---

114 National Renewable Energy Laboratory, Prepared for the U.S. Department of Energy, "Advanced Energy Retrofit Guide—K-12 Schools." February 2013.

115 Ibid.

116 Resource Solution Group, "School Energy Efficiency Program." <http://www.schoolenergyefficiency.com/>. Accessed June 13, 2013.

117 Energy Efficiency Schools Initiative, "Energy Management/Education Program." <http://tn.gov/eesi/EMEducProp.shtml>. Accessed June 13, 2013.

118 PG&E, "Fall 2012 Bright Ideas Grant Winners!" <http://pge.need.org/>. Accessed June 13, 2013.

119 NEED, "Schools Going Solar: Activities to Incorporate Installed Photovoltaic Systems into the Classroom Learning Environment." 2007.

120 Progress Energy, "SunSense Schools." <https://www.progress-energy.com/florida/business/save-energy-money/sunsense/solar-school.page>. Accessed June 13, 2013.

Program funds the cost of the system and installation, though the school is responsible for funding its operations and maintenance. Additionally, one public post-secondary school is selected each year to receive a system of up to 100 kW. Selection criteria are based on a demonstrated commitment to energy efficiency and renewable energy education as well as number of students, attendance, energy consumption, and energy education plans. Schools must also have an appropriate site available at the school for a ground-mounted PV system and must have facilities that meet the requirements for the interconnection of the PV system to the PEF power system.

For many schools, installing PV systems is as much about student education and awareness as it is about cost savings.[121] PV systems provide students with the opportunity to see energy technologies first hand. Data collected from the PV systems can be integrated into school curricula to teach students about how solar energy works as well as the benefits of saving energy and using renewable energy sources. The system can also get students excited about careers in renewable energy technology fields. Therefore, providing schools with resources to leverage solar power installations as a teaching tool are an important aspect of school solar programs.

Progress Energy Florida's SunSense® schools program helps schools to manage energy costs while promoting energy education. The solar PV system installations are intended to give students, faculty, and administrators an understanding and awareness of renewable energy. The program provides teachers and students with data collection systems, interactive learning activities and training material to support renewable energy education.[122] Schools in the Progress Energy Florida service area that are not eligible or chosen to get solar PV systems can still have access to classroom materials that support hands-on learning, curriculum aligned with state standards, and teacher training to help incorporate energy efficiency and renewable energy in the classroom.

Pacific Gas & Electric provides curriculum and training for the teachers to give them the resources needed to use the company's PV on a stick in the classroom.[123] Teachers can attend PG&E Solar Schools workshops and to receive NEED classroom kits and curriculum. The workshops provide teachers with instruction and background to teach about solar energy and other energy related topics. The program also provides a booklet with ways to integrate energy topic into curriculum with correlations to CA science standards. Additionally, data acquisition systems enable schools to monitor the production of electricity from the system as well as local atmospheric conditions. The data produced by the systems can also be viewed by schools without solar installations on the PG&E Solar Schools website for research and data analysis purposes.

---

[121] NEED, "Schools Going Solar: Activities to Incorporate Installed Photovoltaic Systems into the Classroom Learning Environment." 2007.

[122] Progress Energy, "SunSense Schools." <https://www.progress-energy.com/florida/business/save-energy-money/sunsense/solar-school.page>. Accessed June 13, 2013.

[123] PG&E, "Fall 2012 Bright Ideas Grant Winners!" <http://pge.need.org/>. Accessed June 13, 2013.

Some programs, such as Progress Energy's SunSense Schools Program, provide Solar PV systems to schools, but its selection process is competitive and the company prioritizes those schools designated as Enhanced Hurricane Protection Area (EHPA).[124] Given the impact Hurricane Sandy had on New York, consideration might be given to ways that school Solar PV programs might relate to disaster relief efforts in New York.

## OVERVIEW OF NEW YORK STATE-SPECIFIC PROGRAM CONSIDERATIONS

While the discussion of best practice program designs from other jurisdictions presents solutions to the majority of market barriers facing NYS schools, it does not address *all* barriers. The following recommendations are intended to address these NYS-specific barriers and spur additional program development activities to better meet the unique needs of schools in NYS.

### Develop a Streamlined Process for Approving Energy Efficiency Projects

NY State should conduct a review of the project approval process to determine how best to expedite the start of construction. As previously noted, energy projects are reviewed by the same group at NYSED that is also responsible for reviewing critical school district capital projects. The process review should focus on how a higher priority might be given to energy projects while at the same time ensuring that mission-critical capital projects are not delayed. Pursuing all cost-effective energy efficiency in NYS schools in the near term will require that many more projects will need to be approved annually than have ever been in the past. A streamlined, transparent, and efficient review and approval process will be a necessary component of an increased effort to promote energy projects in schools.

### Develop a NYS School Energy Efficiency Collaborative

As most schools are consumed by the day-to-day requirements of providing a quality education, there are little remaining resources for identifying and pursuing energy projects, even though many such projects may present very desirable economics. As shown in this report, NYS already has significant resources and motivation for pursing energy efficiency in schools; however, these resources are not well integrated statewide. NYS should consider developing a multidisciplinary approach to identify and develop energy efficiency projects in collaboration with NYSED, NYSASBO, NYSSBA, NYPA, LIPA, NYSERDA, energy service companies (ESCOs), utility programs, and other schools administrators. The collaborative could serve to provide support on developing the technical aspects of projects, share case studies and other information on completed projects, develop demonstrations, provide training opportunities for building operators, and provide a comprehensive catalog of informational and financial resources available to schools pursing energy projects. Such a collaborative would reduce redundancies, raise awareness, and promote the efficient implementation of energy projects across the state.

---

[124] Progress Energy, "SunSense Schools." <https://www.progress-energy.com/florida/business/save-energy-money/sunsense/solar-school.page>. Accessed June 13, 2013.

# APPENDIX A | WHERE TO FIND MORE INFORMATION

## UTILITY, POWER AUTHORITY, AND NYSERDA ENERGY EFFICIENCY PROGRAMS

### New York Power Authority

**Website:** www.nypa.gov/services/ESforK12Schools.htm
**Contact:** Eric Alemany, Program Manager, Energy Efficiency
**Phone:** 914-390-8223
**Email:** eric.alemany@nypa.gov

### Long Island Power Authority

**Website:** www.lipower.org/commercial/efficiency
**Phone:** 800-692-2626

### NYSERDA

**Website**: www.nyserda.ny.gov/Energy-Efficiency-and-Renewable-Programs/Commercial-and-Industrial/Sectors/K-12-Schools.aspx
**Phone:** 866-NYSERDA or 518-862-1090
**Email:** info@nyserda.ny.gov

---

### Central Hudson Gas & Electric

**Website:** www.savingscentral.com/index.htm
**Phone:** 800-515-5353 (central air conditioners, central air-source heat pumps, heat pump water heaters, natural gas furnaces and boilers)
866-706-3995 (refrigerators or freezers)
855-236-4832 (commercial lighting)

### Consolidated Edison Company of New York (Con Edison)

**Website:** www.conedci.com
**Phone:** 877-870-6118
**Email:** conedci@lmbps.com

### National Grid

**Website:** www1.nationalgridus.com/EnergyEfficiencyServices
**Phone:** 800-642-4272

### New York State Electric & Gas

**Website:** www.nyseg.com/UsageAndSafety/usingenergywisely/eeps/cirp.html
**Phone:** 888-316-8023
**Email:** EnergySavings@lmbps.com

### Orange & Rockland Utilities

**Website:** www.oru.com/programsandservices/incentivesandrebates/bigenergysolutions.html
**Contact:** Steve Orman
**Phone:** 845-577-3694
**Email:** ormans@oru.com

### Rochester Gas & Electric

**Website:** www.rge.com/UsageAndSafety/usingenergywisely/eeps/cirp.html
**Phone:** 888-316-8023
**Email:** EnergySavings@lmbps.com

## APPENDIX B | LIST OF ACRONYMS

| Acronym | Definition |
|---|---|
| AC | Air Conditioning |
| AHU | Air Handling Unit |
| ASE | Alliance to Save Energy |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| BBtu | Billion British Thermal Units |
| BCR | Benefit-Cost Ratio |
| BOC | Building Operator Certification |
| $CO_2$ | Carbon Dioxide |
| DDC | Direct Digital Controls |
| DEP | Department of Environmental Protection |
| DOE | Department of Education |
| EHPA | Enhanced Hurricane Protection Area |
| EIA | Energy Information Administration |
| EISA | Energy Independence and Security Act |
| EPA | Environmental Protection Agency |
| FY | Fiscal Year |
| GWh | Gigawatt-Hour |
| HELP | High Efficiency Lighting Program |
| HVAC | Heating, Ventilating, and Air-Conditioning |
| IOU | Investor-Owned Utility |
| KEEP | K-12 Energy Education Program |
| LED | Light Emitting Diode |
| LEED | Leadership in Energy and Environmental Design |
| LIPA | Long Island Power Authority |
| LL | Local Law |
| M&V | Measurement and Verification |
| MMBtu | Million British Thermal Units |
| MMSA | Maine Mathematics and Science Alliance |
| MW | Megawatt |
| MWh | Megawatt-Hours |
| NEED | National Energy Education Development Project |
| NIPSCO | Northern Indiana Public Service Company |
| NREL | National Renewable Energy Laboratory |
| NY | New York |
| NYC | New York City |
| NYPA | New York Power Authority |
| NYS | New York State |
| NYSASBO | New York State Association of School Business Officials |
| NYSED | New York State Education Department |
| NYSERDA | New York State Energy Research and Development Authority |
| NYSSBA | New York State School Boards Association |

| Acronym | Definition |
|---|---|
| O&M | Operations and Maintenance |
| PCB | Polychlorinated Biphenyls |
| PEF | Progress Energy Florida |
| PG&E | Pacific Gas and Electric |
| PPA | Power Purchase Agreements |
| PREPS | Program for Resource Efficiency in Private Schools |
| PTAs | Parent-Teacher Association |
| PV | Photovoltaics |
| R&D | Research and Development |
| RCM | Resource Conservation Manager |
| SBC | System Benefits Charge |
| STEM | Science, Technology, Engineering, and Math |
| TA | Technical Assistance |
| TAB | Teacher Advisory Board |
| TRC | Total Resource Cost |