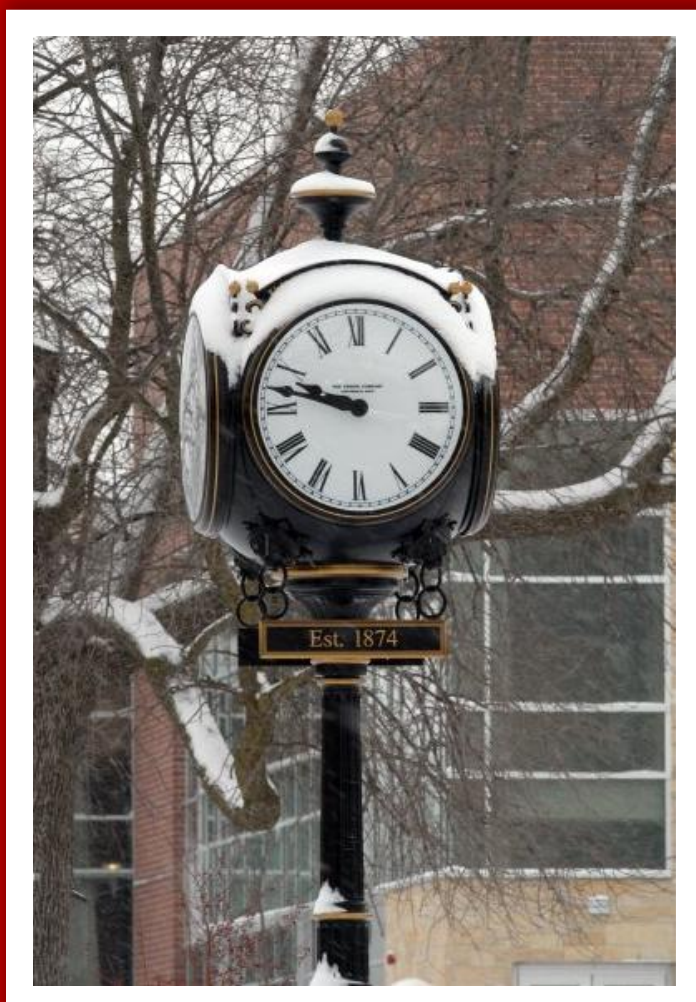
2012 Climate Action Plan

University of Wisconsin – River Falls

Prepared by the St. Croix Institute for Sustainable Community Development



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Acknowledgements

The UWRF 2012 Climate Action Plan is produced by the St. Croix Institute for Sustainable Community Development (SCISCD) in close cooperation with the UWRF Sustainability Working Group (SWG), the SWG Energy Sub-Working Group, the staff of Facilities Management, the Budget and Finance Office, and the Sustainability Faculty Fellows. This document has been co-authored by Kelly Cain and Ian Johnson, but is the work of the many people noted below. Greenhouse gas emissions data were compiled by Bo Storozuk, Haiya Zhang, and Ian Johnson using Clean Air Cool Planet Campus Carbon Calculator™ v6.4. Special Thanks is extended to Mike Stifter, Director of Facilities, Greg Koehler (retired) and especially to Timothy Thum, Facilities Engineer, for his extensive contribution to the carbon footprint data, calculations, and guidance. Special thanks is also extended to Dr. Brian Copp (retired) who was unrelenting in contribution to the curriculum portion of this report, as a sub-set to his primary authoring of the same for the Sustainable Campus~Community Plan.

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Cover photo of campus mall clock by Jens Gunelson, UWRF Photo Services (retired)

Executive Summary

The overarching goal of the UWRF Climate Action Plan (CAPlan) is to provide informed guidance and recommendations for achieving institutional leadership as a sustainable campus~community, especially in regards to carbon neutrality at a minimum — and 'Cash Positive - Carbon Negative' as the preferred and necessary outcome.

This document provides the critical information and assumptions necessary for successful strategies and budget decisions that collectively achieve carbon negativity through curriculum programming, facility design and operational systems, administrative processes, financial investment, and most critically through the behavioral choices of our students, faculty, staff, and stakeholders. This document also notes that carbon neutrality – in the simple form of carbon credit purchases – can be achieved today for approximately $317,021. This option, while achieving the minimum goals set forth by this plan and the SWG, offers the least amount of curriculum and research integration and no direct financial payback.

The UWRF CAPlan will ultimately lead 'beyond sustainability' to climate restoration being reinforced in the UWRF mission, vision, and values, educational programming, facilities design, operational systems, administrative processes, financial management, and social and organizational investments.

A brief review of the major milestones leading up to the production of the CAPlan follows:

> In September of 2006, Governor James Doyle targeted UWRF as one of four UW System campuses to go "off the grid by 2012". In December of 2006, former UWRF Chancellor Don Betz signed the American College and University Presidents' Climate Commitment (ACUPCC) as one of the charter signatories to publicly proclaim that UWRF will take steps to plan and achieve climate neutrality (see Appendix B).
>
> In May of 2007, with Goal 2 of the campus strategic plan (i.e., UWRF will model and champion the principles of sustainable community development), the St. Croix Institute for Sustainable Community Development (SCISCD) was established to carry out that goal both on campus and in communities across the region and beyond. In addition, the Sustainability Working Group (SWG) was formed to address the key tasks of Goal 2.
>
> The ACUPCC commitment requires that a full carbon footprint be calculated for the campus. This was completed in 2008 totaling approximately 30,000 metric tons for the 2006-07 benchmark year. UWRF also institutionalized several policy initiatives, and began making plans for a CAPlan required within two years of the original commitment in 2006.
>
> In December of 2009, Chancellor Dean Van Galen publicly reinforced his unequivocal reaffirmation of the ACUPCC commitment and development of the CAPlan (see Appendix A). The SCISCD, the CAPlan Steering Committee and others have subsequently produced this document.

> The 2012 Strategic Plan, Pathways to Distinction, has once again strongly affirmed the campus commitment to sustainability.

The 2012 Climate Action Plan examines our campus progress to date on climate action, discusses the integration of educational, operational and financial dimensions, future greenhouse gas (GHG) reduction strategies, and includes these notable elements:

- Updates the 2006 emissions level baseline resulting from the most recent emissions inventories for 2007-08 and 08-09, with cumulative reporting back to 1990;
- Sets carbon neutrality target dates with farthest horizon of 2018;
- Presents and evaluates data on the campus that includes emission reduction projects and funding mechanisms that will help to guide the campus to our 2018 target;
- Establishes a cash positive - carbon negative, campus rolling target of at least 10% beyond carbon neutrality;
- Commits to annual carbon footprint and CAPlan updates; and
- Integrates climate action initiatives with UWRF strategic planning.

Introduction

Sustainability is already a fundamental mission of UWRF as a result of our strategic plan. UWRF has a long history of "sustainability-based" initiatives as part of its cultural fabric. The campus is committed to providing a premier national model and leadership in this regard.

This UWRF Climate Action Plan (CAPlan) is a core document that will impact the future direction of the campus and community. It will guide the evolution of our *Pathway to Distinction* strategic plan, our Sustainable Campus~Community Plan, our Campus Master Plan, and our commitment as a signatory to the American College and University Presidents' Climate Commitment (ACUPCC).

Moreover, the CAPlan is also a strategic response to Wisconsin state directives and policies for leadership in energy independence, greenhouse gas reduction, and economic security. From the Governor's Office to the Department of Administration, Office of Energy Independence, Department of State Facilities, UW System, and Focus on Energy, the trend for higher and higher levels of sustainability-based energy and carbon performance are unquestionable. Appendix C provides the most critical references in this regard.

The ACUPCC commitment directly and indirectly pledges application of carbon neutrality across all facets of the university. For use with an integrated planning approach, this includes, but is not limited to: mission, vision, and values; learning objectives and assessment; academic programming (curricular and co-curricular); campus planning; facility design; operational systems; administrative processes; and budgetary decisions and financial advancement.

As Chancellor Van Galen expressed in his formal charge of December 15, 2009 (see Appendix A), the Sustainability Working Group (SWG) is to produce a Climate Action Plan and the Sustainable Campus~Community Plan, with his unequivocal support for these initiatives.

Ironically, at this writing (2012), U.S. public opinion leans toward some level of "doubt" regarding the degree to which global climate change is a real threat, but especially to the degree to which it is anthropogenic (human caused). The evidence suggests that there is significant influence on public opinion based on scientific literacy versus personal experience and political viewpoints, as well as confusion between climate and weather.

The most recent Proceedings of the National Academy of Science found that "…97–98% of the climate researchers most actively publishing in the field support the tenets of ACC [anthropogenic climate change] outlined by the Intergovernmental Panel on Climate Change" and that "the relative climate expertise and scientific prominence of the researchers unconvinced of ACC are substantially below that of the convinced researchers." http://www.pnas.org/content/early/2010/06/04/1003187107.full.pdf+html The opinion of the general public, however, lags well behind this consensus according to the latest Pew Research Center survey: "Roughly a third (34%) say that global warming is

occurring mostly because of human activity, such as the burning of fossil fuels…"
http://people-press.org/2010/10/27/little-change-in-opinions-about-global-warming/

Political compromises on the world stage currently target an 80% reduction of 1990 CO_2 equivalent emissions by 2050 in order to presumably reach carbon neutrality by 2100 and level off at 450 ppm CO_2 equivalent (hoping to limit the planet to a 2 degree Centigrade average temperature rise).

Meanwhile, a select group of scientists led by James Hansen (Chief Climate Scientist and Director of the NASA Goddard Space Institute at Columbia University), is calling for radical carbon negative and carbon tax strategies to return the atmosphere to 350 ppm as quickly as possible (from the current seasonal average of 392 ppm, rising at ~ 2.5 ppm annually).

The Intergovernmental Panel on Climate Change (IPCC) is very clear in stating the cause and effect relationship between human activity, observed temperature changes, and resulting global conditions. As per the 4th Assessment Report in 2007:

> Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004 {2.1}
>
> Global atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. {2.2}
>
> There is *very high confidence* that the net effect of human activities since 1750 has been one of warming.[6] {2.2}
>
> Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations.[7]
>
> http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms2.html

It is the collective judgment of the UWRF SWG that the data, analysis, synthesis, and conclusions of the national and international climate science community point to the need to act quickly and decisively. This need reflects not only the educational, technical, and financial advantages to a decisive response, but also a moral responsibility we have to future generations.

As a charter and leadership signatory to the ACUPCC in 2006, and as a community of science, we choose to meet and exceed carbon neutrality with a commitment to national leadership as a sustainable campus~community. The unpredictability of the speed of climate change in addition to the changing carbon footprint of the campus calls for a "Cash Positive - Carbon Negative" agenda.

To lead this effort, we choose to recognize and respond through innovation and entrepreneurial driven opportunity, in a way equal to or greater than the technical and time sensitive scale of the issue.

This plan focuses on the "Best Design and Management Practices" (BDMPs) currently being considered by campuses across the country and internationally. We will adapt and synergize these BDMPs to our unique circumstances to maximize the triple bottom line performance (ecologic, social, and economic), and demonstrate exemplary leadership to our students, our local and regional stakeholders, the taxpayers of the state, and beyond.

Fundamental and paramount to this effort (as an equal partner to technical solutions), is the educational benefit to our students. This plan provides recommendations for a sustainability-based curriculum and pedagogical initiative that immerses our students (as well as faculty and staff), in a place-based experiential environment. It is a model by which the values, principles, and practices of carbon-negative sustainable community development become integrated into their personal, professional, and civic lives, as per the spirit-of-intent of our official sustainability definition ....

"UWRF defines sustainability as our local and global responsibility to meet the needs of present and future generations, as demonstrated by an integrated set of *ecologic, social, and economic* values, principles, and practices that frame how we think, choose, and act in personal, professional, and community life."

To be relevant and viable as a public supported institution amidst the sustainability-based challenges of the future, UWRF chooses to provide real life solutions. These solutions strive to meet the environmental and social needs of the average person in an economically positive way.

This climate action plan represents our current best thinking in how to take this first step from strategic planning to strategic doing. We invite the campus and the community to join in this effort that is clearly one of the most important initiatives in the history of this institution.

A ***Cash Positive – Carbon Negative – Energy Self-Sufficiency*** approach is ultimately where the climate science indicates we need to go, and ultimately "where the money is" in the long term .... We choose to go now.

Thank You
The Sustainability Working Group
UW-River Falls

Core Objectives & Recommendations

The proposed 2012-17 Climate Action Plan (CAPlan) aims higher than ordinary commitments to reduce emissions by seeking to eliminate or offset all greenhouse gas (GHG) emissions to net zero by 2018. The objective has been to identify strategies for reducing UWRF emissions as inexpensively as possible and in an economically positive manner over the long term through conservation, efficiency, production, and external offset purchase across the three scopes outlined in the Greenhouse Gas Protocol Initiative as well as Curriculum and Research:

Table 1: Summary of Reduction Strategies

Conservation	Efficiency	Production	Offset Purchase	Total
5,823 mT CO_2e	1,135+ mT CO_2e	13,151+ mT CO_2e	35,114+ mT CO_2e	55,223+ mT CO_2e

The university can save energy and reduce emissions economically by adopting conservation practices in daily life and infusing them into the curriculum, investing in cost-effective measures that reduce energy bills and improve performance and efficiency, investing in localized and commercial scale renewable energy production, investing in local carbon capture and offset efforts, and purchasing external carbon offsets where other methods cannot effectively be used. It is generally recognized that the preceding list of efforts is the order of priority from a return on investment standpoint, whereby the lowest hanging fruit can have the biggest impact per time and money investment through conservation and education efforts, while the purchase of offsets has very little economic return on investment and should be reserved as a last option when the other four options are not feasible in any way.

The core objectives of the 2012 UWRF CAPlan are the following:

- To provide a Climate Action Plan consistent with sustainability as a part of UWRF's strategic planning.
- To create, publish, and promote a premier model GHG reduction strategy that informs and is integrated into the campus master plan, strategic initiatives, and especially academic programming.
- To assess the technical, economic, and GHG reduction feasibility for achieving carbon neutrality (as the foundation for at least a ten percent carbon negative performance) for UWRF by the year 2018 through a prioritized combination of energy conservation, technological efficiency, renewable energy production, and carbon credit offsets.
- To identify the optimum combination of behavioral changes, curriculum integration, campus-wide policy initiatives, facility and operational best design and management practices (BDMPs), cost-saving technology, innovative

financing mechanisms, and a carefully phased implementation plan to achieve this goal.
- To inform the UW System Board of Regents, state agencies, and others of the UWRF CAPlan, and to seek support for implementation strategies, recommended projects, and financing.

Recommendations: Each department has been asked to evaluate their impacts on GHG emissions at UWRF based on the most recent GHG inventory. The inventory breaks emissions down into three scopes[1] depending upon degree of responsibility the university has for those emissions. See Table 2 for information regarding the latest GHG emissions inventories.

This plan and its recommended strategies, initiatives, and budget recommendations are simply that: recommendations. The plan in no way (implied or explicit) dictates any actions or prescribes administrative or executive decisions due to unpredictability of:

- State policy, mandates, budget support and decisional flexibility
- Federal and other external funding sources
- Availability of state of the art technologies at an affordable price
- Price or valuation of carbon
- Price of commodity resources: thermal & electrical rates
- UWRF Foundation performance & support
- Student tuition & fee support
- Necessary executive flexibility to address challenges and to seize opportunities

[1] Scope 1 emissions are defined as all direct emissions the university is responsible for such as the heating plant, direct university travel, and agriculture; Scope 2 emissions are defined as indirect emissions resulting from the consumption of purchased electricity, heat, and steam; Scope 3 emissions are defined as all other indirect emissions such as waste disposal, transmission distribution and losses resulting from Scope 2 activities, employee and student commuting, outsourced activities, etc.

Table 2: Annual Emissions Breakdown by Sector
See Appendix D for full GHG Emissions Inventory

	mT CO_2e			
Scope 1 Emissions	**2006**	**2007**	**2008**	**2009**
Heating Plant Combustion	9,878.2	10,440.8	10,031.5	8,433.6
Direct Transportation (University Fleet)	305.3	301.0	296.5	291.4
Fugitive Refrigerants and Chemicals	64.0	92.5	92.5	91.2
Agriculture	550.6	594.2	605.5	597.1
Total Scope 1 Emissions	**10,798.1**	**11,428.6**	**11,026.0**	**9,413.3**
Scope 2 Emissions				
Purchased Electricity	13,872.2	10,282.5	9,601.8	9,096.0
Total Scope 2 Emissions	**13,872.2**	**10,282.5**	**9,601.8**	**9,096.0**
Scope 3 Emissions				
Faculty/Staff Commuting	558.0	578.7	583.5	599.4
Student Commuting	2,981.1	3,135.7	3,185.8	3,269.9
Falcon Programs Travel	-	-	-	3.2
Study Abroad Air Travel	1,508.1	1,904.9	2,307.2	2,652.8
Solid Waste	396.8	391.4	585.5	487.9
Paper	204.0	204.0	204.0	204.0
Scope 2 Transmission & Distribution Losses	1,372.0	1,070.0	949.6	899.9
Total Scope 3 Emissions	**7,020.0**	**7,231.7**	**7,815.6**	**8,116.8**
Offsets				
Sequestration by University Owned Forest Preserve	-21.0	-21.0	-21.0	-21.0
Composting	-0.4	-0.4	-0.4	-0.4
Renewable Energy Credit Purchases	-520.1	-556.0	-1,319.1	-2,638.3
Total Offsets	**-541.5**	**-2,659.7**	**-1,340.5**	**-2,659.7**

Cost Implications

Each reduction strategy typically has a cost associated with it. However, those costs are often offset by future savings in power, fuel, or other. Each reduction strategy has, to the best of our ability, been evaluated for initial costs, future savings, and immediate cost avoidances. In many cases, the costs to implement the strategy are offset in immediate cost avoidances, as with Efficiency Reduction Strategy 2 or are recouped within a short window. Others have a decided up-front cost and gradual ROI, while others may never pay for themselves outright. Few infrastructure expenditures, however, have an ROI; when was the last time a new building paid for itself over *any* period of time? Looking simply at ROI is often a misguided accounting method that ignores at least two of the three bottom line measures involved in true cost accounting.

No attempt has been made to account for the price of carbon. At the time of this writing, the North American market for carbon emissions is closed, while the European and Australian markets continue to hold values near or above $20USD per mT. Despite the closing of the North American market in 2010, a re-emergence is all but guaranteed. Carbon emitters are simply at the end of the era where they are allowed to dump emissions into Earth's atmosphere for free – one need simply note the scrambling for long-term carbon credit contracts by nearly all power producers (gas, oil, and coal companies) as a barometer of things to come. In the spirit of speculation, the following is a valuation of current university carbon emissions at various levels:

Table 3: University CO_2e Emissions Valuations

$0.10/mT	$0.20/mT	$0.50/mT	$1/mT	$2/mT	$5/mT	$10/mT	$15/mT	$20/mT	$25/mT	$30/mT
$2,396	$4,792	$11,980	$23,966	$47,932	$119,830	$239,664	$359,496	$479,328	$599,160	$718,992

With these numbers in mind, the cost of business as usual becomes increasingly expensive as carbon emissions begin to assume a value worldwide. Indeed, the cost of doing nothing (i.e., business as usual) becomes nearly a three-quarter million dollar liability should we begin to value carbon the way a large portion of the rest of the world currently does. Add this liability to the foregone immediate cost avoidances and annual savings on expenditures outlined in the following reduction strategies, and business as usual quickly becomes a losing endeavor in which our university assumes millions in expenditures over the cumulative savings of carbon-negativity through a combination of the strategies that follow.

As for a carbon-negative strategy … it doesn't take much imagination to see the associated positive cash flow.

Recent Reductions

UWRF has been actively reducing emissions through conservation and efficiency projects for many years – since the early 1970's from a recent account. A partial list of recent and planned projects since our last (2009) Greenhouse Gas Emissions Inventory attempting to give evidence of our action-oriented mindset follows:

Table 4: Recent/Planned Emissions Reductions Strategies

Emissions Reduction Strategies Recently Implemented, in Progress, or Planned	
Strategy	**Information**
Campus Utilities Master Plan	The FY12 Campus Master Plan applies to utilities and associated emissions
Energy Efficiency Throughout Building Design Process	Division of State Facilities requires all buildings to be built to LEED Silver standards or higher; University Center has countless sustainability design features; South Fork Suites II will be LEED Silver certified; Falcon Center (FY15) is planned to be LEED Silver Certifiable; University Center is a prime candidate for LEED-EB certification
Commit to Renewable Energy Demonstration Projects	Commissioned a study in partnership with Energy Center of Wisconsin/WPPI to identify an off-the-grid pathway (FY08); Partnered with Focus on Energy for a Wind Turbine Feasibility Study (FY11); RDI was first building on campus to incorporate solar hot water in FY10; South Fork Suites II have 16 solar hot water panels following the feasibility demonstrated by RDI; 17kW photovoltaic project on RDI planned for FY13; Campus Heating Plant has experimented with biomass in lieu of coal
Retro-commissioning Projects	Ongoing; examples include RDI; upcoming projects include Rodli, Johnson Hall, etc.; Attention given over multiple FY's to 'fine-tuning' operational items, HVAC, energy tracking, etc. in multiple buildings that may not otherwise fall under "Retro-commissioning"

Lighting Update/ Campus Lighting Policy	De-lamping project in process; lighting standards scheduled to be developed by FY13
Fume Hood Energy Consumption	Sash labels for education/awareness; fine tune to meet standards but not excessively exhaust (FY09)
Residence Hall Appliance Policy	All rooms will be provided with energy efficient micro-fridge; no outside fridges allowed to be brought in (FY12)
Dining Services	(FY11) Hoods put on variable speed drives tied to air quality sensors
Correct Inefficiencies in Campus Utility Distribution Systems	(FY10) Removed bottlenecks and incorporated valve efficiencies to take individual buildings offline during summer – expand into the future; (FY13/14) Electrical distribution project to rebuild substation w/ looping, etc. for system efficiencies
Energy Monitoring	(FY09) KFA ventilation project and sensor integration improved IAQ without increase in energy use; (FY12) Remote sensor/monitoring/control incorporated into campus utility systems
Centralize Utility Systems	Chilled water plant centralization
Develop Boiler Efficiency and Emissions Reductions	(FY09-10) Rebuilt boilers 1 and 2 to also be more efficient
Alternative Energy Sources	Test firings at central heat plant with biomass pellets (FY09)
Integrate use of Variable Frequency Drives Where Possible	Continuous expansion – (FY08) Wyman Education Center
Evaluate Feasibility of a Carbon Neutral Power Plant	Energy Center of Wisconsin study on campus carbon neutrality (FY09)

Reduction Strategies

Reduction strategies are organized by priority of impact, with conservation reductions having the biggest 'bang for the buck' and offsets being the least effective from both a return on investment standpoint, as well as a lack of further educational benefit.

Potential curriculum/research integration strategies are also suggested, although this is by no means exhaustive. These suggestions are purely a small sample of the large number of multi-disciplinary contexts that could be realized. They are not prescriptive in any way and are simply meant to open the dialogue to pedagogical means by which we, as an institution of higher education, engage our students in cutting-edge, real-world application of sustainability-based values, principles, and practices.

In order to provide the most comprehensive breakdown by which to consider reduction strategy options, fullest consideration has been given to the cost, time, and processes required in addition to the reduction in GHG emissions. Directors or personnel who are responsible for the areas outlined have evaluated these strategies. However, because of the nature and scope of many of these projects, numbers are still estimates at best and not intended to quantify actual costs, emissions reductions, or other. These are simply presented as a guide of projects that could lead UWRF to carbon-negativity and the associated costs and benefits.

Table 5: Summary of Reduction Strategies

	Approx. GHG Reduction Impact (mT CO_2e)	Cost to Implement	Timeframe to Implement	Simple Payback
Conservation				
Strategy 1	2,286	$10,000	0-2 years	0 years (Immediate)
Strategy 2	2,286	$2,000	0-2 years	0 years (Immediate)
Strategy 3	399.3	$150,000	2 years	3 years
Strategy 4	359.4	$300,000	4 years	8 years
Strategy 5	227	$12,000	0-2 years	Unknown
Strategy 6	227	Unknown	5 years	Unknown
Strategy 7	39	Varied	1-5 years	None
Efficiency				
Strategy 1	35.3	$45-55,000	0-5 years	7-10 years
Strategy 2	Unknown	$2,800,000	0-5 years	0 years (Immediate)
Strategy 3	760.7	None	4 years	0 years (Immediate)
Strategy 4	145.7	None	0-5 years	0 years (Immediate)
Strategy 5	79.9	$80,000	2 years	14 years
Strategy 6	74.5	$80,000	2 years	14 years
Strategy 7	39	$6,000	0-2 years	1 year
Strategy 8	Unknown	Minimal	Unknown	2-5 years
Production				
Strategy 1	1,150.7	$2,610,000	5+ years	31 years
Strategy 2	7,327	$7,000,000	0-5 years	Varied

Strategy 3	4.2	$12,800	1 year	31 years
Strategy 4	113.9	$6,600	0-2 years	Unknown
Strategy 5	3,703.9	$80-160,000	2-3 years	12 years
Strategy 6	832	$30-60,000	2-3 years	17 years
Strategy 7	18.8	$25,000	0-1 year	15 years
Offset				
Strategy 1	23,966.4	$317,021	1-5 years	None
Strategy 2	8,435.4	Unknown	5+ years	Unknown
Strategy 3	Unknown	None	0-3 years	N/A
Strategy 4	2,652.9	$3,000	0-3 years	None
Strategy 5	Unknown	$1,000	0-2 years	None
Strategy 6	1.78	$1,500	3-5 years	2.5 years
Strategy 7	64.6	$40-60,000	0-2 years	5.5-14.5 years
Applicable Totals	**55,229+** [2]	**$13,755,720-13,895,720+**		

[2] This number includes a total offset purchase for all university emissions. However, even excepting total offset purchases outlined in Offset Strategy 1, the total strategies outline 31,256 mT CO_2e – enough to bring the university to 30% carbon negativity.

Conservation · Reduction Strategy 1:

Campus-wide awareness program (Behavior modification)

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

22,860 mT CO_2e (all campus emissions)

Approximate impact of strategy on GHG emissions:

Up to 2,286 mT CO_2e annually (UNEP, 2007; USDOE, 2007)

Scope(s) Impacted:

Scope 1 Scope 2 Scope 3

Timeframe to implement:

0-2 years; ongoing assessment required

Steps required to implement:

- Develop baseline information
- Possible campaigns include: Create a Conservation Fellowship Program; Create a Building Stewardship Program for building users; Redesign the Sustainability Kiosk in the University Center; Various third party tracking/dashboard proposals

Approximate cost to implement strategy:

Initial Cost:

Approx. $10,000 based on recent proposal

Recurring Costs:

Approx. $10,000 annually based on recent proposal

Immediate Cost Avoidances:

Up to $225,600 (based on 10% energy usage/emissions reduction)

Simple Payback:

Immediate

Primary department/director/office to handle implementation:

Sustainability, Facilities

Curriculum/Research Integration:

Develop marketing courses to facilitate conservation awareness (i.e., student designed campus-wide survey to gauge student, faculty, and staff behavioral tendencies and practices, etc.); General Education course focus on reading and writing across the curriculum on sustainability; create SCISCD Undergraduate and/or Graduate Fellowship program to enhance awareness and develop future reduction strategies.

Conservation · Reduction Strategy 2:

Reinstate residence hall energy contest

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

22,860 mT CO_2e

Approximate impact of strategy on GHG emissions:

Up to 2,286 mT CO_2e (UNEP, 2007; USDOE, 2007)

Scope(s) Impacted:

Scope 1 Scope 2 Scope 3 (Depending on parameters of contest)

Timeframe to implement:

0-2 years for redesign and implementation of contest

Steps required to implement:

- Decide on parameters (i.e., one/month vs. 9 months; include commuting habit elements, etc.)
- Install any additional metering necessary
- Determine any third party administration/dashboard implementation, etc.

Approximate cost to implement strategy:

Initial Cost:

Approx. $2,000 for advertising, prizes, and staff administration

Recurring Costs:

Approx. $2,000 annually for advertising, prizes, and staff administration

Immediate Cost Avoidances:

Up to $225,600 (based on 10% energy usage/emissions reduction)

Simple Payback:

Immediate

Primary department/director/office to handle implementation:

Residence Life, Sustainability, Facilities

Curriculum/Research Integration:

Course project for documenting relationships of technology implementation, behavior monitoring, and data tracking that results in residence hall energy performance outcomes; theater arts one-act plays on sustainability-based behavioral dilemmas.

.

Conservation · Reduction Strategy 3:

Campus-wide de-lamping project

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,849.2 mT CO_2e

Approximate impact of strategy on GHG emissions:

399.3 mT CO_2e (40% of campus elect. load is assumed to be lighting; removal of 10% of lamps from service reduces load by ~600,000 kWh/yr. and accompanying Scope 3 T&D losses)

Scope(s) Impacted:

Scope 2 Scope 3

Timeframe to implement:

2 years

Steps required to implement:

- Conduct a detailed lighting level audit
- Establish campus lighting level standard
- Design documents
- Implement project

Approximate cost to implement strategy:

Initial Cost:

$50,000 in survey/design

$100,000 labor

Recurring Costs:

None

Immediate Cost Avoidances:

$48,000 annually

Simple Payback:

3 years

Primary department/director/office to handle implementation:

Facilities

Curriculum/Research Integration:

Physics class project for measuring light quantity and quality changes in relationship to desired functional / use needs of the space.

Conservation · Reduction Strategy 4:

Install motion/occupancy sensors across campus

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,849.2 mT CO_2e

Approximate impact of strategy on GHG emissions:

359.4 mT CO_2e (assuming additional 10% reduction in energy usage from sensors and accompanying Scope 3 T&D loss reductions)

Scope(s) Impacted:

Scope 2 Scope 3

Timeframe to implement:

4 years

Steps required to implement:

- Conduct space survey
- Design document
- Implement project

Approximate cost to implement strategy:

Initial Cost:

Survey/design: $50,000

Labor: $250,000

Recurring Costs:

$5,400 annually in sensor maintenance/ballast replacement

Immediate Cost Avoidances:

$43,800 annually

Simple Payback:

8 years

Primary department/director/office to handle implementation:

Facilities

Curriculum/Research Integration:

Engineering Technology Internship for installation and tracking energy performance in the buildings effected.

Conservation · Reduction Strategy 5:

Zimride university carpool system

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

3,869.3 mT CO_2e

Approximate impact of strategy on GHG emissions:

227 mT CO_2e (Based on avg. savings advertised on ZimRide website)

Scope(s) Impacted:

Scope 3

Timeframe to implement:

0-2 years

Steps required to implement:

- Update quote from Zimride
- Secure funding/budget allocation

Approximate cost to implement strategy:

Initial Cost:

$12,000

Recurring Costs:

$12,000 annually

Immediate Cost Avoidances:

Unknown

Simple Payback:

Unknown

Primary department/director/office to handle implementation:

Student Life, Sustainability

Curriculum/Research Integration:

Total cost accounting course project to quantify emissions savings over ‘business as usual’ commuting and transportation options (‘business as usual’ is currently grossly estimated)

<u>Conservation · Reduction Strategy 6:</u>

UWRF car rental/rideshare using depreciated fleet vehicles

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

3,869.3 mT CO_2e

Approximate impact of strategy on GHG emissions:

227 mT CO_2e (Based on ZimRide carpooling/rideshare program estimates)

Scope(s) Impacted:

<u>Scope 3</u>

Timeframe to implement:

5 years

Steps required to implement:

Obtain state variance for depreciated vehicle use

Approximate cost to implement strategy:

Initial Cost:

Unknown

Recurring Costs:

Unknown

Immediate Cost Avoidances:

Unknown

Simple Payback:

Unknown

Primary department/director/office to handle implementation:

Facilities/Sustainability

Curriculum/Research Integration:

Business entrepreneur internship for planning, design, implementation and tracking outcomes of the program

Conservation · Reduction Strategy 7:

Provide additional bike racks, winter bike storage, and dedicated bicycle lanes on campus

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

3,869.3 mT CO_2e

Approximate impact of strategy on GHG emissions:

39 mT CO_2e (Pucher & Buehler, 2011)

Scope(s) Impacted:

Scope 3

Timeframe to implement:

1-5 years

Steps required to implement:

- Identify areas lacking sufficient bike parking (racks)
- Identify areas for winter bike storage
- Identify & mark/construct dedicated bicycle lanes

Approximate cost to implement strategy:

Initial Cost:

$200 per bike for saddleback racks; $1,200 per bike for covered locker pods; unknown cost to integrate dedicated bicycle lanes

Recurring Costs:

None

Immediate Cost Avoidances:

None

Simple Payback:

None

Primary department/director/office to handle implementation:

Facilities, Sustainability

Curriculum/Research Integration:

GIS-based course projects for integration of design components of future bike lanes, need for additional bike racks and storage, and effects of lanes, racks, and storage on ridership

Efficiency · Reduction Strategy 1:

Chilled water efficiency projects

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

9,187.2 mT CO_2e (Purchased electricity & Refrigerants & Chemicals)

Approximate impact of strategy on GHG emissions:

35.3 mT CO_2e

Scope(s) Impacted:

Scope 1 Scope 2

Timeframe to implement:

0-5 years

Steps required to implement:

- Determine most efficient combination of equipment to operate; add air separator to the system

(1450lb of R-11 has been removed from chillers @ KFA and CSA; 2105lb of R-134a has been removed from chillers @ SFS, South Hall, and Rodli)

Approximate cost to implement strategy:

Initial Cost:

$45,000-55,000

Recurring Costs:

None

Immediate Cost Avoidances:

$500 in annual operational savings

$4,900-5,900 in annual utility savings

Simple Payback:

7-10 years

Primary department/director/office to handle implementation:

Facilities

Curriculum/Research Integration:

Math and engineering class use of professional engineering case studies of the chilled water projects and their impact on the energy and carbon performance of the campus

Efficiency · Reduction Strategy 2:

Centralize cooling at chilled water plant

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

9,187.2 mT CO_2e (Purchased electricity & refrigerants & chemicals)

Approximate impact of strategy on GHG emissions:

Unknown

Scope(s) Impacted:

Scope 1 Scope 2

Timeframe to implement:

0-5 years

Steps required to implement:

1450lb of R-11 has been removed from chillers @ KFA and CSA and 2105lb of R-134a has been removed from chillers @ SFS, South Hall, and Rodli; these have been replace with 1,650lb of R-123 at the central chilled water plant. Future removal of N. Hall chiller (200lb of R-22) and WEB Chiller (1010lb of R-134a) are possible future projects.

Approximate cost to implement strategy:

Initial Cost:

$2.8M (for future removals noted above)

Recurring Costs:

None

Immediate Cost Avoidances:

$3.2M (@ $2,500/ton replacement cost)

Simple Payback:

Immediate

Primary department/director/office to handle implementation:

Facilities

Curriculum/Research Integration:

Math and engineering class use of professional engineering case studies of the centralized cooling at chilled water plant and its impact on the energy and carbon performance of the campus

<u>Efficiency · Reduction Strategy 3:</u>

Ground source heat pump (GSHP) project for Falcon Center (see Appendix H) powered by renewable energy blocks

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,435.4 mT CO_2e (Campus heating plant)

Approximate impact of strategy on GHG emissions:

760.7 mT CO_2e

Scope(s) Impacted:

<u>Scope 1</u> <u>Scope 2</u>

Timeframe to implement:

4 years

Steps required to implement:

- Specify GSHP as the option being pursued for Falcon Center (GSHP is the most economically advantageous option per Appendix H)
- Design and construct system in conjunction with Falcon Center
- Contract for purchase of 3,245 additional renewable energy blocks @ $3 per block (Based on estimated electrical consumption as outlined in Appendix H)

Approximate cost to implement strategy:

Initial Cost:

No additional costs over base case construction – see *Immediate Cost Avoidances* below

Recurring Costs:

No additional costs over base case construction – see *Long-term ROI* below

Immediate Cost Avoidances:

$200,265 in avoided capital costs over base case construction after renewable energy purchases

$9,136 annually in avoided fuel & electric expenses <u>after</u> renewable energy purchases

Simple Payback:

Immediate

Primary department/director/office to handle implementation:

Facilities, Sustainability

Curriculum/Research Integration:

Math and engineering class use of professional engineering case studies of the GSHP proposal and their impact on the energy and carbon performance of the campus

Efficiency · Reduction Strategy 4:

Phase out depreciated fleet vehicles with high-efficiency vehicles: plug-in electric vehicles, Neighborhood Electric Vehicles (NEVs) hybrids, and diesel vans capable of burning 100% biodiesel already being produced in limited quantities on campus

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

291.4 mT CO_2e

Approximate impact of strategy on GHG emissions:

145.7 mT CO_2e

Scope(s) Impacted:

Scope 1

Timeframe to implement:

5 years (as depreciated vehicles are replaced)

Steps required to implement:

- Determine parameters of program
- Begin phase out as vehicles are depreciated

Approximate cost to implement strategy:

Initial Cost:

No additional cost anticipated over existing vehicle replacement

Recurring Costs:

$1,022.25 (assumes 50% of fleet diesel is replaced with biodiesel having a $0.75 production cost/gallon)

Immediate Cost Avoidances:

$60,901 [assumes a 50% reduction in fleet gasoline and diesel at $3.75/gal for gasoline and $3.25/gal for diesel;($4/gal savings minus assumed $0.75/gal production cost for biodiesel)]

Simple payback:

Immediate

Primary department/director/office to handle implementation:

Facilities

Curriculum/Research Integration:

Biodiesel production is already integrated with curriculum; expansion of alternative transportation vehicles provide greater exposure and opportunity for student research projects

Efficiency · Reduction Strategy 5:

Community-wide dimmable LED/motion sensor parking lot projects (to increase purchasing power): Q Lot, Shopko, Nash-Finch, etc.

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,849.2 mT CO_2e

Approximate impact of strategy on GHG emissions:

79.9 mT CO_2e with associated reductions in Scope 3 T&D losses

Scope(s) Impacted:

Scope 2 Scope 3

Timeframe to implement:

2 years

Steps required to implement:

- Identify cost-effective replacement heads
- Replace 80 parking lot lights w/LED and sensors (75% reduction)

Approximate cost to implement strategy:

Initial Cost:

~$1,000/fixture = $80,000

Recurring Costs:

None

Immediate Cost Avoidances:

$5,600 annually in reduced power consumption

Simple Payback:

14 years

Primary department/director/office to handle implementation:

Facilities, Sustainability

Curriculum/Research Integration:

Class project and/or undergraduate student research project for product comparison, cost-benefit analysis, and return on investment to campus for both energy costs and carbon accounting

Efficiency · Reduction Strategy 6:

Retrofit pathways with LED lights

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,849.2 mT CO_2e

Approximate impact of strategy on GHG emissions:

74.5 mT CO_2e with associated reduction in Scope 3 T&D losses

Scope(s) Impacted:

Scope 2 Scope 3

Timeframe to implement:

2 years

Steps required to implement:

- Identify cost-effective replacement heads
- Replace 200 pathway lights w/LED (75% reduction)

Approximate cost to implement strategy:

Initial Cost:

~$400/fixture x 200 = $80,000

Recurring Costs:

None

Immediate Cost Avoidances:

$5,600 annually in reduced energy expenditures

Simple Payback:

14 years

Primary department/director/office to handle implementation:

Facilities

Curriculum/Research Integration:

Land use planning / GIS-based site design class project and/or undergraduate student research project for product selection, lay-out, and impact of new system

Efficiency · Reduction Strategy 7:

Re-zone parking spaces to give priority to high efficiency, electric and pooled passenger vehicles including motorcycles and mopeds

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

3,869.3 mT CO_2e

Approximate impact of strategy on GHG emissions:

39 mT CO_2e

Scope(s) Impacted:

Scope 3

Timeframe to implement:

With redevelopment of campus master plan (0-2 years)

Steps required to implement:

- Identify low-emission vehicles that qualify
- Design program parameters (cost-reductions, parking space proximities, etc.)
- Redesign 'other' parking program parameters to incur revenues to pay for program

Approximate cost to implement strategy:

Initial Cost:

$6,000 in staff time

Recurring Costs:

None – program would be designed to be self-sustaining

Immediate Cost Avoidances:

None

Simple Payback:

1 year

Primary department/director/office to handle implementation:

Parking, Sustainability

Curriculum/Research Integration:

Land use planning / GIS-based site design class project and/or undergraduate student research project for redesign of parking spaces; case study for critical analysis of professional consultant work on the same and study of impact on transportation behaviors

<u>Efficiency · Reduction Strategy 8:</u>

Incorporate intensive grazing techniques into ruminant animal curriculum

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

597.1 mT CO_2e

Approximate impact of strategy on GHG emissions:

Unknown [Studies show reductions in GHG emissions from intensive rotational grazing (Bosch, 2008)]

Scope(s) Impacted:

<u>Scope 1</u>

Timeframe to implement:

2-5 years

Steps required to implement:

- Determine parameters of intensive rotational grazing
- Implement logistics to achieve intensive rotational grazing techniques
- Evaluate reductions in GHG emissions

Approximate cost to implement strategy:

Initial Cost:

Unknown; minimal

Recurring Costs:

None anticipated

Immediate Cost Avoidances:

None

Simple Payback:

Unknown

Primary department/director/office to handle implementation:

Agricultural Science

Curriculum/Research Integration:

Integrate into agricultural science courses for study of animal health; study impacts on meat production, quality, and consumer taste preferences; study effects on greenhouse gas emissions reductions

Production · Reduction Strategy 1:

Co-generation (assuming 20k lb/hr boiler @ 900 psia w/back pressure 900 kW turbine @ 100 psia providing 75% of campus heating load)

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

17,284.6 mT CO_2e (Campus heating plant and purchased electricity)

Approximate impact of strategy on GHG emissions:

1,150.7 mT CO_2e (assumes increased natural gas usage of 15,000 MMBtu/year and electric production of 3,300,000 kWh/year)

Scope(s) Impacted:

Scope 1 Scope 2 Scope 3

Timeframe to implement:

5+ years

Steps required to implement:

- Install 20,000 lb/hr high pressure boiler (900 psia)
- Install a 900 kW steam turbine/generator set

Approximate cost to implement strategy:

Initial Cost:

$2,610,000

Recurring Costs:

$20,000 annually – turbine maintenance

Immediate Cost Avoidances:

$105,000 annually after electric production savings and extra fuel expenditures

Simple payback:

31 years

Primary department/director/office to handle implementation:

Facilities

Curriculum/Research Integration:

Alternative energy courses integrating student projects for critical analysis of design and prediction of impacts on energy and carbon performance; math courses utilizing system design for student practice with sustainability-based calculations

Production · Reduction Strategy 2:

Replace natural gas (or coal) use at campus heating plant with biomass (wood pellets) (2009 fuel usage would equal approx. 7,500 short tons of wood pellets)

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,435.4 mT CO_2e (Campus heating)

Approximate impact of strategy on GHG emissions:

7,327 mT CO_2e

Scope(s) Impacted:

Scope 1

Timeframe to implement:

0-5 years

Steps required to implement:

Install winter (50,000 lb/hr) and summer (10,000 lb/hr) rated biomass boilers and material handling systems

Approximate cost to implement strategy:

Initial Cost:

$7,000,000

Recurring Costs:

No additional costs when compared to traditional handling/storage costs of coal on campus

Immediate Cost Avoidances:

$4.84/MMBtu (2011) less cost of biomass fuel

Simple Payback:

Variable depending on cost of biomass fuel

Primary department/director/office to handle implementation:

Facilities

Curriculum/Research Integration:

Alternative energy courses integrating student projects for critical analysis of design and prediction of impacts on energy and carbon performance; math courses utilizing system design for student practice with sustainability-based calculations; forestry courses utilizing for biomass production management scenarios analysis

<u>Production · Reduction Strategy 3:</u>

Retrofit existing residence halls with solar hot water panels

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,435.4 mT CO_2e

Approximate impact of strategy on GHG emissions:

4.2 mT CO_2e per building (avg.)

Scope(s) Impacted:

<u>Scope 1</u>

Timeframe to implement:

One building per year

Steps required to implement:

Install structure and path from roof to mechanical room in conjunction with remodeling projects

Approximate cost to implement strategy:

Initial Cost:

$12,800/building

Recurring Costs:

None

Immediate Cost Avoidances:

$413 annually

Simple Payback:

31 years

Primary department/director/office to handle implementation:

Facilities, Sustainability

Curriculum/Research Integration:

Alternative energy courses integrating student projects for critical analysis of design and prediction of impacts on energy and carbon performance; math courses utilizing system design for student practice with sustainability-based calculations; psychology student projects for assessing student, faculty, and staff perceptions of aesthetic versus utility value

Production · Reduction Strategy 4:

Replace nitrogen fertilizer being used on lab farms with compost that is proposed to be produced on campus (See Offset Reduction Strategy 7)

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

637.4 mT CO_2e

Approximate impact of strategy on GHG emissions:

113.9 mT CO_2e

Scope(s) Impacted:

Scope 1

Timeframe to implement:

0-2 years

Steps required to implement:

Secure contract for composting facility

Approximate cost to implement strategy:

Initial Cost:

$6,600 for purchase of compost @ $30/yd

Recurring Costs:

$6,600

Immediate Cost Avoidances:

None

Simple Payback:

Unknown

Primary department/director/office to handle implementation:

Dining Services, Agricultural Science, Facilities, Sustainability

Curriculum/Research Integration:

Soils course projects for comparing effectiveness of composted food waste to synthetic fertilizers and their impacts on soil fertility, soil structure, and crop production

Production · Reduction Strategy 5:

4MW wind turbine project

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,849.2 mT CO_2e

Approximate impact of strategy on GHG emissions:

3,703.9 mT CO_2e based on 5,565 MWh of production annually and associated Scope 3 T&D loss reduction

Scope(s) Impacted:

Scope 2 Scope 3

Timeframe to implement:

2-3 years

Steps required to implement:

- Identify tax investors willing to pursue renewable energy projects on campus
- Pursue approval of UWRF for economically advantageous wind turbine projects
- Arrange favorable rate tariffs from power provider(s)
- Pursue approval of wind turbine projects on lab farms through DSF
- Construct service road and wind turbines

Approximate cost to implement strategy:

Initial Cost:

$80,000-160,000 (1-2% of initial cost up front) for admin, legal, etc.

Recurring Costs:

Approx. $4M mortgage to be assumed at year 5 (50% of total project cost)

Immediate Cost Avoidances:

Negotiated portion of power generation savings and land lease money

Simple Payback:

12 years including initial 5-year investment period

Primary department/director/office to handle implementation:

VCAF, Facilities, Sustainability

Curriculum/Research Integration:

Alternative energy courses integrating student projects for critical analysis of design and prediction of impacts on energy and carbon performance; business and math courses utilizing system design for student practice with sustainability-based calculations; psychology student projects for assessing student, faculty, and staff perceptions of aesthetic versus utility value

<u>Production · Reduction Strategy 6:</u>

Tax investor financed solar PV projects on campus land (per 1MW of installation)

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,849.2 mT CO_2e

Approximate impact of strategy on GHG emissions:

832 mT CO_2e (per 1MW of installation) with associated Scope 3 T&D loss reduction

Scope(s) Impacted:

<u>Scope 2 Scope 3</u>

Timeframe to implement:

2-3 years

Steps required to implement:

- Identify tax investors willing to pursue renewable energy projects on campus
- Pursue approval of UWRF for economically advantageous solar energy projects
- Arrange favorable rate tariffs from power provider(s)
- Pursue approval of solar energy projects on state-owned land through DSF
- Construct canopies, arrays, and sub-station tie-in

Approximate cost to implement strategy:

Initial Cost:

$30,000-60,000 (1-2% of cost up front) for admin, legal, etc. (per 1MW of installation)

Recurring Costs:

Approx. $1.5M mortgage to be assumed at year 5 (50% of total project cost)

Immediate Cost Avoidances:

Negotiated portion of power generation savings and land lease money

Simple Payback:

17 years including initial 5-year investment period

Primary department/director/office to handle implementation:

VCAF, Facilities, Sustainability

Curriculum/Research Integration:

Alternative energy courses integrating student projects for critical analysis of design and prediction of impacts on energy and carbon performance; business finance and math courses utilizing system design for student practice with sustainability-based calculations; psychology student projects for assessing student, faculty, and staff perceptions of aesthetic versus utility value

<u>Production · Reduction Strategy 7:</u>

RDI rooftop/Wild Rose Ave. PV Project (11.3kW fixed on RDI and 6kW dual-axis tracking post mounted panels on Wild Rose Ave.)

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,849.2 mT CO_2e

Approximate impact of strategy on GHG emissions:

18.8 mT CO_2e with associated Scope 3 T&D loss reductions

Scope(s) Impacted:

<u>Scope 2 Scope 3</u>

Timeframe to implement:

<1 year

Steps required to implement:

- Seek approval through DSF (siting and structural analysis) (approval granted May 2012)
- Locate applicable incentives and negotiate rate tariffs
- Secure funding/budget allocation

Approximate cost to implement strategy:

Initial Cost:

Approx. $25,000 after incentives and DSF contribution

Recurring Costs:

$735 in interest costs annually (increases to $1,145 in year 12 based on 3% annual energy inflation, then decreasing until payoff), through year 16.

Immediate Cost Avoidances:

Approx. $0.30 based on rate tariff negotiations

Simple Payback:

15 years

Primary department/director/office to handle implementation:

Facilities, Sustainability, VCAF

Curriculum/Research Integration:

Alternative energy courses integrating student projects for critical analysis of design and prediction of impacts on energy and carbon performance; business finance and math courses utilizing system design for student practice with sustainability-based calculations; psychology student projects for assessing student, faculty, and staff perceptions of aesthetic versus utility value

<u>Offset · Reduction Strategy 1:</u>

Additional segregated fees to purchase additional offsets

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

23,966.4 mT CO_2e

Approximate impact of strategy on GHG emissions:

23,966.4 mT CO_2e

Scope(s) Impacted:

<u>Scope 1 Scope 2 Scope 3</u>

Timeframe to implement:

1-5 years

Steps required to implement:

- Approve additional segregated fees through shared governance for offset purchases
- Build portions of offsets into local or university owned offset projects

Approximate cost to implement strategy:

Initial Cost:

$317,021 through TerraPass

Recurring Costs:

$317,021 annually

Immediate Cost Avoidances:

None

Simple Payback:

None

Primary department/director/office to handle implementation:

Sustainability, VCAF

Curriculum/Research Integration:

Business and finance course projects for analysis of campus-based carbon economics; education and psychology course projects for design of climate change literacy programs and materials

<u>Offset ·Reduction Strategy 2:</u>

Carbon capture and storage (CCS) at campus heating plant

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

8,435.4 mT CO_2e

Approximate impact of strategy on GHG emissions:

8,435.4 mT CO_2e

Scope(s) Impacted:

<u>Scope 1</u>

Timeframe to implement:

5+ years

Steps required to implement:

- Wait for federal and state directives and funding

Approximate cost to implement strategy:

Initial Cost:

Recurring Costs:

Immediate Cost Avoidances:

Simple Payback:

Primary department/director/office to handle implementation:

Facilities, Agricultural Science

Curriculum/Research Integration:

Faculty and undergraduate/graduate research project for capture and feed of heating plant CO_2 emissions as a feedstock to algae farm for biodiesel production

Offset · Reduction Strategy 3:

Team budgeting, event ticket fees, or tuition surcharges to purchase offsets for athletic team travel

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

Unknown – Directly financed air travel and other travel for athletic team travel is poorly tracked

Approximate impact of strategy on GHG emissions:

Up to 100% of emissions due to athletic team travel

Scope(s) Impacted:

Scope 3

Timeframe to implement:

0-3 years

Steps required to implement:

- Implement methods to accurately track athletic team travel/emissions
- Determine method of offset funding
- Implement policies to fund offsets
- Purchase offsets

Approximate cost to implement strategy:

Initial Cost:

None – offsets would be covered through team budgeting, event ticket fees, or tuition surcharges

Recurring Costs:

None – offsets would be covered through team budgeting, event ticket fees, or tuition surcharges

Immediate Cost Avoidances:

None

Simple Payback:

None

Primary department/director/office to handle implementation:

Athletics, Sustainability

Curriculum/Development Integration:

Total cost accounting course providing a model of the ROI and campus revenue potential for various surcharge scenarios

<u>Offset · Reduction Strategy 4:</u>

Implement study abroad offset policy (service learning, offset purchase, or other)

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

2,652.9 mT CO_2e

Approximate impact of strategy on GHG emissions:

2,652.9 mT CO_2e

Scope(s) Impacted:

<u>Scope 3</u>

Timeframe to implement:

0-3 years

Steps required to implement:

- Determine offset methods: additional fees to purchase offsets; service learning component w/offset value, etc.
- Design service learning programs to accompany study abroad program
- Implement policies through Global Connections to achieve offsets

Approximate cost to implement strategy:

Initial Cost:

$3,000 estimated for staff time

Recurring Costs:

None

Immediate Cost Avoidances:

None

Simple Payback:

None

Primary department/director/office to handle implementation:

Global Connections, Sustainability

Curriculum/Research Integration:

Opportunity for domestic and foreign service learning projects that provide student and faculty labor to offset carbon footprint of travel (e.g., assisting locals with renewable energy projects; planting trees, etc.)

Offset · Reduction Strategy 5:

Catalog tree plantings/South Fork of Kinnickinnic River restoration sequestration capacities

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

23,966.4 mT CO_2e

Approximate impact of strategy on GHG emissions:

Unknown

Scope(s) Impacted:

Scope 1 Scope 2 Scope 3

Timeframe to implement:

0-2 years

Steps required to implement:

- Review historical aerial photographs to determine areas of restoration/reforestation
- Calculate additional sequestration captured by tree plantings/restoration/reforestation

Approximate cost to implement strategy:

Initial Cost:

Approximately $1,000 in work study

Recurring Costs:

None

Immediate Cost Avoidances:

None

Simple Payback:

None

Primary department/director/office to handle implementation:

Sustainability

Curriculum/Research Integration:

Biology and geography course projects for benchmarking and tracking of habitat changes and resulting carbon performance attributes; SCISCD Research Fellows project (on-going)

Offset · Reduction Strategy 6:

Restore areas to native/sequestrative groundcover

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

291.5 mT CO_2e (Mobile combustion from fleet gasoline and diesel used for transportation and maintenance vehicles, mowers, tractors, etc.)

Approximate impact of strategy on GHG emissions:

1.78 mT CO_2e per acre annually (Tilman, 2006)

Scope(s) Impacted:

Scope 1 Scope 2 Scope 3

Timeframe to implement:

3-5 years for full restoration

Steps required to implement:

- Identify suitable areas
- Burn or remove existing non-native groundcover
- Seed with native plants/grasses
- Burn or mow after 3-5 years

Approximate cost to implement strategy:

Initial Cost:

Approx. $1,500/acre for initial restoration and maintenance

Recurring Costs:

None; Occasional burns (3-6 year intervals) can be handled by ESM-190

Immediate Cost Avoidances:

$600/acre

Simple Payback:

2.5 years

Primary department/director/office to handle implementation:

Facilities/Grounds, Environmental Science, Sustainability

Curriculum/Research Integration:

Service learning integration into botany, horticulture, wildfire training classes; utilize ESM-190 students to maintain areas through periodic burns

Offset · Reduction Strategy 7:

Compost food waste

Total GHG emissions in area being considered for reduction (see full GHG emissions report in Appendix D):

487.9 mT CO_2e (From campus solid waste)

Approximate impact of strategy on GHG emissions:

64.6 mT CO_2e (Assumes 44 tons of waste diverted from landfill and composted on site)

Scope(s) Impacted:

Scope 3

Timeframe to implement:

0-2 years

Steps required to implement:

- Determine appropriate site for composting
- Determine compostable material (food only; food and disposable/compostable wares, campus vegetation/chipped brush for bulking agent etc. – agreement already in place with RFHS material)
- Determine logistics for transporting waste to compost facility
- Construct facility

Approximate cost to implement strategy:

Initial Cost:

$30,000-50,000 for high-tunnel style hoop house to contain waste during composting

$10,000 for purchase of windrow turner

Recurring Costs:

$4,000-5,000 annually in transportation and operation costs

Immediate Cost Avoidances:

$6,000-8,000 annually from sale of compost; $3,090 avoidance from reduced waste hauling (assuming 50% waste diversion)

Simple Payback:

5.5—14.5 years

Primary department/director/office to handle implementation:

Student Life, Sustainability, Agricultural Science, Facilities

Curriculum/Research Integration:

Biology, agriculture, and food science courses determine nutrient content/fertilizer applicability of compost; agriculture and business courses calculate economic and carbon market value of waste food compost

References

Bosch, D. (2008). Effects of rotational grazing on carbon dioxide emissions and greenhouse gas credits. *Journal of Soil and Water Conservation,* 63(2).

Pucher, J., & Buehler, R. (2011). *Analysis of bicycling trends and policies in large North American cities: Lessons for New York*. University Transportation Research Center.

Tilman, D., Hill, J., & Lehman, C. (2006). Carbon-negative biofuels from low-input high-diversity grassland biomass. *Science,* 314, 1598-1600.

UNEP. (2007). *Assessment of Policy Instruments for Reductin Greenhouse Gas Emissions from Buildings*. Budapest: United Nations Environment Programme.

University of Connecticut. (2009). *The University of Connecticut Climate Action Plan: Guiding the path toward Carbon Neutrality*. Storrs Campus. University of Connecticut.

USDOE. (2007). *Creating an Energy Awareness Program: A Handbook for Federal Energy Managers*. U.S. Department of Energy.

USDOT. (2007). *Transit Bus Life Cycle Cost and Year 2007 Emissions Estimation*. Morgantown, WV: U.S. Department of Transportation.

VonNeida, B., Maniccia, D., & Tweed, A. (2000). *An analysis of the energy and cost savings potential of occupancy sensors for commercial lighting systems*. IES Paper #43.

Appendix A: Chancellor Van Galen's Charge Memo

Office of the Chancellor • 116 North Hall • (715) 425-3201• Fax (715) 425-3304 • dean.vangalen@uwrf.edu

December 15, 2009

TO: Sustainability Working Group:
Dale Braun, Campus Planner
Kelly Cain, Director of Sustainability
Brian Copp, Professor of Sociology
Dale Gallenberg, Dean, College of Agriculture, Food & Environmental Sciences
Claire Kilian, Director, Master of Business Administration
Greg Koehler, Associate Director of Facilities Management
Katrina Larson, Director of Outreach
Jim Madsen, Professor of Physics
Dean Olson, Chair & Associate Professor, Agricultural Engineering Technology
Sandi Scott-Duex, Director of Residence Life
Mike Stifter, Director of Facilities Management
Bo Storozuk, Student
Tim Thum, Senior Facilities Engineer, Facilities Management
Jerry Waller, Director of Dining Services
Pam Weller, Lecturer, Plant & Earth Science
Lisa Wheeler, Vice Chancellor for Administration & Finance
Mary Wright, Professor of Teacher Education

CC: David Rainville, Professor of Chemistry and Faculty Senate Chair
Fernando Delgado, Provost & Vice Chancellor for Academic Affairs
Josh Brock, Student Senate President

FR: Dean Van Galen, Chancellor

RE: **Formal Charges to Sustainability Working Group**

Let me begin by expressing my unequivocal support for sustainable community development as outlined in Goal 2 of the strategic plan, Living the Promise and to reaffirm the University's commitment to the American College & University Presidents Climate Commitment of which UWRF is a charter signatory.

I understand that the Sustainability Working Group was established in 2007 as an ad hoc Faculty Senate Committee with the primary responsibility for helping the campus realize both the various elements of Goal 2 of the strategic plan goal and to deliver on our commitment to address climate change under the American College & University Presidents Climate Commitment. I request the leadership of the Sustainability Working Group in ensuring that our actions in both of these areas move forward based on effective planning and coordination.

In pursuing a more sustainable campus, it is important to encourage broad understanding of and wide engagement by our campus and beyond. Our approach to sustainable campus community development should be integrative and inclusive, and should foster a culture of learning and action that is globally informed and socially inclusive. Our commitment to this effort must be strong, and should position UW-River Falls as a leader in the State of Wisconsin and, at least in some areas, a national leader.

Thus, I respectfully provide you with the attached “charges” and ask that it guide your work for the remainder of the 2009-2010 academic year. Thank you.

Chancellor’s Charge to Create a Sustainable Campus Community Plan (SCCP)

I request that the Sustainability Working Group, working closely with the Office of Integrated Planning and other groups and individuals as appropriate, develop a comprehensive Sustainable Campus Community Plan (SCCP) by the end of the 2009-2010 academic year.

The SCCP should:

- Identify and summarize all major sustainability-related efforts since the 2007 start date of Living the Promise, and earlier, as appropriate;
- Outline a comprehensive plan that integrates the wide range of activities at UWRF into a single cohesive plan;
- Articulate options and opportunities, and provide recommendations of how UWRF can effectively pursue its on-going commitment to sustainable campus community development through 2012 and beyond;
- Include a relative short list of “priority activities” that should be pursued over the next three years that have high potential for significant impact and are achievable in light of our finite resources. For each of these, the plan should specify:
    - The individual or group that is recommended to take primary ownership
    - The associated financial costs
    - Potential sources of funding
- Consider the needs and aspirations of the many internal and external constituencies, including students, faculty, staff, administration, alumni, and local and regional communities.

The SCCP should be submitted to the Faculty Senate and Student Senate, as well as the Chancellor’s office, during the spring, 2010 semester in a timeframe that would enable those governance bodies to have an opportunity to consider and affirm the SCCP should they choose to do so.

Chancellor's Charge to Develop a Climate Action Plan (CAP)

I request that the Sustainability Working Group, working closely with the Office of Integrated Planning and other groups and individuals as appropriate, develop a Climate Action Plan by the end of the 2009-2010 academic year.

The CAP should:

- Reaffirm the University's commitment as described in the American Colleges and Universities Presidents Climate Commitment (ACUPCC);
- Develop a Climate Action Plan that is based on this commitment including the goal of achieving carbon neutrality;
- Include options and recommendations (technical and programmatic) to help UWRF achieve carbon neutrality, and establish a target date based on these options for the campus to achieve its carbon neutrality goal;
- Extend the 2006-2007 assessment of the campus carbon footprint (ca. 31,000 metric tons) and establish an annual process and responsibility center for future annual footprint calculations and reporting;
- Consider the needs and aspirations of the many internal and external constituencies, including students, faculty, staff, administration, alumni, and local and regional communities.

The CAP should be submitted to the Faculty Senate and Student Senate, as well as the Chancellor's office, during the spring, 2010 semester in a timeframe that would enable those governance bodies to have an opportunity to consider and affirm the CAP should they choose to do so.

Appendix B: UWRF ACUPCC Signatory Commitment Letter (Dec. 2006)

AMERICAN COLLEGE & UNIVERSITY
PRESIDENTS CLIMATE COMMITMENT

We believe that rising to meet the challenge of global warming is one of the most important initiatives for higher education and its leaders and we urge you to join us in this effort.

Sincerely,

The Founding Members of the Presidents Climate Commitment Leadership Circle

Loren Anderson, President
Pacific Lutheran University

Michael Crow, President
Arizona State University

Nancy Dye, President
Oberlin College

Jo Ann Gora, President
Ball State University

David Hales, President
College of the Atlantic

Bernard Machen, President
University of Florida

Gifford Pinchot III, President
Bainbridge Graduate Institute

Kathleen Schatzberg, President
Cape Cod Community College

Mary Spilde, President
Lane Community College

Douglas Treadway, President
Ohlone College

Darroch Young, Chancellor
Los Angeles Community College District

Paul Zingg, President
California State University, Chico

American College & University
Presidents Climate Commitment

AMERICAN COLLEGE & UNIVERSITY PRESIDENTS CLIMATE COMMITMENT

We, the undersigned presidents and chancellors of colleges and universities, are deeply concerned about the unprecedented scale and speed of global warming and its potential for large-scale, adverse health, social, economic and ecological effects. We recognize the scientific consensus that global warming is real and is largely being caused by humans. We further recognize the need to reduce the global emission of greenhouse gases by 80% by mid-century at the latest, in order to avert the worst impacts of global warming and to reestablish the more stable climatic conditions that have made human progress over the last 10,000 years possible.

While we understand that there might be short-term challenges associated with this effort, we believe that there will be great short-, medium-, and long-term economic, health, social and environmental benefits, including achieving energy independence for the U.S. as quickly as possible.

We believe colleges and universities must exercise leadership in their communities and throughout society by modeling ways to minimize global warming emissions, and by providing the knowledge and the educated graduates to achieve climate neutrality. Campuses that address the climate challenge by reducing global warming emissions and by integrating sustainability into their curriculum will better serve their students and meet their social mandate to help create a thriving, ethical and civil society. These colleges and universities will be providing students with the knowledge and skills needed to address the critical, systemic challenges faced by the world in this new century and enable them to benefit from the economic opportunities that will arise as a result of solutions they develop.

We further believe that colleges and universities that exert leadership in addressing climate change will stabilize and reduce their long-term energy costs, attract excellent students and faculty, attract new sources of funding, and increase the support of alumni and local communities.

Accordingly, we commit our institutions to taking the following steps in pursuit of climate neutrality:

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.

   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.

(continued...)

c. Within two years of signing this document, develop an institutional action plan for becoming climate neutral, which will include:

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.

3. Make the action plan, inventory, and periodic progress reports publicly available by providing them to the Association for the Advancement of Sustainability in Higher Education (AASHE) for posting and dissemination.

In recognition of the need to build support for this effort among college and university administrations across America, we will encourage other presidents to join this effort and become signatories to this commitment.

Signed,

President /Chancellor Signature

Don Betz

President /Chancellor Name

University of Wisconsin-River Falls

College or University

December 27, 2006

Date

AMERICAN COLLEGE & UNIVERSITY
PRESIDENTS CLIMATE COMMITMENT

LETTER OF INTENT

Anthony D. Cortese, Sc.D.
Co-Director, Presidents Climate Commitment
Second Nature
18 Tremont Street, Suite 1120
Boston, MA 02108

Dear Dr. Cortese,

I agree with the goals of the *American College & University Presidents Climate Commitment.* Addressing climate change in our curriculum as well as campus operations is an urgent and integral part of our mission as educators and our social obligation to society. Higher education plays a critical role in preparing the new workforce and creating the knowledge that will help society create the strategies, technologies, policies and economic opportunities that will allow humanity to thrive while protecting our life-supporting environment.

I will work to get broad involvement and support in my institution for achieving the goals of the *Presidents Climate Commitment* and will be a charter signatory to it. I also plan to attend the June 2007 summit of my colleagues from other colleges and universities in a joint effort to implement and publicize the *Presidents Climate Commitment.*

In recognition of the need to build support for this effort among college and university administrations across America, I will do whatever I can to promote this initiative to my colleagues at other institutions.

Sincerely,

President /Chancellor Signature

Don Betz
President /Chancellor Name

University of Wisconsin-River Falls
College or University

December 27, 2006
Date

Appendix C: State Directives and Standards for Energy and GHG Performance

Sustainable Facilities Standards (2010a) – WI Department of Administration (Division of State Facilities)

ftp://doaftp04.doa.state.wi.us/master_spec/Sustainable%20Facilities%20Standards/Sustainable%20Facilities%20Standards.pdf

Appendix D: Campus Greenhouse Gas (GHG) Emissions Inventory

GHG emissions are organized as Scope 1, 2, and 3 as defined by international protocols. UWRF chose to use the Clean Air – Cool Planet (CACP) Campus Carbon Calculator™, Version 6.4 for reporting these scopes for our campus. The ACUPCC commitment requires that all three scopes be addressed, including the commuting of students, faculty, and staff, which is considered controversial and not within the campus ability to influence by some. This will be addressed later.

Scope 1: Direct combustion of fossil fuels by equipment owned and controlled by the campus such as boilers, furnaces, fleet vehicles, etc. It also includes "fugitive emissions" from on-campus releases of chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFC's), and methane from farm animals, etc.

Scope 2: Purchased electricity, steam, heating, and cooling.

Scope 3: Business air travel for students, faculty, or staff paid for by or through the campus (including administrative meetings, conferences, athletics, domestic and international study tours, etc.). It also includes commuting by students, faculty, and staff to and from campus.

The GHG inventory tool is essentially a spreadsheet, which calculates the schools' carbon footprint once all data is collected and entered. The raw data generally falls into the following categories:

- Purchased Electricity
- Purchased Steam / Chilled Water
- On Campus Stationary Sources (energy generation)
- Transportation (commuting, air travel, campus fleet)
- Agriculture (fertilizer use, animal waste)
- Solid Waste (incinerated, landfill)
- Refrigerants and other chemicals
- Offsets (Renewable Energy Credits purchased, composting, forest preservation, local offset projects such as Green Block Electricity, etc.)

UWRF greenhouse gas emissions were calculated using the CA-CP Calculator. All greenhouse gas emissions were converted into effective CO_2 (CO_2e) for ease in reporting and comparisons. Emissions data has been collected and reported to the ACUPCC back to 1990.

Because the first official inventory was actually performed and benchmarked for 2006, data for previous years is incomplete for Scope 3. Therefore, 2006 is used as the baseline year in UWRF's projections at just over 31,000 metric tons of CO_2e. (See Table 1 and Fig. 1)

The 2009 net emissions total for UWRF was 23,966.4 metric tons of CO_2e. This is a 23% reduction from 2006 levels (see Fig. 3). While some of this decrease is due to lowered demand (particularly in purchased electricity), the majority of emissions remain rather constant, following the trend line established by on-campus stationary emissions sources (a.k.a. central heating plant) (see Fig. 4). The decrease evident from 2006 to 2009 can be directly attributed to lower prices in natural gas resulting in less coal being burned in the central heating plant.

For 2009, purchased electricity was the largest emissions source at 34% of total emissions with the heating plant following closely at 32% (see Fig. 5). Projections for subsequent years follow an average linear trend (see Fig. 3) and are based on "business as usual" assumptions. The total projected net CO_2e emissions in 2012 based on this trend is 24,146.7 metric tons.

Table 2 (p 11): Annual Emissions Breakdown by Sector

	mT CO_2e			
Scope 1 Emissions	**2006**	**2007**	**2008**	**2009**
Heating Plant Combustion	9,878.2	10,440.8	10,031.5	8,433.6
Direct Transportation (University Fleet)	305.3	301.0	296.5	291.4
Fugitive Refrigerants and Chemicals	64.0	92.5	92.5	91.2
Agriculture	550.6	594.2	605.5	597.1
Total Scope 1 Emissions	**10,798.1**	**11,428.6**	**11,026.0**	**9,413.3**
Scope 2 Emissions				
Purchased Electricity	13,872.2	10,282.5	9,601.8	9,096.0
Total Scope 2 Emissions	**13,872.2**	**10,282.5**	**9,601.8**	**9,096.0**
Scope 3 Emissions				
Faculty/Staff Commuting	558.0	578.7	583.5	599.4
Student Commuting	2,981.1	3,135.7	3,185.8	3,269.9
Falcon Programs Travel	-	-	-	3.2
Study Abroad Air Travel	1,508.1	1,904.9	2,307.2	2,652.8
Solid Waste	396.8	391.4	585.5	487.9
Paper	204.0	204.0	204.0	204.0
Scope 2 Transmission & Distribution Losses	1,372.0	1,070.0	949.6	899.9
Total Scope 3 Emissions	**7,020.0**	**7,231.7**	**7,815.6**	**8,116.8**
Offsets				
Sequestration by University Owned Forest Preserve	-21.0	-21.0	-21.0	-21.0
Composting	-0.4	-0.4	-0.4	-0.4
Renewable Energy Credit Purchases	-520.1	-556.0	-1,319.1	-2,638.3
Total Offsets	**-541.5**	**-2,659.7**	**-1,340.5**	**-2,659.7**

Figure 1: Annual Emissions by Scope

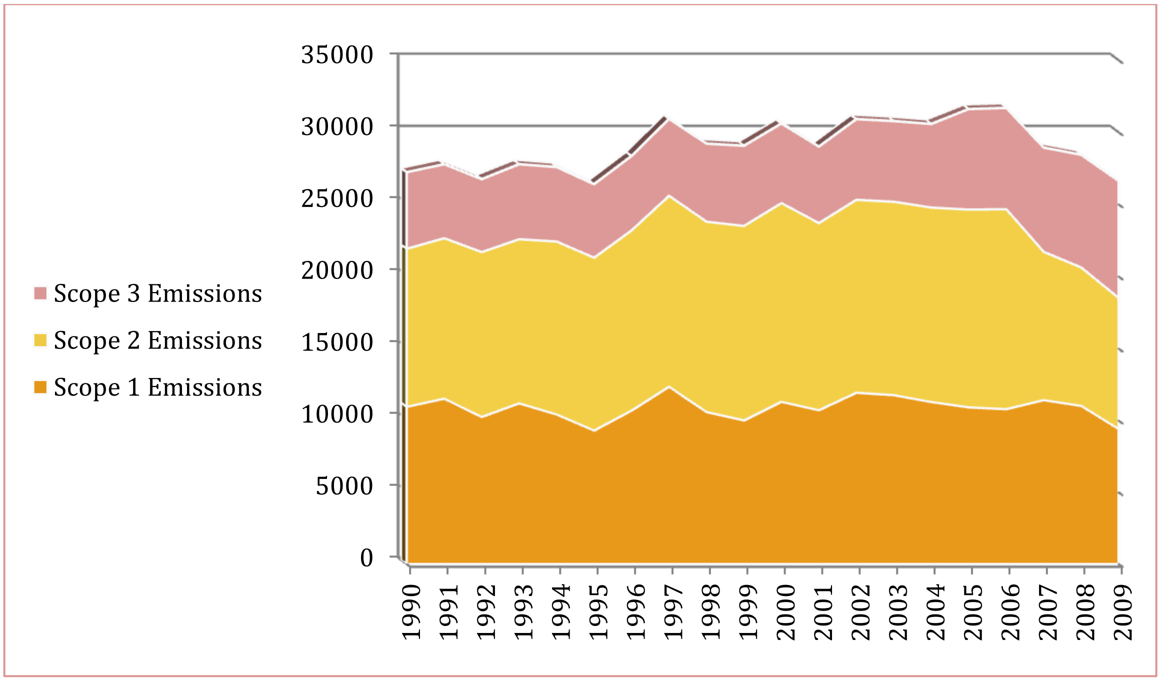


Figure 2: 2009 Emissions by Scope

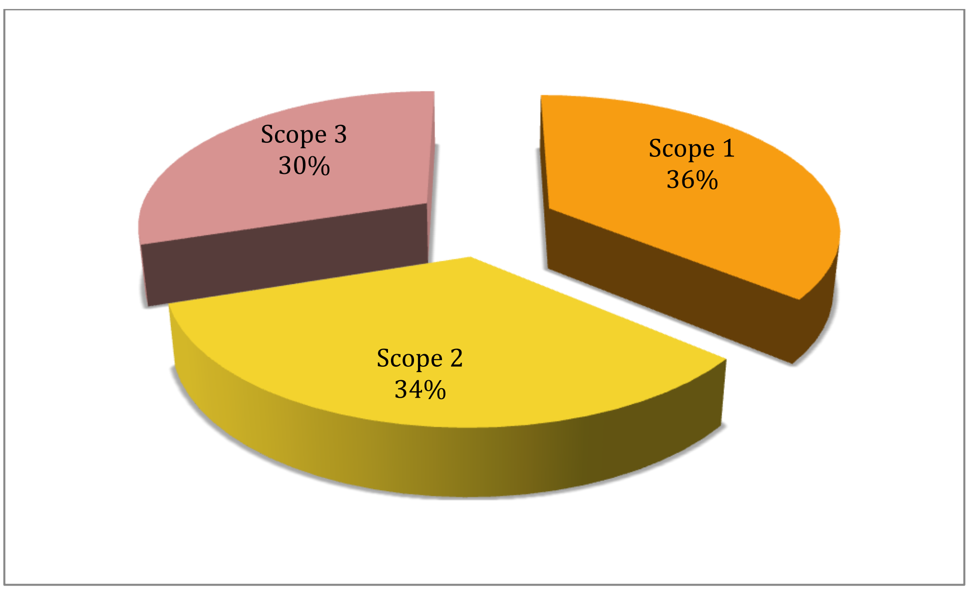


Figure 3: Total Annual and Projected Emissions (mT CO_2e)

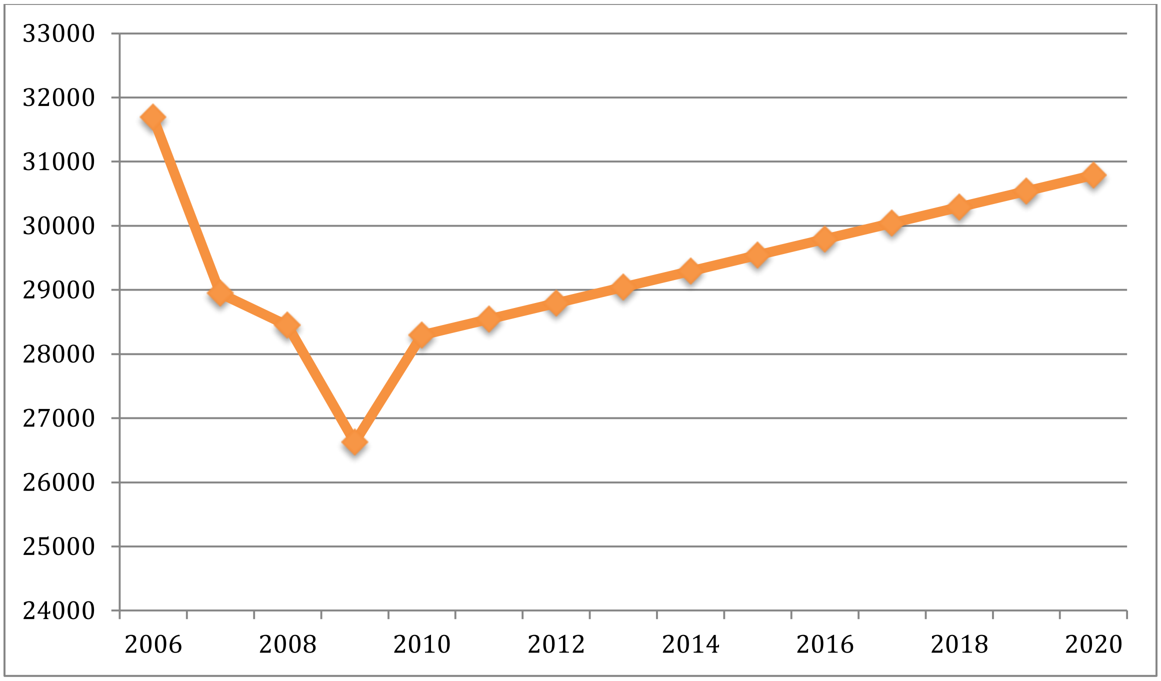


Figure 4: Total Annual and Projected Emissions by Sector (mT CO_2e)

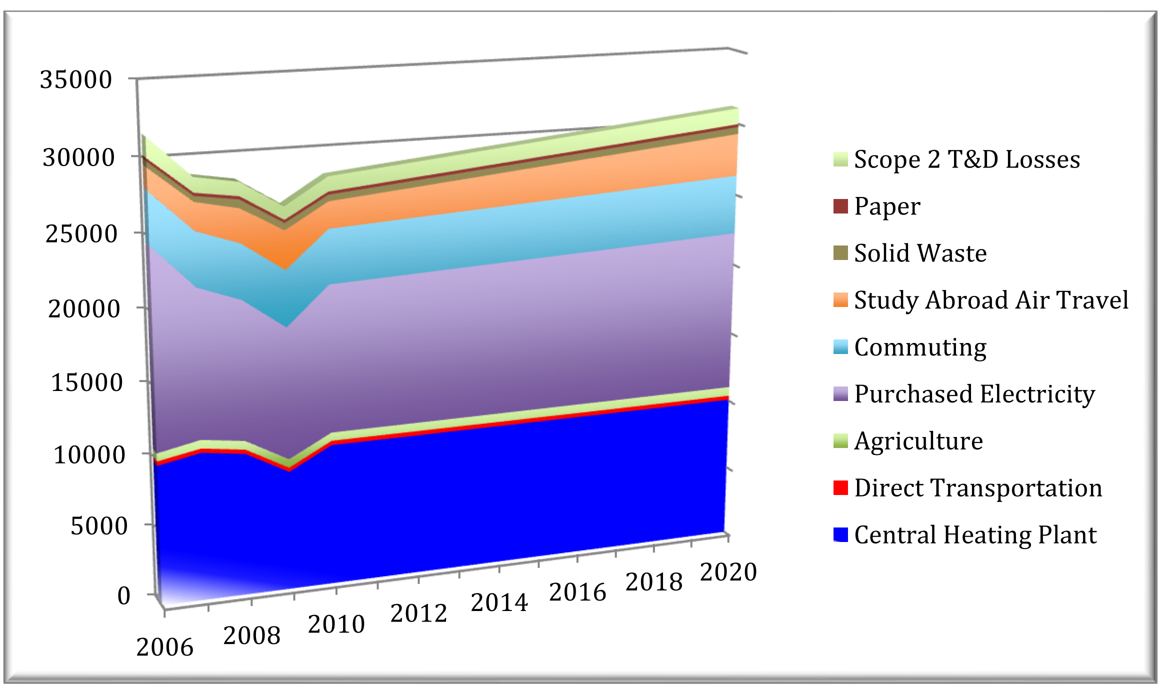
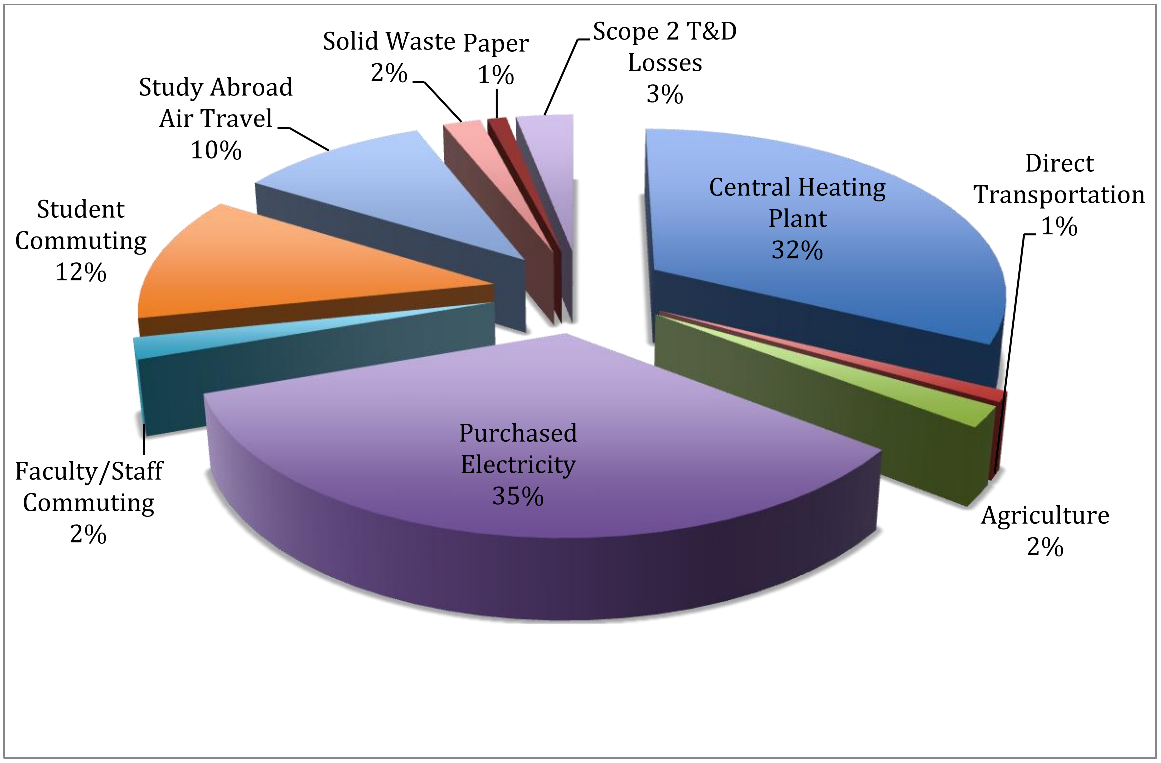


Figure 5: 2009 Emissions by Sector



A detailed greenhouse gas inventory for UWRF is available annually from 1990 to 2009 at: http://rs.acupcc.org/search/?institution_name=River+Falls&carnegie_class=%3F%3F&state_or_province=%3F%3F

Appendix E: 2011 National Campus Sustainability Report Card (UWRF Overall Grade: A-)

(Go to http://greenreportcard.org/report-card-2011/schools/university-of-wisconsin-river-falls for full report)

Appendix F: AASHE STARS® 2011 Report

(Go to https://stars.aashe.org/institutions/university-of-wisconsin-river-falls-wi/report/2012-01-13/ for full report)

Appendix G: 2010-12 Energy Reduction Plan

(Adapted from report submitted by Director of Facilities – Mike Stifter)

The Energy Reduction Plan is required every two years and will be reviewed by DSF, UW System staff, the Joint Committee of Finance and various energy-related legislative committees. Several of the projects are in the works or are funded and to be completed in the next year. Other projects are a bit lofty and yet others are no cost (education and awareness).

The following is around targets set forth by the State in regards to the off-the-grid definition now being used:
-30% energy conservation based on FY05 benchmark
-30% renewable energy blocks/credits
-30% renewable energy generation
-10% open and to be applied to any of the others

Currently we've hit our energy conservation target of 15% as of FY09 (weather adjusted). This year the goal is 20% ending on June 30. UWRF now leads the State in electrical efficiency per gross square foot and are a close third in thermal efficiency. Executive Order 145 required a 5% reduction each year ending with the 20% for this fiscal year. It would be reasonable enough for us to continue with an additional 5% goal for FY11 as well as FY12, which would get us to 30% (and by 2012, which was the off-the-grid timeline). This will not be easy, but we are confident it can be done.

UWRF is very invested in the Renewable Energy Block participation purchase program. The 100% contribution on the student Program Revenue (PR) side, in combination with the State's participation on the GPR side (10% currently and to become 20% this next fiscal year), results in roughly 75%-90% "off-the-grid" electrically for the campus, depending on how one calculates the GPR portion. This approach is feasible until we can afford even greater contributions in conservation and efficiency, but especially our own local renewable generation.

Regarding generation, the models currently indicated that the Lab Farm 2 Wind Turbines alone could generate approximately 55-60% of our electrical needs. This in addition to some PV, small wind, solar thermal and other electric offset projects, and UWRF could be off the grid much more quickly than might be thought.

Exec Order 145 Energy Reduction Report

ENERGY COST REDUCTION PLAN

Agency: UW System
Institution: River Falls
Time Period: July 1, 2010 to June 30, 2012

Executive Order 145, Article 1 Goals: Reduce BTU/GSF from FY 2005

10% by beginning of FY 2008

20% by beginning of FY 2010

Anticipated Methods of Funding Energy Conservation Opportunities:

Funding Source	EE or RE Measure	Cost of Project	Energy Savings BTU/YR	Energy Cost Reduction
WS15 SP Energy Conservation Project Funds	Project # 1 (EE)	$8,000	66 MM Btu/yr	$1,550/yr
	Project # 2 (EE)	$39,900	303 MM Btu/yr	$7,100/yr
	Project # 3 (EE)	$16,000	68 MM Btu/yr	$1,600/yr
	Project # 4 (EE)	$50,000	298 MM Btu/yr	$7,000/yr
	Project # 5 (EE)	$60,000	341 MM Btu/yr	$8,000/yr
	Project # 6 (EE)	$25,000	300 MM Btu/yr	$3,000/yr
	Project # 7 (EE)	$6,000	100 MM Btu/yr	$1,000/yr
	Project # 8 (EE)	$40,000	400 MM Btu/yr	$4,000/yr
	Project # 9 (EE)	$0	213 MM Btu/yr	$5,000/yr
	Project # 10 (EE)	$0	213 MM Btu/yr	$5,000/yr
	Project # 11 (EE)	$0	213 MM Btu/yr	$5,000/yr
	Project # 12 (RE)	$100,000	100 MM Btu/yr	$10,000/yr
	Project # 13 (RE)	$100,000	100 MM Btu/yr	$10,000/yr
	Project # 14 (RE)	$250,000	500 MM Btu/yr	$50,000/yr
	Project # 15 (RE)	$295,000	91 MM Btu/yr	$2,130/yr
	Project # 16 (RE)	$165,000	173 MM Btu/yr	$4,050/yr

	Project # 17 (RE)	$9,000,000	26,288 MM Btu/yr	$432,000/yr
Performance Contracting-Agency				
Performance Contracting-Private				
Agency Funds (PR)	Project # 18 (EE) Project # 19 (EE) Project # 20 (EE) Project # 21 (EE) Project # 22 (EE) Project # 23 (EE) Project # 24 (EE)	$50,000 $50,000 $450,000 $375,000 $235,000 $40,000 $5,000	298 MM Btu/yr 1,000 MMBtu/yr 125 MM Btu/yr 2,000MM Btu/yr 1,000MM Btu/yr 400 MM Btu/yr 500 MM Btu/yr	$7,000/yr $10,000/yr $1,250/yr $20,000/yr $10,000/yr $4,000/yr $500/yr
All Agency Funds (GPR)	Project # 25 (EE) Project # 26 (EE)	$1,900,000 $50,000	469 MM Btu/yr 500 MM Btu/yr	$11,000/yr $5,000/yr
Utility Programs				
Equipment Lease or Lease Purchase				
Gifts & Grants				
Total		$13,309,900	36,059 MM Btu/yr	$625,180/yr

Appendix H: South Campus Utility Plant Options

The pending development of the Health and Human Performance (HHP) building offers a unique opportunity for reviewing the new thermal load and opportunities to serve and possibly integrate the existing thermal loads of adjacent facilities (specifically Hunt Arena, Knowles Physical Education and Recreation Center, and Knowles Locker Room Addition[3]) from service from a new central plant. Individually, the respective thermal demand and service loads of the existing facilities and future facility are relatively small. Consolidation of the thermal demand and service loads of the South Campus (Hunt, Knowles, and HHP) affords consideration of alternate configurations and technologies in a central plant that are not amenable to the smaller installed capacity and service requirements of the individual buildings. Consolidation is also a cost effective strategy to realize the stated goal of n+1 service redundancy for campus utilities, most typically heating utility service capacity.

Existing and Future Energy Consumption

Existing Facilities

Fuel and electric consumption for the operation of the existing facilities, Hunt and Knowles, is based on historic purchases of utility service: natural gas and electricity. The average natural gas consumption from CY2009 and CY2010 is used to establish the fuel requirements of Hunt and Knowles. The utility bills for CY2010 establish the corresponding electric consumption basis of these existing facilities.

Total natural gas consumption at Hunt and Knowles is approximately 6,855,942 kBTU: 3,251,403 kBTU for the operation of Hunt and 3,604,539 kBTU for Knowles. Natural gas consumption is inclusive of space heating and heating of domestic hot water (DHW).

[3] Knowles Physical Education and Recreation Center and Knowles Locker Room Addition are collectively referred to as Knowles.

Natural Gas Consumption
Hunt-Knowles

	Hunt	Knowles	TOTAL
Natural Gas, kBTU			
Heating	3,088,833	3,099,660	6,188,493
DHW	162,570	504,879	667,449
Sub-Total, Existing	3,251,403	3,604,539	6,855,942

Natural gas consumption for the production of DHW is estimated to be about 5% and 14% of the total annual natural gas consumption at Hunt and Knowles, respectively. On an annual basis, the natural gas consumption for DHW is typically less than peak load percentage. Natural consumption gas for production of DHW is estimated to be 162,750 kBTU at Hunt Arena and about 504,879 kBTU at Knowles. The higher annual rate of natural gas consumption reflects the additional DHW requirements of the training and laundry facilities located within Knowles. The general allocations of natural gas consumption to DHW production is based on cursory review of monthly consumption patterns.

The corresponding annual consumption of electricity at Hunt and Knowles is about 1,285,800 kWh: 880,800 kWh and 405,000 kWh, respectively. Of this annual consumption approximately 702,720 kWh is used to drive the chillers that support the ice sheet in the Hunt Arena, and approximately 42,000 kWh is used to provide cooling at Knowles. The general allocation of electric consumption to cooling loads is based on cursory review of monthly consumption patterns.

Electric Consumption
Hunt-Knowles

	Hunt	Knowles	TOTAL
Electricity, kWh			
General	178,080	363,000	541,080
Cooling	702,720	42,000	744,720
Sub-Total, Existing	880,800	405,000	1,285,800

Future Facility

The anticipated natural gas and electric requirements of HHP incorporate the design and operating characteristics identified in the Pre-Design Final Report for Health and Human Performance Building, Alternate 2: 30% code improvement. The natural gas and electric consumption estimated for HHP reflects adjustments for a 145,000 square foot facility without a swimming pool (rather than 169,000 square feet with a swimming pool): 6,405,375 kBTU of natural gas for space heating, 104,757 kBTU of natural gas for DHW and 1,397,000 of electricity, inclusive of 353,000 kWh for cooling.

Fuel and Electricity Forecast
Health and Human Performance Building

Natural Gas, kBTU	
Heating	6,405,375
DHW	104,757
Sub-Total, Future	6,510,132
Electricity, kWh	
General	1,044,000
Cooling	353,000
Sub-Total, Future	1,397,000

South Campus

On this basis, the total expected natural gas consumption of the South Campus area, inclusive of Hunt, Knowles and HHP, is 13,366,074 kBTU. The corresponding electric consumption is 2,682,800 kWh.

South Campus Fuel and Electric Forecast
Hunt-Knowles & HHP

	Service Area Square Feet	Natural Gas kBTU	Electricity kWh
Hunt	39,200	3,604,539	880,800
Knowles	76,300	3,251,403	405,000

Sub-Total, Existing	115,500	6,855,942	1,285,800
HHP	145,000	6,510,132	1,397,000
Total, South Campus	260,500	13,366,074	2,682,800

Base Case and Utility Plant Options for South Campus
Three options are considered and evaluated relative to a Base Case:

Base Case: Central Plant to serve the space heating requirements of the South Campus facilities (existing and new) featuring three natural gas 4,000 kBTUH boilers. Cooling systems and respective service loads remain separate and independent.

Option 1: Central Plant to serve the space heating requirements of the South Campus facilities (existing and new) featuring two natural gas 4,000 kBTUH boilers and one biomass (wood pellet) 4,000 kBTUH boiler. Cooling systems and respective service loads remain separate and independent.

Option 2: Central Plant to serve the space heating requirements of the South Campus facilities (existing and new) and cooling load of HHP featuring two natural gas 4,200 kBTUH boilers and a 300 ton ground source heat pump system. Cooling systems and service loads remain separate and independent.

Option 3: Central Plant to serve the space heating requirements of the South Campus facilities (existing and new) three natural gas 4,000 kBTUH boilers with a 200 kW engine cogeneration system to drive the chillers of Hunt Arena and charge a 1,600 ton-hour thermal storage system to serve the cooling load of HHP. The cooling system and service load of Knowles remain separate and independent.

The concept of a new central plant serving the heating loads of South Campus is discussed in the pre-design final report for HHP, and is also consistent with the objective of the campus for firm capacity service reliability of heating plant infrastructure. The Base Case and Options are compared on the basis of incremental capital cost of implementation and anticipated avoided operating expense, specifically in terms of fuel, electricity and incremental maintenance. The unit price of natural gas and electricity reflects the weighted average cost from utility bills:

Natural Gas: $0.007/kBTU ($7/MMBTU) Electricity: $0.094/kWh

Base Case

The viability of options is best considered relative to a Base Case. In this instance the Base Case is defined as a new central plant developed in conjunction with HHP. The new central plant will serve the space heating loads of the South Campus facilities (Hunt-Knowles and HHP), and the DHW load of Hunt[4]. The capacity and configuration of the plant will provide firm service capacity to the facilities: often referred to as n+1 service redundancy, the aggregate peak demand of the facilities can be served with the largest single boiler out of service. The installed chiller capacity is unaffected by this option.

The total service area of HHP and the Hunt and Knowles facilities is about 260,500 square feet: 145,000 square feet, 39,200 square feet and 76,300 square feet, respectively. Using a maximum thermal demand of 23.56 BTU/square foot-hour and an allowance of 8% for parasitic loads and distribution losses, yields a potential service demand of 6,680 kBTUH:

$$(260{,}500 \text{ SF} \times 23.56 \text{ BTU/SF-Hr}) \div (1\text{-}8\%) \div 1{,}000 \text{ BTU/kBTU} = 6{,}680 \text{ kBTUH}$$

A plant configuration consisting of three (3) 4,000 kBTUH provides n+1 service redundancy for this magnitude of service demand. Each boiler is capable of serving approximately two-thirds (⅔) of the maximum service demand. With one boiler out of service, 8,000 kBTUH of capacity is available to serve the maximum demand of 6,680 kBTUH. The central plant will also feature chiller capacity: 300 Tons to serve the cooling load of HHP.

Capital Cost Summary
Option 1: Central Plant, Natural Gas

Project Component	**Cost**
Plant Building	$ 1,200,000
Boilers: 3 x 4,000 kBTUH	$ 300,000
300 Ton Chiller	$ 750,000
Interconnection	
Mechanical	$ 180,000
Sub-total, Construction Cost	$ 2,430,000
Contractor, 10%	$ 243,000
Design, 10%	$ 243,000
Detail, 25%	$ 729,000

[4] DHW production at Hunt will continue to use the existing steam heat exchanger.

Sub-total, Development Cost	$ 1,215,000
Total	$ 3,645,000

The capital cost estimate of Option 1 is about $3.65 M, consisting of construction cost and development cost. The construction cost[5] includes allowances for a plant structure (6,000 square feet at $200/SF), and the installed cost of biller and chiller capacities: $300,000 (3 x 4,000 BTUH package tube boilers at $25/KBTUH) and $750,000 (300 tons at $2,500/ton for water cooled chiller and tower), respectively. Development costs include contractor margin (10% of construction cost), engineering fees (10% of construction cost) and unknown design detail (25% of construction cost, contractor margin, and design fees).

The anticipated fuel requirements for serving the existing heating loads of Hunt and Knowles and associated DHW load of Hunt is reduced by 5% from the previously discussed natural gas consumption profiles, a modest recognition for the increased efficiency of new equipment and associated systems. The total adjusted natural gas consumption of Base Case and subsequent central plant options is then 13,048,522 kBTU. The central plant of the Base Case is expected to have negligible effect on existing and anticipated electric consumption profiles for the South Campus: 2,682,800 kWh.

The total energy expense of the Base Case is $342,717, comprised by $91,430 for natural gas (13,048,522 kBTU x $0.007/kBTU) and $251,377 for electricity (2,682,000 x $0.094/kWh).

Energy Consumption and Expense
Base Case

Consumption	**Base Case**
Natural Gas, kBTU	
Heating	
Knowles	2,944,678
Hunt	2,934,391
HHP	6,405,375
Sub-Total, Heating	12,284,444
DHW	

[5] Construction costs are rounded up to the next thousand dollars.

Knowles		504,879
Hunt		154,442
HHP		104,757
	Sub-Total, DHW	764,078
Total, Natural Gas		13,048,522
Electricity, kWh		2,682,200
Expense		
Natural Gas	$ 0.007/kBTU	$ 92,829
Electricity	$ 0.094/kWh	$ 251,377
	Total	$ 342,717

<u>Option 1: South Campus Central Plant, Natural Gas and Biomass</u>

One of the three central boilers of the Base Case is capable of using biomass, specifically wood pellets. All other aspects of equipment and operation are the same as the Base Case: a new central plant serving the space heating requirements of Hunt, Knowles and HHP with N+1 utility service redundancy.

The total annual fuel requirement remains the same as that of the Base Case: 13,048,522 kBTU. The biomass boiler is assigned to 45% of annual thermal load production and fuel consumption (for space heating of HHP, Hunt and Knowles and DHW production at Hunt). Two biomass scenarios are considered: wood pellets and wood chips. Wood pellets, as a processed fuel, have a heat value of 14,000 kBTU/ton. Wood chips, largely unprocessed delivered with varying moisture content, may have an average heat value of 10,000 kBTU/ton. On this basis, biomass fired boiler will require approximately 395 tons of wood pellets (.45 x 12,438,886 kBTU ÷ 14,000 kBTU/ton = 395.3 tons) or 560 tons of wood chips. Electric consumption is increased slightly to 2,727,440 kWh, to account for additional motors and fans necessary to support biomass combustion (15 HP and 4,000 hours of operation).

The total energy expense of Option 1 is $355,152 if wood pellets are used (option 1a): $255,559 for electricity (2,727,440 kWh x $0.094/kWh); $52,157 for natural gas {13,048,522 – (.45 x 12,438,866 kBTU) x $0.007/kBTU}; and $47,436 for wood pellets (395.3 tons x $120/ton). As an unprocessed fuel, wood chips are considerable less expensive, $45/ton rather than $120/ton for wood pellets. The total energy expense of Option 1 if wood chips are used (Option 1b) is then $332,907, reflecting the expense differential of 560 ton of wood chips at $45/ton in lieu of 395 tons of wood pellets at $120/ton.

Energy Consumption and Expense
Base Case, Option 1a: Wood Pellets or Wood Chips

Consumption	Base Case	Option 1:a	Option 1:b
Natural Gas, kBTU			
Heating			
Knowles	2,944,678	1,619,573	1,619,573
Hunt	2,934,391	1,613,915	1,613,915
HHP	6,405,375	3,522,956	3,522,956
Sub-Total, Heating	12,284,444	6,756,444	6,756,444
DHW			
Knowles	504,879	504,879	504,879
Hunt	154,442	84,944	84,944
HHP	104,757	104,757	104,757
Sub-Total, DHW	764,078	704,580	704,580
Total, Natural Gas	13,048,522	7,451,024	7,451,024
Wood, kBTU		Pellets	Chips
Heating			
Knowles		1,325,105	1,325,105
Hunt		1,320,476	1,320,476
HHP		2,882,419	2,882,419

Sub-Total, Heating			5,528,000	5,528,000
DHW				
Knowles				
Hunt			69,498	69,498
HHP				
Sub-Total, DHW			69,498	69,498
Total, Wood			5,597,498	5,597,498
Total, All Fuels		13,048,522	13,048,522	13,048,522
Electricity, kWh		2,682,200	2,727,440	2,727,440
Expense				
Natural Gas	$0.007/kBTU	$ 91,340	$ 52,157	$ 52,157
Wood, Fuel			$ 47,436	$ 25,191
Wood, Ash Disposal/Procurement			$2,300	$3,300
Electricity	$ 0.094/kWh	$ 251,377	$ 255,559	$ 255,559
Total		$ 342,717	$ 357,452	$ 336,207

The total expense of Option 1 includes an incremental expense for managing wood as a type of fuel[6], specifically $75/ton for ash disposal (1% of delivered wood by weight) and an allowance of $5/ton for procurement of wood fuel: $2,300 for wood pellets or $3,300 for wood chips.

With a configuration consisting of two 4,000 kBTUH natural gas boilers and one 4,000 kBTUH biomass boiler the capital cost increases to approximately $3.95M if using wood pellets or $4.06M if using wood chips. The increase of capital cost reflects the higher cost of the biomass boiler capacity and higher cost allowance for mechanical interconnection of systems and

[6] Round3ed up to next hundred dollars.

equipment. The biomass boiler reflects an installed cost of $180,000 (4,000 kBTUH x $45/kBTUH) plus $100,000 for a fuel storage bin for wood pellets or $180,000 for storage of the relatively bulkier wood chips. The cost allowance for mechanical interconnection has also been increased to $200,000 from $180,000 for the Base Case to account for the additional equipment connections for biomass operation.

Capital Cost Summary
Option 1b: Central Plant, Natural Gas & Biomass

Project Component	**Cost**	
	Wood Pellets	**Wood Chips**
Plant Building	$ 1,200,000	$ 1,200,000
Boilers: 2 x 4,000 KBTUH	$ 200,000	$ 200,000
Biomass Boiler: 4,000 kBTUH	$ 180,000	$ 180,000
Biomass Storage Bin	$ 100,000	$ 180,000
300 Ton Chiller	$ 750,000	$ 750,000
Interconnection		
Mechanical	$ 200,000	$ 200,000
Sub-total, Construction Cost	$ 2,630,000	$ 2,710,000
Contractor, 10%	$ 263,000	$ 271,000
Design, 10%	$ 263,000	$ 271,000
Detail, 25%	$ 789,000	$ 813,000
Sub-total, Development Cost	$ 1,315,000	$ 1,355,000
Total	$ 3,945,000	$ 4,065,000

Option 2: Central Plant with Ground Source Heat Pump System

Option 2 features a ground source heat pump system (GSHP) and conventional natural gas boilers. The GSHP system is sized for the cooling load of HHP: 300 tons. THE GSHP is capable of moving 300 tons of thermal load, removing heat from the building to the ground in a cooling mode during the summer or providing 300 tons of heat from the ground to the building in a heating mode during the winter. To provide an equivalent capacity as Option 1 and n+1 service redundancy, two (2) 4,200 kBTUH natural gas boilers will be installed in conjunction with the GSHP system. Total installed heating capacity is 12,000 kBTUH (2 x 4,200 kBTUH + 300 tons x 12 kBTU/ton). The resulting n+1 service capacity 7,800 kBTUH, sufficient to serve the anticipated maximum demand of 6,680 kBTUH.

Capital Cost Summary
Option 2: Central Plant with GSHP System

Project Component	**Cost**
Plant Building	$ 1,200,000
Boilers: 2 x 4,200 kBTUH	$ 210,000
300 Ton GSHP	$ 630,000
Interconnection	
Mechanical	$ 250,000
Sub-total, Construction Cost	$ 2,290,000
Contractor, 10%	$ 229,000
Design, 10%	$ 229,000
Detail, 25%	$ 687,000
Sub-total, Development Cost	$ 1,145,000
Total	$ 3,435,000

The estimated capital cost of this option is approximately $3.44M, reflecting an installed cost of $630,000 for the GSHP system (300 tons x $2,100/ton installed—a system of this capacity would typically use vertical wells for exchanging heat. The actual number of wells necessary for the system will be dependent on depth of the wells and the thermal characteristics of the soil. Using a nominal ratio of 100 feet per ton of capacity and depth of 250 feet, a 300 ton GSHP system would require 120 wells.) Because the GSHP system is capable of serving heating and cooling loads, the chiller capacity and associated capital cost included in the Base Case and Options 1 and 2 are unnecessary. However, the cost allowance for mechanical interconnection has been increased to $250,000, accounting for a more complicated utility system.

Based on historic and expected fuel consumption patterns and operation as primary heating capacity, the GSHP is forecast to deliver approximately 5,705,424 kBTU, or 475,452 ton-hours (5,705,424 kBTU ÷ 12 kBTU/Ton-hr) for the space heating requirement of the South Campus facilities. This heating contribution represents a potential natural gas offset of 7,131,780 kBTU (5,705,424 kBTU ÷ 80% conventional boiler efficiency): primarily reducing the fuel requirements of HHP, then Hunt and Knowles. The remaining natural gas consumption is then 5,916,742 kBTU (13,048,522 kBTU – 7,131,780 kBTU).

As discussed previously, the cooling load of the HHP building is forecast to require a 300 ton water cooled chiller consuming approximately 353,000 kWh to serve a potential load of for a potential cooling load of 451,656 ton-hours. On this basis, the GSHP system delivers 927,108 ton-hours of service to the South Campus facilities (451,656 cooling load ton-hours plus 475,452 heating load ton-hours), requiring 973,364 KWh of electricity (1.05 kw/ton—blended annual average accounting for heating and cooling cycles). The total electric consumption of Option 2 is then 3,303,263 kWh: 1,285,800 kWh for Hunt-Knowles plus remaining non-cooling electric load of HHP, 1,044,000 kWh plus 973,463 kWh consumed by GSHP system.

Energy Consumption and Expense
Base Case and Option 2

Consumption	Base Case	Option 2
Natural Gas, kBTU		
Heating		
Knowles	2,944,678	2,036,865
Hunt	2,934,391	2,899,109
HHP	6,405,375	216,690
Sub-Total, Heating	12,284,444	5,152,664
DHW		
Knowles	504,879	504,879
Hunt	154,442	154,443
HHP	104,757	104,757
Sub-Total, DHW	764,078	764,078
Total, Natural Gas	13,048,522	5,916,742
Electricity, kWh		
Cooling		
Knowles	42,000	42,000
Hunt	702,720	702,720
HHP	353,000	
Sub-Total, Cooling	1,097,720	744,720
General		
Knowles	363,000	363,000
Hunt	178,080	178,080
HHP	1,044,000	1,044,000

Sub-Total, General		1,585,080	1,585,080
Ground Source Heat Pump			973,463
Total, Electricity		2,682,800	3,303,263
Expense			
Natural Gas	$0.007/kBTU	$ 91,340	$ 41,417
Electricity	$0.094/kWh	$ 251,377	
Electricity	$0.086/kWh		$ 282,429
Total		$ 342,717	$ 323,846

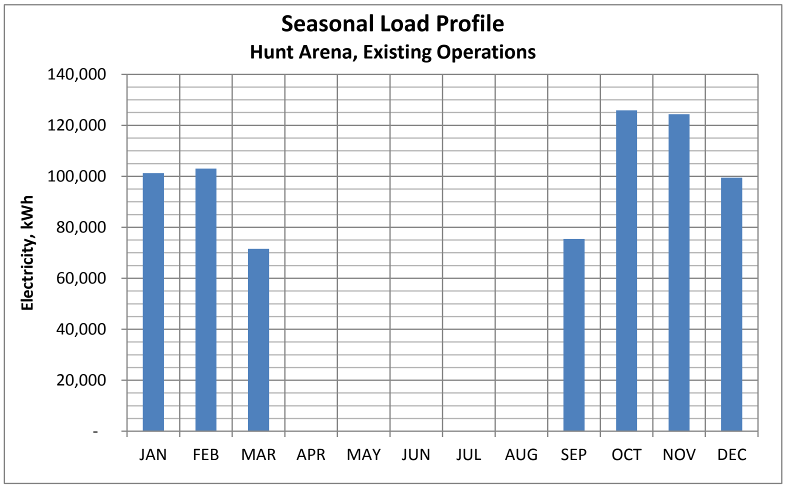
The unit prices of natural gas and electricity for the Base Case are $0.007/kBTU and $0.094/kWh, respectively. In consideration of the higher load factor attributable to the operation of the GSHP system, the unit price of electricity for Option 2 is reduced slightly, by a factor of about 5%, to $0.086/kWh[7]. The energy expense of Option 3 is $323,846: 5,916,742 kBTU x $0.007/kBTU + 3,303,263 kWh x $0.086/kWh.

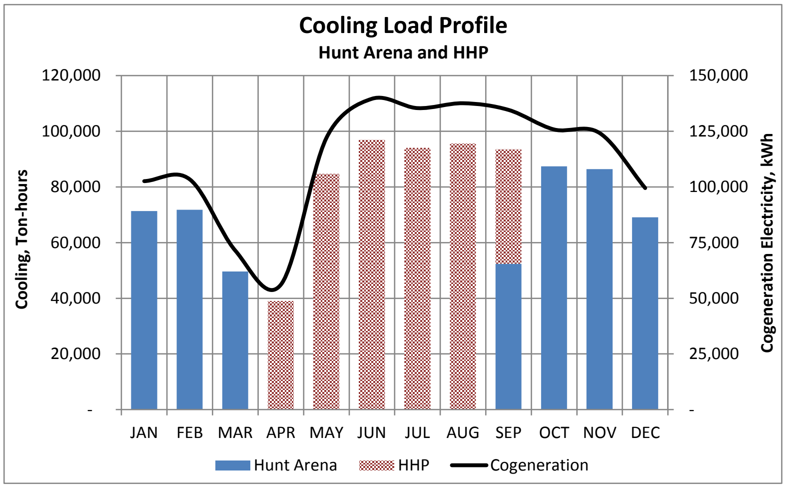
<u>Option 3: Central Plant and Cogeneration</u>

Option 3 consolidates the heating and cooling operations of the South Campus facilities. The central heating plant uses the same configuration as Option 1: three (3) 4,000 kBTUH natural gas boilers to provide n+1 heating utility service redundancy. For cooling operations, a 200 kW engine cogeneration system is installed to provide electricity to drive the chillers in Hunt Arena. Heat recovered from the cogeneration system (approximately 5,720 BTU/kW) will supplement the heating and DHW requirements of the South Campus facilities. Note: Conventional boiler capacity of the central plant was not adjusted to reflect heat recovery capacity.

[7]With a higher load factor, more kilowatt-hours are consumed during the billing period of a demand charge, yielding a lower average unit price of electric service.

The chillers of Hunt Arena are not used during the summer months, as exhibited by the accompanying chart. With this option the operation of these chillers is expanded to summer to serve the base cooling load of HHP, and to charge a thermal storage system for peak cooling demand periods of HHP—nominally a 1,600 Ton-hour system capable of serving a 200 ton cooling load over a 8 hour period. The thermal storage system would have a nominal volume of about 225,000 gallons, reflecting 1,600 Ton-hours, a temperature differential of 12° F and a discharge factor of 85%.





The anticipated electric consumption for cooling HHP is 353,000 kWh, or approximately 452,000 Ton-hours (0.78kW/Ton). The apparent seasonal load to produce the ice sheet in the arena is approximately 702,720 kWh from September through March. A balance of the existing seasonal load profiles of Hunt and the expected cooling profile of HHP is used to determine the operating requirements of the cogeneration unit. To support the existing cooling load of Hunt Arena and the anticipated cooling load of HHP, the cogeneration unit will generate about 1,352,200 kWh of electricity and provide 3,513,764 kBTU[8] of useable heat to the South Campus facilities—specifically the heating and DHW loads of Hunt and Knowles. This delivered heat represents about 4,392,205 KBTU of fuel consumption based on a thermal efficiency of 80% (3,513,764 kBTU of delivered heat ÷ 80%).

[8] Usable recovered heat from the cogeneration system is limited to the existing and anticipated thermal loads of the South Campus facilities during the months of June July and August.

Energy Consumption and Expense
Base Case and Option 3

Consumption	Base Case	Option 3
Natural Gas, kBTU		
Heating		
Knowles	2,944,678	1,910,641
Hunt	2,934,391	
HHP	6,405,375	6,405,375
Sub-Total, Heating	12,284,444	8,316,016
DHW		
Knowles	504,879	227,399
Hunt	154,442	8,145
HHP	104,757	104,757
Sub-Total, DHW	764,078	340,301
Cogeneration System		14,331,300
Total, Natural Gas	13,048,522	22,987,617
Electricity, kWh		
Cooling		
Knowles	42,000	42,000
Hunt	702,720	
HHP	353,000	
Sub-Total, Cooling	1,097,720	42,000
General		
Knowles	363,000	363,000
Hunt	178,080	178,080
HHP	1,044,000	1,044,000
Sub-Total, General	1,585,080	1,585,080

Total, Electricity		2,682,800	1,627,080
Expense			
Natural Gas	$0.007/kBTU	$ 91,340	$ 160,913
Electricity	$0.094/kWh	$ 251,377	
Electricity	$0.098/kWh		$ 160,079
Cogeneration Maintenance			$ 33,805
	Total	$ 342,717	$ 354,797

The remaining load for purchased electric service is 1,627,080 kWh, or the non-cooling electric requirement of Hunt (178,080 kWh) plus the non-cooling load of HHP (1,397,000 total kWh – 353,000 cooling kWh = 1,044,000 kWh) plus the electric consumption of Knowles (405,000 kWh). The annual expense for the remaining electric load is $160,079, based on a unit price of $0.098/kWh[9] and 1,627,080 kWh of purchased utility service.

Fuel consumption increases significantly with cogeneration to 22,987,617 kBTU, reflecting the remaining fuel requirements after accounting for fuel displaced by heat recovery (13,048,522 kBTU – 4,392,205 kBTU = 8,656,317 kBTU) plus the fuel for operation of the cogeneration system (14,331,300 kBTU). The corresponding fuel expense is $160,913 (22,987,617 kBTU x $0.007/kBTU).

An additional operating expense is included in Option 4 for incremental maintenance of the cogeneration system at a unit rate of $0.025/kWh generated, or $0.025/kWh x 1,352,200 kWh cogenerated electricity. The total comparative expense of Option 4 is $354,797: $160,913 for natural gas, $160,079 for the remaining purchased electric service and $33,805 for maintenance of the cogeneration system.

Capital Cost Summary
Option 3: Central Plant with Cogeneration
and Consolidated Cooling Loads

[9] A higher unit price is used because the cogeneration system is essentially operated as base load. Therefore the load factor of the remaining purchased electric is lower, yielding a higher average weighted cost of service inclusive of demand and energy charges: the demand charge is applied to fewer kWh increasing the unit price of purchased electric service.

Project Component	Cost
Plant Building	$ 1,200,000
Boilers: 3 x 4,000 kBTUH	$ 300,000
200 kW Cogeneration System	$ 350,000
Thermal Storage: 225,000 Gal	$ 563,000
Interconnection	
Mechanical	$ 250,000
Electrical	$ 50,000
Sub-total, Construction Cost	$ 2,713,000
Contractor, 10%	$ 271,300
Design, 10%	$ 271,300
Detail, 25%	$ 813,900
Sub-Total, Development Cost	$ 1,306,500
Total	$ 4,069,500

The estimated capital cost of Option 3 is approximately $4.1M. Interconnection costs have been increased to $300,000: $250,000 for mechanical systems and $50,000 for interconnection of electric systems and equipment. The expenditures for the plant building and boilers are the same as the Base Case: $1,200,000 and $300,000, respectively. The size of the plant building does not change because the boiler configuration is the same as the other options and the cogeneration unit would be installed in the mechanical room of Hunt Arena (since the existing boiler can be removed as the capacity is redundant with the new plant). The cost of the cogeneration system and thermal storage tank, $913,000, is in lieu of the 300 ton water cooled chiller for HHP included in the cost of the other options.

Summary of Variables

Fuel and Energy Prices	
Natural Gas	$7/MMBTU
Electricity	
Existing Demand Profile	$0.094/kWh
High Demand Profile, GSHP	$0.086/kWh
Low Demand Profile, Cogeneration	$0.098/kWh
Biomass, Wood Pellets, 14,000 kBTU/Ton	$120/Ton
System Efficiencies and Performance	
Conventional Boilers, New	80% Fuel Efficiency
Hunt Arena Chillers	1.44 kW/Ton
Knowles Air Cooled Chillers	1.25 kW/Ton
New Water Cooled Chiller	0.78 kW/Ton
Ground Source Heat Pump System	1.05 kW/Ton
Cogeneration	
Fuel Consumption	10,599 BTU/kWh
Heat Recovery	5,720 BTU/kWh
Capital Costs: Installed Unit Cost	
Conventional Boilers	$25/kBTUH Capacity
Biomass Boiler	$45/kBTUH Capacity
Biomass Storage Bin	$100,000
Water Cooled Chiller	$2,500/Ton
Thermal Storage Tank, Chilled Water	$2.50/Gal
Utility Building/Mechanical Room	$200/Square Foot
Ground Source Heat Pump System	$2,100/Ton

Cogeneration System	$1,750/kW
CO_2 Emission Factors	
Natural Gas	52.7557 kg/MMBTU
Electricity	781,389 kg/MWh
Biomass, Wood	93.80 kg/MMBTU

Abbreviations and Acronyms

kBTU	Thousands of BTUs
MMBTU	Millions of BTUs
kBTUH	Thousands of BTUs per Hour
kWh	kilowatt-hour
SF	square foot/feet
kW	kilowatt
Tonne	1,000 kilograms

Capital Cost Summary Comparison

	Base Case	Option 1a	Option 1b	Option 2	Option 3
Plant Space/Building	$ 1,200,000	$ 1,200,000	$ 1,200,000	$ 1,200,000	$ 1,200,000
Major Equipment					
Boilers					
One 3,710 kBTUH, Natural Gas					
Three 4,000 kBTUH, Natural Gas	300,000				$ 300,000
Two 4,000 kBTUH, Natural Gas		200,000	200,000		
Two 4,200 kBTUH, Natural Gas				210,000	
One 4,000 kBTUH, Biomass		180,000	180,000		
Biomass Storage		100,000	180,000		
Chiller					
One 300 Ton Water Cooled	750,000	750,000	750,000		
GSHP System, 300 Tons				630,000	
200 kW Cogeneration System					$ 350,000
Thermal Storage Tank					$ 563,000
Interconnection					
Mechanical	180,000	200,000	200,000	250,000	$ 250,000
Electrical					$ 50,000
Sub-total, Construction Cost	$ 2,430,000	$ 2,630,000	$ 2,710,000	$ 2,290,000	$ 2,713,000
Contractor, 10%	$ 243,000	$ 263,000	$ 271,000	$ 229,000	$ 271,300
Design, 10%	243,000	263,000	271,000	229,000	$ 271,300
Detail, 25%	729,000	789,000	813,000	687,000	$ 813,900
Sub-total, Development Cost	$ 1,215,000	$ 1,315,000	$ 1,355,000	$ 1,145,000	$ 1,356,500
Total	$ 3,645,000	$ 3,945,000	$ 4,065,000	$ 3,435,000	$ 4,069,500
Incremental Capital Cost	N/A	$ 300,000	$ 420,500	$ (210,000)	$ 424,500

Base Case: Adjacent Buildings, Separate Utilities
Option 1: Central Heating Plant, Separate Cooling
Option 2: Central Plant with Biomass, Separate Cooling
Option 3: Central Plant with Ground Source Heat Pump, Separate Cooling
Option 4: Central Plant, Cogeneration System, Consolidated Cooling for Hunt and HHP, Separate Cooling for Knowles

Summary of Incremental Capital Cost and Avoided Expense

	Fuel & Electric Expense	Incremental Maintenance	Operating Expense	Avoided Expense	Incremental Capital Cost	Simple ROI
Base Case	$ 342,717		342,717	N/A	N/A	N/A
Option 1a	$ 355,152	$ 2,300	357,452	(14,735)	$ 300,000	-4.9%
Option 1b	$ 332,907	3,300	336,207	6,510	420,000	1.6%
Option 2	$ 323,846		323,846	18,871	(210,000)	###
Option 3	$ 320,992	$ 33,805	$ 354,797	$ (12,080)	$ 424,500	-2.8%

Summary of Fuel and Electric Consumption Comparison of CO_2 Emissions

	Natural Gas kBTU	Biomass kBTU	Electricity kWh	CO_2 Emissions Tonnes	Differential Tonnes
Base Case	13,048,522		2,682,800	2,784.7	N/A
Option 1a	7,451,024	5,597,498	2,727,440	3,049.3	264.6
Option 1b	7,451,024	5,597,498	2,727,440	3,212.9	428.2
Option 2	5,916,742		3,303,263	2,893.3	108.6
Option 3	22,987,616		1,627,080	2,484.1	- 300.6

Note: More wood fuel is consumed with Option 1b relative to Option 1a for delivery of the same amount of heat, resulting in higher CO_2 emissions.

CO2 Emission Factors:
Natural Gas, Clean Air Cool Planet Carbon Calculator: 52.75574094 kg/MMBTU
Electricity, eGrid 781.389 kg/MWh
Biomass, EPA Reporting Factor, Table C-1, Subpart C, Part 98 93.80 kg/MMBTU

Base Case: Central Heating Plant, Separate Cooling

Option 1: Central Plant with Biomass, Separate Cooling (1a: Wood Pellets; 1b: Wood Chips)

Option 2: Central Plant with Ground Source Heat Pump, Separate Cooling

Option 3: Central Plant, Cogeneration System, Consolidated Cooling for Hunt and HHP, Separate Cooling for Knowles