Audit to Audit:
An Analysis of MARSD's Energy Sustainability Projects and Policies

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Report Background

The information contained in this report is intended to be used as guidance for the Matawan-Aberdeen Regional School District. This report was put together with input from the District's Business Office, architect of record, engineer of record, information from the Local Government Energy Audits dated November 2013 and October 2020, and tracking data from the District's Energy Star Portfolio Manager account.

The original version of this policy guidance document was published and distributed to the Board of Education in June of 2015. Its intention was to help the district navigate a complex web of funding options to improve the sustainability of operations. Along the way, there have been many unforeseen circumstances that also affected the direction but never the outcome or stated goals. The additional flexibility that these projects added has enabled the Matawan Aberdeen Regional School District to operate at a higher level of support for the students, staff, and learning process as well as extend the lifespan of the buildings for a projected 25 years beyond their original design specifications.

This update provides context for several separate but related projects. The District was awarded ROD (section 15) grants through the NJDOE in 2013 for various upgrades to the buildings including new HVAC upgrades at two schools and new boiler systems that replaced all but two of the 21 heating boilers. In 2015, the District participated in a program through the NJ Clean Energy Program which provided substantial offsetting funds and provided replacement of high priority HVAC units. In November of 2015, the district and community passed a bonding referendum to raise $19.9 million to continue the quest of replace existing, often original, HVAC systems. The project to date has replaced about 160 classroom unit ventilators, 116 multi-room VAV systems, and 87 roof top units in addition to exhaust and makeup air systems.

Lighting upgrades were also initiated in all district buildings starting in 2017. The first phases were included as extra work around the bonded referendum construction. This has been continued through the present with a project that started last year to replace 1,900 2'x 4' T-8 troffers with equivalent LED replacements. The biggest impact of the COVID-19 pandemic has been the delay in installing these lights, which were done in-house and are due for completion in December of 2020. For a complete list of the projects and their funding mechanisms, please see Appendix A.

Introduction

The New Jersey State Legislature approved Assembly Bills A1185, A2313 and A2564, giving specific public entities the ability to enter into contracts for up to 15 years to finance energy conservation and/or renewable energy production projects. The Bills allow for the contracts to be paid for with the projected resulting savings from the projects in an Energy Savings Improvement Program (ESIP) which serves as the vehicle through which the savings are outlined and an investment case is made. It provides various agencies with an outline to highlight a path to improve utility consumption while having as little impact as possible on an operating and capital budget. The guidelines of this program are contained in Department of Community Affairs Local Finance Notice 2009-11 and further refined through the Board of Public Utilities Docket Number EO09020128 2/24/2009 for calculation guidance.

After completion of a Local Government Energy Audit (LEGA), associated Energy Conservation Measures (ECMs) were evaluated on a case by case basis and rolled into an Energy Savings Plan (ESP). The LGEA was conducted in accordance with the standards developed by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for a Level II Audit. In 2015, MARSD created an extension of the Long Range Facilities Plan (LRFP) to allow for a case to be made for capital expenditures on such projects. This method was used because the specific ECMs highlighted in the Energy Audit would not attract an Energy Services Company (ESCO) proposal as the payoff periods were in excess of 15 years. Determinations on these positions are contained in this report as to how they were resolved or, if still pending, what future financial mechanism should be examined.

With the lack of the ESIP option, other funding mechanisms were examined for use and categorized by impact on operational budgets. The first was creating a budgeted line item during the budget development process. This can be paid for several ways. Direct inclusion in the next year's tax levy is the simplest way, though this is subject to the 2% cap on yearly local tax levy increases. If there are capital reserve funds available, these types of projects qualify for withdrawals if they are included in the district's LRFP. These projects would not be subject to the 2% tax levy increase cap. Utilizing available grant programs through the state Department of Education or Clean Energy Fund is a method of offsetting expenses from the first two revenue mechanisms. Offsetting funds have been crucial for many projects, especially those who choose to follow the route of public referendum. Bond proceeds from the state level are made available to public entities in the form of an offset of as much as 40% of the local coupon payments made until maturity. The Matawan Aberdeen Regional School District has used all these methodologies to fund improvements.

In order to tie the projects together, for illustrative purposes to the community, an overarching strategy needed to be chosen. The goal of sustainability in the process and operation, specifically with the triple bottom line model of decision making, was chosen to drive the project design and implementation. This continues to be the goal of any capital investment decisions and a process to examine the sustainability of decisions through this lens is conducted regularly. The goal of this document is to examine how this analysis takes place through the tools available to local school districts to blend together the social, environmental, and financial priorities of each entity.

Objectives

The patchwork nature of the projects and their funding mechanisms required there to be a comprehensive set of objectives put in place to guide the design and implementation. The focus was the core of the educational function, to create the optimal learning and teaching environments. The lens this was evaluated with was the triple bottom line model, the core of sustainable building concepts. Great pains were taken to design as much of the work as a whole and break down projects individually from the whole however, the first project was implemented before this overarching methodology was implemented. This work in 2013 was emergency in nature and, due to the foundational threat, was later designed around to ensure ease of transition in the future.

The first objective was to create stable indoor environmental quality (IEQ). The original systems were loud, inefficient, and expensive to maintain with little IEQ improvement save for heating the air. Most equipment was in excess of 50 years old. The new systems would need to be able to heat and cool as well as improve IEQ through filtration and increased ventilation. This goal of better IEQ as a foundation of a more suitable educational environment is supported through the ASHRAE Standard 62, the USEPA's Tools for Schools Program and a body of academic research (a comprehensive list can be found in Appendix B). This IEQ goal is translated through the U.S. Green Building Council's LEED program as a sustainable goal through equipment capable of advanced filtration, adaptable ventilation, humidity and carbon dioxide level (demand) control, as well as heating and cooling (with less environmentally impactful refrigerants).

The second objective was to implement lighting and sound level improvements as dictated by the state of New Jersey per statute in N.J.A.C. 6A-26. This is an area that is ripe for research as evolving technology, especially in the field of lighting, is outpacing the academic research as to effectiveness in different environments. Objective levels to be met were set at a maximum of 50 dB of background noise in classrooms and a minimum of 50 foot candles of light at desk height. These limits took on heightened significance during the latter design stages as financial pressures began to exert themselves on the sustainability model. The benchmarks were still achieved but a major design change had to occur to accommodate the noise levels.

Finally, during the marketing of the bonding referendum before the public vote, I made a commitment to the Board of Education and community and issued the challenge to our team; to make sure the operational expenses of the outcome would be budget neutral. This meant that existing budgeting formulas would continue to be utilized for utilities and operation. Additionally, the referendum was put to a public vote when there was existing debt maturing. The first question consisted of $13,000,000 in projects that would not increase the debt service cost to the community. The second question was for an additional $6,456,000 that was above and beyond the existing debt load. Both questions passed and the full referendum amount was bonded. Subsequently, this goal was modified to try to contain the additional costs to only those approved during the referendum from the benchmark at that time. This analysis will include a follow up on this commitment.

Executive Summary

In 2015, the Operations & Maintenance Department began researching a way to implement an ESP through an ESIP in accordance with NJ Public Law 2009, Chapter 4. The ESP was a working document built as an extension of the LRFP. The intention of this was to assess the feasibility of different scenarios for the funding portion of the ESIP though outsourced financing, a hybrid outsourced/self-funded model, or a completely self-funded model.

Through the ESP, a look at energy savings over a 15 year time frame was examined. This savings baseline allowed for the District to seek external financing for implementation of the projects through an Energy Services Company (ESCO). In order for the ESCO to bid a project, the savings must outweigh the costs over a 15 year timeframe. In almost every case examined according to our Energy Audit's ECMs, it was found that this scenario was not feasible. The conclusion eliminated two of the three options for financing, leaving only the self-financed method for implementation. This was true in 2015 and is again true in 2020.

In coming to this conclusion, we examined not only the historical utility data, but also the newly updated data and projections for the coming 15 years. The reasoning for this was brought about by the recently installed capital equipment which will set a new baseline for operation, beyond what was projected in the 2014 Energy Audit which was conducted prior to the installations. Additionally, the stated goal from the beginning of the project was to improve the sustainability of operations of the district. This included creating better learning outcomes through environmental improvements in the classrooms. It also included a reduction in the amount of R-22 refrigerant and tighter control on the operation of the equipment installed to reduce run time as much as possible.

At present, the biggest achievement is the stability of energy bills with the addition of cooling to 70% of the district's approximately 617,500 square foot footprint (up from approximately 26%). This has produced a net *savings* in utilities of approximately $17,000 per year compared to costs in 2014, a decrease of about 2% (see Appendices D and E). This was achieved while adding 1,298 tons of cooling capacity, a 260% increase, to the district (previous was approximately 496 tons; current is now 1,794 tons). We have simultaneously decreased our boiler heating capacity from approximately 59 MMBTUs to 34 MMBTUs, a reduction of 42%, through updated design and capabilities. These benchmarks were evaluated before the onset of COVID-19 related operational changes to give a true comparison to operational conditions. Further evaluation is needed to quantify student academic improvement and the impact of ongoing lifecycle costs related to these projects to understand if this will ultimately be labeled a "success". Continued research in the future will be essential in understanding whether these conditions contribute to closing the educational gap that has been exacerbated by virtual learning once students return to the classroom.

2013 vs. 2020 Energy Audit Results

This section will review the results of the 2013 audit versus where the District is in 2020. Many of the existing ECMs were completed and are marked as such. Those still in progress list what has been done and what remains. Any new measures will be listed in the next section. Copies of all of the audits can be found at https://www.marsd.org/Page/18807.

ECM-1 Window Replacements and Reduced Glazing

2013 – Cambridge Park was the only building highlighted in this ECM. The project cost was projected to be $409,900 with the resulting savings being $5,685 per year. A payback period of greater than 15 years determined that this measure was not feasible for an ESIP.

2020 – The first phase of this project was completed in 2018 on the Pre-K and Core areas of the building. The District Administrative Offices have not been completed and still have single pane windows. The improvements have been delayed due to the ever-shifting future usage possibilities, namely the potential need for additional pre-k educational space. Being that the HVAC is also in need of replacement, it makes sense from a project management standpoint to bid them together as a complete project once the future of the space becomes clear.

Conclusion – This ECM has been marked partially complete. The administrative pod needs to be completed in conjunction with a future project.

ECM-2 Replace Boilers with Condensing Hot Water Boilers

2013 – This project was completed in the summer of 2014 district wide. The project cost was projected to be $1,419,629 with the resulting savings being $18,826 per year. A payback period of greater than 15 years determined that this measure was not feasible for an ESIP. The need remained because the equipment was at end of life and was included in summer 2014 capital projects. In addition to this, rebates in the amount of $16,000 were obtained from the NJ Clean Energy Program, post project, to offset a small portion of initial costs.

2020 – Additionally, there were two hot water boilers that were replaced at the Cliffwood Avenue Elementary School that were paid for as part of offsetting funds through the NJ Clean Energy Program in 2015. The existing 80% efficient units were replaced with 94% efficient condensing boilers. As of now, all of the District's boilers have been replaced. Units are seven years old or less.

Conclusion – This ECM has been completed.

ECM-3 Replace Window A/C Units with Ductless Splits

2013 – This project cost was projected to be $584,800 with the resulting savings being $1,298 per year. The payback period of greater than 15 years determined that this measure was not feasible for an ESIP.

2020 – This was completed as part of the various HVAC projects. Additionally, there are five classrooms at Cliffwood Elementary that are being cooled with portable units that we will look to install permanent units is as part of ongoing capital replacements.

Conclusion –The ECM has been completed but projects are now weighted more toward learning environment improvements, not necessarily energy savings improvement measures.

ECM-4 Replace Old Motors with Premium Efficiency Motors

2013 – This project encompassed Cambridge Park and Ravine Drive Schools. The projected cost was $6,065 with a resulting savings of $508. A payback period of less than 15 years determined that this project was feasible and Cambridge Park was included in the boiler replacement project during the Summer of 2014. Remaining motors at Ravine Drive are being phased in as part of regular maintenance.

2020 – These projects have been ongoing, with full upgrades complete at the Middle School, Cambridge Park, and Ravine Drive. Partial upgrades are complete at Lloyd Road School and the High School. Strathmore Elementary and Cliffwood Avenue Elementary are still pending and grants/rebates still being pursued.

Conclusion – This ECM has been completed. Ongoing maintenance and replacement are always completed with premium efficiency motors versus standard duty to ensure future compatibility with variable frequency drives.

ECM-5 Install Variable Frequency Drives (VFDs) and Premium Pumps on Hot Water Pumps

2013 – This project cost was projected to be $69,509 with the resulting savings being $7,628 per year and originally encompassed the Lloyd Road, Cliffwood Avenue, Middle, and Strathmore Schools. The payback period was determined to be less than 15 years making this project feasible for an ESIP. During the boiler replacement project of 2014, VFDs were incorporated into the designs of Cambridge Park (along with ECM-4) and added to the High School and Middle School designs (along with premium motors). VFDs will be incorporated into regular maintenance change-outs going forward at the remaining schools.

2020 – This has been ongoing for building hot water pumps. VFD's have also been introduced on booster pumps and certain exhaust systems where balancing is a critical need. Advancement in digital controls since 2013 has enabled more and more of the smaller fans (for example ceiling recirculating fans) to vary their speed depending on other sensor controlled readings.

Conclusion – This ECM has been expanded in the new 2020 ECM's. More information is listed in the 2020 ECM section.

ECM-6 HVAC Replacement of Rooftop Units

2013 – This project cost was projected to be $32,000 with an annual savings of $42. A payback period of greater than 15 years made this project not feasible for an ESIP. In the spring of 2015, another district wide assessment was done on rooftop units through the NJ Clean Energy Program's Direct Install Program. Every school but the Middle and High Schools qualified for the 70/30 cost sharing program. In total, six rooftop units were replaced as part of the project, with the district responsible for 30% of the costs. The High School and Middle School rooftop units (RTUs) will need to become part of a phase out program as part of regular maintenance going forward, especially as the government and manufacturers phase out the R-22 refrigerant used in the cooling systems.

2020 – There are now 15 rooftop units remaining that were installed before 2013. These units will need to be replaced in the upcoming years as part of ongoing capital projects. 87 units have been replaced at this time but addition to or reduction of that number is contingent on classroom HVAC design requirements.

Conclusion – This ECM is completed but also is subject to ongoing capital replacement cycles.

ECM-7A/ECM-7B Replace Existing Condensing Units with Standard Efficiency Units or with Higher Efficiency Units

2013 – The project cost was projected to be $96,900 with an annual savings of $695 for standard efficiency models and $116,700 with an annual savings of $943 for higher efficiency units. A payback period of greater than 15 years made this project not feasible for an ESIP. This project will need to become part of a phase out program as part of regular maintenance going forward, especially as the government and manufacturers phase out the refrigerant used in the systems.

2020 – This project was approved in fiscal 2020 and has yet to be installed. It is being done through the NJ Clean Energy Direct Install Program with an 80/20 cost split with the state, the District being responsible for 20%.

Conclusion – The ECM is ongoing.

ECM-8 Replace Existing Packaged Terminal Air Conditioner Unit

2013 – The project cost was projected to be $5,400 with an annual savings of $10. A payback period of greater than 15 years made this project not feasible for an ESIP. This project will need to become part of a phase out program as part of regular maintenance going forward, especially as the government and manufacturers phase out the refrigerant used in the systems.

2020 – This ECM is not complete. These units are installed in some of the offices in the administrative pod and would not be subject for removal until a new HVAC system is installed.

Conclusion – This will be completed as part of the referendum's closeout phase.

ECM-9 Install Demand Control Ventilation (DCV)

2013 – This project cost was projected to be $45,000 with an annual savings of $16,153. A payback period of less than 15 years made this project feasible for an ESIP. The original scope of the project was Lloyd Road, Cliffwood, Middle and Strathmore Schools. In the spring of 2015, another district wide assessment was done on rooftop units through the NJ Clean Energy Program's Direct Install Program. Every school but the Middle and High Schools qualified for the 70/30 cost sharing program. In total, six rooftop units were replaced and equipped with DCV as part of the project, with the District responsible for 30% of the costs. The High School and Middle School RTUs will need to become part of a phase out program as part of regular maintenance going forward, especially as the government and manufacturers phase out the refrigerant used in the cooling systems. DCV will be incorporated into the new units as they are replaced.

2020 – This ECM is almost complete. Most of the units are using DCV with carbon dioxide levels to control the amounts of outside ventilation needed. Due to COVID-19 ASHRAE guideline changes, these control schemes have been temporarily suspended to allow for more fixed ventilation. More information on this ECM in the 2020 ECM section.

Conclusion – This ECM is not complete but is still in progress.

ECM-10 Install Vending Machine Controls

2013 – This project cost was projected to be $3,600 with an annual savings of $3,174. A payback period of less than 15 years made this project feasible for an ESIP. This measure will be explored further in the coming fiscal year as part of the regular operating budget.

2020 – Access to vending machines has been greatly reduced due to elimination of availability of non-nutritious snack food and drink to the students. Prevalence of the machines on District grounds has been significantly reduced.

Conclusion – This ECM is not complete and is included in the new ECMs.

ECM-11 Install Network Controller

2013 – This project cost was projected to be $10,000 with an annual savings of $5,817. A payback period of less than 15 years made this project feasible for an ESIP. This measure is very dynamic in the sense that new technology may have already removed the need for a separate device to control the District's computer network. With the changeover to energy efficient Chromebooks and the phasing out traditional Windows-based desktops, the District will need to re-evaluate its technology model before implementing any changes.

2020 – Most of the traditional Windows based student desktops have been replaced with Chromebooks that charge off peak hours. The remaining desktops are mostly used by staff and have been replaced with CPUs with power supplies that use around 150 peak watts of power, about half of what the standard was around 2013. The number of computers available has increased however, often offsetting this savings. The District is pursuing a 1-to-1 technology ratio. Additionally, the shift to virtual servers has reduced the number of on-site servers resulting in a significant decrease in the electrical usage and need for supplemental cooling in those previously dedicated spaces.

Conclusion – This ECM is not complete but has become mostly obsolete due to a shift in computing and network controls.

ECM-12A Replace Electric Domestic Hot Water Heaters with Natural Gas

2013 – This project cost was projected to be $40,341 with an annual savings of $2,396. A payback period of greater than 15 years made this project not feasible for an ESIP. The original scope consisted of Cambridge Park and Cliffwood Schools. The Cambridge Park portion of the project was included in the boiler replacement project of 2014. The Cliffwood portion will be examined as part of regular maintenance. In addition, there is one electric heater in the ASB Building at the High School. This was replaced this year with another electric heater as there is no gas currently run to the building.

2020 – The electric hot water heater at Cliffwood was replaced with another in 2019. There is a heat exchanger that was installed as part of the boiler changeout that we have since brought online to offset the use of that electric during the heating season (there are two steam boilers in that area of the building). All the HVAC upgrades in that area have heat exchangers from steam to hot water. When it is favorable to convert those two boilers, the rest of the building is ready to roll into the system.

Conclusion – This ECM was partially completed and is not included in the new ECMs.

ECM-12B Replace Gas-Fired Domestic Hot Water Heater with Condensing Natural Gas Domestic Hot Water Heater

2013 – This project cost was projected to be $10,997 with an annual savings of $152. A payback period of greater than 15 years made this project not feasible for an ESIP. The scope only encompassed Cliffwood School and will be examined as part of the response in ECM-12A.

2020 – The hot water heater in question is still operational and we are waiting for it to come to end of life before switching over. Hot water heaters in Ravine Drive, Cambridge Park, and the High School have been replaced with condensing units.

Conclusion – This ECM is not complete and is not included in the new ECMs.

ECM-13 Install Kitchen Hood Controller

2013 – This project cost was projected to be $77,000 with an annual savings of $422. A payback period of greater than 15 years made this project not feasible for an ESIP.

2020 – These have not been completed but the ECM was updated for the 2020 version.

Conclusion – This ECM is not complete but has been modified for the 2020 audit as technology has improved for VFDs.

ECM-14 Install Walk-in Cooler/Freezer Controls

2013 – This project cost was projected to be $60,000 with an annual savings of $3,571. A payback period of greater than 15 years made this project not feasible for an ESIP. We are looking at a possible overhaul as part of regular maintenance and this would be included in that portion of the project.

2020 – This has not been completed. Incentives are being examined for upgrades and inclusion in the food services contract in the future.

Conclusion – This ECM has not been completed and is ongoing.

ECM-L1 Lighting Replacement/Upgrades

2013 – The project cost was projected to be $1,112,167 with an annual savings of $37,969. A payback period of greater than 15 years made this project not feasible for an ESIP. A portion of this project is being included in the NJ Clean Energy Direct Install Program project this summer.

2020 – This is an ongoing project and represents the largest opportunity for savings in the new audit (see breakdown in Appendix C). The District has focused on direct replacement rather than upgrades by replacing T-12 and T-8 troffers with 2' x 4' LED flat panel direct replacements. The new units are 40 watts each with 50 watt units in areas with ceilings above 10', down from 64 and 128 watts respectively.

Conclusion – This is ongoing and represents the largest energy efficiency project currently in progress. This will continue as long as the state's enhanced rebates are available.

Photovoltaic Rooftop Solar Power Generation

2013 – As part of the Energy Audit, solar power generation was examined for feasibility on the rooftops of the District's buildings. The projected cost of the project was $9,800,000 for an aggregate 2,450 kW system. Total annual savings would be approximately $374,455 annually. While the payback period is less than 15 years, a timeframe of 10-12 years is used especially with regards to projects funded with bond proceeds when assessing solar projects.

2020 – Due to roof layout changes regarding additional roof top HVAC units, the size of the system possible has been reduced to 1,270 kW. The projected cost is $3,302,000 with an annual savings of $175,670. The payback period is now 18.7 years and not feasible for an ESIP without incentives. As more incentives become available, this determination will be re-evaluated.

2020 Additional ECMs

The following ECMs were identified in the 2020 audit as feasible with the current technological possibilities of commercially available equipment. The full chart and breakdown is contained in Appendix C. These are the measures that were determined, through looking at simple payback periods, as being feasible for the next stages of energy efficiency upgrades. Notes are added to give context to the measures.

Lighting Upgrades

ECM 1 – Install LED Fixtures
ECM 2 – Retrofit Fluorescent Fixtures with LED Lamps and Drivers
ECM 3 – Retrofit Fixtures with LED Lamps

Notes: This is the largest remaining area for improvement and is already in progress. Incentives have recently been increased for qualifying public agencies (of which K-12 public schools are). Consistent investment in this area over the next two years should be sufficient to switch over all lighting in a reasonable timeframe. Constraints of timing due to COVID-19 closures have delayed, but not stopped, this implementation.

Lighting Control Measures

ECM 4 – Install Occupancy Sensor Lighting Controls
ECM 5 – Install High/Low Lighting Controls

Notes: Occupancy sensors were integrated into the HVAC controls either using existing lighting sensors or new dedicated sensors. These existing capabilities can be expanded using the dry contacts on the sensors themselves or configuring the existing Building Management System (BMS) to communicate with the 0-10 vdc inputs on the LED drivers installed in the previous section. Additional attention should be paid to controls for lighting colors as research becomes available on efficacy of lighting colors in classrooms and other applications on human productivity and learning.

Variable Frequency Drive (VFD) Measures

ECM 6 – Install VFDs on Constant Volume (CV) Fans
ECM 7 – Install VFDs on Heating Water Pumps
ECM 9 – Install VFDs on Kitchen Hood Fan Motors

Notes: This section has been made easier as digital motors have become more widely available in a variety of applications. More information will be needed on how to control these applications as integration into a larger system may have unintended consequences and violate current building codes (ex: laboratory hoods).

HVAC System Improvements

ECM 12 – Implement Demand Control Ventilation
ECM 13 – Install Pipe Insulation

Notes: The majority of the new equipment that has been installed is controlled via demand control ventilation. This measure is applicable to some of the older equipment that has fixed ventilation at around 10-15% of airflow. However, ASHRAE is currently recommending a suspension of DCV schemes in favor of fixed ventilation rates during the current public health crisis. The pipe insulation measure is due to asbestos abatement work that was performed in the past. This will be budgeted for next fiscal year out of capital funds.

Domestic Water Heating Upgrades

ECM 15 – Install Low-Flow DHW Devices

Notes: This is being evaluated for future implementation as more efficient point of use devices become available.

Food Service & Refrigeration Measures

ECM 16 – Refrigerator/Freezer Case Electrically Commutated Motors
ECM 17 – Refrigeration Display Case Doors or Covers
ECM 19 – Replace Refrigeration Equipment
ECM 20 – Vending Machine Control

Notes: These measures are evaluated through the lens of the food services budgets. This was a subject of discussion pre-COVID and will continue into the next budget cycle. Some thought should be given to absorbing costs into the outsourced service contract that manages the District’s kitchens and equipment.

Historic Energy Consumption and Costs

The District's buildings are currently delivered electricity from Jersey Central Power & Light and natural gas from NJ Natural Gas. Our supplies of both are contracted through the Alliance for Competitive Energy Services (ACES) Purchasing Cooperative provided by the New Jersey School Boards Association. The historical data being used in this assessment is benchmarked comparing data from the calendar year ending in 2014 and calendar year ending 2019 in order to avoid what will be skewed 2020 data due to COVID-19 related shutdowns. The table in Appendices D and E contain the relevant comparison data.

From evaluating the time frames using Energy Star's Portfolio Manager, the addition of cooling capacity increased the electric consumption by approximately 555,000 kWh per year. However, the adjustments in boiler system sizes as well as sequences in operations ended up decreasing natural gas consumption by about 27,200 therms per year. This offsetting consumption shifted budgetary funds from one fuel source to another allowing for the increased consumption from air conditioning. This was the first year of operation of an almost full cooling capacity. Further refinements to scheduling and operational sequences as well as the savings from the LED light installations will further reduce electricity consumption. Keeping true to the concept of an ESIP, savings will be rolled into further improvements with offsetting funds.

Conclusion

In conclusion, the findings of this report indicate that the self-financed model for an ESIP will continue to be the most cost effective. During the research for this report, a representative from one of the nation's top ESCOs, Honeywell, was brought in to give perspective from the point of view of the businesses that support the fully outsourced and hybrid financed models. Their assessment was in line with this report's findings. Much of the low cost, high return items have been completed and the remaining items, aside from lighting, do not warrant an immediate energy efficiency reasoning for replacement. Going forward, capital projects and smaller replacement projects from the regular operating budget will be the basis of funding for improvements. It is suggested that replacement of these items be included in preventative maintenance planning in the future. It is also suggested that offsetting funding be obtained as much as possible from grant funding through the NJ Clean Energy Program and others to lighten the burden on the additional costs of upgrading to energy efficient equipment.

Additionally, the opportunity for identifying education outcomes due to these improvements is something that should be studied. The recent increase in testing data that has become available since the start of these projects needs to be evaluated to see if there has been any tangible benefit besides anecdotal theoretical conclusions. We know from past academic research that this ***should*** be the case. We know from occupant and employee satisfaction surveys this ***should*** be the case. But there is nothing that serves as a smoking gun that in fact these improvements have actually improved educational outcomes. Controls for improved curriculum and better technology would need to be taken into account to definitively identify a clear causation argument rather than the current correlation we see. However, that type of conclusion is beyond the scope of this report.

In closing, let's evaluate the outcomes through the triple bottom line model that tied together the objective of these projects. First, the occupants and students have been afforded a learning and working environment with stable temperatures, cleaner air, quiet space, and brighter lighting. The equipment installed operates in a cleaner, more environmentally friendly fashion using updated refrigerants that if leaked, are not as harmful as before. Finally, all of this was done in a way that has had as little initial impact to taxpayers as possible from the initial baseline. The long-term impacts will continue to be evaluated and adjusted for as the equipment progresses through its lifecycle. The social, environmental, and financial considerations of this group of projects are what will ultimately be left behind and how those are viewed by history should be as the most sustainable decision that could have been made at the time. There will no doubt be improvements in technology that will make these decisions obsolete at one point or another, but viewed through a snapshot in time, there is no longer a need to keep looking behind, only forward at future projects to improve the District's sustainability.

Appendix A – Complete List of Projects

Year	Project	Hard Costs	Soft Costs	Funding Source(s)	Funding Offset
2013	Boiler Replacement @ Cliffwood	$504,780	$173,130	Capital Reserve	None
	ST & LR Boiler Replacement, MS & HS RTU Replacement	$873,400		Capital Reserve	None
2014	HS & MS Boiler Replacement	$917,000	$155,928	Capital Reserve/SDA	ROD Grant
	CP, ST, RD, LR Boiler Replacement	$897,800		Capital Reserve/SDA	ROD Grant
	Asbestos Abatement	$114,475	$46,413	Capital Reserve/SDA	ROD Grant
2015	CL, CP, RD, LR, and ST Direct Install Projects	$277,019	$0	Operating Budget/NJCEP Grants	$194k Grant
	Asbestos Abatement	$75,050	$25,104	Operating Budget	None
	HVAC 400 Wing HS/ CP Controls	$1,260,271	$73,823	Capital Reserve	None
	CL HVAC 2nd Floor	$797,485	$40,073	Capital Reserve/SDA	ROD Grant
	LR HVAC 2nd Floor	$1,256,786	$61,200	Capital Reserve/SDA	ROD Grant
	HS & MS Locker Rooms HVAC	$255,249	$25,000	Capital Reserve/SDA	ROD Grant
	HS Rm 202 HVAC	$249,270	$1,319,332	Bond Proceeds	40% Debt Service Aid
2016	CP HVAC Referendum Ph 1	$1,417,624		Bond Proceeds	40% Debt Service Aid
	CL HVAC Referendum Ph 1	$1,695,191		Bond Proceeds	40% Debt Service Aid
	LR HVAC Referendum Ph 1	$2,666,653		Bond Proceeds	40% Debt Service Aid
	RD HVAC Referendum Ph 1	$802,029		Bond Proceeds	40% Debt Service Aid
2017	HS HVAC Referendum Ph 2	$1,478,810		Bond Proceeds	40% Debt Service Aid
	MS HVAC Referendum Ph 2	$2,774,880		Bond Proceeds	40% Debt Service Aid
	ST HVAC Referendum Ph 2	$1,089,500		Bond Proceeds	40% Debt Service Aid
	RD HVAC Referendum Ph 2	$1,478,513		Bond Proceeds	40% Debt Service Aid
	Asbestos Abatement	$108,400	$20,520	Bond Proceeds	40% Debt Service Aid
	CP Windows	$443,400	$39,000	Capital Reserve	None
	RD Cafeteria/Gym LED Lighting	$3,540	$0	Operating Budget/NJCEP Grant	$975 Grant
	MS Classrooms, Offices, Halls LED Lighting	$7,280	$0	Operating Budget/NJCEP Grant	$1,900 Grant
2018	HS HVAC Referendum Ph 3	$2,262,900	See Above	Bond Proceeds	40% Debt Service Aid
	MS HVAC Referendum Ph 3	$796,332		Bond Proceeds	40% Debt Service Aid
	ST HVAC Referendum Ph 3	$1,214,000		Bond Proceeds	40% Debt Service Aid
	Asbestos Abatement	$228,905	$8,540	Bond Proceeds	40% Debt Service Aid
	HS HE Water Heaters	$23,112	$0	Capital Reserve	None
2019	Prescriptive Lighting (1900 LED Troffers)	$165,000	$0	Operating Budget/NJCEP Grant	$95k Grant
2020	CP Direct Install Project	$117,939	$0	Operating Budget/NJCEP Grant	$95k Grant
	Total Internal ESIP Project Costs	$26,252,593	$1,988,062		

Appendix B – Listing of IEQ Research Reviewed

Apte, M., W. Fisk, and J. Daisey. 2000. "Associations between indoor CO2 concentrations and sick building syndrome symptoms in U.S. Office buildings: An analysis of the 1994-1996 BASE study data." Indoor Air 10: 246-257.

Fang, L., G. Clausen, and P.O. Fanger. 1998. "Impact of temperature and humidity on perception of indoor air quality during immediate and longer whole-body exposures." Indoor Air 8: 276-284.

Fang, L., G. Clausen, and P.O. Fanger. 1998. "Impact of temperature and humidity on the perception of indoor air quality." Indoor Air 8: 80-90.

Fang, L., P. Wargocki, et al. 1999. "Field study on the impact of temperature, humidity and ventilation on perceived air quality." Proceedings, Indoor Air '99: The 8th International Conference on Indoor Air Quality and Climate. Edinburg, Scotland. 2:107-112.

Mendell, M. 1993. "Non-specific symptoms in office workers: A review and summary of the epidemiologic literature." Indoor Air 3 (4):227-236.

Myhrvold, A.N., E. Olsen, and O. Lauridsen 1996. "Indoor environment in schools — Pupils health and performance in regard to CO2 concentrations." Proceedings, Indoor Air '96: The 7th International Conference on Indoor Air Quality and Climate. Nagoya, Japan. 4:369-371.

Seppänen, O., W.J. Fisk, et al. 1999. "Association of ventilation rates and CO2 concentrations with health and other responses in commercial and institutional buildings." Indoor Air 9 (4):226-252.

Shaughnessy, R.J., et al. 2006. A preliminary study on the association between ventilation rates in classrooms and student performance. Indoor Air 16(6): 465-468.

Sundell, J. 1994. "On the association between building ventilation characteristics, some indoor environmental exposures, some allergic manifestations and subjective symptom reports." Indoor Air Supplement 2:94.

Sundell, J., T. Lindvall, and B. Stenberg. 1991. "Influence of type of ventilation and outdoor airflow rate on the prevalence of SBS symptoms." Proceedings, IAQ '91, Healthy Buildings. Conference of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Washington, DC. 85-89.

Wargocki, P., D.P. Wyon, et al. 1999. "Perceived air quality, SBS-symptoms and productivity in an office at two pollution loads." Proceedings, Indoor Air '99: The 8th International Conference on Indoor Air Quality and Climate. Edinburg, Scotland. 2:131-136.

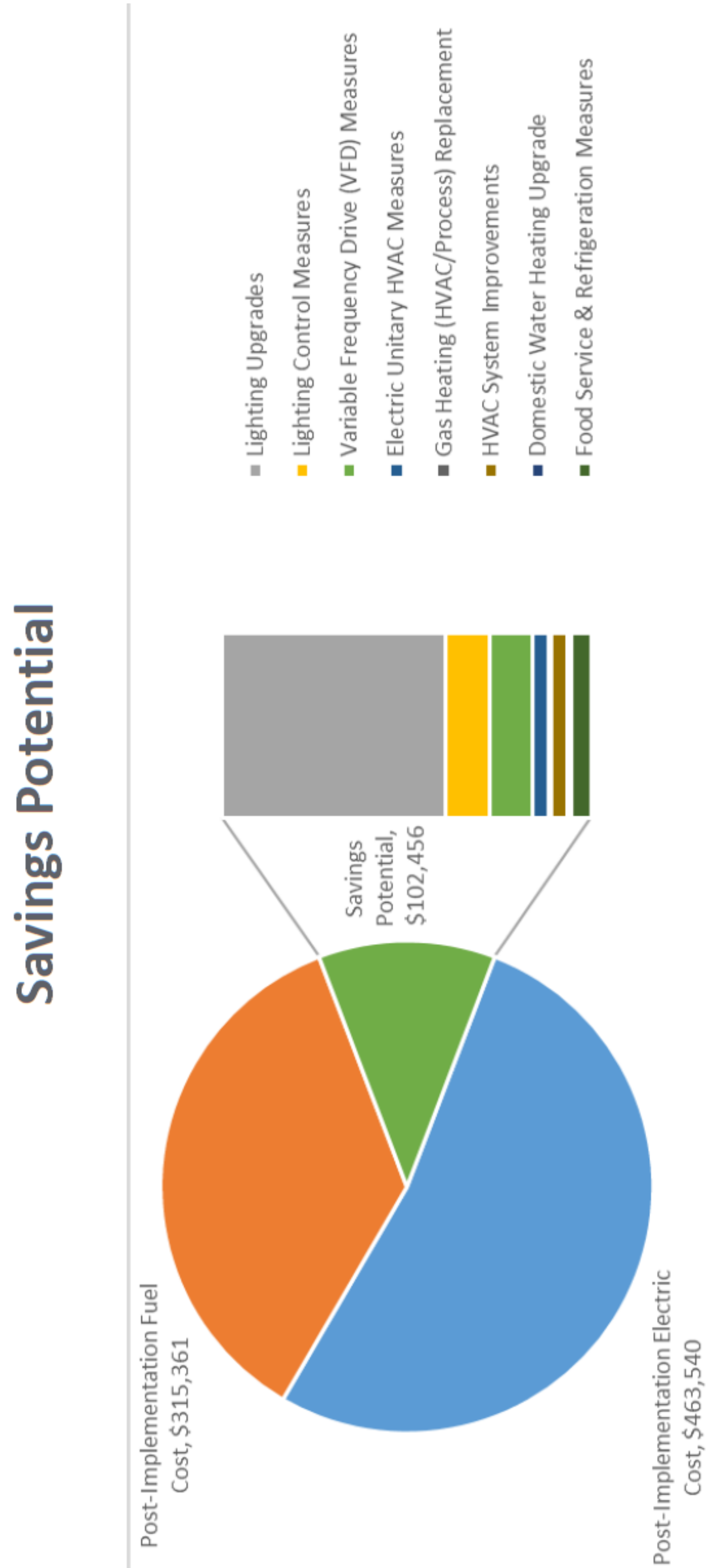
Appendix B – Listing of IEQ Research Reviewed (cont.)

Wargocki, P., D.P. Wyon, et al. 2000. “The effects of outdoor air supply rate in an office on perceived air quality, sick building syndrome (SBS) symptoms and productivity.” Indoor Air 10 (4):222-236.

Wargocki, P. D.P. Wyon. 2006. “Research report on effects of HVAC on student performance.” ASHRAE Journal October 2006:22-28.

Wargocki, P. D.P. Wyon. 2007. “The effects of moderately raised classroom temperatures and classroom ventilation rate on the performance of schoolwork by children.” HVAC&R Research 13 (2):193-220.

<u>Appendix C - Breakdown of 2020 ECMs</u>



Appendix C - Breakdown of 2020 ECMs (cont.)

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**524,013**	**146.1**	**-105.4**	**$61,868**	**$208,514**	**$104,058**	**$104,456**	**1.7**	**515,338**
ECM 1	Install LED Fixtures	16,688	0.0	0.0	$2,018	$7,302	$1,000	$6,302	3.1	16,804
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	496	0.3	-0.1	$56	$336	$72	$264	4.7	491
ECM 3	Retrofit Fixtures with LED Lamps	506,830	145.8	-105.3	$59,794	$200,877	$102,986	$97,891	1.6	498,043
Lighting Control Measures		**105,417**	**22.9**	**-22.0**	**$12,433**	**$106,591**	**$38,175**	**$68,416**	**5.5**	**103,577**
ECM 4	Install Occupancy Sensor Lighting Controls	75,814	17.3	-15.8	$8,962	$73,966	$16,330	$57,636	6.4	74,492
ECM 5	Install High/Low Lighting Controls	29,603	5.5	-6.2	$3,471	$32,625	$21,845	$10,780	3.1	29,085
Variable Frequency Drive (VFD) Measures		**88,871**	**25.0**	**20.9**	**$10,961**	**$93,870**	**$25,600**	**$68,270**	**6.2**	**91,934**
ECM 6	Install VFDs on Constant Volume (CV) Fans	78,689	24.0	0.0	$9,499	$82,707	$21,850	$60,857	6.4	79,239
ECM 7	Install VFDs on Heating Water Pumps	9,129	1.1	0.0	$1,125	$8,152	$3,600	$4,552	4.0	9,193
ECM 9	Install VFDs on Kitchen Hood Fan Motors	1,053	0.0	20.9	$338	$3,010	$150	$2,860	8.5	3,502
HVAC System Improvements		**3,538**	**0.0**	**87.8**	**$1,330**	**$8,405**	**$172**	**$8,233**	**6.2**	**13,839**
ECM 12	Implement Demand Control Ventilation (DCV)	3,538	0.0	68.9	$1,123	$8,157	$0	$8,157	7.3	11,629
ECM 13	Install Pipe Insulation	0	0.0	18.9	$207	$248	$172	$76	0.4	2,210
Domestic Water Heating Upgrade		**695**	**0.0**	**33.6**	**$443**	**$918**	**$656**	**$262**	**0.6**	**4,638**
ECM 15	Install Low-Flow DHW Devices	695	0.0	33.6	$443	$918	$656	$262	0.6	4,638
Food Service & Refrigeration Measures		**35,723**	**4.0**	**0.0**	**$4,285**	**$16,586**	**$1,800**	**$14,786**	**3.5**	**35,972**
ECM 16	Refrigerator/Freezer Case Electrically Commutated Motors	3,794	0.4	0.0	$445	$3,033	$800	$2,233	5.0	3,821
ECM 17	Refrigeration Display Case Doors or Covers	2,264	0.3	0.0	$275	$1,003	$300	$703	2.6	2,279
ECM 19	Replace Refrigeration Equipment	17,757	2.0	0.0	$2,130	$10,250	$0	$10,250	4.8	17,881
ECM 20	Vending Machine Control	11,907	1.4	0.0	$1,435	$2,300	$700	$1,600	1.1	11,991
TOTALS		**758,257**	**198.1**	**14.9**	**$91,322**	**$434,883**	**$170,461**	**$264,423**	**2.9**	**765,299**

Appendix D-
Current Energy Performance Data Comparisons
2014 vs. 2019

Energy Performance
Date Downloaded: 11/27/2020 02:25 PM EST
Date Generated: 11/27/2020 02:24 PM EST
Number of properties in report: 10
Comparing Year Ending: 12/2014 with 12/2019

Property Id	Property Name	Site EUI (kBtu/ft²) Change	Source EUI (kBtu/ft²) Change	Weather Normalized Site EUI (kBtu/ft²) Change	Weather Normalized Source EUI (kBtu/ft²) Change	Site EUI - Adjusted to Current Year (kBtu/ft²) Change	Source EUI - Adjusted to Current Year (kBtu/ft²) Change	National Median Site EUI (kBtu/ft²) Change	National Median Source EUI (kBtu/ft²) Change	% Difference from National Median Source EUI Change	Energy Cost ($) Change
3760884	Cliffwood Elementary School	-1.5	4.1	3.2	8.7	-16.8	-17.5	7.9	16.5	-13.9	-1736.46
3760902	Matawan Aberdeen Middle School	-7	-14.3	-4.4	-11.6	-17.3	-32.8	7.8	12.1	-24.5	-23745.43
3760961	Matawan Regional High School	5.8	13.1	10.1	17.7	-0.3	3.1	3.8	9.8	2.2	5267.68
3760972	Ravine Drive Elementary School	-16.6	-8.1	-12.6	-3.9	-30.2	-28.2	-0.5	16.5	-21.1	-6992.07
3760977	Strathmore Elementary School	-8.2	-10.7	-4.3	-6.7	-8.4	-11	-1.2	0.4	-9	-9282.71
4353674	Lloyd Road Elementary School	6.4	25.4	9.5	28.7	-11.9	-1	8	31.5	-0.1	26140.58
4353743	Administration Building & Pre-K	-12.5	-6.6	-8.8	-3.4	-25.5	-26.4	2.8	18.1	-17.7	-6764.69
12440343	Matawan Regional High School (Campus)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	-39.7	-40	Not Applicable	Not Applicable
12440457	High School All Sports Building	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	0	0	Not Applicable	Not Applicable
12440459	High School Maintenance Building	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	0	0	Not Applicable	Not Applicable
										Total	-$17,113.10

Appendix E – Yearly Energy Cost Comparisons 2014 to 2019

Fuel Performance
Date Downloaded: 11/29/2020 09:02 AM EST
Date Generated: 11/29/2020 09:02 AM EST
Number of properties in report: 10
Comparing Year Ending: 12/2014 with 12/2019

Property Id	Property Name	Site Energy Use (kBtu) Change	Energy Cost ($) Change	Electricity Use - Grid Purchase (kWh) Change	Electricity (Grid Purchase) Cost ($) Change	Natural Gas Use (therms) Change	Natural Gas Cost ($) Change
3760884	Cliffwood Elementary School	-99774	-$1,736.46	63213.3	$8,198.21	-3154.576958	-$9,934.67
3760902	Matawan Aberdeen Middle School	-617435.9	-$23,745.43	-116348.5	-$12,597.19	-2204.547081	-$11,148.24
3760961	Matawan Regional High School	882398.6	$5,267.68	181762.3	$18,242.00	2622.256438	-$12,974.31
3760972	Ravine Drive Elementary School	-807342.2	-$6,992.07	75884.5	$8,195.94	-10662.60323	-$15,188.00
3760977	Strathmore Elementary School	-516371.5	-$9,282.71	-21562.7	-$2,326.37	-4427.997095	-$6,956.34
4353674	Lloyd Road Elementary School	651616.3	$26,140.58	321006.5	$39,906.28	-4436.580557	-$13,765.70
4353743	Administration Building & Pre-K	-580666.4	-$6,764.69	50664.7	$4,671.23	-7535.34485	-$11,435.92
12440343	Matawan Regional High School (Campus)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	2622.256438	-$12,974.31
12440457	High School All Sports Building	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
12440459	High School Maintenance Building	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
	Total	-1087575.1	-$17,113.10	554620.1	$64,290.10	-27177.13689	-$94,377.49