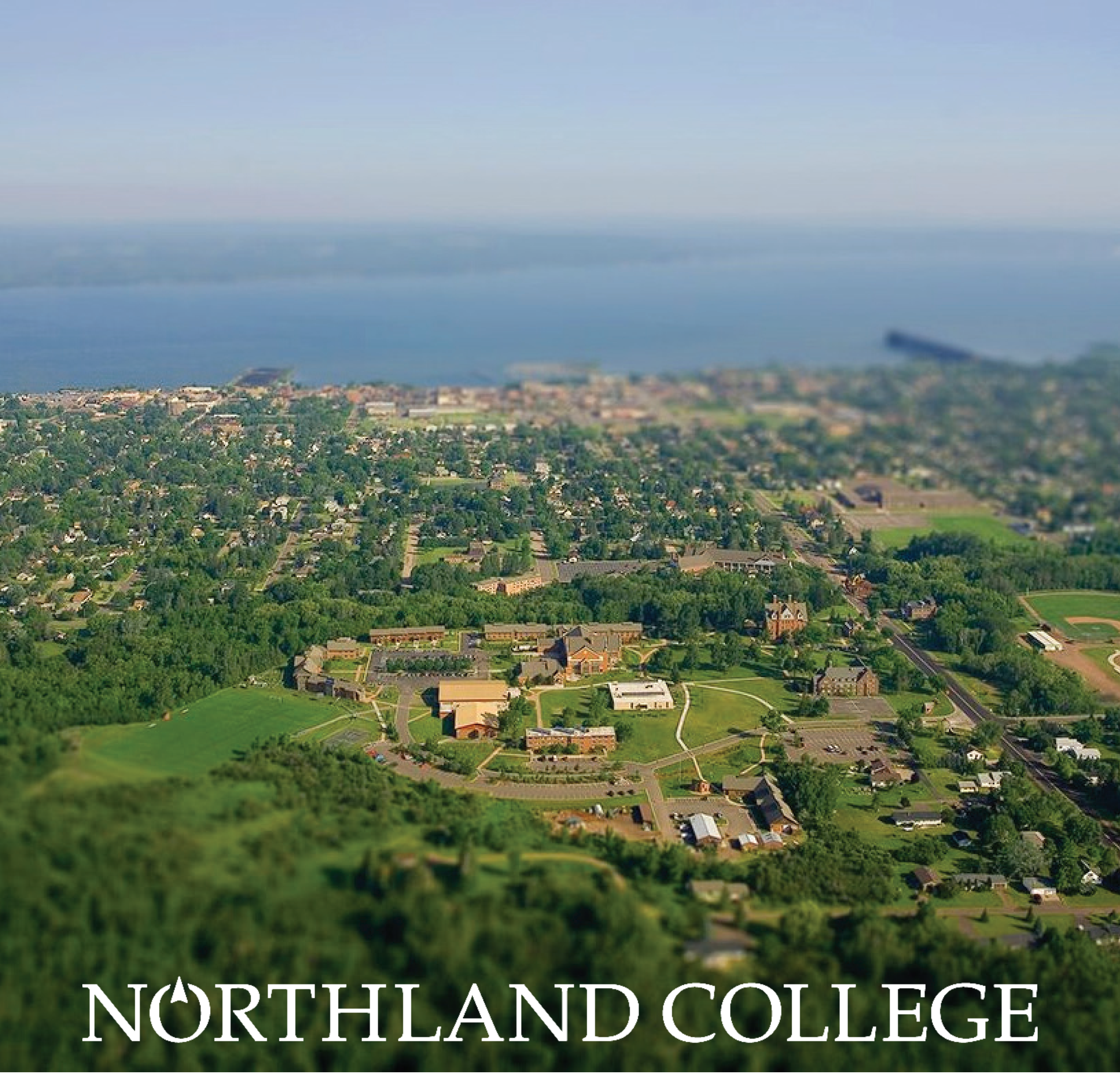

# NORTHLAND COLLEGE

# ENERGY STUDY FOR CLIMATE ACTION PLAN

October 2015

AEI Affiliated Engineers

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NORTHLAND COLLEGE

Office of the President

October 8, 2015

In 2007, my predecessor Dr. Karen Halbersleben made Northland College a signatory to the American College and University Presidents' Climate Commitment. When I took over the presidency in 2010, I reaffirmed our commitment to sustainability leadership and to continuing to pursue carbon neutrality for the campus. As a part of this commitment, the College seeks to become carbon neutral by 2030.

A Sustainability Work Group was established and in August 2014, acting under my direction, issued a request for proposals. The ensuing selection process led to the College's engagement with Affiliated Engineers to perform a study looking at the costs and benefits for the options available for reducing campus CO2 emissions from our current level of about 3,500 metric tons of CO2e to net zero by 2030.

The College seeks to maintain and expand its role as a national leader in campus, curricular and community sustainability. This commitment recognizes how critically important energy is to supporting Northland's educational mission and emphasizes Northland's belief that we must be holistic and comprehensive in our approach to sustainability. We know that to continue educating generation after generation of students requires an efficient, clean, safe, and reliable campus energy infrastructure that will continue to serve us indefinitely into the future.

The result of the study is an inspiring vision and master plan for Northland to achieve carbon neutrality by 2030. Taken together with the work Northland is also pursuing through the Mary Griggs Burke Center for Freshwater Innovation, Sigurd Olson Environmental Institute, Center for Rural Communities, Indigenous Cultures Center, and the emerging food systems center, we have developed an approach to what we are calling "full spectrum sustainability," that will be affordable and replicable.

This approach promotes coordination of comprehensive and integrated facets of sustainability including water, food, health, economy, energy, and culture.

We will leverage these interconnections to provide a model for tangible solutions to the overarching and systematic challenges we are facing at Northland College, in the greater Chequamegon Bay region, and across the world. By implementing the recommendations outlined on the following pages, we will be acting to fulfill our vision to model and lead in everything we do to create sustainable and thriving communities and regions.

Sincerely,

Michael A. Miller, Ph.D.

1411 Ellis Avenue • Ashland, Wisconsin 54806-3999 • (715) 682-1202 • **northland.edu**

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# EXECUTVE SUMMARY

Northland College seeks to excel as a leader in sustainability among U.S. colleges and universities. Two things that are distinct about sustainability efforts at Northland College are critical to its path forward and fundamental to the recommendations made in this report.

First, the college has an earnest interest in advancing sustainability in its region. As evidence, Northland College is home to the Sigurd Olson Environmental Institute and the Mary Griggs Burke Center for Freshwater Innovation. The Sigurd Olson Environmental Institute has, since 1972, engaged Cheguamegon Bay residents, businesses and government to address the region's environmental challenges. The Mary Griggs Burke Center for Freshwater Innovation (established in 2015) assumes a larger definition of region, that of Lake Superior. This group celebrates the region's connections of its freshwater resources to the arts, sciences and the environment. It works to advance awareness of the most important research and innovations and propel public policy forward to better protect freshwater resources. Other college centers -- the Indigenous Culture Center (established in 2010), the Center for Rural Communities (established in 2014) and the emerging local foods center – focus on specific aspects of the college's larger community. Further, every major at the college incorporates the institution's concern for learning about the environment. Professors bring students to experience and understand the geography of their setting as a vehicle for this learning. The college leverages the local economy by purchasing much of its food from local vendors. Currently at 39%, this program will expand until 80% of the college's food budget is spent on local products.

The second distinction is that Northland College is proof of scale. Northland, a college with a student population of under 700[1] has a thriving sustainability program organized to advance reliance on local food, on energy independence and on water conservation. Of the 685 higher education intuitions that have pledged to the American College & University President's Climate Commitment (ACUPCC), there are only 24 that can be considered to be peers as a function of size and educational model.

This study was undertaken to refresh the college's 2010 Climate Action Plan. Through this study, the college asked fundamental questions about how to best achieve its goal of carbon neutrality in a way which advances its engagement in the region, its proof of the viability of sustainability as this scale of an institution, and its interests in food, energy and water. The result is a plan that does this and accomplishes it with obvious concern for efficiency of investments. In its simplest form, the plan call for three things:

- The college will operate and occupy campus buildings to realize improved energy efficiency
- The college will grow its building footprint without increasing its building-related rate of carbon emissions
- The college will transition from reliance on fossil fuels – its current use of natural gas and utility-provided electricity – to renewable sources

The text that follows describes the logic of this strategy, its elegance, its timing and its cost.

1 Of the nation's 4,634 classified higher education institutions, Northland College is classified by the Carnegie Classification of Institutions of Higher Education™ as one of 140 U.S. colleges and universities that are four-year, highly residential, with a student population of under 1,000 and greater than 80% of the students enrolled as full-time students. This category represents 3% of all institutions and serves 0.5% of the student population.

# CONTEXT

## INTRODUCTION

Established in 1906, Northland College changed the course of its destiny in 1971 when it adopted an environmental lens as focus for its liberal arts mission. Today, the college serves 550 students on a 120-acre campus. Its mission is to integrate liberal arts with an environmental emphasis. The college's academic mission is pursued with equal vigor in the community as in the classroom. Seeking to reinforce and offer additional means of learning about the environment, college administrators are proud of the many steps they have taken to create a campus environment consistent with the institution's academic values.

Limiting carbon emissions associated with campus operations is an important and obvious element of the Northland College experience. As the following timeline establishes, Northland College has taken many steps to reduce its carbon impact. Many of these are valued in part for their visibility to the college's students and the opportunity that they offer for students to extend classroom learning into other dimensions of their lives.

| | |
|---|---|
| 1998 | Northland College invests in solar hot water system and a wind turbine for McLean Environmental Living & Learning Center. |
| 2000 | Northland College establishes a green building policy that commits to adhere to the Minnesota Sustainable Design Guide. |
| 2001 | Northland College's first geothermal investment is made (Craig A. Ponzio Campus Center). |
| 2006 | A campus energy audit is undertaken. It documents the need for energy conservation investments in many campus buildings. |
| 2007 | Northland College commits to LEED® Silver standard for all new construction and major renovations. |
| 2007 | Northland College becomes a signatory to the ACUPCC. This commits the college to a number of specific steps and an ultimate goal of reaching carbon neutrality as soon as it is practical. |
| 2007 | Northland College's second solar hot water system investment is made (McMillan Hall). |
| 2008 | Northland College students install a solar array at the President's House. |
| 2008 | Northland College's second geothermal investment is made (Dexter Library). |
| 2008 | Northland College students vote to double the per semester contribution to the college's Renewable Energy Fund. |
| 2008 | Northland College starts annual inventories of campus carbon[2] emissions. |
| 2009 | Northland College students install solar panels on the Dexter Library roof. |
| 2010 | Northland College issues its Climate Action Plan. |
| 2010 | Dexter Library renovations project earns LEED® Gold status. |
| 2011 | Northland College pledges to participate in the Billion Dollar Green Challenge. This is an educational network of higher education institutions with energy conservation revolving loan funds. |
| 2014 | Northland College issues a facility assessment which describes a number of building conditions that need addressing, including many that are limiting building energy efficiency. |
| 2014 | Energy Retrofit Program report issued. It details energy conservation measures implemented since 2008 and still-outstanding energy conservation opportunities. The report describes that investments to date represent an annual savings of 775,765 kWh. |

2 CO2e

The Northland College Climate Action Plan was issued in 2010 to officially launch the college's climate mitigation trajectory. It commits the college to reducing Scope 1, Scope 2, and Scope 3[3] greenhouse gas emissions by 75% by 2025 and to achieve a net balance of zero carbon emissions by 2030. The Climate Action Plan dedicates the college to investing in energy conservation measures and renewable energy, in that order of priority. It acknowledges barriers, specifically college spending capacity and the decentralized configuration of heating.

Now, five years into plan implementation, Northland College has asked for a study to refresh its exploration and wisdom, testing those ideas in the current context. Among other reasons, the plan is justified because the campus GHG emissions (MTCo2e) have been relatively flat since plan issuance.[4]

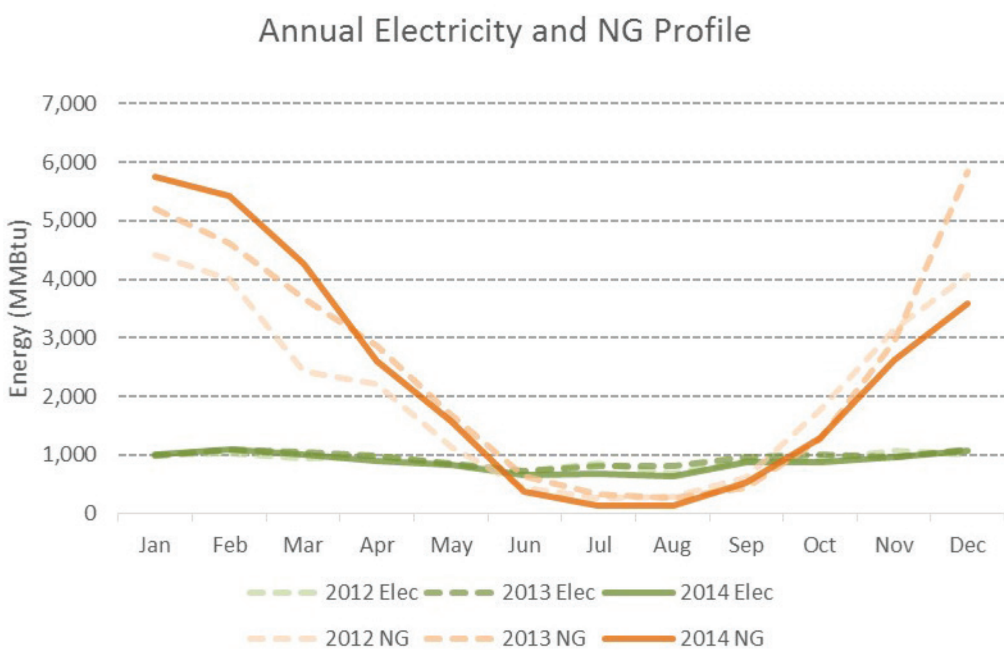



Table 1. Northland College's Electricity and Natural Gas Profile

3 Those that are relevant to the campus.
4 MTCO2e has varied from a 2010 starting point of 3,211 MTCO2e (as reported in the 2010 Climate Action Plan) to a low as 2,794 MTCO2e (-13% from base year. Source: AEI analysis of 2012 utility bills) and a high of 3,095 MTCO2e (-3.6% from base year. Source: AEI analysis of 2013 utility bills).
5 Northland College's natural gas has been normalized for heating degree days to allow for best comparison over time.

This study identifies and plans for Northland College investments that speak to its national position as a leader in campus sustainability and honor its stated goal of realizing carbon neutrality by 2025. Specifically, these activities were vetted to ensure that they are:

- impactful relative to carbon reduction
- a good fit to the college's financial and administrative capabilities
- justified in a lifecycle cost analysis
- true to the college's environmental values and
- Intriguing ways to advance the college's commitment to community

Northland College commissioned this study in 2015 to identify and assess the costs and benefits of options for the college to reach net zero carbon emissions. This study was undertaken in in the context of an expectation of near-term growth that will increase the student population to at least 750 people and construct approximately 100,000 sf of buildings. This study was requested by President Miller to specifically address:

1. Replacing existing building boilers with a less carbon intensive alternative
2. Improving energy management practices and technologies and
3. Serving the campus with less carbon intensive electricity

## GETTING STARTED: PARTNERING WITHIN THE REGION

Northland College sits in Ashland, the capital of Ashland County, Wisconsin. Its population density -- 15.5 persons per acre – is expected to remain stable for the next three decades. Short-term economic projections for the region are positive. The state projected 11% job growth for northern Wisconsin in the 2010-2020 decade, is largely in professorial and business services, lea sure and hospitality.[6]

Northland College's mission and position as a major employer and an important intellectual voice in the region compelled this study to identify opportunities for Northland College to learn from others and/or partner within the region to pursue its carbon emissions reductions goals. This exploration found:

1. Xcel Energy and Memorial Medical Center share expertise and helped to strengthen Northland College's confidence in shifting from natural gas to biomass as its primary heating source. Biomass at Northland College can easily be procured from locally harvested lands and involved vendors will assure their compliance with the state's forest management guidelines.
2. Northland College's nearby institutional neighbors – Memorial Medical Center and Wisconsin Indianhead Technical College -- have energy interests similar to Northland College's. This study's consideration of the potential to share systems with these neighbors suggested that the college and the Memorial Medical Center might find that their scale, proximity, year-round energy needs, and intuitional experiences are the basis of a viable energy management partnership. The technical college's operational schedule and recent facility investments sets it apart.
3. Bayfield County and the Bad River Band of Lake Superior Chippewa tribe represent appealing energy management partners in terms of access to resources and presence within the region. The dialogue accomplished through this study will be regularly revisited.
4. There are local business owners, including farmers, who rely on low/no carbon fuels and technologies and who stand ready to partner with Northland College with an open consideration of what

Bailey's Greenhouse is a local example that proves the business case for renewables. The Bayfield, Wisconsin complex includes a 10,000 sf greenhouse with related buildings. It is approximately 75% reliant on a combination of biomass fuel (gasification boilers) and grid-tied solar photovoltaics. Utility provided electricity demand for heating has been reduced by 80%, and, for equipment and lights, by 73%. With the benefit of federal subsidies, tax credits and opportunity to claim capital depreciation, the solar photovoltaics is showing a payback performance of 8.5 years and the boilers promise to save on fuel costs to provide a payback of under 5 years.

6 Wisconsin Department of Workforce Development

that energy management path might entail.

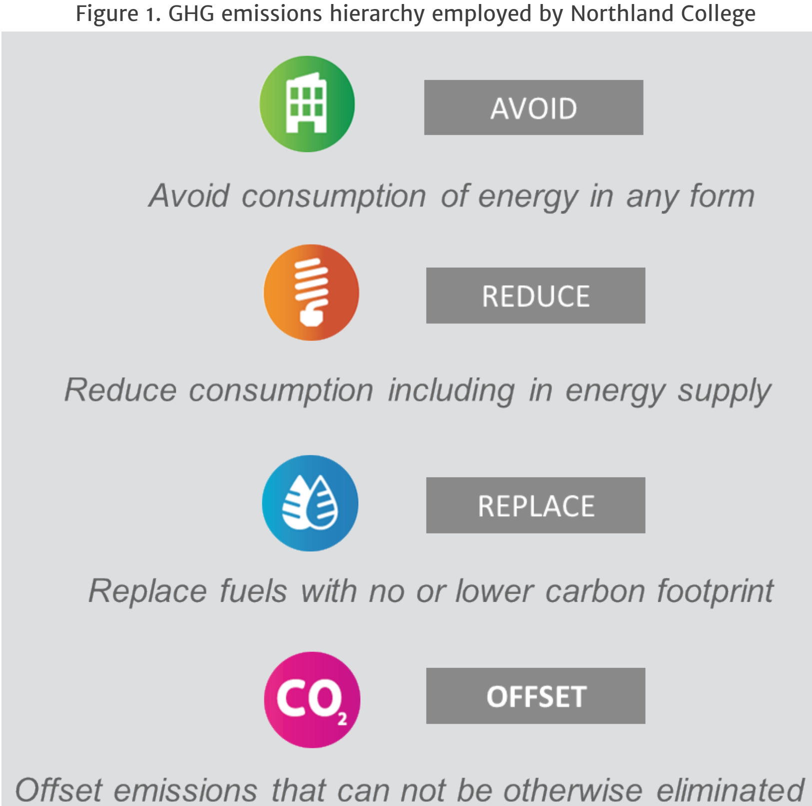
# CHARTING THE COURSE

## ENERGY HIERARCHY

This plan applied a hierarchy of investments that many U.S. colleges and universities employ to generate the most effective strategy for their campus carbon emissions reductions.

The **first** priority is to avoid consuming energy in any form. Generally, higher education campuses do this through initiatives that inform and motivate students, faculty and staff on means of occupying and managing campus facilities in energy-efficient ways. This might include creating or modifying policies that guide building temperature settings, use of lighting in unoccupied spaces and equipment use. It involves developing standard information to teach and remind the campus community of how individuals can reduce energy in the ways that they use (occupy) buildings. "Avoid" strategies are typically relatively low and even no-cost.

Figure 1. GHG emissions hierarchy employed by Northland College




The **second** priority is to reduce energy consumption. Investments in this category employ capital costs of varying size and payback terms. Most commonly, "reduce" activities target means of conserving building energy use. This conservation approach can also be applied to campus energy supply, often triggering significant investment at campus central plants and/or distribution systems to gain dramatic energy efficiencies.

**Third,** is the replacing of carbon generating fuels with ones that are more carbon efficient and/or carbon neutral. This activity can range from retrofitting equipment to use alternative fuels to procuring new energy generating equipment that has relatively low-or no-carbon emissions.

**Fourth,** college and universities turn to renewable energy credits (RECs) and carbon offsets. This option relies others' activities rather than that of the institution. Many criticize RECs and offsets because they have little-or no-visibility or value to the institution. Others are comfortable with this form of greenhouse gas emissions mitigation, particularly where they represent activity that is near to the campus location and/or represents a means of realizing carbon reduction goals at a reduced capital commitment and cost[7]. They also may be used as a low cost interim strategy that allows time for new and emerging technologies (potential fits for Northland College) to gain better traction in the market.

## LESSONS FROM PEER INSTITUTIONS

In a class of higher education institutions recognized for their sustainability, Northland College is concerned to compare its activities and aspirations of its peers. For this purpose, peers were identified as U.S. higher education institutions with student populations of 5,000 and less who have won recognition through the Association for the Advancement of Sustainability in Higher Education (AASHE STARS Gold), through pledge to the ACUPCC, and at least one other form of sustainability program recognition (such as by the Sierra Club or Princeton Review). These peers are Bard College, Chatham University, Colby College, Colgate University, Dickinson College, Green Mountain College, Haywood Community College, Lewis & Clark College, Macalester College, Middlebury College, Oberlin College, Unity College and the University of Minnesota Morris. Of these 13 peer institutions, 12 have low-or no-fossil fuel energy systems, 10 have purchased offsets and/or RECs, 9 have comprehensive strategies to invest in building energy demand management, 6 have committed to purchasing Energy Star equipment whenever it is possible and 5 have design standards of LEED® Silver or higher. Three of these institutions – Colby College, Green Mountain College and the University of Minnesota Morris – report that they are carbon neutral[8].

A second consideration of peer group places Northland College with more than 75 colleges that operate a revolving loan fund to finance building energy conservation investments and/or fossil-free fuel investments. Generally, these funds are used to support projects with high probability of return on investment and a median return on investment of less than 6 years. Most of these institutions are private and small: the median

7 Northland College has expressed interest in offsets only when they also offer visibility to students and for the college. This is presumed to occur when the offset activity is local to the college.
8 Note that Institutions exercise some latitude in establishing their use of the term "carbon neutral". For example, some exclude Scope 3 emissions (all indirect emissions that occur in the value chain except for those include din Scope2).

fund size is less than $500,000. The following list of institutions combines Midwest institutions and some which appear on the list of 13 key peers, described above. As Northland College develops its nascent revolving loan program, it might engage these to learn first-hand of their experiences:

- Carleton College: $80,000 fund established in 2007
- College of St. Benedict/St. John's University: $0.1M established in 2010
- Dennison University: $0.7M established in 2011
- Hampshire College: $80,000 fund established in 2011
- Iowa State University: $1M fund established in 2008
- Miami University of Ohio: $50,000 established in 2009
- Middlebury College: $0.03M established in 2011
- Unity College: $.1M established in 2011
- University of Illinois (UC): $1.5M fund established in 2009
- University of Minnesota Duluth: $0.1M established in 2011
- University of Minnesota Twin Cities: $4M established in 1998
- University of Notre Dame: $2M fund established in 2008

## FINANCING NORTHLAND COLLEGE'S CARBON REDUCTION

This study considered the technical, social and economic benefits and costs of many individual and combined options for Northland College to reach its carbon reduction goal. Economic considerations started with developing a profile of the college's pattern of utility, energy equipment/systems and building maintenance so that the study could draw conclusions on relative first and life-cycle costs and carbon emissions of alternative activities and investments. The following characterize the college's financial investments of the last decade:

1. Deferred maintenance is impacting the operating efficiency of many campus buildings, causing unnecessary energy cost and greenhouse gas emissions. Further, the college does not have a protected set-aside fund to invest in deferred maintenance or failed facility operation[9].
2. Most capital investments are gift-dependent.
3. The college's revolving fund for energy conservation is not operational.

9 Industry standard practice is to provide for annual access to 2% of building replacement value to address deferred maintenance or mitigate its occurrence.

The college provided assumptions to structure this report's financial analysis:

- Northland College will increase its annual investment in arresting deferred maintenance with a target level of an annual investment equal to 2% of the campus' building replacement value[10].
- Most capital investments in energy systems and building energy efficiency are expected to be gifts and grants or will be leveraged through contracts with energy service contract entities. The college development officers will launch a campaign to support this plan and will test crowdfunding as a means of stimulating alumni support for the small and innovative projects described in this study. In the immediate, Northland College will engage in an exploratory process to gauge the promise of contracting with energy service companies (ESCOs). Through this, the college will establish the needed understanding of what competitor companies might offer to advance investments contemplated in this plan. This process will enable Northland College to anticipate the financial obligations any engagement in a contract with an ESCO might entail and be well prepared (perhaps through independent analysis) to ensure its ability to wisely procure these services.[11]

Table 2. Financing Options for Northland College's Preferred GHG Emissions Reductions Scenario

| ELEMENT | TRADITIONAL | CROWDS | FOUNDATION | PARTNERS | ESCO | PPA | XCEL |
|---|---|---|---|---|---|---|---|
| Behavioral Change | Yes | Yes | Yes | | | | |
| Buildign Automation System | Yes | | | | Yes | | |
| LED lighting Retrofit | Yes | Yes | Yes | | Yes | | Yes |
| Zero Energy Buildings | Yes | | | | | | |
| Retro-commissioning | | | | | Yes | | |
| Strategic ECMs | Yes | Yes | | | Yes | | Yes |
| Biomass Boiler | Yes | | | | Yes | | |
| Large Scale Solar | Yes | | | | Yes | Yes | |
| Farmer Friendly Solar | Yes | Yes | Yes | Yes | | Yes | |

- The college remains committed to engaged exploration with the region's tribes[12], institutional neighbors, counties and city government, and Xcel Energy to keep active the possibility of establishing mutually beneficial carbon emissions-reduction partnerships. At this writing, the most likely partnership would be development of an expanded biomass boiler at Memorial Medical Center to serve Northland College

10 Inclusion of an assumed 2% of building replacement for maintenance implies that the costs referenced in this plan can be compared to both a base (with the 2%) and a business-as-usual financial case (which assumes that the physical stock will be maintained in the future as it is today).

11 The State of Wisconsin offers a list of 14 ESCO vendors that it has certified to work in state owned facilities and other advice for contracting with energy service companies. See: http://www.stateenergyoffice.wi.gov/category.asp?linkcatid=3852&linkid=1844&locid=160

12 At this writing, tribal governments can access federal Qualified Energy Conservation Block funding and Tribal Energy Program Grants, both of which can potentially be developed as a partnership initiative with Northland College.

and the Memorial Medical Center's near-term expansion plans and boiler replacement needs. While only a concept at this writing, sizing the facility to support both institutions will translate into reduced total first cost and operating cost.[13]

- The college recognizes that the cost of acquiring renewable energy credits (REC) and carbon offsets for the term of this plan (2039 forecast year) might be a more cost effective route. Prices for RECs and carbon offsets vary significantly depending on the market and vendor and have decreased significantly in the U.S. due to legislation impacted the carbon cap and trade markets[14]. As evidence of the variability, the 2014 global average voluntary price was $3.8/MTCO2e and the 2014 average broker price was $1.1/MTCO2e[15], whereas the U.S. government prices the social cost of carbon at $37/MTCO2e[16] for the purpose of regulatory impacts. For Northland, this gives a cost range of NPV of $166,000 to NPV of $4,550,000 over the term of this plan.

While recognizing this difference and the fact that many of the college's peer institutions employ such vehicles, Northland College adheres to its position, articulated in the Northland College Climate Action Plan, that purchased offsets are "ethically problematic" because the activities that they sponsor don't motivate behavior change and the college community is uncomfortable with the lack of transparency of such purchases. The text of the 2010 document recognizes that the transparency problem is one that might be resolved and that such a purchase may ultimately be justified to close the gap between what is possible to achieve on campus and the college's ACUPCC pledge. In the immediate purview of this report, the college instead looked for opportunities to marry the concept of offsets with its commitment to form and expand partnerships within the region.

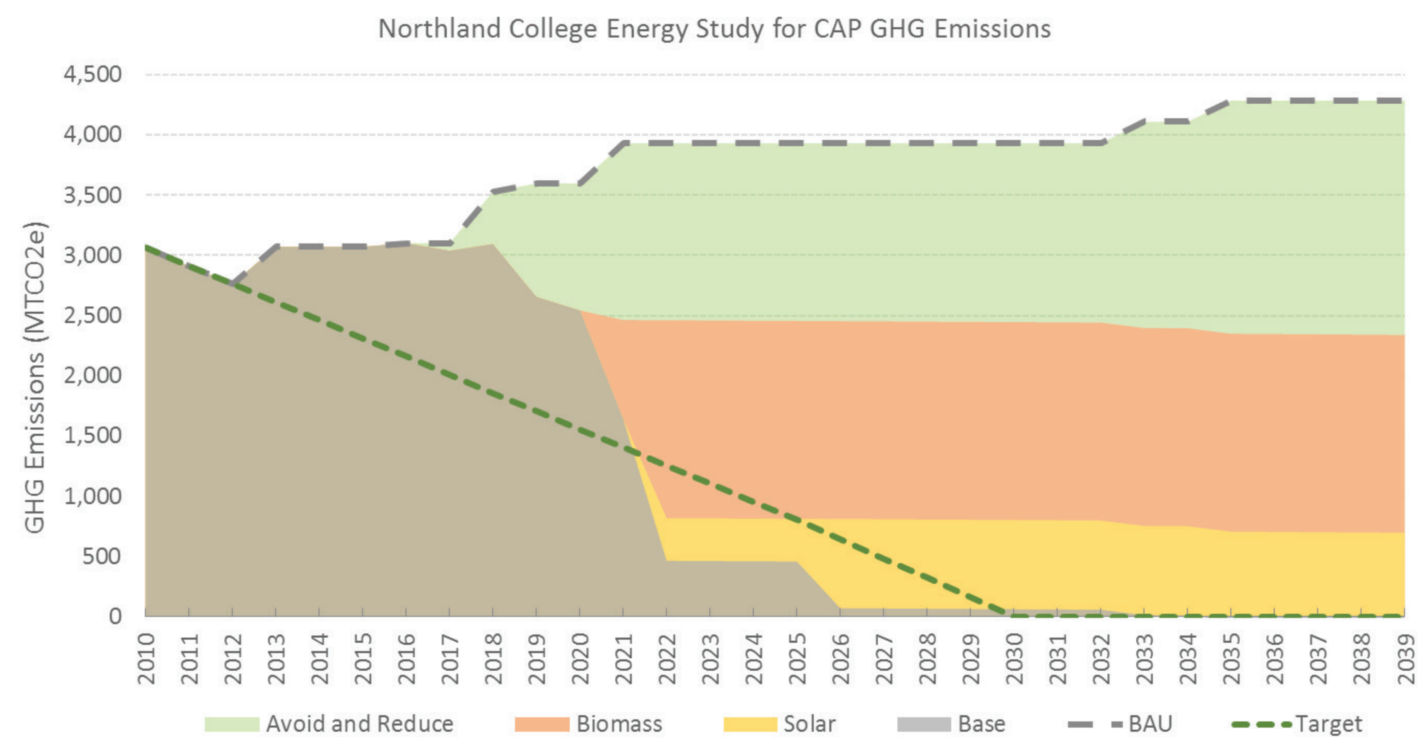
## NORTHLAND COLLEGE'S CARBON REDUCTION STRATEGY

Northland College considered a broad range of options before arriving at three scenarios and, ultimately, a preferred approach to its pursuit of net zero carbon emissions. In the preferred scenario, approximately one third of campus carbon emissions reduction is associated with "avoid and reduce" investments and the remainder is associated with capital investments to improve energy supply efficiencies and replace fossil fuel sources with non-fossil fuel energy sources.

13 It is premature to speculate on the magnitude of any savings of a shared biomass boiler system.
14 *Ahead of the Curve: State of the Voluntary Carbon Markets* 2015, Ecosystem Marketplace, June 2015
15 Ibid.
16 *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis*, White House Office of Management and Budget, July 2015, https://www.whitehouse.gov/blog/2013/11/01/refining-estimates-social-cost-carbon



Figure 2. Carbon Wedge Diagram of Preferred GHG Emissions Reduction Scenario




**"Avoid and Reduce"** investments offer the most favorable returns-on-investment among the significant investments studied, provide appealing visibility on-campus and beyond, and opportunity for meaningful student engagement. Some will be appealing to Northland College's donor pool. Northland College will invest in:

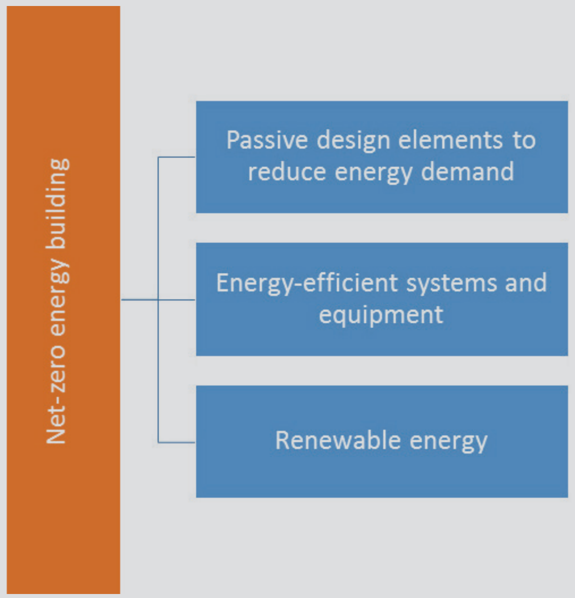
- **Behavioral change** – a targeted program[17] to inform and motivate the Northland College community (students, faculty and staff) about ways that they can change their behavior to reduce building energy demand.
- **Building automation system** – a central system that monitors and optimally controls all conditioned buildings' systems (energy related and related to security and smoke/ fire hazard)[18].
- **LED lighting retrofit** – energy efficient lighting to replace about half of the campus' (energy performance-inferior) lighting[19].

### Elements of a Successful Building Occupant Behavioral Change Program

- Start with self-selected building(s)
- Measure energy and electricity performance
- Communicate – nudge, instruct, report, applaud – everyone's interest and responsibility
- Sustain the momentum
- Provide incentives

17 The most successful building occupant behavioral change programs at colleges and universities are typically those which target science classroom buildings, labs, and administrative buildings. This study recommends a capital investment be made every 5 years to "refresh" this program.
18 This will replace the existing partial system with one that supports all of the campus' conditioned buildings and is superior in technology.
19 LED lighting will be installed where the campus has not recently upgraded its lighting. This equates toto edfwef to approximately 250,000 gsf. to approximately 250,000 gsf.

- **Net zero energy buildings** – new buildings are to be designed to be energy neutral. Note that the premium cost for energy neutrality will be considered as part of the college's carbon neutrality strategy for the next two building projects – the athletics facilities and the Eco-Village. Building construction projects undertaken afterwards[20] are calculated in this study as zero-energy, but because building codes/standards will drive this building performance, the premium cost (which will lessen in relative size) these projects are not considered in this study to be part of the college's cost to realize carbon neutrality.




According to the U.S. Department of Energy, net zero energy buildings produce as much energy as they use in a year. To accomplish this, the design team will create a building with as limited an energy demand as possible and renewable energy supply to offset remaining demand.

Two net zero energy buildings close to Northland College are interesting models. The Aldo Leopold Legacy Center in Baraboo, Wisconsin is an 11,900 square foot office and interpretive center that celebrates Aldo Leopold's legacy through its net zero energy status and its LEED® Platinum designation. The building's efficient design is so limited in energy demand that its energy need is more than that which is supplied by the building's rooftop photovoltaic array. Second, is the Science House at the Science Museum of Minnesota. This building is entirely electric and generates electricity of its demand in its rooftop photovoltaic installation.

- **Retro-commissioning** – third party-contracted services[21] to identify and address mechanical system variance from optimal performance, campus wide and building-specific education for facilities staff to improve their building operations and maintenance.

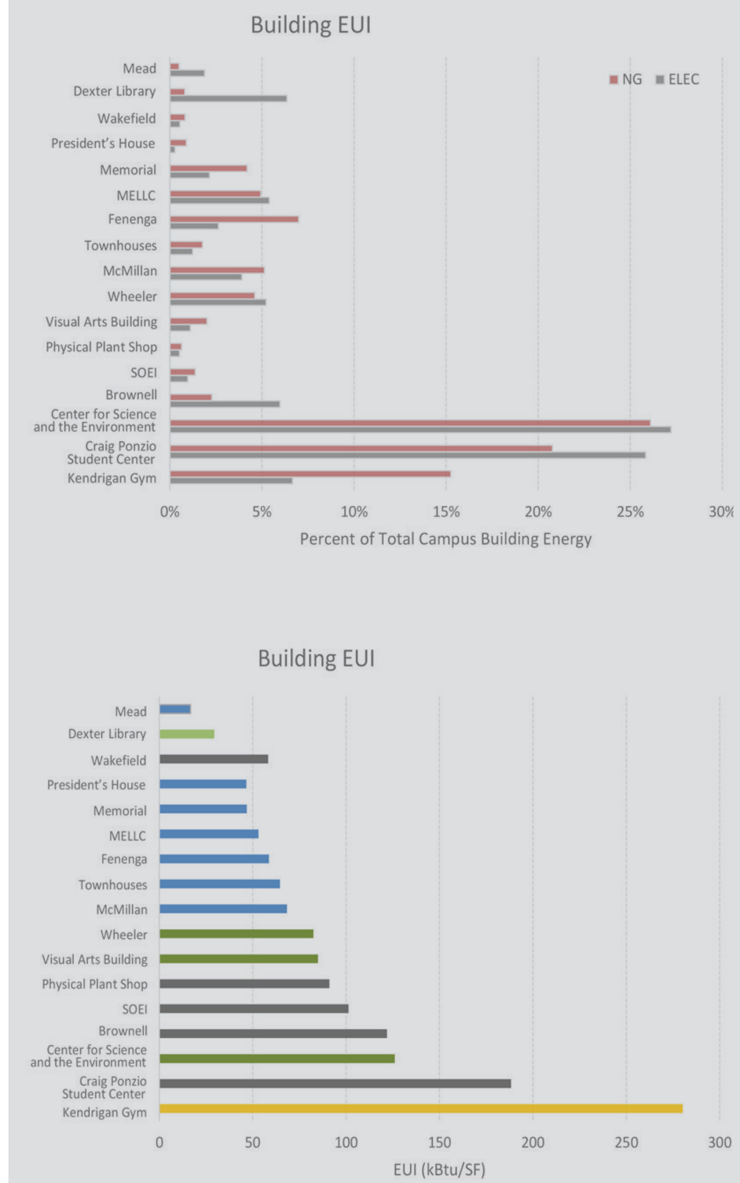
- **Strategic energy conservation** – so-called "deep" energy conservation in the four campus buildings with the best potential for reduced energy demand (Science, Ponzio, SOEI and Brownell). These buildings represent a combination of relatively large energy use and significant proportional opportunity for reductions. The reference to deep energy conservation recognizes that Northland College has already undertaken some cost-favorable energy conservation measures and that other appealing energy conservation measures -- building automation systems, LED lighting retrofit and retro-commissioning are listed above as recommended broad-scale campus investments – which leaves the "deep" investments as the remaining recommended energy conservation measures for these buildings.

20 After 2030.
21 This study recommends retro-commissioning on a schedule of every 5 years to maintain optimal operation of all conditioned buildings.



While these avoided and reduced energy demand activities will have a significant impact on college greenhouse gas emissions generation, it is necessary for Northland College to **"Replace"** its technologies and fuel sources if it is to realize its carbon neutrality goal. The college will undertake two replacement activities.

Figure 3. Consideration of energy use intensity of campus buildings established the rationale for targeted investments in campus energy conservation measures.




1. In recent years, the college's facilities staff has endeavored to extend the functional lives of the campus' natural gas boilers. But, there are limits to the benefit of these efforts and the campus faces a schedule of regular investments to replace these boilers in kind or transform to a new system. This condition is the ideal time to consider a new system. A **central system fueled by biomass**[22] represents measurable reduced campus heating costs and significantly reduced greenhouse gas emissions.[23] Biomass is an obvious fuel choice for Northland College because it is readily available, more cost effective than natural gas, and can be procured with safeguards to ensure desired forest practices.[24] Xcel Energy's Bay Front plant (Ashland, Wisconsin) consumes up to 1,000 tons of wood biomass daily, most of which comes from logging operations undertaken within a 75-mile radius of the plant. Development of waste wood as a fuel source fortifies the region's logging industry as a supplemental source of income. Timing of transition to a central boiler is ideal as the college is at the start of a cycle of significant investment in replacing individual building boilers. An ongoing assessment of the quality and age of campus boilers reinforces the real near-term risk of continued building boiler failures. The boiler

22 This study modeled the boiler to be sized to service the entire campus and calculates the need for a 350 boiler horsepower (bhp).
23 For explanation of the Intergovernmental Panel On Climate Change's consideration of fossil fuel CO2 emissions associated with biomass see: http://www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=36
24 As is done by Xcel Energy and others in the region, state, and nationally.

distribution system lends itself well to phasing – the main campus will be served in the immediate with later investments made to access more remote building locations (such as crossing the ravine to access the Science Building Institute Building, crossing the public way to access Brownell and reaching the future building sites illustrated in the Northland College master plan, such as for the Eco-Village project).

2. **Large-scale solar investment**[25] is the optimal no-carbon alternative to Northland College campus electricity use. This investment lends itself well to incremental investments and programmatic flexibility. Locations for on-campus solar include the campus gateway (the President's House and property across Ellis Avenue from it), on parking lots (canopy style) and in traditional arrays in campus fields that are remote from the core campus area. This opportunity includes the possibility of hosting or participating in a community energy garden partnership with neighbors (Xcel's upcoming offering). Off-campus investments in solar technologies speak to the college's interest in partnerships and tie two of its sustainability themes – energy and food—together. A "farmer friendly" partnership is an avenue for Northland College to expand on the success of its food programs by offering its food vendor farmers (and other farmers in the region) a partnership where the college will install solar on a farm and the farmer will pay the college an amount equivalent to its monthly electricity bill (at a discounted rate) and gift the environmental attributes of the facility to Northland College.

Table 3. Summary BAU Case and Incremental Changes Associated with the Preferred Scenario

| | O&M COST (NPV $1000) | TOTAL COST, CAPITAL | 2015-2039 ($1,000) O&M |
|---|---|---|---|
| BAU | $54,159 | - | 89,754 |
| Avoid and Reduce | ($1,049) | $6,093 | ($8,613) |
| Biomass | ($3,415) | $10,141 | ($6,345) |
| Solar | ($698) | $4,075 | ($2,224) |
| **Total** | | **$20,309** | **($17,182)** |

This table shows the college's operations and maintenance (O&M) in its business-as-usual (BAU) projection as a net present value (NPV) and as a total over the course of the study term. That is compared with the reduced O&M of the preferred scenario (as elements and in total) as well as the capital investment needed to develop the preferred scenario.

25 This study modeled the solar need for the existing campus at 900kw.



Figure 4: An Illustration of Campus Accommodations for Large Scale Solar and Biomass Installations


Note that the indication of large scale solar (in blue) should be read to be the amount of acreage that will be needed from adjacent land (which the college expects to annex into the campus). This acreage will actually need to be larger or smaller depending on the extent to which the college ultimately follows its plan to partner with farmers on solar projects and its use of other campus acreage for solar installations, as illustrated in figure 4.

## IMPLEMENTATION SCHEDULE

Following, is an implementation schedule that displays investments proposed for Northland College to reduce its carbon emissions to nearly zero by 2030, its goal year as established in the college's climate action plan. Northland College developed this with concern to balance practicality with ambition. The schedule of activity is practical to the college's planning, administrative and capital development abilities and it realizes the college's GHG emissions reduction goal[26]. With this schedule is a description of capital costs and operational savings compared to the college's business-as-usual expenditures through the term of this study.

Figure 5: Implementation Schedule[27]

| ELEMENT | START YEAR | 2030 EMISSIONS[28] | PROPOSED INVESTMENTS[29] (2015-2039) | OPERATIONAL SAVINGS (2015-2039)[30] |
|---|---|---|---|---|
| Behavioral Change | 2016[31] | 104 MTCO2e reduced | $307,000 | $594,000 |
| Retro-commissioning | 2017[32] | 419 MTCO2e reduced | $1,103,000 | $2,305,000 |
| Building Automation System | 2017[33] | 279 MTCO2e reduced | $917,000 | $1,537,000 |
| LED lighting retrofit | 2017[34] | 155 MTCO2e reduced | $487,000 | $892,000 |
| Strategic energy conservation | 2018[35] | 140 MTCO2e reduced | $802,000 | $744,000 |
| Net zero energy buildings | 2018[36] | 388 MTCO2e reduced | $2,477,000 | $2,540,000 |
| Biomass boiler, on campus | 2020[37] | 1,644 MTCO2e reduced | $10,141,000 | $6,345,000 |
| Solar I | 2021[38] | 354 MTCO2e reduced | $1,925,000 | $1,157,000 |
| Solar II | 2025[39] | 387 MTCO2e reduced | $2,150,000 | $1,067,000 |
| **Total** | | **3,869 MTCO2e** | **$20,309,000[40]** | **$17,182,000** |

26 With the exception of a di minimis level of emissions.
27 This presentation of energy savings understates actual savings as it is only accounting for savings in a 25-year timeframe. Many of the investments will have provide enduring savings beyond the term of this study's calculations.
28 Reduced from BAU (3,931 MTCO2e modeled for 2030)
29 Investments represent sum of costs over 25 yr study period
30 As compared to BAU.
31 This is proposed to need an 8- month lead time to secure funding and develop an implementation plan.
32 This is assumed to need a 12- month lead time to secure funding and develop an implementation plan.
33 This is proposed to need an 18- month lead time to secure funding and develop an implementation plan.
34 This is proposed to need an 18- month lead time to secure funding and develop an implementation plan.
35 This is proposed to need an 18- month lead time to secure funding and develop an implementation plan.
36 This is proposed to accelerate the college's typical new-building campaign time given the added appeal of a net zero energy building.
37 This is assumed to need a 24- month lead time to secure funding and develop an implementation plan.
38 This is proposed to need an 18- month lead time to secure funding and develop an implementation plan.
39 This is proposed to need an 18- month lead time to secure funding and develop an implementation plan.
40 Cost of biomass boiler has been adjusted to show avoided cost of replacing existing natural gas boilers.



The financial modeling for this project constructed a business-as-usual case using college data on facility operations and maintenance expenditures in recent year. The college does not have an account (a financial mechanism) for funds to support addressing deferred maintenance. It was observed, however, that approximately $70,000 per year is spent to address energy-related deferred maintenance. This amount was included in the model as an assumed expenditure. At this writing, the college facilities management staff is chronicling campus deferred maintenance and, germane to this study, has specific concern about the need to replace the campus building boilers. The business-as-usual model for this plan recognizes the pending cost of replacing campus boilers and assigns a cost for this on an annual basis until all of the aged boilers are replaced.

Consideration of this critical need for boiler replacements prompted the call by the college for this study to generate a base case, one that assumes the college does create a fund equal to 2% of the value of campus buildings, as is the recommended standard, to address deferred maintenance. The reader will note that some of the investments recommended in this plan (such as retro-commissioning, strategic energy conservation and LED light retrofitting) could be financed from this deferred maintenance account if it is created.

# APPENDIX

## A. PLANNING PROCESS

Phase 1. Discovery. This phase (December 2014 to February 2015) established a shared understanding of the campus and its planning environment, its operations, sustainability innovations, student engagement, and environmental footprint. During this phase, the project's steering committee members and other important stakeholders shared their visions, desires, and concerns about the project with the consultant team. Stakeholders included:

1. Mark Abels-Allison, Count Administrator, Bayfield County
2. Bill Bailey, Owner of Bailey Greenhouse
3. Gayle Chatfield, Owner of Bailey Greenhouse
4. David Fulweber, Bay Front Plant Manager for Xcel Energy
5. Ted May, Academic Dean of Wisconsin Indianhead Technical College
6. Michael A Miller, President of Northland College
7. Kevin Rowe, Facility Maintenance Supervisor of Wisconsin Indianhead Technical College
8. Joel Shilman, Environmental Systems Coordinator for Ashland Memorial Medical Center
9. Mike Wiggins, Jr. Bad River Tribe Chairman
10. Northland College Academic Affairs Committee
11. Northland College Building and Grounds Committee
12. Northland College Executive Committee

The project's steering committee also met with the consultants to review Northland College's greenhouse gas emissions reductions progress to date, the condition of campus facilities as relates to energy management, and to establish key assumptions to be applied in the planning project.

**Phase 2.** Ideation. This phase (February 2015) involved the project steering committee and the greater college community (student forum, faculty forum, president's cabinet, and Mark Peterson, Director of the Sigurd Olson Environmental Institute) in articulation of energy management priorities. The project steering committee was lead through a process of considering screening criteria – metrics that reflect their values for the project -- to be applied to project scenario options.

**Phase 3.** Analysis. This phase (February to May 2015) developed those elements that survived screening project opportunities to respond to the project steering committee's criteria. The result was development of three scenarios. Each was then developed in further detail and presented to the project steering committee for further consideration and ultimate selection of a preferred direction. During this phase, the project's steering committee continued its close consultation with the president's cabinet to ensure their awareness of the process and to provide ample opportunity for idea exchange and their input into the plan's creation.

**Phase 4.** Report Creation. The report for the Northland College Energy Study for Climate Action Plan was developed between May and October 2015. It was presented at a campus and community forum in October 2015 after consideration of it by the college's Buildings and Grounds Committee of the Board of Trustees.

## B. KEY ASSUMPTIONS

1. The forecast year is 2039, a 25-year time horizon from the start of the plan's development.
2. Northland College's growth plan is:
   - Food Lab (Compost Building) - 4,300 sf (2015)
   - Field House – 60,000 sf (2017). This is a practice facility with little to no spectator seating. (Limited need for mechanical cooling, potential to optimize natural ventilation or mixed-mode ventilation. Heating for winter. Assume intended summer use is primarily as an alternate practice space during bad weather, providing ventilation such that indoor conditions aren't noticeably less comfortable than outside may be an option. Good ventilation strategies could achieve this without mechanical cooling.)
   - Athletic offices and support – 10,000 sf (2018)
   - Eco-Village – 47,000 sf (2020)
   - 2030's growth -- 25,000 in 2032 and 25,000 in 2034 (all assumed to occur – no program or plans in place)
3. The college will maintain its current staff capacity to manage projects (development, planning and execution)

4. The college will maintain its current base of operations and maintenance expenditures with elements increased for inflation and cost escalation, as follows:
    - Annual general inflation rate: 1.8% (2014 EIAAEO)
    - Annual escalation electricity: 2.2% (2014 EIAAEO)
    - Annual escalation gas & oil: 3.1% (2014 EIAAEO)
    - Annual escalation other accounts : 1.8%
5. Northland College building value per sf: $250
6. The college will maintain its current staff capacity for operations and maintenance
7. Current campus annual energy use is:
    - Electricity (2013): 3,285,313, kWh ($296,589)
    - Natural gas (2013): 29,513 MMBtu ($236,104)
8. 2039 projected campus annual energy use is:
    - Electricity (2013): 4,597,481 kWh ($697,564)
    - Natural gas (2013): 41,175 MMBtu ($685,385)
9. Current campus utility rates:
    - Electricity (2013): $0.09 kWh
    - Natural gas (2013): $8.00 MMBtu
10. CACP conversion rates employed:
    - 52.72E-08 MTCO2e/Btu
    - 4.60E-04 MTCo2e/kWh
11. Parallel generation energy credit:
    - Electricity (2013): $0.04 kWh on-peak and $0.03 off-peak
12. Biomass fuel costs (2013):
    - $30.00/ton

## C. BUSINESS AS USUAL AND BASE CASE

| BUSINESS AS USUAL (BAU) & BASE CASE | BUSINESS AS USUAL (BAU) & BASE CASE PROJECTED OPERATION & MAINTENANCE CASH EXPENDITURES & GREENHOUSE GAS EMISSIONS (9/23/15) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Average 2013 & 2014 Actual | Year (Fiscal Years Ending June 30th) 0 2015 | 5 2020 | 10 2025 | 15 2030 | 20 2035 | 24 2039 |
| Institutional Data | | | | | | | |
| Building Space, SF | | | | | | | |
| Starting | 433,498 | 433,498 | 0 | 0 | 0 | 0 | 0 |
| New Construction (1) | | 4,300 | 47,000 | 0 | 0 | 0 | 0 |
| Total | 433,498 | 437,798 | 554,798 | 554,798 | 554,798 | 604,798 | 604,798 |
| Replacement Value Subject to BAU Factor, $ | | 109,450,000 | 119,662,000 | 165,788,000 | 181,256,000 | 198,167,000 | 232,005,000 |
| Business as Usual (BAU), $ (2) | | | | | | | |
| O&M Expenses | | | | | | | |
| Total O&M before Depreciation | 2,290,982 | 2,197,462 | 2,547,726 | 3,428,692 | 3,788,152 | 4,290,178 | 4,946,929 |
| Other Energy Systems | 70,000 | 71,300 | 78,000 | 85,200 | 93,200 | 101,900 | 109,400 |
| Total Uses of Cash | | | | | | | |
| O&M Expenses | 2,290,982 | 2,197,462 | 2,547,726 | 3,428,692 | 3,788,152 | 4,290,178 | 4,946,929 |
| Other Energy Systems | | 71,300 | 78,000 | 85,200 | 93,200 | 101,900 | 109,400 |
| Total BAU | | 2,268,762 | 2,625,726 | 3,513,892 | 3,881,352 | 4,392,078 | 5,056,329 |
| Net Present Value, NPV$ | | 54,158,989 | | | | | |
| Levelized Base Case, $ | | | | | | | |
| Adjustment to BAU for: | | | | | | | |
| Enhanced Maintenance Fund (3) | | 1,823,890 | 1,990,830 | 2,781,090 | 3,040,510 | 3,324,180 | 3,901,710 |
| Base Case Total Uses of Cash for O&M | | 4,021,352 | 4,538,556 | 6,209,782 | 6,828,662 | 7,614,358 | 8,848,639 |
| Present Value | $95,000,000 | | | | | | |
| Greenhouse Gas Emissions | | | | | | | |
| Scope 1: On Campus Stationary Sources | | | | | | | |
| Natural Gas, MMBtu | 29,513 | 29,513 | 34,571 | 37,771 | 37,771 | 41,175 | 41,175 |
| Natural Gas, MTCO2e | | 1,556 | 1,823 | 1,991 | 1,991 | 2,171 | 2,171 |
| Biomass, MMBtu | | | | | | | |
| Biomass, MTCO2e | | | | | | | |
| Scope 2: Electricity | | | | | | | |
| Purchased Electricity, kWh | 3,295,313 | 3,295,313 | 3,860,118 | 4,217,397 | 4,217,397 | 4,597,481 | 4,597,481 |
| Purchased Electricity, MTCO2e | | 1,516 | 1,776 | 1,940 | 1,940 | 2,115 | 2,115 |
| Total Emissions, MTCO2e | | 3,072 | 3,598 | 3,931 | 3,931 | 4,286 | 4,286 |
| Net Present Value | | 60,772 | | | | | |

(1) See "Decision Criteria" file assumptions for new construction. O&M factor lags by 5 years for new buildings.
(2) Assumes natural gas and electricity usage and all costs increase pro-rata to changes in total building space. Costs increase by the assumed escalation rate as well.
(3) Incremental levelized maintenance calculated as 2% of building replacement value less budgeted BAU "Repairs and Maintenance" and "Maintenenance Agreement"

## D. DEFINITIONS

| | |
|---|---|
| **ACUPCC** | American College and University Presidents' Climate Commitment |
| **BAS** | An automatic, centralized system that controls building heating, ventilation, air conditioning, and lighting |
| **BAU** | The expected pattern if current practices are extended over time |
| **Biogas energy** | Use of organic material to produce gas (in absence of oxygen) that is used as an energy source |
| **Biomass energy** | Biologically-derived material used to generate energy |
| **Carbon offsets** | Credits procured for GHG emissions reduction that are accomplished by a third party |
| **CAP** | Climate Action Plan, a set of strategies to reduce an entity's greenhouse gas emissions |
| **CHP** | Combined heat and power (or cogeneration) refers to the simultaneous generation of electricity and heat from a single fuel source and can provide on-site generation of electricity and recovery of waste heat |
| **Crowdfunding** | Fund raising for a project with support from a large number of sources, typically solicited on the internet |
| **ECM** | Energy conservation measure is an investment made in a building with the expectation that it will reduce building energy demand. ECMs vary widely in terms of first cost, savings, and longevity of savings. |
| **Geo-thermal** | Sometimes referred to as ground source heat pumps or geo-exchange, geothermal technology is used to provide building heating and cooling and operates by using ground or water sources as a heat source and heat sink. |
| **GHG** | Greenhouse gases, primarily carbon dioxide, methane, nitrous oxide and fluorinated gases |
| **GHG abatement** | A lessening or reduction of greenhouse gas (GHG) emissions |
| **GHG Scope** | Standard categorization of greenhouse gases:<br>• Scope 1 are direct emissions from the University and includes items such as fuels and refrigerants.<br>• Scope 2 are indirect emissions from purchased electricity and purchased steam<br>• Scope 3 are indirect emissions from activities such as commuting, air travel and waste disposal |
| **LED lighting** | A highly energy-efficient form of lighting created through light-emitting diodes technology |
| **MTCo2e** | Metric tons (1,000kg) of carbon dioxide equivalent |
| **Photovoltaic** | Conversion of solar energy into direct current electricity through use of semiconducting materials |
| **Plug load** | Energy used by products that are powered through use of an ordinary AC plug |
| **Savings/Cost** | Savings or Cost per metric ton of carbon emissions avoided refers to a calculation of annual financial impact for recommended investments. This number is the present value of the changes in the cost of purchased fuels, electricity, operating expenses and investment capital for every unit of GHG avoided. |

## E. ACKNOWLEDGEMENTS

This report was inspired by the thoughts and passions of many who are associated with Northland College, both on the campus and in the community. The authors[41] recognize and express gratitude to those individuals and, in particular, recognize those most involved in the plan's development:

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41 Willa Kuh, Andrew Price, and William Talbert of Affiliated Engineers, Inc. with Nick Travis of Energy Strategies, LLC



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