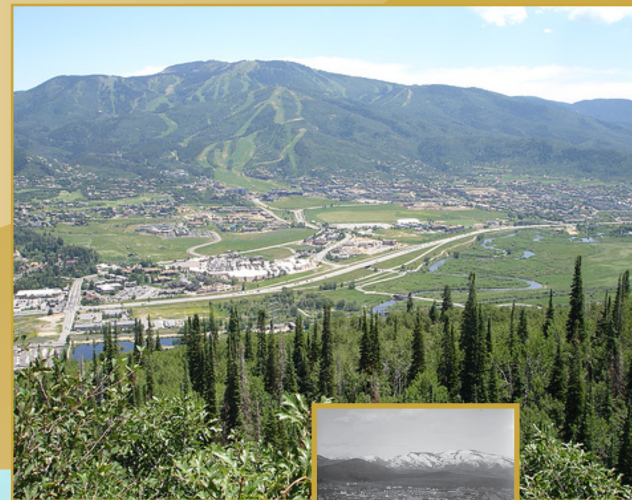
THE BRENDLE GROUP, INC.
ENGINEERING CONSULTING
226 South Remington #3
Fort Collins Colorado 80524
www.brendlegroup.com
970.207.0058

greenteam

City of Steamboat Springs



CITY OF STEAMBOAT SPRINGS

SUSTAINABILITY MANAGEMENT PLAN

A proven and practical approach for optimizing the City of Steamboat Springs' Triple Bottom Line:

ECONOMIC | ENVIRONMENTAL | SOCIAL

City of Steamboat Springs Sustainability Management Plan

Prepared By:

The Brendle Group, Inc.
226 S. Remington St. #3
Fort Collins, CO 80524
(970) 207-0058
www.brendlegroup.com

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Acknowledgements

City of Steamboat Springs Green Team

- Judy Plumb - City Clerk
- Gavin Malia - Geographic Information Systems
- Kent Morrison - Information Systems
- Linda Kakela - Intergovernmental Services
- Winnie Delliquadri - Intergovernmental Services
- Christina Freeman - Parks, Rec. & Open Space
- Bob Keenan - Planning Services
- Sid River - Planning Services
- Suzanne Bott - Planning Services

Interested Community Members

- Bill Wallace - Engineers Without Borders
- Erik Griepentrog - Landmark Consultants, Inc.
- Fred Robinson - Intergalactic Imports
- Jeffrey Campbell - Simply Radiant Heating
- Lynn Halliday - Steamboat Ski & Resort Corporation
- Robert Hawkins - Hawkins Architects
- Steve Lewis - Structural Engineer
- Susan Holland - Department of Energy Consultant
- Norm Weaver, Energy Consultant
- Craig Schifter, Yampa Valley Recycles
- David Epstein, Home ReSource, Twin Landfill
- Mike Zopf, Routt County Director of Environmental Health
- Nancy Stahoviak, Routt County Commissioner
- Jack Major, Major Geothermal
- Clint Nebeker, Major Geothermal
- Ted Allen, Routt County Building Official
- Judy Wagar, Due West Land LLC, Marabou Land Preservation Subdivsion

Interested Community Organizations

- Community Alliance of the Yampa Valley
- Yampa Valley Construction Trades Association
- Yampa Valley Recycles

Project Coordinator

Gavin Malia, Green Team Chairman and GIS Coordinator, City of Steamboat Springs

Facilities Tour Guide

Patrick McCannon, Facilities Maintenance Crew Leader, City of Steamboat Springs

Executive Summary

Building on momentum generated by the City of Steamboat Springs' Green Team, this management plan provides immediate direction and a suggested framework for advancing sustainability in the internal operations of the City. Simultaneous emphasis is placed on top-down concepts (e.g., vision, mission, management commitment, etc.) that provide long term support of sustainability and bottom-up practices (e.g., lighting retrofits, heat recovery, air conditioning technologies, etc.) that can provide early financial and political capital for sustainability efforts.

Factors such as cost savings and the opportunity to lead the community are common drivers for municipalities incorporating sustainability into their operations. The City Council has also identified the environment as one of its top five priorities. By engaging in this visionary effort, the City of Steamboat Springs stands to benefit in all aspects of its operation.

Numerous examples of sustainable practices already exist within the City organization and more initiatives are put into motion regularly. For example, during the four-month development of this plan, the City moved forward with efforts to purchase a hybrid electric diesel bus, opened discussions with the resort community on increasing transportation efficiency, held a Charrette to evaluate the new Community Center's potential for certification under Leadership in Energy and Environmental Design (LEED) standards, and continued pursuing funding opportunities for the installation of three photovoltaic systems on City facilities. However, the list of additional opportunities to pursue is equally long. By organizing and formalizing efforts towards sustainability under this plan, the City stands to take advantage of many unrealized opportunities, while approaching sustainability in a more comprehensive and strategic fashion.

The development of this Sustainability Management Plan (SMP) was a collaborative effort that involved the City's Management Team and Green Team. The first step was creating an understanding of the scope of City operations and the field of existing sustainable practices. Next, a combination of meetings and facility tours helped to establish awareness of organizational culture and opportunities for increased sustainability in operations. Finally, the formation of the SMP was an iterative process with continued opportunity for input from City stakeholders.

The SMP highlights eleven priority opportunities that provide the largest potential gains in sustainability for the City's operations. These opportunities include:

Priority A: Sustainability Mission Statement

> A mission statement becomes the driving force for sustainability programs, providing both top management support and a unifying theme for employees.

Priority B: Employee Education

> Effective organizational change requires a period of education and outreach to employees.

Priority C: Funding Models for High Performance Buildings

> Funding opportunities are available to support the City's efforts to improve building performance.

Priority D: Facilities Manager Position

A facilities manager would enable the City to have increased involvement the full life-cycle of its facilities operations and might yield annual utility cost savings of $40,000-$120,000.

Priority E: Integrated Design for New Construction

Integrated building design not only looks at how materials, systems, and products of a building connect and overlap, but also considers how the building and its systems can be integrated with supporting systems on its site and in its community. This process ensures that efficient and appropriate equipment is installed at the time of construction, when it will yield the greatest benefit and cost savings. A 2% investment in design/construction typically yields a 40% ROI.

Priority F: Building Commissioning

Commissioning is the process of insuring that a facility's actual operational characteristics meet the criteria prescribed during design. Studies indicate that commissioning can yield energy savings of 6-12% for new structures and 7-30% for existing buildings.

Priority G: Environmentally Preferable Purchasing

Instituting a formal environmentally preferable purchasing practice insures that city operations are supported by the most sustainable product options. These products are often less costly to purchase and operate, safer for employees, and easier to dispose of in an environmentally responsible manner.

Priority H: Interface between Green Building and Historical Preservation

Green building practices are becoming pervasive in all aspects of construction, from new buildings to renovations. As the City renovates and maintains its significant historical structures, it is of interest that these buildings adopt green aspects such that they do not present an operations and maintenance burden.

Priority I: High Bay Lighting

Lighting fixtures in rooms with high ceilings (high bays), such as warehouses, work areas, and athletic facilities, are often attractive opportunities to reduce energy costs by retrofitting existing equipment with new technologies. For observed opportunities in City of Steamboat Springs' facilities, annual savings are estimated at $11,500, providing a payback of 6 to 7 years.

Priority J: Ice Rink Heat Recovery

The City's ice rink has a number of efficiency aspects already incorporated. From a brief walk-through of the facility, two opportunities for heat recovery were identified.

Priority K: Minimize Refrigerant-based Air Conditioning Practices

Air conditioning systems that use refrigerants often are a building's most expensive and energy-intensive process. The City has the opportunity to take advantage of its climate and altitude to minimize the need for refrigerant-based air conditioning.

The majority of the highlighted opportunities are programmatic in nature; providing the framework to foster future sustainability efforts and therefore helping sustainability grow in the organization.

The final section of the SMP illustrates a rigorous programmatic framework for sustainability management that demonstrates the City's significant progress to date as well providing future guidance. Building on the successes of the Green Team and this SMP, ongoing efforts toward such a framework will serve to sustain the sustainability.

Future steps that would build this SMP into a comprehensive sustainability management system (SMS) include:

- Empowerment and continuation of the Green Team to pursue implementation of the recommendations within this SMP
- Development of metrics to evaluate city performance and progress in sustainability
- Annual publication of a Sustainability Report to communicate progress and emerging goals with city management, staff, citizens, and external stakeholders
- Facilitation of a community-based visioning process to develop and communicate a clear picture of what a sustainable City of Steamboat Springs will look like in the future.

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1.0 Background

Sustainability is the driving force behind this Sustainability Management Plan or SMP. In order to provide context for the plan, understanding the meaning of sustainability is significant. The most uniformly accepted definition comes from the 1987 Brundtland Commission Report:

> *"Meeting the needs of the present without compromising the ability of future generations to meet their own needs."*

A definition more specific to sustainable communities comes the International Council for Local Environmental Initiatives (ICLEI):

> *"A sustainable community is defined as one that maintains the integrity of its natural resources over the long term, promotes a prosperous economy, and hosts a vibrant, equitable society."*

The definition of sustainability for the City of Steamboat Springs is captured in the mission statement presented later in this SMP. The mission statement embraces the above definitions of sustainability and recognizes that good environmental policy, social policy, and economic policy are one and the same. This mission statement and the recommendations contained within this SMP will guide the City's next steps in becoming a more sustainable organization.

This SMP provides the City of Steamboat Springs with direction on programmatic changes and some highlighted technical opportunities. The priorities highlighted in this SMP represent some of the largest single opportunities the City has to enhance its sustainability.

While this SMP addresses only the internal operations of the City, the City recognizes the opportunity to lead by example, promoting the sustainability of Steamboat Springs in general beginning with its own operations. The City already is practicing sustainability in many areas; however, this SMP will accelerate the City's progress in a more coordinated manner and help the City achieve superior outcomes.

The SMP describes existing practices and emerging opportunities in sustainability, methodology, and expected benefits from pursuing a number of key opportunities. It also presents recommended goals and next steps surrounding these opportunities, as well as resources for getting started.

1.1 Motivation For and Benefits of a Sustainability Management Plan

Numerous municipalities worldwide are embracing sustainability as a tool to enhance the viability of their organizations and communities, improve economics, enhance social services, drive innovation, and preserve valuable environmental qualities. Based on ICLEI membership, an estimated 475 municipalities representing nearly 300 million people worldwide are working on sustainability initiatives. In Colorado, Denver, Fort Collins, and Aspen have sustainability programs in place.

Adopting sustainability as a mission enables a community to minimize the negative impacts of unsustainable practices, such as pollution and traffic congestion, while simultaneously motivating employees and citizens to make innovative changes in practice that often lead to improved performance and cost savings.

The communities adopting sustainable practices are taking different approaches. Some choose a strictly policy based approach, others seek to educate the community, and some focus on greenhouse gas emissions only. All of these approaches are relevant and have their place in a broad-based sustainability initiative. In order to achieve the maximum economic, social, and environmental benefit, this SMP seeks to incorporate a balance of approaches.

The SMP also seeks to balance top-down concepts (e.g., vision, policy, management commitment, etc.) with bottom-up practices (e.g., lighting retrofits, heat recovery, air conditioning technologies, etc.) that can provide early wins for the initiative.

Some of the direct outcomes communities have experienced as a result of adopting sustainability management plans include these benefits:

- Assessing internal successes and prioritizing future opportunities
- Opportunities arise internally and tend to be compatible with organizational culture
- Highlighting successes while adapting to change
- Creating efficiencies, synergies, and consistencies among policies, plans, and programs
- Maximizing cost savings opportunities
- Providing community leadership in sustainability
- Aligning with agency counterparts for grant funding opportunities
- Creating goals to measure progress toward sustainability
- Providing sustainable vision that attracts and retains the best and brightest potential employees

1.2 How the Team and the Process Worked

The elected process for this SMP was a highly interactive one that encouraged all stakeholders to participate throughout the course of development. The City's Management Team and Green Team both were amenable to this concept and willingly offered guidance in directing the course of this document. This early Management Team interaction demonstrates the long-term commitment to the success of these initiatives.

The process used to develop the SMP was modeled on that suggested by Resourceful Government Guide[1] and involved the following elements:

[1] City of Portland and Multnomah County Sustainable Development Commission, Resourceful Government Guide, http://www.portlandonline.com/mayor/index.cfm?a=88250&c=38728

Background and Understanding of City Operations

- Reviewed Green Team documentation and initiatives thus far
- Reviewed and augmented utility data compiled by the Green Team
- Identified high priority facilities for site visit tour
- Facilitated Green Team warm-up to direct development of a mission statement

City of Steamboat Springs' Green Team and Management Team Meetings with Consulting Team

- Green Team meeting explored sustainability mission statements, likely opportunities to be addressed, and potential outcomes of the SMP and their appropriateness.
- Conducted a Management Team session that included similar topics to those covered in the Green Team meeting, but also incorporated Green Team feedback and initial results from the facility tours.

Facility Tours

- Conducted a facility tour to review daily operational practices, identify site-specific opportunities, and determine broader programmatic opportunities. The following facilities were included in the one-day tour:
    - Centennial Hall
    - City Hall
    - Tennis Center
    - Ice Rink
    - Public Safety
    - Airport Terminal
    - Stockbridge Transit Center
    - Ski Time Square Parking Garage
    - Public Works

  Though numerous aspects of sustainable practice were considered during these facility tours, energy use was the keystone of these initial assessments because it was easy to quantify and generally yields good opportunities for improvement. Therefore, the determination of which facilities to tour was based in part on energy intensity per square foot of floor space and the nature of equipment employed by the facility. Input from City staff members and the opportunity to review the success of recent renovation or construction efforts were also considered.

  The last four facility visits were extremely brief and were conducted to assess the potential for specific opportunities identified during earlier discussions or based on The Brendle Group's building audit experience.

It should be noted that these facility tours were not investment grade audits. The goal of these tours was to visit numerous City facilities quickly and establish a list of opportunities that might provide early sustainability successes for the City. This type of facility tour also conveyed a better general picture of City operations than would have been gained from a more focused visit to one building.

SMP Development

- Documented existing practices to raise awareness of successes and provide a baseline for improvements.
- Established primary recommendations, including both programmatic changes and site-specific projects, that represent some of the most effective measures the City can take toward more sustainable practices.
- Developed goals and targets surrounding recommendations and suggested resources to support these initiatives.
- Outlined next steps toward refining the SMP into a more comprehensive and in-depth SMS.

2.0 Existing Practices and Opportunities Assessment

In order to plan the City of Steamboat Springs' future efforts in sustainability, it is imperative to understand what practices are already in place. It also is helpful to recognize these practices as potential foundations for new initiatives in sustainability.

In addition to documenting existing practices, the process also involved determining opportunities for improvement. These may not be high priority opportunities but they represent the diversity of improvements the City might consider. High priority recommendations are discussed in detail in Section 3.

This section includes an inventory compiled from generalized observations from the facilities tour, discussions with City staff, and the Green Team's inventory from its December 2005 report. Attachment 1 contains site-specific inventories.

2.1 Existing Practices

This section documents existing sustainable practices within the City organization that are fairly pervasive.

Energy

- Three 40-kW solar installations planned
- Efficient lighting and window upgrades generally included in renovations
- Forty blocks (100 kWh each) of wind power acquired
- Exterior lighting control (e.g., time clocks, photocells, etc.)
- ENERGY STAR office equipment, especially copiers and computer monitors
- Efficient heating/cooling products and practices, including programmable thermostats and economizing equipment/modes as well as high-efficiency equipment and boiler outdoor air reset controls in select applications

Water

- Irrigation using raw water from the Yampa River
- Low flow end-use fixture upgrades generally included in renovations, including toilets/urinals, faucets and showerheads

Waste

- Comprehensive fluorescent lamp recycling
- Comprehensive recycling services reported for every building
- Good purity of recycling streams

- Comprehensive large electronic equipment recycling practices (TVs, monitors, computers)
- Wastewater sludge composting at offsite location
- Post-consumer recycled office paper for all printers and copiers
- Christmas tree, right-of-way tree, and large cut branch reuse (mulch for City parks)

Social

- Open space and public lands maintenance for 2,200 acres
- Comprehensive wellness program
- Good health benefits for employees

Transportation

- Free public transit system
- Growing alternative transportation programs
- Alternative transportation month every June

Operations

- Intergovernmental Office has a history of successfully pursuing grants that are applicable to sustainability initiatives
- Indoor air quality (IAQ) mold testing on case-by-case basis
- Good floor mat cleaning practices (IAQ)
- Low- or no-volatile organic carbon (VOC) paints (IAQ)
- Historic Preservation policies that renovate historic structures for modern use
- Consideration of geothermal opportunities for infrastructure of new base development at the ski area

2.2 Opportunities

This section documents opportunities in sustainable practices that apply generally across many facilities or departments in the City organization.

Energy

- Utility usage unexpectedly high at Stockbridge transit facility, check billing history for accuracy

- Expanded use of interior lighting occupancy sensors
- Expand use of efficient heating/cooling products and practices, including the installation high-efficiency equipment (including rooftop units, package terminal air conditioners, chillers, etc.) and boiler outdoor air reset controls
- Implement controls for heat tape in building gutters

Water

- 0.5 gallon-per-minute aerators for new construction and retrofits
- Expanded use of waterless urinals
- Awareness of potential changes to codes regarding greywater and/or water collection practices
- Irrigation system efficiency improvements
- Expanded raw water use (current practices to be confirmed)
- Increased Xeriscape practices
- Synthetic turf for outdoor sports fields

Waste

- Expanded use of Techno-trash recycling containers (e.g., computer disks, DVDs, cell phones, etc.)
- Mercury bulb recycling (to be confirmed)
- Smaller electronics recycling (e.g., VCRs, etc.)
- Computers recycling with companies based in Wyoming (market advantages?)
- Improved implementation of recycling requirement for City/community special events
- Composting services
- Proper hazardous material disposal at landfill
- Consistent toner recycling program
- Paperboard recycling
- Recycling programs at vendor operated sites
- Low- or no-VOC paints policy
- Glass crushing equipment exists but current status is in question and should be investigated, other entities should be considered to assume responsibility for the resource and identify potential uses for the product

Transportation

- Influence new vehicle purchases through Police Service
- Employee vehicle miles traveled (VMT) reduction programs
- Idling policy
- Bicycle Commuters Benefits Act, S. 2635 (not yet passed) awareness

Integrated/General

- Green building/integrated design for new construction: Community Center, Recreation Center, second sheet at Ice Rink, Parks and Recreation renovation, and Elkins House (fire prevention) renovation
- Green building practices for library expansion
- Green building/historical preservation at Legacy Ranch
- Greenhouse gas baseline (a rough baseline is provided in Attachment 2), reductions, and offsets (CARROT[2] an opportunity for comparison with other municipalities)

[2] California Climate Action Registry (CARROT), http://www.climateregistry.org/

3.0 Management Plan Recommendations

In general, this SMP seeks to provide a framework for advancing sustainability within the City of Steamboat Springs' operations. The recommendations presented in this section expand on those presented in Section 2 and represent some of the most significant actions that can be taken in the interest of sustainability.

While individual projects will provide benefits and savings annually that can generate momentum toward sustainability, they do not usually provide the organizational framework to carry that momentum. For this reason, most of the recommendations provided in this section address issues of policy and practices because programmatic changes tend to foster growth of sustainability within an organization. However, a number of individual, site-specific initiatives also are recommended to provide some early tangible results that can help to support the growth of the sustainability with both political and financial capital.

The priorities are not presented in a formally decided order. Generally, they are in the order of perceived importance to constructing a framework for sustainability within the City organization:

Priority A: Sustainability Mission Statement

Priority B: Employee Education

Priority C: Funding Models for High Performance Buildings

Priority D: Facilities Manager Position

Priority E: Integrated Design for New Construction

Priority F: Building Commissioning

Priority G: Environmentally Preferable Purchasing

Priority H: Interface of Green Building and Historical Preservation

Priority I: High Bay Lighting

Priority J: Ice Rink Heat Recovery

Priority K: Minimize Refrigerant-based Air-conditioning Practices

The City may consider reprioritizing this list based on some of the following attributes:

- Economics
- Employee well-being
- Environment
- Cost effectiveness
- Ease of implementation
- Visibility/management support/timeliness

Priority A: Sustainability Mission Statement

The foundation of a robust sustainability program is a well-crafted mission that recognizes the particular interests and needs of the City. The mission statement becomes the driving force for a program, providing both top management support and a unifying theme for staff members.

Some elements of a strong mission statement are included here:

- Implies visible management support
- Reflects organizational culture and style
- Is consistent with other organizational policies
- Applies to all major operations
- States beliefs and intentions (what), not ways for meeting intentions (how)
- Provides direction for decision-making
- Provides a foundation for planning and action
- Is documented and clearly communicated to all employees
- Drives change in the workplace
- Inspires commitment
- Serves as a unifying theme

As an example, the City of Portland's Sustainable Development Commission's *Resourceful Government Guide* has a good section on mission statement development:

http://www.portlandonline.com/mayor/index.cfm?a=88250&c=38728.

Through this SMP process, a draft mission statement was developed for the City of Steamboat Springs:

> *"The City of Steamboat Springs will serve as a community leader in sustainability by striving to conduct our daily operations with the optimal mix of resource efficiency, cost effectiveness, and employee well being. We will use a sustainability framework for making decisions and identifying emerging opportunities that contribute to our goal of becoming a sustainable city. We will inspire commitment to this mission from our employees and work with other organizations to further our common goals."*

Goal: The mission statement and this management plan will be adopted by the City Council to provide guidance for the City of Steamboat Springs toward sustainability at all levels of operation.

Next Steps: Put the mission statement and this management plan, before City Council. Upon adoption, employees should be appropriately educated on the mission statement such that decision making is influenced at all levels. The City should then proceed with implementing the priority recommendations of this management plan.

Priority B: Employee Education

Effective organizational change requires a period of education and outreach to staff members. Educational efforts should cover both general concepts of sustainability as well as specific initiatives or programs.

Potential educational methods are described below:

- Develop education and outreach materials for all staff members.
- Include sustainability in new employee education.
- Hold brown bag lunches for staff members to learn about specific practices or products related to sustainability.
- Include presentations on sustainability at City-wide event.
- Develop customized presentations to individual service areas and departments.

In general, staff should be made aware of the concept of sustainability and the City's mission regarding it (see previous recommendation). City staff is in the best position to recognize opportunities for sustainability in day-to-day operations. With these concepts in mind, staff members are more likely to initiate positive changes in their daily work habits.

Also important is education regarding specific sustainability initiatives. In particular, initiatives altering current working practices, such as introducing a recycling program that covers a material that was previously disposed of in the trash, should receive educational focus. Reinforcing awareness of existing initiatives is also worthwhile and can often be achieved with simple measures such as the introduction of signage. Ultimately, the success of any measure will require that the staff members responsible for implementing it understand and support the measure.

The City of Portland's Sustainable Development Commission's *Resourceful Government Guide* recommends mapping orientation and training needs and existing orientation and training tools against various employee groups including the sustainability team (Green Team), management, and all other employees. This effort insures that new educational tools will not be developed when some existing tool might provide the need services.

Goal: Appropriately support the sustainability mission statement and initiatives with comprehensive educational efforts that engender staff understanding and participation.

Next Steps:

1. Ensure that existing sustainable practices, such as those listed in Section 2.0 or Attachment 1, are receiving appropriate educational support. Survey staff members to

determine their awareness of these efforts and judge if additional support is necessary. One example of a successful educational effort is the general recycling program. The level of participation and low contamination rates for recycled materials suggest that staff have been appropriately informed of this program. However, it is important to remember that recycling is becoming a common practice for many individuals at home and at work and may require less education than other initiatives.

2. Introduce general sustainability concepts and the City's mission to help employees understand the motivation behind these efforts. Encourage employees to seek opportunities for sustainability in their daily work.
3. Require that an education plan be submitted in concert with any proposed sustainability initiative.

Priority C: Funding Models for High Performance Buildings

Steamboat Springs has an opportunity to capitalize on resources available for organizations pursuing high performance buildings.

These resources are described below:

- Performance contracting (PC): PC is a financing arrangement to implement utility saving measures and equipment upgrades even if an organization does not have the capital or expertise. By definition, a PC is the process where a customer partners with a qualified service provider to develop a program consisting of financial, technological, and operational solutions that meet specific performance criteria (e.g., utility savings). The solutions can be customized for an organization, but often include investment-grade assessments, design and construction for implementation of measures and upgrades, and guarantees of project costs and savings. An energy service company (ESCO) is a performance contract service provider. Although organizations may be able to accomplish savings measures and equipment upgrades on their own at a lower cost, the benefits of a PC often include larger-scale efforts supported by an ESCO with expertise in implementing efficiency measures that can be accomplished on an accelerated timeline, thereby avoiding the cost of delaying these projects. While PCs traditionally have been applied to measures and upgrades of existing buildings, a similar model also can be applicable for new construction.

  Based on industry rules-of-thumb, PC measures and retrofits are typically projected to save at least 10 percent of an organization's annual utility budget. For the City, this rule-of-thumb translates to approximately $80,000 in savings per year. The simple payback criteria (combined for all measures and retrofits) for PCs typically is 7 to 10 years. Although the City's recent renovations have included upgrading much of the lighting in existing buildings, the City likely could have the opportunity for a modest-sized PC. Specific measures and upgrades would be identified through a PC investment-grade assessment and would likely including high-bay lighting upgrades (see Priority I), irrigation system upgrades, light-emitting diode (LED) traffic light conversions, ice rink heat recovery (see Priority J), heating/cooling controls system improvements, and other measures.

An excellent resource on performance contracting available to the City of Steamboat Springs is Rebuild Colorado, a program of the Governor's Office of Energy Management & Conservation. Rebuild Colorado can help to determine the applicability of performance contracting for public organizations. If applicable, Rebuild Colorado offers free services to facilitate performance contracts, including technical and financial advice/review, as well as sample documents. More information is available at: www.colorado.gov/rebuildco.

- Grant Funding: City staff members report significant success in securing grant-related funding. The City already has identified the Kresge Foundation grants as possible resources for green building efforts. Grant funding also may be available to the City through the Strategic Environmental Project Pipeline, or StEPP Foundation. Based out of Colorado, the StEPP Foundation's charge is to fund renewable energy, energy efficiency, or pollution prevention projects on a national level. StEPP funding is available through two avenues: (1) issue solicitations and (2) general project pipeline submissions. StEPP will issue solicitations from time to time that have specific criteria requirements, often including geographic and project type parameters. Alternatively, organizations can submit funding requests at any time into StEPP's project pipeline, which is a database that is used to match specific funding criteria and funding sources with the best potential project or projects available. More information is available at www.steppfoundation.org.

Goals:

1. Leverage city funds to access additional capital to implement efficiency measures, related upgrades and other green building strategies.
2. Pursue funding through the StEPP Foundation and other applicable grants to support renewable energy, energy efficiency, or pollution prevention projects.

Next Steps:

1. Contact the Rebuild Colorado (www.colorado.gov/rebuildco) program for assistance with evaluating the applicability of performance contracting for the City.

2. Consider submitting a funding request to the general StEPP pipeline to support follow-up and/or implementation of a performance contract and/or Priorities B, F, G-K.

Priority D: Facilities Manager Position

The City's increased involvement in its own daily operations is pivotal to increasing its sustainability. Close interaction between stakeholders through all phases of a facility's life cycle, including design, construction, and operations/maintenance, help to insure that opportunities for sustainability are realized. A facilities manager position would provide this needed interaction. The position might oversee facility maintenance, upgrades, utility management (energy, water, waste), and potentially could represent the City's green building priorities in future construction projects.

The advantages of having a management level position for maintenance and upgrades include quick dissemination of successful measures across facilities and awareness of opportunities for aggregating projects across departments to reduce cost. The savings from such efforts can be significant. For example, a facilities manager is likely to recognize the opportunity for numerous projects similar to those evaluated under Priorities I, J, and K.

Utility management, or resource conservation management (RCM), provides dedicated awareness of billing that can help to identify patterns, recognize and correct billing inconsistencies or errors, and spot opportunities to manage overall cost through such efforts as equipment replacement and leak repairs. Washington State University and the Oregon Department of Energy both maintain good resources for RCM.

http://www.energy.wsu.edu/projects/rem/rcm.cfm

http://www.oregon.gov/ENERGY/CONS/RCM/rcmhm.shtml

The average annual salary for an RCM position ranges from$40,000 to $80,000. Both of the above sources agree that the average first year RCM position will produce approximately 5 to 15 percent savings in utility bills, which translates to $40,000 to $120,000 of potential savings for the City.

Finally, a facilities manager could oversee green building interests in the City's construction projects and participate in the integrated design process described in Priority E. Having a knowledgeable individual to champion these efforts will ensure that the most cost-effective measures are implemented. A LEED™ Accredited Professional (http://www.usgbc.org/DisplayPage.aspx?CategoryID=19), certified energy manager (http://www.aeecenter.org/certification/CEMpage.htm), certified facility manager (http://www.ifma.org/learning/fm_credentials/cfm_index.cfm), or someone with similar qualifications might be considered for this position.

Traditionally, operations/maintenance, utility management, and green building management would be separate within an organization. However, considering the size of the City organization and the facilities for which it is responsible, a single person may be adequate. In addition to being cost effective, the position is likely to pay for itself rapidly with utility cost savings. Integrating these roles into a single position also will increase the coherence of sustainable decision making from cradle-to-grave in City facilities.

Goal: Create a position within the City organization to oversee facilities maintenance, manage utilities, and promote green building practices for new construction. The candidate should be qualified in resource efficient upgrades, green maintenance practices, utility management, and green building concepts.

Next Steps: Numerous opportunities exist to engage the skills of a potential facilities manager to complete some of the recommendations in this SMP, as well as to oversee upcoming construction efforts such as the new community center. Promptly creating this position will ensure the maximum effectiveness of sustainability measures related to facilities.

Priority E: Integrated Design for New Construction

Traditionally, the building design process largely analyzes individual components and subsystems of each building, optimizing them separately. Integrated building design not only looks at how materials, systems, and products of a building connect and overlap, but also considers how the building and its systems can be integrated with supporting systems on its site and in its community. A successful integrated design is a solution that is greater than the sum of its parts.

The fundamental challenge of whole building design is to understand that all building systems are interdependent. Through a systematic analysis of these interdependencies, a much more efficient and cost-effective building can be produced. Green building standards, such as LEED™, can serve as a resource for investigating integrated design opportunities, even if official certifications of the standards are not pursued. For example, the choice of a mechanical system might, for example, affect the quality of the air in the building, the ease of maintenance, global climate change, operating costs, fuel choice, and whether the windows of a building are operable. In turn, the size of the mechanical system will depend on factors such as site development, the type of lighting used, how much natural daylight is brought in, how the space is organized, and the facility's operating hours.

For the City, installing efficient equipment, from heating/cooling equipment to office equipment, is an important aspect of integrated design. Generally, the cost benefits of energy-efficient equipment upgrades at the time of new construction typically greatly outweigh implementing measures later as retrofits. This priority may be particularly applicable to the City's upcoming building efforts, such as the new community center, an expansion of the ice rink, or a recreation center.

Goals:

Ensure new construction and major remodel projects balance first costs with operating and maintenance costs, durability and occupant comfort.

Next Steps:

1. Create integrated (or sustainable) design guidelines for the City
2. Incorporate integrated (or sustainable) design language into the City's building bid solicitations
3. Evaluate the use of the LEED criteria on a case-by-case basis, including the upcoming building efforts for the new community center, an expansion of the ice rink, and/or recreation center.
4. Submit a funding request to the general StEPP pipeline to support follow-up and/or implementation of a performance contract and/or Priorities B, F, G-K.

Priority F: Building Commissioning

Commissioning is defined as documented confirmation that building systems function in compliance with criteria set forth in the project documents to satisfy the owner's operational needs.[3] Retro-commissioning is using the commissioning process on existing buildings. Regardless of whether the effort is completed on new construction or an existing building, commissioned building systems can include the following:

- Lighting, including day lighting, controls
- Electrical
- Mechanical/plumbing (including test and balance)
- Irrigation
- Kitchen equipment
- Fire/alarm security
- Test and balance

Commissioning can be thought of as the step that bridges the gap between a building on paper and the fully functional, energy efficient building in practice. The benefits of commissioning are considerable:

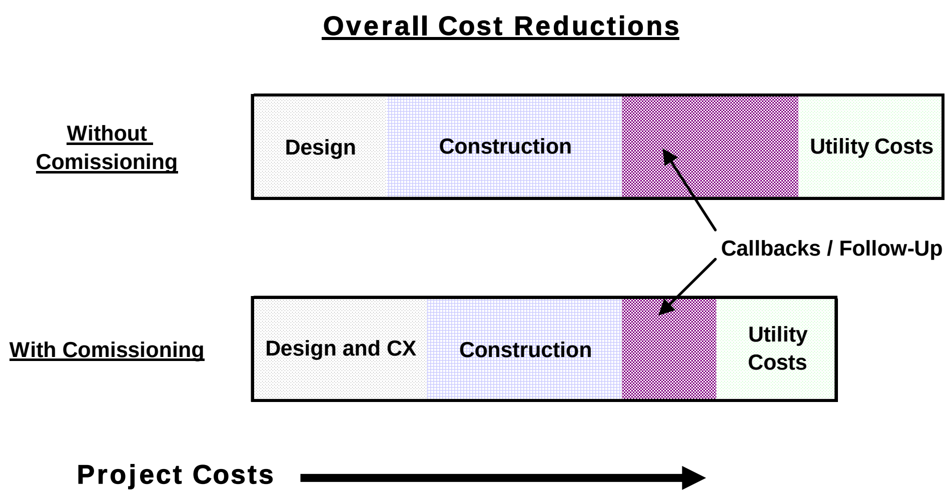
- Larger and more sustained energy savings
- Reduced maintenance costs
- Reduced warranty and follow-up
- Fewer construction litigation problems
- Better building systems operation
- Greater budgeting accuracy
- Assured performance of leading-edge building technologies

The following table provides typical data on energy savings and the payback period of commissioning from proceedings of the 1997 National Conference on Building Commissioning.

Construction	**Energy Savings**	**Payback Period**
New	6-12 percent	2 to 6 years
Existing	7-30 percent	Less than 2 years

[3] *www.bcxa.org.*

As shown in the figure[4] that follows, commissioning reduces overall project costs by reducing construction costs, follow-up costs, and operational costs. However, there are added costs for commissioning.



Two aspects of commissioning that are critical for the City are presented here:

- As stated in Priority D, it is important for the City to increase its involvement in daily operations. Commissioning can serve as a key strategy to this end, as it is a conduit for communications from the design team to the facilities staff charged with the day-to-day operation.
- A targeted effort to develop and document building-specific maintenance plans.

Rebuild Colorado (www.colorado.gov/rebuildco) offers free services to identify the best commissioning approach for an organization, facilitate a retrocommissioning project, make presentations to decision-makers, and provide sample requests for qualifications and specifications as well as ongoing engineering.

Goal:

Ensure that City buildings are operating as designed and as efficiently as possible.

Next Step:

Contact Rebuild Colorado for assistance with identifying the best approach to commissioning (new construction) and/or retro-commissioning.

[4] Wolpert, Jack. March 2000. Commissioning presentation at the Sustainable Design Workshop: An Integrated Approach, Fort Collins, Colorado. E Cube, Inc. March 2000. Boulder, Colorado, *www.ecube.com*.

Priority G: Environmentally Preferable Purchasing

Formalizing an Environmentally Preferable Purchasing (EPP) policy helps to assure that day-to-day operations are supported by equipment and materials that represent the most sustainable options in their respective markets. While many such purchasing practices are already informally in place, formalizing a policy can facilitate bulk purchasing and increase the adoption rate for new products as they become available.

Environmentally preferable products often have some of the following advantages over conventional products:

- Less costly (e.g., remanufactured printer cartridges)
- Less toxic or hazardous, therefore safer for employees to use and less costly to dispose of (e.g., propylene glycol instead of ethylene glycol)
- Less costly to operate (e.g., ENERGY STAR™ rated equipment)
- Reduced environmental impact throughout product life cycle

Fundamentally, an EPP directs purchasing decisions to take into account a product's full life cycle. At the end of a particular product's useful lifetime, the following steps illustrate the process for which an EPP can provide guidance:

1. Can the product be reused, donated, or recycled?
2. Does the product need to be replaced? Is there an alternative product or service that can provide the same function in a more sustainable fashion (e.g., recycle a non-functional fax machine and replace it with a less wasteful service such as electronic fax)? Can the replacement be leased (e.g., large office equipment)?
3. Can the replacement be downsized? Can it be combined with another needed function (e.g., multipurpose office equipment)?
4. What new product has the best life cycle sustainability in terms of the following factors?
   - Material composition
   - Transport
   - Manufacturing
   - Packaging
   - Product use
   - End of life disposal

Some purchasing areas in which an EPP can provide effective guidance include:

- Automotive Vehicles and Equipment

- Building Materials
- Cleaning and Coating Materials
- Food
- Office Equipment
- Office Furnishing
- Paper Products
- Other

It should be noted, that the EPP provides an opportunity to encourage City departments to purchase more sustainable automobiles. While there may not be sustainable alternatives for specific utility vehicles, such as snow plows, more general use vehicles might be replaced with hybrids or alternative fuel vehicles as appropriate.

The Pollution Prevention Resource Exchange provides a good general overview of green purchasing practices and the motivation for adopting them:

http://www.p2rx.org/topichubs/toc.cfm?hub=13&subsec=7&nav=7.

The Environmental Protection Agency's (EPA) EPP site, http://www.epa.gov/oppt/epp/, provides criteria and product suggestions in a number of these purchasing areas. It also provides case studies, sample documents, training materials, and various other tools that can be used to support an EPP.

Another good resource that provides guidelines for the recycled content level and specifications of products is the EPA's Comprehensive Procurement Guidelines, http://www.epa.gov/cpg/products.htm#non. A database of suppliers for products meeting these guidelines also is provided at http://www2.ergweb.com/cpg/user/cpg_search.cfm.

In addition, the Sustainable Products Purchasers Coalition, made up of various organizations and municipalities, is seeking to promote using life cycle analysis tools to transform industry toward more sustainable products (http://www.sppcoalition.org/index.html).

Goal: Integrate principles of sustainability, particularly optimizing the triple bottom line, in purchasing decisions.

Next Steps: Compile resources for and complete development of EPP guide. Design and administer associated training to support employee implementation of EPP practices. Coordinate with employees to update and improve EPP practices over time.

Priority H: Interface Between Green Building and Historical Preservation

The City owns and operates a number of structures that have historical significance. Furthermore, there is some indication that the City will be increasing its involvement with historic structures in the interest of enhancing and promoting them as an asset for tourism. Many of these structures are likely to need renovation, and it is in the City's interest that these antique structures not present an operations and maintenance burden.

To that end, it is important to improve a building's performance while simultaneously preserving historical character in the course of renovation. While there are no blanket solutions for achieving these goals, there are a number of strategies that can lead to renovations that will satisfy both interests. These strategies include such things as a detailed design review of historical elements and innovative modification of new technologies to allow integration into the historical environment without distracting from its qualities.

Case Study: The Smiley Building, Durango, CO




The Smiley Junior High School in Durango was constructed in 1935. In 1995, the building was declared surplus by the school district after a replacement facility was completed. Damaged by water leaks and vandalism, and showing the neglect of years without regular maintenance, the building began a new life in 1997 with a private renovation as a community arts center.

The renovation efforts at the Smiley building are a model of integration between historical preservation and green interests. Some of the features that were incorporated include:

- Waterless urinals
- Low-flow toilets
- Point of use water heaters
- Salvaged radiators, sinks, doors
- Occupancy sensors
- Sun tubes for interior day lighting
- Energy efficient compact fluorescent light bulbs used in most historic fixtures
- Attic fan for cooling
- Medex, a formaldehyde-free fiberboard made from small diameter wood and waste fibers used in window and door renovation
- Solar thermal collectors providing space heating and domestic hot water, serving 25 percent of space heating in winter and almost all in the spring and fall. Domestic hot water served year round.
- Photovoltaic cells (PV) provide 40 percent of building energy
- Xeriscaping
- Steam piping from original building reused as landscaping material

To learn more visit
http://www.coloradohistory-oahp.org/programareas/shf/projects/2002/smiley.htm
http://www.smileybuilding.com/

Generally, even renovated historical structures are going to be more costly to operate than their modern counterparts given the antiquated design and construction techniques and the aging of original building materials. For the same reasons, occupant comfort also can be substandard in these buildings. By employing concepts from high performance building, there is significant opportunity to reduce operating costs while simultaneously increasing occupant comfort.

Architectural preservation professionals suggest a number of strategies for enabling projects to succeed at both historic preservation and increased performance. One key strategy is to avoid wholesale replacement of historical features (i.e., windows). This practice is common because it generally leads to higher performance, can be less costly, and is more expeditious. In addition, contractors do not like to assume the liability associated with repairing historical features, preferring instead to pass the liability on to the manufacturer of the new feature (e.g., windows). Unfortunately, this practice can lead to replacing still functional features that might need very little repair or retrofit. This practice also can significantly impact the historical qualities of a structure.

Instead, it is recommended that each historical element be reviewed in sufficient detail to determine if repair is a viable option. This can be less costly in some cases and preserves the historical qualities of the building.

Consequently, this attention to historical details will often earn the trust and respect of those championing the interests of historical preservation, thereby providing a more amiable forum for discussing other building enhancements, such as those described in the case study.

The National Park Service maintains a series of briefs on many aspects of historical preservation and renovation. These can provide good insight into the intricacies of various renovation projects: http://www.cr.nps.gov/hps/tps/briefs/presbhom.htm.

In addition, the Architectural Preservation Institute at Colorado State University has participated in numerous renovation efforts involving historical preservation and a desire for enhanced building performance: http://www.api.colostate.edu/.

Numerous case studies of successful integration exist and could be good models for the City's future work in historical renovation at sites such as the Elkins House and Legacy Ranch.

Goal: Achieve the highest possible performance for renovated historical structures without compromising historical characteristics.

Next Steps: Placing a quantitative target on the above goal, such as setting a threshold for utility cost per square foot, is difficult considering the wide variety of structures to which this recommendation might apply. At a minimum, the City should seek to improve the occupant comfort of renovated structures where appropriate without decreasing the utility performance over the original structure.

Priority I: High Bay Lighting

Lighting fixtures in rooms with high ceilings (high bays), such as warehouses, work areas, and athletic facilities, are often attractive opportunities to reduce energy costs by retrofitting existing equipment with new technologies. Improvements in fluorescent lamp and ballast technology now enable banks of fluorescent lamps to perform lighting tasks previously served only by metal halide or sodium lamps. The retrofit involves replacing existing metal halide fixtures with high-bay fluorescent fixtures containing numerous T5 lamps or T8 lamps with high output ballasts. High-bay fluorescent fixtures have many advantages over metal halides:

- Use 40 to 50 percent less electricity
- Have longer lift, higher light output, and better color rendering (making people and surroundings look better)
- Have instant-on, dimming, and can be controlled with multilevel switching
- Lower risk of catastrophic failure, which can potentially reduce the facility's insurance costs

Applications for this retrofit were observed specifically at the tennis center, ice rink, public works, and parks and recreation facilities. It should be noted that some of these facilities may not currently be ideal candidates for retrofit lighting. For example, the tennis center was just recently completed and the ice rink has recently been updated with long-life replacement lamps. While the retrofit may be cost effective even considering these recent investments, it may be more of a future consideration as existing fixtures age. It also would be necessary to determine the availability of up-lighting fluorescent fixtures for the tennis center.

The projected savings associated with replacing all of the metal halide fixtures at the above-mentioned facilities are outlined below. These savings may prove to be estimates for several reasons. Fixture operating hours may be longer than assumed, certain areas may prove to be over lit (and require fewer fixture replacements), additional lighting fixtures for retrofit and/or occupancy sensor opportunities may be identified through a more detailed assessment.

- Estimated energy savings: 120,000 kWh/yr
- Estimated total cost savings: $11,500/yr
- Estimated implementation costs: $80,000 (no rebates)
- Estimated payback period: 6 to 7 years

As previously indicated, there are a number of potential funding models, such as PC, that may apply in the absence of necessary capital. However, if the capital is available, this may be a viable project for the City to assume independently.

Goal: Choose fluorescent alternatives for all applicable high-bay lighting situations.

Next Steps:

1. Retrofit metal halide fixtures at public works, perhaps as part of an aggregated performance contract.
2. In likely upcoming renovation of the parks and recreation facility, design for high-bay fluorescents.
3. Consider a retrofit at the ice rink before purchasing replacement metal halide lamps.
4. Consider a retrofit at the tennis center before purchasing replacement metal halide lamps or if operational issues should arise with existing metal halides.

Priority J: Ice Rink Heat Recovery

The City's ice rink has a number of efficiency aspects already incorporated. From a brief walk-through of the facility, two opportunities for heat recovery were identified. The primary opportunity for heat recovery at the ice rink is to use waste heat off of the refrigeration system. This recovered heat could be redirected to preheat the water used for ice making and/or locker room showers. The secondary opportunity for heat recovery is to use locker room exhaust to supplement the space heating of the locker rooms' make-up air units.

Attachment 3 is included as a resource related to ice rink efficiency, particularly public ice arenas. The report addresses efficiency opportunities ranging from operations and maintenance to refrigeration systems.

Goal:

Use heat recovery to improve the ice rink's operational efficiency.

Next Steps:

1. Review Attachment 3 and share with Ice Rink operators.
2. Complete an in-depth energy-efficiency assessment of the Ice Rink to specify heat recovery opportunities and determine opportunity paybacks to inform implementation decisions.
3. Consider ice rink efficiency opportunities, including heat recovery, for future ice rink expansion.

Priority K: Minimize Refrigerant-based Air Conditioning Practices

Air conditioning systems that use refrigerants often are a building's most expensive and energy-intensive process. The City has the opportunity to take advantage of its climate and altitude to minimize the need for refrigerant-based air conditioning.

The first option for minimizing the use of air conditioning is to minimize a building's need for cooling. Through integrated design (Priority F), building systems such as the envelope (insulation, windows, etc.) and site landscaping can be designed to minimize the need for cooling. Even if refrigerant-based air conditioning equipment is installed at a building, these practices are important to minimize the time that the equipment is used.

The second option for minimizing the use of air conditioning is to use alternative cooling systems. In Steamboat Spring's climate, evaporative cooling applications can be an important alternative system. Evaporative cooling can be either stand-alone applications (e.g., swamp coolers) or add-ons to refrigerant-based cooling equipment (e.g., roof top units). Stand-alone evaporative cooling removes heat by adding moisture directly to the airflow. Direct evaporative cooling will decrease incoming air temperatures, but will subsequently increase moisture content. Add-on applications used in conjunction with refrigerant-based cooling equipment serve to pre-cool incoming air, displacing and/or minimizing cooling energy.

Other alternative system options and/or practices can include the following:

- Natural ventilation: This practice uses a chimney effect and is maximized through the integrated design of a building's architecture.
- Nighttime cooling: This option uses cool night air, such as fan scheduling.
- Mechanical cooling: Ceiling fans circulate air and exhaust fans promote cross-ventilation.

Goal:

Use alternatives to refrigerant-based air-conditioning as applicable in upcoming building renovations and new buildings.

Next Steps:

1. Consider evaporative cooling applications for upcoming air-conditioning replacements (such as the RTU to be replaced in the existing area of the Tennis Center next summer).
2. Employ integrated design to new construction and major renovation projects to minimize air-conditioning loads and use of alternative cooling approaches.

Disincentives for Sustainability in the Current City Structure

While the benefits of project related recommendations (i.e., high bay lighting, heat recovery, air conditioning practices, etc.) are relatively easy to demonstrate, benefits from programmatic changes are a greater challenge to characterize. Recognizing the missed opportunities resulting from current City practices underscores the need for, and potential benefits of, operational changes.

The many existing sustainable practices observed within City operations indicate that the City and its employees value sustainability and have already started to embrace it, even in the absence of formal guidance. However, the equally long list of opportunities reinforces the need for a formal mission statement, organizational support for taking action on that mission, and appropriate education in order to infuse sustainable decision making and actions into the City's institutional and operational structure.

To demonstrate these needs and the impacts of the City of Steamboat's missed opportunities, consider as an example the absence of a City-wide facility manager with centralized utility management responsibilities. In general, the City facilities are expected to function adequately with the current practice of significant maintenance outsourcing. However, this practice fundamentally lacks the motivation for City-wide sustainability improvement because of insufficient ownership/authority, resources, and focus on City operations. In particular, the structure lacks:

- direct responsibility for monitoring utility use and maximizing utility efficiency on a City-wide basis
- departmental incentives to optimize use and promote conservation (departments have no knowledge about their usage levels and associated costs)
- tracking of implemented upgrades and, thus, the opportunities to identify and highlight the upgrade benefits and savings
- City-wide ability to ensure funding for high performance buildings, integrated design, and commissioning

Fundamentally, the identified disincentives relate to the responsibility, management, and communication that a facility manager position can offer.

4.0 Sustaining the Sustainability

Implementing the recommendations made in Section 3 will put the City of Steamboat Springs on a solid path toward more sustainable operations. These measures provide some of the institutional framework necessary to perpetuate sustainability, lead to cost savings, conserve resources, provide for a safer and more comfortable working environment for City employees, and empower City employees to perform their day-to-day work with sustainability in mind. However, these recommendations are merely steps along the way to sustainability, and will not achieve sustainability in isolation. While the previous sections of the SMP address the topics of "What", this section addresses the "How" of sustainability. Specifically, how to institutionalize sustainability so that it's practiced long after the pioneers that captured the City's early wins are retired.

As the inventories in Section 2 and Attachment 1 indicate, there are many other significant opportunities for the City to pursue to further sustainability. As time passes, new opportunities will arise and existing initiatives may need to be revised. Managing the full scope of sustainability, the breadth of available opportunities, and depth of potential penetration into City operations will likely become a challenging task. Continuing progress toward a comprehensive Sustainability Management System may be the appropriate direction to take for the City to sustain the sustainability and build on the success of this SMP.

Many readers will be familiar with the concept of an Environmental Management System (EMS). For many years the EMS has represented the pinnacle of environmental planning and it forms the basis of ISO14001 certification. Recently, the SMS has emerged as a management system framework, such as ISO14001, overlaid with a sustainability framework, such as The Natural Step.

The following gap analysis compares the City of Steamboat Springs' sustainability status at the time of publication of this SMP to a model SMS framework based on Jamie Macdonald's *An Integrated Framework for Sustainability Management Systems*[5], which has its roots in an ISO approach. It should be noted that there are a number of sustainability frameworks that the City might apply in moving toward a management system and Macdonald's is applied here as a metric of progress made to date and the necessary steps to achieve a comprehensive SMS. The City's choice of frameworks may not need to be as rigorous as presented here.

[5] Macdonald, Jamie. An Integrated Framework for Sustainability Management Systems. Dalhousie University, School for Resource and Environmental Studies, Halifax, Nova Scotia, November 4, 2001.

	Category	Content/Steps	Status (Not Started, In Progress, or Largely Done)	Documentation Notes
1	**Preparation (A)**			
1.1	**Introduction to sustainability**	Basic understanding of concept, applicability to City, motivations, and potential frameworks such as The Natural Step	In Progress	Green Team has initiated process of introducing organization and Management Team to Sustainability concepts
1.2	**Determination of stakeholder participation**	Identify direct and indirect stakeholders (employees; community; shareholders; members; customers; future generations; etc.). Consult them (where possible) to determine an appropriate level of involvement, and prepare an acceptable framework for engagement throughout the process.	Largely Done	Established Green Team team; project lead; external sustainability expert participation/review; discussion about future plans for expanding to include more stakeholders
1.3	**Preparation of implementation plan**	Prepare an implementation plan to guide the process of developing and implementing a SMS through to completion.	Largely Done	SMP document provides foundation of implementation plan for developing SMS
2	**Baseline Analysis (B)**			
2.1	**Identification of environmental aspects (system condition #1, #2, #3)**	Identify products, processes and services the organization delivers, and the processing stages that make up each process.	In Progress	Process started in SMP as documentation of existing practices and GHG Baseline including topic areas of Water, Transportation, Waste, Electric Consumption, and Natural Gas Consumption; based on discussion, site visit, and utility data
2.2	**Identification of social aspects (system condition #4)**	Identify the contribution of products, services, processes and operations in meeting human needs or inhibiting the meeting of human needs in communities both near and remote.	Not Started	Hasn't adopted The Natural Step framework at this point, so hasn't specifically analyzed operations in terms of system condition violations.
2.3	**Determination of significant environmental and social aspects**	Conduct a system condition #1 analysis of each process step in product or service delivery.	Not Started	Hasn't adopted The Natural Step framework at this point, so hasn't specifically analyzed operations in terms of system condition violations.
3	**Planning (C/D)**			

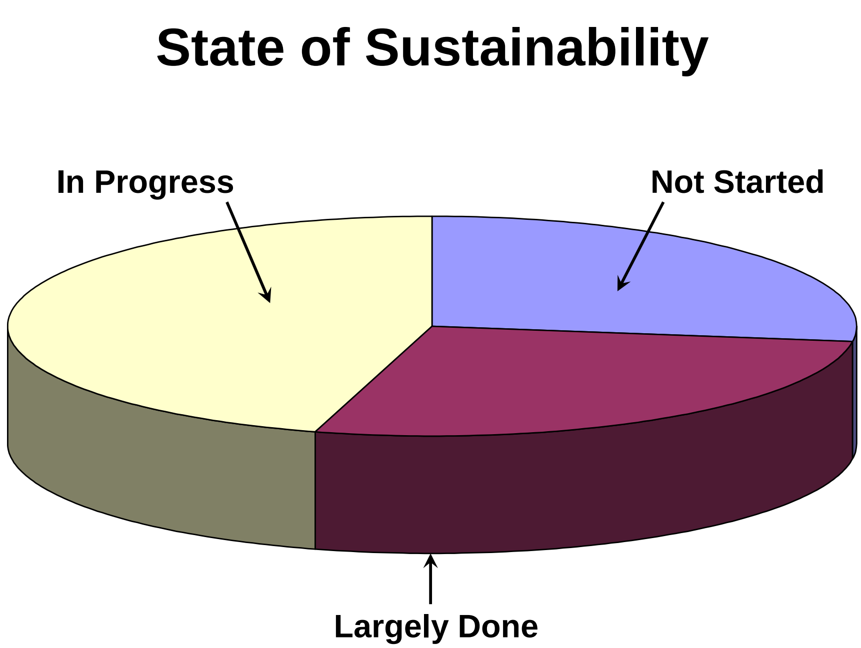
	Category	Content/Steps	Status (Not Started, In Progress, or Largely Done)	Documentation Notes
3.1	**Articulation of core values and purpose**	Revisit organizational core values and identify and clarify the fundamental value, utility or quality of the organization's product or service. Ensure this is not at odds with the requirements for a sustainable society.	In Progress	As part of development dialogue included some discussion of mission and positioning sustainability within this mission. Further consideration necessary.
3.2	**Envisioning a sustainable organization**	Create a vision for the organization in a sustainable society by developing alternative options for delivering your current product or service within the boundaries of the system conditions, or by offering a different product or service to meet clients' needs.	In Progress	Development of policy and working to identify priorities is intrinsically linked to visioning. Comprehensive visioning exercises remain to be done.
3.3	**Creation of a sustainability policy**	Articulate a sustainability policy based in part on the system conditions and other organization-specific information to serve as a guiding compass for the management plan.	Largely Done	Green Team initiated process of creating a draft statement as part of the SMP process. Management Team to finalize policy and put before City Council.
3.4	**Identification of key leverage areas and priorities**	Identify key leverage areas based on system condition analysis and prioritization.	Largely Done	The Natural Step (and therefore system conditions) was not employed as a sustainability framework. However, some key leverage areas and priorities were identified in Section 3 of the SMP to provide Steamboat Springs' some sustainability momentum to drive future initiatives.
3.5	**Creation of ultimate objectives and interim targets**	Set and document the ultimate objective of aligning the organization's value chain with system condition #1, and interim targets (based on key leverage areas) to move toward that objective by eliminating your organization's contribution to violations of it.	Largely Done	Again, TNS was not specifically employed. However, goals and next steps were identified for the priorities outlined in Section 3 of the SMP.

	Category	Content/Steps	Status (Not Started, In Progress, or Largely Done)	Documentation Notes
3.6	**Internal strategy development**	Internal strategy formulation requires the development of an appropriate mix of dematerialization and substitution strategies (given the nature of the organization's product or service) to align it with the four system conditions over the long term. Different organizations will require emphasis on different strategies (within the mechanisms of dematerialization and substitution below), and not all will apply or be necessary in order for the organization to meet the conditions for sustainability.	In Progress	Again, while TNS and system conditions were not specifically employed, the SMP does begin to inventory strategies for dematerialization or substitution within City operations.
3.7	**Barrier identification**	Identify internal and external barriers that are preventing the organization from moving into alignment with the system conditions.	In Progress	Various interactions, including the Green Team meeting, Management Team session, and facilities tours, have begun to identify some of the barriers that exist between the City and sustainability. Some of these are addressed in Section 3.
3.8	**External strategy development**	Create strategies to overcome the external barriers preventing the organization from moving into alignment with the system conditions.	Not Started	
3.9	**Strategy testing and decision-making**	Strategy testing and decision-making require a balanced evaluation of the spectrum of strategies identified earlier against the following criteria: high ROI, flexibility, high likelihood of success, precautionary approach, and critical to prevent system collapse	Not Started	
3.10	**Action development**	Develop concrete actions consistent with strategies to align with the system conditions.	In Progress	Next steps in priority areas.
3.11	**Indicator development**	Create management indicators that focus on evaluating how actions comply with the overall plan.	In Progress	The Green Team's utility analysis and the GHG baseline prepared for the SMP could form the foundation for future indicator development.

	Category	Content/Steps	Status (Not Started, In Progress, or Largely Done)	Documentation Notes
3.12	**Tool selection**	Select tools to assist in the implementation and monitoring of strategies and actions to meet ultimate objectives.	Not Started	
3.13	**Sustainability program development**	Articulate timelines, incentives, responsibilities and accountability for achieving objectives and targets through strategies.	Not Started	
3.14	**Identification of legal and other requirements**	Identify legal and other requirements of the organization, and develop a process for keeping this list up to date.	Unknown	Some other mechanisms may already exist within the organization to manage legal requirements.
4	**Implementation and Operation**			
4.1	**Training, Awareness and Competence**	Build a deeper understanding of the sustainability frameworks and their application.	In Progress	Some awareness building was integrated into project through meetings and facility tours. Additional training will be necessary and is recommended in the SMP.
4.2	**Communication, disclosure and reporting**	Develop a sustainability reporting framework for internal and external stakeholders using The Natural Step framework as an umbrella.	Not Started	Recommend that City consider an annual sustainability report.
4.3	**Documentation, document control, and records**	Develop documentation that outlines the basic elements of the management system and responsibilities in ensuring they remain current and that records are maintained where required.	Not Started	
4.4	**Operational control**	Create procedures for monitoring significant environmental and social aspects corresponding to strategies where their absence might lead to non-conformances.	Not Started	
4.5	**Emergency preparedness and response**	Create and test (where possible) an emergency preparedness and response plan.	Unknown	Emergency preparedness plans likely exist within the organization but have not yet been incorporated into the sustainability system.
5	**Checking and Corrective Action**			
5.1	**Monitoring and measurement**	Create procedures for monitoring significant environmental and social aspects and appropriate management indicators (as developed in the Planning section).	Not Started	

	Category	Content/Steps	Status (Not Started, In Progress, or Largely Done)	Documentation Notes
5.2	**Non-conformance and corrective and preventive action**	Develop a procedure for recording, reporting and analyzing non-conformances in the management system.	Not Started	
5.3	**Sustainability management system audit**	Create a written procedure that defines the scope, schedule, frequency, methodologies, and responsibilities for conducting and reporting SMS audits.	Not Started	
6	**Management Review**			
6.1	**Management review**	Prepare a management review procedure and retain records of meetings.	Not Started	

The status indicators developed in the above table are summarized in the following graph. The work of the Green Team and this SMP has put the City of Steamboat Springs well on its way to achieving a comprehensive system of management for sustainability. Moreover, the initial tasks related to preparation and planning are generally more complete than tasks that fall later in the system framework, indicating that the City is proceeding in a logical order in moving toward sustainability.



The priorities developed in Section 3 and the gap analysis presented here provide the City with concrete tasks to get a jump start on sustainability as well as a road map to insure that the concept is institutionalized at all levels. With these tools in hand, the City of Steamboat Springs has prepared itself to reach its sustainability goals today and in the future.

The most relevant steps for working to expand this SMP into an SMS include:

- Empower a team, such as the existing Green Team, to oversee implementation of SMP recommendations
- Publish an annual sustainability report of progress on action plan and metrics
- Conduct community-based visioning exercises
- Decide on indicators to track progress

Attachment 1 – Existing Practices and Additional Opportunities

CENTENNIAL HALL

Existing Practices

Energy

- LED exit signs in place
- Time clock control of exterior lights
- T8/electronic ballasts for all linear fluorescent fixtures
- Compact fluorescent fixtures in geographic information system (GIS) areas
- Energy-efficient office equipment, including flat-panel monitors and ENERGY STAR copiers
- White roof

Water

- Low-flow aerators on kitchen sinks
- Low-flow toilets
- Infrared controls for restroom sinks

Social

- Auto-flush toilets (sanitation)
- Infill and building reuse

Additional Opportunities

Energy

- Retrofit halogen wall wash fixtures with compact fluorescent track fixtures
- Retrofit pendant incandescent fixtures with compact fluorescents (on fixtures that do not have or do not use dimming switches)
- Replace incandescent lamps with compact fluorescent lamps in kitchen area
- Relocate server condensing unit to outdoor location
- Confirm programmable thermostats closely match area occupancy schedules

- Demand controlled ventilation for council chamber
- Explore use of small natural gas backup generator (to be installed) for peak demand management
- Install premium efficiency motors (e.g., hot and chilled water pumps)
- Install ENERGY STAR-rated models for all office equipment replacements, including printers, copiers, desktop computers, etc.
- Explore ENERGY STAR availability of plotters
- Consider altering summer operation policy for boilers
- Install occupancy sensors for file archives and restrooms

Water

- Confirm kitchen pre-rinse spray nozzle is low-flow (1.6 gpm)
- Replace restroom 1.5-gpm aerators with 0.5-gpm aerators

Social

- Address thermal comfort issues in GIS area

TENNIS CENTER

Existing Practices

Energy

- Outdoor air used for cooling (to be confirmed)
- ENERGY STAR programmable thermostats installed
- Insulated oversized doors

Additional Opportunities

Energy

- Upgrade T12/magnetic linear fluorescents with T8/electronic models
- Implement air distribution using duct sox
- Install infrared tube heaters

- Relocate programmable thermostats away from hot breaker boxes and confirm programming
- Replace existing high intensity discharge (HID) fixtures with high-bay fluorescent fixtures (energy savings from efficient fixtures and ease of shutdown during unoccupied hours)
- Install de-stratification ceiling fans
- Insulate roof peak
- Repair fallen wall insulation
- Remove barriers to ventilation airflow (e.g., court curtains)
- Replace incandescent lamps in wall sconces with compact fluorescents
- Purchase high-efficiency model for upcoming replacement of rooftop unit that serves older building area (i.e., the pro shop and locker rooms)

Water

- Retrofit toilets with low-flow models (1.6 gallons per flush rating)
- Retrofit showerheads with low-flow models (1.5 gpm rating)
- Install infrared aerator controls

Waste

- Consider recycled content for two unfinished court surfaces and in future resurfacing

Operations

- Ease replacement of filters on air-handling units (currently 42 feet above ground level)
- Ease replacement of HID lighting fixtures (approximately 15 to 20 feet above ground level)

CITY HALL

Existing Practices

Energy

- Photocell control of exterior lighting
- LED exit signs
- Simultaneous heating/cooling minimized

Water

- Low-flow toilets (1.6 gpf)

Waste

- Recycling
- Technotrash recycling container (e.g., computer disks, DVDs, cell phones, etc.)

Additional Opportunities

Energy

- Turn off exterior lighting after midnight (currently photocell controlled)
- Install vending misers for vending machines
- Install timer for electric heat tape on janitorial closet piping
- Replace T12 fixtures in trailer adjacent to building
- Install occupancy sensors in restrooms

Water

- Install infrared aerator controls

Social

- Address thermal comfort issues associated with master/slave thermostats
- Use of window films to improve occupant comfort

<u>PUBLIC SAFETY</u>

Existing Practices

Energy

- T12/magnetic linear fluorescents upgraded with T8/electronic models

Water

- Low-flow toilets (1.6 gpf)

Waste

- Shredded paper (larger cut) recycled
- Recycling: newspaper, commingled, microfilm cartridge recycling

Additional Opportunities

Energy

- Use oversized boiler

Water

- Retrofit showerheads with low-flow models (1.5 gpm rating)
- Install infrared aerator controls

Waste

- Consider recycling or composting for shredded paper (fine cut)
- Install dishwasher to encourage use of reusable flatware, plates, cups in kitchen area (vs. disposable items)
- Explore conversion to digital archive vs. microfilms

PUBLIC WORKS

Additional Opportunities

Energy

- Upgrade T12/magnetic linear fluorescents with T8/electronic models
- Replace existing HID fixtures with high-bay fluorescent fixtures (energy savings from efficient fixtures and ease of shutdown during unoccupied hours)

SKI TIME SQUARE PARKING GARAGE

Additional Opportunities

Energy

- Install induction lighting
- Install lighting controls

ICE RINK

Existing Practices

Energy

- High lighting settings used only during game times
- Low e ceilings
- Infrared tube heaters over spectator areas
- Refrigeration waste heat used to melt disposed ice
- East side exterior lights on motion sensors
- West side exterior lights on photocell control
- Insulated oversized doors
- Duty-cycling of refrigeration compressors

Water

- Low-flow toilets (1.6 gpm)
- Low-flow restroom aerators (0.5 gpm)

Waste

- Recycling: pizza boxes, office paper, newspaper

Operations

- Ice-making system outlined for staff training

Additional Opportunities

Energy

- Refrigeration compressor rebuild in 2007

- Install premium efficiency motors
- Upgrade T12/magnetic linear fluorescents with T8/electronic models
- Confirm programmable thermostats closely match area occupancy schedules
- Eliminate heating of entryways off hallways to locker rooms
- Install hot water piping insulation
- Install large V-belt for direct drive compressors (replacing individual belts)
- Install premium efficiency motors
- Install two-speed cooling tower motor
- Replace existing HID fixtures with high-bay fluorescent fixtures (energy savings from efficient fixtures and ease of shutdown during unoccupied hours)
- Install occupancy sensors for locker rooms

Water

- Explore reuse of waste ice
- Reverse osmosis in ice-making

Operations

- Develop facility maintenance plan

PARKS AND RECREATION

Existing Practices

Energy

- Infrared tube heaters over work area

Water

- Sand/oil separator added to drain system
- Low-flow toilets (1.6 gpf)

Waste

- Techno-trash recycling container (e.g., computer disks, DVDs, cell phones, etc.)

Additional Opportunities

Energy

- Upgrade T12/magnetic linear fluorescents with T8/electronic models
- Replace existing HID fixtures with high-bay fluorescent fixtures (energy savings from efficient fixtures and ease of shutdown during unoccupied hours)
- Install solar wall
- Use waste oil for heating
- Install vending miser

Social

- Address indoor air quality

Operations

- Address outdoor equipment storage
- Address wash practices

Attachment 2 – Greenhouse Gas Baseline

As the City advances sustainability initiatives and begins tracking program progress, greenhouse gas (GHG) emissions could provide a metric for the success. The following table provides a historical baseline against which future status might be compared.

In addition, this table provides useful background should the City pursue a greenhouse gas offset program.

The following rough baseline is based on 2004 utility data gathered by the Green Team for their report of December, 2005.

	GHG Source (unit)	Total Quantity (unit)	GHG (tons eCO2)
Utilities	Natural Gas Consumption (therms)	221033	1305.20
	Electrical Consumption (kWh)	5866465	2728.79
	Water (consumptive Use) (gal)	13008000	13.31
Transportation	Gasoline (gal)	65355	676.70
	Diesel (gal)	131161	1375.10
Waste	Landfilled Solid Waste (cubic yards)	6506.7	380.64
Recycling	Cardboard (cubic yards)	230.4	-32.95
	Newsprint (gallons)	16588.8	-67.63
	Mixed office paper (gallons)	14745.6	-46.61
	Commingled (tons)	11.3	-37.52
	TOTAL	**--**	**6,295 tons**

Attachment 3 – Ice Rink Guidelines

COST-EFFECTIVE ENERGY EFFICIENT IMPROVEMENTS FOR MINNESOTA'S PUBLIC ICE ARENAS: OVERVIEW OF 20 OPTIONS

Prepared By:
Center for Energy and Environment
100 6th St. North, Suite 412A
Minneapolis, MN 55403-1520

Principal Investigators:
Russell Landry P.E.
Mark Hancock
Mario Monesterio
David Bohac P.E.

612/335-5858

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CEE/TR98-2 CM

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OPERATION AND MAINTENANCE IMPROVEMENTS

*Increase Ice Temperature

Many arenas can substantially reduce energy costs by increasing the average ice temperature. The ice sheet constantly absorbs heat from the warmer air and building around it and the rate of heat absorption naturally decreases as the temperature of the ice sheet goes up. Because the refrigeration system must work to remove the heat that the ice sheet absorbs, its energy use also decreases whenever the ice sheet temperature can be raised even slightly. The reduced heat absorption also reduces the amount of energy needed to heat the arena and the higher average ice sheet temperature causes the refrigeration system to operate more efficiently.

Because the overriding concern of arena operators must be to maintain the ice sheet integrity, temperature controls are often set at a conservatively low value that will maintain ice sheet quality under the most adverse conditions. Because the ice sheet might be subjected to such adverse conditions for only a few hours, days, or weeks, a conservatively low temperature setpoint will keep the ice sheet colder than it really needs to be the majority of the time. Depending on an arena's schedule and refrigeration system, it may also be practical to substantially increase the ice temperature during long unoccupied periods (e.g. overnight and throughout the morning). Unless an automatic set-back control is used, adjusting ice temperatures may require daily, manual adjustments. Annual energy cost savings from increasing the average ice temperature only 1°F range from $200 to $800 for a six-month arena and from $800 to $1,600 for a year-round facility.

*Reduce Ice Sheet Thickness

Control and reduction of ice sheet thickness can reduce energy costs while also providing more consistent ice quality. While the minimum acceptable ice sheet thickness varies somewhat from arena to arena, a typical optimal thickness is one inch or less for arenas with an even concrete base; arenas with a sand base may need ice at least two to three inches thick to provide adequate support for the resurfacer. Reducing the ice sheet thickness by one-quarter inch will allow the ice surface temperature to be kept the same while the coolant or slab temperature setting is increased by two-thirds of a degree. Increasing the coolant and slab temperatures saves energy by increasing the efficiency of the refrigeration system. Typical annual energy cost savings from increasing the ice temperature one degree (one-half inch reduction in ice thickness) are approximately $145 for a six-month arena and $300 for facility that operates more than 9 months. In addition to energy savings, closely controlling ice thickness also makes the quality of ice more consistent because the ice surface temperature is closer to the rink floor and coolant temperature.

*Reduce Refrigeration System Head Pressure Controls

Energy consumption in many ice arenas can be reduced by adjusting the refrigeration system's head pressure controls. The refrigeration system keeps the ice sheet cold by recirculating refrigerant. The refrigerant absorbs heat from under the ice sheet and then dumps that heat to the

* Possible low-cost/no-cost improvement

outside air through a condenser. In order for heat to flow from the refrigerant in the condenser to the outside air, the refrigerant must be at a high temperature and pressure (referred to as the head pressure). This high temperature and pressure is generated by the compressors that pump the refrigerant through the various parts of the refrigeration system. Since the compressors are the primary energy users in the refrigeration system, reducing the head pressure will save significant amounts of energy and reduce wear on the compressors. Many direct refrigeration systems will operate properly with head pressures as low as 150 psi, while many indirect systems (those with thermostatic expansion valves) may need higher pressures of 175 psi. Typical annual energy cost savings that can be realized with only a 20 to 25 psi reduction are $400 to $1,000 for a six-month arena and $900 to $1,800 for facilities that operate 9 months or more.

The head pressure can be reduced in two ways: (1) by manual adjustment or (2) by replacing standard condenser controls with more efficient automated condenser control systems (see refrigeration system section). The refrigeration industry has traditionally encouraged maintaining a higher than necessary head pressure by turning off fans that blow outside air through the condenser and/or by using a pump that sprays water over the condenser. These approaches are very conservative in terms of ensuring adequate cooling of the ice under the most taxing conditions; however, these practices unnecessarily increase energy costs and wear on the compressors during periods of normal arena operation. This energy conservation method has already been successfully implemented in several Minnesota ice arenas.

LIGHTING IMPROVEMENTS

Efficient Lighting Fixtures for Public Spaces

A number of existing technologies can make interior and exterior lighting significantly more energy efficient. The impact any particular lighting improvement has on operating costs depends heavily on the hours of operation. Obviously, fixtures which are operated 24 hours a day will provide more savings from high efficiency improvements than similar fixtures that only operate for a fraction of each day. Maintenance costs for replacing spent fixtures must also be considered when calculating the paybacks of lighting improvements.

There are six main types of lighting improvements which are feasible in most ice arenas. Ice sheet lighting recommendations are dealt with in the next section.

1. Replacing standard incandescent lamps or “light bulbs” with more efficient fluorescent lamps will use 30 to 80 percent less electricity per lamp while producing the same light levels. In addition, maintenance costs will be reduced since fluorescent lamps last 5 to 12 times longer than standard incandescents.

2. Replacing existing four or eight foot fluorescent fixtures with high efficiency fluorescent T-8 lamps and improved electronic ballasts can provided significant cost savings.

3. Public areas such as halls, corridors, and lobbies often have more fixtures than are needed for desired light levels. Wasted light can easily be eliminated by either using lower wattage ballasts (dewatting) or disconnecting unnecessary ballasts (delamping).

4. Replacing incandescent or compact fluorescent exit signs with low power LED lamps can save from 14 to 39 watts per fixture. Since LED lamps have a life expectancy of over 20 years, maintenance costs can also be significantly reduced.

5. Exterior incandescent or quartz flood lights can be cost effectively upgraded to energy efficient high intensity discharge lamps, such as metal halide or high pressure sodium fixtures.

6. Timed switches and occupancy sensors are automatic controls which turn off lights in unoccupied areas and turn them on only when needed. Storage areas, public restrooms, hallways, offices, meeting rooms, and outdoor entrances are often cost-effective applications for these automatic controls.

All of the previous lighting recommendations have been implemented successfully in hundreds of commercial buildings in Minnesota. The payback of any lighting improvement must be calculated on an area by area basis since operating hours and other conditions may vary significantly. Many electric utilities offer lighting efficiency rebates. A few arenas that have recently upgraded public space lighting are listed below.

Arena	Contact Person	Phone
Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842
Farmington Civic Arena	Jim Bell	(612) 463-1851
Cottage Grove Arena	Dean Mulso	(612) 458-2846
Lily Lake (Stillwater)	Diane Deblon	(612) 430-8811
West St. Paul Arena	Dave Malay	(612) 552-4155

Ice Sheet Lighting Recommendations

Ice sheet lighting costs can be reduced by replacing or upgrading inefficient light fixtures and by varying ice sheet light levels based on activity. Common lighting fixture upgrades that are often cost-effective include changing from standard fluorescent or mercury vapor fixtures to metal halide or high pressure sodium fixtures. A relatively new option that can provide even greater energy savings is to upgrade to compact fluorescent fixtures designed specifically for athletic facilities. In addition to providing energy cost savings, the lighting fixture upgrades mentioned above also tend to result in lower maintenance costs, better quality lighting, and increased control options. Three arenas in Minnesota that are using the newer compact fluorescent fixtures over the ice sheet are listed below.

Arena	Contact Person	Phone
Cottage Grove Arena	Dean Mulso	(612) 458-2846
Vogel Arena (New Ulm)	Jim Krapf	(507) 354-8321
St. Louis Park Arena	Craig Panning	(612) 924-2545

The level of illumination required for any sports lighting installation depends upon many factors, including the general nature of the task, the speed of the action, the skill of the players, the number of spectators and their distance from the field of play. Recommended illumination levels for various ice activities from the Illuminating Engineering Society are listed below.

Recommended Ice Rink Illumination Levels

Activity	**Foot-candles**
Pro Hockey	100
Amateur Hockey	50
Recreational Hockey	20
Figure Skating	15
Curling	10-20
Recreational Skating	10

Because ice sheet lighting requirements vary significantly for different types of on-ice activities a lighting system which can respond to changing light level requirements will be most energy efficient. In addition to using more electricity, ice rink lighting systems which over-illuminate also cause the refrigeration system to work harder than necessary. Multi-level lighting systems provide energy savings by more closely matching the light output and energy usage to the activity on the ice. Multi-level systems are usually more cost-effective than dimming systems. Some rinks have tried to bank their lighting system to achieve similar results, but this approach tends to produce shadows and non-uniformity that can make it difficult for players and spectators to follow the puck. Many electric utilities offer lighting efficiency rebates.

RESURFACING IMPROVEMENTS

Demineralized Flood Water Treatment

Water purity has a direct effect on the quality of ice and the amount of energy used to produce and maintain the ice surface. Ice arenas are extremely large users of water. A moderately busy ice arena with an average of 6 resurfacings a day will use approximately 1,000 gallons of water per day. The majority of this water is use to recondition the ice surface. As a general rule, heated city water is used to fill the resurfacer tank which in turn are used to flood the ice sheet. The water is heated to provide a better bond to the existing ice and to melt and fill in cracks in the ice caused by skate blades. With the use of demineralized flood water the need for heating is eliminated because pure water bonds very easily to the existing ice sheet. A reduction in the water temperature also reduces the amount of energy needed to freeze the flood water thereby reducing the work of the refrigeration system. Pure water also provides a harder ice surface that is more resistant to cuts.

Demineralized water can be achieved by two different methods. The first is an ion-exchange method that uses chemicals to remove the minerals. The second is a reverse osmosis filter that allows only pure water to pass through a filtering membrane. Both methods are extremely effective in removing the impurities in common water supplies. Installation costs for the ion-exchange demineralization and the reverse osmosis filtration systems are approximately $18,000. Operational costs for the two systems are different. The ion-exchange requires chemicals that cause the operational costs to be around $15 per 1000 gallons of processed water. Instead of requiring chemicals, the reverse osmosis systems require additional pumping power to force the water through the filtering membrane. Operational costs for the reverse osmosis systems average $3 to $5 per 1000 gallons. The paybacks on both systems typically span 6 to 10 years. The paybacks can be reduced by a change in the temperature of the ice sheet. With the use of demineralized water the temperature of the ice sheet can be raised slightly to accommodate the reduction of energy needed to freeze pure water as compared to water with dissolved solids. Several arenas that use either temporary ion-exchange tanks or a reverse osmosis flood water demineralization system are listed below.

Demineralization Type	Arena	Contact Person	Phone
Reverse Osmosis, Tanks	Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842
Reverse Osmosis	Hutchinson Civic Arena	Marv Haugen	(320) 234-4227
Reverse Osmosis	Cottage Grove Arena	Dean Mulso	(612) 458-2846
Reverse Osmosis	Victory (Minneapolis)	Virgil Oldre	(612) 627-2953

Electric Ice Resurfacer

Ventilation with outside air is extremely important in ice arenas where resurfacers driven by internal combustion engines are used. The airborne pollutants emitted during the combustion process must be removed from the space or diluted to a concentration level that will not harm arena occupants. A fine balance must be found to ensure that sufficient outdoor air is provided to dilute combustion contaminants, while minimizing excessive levels to reduce dehumidification and heating loads. Using electric resurfacers eliminates the need for extra outdoor air ventilation to dilute combustion products. The only remaining need for ventilation is to assure adequate occupant comfort.

Electric resurfacers have been improved with technology from the forklift industry. Electric powered forklifts have been in use for many years and have performed indoors without problems. The power requirements of an ice resurfacer are somewhat higher than a forklift, but this is easily overcome with the addition of a larger battery pack. The alternative to the battery operated machine is to plug the resurfacer into an electrical supply grid. This is accomplished with the use of a tether that is supported in the ceiling of the arena. Costs for electric resurfacers range from $72,000 for tethered machines to $75,000 for battery models. Simple paybacks for electric resurfacers can be somewhat high when only considering the incremental cost over a new propane resurfacer. A new propane powered resurfacer has a cost of $55,000 which results in an incremental cost of $20,000. The resulting payback is typically over 10 years. Paybacks are reduced when operational costs are considered. The typical propane resurfacer will use approximately $1,620/yr in propane where as an electric resurfacers performing the same number of resurfacings will use only $420/yr, resulting in a $1,200/yr savings in operational costs alone. Replacing a propane powered resurfacer will provide the immediate benefit of improved indoor air quality even though the economic payback is longer than for many other improvements.

Resurfacer	Arena	Contact Person	Phone
Battery	Victory Memorial Arena	Virgil Oldre	(612) 627-2953
Battery	Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842
Battery	Parade Ice Garden	Tom Herbst	(612) 370-4846
Tethered	Fogerty Arena	Mark Clasen	(612) 780-3323
Tethered	Edison Youth Hockey	John Myers	(612) 782-2123

*Automatic Flood Water Fill Shut-off Nozzle

Overfilling resurfacer flood water tanks wastes water and energy. After every resurfacing, the flood water tank is refilled so it is ready for its next use, usually every hour. When fully opened, most water hoses will fill the flood water tank in 20 - 30 minutes, but an employee must turn off the valve to avoid overflowing. In some arenas the flow rate is reduce so the flood water tank is filled in approximately an hour, or the time allotted between resurfacing. Overflowing is common in either method and results in wasting water which is expensive. It is even more costly in terms of energy consumption in arenas which use heated water for resurfacing because overflowing a tank is like pouring hot water down the drain.

Arenas can conserve water and energy by installing a simple, inexpensive device used on all gasoline pumps. An automatic shut-off nozzle can be attached to the end of the fill water hose and when the tanks are full the nozzle will automatically turn off the water. The cost for an automatic shut-off nozzle is around $30 dollars and if only one gallon of water is eliminated from spilling at every resurfacing, the payback is estimated at 6 years based on water charges alone. If the cost for heating the water is factored in, the payback decreases to only 3 years. Automatic shut-off nozzles also decrease staff time required to monitor the tank levels between resurfacing periods. Automatic shut-off nozzles are used in many Minnesota ice arenas.

REFRIGERATION SYSTEM IMPROVEMENTS

Condenser Fan Variable Speed Drive

A condenser fan variable speed drive will not only reduce the condenser energy use, but also save on compressor energy use by lowering the average head pressure. The lower and much steadier head pressure will also reduce wear on the compressors.

Energy consumption in many ice arenas can often be reduced by lowering the head pressure that is maintained by the condenser fan and/or pump controls. The refrigerant that is circulated through the refrigeration system first absorbs heat from underneath the ice sheet and then dumps that heat to the outside air through a condenser. In order for heat to flow from the refrigerant in the condenser to the outside air, the refrigerant must be at a high temperature and pressure (referred to as the head pressure). This high temperature and pressure is generated by the compressors that pump the refrigerant through the various parts of the refrigeration system. The compressors are the primary energy users in the refrigeration system, and reducing the head pressure that they must generate will dramatically reduce the arena’s energy use and equipment maintenance needs. Therefore, the condenser controls should be set to provide the minimum

* Possible low-cost/no-cost improvement

head pressure needed for proper system operation whenever it is possible. Most ice rink refrigeration equipment can operate with lower head pressures during mild and cool weather because the condensers can more easily dump heat to the outside air. However, typical condenser fan and pump controls are not capable of tight, consistent head pressure control so they are set to operate the equipment well above the lower head pressure limits. Retrofitting existing equipment with a variable speed drive on the condenser fan motor is often the best way to continually keep the head pressure near its minimum operating limit.

Maximizing the cost-effectiveness of a condenser fan variable speed drive retrofit usually requires some changes to the condenser control strategy. Therefore, a new control unit for both the condenser fan and pump (for evaporative condensers) is often needed. The new control strategies used with variable speed drives virtually eliminate the short-term on and off cycling of condenser fan and pump motors and the associated head pressure fluctuations.

Although installed costs for recently completed retrofits have averaged $7,000, there has been a wide variation in cost from project to project. Typical energy cost savings are $1,200 annually. Contact information for a number of arenas that have installed a condenser fan variable speed drive control is listed in the table below.

Arena	Contact Person	Phone
West St. Paul Arena	Dave Malay	(612) 552-4155
Litchfield Civic Arena	Steve Olson	(320) 693-2679
Farmington Civic Arena	Jim Bell	(612) 463-1851
Hutchinson Civic Arena	Marv Haugen	(320) 234-4227
Cottage Grove Arena	Dean Mulso	(612) 458-2846
Victory (Minneapolis)	Virgil Oldre	(612) 627-2953

Reclaiming Waste Heat from the Refrigeration System

Waste heat generated by the ice sheet refrigeration system can often be cost-effectively captured and used to supplement an arena’s heating needs, thereby reducing heating fuel use. The ice sheet refrigeration system normally takes all of the heat that the ice sheet absorbs (plus some extra heat added by the refrigeration system itself) and then dumps that heat to the outside air through an outdoor condenser. However, much of the heat that the refrigeration systems normally rejects to the outside air can instead be reclaimed to provide useful heat. The reclaimed heat can be used to heat air or water up to a temperature of 90°F or more. Typical uses of reclaimed heat include: heating the air in the arena, heating service hot water, and/or melting the snow scraped off by the resurfacer. More than half of the ice arenas in Minnesota use well-established heat reclaim technology to provide heat for one or more of these uses. Adding heat reclaim equipment costs at least several thousand dollars, but in some cases the investment will pay for itself in just a few years.

Cooling System Pump Control

More closely matching the ice sheet coolant pumping rate to the exact amount of cooling that is needed saves energy. The pump that circulates coolant under the ice sheet is chosen so that it can provide the highest coolant pumping rate that will ever be needed to maintain the ice; however, a much lower coolant pumping rate will provide adequate cooling 75 to 95 percent of the time. Controls that provide multiple levels of pumping capacity greatly reduce the energy penalty from continuously operating large, high capacity coolant pumps at their maximum capacity.

The cooling system pump control options available include:

1. using a variable speed drive to adjust the speed of the pump's motor
2. cycling single or multiple pumps on and off
3. using a two-speed motor to power the pump

The first two control options have been used successfully in Minnesota ice arenas. The third control option is commonly used in industrial applications and is also appropriate for ice arenas. Two-speed motors provide a lower cost alternative that is particularly cost-effective when a pump motor needs to be replaced. The approximate costs for these options range from $1,500 to $12,000 and the payback on investment is often attractive--even for short season ice arenas. The implementation of cooling system pump control should be considered in conjunction with improving ice temperature control and implementing automatic capacity control for compressors. In Minnesota, a number of newer packaged refrigeration systems have two different sized pumps that are automatically controlled. Contact information for two arenas that have variable speed drive control of the pump motor is listed below.

Arena	Contact Person	Phone
Litchfield Civic Arena	Steve Olson	(320) 693-2679
Lily Lake (Stillwater)	Kevin Shields	(612) 430-1234

Improve Ice Temperature Control

Improvements to ice temperature controls can often provide better ice quality and reduce energy costs by consistently maintaining the ice surface at the highest acceptable temperature level. The ice sheet absorbs heat from the warmer air and building which surround it. As the temperature of the ice sheet increases, less heat is absorbed thus reducing the amount of energy needed for the refrigeration system. The reduced heat absorption into the ice sheet not only reduces the refrigeration system energy use, but also reduces the amount of energy needed to heat the arena.

The ice surface temperature can often be increased by using two control technologies:

1. infrared ice temperature sensors
2. overnight setback of ice temperature

Infrared sensors can be mounted above the ice sheet to measure the ice temperature by sensing the amount of infrared light radiated by the ice sheet. Although this promising technology has not yet been applied in Minnesota, it has been successfully used in a number of arenas in the United States and Canada. Overnight setback of ice temperature (e.g. from a normal setpoint of 20°F to 24°F) provides another opportunity to reduce refrigeration system energy use. This technology allows the ice sheet to warm during non-use and then automatically cools the ice sheet before skaters return to the ice arena (without affecting ice quality).

Making energy saving improvements to an ice temperature control system can sometimes cost as little as $1,000, but significant upgrades usually cost at least $9,000, with a resulting energy savings payback period that is typically several years long or longer. The implementation of improved ice temperature control should be considered in conjunction with implementing automatic capacity control for compressors and installing cooling system pump controls. Arenas that have infrared ice temperature control and/or ice temperature setback are listed below.

Arena	Contact Person	Phone
Litchfield Civic Arena	Steve Olson	(320) 693-2679
Farmington Civic Arena	Jim Bell	(612) 463-1851
Cottage Grove Arena	Dean Mulso	(612) 458-2846
Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842

Automatic Capacity Control of Compressors

The compressors in ice arena refrigeration systems are sized large enough to be able to handle the initial freezing of the ice sheet. During lower cooling load periods, such as overnight and in winter, the compressors are oversized and waste energy. Many control systems simply cycle an arena’s compressors on and off—even when the potential to vary compressor capacity is built into the system. Automatic capacity control of the compressors can provide more efficient operation of the compressors by supplying a more consistent feed of refrigerant at a slightly higher average temperature. The higher temperature allows the refrigeration system to operate more efficiently and use less energy.

Additional savings can also be realized by a reduction in an arena’s monthly electric demand charge. The electric utility bases an arena’s demand charge on the highest power draw over a fifteen minute interval during a given month. The power draw for compressors with a simple on-off cycling control is high because the compressors operate near their maximum capacity whenever they are on. In contrast, automatic capacity control allows the compressors to operate at significantly reduced power draws most of the time. The reduction in monthly demand charges (kilowatt or kW) can be significant, amounting to more than the savings associated with total monthly electric use charges (kilowatt hours or kWh).

Automatic capacity control of compressors has long been used by a number of ice arenas in Minnesota. The cost to upgrade an existing refrigeration system with a new control system using automatic capacity control is usually several thousand dollars or more, which typically leads to a long energy cost savings payback time period. However, the most important benefit of automatic capacity control is often the reduction in the personnel time and expertise necessary for day-to-day operation of the refrigeration system. This is because the simple on-off control systems used in many ice arenas often demand significant arena staff time to frequently check on the system and make manual adjustments. The implementation of automatic capacity control of compressors should be considered in conjunction with the decisions to implement improved ice temperature control and/or cooling system pump control. Two arenas that have recently added automatic capacity control are listed below.

Arena	Contact Person	Phone
Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842
Cottage Grove Arena	Dean Mulso	(612) 458-2846

HEATING, DEHUMIDIFICATION AND VENTILATION IMPROVEMENTS

Low Emissivity Reflective Ceiling

Reducing the amount of heat that the ice sheet absorbs will result in lower energy bills and improved ice quality. One of the main sources for heat in an ice arena is infrared radiation. Infrared radiation can account for more than 35 percent of the total cooling load of an ice sheet. Although it can not be seen or felt, heat from the ceiling and lights radiates down on the ice sheet and increases the load on the refrigeration system. The amount the refrigeration system has to work varies from day-to-day depending on the outside temperature, arena air temperature, ice temperature, and direct sunlight on the roof. The infrared radiation load also varies from site to site due to the amount of roof insulation, the ceiling height, and the ceiling's ability to transmit energy.

Installation of a barrier between the ceiling and ice sheet can effectively stop the infrared radiation. There are typically two types of barriers used in ice arenas: low emissivity paint applied directly to the ceiling, and low emissivity fabric suspended just below the ceiling. Both products reduce the amount of heat that is radiated down to the ice sheet. The installation cost of the low emissivity paint ranges from $20,000 to $100,000 depending on the roof structure and amount of prep work needed. Paybacks for low emissivity paints are typically from 2.5 to 12 years with a functional life span of four to five years. The low emissivity fabric ceilings can be installed for $23,000 to $28,000 and generate a payback of approximately 2 years in arenas which operate 11 months a year. The useful life of low emissivity fabric is over 20 years. Both low emissivity paints and fabrics have been used in Minnesota arenas with proven success. A number of sites with low emissivity fabric are listed below.

Arena	Contact Person	Phone
Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842
Hutchinson Civic Arena	Marv Haugen	(320) 234-4227
Farmington Civic Arena	Jim Bell	(612) 463-1851
Cottage Grove Arena	Dean Mulso	(612) 458-2846
Victory (Minneapolis)	Virgil Oldre	(612) 627-2953

CO_2 and CO Ventilation Control

Typically ice arenas are over-ventilated to assure that occupants are not harmed from the exhaust gases from ice resurfacers. The gases carbon dioxide (CO_2) and carbon monoxide (CO) are by-products of the internal combustion engines that power some types of resurfacers. CO_2 is also released when skaters and spectators exhale. Ventilating the arena removes the potential harmful gases by replacing polluted air with fresh air. Ventilation also assures that the arena will pass the required weekly air quality check that is required by the Minnesota Department of Health. If the rate of outside air introduced into an arena is not controlled properly the arena will be either under- or over-ventilated. If it is under-ventilated the arena will fail its air quality checks and possibly cause health problems for the occupants. Over ventilation increases energy consumption in two ways. First, during winter heated air is vented outside and make-up air taken from outside is brought into the building. The heating system works harder because the fresh air must be heated to the desired indoor temperature. Second, the introduction of warm moisture air during the summer into the cool arena causes moisture problems in the form of fog and condensation on the building which significantly increases the refrigeration system's energy consumption.

The installation of sensors that measure CO_2 and CO along with an exhaust fan control system provide active and accurate control of the amount of fresh air brought into an arena. A minimum air flow will typically be called for during periods of limited use (i.e. ice skating lessons) or non-occupancy. The level of outdoor air is automatically increased during higher occupancy and reduced during low occupancy periods. The system is programmed to ventilate at its maximum capacity during the time the resurfacer is in operation and then to monitor for CO and adjust the ventilation rates as the concentration of CO decreases. Thus, ventilation levels are optimized for sufficient indoor air quality while energy costs are minimized. Installation costs vary depending on the number of exhaust fans and the type of control system that is currently in use. Typically these costs will be between $2,000 and $5,000 with a payback ranging from 1 to 5 years. This type of ventilation control has been implemented in several arenas around Minnesota.

Arena	Contact Person	Phone
Mankato Civic Center	Marshal Madsen	(507) 389-3000

*Time-of-Day Heating and Ventilation System Control

Implementation of time-of-day controls for heating and ventilation systems can significantly reduce the operating expense of ice arenas. Manual operation of heating and ventilation systems is only efficient if ice arena employees adjust controls whenever heating or ventilation needs change. For example, when an internal combustion, engine-driven resurfacer is operating, employees must manually activate exhaust fans to provide adequate ventilation for the arena. If these fans are left on too long after resurfacing the arena will be over-ventilated which can cause moisture problems, added heating and cooling costs, and added refrigeration loads. The efficiency of manual controls is dependent on how well the arena staff understands the heating and ventilation systems and how often energy conserving practices are followed. Automatic operation of the heating and ventilation systems based on time-of-day and occupancy can result in optimum control of an arena's indoor conditions and minimal energy use. Some of the measures that can be installed to provide energy savings include:

1. Night setback of heating setpoints to allow arena temperature to drop at times of non-use.

* Possible low-cost/no-cost improvement

2. Automatically cutting back on the amount of ventilation during unoccupied periods.
3. Automatically controlling exhaust fans during and after resurfacing.

Each of these measures has the benefit of being automatically activated at prescribed times of the day. Once a time of use schedule is developed for each piece of equipment, there is no need to worry about making manual adjustments to operate that system. Installation costs for each of the above measures are typically $1,000 to $2,000 a piece. Paybacks are typically less than 12 months but also depend on the current operation of the arena. Regardless of energy savings, properly programmed time-of-day controls provide optimal space heating and ventilation under a variety of conditions. Night setback thermostats, automatic ventilation systems, and automatic exhaust fans have all been used successfully in Minnesota arenas. Some examples are listed below.

Application	Arena	Contact Person	Phone
Setback thermostat	Cottage Grove Arena	Dean Mulso	(612) 458-2846
Ventilation while resurfacing	VFW (E. Grand Forks)	Dale Skyberg	(218) 773-1181
Ventilation while resurfacing	Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842

Spectator Radiant Heating

Ice arenas have unique heating requirements because only certain areas of the building such as spectator seating and players benches need to be heated. Heating ice arenas with traditional forced air furnaces can result in high energy costs and overheating of areas that do not require heat. Forced air furnaces draw air from a central location and pass it through a heater exchanger were the air is heated. The air is then distributed throughout the arena to maintain a desired temperature. The air movement around the arena causes a disturbance in the stratification of air over the ice sheet. Air currents over the ice increase the convective heat loss on the ice sheet and force the refrigeration system to work harder to maintain the ice sheet's temperature. The warm air supplied by the forced air furnace also tends to accumulate at the ceiling were it will add to the infrared heat gain to the ice surface by maintaining the ceiling at a higher temperature than what is needed.

Heating with low intensity infrared heaters solves this problem by only heating surfaces such as walls, floors, and people. These surfaces, in turn, act as heat reservoirs and release heat to the surrounding air. Infrared heaters are positioned over spectator areas and players boxes were the heat is needed. The heaters are also directed away from the ice sheet so that they will not emit any heat towards the ice. The air over the ice is not disturbed so the refrigeration system doesn't have to work as hard as it would with a forced air system. Infrared heating has the added benefit of being a negative pressure system so that the noxious combustion gases are expelled outside and do not cause indoor air quality problems. Low-intensity infrared heating has been used in a wide variety of Minnesota arenas with great success. Installation of infrared heating systems cost approximately $15,000 to $20,000. Paybacks have to be analyzed on an arena by arena basis. Some of the arenas in Minnesota that use infrared heaters are listed below.

Arena	Contact Person	Phone
Hoyt Lakes	Tom Ferris	(218) 225-2226
Hodgins Berardo (Coleraine)	Pat Guyer	(218) 245-3525
West St. Paul	Dave Malay	(612) 552-4155
Farmington Civic Arena	Jim Bell	(612) 463-1851
Bud King (Winona)	Bob Monstrose	(507) 454-7775
Cottage Grove Arena	Dean Mulso	(612) 458-2846

Desiccant Dehumidification

Elevated relative humidity in ice arenas negatively affects skaters, spectators, and building components. High humidity is typically uncomfortable for skaters and spectators and can result in the formation of fog over the ice which restricts visibility. The humid air also condenses on the cooler building structural components which can cause deterioration of the building and dripping onto the ice surface. Condensation causes steel components to prematurely rust and results in high building maintenance costs through added repairs and repainting. Wet building components also provide growth sites for mold and bacteria. High relative humidity also wastes energy by causing increased condensation on the ice sheet. Extra condensation forces the refrigeration system to work harder to maintain the ice sheet temperature. Without proper ice maintenance, the thickness of the ice sheet will also increase which also increases the refrigeration system's workload.

Controlling moisture is essential for arenas which operate for 10 to 11 months a year. The use of conventional direct expansion air conditioning equipment can handle the moisture load for the majority of summer months but at an extremely high energy cost. The use of desiccant dehumidification equipment is ideally suited for high moisture load applications. Desiccant dehumidification systems work by absorbing moisture. These systems primarily use natural gas which can be purchased at a reduced cost in off-peak summer months when they are needed. Installation costs for desiccant dehumidification systems can be high ($150,000 to $300,000) but the addition of the dehumidification systems can result in an extension of the operating season from 7 months to year round operation. Paybacks on dehumidification systems are difficult to determine due to the change in the operating season and must be calculated on an arena by arena basis. Desiccant dehumidification systems are only appropriate for arenas which operate during the summer months. Several arenas in Minnesota that have added desiccant dehumidification systems to extend their operating season are listed below.

Arena	Contact Person	Phone
Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842
Cottage Grove Arena	Dean Mulso	(612) 458-2846
Blake	Tom Donahue	(612) 988-3825
West St. Paul	Dave Malay	(612) 552-4155
Hutchinson Civic Arena	Marv Haugen	(320) 234-4227

MISCELLANEOUS IMPROVEMENTS

Power Factor Correction

By eliminating a power factor correction penalty, electric bills in many ice arenas can be reduced without changing the amount of electric used by the arena. Often when older electric motors are used to operate equipment they have low power factors. The power factor is the ratio of actual power being used in a circuit (in kilowatts) to the power which is apparently being drawn from the line (in kilovolt-ampere). The actual power is the “real” power that performs useful work such as causing a motor to rotate or creating heat in a resistive element. Apparent power is the power required to establish an electrical field for the motor. The apparent power is used by the motor and returned back into the electrical system to establish a circuit. The apparent power level is used by the utility to size all system components from generation capacity and distribution lines to transformers at the building site. Electric utilities penalize customers for low power factors because they have to have generate more electric than what is required by their customers.

Low power factors can usually be corrected by installing capacitor banks at the point where the supply of electricity enters the building. Capacitor banks act as storage devices that store current needed by the electric motor and release the current to the motor at the correct time thereby improving the overall power factor of the building. Power factor correction is typically performed if utility bills indicate that the overall power factor for the site is below 90 - 95 percent, depending on the utility. Not all utilities charge power factor penalties. Power factor correction equipment can be installed by most electricians and ranges in price based on the voltage supplied to the building, amount of capacity needed to correct the problem, and the total electrical load of the building. Typical paybacks are less than 5 years for a building with a power factor of 80 percent or lower.

High Efficiency Motor Replacement

About half of the world’s electricity is used by motors. The electric bill for America’s motor driven systems is about $90 billion per year. Given the significant amount of energy and money devoted to motor-driven systems, even modest improvements in their efficiency hold the promise of huge savings.

The electric motors currently being used in arenas for refrigeration systems, pumps, and exhaust fans have a large impact on total arena electrical consumption. Electric motors are relatively cheap to purchase and extremely expensive to operate. The cost of electricity to run a typical commercial or industrial sector motor with a duty factor of at least 4,000 hours per year is equivalent to ten times its capital cost. The replacement of an older standard efficiency motor with a new high efficiency motor may result in double savings. First, savings will occur by significantly reducing energy consumption. High efficiency motors will use less energy than an older motor with the same horsepower rating and load. Second, if an arena is charged a power factor correction penalty by their electric utility, this penalty will likely be eliminated by replacing older motors. Older motors have power factors in the range of 70 to 80%. New high efficiency motors have power factors of better than 95%, which do not incur power factor penalties.

Motor replacement is not always recommended in every situation. The hours of operation, motor load, and the ability to downsize the new motor all have to be considered during the evaluation of a potential motor replacement. In many applications replacing a relatively new standard efficiency motor with a high efficiency motor will produce a payback within a year. Capital costs for high efficiency motors are based on the size and type of motor but are typically 30% to 50% higher than standard motor replacements. Over the life of a typical industrial motor, a one-percentage-point efficiency gain will pay for the incremental cost of the more efficient motor several times over, and may even save as much as the entire capital cost of the motor. Many electric utilities offer rebate programs for replacing inefficient motors. Three arenas that have carried out high efficiency motor replacements are listed below.

Arena	Contact Person	Phone
Farmington Civic Arena	Jim Bell	(612) 463-1851
Bloomington Ice Gardens	Andy Baltgalvis	(612) 948-8842
Cottage Grove Arena	Dean Mulso	(612) 458-2846