IV. ENERGY AND INFRASTRUCTURE

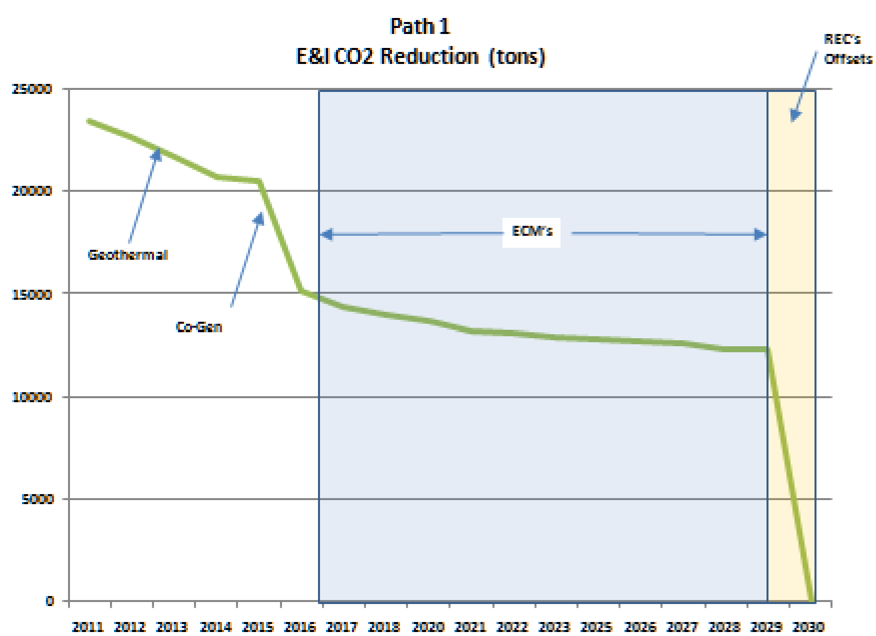
Xavier University's Physical Plant Department has responsibility for managing the physical fixed assets of the University in a responsible, professional manner. This includes adherence to a strong sustainability and fiscal policy to minimize waste and reduce consumption, thereby reducing carbon dioxide emissions to the absolute minimum.

PURCHASED ENERGY

Long-Term Vision: To minimize GHG emissions from the purchase and use of electricity and natural gas (stationary fuel sources) to the fullest extent possible, considering the mix of buildings, available and future technologies, capital investment requirements, and the impact of market forces. Two paths have been identified from which to choose the initial reductions in the GHG emissions from purchased electricity and stationary fuel sources. To achieve our goals, investments in a multitude of alternative energy, energy conservation measures, and offsets to are necessary. The trajectory of emissions reductions will depend on the path taken.

Path 1:

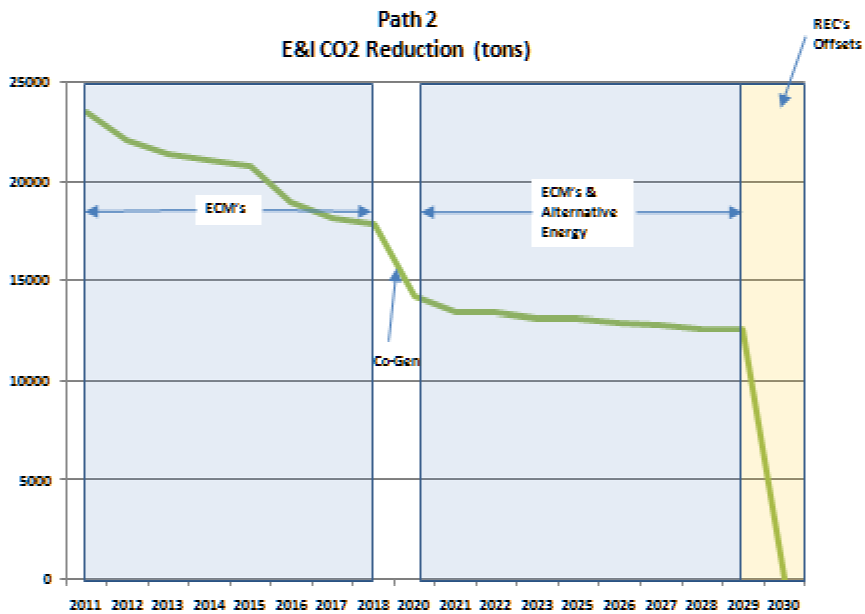
- Invest in alternative technologies such as solar, geothermal, co-generation and fuel cells to achieve at least a 7% reduction from 2008 levels by 2012 and use the cost avoidance savings to fund other carbon reduction initiatives.
- Further reduce greenhouse gas emissions to 50% reduction (an additional 43%) by 2030 through other alternative energy and energy conservation measures with an intermediate step of 35% reduction by 2018.



IV. ENERGY AND INFRASTRUCTURE

Path 2:

- Gradually reduce our greenhouse gas emissions to achieve a 25% reduction by 2018 through higher ROI energy conservation measures.
- Further reduce greenhouse gas emissions to 50% reduction (an additional 25%) by 2030 through higher ROI alternative energy and energy conservation measures.



Regardless of the path chosen:

- Investment in offsets (preferably tangible, measureable initiatives in the surrounding community) will probably be required for the remaining 50% by 2030.
- All subsequent planning and new construction will require that achieving carbon neutrality is key to the overall design.

PATH 1

A. Alternative Energy Systems First

The University can have the most significant impact on GHG emissions by investing in alternative or renewable-energy projects.

Goal: To invest in energy saving capital investment projects that achieve a reasonable annual return-on-investment (ROI) and also effectively reduce the overall carbon footprint and enhance our good citizenship and green image.

IV. ENERGY AND INFRASTRUCTURE

1. ACTION PLAN:

Short-term Goals (1-2 years)

- *Invest in alternative energy projects that maximize monetary savings while at the same time reducing GHG emissions by 7%. The savings from these investments would fund other GHG reduction strategies. See Appendix "D" for details concerning alternative energy options.*
- *Track the costs, commodity markets, and suppliers of renewable energy credits and GHG offset credits.*

Mid-term Goals (3-5 years)

- *Invest in alternative energy projects with longer-term ROI. As the payback period for a potential project increases, a point is reached where the ROI target is no longer met. Longer payback projects still earn a ROI that is better than buying GHG credits which have no ROI. Again, refer to Appendix "E" for details.*
- *Invest in other alternative energy and high ROI ECMs (see Path 2 below) to achieve a cumulative 35% reduction.*
- *Research technological advances and incorporate into a revised strategy as they become viable.*

Long-term Goals (5-10 years)

- *Invest in alternative energy technologies that matured to the point they have a reasonable payback period (highly dependent on the cost of credits at this time).*
- *Invest in higher ROI ECMs keeping in mind that the goal is to achieve a 50% reduction by 2030.*
- *Invest in off-campus energy-saving projects that avoid the need to buy GHG credits to achieve zero emissions.*[1]
- *Avoid the purchase of GHG credits or renewable-energy credits, which are a pure cost and have no savings stream.*

2. CHALLENGES AND FUNDING:

- The current technology is undergoing rapid change. It is doubtful that investing in the current state-of-the-art technology will provide the same advantages as later-stage technology. Having said that, it is important to seize opportunities as soon as possible because grants and other sources of funding may not be available later. The sooner investment is made in renewable sources, the sooner the University can realize the benefits.
- The market price for a REC at the present time has a wide range ($0.001 to $0.030 per kWh). Market forces will likely drive this price much higher in the future as more building owners seek to reduce their carbon footprint.

[1] For projects that save electric energy, the maximum target discounted payback period ranges from zero years if there is no cost for credits, up to 1.2 years if credits cost $20/ton/year. For projects that save natural gas, the maximum target discounted payback period ranges from zero years if there is no cost for credits, up to 1.5 years if credits cost $20/ton/year. **The conclusion is that the University should invest in off-campus projects as an investment in the community, not as an economical path to GHG emission reductions.**

IV. ENERGY AND INFRASTRUCTURE

PATH 2

A. Retrofitting Existing or Constructing New Buildings First

Investment in physical fixed assets through proper application of energy-saving projects produces monetary savings for XAVIER UNIVERSITY and reduces the amount of GHG credits that must be purchased to achieve zero emissions.

Goal: Future buildings and building retrofits must be as efficient as economically possible.

1. ACTION PLAN:

Short-term Goals (1-2 years)

- *Devise ways to achieve academic program goals while building as little new space as possible. Construction costs, energy costs, and emissions would be lower. No amount of conservation can avoid increasing University emissions when additional square footage is built. Strategies could include better monitoring of space utilization to guide needs, "congestion pricing" for academic departments and tuition rates (lower rates at times when space usage is low), and building more flexible space that can be used for more functions more hours of the day.*
- *Perform operational optimization through effective use of the building controls system. This could mean establishing thermostat set points and reducing the ability of the end user to modify set points. If the University adopted a policy of uniform temperature settings (74 degrees during the cooling season and 70 degrees during the heating season), an 8% - 10% savings could be realized. Specifically, the University could anticipate saving $200,000 in electric cost (or 2,300,000 kWh of electricity) as well as $60,000 (or 10,000 MCF of natural gas).*
- *Identify and implement high-value Energy Conservation Measure (ECM) projects in the existing buildings and central utility plants.*
- *Review, verify and update University data. Refine the calculation methodology used in this plan based on individual ECM investigations on a building-by-building and system-by-system basis. Identify and verify the University facilities with the highest energy consumption per square foot. This will require additional metering and/or modeling. Organize the data streams using automated tools, dashboards, and smart reporting. Communicate performance to all participants (building occupants, Physical Plant, academic departments). While not a direct energy saver, metering can provide valuable information on where attention and investment should be focused. It can help spot anomalies and wasteful practices, guide facility policies, and allow charge-back of energy costs to the end users (to incentivize conservation).*
- *Follow the development and commercialization of new technologies that would be applicable to the University, including more effective lighting and better control algorithms.*
- *Be flexible in the program direction based on changing energy price signals, particularly higher electric rates that would make electrical savings more valuable. GHG emissions are strongly impacted by electricity use.*

- *Take advantage of incentive programs and grants. Recently, Duke Energy adopted their Save-A-Watt campaign in Ohio which pays for part of the cost of energy analyses and is integrated with their prescriptive and custom incentive (rebate) programs.*
- *Develop a different financing model. The cost of new buildings are traditionally benchmarked against buildings of similar function and size that other entities have built. Budgets are usually set early in the project and the entire design and construction team works to meet that cost-per-SF, cost-per-bed, or cost-per-classroom-seat budget. Most historical cost data is from buildings that were not energy efficient or only make modest attempts to be more efficient. Perhaps a new model would involve benchmarking the construction cost to a base-building performance concept, then adding incremental funding to support "super efficient" concepts. This incremental funding could come from a different University budget, outside donors (naming rights for the energy systems?), or third-party investors who would finance the incremental investment over time.*
- *Set higher energy design standards for new and renovated buildings. Go beyond LEED certification as the benchmark. There is evidence that LEED buildings do not necessarily reduce GHG emissions[2]. As a result, systems are selected that have been routine over the last 20 years[3]. An alternative would be to set BTU/SF/year targets, use the "Energy Star" points system, or the "ASHRAE EQ Rating System" rather than a single percentage-reduction benchmark.*
- *Perform enhanced modeling – most building and energy system modeling is done after the concepts are established, to verify that the building meets code and to see how many LEED points can be earned. Modeling should be done early in the design process to examine dozens of variables and concepts while changes can still be easily made.*
- *Require equal marginal performance analyses for all systems and components. That is, if the desired ROI is 10%/year, the efficiency of every component and subsystem should be improved until the ROI limit is reached.*
- *Insure that the construction-cost benchmarks adapt to the GHG emission-reduction goals. Incentivize the design and construction teams to respond appropriately. State the cost of achieving net zero emissions – require the design team to calculate the life-cycle cost of the proposed building design, including purchasing renewable energy credits or GHG credits to offset all purchased energy. The life-cycle cost*

[2] John H. Scofield, Oberlin College, examined the data from 121 LEED certified buildings and in his paper *A Re-examination of the NBI LEED Building Energy Consumption Study* stated the following: "*All strategies for reducing our nation's GHG emission start with improving building efficiency. LEED certification has not been useful at reducing building primary energy consumption and, by inference, GHG emission associated with building operation. There may be many green benefits from LEED certification – but reduction of primary energy consumption for building operation is not one of them…… There then appears to be no scientific basis for institutions such as colleges, universities, or the Federal Government to require that, as a GHG or energy reduction strategy, all new buildings obtain LEED certification. Similarly there is no justification for USGBC claims that LEED Certified commercial buildings are using significantly less electricity or have significantly lower GHG emission associated with their operations than do conventional buildings*."

[3] LEED points are earned for the %age cost reduction that the proposed building is expected to achieve compared to a base building, as defined by ASHRAE Standard 90.1. Depending on the type of building and the utility sources, Standard 90.1 is an inconsistent benchmarking tool. For example, small proposed buildings are allowed to be compared to less efficient base buildings, making the % savings appear higher even though the BTU/SF/year is no better than a large building would achieve. No credit can be earned for passive solar features or improved building massing. There is no baseline performance for fume hoods, IT equipment, and electrical equipment. The comparisons are made based on utility cost, not GHG emissions or source energy use. Thus, a proposed design may be more cost efficient but have higher GHG emissions due to greater reliance on electricity.

would equal the building first cost + the net present value of [the annual utility costs + the annual cost of GHG credits + the annual cost of maintenance]. This would insure that the building optimization process includes all future costs of the building in line with the University's environmental goals.

Mid-term Goals (3-5 years)

- *Continue to insure that the construction-cost benchmarks adapt to the GHG emission reduction goals.*
- *Add a cogeneration system. The larger the system, the greater the number of buildings that should be served from the new Central Utility Plant (CUP) so the recovered energy has a place to be used.*
- *Continue to identify and implement high-value "Energy Conservation Measure" (ECM) projects in the existing buildings and central utility plants.*

Long-term Goals (5-10 years)

- *Implement the remaining ECMs that apply to future buildings or require technology advancements as buildings are designed or as the technology becomes economical.*
- *Research technological advances and incorporate into a revised strategy as they become viable.*

2. ENERGY CONSERVATION MEASURES (ECMs)

Existing Buildings

The proposed ECMs for the existing buildings were arranged in order of increasing simple payback period and plotted against cumulative GHG emissions. Future technologies, such as LED lights and fuel cells, and central utility technologies, such as geothermal and photovoltaic, were not included.
Figure 1 shows that about 18-20% of the existing-building emissions can be cost-effectively reduced with ECMs that have a 10-12 year or lower simple payback period. To increase the emission reduction another 5% to 25% requires extending the allowable simple payback period to about 25 years.
The 12-year simple payback period cut-off excludes improved utility metering. The metering is valuable to allow monitoring of building performance and should be included in the mix. Most of the existing-building ECMs cost less than $400/ton of GHG emissions saved.
Figure 2 shows the cumulative capital investment as the GHG emission reduction increases. A capital investment of approximately $3.3mm would be required (including the cost of submetering) to achieve a 20% GHG reduction. The cumulative annual savings of $550,000 would result in an overall simple payback period of 6 years.

The ECMs included in the mix are:

1. Revised air filter program
10. Infiltration reduction

2. Compact fluorescent lamps
3. Power management
4. Occupancy sensors
5. Variable speed drives
6. Modify controls
7. Motor replacements
8. Recommissioning
9. T5/T8 lamp conversions
11. "Energy Star" appliances/equipment
12. Pool upgrades
13. Ventilation energy recovery
14. Kitchen refrigerators - heat recovery
15. Shading devices
16. Water conservation measures
17. Mall piping replacement

Existing + Future Buildings

The proposed ECMs for all buildings were arranged in order of increasing simple payback period and plotted against cumulative GHG emissions. Included were three major technologies: About 30% of the 50% reduction in the total emissions is due to three ECMs – LED lights, "next level" new buildings, and cogeneration. Due to the uncertain economics of these items there could be considerable variation in the actual cost-effective outcome (will LEDs become cost effective? can future buildings have 30% lower emissions? how much heat can really be recovered from a cogeneration system?).

Figure 4 shows that about 30% of the projected future emissions can be cost-effectively reduced with ECMs that have a 10-12 year or lower simple payback period. If the allowable marginal payback period is extended to about 14 years, a natural-gas-fired cogeneration system can be included in the CUP. This would increase the emissions reduction to 50%.

Figure 5 shows the cumulative capital investment as the GHG emission reduction increases. A capital investment of about $11mm would be required (including the cost of submetering) to achieve a 50% reduction. The cumulative annual savings of $1.5mm would result in an overall simple payback period of about 8 years.

1. Revised air filter program
2. Compact fluorescent lamps
3. Power management
4. Occupancy sensors
5. Modify controls
6. Lower coil/duct/filter velocities
7. Infiltration reduction
8. Recommissioning
9. Motor replacements
10. T5/T8 lamp conversions
11. Variable speed drives on pumps and fans
12. Energy Star appliances, equipment
13. Pool upgrades
14. 30% energy savings in new buildings
15. LED light fixtures
16. Ventilation energy recovery
17. Daylighting
18. Kitchen refrigerators - heat recovery
19. Boiler energy recovery (condensing economizer)
20. Shading devices
21. Super insulation
22. Water conservation measures
23. Mall piping replacement
24. Logan boilers decommission – serve from CUP
25. Cogeneration system

A geothermal heating system and a heat recovery chiller, while having better payback than the cogeneration system, is not as effective at reducing GHG emissions. These types of systems substitute greater use of coal-generated electricity for natural gas. The cogeneration system produces electricity from natural gas which results in a large reduction in GHG emissions. As long as a significant portion of the waste heat can be used, cogeneration is a better choice .from a GHG reduction perspective only. The cogeneration system costs about $275/ton of GHG emissions saved. For comparison purposes, the geothermal system costs $5,000/ton and the heat recovery chiller costs $1,500/ton. Geothermal provides better ROI and if employed the savings could be used to fund other ECM's.

Most of the future-building ECMs cost $500-$1,500/ton of GHG emissions saved. This is higher than the existing-building ECMs indicating a dependency on longer-payback, new-technology items.

Figure 6 shows how the capital investment is related to the emissions reduction. The investment level is nearly linear with increasing emissions reduction.

*Figure 7*a shows the net present value of the capital investments, energy savings, and GHG credit costs at $3/ton/year credit cost. The optimum net present value is at the 30% GHG reduction level. If the cost of GHG credits is increased to $20/ton/year, as shown in *Figure 7b*, the optimum GHG reduction %age increases to about 45-50% (the cogeneration system is cost effective). The curve is also shifted downward (lower net present value at every point).

Figure 8a shows the net present value of the capital investments, energy savings, and cost of purchasing green power. It was assumed that green power at $0.002/kWh would be purchased for all purchased electricity remaining after the ECMs are implemented. The optimum net present value is at about the 35% GHG reduction level (this does not include the cogeneration system).

If the cost of green power is increased to $0.015/kWh, as shown in *Figure 8b*, the optimum GHG reduction %age is still about 35%. The curve is also shifted downward (lower net present value at every point).

After implementation of the economical ECMs, the University site-energy intensity (without accounting for the cogeneration system) would be:

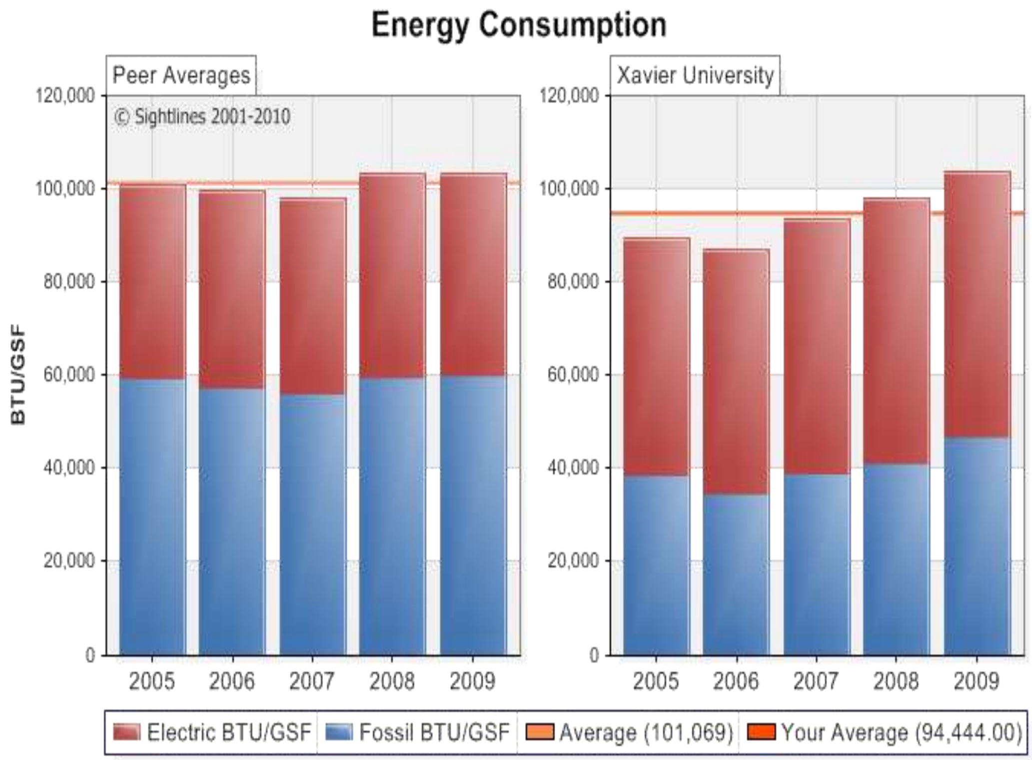
	Base Case, BTU/SF/Year	After ECMs, BTU/SF/Year
Existing buildings	104,000	59,000
Future buildings	73,000	40,000
All buildings	89,000	50,000

Implementation of the cogeneration system increases the University site-energy intensity to about 65,000 BTU/SF/year but decreases the overall GHG emissions. As the result of all ECMs, emissions would be reduced from 43,500 tons to about 22,500 tons (45-50% decrease).

3. CHALLENGES AND FUNDING:

- From a study performed by "Sightlines" (a company employed to benchmark Physical Plant in 2010), from 2005 to 2010, on a BTU/GSF basis, the University has increased consumption of all purchased energy, especially electrical energy, and currently exceeds the peer average. The root cause is unknown at this point, but it is suspected that increased use of the larger facilities and increased enrollment are factors.

IV. ENERGY AND INFRASTRUCTURE



- The future buildings being proposed could double the area of the campus under roof. No building can be made net-zero (without the inclusion of renewable-energy systems). They will only increase the carbon footprint of the University.
- Increased enrollment will place greater demands on all facilities and eventually cause an increase in purchased energy.
- Investment in super efficient buildings places a strain on University finances. In the short term, additional funds may need to be borrowed thus potentially affecting programming, scope and other features.

IV. ENERGY AND INFRASTRUCTURE

WATER CONSERVATION

Long-term Vision: To reduce the use of fresh water for University purposes by:

- Balancing the withdrawal of freshwater from the ecosystem to match the natural replenishment.
- Reducing energy consumption due to water pumping, delivery and wastewater treatment facilities.

Water used at the University is from the Ohio River, essentially an inexhaustible supply. Thus, the campus does not have a sustainability issue in terms of water supply. However, the water used at the University is processed by the GCWW to drinking water standards, an expensive process. So, in addition to the financial benefits from water conservation measures, the measures that reduce consumption by flushing toilets, bathing, cleaning, and irrigation also reduce the impact on GCWW and MSD.

A. Reduce the Consumption and Withdrawal of Fresh Water

Goal: To reduce overall water consumption levels by 40% from 2010 levels.

1. ACTION PLAN:

Short-term Goals (1-2 years)

- *Review, verify and update campus water consumption data. Identify the campus facilities with the highest water consumption.*
- *Provide water usage feedback and education to campus users.*
- *Initiate dorm competitions and provide water consumption data.*
- *Install faucet restrictors on any sinks that have not received flow restrictors.*
- *Investigate the reuse of captured storm water for irrigation.*

Mid-term Goals (3-5 years)

- *Encourage student, faculty and staff to report water waste on campus.*
- *Replace older high-volume flush toilets with low-volume flush toilets.*
- *Replace older high-volume urinals with low-volume urinals.*
- *Consider replacing the natural grass on Hayden Field with an artificial grass surface to reduce irrigation and maintenance costs.*
- *If feasible, implement the use of retained storm water for irrigation of turf areas.*

Long-term Goals (5-10 years)

- *Reduce irrigation needs through landscape design and planting of selective drought-tolerant species.*
- *Continue to encourage student, faculty and staff to report water waste on campus.*
- *Expand the use of retained storm water for irrigation of turf areas*

2. CHALLENGES AND FUNDING:

- Without significant assistance from grants and other sources, most of the proposed goals requiring large capital expenditures cannot currently be funded and may be delayed.

STORM WATER MANAGEMENT

Long-term Vision: To reduce stormwater runoff by:
- Retention of water on site.
- Reduction of the rate of runoff.

Stormwater runoff is a matter of serious concern to Cincinnati's Metropolitan Sewer District (MSD) due to combined sewer overflows (CSOs). In addition, pollutants from parking and roof areas are conveyed untreated to rivers and streams and cause depletion of groundwater resources.

A. Storm Water Runoff from all Manmade Surfaces

Goal: To reduce storm water runoff by 10,000,000 gallons per year within 5 years.

1. ACTION PLAN:

Short-term Goals (1-2 years)

- *Analyze multiple options to determine the feasibility of each, as well as quantify the potential reduction in storm water discharge into the MSD combination sewers.*
- *Obtain geotechnical data to determine the feasibility of storm water management features into the soils in various areas.*
- *Consider the installation of green roofs for all new construction.*
- *Investigate the reuse of captured storm water for irrigation.*
- *Perform routine cleaning of parking lots.*
- *Install educational and informational signage at all rain gardens or other retention areas.*
- *Conduct ongoing storm water public education and outreach programs. Schedule public education events to coincide with "Earth Day" or "Sustainability Day" activities.*
- *Expand the Sustainability website to include Storm Water Management education.*

Mid-term Goals (3-5 years)

- *Capture storm water runoff from the Cintas Center and Cohen Center parking lots to possibly provide irrigation for the intramural field located north of the Cintas Center.*

- *Convert the existing detention basins at the north end of the Cintas Center parking lots to retention ponds to provide a storage mechanism for the runoff from the Cintas Center and Cohen parking lots during the winter (non-irrigation) months.*
- *If porous pavements are viable, install areas of pervious pavement, bioswales, and/or rain gardens within the Cintas Center and Cohen Center parking lots to promote soil infiltration rather than direct storm water runoff from these areas.*

Long-term Goals (5-10 years)

- *Install an underground detention structure on the west side of the Gallagher Student Center to provide irrigation in areas on the west side of Victory Parkway. Hayden Field and/or the open space area to the north of Hayden Field could be possible areas to irrigate using the stored water from the underground detention structure.*
- *Replace the 7-year old Corcoran Field synthetic turf. An increased size of the gravel base below the field could be utilized to provide increased storm water storage and infiltration.*
- *Install an underground vault near the Learning Commons, College of Business, and/or the new Residence Hall sites to capture storm water runoff from the roofs of the buildings to use as irrigation water on the site(s). Irrigation of the exterior areas surrounding the Schott Hall Admissions Office could be serviced from the Learning Commons underground vault to inform campus visitors of the University's commitment toward the application of green building principles.*
- *Install multiple underground irrigation vaults within the Academic Mall area to capture storm water runoff from the roofs of the surrounding buildings for irrigation uses in the Academic Mall.*
- *Install an underground irrigation vault by capturing runoff from Husman Hall for irrigation use in the open space on the west side of Husman Hall.*

2. CHALLENGES AND FUNDING:

- Without significant assistance from grants and other sources, most of the proposed goals requiring large capital expenditures cannot currently be funded and may be delayed. Fortunately, MSD is currently promoting a Green Infrastructure Demonstration Program. This program requires a two-step application process. The initial application (Part I) is a concept application that is submitted to MSD and outlines the planned strategy of incorporating storm water management initiatives. The cost for this step is $13,000 and must be completed in 2010. Upon review of the Part I application, MSD will determine if the proposed project is eligible for participation in the Green Infrastructure Program. The Part II Design and Implementation application would then be completed if the project is selected for inclusion into the program. MSD will fund all of Part II.

IV. ENERGY AND INFRASTRUCTURE

SOLID WASTE MANAGEMENT

Long-term Vision: To remove solid waste through conservative practices including materials purchased by the University, materials carried in from off campus, and materials generated on campus. Solid waste is transported by Rumpke to landfills designated for the various types of waste. The amount of solid waste to be removed from the campus can be reduced in a number of ways:

- Through conservative practices that minimize the amount of materials that are used and/or wasted,
- Through the reuse of items that can still serve a function, be valued by another user, or have salvageable parts, and through
- Recycling of used materials and redeploying them as new products.

Solid waste reduction is often a lifestyle choice that requires behavior modification at the individual level.

A. Increased Recycling and Landfill Waste Minimization

Goal: Prevent useful material resources from being wasted and reduce the consumption of raw materials by 30% from FY09-10 levels within 5 years, thereby reducing energy usage along with the associated greenhouse gas emissions required to create the original material or product.

1. ACTION PLAN:

Short-term Goals (1-2 years)

- *Create a solid waste oversight committee tasked with developing policies and programs while providing reports on recycling initiatives and performance.*
- *Encourage users(through signage and other means) to use the scanning function in the existing photocopiers and print and copy double-sided instead of single-sided.*
- *Reuse paper from bad print jobs for scrap paper and notes.*
- *Eliminate individual trash cans and only provide recycling bins at the desk. Regular trash can still be deposited in centralized locations.*
- *Enhance the current campus recycling efforts for paper, newspaper, cardboard, print cartridges, cell phones, cans, bottles and scrap metal.*
- *Devise methods to combat contamination of recycled materials with other waste.*
- *Add additional recycling receptacles in strategic locations.*
- *Encourage dependence on information technologies (e.g., University servers and portable media; backup software) that can reduce printing and photocopying (and their production of waste paper). Provide case studies of individuals already performing their work in a paperless manner.*
- *Recycle at all campus events such as athletic competitions, concerts and graduation ceremonies.*

- *Expand "Recyclemania" through additional resources (student involvement, dedicated staff, funding, improved weighing system) and better education.*
- *Further reduce or eliminate take-away food containers that cannot be recycled or composted (e.g., polystyrene cups, most plastics, aluminum foil) and replace with recyclable/biodegradable plastics and wax-free paper products.*
- *Investigate organic/inorganic trash management systems and produce a feasibility report.*

Mid-term Goals (3-5 years)

- *Enhance and publicize policies and procedures for existing collection sites that collect potentially hazardous waste (e.g., batteries, electronics, light bulbs, paints/polishes/removers, cleaners, lighters, medicines, etc.).*
- *Expand paper reduction in computer labs by either increasing the user fee or reducing the number of pages that can be printed before a fee is incurred.*
- *Increase "Recyclemania" participation to 50% and include additional levels of participation.*
- *Improve residence hall recycling in general, especially on move-in and move out days. Create processes and procedures for carpeting, food, clothing, shoes, furniture, computers, CDs, paper, cardboard, etc.*
- *Develop a campus-wide solid waste management educational series*

Long-term Goals (5-10 years)

- *Compost all grounds and compostable waste on site.*
- *Create a campus-wide online exchange program to increase reuse.*
- *Institute a trash bag fee that discourages disposal and encourages recycling. Bags with a green(recycling) tag are free, but bags with a black tag are not. Special procedures may be necessary for retail and other large-scale operations on campus.*

2. CHALLENGES AND FUNDING:

- The major challenge associated with solid waste management is modification of individual behavior. Either the individual chooses not to participate or is not diligent about the choice of waste receptacle resulting in contamination of recycled materials with other waste. When contamination occurs, the entire load is rejected to the landfill, negating the recycling efforts of most of the campus community.
- Additional funding is required to implement many of the goals.

IV. ENERGY AND INFRASTRUCTURE

GROUNDS MAINTENANCE

Long-term Vision: To provide clean, aesthetically rewarding outdoor facilities for all students, staff, and visitors.
Sustainable grounds landscaping and maintenance practices can have a positive impact upon the environment and play a role overall in campus sustainability efforts. Xavier University has received many awards for the beautifully landscaped grounds throughout the campus. The 130 acre site is undergoing significant changes as newly acquired properties are incorporated into the landscape inventory. The more developed areas of campus provide a beautiful environment for reflection, education and, yes, even play.

A. Sustainable Groundskeeping.

Goal: Reduce dependence on fossil fuels, other extracted minerals, chemical fertilizers and pesticides while retaining an award-winning appearance.

1. ACTION PLAN:

Short-term Goals (1-2 years)

- *Develop policies to ensure that sustainability is incorporated into landscape design, maintenance and management.*
- *Continue the selection of plantings appropriate to the Cincinnati environment. Increase the planting of native species and remove invasive non-native species.*
- *Incorporate leaf mulching for turf areas as a standard practice.*
- *Expand the use of wood refuse that is run through a chipper and converted into mulch for use in campus flower beds.*
- *Increase the use of perennial plantings to replace annuals.*
- *Expand the use of biodegradable and environmentally-safe, ice-melting chemical treatments.*
- *Reduce the use of ice-melting chemicals by utilizing more sand and biodegradable materials where appropriate.*
- *Increase the use of drip irrigation to reduce water use.*
- *Continue grounds keeping educational offerings for students, faculty and staff.*

Mid-term Goals (3-5 years)

- *Incorporate cellulosic bio-diesel in all diesel fueled equipment.*
- *Incorporate plantings of diverse plant species and native species, especially drought-resistant varieties*
- *Compost all grounds and compostable waste on site.*
- *Devise methods that will enhance the storm water management recommendations stated above (i.e., improved maintenance of rain gardens to decrease storm water runoff).*

- *Test herbicides claiming to be environmentally safe to determine their effectiveness; if the products work, the campus should minimize the use of conventional chemical herbicides such as "Roundup".*
- *Replace current grass species with a variety that is more drought-tolerant and reduces mowing.*

Long-term Goals (5-10 years)

- *Enlarge composting site to enhance composting capacity.*
- *Build a greenhouse to propagate plants and increase the amount of available plant material. If a greenhouse is available, the campus would be able to reuse existing plants rather than throw away and purchase new each year. (A greenhouse would also support other sustainable and education activities on campus.)*

2. CHALLENGES AND FUNDING:

- The development of a more sustainable approach to landscape design and planning requires a change in thinking and must incorporate the best knowledge available. This may initially involve a high level of uncertainty followed by monitoring and re-evaluation of plans in order to optimize the process and, thus, 'learn by doing.'
- Perennials have a shorter flowering time possibly resulting in a less colorful campus.
- Additional funding is required to implement many of the goals, especially the greenhouse.

IV. ENERGY AND INFRASTRUCTURE

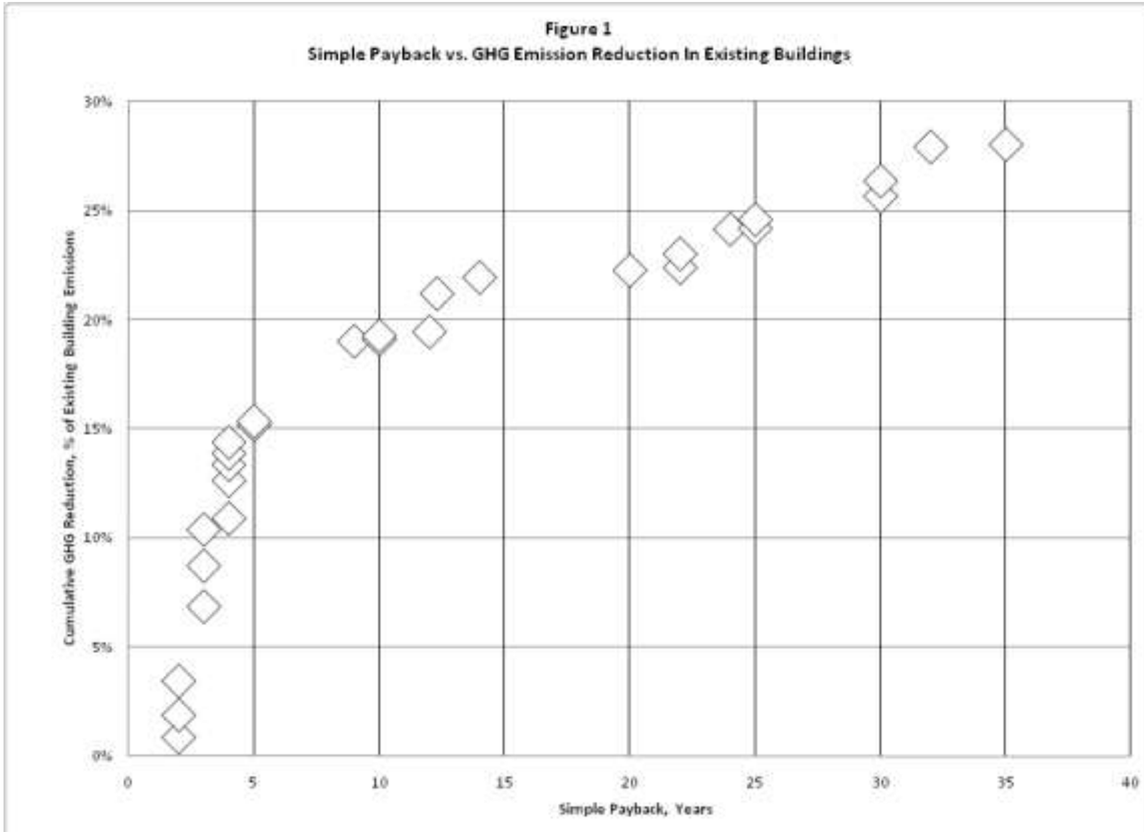
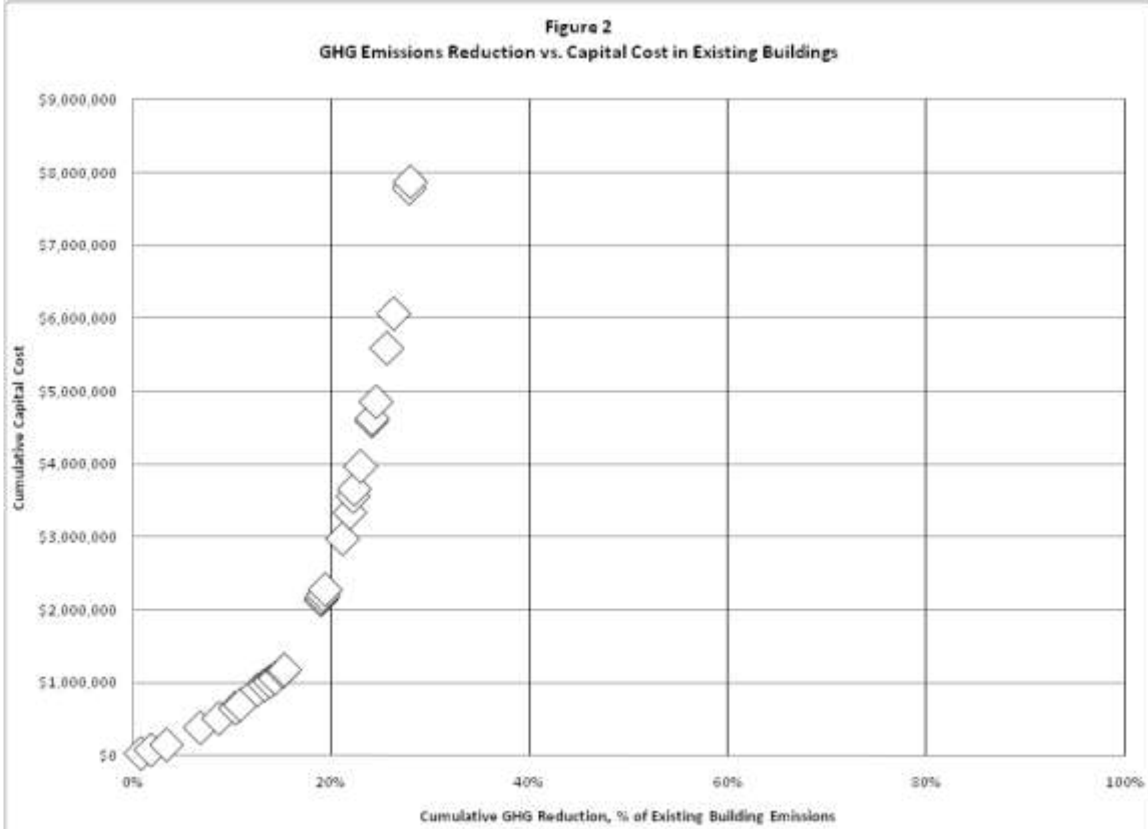
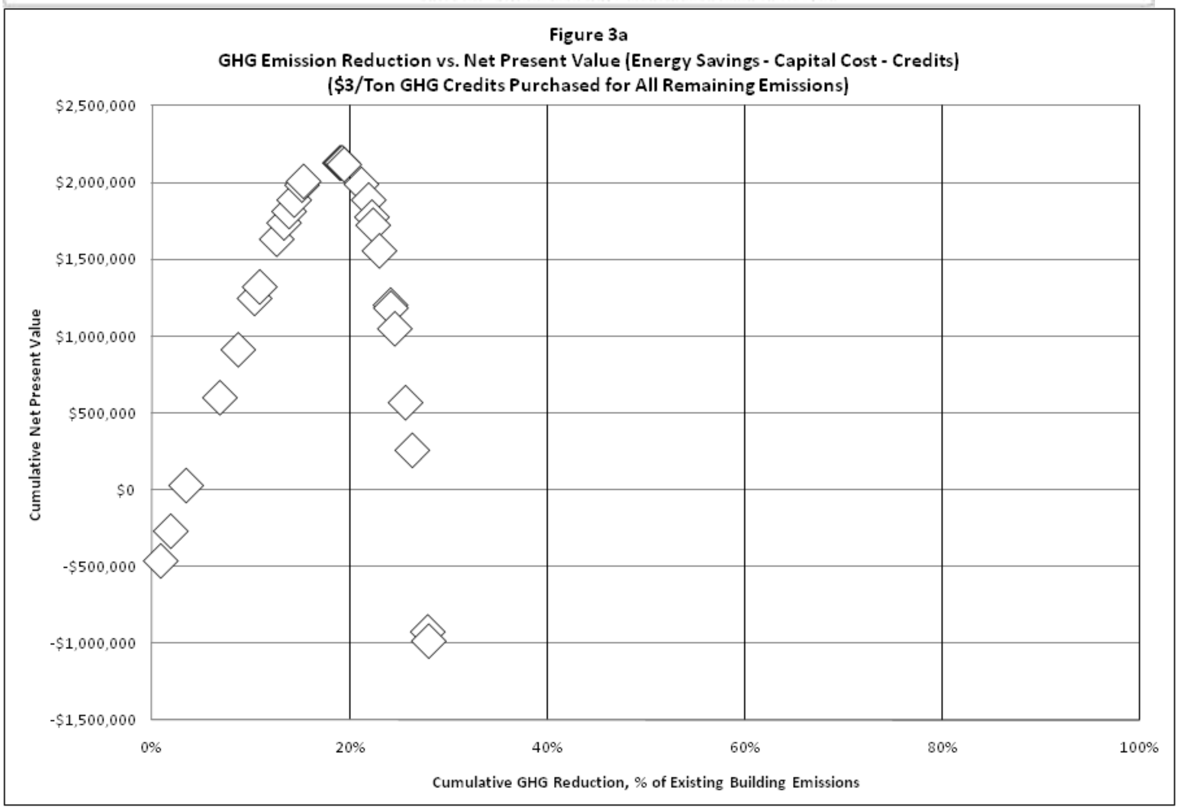


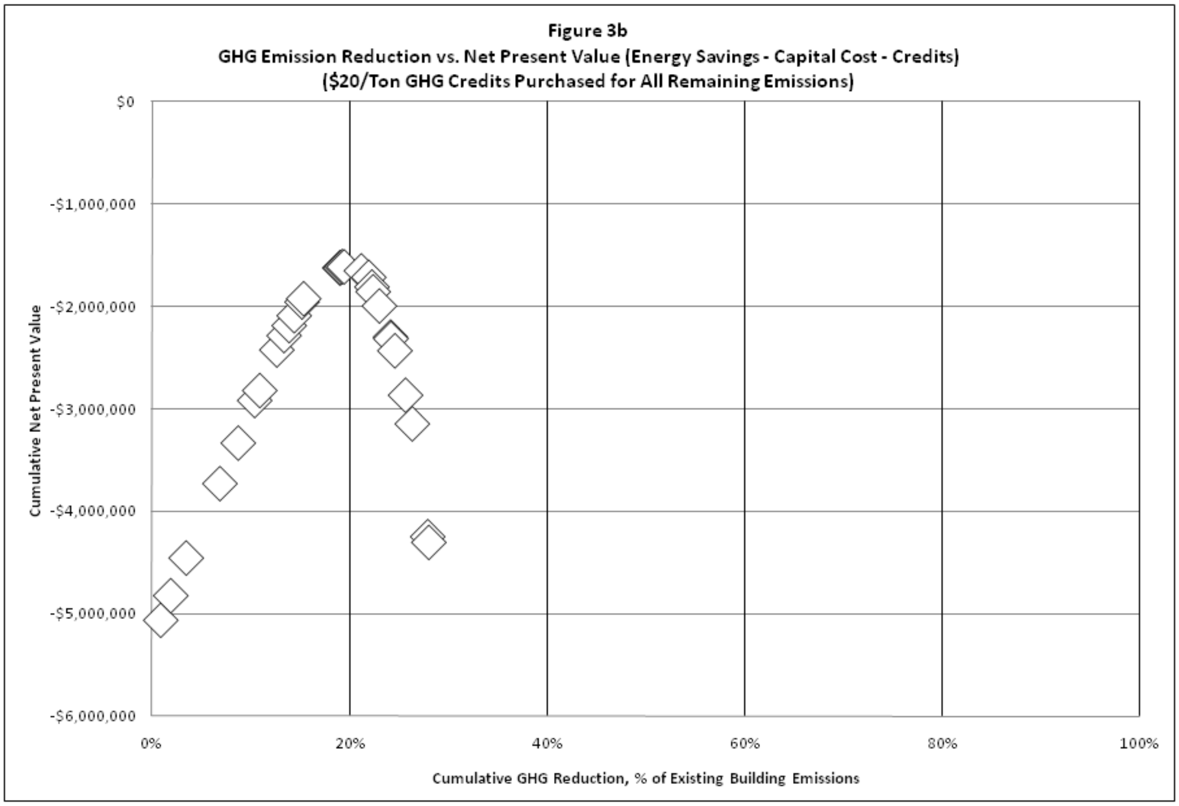
Figure 1
Simple Payback vs. GHG Emission Reduction In Existing Buildings

IV. ENERGY AND INFRASTRUCTURE

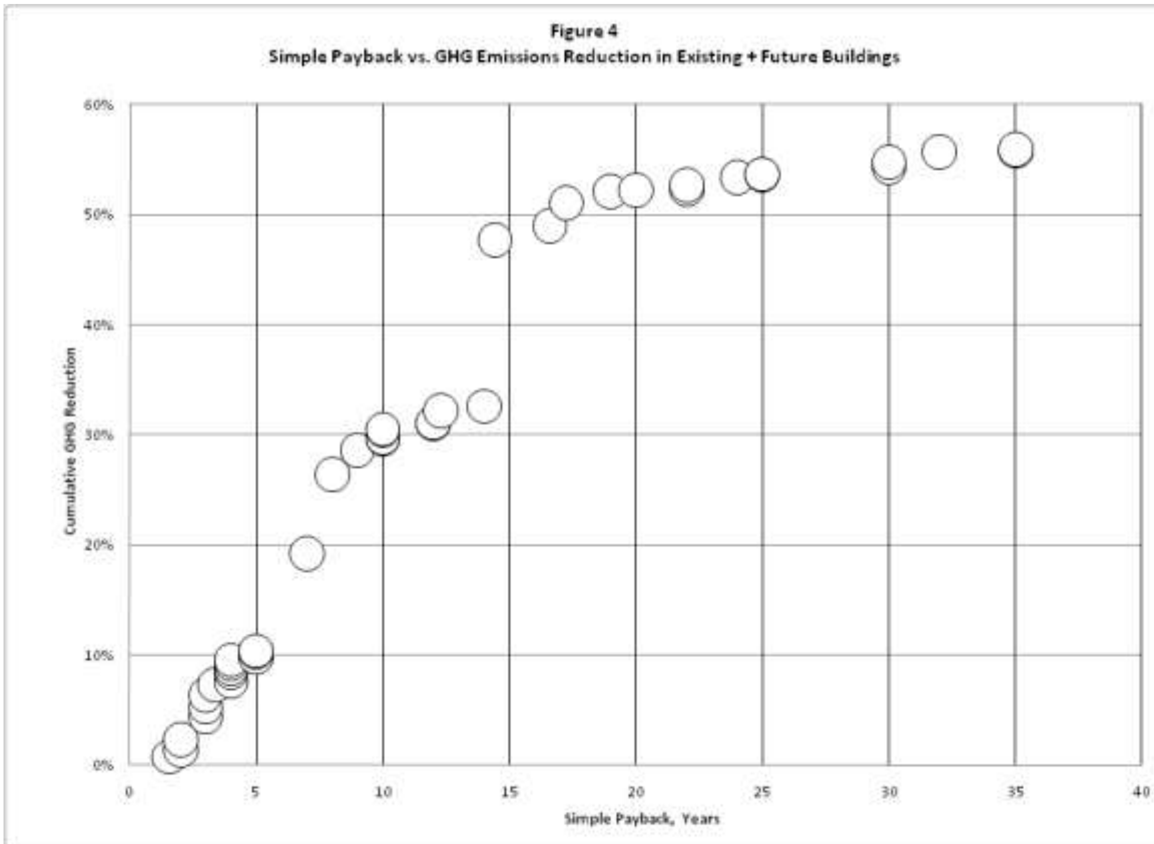




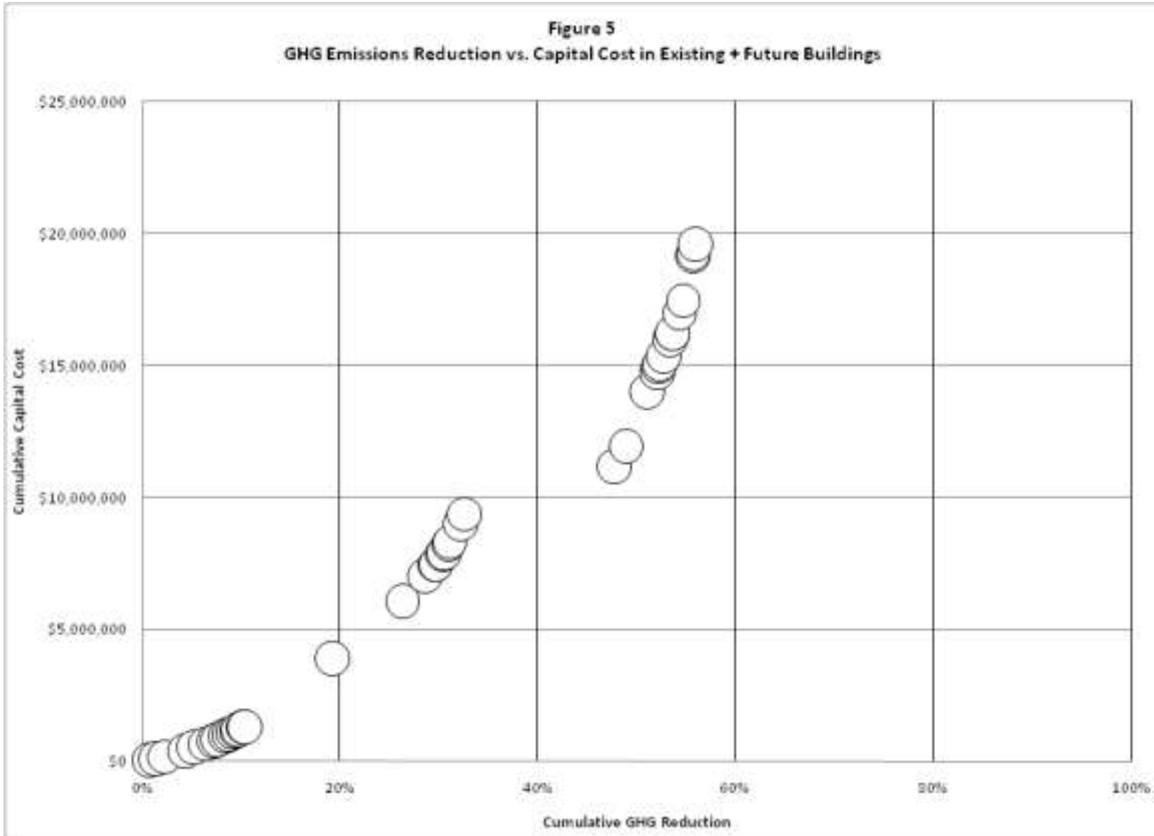
IV. ENERGY AND INFRASTRUCTURE



IV. ENERGY AND INFRASTRUCTURE



IV. ENERGY AND INFRASTRUCTURE



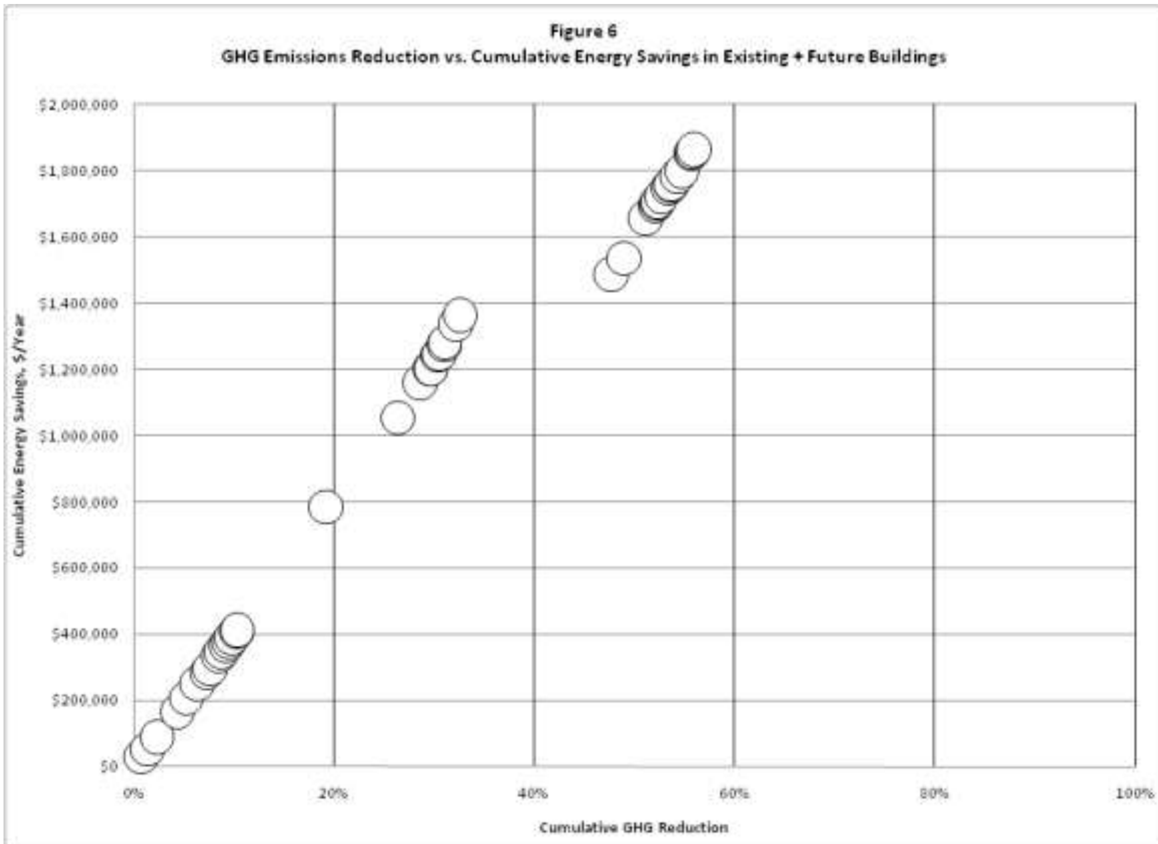


Figure 6
GHG Emissions Reduction vs. Cumulative Energy Savings in Existing + Future Buildings
Cumulative Energy Savings, $/Year
$2,000,000
$1,800,000
$1,600,000
$1,400,000
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
0%
20%
40%
60%
80%
100%
Cumulative GHG Reduction

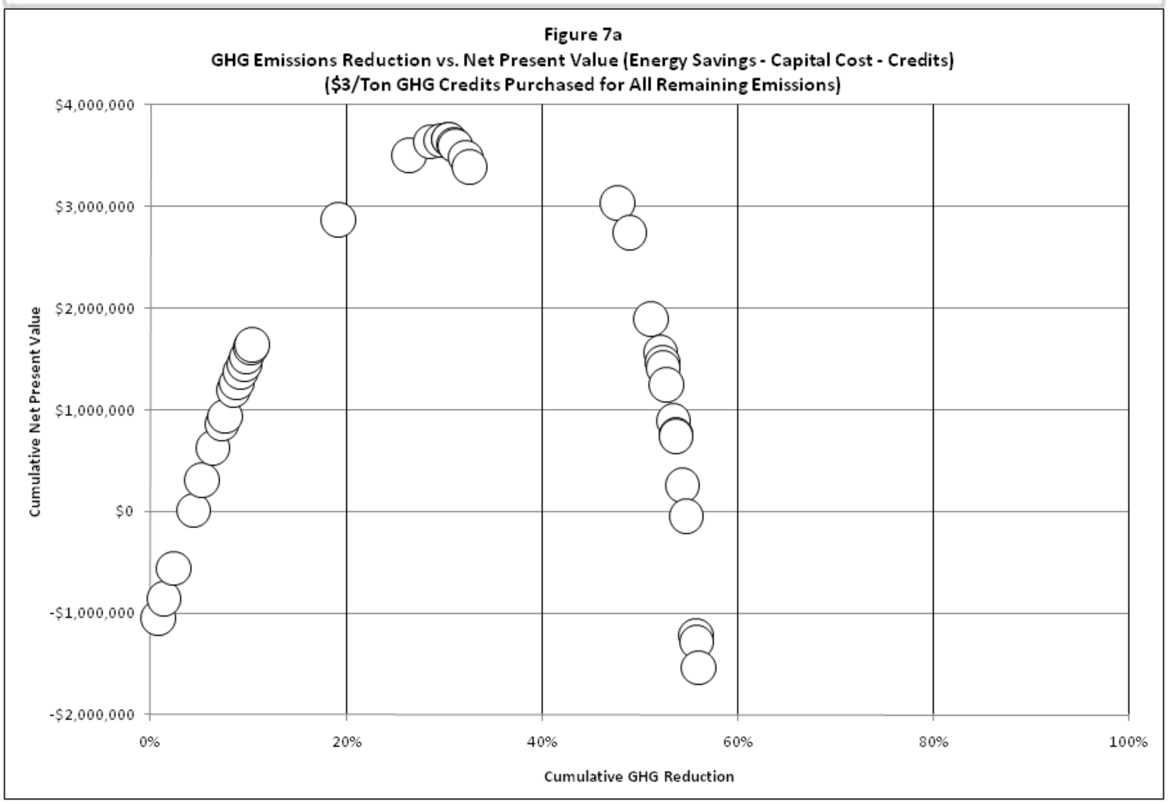


Figure 7a
GHG Emissions Reduction vs. Net Present Value (Energy Savings - Capital Cost - Credits)
($3/Ton GHG Credits Purchased for All Remaining Emissions)
Cumulative Net Present Value
$4,000,000
$3,000,000
$2,000,000
$1,000,000
$0
-$1,000,000
-$2,000,000
0%
20%
40%
60%
80%
100%
Cumulative GHG Reduction

Figure 7b
GHG Emissions Reduction vs. Net Present Value (Energy Savings - Capital Cost - Credits)
($20/Ton GHG Credits Purchased for All Remaining Emissions)

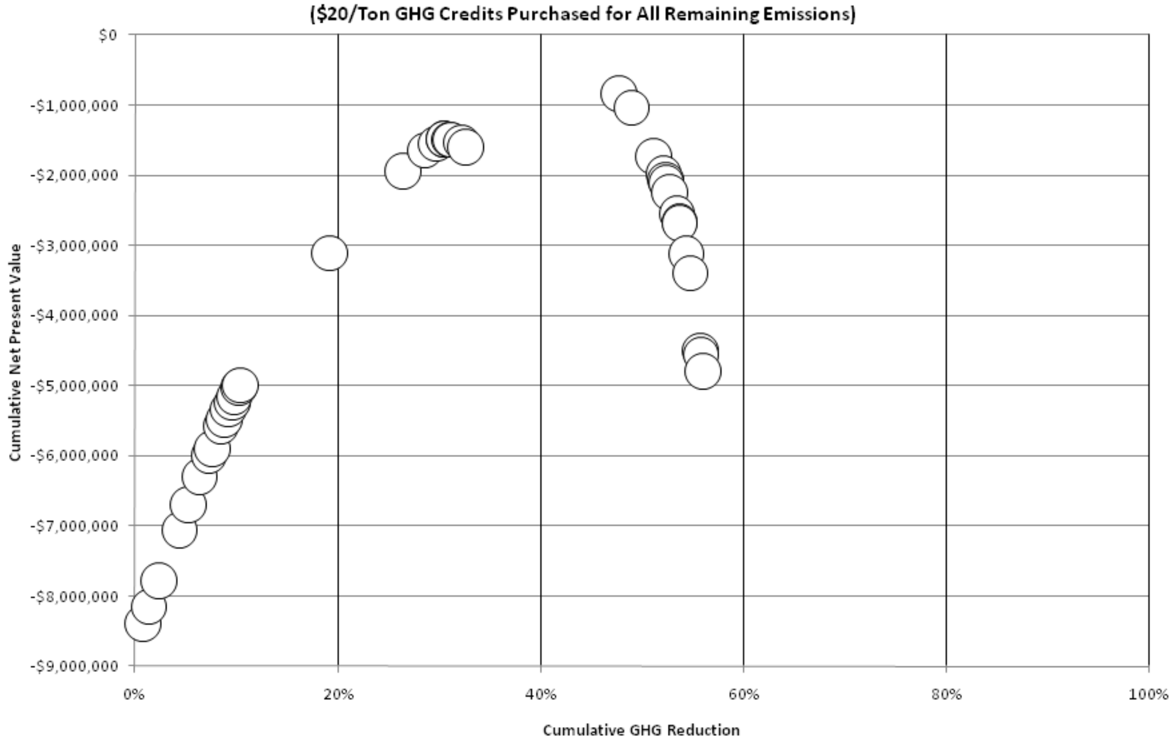
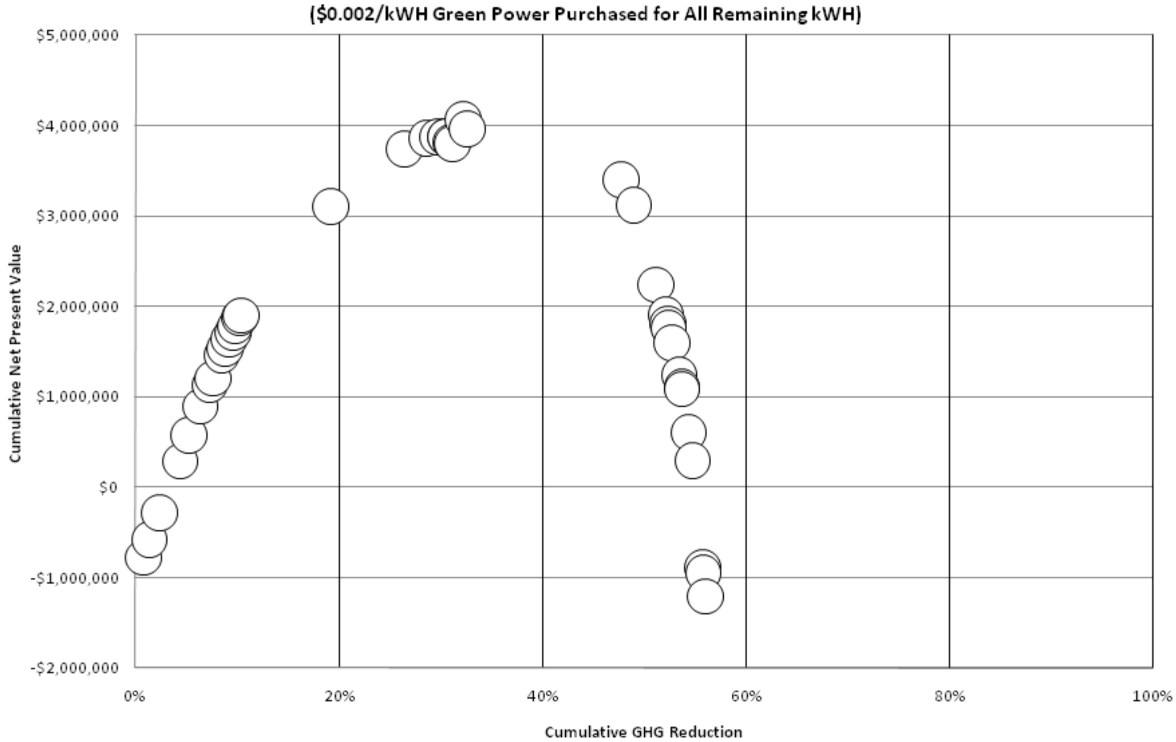
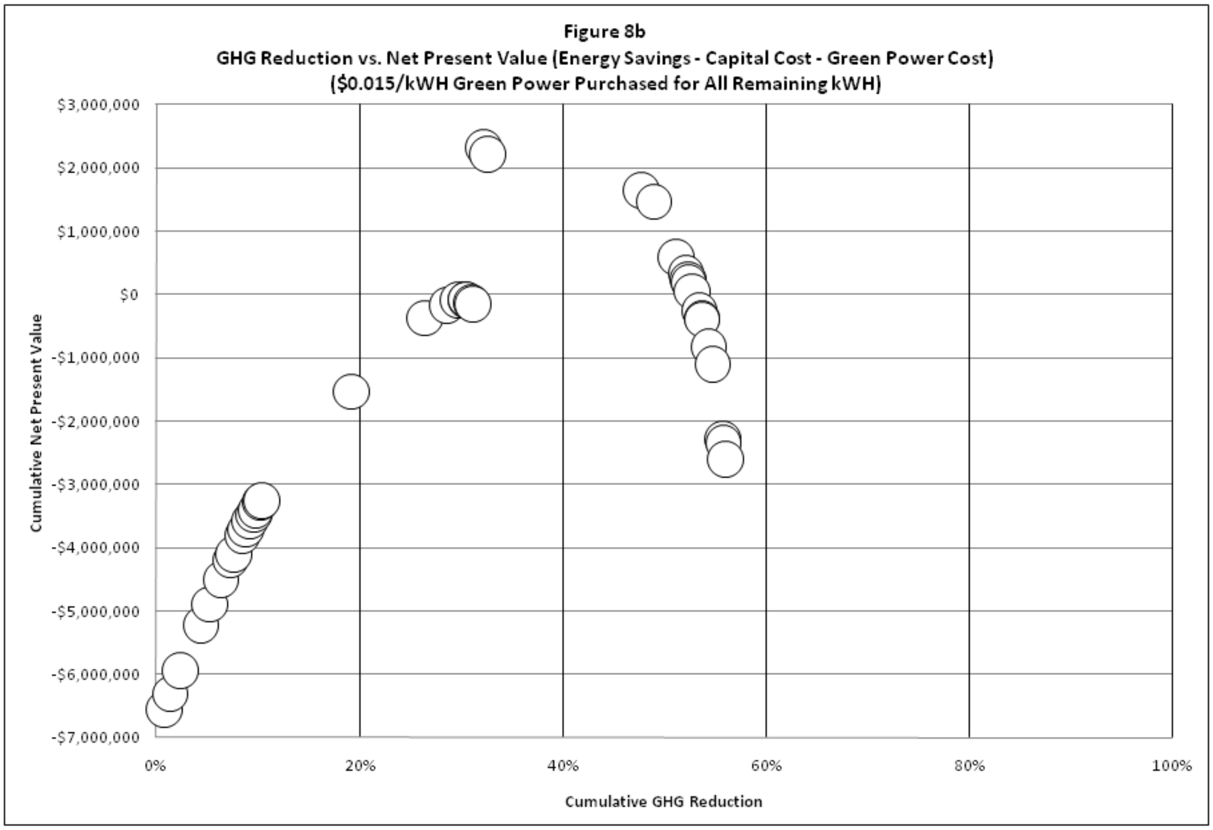


Figure 8a
GHG Reduction vs. Net Present Value (Energy Savings - Capital Cost - Green Power Cost)
($0.002/kWH Green Power Purchased for All Remaining kWH)



IV. ENERGY AND INFRASTRUCTURE



IV. ENERGY AND INFRASTRUCTURE

Energy Conservation Measure	Category	Capital Cost	Annual Energy Savings	Average Simple Payback Period, Years	CO2 Reduction, Tons/Year	Capital Cost per Ton/Year GHG Savings	NPV per Ton/Year GHG Savings
Phase 1 Existing Buildings							
Revised air filter program	Ventilation	$46,000	$29,000	1.6	330	$137	$760
Compact Fluorescent Lamps	Lighting	$46,000	$23,000	2.0	270	$173	$723
Power management	Powered Equipment	$71,000	$36,000	2.0	410	$173	$723
Occupancy Sensors	Lighting	$234,000	$78,000	3.0	900	$260	$637
Modify controls	Cooling	$123,000	$41,000	3.0	380	$325	$789
Variable speed drives	Ventilation	$128,000	$43,000	3.0	490	$260	$637
Infiltration reduction	Ventilation	$47,000	$12,000	4.0	140	$347	$550
Recommissioning	Cooling	$165,000	$41,000	4.0	380	$432	$678
Motor replacements	Ventilation	$47,000	$12,000	4.0	140	$347	$550
T5/T8 Lamps	Lighting	$67,000	$17,000	4.0	190	$347	$550
VFDs on pumps and fans	Cooling	$47,000	$12,000	4.0	140	$347	$550
Energy Star appliances, equipment	Powered Equipment	$91,000	$18,000	5.0	210	$433	$463
Pool upgrades	Cooling	$24,000	$5,000	5.0	40	$573	$603
Ventilation energy recovery	Cooling	$958,000	$106,000	9.0	970	$991	$140
Kitchen refrigerators -heat recovery	Other Gas	$14,000	$1,000	10.0	10	$1,307	$30
Shading devices	Cooling	$39,000	$4,000	10.0	50	$867	$30
Water conservation measures	Other Gas	$73,000	$6,000	12.0	50	$1,568	-$231
Academic Mall piping replacement	Cooling	$698,000	$57,000	12.3	460	$1,518	-$254
Logan boilers decommission	Heating	$358,000	$26,000	14.0	200	$1,830	-$493
Enhanced submetering		$250,000	$0	-	0	-	-
Subtotal		**$3,526,000**	**$566,000**	**6.2**	**5,740**	**$615**	**$401**
Phase 2 Cogeneration System							
Cogeneration system	**Total Elect**	**$1,805,000**	**$125,000**	**14.4**	**6,580**	**$274**	**-$54**
Phase 3 Future Buildings, New Technology							
Additional 30% savings	Total Elect	$2,598,000	$371,000	7.0	3,850	$674	$319
LED Lighting	Lighting	$2,161,000	$270,000	8.0	3,120	$693	$203
Boiler energy recovery (condensing)	Heating	$400,000	$40,000	10.0	310	$1,307	$30
Daylighting	Lighting	$407,000	$41,000	10.0	470	$867	$30
Lower coil/duct/filter velocities	Ventilation	$116,000	$34,000	3.4	400	$292	$604
Super insulation	Heating	$342,000	$29,000	12.0	220	$1,568	-$231
Subtotal		**$6,024,000**	**$785,000**	**7.7**	**8,360**	**$721**	**$248**

Totals		**$11,355,000**	**$1,476,000**	**7.7**	**20,700**	**$549**	**$194**