FINAL REPORT

AUG 17 2001

1999 Project Abstract
For the Period Ending June 30, 2001

TITLE:	Subd. 9(a) Ice Arena Design for Efficiency and Air Quality-Continuation
PROJECT MANAGER:	Russell Landry, P.E.
ORGANIZATION:	Center for Energy and Environment
ADDRESS:	211 North 1st Street, Suite 455 Minneapolis, MN 55401
WEB SITE ADDRESS:	www.mncee.org

Legal Citation: ML 99, Chap. 231, Sec. 16, Subd. 9(a).

Appropriation Amount: $100,000

Overall Project Outcome and Results This project accelerated the installation of energy and indoor air quality improvements in ice arenas through audits, technical assistance and promotion. Project spending was only $31,690. This is primarily because limited staff availability prevented CEE from going above and beyond the minimal work program requirements in many areas where more thorough work was originally envisioned (e.g. instead of tailoring brochures to each group of recipients, the same brochure was mailed to arena managers, high level city officials and designers).

Fourteen ice arenas received audits that recommended $665,000 worth of arena upgrades with annual energy cost savings of $212,000 ($15,100 per average arena). Assistance with implementation was provided in the form of engineering bid specifications for most of the complicated projects. We also intended to provide additional assistance in the form of construction oversight and post-installation inspections for a limited number of arenas, but arenas did not have time to complete improvements.

Facility expansions, longer operating hours, and incorrect settings of new refrigeration controls contributed to the lower than expected apparent savings (about half) observed in arenas that previously implemented energy saving improvements.

Project Results Use and Dissemination The benefits of arena energy and air quality improvements were promoted statewide. Case study information was incorporated into promotional flyers that were mailed to the following groups: managers of 203 ice arenas, 363 higher level city officials, and 33 local ice arena designers. Additional targeted outreach included two presentations and a newsletter article. Promotional efforts also provided for further dissemination of a report prepared with previous LCMR funding. This previous report, entitled *Cost-Effective Energy Efficient Improvements for Minnesota's Public Ice Arenas: Overview of 20 Options*, was made available for download, promoted in program literature and handed out at a presentation to arena managers.

Date of Report: July 1, 2001
Date of Workprogram Approval: June 16, 1999
Project Completion Date: June 30, 2001

LCMR Final Work Program Report

I. PROJECT TITLE: Subd. 9(a) Ice Arena Design for Efficiency and Air Quality-Continuation

Project Manager:	Russell Landry, P.E.
Agency Affiliation:	Center for Energy and Environment
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Total Biennial Project Budget:

$ LCMR:	$100,000	**$ Match:**	$0
-$ LCMR Amount Spent:	$31,690	**-$ Match Amount Spent:**	$0
=$ LCMR Balance:	$68,310	**=Match Balance:**	$0

A. Legal Citation: ML 99, Chap. 231, Sec. 16, Subd. 9(a).

Appropriation Language: (a) Ice Arena Design for Efficiency and Air Quality – Continuation $100,000 is from the future resources fund to the amateur sports commission for an agreement with Center for Energy and Environment in cooperation with the department of health to enhance energy efficiency and assure indoor air quality in new and existing ice arenas in Minnesota through technical assistance and energy audits.

B. Status of Match Requirement: Not applicable.

II. AND III. FINAL PROJECT SUMMARY.

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IV. OUTLINE OF PROJECT RESULTS:

Timeline For Completion Of Results (Original)

		7/99	10/99	1/00	3/00	6/00	9/00	12/00	3/01	6/01
Result 1a.	Energy Audit Reports		X	X	X	X				
Result 1b.	Aid Implementation			X	X	X	X	X	X	X
Result 2a.	Compile Case Studies	X	X	X	X					
Result 2b.	Promote Technologies		X	X	X	X	X	X	X	X

Result 1: Technical Analysis and Other Assistance for Existing Arenas

LCMR Budget:	$70,000	Match Budget:	$0
LCMR Balance:	$47,641	Match Balance:	$0

Completion Date: June 30, 2001

1. Fourteen arenas were given the technical assistance necessary to select and implement cost-effective upgrades that save energy or improve air quality. Before each arena received an audit the arena operators were required to sign a statement which specifies that the arena is in compliance with the indoor ice facilities prime ice time and gender preference requirements in Minnesota Statutes, section 15.98.

A. Energy Audit Reports. Because of the wide variability in the applicability of individual improvements from arena to arena, site-specific engineering and economic analyses were required to select the most appropriate technologies to improve energy efficiency and/or indoor air quality in each arena. The results of these analyses, along with recommendations, were compiled into site-specific audit reports that were given to arena administrators. This sub-result was completed for 14 arenas, two of which were completely funded by another source. The arenas receiving audit reports are listed below. Although the on-site visits occurred between June of 2000 and March of 2001, the majority of engineering study reports were not finalized until June of 2001. The slow

completion of the reports and failure to complete engineering studies for 15 arenas were both caused by limited staff availability. The limited staff availality was one of the cause for the large balance at the end of the project because we did not—as we originally hoped to—go out of the way to find opportunities to do ground-breaking, in-depth assessments of improvement technologies that we had not had a chance to fully assess in the past. Another reason for the balance is that all work for two of the facilities was fully funded by an independent source.

Arenas Receiving Engineering Studies

Location	Facility Name	# of Arenas
Burnsville	Burnsville Ice Center	2
Faribault	Shattuck-St. Mary's Ice Arena*	1
Fergus Falls	Fergus Falls Community Ice Arena	2
Forest Lake	Maroon and Gold Arena*	1
Grand Rapids	Grand Rapids IRA Civic Center	2
Minneapolis	Edison Youth Hockey Civic Arena	1
New Hope	New Hope Ice Arena	2
St. Louis Park	St. Louis Park Recreation Center	2
Two Harbors	Lake County Arena	1
Total		14*

*Engineering study funding for two arenas provided by alternate sources.

The table below summarizes the economics for the cost-effective improvement opportunities identified at the above facilities and compares the overall potential savings to what was projected before the engineering studies were started. The overall per arena potential energy cost savings of $15,133 was consistent with expectations, but these savings can be realized at a lower up-front capital cost than originally expected. In fact, nearly one-third of the savings identified can realized through no-cost or low-cost adjustments to equipment controls. The costs include recommendations for 16 improvements that address air quality issues and 59 improvements that primarily provide energy cost savings. Although they represent 21% of the individual recommendations, the costs of the proposed indoor air quality improvements represent only 5% of the total costs.

Summary of Improvements Identified by Engineering Studies

	Annual Energy Savings	Initial Cost	Cost Payback Period	10 Year Return on Investment
Projected for 15 Arenas	$225,000	$1,125,000	5.0 years	15 percent
Identified in 14 Arenas	$212,000	$665,000	3.1 years	29 percent

B. Aid Implementation. Engineering specifications for possible improvements were provided for the majority of the larger-scale and/or complex improvements recommended (74% of the 39 projects costing more than $5,000). The program's intent was to help arenas deciding to go ahead with improvements by providing various levels of technical

assistance in the form of bid specification, bid solicitation, and/or construction oversight to the level that each arena desired. The late delivery of the initial reports made the emphasis of technical assistance in the form of bid specifications most appropriate. Firm commitments to implement the recommended improvements had generally not been made at the time that the project was completed, but it is anticipated that half of the arenas will proceed and achieve total yearly energy cost savings of at least $30,000 by installing at least $150,000 worth of improvements. The full impact of these activities will not be known for some time because of the time it takes to allocate funds and because some projects can only be carried out when the ice sheet is not in place.

Result 2: Demonstrate the On-going Benefits of Energy Efficient Ice Arena Improvements

LCMR Budget:	$30,000	Match Budget:	$0
LCMR Balance:	$20,669	Match Balance:	$0

Completion Date: June 30, 2001

2. These efforts promoted awareness and trust of viable ice arena energy and air quality technologies among individuals involved in arena design and financial decision making. This will result in consideration and implementation of progressive technologies in new ice arenas and existing ice arenas that could not otherwise be directly served by this project. The two primary reasons for the significant balance for this result are: 1) lower than expected staff time for compiling cases studies and preparing the promotional brochures, and 2) limited staff availability did not allow us to go beyond the work program's minimum requirements in the areas of promotional efforts with the Minnesota Ice Arena Manager's Association (item B-2) and promotions at industry meetings of architects, engineers and city officials (item B-5).

A. Compile Case Studies. Arenas that completed retrofits through previous LCMR funding have been contacted to compile case study information. Interview and utility billing information has been compiled for 11 of the 13 arenas that underwent retrofits, and the improvements in the other 2 arenas were not expected to be able to provide energy savings that could be measured through utility bills. Except for one arena that has had reliability and performance problems with new refrigeration controls, the interview responses have been overwhelming positive. Utility bill confirmation of savings was imprecise because of a universal trend towards more ice rentals per day that was not corrected for, plus a number of arenas underwent other arena renovations that affect energy use or had a percentage savings that was low compared to normal variations in energy usage. While the increased ice rentals and various renovations tended to decrease the apparent savings measured from the utility bills, the overall average cost savings of 53% of predictions was still lower than was expected with these trends. Based on the manager interviews and analysis, it appears that a key reason for lower than expected savings in many of the arenas was less than optimal setting and adjustment of new refrigeration system controls.

Even though savings were generally lower than expected, nine of the arenas had clear documentation of significant savings. The energy savings and manager testimonials were combined to develop local demonstration site information that was used in the energy efficiency promotional efforts outlined below.

B. Promote Technologies. Information from the demonstration sites was incorporated into flyers, presentation materials, and publication articles that were used to encourage more widespread use of technologies that improve energy efficiency and/or air quality in Minnesota ice arenas. Specific promotional efforts are listed below, along with notes on how changing circumstances affected the efforts. Copies of the promotional flyer are also enclosed.

1. Promotional flyers were mailed directly to the arena managers for the 203 identified arenas in Minnesota. Changes and uncertainty in the Minnesota Department of Health's role in overseeing indoor air quality monitoring made it impracticle to coordinate the inclusion of the promotional flyers in mailings from the Minnesota Department of Health as was originally planned. However, there are enough flyers leftover for inclusion if the Minnesota Department of Health has future mailings to arena managers. Besides generally promoting improvements to ice arenas, these efforts have further disseminated the informational report entitled *Cost-Effective Energy Efficient Improvements for Minnesota's Public Ice Arenas: Overview of 20 Options*, which is available for download from CEE's website at www.mncee.org. This document was prepared with previous LCMR funding and has general information sheets (roughly one page each) for commonly applicable ice arena improvements.

2. Promotional efforts in cooperation with the Minnesota Ice Arena Managers Association (MIAMA) have been completed. These activities included a promotional article that was published in the February 2000 issue of the MIAMA newsletter and co-leadership of a roundtable discussion at the group's annual meeting on September 8, 2000. These efforts also promoted further dissemination of the document mentioned in the above paragraph via CEE's web site and distribution of 42 copies of the report to MIAMA members that attended the September 8 roundtable discussion on Energy Saving Ideas.

3. Promotional flyers were mailed to a total of 363 high level city officials in the 128 cities that are known to have indoor ice arenas. Contact information was obtained by cross-referencing information from the Minneosta Department of Health, the Minnesota Ice Arena Managers Assocation, and the League of Minnesota Cities.

4. Promotional flyers were mailed to 22 architects and engineers, plus 11 design/build contractors (that may or may not have on-staff architects and/or engineers), that have designed recent ice arena projects in Minnesota. These were identified by information from F.W. Dodge Reports.

5. CEE's project manager made a 50 minute seminar presentation entitled *Ice Arena Energy Efficiency* in conjunction with the monthly meeting of the Minnesota Chapter of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) on January 11, 2000.

6. Although the Minnesota Amateur Sports Commission was slated to encourage Mighty Ducks Grant applicants to use energy efficient technologies and seek technical assistance from CEE, the discontinuation of Mighty Ducks grants made this task irrelevant.

V. **DISSEMINATION:** See section B of Result 2 above for detailed dissemination plans.

VI. **CONTEXT**

A. **Significance:** This project will overcome the barriers to incorporating energy efficient and air quality enhancing technologies in Minnesota's ice arenas by providing free expert assistance from an objective source and increasing the local visibility of the most cost-effective ice arena retrofit technologies. It has been demonstrated through a previously funded LCMR project that existing ice arenas can cost-effectively reduce their energy use by an average of nearly 30 percent. Many cost-effective energy efficient technologies that are widely used in Canadian ice arenas or other types of buildings are found in only a small number of ice arenas in Minnesota because of market barriers that this project will help to overcome. One key market barrier is limited awareness of some technologies, so highlighting local, successful installations will increase awareness and confidence in these technologies. Secondly, arena owners and operators generally don't have the technical expertise necessary for a thorough, objective evaluation of the cost-effectiveness of various technologies that save energy or improve air quality. Free energy audits and follow-up technical assistance will provide a road map that arena owning entities can follow to achieve long-term cost savings and/or air quality improvements.

This project is a continuation of the Energy Improvements in Public Ice Arenas project that received LCMR funding in 1995. The previous project included surveying Minnesota's ice arenas, evaluating efficient technologies, performing energy audits of 28 ice arenas, and providing matching grants for facility upgrades that totaled $½ million. The continuation builds upon the success of the previous project by extending the energy audit and technical assistance services to 15 more arenas and by using some of the previously served arenas as demonstration sites that show the benefits of energy efficiency and air quality upgrades to key arena decision makers. Previous dissemination efforts used estimated savings information and focused primarily on arena managers, while the new project will use measured savings and expand energy efficiency/air quality promotional efforts to include higher level city administrators and arena designers.

A second related project entitled Optimizing the Efficiency of Gas-Fired Desiccant Dehumidification systems was funded in 1998 by Minnegasco. This project provided valuable information about the cost-effectiveness of various energy efficient design options for gas-fired dehumidification equipment and involved the development of useful arena heating and dehumidification analysis tool. Both the cost-effectiveness analysis results and the analysis tool will contribute to the evaluation of equipment upgrade options in a number of the 15 arenas that will receive energy audits. A demonstration site for the promotion of energy efficiency and air quality upgrades may also be chosen from among the arenas that participated in the Minnegasco funded project. Therefore, through application of this project's results to engineering analyses for specific arenas, and possibly through the widespread promotion of a demonstration site, LCMR funding will increase the dissemination and direct application of the results of this Minnegasco funded project.

B. Time: The proposed project will be completed in the two year time frame, but it is a continuation of a 1995 LCMR project. Most of the additional funding and time is being used to serve 15 more arenas that were not planned for in the original project. This additional application of the expertise and analysis methods developed in the previous LCMR project, and a Minnegasco funded project, will make the continuation more cost-effective than the original project in terms of impact per LCMR dollar spent. The additional time and funds will also allow for documented verification of energy savings achieved by improvements that were installed as part of the earlier project. This was not possible in the earlier project because the improvements were made at the end of the project and a full year's worth of post-retrofit energy use data is needed for reliable documentation of energy savings. Field verification efforts in the earlier study focussed on short-term performance measurements that provided valuable verification of savings calculation methodologies, but not direct documentation of installed retrofit energy savings. The project continuation will also allow for greater dissemination of information to reach key arena design and renovation decision makers.

C. Budget Context:

1. LCMR Budget History: $470,000 (+ $290,000 Match & Other); Energy Improvements in Public Ice Arenas

From 1995 to 1998 CEE surveyed ice arenas, evaluated improvements, developed analysis tools, performed analysis of 28 arenas, and provided matching grants to pay for energy and air quality improvements. The proposed project builds upon this work by promoting the previous success of these retrofits and by applying the knowledge learned to 15 more existing arenas.

2. Non-LCMR Budget History:

(A) $75,000; Optimizing the Efficiency of Gas-Fired Desiccant Dehumidification Systems (funded in 1998 by Minnegasco) CEE is developing a computer model and evaluating the energy savings of arena heating and dehumidification system options for three arenas. With LCMR funding this model will be shared with rink designers throughout Minnesota.

(B) Estimated $1,500,000; Mighty Ducks Grants This is the matching grant amount that has been awarded from 1995 through 1998 for renovations that directly affect energy use or indoor air quality. Local funding sources more than doubled the Mighty Ducks Grants expenditures. The proposed project would maximize the energy cost reductions and air quality benefits of future expenditures by providing technical assistance and spreading awareness of the energy efficient technologies that should be included in arena renovations.

3. Total Budget History: $2.3 million

4. **BUDGET:**

Budget Summary

Personnel Total (see below for detail)	$91,000
Equipment	$0
Acquisition	$0
Development	$0
Other	
Subcontractors	$6,500
supplies, printing, misc. expenses	$700
travel	$1,600
conference expenses	$200
Total	**$100,000**

Personnel & Cooperators Breakdown

Position Title and Affiliation	Employee Name	Responsibilities	% of Time Spent on Project	Amount Allocated
Energy Engineer, CEE	Russell Landry	Project management, refrigeration & other analyses, promotional efforts	40 %	$50,000
Energy Engineer, CEE	Mark Hancock	HVAC, utility bill & other analyses	20%	$25,000
Energy Analyst, CEE	Mario Monesterio	Conduct lighting analyses	15%	$12,000
Graphics/Clerical, CEE	Judith Thommes	Flyer layout & production, data entry	5%	$4,000
Subcontracted Ice Arena Consultant, Independent	Richard Holmsten	Provide input into design options	2%	$6,500
Minnesota Amateur Sports Commission	Chris Heineman	Promotion to Mighty Ducks grant applicants	<1%	no associated costs
President, Minnesota Ice Arena Managers Association	Jay Strachota	Facilitate MIAMA promotion through newsletter & conference	<1%	no associated costs
Minnesota Department of Health	Laura Oatman	Facilitate joint mailing & other promotion	<1%	no associated costs

2. **See attachment A for more specific budget information.**

VII. **Cooperation:**

- **A.** Richard B. Holmsten, Ice Arena Consultant (operates independently)
- **B.** Paul Erickson, President, Minnesota Amateur Sports Commission
- **C.** Jay Strachota, President, Minnesota Ice Arena Managers Association
- **D.** Laura Oatman, Minnesota Department of Health

VIII. **Location:** The 14 arenas that received audits are located throughout the state and literature was disseminated to arenas and high level city officials in 128 cities throughout the state.

IX. **Reporting Requirements:** Periodic workprogram progress reports will be submitted not later than April 1, 2000 and October 1, 2000. A final workprogram report and associated products will be submitted by June 30, 2001, or by the completion date as set in the appropriation.

IX. **Research Projects:** Not applicable.

Attachment A. Deliverable Products and Related Budget

LCMR Project Biennial Budget

	Result 1	Result 2	
Budget Item	Technical Analysis and Other Assistance for Existing Arenas	Demonstrate the On-going Benefits of Energy Efficient Ice Arena Improvements	**ROW TOTAL**
Wages, salaries & benefits	Russell Landry $32,000 Mark Hancock $18,000 Mario Monesterio $12,000 Total $62,000	Russell Landry $18,000 Mark Hancock $7,000 Judith Thomas $4,000 Total $29,000	Russell Landry $50,000 Mark Hancock $25,000 Mario Monesterio $12,000 Judith Thommes $4,000 Total $91,000
Space rental, Maintenance & utilities	$0	$0	$0
Printing & advertising	$0	$500	$500
Communications, telephone, mail, etc.	$0	$200	$200
Contracts			
Professional/technical	$6,500	$0	$6,500
Other contracts	$0	$0	$0
Local automobile mileage	$800	$200	$1,000
Other travel expenses in Minnesota	$700	$100	$800
Travel outside Minnesota	$0	$0	$0
Office Supplies			$0
Other Supplies	$0	$0	$0
Tools & Equipment	$0	$0	$0
Office equipment & computers	$0	$0	$0
Other Capital equipment	$0	$0	$0
Other direct operating costs	$0	$0	$0
Land acquisition	$0	$0	$0
Land rights acquisition	$0	$0	$0
Buildings or other land improvement	$0	$0	$0
Legal fees	$0	$0	$0
COLUMN TOTAL	$70,000	$30,000	$100,000