University of Maryland
Center for Environmental Science
Appalachian Laboratory

Campus Sustainability Report
Emissions Inventory & Climate Action Plan

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About this report:.

The following report summarizes the UMCES Appalachian Laboratory greenhouse gas emissions for the three scopes defining emission sources and defines our plan of actions to reduce these emissions.

Scope 1 – Direct sources. These are emissions from sources that are owned and operated by the institution such as produced electricity, heat and steam, fleet vehicle use and fugitive emissions.

Scope 2 – Imported energy sources. These are emissions from imported energy such as purchased electricity, heat, and steam.

Scope 3 – Indirect sources. These are emission sources that may result from activities of the institution but are not owned or controlled by the institution such as business travel, commuting habits, solid waste disposal, waste water, and electricity transportation and distribution losses.

The software used to compute carbon emissions is the Campus Carbon Calculator, v6.7, provided free of charge by the Clean Air-Cool Planet organization. http://www.cleanair-coolplanet.org

The AL Carbon Emissions inventory team consists of the following individuals:

Barbara Jenkins, Staff – *provided personnel data, compiled and entered data from other members, and prepared the summary report*
Stacy Cutter, Staff – *updated emissions inventory, provided utility and travel data*
Cami Martin, Staff – *provided fleet use data*
Heather Johnson, Assistant Director - *provided budget data*

Special note: Dan Fiscus, a Graduate Student at AL collected and compiled the data used for the first 5 years while completing his thesis. He shared this data with us to use when compiling our first emissions inventory.

The AL Environmental Sustainability Council consists of the following individuals:

Barbara Jenkins – Chair & Facility representative
Heather Johnson – Budget Office representative
Stacy Cutter – Business Office representative
Katia Engelhardt - Faculty representative
Roy Weitzell - Student representative

Ad hoc members include:
Katie Kline – Laboratory and Safety Manager
Cami Martin – Business Office, Fleet Manager
Tim Hockman – HVAC Maintenance Technician
Eric Farris – IT Administrator

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Section 1: History, Introduction, & Background

1.1. History

The Appalachian Laboratory (AL), located in the mountains of western Maryland, is an environmental research facility and is seen as a vital research component for understanding the Chesapeake Bay Watershed. AL is part of one of the world's leading coastal research institutions, the University of Maryland Center for Environmental Science (UMCES). UMCES is the premier research institution aimed at advancing scientific knowledge of the environment and, although a non-degree granting institution, it is extensively involved in graduate education in the environmental science programs within the University System of Maryland. The sister institutions within UMCES are Horn Point Laboratory (HPL), on Maryland's Eastern Shore, the Chesapeake Biological Laboratory (CBL), at the mouth of Patuxent River in Southern Maryland, the Institute of Marine and EnvironmentalTechnology (IMET), located in the Columbus Center on Baltimore's Inner Harbor, Baltimore Maryland, and the Maryland Sea Grant College (MDSG) located in College Park.

The Appalachian Laboratory (AL), established in 1961 as a field station of the Inland Resources Division of the University of Maryland's Natural Resources Institute, consisted of portions of two rented buildings and a storage facility along Route 40 in LaVale, a suburb of Cumberland, Maryland. In 1973, the Institute became part of the University of Maryland's new Center for Environmental and Estuarine Studies (CEES) and the Inland Resources Division in College Park was abandoned, its positions divided among the three Laboratories.

To provide more adequate facilities and encourage cooperative relationships with other institutions in western Maryland, the Laboratory was relocated to Gunter Hall, a converted dining hall and kitchen, on the Frostburg State University Campus, in the fall of 1975. Its current location is within a three county region (Garrett, Allegany, and Washington) that provides direct access to several state parks, forests, and wildlife management area.

In 1996, UMCES negotiated the transfer of 10.59 acres at the south end of Frostburg State University campus near the corner of University Drive and Braddock Road and constructed a new facility that was occupied in December of 1998. The new physical plant consists of 4 structures totaling 48,327 GSF.

The Appalachian Laboratory (AL) seeks to understand the consequences of land use change on terrestrial and freshwater ecosystems dynamics, with special focus on the impacts within the Chesapeake Bay watershed. AL researchers pursue this goal by designing and executing studies of the effects of natural and human-induced changes on organisms, landscapes, and biogeochemical and hydrological cycles. Scientific results from these studies reveal the consequences of environmental change across scales of organization and inform the management of natural resources, the restoration of ecosystems, and the fostering of environmental awareness. The research conducted at AL is notably diverse and inter-disciplinary and spans scales from genes to landscapes and watersheds, and encompasses terrestrial, wetland, and aquatic ecosystems. This breadth of scientific enquiry, coupled with a strongly collaborative faculty, has enabled us to address a variety of research needs within the state, the country, and throughout the world.

Historically, AL had its roots in fisheries, wildlife, and conservation ecology. Faculty members have a strong record of assisting the state in addressing problems concerning the population status of terrestrial and aquatic organisms. Studies often aimed to link local processes to regional or global phenomena, with many studies relying on extensive, long-term (sometimes spanning more than 20 years) data sets derived from detailed field measurements as well as field and laboratory analyses of water, soil, atmospheric, and plant samples using high quality analytical techniques.

In the early 1990's AL began building strengths in ecosystem ecology with a particular focus on spatial scales of the entire Potomac landscape and its sub-watersheds. This initiative established a new and broader role for AL within UMCES that complemented the more estuarine and marine focus of the other laboratories, and extended the overall breadth of UMCES by integrating the Chesapeake Bay and its watershed into a central "mountains to sea" vision. Ecosystem ecology is a natural entry point for studies on global change, and consequently the research at AL has increasingly focused on revealing the varied effects of anthropogenic disturbance and climate variability on organismal responses, community biodiversity, and the functioning of terrestrial and aquatic ecosystems. Some of these environmental threats have been known for some time, such as habitat fragmentation, urban runoff and estuarine eutrophication, while other threats like climate change, sea level rise, large-scale energy development (e.g., wind farms, natural gas fracking), and the spread of invasive pests and pathogens recently have emerged as causes of concern.

AL researchers are dedicated to staying at the forefront of the approaches needed to address the most pressing environmental problems. Faculty appointments in the last 5 years have greatly expanded AL's research breadth with new expertise focused on remote sensing, geospatial modeling, stable isotopes, and molecular ecology and genomics. These new research areas address questions across a wide variety of spatial scales (local populations, communities, landscapes), habitat types (terrestrial, aquatic), and taxonomic groups (animals, plants, microbes), thereby providing enormous collaborative potential not only within AL but also across UMCES labs, jointly contributing to the growth of the Center and the Appalachian Laboratory.

Appalachian Laboratory is the headquarters and administrative lead of the Chesapeake Watershed Cooperative Ecosystem Studies Unit (CW CESU), a partnership among 23 universities and research institutions, and 9 federal agencies whose members strive to understand and protect the natural and cultural resources of the region. The CW CESU is part of the CESU national network of 17 similar partnerships. The primary objective of the network is to foster stewardship of the environment through collaborative research, technical assistance and education that support integrated ecosystem management.

1.2. Introduction

On December 18, 2007, UMCES President, Dr. Donald Boesch, signed the American College & University Presidents Climate Commitment (http://www.presidentsclimatecommitment.org/). The effective date of the initiation of this commitment is January 15, 2008. The Environmental Sustainability Council (ESC) was created to provide leadership, advice, and assistance in implementing practices that enhance the environmental sustainability of the operations of the University of Maryland Center for Environmental Science (UMCES). The UMCES ESC functions as a task group and advisory body to the President and Administrative Council. Members are appointed by the President from among the faculty, staff and students at the Center's three laboratories, Center Administration and the Maryland Sea Grant College Program.

The Appalachian Laboratory Environmental Sustainability Council (ALESC) serves as the laboratory/department level advisory council and has worked with the Administration to complete a comprehensive inventory of greenhouse gas emissions and will continue to work with the Administration to complete an institutional action plan for becoming climate neutral and initiate two or more of the identified tangible actions to reduce greenhouse gases. These efforts shall be consistent with the standards provided in the ACUPC Implementation Guide (http://www.presidentsclimatecommitment.org/pdf/ACUPCC_IG_Final.pdf).

ALESC members are: Barbara Jenkins – Facility representative, Heather Johnson – Budget Office representative, Stacy Cutter – Business Office representative, Katia Engelhardt - Faculty representative and Roy Weitzell - Student representative. Ad hoc members include Katie Kline – Laboratory and Safety Manager, Cami Martin – Business Office, Eric Farris – IT Administrator, and Tim Hockman – HVAC Maintenance Technician.

Additionally, as a provision to the University System of Maryland Sustainability Initiative, institutions are required to make a serious environmental commitment to the concept of reducing greenhouse gas emissions and combating climate change when preparing Facilities Master Plans (FMP) for campus development, utilities, infrastructure, new building and renovations. A FMP establishes a framework for orderly growth and development of capital improvements on campus and must be responsive to an institution's current and projected needs and be flexible to accommodate changes that can be expected to occur.

A greenhouse gas inventory estimates the amount of carbon-based gases emitted into the atmosphere as a result of an institution's activities. The Appalachian Laboratory's (AL) inventory will help evaluate energy use as the first step toward reducing our greenhouse gas (carbon) emissions and overall climate footprint. The AL building construction was not completed and ready for occupancy until December 1998. We will use data from a ten-year time period to complete our annual inventories to provide a living and current document to track our progress and goals.

Conducting an inventory, setting goals for reduction, and implementing the methods to meet these goals will give faculty, staff and students at AL first-hand knowledge of the policies and technologies emerging to address global warming.

1.3. Background

In May 1992, at the United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit, the international treaty the ***United Nations Framework Convention on Climate Change (UNFCCC)*** was created and opened for signature. The Convention enjoys near universal membership, with 195 countries having ratified the treaty. The US joined the convention in June 1992 and ratified their membership in October 2002. The UNFCC was entered into force on March 21, 1994. Members began to consider what could be done to reduce global warming and to cope with whatever temperature increases are unavoidable. Members of the Convention agree to gather and share information on greenhouse gas emissions, national policies and best practices; launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and cooperate on preparing for adaptation to the impacts of climate change. The Convention basically sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. However, this framework does not set mandatory limits, is non-binding and contains no means for enforcement. To handle this, the treaty makes provisions for updates called "protocols" that will mandate, bind and enforce emissions limits. Each protocol must be signed and ratified on its own as membership in the convention does not convey to any future updates.

The ***Kyoto Protocol***, the powerful, legally binding first update to the UNFCCC, is particularly important because the signatories committed for the first time to implement quantified targets for greenhouse gas emissions. Countries that ratify this protocol commit to reduce their emissions of carbon dioxide and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases. The treaty was adopted in Kyoto, Japan, in December 1997. The protocol was enforced in February 2005 and the current targets will expire 2012.

As of October 2010, 193 parties have signed and ratified the Kyoto Protocol. Although the Protocol now covers 193 parties globally, this only covers 63.7% of countries in terms of global greenhouse gas emissions. United States is currently the only country that has signed but not ratified the protocol. President Bush withdrew U.S. support for the Kyoto Protocol and refused to submit it to Congress for ratification shortly after he took office in 2001. He opposed the Kyoto Protocol, not because he did not support the Kyoto principles, but because it exempts developing countries of the world, including major population centers such as China and India, from compliance, and he believed ratifying the protocol would cause serious harm to the U.S. economy. Without being ratified by the administration, the U.S. is not legally bound to meet the Kyoto reduction target.

However, the United States federal government established a comprehensive policy to address climate change with three basic objectives: 1) Slowing the growth of emissions; 2) Strengthening science, technology and institutions; and 3) Enhancing international cooperation. In February 2002, the United States government announced a comprehensive strategy to reduce the greenhouse gas intensity of the U.S. economy by 18 percent over the 10-year period from 2002 to 2012. Greenhouse gas intensity measures the ratio of greenhouse gas emissions to economic output. Meeting this commitment will prevent the release of more than 100 million metric tons of carbon-equivalent emissions to the atmosphere (annually) by 2012 and more than 500 million metric tons (cumulatively) between 2002 and 2012. The multi-agency Climate Change Technology Program (CCTP) and the Climate Change Science Program (CCSP) were also established in February 2002, to accelerate the development and deployment of key technologies; to investigate natural and human-induced changes in the Earth's global environmental system; to monitor, understand and predict global change; and to provide a sound scientific basis for national and international decision-making.

Additionally, despite the Bush Administration's position on the Kyoto Protocol, support in the U.S. for emission reductions remains strong. Institutions and municipalities within the U.S. have made commitments to reduce their own emissions in accordance with the Kyoto goal. With more and more cities, businesses and universities pledging to reduce emission by conducting greenhouse gas inventories, and then following through in development and implementation of local action plans for reducing emissions, these institutions and agencies can make a significant difference, even in the absence of the U.S. participation in Kyoto.

On April 20, 2007, Maryland Governor Martin O'Malley signed Executive Order 01.01.2007.07 establishing the Maryland Climate Change Commission (MCCC) charged with collectively developing an action plan to address the causes of climate change, prepare for the likely consequences and impacts of climate change to Maryland, and establishes firm benchmarks and timetables for implementing the Commission's recommendations.

The Commission included members representing academia, business, industry, environmental groups and many levels of government. It was staffed jointly by the Maryland Department of the Environment and Department of Natural Resources in coordination with other state agencies.

On May 31, 2007, President Bush announced a new initiative to develop and contribute to a "post-Kyoto" framework on energy security and climate change by the end of 2008. This effort contributed to existing national, bilateral, regional and international programs to address the long-term challenge of global climate change and reinforced President Bush's firm commitment to taking action on climate change at home and abroad.

Another international treaty of significance to our goals for reducing our climate footprint is the ***Montreal Protocol on Substances that Deplete the Ozone Layer.*** This protocol was opened for signature on

September 16, 1987 and enforced on January 1, 1989. The US signed the protocol on September 16, 1987 and ratified it on April 21, 1988. The treaty is structured around several groups of *halogenated hydrocarbons* that have been shown to play a role in ozone depletion. All of these ozone depleting substances contain either chlorine or bromine. The treaty provides a timetable for each group on which their production must be phased out and eventually eliminated. Due to its widespread adoption and implementation it has been hailed as an example of exceptional international co-operation. Kofi Annan, former Secretary General of the UN is quoted as saying it is "Perhaps the single most successful international agreement to date...".

As of January 2012, 197 nations have become party to the Montreal Protocol. Each signatory to the treaty states that they recognize that world-wide emissions of certain substances can significantly deplete and otherwise modify the ozone layer in a manner that is likely to result in adverse effects on human health and the environment, and they are determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it. The ultimate objective is the elimination of harmful substances based on scientific knowledge. The treaty acknowledges that special provision is required to meet the needs of developing countries. The Parties to the Protocol are also required to base their future decisions on the current scientific, environmental, technical, and economic information that is assessed through panels drawn from the worldwide expert communities.

This is one of the first international environmental agreements that include trade sanctions to achieve the stated goals of a treaty. It also offers major incentives for non-signatory nations to sign the agreement. The treaty negotiators justified the sanctions because depletion of the ozone layer is an environmental problem most effectively addressed on the global level. Furthermore, without the trade sanctions, there would be economic incentives for non-signatories to increase production, damaging the competitiveness of the industries in the signatory nations as well as decreasing the search for less damaging Chlorofluorocarbons *(*CFCs*)* alternatives.

On July 6-9, 2008, the US participated in the 34th G-8 Summit in Hokkaido Toyako Japan. The Group of Eight (G8) is an international forum for the governments of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States. Environment and Climate Change was a main theme of this Summit and the objective was to take initiatives in addressing global environmental issues, in particular, promote discussions at the UN level to create an effective framework beyond 2012 (post Kyoto). With the ***G8 Declaration on Environment and Climate Change,*** the G8 leaders agreed on the need for the world to cut carbon emissions blamed for global warming by at least 50 percent by 2050 and for each nation to set its own target for a nearer term.
In 2009, the state of Maryland launched the "Smart, Green and Growing" website, where Marylanders come together to restore the Chesapeake Bay, preserve our land, revitalize our communities, create green jobs, improve transit, conserve energy and address climate change. This is an interactive website that contains information, maps, and statistics on *green* initiatives throughout the state. In August 2009, University of Maryland Center for Environmental Science joined the *Maryland Green Registry*, a self-certification program offering tips and resources to help organizations set and meet their own goals on the path to sustainability.

In December 2009**,** The United Nations Climate Change Conference, commonly known as the ***Copenhagen Summit***, was held in Copenhagen, Denmark. The conference included the 15th Conference of the Parties (COP 15) to the United Nations Framework Convention on Climate Change and the 5th Meeting of the Parties (MOP 5) to the Kyoto Protocol. A framework for climate change mitigation beyond 2012 (when the present round ends for the Kyoto Protocol) was negotiated at COP 15 and extended in COP 16. President Obama and world leaders came together to negotiate the ***Copenhagen Accord*** as the framework for major developed and developing economies to implement measures to limit their greenhouse gas emissions and to do so in an internationally transparent manner. The agreement made was non-binding but US President Obama said that countries could show the world their achievements. More confidence building between emerging economies, the least developed countries and the developed countries is needed before a legally binding global agreement on climate change can be reached. He said that if they had waited for a binding agreement, no progress would have been made. The Accord is not legally binding and although it endorses the continuation of Kyoto beyond 2012, it does not commit countries to agree to a binding successor to the Kyoto Protocol. The most important result in Copenhagen was, according to US President Barack Obama, that large emerging economies began “for the first time” to open up to taking on responsibilities for limiting growth of greenhouse gases.

University of Maryland Center for Environmental Science completed and submitted our initial Climate Action Plan to the ACUPCC in May of 2010 completing the initial requirements as a signatory to the President’s Climate Commitment. The plan is available on the UMCES sustainability webpage as at http://www.umces.edu/about/sustainability as well as the UMCES AL sustainability webpage at http://www.umces.edu/al/sustainability .

Section 2: Operational Boundaries, Data Collection & Emission Sources

2.1. Operational Boundaries

The operational boundaries of AL's inventory included the following sources of emissions (Table 1): ***Scope 1:*** direct sources include heating, emergency generator use, fleet transportation and fugitive emissions; ***Scope 2:*** imported sources including purchased electricity; ***Scope 3:*** indirect sources including employee business travel, solid waste disposal, wastewater, electric transportation and distribution (T&D) losses, employee commuter miles (starting with FY08), and paper purchases (starting with FY08). ***Offsets***: AL currently has no on-campus activities and has not purchased any Renewable Energy Credits (RECs) directly to offset carbon emissions. However, in 2011 the University of Maryland System made renewable energy purchases from Roth Rock Wind North. A second wind project, the Pinnacle is due to come on line in 2012 as well as a solar installation at Mt. St. Mary's. The RECs' among these projects are proportioned among the USM Intuitions. Although several of the sources may qualify as *De Minimus Emissions* sources, they have been included to establish a baseline and to maintain consistency with the other UMCES laboratories.

Table 1: Emission Sources & Offsets

Scope 1 - Direct	***Scope 2 - Imported***	***Scope 3 - Indirect***	***Offsets***
On Campus Stationary Source 1 (OCSS1) - Natural Gas	Purchased Electricity	Air, Rail, Bus Transportation	Wind Energy Projects
On Campus Stationary Source 2 (OCSS2) - Fuel Oil #2		Solid Waste	Solar Projects
Fugitive Emissions: Refrigerants & Other Chemicals		Wastewater	RECs
University Owned Fleet		Commuter Miles	
		Electric T&D Losses	
		Paper Purchases	

2.2. Data Collection

This inventory covers ten fiscal years, FY02 – FY11. The study period was adjusted for the FY08 update from calendar year to FY year reporting. UMD fiscal year runs from July 1 – June 30. Dan Fiscus, a PhD student at AL conducting his thesis research, collected and compiled the utility data from the monthly bills for FY00 – FY05. Raw data is continually compiled from actual utility bills to extend the study period and keep the GHG inventory current.

2.3. Emission Sources

<u>2.3.a. Scope 1: Direct Sources</u>

Direct sources of emissions include those from sources that are owned or controlled by the institution. Currently, direct sources at AL include on campus stationary sources (OCSS) for heating and emergency generator use, fleet transportation and fugitive emissions.

On-Campus Stationary Source 1: Natural Gas

The first source of on-campus stationary emissions is from natural gas (Table 2). Natural gas is used to heat the building by the use of two Clever Brooks boilers, one serves as a backup system. Natural gas is also used to heat domestic hot water. Usage amounts were compiled from Columbia Gas bills and converted to *MMBTUs* for purposes of this inventory. Over the 10 year study period, 3,636.6 mt eCo_2

were emitted due to the burning of natural gas. This equates to 19.74% of our total emissions making it our second largest contributor of carbon emissions.

Table 2: Natural Gas				
FY	**CF**	**BTUs**	**MMBTUs**	**mt eCo_2 emissions**
FY02 (7/01 - 6/02)	5929200	6107076000	6107.076	**323.2**
FY03 (7/02 - 6/03)	7377000	7598310000	7598.310	**402.1**
FY04 (7/03 - 6/04)	6490700	6685421000	6685.421	**353.8**
FY05 (7/04 - 6/05)	5998300	6178249000	6178.249	**326.9**
FY06 (7/05 - 6/06)	6805100	7009253000	7009.253	**370.9**
FY07 (7/06 - 6/07)	7040000	7251200000	7251.200	**383.7**
FY08 (7/07 - 6/08)	6534400	6730432000	6730.432	**356.2**
FY09 (7/08 - 6/09)	7182200	7397666000	7397.666	**390.4**
FY10 (7/09 - 6/10)	6460000	6653800000	6653.800	**351.3**
FY11 (7/10 - 6/11)	6957500	7166225000	7166.225	**378.1**

On-Campus Stationary Source 2: Fuel Oil #2

The second on-campus stationary source is fuel oil #2. Fuel oil is used to supply the emergency generator and is also used as a backup supply for the boilers. There are two above ground oil tanks – a 3,000 tank and 2,000 gallon tank. Both tanks were filled in 1998 with the construction of the new facility. However the generator is, as stated, only used as an emergency power source and the boilers normally operate on natural gas, so the use of fuel oil is very minimal. The tanks have only been topped off twice during the 10-year Study period, once in FY02 (1,062 gallons) and once in FY10 (2,786.70 gallons).

Over the 10-year study period only 38.5 mt eCo_2 has been emitted from burning fuel oil #2. This comprises only 0.21% of AL's total emissions. On-Campus Stationary Sources have emitted a total of 3,675.1 mt eCo_2 over the course of the study period. This comprises 19.95% of our total emissions.

Fleet Use – Gasoline

Gasoline consumption (Table 3) was compiled from current fleet fuel provider bills for the AL vehicle fleet use. Fleet vehicles are provided to support University activities including **official lab business -** *travel to events or meetings as an official representative of the Appalachian Laboratory, UMCES, or University System of Maryland*; **field work -** *travel in support of scientific research*; **research and/or collaboration** – *travel to meet with various state/federal officials to discuss research projects or grants, or meet with colleagues at different institutions to work on proposals to secure external funding, grants and/or contracts;* and **conference travel -** *travel to scientific conferences*. *Gallons* are used for this inventory.

Over the 10-year study period, 606.5 mt eCo_2 were emitted due to fleet use. This equates to 3.29% of AL's total emissions.

Table 3: Gasoline - Fleet Use				
FY	**Gallons**	**Litres**	**Kilolitres**	**mt eCo_2 emissions**
FY02 (7/01 - 6/02)	6366.84	24101.029	24.101	**56.8**
FY03 (7/02 - 6/03)	8316.69	31482.006	31.482	**74.1**
FY04 (7/03 - 6/04)	8084.96	30604.819	30.605	**72.2**
FY05 (7/04 - 6/05)	6775.89	25649.464	25.649	**60.5**
FY06 (7/05 - 6/06)	6774.19	25643.015	25.643	**60.5**
FY07 (7/06 - 6/07)	6254.30	23675.008	23.675	**55.8**
FY08 (7/07 - 6/08)	5023.99	19017.816	19.018	**44.9**

FY09 (7/08 - 6/09)	7322.63	27719.091	27.719	**65.4**
FY10 (7/09 - 6/10)	8506.69	32201.239	32.201	**66.2**
FY11 (7/10 - 6/11)	5610.94	21239.645	21.240	**50.1**

Fugitive emissions

Fugitive emissions (Table 4) from refrigerants were estimated by compiling direct purchase records for refrigerant and contractor records for refrigeration unit repairs to calculate the amount of refrigerant that has been replaced. A total of 380 pounds of R22, 30 pounds of R404A and 3.38 pounds of R134A have been replaced over the study period of this inventory (FY02-FY11). Additionally, 128 pounds of R22 have been reclaimed and subtracted from the total R22 purchased.

Over the study period, 454.5 mt eCo_2 have been released due to fugitive emissions. This contributes only 2.47 % to our total emissions.

Table 4: Refrigerant Replacement				
FY	**Type-R-22 (lbs)**	**Type-134A (lbs)**	**Type-R404A (lbs)**	**mt eCo2**
FY02 (7/01 - 6/02)	60.0	0.00	28.0	**87.7**
FY03 (7/02 - 6/03)	1.0	0.00	0.0	**0.8**
FY04 (7/03 - 6/04)	140.0	0.00	2.0	**110.9**
FY05 (7/04 - 6/05)	-3.0	0.00	0.0	**-2.3**
FY06 (7/05 - 6/06)	0.0	0.00	0.0	**0.0**
FY07 (7/06 - 6/07)	0.0	0.00	0.0	**0.0**
FY08 (7/07 - 6/08)	30.0	0.44	0.0	**23.4**
FY09 (7/08 - 6/09)	152.0	2.00	0.0	**118.4**
FY10 (7/09 - 6/10)	75.0	0.00	0.0	**57.8**
FY11 (7/10 - 6/11)	75.0	0.00	0.0	**57.8**

Total emissions for Scope 1, direct sources of emissions, over the 10 year study period were 4,736.10 mt eCo_2. This equates to 25.71% of our total emissions.

<u>2.3.b. Scope 2: Imported Energy Sources</u>

Currently, imported energy sources at AL include purchased electricity.

Purchased Electricity

Purchased electricity (Table 5) use was collected from Allegany Power and Reliant and Pepco utility bills. Total *KWH* were used for this inventory. Over the course of the study period, 11,358.7 mt eCo_2 were released due to electric usage. This comprises 61.66% of our total emissions, making electricity our principal source of carbon emissions. Note, emissions from electricity lost in transportation and distribution are calculated in the Scope 3 emissions.

Table 5: Electricity			
FY	**KWH**	**MWH**	**mt eCo_2 emissions**
FY02 (7/01 - 6/02)	1514517	1470.243	**1397.6**
FY03 (7/02 - 6/03)	1430624	1458.327	**1320.2**
FY04 (7/03 - 6/04)	1508157	1411.832	**1391.8**
FY05 (7/04 - 6/05)	1362463	1438.225	**1257.3**
FY06 (7/05 - 6/06)	1431620	1424.252	**1321.1**
FY07 (7/06 - 6/07)	1435533	1435.533	**1014.5**
FY08 (7/07 - 6/08)	1471911	1471.911	**1040.2**

FY09 (7/08 - 6/09)	1315555	1315.555	**929.7**
FY10 (7/09 - 6/10)	1263923	1263.923	**893.2**
FY11 (7/10 - 6/11)	1320272	1320.272	**793.1**

Electricity is our only Scope 1, imported energy source. Our total Scope 1 emissions over the 10 year study period were 11,358.7 mt eCo_2. This equates to 61.66% of our total emissions.

The 2011 FY shows a slight decrease from previous years. In 2011 the University of Maryland System made renewable energy purchases from Roth Rock Wind North. A second wind project, the Pinnacle is due to come on line in 2012 as well as a solar installation at Mt. St. Mary's. The RECs' among these projects are proportioned among the USM Intuitions. On average, these renewable sources will be approximately 15-16% of our purchased energy requirements. We have created a custom fuel mix for emissions calculations within the carbon calculator to account for these renewable energy sources. Our custom fuel mix for FY 11 is 85% purchased electricity and 15% renewable wind/solar energy. With the creation of the custom fuel mix the MeCo2 emissions are automatically adjusted to represent the renewable energy emissions reductions. This reduction equated to approximately 76 RECs for UMCES. These are proportioned among the individual UMCES laboratories providing for 23 RECs for the Appalachian Laboratory.

2.3.c. Scope 3: Indirect Sources

Indirect sources of emissions include those that result from the activities of the institution but occur from sources owned or controlled by another company. Currently, indirect sources of emissions at AL include employee business travel, solid waste disposal, wastewater, employee commuter miles, electric T&D losses, and paper purchases.

Transport – Air, Bus and Rail Miles Traveled

Employee transport miles (Table 6) - Air, Rail and Bus - include travel by faculty, staff and students while on business that were both arranged and paid for directly by the our staff or arranged by the employee and expensed back to our institution. Travel arranged and paid for by other agencies were not included. For FY01-FY05, transport *kms* were compiled from all air, rail and bus trips and were converted to miles. From FY06, data was collected in *miles* traveled, which is the required format for the CA-CP calculator.

Employee travel by air, rail and bus emitted 814.8 mt eCo_2 over the 10 year study period. Transport comprises 4.42% of our total emissions.

Table 6: Air, Rail and Bus Travel

FY	P KM	000 P. KM.	Miles	mt eCo_2 emissions
FY02 (7/01 - 6/02)	205528	205.53	127709	**99.1**
FY03 (7/02 - 6/03)	226163	226.16	140531	**109.1**
FY04 (7/03 - 6/04)	395010	395.01	245448	**190.6**
FY05 (7/04 - 6/05)	187072	187.07	116241	**90.2**
FY06 (7/05 - 6/06)	121064	121.06	75226	**58.4**
FY07 (7/06 - 6/07)	125342	125.34	77884	**60.5**
FY08 (7/07 - 6/08)	159253	159.25	98955	**76.8**
FY09 (7/08 - 6/09)	80274	80.27	49880	**38.7**
FY10 (7/09 - 6/10)	120234	120.23	74710	**58.0**
FY11 (7/10 - 6/11)	691160	69.16	42974	**33.4**

Solid Waste Disposal

To manage solid was disposal (Table 7), AL has one 8-cubic yard dumpster hauled by an external trash removal company and sent to Mountain View Landfill. Mountain View currently operates a passive flare system that runs on solar power with battery backup. The landfill is in the process of starting construction on an active landfill gas system that will consist of a flare unit that will flare off the landfill gas. Based on gas generation and output, the possibility exists for the landfill to produce alternate energy in the future.

From FY01 until FY06, the dumpster was emptied once every week, assuming 0.40 tons per week. In FY07, due to increased recycling efforts, the dumpster hauls were reduced once every other week, assuming 0.20 tons per week. Solid waste disposal has resulted in 48.0 mt eCo_2 emissions over the course of the study period. This equates to 0.26% of our total emissions.

Table 7: Solid Waste Disposal			
FY	**Dumpster Size**	**Tons/Yr**	**mt eCo_2 emissions**
FY02 (7/01 - 6/02)	8 CY	20.80	**6.4**
FY03 (7/02 - 6/03)	8 CY	20.80	**6.4**
FY04 (7/03 - 6/04)	8 CY	20.80	**6.4**
FY05 (7/04 - 6/05)	8 CY	20.80	**6.4**
FY06 (7/05 - 6/06)	8 CY	20.80	**6.4**
FY07 (7/06 - 6/07)	8 CY	10.40	**3.2**
FY08 (7/07 - 6/08)	8 CY	10.40	**3.2**
FY09 (7/08 - 6/09)	8 CY	10.40	**3.2**
FY10 (7/09 - 6/10)	8 CY	10.40	**3.2**
FY11 (7/10 - 6/11)	8 CY	10.4	**3.2**

Wastewater

Wastewater (Table 8) from AL is collected by the Braddock Run Sanitary District and flows to the Wrights Crossing Pumping Station. The WCPS receives the combined sewer flow from Frostburg and conveys it to LaVale Sanitary Commission's system which then conveys the combined sewer flow to the City of Cumberland's Wastewater Treatment Plant. The City of Cumberland's Wastewater Treatment Plant is a regional 15 million gallons per day biological nutrient removal facility followed by anaerobic digestion for biosolids. This anaerobic digestion treatment process reduces the carbon emissions from waste treatment when compared to other waste treatment processes.

Wastewater resulted in only 1.5 mt eCO2 emissions over the study period and comprises less than 0.01% of our emissions.

Table 8: Wastewater		
FY	***Gallons***	***mt eCo_2 emissions***
FY02 (7/01 - 6/02)	441500	**0.2**
FY03 (7/02 - 6/03)	289200	**0.2**
FY04 (7/03 - 6/04)	434300	**0.2**
FY05 (7/04 - 6/05)	301600	**0.2**
FY06 (7/05 - 6/06)	385800	**0.2**
FY07 (7/06 - 6/07)	117700	**0.1**
FY08 (7/07 - 6/08)	270300	**0.1**
FY09 (7/08 - 6/09)	187800	**0.1**

FY10 (7/09 - 6/10)	159200	**0.1**
FY11 (7/10 - 6/11)	374500	**0.2**

Commuter Miles
Commuter miles (Table 9) were compiled by surveying all resident personnel at the lab starting with the FY08 inventory. All personnel were surveyed the initial two years of employment. Commuter miles for every year thereafter have been estimated based on home zip codes and most common route of travel. The minimal turnover in personnel does not require a yearly survey. The survey estimates number one way trips per week, number of weeks per year, and mileage for each trackable group. Additionally, the percentage personal vehicle and carpooling are used is estimated. For data input, CACP separates personnel into three categories: Students, Faculty and Staff. However, the calculator then tallies emissions by two commuter categories, Faculty/Staff commuters and Students commuters.

Commuters' miles resulted in a total of 332.70 mt eCO2 emissions over the study period. This contributes 1.80% to our total emissions.

Table 9: Commuter Miles					
FY Commuter Miles	**Faculty/Staff Miles**	**Student Miles**	**Total Miles**	**Gallons Gasoline Consumed**	***mt eCO2 Emissions***
FY08 (7/07-6/08)	192,236	16,074	208,310	9,426	**90.7**
FY09 (7/08-6/09)	185,622	13,077	198,699	8,991	**85.6**
FY10 (7/09 - 6/10)	172,258	16,218	188,476	8,528	**82.7**
FY11 (7/10 - 6/11)	167,150	15,239	182,389	7,563	**73.7**

Electric T&D Losses
Emissions due to electricity lost in transmission and distribution, T&D Losses (Table 10) is calculated based on the emissions factors provided by the CACP calculator, V 6.0. These emission factors are taken from the EPA's eGRID electric emissions database, which uses plant specific emission factors for each electrical region in the United States. This calculation is different from previous versions of the calculator, which included these losses in the institution's Scope 2 emissions. This was methodology error that has been corrected in V 6.0 and now includes the emissions due to these losses in Scope 3, indirect emissions.

Electric T&D losses resulted in a total of 1,123.2 mt eCO2 emissions over the study period. This contributes 6.10% to our total emissions.

Table 10: Electric T&D Losses	
FY	***mt eCo2 emissions***
FY02 (7/01 - 6/02)	**138.2**
FY03 (7/02 - 6/03)	**130.6**
FY04 (7/03 - 6/04)	**137.6**
FY05 (7/04 - 6/05)	**124.3**
FY06 (7/05 - 6/06)	**130.7**
FY07 (7/06 - 6/07)	**100.3**
FY08 (7/07 - 6/08)	**102.0**
FY09 (7/08 - 6/09)	**91.1**
FY10 (7/09 - 6/10)	**88.3**
FY11 (7/10 - 6/11)	**78.4**

Paper Purchases
The collection of data for paper purchases (Table 11) was added to this inventory starting with FY 2008. Note: In August 2009, our purchaser began purchasing general office paper with a recycled content of not less than 30% and in 2010 AL began purchasing 100% recycled general use copy paper.

Upstream emission from purchases of paper resulted in 6.90 mt eCo2. This contributes to less than 0.01% of our total emissions.

Table 11: Paper Purchases				
FY	**Pounds 100% Recycled Content**	**Pounds 30% Recycled Content**	**Pounds 0% Recycled Content**	***mt eCO2 Emissions***
FY08 (7/07 - 6/08)	0	0	1850	**2.4**
FY09 (7/08 - 6/09)	0	0	1650	**2.1**
FY10 (7/09 - 6/10)	900	400	0	**1.2**
FY11 (7/10 - 6/11)	1500	0	0	**1.2**

Total emissions for Scope 3, indirect sources of emissions, over the 10-year study period were 2327.1 mt $eCo_{2.}$ This equates to 12.63% of our total emissions

Section 3: Budget, Personnel, & Organizational Boundaries

3.1. Budget Data

Operating, research and energy budget data (Table 12) have been provided for each of the fiscal years. AL energy costs over the study period average 29% of the operating budget and average 7% of the total operating and research budget.

Table 12: Budget Data

	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY 11
Operating Budget	780,267	780,267	578,886	544,466	540,987	583,609	562,182	524,066	478,087	458,035
Research Dollars	1,885,653	2,642,408	2,562,708	3,477,424	1,824,614	1,619,316	2,096,085	1,635,780	2,329,699	1,470,448
Total Budget (R&O)	**2,665,920**	**3,422,675**	**3,141,594**	**4,021,890**	**2,365,601**	**2,202,925**	**2,658,267**	**2,159,846**	**2,807,786**	**1,928,483**
Energy Budget										
Electricity	70,387	75,747	76,587	70,294	76,583	103,932	139,224	137,288	111,975	125,605
Natural Gas	54,325	64,047	86,868	66,988	93,411	81,429	79,751	90,104	50,250	68,515
Water/Sewer	6,886	4,014	2,536	4,411	3,681	2,388	3,335	2,573	2,732	4,590
Total Energy Costs	**131,598**	**143,808**	**165,991**	**141,693**	**173,675**	**187,749**	**222,310**	**229,965**	**164,957**	**198,710**
Energy % of Operating	**17%**	**18%**	**29%**	**26%**	**32%**	**32%**	**40%**	**44%**	**35%**	**43%**
Energy % of Total	**5%**	**4%**	**5%**	**4%**	**7%**	**9%**	**8%**	**11%**	**6%**	**10%**

3.2. Personnel Data

Personnel at the AL facility have reached an average level of about 60 (Table 13). Personnel counts were derived from the SGAP reports filed each February and are based on personnel as of the previous Fall semester. Additionally, Faculty Research Assistants (FRAs) were included with staff numbers until FY04. In FY04 they were corrected to be included in the Faculty count, justifying the difference in number patterns between the years.

Table 13: Personnel Data

FY	Full Time Students	Full Time Eq. Faculty	Full Time Eq. Staff	Number of Employees
FY02 (7/01 - 6/02)	22	14	34	70
FY03 (7/02 - 6/03)	23	15	33	71
FY04 (7/03 - 6/04)	13	29	15	57
FY05 (7/04 - 6/05)	13	31	14	58
FY06 (7/05 - 6/06)	16	31	14	61
FY07 (7/06 - 6/07)	16	27	16	59
FY08 (7/07 - 6/08)	9	26	19	54
FY09 (7/08 - 6/09)	12	23	20	55
FY10 (7/09 - 6/10)	11	26	19	56
FY11 (7/10 - 6/11)	13	25	16	54

3.3. Organizational Boundaries

The UMCES Appalachian Laboratory sits on 10.59 acres at the south end of the Frostburg State University campus near the corner of University Drive and Braddock Road. Figure 1 below is the 1997 civil drawing showing the actual property boundaries for the AL campus just prior to commencing construction.

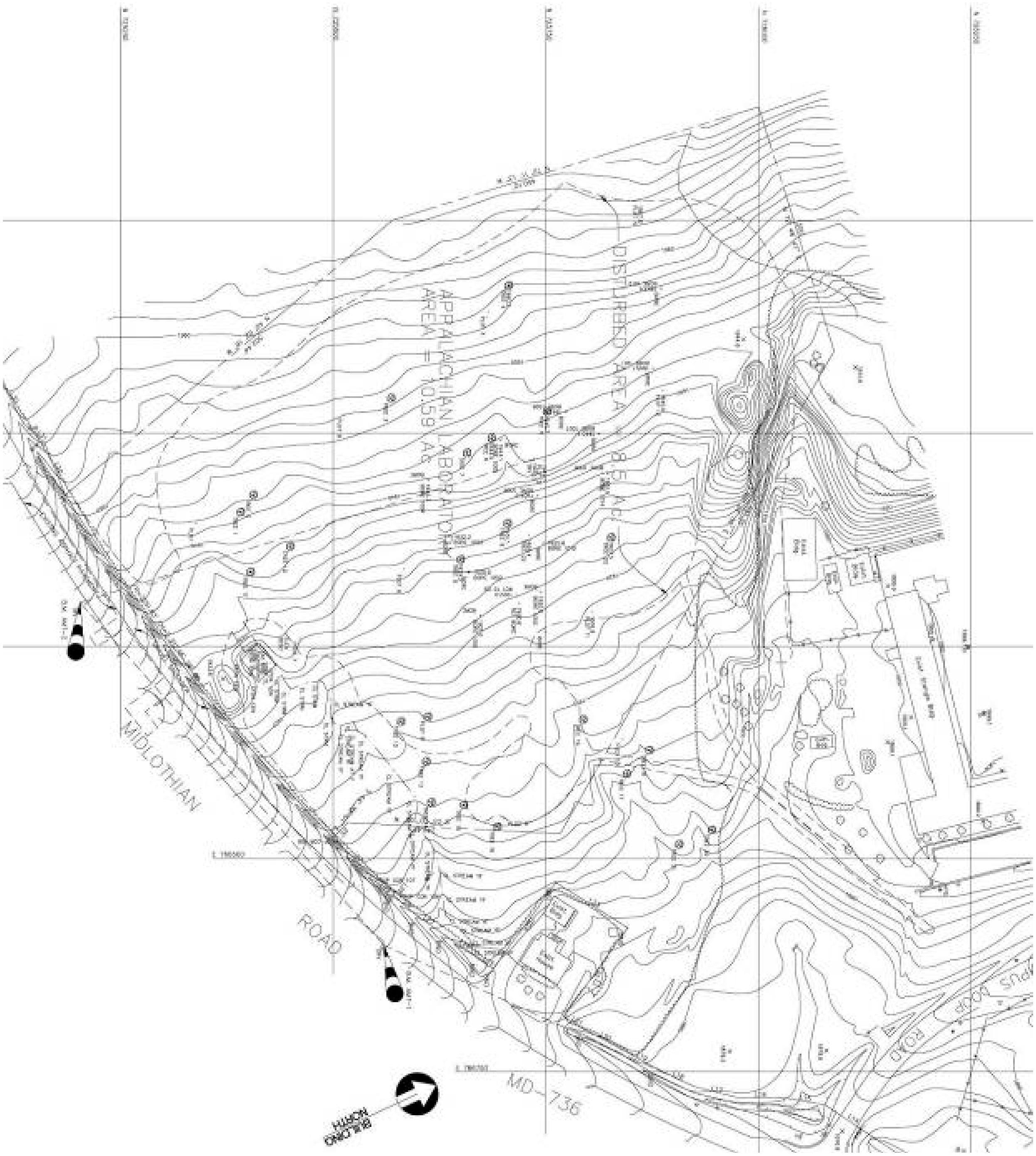


Figure 1: Property Boundaries

The Appalachian Laboratory campus currently includes 4 buildings: The main laboratory/administration building (42,843 GSF); the greenhouse (4,266 GSF); a chemical storage building (363 GSF) and a garage (855 GSF), comprising 48,327 GSF of building space accounted for in this inventory. All buildings currently share the same utility meters so the inventory has been completed on a campus wide scale. Without a separate meter on each building, it not possible to break out the usage by individual buildings.

Approximately 8.5 acres were disturbed during building construction, leaving the remaining 2.09 acres undisturbed. Most of this is forested. Although this forested land does improve our climate footprint, it does not qualify as an offset to our emissions under the guidelines of ACUPCC because they are not additional and therefore there are no measurable emissions reductions.

Figure 2 is an October 2009 image courtesy of Google Earth™ 2012 showing an aerial view of the AL campus.

Figure 2: Aerial View of AL Property

Section 4: Methods & Results

4.1. Methods

There are a wide number of tools available for conducting GHG emissions inventories. For this inventory, AL used the Clean Air – Cool Planet Campus Carbon Calculator v6.7 developed through collaboration with the University of New Hampshire and the organization Clean Air – Cool Planet (CA-CP). We chose to use the CA-CP model because it is designed for campus environments and has already been widely used by Colleges and Universities across the country. Additionally, using this model will provide for consistency and fair comparisons of emissions. Another commonly used GHG emission calculator is the United Nations Environment Programme's (UNEP) comprehensive GHG Indicator. Both calculators provide guidelines for calculating greenhouse gas emissions as well as spreadsheets for calculating data that can be customized to the organization.

Both the UNEP GHG Indicator and the Clean Air – Cool Plant Calculator use internationally accepted reporting procedures and conversion factors that are already applied at a regional, national or international level by companies and other organizations.

Data collected were entered into the CA-CP calculator to obtain the mt eCo_2 emissions for each source. As new versions of the calculator are released, the new and existing data are entered into the most recent calculator so data are current with the latest emission factors. The emissions tables are updated annually to reflect any changes.

4.2. Results

As reflected in the following table (Table 14) and the following chart (Chart 1), AL emissions tend to rise and fall to some extent over the study period. However, there is a notable decrease in overall emissions after 2004. Pre-2004 emissions can be attributed to the fact that the building was a new facility and the cost associated with running the facility did not yet have a baseline. Additionally, it takes time to determine where and what resources at a new facility can be adjusted to save energy and cut costs without impacting research and education goals. Once the facility became established, areas for cost and energy saving were addressed as appropriate.

The drops from 2004 on can be attributed to the adjustment and stream lining of facility practices. Areas such as increased recycling followed by a reduction in solid waste disposal, light and heat conservation both by building and individual offices, and increased use in video conferencing all contributed to a decrease in carbon emissions and our climate footprint.

The slight increase in FYs 08 and 09 can partially be attributed to the addition of the commuter travel and paper purchase study areas to the emissions inventory. Additionally, although an established facility allows for better understanding of the facility practices for energy and cost reductions, it also implies that the equipment has acquired some age. As of December 2008, most of the major equipment, boilers, heating and AC, generator, etc. were 10 years old and therefore may not be as energy efficient as they were when new. This would account for the increase in energy cost and emissions, even with usage reductions.

The 2011 FY shows a slight decrease from previous years. In 2011 the University of Maryland System made renewable energy purchases from Roth Rock Wind North. A second wind project, the Pinnacle is due to come on line in 2012 as well as a solar installation at Mt. St. Mary's. The RECs' among these projects are proportioned among the USM Intuitions. On average, these renewable sources will be approximately 15-16% of our purchased energy requirements. We have created a custom fuel mix for emissions calculations within the carbon calculator to account for these renewable energy sources. Our custom fuel mix for FY 11 is 85% purchased electricity and 15% renewable wind/solar energy. With the creation of the custom fuel mix the MeCo2 emissions are automatically adjusted to represent the renewable energy emissions reductions. This reduction equated to approximately 76 RECs for UMCES. These are proportioned among the individual UMCES laboratories providing for 23 RECs for the Appalachian Laboratory.

Table 14: Summary of eCO_2 emissions by source and year.

The following table shows a summary of the Appalachian Laboratory's eCO_2 emissions in metric tons by year and sources, as well as a total for all sources. *Note: Commuter miles & paper purchases were added to the inventory in FY08.*

Table 14: mt eCO2 emissions by source and FY

	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	***Total by Source***
Electricity	1397.60	1320.20	1391.80	1257.30	1321.10	1014.50	1040.20	929.70	893.20	793.10	**11358.70**
OCSS 1: Natural Gas	323.20	402.10	353.80	326.90	370.90	383.70	356.20	390.40	351.28	378.10	**3636.58**
OCSS 2: Fuel Oil #2	10.70	0.00	0.00	0.00	0.00	0.0	0.00	0.00	27.82	0.00	**38.52**
Fleet	56.80	74.10	72.20	60.50	60.50	55.80	44.90	65.40	66.20	50.10	**606.50**
Fugitive Emissions	87.70	0.80	110.90	-2.30	0.00	0.0	23.40	118.40	57.80	57.80	**454.50**
Solid Waste	6.40	6.40	6.40	6.40	6.40	3.20	3.20	3.20	3.20	3.20	**48.00**
Wastewater	0.20	0.10	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.20	**1.50**
Air, Rail, Bus Travel	99.10	109.10	190.60	90.20	58.40	60.50	76.80	38.70	58.00	33.36	**814.76**
Commuter Miles	-	-	-	-	-	-	90.70	85.60	82.70	73.70	**332.76**
Electric T&D Losses	138.20	130.60	137.60	124.30	130.70	100.30	102.90	91.90	88.30	78.40	**1123.20**
Paper Purchases	-	-	-	-	-	-	2.40	2.10	1.20	1.20	**6.90**
Total by FY mt eCO2	***2119.90***	***2043.40***	***2263.50***	***1863.50***	***1948.20***	***1618.10***	***1740.80***	***1725.50***	***1629.80***	***1469.16***	***18421.86***
Offsets – Wind/Solar Renewable Energy	-	-	-	-	-	-	-	-	-	**(0.01)**	
Net mt eCO2	***2119.90***	***2043.40***	***2263.50***	***1863.50***	***1948.20***	***1618.10***	***1740.80***	***1725.50***	***1629.80***	**1469.15**	***18421.85***

With continued monitoring of our emissions, our goal is to keep our emissions on a downward slope as reflected in FY11. This will require continued close monitoring and better maintenance of equipment to gain as much energy efficiency as possible from existing equipment, replacement of non-energy efficient equipment, and continuation of recycling and conservation efforts already in place.

The following charts provide a graphical representation of our emissions data based CACP Carbon Calculator results.

Chart 1: Total carbon emissions by FY year over the study period.

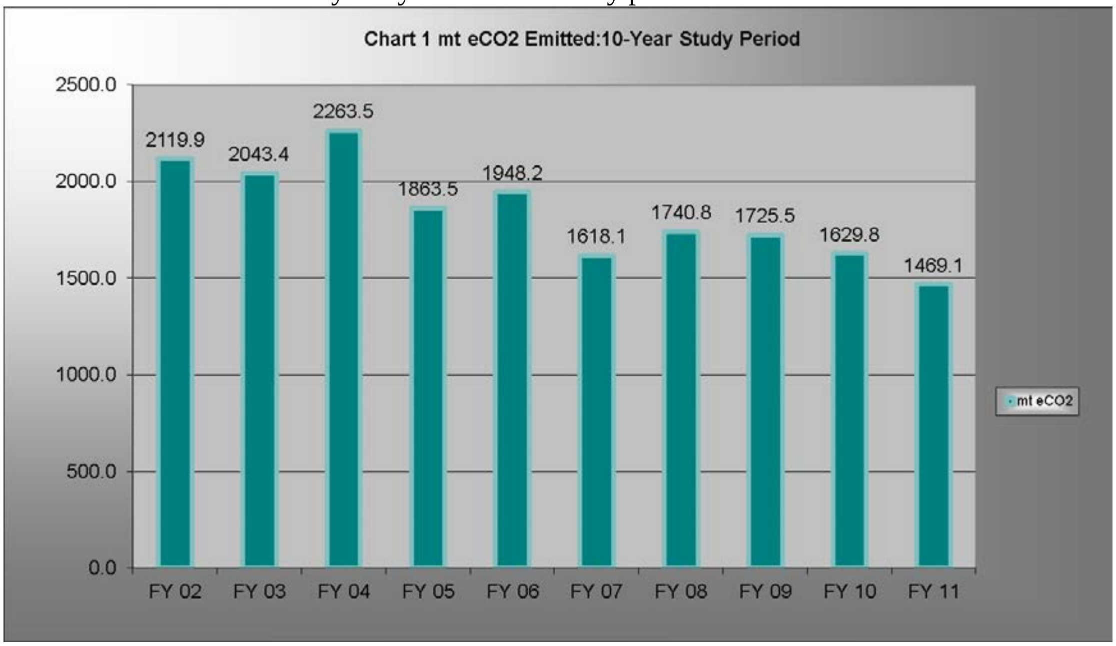


Chart 2: Carbon emissions by source and year over the study period.

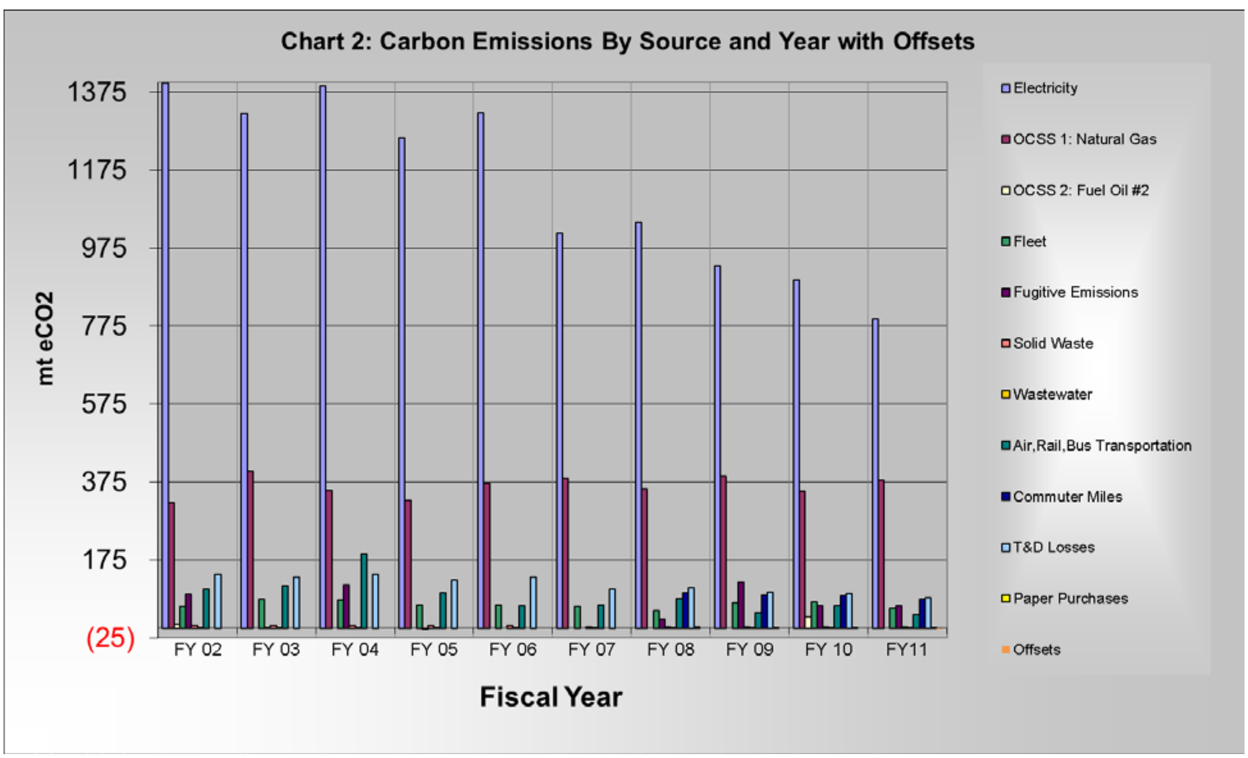


Chart 3: Break-out comparison of carbon emissions by source.

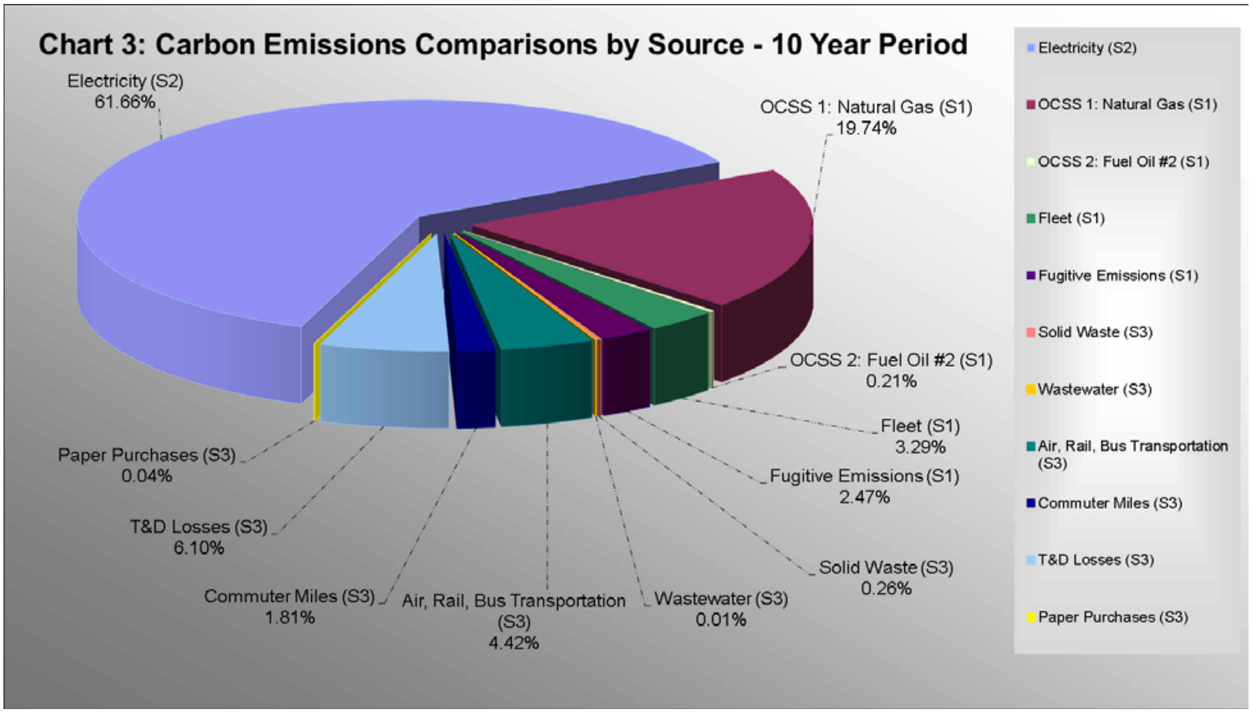


Chart 4: mt eCO_2 emissions trend over the study period

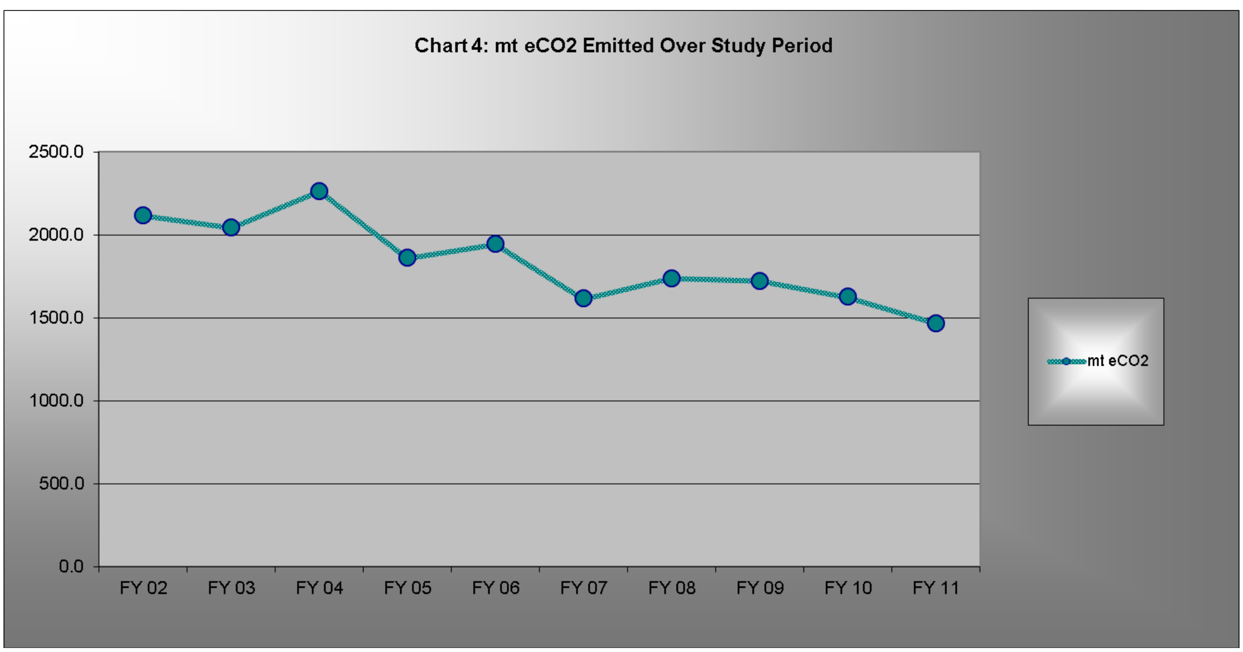
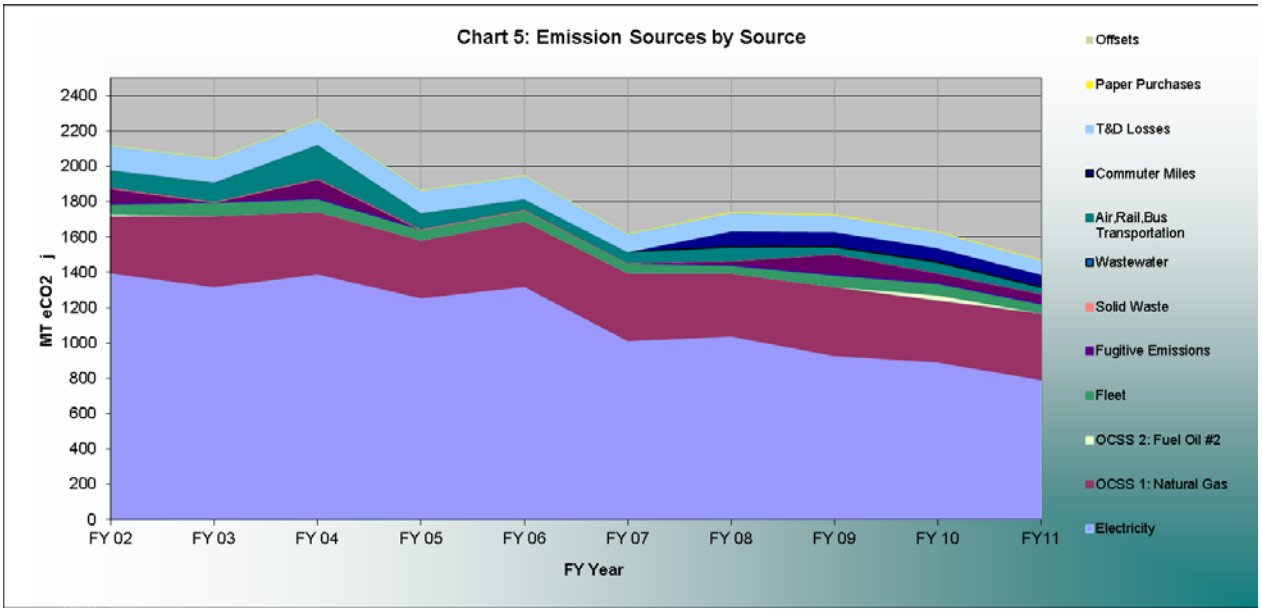


Chart 5: Total emissions over the study period by source.



Charts 6 & 7: Total emissions over the study period by emission scope

Chart 6 shows the total emissions by scope over the study period as generated by the Clean Air-Cool Planet Calculator.

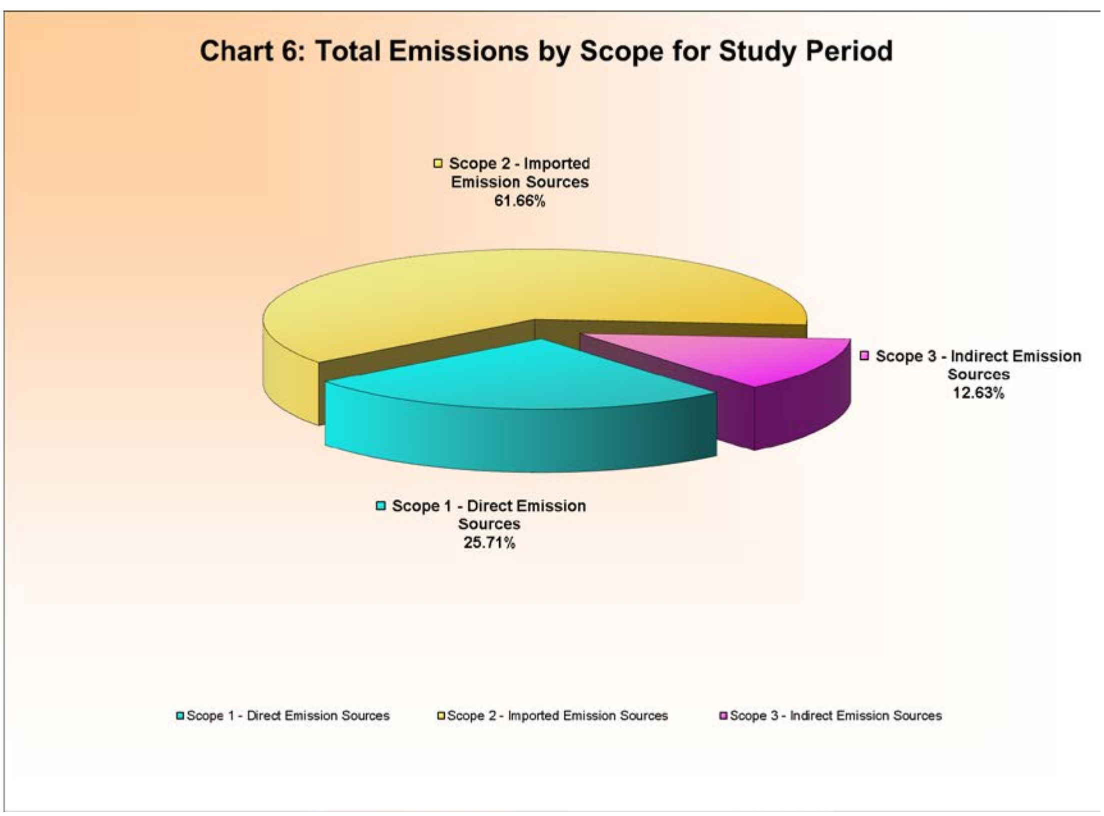
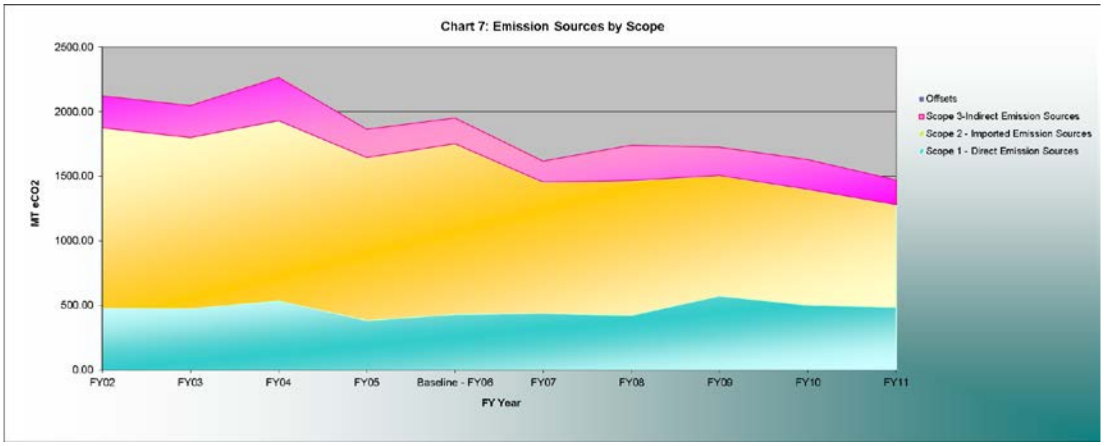


Chart 7 provides an area view of the total emissions by scope over the study period as generated by the Clean Air-Cool Planet Calculator.



Section 5: Conclusions & Actions

5.1. Conclusions

Our GHG inventory shows that 67.76% of the Appalachian Lab's CO_2 emissions result from ***electricity*** use. 61.66% is from electricity use and 6.10% is from electricity transmission and distribution losses. ***On-Campus Stationary Sources*** contribute a total of 19.95%, 19.74% is from ***natural gas*** and 0.21% is from ***fuel oil #2.*** Comparatively, only 4.42% is from ***air, rail and bus transportation,*** 3.29% is from ***fleet use,*** 2.47% is from ***fugitive emissions,*** 1.81% is from ***commuter travel,*** 0.26% is from ***solid waste disposal,*** less than 0.04% is from ***paper purchases*** and less than 0.01% is from ***wastewater.*** The bulk of the electricity and natural gas usage is for lighting, heating and cooling of the facility.

Although our emissions have been on a slight decrease for the last several years, we still find that 87.71% of the total emissions are from the building lighting and HVAC. Our first step toward continuing our reduction of our climate footprint must focus on the use and consumption of energy within the building.

5.2. Actions

UMCES Appalachian Laboratory has and will continue to use the results from this GHG inventory to help set reduction targets and lessen our potential climate footprint. Several plans are in place and are being developed to help reach this goal. Our primary targets will begin with addressing the emissions from the building itself and working outward. Below is a list of our current and planned courses of action for reductions. These are defined in greater detail in the Climate Action Plan with strategies and suggested policies to implement them.

Current courses of action:

1) Administrative Policy Modifications
2) Revised Building Maintenance Plans
3) Stringent Fleet vehicle assignments
4) Hybrid vehicle purchases
5) Greener landscaping
6) Meadow and tree plantings
7) Environmentally Preferred Procurements
8) IT Policies
9) Recycling Program

Planned courses of action to reduce our climate footprint are:

10) Power-down policy
11) Chemical laboratory re-design
12) Installation of solar film on windows
13) Increased video conferences
14) Installation of a renewable energy source
15) Increased building insulation
16) Gray water and/or Barrel collection systems
17) Renewal Energy Certificates (REC)
18) Carbon Offset Projects

AL facility staff are currently reviewing the list of recommendations provided by the site audit as part of the Energy ***Performance Contract*** (EPC) with Constellation Energy.

Section 6: Climate Action Plan (CAP)

6.1. CAP Introduction

As a signatory to the American College and University Presidents Climate Commitment, the following milestones have now been set in place. Dr. Boesch signed the commitment on December 18, 2007 with an effective date of January 15, 2008.

1. *Initiate the development of a comprehensive plan to achieve climate neutrality as soon as possible.*
    - *a* Within two months of signing this document, create institutional structures to guide the development and implementation of the plan. – *Completed 2/12/2008*
    - *b* Within one year of signing this document, complete a comprehensive inventory of all greenhouse gas emissions (including emissions from electricity, heating, commuting, and air travel) and update the inventory every other year thereafter. - *Completed in July 2008; is being updated every fiscal year there after*.
    - *c* Within two years of signing this document, develop an institutional action plan for becoming climate neutral, which will include: **-** *Completed 5/26/2010***.**
        - i A target date for achieving climate neutrality as soon as possible.
        - ii Interim targets for goals and actions that will lead to climate neutrality.
        - iii Actions to make climate neutrality and sustainability a part of the curriculum and other educational experience for all students.
        - iv Actions to expand research or other efforts necessary to achieve climate neutrality.
        - v Mechanisms for tracking progress on goals and actions.
2. *Initiate two or more of the following tangible actions to reduce greenhouse gases while the more comprehensive plan is being developed.*
    - a Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.
    - b Adopt an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR certified products in all areas for which such ratings exist.
    - c Establish a policy of offsetting all greenhouse gas emissions generated by air travel paid for by our institution.
    - d Encourage use of and provide access to public transportation for all faculty, staff, students and visitors at our institution.
    - e Within one year of signing this document, begin purchasing or producing at least 15% of our institution's electricity consumption from renewable sources.
    - f Establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where our institution's endowment is invested.
    - g Participate in the Waste Minimization component of the national RecycleMania competition, and adopt 3 or more associated measures to reduce waste.
3. *Make the action plan, inventory, and periodic progress reports publicly available by providing these to the Association for the Advancement of Sustainability in Higher Education (AASHE) for posting and dissemination. – All of our documents are currently available on our Sustainability website at http://www.al.umces.edu/alesc/ launched in July 2008.*

6.2. Climate Commitment

Our commitment to climate change is echoed in the development of an UMCES-wide Environmental Sustainability Council (ESC) that consists of students, faculty and staff from the Center's three laboratories, Center Administration, UMCES @IMET and Maryland Sea Grant College Program. The ESC functions as a task group and advisory body to the President and Administrative Council.

The mission of the ESC includes:

1. *Engaging the faculty, staff and students in an ongoing dialogue about reaching environmental sustainability.*
2. *Providing assessments of the sustainability of operations and recommendations to the President and Administsrative Council for improved practices and policies.*
3. *Serving as the "institutional structure" to guide the development and implementation of a comprehensive climate action plan in fulfillment of the American College & University Presidents Climate Commitment signed by Dr. Donald F. Boesch on December 18, 2007.*

In order to support the UMCES ESC, the Appalachian Laboratory Environmental Sustainability Council (ALESC) was created to serve as the laboratory/department level advisory council. This council worked with the Administration to complete a comprehensive inventory of greenhouse gas emissions and will continue to work with the Administration to complete and implement an institutional action plan for becoming climate neutral. These efforts shall be consistent with the standards provided in the ACUPC Implementation Guide (http://www.presidentsclimatecommitment.org/pdf/ACUPCC_IG_Final.pdf).

Our Climate Action Plan is the next step to help the Appalachian Laboratory achieve the goal of becoming carbon neutral. Therefore, this plan is a “living document” that will be updated regularly to meet this new commitment by our University, State and Nation. The recommended goal for the State of Maryland is to introduce legislation requiring the development and implementation of programs to reduce GHG emissions by 90% by 2050 with interim goals and updates. Many agencies are following this lead by setting the same or similar goals for reductions.

The timeline (Table 15) for our goals for carbon emissions reductions are based on FY06 levels. Our FY06 emissions were 1948.10 MT eCO_2

Table 15: Goals for Emissions Reductions

Table 15: Goals for Emissions Reductions			
Fiscal Year	GHG Emissions MT eCO_2	Appalachian Laboratory Reduction Goals	State of Maryland Reduction Goals
2006 (baseline)	1948.10	N/A	N/A
2012	1753.29	10% below 2006 levels	10% below 2006 levels
2015	1655.89	15% below 2006 levels	15% below 2006 levels
2020	-	N/A	20%-50% below 2006 levels
2030	1461.07	25% below 2006 levels	N/A
2040	974.05	50% below 2006 levels	N/A
2050	194.81	90% below 2006 levels	90% below 2006 levels

6.3. Carbon Footprint

Our GHG inventory shows that 67.76% of the Appalachian Lab's CO_2 emissions result from ***electricity*** use. 61.66% is from electricity use and 6.10% is from electricity transmission and distribution losses. ***On-Campus Stationary Sources*** contribute a total of 19.95%, 19.74% is from ***natural gas*** and 0.21% is from ***fuel oil #2.*** Comparatively, only 4.42% is from ***air, rail and bus transportation,*** 3.29% is from ***fleet use,*** 2.47% is from ***fugitive emissions,*** 1.81% is from ***commuter travel,*** 0.26% is from ***solid waste disposal,*** less than 0.04% is from ***paper purchases*** and less than 0.01% is from ***wastewater.*** The bulk of the electricity and natural gas usage is for lighting, heating and cooling of the facility.

Although our emissions have been on a slight decrease for the last several years, we still find that 87.71% of the total emissions are from the building lighting and HVAC. Our first step toward continuing our reduction of our climate footprint must focus on the use and consumption of energy within the building.

With continued monitoring of our emissions, our goal is to continue to reduce emissions through time. Reductions will require closer monitoring and better maintenance of equipment to gain as much energy efficiency as possible from existing equipment, replacement of non-energy efficient equipment and continuation of recycling and conservation efforts already in place.

In order to reduce our footprint, the AL facility staff is currently reviewing the list of recommendations provided by the site audit as part of the ***Energy Performance Contract*** (EPC) with Constellation Energy. Specific preliminary energy conservation measures include:

ECM#1: Installation of Variable Frequency Drives on the central plant distribution CW and HW pumps.
ECM#2: Installation of Variable Frequency Drives on the fume hood exhaust fan
ECM#3: Air Balancing/Retro-Commissioning AHUs
ECM#4: Metasys (direct digital controls) DDC Control Retro-Commissioning – operation check and control re-calibration due to age
ECM#5: Retrofit lamps to 25 watt
ECM#6: Retrofit Metal Halide Lamps to T5
ECM#7: Building Envelope: Caulking and Sealing
ECM#8: Insulation of brick wall that connects to lobby glass curtain walls.

As of November 2011, AL has an approved Energy Conservation Project funded through the Maryland Energy Administration State Agency Loan Program to address these Energy Conservation Measures (ECMs). The first project to be completed is ECM #2, the installation of the VFD's on the exhaust fans. It was determined with that this ECM would provide the most return in savings on both our budget and energy consumption so this will be the first priority. After this initial project is complete, remaining funds will be used to complete the additional ECMs, prioritized on the budget and energy consumption saved with each one.

6.4. Mitigation Strategies

In order to meet our reduction goals, the following strategies have already been or are being implemented.

<u>6.4.a. Administrative Practices</u>
Through our Capital Improvement Planning process, AL will ensure that all new buildings, renovations and additions are built to meet or exceed the LEED Silver Certification. New buildings, when construction is necessary, will employ the latest technologies and be designed with upfront commitment to energy efficiency that will reduce GHG emissions and lower operating costs.

Facilities Renewal projects will incorporate "green" upgrades and improvements into existing buildings in order to build a more sustainable campus.

To avoid increasing our carbon footprint with new buildings, we will continue to maximize the use of existing spaces, and will investigate ways to renovate, modernize and retrofit unused or less desirable areas to meet new needs and avoid the necessity for additional construction.

The Appalachian Laboratory Environmental Sustainability Council (ALESC) will be responsible for the preparation and maintenance of an emissions inventory as a guiding tool for campus sustainability and ongoing efforts to reduce our carbon emissions. This will enable the tracking of AL's goals and achievements.

The ALESC Sustainability Website designed to educate, encourage and promote sustainability efforts was launched in July 2008. The website contains the sustainability reports, recycling efforts, "green" tips as well as other information relating to a sustainable campus.

6.4.b. Facilities Operations

Heating and cooling thermostats are programmed to operate in occupied mode 24 hours a day with minimum and maximum thresholds established for many building zones as most of the lab spaces require continuous operation. This policy was established since temperature recovery was too long to meet the required needs, causing comfort issues. If necessary, when an area is unused for a longer stretch of time, the thermostats can be set back during this unoccupied time period for maximum efficiency. Additionally, all windows were re-caulked and sealed in March 2008 to prevent unnecessary heating and cooling losses.

Landscaping has been simplified to minimize maintenance, i.e. grass has been planted in previously mulched / bedded areas to decrease maintenance costs, both employee time and materials. Additionally, a natural species meadow has been planted on the grounds as a demonstration area and to reduce maintenance efforts.

AL's ***Recycling and waste minimization*** program currently includes all mixed office paper, cardboard, paperboard, magazines, toner cartridges, plastics #1 & #2, batteries (alkaline and rechargeable), CPUs, cell phones, monitors, printers and mixed metals through the Allegany County Recycling program.

a. Prior to 2002, all of AL's recyclables were included with Frostburg State University.
b. January 2002, AL initiated their own recycling program, recycling all mixed office paper, magazines, toner cartridges, wet cell batteries, CPUs, cell phones, monitors, printers and mixed metals
c. February 2004, rechargeable batteries and corrugated cardboard were added to the recycling program.
d. September 2004, plastics 1 & 2 were added to the recycling program.
e. October 2007, alkaline batteries were added to the recycling program.
f. February 2008, paperboard was added to the recycling program
g. December 2011, glass was added to the recycling program.

Our program makes provisions for recycling the required glass, plastic (1&2), aluminum and paper to be in compliance with Environment Article § 9-1706 (b) and (c) of the Annotated Code of Maryland. Additionally our program also includes mixed cans, cardboard, batteries, lamps, books, toner, white goods, and electronics.

Continued recycling efforts have enabled AL to keep our solid waste to a minimum since 2007, when the amount of solid waste was decreased from a dumpster pickup once a week to once every-other week.

This was a 50% reduction in solid waste going to the landfill, which also resulted in a reduction in emissions from the disposal company trucks, and cost savings for the lab.

AL maintenance staff has ***increased maintenance*** on aging equipment to gain as much energy efficiency as possible and we are replacing non-energy efficient equipment with newer ***Energy Star*** models when available and when replacement is necessary.

In areas that have been over-lit, extra lamps are removed. This is a simple, cost-less way to reduce electricity use. Almost all offices and labs have windows, so ***de-lamping*** in these areas goes mostly unnoticed.

6.4.c. Procurement Practices

AL will continue to augment the fleet with ***flex fuel***, ***energy efficient*** vehicles if appropriate and fiscally possible.

AL paper purchases will, at a minimum, contain 30% post-consumer ***recycled paper.*** In October 2009 we moved to 100% post-consumer recycled paper. Other recycled ***office products*** will be purchased when available.

The University of Maryland is committed to purchasing energy efficient and environmentally friendly products and provides tools and quick tip sheets to help locate and purchase these environmentally friendly products. Both of the approved USM Master Contracts for office supplies now include an extensive selection of ***green products***.

6.4.d. Technology Practices

New IT purchases look to computer systems that support video and sound so that meetings can be held for small groups over ***web based conferencing*** software. This software is normally open source, simple to use and has helped eliminate the need for faculty and staff to travel in order to keep research collaborations and business communications open. AL purchased such a system in 2009 for our common use office so that it is available to the entire AL community.

CRT monitors are being surplused and replaced with ***LCD monitors***. Overall, LCD monitors can reduce energy consumption by 60% when compared to an equivalant viewing area sized CRT. Additionally, LCD's are now priced comparatively to CRTs, their carbon footprint is much smaller for the equivalant viewing area, the image quality is excellent and they reduce eye strain as there is no glare or screen flicker.

AL's IT administrator is currently moving toward ***virtualization***, one path on the rapidly growing ***Green IT*** road. Virtual machines have allowed the power down of 12+ servers without affecting applications or users. This is a significant decrease in energy consumption and cost without a decrease in the service provided to the AL community. Virtualization has eliminated wasteful network equipment and has reduced energy consumption and floor space requirements.

In November 2010 our 12-year-old 61" rear projection monitors in the IVN room were beginning to darken and fade and show the early signs of failing. To decrease the risk of failure during and on going class, these monitors were replaced. Our replacement monitors are two Energy Star Qualified LG 55" LED monitors with Smart Energy Saving features.

Many office users are opting for ***laptop computers*** instead of traditional desktop computers. In addition to providing portability, these machines can use as little as 25% of the electricity of a standard desktop computer and monitor.

Over long breaks and holidays, only the main critical systems in the computer center remain powered on, all other systems are powered off.

Our IT administrator has installed ***Kill-A-Watt meters*** on various types of equipment such as copiers, printers, switches, monitors (both CRT and LCD) etc. to determine the best practices when it comes to management of this equipment, decisions on replacements and priorities for replacement.

As stated earlier, all obsolete or damaged IT equipment is cannibalized and then ***e-cycled*** through the county recycling program. As newer equipment is purchased based on computational need, older viable equipment is re-deployed to areas with less demand.

6.4.e. Transportation Practices

AL fleet manager will continue to assign ***fleet vehicles*** based on needs and fuel efficiency. The large 4WD vehicles are not assigned for single person trips or used for non-field related travel except when absolutely necessary.

Due to our remote location, public transportation does not play a role in our transportation practices and policies. However, many faculty and staff live locally, so ***biking and walking*** to work are often standard practice and have been encouraged by providing safe, dry, inside storage areas for bicycles.

AL and UMCES have evaluated the location and distances traveled to frequent administrative meetings, revising schedules and, when appropriate, substituting the Interactive Video Network, or ***web based conferencing*** programs such as Adobe Connect and Skype in lieu of face-to-face meetings.

6.5. Suggested Energy Conservation Measures (ECMs)

6.5.a. Power Down Policy

AL will implement and enforce policies to ***"power down"*** during non-working hours. This should include computers, printers, equipment, lights, etc. All power sources that will not be harmed by being powered off should be addressed. Implementing software that automatically powers down computer monitors when not in use would aid to this adjustment.

6.5.b. HVAC Re-design Options

Appalachian Laboratory's chemical laboratories are designed as negative pressure labs for containment purposes, which results in significant losses of heated or cooled air from the building. Plans to re-engineer the facility to allow more control over these individual rooms and adjust the exhaust when facility use and needs change have been discussed but consultation with an engineer is important to ensure health and safety of laboratory users. This could significantly decrease the building's energy usage but any such project would incur significant up-front costs. Other options, such as installation of variable frequency drives on the exhaust fan (ECM-2), variable frequency drives on the HW & CW pumps (ECM-1), and re-commissioning of all equipment controls to ensure proper operation based on current building needs (ECM-3 & 4). As of November 2011, AL has an approved Energy Conservation Project funded through the Maryland Energy Administration State Agency Loan Program to address these Energy Conservation Measures (ECMs). The first project to be completed is ECM #2, the installation of the VFD's on the exhaust fans. It was determined with that this ECM would provide the most return in savings on both our budget and energy consumption so this will be the first priority. After this initial project is complete, remaining funds will be used to complete the additional ECMs, prioritized on the budget and energy consumption saved with each one.

6.5.c. Additional Building Insulation

1. Installation of insulating window film. These films reduce the amount of solar heat transmission through window glass by increasing the solar reflection (not necessarily visible reflection) and solar absorption of the glass to save on cooling and by reflecting more of the interior room heat back into the room where it is needed to save on heating costs.
2. Installation of additional attic insulation to help increase energy efficiency of the entire building and reduce our emissions.
3. Installation of additional insulation between brick and glass curtain walls in the lobby. The brick wall may not contain insulation at the window frame to reduce heat loss. Adding insulation panels will reduce heat loss and the heat transfer along the brick wall and behind the window frame. (ECM-8)
4. Inspection and review of building exterior to determine the condition and need for additional caulking and sealing of building seams and cracks to reduce both air infiltration and the building heating load. (ECM-7)

6.5.d. Additional IVN System

Installation of an additional IVN Video Conferencing System has been suggested to help reduce the necessity for travel to educational and administrative meetings. However, given the advance technologies in web conferencing programs, this may no longer be priority. Further evaluation will be needed to determine the justification for an addition system.

6.5.e. Retrofit Lighting System

Retrofit existing lighting fixtures to allow for use of more efficient ballasts and lower wattage lamps. (ECM-5 & 6)

6.5.f. Renewable Energy Sources (Local & System Wide)

1. ***Wind Energy***: Site locations for wind turbines must be Class 1 or at least 4.4 mps average wind speed in order to be an effective alternate energy source. After review by the Maryland Energy Administration in November 2007 and confirmation from wind speed history reports from our greenhouse anemometer, it was determined Appalachian Laboratory's location does not meet the minimum recommended speed for use of a wind turbine, thus this would not be a viable option at this time.
2. ***Wind Energy*** (System wide): In 2011 the University of Maryland System made renewable energy purchases from Roth Rock Wind North. A second wind project, the Pinnacle is due to come on line in 2012 as well as a solar installation at Mt. St. Mary's. The RECs' among these projects are proportioned among the USM Intuitions. On average, these renewable sources will be approximately 15-16% of our purchased energy requirements
3. ***Solar Energy:*** The next option is to research the possibility of photovoltaic solar system as an alternate energy source. This could be grid-tied or off grid depending on the final application of system. The AL site would need to be surveyed by certified installer to determine options for location, size, and type of solar system.
4. ***Solar Hot Water System:*** The south side of the building would be a prime location for this type of a system; however a water use survey would need to be conducted at lab as the initial step in determining if the quantity of hot water used at the lab warrants further investigation into this system.

6.5.g. Water Collection and Re-use

1. ***Gray water system*** to collect, treat and re-use water from wash areas in the building as a source of plant irrigation, to reduce use of fresh (drinking) water and to reduce the water sent to treatment plant.
2. ***Barrel system*** to collect and store rainwater for later use on demand.

6.5.h. Carbon Offset Projects

Carbon offset projects to reduce or remove carbon dioxide equivalent (CO2e) greenhouse gas (GHG) emissions that is used to counterbalance or compensate for ("offset") emissions from other activities of the institution. Carbon offsets represent the act of reducing, avoiding, destroying or sequestering the equivalent of a ton of greenhouse gas (GHG) in one place to "offset" an emission taking place somewhere else. Offsets generally represent direct emission reductions or sequestration and can be from non-electric sources, such as planting new tress on previously un-forested acreage. Offsets should be used to reduce Scope 1 and Scope 3 emissions ensuring that each ton emitted is wholly counterbalanced by an additional emission reduction.

6.5.i. Renewable Energy Certificates

Renewable energy certificates, or RECs, represent one megawatt hour (MWh) of energy generated from a clean, renewable source, such as wind, solar, hydro, or certain types of renewable biomass. Renewable energy credits (RECs) bought - either from the utility as "clean energy" or from independent REC suppliers - in addition to actual electricity, are usually used to neutralize Scope 2 emissions by matching out each "dirty" megawatt of electricity an institution uses with a "clean" megawatt represented by a REC.

6.6. Barriers and Solutions

6.6.a. Power Down Policy

Implement and enforce policies to power down during non-working hours. This should include computers, printers, equipment, lights, etc. All power sources that will not be harmed by being powered off should be addressed. This is directly related to our primary emission source, purchased electricity and could, if implemented, effectively reduce our emissions.

> Barriers: The only barriers associated with a power-down policy are personnel related. With often hurried schedules, people simply forget.
>
> Solution: This is one of the easiest actions that can be implemented building wide. However, just asking does not always work. Policies and possible software to support the "power down" efforts and also to educate and train employees how to set up power save functions on equipment need to be implemented. In order to successfully implement our Climate Action Plan, those who work and live within the AL community need to be fully "on board" with policies and programs where their active participation is required. This is assured through education that aims to teach the value of resources, how to use them wisely, and the consequences of not doing so. In addition, sustainability education can serve to unite the community by fostering a common understanding of the challenges faced in seeking to live and work sustainably.

6.6.b. HVAC Re-design Options

Appalachian Laboratory's chemical laboratories, designed as negative pressure labs for containment purposes, are the major loss of heating and cooling in the building. Designs to re-engineer the facility to allow more control over these individual rooms and adjust the exhaust when facility use and needs change have been discussed. This could significantly decrease the building's energy usage.

> Barrier: This option was not one that was further recommended for implementation during our energy audit in 2009 because the audit showed that the re-engineering costs are more than what could be recouped from savings over 15+ years.
>
> Solution: There may be other options to modify this system to reduce energy loss without a full re-design. These options are being investigated further as recommended by our energy audit in the

following ECMs: ***ECM#1:*** Installation of Variable Frequency Drives on the central plant distribution CW and HW pumps. ***ECM#2:*** Installation of Variable Frequency Drives on the fume hood exhaust fan; ***ECM#3:*** Air Balancing/Retro-Commissioning AHUs; ***ECM#4:*** Metasys (direct digital controls) DDC Control Retro-Commissioning – operations check and control re-calibration due to age.

6.6.c. Additional Building Insulation

1. Insulating window film reduces the amount of solar heat transmission through window glass by increasing the solar reflection (not necessarily visible reflection) and solar absorption of the glass to save on cooling and by reflecting more of the interior room heat back into the room where it is needed to save on heating costs.

Barrier: The primary barriers to this option are the cost and the displacement of personnel during the installation. Additionally, since it is not a critical need, renewal funds for this type of project are difficult to obtain, especially in tough budget years.

Solution: Plans to find other ways to fund this are being discussed. In the interim, all windows were resealed and caulked to reduce heating and cooling loss.

2. The installation of additional insulation in the attic to help increase energy efficiency of the entire building and reduce our emissions is being examined.

Barrier: Until the HVAC system can be modified, management feels the insulation of the attic would provide no additional energy savings.

Solution: The installation of additional insulation in the attic could be scheduled with the HVAC system modifications to increase and supplement the energy savings. However, should the funds become available earlier, this project would be completed as a precursor to the HVAC modifications.

3. Adding insulation panels (ECM-8) to reduce heat loss and the heat transfer along the brick wall and behind the window frame at the glass curtain walls in the lobby.

Barrier: Primary barrier is cost.
Solution: AL will complete this insulation as soon as funds are available.

4. Additional caulking and sealing of building envelope (ECM-7) to reduce air flow.

Barrier: Primary barrier is cost.
Solution: AL will complete this caulking and sealing as soon as funds are available.

6.6.d. Additional IVN System

Installation of an additional IVN system in order to reduce the traveling necessary for faculty and staff to attend educational and administrative meetings to cut travel emissions. However, given the advance technologies in web conferencing programs, this may no longer be priority. Further evaluation will be needed to determine the justification for an addition system.

Barrier: The barriers to this option are the cost of an additional IVN installation and the anticipated level of usage. Currently we have a single IVN system used for courses and meetings. USM courses take precedence, so an IVN system is not always available for meetings that conflict with the class schedule. However, the cost of a new system does not sufficiently offset the inconveniences that the conflicts produce.

Solution: New IT purchases look to computer systems that support video and sound so that meetings can be held for small groups over web based conferencing software. This software is normally open source, simple to use and has helped eliminate the need for faculty and staff to travel in order to keep research collaborations and business communications open. AL purchased such a system in 2009 for our common use office so that it is available to the entire AL community.

6.6.e. Retrofit Lighting System

The ***Lighting systems*** in the facility are largely energy efficient with the current energy efficient 32 watt, T8 lamps with electronic ballasts. However, AL is looking at recommendations (ECM-5) to retrofit our existing 32 watt lamps with newer 25 watt lamps that support the new super saver electronics ballasts to further reduce electric consumption. Some facility lights must remain on 24 hours a day as these are emergency lights – this retrofit could noticeably reduce the consumption from these lights.

Ambient light in the building lobby reduces the need for lights during daylight hours, however this area is supplemented by 150 watt metal halide light fixtures. We are looking at recommendation (ECM-6) to retrofitting the existing lamps in the building lobby from the current 150 watt Metal Halide lamps to fluorescent, T5 fixtures to reduce energy consumption.

Barrier: Primary barrier is cost and possible displacement of personnel during install.

Solution: AL will complete these retrofits as soon as funds become available.

6.6.f. Water Collection and Re-use

1. Gray water (wash water) systems are designed to collect, treat and re-use water from wash areas in the building as a source of plant irrigation, to reduce use of fresh (drinking) water and to reduce the water sent to treatment plant. Additional research on gray water and barrel systems is needed before an estimate on the emissions reductions can be established.

Barriers: The main barriers to a gray water system are the costs associated with retrofitting the building facilities in order to re-route wash water to a gray water system. Local authorities and health officials would need to be contacted regarding any special/local concerns and regulations with respect to gray water systems. A professional engineer would need to be involved to insure that only wash water, that is, bath, dish, and laundry water excluding toilet wastes and free of garbage-grinder residues, is re-routed.

Solutions: Additional data collection to determine if the amount of wash water would warrant the installation of a gray water system.

2. A barrel system is designed to collect and store rainwater for later use on demand.

Barriers: The main barriers to a barrel system are, again, the costs associated with retrofitting the building facilities in order to re-route rainwater to the barrel system. A well designed system that would provide for overflow, insect and mosquito control and easy access to water is a requirement.

Solutions: To decrease the cost associated with the design, a barrel system could be engineered to collect rainfall from the greenhouse only. This water could then be used to operate the greenhouse. As the greenhouse facility is the largest consumer of water we have, it would be good business practice to make this the first structure to be fitted for this type of system. Again, this would be an excellent test model that could be expanded to other structures if successful and feasible. The Appalachian Laboratory's storm water management facilities are scheduled to be upgraded, so it may be possible to engineer a barrel system as part of the upgrade.

6.6.g. Renewable Energy Sources

Installation of a renewable energy source to supplement energy demand at AL. Additional research on renewal energy sources is needed before an estimate on the emissions reductions can be established.

Wind Energy:

Barrier: Site locations for wind turbines must be Class 1 or at least 4.4 mps average wind speed in order to be an effective alternate energy source. After review by the Maryland Energy Administration in November 2007 and confirmation from wind speed history reports from our greenhouse anemometer, it was determined Appalachian Laboratory's location is such that our average wind speed does not meet the minimum recommended speed for use of a wind turbine, thus this would not be a viable option at this time.

Solution: Participate and promote in system wide efforts to use renewable sources of energy that will benefit all institutions. This started in 2011 when the University of Maryland System made renewable energy purchases from Roth Rock Wind North. A second wind project, the Pinnacle is due to come on line in. The RECs' among all renewable energy projects are proportioned among the USM Intuitions. On average, these renewable sources will be approximately 15-16% of our purchased energy requirements.

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Solar Energy:

Barrier: There are several major barriers to solar energy. Currently, prices of highly efficient solar cells can be above $1000, and most applications need more than one. This makes the initial installation of solar panels very costly. Solar energy is only able to generate electricity during daylight hours. This means for around half of each day, solar panels are not producing energy. The weather and pollutions levels can affect the efficiency of solar cells.

Solution: Although, at first glance, this does not appear to be the most viable or practical application for AL, the installation of a solar array that would power our greenhouse, would be an excellent test model and something that is being explored. One possibility is a photovoltaic solar system as an alternate energy source that could be grid-tied or off grid depending on the final application of system. The AL site would need to be surveyed by certified installer to determine options for location, size, and type of solar system.

Additionally, we will continue to participate and promote system wide efforts to use renewable sources of energy that will benefit all institutions. A solar installation is scheduled to come line in 2012 at Mt. St. Mary's. The RECs' among all renewable energy projects are proportioned among the USM Intuitions. On average, these renewable sources will be approximately 15-16% of our purchased energy requirements.

6.6.h. Carbon Offset Projects

A carbon offset is a reduction or removal of carbon dioxide equivalent (CO2e) greenhouse gas (GHG) emissions that is used to counterbalance or compensate for ("offset") emissions from other activities of the institution. Carbon offsets, represent the act of reducing, avoiding, destroying or sequestering the equivalent of a ton of greenhouse gas in one place to offset an emission taking place somewhere else. Offsets generally represent direct emission reductions or sequestration and can be from non-electric sources, such as planting new tress on previously un-forested acreage. Offsets should be used to reduce Scope 1 and Scope 3 emissions ensuring that each ton emitted is wholly counterbalanced by an additional emission reduction.

Barriers: Offsets face strict rules for approval, including the requirement that the emission reduction credited be real, permanent, verifiable, and most importantly, additional to a business-as-usual scenario. This will present an actual cost to the institution. Budget concerns always impact all new projects, especially ones that provide no tangible products or results.

Solutions: Offsets provide for a direct reduction in an institution's carbon footprint, usually from Scope 1 & 3 emissions. Emissions must be reduced by all other methods in order to reach the lowest reduction point. Once this is done, the quantity of offsets that needs to be created in order to offset emissions from sources that can not be reduced or avoided will be more attainable.

6.6.i. Renewal Energy Certificates

Renewable energy certificates, or RECs, represent one megawatt hour (MWh) of energy generated from a clean, renewable source, such as wind, solar, hydro, or certain types of renewable biomass. Renewable energy credits (RECs) bought - either from the utility as "clean energy" or from independent REC suppliers - in addition to the actual electricity, are usually used to neutralize Scope 2 emissions by matching out each "dirty" megawatt of electricity an institution uses with a "clean" megawatt represented by a REC.

Barriers: Renewable technologies are still relatively expensive and in most cases require up-front investments, which then get offset by "free fuel" over a longer period of time. Each form of renewable energy, be it wind power, solar power, biomass, hydropower, or geothermal, has its own set of environmental problems and/or limitations that need to be investigated further before the purchase of RECs is considered.

Solutions: RECs allow for procuring green power across a wide geographical area and applying the renewable attributes to the electricity used at a facility of choice. This flexibility allows organizations to support renewable energy development and protect the environment when green power products are not locally available.

In 2011 the University of Maryland System made renewable energy purchases from Roth Rock Wind North. A second wind project, the Pinnacle is due to come on line in 2012 as well as a solar installation at Mt. St. Mary's. The RECs' among these projects are proportioned among the USM Intuitions. On average, these renewable sources will be approximately 15-16% of our purchased energy requirements. We have created a custom fuel mix for emissions calculations within the carbon calculator to account for these renewable energy sources. Our custom fuel mix for FY 11 is 85% purchased electricity and 15% renewable wind/solar energy. With the creation of the custom fuel mix the MeCo2 emissions are automatically adjusted to represent the renewable energy emissions reductions. This reduction equated to approximately 76 RECs for UMCES. These are proportioned among the individual UMCES laboratories providing for 23 RECs for the Appalachian Laboratory.

Additional RECs can be considered once all other energy reductions and offset projects are complete and in place.

6.7. Costs and Financing

Affordability is a key issue when dealing with any changes to the way that we do business. In order to see that our Climate Action Plan is successful, we must implement the changes that will provide the most return for our dollars. As the University, State and Nation deal with continued budget cuts, non-critical projects and programs are the first to be hit, therefore funding for sustainability projects will need to be a justifiable expense that will guarantee a return in order to be financially supported. The Appalachian Laboratory Administration is committed to provide available funding for 'green' initiatives although further budget cuts are anticipated. The continued support of the recycling program at the Appalachian Laboratory and the purchase of available and affordable recycled materials is a priority for the institution as is the purchase of high efficiency motor vehicles.

6.8. Communication and Dissemination

UMCES Appalachian Laboratory will use a variety of sources in order to communicate our sustainability efforts and progress to the AL community, UMCES community and the general public.

ALOnline is the Appalachian Laboratory intranet with a multitude of features to allow the AL community to easily share information. The URL is http://alonline.al.umces.edu Individuals set up their own account on the homepage and then can add/create/edit content to be shared with other AL-ers.

The Appalachian Laboratory Environmental Sustainability Initiative webpage http://www.umces.edu/al/sustainability highlights the sustainability efforts, goals and resources at the Appalachian Laboratory. This website is publically available.

UMCES, being one of the signatory institutions to the ACUPCC, agrees to make our climate action plan, inventory, and progress reports publicly available by providing them for posting and dissemination per the timelines set up by the plan based on our signing date.
http://www.presidentsclimatecommitment.org/reporting

In August 2009, University of Maryland Center for Environmental Science joined the *Maryland Green Registry*, http://www.green.maryland.gov/registry/index.html a self-certification program offering tips and resources to help organizations set and meet their own goals on the path to sustainability.

An open door policy for suggestions, ideas, comments etc., has always been in place within the AL community and will continue to be the policy for our sustainability program.

6.9. Tracking and Monitoring

The Appalachian Laboratory Environmental Sustainability Council (ALESC) will be responsible for the maintenance and update of the emissions inventory as a guiding tool for campus sustainability and ongoing efforts to reduce our carbon emissions. Efforts will be monitored through the carbon calculator and actions adjusted as needed to stay on course in meeting our climate commitment.

6.10. CAP Conclusions

UMCES Appalachian Laboratory has and will continue to use the results from this GHG inventory and the site audit as part of the ***Energy Performance Contract*** (EPC) with Constellation Energy to help set reduction targets and lessen our potential climate footprint. Several plans are both in place and being developed to help reach this goal. Our primary targets will begin with addressing the emissions from the building itself and working outward.

With implementation of some of the key strategies, the Appalachian Laboratory anticipates meeting the climate commitment goals we have set in place. Ultimately, when emissions have been reduced as much as possible through the energy conservation measures addressed here, our carbon reductions may need to be further reduced by the purchase of carbon offsets from reputable traders in renewable energy credits in an amount equal to the number of tons of carbon dioxide equivalents (CDEs) remaining.

This plan will need to be revised and enhanced continually to keep up with new developments, personnel changes, and facility changes, but these changes should not alter our overall commitment to achieving and maintaining a sustainable campus.

Section 7: References

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