Sustainability Action Plan

Vertex Pharmaceuticals Inc. Fan Pier Annex Building

THE SCIENCE of POSSIBILITY

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FORWARD

This Sustainability Action Plan was prepared for the Vertex Pharmaceuticals Fan Pier Annex Building to fulfill the Capstone Thesis Requirement for the Master in Liberal Arts with concentration in Sustainability at the Harvard Extension School in the Fall of 2016. The plan was prepared by AML degree candidate to help Vertex leveraging what is currently doing and identifying what is appropriate for the implementation of the Sustainability Program particular to the Annex Building.

This a great opportunity to express appreciation to Vertex Pharmaceuticals GxP Operations, EH & S and Corporate Engineering departments and the faculty associated with Harvard University for the opportunity to consult the facility and present the Sustainability Action Plan. Special thanks are given to Wayne McFarland and Charles Pappalardo for believing in this initiative. A very sincere thanks is given to Adam Wyner for all the support, time, and guidance during the plan development, and to Capstone Instructor and Faculty Advisor William O' Brian for his mentoring through the capstone process.

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INTRODUCTION & BACKGROUND

Vertex Pharmaceuticals Inc. is a global biotechnology company that aims to discover, develop and commercialize innovative medicines so people with serious diseases can lead better lives. Founded in 1989 in Cambridge, Massachusetts and headquartered in Boston's Innovation District, Vertex today has global presence in the United States, Europe, and Canada.

Vertex Proxy Statement disclosed in April, 2016 reassures the "company's commitment with natural resources conservation, reduction or elimination of adverse health, safety, and environmental impacts associated to its operations, and promotion of waste minimization, recycling, and energy efficiency in its business activities" (Vertex-A, 2016). This commitment towards sustainability was the main driver to pursue the USGBC LEED Gold certifications for the Vertex Pharmaceutical Headquarters buildings, as well as green initiatives that focus in waste reduction, alternative commuting, continuous improvement, energy efficiency, and community engagement. Vertex is not indifferent to Sustainability. For Vertex, integrating sustainability to the company's mission and values is necessary for the long-term value they produce to its shareholders and stakeholders, and to continue discovering, developing, manufacturing and commercializing medicines for serious diseases. As Paul Hawken, author of *The Ecology of Commerce*, said about the power of businesses to produce the changes necessary to reverse global environmental and social degradation, Vertex has the power to contribute in this change by becoming a more social responsible company.

To further promote sustainable practices in Vertex Pharmaceuticals' operations, strategic planning is necessary to prioritize among possible actions towards sustainability (Blackburn, 2008). Having a Sustainability Action Plan helps Vertex focus its resources on those things that provides greatest value. Alignment and coordination on key priorities are necessary to produce significant results with the least resources.

INTRODUCTION & BACKGROUND

The heart of the Sustainability Action Plan is "Action". The Plan is intended to serve as a toolkit that companies, like Vertex Pharmaceuticals, can use to develop their own sustainability actions under a consistent framework. It is also a resource to engage company's stakeholders in sustainable practices. Furthermore, the Sustainability Action Plan is a pathway that Vertex Pharmaceuticals Inc. can follow to reduce direct and indirect greenhouse gas emissions from company's operations, prepare for climate-readiness and resiliency planning, foster a healthy economy, and promote social responsibility.

This Sustainability Action Plan is focused in the Vertex Pharmaceuticals Fan Pier Annex Building located at One Harbor Street in Boston, Massachusetts. The Annex building is a 59,000 sq. ft. research and commercial facility that houses Quality Control, Analytical, Release and Stability Laboratories; Drug Product Development Areas including a Continuous Manufacturing Operation RIG; warehouse support spaces; utilities rooms; break room; and office areas. The Plan was developed in a way that recognizes the many sustainability efforts already underway in the Annex Building, and identifies additional actions that have been yet to be taken. The Sustainability Action Plan is a living document, and it is only a first step on the road toward making the Annex Building truly sustainable. Accountability and continued engagement will be crucial in the implementation, updating, and success of the Sustainability Action Plan.

QUICKVIEW OF THE SUSTAINABILITY ACTION PLAN

1. Understanding Sustainability	• Provides common understanding of sustainability, and what it means for Vertex.
2. Client Requirements	• Identify requirements particular for the Vertex Annex Building
3. Opportunities & Risks	• Provides advantages and disadvantages of having or not having the Plan
4. Key Stakeholders	• Identify Vertex Key players for this Plan
5. Sustainability Key Priorities & Recommendations	• Explain building current state and pinpoint opportunities of improvements from priorities.
6. Change Management	• Provide guidance in how to foster sustainability behavior in the building.
7. Sustainability Capital Reserve	• Provide Opportunties for funding sustainability projects
8. Performance Metrics, Reporting, and Benchmarking	• Provide the Key Performance Indicators based on identified priorities and frameworks for reporting and benchmarking
9.0 Roadmap	• Provides timeline for SAP implementation

SUSTAINABILITY ACTION PLAN- STEP #1

1.0 Understanding Sustainability

Where sustainability work best is where an organization's leadership gets it and wants it to happen and enables it to happen so everyone from the person who sweeps the floor to the finance director feels part of the conversation."
-Will Day

Corporate Sustainability is defined in the *Mainstreaming Sustainability* book, as the "balancing environmental stewardship, social well-being, and economic prosperity while driving toward a goal of long-term success for health of the company and its stakeholders" (Farver, 2013).

In order to achieve this balance, companies like Vertex Pharmaceuticals should develop a plan to ensure the executive leadership and employees understand what is sustainability, what does it means to Vertex Annex Building, and what it could means for each of the building areas. The idea is to become aware in social, political, cultural, and environmental issues that bear in the business in order to move from a reactive to proactive position on Sustainability.

Is sustainability the same as "going green"? No, but they are related. "Going green" is a popular way of referring to actions that reduce impact on the environment. Sustainability includes the consideration of environmental impacts, but also includes the social and economic dimensions of organizations decisions. For Vertex Pharmaceuticals Inc., sustainability is defined *"as embracing the company's impact on the environment and the community by developing products that have less impact across the value chain".* This definition can make Vertex stronger and more competitive, but it has to be integrated at the core of its vision.

1.1 Vision of Sustainability for Vertex

Leading companies that are succeeding in sustainability have successfully made the connection between financial benefit and sustainable practices into their vision. Vertex should use the same approach to demonstrate its commitment to sustainable practices in the business operations.

SUSTAINABILITY ACTION PLAN- STEP #1

Drafting a sustainability vision statement for Vertex helps articulate how sustainability relates the company, and is an important step for long-term integration of sustainability. Setting a sustainability vision matters because once it's defined in the context of Vertex, the company can easily prioritize actions and goals.

The first thing in developing the Vertex's vision is aligning its value with the interests of the employees, patients, communities, environment, and regulatory agencies. Aligning those interests enables key stakeholders to shape and influence the company's vision (Goggins, 2007). Using the company's tagline *"Science of Possibility"*, it is recommended to create a clear a sustainability vision that is a vivid description and inspirational towards possibility for the shareholders, employees, communities, suppliers, and patients that integrates the social, economic, and environmental pillars into one story. The proposed sustainability vision aligned to the "Science of Possibility" tagline is:

As a company that focus on the Science of Possibility, we invest in bold innovations that improve the life of our patients without harming our planet"

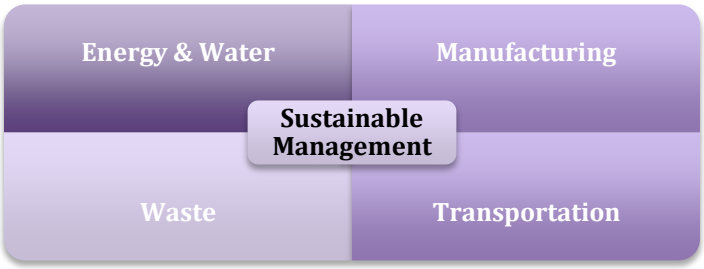
This proposed vision might evolve over time, but specifying a vision early in the planning process can provide the perception about how committed is Vertex with Sustainability.

2.0 Client Requirements

Vertex Pharmaceuticals Inc. has been conducting periodic meetings to discuss the potential development of a *Corporate Social Responsibility Program*. Representatives of different departments were tasked to generate a story line on sustainability related efforts throughout the company, including sites of San Diego, Paddington, Laval, and Boston. One of the major goals is to obtain commitment from key decision makers from the company to develop a sustainability program that identifies Vertex's sustainability core competencies and attributes, opportunities of improvements, goals, and tools that ensure trending in the right direction of environmental and social responsibility.

Most of the efforts were common across sites and focused in specific categories such as energy efficiency, waste management, technology and manufacturing, and GHG emissions reduction from transportation. These efforts are aligned with the key priorities identified by the client for the Vertex Annex Building. Therefore some initiatives proven to be successful in other sites can by apply to this building. Furthermore, this Sustainability Action Plan can be extended to the corporate initiative as guidance to sustainable practices.
The requirements identified by the client for this Sustainability Action Plan are summarized as follow:

- Sustainability Action Plan that focuses in the following key priorities or areas identified for the Vertex Annex Building:



- Integration of sustainability pillars to company's mission and core values.
- Stakeholder engagement strategy to enhance communication, behavior, and attitude towards Vertex's commitment to sustainable practices and social responsibility.
- Innovative plan that helps Vertex to be ahead of the curve.

3.0 Opportunities and Risks

There are different reasons in why corporations choose to follow a Sustainability Action Plan. Some companies understand that the major benefits from having a plan are opportunities of new markets, profitability gains, and increased value. For other companies, it represents the basis for a Corporate Strategy. The reality is that no companies, big or small, locally or globally, in manufacturing or services, can afford to ignore the environmental and social impact from their operations (Esty, D; Winston, A., 2009). However, the opportunities and risks from a Sustainability Action Plan implementation vary by company and industry.

Potential opportunities for the Vertex Annex Building after implementation of the Sustainability Action Plan provide a balance between environmental protection and conservation, community awareness, and preservation of building's financial health. Those opportunities include:

- Reduction of building/operating costs without negatively affecting the product quality.
- Reduction of Scope 1, Scope 2, and Scope 3 greenhouse gas emissions to the environment due to company's operations.
- Significant staff engagement and proactive attitude to ensure Vertex's commitment to sustainable practices.
- Staff productivity and loyalty growth.
- Strength Vertex's transparency and reputation.

Some risks that the company may face by not implementing the plan are:

- Loss of funding from capitol investors.
- Staff turnover growth.
- Reduction in profits from higher building operating and maintenance costs.
- Loss of consumers.
- Perception of a company that is not social and sustainable responsible.
- Increase of carbon footprint in a long-term.

Through this plan, the Vertex Annex Building has a great opportunity to transform its business model to generate a triple win: operational efficiencies that cut costs, reduce demand on shared natural capital, and improve quality of life for community of people the company serves.

4.0 Key Stakeholders

Successful implementation of the Sustainability Action Plan requires full commitment from Vertex, especially at the highest levels. The support of key stakeholders is essential for the development, successful operation, and long-term sustainability of the Vertex Annex Building. The key stakeholders should include a "*Champion*", at a highest level, and key staff members or "*officers*" that truly understand the best interests of the company. Specific officers should be empowered with the authority and responsibilities to oversee the Sustainability Action Plan development and implementation, and provides recommendations (Farver, 2013; pp. 151)

While Vertex Pharmaceuticals Inc. does not have a dedicated team for a Corporate Sustainability Program, Mr. Charles Papparlardo, VP for Corporate Real Estate and Operations at Vertex Pharmaceuticals, agreed to act as the "*Champion"* for the Vertex Annex Building Sustainability Action Plan. Several staff members that have been involved in Sustainability initiatives across Vertex as well as staff members dedicated to the Annex Building were added to the team as *"Officers"*.

- *Key Officer*: Mr. Adam Wyner, EH&S Sr. Manager at the Vertex Annex Building, is the key contact person for this Sustainability Action Plan. In addition, he is one of the Sustainability Motivators for the potential Corporate Sustainability Program at global level
- *Officer*: Randy Boles- Sr. Director EH&S Vertex Headquarters, is Sustainability Motivator for the potential Corporate Sustainability Program at global level.
- *Officer*: Jacqueline Van Sipe- Sr. Manager EH&S, is Sustainability Motivator for the potential Corporate Sustainability Program at global level.
- *Officer*: Matt Ziccaro, Director of Corporate Engineering is the Global Energy Efficiency Program Lead for Sustainability Initiative.
- *Officer:* Mr. Wayne McFarland, Sr. Director GxP Operations, is the head of facilities and operations at the Vertex Annex Building
- *Support:* Mr. Dennis Berrios, Associate Director GxP Operations, provides leadership in facility maintenance and calibration at the Annex Building.
- *Support:* Mr. Phani Sukhavasi, Lead Engineering- GxP Operations, is the engineering and project support at the Annex Building.
- *Support:* The GxP Operations Team is the staff that provides technical support to the operations and maintenance at the Vertex Annex Building and the ability to respond any questions related to the building operations.

Figure 4.1 shows the Key Stakeholder structure for this Sustainability Action Plan.

SUSTAINABILITY ACTION PLAN- STEP #4

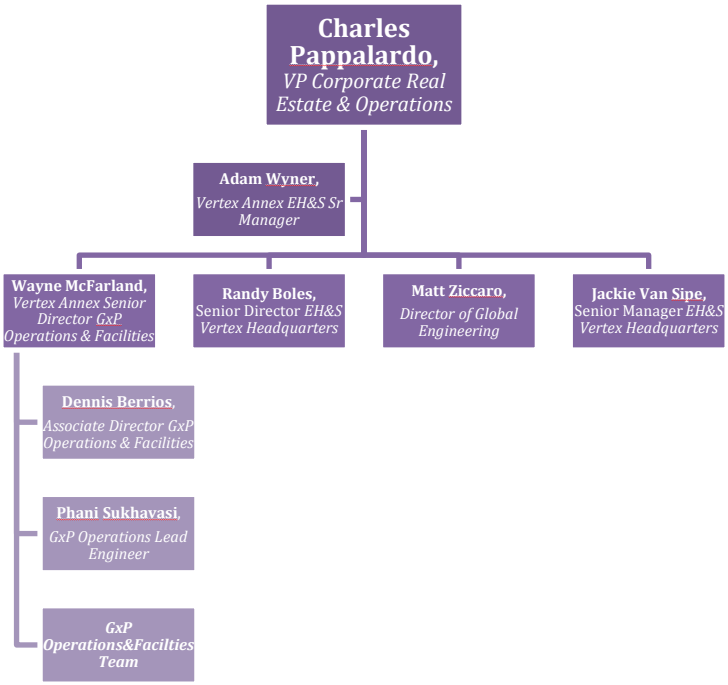


Figure 4.1: Vertex Pharmaceuticals Fan Pier Annex Building SAP Key Stakeholders

These key stakeholders will be supporting discussions of relevant issues, making decisions about the different sustainable initiatives, and ultimately implementing the Sustainability Action Plan.

5.0 Sustainability Key Priorities and Recommendations

5.1 Vertex Annex Building Carbon Footprint

In order to provide initiatives that truly have an impact in the performance of the Vertex Annex Building, it is imperative to understand the environmental footprint of the facility. The carbon footprint is defined as the measure of the environmental impact, or greenhouse gas (GHG) emissions, of a particular company's operation, measured in units of carbon dioxide (Rouse, 2010). The GHG emissions are one of the key performance indicators that are most requested by stakeholders. The Greenhouse Gas Protocol has established three categories of GHG emissions (Scope 1, Scope 2, and Scope 3) to help companies categorize GHG emissions into those they control (e.g. Scope 1) versus those that they can influence (e.g. Scope 2). The following table shows the definitions of the different GHG emissions categories:

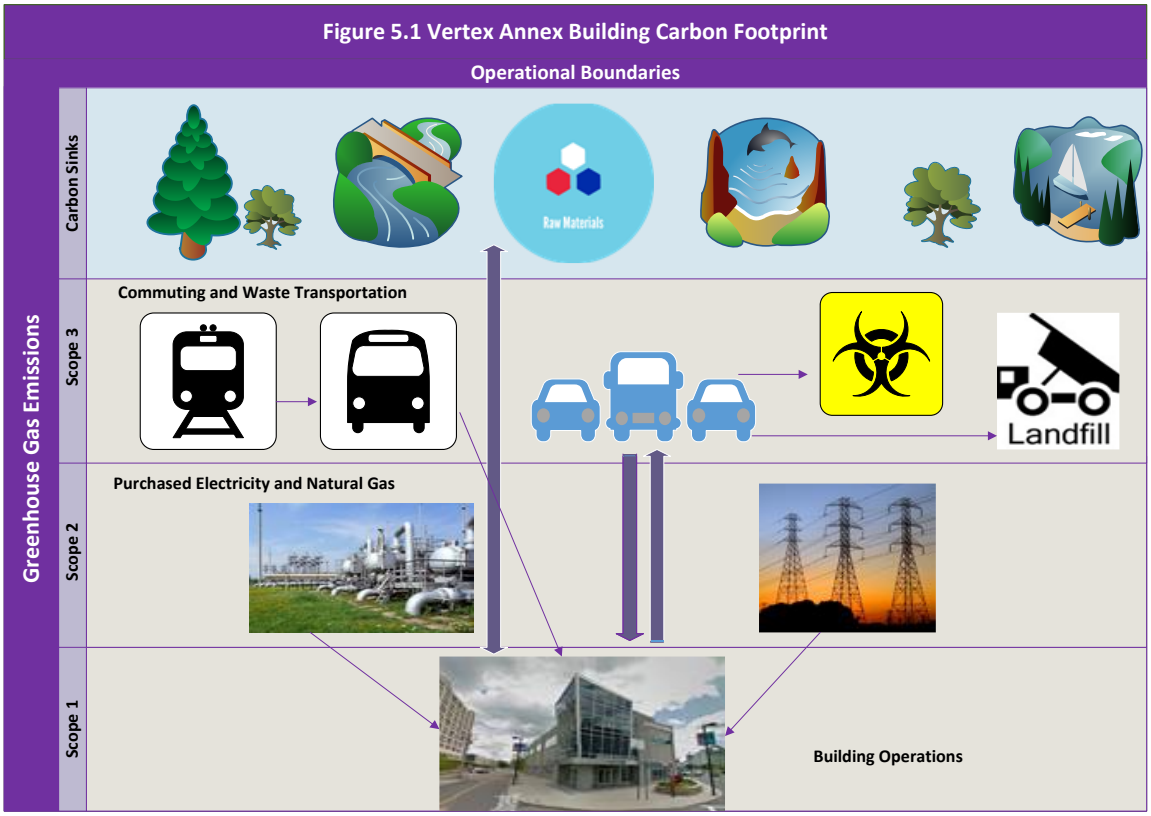
GHG Category	Definition	Types of Emissions	Applicable to Vertex
Scope 1	Also referred to Direct GHG. Emissions from sources that are owned or controlled by a company. For the majority of companies, the stationary and mobile combustion sources are the most relevant.	Stationary Combustions: from the combustion of fossil fuels for comfort heating or other industrial applications.	X
		Mobile Combustion: from the combustion of fossil fuels used in the operation of vehicles of other forms of mobile transportation.	X
		Process emissions: emissions released during the manufacturing process in specific industry sectors (i.e. cement, metal, adipic acid, ammonia).	N/A
		Fugitive emissions: Unintentional release of GHG emissions from sources including refrigerant systems and natural gas distribution.	X
Scope 2	Also referred to Indirect GHG. Emissions from the consumption of purchased electricity, steam, or other sources of energy generated upstream from the organization.	Electricity Natural Gas Steam Chilled Water Fuel	X
Scope 3	Also referred to Other Indirect GHG. Emissions that are a consequence of the operations of the organizations.	Employee Commuting Business Travel Third-Party distribution and logistics Production of Purchased Goods Use of sold product, etc.	X

Table 5.1: Greenhouse Gas Protocol Emissions Categories

Each of these categories can be measured using the sustainability footprint to illustrate the flows of energy and materials from a given activity within the established footprint boundary.

A Sustainability footprint has been developed for the Vertex Annex Building, using elements from Life Cycle Analysis, to highlight areas where non-renewable resources use can be reduced and money can be saved, while simultaneously reducing Vertex's environmental impact. The boundary of the footprint analysis is confined to the building only, but it can be extended to suppliers, customer use, and other facilities as the Sustainability Program advance to the continuous implementation phase. Refer to Figure 5.1 for Vertex Annex Building Sustainable Footprint.

Figure 5.1 Vertex Annex Building Carbon Footprint



Vertex Annex Building's footprint is aligned to the key priorities such as energy and water consumption, waste management, and transportation, which were identified to investigate and find alternatives to reduce their impact over the next years.

5.2 Key Priority #1: Energy and Water

5.2.1 Energy & Water Assessment

As part of the Sustainability Action Plan, a comprehensive energy audit was performed to the Vertex Annex Building to identify opportunities to save money and energy, while reducing the building's greenhouse gas emissions.

This audit meets the Level I requirements established by ASHRAE[1] as the standard for Vertex Fan Pier Annex Building energy audit. As a result, this audit includes the following: an historical analysis of all building utility consumption (electricity, natural gas, and city water); specific efficiency improvement recommendations for the primary building systems (HVAC equipment and distribution, electricity, water and building envelope); and financial analysis for some of the recommendations, which includes the Return of Investment (ROI). This comprehensive approach uses structured techniques to provide a valuable framework for substantial and measurable utilities savings.

5.2.1.1 Occupancy and Use Schedule

The office space, manufacturing, and common areas at Vertex Annex Building are typical occupied during work hours (8 a.m. – 5 p.m.) by the staff of the building. Security staff typically occupies the lobby area after 5 p.m. and during the weekends. Payback calculations for conservation projects included 70 full time occupants and a visitor average of 5 per day. These occupancy patterns are leveraged in the energy conservation strategies included in this report.

5.2.1.2 Recent Building System Upgrades and Existing Conditions

Since its construction in 2013, there have been a few renovations to the existing building to add more capacity to the washroom at the Drug Product Facility, add a new laboratory and data center space at the second floor, and provide additional office space in the second floor of the building. As of now, no sustainability upgrades have been made to the building. The Vertex Annex Building is not connected to district heating or cooling network. Therefore, all heating and cooling is generated with on-site equipment.

[1] American Society of Heating Refrigeration and Air Conditioning Engineers

The following sections describes the existing primary conditions of the building systems:

HVAC System:

The Vertex Annex Building is designed to meet the following conditions:

Indoor Summer	Indoor Winter	Outdoor Summer	Outdoor Winter
70°F ± 2°F DB 50% ± 5%	70°F ± 2°F DB 30% ± 5%	91 °F DB/ 73 °F WB	-2°F DB- MFG units 1°F DB – Office Units

Three rooms (Room 139, 141, and 142) require relative humidity control from 20% to 60% ± 5%, which means, a user can select any value in this range, depending on the process requirements. The environmental classification in the GMP spaces is ISO Class 8, CNC. The design airflow rate is 10 air changes per hour, 100% outside air. The design provides adequate ventilation for solvent that may be present, as well as minimizing the chances of cross-contamination from recirculating system.

Heating: The Heating Hot Water (HHW) system consists of three (3) packed condensing gas-fired boilers serving the HHW distribution loops. HHW is circulated throughout the building via two (2) pumps, operating in a lead/lag configuration.

Cooling: Cooling is provided by chilled water-glycol system, using modular air-cooled Multi-stack chillers located at the roof of the Annex Building. Chillers staging are designed to maintain chilled water (CHW) supply temperature of 45 °F. CHW is circulated throughout the building via primary and secondary pumps configuration, intended to operate in a lead/lag configuration. The pumps were observed to be operating simultaneously.

Ventilation: Four rooftop air handling units (AHUs) provide the require airflow for the Vertex Annex Building.

- 5100-AHU-001: This Trane unit provides once throughout air to the Drug Product Facility (DPF) suites. This AHU is equipped with heat recovery coils in the exhaust streams due to the supply of large quantities of outside air. Exhaust air is discharged through high plume fans. The operating schedule for the unit is 24/7.
- 5200-AHU-002: The Munters packed desiccant humidifier is intended to control humidity in a portion of the 5100-AHU-001 supply air for the DPF rooms 139, 141, and 142. This unit

includes dehumidification and humidification mode, and a bypass damper when dehumidification is not required. A reheat coil followed by a steam humidifier is provided to humidify spaces when desired for specific products. The operating schedule for the unit is 24/7.

- 5300-AHU-003: This Trane unit provides once throughout air to the Kilo Labs, Analytical Labs, War Room, and Support Spaces. This AHU is equipped with heat recovery coils in the exhaust streams due to the supply of large quantities of outside air. Exhaust air is discharged through high plume fans. The operating schedule for the unit is 24/7.
- 5400-AHU-004: This unit provides re-circulated air to the office areas, corridors, and restrooms. This AHU is equipped with an economizer but is not currently in use. Exhaust air is discharged through high plume fans. The operating schedule for the unit is 24/7.

Air handling units 5300-AHU-003 and 5400-AHU-004 are configured with the following temperature setbacks:

Outside Temperature	Discharge Temperature
23 °F	63 °F
53 °F	53 °F

VAV boxes with HHW reheat coils control the temperature for the spaces served by 5400-AHU-004. CAV boxes with HHW reheat coils are used to control the temperature for the spaces served by 5100-AHU-001, 5200-AHU-002, and 5300-AHU-003.

Fume Hoods

Vertex Annex Building labs are equipped with fume hoods that are 100% exhausted. The hoods have vertical and horizontal sashes, depending on their size. The total airflow in the labs varies to maintain the correct face velocity across the hood opening. The required fume hood face velocity during occupied mode is 100 ft./min. Fume Hood operations is one of the biggest challenges when it comes to energy consumption, and was identified during the audit process. As an example, if one hood is 100% open for extended period of time, a flow of 42,000 CFM would be required, which would require over 150 tons of chiller capacity just for one lab. Some of the fume hoods are left open in the building when they are not in use.

Water

The Vertex Annex Building water system is classified as follow:

Potable and Tepid Water: Potable water is provided from a 3" city water supply. The potable water is supplied to the building at 80 psig from the city water booster pump. Tepid water is supplied to the emergency safety showers.

Domestic Hot Water: The domestic hot water is supplied by one AO Smith 150-gallons freestanding natural gas-fired water heater (GWH-1). Whenever Room 232 VAV flow rises above 2000 CFM, BMS disables GWH-1. Once Room 232 VAV flow falls back below 1800 CFM, BMS enables GWH-1.

Reverse Osmosis (RO) Water: The RO water generation source is provided by non-potable cold water. RO water supplies water to the purified water system (manufacturing), laboratories, and humidification systems on a demand basis. The RO generation system has a pre-treatment module and generation module that consists of RO units that operate lead-lag. The RO supply has local and remote flow rate monitoring. The RO water effluent flow rate has local monitoring only.

Sanitary Waste: Sanitary wastewater, associated to the RO water effluent, is tied to the underground sanitary sewer line.

Process Wastewater: Process wastewater is generated from the manufacturing areas, filling areas, filling areas, packaging areas, and laboratories. Waste stream from these areas are discharged to the sewer after neutralized. The pH neutralization system is provided to treat wastewater high or low pH swings from laboratories and manufacturing, and to ensure discharge permit compliance. Process wastewater is monitored by local pH neutralization system to be within a pH range of 5.5-12.

Plumbing: There are restrooms available in the first and second floors of the building. All toilet fixtures are powered infrared sensor flush units equipped with 1.6 gallons per flush (gpf) flushometer. Some of the bathroom sinks are fitted with 0.5 gallon per minute (gpm) infrared faucets. All the faucets are equipped with instant hot water heaters. Some of the faucets are currently not working.

Electrical Metering

The electrical system at the Vertex Annex Building consists of underground Medium Voltage (MV) feeder, MV switch and transformer, and 480/277V, 3-phase, 4-wire and 208/120V secondary distribution system. Critical and Code-Required Emergency loads are supplied from a 480V/277V natural gas generator installed at the building penthouse. An Uninterruptible power system is provided to serve critical computing and process equipment. The building has a single utility meter. The power distribution system is estimated to provide building loads as follow:

- Process Load: 1000 kVA
- Facility Equipment Load: 1400 kVA
- 80% Demand Total: 1920 kVA

Lighting

T8 and T5 lamps, high frequency electronic ballasts, and lamps throughout the building provide interior lighting. Occupancy sensors, daylight sensors, and manual switches control the interior lighting.

Gasket light fixtures are provided in the manufacturing processing rooms to prevent powder infiltration. Recessed lighting is provided in the labs, offices, conference rooms, and lobbies. Strip or industrial fixtures are observed in mechanical and electrical rooms, and storage areas.

Building Automation Control

The building automation control consists of a GMP (SCADA) and a non-GMP Building Management System (BMS), and various local control equipment package controls and PLCs. The BMS monitors plant mechanical utilities. The electrical utilities are not monitored by any of the building automation control system.

The Vertex Annex Building has recently installed a Continuous, monitoring-based, commissioning program (Analytika) to the BMS that includes 24/7/365 data collection and analysis to ensure the building system maintains HVAC efficiency and comfort.

5.2.2 Renewable Energy Assessment

As part of the auditing process, the possibility of adding renewable energy technologies at the Vertex Annex Building was examined. Some of the technologies evaluated include: solar photovoltaic (PV), solar hot water, and small-scale wind turbines. This analysis is meant to provide general information regarding existing conditions at the building and is not meant to serve as a guarantee regarding the feasibility of installing any of these systems.

- *Solar PV*: The building contains flat roof sections that could possibility be used to install solar panels. The open roof will allow for panels to be oriented in the southern directions to maximize the exposure to the southern sun. Surrounding buildings are slightly shorter than the Annex Building, therefore and they could not shade portions of the roof and won't affect the amount of usable sunlight.

- *Solar Hot Water*: The flat roof and sunlight hours/yr emitted to the Vertex Annex Building would make it a possible candidate for a solar hot water installation.
- *Small Scale Wind*: This option is not recommended for the building for multiple reasons. The variability of the wind strength would not produce the same amount of electricity all the time, the noise levels can be too high for the area, the installation might not be allowed by the building owner since they could be considered unsightly structures and not pleasant to look at to the city location, and the height should not exceed 200' due to its proximity to the airport.

Renewable technologies are recommended as future initiatives or capital projects to be implemented at the Vertex Annex Building. Refer to Section 5.6 for further details and cost benefits.

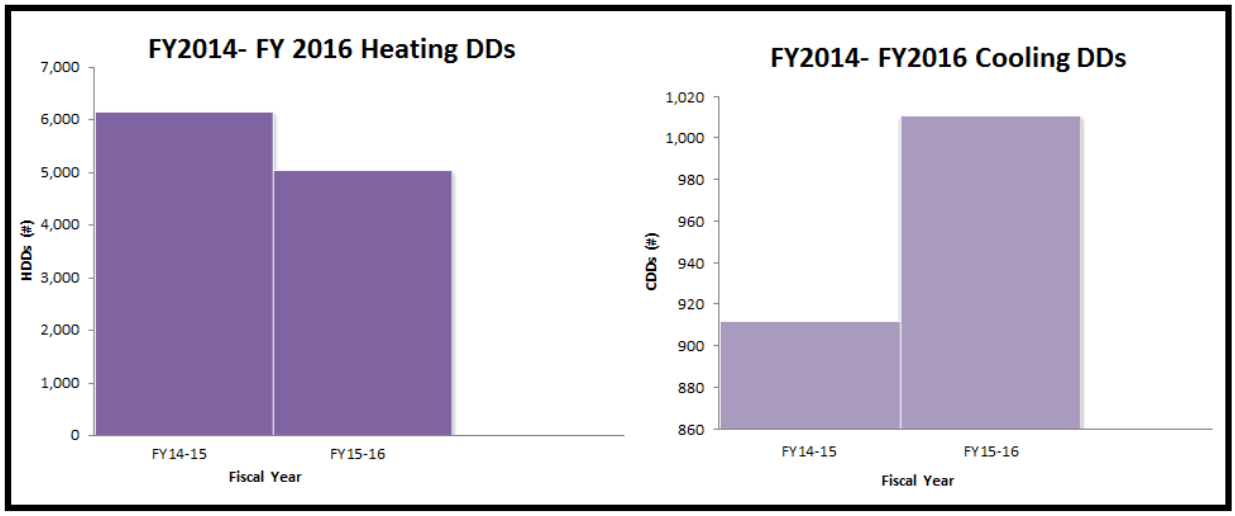
5.2.3 Utility Bill Analysis

5.2.3.1 Annual Degree Days FY2014-FY2016

The graphs below provide the number of heating and cooling degree-days for Boston, MA for the past two (2) fiscal years:

- October 2014- September 2015
- October 2015- September 2016

A heating degree-day (HDD) is the number of degrees that a day's average outside air temperature is below 65°F and a building's interior is typically heated. A cooling degree-day (CDD) is the number of degrees that a day's average outside air temperature is above 65°F and air conditioning is typically used to cool a building's interior spaces.



5.2.3.2 Utility Performance by Fiscal Year

Total Energy Consumption

Examining the historical utility data of the Vertex Annex Building is a requirement of an ASHRAE Level I audit. The utility performance analyzed for this SAP consisted in the following:

- FY2014-2015 Period: October 2014- September 2015
- FY2015-2016 Period: October 2015- September 2016

The graphs shown in Figure 5.2.3.2.1 and 5.2.3.2.2 visually represents the trend in total building energy consumption and consumption associated to individual source over these years. Overall, total energy use at Vertex Annex Building decreased by 36% between 2015-2016.

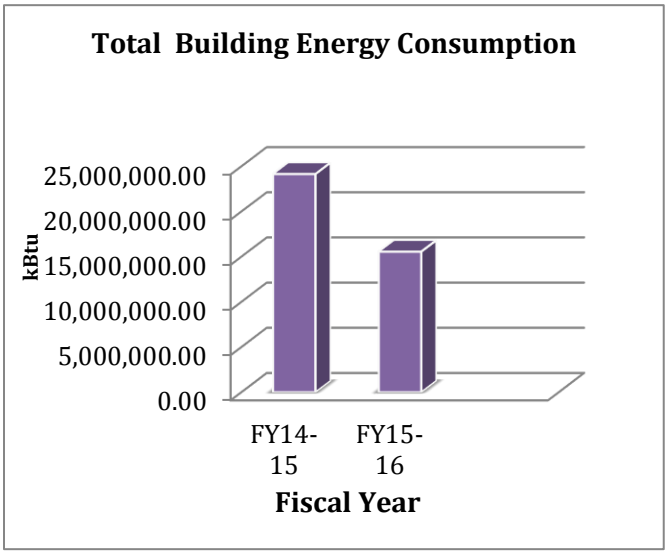


Fig. 5.2.3.2.1

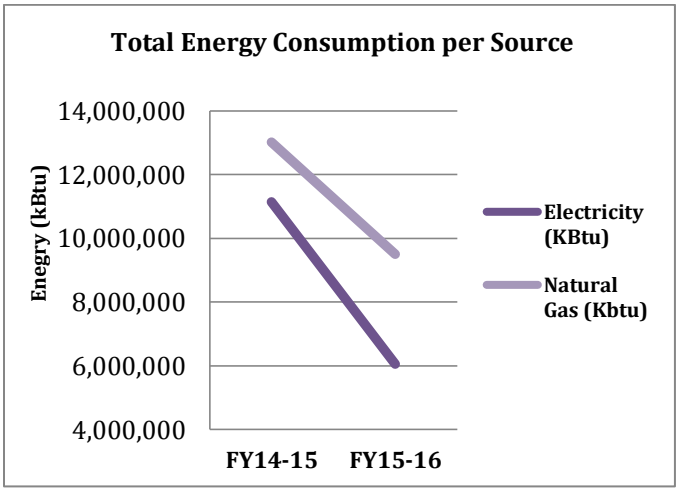


Fig. 5.2.3.2.2

Electricity vs. Cooling Degree Days

The graph shown in Figure 5.2.3.2.3 illustrates the relationship between electrical consumption and weather variance. In general, when there is an increase in annual number of cooling degree days, electrical consumption should also increase and vice versa. Looking at the graph, during FY15-16 electrical consumption decreased by 46% while the number of cooling degree-days increased 10.82%. This and other discrepancies suggest that there is a relatively weak relationship between electrical consumption and weather variance.

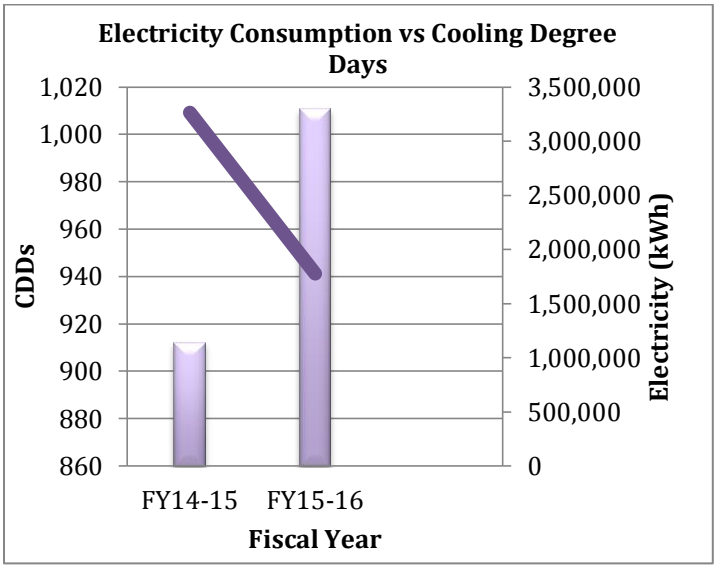


Fig. 5.2.3.2.3

The graph shown in Figure 5.2.3.2.4 illustrates the amount of electricity consumed per cooling degree-day over the past fiscal years. In general, this graph shows how efficiently the building was cooled and should be relatively consistent with the changes in electrical consumption and cooling degree-days as illustrated in the graph on the previous page. It is observed that during 2015-16, the energy intensity declined by 45.62%, while the cooling degrees-day increased during the same period. This finding shows that the building was not efficiently cooled during this time. Due to such inconsistencies, there may be opportunities to verify electricity data reporting and cooling the building more efficiently.

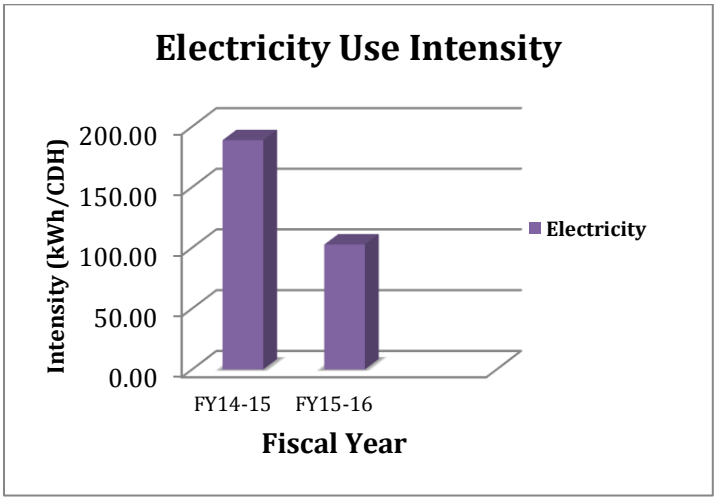


Fig. 5.2.3.2.4

Boiler Natural Gas vs. Heating Degree Days

The graph shown in Figure 5.2.3.2.5 illustrates the relationship between natural gas consumption and weather variance. In general, when there is a decrease in annual number of heating degree days, natural gas consumption should also decrease and vice versa. Total natural gas consumption has decreased by 27% since FY15. Furthermore, the number of heating degree-days decreased 18% during the same period. These consistencies suggest that there is a strong relationship between natural gas consumption and weather variance.

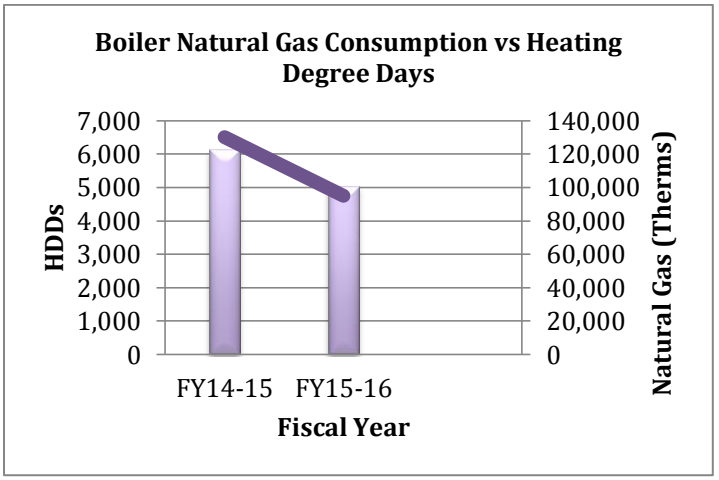


Fig. 5.2.3.2.5

Figure 5.2.3.2.6 illustrates the amount of natural gas consumed per heating degree-day. In general, this graph shows how efficiently the building was heated and should be relatively consistent with the changes in natural gas consumption and heating degree-days as illustrated in the graph on the previous page. It is observed that during 2015-16, the natural gas intensity declined by 27%, which is consistent with the declined in both natural gas consumption and heating degree-days. This consistency shows efficient heating in the building.

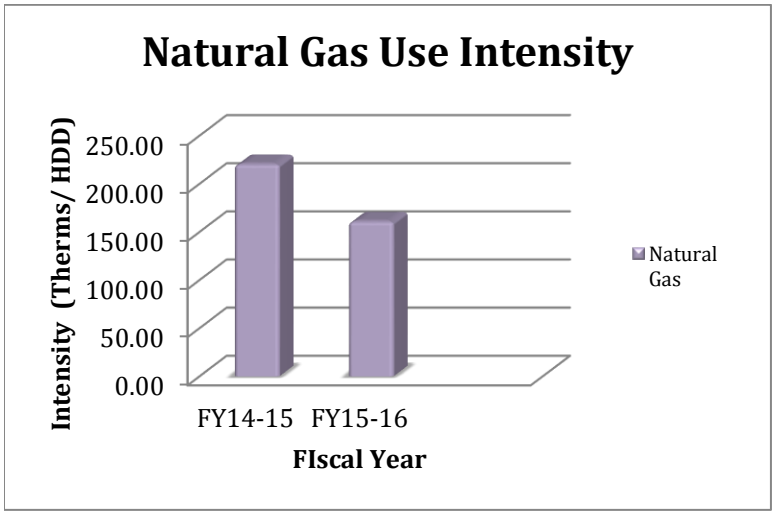


Fig.5.2.3.2.6

Total Water Consumption

Figure 5.2.3.2.7 shows the Vertex Annex Building water consumption from fiscal years as follow:

- FY2014-2015 Period: November 2014- October 2015
- FY2015-2016 Period: November 2015- October 2016

It is observed that the water consumption has significantly increased during FY2015-2016 period. This increased is aligned with the FDA approval of a new drug production in the summer of 2015, and the increase of cleaning activities due to more periodic production runs.

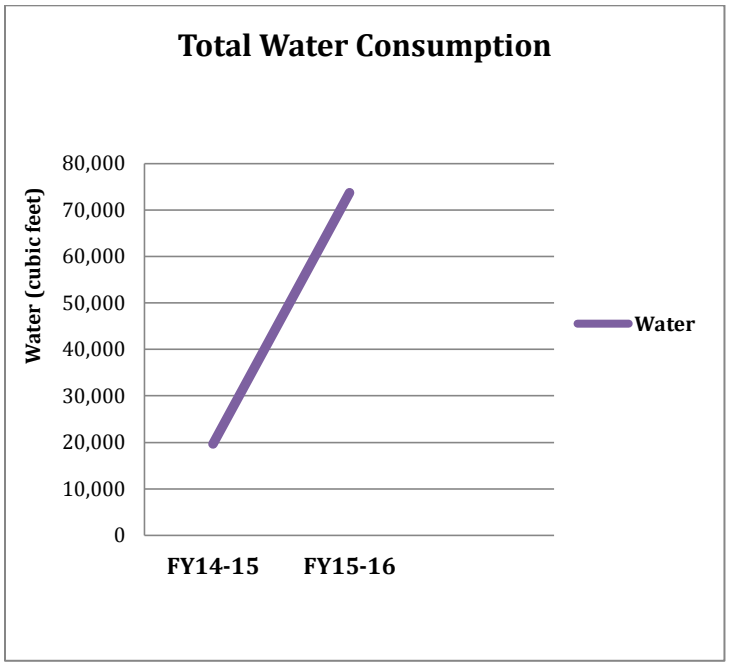


Fig.5.2.3.2.7

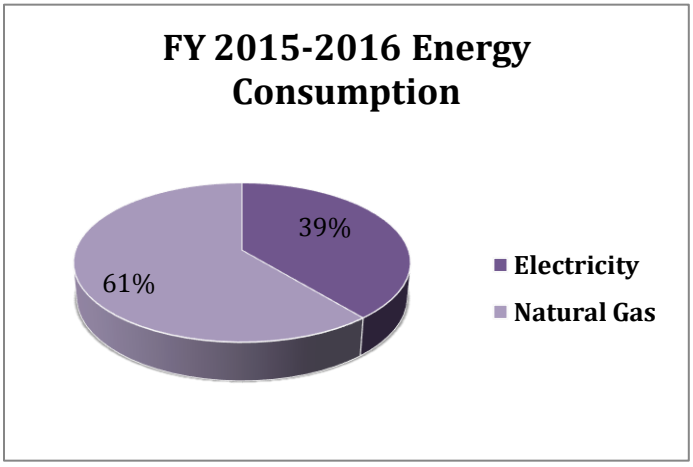
Energy and Water Performance Summary

The following table shows a summary of Energy and Water Performance by Fiscal Year.

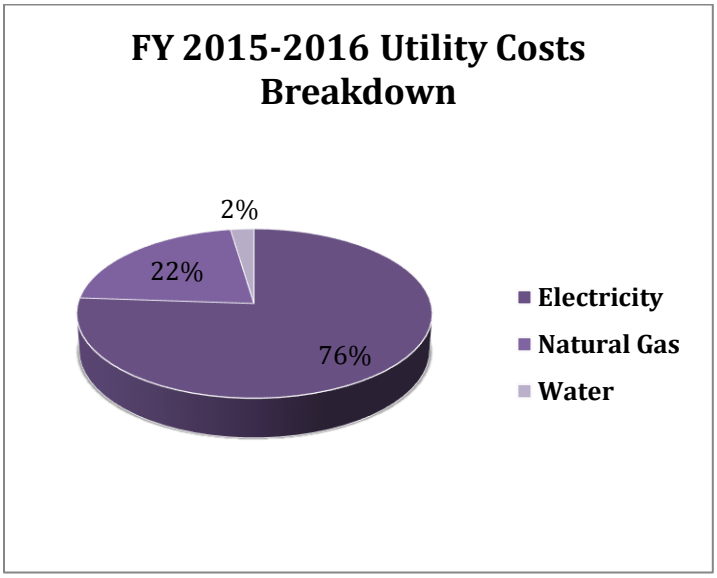
Energy and Water Performance Summary per Fiscal Year						
Year	**Energy Type**	**Metric Tons of CO2 Equivalent**	**Total Annual Use**	**Conversion Multiplier**	**Thousands BTU (kBtu)**	**Total Annual Cost**
2014-15	Electricity (kWh)	1132.4	3,263,449	3.412	11,134,888	$574,283.00
	Natural Gas (therms)	691.9	130,098	100	13,009,800	$105,431.00
	Water (cF)	-	19,620	-	-	$2,260.00
	Total	**1824.3**	**-**	**-**	**24,1144,688**	**$681,974.00**
2015-16	Electricity (kWh)	615.9	1,774,807	3.412	6,055,641	$300,496.00
	Natural Gas (therms)	505.0	94,955	100	9,495,500	$85,061.00
	Water (cF)	---	73,670		-	$9,410.00
	Total	**1120.80**	**-**	**-**	**15,551,141**	**$394,968.00**

5.2.3.3 Utility Component Breakdown

In FY15-16, Vertex Annex Building used a total of 15,551,141 kBtu of energy including electricity and natural gas. The chart below proportionally illustrates energy use breakdown by utility category. Natural Gas represents 61% of the total energy consumption while electricity represents 39%.



In FY15, Vertex Annex Building spent a total of $394,968.00 on all utilities including electricity, natural gas, and city water. The chart below proportionally illustrates the cost breakdown by utility category. 76% of the total utility cost was comprised of electricity while 22% of the total cost was Natural Gas. City water accounted for 2% of all utility cost. This chart is inconsistent with the energy use breakdown and shows that while Natural Gas represented the highest consumption, electricity represented the highest percentage of total cost.



5.2.3.4 Energy Use and Cost Indices by Fiscal Year

Calculating historical energy usage on a square footage basis is a requirement of an ASHRAE Level I audit. The EUI information can be helpful in comparing energy intensity in buildings of similar space types in similar geographical locations on a per square footage basis. Additionally, the cost index can be helpful in comparing one building's operation costs to that of similar buildings.

The table below displays the energy performance data in consumption and cost per square foot. The annual utility cost indices for Vertex Annex Building, in dollars per square foot, are highlighted in red. Although the FY16 is included in the table, the values are not considered as part of the analysis since the year has not been concluded. The Sustainability Action Plan will be updated with the information from the bills at the end of the year.

Energy Use and Cost Indices by Fiscal Year			
FY Year	**Index Type**	**Metric**	**Units**
2014-15	Energy Utilization Index	402.93	kBtu/ft^2/year
	Energy Cost Index	$11.52	$/ft^2/year
	Utility Cost Index, Including Water	$11.56	$/ft^2/year
2015-16	Energy Utilization Index	263.58	kBtu/ft2/year
	Energy Cost Index	$6.53	$/ft2/year
	Utility Cost Index, Including Water	$6.69	$/ft2/year

5.2.3.5 Electrical Demand

Review of electrical demand data is a requirement of an ASHRAE Level I audit. The table below illustrates the maximum electrical demand as well as demand per square foot.

Demand declined by 15%. The reduction of energy use indicates that seasonal changes have an effect the electricity demand.

Fiscal Year	Summary of Electrical Demand		
2014-15	Total Demand	6,726	kW
	Demand per unit area	114.0	W/ft2
2015-16	Total Demand	5,664	kW
	Demand per unit area	96	W/ft2

SUSTAINABILITY ACTION PLAN- STEP #5

5.2.4 Sustainability Initiatives Opportunities- Energy

5.2.4.1 Energy and Water Management Program

Developing an Energy and Water Management Program is recommended to highlight the importance of energy and water conservation as a business goal and to provide guidance for managing the mechanical and electrical utilities throughout the Vertex Annex Building.

Some success stories of other Pharmaceuticals having Energy and Water Management Program in their operations include:

Abbot Diagnosis- Ireland

- 2016 Energy Management Leadership Award
- Energy Management System ISO 50001
- Annual Energy Costs Savings: 1.4M/ Energy Performance Improvement: 65.3%
- Cost of Implementation: $6,680.00
- Payback < less than 1 year

Allergan- NJ

- 2016 Partner of the Year Sustained Excellence- Energy Management Award
- Energy Management System: Energy Star
- More than 1% reduction in annual EUI for US operations while integrating the operations of 2 pharmaceutical companies
- Integrate EM practices in their supply chain.

Bristol-Myers Squibb- NY

- 2016 Partner of the Year-Energy Management Award
- 14% energy and 17% GHG emissions reductions since 2009.
- After $35M investment for more than 300 efficiency projects, BMS have been saving $14.5M annually.
- Energy Treasure Hunt Stakeholders Engagement Program

Table 5.2.4.1 shows the benefits of having this type of program implemented in the Vertex Annex Building:

Having a Program	Not Having a Program
Opportunities to obtain external support from utilities companies to achieve significant energy savings.	Excessive consumption of energy and water.
Project investment and funding.	Limited budget for project implementation.
Opportunities for improvement are continuously identified and implemented.	Opportunities are maybe known but not implemented because of organization barriers.
Strong organizational commitment.	Lack of commitment and staff engagement.
Baseline of energy and water use and goals are identified.	Poor accountability for measures.
Staff engagement during action plan.	Organizational inertia to changes fro status quo.
Improve communication and recognition for accomplishments.	Poor understanding of how to create support for an efficiency project.

Table 5.2.4.1: Benefits of Having Energy Management Program

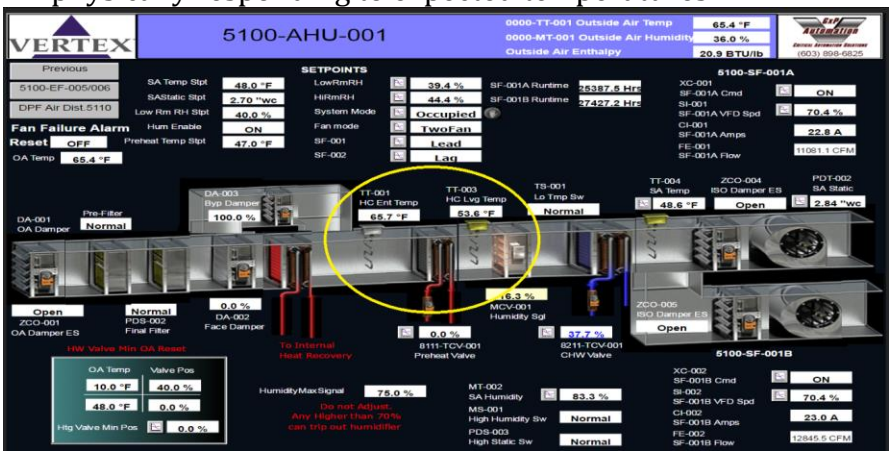
The program should include a clear method for monitoring and collecting the energy and water use data, maximizing the use of the new continuous commissioning monitoring system, establishing and promoting targets for energy and water efficiency throughout the building, identifying roles and responsibilities, conservation campaign and staff engagement approach, and roadmap for implementation. Tools such as Energy Star Strategic Energy Management or ISO 50001: 2011- Energy Management can be used to develop a program for more efficient use of energy, use data for better understanding and decision making, measure results, review how the program works, and continually improves energy management (ISO, 2016). The program requires a low initial investment and allocation of resources, but low payback period as well as high operating and maintenance costs savings.

5.2.4.2 HVAC Controls and Sequence of Operations:

The following section provides recommendations that should be taken correct BMS control issues with HVAC components to ensure system operates efficiently. Some of these observations were also noted in the Continuous Monitoring System (AnalytiKa) report for November 2016.

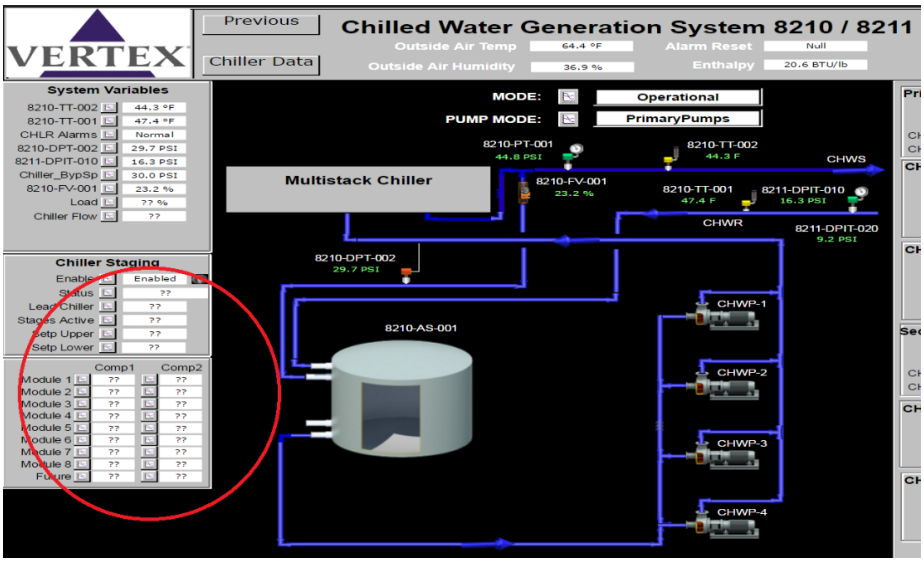
- AHUs Sequence of Operations: Several engineering change controls were implemented after installation and programming of the original sequence of operations of all AHUs to the BMS to ensure cooling and heating were supplied to different areas to pre-determined set points. The changes have been effective to provide appropriate heating and cooling when needed, but the overall operation is consuming more energy than expected since some of the system components intended to economize, or recover energy have been override or disabled. It is recommended to define a solid sequence of operations for all AHUs since control deficiencies have integrated response in other system control sequences such as chillers, boilers, and dampers; and is interrelated to efficient operation and energy consumption. This process will require re-commissioning and trending analysis.
- Inconsistent operation of Dampers in BMS: Several dampers were found to be override and in close position at the BMS, which might be reducing the airflow in the different AHUs. Confirmation on the field is required to verify dampers are operating correctly for:
    - AHU-5100-001: Supply Fan #1 Isolation Damper

  - AHU-5300-003: Supply Fan #2 Isolation Damper
  - AHU-5300-003: Exhaust Fan #1 Isolation Damper
  - AHU-5400-004: Return Fan #4A Isolation Damper
- Inconsistent operation of Static Pressure Safety Devices in BMS: Several static pressure safety devices were found to be override in the BMS. The devices are needed to be functional to ensure that the AHUs are tripped if the pressure conditions are below or high than the pressure set point. Confirmation of the field is required to verify proper operation of the following static pressure switches:
  - AHU-5300-003: Supply High Static Pressure Switch
  - AHU-5300-003: Exhaust Low Static Pressure Switch
  - AHU-5400-004: Exhaust Fan #4A Static Pressure Switch
- Inconsistent operation of Humidity and DP Switches in BMS: Several humidity switches were found to be override in the BMS. Confirmation of the field is required to verify proper operation of the following instruments:
  - AHU-5100-001: High Humidity Switch
  - AHU-5300-003: Air Filter DP Switch
  - AHU-5400-004: Supply Air High Humidity Switch
- Inconsistent readings in 5100-AHU-001 Temperature Indications: Mixed air temperature is to be expected to be in-between the outdoor air temperature and the return temperature. The temperature values in the BMS are contradicting the expected response, however the system is physically responding to expected temperatures.

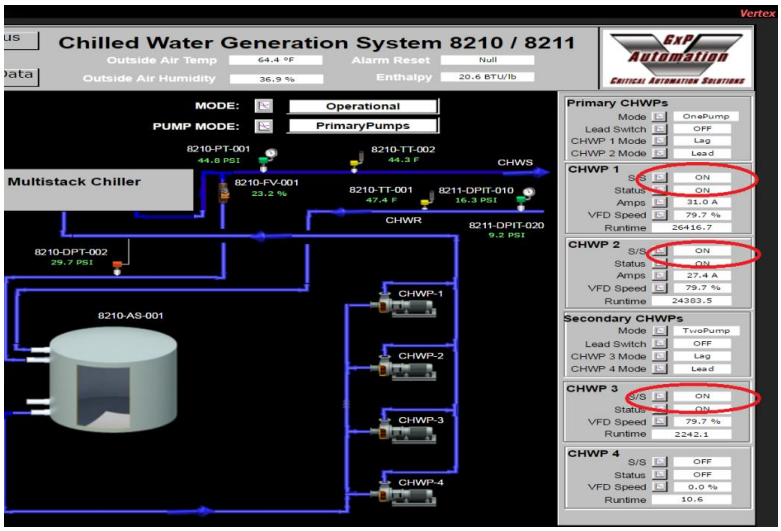


It is recommended to perform calibration to the Temperature RTDs and perform PID tuning to the cooling and heating loop to correct any deficiency with remote monitoring.

- Communication issues of Multi-stack chillers system with the BMS: This system is configured to provide both local and remote monitoring. The BMS was found to not receiving signal from the Multi-stack chillers system. Integrator/ programmer contractor is needed to re-configure the system to the BMS.



- Inconsistent Chilled Water Pumps Sequence Configuration: Per design documents, the CHW pumps are expected to operate in lead/lag configuration. Primary CHW pumps are activated whenever chillers are operational and AC units CHW valves are open. Secondary CHW pumps are activated when Outside Air is less than 53 °F for 2 hours and AC unit CHW valves are 0% open. BMS revealed inconsistencies in the pumps operation. Three of the CHW pumps were found to be running at the same time and one pump was found to be in override position.



This information was confirmed in the Analytika report. The report showed that two of the CHW pumps were operating continuously during the month of October. The same report showed that one of the pumps was operating occasionally, and one pump did not operate during the monitoring period. The sequence of operations of these pumps needs to be revised to make sure the pumps are operating with the expected lead/lag configuration to varying pump system demand, reduce the chances of having the pumps failing at the same time, extend pumps life-span, and reduce energy required to transfer specific chilled water volume.

- Inefficient Operation of 5400-AHU-004: Per design documents, this AHU was equipped with an economizer to allow minimum required outside airflow. The economizer is not currently in use. Analytika report, from October 2016, revealed that 5400-AHU-004 is using insufficient outside air, and therefore the unit is using excess mechanical cooling. The recommendation is to operate the unit with maximum economizer efficiency once all the sequence of operations issues are corrected. Based on the data monitored by the Analytika system for outside air temperature, supply airflow, return and mixed air temperature, and cooling discharge temperature, the following cooling energy saving are estimated if implemented this initiative:

Cooling Energy Savings per Year				
Energy (Btu)	Ton Hours	Electricity (kWh)	Cost Savings	CO2 Emissions
786,770,643	65,564	52,451	$9,374.00	27.35

- Simultaneous Heating and Cooling in AHUs: Analytika report, from October 2016, revealed simultaneous heating and cooling for 5300-AHU-003 and 5400-AHU-004. The units are cooling and heating when heating is unexpected. It is recommended to verify all heating and cooling valves for proper operation.
    - Verification of corrective maintenance work orders revealed that this issue could be attributed to the improper operation of the chilled water control valves. These valves are the electronic pressure independent valves that have self-calibrating actuators and can modulate to pressure variations. However, the valves lose scaling/calibration very often, forcing the valve to not operate as expected. It is recommended to replace the valve auto-calibration actuator for a 0-10V actuator to ensure valves are closing or opening as expected temperature conditions.
    - If the valves are closed and supply is still heated or cooled when unexpected, valves seats may need replacement.
    - It is also recommended to review the sequence of operations of the units to verify damper operations.

  Based on the data monitored by the Analytika system for airflow, heat recovery coil discharge air temperature, pre-heat coil discharge temperature, cooling coil discharge air temperature, and Boston (airport area) typical meteorological data for a year the following cooling and heating energy savings are estimated if implemented this initiative:

Cooling and Heating Energy Savings per Year				
5300-AHU-003				
Cooling Energy (Btu)	Ton Hours	Electricity (kWh)	Cost Savings	CO2 Emissions (MT)
840,046,387	70,004	56,003	$10,009	29.20
Heating Energy (Btu)	Therms	Cost Savings		CO2 Emissions (MT)
523,883,543	5,226	$4,286.00		27.80
5400-AHU-004				
Cooling Energy (Btu)	Ton Hours	Electricity (kWh)	Cost Savings	CO2 Emissions (MT)
322,520,889	26,877	21,501	$3,843.00	11.21
Heating Energy (Btu)	Therms	Cost Savings		CO2 Emissions (MT)
358,356,543	3,584	$2,939.00		19.02

5.2.4.3 Integrate Electrical Power System Monitoring to the BMS

Studies from the US Department of Energy have revealed that improper configuration of BMS systems are believed to account for 20% of building energy usage, or approximately 8% of total energy usage in the United States (Brambley, 2005). BMS systems are considered a critical component to managing energy demand.
Although Vertex Annex Building monitors the mechanical utilities, the electrical power distribution and lighting systems are not currently monitored by the BMS.

It is recommended to add the electrical power distribution and lighting to some of the available BMS points to ensure data is consolidated into a single system to improve reporting, information management and decision- making. Some of the benefits of adding monitoring the system through BMS include:

- Real time display of building operations utility usage.
- Remotely monitor critical loads during normal operations or emergency to save money
- Trend and track critical loads to maximize building capacity.
- Change lighting schedule based on usage demand.
- Optimize energy management strategies and targeting energy consumption.

These benefits obtained by monitoring the electrical power distribution and lighting system minimize building operational costs by decreasing false alarms, improving routine maintenance based on trends, empowering GxP Operations technicians, and simplifying training.

The BMS points, associated to the electrical power distribution and lighting system, should be also monitored by the Analytika Continuous Commissioning program. The program will be able to reduce energy consumption and carbon emissions from the overall utilities by detecting and diagnostic hidden issues that cause excessive usage, waste, and other serious problems. Overall energy costs savings are estimated in 5% or more by adding the electrical system monitoring to the Analytika Continuous Commissioning Program. Wyeth Fort Dodge facility in Brazil saved 48% of electricity use and 10% of utility costs after enabling the continuous commissioning monitoring system to target electrical demand during peak periods.

5.2.4.4 Fume Hoods Optimization

A total of 24 are available in the laboratory spaces of the Vertex Annex Building. The average fume hood costs approximately $5,000/yr to operate due to the strict airflow requirements in the Vertex Annex Building laboratories. The cost and environmental impact of a running fume hood comes from the energy needed to run the blower fan and from energy needed to heat or cool the make-up air. Some studies shows that ventilation systems account for nearly half of all energy used in a lab (Mygreenlab.com, 2016). It is estimated that a fume hood in US consumes approximately 3.5-times as much energy as a typical home (fumehoodcalculator, 2016). The Vertex Annex Building uses energy for fume hoods equivalent to 84 homes in US.

The simple solution is to reduce the energy use of a fume hood by making sure that users lower the sash when not in use. This is because fan speed and volume of air being exhausted are also lowered when the sash is lowered. Therefore, the following initiatives are suggested:

- Implement an information campaign geared to "Shut the Sash" (similar campaign use at the Vertex Headquarter Buildings), including awareness posters in the labs The "Shut the Sash" campaign encourages lab analysts to save energy through the simple action of closing the laboratory fume hoods when not in use. To supplement this initiative, sash position stickers, as shown in Figure 5.2.3.4-1, can be installed on the fume hoods. The stickers will remind analysts to close the sash after use, maximizes VAV system efficiency and analyst safety, increase sash closure persistence, and build professional work habits. This campaign can be also extended to the down flow booths in the DPF manufacturing and laboratory areas.

Figure 5.2.3.4-1: Fume Hood Sash Sticker

- Improve housekeeping and storage practices to avoid fume hoods use as temporary storage spaces for chemicals and laboratory equipment. Temporary storage in Fume Hoods requires hood exhaust system to run continuously. Improving storage practices and maintaining unused fume hoods closed would reduce energy consumption.

- Add occupancy sensor to the sash in the RSL and DFP fume hoods to become more energy efficient without

compromising safety. When no one is detected in the hood, for the entire pre-selected delay time, the sash will revert to unoccupied mode, thereby reducing the fume hood's overall energy consumption rate. Sensitivity and time delay can be configurable on the sensor and associated HMS fume hood controller. (Examples: Triatek ZPS or Phoenix Controls ZPS). Due to safety challenges, this alternative is not feasible for the Kilo Lab fume hoods. As a future initiative, the Kilo Lab fume hoods could be replaced with new efficient fume hoods as described in Section 5.6.

These initiatives are estimated to reduce energy use by 30%, eliminate at least 6 tons of carbon emissions, and save an average of $1500 fume hood operations costs/ year.

5.2.4.5 Installation of Energy Misers in Vending Machines

It is recommended to install misers to the Snack and Cool Drink Machines to save significant amount of energy during unoccupied hours.

The SnackMiser™ from Energy Miser is a recommended alternative for the snack machine. This miser uses a Passive Infrared Sensor to determine if there is anyone within 25 feet of the machine. It has a vacancy delay of 15 minutes to powers down the machine. The machine will power up immediately after sensing occupancy. According to the product information provided by EnergyMiser, the miser reduces energy consumption by approximately $50/yr, reduces CO2 emissions by 0.21 metric tons, has an early Return of Investment (ROI), and increases the lifespan of the machine.

A similar alternative is recommended for the cool drink machine with greater benefits. The VendingMiser™ from EnergyMiser Company powers down the machine when the surrounding area is vacant, monitor the room's temperature, automatically repower the cooling system at one- to three-hour intervals, independent of sales, to ensure drinks are maintain cold. The following costs benefits are estimated after installing the VendingMiser™ from EnergyMiser Company for the cool drink machine:

Energy Conservation Measure: Installation of Miser in Cool Drink Machine	
Assumptions	
Energy Costs (Electricity)	$0.178/kWh

Energy Conservation Measure: Installation of Miser in Cool Drink Machine			
CO2 Emissions Factor			0.0000347 MT/kWh
Annex Building Occupied Hours (12hrs/day)			60 hrs/week
Number of Cold Drink Machines			1
Required Power for Operation			400 W
VendingMiser Price (from EnergyMiser)			**$189.00**
Attribute	**Current**	**Projected**	**Total Savings**
Total Energy	3494 kWh	1622 kWh	1872 kWh
Total Costs of Operations	$622.00/yr	$288.00/yr	$333.22/yr
CO2 emissions	0.12 MT/yr	0.056 MT/yr	0.064 MT/yr
Cost Benefits @ 5 years			
ROI	ROI= Total Savings/Total Costs		176%
ARR	ARR= Total ROI/Life of Investment		35%
Payback Period			6 Months

5.2.5 Sustainability Initiatives Opportunities- Water & Building Envelope

5.2.5.1 Improve building insulation and lifetime of the roof

By installing a green garden in the flat roof, the Vertex Annex Building can improve the insulation against both hot and cold weathers by providing both heat (in winter) and cooling (in summer). In addition, a green roof can increase the lifetime of the roof and reduce air pollution and dust in the environment caused by heavy storms. It also provides an environmental friendly alternative to eliminate leakage from rain to the building by absorbing the rain and slowing the run-off to local storm drains.

5.2.5.2 Monitor and Recover RO Water Effluent

During verification of the monitored parameters at local display of Reverse Osmosis (RO) Water system, it was observed that the system is discharging more water than what is currently consuming for manufacturing and lab processing. Water scarcity is becoming a significant issue across a greater number of regions, and especially in areas susceptible to drought and water shortages. Diminishing water supply is particularly disruptive to industries that are reliant on high quality process water for use in manufacturing. This finding provides a great opportunity for the Vertex Annex Building to make a positive impact to the Boston community. The first recommendation is to monitor the RO Water system discharge flowmeters through the BMS. The building BMS has the capability

to store the flow and discharge rates for extended periods, and provides trends of the RO system behavior. Using this information, the GxP Operations team could identify the feasibility to recover and recollect the effluent water. The recovered water can be:

- Used for toilet flushing
- Used as boiler make up water
- Supplied to the rest of the building tenants for bathrooms, HVAC, or any other non-potable use the building owner may deemed as necessary.

The benefits of implemented this low cost initiative reduces the Vertex Annex Building sewer costs, as well as showing commitment with the preservation of natural resources and good citizenship in the city of Boston.

5.2.6 Utility Bills

It is recommended to upload original utilities bills to the SourceOne web-based software to make original data is available once questions or incongruences are found during the metric process.

5.3 Key Priority #2: Waste Reduction

5.3.1 Waste Management Program Assessment

The Vertex Annex Building waste is classified in the following main categories: hazardous waste, non-hazardous waste, and process wastewater. Hazardous and non-hazardous wastes have been tracking since fiscal year 2015. Table 5.3.1 shows a summary of the total waste that has been tracked by the building form FY2014-FY2016.

Vertex Annex Building Waste Disposal Costs				
Year	**Haz (lbs)**	**Non Haz (lbs)**	**Total (lbs)**	**Cost**
2015	85000	No Tracking record	-----	$103,333.00
2016	19615	9545	29160	$54,000.00*
				***As of 01NOV2016**

Table 5.3.1 Vertex Annex Building Waste Disposal Costs

Process wastewater is generated from the manufacturing areas and laboratories, and discharged to the sewer after neutralized. The sewer total cost for fiscal year 2015 was $1,436.00.

Hazardous waste including flammable solvents and aqueous waste are disposed by Veolia Environmental Services. Non-Hazardous waste including lab debris and non-hazardous excipients are

disposed by Veolia Environmental Services. Other waste that does not fall under these categories and is not recycled or composted is disposed to landfill.

The following diagram shows the types of waste generated in each of the Vertex Annex Building location.

Figure 5.3.1Type of Waste Vertex Annex Building Locations

5.3.2 Current Waste Reduction Initiatives

<u>Waste Reduction in Break room/ Kitchen Area</u>

The Vertex Annex Building has joined forces with the headquarters facilities at Boston, MA to reduce, recycle, and compost waste in the kitchen area. Inspired by feedback and ideas from Vertex staff, the program started in the building in summer 2016.

<u>Waste Reduction in Offices Areas</u>

The offices areas are equipped with recycling bins to collect recyclable office supplies such as paper and card boards. During 2016, a total of 31.41% of material from single stream and wood has been recycled between the Vertex Annex Building and the headquarter facilities at Boston, MA.

<u>Waste Reduction in Lab Areas</u>

The Vertex Annex Building has been participating with the headquarters to divert usable solvent kegs from landfill. A total

of 8,524 lbs. of cardboard boxes and glass bottles have been diverted from landfill in the first two quarters of 2016.

5.3.3 Sustainability Initiatives Opportunities

5.3.3.1 Waste Management Plan and Metrics

To strength the current waste metric system employed at the building, a robust waste assessment should be performed to each of the locations identified in Figure 5.3.1. The main of this objective is to identify how waste is generated, where energy is consumed, areas with highest waste generation, and where waste reduction would be more cost effective (Sitarz, 2008, pp 118). The information will help to obtain measurable data that can be tracked and evaluated periodically for effectiveness of any waste reduction action taken.

It is recommended to develop a Waste Reduction Plan based on the robust waste assessment performed in the Building to evaluate, list, and select waste reductions that are cost effective and reduce the environmental impact. The plan should include waste reduction goals and targets, and possible reduction alternatives prevention, recycling, composting, and purchasing methods that are effective within the building operations. Waste Reduction campaign must be geared. The program must be evaluated periodically to track success and cost savings, establish long-term goals, identify new ideas for waste reduction and areas of improvement, and keep staff motivated.

The staff must be periodically communicated about the program implementation and progress for awareness to ensure commitment and engagement.

5.3.3.2 Office, Material Management, Warehouse, and Break Room Areas Waste Reduction Opportunities

The following recommendations can be implemented for the office areas:

- "Pre-cycle" Office supplies: "Pre-cycling" refers to the act of reducing non-recyclable waste before it starts. The idea is to choose products packaged in materials that are easily recyclable, but it can also apply to your office supplies. Provide awareness of supplies use or tips including the use of paper clips instead of staples for easy re-use, use of reusable tape dispenser, reuse of folders and boxes as long

as possible before throwing them out. It is recommended to buy products that are reusable, returnable or refillable.

- Reduce Paper and Printer Ink Use: According to US EPA, the average office worker in the U.S. uses 10,000 sheets of copy paper each year. There is opportunity for Vertex Annex Building to make a difference by reducing paper use and printer ink, and shrinking the office footprint:
    - Paper use can be limited by emailing important documents or using the SharePoint to Vertex staff, or emailing documents to suppliers, and clients.
    - Font size in word processor system can be changed to 11.5 point. This change reduces document size by 5% (US EPA, 2012).
    - Font type/ size in word processor system can be changed to Times New Roman (Size 12), Calibri (Size 11), and Verdana (Size 11) to reduce printer ink use.
    - Printer default settings can be changed to ensure both sides of the paper are used whenever possible.
    - Use paper that has at least 30% post-consumer recycled content.
    - Increase awareness of recycling paper that is used in the office area.
    - Use Print Management Software, similar to "ObjectPrint" or "Papercut" software, to track paper and ink reductions, costs savings and encourage employees to reduce paper usage. These software has free editions depends on the level of applications and metrics the Annex Building would like to use or customized.
- Disposable cups can be replaced with the Vertex coffee mugs and water bottles to encourage staff to reduce waste. These items can be gave away to the staff during the holidays to keep them motivated and promote the initiative.
- Green Products: Substitute less toxic or non-toxic products for products such as inks, paints, and cleaning solvents.
- Printer cartridges should be refilled or returned to supplier for remanufacture.

5.3.3.3 Laboratories and DPF Areas Waste Reduction Opportunities

The following recommendations can be implemented for the laboratory and DPF areas to help the building diverting hard-to-recycle materials from landfill and support waste reduction goals:

- Partnering with Kimberly-Clark to recycle nitrile gloves: The RightCycle® program from Kimberly-Clark enables customers, like Vertex Pharmaceuticals Inc., to collect hard-to recycle materials like nitrile gloves and have them turned into eco-responsible consumer goods (KC, 2016).
- Partnering with Millipore to recycle Lab Purified Water Filters. The ech2o™ Collection and Recycling Program from Millipore is focused to reduce environmental impact from lab purified water cartridges, and offers users traceability, as well as a streamlined collection and recycling process (Millipore, 2016).
- Manufacturing Waste Reduction in the DPP area (DLR)- To be discussed in Section 5.4

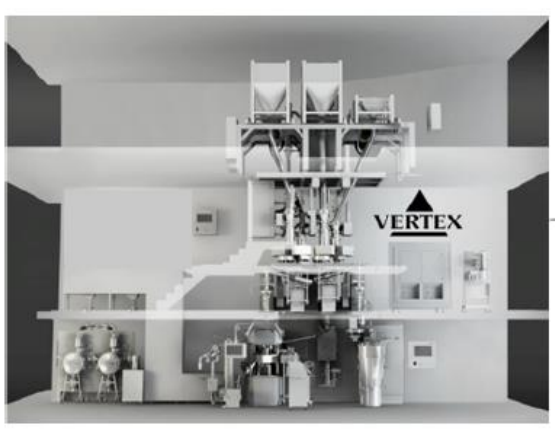
5.4 Key Priority #3: Manufacturing

5.4.1 Continuous Manufacturing Technology Overview & Opportunities

As a company that focuses on the *Science of Possibility*, Vertex Pharmaceuticals Inc. is investing in bold manufacturing innovations that enhance operational efficiencies and reduce the environmental impact. The Vertex Annex Building is only facility in the World with the first wet granulator product manufactured using the elements of Continuous Manufacturing Technology. The continuous multi-story suite is located at the Vertex Annex Building's Development and Launch Rig in the DPF area.

The DLR continuous manufacturing technology produces commercial ready medicines with fewer raw materials, less energy, and less waste than the traditional multi-step, multi-location batch process. The raw material used to produce tablets is fed into the continuous running Rig that includes real-time testing and creates commercial-ready tablets in one day.

The following diagram shows the Vertex Annex Building's DLR benefits compared to traditional tablet production areas:



Benefits:

- Reduce **space size** by more than half of a traditional tablet production area from 12,636 sq.-ft. to 3,130 sq.ft.
- Reduce manufacturing **waste**.
- Increase tablet **production** rate/ hr.
- Minimize raw material use, energy, and water **consumption**.
- Quicker **response** to market demands.

Figure 5.4.1: Continuous Manufacturing Tablet Production Area vs Traditional Tablet Production Area

Although the continuous RIG design was designed so that the small size would represent lower operation and maintenance costs, and production rates up to 100,000 tablets/hr, efficiencies within the process are always being evaluated. These development efforts are focused towards reducing the "*Seven Wastes of Manufacturing*", defined as any activity that consumes resources but does not add any value to the customer. Within most pharmaceutical processes, the activities that add value accounts for a small percentage of the total production activities. Reducing the waste in the Annex Building represents a significant opportunity for performance improvement and reaching the goals of continuous manufacturing technology and sustainable goals for the facility. The following table shows a summary of the Seven Manufacturing Wastes and potential opportunities within the Vertex Annex Building's continuous RIG.

Waste	Description*	Tendency in RIG	Possible Causes
Overproduction	Producing more product than needed	Unlikely	Unlikely tendency due to the nature of the drug produced.
Inventory	Any supply in excess to produce product	X	Piling up raw material or finished product; Variability in Scheduling
Waiting	Idle operator or machine time	X	Unplanned downtime; skilled manpower; Variability in Operations schedule and raw materials; major cleaning; training.
Motion	Movement of people or machine which does not add value	Low	Low tendency due to the current space layout. Ongoing ergonomics improvements have been implemented to minimize the manual lifting of heavy components.

Waste	Description*	Tendency in RIG	Possible Causes
Transportation	Any material movement that does not directly support value added operation.	Low	Low tendency due to the current space layout.
Defects	Making defective product that will require rework or re-run.	X	Equipment Performance; Skilled Manpower; Material handling; Training; adequate documentation.
Excess processing	Any process that does not add value to product	X	Aligning the equipment design to the quality requirements; implementing equipment technology and upgrades as knowledge is increased relative to process function.

*** Description from http://leanmanufacturingtools.org/77/the-seven-wastes-7-mudas/**

Table 5.4.1: Common Lean Manufacturing Wastes

Lean Manufacturing and the various lean tools can be applied to the continuous RIG to identify value according to customer needs and eliminate waste through continuous improvement and synchronization of the production process in a way that flows through Vertex at the pull of the customer (Mahapatra; Mohanty, 2007). Developed by the Toyota executive Taii Ohno during the post-Second World War Reconstruction period in Japan, lean manufacturing is a systematic method to eliminate or reduce "*Muda*", reduce costs and environmental effects in manufacturing process. The following Lean Manufacturing tools can be applied to the Continuous Manufacturing technology available in the DLR to ensure sustainable manufacturing excellence for some of the seven wastes identified in table 5.41:

- Value Stream Mapping (VSM): This tool is recommended to map the current state of the process of the most complex tablet batch (VX-809) produced in the Rig. The idea is to highlights the flows of the tablet production and identifying wastes including redundant activity, wait time, non-value added work, and opportunities to enhance value added work. The VSM is a multi-disciplinary team process that should take place in the Rig. The VSM should include material and information flows (inventory, delivery, change over, testing) and the total lead-time of the process. The VSM creates a common vision, priorities, and direction for continuous improvement.
- Continuous Improvement (Kaizen): The same multi-disciplinary team formed during the VSM phase should be grouped to analyze and provide solutions to eliminate manufacturing waste and achieve efficiency and

manufacturing excellence. The team should provide ideas or opportunities for improvement with low or no costs. Some tools that could be use during this process are 5S, Total Productive Maintenance, and Six Sigma.

- Failure Mode Effect Analysis (FMEA): approach for identifying all possible failures or defects during the tablet production process. Failures are prioritized according to how serious their consequences are, how frequently they occur and how easily they can be detected. This tool can be also used for the Process Analytical Tool (PAT) equipment to improve efficiency of quality testing performance.
- Inventory Management for Production and Spare Parts: This tool should be implemented using Just in Time to reduce inventory at all times, estimation of reorder quantities for every components, estimation of JIT re-order periods, components and materials segmentations, practices to reduce part numbers and stored items, and lessons learned from Material Management and Spare Parts system owners.

The application of Lean Manufacturing will help to obtain measurable data that can be tracked and evaluated periodically for the minimization of waste, energy and water consumption, and raw material use as well as effectiveness of Vertex Annex Building's continuous manufacturing Rig when compared with traditional tablet manufacturing facilities.

5.5 Key Priority #4: Transportation

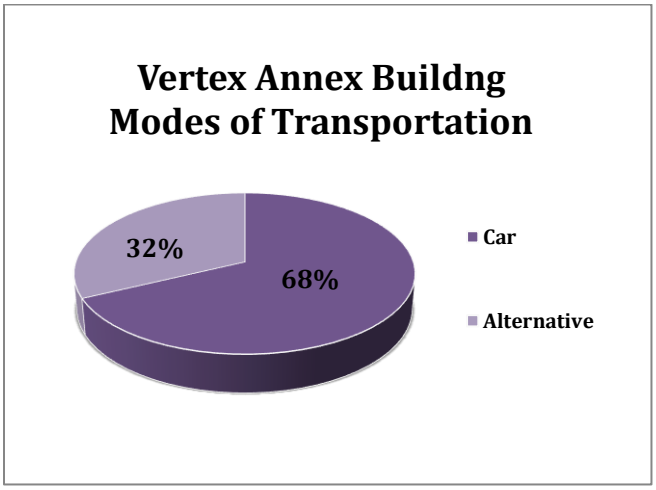
5.5.1 Transportation Assessment

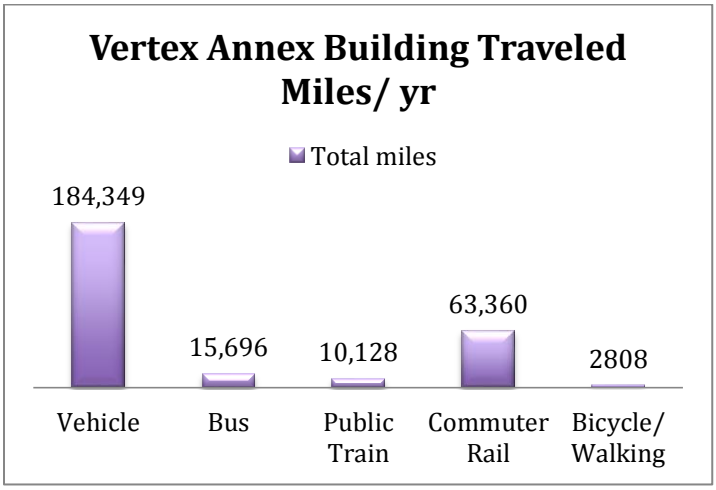
Transportation is one of the most energy-intensive and polluting activities in the World. According to EPA, transportation accounts for about 26% of total USA GHG emissions, making it the second largest contributor of US GHG after electricity (EPA, 2016). As a global organization, reducing the impact of transportation is integral to reducing overall impact of Vertex's scope 3 emissions. Vertex's commuter benefits program are supported by quality public transit system in the cities that the company's offices and research sites are located. In 2016, half of the Boston employees used public transportation to commute to work, reducing approximately 1,497 Metric-Tons of CO2 emissions/ yr to the environment.

As part of this plan, an employee survey was conducted to the staff at the Vertex Annex Building. The survey collected information of

commuting transportation mode to work, frequency of the mode of transportation used per day, miles traveled per day, vehicle information, and alternative transportation they were willing to use in a future. Approximately half of the staff participated during the survey. The employee to sample ratio for the survey used for the total CO2 emissions from transportation was 2.39. The transportation calculations were estimated using a period of 48 weeks as a full year.

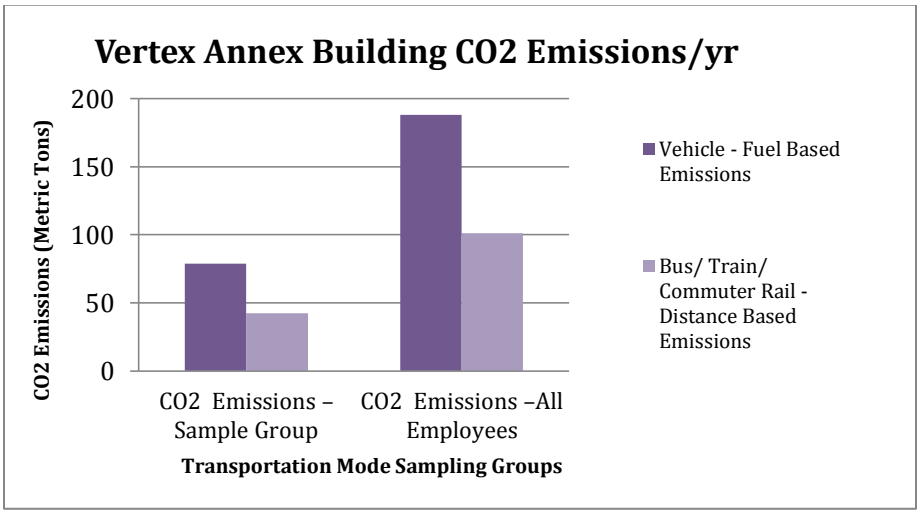
Based on the results, approximately 276,341 miles are traveled in a year for commuting to Vertex Annex Building. The majority of the employees use their vehicles to commute for work (See Chart 5.5.1).





The overall total of CO2 emissions from transportation is estimated to 313.36 Metric Tons. The following tables show a summary of the CO2 emissions results:

Transportation Annual CO2 Emissions	CO2 Emissions (Sample Group)	Employees to Sample Ratio	CO2 Emissions (All Employees)
Overall Total	131.11 Metric Tons	2.39	**313.36 Metric Tons**



A total of 100% of the staff expressed interest in using alternative transportation modes to commute for work.

5.5.2 Sustainability Initiative Opportunities:

Based on the results from the survey, the following initiatives can be implemented:

- Extend the shuttle services from Public Train Stop South Station to the Annex Building: The current shuttle will drop public transportation users from South Station to Vertex Head Quarters Building. Annex Building employees then have to take another internal shuttle to the building or walk a 0.8 miles distance. Several public transportation users and vehicle owners expressed how slowly can be the process while waiting for the internal shuttle or during rainy or cold dates to take them in or out of the Vertex Annex Building. This waiting time combined with the time waiting at South Station could let the employees to use their own vehicle instead of using alternative transportation. It is recommended to extend the Shuttle route to the Annex Building to reduce waiting time and avoid employees' dependence in vehicles.
  - Some employees suggested the option to provide dedicated "Segways" to facilitate the internal commuting and reduce the use of internal shuttle system between the Vertex Buildings in the Seaport Area. This option is not recommended due to Docket #0555, "*Ordinance Regulating the Use of Segways in the city of Boston"*. The ordinance prohibited the use of these mobility devices in

the public property of the city of Boston based upon the interest of public safety (Feeny, 2011).

- Provide Vanpool/ Carpooling Service: The Vertex Bus initiative has been considered as part of Vertex's long-term goals to provide vanpool transportation. If the initiative is implemented, approximately 60% of the Annex Building's vehicle drivers will be willing to use this mode of transportation. It is recommended to use low emission vans to ensure the low environmental impact with the use of this mode of transportation.

  In addition to the Vanpool, Vertex could sponsor and provide the eRide Share Employer Carpooling Service: Ride Share offers carpooling service for large employers like Vertex that includes carpool reporting functionality to support incentive programs and corporate environmental benchmarking, as well as mileage, fuel and emissions reduction calculations.

  The table below shows the estimated CO2 emissions reduction from vehicles if implemented any of the carpool/vanpool initiatives.

Total Miles Traveled by Vehicle		Car- CO2 Emissions (Sample Group) Metric-Tons		Car- Employees to Sample Ratio Metric-Tons		Car-CO2 Emissions (All Employees) Metric-Tons	
Without Vanpool	**With Vanpool**	Without Vanpool	**With Vanpool**	Without Vanpool	**With Vanpool**	Without Vanpool	**With Vanpool**
184,349	**6528.76**	**78.67**	**23.98**	**2.39**	**2.39**	188.25	57.31

- Provide Telecommuting option few days a month: This option provides the opportunity to reduce the emissions considerably and ease the traffic congestion in Boston downtown and Seaport areas. A total of 58% of the survey participants will be willing to telecommute for work.
- Offering a financial incentive for the purchase or lease of electric cars.
- Extend transportation assessment to Vertex-owned vehicles, air travel, and shipping (in-out): The assessment will provide a baseline from which Vertex can develop a plan to reduce overall Scope 3 carbon emissions.

5.6 Future Initiatives

5.6.1 New Fume Hood Installation

It is recommended to replace the existing fume hoods in the Kilo Lab with the Labconco Protector XStream fume hoods. These hoods reduce the required volumetric rate without reducing the required face velocity of 100 ft./min. These units, as opposed to traditional hood, minimizes the airflow requirements through openings other than sash opening, and therefore reducing the total volumetric rate without compromising containment, access, and hood mechanical system operation (Savage, 2013). A typical Kilo Lab fume hood can consume 1250 CFM of air with the sash fully open. The proposed unit operating at 100 ft./min with the sash fully open consumes 1150 CFM; approximately 100 CFM less than the typical hood (Savage, 2013).

The following table shows a summary of costs savings if acquiring this unit:

Kilo Lab Fume Hoods Costs Savings	
Assumptions	
Fume Hood Average Annual Cost/CFM	$7.00
Fume Hood Operating Hrs	6420 hrs
Existing Fume Hood	
Total of CFM when fully open	1250 CFM
Annual Costs/ Hood	$8750/yr
Proposed Fume Hood	
Total of CFM when fully open	1150 CFM
Annual Costs	$8050/yr
Total Savings per Hood	**$700/yr**
Total Savings in Kilo Lab for all Hoods (total of 10)	**$7,000/yr**

5.6.2 Solar Photovoltaic (PV) System

It is recommended to install a solar PV system to supply electricity to the building. Implementing this technology can reduce the amount of energy that is needed from the grid as well as the Scope 2 CO2 emissions from purchased electricity. To consider this technology, the National Renewable Energy Laboratory (NREL) recommends performing an evaluation of the solar resource availability, incentives, angles of the panel, shading, electrical system interconnection, and price of electricity for the building.

A preliminary evaluation of the solar resource was performed to the Vertex Annex Building using the Google Project Sunroof tool. The tool revealed that the building location has a total of 1,448 hours of usable sunlight per year. There is limited sings of shades and sun obstruction in the roof since surrounding buildings heights are smaller than the building. The pictures below show the sunlight intensity and area available in roof of the Vertex Annex Building to support this technology using the Google Project Sunroof tool.

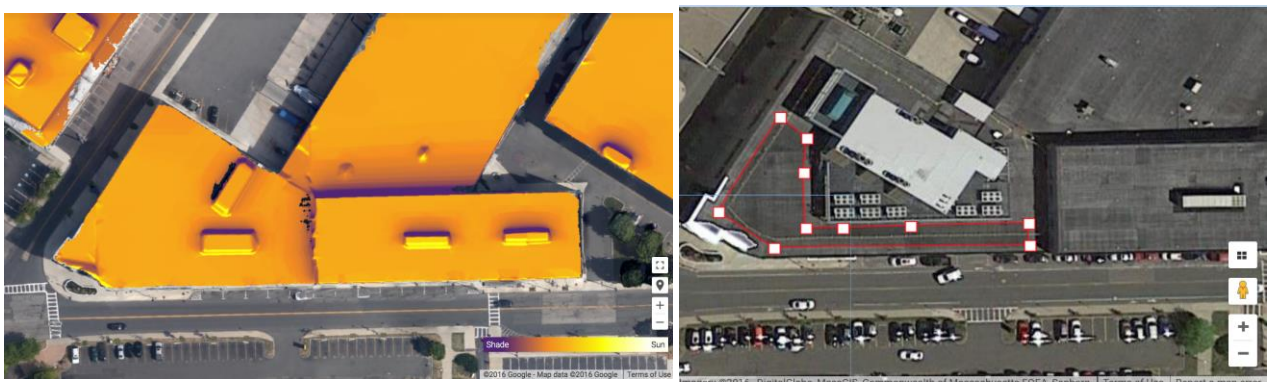


Figure 5.6.2.1 Sunlight Intensity and Roof Area

An estimate from the Solar-Estimate tool was used to verify the feasibility of PV system installation into the Vertex Annex Building. The estimate concluded that the solar rating for the building is good.

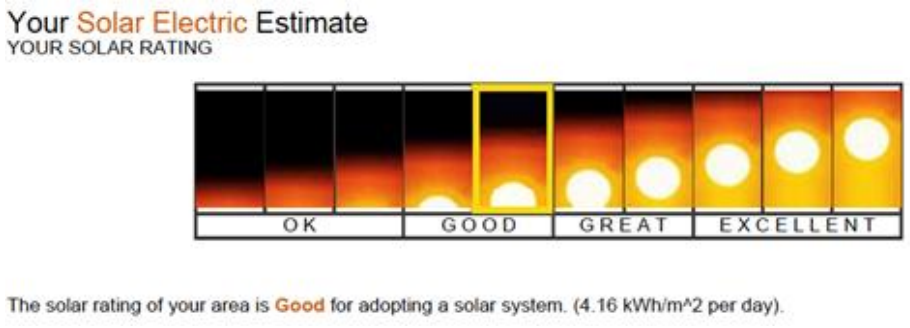


Figure 5.6.2.2 Roof Area Solar Rating

The following section provides a summary of the Cost Benefits for the building if installing PV system.

Energy Conservation Measure: Installation of PV System for Electricity			
Assumptions			
Price Installed			$3/Watt DC
Monthly Electric Usage (average)			147,901 kWh/month
Monthly Electricity Bill (average)			$40,000/month
Annual Inflation Rate			3.8%
Utility Savings Method			Net Metering
Federal Income Tax Rate			28%
State Income Tax Rate			9.0%
Estimated Rating			
Solar Rating	**Required Solar Capacity**	**Roof Area needed**	**Equivalent Annual Production**
4.16 kWh/m²/day	787.05 kW	78,705 ft²	887,399 kWh
Estimated Gross Costs			**$2,361,151**
Financial Incentives			
MA-SREC II	$0.285 per kWh x 10 years		$1,927,196
Federal Tax Credit	30% of Net Cost at Installation		$708,345
Depreciation	5 Yr		$-274,391
Estimated Net Cost at Installation			$1,652,805
Savings and Benefits			
Payback Period			5 Yr
First-Year Utility Savings			$236-050 to $613,729
Average Annual Utility Savings (over 25-year expected life of the system)			$396,201 to $1,030,122
25-Year Utility Savings			$9,905,016 to $25,753,040
ROI			627%
IRR			39.1%-100%
Profitability Index			4.2-9.3
Greenhouse Gas (CO2) Emission Saved (over 25-year expected life of the system)			18,192 tons (36,384,000 auto miles)

Implementation of this project will require approval of the building owner since Vertex is currently leasing the area for a 15-years term. If approval is granted from building owner, Vertex Annex Building should lease the PV system aligned with the building leasing term. This installation has a great opportunity for the building owner to provide solar electricity to the other building tenants. The entire facility campus, in which the Vertex Annex Building is located, has roof conditions that exceed the ones

presented in the report as well as more square-ft area. The picture below shows the available area to installed Solar PV system in the whole facility.

Figure 5.6.2.3 Sunlight Intensity and Proposed Roof Area

Vertex could partner with the building owner to support this initiative and reduce the environmental impact not only of the Annex Building but the entire campus composed of restaurants, banks, offices, and warehouse areas.

5.6.3 Solar Hot Water Heater

It is recommended to replace the existing natural gas domestic hot water heater for a solar domestic hot water heater (SDWH). According to the NREL, Natural Gas water heaters consumes enormous amount of energy in United States. The SDWH serves different temperature ranges and different climates, and their panels can be installed anywhere on a building where the space is available. The considerations to be taken into account during evaluation of this technology include solar resource availability, freeze protection, incentives, hot water requirements, and annual costs savings. From the assessment performed for PV system, the Vertex Annex Building roof is suitable for the installation of SDWH system. The solar rating is 4.16 kWh/m^2, which is considered good for the location.

SUSTAINABILITY ACTION PLAN- STEP #5

The SDWH models from AO Smith could provide the following benefits to the Vertex Annex Building:

Benefits

- Qualify for a 30% federal tax credit of the total installed costs (no cap)
- Reduce Energy costs for water heating by 70%.
- Substantial ROI and payback period.
- Reduce building operating costs
- Reduce GHG emissions from Natural Gas

6.0 Sustainability Change Management

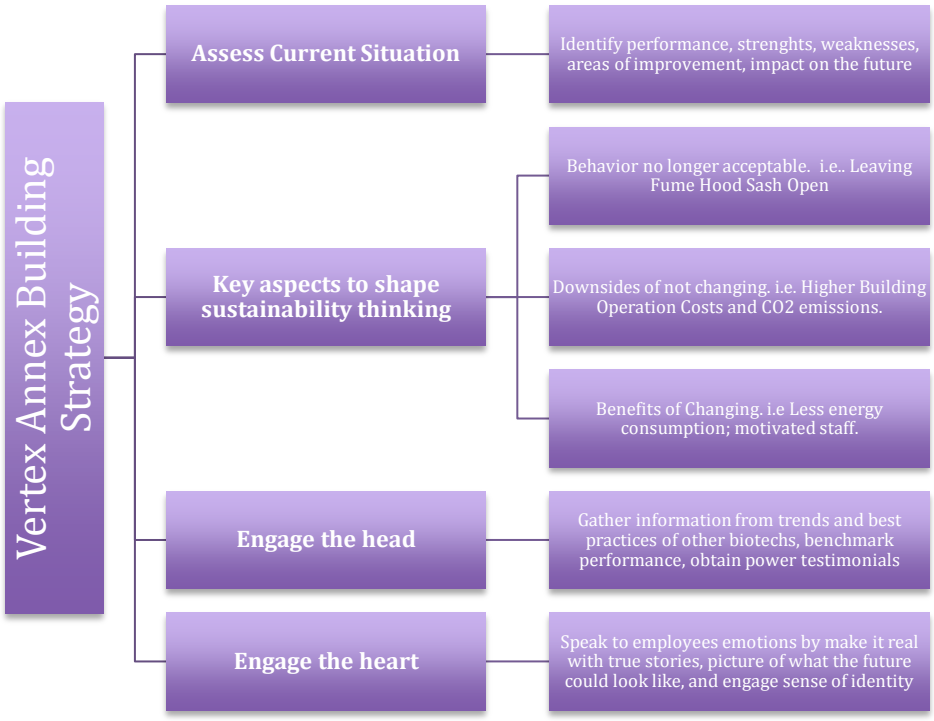
Nowadays, many companies, including pharmaceuticals and biotechnology companies, are making sustainability a priority, since its adoption represents operational cost savings while increasing market share, reducing risk, and increasing productivity and stakeholder engagement. The McKinsey Global Survey performed in 2011 revealed that about that 57% of participants have integrated sustainability into their company strategic planning; 67% has been integrated sustainability into their mission and values; and 60% has been integrated sustainability into their external communications. However, despite of discussions about sustainable actions to be taken and technologies and policies to implement, some of the initiatives in these companies have failed, leading to waste resources, skepticism, and lack of motivation. According to Bob Dopplelt, author of *Leading Change Toward Sustainability*, the implementation of a Sustainability Program requires behavioral change rather than technical, financial, or political factors. Change is often not easy to implement within a company due to cultural habits and processes built up over the years. Leaders experience the greatest success implementing change when they can demonstrate a case for improving the status quo. Change Management is not the exception for Vertex Annex Building. Successful integration of sustainability into Vertex's business requires fundamental organizational and cultural changes to face the new and more challenging market environment.

6.1 Fostering Sustainable Behavior and Cultural Change

In the *Leading Change* article authored by John Kotter, it is established that cultural change process go through a series of phases that requires time for implementation, and if implemented correctly would prompt momentum, commitment, and motivation. Vertex can take advantage of Kotter's 8-Steps Transformation process to change its cultural behavior and effectively integrate sustainability into the company's vision.

Step #1: Create Sense of Urgency

The first aspect to consider by sustainability leaders during the change process is to ensure everyone at the Vertex Annex Building understand the need for the change and the importance of acting immediately. The strategy to achieve this step is described in the following diagram:



Step #2: Build Guiding Coalition

Forming a powerful coalition, or *"Sustainability Team"*, is about making sure Vertex Annex Building have a committed team from different areas with the expertise to assist in achieving the outcomes needed from the sustainability change initiative. Without the right people to help in the building, the change effort can stall and important perspectives and information can be lost. The process to engage this step includes:

Step #3: Form a Strategic Vision and Initiatives

In this step, the coalition team will work together to create Vertex Annex Building's vision. Creating a clear and inspirational vision of sustainability, similar to the one proposed in section 1.0, will tell Vertex stakeholders where the company wants to go. A good vision keeps employees motivated and focused and leads to efficiency and high levels of collaboration because everyone knows the destination. It is necessary that Vertex connect the vision for sustainability with other existing or strategic initiatives.

Step #4: Enlist a Volunteer Army

The volunteer army can be defined as the group of employees across different levels in the Vertex Annex Building. This step helps to bring together all the efforts taken by having an employee-based army that can connect the value and urgency to get started. Vertex needs to seek volunteers that want to be part in the implementation of the Sustainability and initiatives. This army will stabilize the new changes, leads by example, and helps share the buy-in of the change initiative.

Step #5: Enable Action by Removing Barriers

As Kotter states in the 8-step process guide, removing barriers provide leaders the freedom necessary for employees to work across boundaries and create real impact. This is the opportunity to really encourage employees to take ownership for the proposed change. By owning the change, employees will be less inclined to create barriers to change. They will begin to participate in the process and come up with innovative solutions to achieve the desired outcomes. At this stage it is important to build a culture that encourages and rewards knowledge sharing and provides employees with opportunities to impact processes and the meeting of Vertex Annex Building Sustainability's goals.

The strategy to implement this step is identifying behavior barriers that will inhibit employees from engaging in any sustainability initiative adopted by Vertex Annex Building. The idea is to ensure that when

behaviors are found to be not divisible, strategies are created to achieve the end-state of that behavior (McKenzie-Mohr, 2011). The following table shows potential barriers of sustainable behaviors that Vertex Annex Building would like to accomplish and recommended strategies to mitigate the barrier and reach the behavioral end-state.

Category	Sustainability Behavior	Impacted Group	Potential Barrier	Recommended Strategy for Mitigation
General	SAP Approval and Support	Key Stakeholders	Skepticism	Awareness/ Training
			Costs and Initial Investment	Benchmark success of the SAP in similar industries.
			Different Views & Opinions	
	SAP Implementation	Sustainability Team	Time Management	Awareness/ Training
			Lack of Commitment	Program Participation Reward/ Compensation
			Lack of Support due to other work related responsibilities	
	Sustainability Initiatives Metrics & Trackers Implementation and Periodic Updates	Sustainability Team	Time Management	Awareness/ Training
			Roadblocks during Data Collection	Provide reference materials and templates
			Complicated Process	
				Standardize data collection process between Sustainability team and impacted areas.
Energy & Water Reduction	Energy & Water Management Plan and Implementation	GxP Operations	Skepticism	Awareness/ Training
		Sustainability Team	Lack of Budget	Provide reference materials and templates
			Lack of resources	Benchmark success of the SAP in similar industries.
	HVAC Controls/ Sequence of Ops Implementation	GxP Operations	Concerns in possible HVAC disruption in the manufacturing areas, affecting product quality and triggering investigations.	Skilled Manpower
	Fume Hoods Optimization Implementation	Kilo Lab & RSL analysts	Leaving fume hoods open (Forget to Act)	Awareness/ Training

SUSTAINABILITY ACTION PLAN- STEP #6

Category	Sustainability Behavior	Impacted Group	Potential Barrier	Recommended Strategy for Mitigation
Waste Reduction		GxP Operations	Safety concerns for occupancy sensors installation in sash	Prompts, stickers, flyers in the laboratory areas
		EH&S	Lack of budget to replace existing hoods.	Perform assessment of potential hazards or safety impacts
				Present potential savings, and ROI with the installation of the new units.
	Installation of Misers in Vending Machines	GxP Operations	Initials Costs	Awareness in benefits or reducing energy during unoccupied hours.
	Installation of Green Roof	GxP Operations	Skepticism	Awareness/ Training
			Initials Costs	Highlight benefits to the building in terms of air pollution reduction, environmental quality, and wellness.
				Benchmark potential opportunities for BREEAM certification
	Installation of PV System	GxP Operations	Initial Costs	Awareness/ Training
		Senior Management	Not having approval from building landlord	Benchmark potential opportunities for BREEAM certification
				Highlight opportunity of Building to participate in the Boston's Carbon Cup
	Waste Management Plan Implementation	Sustainability Team	Skepticism	Awareness/ Training
		EH&S	Lack of Budget	Provide reference materials and templates
			Lack of resources	Benchmark success of the SAP in similar industries.
	Reduce Waste in Office, Labs, Manufacturing, and Warehouse Areas	Vertex employees	Skepticism	Awareness/ Training
			Lack of motivation	Prompts, Email communications with sustainability tips.
			Lack of information about recycling and composting	Update about company progress with Waste Reduction Initiative

SUSTAINABILITY ACTION PLAN- STEP #6

Category	Sustainability Behavior	Impacted Group	Potential Barrier	Recommended Strategy for Mitigation
Continuous Manufacturing			programs for the different areas	Norms for Waste Management
			Habits	Incentivize/ Recognize departments with the lowest waste generation.
	Implementation of Lean Manufacturing Initiative	Key persons from all departments that support the RIG Sustainability Team	Time Constraint	Awareness/ Training
			Lack of resources	Skilled Manpower
			Unskilled Manpower	Dedicated consultant
			Production Schedules and Deadlines	Prompts
Alternative Transportation	Support Vanpool/ Carpool Implementation	All vehicle drivers	Lack of Budget to support Vanpool Program	Awareness/ Training
		Corporate/ Senior Management	Legal/ Insurance constraints due to Ride share program.	Benchmark potential opportunities for BREEAM certification
			Restriction/ Limited of commuting hours.	Program Participation Reward/ Compensation
			Lack of transportation during emergency	Provide transportation options (Uber, Lift) during emergency.
			Habits	

Recommended strategies are discussed further in Section 6.4.

Step #6: Generate Short-Term Wins

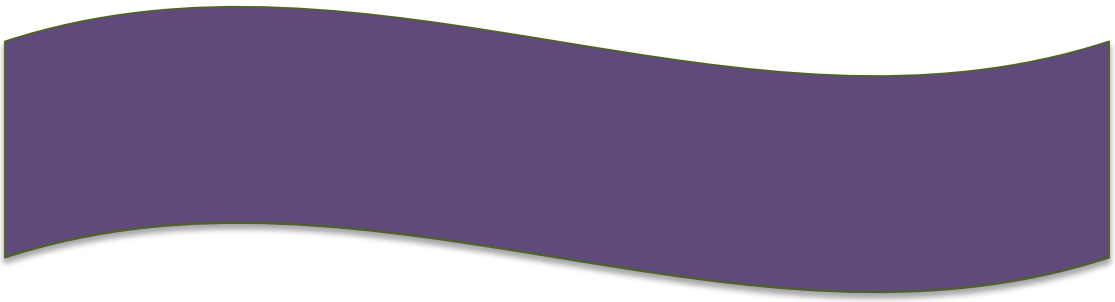
During this step Vertex will be celebrating short-term wins in order to build momentum and motivation for the change. As Kotter states in his guide, this is the time to collect, categorized, and communicate, early and often, to track progress and boost the volunteers to drive the change. Without progress evidence, the initiatives may be considered hard to achieve, skeptics become more difficult to convince, and momentum could be loss. Visible proof is the most powerful tool argument of progress. Section 8.0 provides a complete list of Key performance Metrics specifics for Vertex Annex Building that will help the Sustainability Team to report progress periodically and keep the employees and volunteers engaged and working towards the vision.

This guide will help the team to determine what will make the most effective short-win to celebrate:

SUSTAINABILITY ACTION PLAN- STEP #6

Measurable	Visible	Timely	Relevant to Stakeholders	Relevant to the Situation
• Initiatives with convincing improvements	• Real evidence to validate the change.	• Results are shown quarterly • Partial or Progressive Results are valid	• Initiatives are valuable to the majority of the Vertex employees.	• Wins should support the vision.

Step #7: Sustain Acceleration



At this point, Vertex would have moved through steps 1-6 and will be making change implementation traction. The idea is that the initiatives are implemented, barriers are removed, actions are enabled, and short-term wins are being celebrated. The objective in this phase of this change management process is to keep that momentum moving forward, identify, implement, and monitor key strategic initiatives, practices, people, and systems needed to maintain the speed and quality of carrying out the change visions. As such, proactive management is essential to ensure that such principles are put to practice and to stay the course towards the vision.

Step #8: Institute Change

In this final step, the expectation is to make the sustainability change permanent, to embed it in the culture of Vertex, and making the change "the way we do things around here" so these new behaviors are repeated over the long term. At this point Vertex:

- Persist, monitor, and measure progress without declaring victory prematurely.
- Recognize, reward, and model the new behavior.
- Have the employees tell the story of the change.

- Reinforce the culture with every new employees

6.2 Leadership's Role and Employee Engagement

The Baldrige Criteria, a framework that emphasizes the importance of stakeholder engagement, considers leadership to be an important component for driving performance excellence in any company. According to the criteria, leaders are entitled to formulate and communicate the company's vision, provide direction to balance the value and interests of the stakeholders, and allow for action and innovation based on those interests (Baldrige, 2015-2016). As discussed earlier, the success during the implementation of this Sustainability Action Plan at the Vertex Annex Building requires full commitment from the executive leadership. The Green Team Toolkit as well as the Accountability Stakeholder Engagement Manual provides guidance to companies like Vertex to define the leadership's role as developer of organizational culture and employee engagement.

Role and Process

Vertex's executive leadership must agree in the Sustainability Action Plan in order to motivate the members of the Sustainability Team, and demonstrate to the employees their commitment to Sustainable Practices.

In order to understand the real value of Vertex's employees and boost their motivation, the executive leadership should follow the following stakeholder engagement process:

SUSTAINABILITY ACTION PLAN- STEP #6

Commitment & Integration

- Include employees at all levels, making sure they are part of the decision-making process (Inclusivity).
- Find the most relevant and important issues for the employees (Materiality)
- Include the alternative chosen, action taken, performance, and communication that pertain to material issues (Responsiveness)

Purpose, scope, and stakeholders

- Purpose of employee engagement needs to be linked to Vertex sustainability activities.
- Scope of the engagement of each of the sustainability activities and the employee groups that will be included iin the engament process must be defined.

Stakeholders engagement process

- Vertex must follow an appropirate plan and process to ensure successful engagement.
- Some opportunities to motivate employees include working with project managers/ leads to establish Vertex's targets and goals; provide incentives for participation in each project as well as incentives of a project completion at varying levels of success; adopt a work hard/play hard approach during project implementations ; create budget, outline expectations, and support the Sustainability Team in ideas and proposal.

Benefits of Employees Engagement to Vertex

With the appropriate commitment and process in place, employees can provide real value to Vertex. Some of the benefits of employee engagement identified by Accountability include:

- Better management of risk in operations
- Better understanding of business direction
- Product and process improvement
- Improving impacts on the environment and society through informing and influencing other stakeholders (community, suppliers).
- More equitable management based upon input from employees and influencing decisions.
- Building trust with employees
- Pooling resources from different areas of groups within the building to resolve technical, social, environmental, or economic problems.

Vertex Annex Building's employees can be encouraged in the company by raising awareness within management regarding benefits previously discussed, providing access to training and tools available for engagement, and rewarding managers who pursue employees engagement (Blackburn, 2007).

In summary, executive leadership and management are responsible for the overall performance of the Vertex Annex Building, but that responsibility also falls to every employee in the building.

6.3 Branding, Communications and Marketing

"As reputation can be gained or lost through peer-to-peer communications online, it's indispensable to have sustainable practices in place and communicate them to consumers." –T. Whelan

Sustainability communication and marketing at Vertex is an instrument of effective program making and employee participation. Transparency is required during this process to ensure Vertex is openly and honestly communicating about the challenges it faces towards sustainability goals as well as its plans for improvement. In addition, both internal and external communication is required for Vertex as part of its behavioral and cultural change. Without internal communications, the company won't be successful in implementing sustainable initiatives, momentum is loss, and employees are disengaged. Without external communication, Vertex risks losing sales, partnerships, and capital investment from social responsible stakeholders, as well as being perceived as company that is not balanced in the environmental, social, and economic sustainable pillars. The following sections provide recommendations in how Vertex can improve and strength its branding and both internal and external communication in Sustainability.

Branding and Marketing Sustainability

The first thing that the Vertex should develop to brand its commitment towards sustainable practices is the creation of a logo that embraces the triple-bottom line of corporate social responsibility with the company's tag line *"Science of Possibility*." One possible symbol to represent this integration is using a similar molecule, from the company's website, having a chemical bond with the economic, environmental, and social pillars of sustainability (See Figure 6.3.1). The idea is to tell Vertex's commitment with sustainability into one story that is related to company's value to its shareholders and stakeholders.

Figure 6.3.1: Sustainability Logo

In addition to the sustainability logo, Vertex should educate both internal (employees) and external (patients, investors, community, government, suppliers, general public, etc.) stakeholders by branding current sustainable practices that differentiates from other similar industries that are externally communicating about Sustainability. The idea is bring awareness of initiatives in place with tangible results that goes beyond to what is required by regulations, are outside the box, and unique to Vertex. The tangible results should be communicated with information that appeals to any audience and relates to the people. Examples of these communications include: showing a representative picture of environmental attributes that is equivalent to the metric value that was reduce; having videos to tell specific stories about company's technology, employee engagement, patients testimonies, and community services; showing specific awards or recognitions that are unique to Vertex in the biotech sector; adding links to social media. The idea is to communicate Vertex's communication in more than one dimension.

Vertex currently has strong communication for the social responsibility aspect. However, besides a sentence about the company's commitment with Sustainability in the Proxy, the company does not have any external and internal communication about their sustainability practices. The sustainability story can be narrated using key differentiators initiatives in place for each of the key priorities identified in section 5.0.

The following statements should be use to introduce the key differentiator stories for each of the key priorities:

- Energy Reduction: "We invest the projects that reduce our energy consumptions and greenhouse emissions."
- Waste Minimization: "We minimize waste and conserve resources through system improvements and employee education programs."
- Manufacturing: "As a company that focus on the *Science of Possibility*, we invest in bold manufacturing innovations that enhance operational efficiencies and reduce our environmental impact."
- Transportation: "As a global organization, reducing the impact of transportation is integral to reducing our overall environmental impact."

Internal and External Communications

Committing and taking action in sustainability, a critical element of for Vertex Annex Building, but without getting employees on board through a successful internal communications program, sustainable initiatives are much less likely to succeed. In addition, the success of sustainability branding in external communications is achieved by pairing credibility and transparency with innovation and communication. There are opportunities for Vertex to brand sustainability in its communications to achieved this success.

- Avoid "Green" Washing: Putting more effort into talking about how "green" an initiative is than into actually being green damages a company's image. Vertex should communicate about sustainability initiatives that are currently in place, before announcing them. This will make the brand to look credible, and tangible.

- Intranet: Adding a Sustainability tab in the internal intranet to communicate to the employees Vertex commitment with Sustainability. The message in this section should be easy to remember and specific to current practices, goals, metrics dashboard, and actions that need to be taken. The sustainability tab should be updated periodically with any new initiative to be added, progress in the metrics, program meeting dates, volunteering opportunities, awards granted, and educational information (news, documentary, new technology, global sustainability goals) to keep employees engaged with the program.
- Vertex' Website: Adding a Sustainability tab in the website to communicate to the external stakeholders Vertex commitment with Sustainability. The message in this section should be easy to remember and specific to current practices, goals, metrics, links to Vertex social media channels, and recognitions and awards. The sustainability tab should be updated periodically with any new initiative to be added, progress in the metric, awards granted, and community impact with sustainability initiatives.
- Internal Emails: Sending emails periodically to inform about any progress of the sustainability initiatives (Annex-news), and informative-reminder prompts that are specific to initiatives that are current in place in the building that requires behavioral change and actions from the employees.
- Reaching employees where they are: Showing the sustainability message in the different areas of the Building with informative prompts/ posters to limit use of water in the washrooms, waste categories (composting, recycling and waste) in the break room, recycling material in the gowning areas, "Shut the Sash" campaign in the labs, etc.
- Fact Sheet: Create a fact sheet that includes an overview of the company's sustainability plans and efforts that can be provided in the new hire package and Vertex visitors (contractors, suppliers, investors, auditors, etc).
- Social Media: Adding sustainability message to social media channels (Facebook, Twitter, Instagram, Youtube, LinkedIn, Vertex Internal Blog; etc) to ensure two-way conversation. Inviting stakeholder to participate in a conversation about Vertex's sustainability program will further strengthen the brand-stakeholder relationship.
- Align communications with HR and Corporate Communications to be sure all messaging is consistent with Vertex practices: To maintain a sense of trust, clarity and transparency.

6.4 Educational and Motivational Program

> ***"When people are financially invested, they want a return. When people are emotionally invested, they want to contribute."***
> ***– Simon Sinek***

Vertex is continually recognized as a top employer by leading local and national publications (Vertex-B, 2016). This is achieved by providing education and motivational programs that provide employees higher purpose that goes beyond doing a job and earning an income. The employees play part in bringing positive change to the workplace and communities. To extend this purpose in the Sustainability Program, it is recommended to add educational and motivational initiatives/strategies to engage the employees and eliminate barriers that will threaten the sustainable behavioral change.

Educational Initiatives

The purpose of the Vertex Annex Building educational initiatives is creating knowledge and competence in Sustainability. Some tools include:

SUSTAINABILITY ACTION PLAN- STEP #6

Training

- Creating a curriculum in V-Learn dedicated to Sustainability to provide awareness in adopted sustainable practices and key performance indicators.
- Having an employee or external expert share their expertise in a "lunch and learn" or other optional training format.
- Integrating sustainability topics into regular employees check-ins (department meetings, etc.)

Norms

- Making norms about sustaible practices including energy and water conservation, waste reduction, and alternative transportation visibile.

Prompts

- Creating educational and remainder prompts or visual aids to encourage or remind people about sustainable practices to be follow in the labs, offices, manufacturing, warehouse, and break room areas.
- Prompts should be noticiable, self-explanatory, close to the area where the action will be taken, and could be send through email as well.

Reference Material and Templates

- Providing procedures to explain Sustainability Program plans, objectives, and metrics, and process to fill out templates.
- Providing standard and clear templates that facilitate the data collection for metrics, and calculations.

SUSTAINABILITY ACTION PLAN- STEP #6

Motivational Initiatives

The purpose of the Vertex Annex Building motivational initiative is keeping employees engaged with sustainable practices the work environment. Some tools include:

Create the Annex Sustainability Team

- Bringing together a team of Vertex Annex Building employees from all levels and all departments to help guide program direction and activities.

Annex-News (e-news)

- Create the monthly Annex-News to inform Annex employees about all the activities occurring in each departments of the building.
- Activities include production runs schedule, engagement activities, employees' recognition, general building performance and quality metrics, knowledge topic, games, as well as sustainable efforts, commitments, and progress made.
- The idea is to engage employees with current activities in the building and their integration with sustainability.

Competitions, Incentives and Green Awards

- Encouraging competition among employees to embrace new set of goals and volunteerism.
- Providing individual incentives through VOCAP program to reward positive sustainable behavior in energy and water conservation, waste reduction, commuting trasportation, and new project opportunities.
- Create Lab Challenge to promote good sustainable practices between labs.

Green Awards

- Showcasing and providing green award to departments that exceed sustainability goals.
- Providing green award and recognition to employees that are fostering sustainble behavior in their life after work by using the WSP Calculator or maing significant impact to the community through volunteering work.

Employee Recommendations

- Providing "employee suggestion box" in the break room area so employees can deposit any recommendation they would like to see implemented.
- Providing online surveys to assess current practices, evaluate any initiative implemented, and obtain additional feedback about the program.

Partnering with Academics, NGO, Goverment, and Industry Leaders

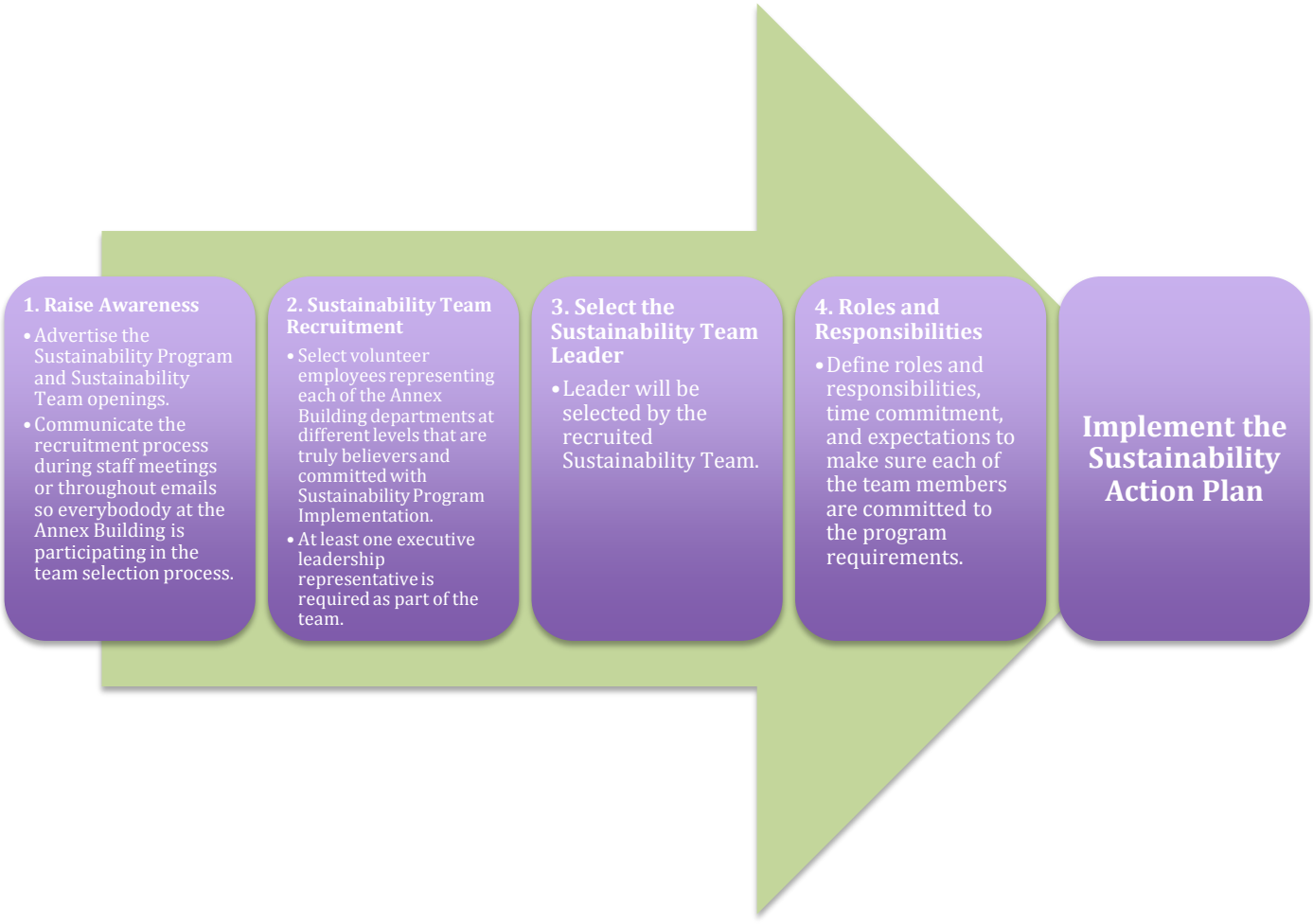
- Promoting employees participation with different sectors to streght their skills, learn about Vertex impact in the communty, and bring awareness.

6.5 Organizational Structure in Support of Sustainability

> ***"Alone we can do so little; together we can do so much"***
> ***– Helen Keller***

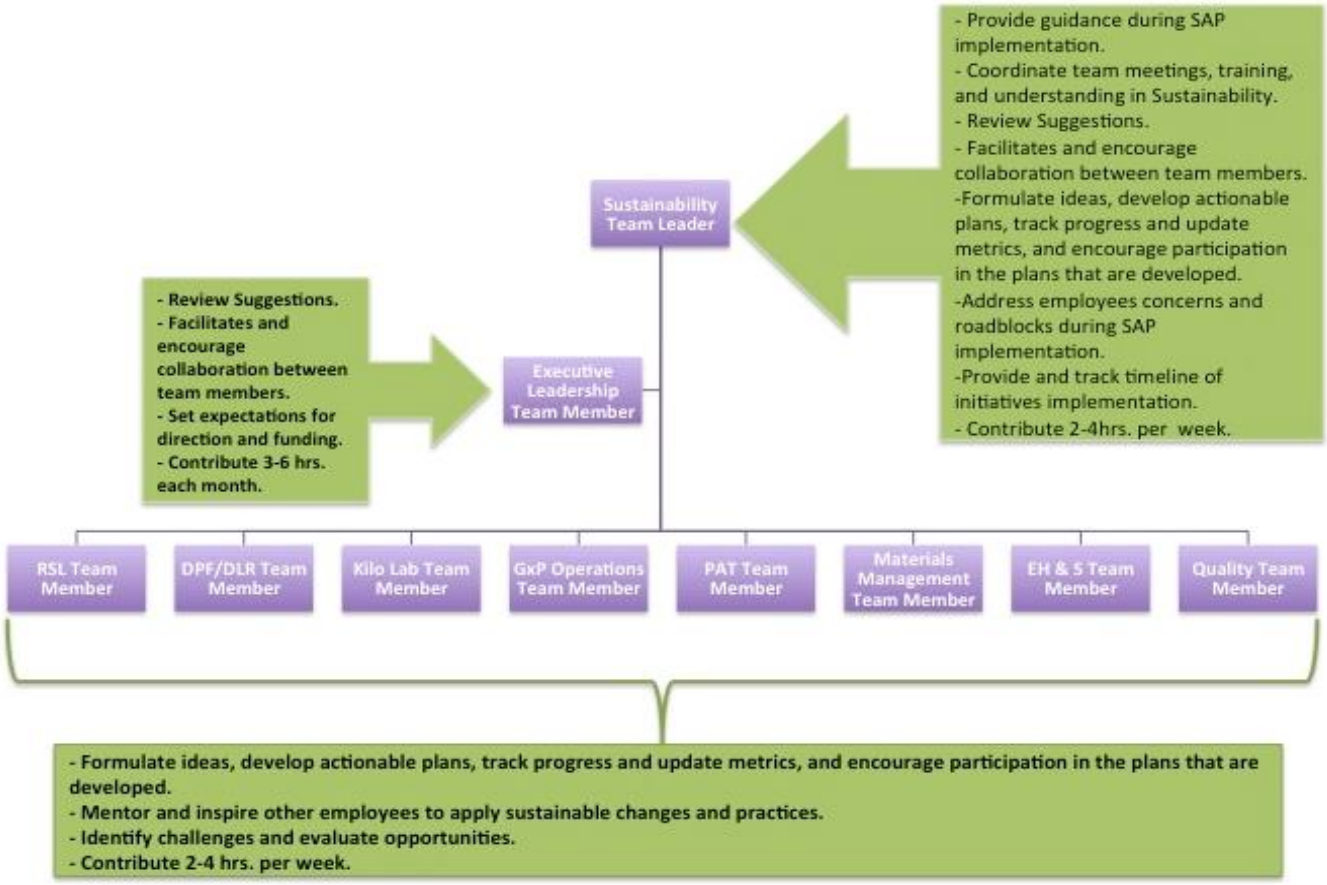
As described in Step #2 of Section 6.1, a guiding coalition or *Sustainability Team*, is an effective way to implement a sustainability program for Vertex Annex Building. Using the team approach helps to ensure that all employees at the building are aware of and participating in the program. In addition, the team approach allows for the work to be distributed among several people of different levels and cross-functional departments.

6.5.1 Sustainability Team Selection and Implementation Process



6.5.2 Sustainability Team Structure and Roles and Responsibilities

The following diagram shows the proposed structure and roles and responsibilities to be followed for the Sustainability Team at the Vertex Annex Building.



7.0 Sustainability Capital Reserve

"A sustainability capital reserve is the idea that money saved by enacting sustainability projects can be saved in total or in part then used toward future sustainability projects".

In general businesses and organizations, the concept of a capital reserve fund is to set aside assets that are outside the usual operating budget, and can be used to offset expenses with projects that must be funded at least partially outside the operating budget. For example, a municipality may want to build a new city hall. If funds are not set aside in the budget to begin preparation for this activity, then the proceeds from a capital reserve may be withdrawn to manage the costs of preparing a tract of land for the new building, creating blueprints, and in general preparing for the construction of the new facility. Depending on the amount of funds in the capital reserve fund, and the regulations that govern disbursements from that fund, it may be possible to finance an entire the entire project. A similar concept can be applied to Sustainability Initiatives that are translated into projects.

It is recommended to Vertex Annex Building set up a Sustainability Capital Reserve for the Vertex Annex Building. Having a sustainability capital reserve ensures that a company like Vertex will always have a source of financing for sustainability projects, thereby building in a system for ongoing savings. For example, Vertex could peel off some of the savings from energy & water, waste reduction, manufacturing projects and set them up as a Sustainability Capital Reserve. This rotating pool of capital can then be used to fund/invest in additional sustainability projects. Although the projects are self-funded, their ROI calculations assure executives that the funds could not be invested more profitably elsewhere (Willard, 2012).

8.0 Performance Metrics, Reporting, and Benchmarking

> ***"If you don't keep score, you are only practicing".***
> ***-Vince Lombardi***

8.1 Performance Metrics

Performance metrics critical to the success of Vertex are called Key Performance Indicators (KPIs). KPIs would include measurable goals intended to provide the necessary information to Vertex Stakeholders regarding progress made toward the building's objectives. Goals are indicators expressed as commitments to achieve some final level of performance or status.

The specific KPIs for, or key priorities, for Vertex Annex Building are identified in Section 5.0. KPIs help the Vertex Annex Building Sustainability Team to keep focus in priorities and prevent the team from being overwhelmed by the number of data points. The following table is an example about what the Sustainability Team should use that was determined material to report, and is connected to the top goals from the strategy process. The goals should have targets that are achievable, not hopelessly beyond grasp, and challenging enough to stimulate real effort and innovative thinking.

Table 8.1: Vertex Annex Building KPI Goals

KPI	Baseline (2015-2016)	2020 Goal	Annual KPI Progress				Method	Comments
			2017	2018	2019	2020		
Energy Consumption	**15,551,141 kBtu/hr**	↓35%	TBP	TBP	TBP	TBP	Utility Bills	Using Boston's Mayor Carbon Cup goal to reduce emissions by 35%.
RO Water Discharge	**TBD**	↓15%	TBP	TBP	TBP	TBP	Utility Bills; BMS trends	Initial assessment needed to determine RO water discharge rate/ month. Vertex can re-use the water internally or distributed to other building tenants.
Compost Organic Food Waste	**TBD**	↑100%	TBP	TBP	TBP	TBP	Composting report & Metrics	Break Room is provided with composting bin and information poster.
Recycle Nitrile Gloves in MFG & Labs	**0 lbs**	↑100%	TBP	TBP	TBP	TBP	Kimberly-Clark recycling report	Vertex to start KC recycling program to divert nitrile gloves starting 2017.

Table 8.1: Vertex Annex Building KPI Goals

KPI	Baseline (2015-2016)	2020 Goal	Annual KPI Progress				Method	Comments
			2017	2018	2019	2020		
Recycle Lab Purified Filter Cartridges	**0 lbs**	↑100%	TBP	TBP	TBP	TBP	Millipore recycling Report	Vertex to partner with Millipore to recycle nitrile gloves starting 2017.
Reduce waste generation	**TBD**	↓35%	TBP	TBP	TBP	TBP	Waste Collection, Diverting, and Recycling Bills	New sustainable, practices and extension of metrics to all building areas to support this goal.
Reduce Waste from Manufacturing	0	↓35%	TBP	TBP	TBP	TBP	Production Rate Report, Metrics	Lean Manufacturing Continuous Improvement, Six Sigma
Reduce GHG emissions from Commuting using Cars	**6528.76 Metric Tons**	↓60%	TBP	TBP	TBP	TBP	Employee Survey; Vertex Commuter Benefits	Vertex to provide alternative transportation (Vanpool) or carpooling options starting 2017.

The Metrics Navigator from the Global Environmental Management Initiative is another tool that Vertex could use to enhance its performance metric system. The tool is designed to help companies like Vertex to develop non- traditional metrics that compliment the organization's existing performance system, defines what and how to measure, and how to assure effectiveness that support business strategy (GEMI, 2007). Having the right metrics to track success toward Vertex's sustainability goals will ensure continued progress and improvement as well as good citizenship behavior.

8.2 Sustainability Reporting

Sustainability Reporting on performance helps Vertex to drive the cultural and behavioral change discussed in previous section through benchmarking and positive encouragement. External Sustainability Reporting should be a long-term goal for Vertex to pinpoint all the efforts performed to achieve the KPI goals, present the path for success, and spur change and innovation since it invites scrutiny and reaction to performance by stakeholders from whom Vertex needs support.

Ernest & Young Top 4 Reasons US Companies Report

Voluntary reporting can be influential in a company's credibility with stakeholders. In 2013, 57% of the Fortune 500 companies were externally

reporting in Sustainability (Peterson, 2016). The process to formally report would take some time, especially when a Sustainability Program and metrics are at the early stage of implementation. However, any initiative and effort can be aligned to existing sustainability frameworks that provide standard content index to facilitate reporting, guidance in KPI specific categories, and anticipate potential issues that may rise in the future. One framework that Vertex could use to communicate internally its performance today, but could be adapted to the long-term external reporting goal is the Global Reporting Initiative (GRI). Started in 1997 by CERES, this framework is generally accepted for sustainability reporting and commonly used by pharmaceutical and biotech companies around the World. The guideline requires reporting about a company's strategy, organizational structure, governance, stakeholder engagement, as well as its commitments and management in sustainability practices. Based on this plan, Vertex could adapt KPIs in the following categories from GRI:

GRI-G4 KPIs applicable to Vertex Annex Building	
General Standard Disclosure: Stakeholder Engagement	
Index	**KPI Description**
G4-24	List of Stakeholder Groups
G4-25	Basis for identification and selection of stakeholders
G4-26	Approach for stakeholder engagement
G4-27	Key topics and concerns raised through stakeholder engagement
Specific Standard Disclosure	
Category	**Environmental: Energy**
Index	**KPI Description**
G4-EN3	Energy consumption in the Building
G4-EN5	Energy intensity
G4-EN6	Reduction of Energy Consumption
Category	**Environmental: Water**
Index	**KPI Description**
G4-EN8	Total water withdrawal by source
G4-EN10	Total % and volume of water recycled and reused
Category	**Environmental: Emissions**
Index	**KPI Description**
G4-EN15	Direct GHG Emissions (Scope 1)
G4-EN16	Indirect GHG Emissions (Scope 2)
G4-EN17	Other Indirect GHG Emissions (Scope 3)
Category	**Environmental: Effluents/ Waste**
Index	**KPI Description**
G4-EN23	Total weight of waste by type and disposal method
Category	**Environmental: Transport**
Index	**KPI Description**

GRI-G4 KPIs applicable to Vertex Annex Building	
G4-EN30	Significant Environmental Impact of transporting goods, materials, and workforce members
Category	**Environmental: Overall**
Index	**KPI Description**
G4-EN31	Total environmental protection expenditures and investments by type

8.3 Vertex Annex Building Operation Benchmarking

Nowadays, NGOs and government agencies are advocating for policies that would require benchmarking performance metrics in commercial buildings. Energy performance, water consumption, material and resource use, indoor environmental quality and transportation use are components that can present areas of improvement when benchmarked with "rational, agreed-upon" standards or with other similar commercial buildings (USGBC, 2012). Vertex Annex Building can benefit from existing building rating systems to collect key performance data for benchmarking and continuous reducing costs and impact to the environment from its operation. Some of those building rating systems include:

- USGBC LEED for Building Operations and Maintenance (LEED O+M): This rating certification system is applicable to all existing buildings. However, Vertex Annex Building cannot apply for the certification since the rating system is created for whole building, and not tenant space. GxP Operations and Engineering teams still could benefit from this rating system by using some of the credit requirements as a guideline to introduce sustainable practices that will help the building reducing costs and environmental impacts from operations and maintenance, and meet goals' targets in the expected timeline. Some credits under this rating system that address water, energy use, and waste management KPIs are:

Credit #	Description	Rationale for Vertex Annex Building
Water Category		
WE Credit 1	Water Performance Measurement	Water Efficiency & Water Assessment Guideline. Measure building and subsystem performance over time to understand consumption patterns and identify opportunities for additional water savings.
Energy & Atmosphere Category		
EA Pre-Requisite 1	Energy Efficiency Best Management Practices, Planning, Documentation, and Opportunity Assessment	Energy Management Program Guideline. Promote continuity of information to ensure energy management strategies are in place.
EA Credit 1	Optimize Energy Efficiency Performance	Energy Consumption Reduction Guideline. Provide strategies to increase levels of operating energy performance relative to buildings of similar to reduce

Credit #	Description	Rationale for Vertex Annex Building
		environmental impact and costs due to excessive energy use.
EA Credit 2.3	Existing Building On-Going Commissioning	Energy Consumption Reduction. Provides opportunities to maximize the Analytika software reporting in combination of commissioning program to identify opportunities to reduce excessive energy use.
EA Credit 3.1	Performance Measurement- Building Automation System	Energy Consumption Reduction. Provide guidelines to improve and optimize BMS performance.
EA Credit 4	On-site and Off-site Renewable Energy	Renewable Energy guideline for future initiatives (PV and Solar Water Heater) to meet some or all of the building's total energy use.
EA Credit 6	Emissions Reduction Reporting	Energy Management Program Guideline. Provide opportunity to document emissions reduction benefits based on sustainable initiatives implemented.
Waste Management		
MR Pre-Requisite 2	Solid Waste Management Policy	Waste Management Program Guideline to facilitate waste reduction.
MR Credit 6	Solid Waste Management-Water Stream Audit	Waste Assessment Guideline to audit waste generated at each of the building areas and identify opportunities for reduction.
MR Credit 7	Solid Waste Management-Ongoing Consumables	Provide guideline to reduce waste by 50% through recycling, reuse, and composting initiatives.
MR Credit 8	Solid Waste Management-Durable Goods	Provide guideline to reduce waste by 75% through recycling or reuse initiatives.

In the event that the building owner decide certifying the whole building as LEED O+M, Vertex Annex Building would have documented evidence of high efficiency performance. In addition, meeting these credit requirements will facilitate the building to pursuit other building certifications that do not exclude leased buildings.

- WELL Building Standard: This standard focuses on the health and wellness of the building occupants. Like LEED O+M, this rating system excludes leased buildings that occupied more than 10% of the space (IWBI, 2016). However, the standard can be used as a guidance to improve the indoor quality performance of the Vertex Annex Building. The building should use the standard to adopt healthy practices in the following categories:

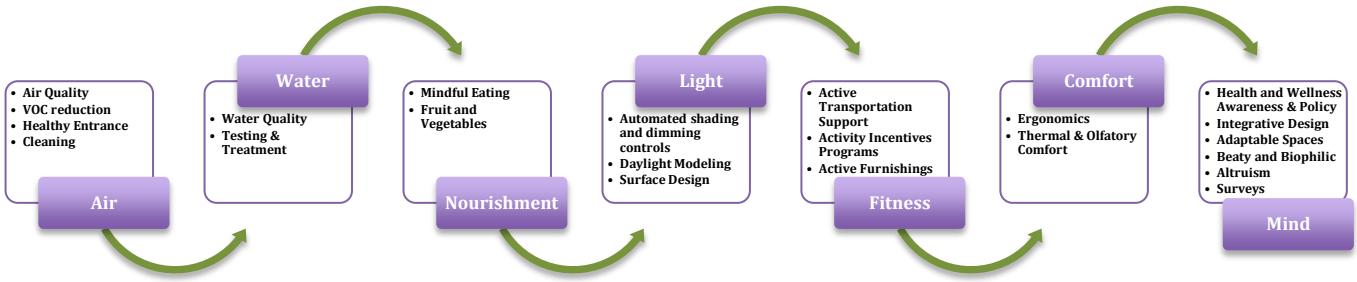


Figure 8.3.1: Well Building Standard Categories for Vertex Annex Building

- BREEAM USA In Use: The BREEAM (Building Research Establishment's Environmental Assessment Method) USA in-use is a sustainability-rating program for existing commercial buildings in use that mitigates operational impacts on the environment in a robust and cost effective manner (BREEAM, 2016). Any building, including lease buildings like Vertex Annex, can register for this rating system. The Vertex Annex Building can perform the BREEAM USA In-Use assessment as "Occupier Management" to benchmark performance in key performance indicators such as energy, water, waste, transportation, and sustainable practices. The following table provides a summary of all the categories and credits associated to this rating system and the possibility of Vertex meeting the minimum requirements for obtaining the certification.

BREEAM USA In-Use Potential Rating for Vertex Annex Building (Occupier Assessment)			
Issue Reference	**Tittle**	**Credits Available**	**Annex Meets Minimum Required?**
Environmental Management			
MAN 14	Environmental Management Policy	4	Possible to achieve
MAN 15	Environmental Management Issues	16	Yes
MAN 16	Environmental Management Implementation	13	Possible to achieve
MAN 17	Environmental Objectives	4	Possible to achieve
MAN 18	Organizational Performance Review	2	Possible to achieve
MAN 19	Sustainability Report	3	No
MAN 20	Green Lease	4	No
Health and Wellbeing			
HEA 25	Occupier Satisfaction	10	Yes
HEA 26	Health and Wellbeing Management Targets	57	Possible to achieve

BREEAM USA In-Use Potential Rating for Vertex Annex Building (Occupier Assessment)			
Issue Reference	**Tittle**	**Credits Available**	**Annex Meets Minimum Required?**
HEA 27	Health and Wellbeing Management Objectives	4	Possible to achieve
HEA 28	View Out	2	Yes
HEA 29	Communal Rest Areas	2	Yes
Energy			
ENE 67	Energy Policy	3	Possible to achieve
ENE 68	Energy Management Arrangements	51	Possible to achieve
ENE 69	Trends in energy performance data	2	Yes
ENE 70	Energy Objectives	4	Possible to achieve
ENE 71	Energy Savings	4	Possible to achieve
Transport			
TRA 05	Transport Requirements	12	Yes
TRA 06	Transport Management Arrangements	59	Yes
TRA 07	Local public transportation	4	Yes
TRA 08	Local Amenities	4	Yes
TRA 09	Transport Objectives	4	Possible to achieve
TRA 10	Transport impact of commuting	2	Possible to achieve
TRA 11	Transport impact of business travel	2	Possible to achieve
TRA12	Transport impact of goods delivery	2	Possible to achieve
Water			
WAT 18	Water Management	3	No
WAT 19	Water Management arrangements	48	Possible to achieve
WAT 20	Water Management Targets	4	Possible to achieve
WAT 21	Water Consumption	2	Yes
Materials			
MAT 15	Material Procurement Selection	7	No
MAT 16	Material Procurement: Management arrangements	52	Possible to achieve
MAT 17	Supplier Approval	3	No
MAT 18	Supplier Quality Policy	4	Yes
MAT 19	Supplier Environmental Management	4	No
MAT 20	Supplier quality management (third party certified)	4	Yes
MAT 21	Supplier environmental management (third party certified)	4	No
MAT 22	Supplier responsible sourcing standard (third party certified)	4	No
MAT 23	Material Procurement Targets	4	Possible to achieve
Waste			
WST 02	Waste Management: Hierarchy	8	Yes
WST 03	Waste Management Recycling & Reclamation	4	Yes
WST 04	Waste management arrangements	51	Yes
WST 05	Waste Monitoring	4	Yes
WST 06	Waste Performance	2	Possible to achieve
WST 07	Waste Management Objectives	4	Possible to achieve

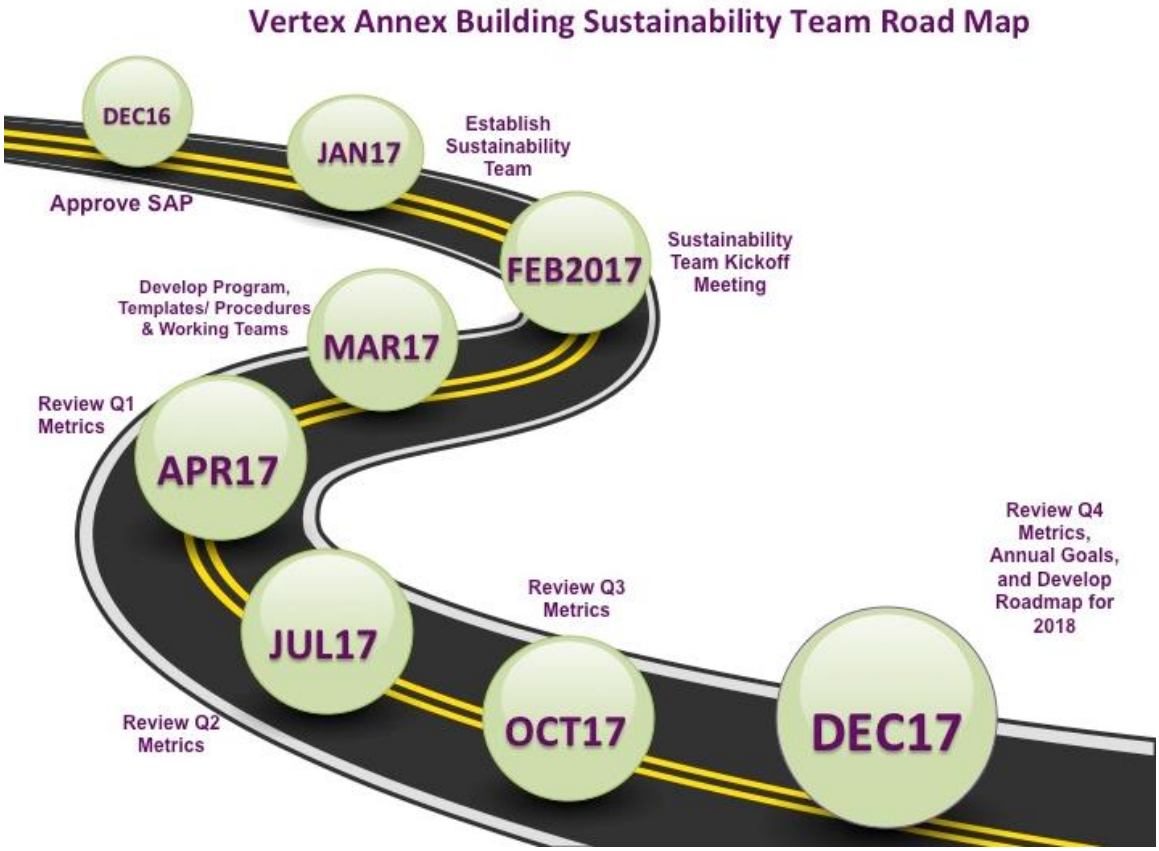
BREEAM USA In-Use Potential Rating for Vertex Annex Building (Occupier Assessment)			
Issue Reference	**Tittle**	**Credits Available**	**Annex Meets Minimum Required?**
WST 08	Waste sent to landfill	2	Yes
WST 09	Waste diverted from landfill	2	Yes
WST 10	Waste sent to incineration	2	Yes
Pollution			
POL 15	Pollution Management	11	No
POL 16	Pollution Prevention Arrangements	52	No
POL 17	Pollution Prevention Targets	4	No

Based on this summary, the Vertex Annex Building has the possibility to become BREEAM USA In-Use "Good Occupier" (Score 40-54) if adopts sustainable practices. In addition, the building can become one of the first buildings in the country to become BREEAM USA In-Use assessed, since the rating system was recently launched is USA.

9.0 Roadmap

> ***"A goal without a plan is just a wish."***
> ***— Antoine de Saint-Exupéry***

The following diagram provides a recommended roadmap that the activities that the Vertex Annex Building Sustainability Team would have to accomplish to ensure effectiveness of sustainability strategy.



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APPENDIX 1: Utility Bills Raw Data

Building Information Bills 2014-2015				Use	Unit	Cost	Rate	
Annex Building	Natural Gas	CCF Meter #13019836	Oct 14	14,586	Therms	$11,557.35	0.79	
			Nov 14	10,484	Therms	$11,911.34	1.14	
			Dec 14	13,809	Therms	$14,374.40	1.040	
			Jan 15	23,876	Therms	$19,384.26	0.810	
			Feb 15	22,315	Therms	$16,145.78	0.720	
			Mar 15	15,556	Therms	$12,523.46	0.810	
			Apr 15	7,193	Therms	$7,697.26	0.810	
			May 15	3,492	Therms	$2,162.11	0.620	
			Jun 15	6,160	Therms	$3,024.73	0.490	
			Jul 15	5,853	Therms	$3,075.71	0.530	
			Aug 15	2,668	Therms	$1,608.75	0.60	
			Sep 15	4,106	Therms	$1,965.50	0.480	
		Total		130,098	Therms	$105,430.65	0.7367	**Demand**
	Electricity	1 Harbor ST Meter #1HarVEr	Oct 15	286,422	kWh	$37,016.51	0.13	578.4
			Nov 15	230,845	kWh	$33,424.01	0.14	525.6
			Dec 15	227,242	kWh	$42,732.17	0.19	432
			Jan 16	243,885	kWh	$63,766.73	0.260	403.2
			Feb 16	252,989	kWh	$74,744.78	0.30	458.4
			Mar 16	252,080	kWh	$59,200.20	0.230	458.4
			Apr 16	250,244	kWh	$38,314.62	0.150	494.4
			May 16	232,071	kWh	$30,925.24	0.130	524.4
			Jun 16	279,674	kWh	$40,537.31	0.140	652.8
			Jul 16	331,155	kWh	$50,631.16	0.150	712.8
			Aug 16	324,185	kWh	$50,115.17	0.150	758.4
			Sep 16	352,657	kWh	$52,874.78	0.150	727.2
				3,263,449	kWh	$574,282.68	0.1767	6726
	Water & Sewer	14501758 Meter- 1 Harbor St	Month	Use	Unit	Water Charges	Sewer Charges	Other Charges
			Nov 14	800	cf	$37.73	$ 48.66	
			Dec 14	1,250	cf	$60.06	$ 76.92	
			Jan 15	2,220	cf	$108.47	$137.52	$0.00
			Feb 15	2,700	cf	$140.30	$177.35	$880.00
			Mar 15	2,800	cf	$147.06	$185.41	$0.00
			Apr 15	2,850	cf	$148.61	$187.68	$0.00
			May 15	1,250	cf	$62.85	$80.63	$0.00
			Jun 15	1,600	cf	$81.67	$104.06	$0.00
			Jul 15	1,500	cf	$76.33	$97.39	$1,230.00
			Aug 15	800	cf	$39.64	$51.12	$0.00
			Sep 15	900	cf	$44.84	$57.73	$0.00
			Oct 15	950	cf	$47.42	$61.00	$0.00
				19,620	cf	$998.98	$1,265.47	$2,110.00

APPENDIX

Building Information Bills 2014-2015	Use	Unit	Cost	Rate
Grand Total - Natural Gas	130,098	Therms	$105,430.65	11.2898
Grand Total - Electricity	3,263,449	kWh	$574,282.68	0.1208
Grand Total - Water & Sewer	19,620	cf	$2,260.45	

* denotes estimated, adjusted, or corrected meter read

Building Information Bills 2015-2016				Use	Unit	Cost	Rate	
Annex Building	Natural Gas	CCF Meter #13019836	Oct 15	6,061	Therms	$2,433.71	0.40	
			Nov 15	8,839	Therms	$12,945.46	1.460	
			Dec 15	17,479	Therms	$16,403.10	0.940	
			Jan 16	8,050	Therms	$10,574.58	1.31	
			Feb 16	15,793	Therms	$15,331.40	0.97	
			Mar 16	9,039	Therms	$11,531.61	1.29	
			Apr 16	7,707	Therms	$9,963.74	1.31	
			May 16	5,339	Therms	$3,245.27	0.61	
			Jun 16	4,106	Therms	$2,631.98	0.64	
			Jul 16	0	Therms	$0.00	0	
			Aug 16	7,698	Therms	$5,104.00	0.24	
			Sep 16	4,844	Therms	$4,348.00	0.9	
				94,955	Therms	$85,060.85	0.9922222	**Demand**
	Electricity	1 Harbor ST Meter #1HarVEr	Oct 15	265,650	kWh	$56,868.83	0.210	568.8
			Nov 15	231,843	kWh	$32,788.03	0.140	518.4
			Dec 15	229,669	kWh	$38,375.15	0.170	408
			Jan 16	223,286	kWh	$40,767.53	0.19	381.6
			Feb 16	202,147	kWh	$37,552.79	0.19	384
			Mar 16	210,293	kWh	$36,300.20	0.17	468
			Apr 16	206,928	kWh	$30,187.92	0.14	412.8
			May 16	204,991	kWh	$27,655.98	0.13	436.8
			Jun 16	270,739	kWh	$40,229.57	0.15	580.8
			Jul 16	303,670		$51,469.50	0.17	712.8
			Aug 16	328,309	kWh	$54,994.95	0.17	792
			Sep 16	343,374	kWh	$51,592.33		
				1,774,807	kWh	$300,496.43	0.1675	5664
	Water & Sewer	14501758 Meter- 1 Harbor St	Month	Consumption	Unit	Water Charges	Sewer Charges	Other Charges
			Nov 15	2,350	cf	$121.60	$154.00	$0.00
			Dec 15	2,150	cf	$111.05	$140.75	$0.00
			Jan 16	2,150	Cf	$110.05	$141.44	$0.00
			Feb 16	2,050	Cf	$105.83	$141.68	$3,483.82
			Mar 16	1,400	Cf	$71.24	$95.99	$0.00
			Apr 16	11,470	Cf	$636.86	$837.44	$0.00
			May 16	19,800	Cf	$1,137.15	$1,500.28	$0.00

			Jun 16	10,650	Cf	$591.58	$778.82	$0.00
			Jul 16	5,050	Cf	$274.41	$362.56	$990.00
			Aug 16	5,150	Cf	$278.80	$368.68	$0.00
			Sep 16	8,400	Cf	$464.23	$611.06	$0.00
			Oct 16	3,050	Cf	$160.83	$213.94	$0.00
				73,670	Cf	$4,063.63	$5,346.64	$4,473.82

Grand Total - Natural Gas	94,955	Therms	$85,060.85	0.9922	
Grand Total - Electricity	1,774,807	kWh	$300,496.43	0.1675	
Grand Total - Water & Sewer	73,670	Cf	$9,410.27		

* denotes estimated, adjusted, or corrected meter read

APPENDIX

CDD & HDD	
Description:	Fahrenheit-based heating degree days/ cooling degree days for base temperatures at and around 65F
Source:	www.degreedays.net (using temperature data from www.wunderground.com)
Accuracy:	Estimates were made to account for missing data: the "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)
Station:	Boston, MA, US (71.00W,42.36N)
Station ID:	KBOS

2014/2016					
Month starting	**Base Temp: 65 F**			**Month starting**	**Base Temp: 65 F**
10/1/2014	290			10/1/2014	17
11/1/2014	671			11/1/2014	0
12/1/2014	830			12/1/2014	0
1/1/2015	1201			1/1/2015	0
2/1/2015	1272			2/1/2015	0
3/1/2015	991			3/1/2015	0
4/1/2015	515			4/1/2015	2
5/1/2015	189			5/1/2015	86
6/1/2015	126			6/1/2015	95
7/1/2015	7			7/1/2015	272
8/1/2015	2			8/1/2015	276
9/1/2015	45			9/1/2015	164
2014/15 HDD	6139			**2014/15 CDD**	912
2015/2016					
Month starting	**Base Temp: 65 F**			**Month starting**	**Base Temp: 65 F**
10/1/2015	354			10/1/2015	11
11/1/2015	498			11/1/2015	7
12/1/2015	626			12/1/2015	1
1/1/2016	1015			1/1/2016	0
Month starting	**Base Temp: 65 F**			**Month starting**	**Base Temp: 65 F**
2/1/2016	883			2/1/2016	0
3/1/2016	709			3/1/2016	3
4/1/2016	551			4/1/2016	4
5/1/2016	274			5/1/2016	51
6/1/2016	47			6/1/2016	134
7/1/2016	11			7/1/2016	333
8/1/2016	1			8/1/2016	341
9/1/2016	64			9/1/2016	126
2015/16 HDD	5033			**2015/16 CDD**	1011

APPENDIX 2: Waste Disposal Raw Data

Vertex #7231 - 11 Fan Pier/Annex - 2016 Diversion Report

*Weight in Tons	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16
Single Stream	3.15	3.15	3.65	3.00	3.15	3.65	3.50	3.60	3.30	3.50
Wood	1.00	0.75	1.25	1.00	1.00	0.00	1.25	1.00	1.00	1.50
Compost	0.00	0.00	3.00	3.90	8.10	7.52	7.79	7.50	7.28	8.10
Trash	6.13	10.80	14.71	9.15	4.17	16.58	9.31	11.32	10.34	10.94
Recycle Percentage	40%	27%	35%	46%	75%	40%	57%	52%	53%	54%

Resources Saved:	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Total
Trees	71	66	134	134	208	190	213	206	197	223	0	0	1,642
Gallons Oil	1,619	1,521	3,081	3,081	4,778	4,356	4,891	4,719	4,514	5,109	0	0	37,668
Kilowatt Hours Energy	16,600	15,600	31,600	31,600	49,000	44,680	50,160	48,400	46,300	52,400	0	0	386,340
Gallons Water	29,050	27,300	55,300	55,300	85,750	78,190	87,780	84,700	81,025	91,700	0	0	676,095
Pounds of Pollutant Effluents	249	234	474	474	735	670	752	726	695	786	0	0	5,795
Landfill Space (Cu Yds)	14	13	26	26	40	37	41	40	38	43	0	0	319

APPENDIX 3: Transportation Raw Data

Staff Commuting Survey

Year: 2016

General					Commuting combination 1						Commuting combination 2					
Name	Distance to work, in miles (round trip)	# days per week you commute to work (on average)	Fuel economy of the car (mpg)	Average # of people in the car (including you)	# days per week you use this combination	Miles by car	Miles by bus	Miles by Transit Rail	Miles by Train	Miles walked or biked	# days per week you use this combination	Miles by car	Miles by bus	Miles by Transit Train	Miles by train	Miles walked or biked
Staff 1	15.0	5	23	1	5	15.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 2	60.0	5	n/a	n/a	5	0.0	10.0	50.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 3	13.0	5	n/a	n/a	2	0.0	0.0	0.0	13.0	0.0	3	0.0	0.0	0.0	0.0	13.0
Staff 4	55.0	5	16	1	5	55.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 5	5.0	5	n/a	n/a	5	0.0	0.0	0.0	5.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 6	11.0	5	22	1	5	11.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 7	25.0	5	n/a	n/a	5	0.0	0.0	0.0	0.0	25.0	0	0.0	0.0	0.0	0.0	0.0
Staff 8	70.0	5	22	1	5	70.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 9	15.0	5	31	1	5	15.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 10	36.0	5	18	1	5	5.0	36.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 11	50.0	5	20	1	5	50.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 12	130.0	5	17	1	5	130.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 13	50.0	5	29	1	5	50.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 14	90.0	5	18	1	5	90.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0

Staff Commuting Survey

Year: 2016

General					Commuting combination 1						Commuting combination 2					
Name	Distance to work, in miles (round trip)	# days per week you commute to work (on average)	Fuel economy of the car (mpg)	Average # of people in the car (including you)	# days per week you use this combination	Miles by car	Miles by bus	Miles by Transit Rail	Miles by Train	Miles walked or biked	# days per week you use this combination	Miles by car	Miles by bus	Miles by Transit Train	Miles by train	Miles walked or biked
Staff 15	10.0	5	30	1	5	10.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 16	88.0	5	n/a	n/a	5	0.0	6.0	82.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 17	27.0	5	26	1	5	27.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 18	90.0	5	24	1	3	15.0	0.0	75.0	0.0	0.0	2	0.0	0.0	80.0	0.0	10.0
Staff 19	30.0	5	32	2	5	15.0	0.0	15.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 20	20.0	5	n/a	n/a	5	0.0	9.0	0.0	9.0	2.0	0	0.0	0.0	0.0	0.0	0.0
Staff 21	28.0	5	29	1	5	10.0	2.0	0.0	15.0	1.0	0	0.0	0.0	0.0	0.0	0.0
Staff 22	1.5	5	n/a	n/a	5	0.0	0.0	0.0	0.0	1.5	0	0.0	0.0	0.0	0.0	0.0
Staff 23	40.0	5	n/a	n/a	5	0.0	0.0	40.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 24	52.6	6	14	1	6	52.6	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 25	13.0	5	n/a	n/a	3	0.0	4.0	0.0	8.0	1.0	2	0.0	0.0	0.0	8.0	5.0
Staff 26	12.0	5	25	1	5	12.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 27	11.0	5	23	1	5	11.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0
Staff 28	120.0	5	29	1	5	120.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0

APPENDIX

CO_2 Emissions from Employee Commuting

Estimation of Activity Data (Distance traveled) for Bus, Light Rail and Train

Year:	2016	A	B	C	D
		Bus Miles	Transit Rail Miles	Train Miles	Walk/Bike Miles
Step 2.1a	For sample group(total weekly miles):	327	1,320	211	220
Step 2.1b	Number of weeks per year	48			
Step 2.2c	For sample group (total annual miles):	15,696	63,360	10,128	10,536

CO_2 Emissions from Employee Commuting

Estimation of Activity Data (Fuel Use) for Car Travel

Staff	Total car miles traveled in a week	Total car miles traveled in a year	Fuel economy (Miles per Gallons)	Quantity of fuel used (Gallons)	Number of occupants in the car	Fuel used per person (Gallons)
Staff 1	75	3600	23.0	156.5	1	156.5
Staff 2	0	0	n/a	n/a	-	0
Staff 3	0	0	n/a	n/a	-	0
Staff 4	275	13200	16.0	825.0	1	825.0
Staff 5	0	0	n/a	n/a	-	0
Staff 6	55	2640	22.0	120.0	1	120.0
Staff 7	0	0	n/a	n/a	-	0
Staff 8	350	16800	22.0	763.6	1	763.6
Staff 9	75	3600	31.0	116.1	1	116.1
Staff 10	25	1200	18.0	66.7	1	66.7
Staff 11	250	12000	20.0	600.0	1	600.0
Staff 12	650	31200	17.0	1835.3	1	1835.3
Staff 13	250	12000	29.0	413.8	1	413.8
Staff 14	450	21600	18.0	1200.0	1	1200.0
Staff 15	50	2400	30.0	80.0	1	80.0
Staff 16	0	0	n/a	n/a	-	0
Staff 17	135	6480	26.0	249.2	1	249.2
Staff 18	45	2160	24.0	90.0	1	90.0

APPENDIX

Staff	Total car miles traveled in a week	Total car miles traveled in a year	Fuel economy (Miles per Gallons)	Quantity of fuel used (Gallons)	Number of occupants in the car	Fuel used per person (Gallons)
Staff 19	75	3600	32.0	112.5	2	56.3
Staff 20	0	0	n/a	n/a	-	0
Staff 21	50	2400	29.0	82.8	1	82.8
Staff 22	0	0	n/a	n/a	-	0
Staff 23	0	0	n/a	n/a	-	0
Staff 24	316	15149	14.0	1082.1	1	1082.1
Staff 25	0	0	n/a	n/a	-	0
Staff 26	60	2880	25.0	115.2	1	115.2
Staff 27	55	2640	23.0	114.8	1	114.8
Staff 28	600	28800	29.0	993.1	1	993.1

Year: 2016

	Step 3.1a			Step 3.1b		Step 3.1c	
		A	B	C	D	E	F
	Type of fuel used	Quantity of fuel used (annual)	Unit	CO_2 emission factor	Unit	CO_2 emissions in kg	CO_2 emissions in metric tons
						E=AxC	
Mode of Transportation							
Vehicle	Gasoline/Petrol	8960.42	Gallon	8.78	kgCO2/ gallon	78,673	78.67

	Step 3.1d: Sum CO_2 emissions:	**78.67**

CO_2 Emissions from Employee Commuting

Distance Traveled Approach

Year: 2016

		Step 3.2a		Step 3.2b		Step 3.2c	
		A	B	C	D	E	F
	Description	Distance Traveled (annual)	Unit	CO_2 emission factor	kg CO2/Unit	CO_2 emissions in kg	CO_2 emissions in metric tons
						E=AxC	
Mode of Transportation							
Train	**Diesel**	10,128	mile	0.277	kgCO2/ mile	2,802	2.8
Transit Rail	**Transit Rail**	63,360	mile	0.550	kgCO2/ mile	34,848	34.8
Bus	**Diesel - Urban**	15,696	mile	0.300	kgCO2/ mile	4,704	4.7

Step 3.2d: Sum CO_2 emissions:	**42.4**

Total Commuting Emissions

Organization's total estimated emissions = Total emissions from sample group x employee to sample ratio

Employee to Sample Ratio (E/S) = Number of employees in organization / number of employees in sample

E/S **2.39**

Year: **2016**

	Step 4		
	A	**B**	**C**
	CO_2 Emissions in Metric Tons	Employees to Sample Ratio (E/S)	CO_2 Emissions in Metric Tons
	Sample Group		All Employees
Mode of Transportation			
Sum - Fuel Based Emissions	78.67	2.39	188.25
Sum - Distance Based Emissions	42.35	2.39	101.35
Total	121.03	2.39	**289.25**