Implementation Plan

Building a Healthy, Energy Efficient Future in Rhode Island Public Schools

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Executive Summary

Rhode Island Public Schools provide a space to learn and work for more than 160,000 students, staff, and teachers. After the recent four year construction moratorium that resulted in deteriorating school building infrastructure, our team developed two public-private partnerships projects that can promote energy efficiency and occupant health. Our selection considered the financial, political and health challenges to provide realistic, achievable options for the state to act upon. Our findings build upon the upcoming report by Jacobs Engineering who performed an energy audit for all 307 K-12 public schools. We concluded that lighting replacement and minor, diverse building envelope upgrades could provide the greatest energy savings and public health benefit at a relatively lower cost compared to projects like solar panel installation. Our first partnership would be the *Bright Future Campaign*. Private partners specifically provide upgraded lighting and fixtures for RI schools by providing money and/or materials for these improvements. The second partnership is *Safe Scholars Securing Success*, an innovative building envelope improvement strategy that addresses small problems that could be considered “low-hanging fruit”. These improvements include caulking windows, improving roof membranes, and/or installing door sweeps. Both efforts could be great opportunities for public relations campaigns that shed light on the importance of improving school infrastructure.

We believe by leveraging public-private partnerships, state- and district-level governments within Rhode Island can receive financial and administrative support from an external partner. External partners could be local organizations, corporate donors, and academic institutions, among others. For example, the external partner may provide upfront capital to aid in financing, especially for a series of smaller scale, “minor” projects. This could also create opportunities for partners interested in contributing in this space but normally lack the opportunity to do it. Our team identified potential external partners and ways they might participate. Additionally, the team provided three novel financing options for Rhode Island to consider: community bonds, a green revolving fund, and pay-for-success. Each of these could be implemented with the support and funding of an external partner.

Project Background

In Spring 2017, a team of law, public health, business, design, and policy graduate students in the Climate Solutions Living Lab at Harvard University were originally charged with developing a plan to generate emissions reduction offsets equivalent to at least 50,000 metric tons of CO_2 annually that an unregulated enterprise (i.e. university or private company) could legitimately and credibly use to offset its own greenhouse gas emissions. The reductions were to be achieved through a suite of repairs and improvements to the 307 K-12 Rhode Island public school buildings.

The team reviewed more than fifteen energy efficiency and renewable energy measures within the context of an offset program and selected six measures for further review: boiler replacements, rooftop solar energy, solar water heaters, cafeteria improvements, lighting replacement, and building envelope upgrades. The costs and benefits of each option were assessed, factoring in co-benefits associated with each, such as public health improvements, community benefits, and local employment opportunities. While these six measures showed significant benefits on their own, translating the energy efficiency and renewable energy benefits of these measures into offsets resulted in a cost-per-offset-generated that was uncompetitive when compared to alternative options offered by other programs.

Overview of Document

This implementation plan will introduce relevant practical and public health context surrounding Rhode Island Public Schools. Then, it will present two novel, scalable, initiatives that target minor projects that improve lighting and building envelope improvements. Our team has identified specific steps for an external partner to take in order to make these projects a reality within the Rhode Island Public Schools system. The external partner role, working closely with the Rhode Island Department of Education (RIDE), will contribute by helping to overcome the challenges in high upfront costs. The idea is to offer upfront capital in various forms that leverage additional funds from new sources by direct investment or by creating new financial instruments. The aim is to ensure that energy efficiency and public health co-benefits are a priority in Rhode Island public schools.

Context of Rhode Island Public Schools

The state of Rhode Island is home to 307 public K-12 schools, which are an average age of 61 years old[1]. More than 160,000 students, teacher, and staff attend these schools each day. By the time a student graduates 12th grade, they have spent 15,600 hours in their school building. Rhode Island recently experienced a four-year construction moratorium on all public schools in order to save money. The moratorium was lifted August 2015 and a new $20M capital fund was announced.[2] Due to the aging infrastructure and four years without necessary repairs, the $20M worth of funds went quickly, and another $80M in funding was approved in the summer of 2016.[3] However, there continues to be an unmet need for school building infrastructure investment, as can be seen from the pictures of the team’s visit to schools in Central Falls, Rhode Island. The images reveal problems like pest intrusion, inadequate heating, poor lighting, etc.

[1] http://www.ride.ri.gov/InsideRIDE/Overview.aspx
[2] http://www.thewesterlysun.com/news/latestnews/7635684-129/lifting-of-school-construction- moratorium-gives-district-time.html
[3] http://www.spartnerships.com/rhode-island-school-district-moves-385m-redesign/

Examples like these add to the urgency of this project because Rhode Island wants to make sure it is creating a safe and healthy environment for all students and teachers.

Understanding the Health Context

According to the National Center for Educational Statistics (NCES), it is estimated a $197 billion is required to renovate, repair, and modernize nearly 100,000 U.S. schools.[4] There is a need for innovative solutions for improving indoor environmental quality with limited financial resources. Rhode Island provides an opportunity to pilot interventions that may be replicated across the country. RIDE recognizes the value of healthy school buildings but primarily focuses on bullying, school violence, nutrition, emergency preparedness, school siting, social and emotional learning, along with other social policies. In recent months, Rhode Island Schools have been making the news for poor environmental quality including indoor air quality, water quality, cracks in the foundation, and lack of sprinkler systems. For example, Barrington School had to test for indoor air quality because concerned parents believed their children were getting sick due to mold and mildew in the building.[5] Air quality tests in Warwick, RI schools revealed elevated carbon dioxide levels,[6] which are known to influence cognitive function and performance as well as serve as proxy for inadequate ventilation. Similarly, in April, Providence's Central High School had to close a total of 19 classrooms due to extensive mold.[7]

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[4] http://www.thewesterlysun.com/news/latestnews/7635684-129/lifting-of-school-construction-moratorium-gives-district-time.html
[5] http://rhodybeat.com/stories/air-quality-concerns-raised-at-barrington-middle-school,21316
[6] http://wpri.com/2017/04/03/results-in-from-air-quality-test-of-warwick-school/
[7] http://turnto10.com/i-team/nbc-10-i-team-mold-causes-leaders-at-one-providence-high-school-to-close-19-classrooms

Children are not little adults

This is a rapid time of neurological, physiological, social, and academic development for Rhode Island students. Compared to adults, children breathe four times the amount of air per body size, have larger pupils, and are linguistically immature. These characteristics make them more susceptible to poor indoor environmental quality. This is exacerbated by childhood poverty and chronic health conditions. Looking at asthma and chronic absenteeism in Rhode Island provides a snapshot of the health burden faced by our students every day.

Asthma

For nearly 160,000 students and teachers, there is an opportunity to protect their health from excess mold, moisture, inadequate lighting, and poor air quality that results in detrimental health impacts. For example, according to the Rhode Island Department of Health, Providence's Local Education Agency (LEA) in 2010-2012 had 1 in 7 (14.5%) children with asthma and in the pre-K to 5th grade students, nearly 1 in 5 (17.6%) had asthma. However, Woonsocket, which is home to 10 city schools, had 16.9% of their total student population with asthma and 19.2% in the pre-K to 5th grade students. In Central Falls and Pawtucket LEA, the rates were slightly lower with asthma rates at 13.6% and 11.4% of the student population, respectively. These rates of asthma may have direct implication on student attendance and performance, and are higher than the state average for total childhood asthma (11.8%). Therefore, it is imperative that indoor environmental quality be improved to reduce harmful exposures that may exacerbate asthma.

Chronic Absenteeism

Chronic absenteeism is of national importance with more than 6.5 million students chronically absent in 2014.[8] It is commonly defined as missing 10% of school days or 18 excused or unexcused absences. It is an important public health measure because it serves as a proxy for health-related illnesses, which cannot be evaluated due to privacy laws such as the Family Educational Rights and Privacy Act (FERPA). Asthma can be an important driver for chronic absenteeism as the EPA reported 13.8 million school days are missed each year due to asthma[9].

The Rhode Island Data Hub, a central public data resource for Rhode Island, followed a cohort of kindergartners from the 2004-2005 academic year for seven years. Their findings showed that chronically absent RI kindergartners had significant reductions in reading and math scores, were more likely to be retained in a grade, and were likely to continue to be chronically absent

[8] https://www2.ed.gov/datastory/chronicabsenteeism.html
[9] https://www.ncbi.nlm.nih.gov/pubmed/28230752

compared to student who regularly attended school,[10] They also showed that chronically absent students were more likely to receive free and reduced lunch, suggesting absenteeism is associated with poverty. Additionally, chronic absenteeism can be associated with housing quality and family mobility. After their homes, children spent the most time in their schools. Therefore, it is essential to provide high quality schools that protect and promote the health of students. The RI Department of Health map below highlights that the childhood health burden in Rhode Island is not equally distributed as shown in the Department of Health (Figure 1). Therefore, improvements to school building infrastructure must be targeted and prioritize the highest risk populations first.

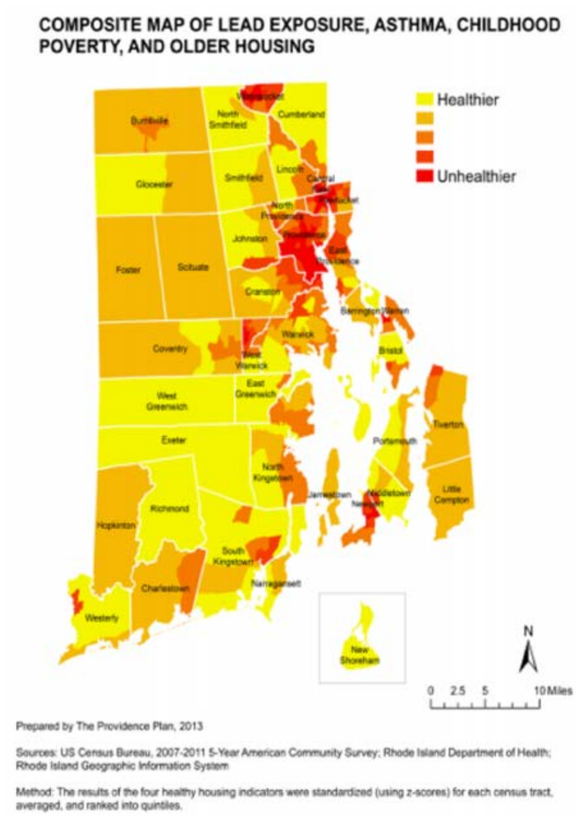

Figure 1: RI Department of Health: Quintiles of Health in Rhode Island Census Tracts

What efforts have been taken?

Schoolhouse Energy Report Card

Our decision-making process was informed by the upcoming release of the Schoolhouse Energy Report Card by Jacobs Engineering. This report discussed the findings of an ASHRAE Level 1 Energy Audit as well as a Facility Condition Assessment. In the assessment are robust findings for each school and identified energy conservation measures, opportunities for implementation, and the expected cost of implementation. This assessment provides information on annual

[10] http://ridatahub.org/datastories/chronic-absenteeism-in-kindergarten/2/

savings and simple payback in years. Unfortunately, many of these projects are very expensive for an unregulated entity or the state to bear alone, which is why the team focused on smaller projects that could be implemented in stages at a lower cost to the school but with significant overall benefit to the students, teachers, and community.

Many of the solutions provided in the Jacobs Energy Assessment report were based on the idea that the schools would be viable for renovation and remain at their current location for the next 20-30 years. However, many buildings are ending their useful lifetime. Additionally, the structures predate many important environmental health policy and research advancements including removal of PCBs in products (i.e. caulking, light ballasts) in 1979 and the Lead and Copper Rule in 1991. Therefore, invasive renovations and capital projects may reveal costly remediation projects that require skilled technicians and may compromise student health while construction is underway.

A valuable example is Pell Elementary School opened in 2013 to nearly 1,000 pre-kindergarten to fourth grade students. Although, a new construction project, this school serves as an example of diverse strategies that improve health and performance. The school was in part funded by RIDE and received energy rebates from National Grid for their high efficiency lighting and variable frequency drive fans[11].

Our Recommendations

Public-private partnerships offer an opportunity to make these projects more feasible. Our implementation plan aims to find ways to reduce the felt overall costs of the projects, present ways to quantify other benefits and co-benefits to represent returns in creative ways, and attract capital while minimizing the external partner's direct role.

An example of a successful PPP between an external partner and a school is Whirlpool in schools in Illinois and California.[12] Teachers and administrators had noticed lower attendance in some of their schools that did laundry less often for students. Students who might not have access to regular laundry facilities at home were often embarrassed to come to school in dirty clothes. Whirlpool believed that donating washers and dryers to schools would make a positive difference by increasing attendance and overall student engagement, which the data proved to be true. Whirlpool didn't receive a return on their investment, but they got some good publicity and were able to help out within their own communities. The example illustrates how creative solutions can lie in rethinking attributes of a problem in ways to appeal to unsuspecting partners.

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[11] http://www.neep.org/sites/default/files/resources/Claiborne%20Pell%20Elementary%20School.pdf
[12] http://www.businessinsider.com/washing-machines-solve-schools-big-problem-2016-8

We believe there are opportunities to explore this funding approach with partners interested in helping make small but impactful improvements in Rhode Island schools.

Our resulting recommendations were informed by a robust Screening Exercise (See **Appendix 1**), followed by a Feasibility Analysis (See **Appendix 2**). With 16 different options, we judged each based on its verifiability, direct costs, feasibility, and additionality. Based on how each project measured against these metrics and what we already knew from the RI Schools report, we narrowed the list down to six options for further analysis: 1) solar panel installations, 2) solar water heaters, 3) lighting upgrades, 4) boiler replacement, 5) cafeteria improvements, and 6) building envelope upgrades. We explored each of the options in greater depth in the Feasibility Analysis, and based on our analysis, we decided to focus on lighting and building envelope upgrades. These are more easily quantifiable but also provide a diverse list of options that can be applied on a school-by-school basis. As a starting place, they also offer an opportunity to grow the program as needed as possible.

Our recommendations come in the form of two campaigns, The Bright Future Campaign for lighting and The Safe Scholars Securing Success Campaign for building upgrades. These campaigns emphasize the value of small changes that affect significant benefits to students, teachers, and the entire state of RI.

The Bright Future Campaign

The vision for ***The Bright Future Campaign*** is one where all public schools in Rhode Island are upgraded to replace fluorescent lighting with LED lighting. Upgrading lighting is a feasible goal for Rhode Island schools in the near-term, in terms of the costs associated with the upgrades and in terms of the amount of construction and minimal disruption required to complete the work.

According to the Rhode Island Department of Education, public schools in Rhode Island spend around $30 million per year on utilities. Each district and each school is different in its energy use. Some districts, like Providence, spend about $1.50 per square foot for their utility costs. Other districts, like Woonsocket, spend about $2.50 per square foot for utility costs. These differences matter. Every dollar spent to keep the lights on and the heat running is a dollar not spent on education.

Moreover, not only are there clear environmental and cost-savings benefits associated with upgrading lighting, but extensive research shows the impact of good lighting (i.e. LED lighting) on improving student performance and on improving students’ ability to focus on class. Proper lighting conditions in classrooms can help regulate students’ circadian rhythms and promote alertness and visual health.

Replacement of fluorescent lighting could include replacing the light fixture and the bulb – or just the bulb alone – with the most benefits associated with replacing both. However, replacing the bulbs alone may be the most feasible option since fixture replacement can be cost-prohibitive.

The ***Bright Future Campaign*** has the potential to be a platform for schools to work with a wide range of external partners who may provide technical, logistical, and financial support to secure the upgrades. Moreover, this campaign could provide more opportunities for partnerships with local unions and local businesses as investing and implementation partners.

In 2017, National Grid partners with the state of Rhode Island to manage the incentive system. Whenever a school performs a lighting upgrade, the project funder submits total project costs to National Grid and the State. National Grid will refund 45% of the total project costs for lighting and then capture those environmental attributes. While the incentive is helpful, this is a reason why this project doesn't present an opportunity for an offset program. Additionally, schools can access money from a statewide funds, like the RIDE Capital Fund and the Rhode Island Building Efficiency Fund, for projects like this, but the funding is limited and in high demand, so often schools only apply for funding in emergency or urgent situations.

Potential for Energy Savings

Today, most schools in Rhode Island use T8 32W fluorescent light bulbs. These bulbs use around 0.15 MWh per year. One option to reduce energy usage in schools would be to replace T8 32W fluorescent bulbs with 18W LED lights (**see Table 1 below**), which would require changing the lightbulb and not the fixture. These LED lights use about 0.09 MWh per year – about 40% less than 32W fluorescents. Another option would be to replace both the bulb and the fixture, which allows for the installation of dimmable LED lights and provides much higher public health, environmental, and cost-saving benefits. LED lights with new fixtures use around 0.06 MWh per year – about 60% less than 32W fluorescents.

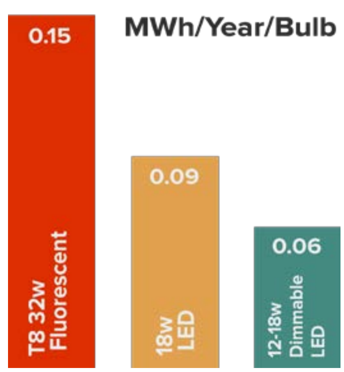

Table 1: Energy Consumed by Various types of Light Bulbs

Assuming Rhode Island chooses to move forward with replacing the lights with new LED bulbs and fixtures, replacing 1,500 lights results in 100 MWh saved per year (see **Table 2**). The residential rate for electricity in Rhode Island is around 18.5 cents per kWh – or more than \$185/MWh. This means that replacing 1,500 bulbs would result in savings of more than \$18,500 per year. Altogether, this represents an annual savings of about \$12.50 for each light replaced, just from reduced energy use alone. In addition, LED lights last longer than fluorescents and thus need to be replaced less frequently, reducing labor costs and saving the school's maintenance staff time and effort.[13]

1,200 lbs CO_2e Per MWh Saved

100 MWh Saved = 120,000 lbs CO_2e

0.9 lbs NO_x Per MWh Saved

100 MWh Saved = 90 lbs NO_x

0.4 lbs SO_2 Per MWh Saved

100 MWh Saved = 40 lbs SO_2

Table 2: Pounds CO_2 equivalent Saved per MWh Energy Reduced from LED Lighting Upgrades

Potential Costs

This is an expensive project. The team performed some basic, back-of-the-envelope calculations (see **Table 3 below**) to test our assumptions and think about how a public-private partnership could potentially reduce these costs on a large scale. These assumptions are based on material costs in small numbers (not wholesale values) and rough labor estimates. The cost savings in the third and fifth columns of **Table 3** are estimated savings schools could obtain by working with local partners to reduce the cost of materials and labor. These savings are not guaranteed but can and should be negotiated at the state and district level.[14]

For lighting in particular, there are potential partnerships that could reduce the costs of both labor and materials. For labor, Rhode Island Community College has an Electrician Apprenticeship program that could be a good partner for the state or a certain district. Though there are strict union requirements for lighting and electrical work throughout RI, there is a potential opportunity for apprentices to gain experience on public school projects and for the work to have

[13] Moreover, reducing energy use by 100 MWh would result in a reduction of 120,000 lbs. of carbon-dioxide equivalent emissions in addition to some reductions in other key pollutants. This emissions reduction is equivalent to the amount of carbon sequestered by around 50 acres of US forests in one year.

[14] This analysis could be stronger with more accurate assumptions based on real data, some of which was provided by the Jacobs Engineering report on a school-by-school basis. Since there wasn't a more detailed breakdown of those assumptions, the team set its own baseline for the purposes of comparison.

a lower cost of labor. Another option is to look to large companies manufacturing lighting. Some examples include GE, Siemens, and Philips. There is a unique opportunity for these companies to donate lights or offer them at a reduced cost in exchange for publicity or environmental attributes if schools forgo the rebates offered by National Grid.

	LED Upgrade	**With Cost Reductions**	**LED Upgrade + Fixtures**	**With Cost Reductions**
Cost per Light (2 Bulbs each)	$100	$20	$200	$100
Number of Lights per School	400	400	400	400
Hourly Installation Cost	$100	$50	$200	$100
Lights Installed/Hour	4	10	2	6
Total Cost per School	**$45,000**	**$10,000**	**$100,000**	**$46,667**
Total Cost for State	**$13,815,000**	**$3,070,000**	**$30,700,000**	**$14,326,667**

Table 3: Estimated Costs for LED Lighting Upgrades

Step-by-Step Implementation Plan

1. **Identify viable schools with the greatest need**
    a. Before schools are selected for improvements, they will undergo a building assessment that identifies the expected lifetime of the building. Proposed lighting upgrades will have potential benefits for the next 20 years. Therefore, buildings that will be decommissioned in the next 5 years will not be eligible for this investment. To identify schools with the greatest need we have created a preliminary survey to be filled out by building occupants (See **Appendix 3**). Priority will be given to schools with windowless classrooms, have T12 light bulbs or PCB-containing ballasts, or are located in low-income school districts.

2. **Determine cost and quantity of lighting upgrades, replacements, materials, and installation per school**
    a. The Rhode Island schools report does a school-by-school breakdown of the costs to install LED lighting replacements across the state. The total cost for all 307 schools came out to $64M. We did some of our own back-of-the-envelope math to compare our assumptions and data with the results of the Schools report. Assuming the ability to purchase materials (lights and fixtures) at a wholesale rate and possibly reduce labor costs by using community college students as installers, we believe the total cost could be much closer to $16-20M for the entire state. And that's before tapping into funds and grants available for exactly this type of project.

3. **Leverage Untapped Funding & Develop Innovative Offset Financing**
    a. **Available Public Funding Options:** Current law allows for a state match of 30 percent for qualified school construction expenses depending on the socioeconomics of a district. Among the options is a revolving fund, the Rhode Island Efficient Building Fund. The second round priority infrastructure projects were announced in January 2017 and include Providence and Woonsocket schools. Some other districts have embedded schools in their overall municipality plans. The state will soon make it possible to get reimbursed for financing provided through this fund by the School Housing Aid Program. It is important to note, however, that the first round of financing closed at $17.2 M of the $60 M requested by applicants which demonstrates the high demand and lack of sufficient resources.
    b. **Available Private Funding Options:** There are also private sector funds and grants available at no financial return obligation in the range of $5,000 to $15,000 and a KEEN Grant of $100,000 that could be applied for on a district-by-district or school-by-school basis. More details can be found in Table 7 on page 26. The unregulated entity could play a role in applying for and combining use of these funds and other rebate programs, reducing upfront and future costs to claim offsets where none of the other parties care to claim the offsets.
    c. **Introducing Innovative Financing**: Another option is for the external partner to set up a revolving fund combining other innovative funding instruments such as community mini-bonds and pay-for-success contracts. The key to the fund will be to be creative about who is engaging in investing and supporting the fund, the philosophy behind the fund as it relates to investor interests, and how savings and co-benefits are manifested and quantified to maintain interests. The fund's value for the state is in ensuring energy efficiency projects stay a priority in Rhode Island by establishing a dedicated fund. For a more precise example and explanation of how a fund could work see the Financing section of this report.

4. **Identify Potential Partners for Implementation**
    a. For lighting materials and installation, there are a number of highly capable partners who have the potential to reduce the cost of the work as well as make it more efficient. First of all, we suggest working with a lighting retailer like Siemens or GE who might be willing to sell their lights at a discounted rate in exchange for the offsets achieved by installing more efficient lighting. Secondly, partnering with the Community College of Rhode Island could be a great way to engage their Electrical Apprenticeship Training students to assist in lighting installations. This would lower installation costs significantly and provide the students with valuable training. National Grid is a crucial partner because of all the work they are already doing with energy projects in the RI public schools, and they might be able to help in negotiations. Finally, unregulated entities like Harvard, Brown, and a RI-based company like Hasbro could also be great partners given their local knowledge, willingness to help the community, and potential desire to acquire energy offsets.
5. **Organize Materials & Logistics**
    a. Order materials based on partnerships developed, or in lieu partnerships, purchase materials at wholesale prices. This must be done at the state (or at least the district) level in order to maximize economies of scale. Then, the materials should be held either at the school if there is storage space available or at one central location within each district until work can be completed. Depending on the agreed upon timeline, work could be completed concurrently at different schools with availability of labor or on a school-by-school basis. Regardless, the work should be completed timely for the sake of RI public schools but also in order to recognize health and environmental benefits as early as possible and demonstrate benefits and savings that can attract and maintain interest by partners.

6. **Get to work!**
    a. This is a coordinated effort that requires sharing best practices across schools. Installation of new light bulbs and equipment will take less than a week for a school and have immediate impacts on students and energy bills. This step can be completed at multiple schools simultaneously and rely on sharing tools, labor, and extra materials as necessary.

Safe Scholars Securing Success

The vision for ***Safe Scholars Securing Success*** is to enhance the indoor environmental quality of Rhode Island Schools through minor projects that promote occupant health and safety. This initiative would leverage external partners who would like to invest in schools but don't have the financial resources for a large capital project. It is important to acknowledge that the average age of school buildings is more than 60 years old, resulting in poorly insulated learning spaces that lead to high levels of infiltration. The types of proposed projects would include adding door sweeps to prevent heat loss and pest intrusion, sealing holes and cracks, caulking windows or adding window films to prevent heat loss, improving roof quality to prevent thermal gain and indoor leaks and moisture. Additionally, schools participating in the Bright Future Campaign could paint their walls with high light reflectance value, low VOC paint to enhance illuminance and provide opportunities to enhance school pride. We believe these minor projects provide immediate public health benefits and increase the longevity of the school until it can be fully renovated. In Rhode Island, the aging infrastructure may lead to expensive, labor intensive renovations.

This initiative provides a marketing and publicity opportunity for local and corporate external partners. There are countless local and regional organizations that could be engaged for this effort. For example, Hasbro, a Rhode Island-based toy manufacturer, is invested in the happiness and well-being of children and can directly support their community by improving student learning spaces. Additionally, companies such as Home Depot or Owens Corning, which manufacture or sell building envelope materials may provide expertise, volunteers, and discounted or donated materials. This approach can occur at many scales - individual classrooms or entire schools and districts.

The ***Safe Scholars Securing Success*** initiative would be launched with specific community engagement opportunities and resources that would be available on the RIDE website. These materials would be co-created with facility managers, teachers, and students. Together they would create simple signage that encourages energy efficiency behaviors (i.e. unplugging equipment during school breaks and turning off the light when they leave a classroom). Easy to implement energy audits that can be incorporated into the science curriculum for high school students. Additionally, they would create an indoor environmental quality awareness campaign that can emphasize the importance of creating and maintaining healthy learning environments.

This approach would specifically target schools with the greatest need as identified by a Health Impact Assessment (HIA). Similar to the Jacobs Engineering Schoolhouse report, these quantitative and qualitative assessments can highlight specific interventions to improve health and performance of students and teachers. Using HIA's from the beginning can help guide what minor projects would provide the greatest energy savings and public health benefit. The Centers for Disease Control and Prevention provide specific tools for completing a HIA in your own community[15] that can be directly applied to RI School environments. Therefore, the ***Safe Scholars Securing Success*** initiative could identify schools that would benefit from a heat

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[15] https://www.cdc.gov/healthyplaces/hia.htm

recovery system or upgraded boiler system but would not provide the financial resources to make these improvements because the scale of the project is too large for this initiative.

Potential for Energy Savings

This initiative attempts to directly reduce infiltration of outdoor air that would increase heating or cooling costs. For example, in the winter, cold air enters through the walls, resulting in school facilities increasing the use of their heating systems to compensate for drafty classroom environments. In order to estimate the energy savings associated with modest reductions in infiltration, we did a building performance simulation, using DesignBuilder, specialized software to estimate the impacts of a reduction. This model used typical characteristics of a Rhode Island classroom in terms of insulation, heating systems, fuel types, and occupancy as well as weather and other Rhode Island-specific factors.

Our typical classroom model with higher infiltration rates would use around 126,000 kBTU[16] per year, which is a measure of the amount of heat needed for the classroom to maintain an appropriate temperature for children, given a typical heating system for a Rhode Island school. A classroom with high infiltration would use around 106,000 kBTU per year. And a classroom with moderate infiltration would result in around 86,000 kBTU per year (see **Table 4**).

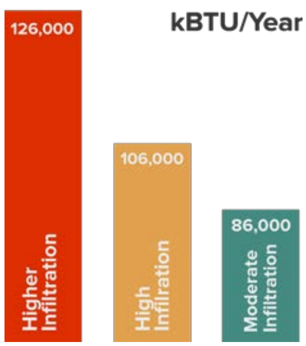

Table 4: Energy (Heat) Consumed by Various Levels of Infiltration

At a rate of $1.50 per 100 kBTU, taking one classroom from higher to moderate infiltration would result in energy savings of around $600 per year, which is equivalent to a savings of 40,000 kBTU. Taking twenty-five classrooms from higher to moderate infiltration would result in energy savings of $15,000 and 1 million kBTU annually. Based on this model, this is the equivalent of going from 70 kBTU per SF to 48 kBTU per SF. The national average for schools is around 58 kBTU per SF. In terms of greenhouse gas emissions reductions, at 117 pounds of carbon dioxide per million BTU, improving one classroom would result in a reduction of 4,700

[16] A British thermal unit (BTU, or in this case "thousand British thermal units" - kBTU) is a traditional unit of heat; it is defined as the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit. As a reference, 1 BTU is the equivalent of 0.293071 Watt Hours, therefore 1 kBTU is equivalent to 293.071 Watt Hours.

pounds of carbon dioxide per year (see **Table 5**). And improving 25 classrooms would result in a reduction of 117,000 lbs. of carbon dioxide per year – equivalent to replacing 1,500 fluorescent bulbs with LED lights.

117lbs CO_2 / MMBtu of Natural Gas

1 Classroom = 4,700 lbs CO_2
25 Classrooms = 117,000 lbs CO_2

Table 5: Pounds CO_2 equivalent Saved per MMBtu Energy Reduced from Building Envelope Upgrades

The main conclusion from this analysis was significant reductions in energy usage in Rhode Island schools can be achieved. Ultimately, saving thousands of dollars per school, through modest reductions in infiltration rates, as appropriate, given current indoor ventilation levels.

Potential Costs

As you can see in our presentation (see **Table 6**), we performed some back-of-the-envelope calculations to try to get a better sense of what baseline costs might be and, more importantly, how partnerships might help us reduce overall project costs. These costs are assumptions and don't reflect true data, but we wanted to better understand the opportunity for cost reductions.

	Window Caulking	**With Cost Reductions**	**Door Sweeps**	**With Cost Reductions**	**Upgraded Insulation**	**With Cost Reductions**
Cost per Unit	$4	$3	$10	$8	$11	$9
Units per School	200	200	100	100	100	100
Installation Cost per School	$2,500	$1,000	$2,500	$500	$16,000	$8,500
Total Cost per School	**$3,100**	**$1,400**	**$3,100**	**$1,300**	**$17,100**	**$9,400**
Total Cost for State	**$951,700**	**$429,800**	**$1,074,500**	**$399,100**	**$5,249,700**	**$2,885,800**

Table 6: Estimated Costs for a Sample of Building Envelope Upgrades

Step-by-Step Implementation Plan

1. **Determine Specific Building Envelope Improvements Needed per Health Impact Assessment**
    a. In order to optimize the cost-benefit of this initiative, we propose partnering with the RI Department of Health to identify and prioritize school districts with the highest levels of pediatric asthma, childhood poverty, and other health performance indicators. At this time, we would consider age of building, results of Indoor Air Quality audits, number of students in the school, and the Jacobs Engineering Report findings.

2. **Evaluate Cost & Quantity of Improvements**
    a. There is great diversity in school building age and condition in Rhode Island. Therefore, a diverse selection of the most common building envelope improvements will be available under the ***Safe Scholars Securing Success*** initiative. Schools will complete an application that includes current energy expenditures and extent of improvement required. This scoping step will identify the quantity of materials, expected time to complete tasks, potential interruption to school schedule. For example, we estimate that installing door sweeps in all 307 schools would cost approximately $1.1M and window caulking would cost $1M. These projects would take a few days to complete an entire school and have minimal disruption to students and teachers because they could be performed after hours or during the weekend.

3. **Engage Diverse Funding Opportunities and Introduce Innovative Financing**
    a. **Available Public Funding Options:** There are a variety of funds and grants available to supplement the cost of the ***Safe Scholars Securing Success*** initiative. In addition to the Efficient Building Revolving Fund mentioned in the lighting plan, we would also recommend seeking out the School Building Authority Capital Fund. Similar to the ***Bright Future Campaign***, schools fall under district, state, and federal jurisdiction. More information will be provided in the financing options section.
    b. **Available Private Funding Options:** There are also private sector funds and grants available at no financial return obligation including the Home Depot Foundation and Lowe's Toolbox for Education, both of which support projects like these. More details can be found in Table 7 on page 26. The unregulated entity could play a role in applying for and combining use of these funds and other rebate programs, reducing upfront and future costs to claim offsets where none of the other parties care to claim the offsets.

c. **Introducing Innovative Financing**: Also mentioned in The Bright Future Campaign implementation plan, another option is for the external partner to set up a revolving fund combining other innovative funding instruments such as community mini-bonds and pay-for-success contracts. The key to the fund will be to be creative about who is engaging in investing and supporting the fund, the philosophy behind the fund as it relates to investor interests, and how savings and co-benefits are manifested and quantified to maintain interests. The fund's value for the state is in ensuring energy efficiency projects stay a priority in Rhode

4. **Identify potential partners for implementation**
   a. To implement a variety of minor projects we hope to work closely with Rhode Island Labor unions who have the expertise and capability to make the proposed upgrades. Additionally, each project may require different types of partners (i.e. financial, administrative, labor, etc.). Similar to lighting, aligning with companies like Owens Corning or Home Depot who can provide discounted materials and gain from publicity efforts. National Grid is a crucial partner because of all the work they are already doing with energy projects in the RI public schools, and they might be able to help in negotiations. In addition, unregulated entities like Harvard, Brown, and a RI-based company like Hasbro could also be great partners given their local knowledge, willingness to help the community, and innovative solutions for energy efficiency.

5. **Organize Materials & Logistics**
   a. Order materials based on partnerships developed, or if no partnerships, it's important to purchase materials at wholesale prices. This must be done at the state (or at least the district) level in order to maximize economies of scale. Then, the materials should be held either at the school if there is storage space available or at one central location within each district until the work can be completed. Depending on the agreed upon timeline, work should be completely concurrently at different schools if there is enough available labor or on a school-by-school basis. Regardless, the work should be completed as possible for the health and environmental benefits to be recognized right away.

6. **Get to work!**
   a. This is a coordinated effort that requires sharing best practices across schools. Installation of new light bulbs and equipment will take less than a week for school and have immediate impacts on students and energy bills. This step can be

completed at multiple schools simultaneously and rely share tools, labor, and extra materials as necessary.

b. When the work is completed, assess if there were improvements to self-reported health and energy costs.

Legal Overview

Given the focus of these projects, the predominant body of law that an external partner would need to be concerned with is Rhode Island state law. Fortunately, within this legal framework a great deal of opportunity exists for both Rhode Island schools and external partners. Much of this opportunity comes from a regulatory distinction between “major” and “minor” projects involving public schools. These “major” and “minor” tiers create differing levels of regulatory burden for the external partner and the schools themselves, and in the context of our suggested projects, an external partner will generally want to focus on a series of smaller, “minor” projects rather than on large-scale “major” projects. This approach maximizes opportunities for both the schools and the external partners, all while keeping cost considerations in mind. As such, it is important for an external partner to be mindful of the “major” versus “minor” distinction as it applies to school construction regulations in Rhode Island. The following section will discuss this distinction as well as the larger regulatory framework that these concepts exist within.

School Project Regulation: The Two “Buckets” of Rhode Island Law

For an external partner who wishes to partner with a school Rhode Island law can essentially be divided into two “buckets.” The first bucket consists of those laws which deal specifically, either in whole or in part, with school construction and renovation projects. The second bucket contains those laws which are widely applicable, such as state contract and permitting law. In order to effectively implement these projects, an external partner would need to be aware of the regulatory opportunities and constraints that exist in this “two bucket” sphere of Rhode Island law. For the purposes of these projects, the two buckets contain four core areas of legal concern. The first is the Rhode Island Department of Education’s Construction Regulations (“RIDE 1.0”). These regulations establish broad regulatory standards in areas of school construction such as design, approval, reimbursement, etc. The next regulation is the Rhode Island Green Buildings Act (“Green Buildings Act”), which adopts the Northeast Collaborative for High Performance Schools Protocol (“NE-CHPS”) as a performance standard for Rhode Island schools. Whereas RIDE 1.0 establishes broad standards and general requirements, NE-CHPS establishes specific design, construction, and verification standards. Finally, in bucket two, the external partner needs to be aware of how Rhode Island contracting and permitting law deals with school districts. The following table serves a reference for these “buckets” and provides a brief description of the general purpose for each law, as well as a brief conclusion on how that law impacts the "major" versus "minor" framework.

Regulatory Framework

Bucket One - School Construction Laws		
Regulation	**Purpose**	**"Major" v. "Minor" Applicability**
The Rhode Island Department of Education's Construction Regulations (RIDE)	Establishes broad design, approval, reimbursement, etc. standards for school construction and renovation projects.	Establishes the "full or partial state funding" requirement, as well as the $500,000 trigger for "major" projects.
The Rhode Island Green Buildings Act ("Green Buildings Act")	Adopts NE-CHPS standards for school construction and renovation projects.	Codifies NE-CHPS as the standard for schools, as well as clarifies the 10,000 gsf "major" trigger for renovations (5,000 gsf for new construction).
The Northeast Collaborative for High-Performance Schools Protocol (NE-CHPS)	Establishes specific design, construction, and verification standards for school construction and renovation projects.	Not directly applicable to a "major" or "minor" trigger, but creates specific burdens which incentivize a "minor" project-centric approach.
Bucket Two - Generally Applicable Laws		
Category of Law	**Purpose**	**"Major" v. "Minor" Applicability**
State Contract Law	In this context: confers broad contracting and purchasing power to Rhode Island Schools.	Not directly applicable to a "major" or "minor" trigger, but allows a school and an external partner to create a two-tiered contractual framework that maximizes the potential of "minor" projects.
State Permitting Law	In this context: schools have no special permitting privileges or difficulties, as such the burden would be shifted to contractors and subcontractors as is standard.	Not directly applicable to a "major" or "minor" trigger, but reinforces the importance of maintaining the "major" versus "minor" distinction in the text of performance contractors.

Table 7: Rhode Island Laws - Reference Table

In bucket one the broadest law is RIDE 1.0, which provides a legal framework for construction projects involving public schools.[17] RIDE 1.0 establishes both general and specific requirements for construction projects, and applies to all new projects where the total cost exceeds $500,000.[18] For example, as a general requirement districts must, among other tasks, ensure that the project

[17] RIDE School Construction Regulations, RIDE 1.0, (5/24/07).
[18] *Id*. at § 1.01. For an example of specific requirements, *see e.g.*, RIDE § 1.05-8 which deals with storm water pollution prevention.

will be completed in a timely and cost effective manner. The district also has a sole and exclusive responsibility for all aspects of a proposed and/or approved project, including all aspects of design, construction, and oversight. As an example of a specific requirement, projects involving instructional spaces must comply with the American National Standards Institute's Guide for Education Facilities Lighting standard.[19] Another such example is that approved projects must also have a useful life cycle of fifty years where they involve new construction or a structural addition to an existing school building.[20]

In defining many of these requirements, most of the language within RIDE 1.0 refers to districts, as such it is important to note that a "district" is defined to include "school districts, regional school districts, charter schools, and any other public school entity seeking approval of the necessity of school construction and/or requesting to fund a portion of the cost of school construction, modernization, or addition projects through reimbursement from the school housing aid program."[21] Further, if a district chooses to pursue a construction project, RIDE 1.0 requires that these districts also address "cross districting issues and possibilities" arising out of site selection in order to better serve the student population and surrounding communities[22] These considerations are required as a way of keeping potential costs at the forefront of a given project.

In dealing with costs and more specifically potential funding limits, RIDE 1.0 establishes a list of nine hierarchically ranked priorities to assess against applications for school construction and renovation requirements. The highest priority is the "[r]eplacement or renovation of a building which is structurally unsound or otherwise in a condition seriously jeopardizing the health and safety of school children, where no alternative exists." For an external partner, this provides regulatory opportunity where a project would offer immediate and tangible safety benefits to students. Conversely, energy considerations rank as priority number six and concern the "[r]eplacement, renovation, or modernization of any school facility to increase energy conservation and decrease energy related costs in the facility."[23] Similarly, any proposed projects involving site and building layouts must maximize the opportunities for on-site renewable energy generation.[24] Rhode Island formally recognizes solar radiation, wind, latent heat from the ocean, small hydro facilities, biomass facilities (using eligible biomass fuels), fuel cells using renewable resources, and waste-to-energy combustion as "renewable energy resources.[25] In order to encourage this kind of efficiency in schools, RIDE 1.0 provides an additional 2-4% in

[19] American National Standards Institute standard number ANSI/IES RP3-00, Guide for Educational Facilities Lighting, (2000).
[20] *Id*. at § 1.03-1.
[21] *Id*. at § 1.01.
[22] *Id*. at § 1.05-3.
[23] *Id*. at § 1.03-3.
[24] RIDE School Construction Regulations, at § 1.05-9(8).
[25] R.I. Gen. Laws § 39-26-5.

reimbursement funds for in new projects that demonstrate energy and water efficiency cost reduction beyond the minimum requirements of NE-CHPS.[26]

Moving to the next significant law within bucket one, the Green Buildings Act establishes requirements for construction and renovation projects on public buildings in order to promote high-performance energy saving measures, reduced water consumption, improved indoor air quality, environmental preservation, and more productive workers and students.[27] Under the Green Buildings Act a public school district that initiates any major facility project, and receives any state funds for that project, must design and construct the project so that it meets either the LEED certified standard, or the NE-CHPS Version 1.1 or above.[28] A "major facility project" is defined as a building construction project larger than five thousand gross square feet ("gsf") of occupied or conditioned space, or a building renovation project which is larger than ten thousand gsf of occupied or conditioned space.[29] The Rhode Island Department of Elementary has adopted the "High Performance Schools Standard" from NE-CHPS as the primary LEED equivalent standard for public schools in the state.[30] As of March 2017, the NE-CHPS standard has been updated to Version 3.1.[31]

There are two cases in which a major facility project does not have to meet NE-CHPS. The first scenario is if there is no applicable high performance standard for a given type of building or renovation project. In that case lesser standards which are appropriate for the project will be established and applied by RIDE.[32] The second scenario occurs when there is no practical way to apply the high performance standard to a particular building or renovation project. In that case lesser standards which are appropriate for the project will be established and applied by RIDE.[33] Applicants may also seek an exception to the high performance standards where they would otherwise apply. These requests must be based on either economic hardships, hardships due to the impracticality of a project achieving the standards, or other hardships, including, but not limited to: disaster reconstruction, structural damage from a fire, vandalism, theft, or an act of God. These requests are subject to the approval and discretion of the State Building Commissioner.[34]

[26] RIDE School Construction Regulations, at § 1.12-2.
[27] *See* R.I. Gen. Laws § 37-24-2(3).
[28] R.I. Gen. Laws § 37-24-4(b).
[29] Rule and Regulations to Implement the Green Buildings Act, Pursuant to RIGL Section 37-24-5, October 2010, at 2.
[30] Rule and Regulations to Implement the Green Buildings Act, at 4; *see also* RIDE § 1.04-1.
[31] Northeast Collaborative for High-Performance Schools Protocol, *NE-CHPS Criteria*, available at http://www.chps.net/dev/Drupal/NE-CHPS.
[32] R.I. Gen. Laws § 37-24-4(c)(1).
[33] *Id*. at (c)(2).
[34] Rule and Regulations to Implement the Green Buildings Act, at 4 – 5.

Where the high performance standard applies to schools, NE-CHPS implements a "points" system wherein certain criteria are assigned a set number of points.[35] Points are divided between "prerequisites" and "implementation." New construction projects, including new buildings on existing campuses, must achieve at least 110 total points. For new projects this total also includes all points from the associated prerequisites. Major renovations must achieve at least 85 points, but only need to meet a narrower band of prerequisites as compared to new projects.[36] A major renovation or modernization occurs when there is a "substantial improvement" to a school of at least two of the following systems: lighting, HVAC, building envelope, interior surfaces, and/or the site. A "substantial improvement" occurs when more than half of the given system or surfaces are replaced or upgraded.[37] Schools projects that perform well beyond minimum point requirements may be listed as "CHPS Verified Leaders™." In order to achieve this status, new projects must earn 160 or more points, while renovations must earn at least 135 points.[38]

NE-CHPS lists requirements based on the categories of "Integration," "Operation & Metrics," "Indoor Environmental Quality," "Energy," "Water," "Sites," and "Materials & Waste Management."[39] Each of these categories has subcomponents. For example, "Indoor Environmental Quality" contains the subpart "Electric Lighting Performance" which establishes specific lighting requirements for new classrooms or renovation projects where classroom lighting is included in the scope of the work.[40] Examples of specific NE-CHPS requirements are included in the appendix for reference (see **Appendix 4)**.

To briefly turn to bucket two, In Rhode Island school districts, school committees, and school boards of trustees[41] have the power to enter into contracts in order to "construct, furnish, and equip schools and improve the grounds upon which the schools are located and to make additions to the schools as may be needed."[42] They may also establish joint purchasing agreements for the purpose of purchasing services.[43] Under Rhode Island law, a contract relating to the "design, planning, construction, alteration, repair, or maintenance" of a building, structure, appurtenance, or appliance must not indemnify the promisee, their contractors, agents, employees, or indemnitees against liability for damages that occurred as a result of negligence on the part of the promise, their contractors, agents, employees, or indemnitees.[44] Additionally, district purchases in Rhode Island within the realm of this project are regulated by the Municipal

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[35] Northeast Collaborative for High Performance Schools, Version 3.1 Northeast CHPS Criteria for New Construction and Renovations, August 2014, at 1.
[36] *Id*.
[37] Collaborative for High Performance Schools, *National Core Criteria – Renovation/Modernization*, available at http://www.chps.net/dev/Drupal/national-core-criteria.
[38] Northeast CHPS Criteria for New Construction and Renovations, at 1.
[39] *Id*. at v – ix.
[40] [28] *Id.* at vi, 124.
[41] R.I. Gen. Laws § 16-2-34.
[42] R.I. Gen. Laws §§ 16-3-11(5), (6); *see also* R.I. Gen. Laws § 16-2-9(18).
[43] R.I. Gen. Laws § 16-2-9-9.2.
[44] R.I. Gen. Laws § 6-34-1.

Purchases Act and not by general state procurement law. This removes the most likely barriers (e.g. competitive bidding) that an external partner might face.[45] For purposes of the permitting process, schools have no special exemptions or privileges and as such general permitting processes would apply and would be largely handled by the contractors and subcontractors themselves.

Implementation: "Major" versus "Minor" Projects

While RIDE 1.0, the Rhode Island Green Buildings Act, and NE-CHPS establish a fairly complex regulatory framework, there are two primary categories created by this framework that are most pertinent when considering a project. The regulations operate on a series of "triggers," which, if engaged, require that a school achieve certain conditions. These conditions are most rigorous for those projects which are considered to be "major," whereas those projects considered to be "minor" have less regulatory hurdles. When considering "business as usual" versus progressive assistance, "minor" projects create fewer obstacles. However, "major" projects still provide opportunities based on the current state of Rhode Island's schools, both physically and in the realm of regulatory requirements – though ultimately "major" projects do create more barriers. Thus, differentiating between "major" and "minor" projects" can be quite beneficial for the external partner who wishes to minimize regulatory complexities.

In Rhode Island a "major" project is defined as a project where: the project is receiving full or partial state funding; and the total cost is above $500,000, *or* more than 10,000 gsf of renovated space is involved.[46] Where these thresholds are met, the exact requirements laid out by both RIDE 1.0 and NE-CHPS are triggered, which means that for purposes of additionality, only those projects which exceed the regulatory standards would be eligible for effective regulatory claims. Conversely, where the above thresholds are *not* met, then the broader regulations are not triggered. This means that insofar as regulations are concerned, the barriers to making claims are much lower. In these "minor" projects general permitting and safety requirements still apply, however there are no per se energy efficiency requirements in the sense of those triggered by a "major" project.

Thus, when targeting specific projects it would be most efficient for the external partner to design a series of "minor" projects where applicable, though a "major" project does not necessarily preclude claims. However, regardless of whether a project is "major" or "minor" Rhode Island contracting law applies across the board. The good news for the external partner is that Rhode Island law allows school districts, school committees, and school boards of trustees to fully enter into contracts. As Rhode Island law provides no significant barrier to contracting with

[45] R.I. Gen. Law §37-2-4.
[46] *See* RIDE 1.0 at § 1.01; R.I. Gen. Laws § 37-24-4; Rule and Regulations to Implement the Green Buildings Act, Pursuant to RIGL Section 37-24-5, October 2010, at 2.

a school directly, we recommend a two part contracting scheme. The upper tier would be a benefit/claim agreement between an external partner and a given school or schools. This would provide the framework that could then be referred to in the second tier performance contracts designed to achieve a specific task, e.g. install new lighting fixtures in a set number of classrooms in a set district. These secondary performance contracts would be structured as a tripartite contract between the external partner, the school, and the contractor(s) to carry out a given project. This allows the external partner to maintain a position "at the table" during the performance and also increases the external partner's credible claims as a result of the project. In essence, a tripartite contract increases an external partner's legal and public-image position.

Implementation: Contracting and Permitting

When drafting these contracts there are two primary areas of focus. The first is the general language of the contract. Since Rhode Island gives schools broad contracting power, the language found in the body of the contract could be quite similar to most other benefit agreements and performance contracts, though a given contract would want to remain mindful of Rhode Island's unique regulatory landscape. As a few examples, the contract would want to define terms such a "project" in a manner that keeps them consistent with the Rhode Island school construction regulations. The contract would also want to, under rights and obligations, ensure that the school agrees to provide site access as needed. Regarding indemnification, the contract would want to clearly define the parties involved; especially if various aspects are covered by either the district itself, or the school board of trustees. Further, as many of the schools in Rhode Island are in poor physical condition, in laying out warranties and representations (as well as assignments), the contract would want to ensure that physical descriptions were accurate. Another area that the contract would want to focus on would be changes in law, primarily those regarding the RIDE 1.0 and NE-CHPS standards should the project be deemed "major." As an example, the contract might provide for a secondary protocol, such as LEED, where NE-CHPS might be inapplicable – a strategy permitted under RIDE 1.0.[47] Broader contracting elements would include force majeure provisions and dispute resolution agreements. Here concepts such as "reasonable costs" would want to be framed in a manner that keeps the project consistent with its "major" or "minor" categorization. A chart of potential terms and categories that might be included in such a contract is included in the appendix (see **Appendix 5)**.

The second portion of the contract, which applies equally to "major" and "minor" projects, would deal more specifically with contractors, subcontractors, and Rhode Island's permitting requirements. Rhode Island has a broad array of safety and construction permits, though there are six permit types that are most likely to be needed in the contexts of lighting and building envelope projects. First, in Rhode Island contractors must maintain general construction permits

[47] R.I. Gen. Laws § 37-24-4(c)(1).

as well as contracting licensure.[48] This requirement would likely apply across the full spectrum of projects, regardless of the specific details. Second, when dealing with substantial changes to lighting or wiring, electrical permits would generally be required.[49] An electrical permit is not required when a contractor simply replaces a bulb, but more extensive retrofits or replacements would require such a permit. Third, roofing permits would be needed for any projects involving changes or renovations to the roof.[50] Fourth, mechanical permits are applicable to any projects that involve modifications to HVAC systems,[51] though this excludes boiler and pressure systems as they have their own permitting scheme.[52] Fifth, hoisting permits are necessary where heavy equipment is needed to move materials or perform other tasks.[53] One possible activity that might require a hoisting permit within the scope of these projects is an extensive façade repair. Sixth, fire code permits are broad and generally applicable, though projects involving insulation will have specific fire code permitting requirements.[54]

Legal: Summary

In summary, an external partner wishing to advance lighting or building envelope projects would maximize benefits in a cost-effective manner by approaching larger endeavors as a series of smaller, “minor,” projects and by carrying out those projects through the use of two tiered contractual scheme involving benefit agreements and tripartite performance contracts which reflect that “minor” versus “major” distinction and also ensure that proper permits will be obtained for the given project.

Financing

In general, Rhode Island provides an inviting environment for an external partner to invest in energy efficiency. It prides itself on being a national leader for energy efficiency programs and policy, and support is high up in government. In 2015, Governor Raimondo signed an executive order to lead by example on energy efficiency starting with government building, and the Clean Water Finance Agency was made into the Rhode Island Infrastructure Bank to bring a new focus to energy efficiency funding. The Office of Energy Resources is proactively facilitating initiatives including the application process for the Efficient Building Fund. The Energy Efficiency and Resource Management Council provides a stakeholder driven model for approaching energy planning and programming across the state, and RIDE is actively interested

[48] R.I. Gen. Law § 5-65 et. seq.
[49] R.I. Gen Law § 5-6 et. seq.
[50] R.I. Gen. Law § 5-73 et. seq.
[51] R.I. Gen. Law § 28-27 et. seq.
[52] R.I. Gen. Law § 28-5 et. seq.
[53] R.I. Gen. Law § 28-26 et. seq.
[54] R.I. Gen. Law § 23-28 et. seq.

in progressing energy efficiency having commissioned a report by Jacobs Consulting. They also recognize schools that are doing well with the Green Ribbon Schools program. The University of Rhode Island contributed by benchmarking exercise and has had its own partnerships with local, state, regional and national decision-makers, energy providers, nonprofits and the business community while training and engaging students. Finally, National Grid administered an Energy Efficiency Partnership in 2015, making its own recommendations and involving all of these entities mentioned. These efforts and the partnership demonstrate a collaborative atmosphere and commitment toward public energy efficiency in the Rhode Island community.

Funds Already Available in Rhode Island

Current law allows a state match of at least 30 percent for qualified school construction expenses depending on the socioeconomics of a district. RIDE offers the School Housing Aid Program to provide reimbursements for school construction and a Capital Fund designed to help fund upfront costs for shovel ready projects.

Additionally, the Rhode Island Infrastructure Bank offers a Rhode Island Efficient Building Fund. The second round of infrastructure projects were announced in January 2017 and includes Providence and Woonsocket schools. Some other districts have embedded schools in the energy efficiency plans for their municipality. The state will also make it possible to get reimbursed for financing provided through the School Housing Aid Program. It is important to note, however, that the first round of financing closed at $17.2 M of the $60 M requested by applicants. This demonstrates the huge demand and the limited amount of resources available for energy efficiency projects. In addition, National Grid offers financial incentives that cover up to 45% of equipment and installation for light and a Pay4Performance that gives incentives as calculated as a percent of project cost for each kWh or thermal unit saved. National Grid is entitled to all of the offsets resulting projects are able to generate.

Additional Small Private Funds and Grants

The table below lists private sector funds and grants available at no financial return obligation for a range of $5,000 to $15,000 and a KEEN Grant at $100,000 that could be applied for on a district by district or school by school basis.

Grant	Amount Available
KEEN Effect Grant Program	$100,000
My Hometown Helper	$15,000
Save Our History Grant	$10,000
Revelation to Action Competition	$5,000
Project Orange Thumb	$5,000
Lowe’s Toolbox for Education	$5,000
Home Depot Foundation	$5,000
Richard C. Bartlett Environmental Education Award	$5,000

Table 8: Private Grant and Funding Options

The external partner could play a role in combining use of the funds above and other aid or rebate programs, reducing upfront and future costs to claim offsets where none of the other parties care to claim the offsets.

Introducing Innovative Financing Mechanisms

A private entity that participates could earn federal tax credits or deduction on direct investments, or better, they could go further to help kick start and ensure energy efficiency projects stay a priority in Rhode Island by establishing a Bright Future for Schools Fund while earning a small financial return. The fund would be an innovative solution to close the gap between what is available and what is still needed by attracting new investors and quantifying savings and co-benefits strategically to expand financial resources. Ultimately, this strategy is a means to unlock new capital by reaching sources that go beyond the usual suspects for energy conservation or school construction.

Whether introducing a new financing mechanism or relying on ones that already exist, Rhode Island schools and the external partner should be creative about three things:

1. Who they decide to engage, finding ways to attract the interests of potential investors and donors beyond the usual suspects and the ones who are already involved in energy efficiency initiatives,

2. How they communicate and do outreach around the initiative to gain the interest of these new investors and donors, and
3. How they quantify and represent savings and co-benefits, using them to maintain this interest.

The example below presents "The Bright Future for Schools Fund." In this fund, the external partner puts up initial capital to attract and leverage more capital from other investors and donors. The fund combines three financial instruments in one to collect private capital and use it for public good: community (mini) bonds, a revolving fund, and pay-for-success contracts.

The Bright Future for Schools Fund

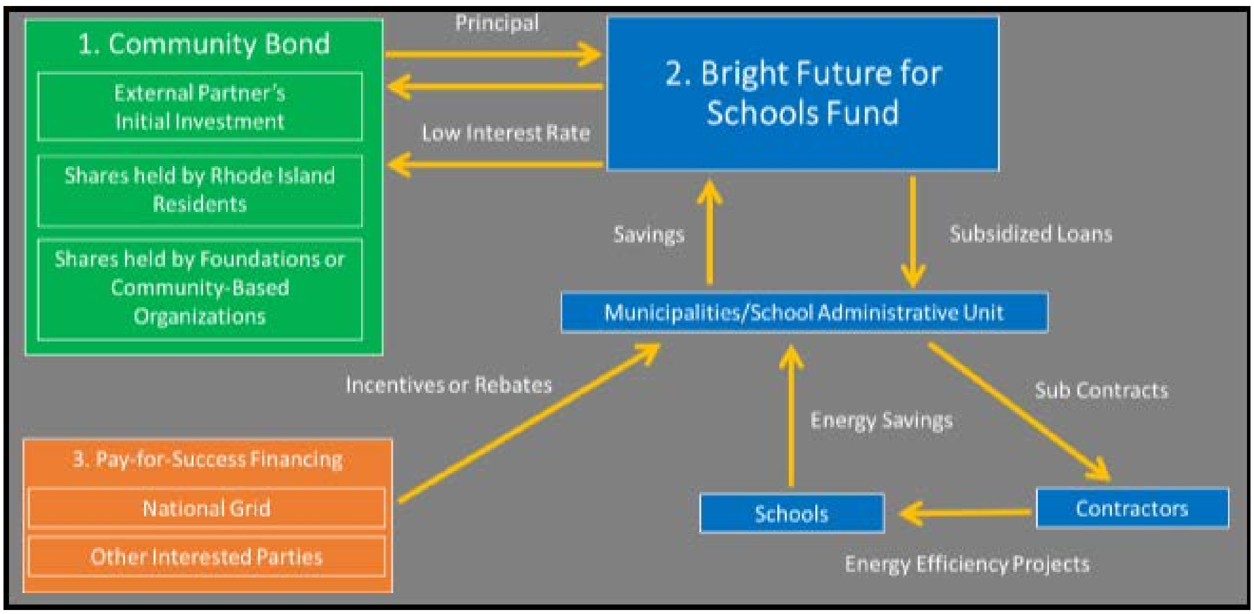

Table 9: Bright Future for Schools Fund Visual Layout

Because of the high upfront costs and low rate of financial return, the model emphasizes a combination of financial and social returns to attract a different kind of investor appetite. It depends on small-scale investors – potentially Rhode Island residents themselves and community-oriented organizations – who would be interested in seeing social returns too.

1. Community Bond

Starting in the top left corner, a community bond is a financial instrument that can be used by a nonprofit or charity to garner financial support for a mission. An example of this, in March 2017, Neighborly Securities issued a community bond in the City of Cambridge in Massachusetts in the amount of $2,000,000 for in an untested market for $1,000 denominations for 5-year maturity at 1.6% interest. The bond sold out in a 5-day order period.[55] Beyond success, the Cambridge example demonstrates a desire among community members, foundations, and organizations in looking to invest in their communities. Municipal bonds are not typically made available with these kinds of investors in mind, but community bonds could offer an alternative, giving these kinds of investors an opportunity to participate, while schools benefit from access to new financial sources.

Another advantage of using a community bond as it is drawn in the model above is that it simplifies the external partner's role. It kick starts the fund, but over time, as the principal gets paid off, the external partner's role diminishes and decision-making power is maintained by the public sector throughout the process.

2. Revolving Fund

A revolving fund is a fund that gets replenished as withdrawals get made. The core Bright Future for Schools Fund is set up like a revolving fund, pooling financial resources from which the decision-making bodies -- that also oversee school construction and make energy bill payments within a district -- can apply for subsidized loans to subcontract energy efficiency projects that fall within criteria prescribed for the fund. The criteria would be set in line with the statewide energy efficiency goal, and schools would qualify to participate based on the state of their infrastructure and energy efficiency needs. Prioritization would be given based on worst energy performers or on the perceived impact of specific projects. Savings would be realized in energy bills and co-benefits and would be used to replenish the fund and contribute to paying off the principal.

3. Pay-for-Success

Pay-for-Success financing is a contract made with the public sector to pay for improved social outcomes. If energy savings and co-benefits are well monitored and diligently quantified, they could be represented to appeal to other potential partners who may be willing to pay for other outcomes associated with the fund. For example, National Grid offers a Pay4Performance program that gives incentives as a percentage of project costs in relation to the number of kilowatts or thermal units saved. If the external partner is willing to forgo claiming offsets, the National Grid option is one way to help replenish the fund. It could be used in combination with other organizations or groups willing to pay for other outcomes. For example, a public health organization might be interested in paying for the public health co-benefits. A well planned communications and outreach strategy could use this mechanism to showcase cross-sectoral cooperation. For example,

[55] Hilltop Securities presentation, Harvard Kennedy School, April 2017.

energy conservationists can demonstrate a way to work with public health advocates and vice-versa.

In setting up a fund, the external partner should consider a mission or philosophy that investors can understand and get behind without too much explanation but is transparent about energy efficiency. In addition, it should add value. In this case, it provides a new source of financing where what is available is not enough, but also provides an opportunity for the community and its local partners to get more involved in improving schools and infrastructure. With all the partners, the associated guidelines and rules for the fund should lay out clear terms for decision-making related to the fund, roles, and expectations for each partner and guidelines for school participation and project proposals.

Financing: Summary

Though there are some tax-based funding schemes that might be able to make these types of projects work, our research has led us to conclude that however an external partner is involved, with the lack of possible monetary returns, the solution will most likely resemble donations from unregulated entities. Altogether, we recommend instead of focusing on a traditional returns on investment or offsets, representing qualitative and quantitative benefits in other ways the external partner can extract: product marketing, employee attraction/retention, training, education, naming buildings, etc. Bringing together innovative financing instruments might also provide an interesting model for unregulated entities to be more involved in communities while taking these kinds of “donations” a little further. While the financial returns may not be explicitly felt by any one entity, they will definitely be felt within the partnership and by society.

In addition to charitable contributions, there are also many grants available for projects like these. Most of the schools aren’t applying because of the time and paperwork necessary to complete the process, so we see an additional opportunity for the unregulated entity or partner to help schools identify available funds and grants as well as help the schools through the application process.

Conclusion

Our project was largely complicated by the cost-benefit analysis per an offset investment by an unregulated entity. Arriving at this realization along the process, the pivot brought gave rise rethinking how to take advantage of existing institutions and infrastructure, reduce overall costs, maximize and rethinking what savings could mean, and most importantly look for ways to involve the community. The biggest barriers to a project like this exist in the high upfront costs, demand and limited resources, and extent of other obligations and priorities felt by schools. Partnering with the right external partner and determining the benefits beyond the obvious ones in ways that relate to all parts of the community offer an opportunity to help pay for the high upfront costs, increase the pool of resources, and ensure that energy efficiency and public health stay a priority. This is not simply a building efficiency program. It is a program to provide safe and healthy institutions to educate and develop an even safer and healthier future for Rhode Island.

Appendix 1
Initial Screening Exercise

Climate Solutions Living Lab, Spring 2017 - *Originally submitted on* February 8, 2017

Team I: Cade Carmichael, Erika Eitland, Karishma Patel, Caroline Quazzo, Sanjay Seth

Project Goal: Develop a feasible plan to obtain emissions reduction offsets, equivalent to at least 50,000 MT CO_2e annually, that an unregulated enterprise could legitimately and credibly use to offset its own emissions.

Results: We have selected Renewable Energy PPAs, Weatherization and Ventilation, and Fleet and Appliance Replacement and Maintenance as the top three categories of interventions that we will take forward into the feasibility analysis portion of the project. Lighting Replacement, Solar Water Heating, and Geothermal Heating were also supported by our screening/ranking exercise as potential categories of intervention.

Screened Interventions:

1. Renewable Energy PPAs (Offsite and/or Onsite Wind, Solar, et al)
2. Weatherization and Ventilation (Windows/Roofs, Pressurization and Sealing, HVAC)
3. Fleet and Appliance Replacement and Maintenance (Hybrids, Buses, EnergyStar, et al)
4. Lighting Replacement and Improvement (LED and Other Lighting)
5. Solar Water Heating
6. Geothermal Heating
7. Building Automation (Occupancy Schedules for Heating and Cooling, APS)
8. Cafeterias (Waste, Food Sourcing)
9. Improved Public Transportation for Students
10. Information Technology (Computers, Data Centers, et al)
11. Transformers (Vending and Computer Management)
12. Waste to Energy (Biomass)
13. Smart Thermostat
14. Renewable Energy Credits
15. Energy Storage

16. General Maintenance and Operations

Primary Criteria:	Secondary Criteria:
1. **Verifiable** 2. **Upfront/Direct Costs** 3. **Feasibility** 4. **Additionality**	1. **Avoided Emissions** 2. **Permanence** 3. **Leakage** 4. **Scalability** 5. **Financing Options** 6. **Indirect Costs** 7. **Partnership Opportunities** 8. **Incentives** 9. **Economic Viability**

Primary Screening Exercise:

Screened Interventions	Verifiable (1= low)	Direct Costs (1= high)	Feasibility (1= hard)	Additionality (1= unlikely)
1 Renewable Energy PPAs	3	1	2	3
2. Weatherization and Ventilation	2	2	3	3
3. Fleet and Appliance Replacement and Maintenance	2	1	2	3
4. Lighting Replacement and Improvement	3	2	3	3
5. Solar Water Heating	2	3	2	3
6. Geothermal Heating	3	1	2	3

7. Building Automation	2	3	3	2
8. Cafeterias	1	3	3	2
9. Improved Public Transportation for Students	1	2	2	2
10. Information Technology	2	3	3	2
11. Transformers	3	3	2	2
12. Waste to Energy	2	3	1	2
13. Smart Thermostat	3	1	1	2
14. Renewable Energy Credits	1	1	3	1
15. Energy Storage	2	1	1	1
16. General Maintenance and Operations	1	2	3	1

Secondary/Narrative Screening Considerations:

1. Renewable Energy PPAs	Renewable Energy PPAs, whether offsite or onsite, have a clear payback period and are real and verifiable emissions reductions. The issues with leakage are less challenging, as this displaces a current expense, rather than provides a significant new revenue stream. The questions with permanence are over the life cycle of the renewable energy generation period of 15 - 25 years, which is unclear. It's unlikely that the schools would pursue rooftop solar, considering that many of these buildings are older and it may be more cost efficient to create a utility-scale solar array somewhere remote. Rooftop solar also happens to be more expensive than utility scale solar, but includes an educational component and could increase the resiliency of the local electrical and communications network. It is also unlikely that the schools would pursue on-site wind energy generation, except for educational purposes or in unique circumstances. Therefore, it is likely that RI would pursue off-site PPAs, ideally within the regional grid system, for which it (or the sponsoring unregulated enterprise) would receive and retire the RECs. The practical additionality is more likely, as these investments require complex financing arrangements and administration that may not be possible with the RI school system in particular in its current state.
2. Weatherization and Ventilation	Initiatives around weatherization and ventilation would target the need for the building to heat (and stay heated) more efficiently. Payback periods should be reasonable, given the proportion of total costs represented by heating. Providing better insulation and increasing filtration and ventilation would improve indoor air quality, reduce heat loss, and reduce moisture, mold,

	dander, and pollen.
3. Fleet and Appliance Replacement and Maintenance	As vehicles and appliances complete their useful term of service, the schools can retire older vehicles and upgrade to more efficient fleets and appliances. These emissions reductions would be significant, but would have to go above and beyond the rising standards for large fleets and appliances set by Federal and State governments, in order to surmount the 'regulatory additionality' argument. The emissions reductions would be real and to a large extent verifiable. The question of permanence and additionality would have to be addressed in the program design.
4. Lighting Replacement and Improvement	Replacing conventional lighting systems with LED and other more modern lighting systems reduces energy costs, improves visual health, stimulates circadian rhythms in schools with poor daylighting (especially during the winter), is easy and fast to accomplish, and feasible for a statewide initiative. The emissions reductions are real and relatively verifiable. However, it's unclear whether they would be additional.
5. Solar Water Heating	Hot-water heating is one of the top three energy uses of a school, especially those in colder climates, which makes it a scalable and replicable model for other schools in the Northeast and elsewhere. This heating could be integrated into rooftop solar heating and/or energy storage systems as another reduction or benefit. There are also other solutions to water heating that can improve upon the aging boiler infrastructure most schools use.
6. Geothermal Heating	Space heating is one of the most expensive energy costs facing schools, especially in the Northeast. Out of all of the potential investments, geothermal heating would require a significant upfront investment, but has a reasonable payback period. Geothermal is a plentiful and consistent resource and is likely to be viable for most schools.
7. Building Automation	Building automation has low upfront costs at less than $5 million to install for all 307 RI schools. The system would require installation, as well as maintenance and monitoring. The payback period would depend upon how the BAS affects energy usage within a specific building. Reductions and cost savings would be real but somewhat harder to verify, due to the unique conditions of each building having an effect on the overall cost/benefit of a BAS. In terms of additionality, there is a potential for a BAS to be considered additional, in the sense of 'technological additionality'. However, as it is a very affordable intervention, it's unlikely that 'financial additionality' could be applied. There is no legal requirement to use a BAS, so 'regulatory additionality doesn't apply.' Overall, the investment seems to have a high cost/benefit ratio, but the question of additionality and permanence makes it

	less clear that it is the highest priority.
8. Cafeterias	Schools could look at their purchasing and menu planning to reduce the GHG intensity of foods served, as well as food-miles traveled. Cafeterias could invest in more sustainable plates, cutlery, trays, and sources of ingredients. This could also be an opportunity to reduce emissions associated with refrigeration equipment, as well as retrofitting cafeterias with energy efficient features like antisweat doors and variable fans.
9. Improved Public Transportation for Students	As part of a reduction program, the schools could work with local, state, and federal departments of transportation to improve walkability and access to public transit, in order to reduce GHGs from cars and school buses. Reducing the number of trips taken by parents to drop their children off, when walking is not an option, could also reduce traffic congestion and some traffic accidents.
10. Information Technology	Schools could make IT practices and spaces more energy efficient, including the appliances themselves. Making IT practices and spaces more energy efficient, including the appliances themselves, load management, putting computers on sleep mode, and applying advance power strips
11. Transformers	Transformers have minimal maintenance and operations requirement.
12. Waste to Energy	Districts or groups of districts, alongside other government entities, have potential for a shared landfill that, if capped, could control methane emissions, generate heat, and reduce barriers to recycling.
13. Smart Thermostat	This has the potential to be very expensive, as it may require extensive electrical work on older buildings. It may require significant maintenance and it would be necessary to have regular monitoring and adjustment of the thermostats.
14. Renewable Energy Credits	These are credits for energy produced elsewhere and have weak co-benefits for the school. They are also purchased in addition to energy consumed and thus present an additional cost.
15. Energy Storage	Energy storage would have a high upfront cost, but could be a good complement to wind or solar, if schools pursue on-site strategies, beyond what can be sold back to the grid under net metering. However, as net metering has recently been expanded in RI, it is unlikely that the virtual battery strategy would be less efficient than having on-site storage. However, this could cut

	down significantly on peak demand charges for energy, depending on when the building is used and how the utility charges the schools.
16. General Maintenance and Operations	Custodial costs are 90% of a school's O&M budget. Green cleaning can reduce a school's carbon footprint and make occupants healthier by buying concentrated cleaning solutions without harmful chemicals. This can be achieved easily in all schools. Low cost but potentially big health benefits.

Appendix 2

Feasibility Analysis for Pursuing Energy Efficiency in Rhode Island Schools

Climate Solutions Living Lab, Spring 2017
Harvard University
Originally submitted on March 10, 2017

Central Falls High School - Central Falls, RI

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Objective

This feasibility analysis is a step toward deciding which measures to pursue further to develop a packaged set of measures to achieve 50,000 MT in carbon dioxide emissions reductions, promote public health and other co-benefits.

Activities Performed

The screened a list of measures for verifiability, high upfront costs, feasibility, and additionality. From the list, the measures were narrowed down to five options:

1. Leasing on-site solar to take on some of the energy consumption
2. Improving the building envelope
3. Replacing light fixtures and bulbs with more efficient options
4. Using solar or geothermal water heating
5. Changing appliances, practices, and food sourcing for cafeterias

During a second the screening the following criteria were utilized and are intended to be used throughout the feasibility analysis and planning:

1. Additionality: What will the financial, environmental, and technological scenario look like without pursuing this measure? That is, does the project go above and beyond "Business as Usual" in that the project would not have happened anyway. Further is the measure additional in the regulatory sense in that it is not already required by law?
2. Avoided Emissions: How much CO2e could be avoided with this measure?
3. Verifiability: Can the intended reductions be verified as actually achieved?
4. Initial Costs Assessment: What are the upfront, maintenance, and additional costs?
5. Benefits: What are the fiscal and environmental benefits? How do these measure up to costs?
6. Co-Benefits: What are all the other potential benefits, including public health, economic, social - and can they be quantified?
7. Permanence: Permanent vs. permanent with conditions vs. not permanent
8. Precedents: Are there successful examples of this intervention at other schools?

Most of the data regarding energy consumption was calculated by Jacobs Consulting who looked at each school's current energy use as reflected by energy bills. The team used these numbers to determine a baseline for current GHG emissions. For each measure, the team determined the potential reductions in emissions by using the forecasted difference before a measure (or the baseline emissions) and after a measure. The team also looked to determine general cost-benefit, savings, co-benefits, additionality, financing options, and legal considerations.

In addition to analyzing the numbers associated with some of these criteria in aggregate across the 307 schools, our team visited Central Falls District for a more qualitative understanding of the school conditions. This revealed that different buildings within the same school -- and even different sections of the same building -- use different consuming devices, accommodate different occupant behaviors, and have different building envelope conditions. This is attributed to the age of the schools and how they have been updated since. For example, many schools were built in the 1940s and are still operating on the original boilers that were installed to last for 20-30 years. Some schools might have started as one building, but have since had additions made that have varying technology for features such as heating and building automations. It is important to note that whatever is installed or updated now might continue to be utilized indefinitely or as long as a school continues to operate. This makes maximizing measures taken now more significant.

Regulatory Framework

In Rhode Island, school districts, school committees, and school boards of trustees[1] have the power to enter into contracts in order to "construct, furnish, and equip schools and improve the grounds upon which the schools are located and to make additions to the schools as may be needed."[2] They may also establish joint purchasing agreements between one another for the purpose of purchasing services.[3] Under Rhode Island law, a contract relating to the "design, planning, construction, alteration, repair, or maintenance" of a building, structure, appurtenance, or appliance must not indemnify the promisee, their contractors, agents, or employees against liability for damages that occur as a result of negligence on the part of the promise, their contractors, agents, or employees.[4]

The Rhode Island Department of Education Construction Regulations ("RIDE 1.0") provide a legal framework for construction projects involving public schools.[5] RIDE 1.0 establishes both general and specific requirements for construction projects, and applies to all new projects which have been approved by RIDE where the total cost exceeds $500,000.[5] For example, as a general requirement districts must, among other tasks, ensure that the project will be completed in a timely and cost effective manner. The district also has a sole and exclusive responsibility for all aspects of a proposed and/or approved project, including all aspects of design, construction, and oversight. As an example of a specific requirement, projects involving instructional spaces must comply with the American National Standards Institute's Guide for Education Facilities Lighting.[6]

Approved projects must also have a useful life cycle of fifty years for new construction or an addition[7] to an existing school building.[8] Within RIDE 1.0 a "district" is defined to include "school districts, regional school districts, charter schools, and any other public school entity seeking approval of the necessity of school construction and/or requesting to fund a portion of the cost of school construction, modernization, or addition projects through reimbursement from the school housing aid program."[9] If a district chooses to pursue a construction project, RIDE 1.0 requires that these districts also address "cross districting

[1] R.I. Gen. Laws § 16-2-34.

[2] R.I. Gen. Laws §§ 16-3-11(5), (6); *see also* R.I. Gen. Laws § 16-2-9(18).

[3] R.I. Gen. Laws § 16-2-9-9.2.

[4] R.I. Gen. Laws § 6-34-1.

[5] RIDE School Construction Regulations, RIDE 1.0, (5/24/07). This $500,000 is inclusive of funds beyond those contributed by RIDE.

[6] American National Standards Institute standard number ANSI/IES RP3-00, Guide for Educational Facilities Lighting, (2000).

[7] "Addition" refers to physical additions to existing structures, and does encompass renovations, or replacements.

[8] *Id*. at § 1.01. For an example of specific requirements, *see e.g.*, RIDE § 1.05-8 which deals with storm water pollution prevention.

[9] *Id*. at § 1.03-1.

issues and possibilities" arising out of site selection in order to better serve the student population and surrounding communities.

In dealing with potential funding limits, RIDE 1.0 establishes a list of nine hierarchically ranked priorities to assess against applications for school construction and renovation requirements. The highest priority is the "[r]eplacement or renovation of a building which is structurally unsound or otherwise in a condition seriously jeopardizing the health and safety of school children, where no alternative exists." Energy considerations rank as priority number six and concern the "[r]eplacement, renovation, or modernization of any school facility to increase energy conservation and decrease energy related costs in the facility."[10] Similarly, any proposed projects involving site and building layouts must maximize the opportunities for on-site renewable energy generation.[11] Rhode Island formally recognizes solar radiation, wind, latent heat from the ocean, small hydro facilities, biomass facilities (using eligible biomass fuels), fuel cells using renewable resources, and waste-to-energy combustion as "renewable energy resources."[12] In order to encourage this kind of efficiency in schools, RIDE 1.0 provides an additional 2-4% in reimbursement funds for in new projects that demonstrate energy and water efficiency cost reduction beyond the minimum requirements of the Northeast Collaborative for High-Performance Schools Protocol ("NE-CHPS"), though these funds are only an incentive and are not guaranteed.[13]

The Rhode Island Green Buildings Act ("GBA") establishes requirements for construction and renovation projects on public buildings in order to promote high-performance energy saving measures, reduced water consumption, improved indoor air quality, environmental preservation, and more productive workers and students.[14] Under the GBA a public school district that initiates any major facility project, and receives any state funds for that project, must design and construct the project so that it meets either the LEED certified standard, or the NE-CHPS Version 1.1 or above.[15] A "major facility project" is defined as a building construction project larger than five thousand gross square feet ("gsf") of occupied or conditioned space. Whereas a "major renovation" is a building renovation project which is larger than ten thousand gsf of occupied or conditioned space.[16] Specific projects would be calculated against these gsf thresholds, therefore these standards are generally considered at the design phase. The Rhode Island Department of Elementary has adopted the "High Performance Schools Standard" from NE-CHPS as the primary LEED equivalent standard for public schools in the state.[17] As of March 2017, the NE-CHPS standard has been updated to Version 3.1.[18]

There are two cases in which a major facility project does not have to meet NE-CHPS. The first scenario is if there is no applicable high performance standard for a given type of building or renovation project. In

[10] *Id*. at § 1.01.
[11] *Id*. at § 1.05-3.
[12] *Id*. at § 1.03-3.
[13] RIDE School Construction Regulations, at § 1.05-9(8).
[14] R.I. Gen. Laws § 39-26-5.
[15] RIDE School Construction Regulations, at § 1.12-2.
[16] *See* R.I. Gen. Laws § 37-24-2(3).
[17] R.I. Gen. Laws § 37-24-4(b).
[18] Rule and Regulations to Implement the Green Buildings Act, Pursuant to RIGL Section 37-24-5, October 2010, at 2.

that case lesser standards which are appropriate for the project will be established and applied by RIDE.[19] The second scenario occurs when there is no practical way to apply the high performance standard to a particular building or renovation project. In that case lesser standards which are appropriate for the project will be established and applied by RIDE.[20] Applicants may also seek an exception to the high performance standards where they would otherwise apply. These requests must be based on either economic hardships, hardships due to the impracticality of a project achieving the standards, or other hardships, including, but not limited to: disaster reconstruction, structural damage from a fire, vandalism, theft, or an act of God. These requests are subject to the approval and discretion of the State Building Commissioner.[21]

Where the high performance standard applies to schools, NE-CHPS implements a "points" system wherein certain criteria are assigned a set number of points.[22] Points are divided between "prerequisites" and "implementation." New construction projects, including new buildings on existing campuses, must achieve at least 110 total points. For new projects this total also includes all points from the associated prerequisites. Major renovations must achieve at least 85 points, but only need to meet a narrower band of prerequisites as compared to new projects.[23] A major renovation or modernization occurs when there is a "substantial improvement" to a school of at least two of the following systems: lighting, HVAC, building envelope, interior surfaces, and/or the site. A "substantial improvement" occurs when more than half of the given system or surfaces are replaced or upgraded.[24] Schools projects that perform well beyond minimum point requirements may be listed as "CHPS Verified Leaders™." In order to achieve this status, new projects must earn 160 or more points, while renovations must earn at least 135 points.[25]

NE-CHPS lists requirements based on the categories of "Integration," "Operation & Metrics," "Indoor Environmental Quality," "Energy," "Water," "Sites," and "Materials & Waste Management."[26] Each of these categories has subcomponents. For example, "Indoor Environmental Quality" contains the subpart "Electric Lighting Performance" which establishes specific lighting requirements for new classrooms or renovation projects where classroom lighting is included in the scope of the work.[27]These specific requirements will be discussed in the applicable sections below.

Emissions Assumptions

According to Jacobs Consulting, the average age of a school in Rhode Island is 60 years with 67% of the schools being between 35 and 85 years old. Rhode Island also has the fourth highest electricity rate in the United States. To determine the current level of emissions, the team used values for emissions in the 2014

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[19] Rule and Regulations to Implement the Green Buildings Act, at 4; *see also* RIDE § 1.04-1.
[20] Northeast Collaborative for High-Performance Schools Protocol, *NE-CHPS Criteria*, available at http://www.chps.net/dev/Drupal/NE-CHPS.
[21] R.I. Gen. Laws § 37-24-4(c)(1).
[22] *Id*. at (c)(2).
[23] Rule and Regulations to Implement the Green Buildings Act, at 4 – 5.
[24] Northeast Collaborative for High Performance Schools, Version 3.1 Northeast CHPS Criteria for New Construction and Renovations, August 2014, at 1.
[25] *Id*.
[26] Collaborative for High Performance Schools, *National Core Criteria – Renovation/Modernization*, available at http://www.chps.net/dev/Drupal/national-core-criteria.
[27] *Id*. at vi, 124.

eGrid Database by the Northeast Power Coordinating Council. It should be noted that Rhode Island is actually more dependent on natural gas than other northeastern states and the team is awaiting a more precise representation of the energy mix from the providers.

On-Site Solar Energy Generation

Rooftop of Central Falls High School Addition with Rooftop Repairs - Central Falls, RI

Existing Conditions

At this point, there are no solar panels installed on any public schools in Rhode Island. The table below shows energy consumption for Rhode Island's schools by source between 2011 and 2014.

Table 1. Energy Consumption for Rhode Island Schools

Year	Electricity (KWh)	Natural Gas (CCF)	Fuel Oil (gal)
2011	107,622,506	6,296,187	2,372,896
2012	97,739,108	5,562,265	1,175,051
2013	101,802,177	6075815	1,147,663
2014	104,941,061	8276714	1,400,054

Source: Draft Rhode Island Schoolhouse Energy Report, Appendix C

For electricity, schools are currently using energy on the main grid, of which 95% is produced from natural gas. Public schools also utilize No. 2 Fuel Oil for space heating. This presents an opportunity for cost reduction as utilities are the biggest budget line item for most schools and a fixed operational cost.

Proposed Measure

Install solar photovoltaic panels at each school, preferably on rooftops where those rooftops are structurally able to support the panels. As schools are currently consuming, this measure alone could not meet school needs. It will require simultaneously increasing energy efficiency and reducing energy consumption to stay within the bounds of energy provided. The unregulated entity would be responsible for upfront and set-term maintenance costs, but would also be - per contractual agreement - able to claim the offsets. The school, likewise, benefits from decreased overhead and a guarantee on maintenance costs for a set period of time.

Costs

Table 2 below estimates the installation costs and simple payback period for installing solar PV in the Central Falls district only, and across the state of Rhode Island.

Table 2. Potential Installation Cost and Savings for the Central Falls School District

School(s)	Installation Cost	Annual Savings	Simple Payback (yrs)
Captain Harold G. Hunt	$384,297	$21,040.00	18.3
Central Falls Senior High	$2,879,659	$157,661.00	18.3
Dr. Earl F. Calcutt Middle	$1,090,515	$59,706.00	18.3
Ella Risk	$832,402	$45,574.00	18.3
Margaret I. Robinson	$409,251	22406.51	18.3
Veterans Memorial Elementary	$839,087	$45,940.00	18.3
Central Falls District Total	**$6,435,211**	**$352,327.51**	**18.3**
Rhode Island State Total	**$246,916,430**	**$13,527,620.00**	**18.25**

Source: Draft Rhode Island Schoolhouse Energy Report, Appendix C, and Central Falls Reports

The payback period for installing solar will be a little more than 18 years, and could save the Central Falls District $13,527,620. However, more data needs to be collected on the actual potential on each school's physical space and what more, if any, space needs to be acquired to fulfill the projected solar energy potential at each school. The costs as they have been reported are on a high level, so further information needs to be collected on line-item costs, though installing solar at all schools could potentially reach as much as 60% of our 50,000 MT goal.

Table 3 Potential Carbon Offsets per System

School(s)	Projected Solar Energy	Annual Carbon Emissions Offsets
Captain Harold G. Hunt	0.096 MWh	221 MT
Central Falls Senior High	0.072 MWh	166 MT
Dr. Earl F. Calcutt Middle	0.273 MWh	627 MT
Ella Risk School	0.207 MWh	476 MT
Margaret I. Robertson	0.102 MWh	234 MT
Veterans Memorial Elementary	0.21 MWh	482 MT
Central Falls District Total	**0.96 MWh**	**2206 MT**
Rhode Island State Total	**150000 MWh**	**39340 MT**

Source: Draft Rhode Island Schoolhouse Energy Report, Appendix C, and Central Falls Report

Co-Benefits

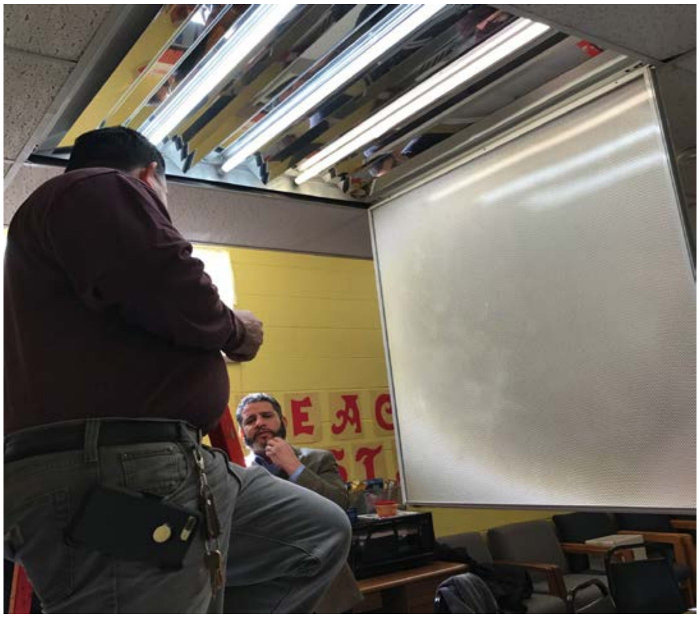
While there is little data on the exact co-benefits from integrating renewable energy in school infrastructure, it could be integrated into student learning and create savings that can be otherwise used for other student needs. Rhode Island Schools could demonstrate institutional values that could be transferred to students. Broadly, adopting solar energy reduces air and water pollution in the area because electricity does not need to be generated by coal or natural gas. Due to the limited scale of solar panels implemented in Rhode Island schools, the health benefits will be small and difficult to accurately quantify. However, we expect small improvements in childhood asthma as well as overall respiratory and cardiovascular health over time[28].

Legal Considerations

Neither Federal nor Rhode Island law requires the installation of an on-site solar system, nor are on-site renewable solar systems are not required by NE-CHPS, however, if constructed they must have a Systems Maintenance Plan which meets NE-CHPS criteria.[29] The Systems Maintenance Plan establishes maintenance practices that will continue post-installation in order to ensure that the system is operating with its intended efficiency.[30] Any solar installations must also involve an independent, third-party commissioning agent who is certified by the state and ensures that the project meets regulatory standards.

[28] https://energy.gov/eere/sunshot/downloads/environmental-and-public-health-benefits-achieving-high-penetration-solar
[29] Northeast CHPS Criteria for New Construction and Renovations, OM 5.0.
[30] *Id*. at 49.

Lighting Replacement & Improvement



LED Lighting Pilot Project at Veterans Elementary School – Central Falls, RI

Existing Conditions

These lights emit minimal heat and have potentially significant cost-saving benefits. In Rhode Island, school districts almost exclusively use 32w T8 fluorescent lighting.

Opportunity

At Pell Elementary School in Newport, RI, more than 77% of classrooms are designed to effectively utilize daylighting and replace at least 25% of total electrical illumination.[31] The building also incorporates daylight dimming and low wattage light fixtures along with occupancy sensors. These standards could be scaled for all schools in Rhode Island.

Proposed Measure

Replace conventional lighting systems with LED and other modern lighting technologies – including dimmable fixtures, daylight and occupancy sensors, and other quality and efficiency enhancements – where viable. Replace outdoor lighting with solar lighting fixtures where viable.

Cost-Benefit, Savings, and Emissions

According to the Draft Rhode Island Schoolhouse Energy Report, switching

[31] http://www.neep.org/sites/default/files/resources/Claiborne%20Pell%20Elementary

Rhode Island schools to LED lighting would generate approximately $2.8 million in annual savings, while improving the quality of indoor lighting. Switching to 12-18w LED bulbs can reduce energy usage by up to 50% compared to similar fluorescent bulbs. The cost of upgrading all of the schools included in the report would come to around $64 million dollars. This results in a simple payback period of around 23 years, which may be a conservative estimate. (It is unclear what assumptions the report's consultants used to arrive at that figure.)

This measure is cost-effective and relatively simple to do. In order to make use of daylight harvesting and dimmable lighting, new fixtures are needed. But energy savings can be realized from replacing the fluorescent bulb alone, without needing to replace the fixture. Simple bulb replacements by contractors or by students, teachers, and general building maintenance staff, without the need for an electrician or other technical assistance. However, more advanced replacements, such as retrofits, etc. would require permitted contractors or staff.

In order to estimate the potential for emissions reductions associated with this measure, we have created a benefits calculator, with emissions profile estimates based on eGRID 2014. A live version of the calculator is available here, where you can change the assumptions or number of units replaced to see the offset potential: http://bit.ly/2m6XmZg

Replacing 10,000 (regardless of location) 32w T8 fluorescent bulbs with 10,000 18w LED bulbs would result in annual energy reductions that equate to roughly 150 MT CO2e. Moreover, because LED bulbs last 60% longer than similar fluorescent bulbs, the maintenance costs associated with lighting replacement are reduced.

Table 4. Emissions Benefit Calculator for Replacing 32w T8 Fluorescent Bulbs with 18w LED Bulbs

Units	
Number of Units Replaced	10,000
Annual Offsets	
Metric Tons, CO2e	153.217
Pounds, CO2e	337784.440
Energy Usage, Total	
Energy Rating (Pre, Watts)	32
Annual Energy Usage (mwh)	1036.800
Energy Rating (Post, Watts)	18
Annual Energy Usage (mwh)	583.200
Energy Savings (mwh)	453.600
Operations	
Number of Days/Year	270
Number of Hours/Day	12

Emissions Profile (eGRID)	
Lbs CO2/mwh	578.2
Lbs NOx/mwh	0.5
Lbs SO2/mwh	0.2
Lbs CH4/gwh	98
Lbs N20/gwh	13.2
Lbs CO2e/mwh	584.2
Emissions Reduction, Total (eGRID)	
Lbs CO2	262 271.520
Lbs NOx	226.800
Lbs SO2	90.720
Lbs CH4	44.453
Lbs N2O	5.988
Lbs CO2e	264993.120

In order to estimate costs, we made the following assumptions:

Assumptions	
Discount Rate	8%
Number of Schools	300
Labor Rate (Electrician)	50
Lights installed per hour	4
Number of Lights per School	300
Cost per light (LED fixtures included)	650
Cost per light (higher quality, non-LED fixtures included)	150
Inflation	2%
Cost per kWh of energy in RI	0.16
LED % Efficiency Increase	80%
Higher Quality Fluorescent Efficiency Increase	40%
Total kWh of RI Schools in 2014	104,941,061
% usage attributable to lighting	75%

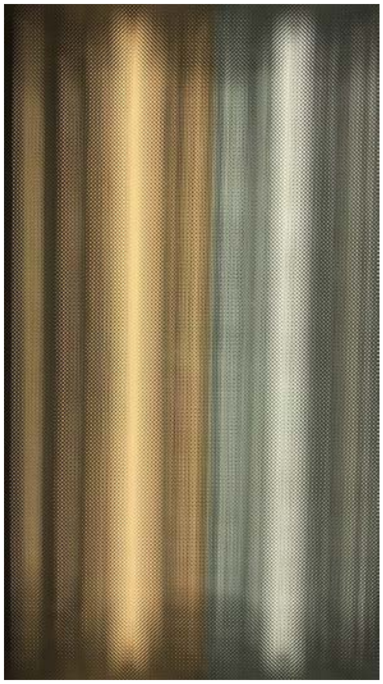
Assuming a lifetime of 20 years before the lights need to be replaced and 10 man-hours of maintenance per school per year, we calculated the NPV of replacing all the lights with LEDs, which would include the costs to the unregulated entity of replacing the light bulbs as well as the fixtures.

NPV (LED Replacement) = -$68,854,172

We also did an NPV calculation for the costs associated with replacing all of the lights in all RI schools with more efficient fluorescent bulbs. We also assumed a 20 year life, but in this case, the lights would have to be replaced every 5 years. And we assumed the lights would require 10 man-hours of maintenance in non-replacing years.

NPV (efficient fluorescents) = -$42,748,104

Co-Benefits



Beyond energy savings, improving lighting in Rhode Island Schools can reduce cases of flickering lights, unwanted glare, as well as provide solutions to windowless classrooms that are common in schools built during the 1970's energy crisis. Good-quality lighting in schools creates optimal viewing conditions for students to see the blackboard and to read and write during classroom learning activities. For many Rhode Island schools, they have taken advantage of rebates offered by National Grid to update lighting to T8 bulbs. For example, Westerly Public Schools, upgraded lighting to T8 four years ago.

Indoor lighting improvements are essential for improving teacher and student wellbeing. Since many of the RI school were built, lighting has evolved over time with the advent of new lighting technologies and changes in the size and presence of windows, which have influenced the quality of light inside the classroom. Lighting exposures primarily come from electric lighting and natural daylight. Beyond visual health, lighting can have acute and long term non-visual impacts on health including, influencing body temperature, melatonin and cortisol secretion/suppression and the regulation of circadian rhythm. Recognizing this important health effect, we propose the implementation of full spectrum, tunable, dimmable lighting. This is a more expensive option but can support student learning, promote alertness, and respond to the needs of students with learning and attention deficits[32].

Legal Considerations

All new classrooms, as well as renovation projects which include classroom lighting in the scope of the work must meet NE-CHPS requirements. LED lighting is not required by the standard.[33] If, however, LED lighting is used then the lighting must have a Color Rendering Index of 80 or higher, be RoHS compliant, have an initial efficiency of at least 50 lumens /watt and at least 70% of their initial light output at 50,000 hours of operation.[34] However, based on current LED market standards these specific requirements are unlikely to create barriers to regulatory additionality claims.

Improving the Building Envelope

Existing Conditions

The existing building conditions of Rhode Island schools are varied. The average age of RI School buildings are 61 years old, with heating and ventilation systems that tend to reflect that age.[35] Most older buildings are lightly insulated, with many cracks and crevices that allow for air and thermal exchange

[32] http://www.nature.com/lsa/journal/v3/n2/full/lsa201422a.html
[33] Northeast CHPS Criteria for New Construction and Renovations, at 124.
[34] *Id*. at EQ §§ 13.1.3, 13.1.1, 13.1.2.
[35] *See e.g.*, http://www.providencejournal.com/article/20140118/NEWS/301189917

across internal and external walls. An example of success is the Pell Elementary School in Newport, RI. Although a new construction project, the well-insulated walls and roofs provide a compact envelope and reduce the energy used by the heating and ventilation systems. High-performance double glazed windows tailored to different solar orientations maximize visible light transmission while reducing solar heat gain. These building conditions give us a benchmark for what Rhode Island can achieve and work towards.

Proposed Measure

Initiatives around weatherization and ventilation would target the need for the building to maintain heat more efficiently. Providing small, diverse projects that improve insulation and filtration and ventilation would improve indoor air quality, reduce heat loss, and moisture.

Cost-Benefit, Savings, and Emissions

Improving the efficiency of the heating and ventilation systems through building envelope improvements can enhance the indoor environmental quality as well as reduce heating and cooling costs. Later this year, Jacobs Engineering will release a power assessment audit that will provide extensive information on the type, quality, maintenance level, and energy usage of each building. This will provide specific information on boiler and ventilation systems. Therefore, in order to discuss costs and benefits, we will be making some rough assumptions from a series of standards and rules-of-thumb. These calculations can be improved when the upcoming Jacobs Engineering report is released.

In order to estimate the emissions reductions potential for building envelope improvements to Rhode Island schools, we are using Design Builder to create a “shoebox” model of thermal transfer in a typical Rhode Island classroom. The Design Builder tool allows us to import certain NIST and ASHRAE standards for building quality and thermal transfer – and use these to very roughly estimate the effectiveness of an intervention, like caulking, improved windows, insulation, and other interventions on the total energy demand of the building, which we can then convert to energy savings and offsets.

The method we are using will create a model of a classroom that includes the parameters of occupancy, external heat exchange, internal heat exchange, infiltration, weather, passive solar heating, cloud cover, building orientation, window-to-wall ratios, lighting, desired temperature, energy generation source, and other parameters to arrive at a function for energy usage intensity for a classroom.

Then, we intend to use the model to test efficiency improvements that would affect some of these parameters, e.g. caulking would reduce external heat exchange by a certain percentage, and test how that would have an effect on building energy usage across a school or district. We are likely to observe significant emissions reductions per dollar spent for this intervention.

We have chosen this modeling and abstract method due to the lack of data. However, if we had data from the Energy Assessment consultants, we could perform a more grounded opportunity study for each individual school and district, in terms of building envelope improvements.

Co-Benefits

Across the state we are seeing problems with indoor air quality in schools. This includes issues of high carbon dioxide levels (a proxy for poor ventilation), and the presence of mold and mildew[36][37]. Extensive mold even resulted in the closure of 19 classrooms in one Providence school[38]. Therefore, addressing leaks, cracks, poor ventilation and other building envelope issues can result in important improvements in allergen concentration, indoor air quality, thermal comfort, and moisture. In Appendix 3, the importance of ventilation and air quality are explored and highlight the impact on health and academic performance. In Rhode Island, the building are 60+ years old, which result in leaky building that pre-date important environmental health regulations including the Toxic Substances Control Act (1979) that removed polychlorinated biphenyl (PCB) from caulking and lighting ballasts, as well as the Lead and Copper Rule (1991) that removed lead and copper from pipes. Renovations that improve energy efficiency could also serve as an opportunity to remediate pre-existing issues. For example, by improving window seals, contractors could remove PCB-containing caulking, which is a known endocrine disruptor and can disrupt thyroid hormone receptors, which are critical for normal brain development and immune system function.

Legal Considerations

Classroom renovation projects involving improvements to the building envelope must meet acoustical performance standards defined within NE-CHPS. In regular classrooms structural and design materials must keep the total background noise to 35 dBA or less with all operable windows closed.[39] When there is a substantial improvement to the envelope which covers more than 70% of classrooms, libraries, and administrative offices the renovation project must consult with a state-certified third -party commissioning agent[40] and incorporate measures such as daylighting optimization and glare protection.[41]

As such, when dealing with a building envelope project, the unregulated entity would want to structure the project in a manner which ensures that not only are the projects designed with these standards in mind, but that the contractors carrying out the tasks are also working within the regulatory framework. For example, a contractor would want to be familiar with the required acoustical standards when they apply, as standard construction regulations are not necessarily a one-for-one comparison to school-specific construction requirements.

[36] http://rhodybeat.com/stories/air-quality-concerns-raised-at-barrington-middle-school,21316
[37] http://wpri.com/2017/01/27/warwick-school-to-test-air-quality-following-complaints-of-illness/
http://wpri.com/2017/04/03/results-in-from-air-quality-test-of-warwick-school/
[38] http://turnto10.com/i-team/nbc-10-i-team-mold-causes-leaders-at-one-providence-high-school-to-close-19-classrooms
[39] Northeast CHPS Criteria for New Construction and Renovations, EQ 14.0.
[40] *Id*. at EE 3.2.
[41] *Id*. at EQ 11.0.

Space Heating and Water Heating

Primary Boiler System at Central Falls High School – Central Falls, RI

Existing Conditions

Although our data for schools in Rhode Island is incomplete, we do know that schools in Rhode Island use more than 6 million CCF of natural gas and around 1.2 million gallons of fuel oil each year. Those fuels are used primarily for cooking and heating. According to a report by Xcel Energy, schools spend around 46% of their energy budget on space heating.[42] So, we could make some conservative estimates about the consumption of the 307 Rhode Island schools which is dedicated to space heating (See Table 5 below). This gives us a very rough baseline of energy usage to estimate the potential for offsets from energy efficiency improvements.

Table 5. Yearly Energy Consumption by Rhode Island Schools

Year	Electricity (KWh)	Natural Gas (CCF)	Fuel Oil (gal)
2011	107,622,506	6,296,187	2,372,896
2012	97,739,108	5,562,265	1,175,051
2013	101,802,177	6075815	1,147,663
2014	104,941,062	8276714	1,400,054

Source: Draft Rhode Island Schoolhouse Energy Report, Appendix C

Proposed Measure

Hot-water heating is one of the top three energy uses of a school, especially those in colder climates, which makes it a scalable and replicable model for other schools. Geothermal heating has proven to be riskier at a higher cost, so we are focusing on solar heating and efficiency improvements for current heating systems, potentially integrated into the on-site solar system and/or an energy storage system as another reduction or benefit.

[42] https://www.xcelenergy.com/staticfiles/xe/Marketing/Managing-Energy-Costs-Schools.pdf

Cost-Benefit, Savings, and Emission

In terms of emissions reductions, we do not have data on the current conditions in schools in Rhode Island, in terms of what boilers they are using and how efficient they currently are. If we use the energy assumptions in the 'existing conditions' section above, we can look at the benefit of converting all existing fuel oil boilers to natural gas boilers, in terms of displacing the total amount of fuel oil used by schools in the state. This analysis is rough, in lieu of data, and is intended mostly to show that there is significant potential for offsets in boiler replacement and upgrading, even by displacing the fuel oil boilers alone - however, an interactive calculator for this data can be found here: http://bit.ly/2qARxFS

Table 5 Emissions Benefit Calculator: Convert Fuel Oil to Natural Gas

Current Usage	
Fuel Oil (Gallons) [Based on current usage]	1,200,000
Emissions Profile	
Lbs of CO2/Gallon (Residual Fuel Oil No. 6)	26
Lbs of CO2/Million btu (RFO No. 6)	173.7
BTU/Gallon of Fuel Oil	138,700
Lbs CO2/thousand cubic feet NatGas	117.1
LBs CO2/ccf	17.001
BTU/ccf	103,200
Current Emissions	
Fuel Oil, Total (MT)	14152.09877
Fuel Oil, Total (Lbs)	31,200,000
Fuel Oil, Total (btu produced)	166,440,000,000
Natural Gas, Total Replacement (MT)	12437.08877
Natural Gas, Total Replacement (Lbs)	27,419,055
Natural Gas, Total Replacement (btu)	166,440,000,000
Natural Gas, Total Replacement (ccf)	1,612,791
Total Emissions Reduction	
Total RI Reduction, MT CO2, from displacing fuel oil boilers alone.	1,715

We calculated the NPV of installing new, energy efficient boilers at all of the RI public school.

Given the following assumptions:

Assumptions	
Discount Rate	8%
Number of Schools	300
Inflation	2%
Boiler Cost	7500
# of boilers per school	3
Man-hours necessary to install a boiler	70
Boiler Installer Hourly Rate	50

We also assumed a 20 year lifetime for the boilers and 10 hours of annual maintenance per boiler.

NPV (Boiler Replacements) = -$13,991,781

Co-Benefits

Upgrading the boilers to operate on natural gas provides an energy efficient solution that improves thermal comfort within schools. If properly installed and vented, it also does not result in adverse effects on indoor air quality. By improving thermal comfort we can improve student academic performance including test scores, concentration and attention. Students are more susceptible to these thermal changes because of their body is still rapidly developing. See Appendix 3 for more information on the health benefits of improving Thermal Comfort.

Legal Considerations

Neither Federal nor Rhode Island law requires the installation of a solar heating system, nor are solar thermal systems required by NE-CHPS, however, if installed they must have a Systems Maintenance Plan which meets NE-CHPS criteria.[43] The Systems Maintenance Plan establishes maintenance practices that will continue post-installation in order to ensure that the system is operating with its intended efficiency.[44] Any solar installations must also involve an independent, third-party commissioning agent.[45]

[43] Northeast CHPS Criteria for New Construction and Renovations, OM 5.0.
[44] *Id*. at 49.
[45] *Id*. at EE 3.0

Cafeteria Improvements

Central Falls High School Cafeteria – Central Falls, RI

Cafeterias are a novel environment within schools to reduce greenhouse gas emissions and improve public health. If we follow food throughout its lifecycle within in a school there are many novel ways to reduce greenhouse gas emission. This approach targets CO_2, HFCs, and PFCs three of the six greenhouse gas emissions targeted by IPCC. The ability to target this environment can have important effects because in 2016, the National School Lunch Program served 30.3 million school lunches, of which 20.1 million

Healthy, Hunger Free Kids Act of 2010 (HHFKA). In Section 201 of the HHFKA requires USDA to update nutrition standards for school meals based on the recommendations of the Dietary Guidelines for Americans. This includes meals that are "right-sized and reflect the appropriate balance between food groups. Based on their age, students are getting the recommended portions." This requires adopting lower-fat dairy, more whole grains, more lean proteins, and almost double the fruit and vegetable offerings.

Existing Conditions

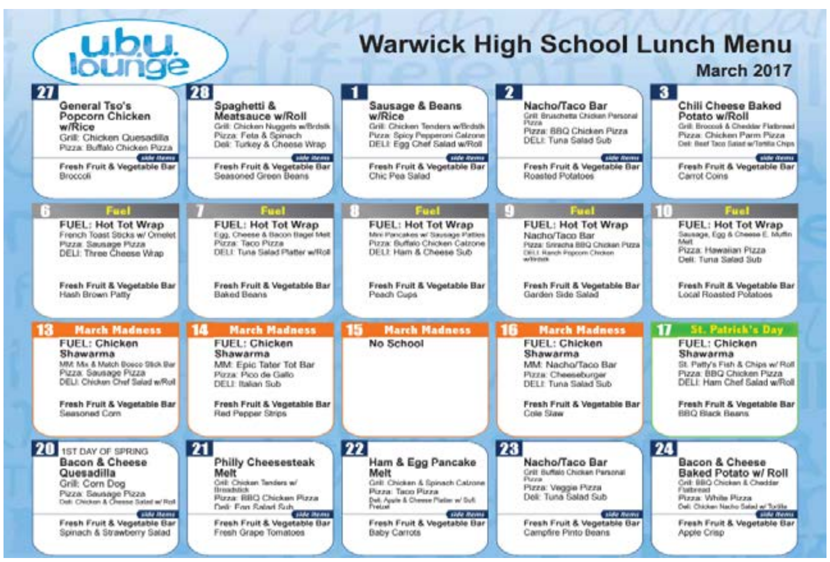
Rhode Island food travels a tremendous distance due to its geographic location and short growing season. Many of the schools do not have full kitchen facilities and rely on outside vendors for daily lunch and breakfast service. In schools with kitchens, many have older appliances with energy intensive equipment such as fryers and cooking vents. On average in the United States, food travels 6760 km in its life-cycle supply chain on average[46]. Food is transported by large refrigerated trucks, which results in CO2

[46] Food-Miles and the Relative Climate Impacts of Food Choices in the United States. Weber, Christopher ; Matthews, H. Environmental Science & Technology, May 15, 2008, Vol.42(10)

emissions. By buying local when possible, Rhode Island can cut back on emissions. Additionally, the current menu at many schools relies on daily meat-based meals as shown in the snapshot of Warwick High School's Lunch Menu. Every day there is a meat offering and many days offer fried foods. Also, when schools offer fresh fruit and veggies they are including fruits that are not in season in New England and require long travel distances. For example, "fresh spinach and strawberry salad" relies on strawberries flown in from Southern California, Florida, or Central/South America resulting in an unsustainable, expensive choice.

Proposed Measure

Schools could look at their purchasing and menu planning to reduce foods with a large carbon footprint due to large food-miles traveled. By purchasing less red meat, schools could have the greatest CO_2/Kg reduction compared to other food groups because red meat produces a large amount of CO2, CH4, and N2O.[47] Instead of fresh fruit flown in from other parts of the planet, flash frozen fruit from local sources (i.e. blueberries from Maine) can provide nutrient-rich choices with less associated GHG emissions. Other menu choices such as reducing the amount of fried food can result in the reduced use of energy intensive fume hoods.



In conjunction to the food served, there is an opportunity to reduce emission in substituting disposable cafeterias trays with compostable or more sustainably manufactured plates, cutlery, and trays.

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[47] Food-Miles and the Relative Climate Impacts of Food Choices in the United States
Weber, Christopher ; Matthews, H. Environmental Science & Technology, May 15, 2008, Vol.42(10), p.3508

Compostable products made of corn can be costly to a school and are not a permanent solution since schools can stop using them at any time. Also, they contain embodied energy for transportation, manufacturing, and waste removal. Therefore, school may revert to polystyrene trays. Using washable cutlery and plates do require energy and water, but can create a great sense of appreciation for food. Offering reusable cutlery can have substantial impact as shown here:

The Case for Reusable Cutlery

In the 2016-2017 academic school year, there are approximately 142,000 students in Rhode Island. Therefore, if every student uses 2 utensils (i.e. fork, knife, or spoon) every day during the 180-day school year they produce more than **51 million pieces of plastic waste**.

180 days x 142,000 students x 2 utensils used/day =51,120,000 wasted plastic items

If they used reusable utensils that could be washed and used for even 1 full year Rhode Island schools could significantly reduce their environmental footprint.

1 time purchase x 142,000 students x 2 utensils used/day =284,000 utensils

Another opportunity to reduce emissions is retrofitting cafeterias with energy efficient appliances and features like anti-sweat doors and variable fans. For example, most refrigeration contains hydrofluorocarbons (HFCs), a common refrigerant and potent greenhouse gas. Industrial HFCs were introduced as a replacement for the ozone depleting compound, chlorofluorocarbons (CFCs), and may have lifetimes ranging from 1.4 to 270 years. HFCs are more effective at absorbing infrared radiation than CO2 and serve as a valuable action point for reducing carbon dioxide equivalent.

Co-Benefits

This approach would result in nutritional improvements for local students. By reducing fried foods and red meat, students would reduce their fat and salt consumption. In 2011, more than 13% of Rhode Island's 10-17 year olds were obese (ranked 41 out of 51 states)[48]. Also, by promoting healthy, local choices in childhood can result in improvements in adult health outcomes[49].

Additionality

Financial: Since the four-year construction moratorium, schools have been hesitant to put in new requests. Cafeterias may not be a priority for some schools when they need new roofs, boilers, and windows. This multi-tiered approach focused on cafeterias would not normally happen because funding is usually allocated for course materials, maintenance, and salaries.

[48] http://stateofobesity.org/states/ri/
[49] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3652568/

Technological: This strategy requires limited technological innovation and may not result in technological additionality.

Regulatory: Neither Federal nor Rhode Island law requires the above measures to be taken; however, if the measures are taken then certain thresholds must be met.

Legal Considerations

Any changes to food variety, or portions thereof, would need to conform to both Rhode Island and Federal Regulations.[50] For example, at least one serving of cooked legumes (dried beans or peas) must be offered each week.[51] If any new piece of equipment or appliance is purchased for a cafeteria, that piece of equipment or appliance must comply with all ENERGY STAR requirements if such a piece of equipment or appliance is covered under an ENERGY STAR category.[52]

Reason for Proposal Rejection

The verifiability of carbon reductions would be difficult for this strategy. This multi-faceted approach would add extensive logistical management (i.e. procurement, verification of reductions, menu planning, etc.). Although, investing in these purchasing and design strategies would result in on-going reductions in carbon emissions, schools can change their purchasing behaviors at any point making the permanence of this solution variable. For example, many of these strategies rely on administrative support, so schools may require incentives to participate in such a program.

Financing Options

We've explored a number of financing options available at the federal, state, local levels that exist from the public sector,[53] and there are a number of options involving the private sector as well. These types of investors might be looking for a more significant return than a project like this would be able to provide, but this could be a good partnership opportunity or way to forgo an investment return for energy offsets as well as associated public health and other co-benefits.

Measure this supports	Name
Solar	Rhode Island Title XVII
All	Tax Equity Investments
All	Private Investors (as part of a portfolio)
Solar	Production Tax Credit
Solar	Investment Tax Credit
All	RI School Building Authority Housing Aid Program

[50] *See* RINR 2009, RI 529 2016 -- H 7657.
[51] *Id*. at 5.
[52] Northeast CHPS Criteria for New Construction and Renovations, OM 11.0
[53] For example, Moses Brown, an independent school in Providence, RI, received funding from the Rhode Island Commerce Corporation Renewable Energy fund to install 50 kW of solar panels on the roof of one of its buildings. This is a path RI public schools could also pursue if the school is determined to have available capacity on its roof.

All	School Building Authority Capital Fund
Lighting, Building Envelope	Rhode Island Efficient Building Fund
Solar	RI Renewable Energy Fund/Grant Commercial Scale (250 kW-1 MW)
Solar	RI Renewable Energy Fund/Grant Small Scale (25 kW)
Solar	RI Renewable Energy Growth (26-250 kW)
Ground Source Heat Pump	National Grid Energy Efficiency Program
Solar	Net Metering
Solar, Heat Pump	RI Renewable Energy Fund (RIREF)
Solar	Rhode Island Commerce Corporation Renewable Energy fund
All	Grant Funds
All	Low Interest Loans

These available funds are primarily a way for the external partner, the individual schools, and the state to reduce the overall costs of the project. Any external partner can help schools get access to these funds or increase the amount of total funding available. The projects presented above will not be able to provide an investor-friendly return. These types of projects will likely have to be incurred as an expense to the funder or provided as a donation. Since the partner cannot claim environmental benefits, they can help the schools access these funds. In Rhode Island, schools are running into one of two problems: either there is funding available, but it is way oversubscribed (like the School Building Authority Capital Fund), or there is funding available, but the schools aren't aware of it or don't have the bandwidth to apply for it. In either case, the external partner can provide funds directly to support these projects (likely a for-profit external partner) or it can help the schools by assisting their access to these various sources of funding (most likely a not-for-profit partner). In either case, a partner could help schools reduce the overall costs of these projects and connect them to individuals and organizations interested in investing in their community by investing in greener, more efficient, and healthier public schools in Rhode Island.

Path Forward

The feasibility analysis suggests that the best measures forward include improving the building envelope and replacing light fixtures and bulbs with more efficient options.

Throughout our analysis lighting has been referred to as a "low hanging fruit." The chief reasoning behind this statement is that, comparatively speaking, lighting is easy to install and maintain. Another reason is that there is an ample amount of data surrounding lighting. For instance, it's not especially difficult to quantify the energy savings when switching from one kind of bulb to another, or even when retrofitting the fixtures with adapters or entirely replacing ballasts. Further, while lighting technology has become more advanced, the basic premise remains the same: you install the bulb, you flip a switch. This is in contrast to HVAC systems – which also involve a switch, but require a far more advanced installation and operation process, so much so that additional training is required to ensure the system is operating sufficiently. With a light, even a "dumb" (that is non-automated) bulb will result in consistent savings over a period of time.

Light fixtures also face relatively few regulatory obstacles. In Rhode Island for instance, there is no requirement that LED bulbs be used in renovation projects. This gets to the issue of regulatory additionality. From the technical perspective, lighting standards are also widespread and accepted. A T8 fixture is a constant, which means that baselines are easier to establish. Thus, if a project is going to roll-out a given option, it's easier to speak in universal terms and to bring up past examples since many aspects of a lighting-centric process will be universal, even where project-specific details vary. From the perspective of schools, this also means that what works for one building, is likely to work – at least in part – for another building, whereas larger projects might not be feasible due to present conditions. The lighting project also has the benefit of being able to be "tacked on" to other improvement projects given its comparatively "small" scale and feasibility of implementation.

Small, diverse building envelope improvements provided both energy efficiency and public health opportunities. In qualitative discussions with National Grid representatives we learned that aging double-paned windows act as single-paned windows, intensive insulation and renovation projects have a slow return on investment, and smaller projects can prevent energy leakage. They reported after replacing gaskets and caulking windows as well as adding door sweeps, schools were able to save thousands of dollars. Investing in improvements that prevent moisture and pest intrusion can improve health outcomes such as respiratory illnesses and thermal comfort. This approach also allows us to leverage our collective expertise and provide a comprehensive solution that results in energy and environmental health benefits. Although, the costs and benefits are hard to quantify, we believe that small efforts can result in meaningful impacts.

Upgrading Lighting	Improve Building Envelope
+ Scalable +Affordable + Easy to Implement + Community Building + Health & Energy Benefits – Small GHG Reductions/Bulb	+ Scalable + Health Impacts + Academic Performance + Large Energy Reductions – More Costly – Labor Intensive

Additional Questions

Energy efficiency and renewable energy programs have the potential to inform the curriculum of schools that are undertaking improvements related to this offset program. For example, at Calcutt Middle School in Central Falls, RI, students have already participated in more than 1,250 hours of energy education initiatives, as part of "The Earth Avengers" Task Force.

How can this energy efficiency program serve the educational mission of the schools, in addition to providing a financial and health benefits?

Appendix 3
Health Research and Tools

Appendix 3a: School Building Impacts on Health
Appendix 3b: Lighting Assessment Tool
Appendix 3c: Building Envelope Assessment Tool
Appendix 3d: Proposed Causal Framework per project
References

Appendix 3a: School Building Impacts on Health

There are numerous building conditions that impact student, staff and teacher health. This is an overview of the key health concepts important for the *Bright Futures Campaign* and *Safe Scholars Securing Success*.

Bright Futures Campaign: Impact of Lighting

Two main attributes of light are its illuminance and color temperature. Illuminance over a given area is determined by the luminous ux per square meter and is measured in units of lux. According to the Illuminating Engineering Society, 350 lux is recommended for normal-sized font and 500 lux for 9 point font or less. Classroom use influences illuminance needs per classroom. For example, science lab benches are recommended to have 1,000 lux. Overall, uniformity of light in a classroom is important for visually impaired and/or sensory sensitive students. Correlated color temperature (CCT) describes the thermal temperature of a light source and is measured in units of Kelvin (K). Lights of low color temperature appear warm (red to yellow), whereas lights of high color temperature appear cold (white to blue). Daylight has a CCT of about 6500K and peaks in the blue spectrum.

Cortisol, a hormone influenced by light exposure, reaches peak levels in the morning upon waking, a process known as the cortisol activation response. In a study of sleep-restricted 12–17-year-old students, students who were exposed to 40 lux of short-wavelength (blue spectrum) LED light in the morning showed a significantly enhanced cortisol activation response compared with students exposed to dim light (<5 lux from an incandescent light), indicating that short-wavelength morning light could stimulate students and help them feel more alert at school.[1]

Safe Scholars Securing Success: Impact of Indoor Environmental Quality

Children have developing lungs with narrow airways and, compared with adults, they breathe larger volumes of air relative to their body size.[2] More than 25 million children — nearly 50% of America's students — attend schools that have not yet adopted an Indoor Air Quality (IAQ) management plan, a strategy used to identify and remediate poor air quality in schools.[3] These plans are not mandatory for schools but are considered best practices. According to the Centers for Disease Control and Prevention's School Health Policies and Practices Study, the number of schools reporting implementation of IAQ management programs dropped from 47.7% in 2012 to 46.1% in 2014.

Ventilation is a key determinant of health in buildings

Ventilation rate is the flow of outside air into a building per unit of time. The aim of good ventilation is to ensure a comfortable, healthy, and productive indoor environment throughout the day and to respond to the number of occupants in a space. Existing guidelines for acceptable IAQ, defined by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), in schools recommend a minimum classroom ventilation rate of 15 cubic feet of outside air per person, or five liters per second per person to keep indoor carbon dioxide (CO2) concentrations at or below 1000 ppm.[4]

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[1] Figueiro & Rea, 2012; Keis et al., 2014
[2] Annesi-Maesano et al., 2013; Schwartz, 2011
[3] U.S. EPA, 2014
[4] ASHRAE (2016). ANSI/ASHRAE Standard 62.1-2013. Ventilation for Acceptable Indoor Air Quality. Accessed

A useful indicator of ventilation is the concentration of CO2

It is continuously exhaled by building occupants. High CO2 levels suggest that there is poor ventilation and movement of air in a space, which could lead to increased concentrations of a variety of irritants. Studies of IAQ in schools have repeatedly found CO2 levels in excess of the ASHRAE threshold.[5] An assessment of 120 classrooms in Texas[6] found that time-averaged CO2 concentrations exceeded 1000ppm in 66% of classrooms and that peak CO2 concentrations surpassed 3000 ppm in 21% of classrooms surveyed. Shendell and colleague (2004) measured CO2 concentrations greater than 1000 ppm in 45% of the 435 classrooms they surveyed in Washington and Idaho. A study in the southwest United States found that 87 of 100 classrooms assessed had ventilation rates below the ASHRAE standard 62.1-2004, which recommended a minimum of 7.1 liters per second per person (L/s/p).[7] In the state of New York, a study of 64 classrooms reported that 20% of measured CO2 concentrations exceeded 1000 ppm.[8]

Adverse effects have been reported for elevated CO2 levels in classrooms, including increased student absence,[9] decreased satisfaction with IAQ,[10] and symptoms of wheezing among children in daycare centers.[11] Lower ventilation rates have been linked to more missed school days caused by respiratory infections;[12] greater prevalence and incidence of symptoms of sick building syndrome;[13] greater mean number of school nurse visits caused by respiratory symptoms;[14] increased asthmatic symptoms, nasal patency, and risk for viral infections;[15] and the transmission of airborne infectious diseases such as chickenpox, measles, and influenza.[16]

Researchers observed a 5% decrement in "power of attention" in poorly ventilated classrooms, roughly equivalent to the impact that a student might feel from skipping breakfast.[17] With similarly poor CO2 levels and ventilation rates in school buildings, students have been observed to experience greater fatigue, impaired attention span, and loss of concentration;[18] poorer performance on tests of concentration;[19] and lower levels of focus among university students during lectures.[20]

Thermal comfort can be highly subjective because it includes individual expectations, metabolic rate,

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March 3, 2016. https://ashrae.iwrapper.com/ViewOnline/Standard_62.1-2013.

[5] Corsi et al., 2002; Dorizas et al., 2015a; Haverinen-Shaughnessy et al., 2011; Muscatiello et al., 2015; Shendell et al., 2004; Toftum et al., 2015

[6] Corsi et al., 2002

[7] Haverinen-Shaughnessy et al., 2011).

[8] Muscatiello et al., 2015

[9] Gaihre et al., 2014; Simons et al., 2010

[10] Chatzidiakou et al., 2014

[11] Carreiro-Martins et al., 2014

[12] Toyinbo et al., 2016a

[13] Chatzidiakou et al., 2015a

[14] Haverinen- Shaughnessy et al., 2015a

[15] Chatzidiakou et al., 2012

[16] Li et al., 2007; Luongo et al., 2015

[17] Coley et al., 2007

[18] Chatzidiakou et al., 2012

[19] Dorizas et al., 2015a

[20] Uzelac et al., 2015

and clothing insulation.[21] Existing thermal comfort models are based on studies done with adult subjects and have often been found to predict students' thermal comfort levels inaccurately.[22] Although young children may not yet have the vocabulary to express their thermal sensations or the difference between temperature and heating, they do show awareness of these basic concepts and the notion of comfort.[23] Young children have higher metabolic rates, higher core body temperature, less developed thermoregulation capabilities,[24] and a wider range of thermal responses. Children are more vulnerable to the effects of heat stress and appear more uncomfortable at higher temperatures than those of adults. They have also been found to prefer cooler environments.[25] Additionally, children's clothing and activity levels are distinct from adults[26] and are likely to have a significant influence on students' thermal preferences. Pre-K and kindergarten students, who may still require assistance with getting dressed, are less able to adapt by adding or shedding extra layers of clothing when they feel uncomfortable.

[21] Zomorodian et al., 2016
[22] Teli et al., 2012; Van Hoof, 2008; Zomorodian et al., 2016
[23] Fabbri, 2013
[24] Garcia-Souto & Dabnichki, 2016; Liu et al., 2015; Zomorodian et al., 2016
[25] Nam et al., 2015; Vanos et al., 2016; Zomorodian et al., 2016
[26] Havenith et al., 2007

Appendix 3b: Lighting Assessment Tool

This is an example of a tool that can be used by teachers and students to evaluate their learning environment for lighting quality. This can be used as a teaching tool and may assist in the submission to prioritize investment from the Bright Futures Campaign.

Lighting Classroom Evaluation:

1.) Measured Illuminance in Classroom: _______________lux
2.) Times the classroom is occupied:____
3.) Does Classroom Have Windows?
   a.) If yes, how many?
   b.) Are they obstructed?
   c.) Do they open?
4.) Are you satisfied with the daylight your room receives?
   a.) Not Satisfied
   b.) Somewhat Satisfied
   c.) Very Satisfied
   d.) Other:__________________
5.) How many lights are in the classroom?
6.) Do you notice any of the following:
   a.) Flicker
      i.) Yes
      ii.) No
      iii.) Other:________________
   b.) Particles or Dust accumulation in or near bulb
      i.) Yes
      ii.) No
      iii.) Other:________________
   c.) Heat release
      i.) Yes
      ii.) No
      iii.) Other:________________
   d.) Consistent, uniform lighting throughout the classroom:
      i.) Yes
      ii.) No
      iii.) Other:________________
   e.) Burnt out bulbs
      i.) Yes
      ii.) No
      iii.) Other:________________
   f.) Glare
      i.) Yes

ii.) No

iii.) Other:_______________

g.) Other lighting concerns

i.) Yes: ________________________

ii.) No

7.) Can your students...

a.) Effectively see the front of the classroom without strain (i.e reading chalkboard,

i.) Never

ii.) Sometimes

iii.) Always

iv.) Other:__________________

b.) Stay attentive and alert throughout the class (i.e. they are not distracted or sleepy)

i.) Never

ii.) Sometimes

iii.) Always

iv.) Other:__________________

c.) Have difficulty reading, writing under current lighting conditions?

i.) Never

ii.) Sometimes

iii.) Always

iv.) Other:__________________

8.) Do students experience myopia (nearsightedness)?

i.) Yes

ii.) No

Appendix 3c: Building Envelope Assessment Tool

This is an example of a tool that can be used by teachers and students to evaluate their learning environment for building envelope quality. This can be used as a teaching tool and may assist in the submission to prioritize investment from the *Safe Scholars Securing Success.*

1. Size of the classroom
   a. _____ft by ______ft
2. Number of Occupants? ___________________
3. Age range this learning space serves? __________________
4. Windows Present?
   a. No
   b. Yes
5. Are the windows operable?
   a. No
   b. Yes
6. What is the condition of the window sealing and caulking?
   ____
7. Are there noticeable holes and cracks in the walls?
   a. If yes, what is the size and shape?____
   b. If yes, how many?____
8. Are there noticeable peeling or flaking paint?
   a. If yes, how large is the area? ____
9. How do classroom occupants feel about the temperature room?
   a. Please tally the occupants responses:

Too Cold	Comfortable	Too Hot

10. What is the humidity of the room? ____
11. What is the temperature of the room? ____
12. Do you feel air moving through the bottom of the door or windows?
    a. No
    b. Yes
    c. Other: _____________________________
13. Are there leaks or signs of moisture?
    a. If yes,
       i. Where?____
       ii. When? ____
14. Are there visible signs of mold or mildew?
    a. No
    b. Yes
15. Is there a musty odor?
    a. No
    b. Yes

16. Are there visible signs for pests (i.e. rodents or insects)?
    a. No
    b. Yes (please describe)
17. Have students required inhaler use in this learning space?
    a. Never
    b. Monthly
    c. Weekly
    d. Daily
18. Do students stay attentive and alert throughout the class (i.e. they are not distracted or sleepy)
    a. Never
    b. Sometimes
    c. Always
    d. Other:__________________

Appendix 3d: Causal Frameworks

These are graphical visualizations of the health impacts of our proposed solutions. After investing in these programs, these frameworks could potentially identify metrics to evaluate the impact of the programs.

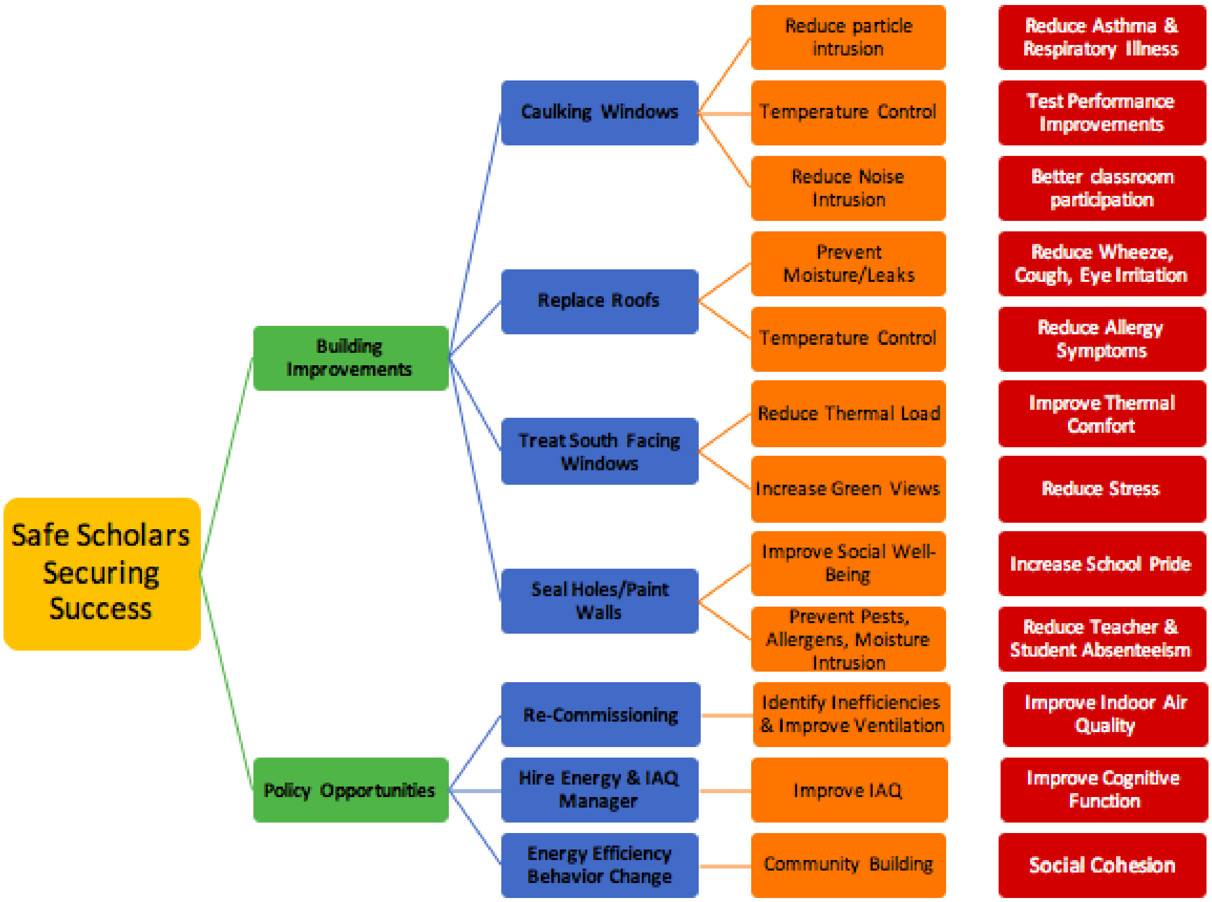

Figure 1: Safe Scholars Securing Success

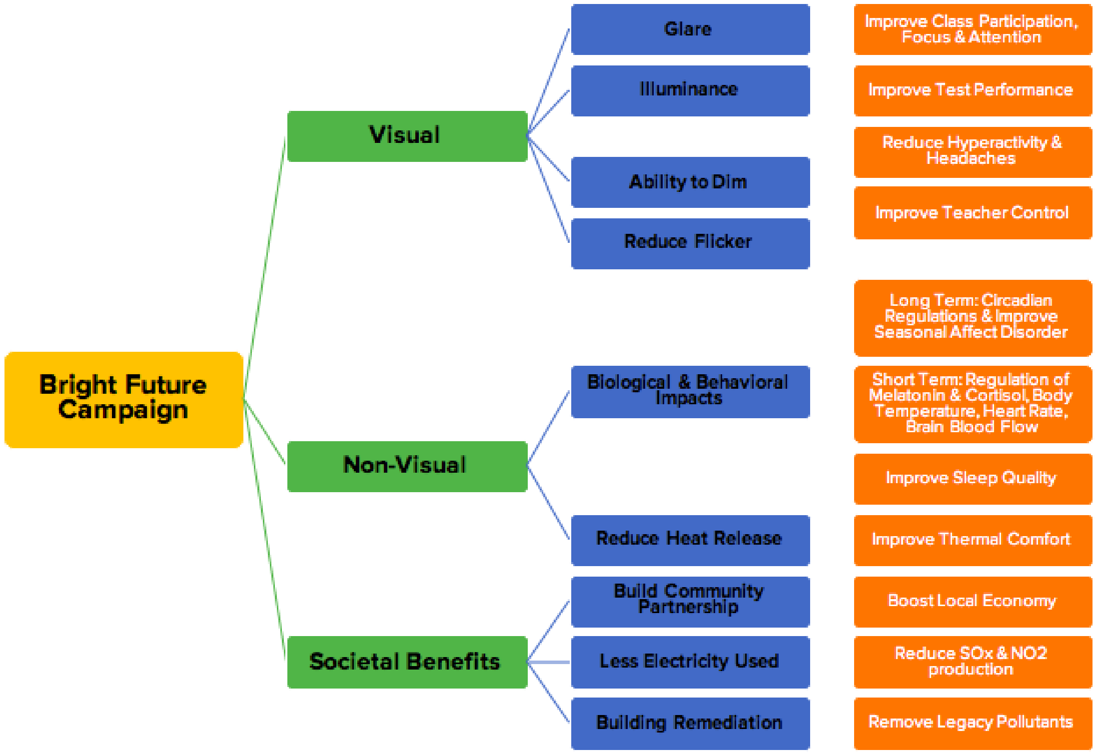

Figure 1: Bright Futures Campaign

References

Annesi-Maesano, I., Baiz, N., Banerjee, S., Rudnai, P., Rive, S., & SINPHONIE Group (2013). Indoor air quality and sources in schools and related health effects. *Journal of Toxicology and Environmental Health, Part B, 16*(8), 491–550.

ASHRAE (2016). ANSI/ASHRAE Standard 62.1-2013. Ventilation for Acceptable Indoor Air Quality. Accessed March 3, 2016. https://ashrae.iwrapper.com/ViewOnline/Standard_62.1-2013.

Carreiro-Martins, P., Viegas, J., Papoila, A.L., Aelenei, D., Caires, I., Araújo-Martins, J., & Rosado-Pinto, J. (2014). CO_2 concentration in day care centres is related to wheezing in attending children. *European Journal of Pediatrics*, *173*(8), 1041–1049.

Chatzidiakou, L., Mumovic, D., Summerfield, A.J., Hong, S.M., & Altamirano-Medina, H. (2014). A Victorian school and a low carbon designed school: Comparison of indoor air quality, energy performance, and student health. *Indoor and Built Environment*, *23*(3), 417–432.

Chatzidiakou, L., Mumovic, D., & Summerfield, A. (2015). Is CO2 a good proxy for indoor air quality in classrooms? Part 1: The interrelationships between thermal conditions, CO2 levels, ventilation rates and selected indoor pollutants. *Building Services Engineering Research & Technology*, *36*(2), 129-161.

Coley, D.A., Greeves, R., & Saxby, B.K. (2007). The effect of low ventilation rates on the cognitive function of a primary school class. *International Journal of Ventilation*, *6*(2), 107–112.

Corsi, R.L., Torres, V.M., Sanders, M., & Kinney, K.A. (2002). Carbon dioxide levels and dynamics in elementary schools: results of the TESIAS Study. *Indoor Air*, *2*, 74–79.

Crowley, S.J., Cain, S.W., Burns, A.C., Acebo, C., & Carskadon, M.A. (2015). Increased sensitivity of the circadian system to light in early/mid-puberty. *The Journal of Clinical Endocrinology & Metabolism*, *100*(11), 4067–4073.

Dorizas, P.V., Assimakopoulos, M.N., & Santamouris, M. (2015a). A holistic approach for the assessment of the indoor environmental quality, student productivity, and energy consumption in primary schools. *Environmental Monitoring and Assessment*, *187*(5), 1–18.

Dorizas, P.V., Assimakopoulos, M.N., Helmis, C., & Santamouris, M. (2015b). An integrated evaluation study of the ventilation rate, the exposure and the indoor air quality in naturally ventilated classrooms in the Mediterranean region during spring. *Science of The Total Environment*, *502*, 557–570.

Fabbri, K. (2013). Thermal comfort evaluation in kindergarten: PMV and PPD measurement through data logger and questionnaire. *Building and Environment*, *68*, 202–214.

Gaihre, S., Semple, S., Miller, J., Fielding, S., & Turner, S. (2014). Classroom carbon dioxide concentration, school attendance, and educational attainment. *Journal of School Health*, *84*(9), 569–574.

Garcia-Souto, M.D.P. & Dabnichki, P. (2016). Core and local skin temperature: 3–24 months old toddlers and comparison to adults. *Building and Environment*, *104*, 286–295.

Havenith, G. (2007). Metabolic rate and clothing insulation data of children and adolescents during various school activities. *Ergonomics*, *50*(10), 1689–1701.http://www.milforddailynews.com/article/20160222/NEWS/160229329

Haverinen-Shaughnessy, U., Moschandreas, D.J., & Shaughnessy, R.J. (2011). Association between substandard classroom ventilation rates and students' academic achievement. *Indoor Air*, *21*(2), 121–131.

Higuchi, S., Lee, S.I., Kozaki, T., Harada, T., & Tanaka, I. (2016). Late circadian phase in adults and children is correlated with use of high color temperature light at home at night. *Chronobiology International*, *33*(4), 448–452.

International Commission on Illumination (2012). A Computerized Approach to Transmission and Absorption Characteristics of the Human Eye, CIE 203:2012 incl. Erratum 1: Vienna, Austria.

J B O'Hagan, M Khazova, & L L A Price. (2016). Low-energy light bulbs, computers, tablets and the blue light hazard. *Eye*, Eye, 2016.

Keis, O., Helbig, H., Streb, J., & Hille, K. (2014). Influence of blue-enriched classroom lighting on students′ cognitive performance. *Trends in Neuroscience and Education, 3*(3), 86–92.

Li, Y., Leung, G.M., Tang, J.W., Yang, X., Chao, C.Y.H., Lin, J.Z., & Sleigh, A.C. (2007). Role of ventilation in airborne transmission of infectious agents in the built environment–A multidisciplinary systematic review. *Indoor Air*, *17*(1), 2–18.

Luongo, J., Fennelly, K., Keen, J., Zhai, Z., Jones, B., & Miller, S. (2016). Role of mechanical ventilation in the airborne transmission of infectious agents in buildings. *Indoor Air, 26*(5), 666-678.

Mariana G. Figueiro, & Mark S. Rea. (2012). Short-Wavelength Light Enhances Cortisol Awakening Response in Sleep-Restricted Adolescents. *International Journal of Endocrinology,* (2012), 229-235.

Muscatiello, N., McCarthy, A., Kielb, C., Hsu, W.H., Hwang, S.A., & Lin, S. (2015). Classroom conditions and CO_2 concentrations and teacher health symptom reporting in 10 New York State Schools. *Indoor Air*, *25*(2), 157167.

Nam, I., Yang, J., Lee, D., Park, E., & Sohn, J.R. (2015). A study on the thermal comfort and clothing insulation characteristics of preschool children in Korea. *Building and Environment*, *92*, 724–733.

Schwartz, J. (2011). Air Pollution and Children's Health. *Pediatrics*, *113*(Supplement 3), 1037 LP – 1043. Retrieved from http://pediatrics.aappublications.org/content/113/Supplement_3/1037.abstract

Shendell, D.G., Prill, R., Fisk, W.J., Apte, M.G., Blake, D., & Faulkner, D. (2004). Associations between classroom CO_2 concentrations and student attendance in Washington and Idaho. *Indoor Air*, *14*(5), 333–341.

Simons, E., Hwang, S.A., Fitzgerald, E.F., Kielb, C., & Lin, S. (2010). The impact of school building conditions on student absenteeism in upstate New York. *American Journal of Public Health*, *100*(9), 1679–1686.

Teli, D., Jentsch, M.F., & James, P.A. (2012). Naturally ventilated classrooms: An assessment of existing comfort models for predicting the thermal sensation and preference of primary school children. *Energy and Buildings*, *53*, 166–182.

Toftum, J., Kjeldsen, B.U., Wargocki, P., Menå, H.R., Hansen, E.M., & Clausen, G. (2015). Association between classroom ventilation mode and learning outcome in Danish schools. *Building and Environment*, *92*, 494–503.

Toyinbo, O., Matilainen, M., Turunen, M., Putus, T., Shaughnessy, R., & Haverinen-Shaughnessy, U. (2016a). Modeling associations between principals' reported indoor environmental quality and students' self-reported respiratory health outcomes using GLMM and ZIP models. *International Journal of Environmental Research and Public Health*, *13*(4), 385.

U.S. Environmental Protection Agency (EPA) (2014). "EPA Releases Guidance to Improve Schools' Air Quality and Energy Efficiency". Press Release. October 17, 2014. Accessed April 4, 2016. https://yosemite.epa.gov/opa/admpress.nsf/6424ac1caa800aab85257359003f5337/f53011817db9d82a85257d74005fd3a4!OpenDocument.

Uzelac, A., Gligoric, N., & Krco, S. (2015). A comprehensive study of parameters in physical environment that impact students' focus during lecture using Internet of Things. *Computers in Human Behavior*, *53*, 427–434.

Van Hoof, J. (2008). Forty years of Fanger's model of thermal comfort: comfort for all? *Indoor Air*, *18*(3), 182–201.

Vanos, J.K., Middel, A., McKercher, G.R., Kuras, E.R., & Ruddell, B.L. (2016). Hot playgrounds and children's health: A multiscale analysis of surface temperatures in Arizona, USA. *Landscape and Urban Planning*, *146*, 29–42.

Zomorodian, Z.S., Tahsildoost, M., & Hafezi, M. (2016). Thermal comfort in educational buildings: A review article. *Renewable and Sustainable Energy Reviews*, *59*, 895906.

Appendix 4
NE-CHPS Examples

Selected Examples of NE-CHPS Requirements

Commissioning

Intent *Verify that building elements and systems are designed, installed, and calibrated to operate as intended, and provide for the ongoing accountability and optimization of building energy performance over time.*
EE 3.0 – Commissioning
EE 3.1 – Additional Commissioning Qualifications
EE 3.2– Building Envelope Commissioning
EE 3.3 – Enhanced Commissioning

Commissioning is vitally important to the performance of the school and are the keys to achieving and maintaining energy efficiency. Commissioning involves a rigorous quality assurance program that ensures the building and its systems are built and operated as designed and that the school district receives the proper training and documentation needed to operate and maintain the building. No building can perform optimally without adequate maintenance.

Buildings, even simple structures, are complex systems of electrical, mechanical, and structural components. High performance buildings are healthy, efficient, environmentally sensitive structures whose performance can be significantly affected if the building has not been designed following the owner's project requirements or constructed according to the designers' specifications. Commissioning is a rigorous quality assurance program administered by a knowledgeable third party that ensures the building performs as expected.

EE 3.0 – Commissioning		**Prerequisite**	
		4 points	
Applicability	**Verification Required**		
All projects.	Design Review	Construction Review	Performance Review

EE 3.1 – Additional Commissioning Qualifications		**Credit**	
		1 point	
Applicability	**Verification**		
All projects.	Design Review	Construction Review	Performance Review

EE 3.0

This prerequisite requires a commissioning process to be in place early in the design process and carries through to the post-occupancy 10-month warranty review and subsequent completion of a commissioning report.

Requirement

Prerequisite	EE 3.0 ALL of the fundamental best practice commissioning procedures must be implemented: Engage an independent, third-party commissioning agent (CxA). The commissioning agent will be responsible for commissioning the following critical building systems: *Electrical Systems*: • Lighting systems and controls (daylight, occupancy, timing switches, etc.); • On-site renewable solar electric or wind systems *Mechanical Systems:* ▪ HVAC systems (such as hot water systems, chilled water systems, central air systems, ventilation systems); ▪ Energy management system ▪ Renewable energy heating systems ▪ Central plant systems in existing schools if they will serve new HVAC work and if they have not been commissioned or retrocommissioned within five years of submitting the project for review *Plumbing Systems:* • Flow control devices • Pumping systems • Special hazardous waste treatment systems (e.g. for lab wastes) • Domestic hot water systems • Graywater systems (if applicable) The commissioning scope of services shall include: • Review Owners Project Requirements (OPR) (formerly known as Design Intent documentation) and Basis of Design (BOD) documentation. • Conduct a focused review of the design prior to the construction documents phase. • Conduct a focused review of the construction documents when close to completion. • Include commissioning requirements in the construction documents. • Develop and utilize a commissioning plan. • Conduct a selective review of contractor submittals of commissioned equipment. • Review the Operations & Maintenance manual. • Verify installation, functional performance testing (including off-season testing), training, and operations and maintenance documentation. A minimum 20% sampling strategy for testing terminal units and repetitive units is permissible. All major systems must be tested. • Participate in training of facility staff in accordance with the training plan (OM.1). • Complete a commissioning report. • Conduct a 10-month warranty, post-occupancy review. Commissioning efforts in this prerequisite shall be coordinated with commissioning requirements in WE 6.0 – Irrigation Commissioning.

1 point	EE 3.1	The commissioning authority responsible for commissioning is a licensed architect or engineer with at least two years' experience in the state when he/she practices.

This criterion is intended to allow project managers to think beyond the typical scope of a commissioning authority, into other useful system testing.

EE 3.2 – Building Envelope Commissioning		**Credit**	
		1 point	
Applicability	**Verification**		
All projects.	Design Review	Construction Review	Performance Review

This full scope of commissioning applies to a new school. For major renovations and a new building on an existing campus this commissioning scope is required based on the scope of the project. The scope of commissioning services for major renovations will depend on the whether the building envelope is being upgraded.

Requirement

1 point	EE 3.2	Commission the building(s) envelope using the National Institute of Building Sciences (NIBS) Guideline 3 or using an equivalent approach. The commissioning authority shall be a licensed architect or engineer with at least two years of building envelope commissioning experience in the state where s/he practices.

EE 3.3 – Enhanced Commissioning		**Credit**	
		1 point	
Applicability	**Verification**		
All projects.	Design Review	Construction Review	Performance Review

This full scope of commissioning applies to a new school. For major renovations and a new building on an existing campus this commissioning scope is required based on the scope of the project. The scope of commissioning services for major renovations will depend on the whether the building envelope is being upgraded.

Requirement

1 point	EE 3.3	In addition to the prerequisite requirements, perform first-year optimization of the building systems and develop a systems manual.

Implementation

EE 3.0

Qualifications of Commissioning Authority

The CxA should satisfy the qualifications of, and perform in accordance with, the Building Commissioning Associations' (BCA) Essential Attributes of Building Commissioning.

The CA must have experience commissioning schools in accordance with this standard.

Consider a commissioning agent recognized by a professional organization such as:

- AABC Commissioning Group (ACG) Certified Commissioning Agent ‖ www.commissioning.org/
- ASHRAE CPMP (Commissioning Process Management Professional) certification www.ashrae.org/education--certification/certification/commissioning-process-management-professional-certification
- Building Commissioning Association (BCA) certification www.bcxa.org/certification/
- Educational certification from University of Wisconsin cx.engr.wisc.edu/
- NEBB Qualified Commissioning Administrator www.nebb.org/certified/nebbs_certification_program/
- TABB Certified Commissioning Supervisor www.tabbcertified.org/site/public/content/index/home

The CA may be a qualified employee of the school district.

Commissioning Scope

The following list describes each of the commissioning steps listed above in greater detail.

- *Engage a commissioning agent.* The commissioning agent (CA) directs the commissioning process and should be hired in time for the design development phase. The commissioning services must be performed by an independent third party, i.e. not part of the design or construction management of the project. The CA may be hired by the owner, the owner's project manager, or the design firm as long as the CA is not an employee of the design firm and reports to both the school district and the design firm. .Review design intent and basis of design documentation. The architect and the design engineer are the most appropriate people to create this document, which should list the owner's project requirements and design intent for each of the systems or features to be commissioned. The CA will review this document, and a copy of the review shall be provided to the owner.

- *Conduct a focused review of the design prior to the construction documents phase.* This review early in the design process should be focused on an assessment of how well the design meets the owner's design intent. Assessment should be made as to how the design meets the functionality, utility performance, maintainability, sustainability, cost, and indoor environmental quality requirements outlined in the design intent. Evidence of the review is to be documented in the commissioning report.

- *Conduct a focused review of the construction documents when close to completion.* This review should be conducted prior to issuing the construction documents for bid and captured in the commissioning report. The review should answer these questions:

    - Does the design meet the owner's design intent?
    - Does the design allow for proper maintenance access?
    - Do the construction documents clearly detail the construction requirements?
    - Do the construction documents clearly define the commissioning requirements?

- *Include commissioning requirements in the construction documents.* All commissioning requirements must be integrated into the construction documents to clearly specify the responsibilities and tasks to be performed. Of particular importance are the delineation of the contractors' responsibilities regarding documentation, functional performance testing, occupant and operator training, and the creation of the operations and maintenance manuals.

- *Develop commissioning plan.* The commissioning plan includes a list of all equipment and systems to be commissioned, delineation of roles for each of the primary commissioning participants, and details on the scope, timeline, and deliverables throughout the commissioning process.

- *Conduct a selective review of contractor submittals and shop drawings related to the commissioned systems*. Contractor submittals for the systems included in the commissioning scope shall be reviewed by the CA in conjunction with the designer's review. The review shall focus on the ability of the submitted product to meet the owner's requirements and review comments shall be provided to the owner and the design team.

- *Review Operations & Maintenance manual.* The Contractor compiles the O&M Manuals prior to commencement of training and the CxA reviews them for completeness, organization and readability. The CxA shall review the O&M Manuals for the following items:

  - As-built sequences of operations for all equipment as provided by the design professionals and contractors, including time-of-day schedules and schedule frequency, and detailed point listings with ranges and initial setpoints.
  - Ongoing operating instructions for all energy- and water-saving features and strategies.
  - Seasonal operational guidelines.
  - Recommendations for recalibration frequency of sensors and actuators by type and use.
  - Guidelines for continuous maintenance of the owner's project requirements (operational requirements) and basis of design (basis of operation).

- *Verify Pre-Functional Testing.* The CxA shall provide the Contractor with the Pre-Functional Checklists (PFC) that include a list of items to inspect and elementary component tests to conduct to verify proper installation of equipment. PFCs are primarily static inspections and procedures to prepare the equipment or system for initial operation. The CxA shall observe, at minimum, the startup procedures for each piece of primary equipment, unless there are multiple units, (in which case a sampling strategy may be used). Extent of CxA observation of Pre-Functional Testing will be at the discretion of the CxA, though spot checking of items on the lists will be performed prior to Functional Testing. PFC's are separate and in addition to the manufacturers installation and start-up forms and shall be reviewed by the CxA and included in the Commissioning Report. Contractor shall certify that installation, prestart, and startup activities have been completed prior to commencing Functional Testing. Certification shall include completed PFC's, manufacturer installation and startup checklists and the final TAB report approved by the A/E.

- *Functional Testing.* The CxA shall develop the functional test procedures in a sequential written form, coordinate, oversee and document the actual testing. Functional Performance Tests (FPT) are performed after Prefunctional testing and startup are complete and test the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Systems shall be tested under various modes and run through all the control system's sequences of operation while components are verified to be responding as the sequences state. Checklists will be completed during the testing process, deficiencies will be added to the Commissioning Issues Log and each included in the Commissioning Report.

- *Participate in training of facility staff in accordance with the training plan.* The CA may be charged with reviewing the training plan, developed by the Construction Manager/General Contractor, for adequacy. The CA may additionally be charged with participating in the training itself.

- *Complete a commissioning report.* The report must show that the building's systems have met the design intent and specifications, have been properly installed, are performing as expected, and that proper O&M documentation and training have been provided. The report should include a compilation of all commissioning documentation described in this criterion, including complete functional testing results and forms and should note any items that have not been resolved at the time the report is issued.

- *Ten month warranty, post-occupancy review*. The commissioning contract shall contain provisions for a 10-month warranty and post-occupancy review. The review is intended to bring the design, construction, commissioning, and facility staff together to solicit the facility staff's comments, suggestions, and areas of concern regarding the systems in their first year of operation. Warranties on any commissioned systems should be reviewed and deficient equipment should be identified and a plan for resolution developed.

Testing Sampling Criteria

The contractors shall submit to the CxA documentation that they have performed installation and functional performance verification in accordance with the commissioning plan for all equipment components and systems. The functional performance test may be demonstrated to the CxA for a sample of systems that comply with all of the following criteria:

- Equipment or systems have similar components and configurations. For component testing, sampling may apply where there are many identical component types with similar applications.

- The systems or equipment have identical sequences of operation, which are implemented using identical control software programming or firmware settings.

- The components and systems to be included in the demonstrated samples shall be chosen by the commissioning authority at the time of demonstration.

- Building Automation System mapping of component to the operators graphic shall be demonstrated for all components.

- The trend logging portions of all functional performance test shall be completed for 100% of the systems or components

Failure Testing

The Commissioning Plan must also identify retesting protocols for components and systems that fail initial testing.

Cross-Category and Other Considerations

This prerequisite relates to all prerequisites and credits that involve operable building systems, including HVAC, windows, and room controls. Good training is critical for good operations, and good operations are critical for good building performance. The prerequisite also relates to the required Systems Maintenance Plan in OM 5.1. The operations & maintenance manual described here will be part of the plan, along with the inventory and schedule of maintenance.

It is recommended that the owner consider using the commissioning process and provider for additional services including acoustic testing and irrigation commissioning. Qualified commissioning authority's can provide quality control on a range of high performance school systems and strategies. Other major systems can include items such as pools or audio-visual systems. Contact CHPS to see if your "major system" qualifies.

EE 3.2

When commissioning the envelope, follow the NIBS Guideline 3 or an equivalent method that at minimum includes drawing review, field inspection (construction checklist) and prior to window installation perform an infrared (IR) mock up to test for thermal breaks or IR testing of the first window installation.

EE 3.3

The prerequisite commissioning scope EE 3.0 does require a 10-month warranty review, but this review may not provide much value if the commissioned systems have not been monitored during the first year of occupancy. The school's O&M staff may not have the manpower to dedicate to such monitoring and potential issues may not be apparent until the expiration of the warranty period.

First year optimization scope shall include, at a minimum:

• Monthly collection of building energy use and benchmark against predicted energy use and average comparable school building in the Northeast (require use of ENERGY STAR Portfolio Manager?)

• Quarterly review and analysis of operations trend data for select commissioned systems to verify continued proper systems operation

• Quarterly review and analysis of space temperature and CO_2 trend data for a sampling of building spaces to verify satisfactory indoor environments

• Quarterly meetings with school O&M staff to review findings from review and analysis of building energy use, commissioned systems and space trend data. These quarterly meetings will also be used to discuss any specific questions or concerns the O&M staff may have regarding the commissioned systems to help direct the commissioning authority's efforts for subsequent review and analysis.

A systems manual organizes equipment information by system and incorporates information above and beyond a regular O&M manual including; BOD, TAB reports, project specific operating considerations, functional performance tests, etc. The commissioning authority is in the best position to develop the systems manual due their project involvement from design through the first year of occupancy.

Documentation Requirements

Design Review Requirements

EE 3.0 & 3.1 – Provide the project's Commissioning Plan and Owners Project Requirements (OPR).

EE 3.0 – Construction drawings must include general notes that commissioning is required, at what stages and where the Commissioning Plan may be found for more information.

EE 3.2: Compliance will be confirmed by reviewing documentation for EE 3.0 and EE 3.1. Be sure to include additional requirements in construction documents as appropriate.

EE 3.3: Compliance will be confirmed by reviewing the additional scope of work for the Commissioning agent submitted in EE 3.0 and EE 3.1.

Construction Review Requirements

EE 3.0, 3.1, 3.2 – Provide the final Commissioning Report.

EE 3.3: Submit the systems manual.

Performance Review Requirements

EE 3.3: Submit a report summarizing the first year optimization process.

Resources

- CHPS Best Practices Manual, Volume V: Commissioning: www.chps.net/dev/Drupal/node/288
- ASHRAE Guideline 1.1-2007: HVAC&R Technical Requirements for The Commissioning Process: www.techstreet.com/ashrae/cgi-bin/detail?product_id=1573306
- ASHRAE Guideline 4-2008 (RA 2013): Preparation of Operations & Maintenance Documentation for Building Systems: www.techstreet.com/ashrae/cgi-bin/detail?product_id=1852923

- The Building Commissioning Association, Essential Attributes of Building Commissioning: www.bcxa.org/essential-attributes-of-building-commissioning/
- ASHRAE Guideline 0 – 2005 The Commissioning Process: www.techstreet.com/ashrae/cgi-bin/detail?product_id=1619765
- The National Clearinghouse for Educational Facilities includes a bibliography on commissioning: www.edfacilities.org/rl/commissioning.cfm
- National Institutes of Building Sciences, NIBS Guideline 3-2012, Building Enclosure Commissioning Process BECx: www.wbdg.org/ccb/NIBS/nibs_gl3.pdf

Daylighting

Intent
Provide high quality daylighting in classrooms to enhance student performance, to improve student productivity through quality daylighting designs that minimize glare and direct sunlight penetration, and ensure energy savings.
EQ 11.0 – Daylighting: Glare Protection
EQ 11.1 – Daylight Availability

Daylighting is fundamentally important to high performance design, and should be the primary source of light in classrooms. Daylighting has a number of advantages, including improved occupant productivity, improved connection to the outdoors, improved health, energy savings, and quality of light.

EQ.11.0 – Daylighting: Glare Protection		**Prerequisite**	
		4 points	
Applicability	**Verification Required**		
All projects.	Design Review	Construction Review	Performance Review

Requirement

Prerequisite	EQ 11.0	Design spaces to optimize daylight while preventing glare by controlling direct sunlight ingress with blinds, shades, overhangs, lightshelves, translucent material, or other effective means. Use any of the following three metrics to document achievement of this criterion, and refer to the implementation section for documentation requirements: • No direct sunlight can strike the teaching surfaces or a work plane located 4 ft. or more inside the exterior walls at 9:00AM, 12:00PM and 3:00PM on the winter and summer solstice and the equinox. **OR** • The maximum illuminance to average illuminance ratio measured in the workplane cannot exceed 15 at 9:00AM, 12:00PM and 3:00PM on the winter and summer solstice and the equinox. **OR** • The maximum Daylight Autonomy (DA_{max}) for the daylit spaces must be below 5% for all daylit spaces. AND • Skylights and roof monitors shall meet the requirements of no direct sun penetration as described above, unless they have diffusing devices such as a haze factor 99%+ or direct transmittance <1%.

EQ 11.1 – Daylight Availability			**Credit**
			5 points
Applicability	**Verification Required**		
This criterion applies to all projects. To earn these points for major renovations, it may be necessary to add skylights or modify the size and location of windows.	Design Review	Construction Review	Performance Review

Requirement

1-3 points	EQ 11.1	For all **classroom** spaces, choose one of the following two options:
	EQ 11.1.1	*Multiple Point in Time Approach*

Daylight Responsive Lighting Controls

To achieve any of the available points for daylighting classrooms a daylight responsive electric lighting system or plan must be implemented for the daylit spaces.

- For photosensor based systems; documentation showing location of sensors, lighting zones, and setpoint and commissioning information for the system.

For strategic switching and occupant education approaches; drawings showing the switching and zones a brief manual to be provided to the building occupants describing the daylighting intent of the space and the recommended function of all daylighting, lighting and shading devices.

AND ONE OF THE FOLLOWING

1 Point	Achieve >20fc annual average illuminance for >75% of classroom area
2 Points	Achieve >35fc annual average illuminance for >75% of classroom area
3 Points	Achieve >50fc annual average illuminance for >75% of classroom area

OR

Spatial Daylight Saturation (sDS) Approach

1 Point	Achieve >50% $sDS_{300/50\%}$
2 Points	Achieve >75% $sDS_{300/75\%}$
3 Points	Achieve >90% $sDA_{300/90\%}$

<table>
<tr>
<td rowspan="2">1-2 points</td>
<td>EQ 11.1.2</td>
<td>
For support spaces, choose one of the following two options:
Multiple Point in Time Approach
<table>
<tr><td>1 point</td><td>Achieve >30fc average Illuminance for >50% of administration office area</td></tr>
<tr><td>1 point</td><td>Achieve >40fc average Illuminance for >50% of library, cafeteria, auditorium and multi-purpose/commons area</td></tr>
</table>
OR
</td>
</tr>
<tr>
<td></td>
<td>
Spatial Daylight Saturation Approach
<table>
<tr><td>1 Point</td><td>Achieve >60% sDS$_{300/50\%}$ for administration office area</td></tr>
<tr><td>2 Points</td><td>Achieve >60% sDS$_{400/50\%}$ for library, cafeteria, auditorium and multi-purpose/commons area</td></tr>
</table>
AND
Daylight Responsive Lighting Controls
To achieve any of the available points for daylighting support spaces a daylight responsive electric lighting system or plan must be implemented for the daylit spaces.

For photosensor based systems; documentation showing location of sensors and lighting zones, and set-point and commissioning information for the system.
For strategic switching and occupant education approaches; drawings showing the switching and zones a brief manual to be provided to the building occupants describing the daylighting intent of the space and the recommended function of all daylighting, lighting and shading devices.

*Any spaces where daylight would have an adverse impact on the use of the space are excluded. Provide documentation illustrating impact
</td>
</tr>
</table>

Implementation

Direct Sunlight Penetration

Requirement EQ 11.0 (direct sunlight penetration) shall be verified by one of the following methods:

- A physical model should be placed on a heliodon or otherwise positioned so that the sun angles represent the dates and times specified in EQ 11.0. Verify by photograph that the 9 conditions do not have any direct sunlight on the workplane or teaching wall. Indicate if automatic or manual blinds or shades are used meet the requirement.

- A model may be set up in a computer based tool that can calculate sunlight on interior surfaces. Verify be rendering images or task plane illuminance calculations that the 9 conditions do not have any direct sunlight on the workplane or teaching wall. Indicate if automatic or manual blinds or shades are used meet the requirement.

- Manually calculate the sun profile angles and show that the criteria are satisfied for the dates and times specified in EQ 11.0 Illustrate the shading strategies provide complete direct sunlight control for the 9 conditions specified.

- Perform an incremental maximum Daylight Autonomy calculation using 300fc or other recommended target illuminance x 10. The DA_{max} should be 5% or less for no more than 5% of the workplane points. Use the Blinds/Shades Operation protocol described in section 2.2.6 of IES LM-83-12, or describe the blinds/shades operation used to achieve the requirement.

- For any manually controlled shading devices included in the above calculations (i.e. Blinds, roller-shades), provide a brief manual that can be given to users, informing of optimal use of shading devices, namely ensuring they are not left down when there is plentiful daylight.

Computer rooms and other spaces where daylight would have an adverse impact on the use of the space are excluded. For renovation projects that do not modify lighting systems, the project need not provide daylighting controls for the electric lighting system

Multiple Point in Time Approach

Option calculations for the requirements may be made with a qualified computer simulation tool.

- Computer Simulation Tool: Any daylighting simulation tool that can perform accurate daylight illuminance calculations for a grid of points under standard CIE skies for the times specified. Commercially available simulation tools include AGI32, Radiance, SPOT, 3DS Max Design, DAYSIM, DIALux

- A minimum analysis grid of 3 ft. by 3 ft. shall be used. The grid shall be positioned so that no analysis points are located closer than 2 ft. and further than 3ft from a wall.

- The annual average illumination should be determined by first calculating the workplane average illuminance for 10 design sky conditions: 9AM, 12PM, and 3PM for winter and summer solstice and equinox under a CIE clear sky and 12PM on the equinox under a cloudy sky condition Use information from the

$$E_{avg} = [(W9 + W12 \times 2 + W3 + (E9 + E12 \times 2 + E3) \times 2 + (S9 + S12 \times 2 + S3) \times 0.5) / 14] \times Sunny\% + EC12 \times Cloudy\% \quad \textbf{A5-16}$$

National Oceanic and Atmospheric Association's (NOAA) National Climatic Data Center, or from a TMY weather file to determine the percentage of cloudy and sunny days. The annual average illuminance is calculated with this formula:

Where:

E_{avg} = estimated annual average illuminance

WX = Sunny winter solstice condition at 9AM, 12PM, and 3PM

EX = Sunny equinox condition at 9AM, 12PM and 3PM

SX = Sunny summer condition at 9AM, 12PM, and 3PM

EX12 = Cloudy equinox condition at 12PM

Sunny % - percent of year with opaque cloud cover <50%

Cloudy % - percent of year with opaque cloud cover >50%

Spatial Daylight Saturation Approach

Option calculations for the requirements must be made with a computer simulation tool.

The Spatial Daylight Autonomy calculations must meet the following criteria:

- Computer Simulation Tool: Any daylighting simulation tool that can perform accurate daylight illuminance calculations for a grid of points under standard CIE skies for the times specified. Commercially available simulation tools include AGI32, Radiance, SPOT, 3DS Max Design, DAYSIM, DIALux.
- A minimum analysis grid of 3 ft. by 3 ft. shall be used. The grid shall be positioned so that no analysis points are located closer than 2ft and further than 3 ft. to a wall.
- A design illuminance of 30fc should be used unless a different illuminance target is recommended – for example 15fc for a computer room or 50fc for a gymnasium. A design illuminance of 40fc (400 lux) is required for library, cafeteria, auditorium and multi-purpose/commons areas.
- Daylight Saturation (DS) aka "Continuous" Daylight Autonomy calculation method to be used. This method gives credit for hours that receive partial daylight contribution. For example, when 20fc of daylight is provided and the design illuminance is 30fc this counts for 20/30 or 0.66 for that time as opposed to 0 given a Daylight Autonomy approach.

- Daylight Autonomy, or an "Incremental" calculation method, to be used for DA_{max} calculations. This method only counts hours that completely meet or exceed this max illuminance with daylight.

- The school occupancy schedule and a representative weather file should be used for the annual DA and DA_{max} calculations. 7AM to 3PM should be used as a standard school schedule. Schools with schedules that vary from this standard should provide documentation of their operation hours.

General Note: Computer rooms and other spaces where daylight would have an adverse impact on the use of the space are excluded.

Documentation Requirements

Design Review Requirements

EQ 11.0 – Use CHPS Verified Plan Sheet to reference plan sheets or specification sections which show required photocontrols, sensors, lighting zones and set points. Provide PDF results of a daylight simulation model, a computer based simulation model, a physical model, or manually calculated sunlight penetration in the classrooms to avoid direct sunlight on teaching surfaces and work planes.

EQ 11.1 – Use the CHPS Verified Plan Sheet to identify spaces that qualify as daylit, and the percentage of daylit classrooms. Fulfill this requirement by completing the CHPS Verified Plan Sheet provided at the point of registration with the CHPS Verified program. Plans and sections will be used for verification. For each classroom group identified on the CHPS Verified Plan Sheet, provide the required computer based simulation results including point-by-point lighting predictions as appropriate.

Construction Review Requirements

Submit photographs of installed light controls.

Resources

- CHPS Best Practices Manual: Volume II: Daylighting and Fenestration Design Chapter: www.chps.net/dev/Drupal/node/31
- Approved Method: IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure: http://www.ies.org/store/product/approved-method-ies-spatial-daylight-autonomy-sda-and-annual-sunlight-exposure-ase-1287.cfm
- Advanced Lighting Guidelines: 2003 Edition: www.newbuildings.org/lighting.htm new version www.algonline.org/
- IES TM-83-13 "IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE)"
- "Daylighting Pattern Guide" at http://patternguide.advancedbuildings.net
- AGI32 Lighting Design Software: www.agi32.com/
- DAYSIM Daylighting Analysis Software: http://daysim.ning.com/
- DOE-2 Building Energy Use and Cost Analysis Software: http://doe2.com/

Electric Lighting Performance

Intent *Integrate high performance electric lighting with daylighting to promote the health and well-being of the occupants while maximizing energy efficiency. Provide high quality and flexible classroom lighting with teacher controls tailored to new teaching methods.*
EQ 13.1 – Electric Lighting Performance
EQ 13.2 – Superior Electric Lighting Performance

The classroom is one of the focal points for preparing students for today's high tech, postindustrial world. New teaching tools such as affordable A/V systems, smart boards, tablets and web-based learning tools have turned the classroom into a dynamic place of learning. As the rate of adoption of these new technologies increases, it is important to give the teacher easy-to-use control of lighting. This will enhance learning by letting the teacher tailor high quality lighting to the type of teaching taking place.

While the use of LED-based lighting systems is not required, the selection criteria included here will help progressive schools select LED-based luminaires that will provide high quality, long-lasting and energy efficient lighting for the classroom.

EQ 13.1 – Electric Lighting Performance		**Credit**	
		3 points	
Applicability	**Verification Required**		
This criterion applies to all new classrooms and can also be earned in renovation projects when classroom lighting is included in the scope of work.	Design Review	Construction Review	Performance Review

Requirement

2 points	EQ 13.1.1 EQ 13.1.2	Color Rendering Index (CRI) Requirements All luminaires shall have light sources with a CRI of 80 or greater. AND RoHS Requirements All luminaires shall be RoHS compliant following the most current European RoHS regulations, including all applicable exemptions.
1 point	EQ 13.1.3	LED Performance If an LED-based system used, all LED-based luminaires shall: • maintain at least 70% of their initial light output (L70) at 50,000 hours of operation. • achieve an initial efficacy of at least 50 lumens /watt. The project must also achieve EQ 13.1.1 and EQ 13.1.2 to qualify for this point.

EQ 13.2 – Superior Electric Lighting Performance		**Credit** **5 points**	
Applicability	**Verification Required**		
All projects.	Design Review	Construction Review	Performance Review

Requirement

2 points	EQ 13.2.1	Achieve all of the following: Provide multi-scene indirect/direct lighting systems for all classrooms, with the exception for specialty classrooms where multi-scene lighting is not required.
	EQ 13.2.2	The lighting system shall work in at least two modes: General and Audio Visual (AV). If daylight-responsive controls are installed, they shall take precedence to set upper light level limits.
	EQ 13.2.3	In general illumination mode, achieve the average illumination at the desk level based on the classroom type in the IES Lighting Handbook, Tenth Edition or its most recent update.
	EQ 13.2.4	In A/V mode the average illumination levels shall be 10 to 30-foot candles, not including contribution from the teaching wall light, for any point in the room greater than 3-feet from the side walls, or 10-feet from the front wall. Limit vertical illumination on the AV screen to no more than 7-footcandles at any point on the screen.
	EQ 13.2.5	*Whiteboard Illumination* Provide a separately switched lighting system that provides white board vertical illumination of at least 30-footcandles average with a maximum-to-minimum illuminance ratio of 8:1 or better for all points on the whiteboard.
1 point	EQ 13.2.6	Achieve all of the following: *Enhanced Teacher Controls* Provide teacher control at the front of the classroom for: • general / AV mode. • white board control • for a manual override of the time delay for the occupancy sensor system. The teacher should be able to adjust for a specific need a of up to 3-hours. At the end of the special period, the delay is automatically reset to its initial, specified setting.
	EQ 13.2.7	*Advanced Classroom Controls* Link the on / off occupancy signal into a school-wide management system

2 points	EQ 13.2.8	*High Performance Lighting Systems* All luminaires shall have light sources with CRI of 85 or greater If LED-based systems are used, they must also meet the following criteria for Flicker and Performance to achieve these points: *Flicker* In all school classrooms and educational learning spaces, the measured percent flicker from LED integrated systems (include driver, LED array, diming controls, daylight sensor) shall be 10% or less across the entire dimming range. *Performance* LED-based luminaires shall maintain at least 70% of their initial light output (L70) at 100,000 hours of operation.

Implementation

Many renovation projects include the installation of new lighting systems, providing an excellent opportunity to install high quality, energy efficient electric lighting that is integrated with the available daylight.

Color Rendering Index (CRI) refers to the ability of a light source to render the colors of the spectrum.

Lumen maintenance is the amount of light produced from a light source or from a luminaire when it is brand new to the amount of light output at a specific time in the future.

To document compliance with these requirements, specify that submittals and cut sheets must contain the required specifications from the manufacturer.

During Audio Visual presentations, an average as low as 10-foot candles is acceptable to allow the teacher to "see" the students' faces and allow them to take notes. An average as high as 30-foot candles is acceptable to keep the contrast level of light at the desk and the screen at desired levels.

Note that percent flicker is a relative measure of the cyclic variation in output of a light source. It is an important consideration for LED-based luminaires to ensure a high quality lighting environment.

Documentation Requirements

Design Review Requirements

EQ 13.1 – Use CHPS Verified Plan Sheet to reference plan sheets or specification sections which specify the required lighting performance qualities and that submittals and cut sheets contain the required specifications from the manufacturer.

EQ 13.2 Construction drawings, particularly the electrical plans must include point-by-point lighting calculations for each classroom type. Construction drawings, ideally the electrical schedule must include the required lighting and system features.

Construction Review Requirements

EQ 13.2 – Submit receipts, proof of purchase or installation for the required lighting system. Submit pictures of installed lighting system in typical classroom.

Resources

- CHPS Best Practices Manual, Volume II: Design, Lighting Guidelines:www.chps.net/dev/Drupal/node/31
- Advanced Lighting Guidelines: 2003 Edition: www.newbuildings.org/lighting.htm.
- IESNA Lighting Handbook: www.iesna.org/handbook/

Acoustical Performance

Intent *Provide classrooms with adequate acoustical environments.*
EQ 14.0 – Acoustical Performance
EQ 14.1 – Enhanced Acoustical Performance

Student learning suffers in acoustically poor environments. Excessive noise and long sound reverberation negatively affect speech communication.

Definitions

Noise can be defined as unwanted sound. Sound can be described by its "level", expressed in units of "decibels". The application of the "A-weighted filter" de-emphasizes low-frequency and very high-frequency sound in a manner similar to human hearing. The abbreviation dBA is typically used when the A-weighted sound level is reported.

Sound reverberation is typically described by the "reverberation time", which can be defined as the time (in seconds) it takes for the sound level to decrease by 60 decibels after the source of the sound has been abruptly interrupted.

For the purpose of this criterion, general terms and definitions are the same as those found in Section 3 of ANSI/ASA Standard S12.60-2010/Part1, with the introduction of the following additional categories:

- *Inter-Classroom* Workspaces (ICWS) include: small spaces in between two or more classrooms where student groups from any of the classrooms can gather for separate activities. For the purposes of the present criteria, Inter-Classroom Workspaces shall not be treated as regular classrooms, except where the district designates the ICWS as a core learning space.
- *Performance Arts Spaces (PAS)* include: music and choir classrooms, dance classrooms, drama classrooms, and theaters.
- *Audio Production Spaces (APS)* include: audio recording studios and control rooms, audio editing suites.
- *Large Assembly Spaces (LAS)* include: multipurpose rooms.
- *Confidential Speech Privacy Rooms* are rooms for which confidential speech privacy, as defined by Appendix X1 of ASTM standard E1130, is required for conversations held at *normal* voice levels.

EQ 14.0 – Acoustical Performance	**Prerequisite**
	7 points

Applicability	Verification Required		
All projects.	Design Review	Construction Review	Performance Review

This prerequisite applies to all newly constructed classrooms and shall be incorporated into classroom renovation projects.

New Construction

This prerequisite applies to all newly constructed classrooms. For new construction, the design of the classroom and the materials specified must ensure compliance.

Renovation

Renovation projects must also meet the acoustics prerequisites as delineated in Table II. Acoustical performance is essential to any high performance school, regardless of project type.

Requirement

Prerequisite	EQ 14.0	*Reverberation Time Requirements* In Core Learning Spaces the maximum reverberation times shall be: • Core learning spaces with volume less than 10,000 ft^3: **0.6 s** • Core learning spaces with volume between 10,000 ft^3 and 20,000 ft^3: **0.7 s** • Core learning spaces with volume greater than 20,000 ft^3 and Ancillary Learning Spaces: **1.0 s** *Performance criteria for background noise* In Core Learning Spaces, the Total Background Noise shall be 35 dBA or less with all operable windows closed. NOTE: For Background Noise Requirements (a) and (b), Section 5.2.3 of ANSI/ASA Standard S12.60-2010/Part1 does not apply. Sections 5.2.2.2 and 5.2.4 of ANSI/ASA Standard S12.60-2010/Part1 apply.

Noise isolation design requirements

a) Outdoor-to-indoor attenuation of airborne sound

Design according to Sections 5.4.1.1 and 5.4.1.3 of ANSI/ASA Standard S12.60-2010/Part1.

Section 5.4.1.2 (including Table 3) of ANSI/ASA Standard S12.60-2010/Part1 does not apply. CHPS adopts no prescriptive requirements for the minimum STC or OITC rating of exterior walls and windows (except for the requirements in section 5.4.1.3 of ANSI/ASA Standard S12.60-2010/Part1). However, the project shall provide full documentation that the exterior noise environment has been appropriately quantified and that the design will achieve the performance criteria outlined in the "Exterior-source background noise" section above.

b) Indoor-to-indoor attenuation of airborne sound

- Wall and floor-ceiling assemblies shall be designed to achieve the minimum STC ratings specified in Table 1. The STC rating requirements also shall apply to the design of temporary partitions that subdivide a learning space. The ratings in Table 1 apply to wall construction only. Design according to Section 5.4.2.2 of ANSI/ASA Standard S12.60-2010/Part1.

Table 1: Minimum STC Ratings for Wall and Floor-Ceiling Assemblies

Adjacency	Minimum STC Rating
Classroom – Classroom	STC 43~~5~~
Classroom – Public Restrooms [a),b)]	STC 53
Classroom – Corridor	STC 38
Classroom – Staircase	STC 40
Classroom – Admin Office	STC 40
Mechanical Equipment Room	STC 60
Classroom – Conference Room	STC 50
Operable partitions	See footnote 4)

a) Table 1 requirements do not apply to toilets opening only into the core learning space and used only by occupants of the core learning space.

b) In any wall between a classroom and a public restroom, no plumbing shall be rigidly attached to the classroom wall framing. The wall assembly shall not contain large penetrations such as for restroom supply dispensers or disposals and shall not support rigidly attached electric hand dryer devices. Sound rating of hand dryer devices shall be clearly documented.

c) The isolation between core learning spaces and mechanical equipment rooms shall have a STC rating of 60 or greater unless it is shown that the sound level in the mechanical equipment room combined with a lower STC rating can achieve the required background noise level from building services in the core learning space. In no case shall the design STC between such spaces be less than 45.

d) Operable partitions shall have same STC minimum STC rating of the wall they replace.

- Doors shall be selected to achieve the minimum requirements specified in Table 3. Interior glazing up to 10 ft^2 immediately adjacent to a door shall have the same minimum STC requirement as the door. In all other cases, interior glazing shall have the same minimum STC requirement as the wall.

Table 3: Minimum STC Rating for Doors

Adjacency	Minimum STC Rating
Classroom – Classroom	STC 40
Classroom – Corridor	See footnote 1)
Conference Room – Corridor	STC 40
Doors of Confidential Speech Privacy Rooms	STC 40
Classroom – Conference Room	STC 45
Classroom – PAC, APS	STC 50
PAC, APS – Corridor	STC 40
Classroom – ICWS	STC 35

1. A minimum sound rating is not required for doors between classrooms and corridors. The absence of such requirement assumes that noise generated by corridor traffic can be controlled administratively by school staff.

c) Structure-borne impact sound isolation

Design according to Section 5.4.3 of ANSI/ASA Standard S12.60-2010/Part1.

d) Classroom audio distribution systems

Design according to Section 5.5 of ANSI/ASA Standard S12.60-2010/Part1.

Systems Maintenance Plan

Intent *Keep key building systems properly maintained over time and ensure on-going performance and system life.*
OM 5.0 – Systems Maintenance Plans

The Systems Maintenance Plan is one of the most important features of a high performance school since it establishes the practices that will continue to ensure the school is operated according to its high-performance intent. The Systems Maintenance Plan is a key part of Commissioning and has a strong connection to other energy efficiency performance items such as Energy Benchmarking.

OM 5.0 – Systems Maintenance Plan		**Prerequisite** **1 point**	
Applicability	**Verification Required**		
All projects.	Design Review	Construction Review	Performance Review

Requirement

1 point	OM 5.0	The school district must create a school Systems Maintenance Plan that includes an inventory of all equipment in the new or renovated school. The plan must address the preventive and routine maintenance needed. The plan should clearly define who is responsible for performing the task, as well as the overall management of maintenance activities. The inventory and plan should cover the following systems: *Electrical Systems*: • Lighting fixtures and controls (daylight, occupancy, timing switches, etc.) • On-site renewable solar electric or wind systems • Telecommunication systems • Electrical distribution systems • Life and safety systems *HVAC Systems*: • HVAC systems (such as hot water systems, chilled water systems, central air systems, ventilation systems) • Domestic hot water systems • Energy Management system • Renewable energy heating systems (if applicable) *Plumbing Systems:* • Flow control devices • Pumping systems • Special hazardous waste treatment systems (e.g. for lab wastes) • Domestic hot water systems • Graywater systems (if applicable) *Building Envelope and Roofing Systems (particularly acid management)* *Significant Plug Loads* *Other High Performance systems as applicable.*

Implementation

Like conventional schools, all high performance schools and their systems require preventive and routine maintenance. The Systems Maintenance Plan encourages districts to plan for preventive and routine maintenance tasks and invest adequate funds in the maintenance of their school facilities.

Documentation Requirements

Design Review Requirements

None

Construction Review Requirements

Provide a copy of an inventory of building system components (HVAC, lighting renewable). Provide a copy of a maintenance plan that includes information on preventative and routine maintenance needs:

Schedule of tasks, by week
Frequency to perform task, i.e. weekly, monthly, bi-annually
Priority ranking for each task
Date task to be completed
Personnel needed to carry out task
Problems encountered and follow up tasks, if any
Special training required to complete task, if any

Provide a copy of the Systems Maintenance Plan that include all regularly scheduled preventative and routine maintenance tasks and their frequency over the lifetime of the building system or equipment. These tasks include cleanings, calibrations, component replacements, and general inspections. Operations and maintenance manuals and commissioning reports developed during the commissioning process should be used as references for developing the maintenance plan. The plan must clearly define who is responsible for performing the task, its frequency, as well as the overall management of maintenance activities.

Resources

- CHPS Best Practices Manual Volume IV – Maintenance & Operations: www.chps.net/dev/Drupal/node/39
- NE-CHPS OMG www.neep.org/public-policy/energy-efficient-buildings/high-performance-schools/northeast-chps-om-guide
- Massachusetts School Building Authority: http://www.massschoolbuildings.org
- Massachusetts Facilities Administrators Association: http://www.massfacilities.org

Anti-Idling Measure

Intent *Reduce the health and environmental effects of vehicle exhaust and decrease use of fuel by preventing unnecessary vehicle idling.*
OM 9.0 – Anti-Idling Measures

According to the US Environmental Protection Agency (US EPA), exposure to diesel exhaust, even at low levels, is a serious health hazard and can cause respiratory problems such as asthma and bronchitis. Diesel emissions are well-documented asthma triggers and may increase the severity of asthma attacks.

OM 9.0 – Anti-Idling Measures		**Prerequisite**	
		1 point	
Applicability	**Verification Required**		
All projects.	Design Review	Construction Review	Performance Review

Requirement

1 point	OM 9.0	Adopt a no idling policy that applies to all school buses operating in the school district and all vehicles operating in the school grounds. The policy must include the following provisions: • School bus drivers will shut off bus engines upon reaching destination, and buses will not idle for more than five minutes while waiting for passengers. This rule applies to all bus use including daily route travel, field trips, and transportation to and from athletic events. School buses should not be restarted until they are ready to depart and there is a clear path to exit the pick-up area. • Post signage expressly prohibiting the idling of all vehicles for more than five minutes in the school zone. • Transportation operations staff will evaluate and shorten bus routes whenever possible, particularly for older buses with the least effective emissions control. • All school district bus drivers will complete a “no idling” training session at least once. All bus drivers will receive a copy of the school district’s No Idling Policy at the beginning of every school year.

Implementation

The term “school grounds” shall mean in, on or within 100 feet of the school, including any athletic field or facility and any playground used for school purposes or functions which are owned by a municipality or school district, regardless of proximity to a school building, as well as any parking lot appurtenant to such school, athletic field, facility or playground.

Establish the length of time an operator on school grounds may idle an engine before such idling becomes prolonged, and the limited circumstances under which the prolonged idling of an engine shall be permitted, including periods necessary to operate defrosting, heating or cooling equipment to ensure the health or safety of a driver or passengers or to operate auxiliary equipment and to undergo inspection or during maintenance.

Prohibit an operator of a school bus from idling a school bus engine while waiting for children to board or exit a bus on school grounds and from starting a school bus engine for any unnecessary period of time in advance of leaving the school grounds, unless the registrar determines that a school bus engine must be fully engaged in order to operate safety devices or that such idling prohibition would otherwise compromise the safety of children boarding or exiting a bus. Such regulations shall further prescribe templates for “no idling” signage to be posted by schools.

Documentation Requirements

Design Review Requirements

Reference specifications for anti-idling signage.

Construction Review Requirements

Provide a copy of the adopted anti-idling policy. Provide picture(s) of the installed anti-idling signage.

Resources

- US Environmental Protection Agency: Diesel Exhaust and Your Health www.epa.gov/ne/eco/diesel/health_effects.html
- The Asthma Regional Council offers a number of tools for the school district to use for its anti-idling program, including a model policy: www.asthmaregionalcouncil.org/indoor-and-ambient-air-quality
- The Massachusetts Department of Environmental Protection offers training to help school bus drivers and municipal employees eliminate unnecessary idling. See the following link for more information: http://www.mass.gov/dep/air/community/schbusir.htm DEP also has a variety of tools for school districts, including fact sheets, sample language for signage, sample newsletters, policy statements, and information on bus routing software

Appendix 5
Contracting

Contracting - Example Terms and Definitions

These are a few examples of terms and definitions that might be included in either a benefit agreement or performance contract. This is not meant to represent a complete list of possible terms and definitions, nor is it meant to be exclusive. This section seeks only to provide a brief contractual overview as a way of assisting with framing how the structural aspects of these contracts might be formatted.

Potential Contractual Structure:

Section	Examples of Terms/Topics
1. Definitions	E.g., Benefit, Project, Governmental Authority
2. Rights & Obligations	E.g., Due Diligence, Site Access, Data Verification
3. Indemnification	E.g., Identify the Parties, Environmental Indemnification, Liability Limits
4. Warranties & Representations	E.g., Ownership, Accuracy, Ability to Perform
5. Assignment	E.g., Nondelegation, Consent, Transferal
6. Change in Law	E.g., Authority, Scope, Effects Thereof
7. Assignment	E.g., Nondelegation, Consent, Transferal
8. Force Majeure	E.g., Acts of God, Material Interference, Extent of Performance
9. Dispute Resolution	E.g., Arbitration, Attorney's Fees, Reasonable Costs
10. Termination	E.g., With Cause, Without Cause, Effects of Thereof

Examples of Potential Terms/Definitions:

"Governmental Authority" ---

"Governmental Authority" means any national, state or local government (whether domestic or foreign), any political subdivision thereof or any other governmental, quasi-governmental, judicial, public or statutory instrumentality, authority, body, agency, bureau or entity (including the Rhode Island Department of Education or a relevant state public utility commission), or any arbitrator (private or public) with authority to bind a party at law.

"Representations/Warranties" ---

Section [] Mutual Representations.

The Parties make the following mutual representations and warranties:

Section [] Due Organization. Each Party represents that it is duly organized, validly existing and in good standing under the laws of its respective formation.

Section [] Due Authorization. Each Party represents that it is duly authorized and has the power to enter into this Agreement and perform its obligations hereunder.

Section [] No Consent Required. Each Party represents that it has all the rights required to enter into this Agreement and perform its obligations hereunder without the consent of any third party, including any Mortgagee.

Section [] Accuracy of Information. The information provided pursuant to this Agreement as of the Effective Date is true, correct and complete in all material respects.

Section [] Additional [Other Parties] Representations.

[Other Parties] make the following additional representations and warranties to Project Owner:

Section [] No Conflict. This Agreement is enforceable against [Other Parties] in accordance with its terms and does not conflict with or violate the terms of any other agreement to which [Other Party] is a party or by which [Other Party] is bound, including, if applicable, [Other Party]'s organizational documents and any agreement pursuant to which [Other Party] has financed the Site or Project.

Section [] Ownership and Control over Premises. [Seller] owns the Premises [subject to ______________________/ [free and clear of all liens, deeds of trust, mortgages, or other encumbrances except those of record as of the Effective Date].

Section [] Ability to Perform. [Other Parties] have no knowledge of any facts or circumstances that could materially adversely affect its ability to perform its obligations

“Covenants” --

Section [] Permits.

During the Term, Seller shall obtain and maintain in effect all Permits, approvals, and other authorizations that may be required by any governmental agency or authority. To the extent that any such Permits must be obtained or owned by Seller, Seller agrees that it will work cooperatively with Service Provider in connection with satisfaction and compliance with such Permits.

Section [] Upgrades.

[Service Provider/Seller?] shall perform (or arrange for the performance of) all normal maintenance and upgrades to maintain the Project in good working order, and such other maintenance and upgrades as may be required by any applicable laws, regulations, ordinances, and codes.

Section [] Maintenance.

a. The Seller shall perform, at its own expense, all regular maintenance as is customarily required for proper care of the Project.

b. Failure to maintain the Project in customary working condition constitutes a material breach of this agreement.

“Damages/Remedies” ---

Default, Remedies and Damages.

a. Default. Any Party that fails to perform its responsibilities as listed below or experiences any of the circumstances listed below shall be deemed to be the “Defaulting Party”, the other Parties shall be deemed a “Non-Defaulting Party”, and each event of default shall be a “Default Event”:

i. failure of a Party to pay any amount due and payable under this Agreement, other than an amount that is subject to a good faith dispute, within ten (10) days following receipt of written notice from the Non-Defaulting Party of such failure to pay (“Payment Default”);

ii. failure of a Party to substantially perform any other material obligation under this Agreement within thirty (30) days following receipt of written notice from the Non-Defaulting Party demanding such cure; provided, that such thirty (30) day cure period shall be extended (but not beyond ninety (90) days) if and to the extent reasonably necessary to cure the Default Event, if (A) the Defaulting Party initiates such cure within the thirty (30) day period and continues such cure to completion and (B) there is no material adverse effect on the Non-Defaulting Party resulting from the failure to cure the Default Event;

iii. if any representation or warranty of a Party proves at any time to have been incorrect in any material respect when made and is material to the transactions contemplated hereby, if the effect of such incorrectness is not cured within thirty (30) days following receipt of written notice from the Non-Defaulting Party demanding such cure;

iv. Seller prevents Service Provider from installing the Project or otherwise failing to perform in a way that prevents the achievement of the project’s goals. Such Default Event shall excuse a party’s obligations to make payments that otherwise would have been due under this Agreement.

b. Remedies.

i. Remedies for Payment Default. If a Payment Default occurs, other than nonpayment due to disputes (e.g. failure to meet quality standards or allow for quality verification), the Non-Defaulting Party may suspend performance of its obligations under this Agreement. Further, the Non-Defaulting Party may (A) at any time during the continuation of the Default Event, terminate this Agreement upon five (5) days prior written notice to the

Defaulting Party, and (B) pursue any remedy under this Agreement, at law or in equity, including an action for damages.

ii. Remedies for Other Defaults. On the occurrence of a Default Event other than a Payment Default, the Non-Defaulting Party may (A) at any time during the continuation of the Default Event, terminate this Agreement or suspend its performance of its obligations under this Agreement, upon five (5) days prior written notice to the Defaulting Party, and (B) pursue any remedy under this Agreement, at law or in equity, including an action for damages. Nothing herein shall limit either Party's right to collect damages upon the occurrence of a breach or a default by the other Party that does not become a Default Event.

"Choice of Law" --

1) Governing Law. This Agreement is made and shall be interpreted and enforced in accordance with the laws of the state of Rhode Island.

Or

2) The law of the state where the Project is located shall govern this Agreement without giving effect to conflict of laws principles.

"Force Majeure" --

a. "Force Majeure" means any event or circumstances beyond the reasonable control of and without the fault or negligence of the Party claiming Force Majeure. It shall include, without limitation, failure or interruption of the production, delivery or acceptance of electricity due to: an act of god; war (declared or undeclared); sabotage; riot; insurrection; civil unrest or disturbance; military or guerilla action; terrorism; economic sanction or embargo; explosion; fire; earthquake; abnormal weather condition or actions of the elements; hurricane; 100-year flood event; the binding order of any Governmental Authority (provided that such order has been resisted in good faith by all reasonable legal means); the failure to act on the part of any Governmental Authority (provided that such action has been timely requested and diligently pursued); failure of equipment not utilized by or under the control of the Party claiming Force Majeure, such as equipment connecting the Project to an external electrical grid.

b. Except as otherwise expressly provided to the contrary in this Agreement, if either Party is rendered wholly or partly unable to timely perform its obligations under this Agreement because of a Force Majeure event, that Party, to the extent that performance is impossible shall be excused from the performance affected by the Force Majeure event (but only to the extent so affected), otherwise, the time for performing shall be extended as reasonably necessary; provided that: (i) the Party affected by such Force Majeure event, as soon as reasonably practicable after obtaining knowledge of the occurrence of the claimed Force Majeure event, gives the other Party prompt oral notice, followed by a written notice reasonably describing the event; (ii) the suspension of or extension of time for performance is of no greater scope and of no longer duration than is required by the Force Majeure event; and (iii) the Party affected by such Force Majeure event uses all reasonable efforts to mitigate or remedy its inability to perform as soon as reasonably possible. The Term shall be extended day for day for each day performance is suspended due to a Force Majeure event.

c. If a Force Majeure event continues for a period of __________ (___) days or more within a twelve (12) month period and prevents a material part of the performance by a Party hereunder, then at any time during the continuation of the Force Majeure event, the Party not claiming the Force Majeure shall have the right to terminate this Agreement without fault or further liability to either Party (except for amounts accrued but unpaid).

“Change in Law” --

Change in Law.

No Change in Law shall affect the buyer’s or seller’s obligations or rights under this agreement.

“Change in Law” means (i) the enactment, adoption, promulgation, modification or repeal after the Effective Date of any applicable law or regulation; (ii) the imposition of any material conditions on the issuance or renewal of any applicable permit after the Effective Date of this Agreement (notwithstanding the general requirements contained in any applicable Permit at the time of application or issue to comply with future laws, ordinances, codes, rules, regulations or similar legislation), or (iii) a change in any utility rate schedule or tariff approved by any Governmental Authority which in the case of any of (i), (ii) or (iii), establishes requirements affecting owning, supplying, constructing, installing, operating or maintaining the Project, or other performance of the Seller’s obligations hereunder and which may have a material adverse effect on the cost to Seller of performing such obligations, including a change in federal, state, county or any other tax law.

“Termination” --

Termination
With Cause. This Agreement may be terminated before the expiration date of the Term on written notice:
(a) by Seller, if a party fails to pay any amount when due and still does not pay within [NUMBER] days after a party receives written notice that the payment is past due;
(b) by Seller, if a party fails to pay any amount when due more than [NUMBER] time[s] in any [NUMBER] month period;
(c) by any Party, if another Party [materially] breaches any provision of this Agreement and either the breach cannot be cured or, if the breach can be cured, it is not cured by the breaching Party within [NUMBER] days after the breaching Party’s receipt of written notice of the breach; [or]
(d) by any Party upon the occurrence of a Force Majeure Event that lasts longer than [NUMBER] days; or
(e) by any Party, if another Party (A) becomes insolvent, (B) is generally unable to pay, or fails to pay, its debts as they become due, (C) files, or has filed against it, a petition for voluntary or involuntary bankruptcy or pursuant to any other insolvency Law, (D) makes or seeks to make a general assignment for the benefit of its creditors, or (E) applies for, or consents to, the appointment of a trustee, receiver or custodian for a substantial part of its property or business.

Effect of Termination.
(a) No Release. The expiration or termination of this Agreement, for any reason, shall not release any Party from any obligation or liability to another Party, including any payment and delivery obligation, that:
(i) has already accrued;
(ii) comes into effect because of the expiration or termination of the Agreement; or
(iii) otherwise survives the expiration or termination of this Agreement.
[Subject to Section [], the Party/Parties] terminating this Agreement, or in the case of the expiration of this Agreement, any Party shall not be liable to any other Party for any damage of any kind (whether direct or indirect) incurred by the other Party because of the expiration or termination of this Agreement.
Following the termination of this Agreement, Seller shall [promptly/, within [NUMBER] days of the termination,] invoice Customer for any outstanding [amounts/fees] and expenses due under this Agreement, and a party shall pay all such [amounts/fees] and expenses to Seller in accordance with the payment terms set forth in Section [NUMBER]. If a deposit or advance payment has been made by a party for any [goods/services] that have not and

will not be delivered to a party following expiration or termination, Seller shall [promptly/within [NUMBER] days] reimburse that payment to a party.

(b) Return of Materials and Property. Each Party shall [promptly/within [NUMBER] days], following the expiration or termination of this Agreement:

(i) return to any Party all documents and tangible materials (and any copies) containing, reflecting, incorporating or based on any Party's Confidential Information[; provided, however, that Customer may retain copies of any Confidential Information of Seller incorporated in the Deliverables or to the extent necessary to allow it to make full use of the [Services and any] [Deliverables]];

(ii) permanently erase all of the other Party's Confidential Information from its computer system, except for copies that are maintained as archive copies on its disaster recovery and/or information technology backup systems in which case such copies shall be destroyed upon the normal expiration of the backup files;

(iii) return to the other Party all tangible property[, including molds, equipment, and tools,] in its possession or control, belonging to the other Party; and

(iv) upon any Party's [written] request, certify in writing to the other Party that it has complied with the requirements of this Section.

(c) Cooperation and Assistance. [Except where this Agreement has been terminated by Seller for cause,] Seller shall provide reasonable cooperation and assistance to a party, [upon a party's written request] [and] [at a party's expense], in a party's transition to a new supplier.

(d) [Work in Process] [and] [Expense Reimbursement]. Except where the Agreement has been terminated by Seller for cause:

(i) a party shall have the right, for a period of [NUMBER] days following its receipt of a Notice of termination, to elect to receive work in process through the date of termination.

(ii) Seller shall have the right, to receive reimbursement for its reasonable out-of-pocket expenses incurred in connection with work in process through the date of termination after using [reasonable/its best] efforts to mitigate such expenses. Such reimbursement amount shall not, in any event, exceed the Prices.