Johns Hopkins University Climate Action Plan – Five Year Progress Review

Compiled by the
Johns Hopkins University Office of Sustainability

March 2014

JOHNS HOPKINS
UNIVERSITY

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REPORT SUMMARY

This report reviews the efforts Johns Hopkins University has made toward reducing Greenhouse Gas (GHG) emissions for the years 2008 through 2013. The recap of projects and programs helps provide context of how the value of sustainability has manifested itself in meaningful actions over a five year period, directly following the commissioning and completion of the first President's Task Force on Climate Change. Upon review and reflection of the university's carbon footprint, a goal to reduce GHG emissions by 51% by the year 2025 was set. As a means of ensuring the progress JHU is making as an institution is robust enough to meet this goal, a new committee of key stakeholders will convene every five years to assess performance, pertinence of projects and programs toward meeting JHU's goal, and identify continued or new priorities for the years to follow. This first five year review will provide insight into the inaugural years of the sustainability program, the impact of efforts across the various Johns Hopkins divisions, and the projected outlook for meeting our goal under current parameters. Additionally, at a pivotal juncture when sustainability programs are becoming established at institutions across the country, it is important to reflect and react on our comparative performance in relevant areas of the field. As a world-renowned research institution whose core mission is rooted in uncovering and providing the knowledge needed to transform our world, the advancement of sustainability and its integration into Johns Hopkins' operations and cultural identity is critical.

HOW DID IT START?

Launch of the Task Force

On July 23, 2007, President William R. Brody announced the formation of the President's Task Force on Climate Change (Task Force) to address the need to reduce greenhouse gas emissions at Johns Hopkins University, within the Baltimore area, and globally. Recognizing that universities must play a central role in meeting the challenge of climate change, President Brody defined three overarching goals for the Task Force:

1. Develop a Comprehensive Climate Strategic Plan for addressing the emissions of greenhouse gases that derive from University operations. The plan should cover a broad collection of technical measures, behavioral incentives, and innovative approaches to reducing carbon emissions on the Johns Hopkins campuses.
2. Spur creativity, innovation, and new avenues of scholarship by reexamining various aspects of climate change from a multi-disciplinary and collaborative research perspective, and translate that perspective into educational achievement.
3. Develop and nurture strong relationships with State, City and community groups within the Baltimore region, and explore collaborative ways to attain our respective goals, transfer knowledge, and share successes.

The Task Force consisted of 20 members, which spanned JHU faculty and staff, including members of the Office of Sustainability, as well as external corporate, government and non-profit experts. Working groups were established for each of the three overarching goals and a year-long effort focusing on greenhouse gas (GHG) emissions and their impacts on Johns Hopkins University was then conducted.

Timeline of Milestones

Assessment Methods

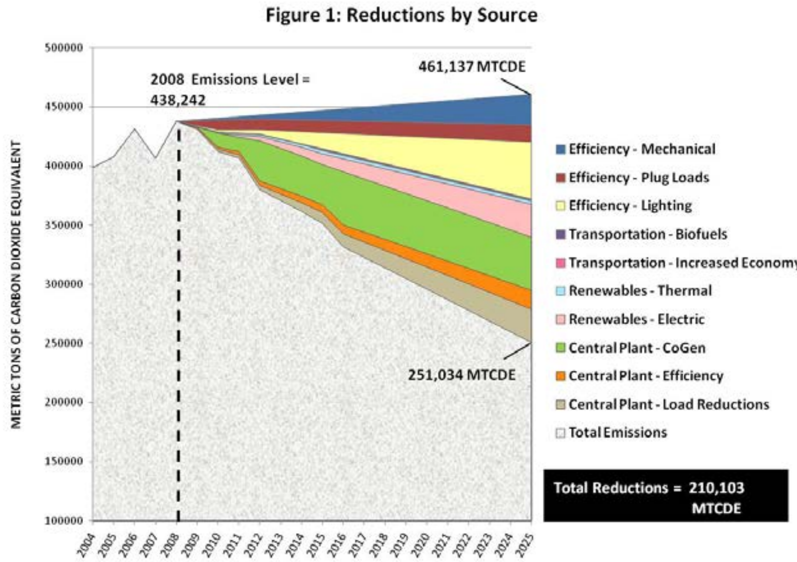
A critical element that needed to be understood by the Task Force was the state of the university's GHG emissions. Utility and usage data from 2004 to 2008 was utilized to derive the university's GHG inventory, which accounted for emissions of all six greenhouse gases specified by the Kyoto Protocol: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. It was however limited to two of the three categories for emission sources. The inventory included emissions that came from "direct" sources (i.e., fuels that we use on campus and over which JHU has direct control) and "indirect" sources, (i.e., electricity that is generated at facilities outside of JHU's control, but the consumption of the electricity remains in JHU's control). Most GHG protocols also identify a third scope of indirect emissions that are outside the university's control, but may be influenced by university policies or actions. These emissions – such as employee commuting, work-related air travel, and solid waste disposal – remained outside of the university's inventory.

As electricity from indirect sources is a major contributor of JHU's GHGs, it is important to know how the electricity is being generated. The mix of fossil fuels and renewable sources varies by geographic region and ultimately affects the university's GHG inventory. Originally, the carbon coefficient came from the U.S. Environmental Protection Agency's e-GRID data, which led JHU's emissions in 2008 to be calculated as 262,600 metric tons of carbon dioxide equivalent (MTCDE). As will be discussed later, the carbon coefficient was later changed and the 2008 inventory and GHG goal were adjusted.

In order to determine a meaningful, yet reasonable GHG goal, several other considerations were also taken into account. First, the university's rate of growth had slowed by 2008. It was therefore expected that the anticipated growth in buildings would translate to a 0.7% annual increase in GHG emissions if operations continued in a "business as usual" scenario. Second, it was deemed to be too early to assume that state and federal policies would significantly change the use of renewables for regional electricity generation, so a fixed 0.545 tons/MWh coefficient was used for future years. Finally, the Task Force recognized that existing and new energy technologies would play an important role in reducing emissions. It was assumed that in the first five years of the Climate Action Plan, existing and proven technologies could be used. In the following years, a mix of current and emerging technologies would bring additional reductions.

Recommendations

In addressing university-derived GHGs, the Task Force focused on goals and actions that could be accomplished in the medium term (2025). The Task Force also acknowledged that the actions should produce real, calculable local carbon reductions, and not rely on alternative measures such as purchasing offsets or other means of transferring the responsibility for emissions reductions to others. The Task Force's recommendations provided a broad framework for meeting the goals and targets identified in the report. For GHG reductions, the Task Force set a goal of reducing University emissions by 141,600 metric tons, or roughly 51% below expected 2025 "business as usual" levels. The Task Force had identified ten areas of opportunity – each capable of contributing a "slice" of reductions to the overall reduction target (Figure 1). The Task Force recognized that there would be no "silver bullet" that will account for all of the emissions over time. Rather, the analysis suggested that there are a number of avenues for reductions within the four main categories of campus emissions. For example, two co-generation projects – one on the Homewood campus and one on the East Baltimore campus – represent the largest single source of this reduction. Also within the category of Efficiency Gains in Buildings, it was clear that there were significant opportunities for reductions in lighting loads, mechanical equipment, personal computing, and more efficient appliances.



In total, the three working groups developed a report that included 35 recommendations for action. Combined with tactical and strategic approaches for addressing emissions, the Task Force also included recommendations for education and research as well as community engagement. To spur creativity and new scholarship, the Task Force focused on a series of actions that could lead to better coordination of existing research agendas and improving the student experience by utilizing the campus as platform for hands-on learning. The Task Force also set out a number of recommendations for leveraging GHG-reduction efforts as a means for engaging the community in a meaningful way.

Implementation Plan

The recommendations of the Task Force were followed in 2009 with a more specific set of strategies in *The Implementation Plan for Achieving Sustainability and Climate Stewardship*. The Implementation Plan contained seven core pieces that would collectively contribute to the fulfillment of the recommendations of the Task Force.

For on-campus GHG reductions:

- *Implement a Resource Reductions Program* that will increase the focus on identifying and advancing energy efficiency and carbon reduction projects on all campuses. The Program will support actions needed to meet the goal of reducing CO_2 by 51% by 2025.
- *Implement an aggressive behavior change program* intended to encourage and empower the Johns Hopkins community to reduce energy consumption.
- *Create a Sustainable IT Committee* to improve the environmental profile of Information Technology at the Johns Hopkins Institutions by identifying actions to reduce energy consumption within all the Johns Hopkins IT organizations.

For the academic, student engagement, and research focus:

- *Form the Johns Hopkins Environment, Sustainability and Health Institute.* This Institute will co-ordinate innovative research and teaching to establish integrated approaches that cut across divisions that address problems stemming from global warming. The Institute will increase the visibility of JHU in climate change and sustainability, and contribute to attracting students, recruiting and retaining faculty, obtaining funding, and improving the translation of research to support environmental policies.
- *Establish a Sustainability House* which will be an environmental showcase and learning lab for visitors, hosting the activities of the Johns Hopkins Office of Sustainability, environmental student groups, and a comprehensive sustainability resource center.

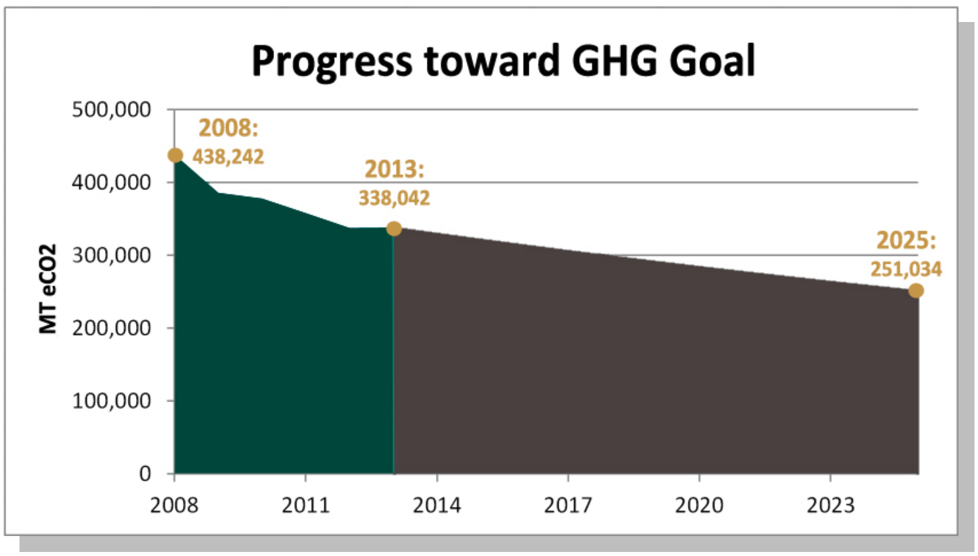
For leadership in the community focus:

- *Broaden opportunities for students to be active contributors to sustainability efforts in the community* by launching a "Green Building Internship" program that will be a clearinghouse of projects for more hands-on experience for students and faculty.
- *Provide sustainability leadership for the Baltimore community by facilitating collaboration across the higher education sector and with local community groups.* We will engage local institutions in ways that lead to greater cooperation in actions that build on the sustainability efforts in the region.

WHAT HAVE WE DONE?

Status of Implementation Plan

Over the course of the past five years, the types and scales of projects at the different Johns Hopkins campuses has been varied. Together, these myriad efforts are helping to reduce consumption of resources and improve efficiency of operations across the board, in turn helping to reduce carbon emissions or mitigate the impact of added capacity. As it stands from 2008 to 2013, we have reduced our emissions by roughly 35%, or 100,200 metric tons of carbon. This will be reviewed further in the "How Are We Doing" section of the report, but the below graph puts progress to date in perspective, while assuming a modest annual reduction up to 2025.



Greenhouse Gas Mitigation

The resource reduction program was launched with a number of successes:

- A large and growing list of energy conservation measures has been developed for all campuses. Some measures have been included into capital projects, some have been advanced by facilities operations, and others were advanced independently through alternative means of funding (the large solar electricity project is an example of this approach).
- A behavior change program was implemented with a particular focus on addressing simple and effective changes that faculty and staff can undertake in their spaces to reduce resource consumption.
- An energy engineer was hired specifically to focus on developing and implementing on-campus energy conservation measures.

- New buildings and major renovations are utilizing the High performance Building Guidelines developed by the Task Force, leading to a higher level of emphasis on energy efficiency and resource conservation in new construction.

The Implementation Plan also identified areas that would be challenging to address, and these same challenges continue to hamper efforts. Specifically, the Plan identified the following:

1. *Difficulty in coordinating efforts across divisions.* Because different divisions and campuses have independent facilities offices, projects are typically developed separately and without coordination or sharing.
2. *There is presently no system in place for continuously looking for new opportunities.* There is a lack of shared engineering resources, which makes a systematic evaluation of energy efficiency opportunities more difficult.
3. *Support comes from multiple sources, with multiple sets of criteria and decision-making.* Currently there is no centralized system for evaluating projects, meaning that projects are often evaluated on an ad-hoc basis with inconsistent parameters.
4. *Projects are often evaluated with narrow criteria.* Projects are often considered viable based on their simple payback criteria, which does not account for carbon, life cycle accounting, or other benefits to the university.
5. *No certainty in mid- or long-term budgeting.* Currently there is no system in place that provides a consistent and transparent funding vehicle for pursuing ECMs.

With the exception of the second point – where the new energy engineer and Sustainability Office staff have satisfied these concerns – these challenges remain throughout the University. One of the strong recommendations in the Implementation Plan was to create a system whereby energy and GHG reduction measures could be collected, evaluated, prioritized, and funded through an efficient central administrative structure.

Projects & Programs

Conservation

The first step toward reducing our carbon footprint begins with identifying opportunities where we can reduce overall energy consumption through means and mechanisms that encourage conservation. Improvements to dusk to dawn sensors, day-light controls and occupancy and vacancy sensors have led to incorporation of these technologies in the building code for comprehensive use inside and out of our buildings. These controls are not just saving electricity, but are also working with our building automation to save heating, ventilation and air conditioning costs.

Window glass and metal frames are a building's biggest contributors of uncontrolled thermal heat loss and solar heat gains. Windows with better thermal performance help cut down on solar heating fit nicely with the new requirements for building insulation. Window films can double the insulating value of a single pane window and nearly eliminate glare and uncontrolled solar heating on all but North facing windows. These projects often result in a simple payback of the investment in less than two years, and products have improved substantially from those used just 10 years ago.

Often overlooked, there are many ways to save energy by picking the right parts and equipment in our electrical systems. Right sizing and using the most energy efficient transformers can save 5-10% over traditional transformer selections. For example, on appropriate applications, increasing wire sizing, so it doesn't run as hot, can save 1-3% on electrical use. Calling for Energy Star appliances and "best in class" energy use for research and specialty equipment has created more choices when selecting these products. Traditionally, these appliances saved 10-20% energy over the minimum standard allowed, but increasingly manufacturers are producing equipment that performs 20-50% better than traditional levels. Additionally, when these efforts and systems save electricity, they almost always qualify for local utility rebates that allow money to be recaptured for reinvestment into new projects.

Efforts to conserve other resources are also a part of the sustainability portfolio. Campus restrooms are being retrofitted with low flow faucets, water saving toilets and urinals; irrigation systems on Homewood campus have been fitted with smart controls to monitor weather and help prevent overwatering, saving saved millions of gallons of treated water each year since the controls were added. The School of Medicine's (SOM) Miller Research Building and Bloomberg School of Public Health's (BSPH) Wolfe Street Building – buildings on JHU's urban, East Baltimore campus - have installed rainwater collection systems to capture rainfall, Reverse Osmosis system back-wash and air conditioning system condensate to replace treated water for toilet flushing and cage pre-wash operations. With so many campuses proximal to the Chesapeake Bay – the largest watershed in North American and one of the most fragile - rain gardens, vegetative swales, green roofs, and permeable pavements are all helping to reduce damaging rainwater surges during and immediately after storms. All new projects and major building renovations are reviewed for the best storm-water mitigation options.

Efficiency

There are numerous ways that older buildings use energy inefficiently. As these spaces are renovated, old infrastructure replaced or entire buildings overhauled, we strive to use systems and equipment that perform 30% better than what is required by energy code. More frequent inspections, audits and tune-ups are helping to find and correct simple deficiencies, and campus architects and engineers seek out the most efficient options available for various operational needs when renovating or constructing new facilities. We seek out the best in class heating and air conditioning systems. LED lighting and fluorescent lighting have replaced almost all other lighting technologies, with LEDs saving 50-80% of the energy consumed by other lighting. New high efficiency, variable flow fume hoods and retrofit kits – which can save 40-70% of the energy wasted by the old constant volume hoods - are going in regularly at labs at BSPH and SOM, though it will take time and resources to retrofit existing hoods and hazardous work stations.

The new Undergraduate Teaching Lab (UTL) facility on the Homewood campus is a showcase of state-of-the-art lab technology for resource efficiency and occupant safety. The Johns Hopkins Biological Repository (JHBR) is a tremendous asset for storing and cataloging research samples, currently holding 60 cryogenic freezing units, with room to expand to 80. Prior to the JHBR space, samples were stored in 8 to 10 various locations spread throughout the BSPH. By consolidating storage locations, it allows for greater energy efficiency for heating and cooling one space outfitted specifically for this purpose. Additionally the cryo-units utilize 100% liquid nitrogen vapor (LN2), a more efficient freezing source, and the state of the art tanks can each hold more samples per unit than previous storage components. Combined heat and power systems, also called Cogeneration, serve Central Plants where the waste heat can be put to good use. These units have efficiencies better than 70%, making them a key component of our GHG reduction plan. JHU has a 1.5MW of CHP at Mount Washington, a 4.6 MW unit at Homewood and two 7 MW units on the Medical Campus. Smaller, building specific CHP units are being tested at Homewood's residence halls, initially at Wolman, which are a great fit for CHP because of their high demand for hot water.

Air conditioning offers the biggest opportunity to reduce electricity use on most of our campuses. Variable speed pumps and fans help eliminate unnecessary over-cooling and the necessity for simultaneous heating in vacant spaces, allowing for much deeper energy reductions without negative impact to the occupant. For every percent fan or pump speed is reduced, energy savings are doubled. Many older (pre-2005) buildings use constant flow pumps and fans. The use of waste heat to perform some of the pre-heating of systems is emerging as one of the most cost effective alternatives when retrofitting existing systems or renovating or building new buildings. These systems showcase their sustainable sensibility when full life cycle cost analysis is considered, often paying for the improvements in less than five years on systems that often operate for more than 40. The university has also seen boiler and heater efficiencies improve 10-20% across the board in the last 10 years.

Innovative Technologies & Renewables

White or vegetated roofs can lower the temperature at the roof by 20-40 degrees. This is important when using roof air for building ventilation and for cooling mechanical equipment. Since many pre-2000 buildings have little roof insulation, the university is reviewing adding roof insulation with any upcoming roofing project to bring them up to today's energy code. Homewood's first vegetated or "green" roof went on the South garage when the underground parking was built. Since then, green roofs have been installed on the Cordish Lacrosse building and on projects on the Medical Campus. In addition to the cooling effect, these help slow rain fall surges to the storm water system.

Phase one of the university-wide solar photovoltaic project saw seven roof-top solar arrays installed in February 2012. These are located at the Homewood Recreation & Athletic Center, Mattin Center, Eastern High School, School of Medicine 2024 E Monument St., School of Nursing Pinkard Building, and the Bloomberg School of Public Health Wolfe St Building and Hampton House. The units combined produce nearly a million KWH annually and offset over a million pounds of carbon. To see real-time feedback on energy production, visit the JHU solar dashboard.

In the fall of 2013, the compressed natural gas (CNG) fueling station behind San Martin Center began operations to support our first campus CNG powered Blue Jay Shuttles. CNG is about 25% the cost of gasoline, and produces less carbon. With plans to bring on a couple new CNG vehicles each year as older vans are replaced, our transportation infrastructure will continue to burn cleaner without compromising comfort or consistency of service. Additionally, free charging stations for electric vehicles were installed in a handful of parking garages in 2011. The units were provided free through a grant from Baltimore City to encourage the development of EV charging infrastructure across the city.

Policies & Process

The LEED building certification process, Energy Star for buildings and a much stricter and prescriptive energy code have made us smarter about features we would want to require in our new construction and renovation projects. This information has become the basis for the Johns Hopkins High Performance Building Standards, and has helped us to describe the features and performance we want to our designers and consultants. Metrics are key to energy measurement, and thus, reduced consumption. Ensuring faulty meters were replaced and meters are being added when possible to measure energy use accurately at the building level. Getting the utility consumption trend information to more stakeholders has improved awareness and resulted in changes in behavior. Additionally, analysis of energy use at each building is helping to identify the buildings needing the most attention.

As our buildings and their heating, air conditioning, plumbing, lighting and electrical systems get more complex, we are being challenged more to ensure they work properly at the end of construction and with increasingly frequent tune-ups during their useful life. Building operators are generally focused on solving comfort complaints and repairing broken equipment, than keeping the systems tuned up. Optimizing equipment for both function and energy performance has gained ground across our campuses, with many testing software applications that look for energy waste and opportunities to improve system performance without compromising comfort, productivity or safety.

To determine the best systems to meet our needs, it takes input from design, operations and occupant stakeholders, but it also requires financial analysis to help prioritize the various options. Energy modeling and comparative Life Cycle Cost Analysis are coming together to help Hopkins make better financial decisions during design and later during operations. Utility bill auditing and trending is also helping to find poorly performing buildings, potential equipment faults and opportunities for energy reduction, allowing operations staff to target and prioritize projects based on ROI. Heating and cooling systems use a lot of a building's energy, and what heat these systems can't easily use, they will often reject. Energy recovery and reuse has become a standard requirement to help us meet or beat the energy code. Using captured energy waste or exhaust streams to pre-heat or pre-cool saves a tremendous amount of energy over the life of these systems.

Other Tools

Web-based tools – like energy and water use dashboards - provide simple, real-time feedback on how our buildings or systems are doing. We use dashboards and graphics to show how our Solar PV system is doing, comparative resource consumption at Homewood's Residence Halls, and to an increasing degree, Operations and Maintenance technicians are using them to indicate where systems may not be working properly, well before occupant comfort complaints start coming in. Rebates for better energy performance have been a tremendous boon to facility upgrades. Since 2011, Johns Hopkins has been awarded $4.5 million in rebates for electrical savings projects. To qualify, a project or retrofit has to reduce energy use better than the minimum allowable alternative.

Campus Engagement, Academics and Research

Behavior Change and Engagement

A behavior change program was implemented with a particular focus on addressing simple and effective changes that faculty and staff could undertake in their offices to reduce resource consumption. For the most passionate and enthusiastic employees, a Green Campus Representatives (GCRs) network was created, as was recommended by the Task Force. This program provided an opportunity for GCRs to meet monthly to get sustainability updates and help develop new campus strategies. Closely tied to the GCR program was the Green Office Certification, which entailed a sustainability audit. Participating offices were awarded a score and ranking. Dozens of individuals enrolled as Green Campus Reps and almost 40 departments have taken part in the Green Office Certification. The GCR program has since evolved into a Green Teams program, in which employees are organized by a building or department, rather than as a collective university group. Each Green Team meets monthly and decides on a sustainability project to undertake. Almost 30 employees participate on six teams, and the Green Teams program is rapidly expanding.

To recognize some of the outstanding and inspirational sustainability work that has been done by university employees and students, the first annual "Green Blue Jay" Awards were held in 2013. Some of the recipients included Green Campus Reps and those who aggressively competed for high Green Office Certification scores.

Two areas included in the Task Force's recommendations that still need to be much more aggressively addressed are laboratory spaces and sharing sustainability data with the campus community. Behavior-based programs for researchers, which would be similar to the Green Teams and Green Office Certification programs for office spaces, are currently in development. Publicly sharing building-level energy data was also to be an important component to motivate changes. An electronic dashboard system was setup for dormitories on the Homewood campus. For the university as a whole; however, collecting and regularly updating building data presents technical challenges. Instead annual reports for each division, which include energy data, have begun to be undertaken and posted online.

Education and Research

Of the two implementation measures, one was successful and one was not. On April 20, 2011, the Energy, Environment, Sustainability and health Institute (E^2SHI) was formally launched as "an interdisciplinary, university-wide institute of Hopkins, formed to address critical issues related to environmental sustainability, including energy challenges and health impacts." The mission of E^2SHI is to facilitate, coordinate, and motivate interdisciplinary and interdivisional projects focusing on research, education, and policy. By helping Johns Hopkins become a leader in research and scholarship on climate and energy, the Institute fulfills one of the overarching goals of the Task Force.

E^2SHI is led by a director, a full-time administrator, and an internal oversight committee comprised of 18 Hopkins faculty and staff. E^2SHI has succeeded, or in some cases is on its way to fulfilling a number of the Task Force's initial recommendations. A seed grant program for Hopkins researchers began in 2011, which has awarded 12 grants to date, totaling almost $300,000. To bridge numerous disciplines and showcase Hopkins' research, there are regular roundtable discussions that foster conversation and understanding among faculty in the social sciences, humanities, natural sciences and engineering, and host an annual Sustainability Roundtable each spring. Their website offers extensive resources for students and faculty on courses, academic programs, internships and other academic or professional opportunities relating to sustainability. Additionally, E^2SHI is currently developing a cross-divisional Sustainability and Health concentration/certificate for doctoral students to set a new bar for sustainability and public health related studies, something intimately connected to our identity as an institution, and to leverage our prowess in the field of public health.

The Implementation Plan also called for the creation of a "Sustainability House," which would create a hub for students, scholars, and staff members who are committed to the advancement of sustainability on the Johns Hopkins campuses. Planning for the House reached the design documents (DDs) phase, where it was then determined that the selected location was unsuitable and cost prohibitive. It remains something that is explored alongside other long term development plans.

Community Initiatives

Bolstered by the stated priority of the president to show more leadership in the surrounding community, the past five years have shown a number of successful initiatives and efforts. Some examples:

- Over a three year period, the Climate Showcase Program trained JHU 18 students to work with area non-profits to reduce their climate impacts. Through the program, students worked with nearly 80 non-profits and identified low- or no-cost changes that would have the collective impact of reducing more than 600,000 pounds of CO_2 per year, while creating $65,000 in annual savings. The program was a collaboration with Baltimore City and the U.S. Environmental Protection Agency. Building on the success of the Climate Showcase Program, three students conducted an additional round of audits at local non-profits and small businesses in the following year. This resulted in the identification of an additional 600,000 pounds of CO_2 that could be avoided per year.
- Student interns worked with the Baltimore Electric Vehicle Initiative (BEVI) to conduct market research and analysis on expanding the zero-emissions vehicles options in the Baltimore region.
- Johns Hopkins led an effort to create a Baltimore-based sustainability consortium of area colleges and universities. Called B'CaUSE (Baltimore College and University Sustainable Environments), the group has been instrumental in advancing good practices and sharing innovative ideas for reducing GHG in the region.

HOW ARE WE DOING?

Evolution of Metrics & Measurement

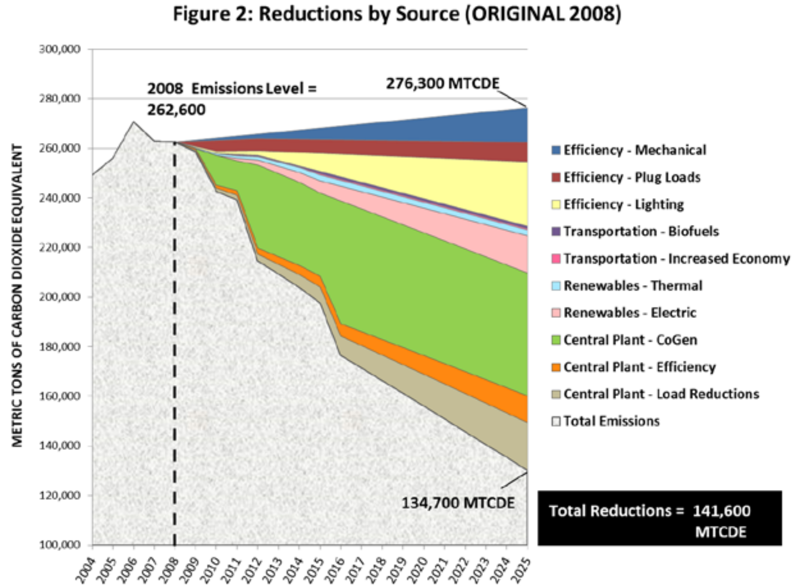
In 2007, the Task Force began its work by creating a series of assumptions on unknowns regarding emissions, institution growth rates, internal and external drivers of energy and greenhouse gases, and the cleanliness of the regional grid. The past five years of comparing these assumptions to performance data has provided a better understanding of some of these factors, and this Five Year Review presents an opportunity to readjust the original assumptions to better reflect realities.

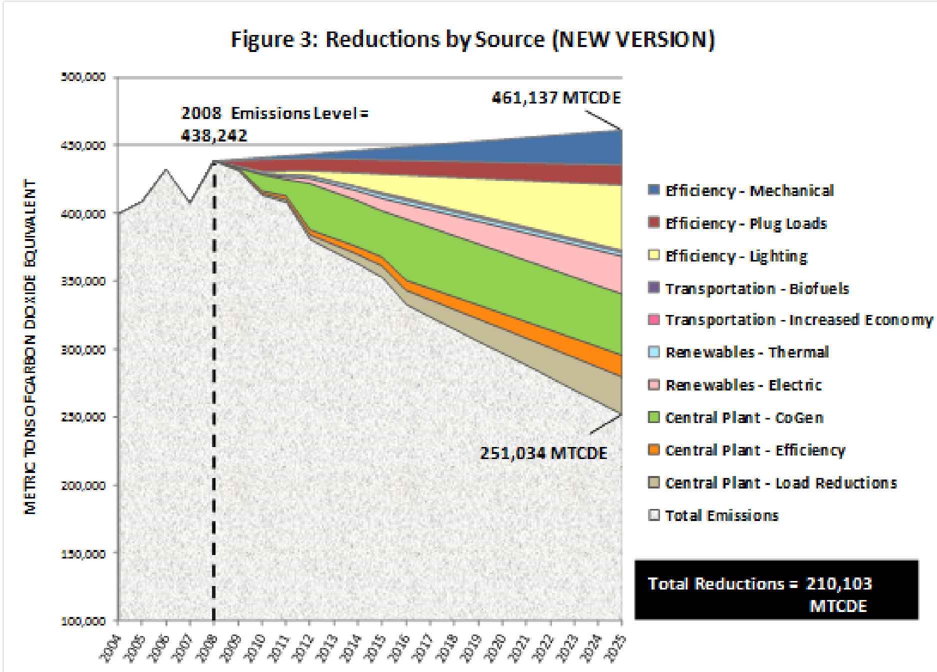
1. Changes to the coefficient

When the Climate Action Plan was implemented in 2008, the baseline carbon footprint for JHU was set based on the U.S. Environmental Protection Agency's (EPA) e-GRID data. E-GRID calculates a carbon coefficient based on regional geography of the United States. The coefficients were also set based on historical data. By using a large region and calculating data based on historical metrics, this presented some challenges when updating the carbon calculator each fiscal year.

In the fall of 2011, the Office of Sustainability learned that their grid operator, PJM, also calculated a carbon coefficient but their coefficient was calculated based on the type of power they distributed (rather than a regional approach) and was updated annually. Since PJM offered better data, JHU's annual greenhouse gas emission calculations were transitioned from e-GRID to PJM carbon coefficients. Figure 2 shows the Emissions Reduction Plan presented in 2008 and Figure 3 shows the updated Emissions Reduction Plan now used.

Figure 2: Reductions by Source (ORIGINAL 2008)

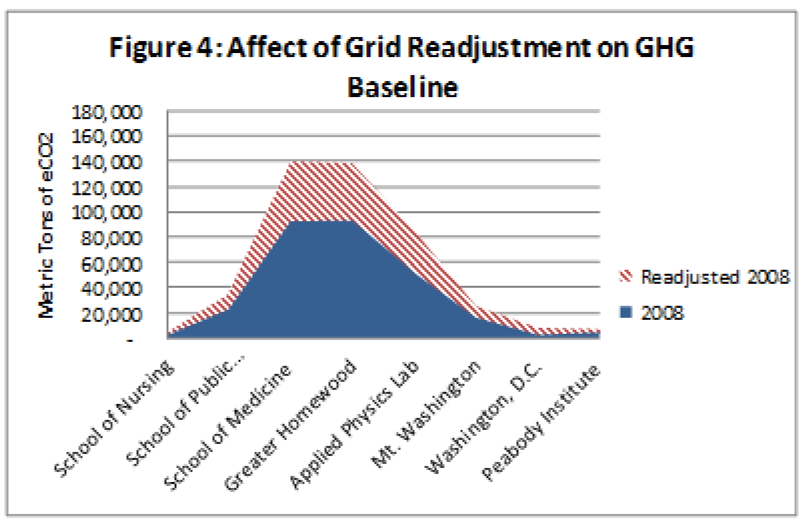




These figures show the difference in total footprint; e-GRID has a much smaller total footprint than PJM. Using PJM's coefficient also comes with a caveat – JHU has to reduce twice as many emissions as they did before. This will be addressed in a later section of the report. Figure 3 gives a different perspective of the increase in emissions, showing how the carbon footprints have changed on a campus level.

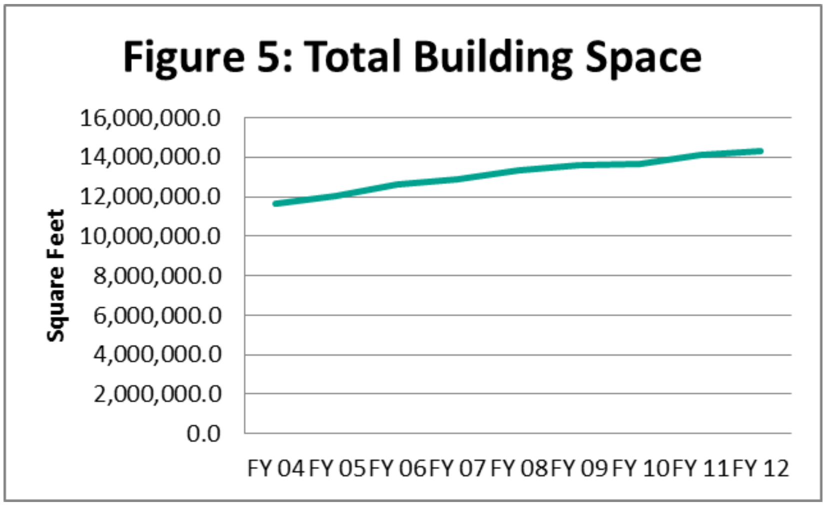
2. Grid Updates

Since PJM updates their carbon coefficient annually and in turn is updated in JHU's carbon calculator, the total carbon footprint is subject to change. From FY2008 to FY2012, the coefficient has affected JHU positively. During these five years, PJM has transformed their power into cleaner power by transitioning from fewer coal fired power plants to more natural gas powered power plants and they have also added more renewable power such as solar and wind. This in turn has benefitted JHU with emissions reductions since the power supplied from PJM contains less carbon content, as shown in Figure 4. But it is important to note that this is not permanent. PJM could transition back to coal plants if the cost of natural gas increases which would increase the amount of carbon and have a negative effect on JHU. In fact, in FY2013 JHU did not see as high of a benefit in emissions reductions because PJM did not have much cleaner power than they did in FY2012.



3. Metric Addition: Density Measurement

During the decade preceding the creation of the Task Force, the University grew at an unprecedented rate. By the time the Task Force began evaluating potential growth rate assumptions for the future projections in 2008, there was a strong sense that the new building boom was largely over. Combined with the deep recession where many were thinking of contraction and not expansion, the consensus of the group was that the university would not add to its building portfolio by any significant means. With this in mind, the Task Force estimated that the University would grow no more than 0.3% per year through 2025.



Since then, it is clear that the slow growth assumptions underestimated the actual continued growth of building space. Instead of a 0.3% growth rate, the University has experienced a 1.45% annual growth rate, reflecting a combination of new construction and the purchase of new buildings, such as the Keswick Buildings. Figure 5 shows the change in total building space since 2004.

With the addition of new square footage, reducing carbon emissions is much harder than anticipated. The change has led many University stakeholders towards discussion of a greenhouse gas per square foot metric moving forward. This way, JHU can continue to construct energy efficient buildings and acquire new square footage without affecting their initial goal. The idea of GHG/sqft will be discussed when the committee reconvenes in the spring of 2014.

4. Data Anomalies

Fiscal year 2013 marks the five years of strong data collection since the initial start of the Climate Action Plan. Since the initiation of the plan, many projects proposed have been constructed and implemented and many changes have occurred. This has led to many unanticipated fluctuations in the data.

Anomaly 1: In FY2011, the power plant in East Baltimore made many meter changes to buildings. Many of these meters were reading lower than the actual building consumption so each of the schools in East Baltimore saw a drastic increase in energy consumption for FY2011 which also increased their total greenhouse gas emissions. To adapt to this change, the Office of Sustainability and East Baltimore facilities members decided to adjust the meter readings for FY2008 to be more on par with current and historical trends. Some of these changes will show spikes in the readings for FY2008.

Anomaly 2: One of the large greenhouse reduction projects proposed in the climate action plan was the conversion of the Homewood power plant to cogeneration. When the plant first came online, many bugs needed to be worked out to get up to capacity and run efficiently. This resulted in a large increase in the amount of natural gas consumed in FY2011. While natural gas has a lower carbon content than electricity, it is still an unanticipated increase in total energy consumption for Homewood and JHU overall.

5. True Footprint

The inventory in 2008 was conducted using the World Resources Institute Greenhouse Gas Protocol, which stipulated that inventories commit to one of two approaches: the "operational" approach, where we count all of the emissions from buildings where we operate, whether we own them or lease them, or the "equity" approach, where we count all of the emissions from buildings we own, regardless of whether we inhabit them or lease the space to third parties. The Task Force opted to go with the equity approach, which better reflected the true nature of the University.

Since the completion of the Task Force, the inventory has been adjusted (1) to include newly constructed or newly purchased buildings that have been added to the inventory; (2) to include buildings that had been excluded because they are jointly owned by the University and the Health System, but later determined to be appropriate for the University footprint; and (3) to include buildings that are currently leased, but will revert to University ownership over time. In the latter two cases, the original baseline was adjusted to reflect the changes.

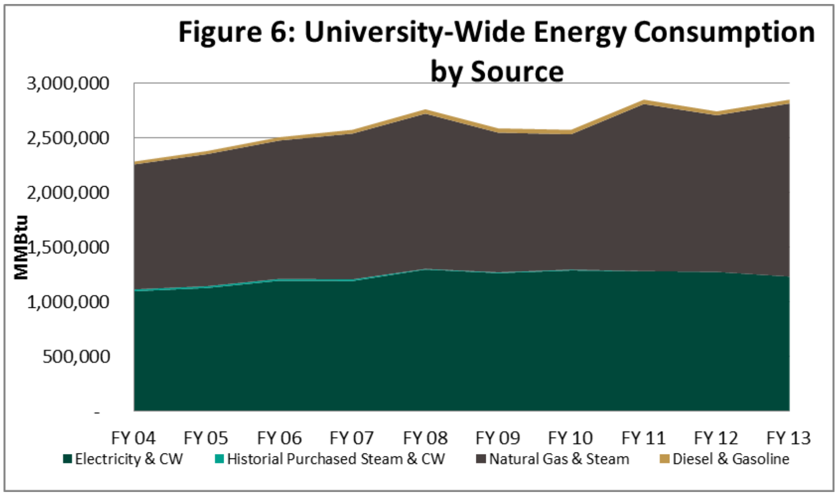
Some of the buildings that have been added since the initial footprint include the Montgomery County Campus, the 2024 East Monument Street building, 98 North Broadway, and the Asthma and Allergy center at Bayview. Since the plan was set up, the Homewood Facilities Management Office has merged with Johns Hopkins Real Estate. This may also create changes in the footprint moving forward to include more properties directly managed by Real Estate.

Data Review for FY2008-FY2013

Energy

Fiscal year 2013 marks the fifth year of data collection since the initial launch of the Climate Action Plan in 2008. Since 2008, JHU has seen an increase in total energy. This is approximately 3.2 percent higher in FY2013 than it was in FY2008. While total energy increase, the energy from different sources fluctuated differently. From FY2008 to FY2013, energy used for chilled water and electricity decreased by just over 65,000 MMBTUs or about 5 percent. Alternatively, energy from natural gas and steam production increased overall. This was about an 11 percent increase, or just over 162,000 MMBTUs higher than FY2008 levels. Diesel and gasoline usage for campus transportation and generators also saw about a 3 percent increase but this energy consumption is minimal in the overall scope of the University. Finally, the energy coming from 'historical purchased steam and chilled water' energy has been phased out since JHU is no longer tracking or operating the location that supplied this information.

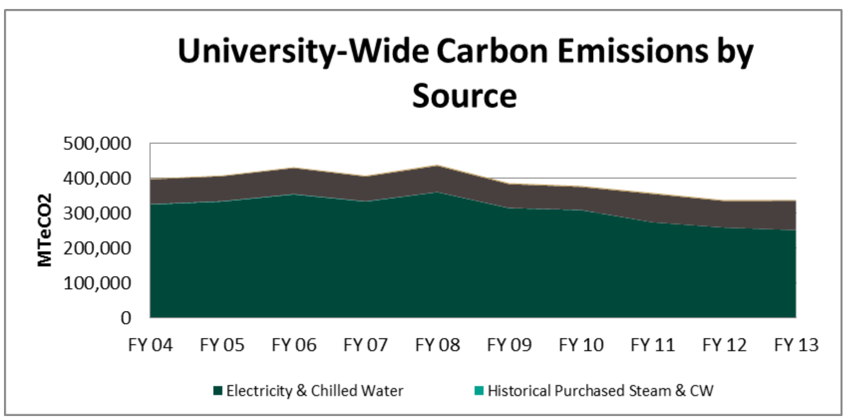
Some of the energy increase can be attributed to new construction that has taken place on multiple different campuses. Since FY2008, Homewood has built three new buildings, Medicine has added two, APL added a couple, and Real Estate purchased and added the Keswick building to their footprint. As time passes, there are plans for new construction which will also add to the total energy increase. This directly relates to the idea of moving towards a reduction per sq. ft. basis rather than totals.



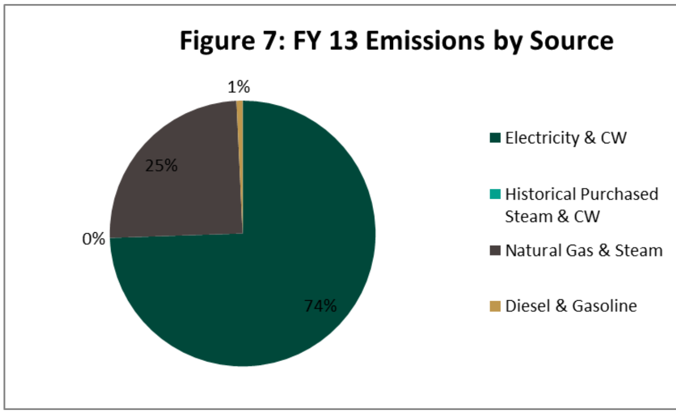
Note how the previously discussed anomalies are reflected in Figure 6. FY2008 has a spike in the data due to the artificial adjustment due to low meter changes and readings. The second anomaly is reflected in FY2011, when the Homewood cogeneration plant began operating and was in the initial phases of working out bugs.

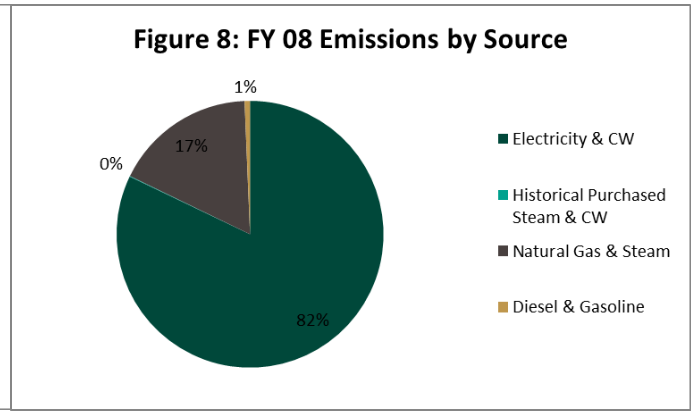
Greenhouse Gases

While energy has been on the incline since FY2008, JHU's total greenhouse gas emissions have declined. Since the start of the climate action plan, JHU has reduced its carbon footprint by almost 35 percent. Roughly 23% of this reduction is attributable to gains from large scale projects - as well as the cleaning of the grid, and approximately 12% from other energy reduction and efficiency measures implemented in our buildings. This is a reduction of just over 100,200 MTeCO2, putting the institution at 338,042 metric tons of carbon emissions as of FY2013.

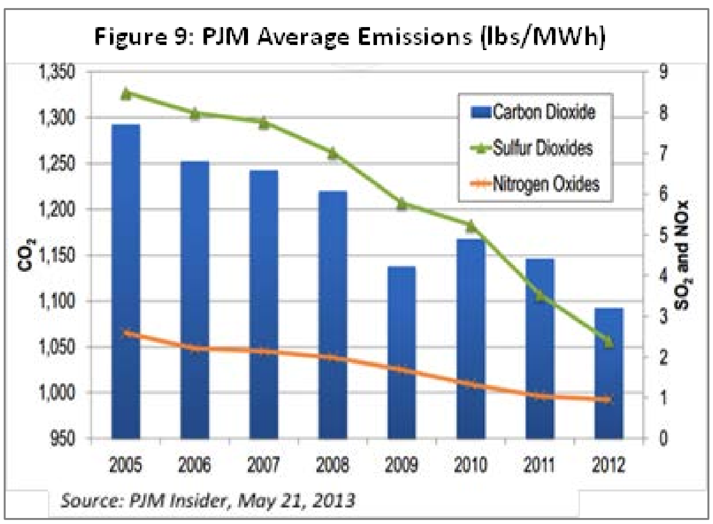


Some the larger scale carbon reduction projects include the cogeneration plants on the Homewood campus and in East Baltimore and the first phase of solar installation at the Homewood and East Baltimore campuses. Cogeneration is beneficial for reducing carbon emissions because the plant converts natural gas into electricity and steam. Creating electricity with natural gas is beneficial to JHU's carbon footprint because natural gas has a much lower carbon content than electricity does. The following two charts (Figure 7 and 8) show more clearly the shift from electricity usage to more natural gas usage.





Solar photovoltaic is also beneficial for reducing the overall carbon footprint because it is carbon free, renewable power. Solar will play more of a role to reduce JHU's carbon footprint moving forward. While these two main projects have helped with carbon reductions, the improvement of the cleanliness of the electricity grid has played more of a factor. Figure 9 from PJM shows how the grid has improved its emissions output since 2005.



HOW DO WE MOVE FORWARD?

Findings and Observations

The past five years have shown that the Task Force recommendations and the Implementation Plan provided an excellent roadmap for GHG reductions and that there

1. *Efficiency first.* All divisions have made progress through energy efficiency projects, and these projects continue to be the most promising areas for further exploration. On-site renewable generation and fuel-switching contribute to reduced carbon emissions, but can be overwhelmed if energy consumption is unaltered. Therefore, efficiency measures have three major benefits; they reduce energy costs, they reduce energy-related GHG emissions, and they maximize the contribution of onsite renewables.
2. *"Low hanging fruit" grows back.* Experience over the past five years demonstrates that new cost-effective means for reducing energy continue to arise. This is because (1) certain technologies mature to a stage where they are more competitive than they were in the past; (2) new technologies come to market that address previously untapped areas of conservation; (3) age deteriorates existing conditions so that the building systems become candidates for replacement, or (4) new thinking on how we use our buildings – labs in particular – leads to new ideas on how to manage energy consumption.
3. *Energy drivers remain significant challenges.* The Task Force recognized that the information age would continue to provide new opportunities for becoming more productive, with the caveat many of these new capabilities would require more energy. Data centers are a prime example of the vast benefits of greater computing power transposed against greater needs for electricity and mechanical cooling. Staying abreast of technology and trends to better predict impacts will be critical to proactively tackling energy conservation and efficiency, instead of reacting.
4. *The Johns Hopkins Community has the potential to be an engine of creative problem-solving.* Several programs are in place to "draw back the curtain" of University operations and administration, and allow students and faculty to cross over from the academic side into operational-based scholasticism. In doing so, students hone their theoretical skills through hands-on experience and faculty gain the opportunity to test out theories, prototypes, or alternative approaches in ways that benefit the school. However, these programs are barely scratching the surface of the potential for using the campus as a laboratory for learning and exploration. Some areas that remain underutilized:

   a. Senior design classes are often framed around solving problems, yet infrequently focus on issues of need in our buildings, grounds, or energy systems.
   b. When students or faculty wish to try out new ideas or test new products, it is difficult to find the right outlets or appropriate decision-makers to proceed. There are few protocols or procedures that can guide them.
   c. The facilities and operations offices are filled with some of the most talented and skillful practitioners in the state. Yet, they remain untapped as a resource for faculty and students who would benefit from their wealth of knowledge and experience.
5. *Visibility still needed.* Unlike the formation of a Task Force or the release of a final report, ongoing efforts often lack the broad visibility or outreach potential for publicity. While GHG activities do not need publicity to be successful from a technical level, the lack of coverage and story-telling at the university level could lead to perception that the program is no longer a priority. New efforts led by the Office of Sustainability are working to bridge the gaps of information sharing on successes, and provide sophisticated resources or materials that tell the sustainability chapter of JHU's story to the past, current and prospective members of our university community.

Next Steps

Moving forward, the five-year mark provides an opportune time to review and revise the Implementation Plan, as well as consider necessary additions to the overall commitment of the university. The following are areas of opportunity for the Climate Action Plan, that are either not included in the original document or are previously identified measures that have potential for improving.

Target Capital Improvements

The emerging protocol for targeting and funding capital improvements provides a key opportunity to address major energy efficiency upgrades in existing buildings. Considerations include:

- *Leverage the Capital Plan.* When evaluating buildings for inclusion in the capital plan list, weigh factors such as total energy consumption, total energy conservation potential, and ability to provide a learning experience during design and construction into the evaluation criteria matrix.
- *Bring buildings up to code.* Ensure that capital improvements capture all of the energy conservation potential, including maximizing the thermal potential in the building envelope. The building code allows for hardship exceptions when renovating existing buildings, but recognizing that renovations and upgrades only arise occasionally, every attempt should be made to ensure that the target buildings are brought completely up to code.
- *Look outside.* Incorporate grounds strategies into building energy and resource conservation and management measures. Often overlooked, the strategic placement of trees, shrubs, and other vegetation can often contribute to significant energy savings within buildings, as well as improve storm water management.

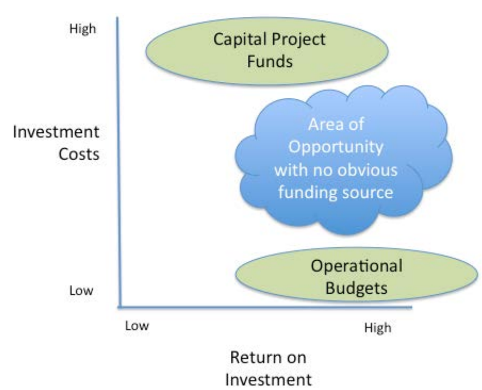
Drive Faculty and Student Involvement

As a research university, Johns Hopkins faculty and students are consistently searching for new ideas and approaches to solving the world's problems. This provides an excellent opportunity to tap into this rich resource base, using the campus as a living laboratory. Considerations include:

- *Budget funds annually for Mechanical Engineering Senior Design work.* The program is based on soliciting funds from outside companies to task our students with solving a technical problem that could lead to a unique or marketable product. By allocating funds for one of the teams to work on campus GHG reduction solutions, the University will be supporting our students while benefiting from their innovative capital.
- *Fast track faculty research projects.* Streamline the process for faculty to interact with University Technical Services and the Design and Construction departments to ensure that there is a fast-tracked and coordinated approach to test new ideas or equipment on the campuses.
- *Make operations more transparent.* Open more of the "behind the scenes" presentations on campuses to the broader university community. As demonstrated by the exceptionally popular Homewood central plant tours, many members of the Hopkins community are eager to learn more about how buildings and systems work, which may lead to more ideas and proposed solutions to reduction GHG emissions, as well as more ownership about personal impacts and opportunities to reduce resource consumption.

Establish an Investment Strategy to Reduce Utility Consumption

Divisions have invested more aggressively in energy and water conservation measures over the past few years, and the results are measureable by a number of performance metrics (e.g., energy per square foot). The majority of investments at the division level tend to fall within one of two categories; (1) large capital projects that impact building infrastructure or address deferred maintenance, or (2) small, quick payback projects that can be folded into annual operating budgets. However, there is a significant group of projects that are in the medium cost/benefit range that are neglected because there is no obvious or consistent source of funding. There is a need for an accessible funding source to address these mid-range projects. Considerations include:



- *Establish sustainable funding source that is replenished by utility savings*. One potential solution to the mid-range project investment problem noted above is to create a dedicated internal investment fund. Savings from projects, plus BGE rebates, should replenish the fund to ensure its financial sustainability over the long run. Ideally, this funding source would be competitive and available to all campuses so that the best projects will always receive funding (regardless of location).

- *Establish financial evaluation tools that include cost of carbon*. Carbon reduction measures are disadvantaged because the true costs of carbon are not included. Providing a value for carbon will produce a more accurate accounting of different projects and opportunities.
- *Focus on tenant fit-outs.* While large building projects get most of the attention, the small renovations and tenant fit-outs represent the more cost effective opportunities for upgrading systems for energy savings. A dedicated internal investment fund (above) could be the mechanism for covering cost premiums associated with energy upgrades included over the original scope of the project.

Explore New Revenue Sources

As noted above, there are significant opportunities to reduce energy and GHG emissions in a cost effective way, but constraints to the access to investment funds is a barrier. With this in mind, it is essential to search for alternative funding and revenue opportunities. Considerations include:

- *Take advantage of the energy markets.* The regional electricity grid is governed by a third party entity called the PJM. They are mandated to balance the supply and demand on the grid, and do so through a series of capacity and ancillary markets. As large electricity users, we can bid into these markets by curtailing our loads at certain times or by manipulating the flow of power with little impact on the campuses. We already participate in some of these markets, but greater opportunity exists.
- *Pursue alternative financing models for energy projects*. The recent completion of a large solar energy system resulted from a creative financing mechanism called a Purchase of Power Agreement (PPA), where the panels were installed at no cost to Johns Hopkins in exchange for a commitment to buy the electricity at below market costs. The first year saw a net savings of over $40,000 with no capital outlay. This is one of a number of alternative "service" agreements possible that can provide needed funding for energy projects.
- *Decouple energy loans from blended rate*. Various state and federal agencies offer subsidized low interest loans for energy efficiency projects (e.g., the Jane Lawton Fund at the Maryland Energy Administration offers 2.5% interest rate). However, there is no incentive for divisions to pursue these loans if what they actually see is the university blended rate.

Rethinking the Way We Work

The traditional work model is being transformed by new advances in technology, staff preferences, and a better understanding of productivity models. The traditional static 40 hour week in one location may not be the model that extends into the 21st century, and focusing on how changes affect workers may also have implications on energy and GHG reductions. Considerations include:

- *Matching work styles and flexibility to building occupancy energy settings*. While many staff need to be on site during normal business hours, an increasing number of people do not. Matching flexible work styles to building hours (i.e., buildings closed every other Friday) can result in savings.
- *Alternatives to the traditional work week*. The standard is a 37.5 hour work week for all employees. However, building in greater flexibility could lead to higher levels of staff satisfaction

and productivity, while creating new opportunities for better utilization of space. For example, some staff might be interested in trading a percentage of salary for less time in the office, greater flexibility, or additional vacation. These all have ramifications on energy use and GHG emissions.

- *Accelerate IT resources as solutions*. IT is a great challenge (greater needs for computing power, servers, data centers) but can also be a crucial part of cost saving solutions. Online learning has proven successful for students, but the university does not take full advantage of the administrative opportunities. IT may be able to identify solutions that can allow meetings without travel, personal computing energy savings, and paperless file storage.

Review and Revise University Policies

Policies have the capacity to provide an underlying framework for future actions. There are some areas where sustainability will benefit from the establishment of policies that help guide future action. Considerations include:

- *Transition from Guidelines to Standards.* For new construction, maximize energy conservation as a priority by transitioning the High Performance Building Guidelines to university standards. While the guidelines have been used well over the past five years, mandating their use as standards will ensure that the University is maximizing new building energy saving potential.
- *Investigate opportunities with space allocation*. At any given time there are classrooms and meeting spaces that are unoccupied because of the different systems of allocating spaces like classrooms, meeting spaces, or conference services. Streamlining the space reservation system may result in better utilization of space and postpone the need for new construction.
- *Create a Clean Transportation Fund to eliminate GHG from campus vehicles*. The recently completed compressed natural gas refueling station for the Blue Jay shuttles is an example of how alternative fuels can save money, reduce GHG emissions, and contribute to a cleaner air environment. A fund, populated by the savings from the CNG project, could cover any premiums associated with replacing campus vehicles with clean air alternatives.

Develop New Incentive Structures

In some cases, a small tweak or change that makes energy more transparent or provides the right motivation for action can produce large impacts. Some considerations:

- *Decouple energy rates from space rates.* The space rate is an all-inclusive charge for all costs associated with the operation and maintenance of buildings. While convenient, the rate buries the true costs of energy and other utilities, and provides no incentive for the occupants to conserve. Removing the real energy costs and charging for them separately will provide the appropriate cost feedback to encourage building occupants to pay more attention to their energy consumption habits.
- *Tie Incentives to faculty offices*. Faculty deserve the best environments to produce world class scholarship, but they are not required to spend time on campus. For those who prefer to work off-site for predictable periods of time during the year, an incentive system may entice

them to share their space with others, which could optimize limited on-campus resources. The recent Gilman renovations provided an insight into how these incentives could work, and the campus utilization study currently being conducted could help inform the development of a programmatic system for this.

- *Provide incentives to remove inefficient and underperforming equipment*. Similar to a "cash for clunkers" program, minimal incentives could be the tipping point for staff and faculty to upgrade aging, energy-inefficient equipment for new, Energy Star models.

CONCLUSION

Five Year Review Committee

With these considerations in mind, a formal Climate Action Plan Five Year Committee comprised of 10 Johns Hopkins administrators, faculty members, and students reviewed our progress to date, and explored key guiding questions, including:

1. How have we performed over the last five years?
2. What circumstances have changed that positively or negatively impact our ability to reach our GHG goal?
3. Does our current goal remain relevant, and/or is in need of modification?
4. How does JHU compare to peer institutions?
5. Where do we go from here?
6. In what ways is sustainability relevant to the university's resiliency in an evolving education climate, and can support long-term sustainability of the institution itself?

New Recommendations

This process resulted in five new formal recommendations for the university to guide its effort over the next five year period and beyond. These help augment the strategy toward reaching our greenhouse gas reduction goal, while also expanding the university's approach to sustainability holistically. Those five recommendations are:

- Develop additional metric for measuring energy consumption per square foot (energy density) as a measure of performance and progress, and correlate GHG reduction goal to this metric accordingly.
- Improve utility billing to better incentivize efficiency and conservation projects, energy budgeting and energy use decision-making.
- Incorporate sustainability at the earliest stage of project planning and maintenance in deliberate ways, including but not exclusive to: capital planning & budgeting; deferred maintenance planning; contract negotiations and RFPs.
- Set an institution wide waste diversion goal.
- Investigate impact of and opportunities associated with university related transportation.

While great progress has been made in a short span of time, opportunities for improvement abound still. At this juncture, the output of the Office of Sustainability should ultimately manifest itself in ways that are *visible, tangible and/or experiential*. Our final recommendations and call to action include the development of a holistic, sustainability strategic plan that considers the following for added goals and department or campus specific implementation plans:

Target opportunities connected to the identity of the institution & high impact

As an example, labs are both the lynchpin to the university's renowned research mission, as well a formidable part of our footprint. While there are a multitude of differences between lab spaces and occupants, there are steps that can be taken to determine commonalities and/or help convert infrastructure or practices toward greater consistency, in an effort to centralize aspects of lab sustainability. In so doing, a large percentage of our campus community will directly interface with "ideas in action," as well as help mitigate the impact of some of the university's largest consumers of resources by square foot. By tying this effort back to the very core of our institution's research endeavors, we can make sustainability synonymous with intellectual pursuits integral to the institution, and help set the bar for our peers.

Help the "s" in Johns intrinsically include sustainability

Success begins and ends with our students to affect comprehensive culture change. As the largest portion of the JHU population and the primary "customer," we are both obligated and would be foolish to not fully determine the implications of how our priorities serve these constituents. From bookending their controlled institutional experiences, to providing diverse opportunities to interface with people, projects and programs, Hopkins students will learn concepts, develop skills, and make memories that foster a revised sense of school spirit predicated on sustainability: from freshmen orientation to commencement, move-in to move-out, our students must be exposed to experiences that reinforce principles of sustainable thought and action, and are shared by all.

Keep pace with the industry, maintain relevancy and stand out amongst peers

This posits exploration of new efforts and opportunities based upon trends in higher education sustainability, such as Sustainability Tracking, Assessment and Rating System (STARS) reporting, best practices in energy performance and GHG measurement, and consideration of other institutions' innovations as they pertain to the JHU context as a priority. Additionally, we should strive to be an exemplar program that plays a powerful role in city, state, regional and national networks.

Position sustainability to lead conversations on the resiliency of JHU

There is tremendous opportunity and urgency to consider our place in the conversation on the viability and efficacy of higher education. As educational formats evolve, and student needs diverge from convention, institutions must adapt their academic models and redefine aspects of their identity as an institution. As these questions are explored, we must also consider, how can sustainability supplement this?