

Energy and the Environment at the University of Alaska Anchorage
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Preparing this report is dependent upon people who have taken time out of their busy schedules to learn about carbon management and gather data that is often obscured in other reports and files. A special thanks goes to Connie Jolin and Wayne Morrison who dug through files to gather utility and fuel purchase data. Larry Foster and Margaret King provided review of the documents and thoughtful comments regarding our approach to the work. The Institute of Social and Economic Research ISER's Nick Szymoniak and Stephen Colt took on the particularly interesting challenge of estimating the carbon foot print associated with commuting and vehicles used by faculty, staff and students. In response to the leadership of Fran Ulmer the Chancellor of the University of Alaska Anchorage, Michael Smith and Christopher Turlettes anticipated the University's need for these metrics and commissioned this report.



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Executive Summary

Sustainable living and environmental stewardship are concepts that have ingrained themselves into popular culture and political discourse. These concepts are also having a profound effect on how companies and institutions are managing their resources, planning future development and molding their reputation. The University of Alaska, like other institutions and organizations is faced with both opportunity and risk as regulatory, environmental and market forces change in response to these trends.

Climate change, which could have a negative affect on the way many people live, has created a sense of urgency to change the way we live with the hope that everyone might live better. Many goals have been, or are being proposed, in response to this challenge. Key among them is to reduce the amount of greenhouse gas emissions that people emit, or more commonly know as a carbon footprint, by minimizing consumption of fossil fuels.

Reducing fossil fuel consumption can be achieved through conservation, better space utilization, and the development of energy systems that make use of renewable energy resources. Each option demands investment to achieve results and has been limited in the past by marginal returns. There are several trends suggesting the value of these investments will improve.

Given the world's explosive economic growth, with more people living above the poverty line than ever before, it is likely that the demand for energy will continue to grow and that the price will continue to increase. In addition to increased demand, regulatory pressure to limit carbon emissions will likely increase the cost of using fossil fuel through either carbon taxes or cap-and-trade costs.

Responding to the challenge of using less fossil fuel on the Anchorage campus can be achieved by the development of several approaches. The fundamentals are simple:

- Conserve energy.
- Consolidate heating loads into a common load through a network of piping to create economy of scale that would allow more efficient use of energy.
- Use fuel more efficiently with a system such as a combined heat and power (CHP) plant.
- Identify untapped alternative energy resources such as landfill gas, wind, and waste wood.
- Develop alternative transportation modes to reduce commuter fossil fuel consumption.

Each of these concepts is dependent upon working together with others in the community and with regulatory agencies in the state.

UAA direct and indirect emissions totaled about 45,000 tons of CO₂ in 2007, of which 25,000 tons fall into categories that are more likely to fall under regulatory purview. In the current voluntary market, the annual cost of offsetting those emissions would be about \$100,000. The cost was expected to climb, but has fallen instead in a rather volatile market. Detailed work is required to focus on the most productive strategy that can be implemented for the campus. It will demand balancing; capital cost, environmental goals, and operational complexity, while protecting against regulatory risk.



Introduction

Environmental stewardship and managing budgetary risk associated with volatile fuel prices have encouraged many institutions and corporations to examine their energy portfolio for ways to reduce consumption of fossil fuel. Using less fossil fuel poses an extraordinary challenge. The world's leading atmospheric scientists tell us that a gradual warming of our climate is underway and will continue. This long-term warming trend means changes in our economy and the environment as we know it. Regulations have been put in place or are being considered on a state by state basis and at the federal level as well. Many multinational organizations are calling for the federal government to act so there is a single set of regulations. Many are also hopeful that a market emerges for trading pollution credits under a uniform set of rules defining a cap and trade program. Like any market, there are both buyers and sellers and money is both made and spent. Understanding the University's potential liability informs its participation in the discussion while rules are being made. It also identifies engineering and fuel solutions that are available to it and the cost of those solutions as a means of managing its emissions.

Environmental stewardship, risk management, fuel flexibility and the wise use of natural resources are all valid reasons to revisit the university's energy options. Opportunities exist in the community to make better use of both energy and fuel and today's energy market and regulatory environment improve the value of those investments.

Current studies indicate that greenhouse gases (GHG) emissions are the primary cause of global warming. The latest Intergovernmental Panel on Climate Change (IPCC) report concluded that, "Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (man-made) greenhouse gas concentrations."¹ The report defines "very likely" as a greater than 90% probability.

These greenhouse gases in the Earth's atmosphere trap heat by blocking some of the long-wave energy the Earth normally radiates back to space. This natural phenomenon keeps the earth warm. Popular debate revolves more around the question whether human activity, specifically, the burning of fossil fuels, enhance the natural greenhouse affect to the point that it upsets the natural energy balance, leading to a warming of the surface and lower atmosphere.

The regulated greenhouse gasses are carbon dioxide (CO₂), followed by methane (CH₄). In addition, Nitrous Oxide (N₂O), Chlorofluorocarbon (CFC), Hydrofluorocarbon (HFC), Perfluorocarbon (PFC) and Sulfur Hexafluoride (SF₆) are included as greenhouse gases. The present atmospheric concentration of CO₂ is about 383 parts per million (ppm) by volume compared to the pre-industrial levels of 280ppm². Future CO₂ levels are expected to rise due to ongoing burning of fossil fuels and land-use change. The rate of rise will depend on uncertain economic, sociological, technological, natural developments, but may be ultimately limited by the availability of fossil fuels. The IPCC Special Report on Emissions Scenarios gives a wide range of future CO₂ scenarios, ranging from 541 to 970 ppm by the year 2100³.

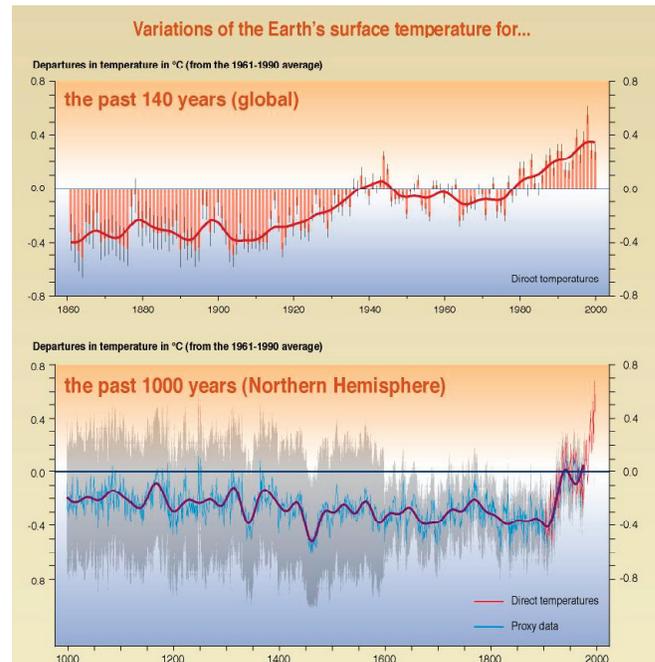


Figure 1- IPCC Published Graphics on Temperature Change

¹ IPCC Report: [Climate Change 2007: The Physical Science](#) February, 2007

² Trends in Atmospheric Carbon Dioxide – Mauna Loa. National Oceanic and Atmospheric Administration

³ IPCC Report: [Climate Change 2001: The Scientific Basis](#) 2001

Climate Change Background

Climate models referenced by the IPCC project that global surface temperatures are likely to increase by 2.0 to 11.5° F between 1990 and 2100.⁴ The range of values reflects the use of differing scenarios of future greenhouse gas emissions and results of models with differences in climate sensitivity. Some observed effects of increased global temperatures include sea level rise, shrinking glaciers, changes in the range and distribution of plants and animals, trees blooming earlier, lengthening of growing seasons, ice on rivers and lakes freezing later and breaking up earlier, and thawing of permafrost.⁵

Some groups believe that natural climatic variability is substantially larger than previously estimated, as is the uncertainty associated with historical temperature reconstructions. However, there is still debate as to the accuracy of the climate models. These models attempt to predict future climatic conditions based on a large number of varying inputs, such as population, energy use, technical development. Data collected by weather satellites since 1979 continue to exhibit evidence of lower atmosphere warming, with estimate trends ranging near the low end of the climate model predictions. However, the climate models predict much higher warming in the upper atmosphere, or tropical troposphere, where as satellite data shows little warming.

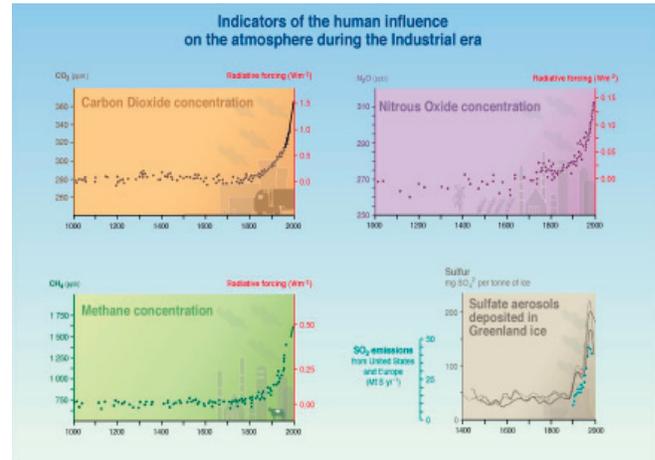


Figure 2- IPCC Published Summary of Human GHG Emissions

⁴ IPCC Report: [Climate Change 2007: The Physical Science](#). February, 2007

⁵ U.S. EPA [Climate Change Basic Information: Health and Environmental Effects](#). Retrieved June, 2007.

⁶ Fraser Institute: [Independent Summary for Policymakers: IPCC Fourth Assessment Report](#). February 2007.

⁷ Fraser Institute: [Independent Summary for Policymakers: IPCC Fourth Assessment Report](#). February 2007.



Carbon Dioxide Equivalency

Carbon dioxide equivalents (CO₂ eq) has become the general standard of measurement against which the impacts of releasing (or avoiding the release of) different greenhouse gases is evaluated. Because the majority of total energy production in North America is based on fossil fuel use,⁸ carbon dioxide equivalents can be used as a useful metric when evaluating energy consumption, as the quantity of carbon dioxide equivalent emitted parallels total energy use.

Carbon dioxide equivalents for various greenhouse gases are measured using Global Warming Potential (GWP), a measurement of the impact that particular gas has on 'radiative forcing'; that is, the additional heat/energy which is retained in the Earth's ecosystem through the addition of this gas to the atmosphere. The GWP of a given gas describes its effect on climate change relative to a similar amount of carbon dioxide. This allows for greenhouse gases to be converted to the common unit of CO₂ equivalent.

GAS	ATMOSPHERIC LIFETIME	GWP
Carbon dioxide (CO ₂)	50-200	1
Methane (CH ₄) ^b	12±3	21
Nitrous oxide (N ₂ O)	120	310
HFC-23	264	11,700
HFC-134a	14.6	1,300
CF ₄	50,000	6,500
C ₂ F ₆	10,000	9,200
SF ₆	3,200	23,900

Figure 3- GWP Equivalents for Selected Gases

Source: U.S. EPA Climate Change: Global Warming Potentials

⁸ OECD Environmental Data Compendium 2002.

⁹ U.S. Green Building Council Buildings and Climate Change. Retrieved June, 2007.

Of the carbon dioxide equivalent emissions in the United States, the commercial and residential building sector accounts for 38% of all emissions, more than any other sector and therefore, a correspondingly high percentage of CO₂ emissions. Most of these emissions come from the combustion of fossil fuels to provide heating, cooling and lighting, and to power appliances and electrical equipment.

Nation/Region	Emissions (10 ⁶ metric tons of carbon equivalent)		
	1990	2003	2010
United States	1,359	1,582	23.2%
OECD Europe	1,116	1,164	17.0%
China	612	966	14.1%
Russia	637	438	6.4%
Other Non-OECD Asia	220	412	6.0%
Japan	276	329	4.8%
Middle East	192	323	4.7%
Other Non-OECD Eurasia	507	305	4.5%
India	158	279	4.1%
Central & S. America	184	275	4.0%
Africa	177	244	3.6%
Australia & New Zealand	79	113	1.7%
South Korea	64	128	1.9%
Canada	129	163	2.4%
Mexico	82	111	1.6%
Total World	5,792	6,831	100%

Source(s): EIA, International Energy Outlook 2006, June 2006, Table A10, p. 93.

Figure 4- CO₂ Emissions by Country

Source: U.S. Department of Energy: Energy Efficiency and Renewable Energy. 2006 Buildings Energy Data Book: World Carbon Dioxide Emissions Figure 3.1.5. Retrieved June, 2007.

Total Greenhouse Gas Emissions

The most widely used accounting tool to quantify all greenhouse gas emissions is the Greenhouse Gas Protocol (GHG Protocol), developed by the World Resources Institute and the World Business Council for Sustainable Development. The GHG Protocol provides the accounting framework for almost all GHG emissions standards and programs. The following is a summary of the accounting of Greenhouse Gas Emissions outlined in the standard:

DIRECT GHG EMISSIONS

Direct GHG emissions occur from sources that are owned or controlled by the company or institution in question. Typically these emissions are from combustion sources such as boilers, furnaces, vehicles, etc. Emissions from chemical production in owned or controlled process equipment would also be included in the direct emissions category. GHG emissions not covered by the Kyoto Protocol, e.g. CFCs, NO_x, etc. are not included but may be reported separately. The most common direct emissions are:

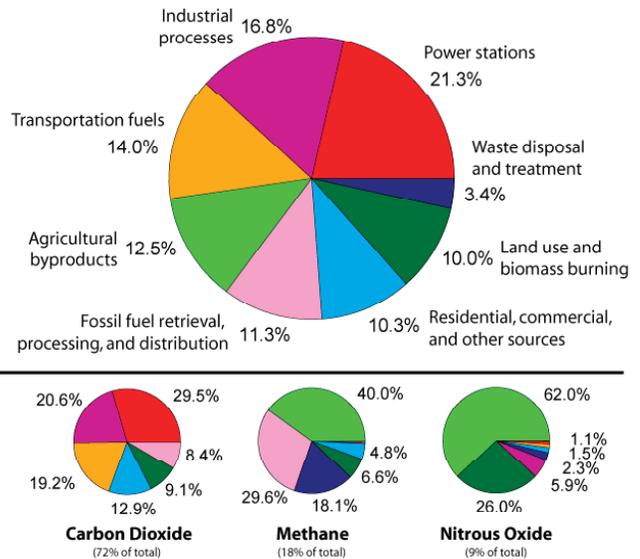
- On-site generation of heating water, steam or electricity.
- Physical or chemical processing Transportation of materials, products, waste, and employees

INDIRECT GHG EMISSIONS

Indirect GHG emissions occur from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the entity. These indirect emissions physically occur at the facility where electricity is generated.

Figure 5

Annual Greenhouse Gas Emissions by Sector



Source: Emission Database for Global Atmospheric Research version 3.2, fast track 2000 project.

OTHER INDIRECT GHG EMISSIONS

This is an optional reporting category that allows for the treatment of all other indirect emissions. These emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. The most common other indirect emissions are:

- Extraction and production of purchased materials and fuels
- Transport-related activities
- Sold electricity
- Leased assets, franchises, and outsourced activities
- Use of sold products and services
- Waste disposal



Greenhouse Gas Emissions Reduction Initiatives

Regulatory pressure to limit carbon dioxide emissions is increasing. The most internationally recognized regulation is the Kyoto Protocol. The Kyoto Protocol is an agreement under which industrialized countries will reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990. The goal is to lower overall emissions of six greenhouse gases - carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, HFCs, and PFCs - calculated as an average over the five-year period of 2008-12. National limitations range from 8% reductions for the European Union and some others to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland.

As of November, a total of 175 countries and other governmental entities had ratified the agreement. The notable exception is the United States. Other countries, like India and China, which have ratified the protocol, are not required to reduce carbon emissions under the present agreement.

Despite the lack of ratification of the Kyoto Protocol, on May 31, 2007, President Bush announced U.S. support for an effort to develop a new post-2012 framework on climate change by the end of 2008. President Bush announced that "the plan recognizes that it is essential that a new framework include both major developed and developing economies that generate the majority of greenhouse gas emissions and consume the most energy, and that climate change must be addressed in a way that enhances energy security and promotes economic growth."

Other notable international discussions on climate change include the non-binding 'Washington Declaration' at the G8+5 Climate Change Dialogue on February 16, 2007 and the 33rd G8 Summit on June 7, 2007. In the 'Washington Declaration,' Presidents or Prime Ministers from Canada, France, Germany, Italy, Japan, Russia, United Kingdom, the United States, Brazil, China, India, Mexico and South Africa accepted that the man-made climate change does exist and agreed in principle to a global cap-and-trade system that would apply to both industrialized nations and developing countries, which they hoped would be in place by 2009.

The same G8 leaders at the 33rd G8 summit issued a non-binding communiqué announcing that the G8 nations would "aim to at least halve global CO₂ emissions by 2050." The details enabling this to be achieved would be negotiated by environment ministers within the United Nations Framework Convention on Climate Change in a process that would also include the major emerging economies. Groups of countries would also be able to reach additional agreements on achieving the goal outside and in parallel with the United Nations process. Implementation of both international discussions is still forthcoming.

In the United States, two proposals for mandatory programs on greenhouse gases have been discussed in the Senate. Senator Bingaman has offered a proposal based on recommendations made by the National Commission on Energy Policy. Senators McCain and Lieberman reintroduced a modified version of their Climate Stewardship Act. A cornerstone of both proposals is an economy-wide tradable permits system, which imposes mandatory targets for large emitters and a market based system for meeting those targets.

In the current United States Presidential elections, Senators Obama and McCain have each outlined proposals for greenhouse gas cap-and-trade systems. Senator Obama's proposals cut U.S. emissions 80% below 1990 levels by 2050 and have provisions for auctioning emission credits and making polluters pay for the right to emit greenhouse gases. Senator McCain still supports the Climate Stewardship act, which would cap emissions from utilities, industry, and transport at 2004 levels by 2012 and then gradually decrease emissions to about 30% of 2004 levels by 2050.

Greenhouse Gas Emissions Reduction Initiatives



PROGRAM ELEMENT/RESULT	KYOTO PROTOCOL	CLIMATE INITIATIVE BUSH ADMINISTRATION	CLIMATE STEWARDSHIP AND INNOVATION ACT S.1151	BINGAMAN PROPOSAL
Mandatory / Voluntary	Mandatory	Voluntary	Mandatory	Mandatory
Target	Absolute 7% below 1990 levels by 2012	Intensity target goal 18% reduction by 2012	Absolute emissions 2000 emissions level after 2010	Absolute based on 2.4% intensity improvement 2010-2018, after 2019 target increases stringency to 2.8%
Offsetting Emissions Allowed for Compliance	Yes no limits specified through Kyoto, though implementing countries have discretion	N/A	Yes not to exceed 15% of allowance allocation	Yes Not to exceed 3%
Cost Cap	No	No	No	Yes - \$7
Stabilizes Emissions	Yes	No (12% above 2000 levels by 2012)	Yes	No (12% above 2010 levels in 2020)

Figure 6- Climate Policy Proposal Comparison

Source: Pew Center on Global Climate Change accessed June 8, 2007

VOLUNTARY REDUCTION INITIATIVES - THE CLIMATE REGISTRY

The predominant voluntary greenhouse gas reporting system in North America is the Climate Registry. It is a nonprofit organization that was created to record and track the greenhouse gas emissions of businesses, municipalities and other organizations. The data is then independently verified to ensure accuracy.

The registry, launched on May 8, 2007, is currently accepting greenhouse gas data to provide information for voluntary carbon-reduction initiatives including the Regional Greenhouse Gas Initiative in the Northeastern United States, the Western Climate Action Initiative, and by individual states. Currently, almost all of the United States and Canada have agreed to the principle goals to track and manage greenhouse gas emissions.



Figure 7- Entities Participating in the Climate Registry

OTHER VOLUNTARY REDUCTION INITIATIVES

Midwest Governors Association

10 Midwestern leaders (WI, MN, IL, IN, IA, MI, KS, OH, SD and Manitoba) attended the Midwestern Energy Security & Climate Stewardship Summit in November of 2007. Goals of the meeting included “transitioning to a lower carbon energy economy” and to “maximize the energy resources and economic advantages and opportunities of Midwestern states while reducing emissions of atmospheric CO₂ and greenhouse gases.”

Western Climate Initiative (WCI)

A group formed in February of 2007 designed to develop regional strategies to address climate change. Arizona, British Columbia, California, Manitoba, Montana, New Mexico, Oregon, Utah, Washington are members. The WCI’s most recent published goal (August, 2007) is to reduce regional greenhouse gas emissions by 15% below 2005 levels by 2020.

Regional Greenhouse Gas Initiative (RGGI)

An effort by Northeastern and Mid-Atlantic states that discussed the design and implementation of a regional cap-and-trade program. The initial scope includes only the carbon dioxide emissions from power plants in the region. In the future, RGGI may be extended to include other sources of greenhouse gas emissions, and greenhouse gases other than CO₂.

Advantages of Managing Greenhouse Gas Emissions



Based on mounting information regarding national and international policy and trading initiatives, managing greenhouse gas emissions may prove to be a valuable asset to the University.

MANAGING GHG RISKS AND IDENTIFYING REDUCTION OPPORTUNITIES

Compiling a GHG inventory will improve the University's understanding of its emissions profile and will prepare the University for any potential GHG liability or "exposure." The University may experience heightened scrutiny and may have to address environmental regulations or policies designed to reduce GHG emissions. Establishing University carbon dioxide equivalent emissions based on direct emissions is a step towards understanding the University's GHG liability, but may miss other indirect GHG sources that could result in a much higher GHG exposure. Conversely, a greater understanding of GHG emissions could result in more effective reduction strategies.

PUBLIC REPORTING AND PARTICIPATION IN VOLUNTARY GHG PROGRAMS

More public concern over the environment has called for a greater disclosure of public entities impact on the environment. Early and voluntary reporting of GHG emissions and progress towards GHG reduction targets can strengthen the relationship between the University and the public and may prove to be a useful marketing strategy.

PARTICIPATING IN GHG MARKETS

Market based approaches to reducing GHG emissions are emerging in North America, where GHG emissions are either taxed or traded. Managing total emissions can determine potential costs associated with a GHG tax or determine new revenue streams based on trading schemes.



Determining Campus Carbon Dioxide Equivalent Emissions

In order to determine campus carbon dioxide equivalent emissions, the following steps are required:

1. Gather all data to determine Scope 1 emissions. This includes fossil fuel consumption of all campus owned equipment and activities: heating fuels, emergency generator fuels, fuel associated with any transportation provided by campus owned vehicles. In addition, Emissions associated with
2. Gather all data to determine Scope 2 emissions. This requires the collection of the amount of all purchased electricity.
3. Determine the extent of Scope 3 emissions to be included in the report. Balance availability of Scope 3 emission information with impact on total carbon dioxide equivalent emissions.

This report includes data that could be reasonably gathered to determine campus carbon dioxide equivalent emissions. Scope 1 data includes all campus and off-campus natural gas usage. Scope 2 data includes all campus and off-campus electricity purchase. Scope 3 data includes transportation data from a February 14, 2008 draft report titled [UAA Inventory: Greenhouse Gas Emissions from Transportation](#). It is the assumption of this analysis that any remaining Scope 1 or Scope 3 data and their associated emissions is minor when compared to the Scope 1, Scope 2 and Scope 3 significant contributors included in the carbon dioxide equivalent emissions of the campus.

Campus Energy Consumption

NATURAL GAS USE

Gas bills from July 1999 through December 2007 were provided for review. Information from the year 1999 was not shown because the data did not cover a complete year. Natural gas serving the Main Campus and remote buildings is provided by Aurora Power. Main campus loads can potentially be consolidated into a heat sink, and so are broken out from the total UAA loads. The potential for creating a heat sink was discussed in more detail in a previous master plan report. Figure 3 shows all gas provided to the University from Aurora Power Resources, including the main campus and outlying buildings. Year to year gas use variations are affected by annual weather variation, the addition of two new buildings in 2004 and a significant conservation effort in 2006.

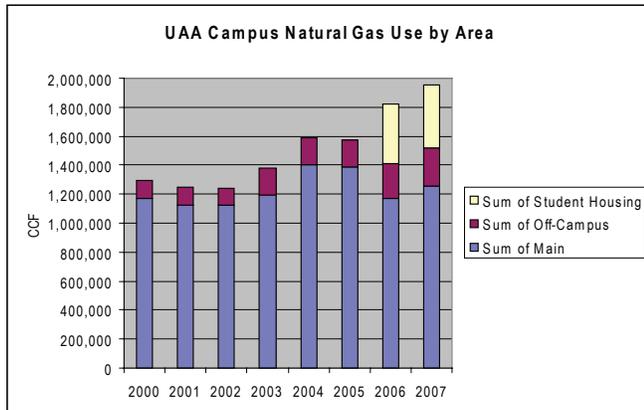


Figure 8- UAA Natural Gas Purchased 2000-2007

ELECTRICITY USE

Electricity bills from July 1999 through December 2007 were provided for review and again, 1999 is not shown. The electricity usage of the Main Campus has the potential for a combined heat and power plant, as outlined in our last report. Electric energy is very steady on campus and is primarily a factor of area served and number of students.

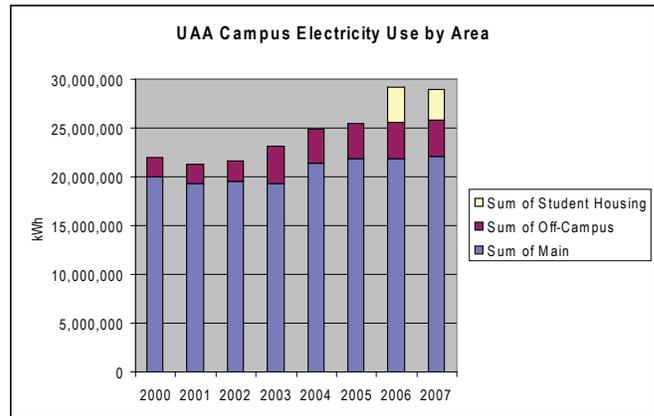


Figure 9- UAA Electrical Purchases 2000-2007

CAMPUS ENERGY INTENSITY

According to the Energy Information Agency, the 2003 national average site energy intensity for education buildings is 91 kBtu/ft².¹⁰ This is the sum of the major fuels serving the site divided by the total square feet, with no differentiation made based on climate or type of education buildings. If we assumed Kansas City, MO, represented an average climate for the lower 48 states, this would be translated to 19.1 btu/sf/HDD, where HDD= 65°F based heating degree days. Kansas City averaged 4765 HDD per year from fiscal year 2000-2006. In that same time period, Anchorage averaged 9661 HDD. For the year 2005, the University of Alaska campus had a site energy intensity of 182 kBtu/ft² or 18.63 btu/sf/HDD. On the surface, this compares favorably with the national average when corrected for weather.

¹⁰ EIA: U.S. Commercial Buildings Energy Intensity Table 7b. December, 2004.



Campus Carbon Dioxide Equivalent Emissions

The table below shows the greenhouse gas emissions (in equivalent carbon dioxide equivalent tons) associated only with campus natural gas use and campus electric use. The gas use is termed direct emissions, while electric use is considered an indirect emission, because the actual emissions take place remotely, at an electric power plant. Total greenhouse gas emissions include all emissions that are a result of direct and indirect activities of the University.

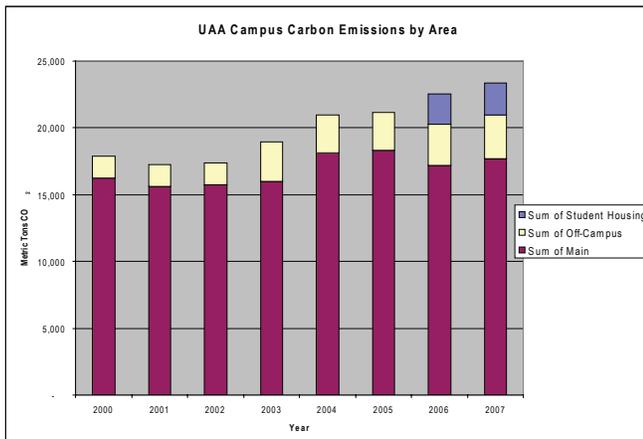


Figure 10- UAA CO₂ Emissions 2000-2007

An emission coefficient of .00049 metric tons of CO₂ / per kWh of electricity was used to generate the equivalent carbon dioxide emissions for electricity purchases. The number reflects a combined emission factor for the state of Alaska listed by the Chicago Climate Exchange and the Greenhouse Gas Protocol Initiative. However, a single emission number for Alaska may be inaccurate, as the foundation of the electricity emission coefficient, the North American Electric Reliability Corporation (NERC), has Alaska broken down into two subregions: AKMS (Most of Alaska) and AKGD (South/Central Alaska). The emission coefficient of the AKGD subregion is approximately 2.5 times as large as the emission coefficient for the AKMS subregion. In addition, The Energy Information Administration (EIA) Voluntary Reporting of Greenhouse Gases Program uses a conversion factor of .000626 metric tons of CO₂ / per kWh of electricity. However, the number is considered outdated, as it uses information from [EIA Updated State-and Regional-level Greenhouse Gas Emission Factors for Electricity \(March 2002\)](#). More investigation of the electricity emission coefficient and the effect of differing emission coefficients may be warranted.

An emission coefficient of .0055 metric tons of CO₂ / per ccf of natural gas was used to generate the equivalent carbon dioxide emissions for natural gas usage. This is based on 12.0593 pounds CO₂ per CCF of natural gas and 1 metric ton of per 2,205 pounds of CO₂ rounded to the most significant digit. (Source: [US DOE 1605\(b\) Voluntary Reporting of Greenhouse Gases Program](#)). Standard calculation tools like the Chicago Climate Exchange and the Greenhouse Gas Protocol Initiative also use .0055 metric tons of CO₂ / per ccf of natural gas.

Scope 3 Carbon Equivalent Emissions: Transportation

A separate analysis of the University of Alaska Anchorage's greenhouse gas emissions from transportation has been prepared by Nick Szymoniak, Kelcie Ralph and Steve Colt of the Institute of Social and Economic Research at the University of Alaska Anchorage. Using a February 14, 2008 draft report titled UAA Inventory: Greenhouse Gas Emissions from Transportation, the following information on the University's Scope 3 emissions was obtained:

- 2007 UAA commuter CO₂ emissions were estimated between 11,203 and 21,612 metric tons.
- UAA air travel was responsible 3,582 metric tons of CO₂ emissions in 2007.

UAA commuter emissions were determined from campus parking permits. The estimation appears to be the most reasonable method for approximating commuter emissions without surveying students and staff. However, the estimation might be affected by several issues:

1. Carpooling. Students with shared housing typically carpool. Excluding carpooling may over estimate total emissions.
2. Students making multiple trips per day to classes or campus activities. Students may not stay on campus for the entire day and may make multiple trips to the university.
3. Standard greenhouse gas emission accounting standards do not allow credit to be taken for commutes with multiple purposes. Protocols require that the University include all of the emissions associated with the trip. Including the credit may under estimate total emissions.

For the purposes of determining total campus carbon dioxide equivalent emissions, an average of the three commuter scenarios was used.

Emissions associated with UAA air travel followed Greenhouse Gas Protocol Initiative standards and appear to follow the most reasonable and accurate methods for estimating emissions.



Total Campus Carbon Dioxide Equivalent Emissions

Emissions Sources	Metric Tons CO ₂ e	Percent Total
Natural Gas - Main	6,911	15.6%
Natural Gas - Off Campus	1,462	3.3%
Natural Gas - Student Housing	2,380	5.4%
Purchased Electricity - Main	10,799	24.4%
Purchased Electricity - Off Campus	1,828	4.1%
Purchased Electricity - Student Housing	1,588	3.6%
Air Travel ¹	3,582	8.1%
Employee Auto Commute ²	1,482	3.4%
Student Auto Commute ³	14,196	32.1%
Total	44,228	Tons CO₂e
Scope 1 & 2 Emissions	24,968	Tons CO₂e
Scope 3 Emissions	19,260	Tons CO₂e

Figure 11 - Estimated 2007 UAA CO₂(e) Emissions

Notes:

- ¹ Air Travel from Draft2 of UAA Inventory: Greenhouse Gas Emissions from Transportation Report dated February 14, 2008
- ² Employee Auto Commute average of Commuter Model Scenarios from Draft 2 of UAA Inventory: Greenhouse Gas Emissions from Transportation Report dated February 14, 2008
- ³ Student Auto Commute average of Commuter Model Scenarios from Draft 2 of UAA Inventory: Greenhouse Gas Emissions from Transportation Report dated February 14, 2008

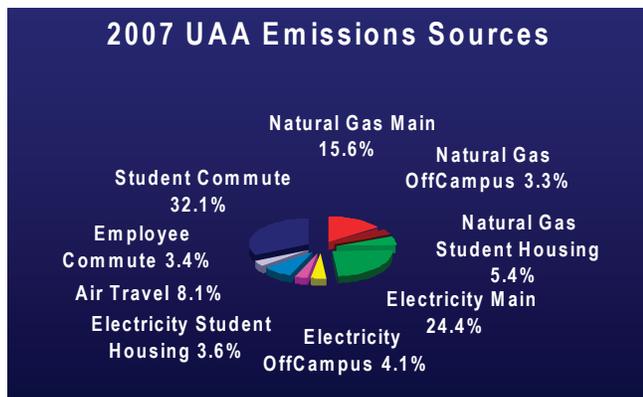


Figure 12- Estimated 2007 UAA CO₂(e) Emission Breakdown

Carbon Dioxide Equivalent Emissions Trading

Emissions trading (or cap and trade) is a market approach used to encourage pollution control by providing economic incentives for achieving reductions in the emissions of pollutants. The development of a carbon project that provides a reduction in Greenhouse Gas emissions is a way by which the University may generate tradable carbon credits.

In such a plan, a central authority (usually a government agency) sets a limit or cap on the amount of a pollutant that can be emitted. Entities or other groups that emit the pollutant are given credits or allowances which represent the right to emit a specific amount. The total amount of credits cannot exceed the cap, limiting total emissions to that level. Entities that pollute beyond their allowances must buy credits from those who pollute less than their allowances or face heavy penalties. This transfer is referred to as a trade.

Emission trading is not a new concept: Sulfur Dioxide (SO_2) has been traded since 1993 as part of the U.S. Environmental Protection Agency sulfur dioxide (SO_2) emissions trading program. An overall cap on SO_2 emissions was imposed on electric power plants to help reduce acid rain. Those power generators that find it expensive to cut sulfur emissions buy allowances from those power generators that make emit sulfur emissions below the cap. 12 million metric tons were traded in 2001 and the market has reached a value of approximately \$2 billion each year for registered trades.

TRADING SYSTEMS

Europe uses the European Union Emission Trading Scheme (or EU ETS) to trade greenhouse gas emissions. It is currently the only international greenhouse gas emissions trading scheme and was created in conjunction with the Kyoto Protocol. 25 countries in the European Union participate in the program since it began trading in January of 2005. The program caps the amount of carbon dioxide that can be emitted from large installations, such as power plants and carbon intensive factories and covers almost half of the EU's Carbon Dioxide emissions.

North America's only greenhouse gas trading scheme is the Chicago Climate Exchange (CCX). It is a voluntary program and has been trading greenhouse gas emission allowances since 2003. The companies joining the exchange have committed to reducing their aggregate emissions by 6% by 2010. An aggregate baseline of 226 million metric tons of CO_2 equivalent is accounted for in the exchange, which is equal to 4% of U.S. annual GHG emissions. The CCX has over 300 participants, including Dow Corning, DuPont, Ford Motor Company, as well as several national universities including the University of California – San Diego, Tufts University, and the University of Minnesota.

Figure 13-Source: Chicago Climate Exchange. Retrieved July, 2008.



MARKET DATA

Carbon emission trading has been steadily increasing in recent years. According to the World Bank's Carbon Finance Unit, 374 million metric tons of carbon dioxide equivalent (mtCO_2e) were exchanged through projects in 2005, a 240% increase relative to 2004 (110 million mtCO_2e) which was itself a 41% increase relative to 2003 (78 million mtCO_2e). In order to trade carbon dioxide equivalents through the Chicago Climate Exchange, participating entities must pay an entrant fee and an annual fee based on the baseline greenhouse emission data, either the average of annual emissions from 1998-2001 or the single year 2000. In addition, members of the exchange must commit to annual greenhouse gas emission reduction targets. Those who reduce below the targets have surplus allowances to sell or bank; those who emit above the targets must comply by purchasing carbon dioxide equivalent credits.

Purchasing Carbon Dioxide Equivalent Emissions Offsets

Using the yearly total carbon dioxide equivalent emissions profile from the yearly total natural gas and electricity allows for an estimate of the cost required to offset the emissions. A sensitivity analysis of carbon prices shows a range of \$93,500 to \$701,000 per year to pay to offset the CO₂ emissions from the current use of natural gas and electricity. The lower range for carbon dioxide equivalents is based on the current trading prices of Chicago Climate Exchange, while the high range of \$30.00/MtCO₂e is based on high carbon prices experienced in Europe in 2006.

Note: Carbon emission trading systems require that only scope 1 and scope 2 emissions are included when offsetting CO₂ emissions. The yearly cost of offsetting CO₂ emissions at \$4.00/MtCO₂e and \$30.00/MtCO₂e increases from \$93,500 and \$701,000 respectively to \$170,500 and \$1,280,000 when scope 3 emissions are included.

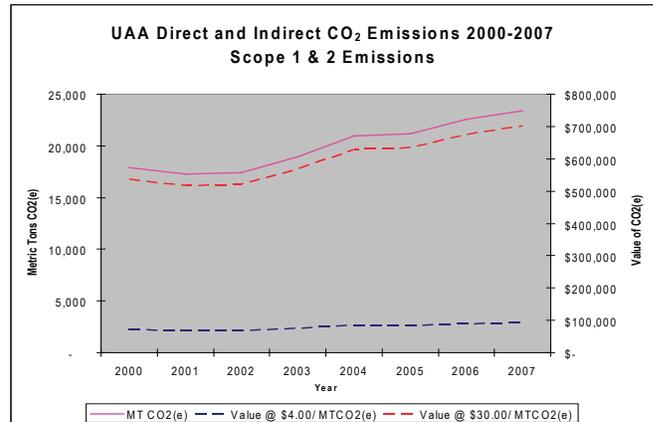


Figure 14- UAA CO₂ Emission Costs 2000-2007: Scope 1 & 2 Emissions Only

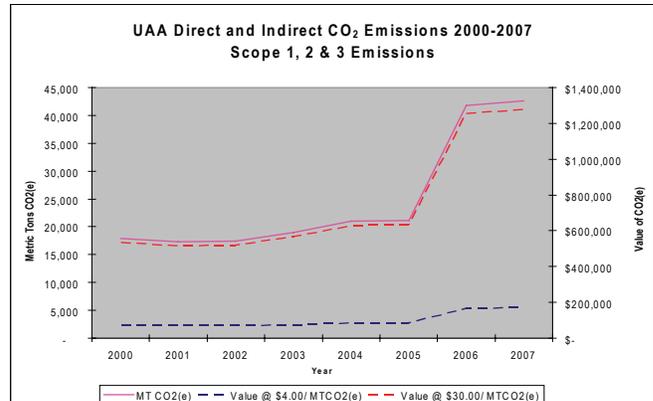


Figure 15- UAA CO₂ Emission Costs 2000-2007: Scope 1, 2 & 3 Emissions

Note: Scope 3 Emission data included in years 2006 and 2007 only



Fossil Fuel Reduction Strategies

The campus emitted almost 25-,000 tons of natural gas and electricity based CO₂ last year at a current voluntary market cost of \$93,500 to offset those emissions. Because the cost to offset those emissions is expected to climb, the University may find value in responding to potential regulations by using less fossil fuel on campus can be achieved by the development of several approaches. This can be achieved using several fundamental approaches:

GHG PROJECT	PROJECT ACTIVITY	PRIMARY EFFECT
Energy Efficiency	Improve energy efficiency of existing power consumers; boiler improvements, upgrading to energy-efficient light bulbs, etc.	Reduction in combustion emissions from on-site combustion sources or generating grid-connected electricity
CHP Plant	Improve energy efficiency of existing systems and generate grid-connected electricity	Reduction in combustion emissions from on-site combustion sources or generating grid-connected electricity
Wind Power	Generate grid-connected electricity from wind turbines	Reduction in combustion emissions from generating grid-connected electricity
Wood Biomass	Generate grid-connected electricity or central heat from waste wood	Reduction in combustion emissions from generating grid-connected electricity or on-site combustion sources using biogenic* carbon
Utilize Landfill Gas	1) Install equipment to capture methane 2) Generate grid-connected electricity from captured methane	1) Reduction in waste emissions 2) Reduction in combustion emissions from generating grid-connected electricity

Figure 16- Fossil Fuel Reductions Strategies

* Biogenic Carbon
Under international greenhouse gas accounting methods developed by the Intergovernmental Panel on Climate Change, biogenic carbon is part of the natural carbon balance and it will not add to atmospheric concentrations of carbon dioxide.¹¹ When biomass fuels contain only biogenic carbon – carbon produced by natural life processes, the carbon dioxide equivalent emission factor is zero.

¹¹ IPCC Greenhouse Gas Inventory Reference Manual: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 3, Pg. 6.28, (Paris France 1997)



Fossil Fuel Reduction Strategies

CONSOLIDATING HEATING LOADS: CAMPUS HEAT SINK

Before evaluating the fossil fuel reduction project options, development of a piping network to consolidate heating loads should be considered to maximize the efficiencies of centralized systems and maximize the economy of scale. The campus network allows for system improvements to apply to the entire campus.

Currently, sixty percent of the existing campus building area is heated by independent boiler plants. There are three main energy modules: EM #1, EM#2 and the housing heating plant that serve the remaining 40% of campus thermal load. Because sixty percent of the campus is heated by independent boiler plants, renewable energy projects employing direct fuel consumption have less economic justification in offsetting fossil fuel use and GHG emissions.

An [Energy Master Plan Report](#) prepared by HGA, Inc. in June, 2006 outlined centralized plant systems utilizing a campus heat sink. In the report, the estimate for establishing a campus heat sink was \$2,500,000. This included distribution piping from the central plant to new buildings, plus the cost of the heat recovery equipment within the plant. The distribution cost can be controlled and possibly reduced by tying in only the larger existing campus buildings to a centralized plant.

CHP: COMBINED HEAT AND POWER

Combined heat and power (CHP) plants reduce fossil fuel use by generating multiple energy streams from a single fuel input. CHP plants capture the byproduct heat of a conventional power plant electricity generation system and convert it into useful heat – typically useful for domestic water and space heating. Natural gas turbines provide the lowest first-cost for generating that electricity that can meet emissions standards. System fuel efficiency improves if the waste heat from the electric generating process is recovered and used to meet heating needs of buildings and process loads. While the efficiency of a conventional generation plant may be about 28 to 40%, CHP can provide fuel utilization efficiencies as high as 90%. This means that less fuel needs to be consumed to produce the same amount of useful energy, and less CO₂ emissions are produced for a given economic benefit.

The 2006 Energy Master Plan for the University of Alaska Anchorage that showed excellent potential for a central power production plant that uses recovered waste heat from the electric generating process to heat the campus. The CHP system is often employed where the price of electricity is high, fuel costs are low and where thermal energy can be aggregated into a centralized steam or hot water load. An estimated project cost for a CHP plant, including the addition of a campus thermal network that also has capacity to serve Providence Hospital is estimated at \$55 Million.

The University has several renewable energy sources that can reduce fossil fuel use: Wind Power, Wood Biomass and Landfill Gas.

WIND POWER

Wind power converts wind energy into more useful forms, usually electricity, using wind turbines. Based on the AWS Truewind Wind Resource Map of Alaska, there are opportunities available for the use of wind turbines to offset fossil fuel use. Anchorage presents slightly less opportunities as the surrounding areas, as its wind power capacity factor are on the low end of the range of completed wind power projects. Carbon dioxide equivalent reductions may provide enough of a benefit to make the projects practical.

WOOD BIOMASS

Depending upon gas prices and the availability of waste wood the University may consider solid fuels in the future as a way to diversify fuel sources or investigate and demonstrate new technologies. Wood fuel has several environmental advantages over fossil fuel. The main advantage is that wood is a renewable resource, offering a sustainable, dependable supply. Other advantages include the fact that the amount of carbon dioxide (CO₂) emitted during the burning process is typically 90% less than when burning fossil fuel. The principle economic advantage of waste wood (wood biomass) energy is that wood is usually significantly less expensive than competing fossil fuels. Public institutions, such as schools, hospitals, prisons, and municipality-owned district heating projects, are prime targets for using wood biomass energy. In 2004, the installed cost of a 1 to 5 million Btu/h (0.3 to 1.5 MW) wood fuel burner/boiler system was estimated at \$50,000 to \$75,000 per million Btu/h (0.3 MW) of heat input.¹²

Figure 14- Comparisons of Wood Biomass, Electric, Thermal and CHP facilities¹³

	Size (MW)	Fuel use (green ton/yr)	Capital cost (million \$)	O&M ^a (million \$)	Efficiency (%)
Electrical					
Utility plant	10–75	100,000–800,000	20–150	2–15	18–24
Industrial plant	2–25	10,000–150,000	4–50	0.5–5	20–25
School campus	N/A	N/A	N/A	N/A	N/A
Commercial/institutional	N/A	N/A	N/A	N/A	N/A
Thermal					
Utility plant	14.6–29.3	20,000–40,000	10–20	2–4	50–70
Industrial plant	1.5–22.0	5,000–60,000	1.5–10	1–3	50–70
School campus	1.5–17.6	2,000–20,000	1.5–8	0.15–3	55–75
Commercial/institutional	0.3–5.9	200–20,000	0.25–4	0.02–2	55–75
Combined Heat and Power (CHP)					
Utility plant	25 (73) ^b	275,000	50	5–10	60–80
Industrial plant	0.2–7 (2.9–4.4)	10,000–100,000	5–25	0.5–3	60–80
School campus	0.5–1 (2.9–4.4)	5,000–10,000	5–7.5	0.5–2	65–75
Commercial/institutional	0.5–1 (2.9–7.3)	5,000	5	0.5–2	65–75

^aOperating and maintenance.

^bSizes for the CHP facilities are a combination of electrical and thermal; the first figure is electrical and the figure in parentheses is thermal. 1MW = 3.413 million Btu/h.

¹² Forest Products Laboratory Techline: Wood Biomass for Energy. April, 2004.

¹³ IBID.

Renewable Energy



Wood biomass is typically combusted or gasified. These systems normally produce steam. Typically, wood in a variety of forms, particularly green chips (45% to 50% moisture content on a wet basis), is shipped and maintained at a holding site by the energy plant. Augers or belt conveyors transport the wood chips to the combustor, where they are burned, and the heat of combustion is transferred to a steam or hot water boiler. Steam is converted to electrical power by steam turbines. Excess steam can be used in other plant processes. Hot water boilers can provide heat to a building through a piping distribution network.

Wood gasification systems heat wood in an oxygen-starved environment until volatile pyrolysis gases (carbon monoxide and hydrogen) are released from the wood. Depending on the final use of the typically low-energy wood (producer) gas (~150 Btu/ft³ (5.6 MJ/m³)), the gases can be mixed with air or pure oxygen for complete combustion and the heat produced transferred to a boiler for energy distribution. HGA recently completed the design of a wood gasification plant for the University of Minnesota Morris campus for an approximate \$7 million in construction costs.

LANDFILL GAS

The EPA's Landfill Methane Outreach Program has identified the following criteria for identifying good landfill gas project sites:

- The site has at least 1 million tons of MSW in place.
- The site either is still receiving waste or has been closed for less than 5 years. (Landfill gas production tends to peak just after the closure of the landfill.)
- The depth of the landfill is 40 feet or more.

The current Anchorage Regional Landfill facility at Glenn Highway and Highland Road near Eagle River meets these criteria. The landfill is reported to have the capacity to produce 3.3 MW of power generation or approximately 38 MMBtu/hr.

Landfill gas is the natural by-product of bacteria decomposing the organic materials contained in landfills. Landfill gas is composed of approximately 55 percent methane and 45 percent carbon dioxide, along with some trace amounts of nitrogen, oxygen, hydrogen and nonmethane organic compounds. The gas has been primarily used to displace conventional fossil fuels by either directly using the landfill gases in fossil fuel-consuming equipment such as boilers or by using the landfill gas in electricity generation.

Direct-use applications typically are the most environmentally and economically attractive. Direct-use applications provide the most thermally efficient use of landfill gas and the greatest opportunity to be cost-competitive with traditional fuel alternatives. Practical and cost limitations typically limit the use of the landfill gas to 5 to 10 mile from the landfill. Where piping landfill gas is costly or impractical, on-site conversion of landfill gas to electricity is the other option. In 2002, the estimated 15-year average revenue required to recover all costs for a 52.5 MMBtu/hour direct-use landfill gas project fueling two 50,000-pound-per-hour steam boilers and provide a 9 percent internal rate of return to develop, construct, and operate a 6-mile pipeline and associated boiler retrofit is estimated at \$2.03/MMBtu. Using 2002 data, the cost of landfill gas would be additive at a nominal value of about \$0.40/ MMBtu. This would result in the total delivered cost of landfill gas at \$2.43/MMBtu. The capital and operating costs of a dedicated pipeline make the net cost of fuel delivered directly a function of distance and capacity.¹⁴ A recent direct-use landfill gas project with 8-miles of pipeline was completed in South Carolina for approximately \$13 million.

¹⁴ WRI Corporate Guide to Green Power: Opportunities with Landfill Gas. September, 2002.



Renewable Energy

On-site conversion of landfill gas to electricity mitigates the key constraint of direct-use projects—having a facility that can utilize the landfill gas within close proximity to the landfill— and expands the potential customer base for landfill gas to the entire electric market. In 2002, the estimated 15- year average revenue required for a 5 MW landfill gas-to- electricity project without any advantaged cost structure can range from \$44 to \$48/MWh. Changes in one or more elements of operating cost can quickly increase or decrease the revenue required to support a generation project. A recent 6 MW on-site electricity generation plant in Florida was completed for approximately \$10 million.

Figure 15- Landfill Gas Electricity CO₂ Equivalent Reductions

3.3 MW Landfill Gas Electricity Generation Total Equivalent Emissions Reduced [Total = Direct + Avoided]		
MMTCO₂E/yr	tons CH₄/yr	tons CO₂/yr
million metric tons of carbon dioxide equivalents per year	tons of methane per year	tons of carbon dioxide per year
0.1423	6,574	18,797

Figure 14- Landfill Gas Electricity CO₂ Equivalent Reductions

Generated from Landfill Methane Outreach Program: Emissions Reductions and Environmental and Energy Benefits for Landfill Gas Energy Projects Calculator

¹⁵ WRI Corporate Guide to Green Power: Opportunities with Landfill Gas. September, 2002.



Additional Fossil Fuel Reduction Project Benefits

Renewable fuel sources can act as a long-term price and volatility hedge against fossil fuels, especially natural gas and oil. In Anchorage all electricity is produced with natural gas, however, the pricing for the gas used to generate the electricity reflects the cost of production, rather than market value in the rest of the nation. Because the natural gas in Anchorage is stranded from the national and international markets, its price is indexed to increase its value and at the same time reduce its volatility. The link between the price of natural gas and the price of electricity has increased substantially as more electricity is generated from natural gas each year. Fuel sources such as waste wood and landfill gas provide a long-term supply of energy that can displace market purchases of natural gas, providing fuel at low, stable prices.



Conclusion

UAA has an opportunity to invest in fossil fuel reduction projects that can both address potential costs associated with greenhouse gas emissions and might provide a new environmental revenue stream through trading of carbon dioxide equivalents. These projects can support upgrades to the utility infrastructure while providing some buffer to high-energy process. Detailed work is required to focus on the most productive strategy that can be implemented for the campus, balancing investment with environmental goals; operational complexity with protecting against regulatory risk.

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