2 copies

MAXI AUDIT

FOR THE

CITY OF BLOOMINGTON

BLOOMINGTON, MINNESOTA

rieke
carroll
muller
associates inc

architects
engineers
land surveyors
planners

p.o. box 130, hopkins, mn 55343, **612-935-6901**

OCTOBER 1981

RCM JOB NO. 801704

CITY HALL BUILDING
COMMUNITY ICE GARDEN
RYAN BUILDING
WATER TREATMENT PLANT
PUBLIC WORKS - WESTERN MAINTENANCE

MAXI AUDIT

OF THE

CITY HALL BUILDING

FOR

BLOOMINGTON, MINNESOTA

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Introduction

This Maxi-Audit Report is a detailed engineering analysis, of the City Hall Building, to identify possible energy conservation measures. These items are shown along with their costs, yearly energy savings and payback times.

Summary

The City Hall is an 18-year-old building that was remodeled and to which space was added in 1970 and 1975. The structure is well maintained and classifed in good condition. It is used for city offices, police station and storage.

The energy saving possibilities are limited, regarding the building shell. All mechanical equipment is run manually and and manually readjusted daily. Automatic controls or computer monitors might be considered for energy management. Further energy savings may or may not be realized from a change in operating procedures, however, it would be advantageous to have temperature monitors (recorders) for seasonal comparison with energy billings.

Retrofitting older equipment is more expensive than initial installations. Consider automatic monitors, should replacement equipment be installed in the future.

Tabulated below are potential energy saving ideas, along with their costs, savings and payback time. More details of these items are contained within this report.

Energy Saving Items

Item	Cost	Savings	Payback Time
New garage doors	$ 1965.00	$417.65	4.7 years
Replace fluorescent lights with watt-miser units	$ 5244.00	$985.45/yr	5.32 years
Install storm sash	$ 3720.00	$ 8.51/yr	21.13 years
Solar domestic water	$ 4000.00	$ 76.04	52.6 years
Solar building heating	$120,000.00	$175.74	102.2 years

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MAXI-AUDIT REPORT

A — CONTACT DATA

BUILDING NAME: City Hall		NAME OF ORGANIZATION: City of Bloomington	DATE: 6-18-81
BUILDING ADDRESS: 2215 West Old Shakopee Road		ADDRESS: 2215 West Old Shakopee Road	
CITY: Bloomington, MN	ZIP CODE: 55431	CITY: Bloomington, MN	ZIP CODE: 55431
PERSON COMPLETING FORM: P.R. Wilcox	TELEPHONE: 612/935-6901	CONTACT PERSON: Arthur W. Jensen	TELEPHONE: 612/881-5811

B — BUILDING ELIGIBILITY CODE

Instructions: For blocks 1 and 2 check the box which best fits the building ownership conditions. For block 3 determine which of the four categories describes the building type and then within the category check off the sub category befitting the building function.

1. OWNERSHIP TYPE
   - [X] Public (PUB)
   - [ ] Non-Profit Association (NAP)

2. ULTIMATE OWNER
   - [ ] County (CNTY)
   - [X] City (CITY)
   - [ ] Township (TOWN)
   - [ ] State (STAT)
   - [ ] Public School (PUSC)
   - [ ] Private School (PRSC)
   - [ ] Non-Profit Association (NPAP)
   - [ ] Indian Tribe (INDN)

3a. SCHOOLS
   - [ ] Elementary (SCHL-ELM)
   - [ ] Secondary (SCHL-SECD)
   - [ ] Coll. or Univ. (SCHL-POST)
   - [ ] Vocational (SCHL-VOCL)
   - [ ] Education Agency (SCHL-ADMN)
   - [ ] Administration (SCHL-ADMN)
   - [ ] OTHER (SCHL-OTHR)

b. PUBLIC CARE
   - [ ] Nursing Home (PBCR-NURS)
   - [ ] Long Term Care (PBCR-TERM)
   - [ ] Rehab. Facility (PBCR-RHAB)
   - [ ] Public Health Ctr. (PBCR-HCTR)
   - [ ] Res. Child Care Ctr. (PBCR-RCCC)

c. LOCAL GOVERNMENT
   - [X] Office (LOCG-OFFC)
   - [ ] Storage (LOCG-STRG)
   - [ ] Service (LOCG-SERV)
   - [ ] Library (LOCG-LBRY)
   - [ ] Police (LOCG-PLCE)
   - [ ] Fire (LOCG-FIRE)
   - [ ] OTHER (LOCG-OTHR)

d. HOSPITALS
   - [ ] General (HOSP-GENL)
   - [ ] Tuberculosis (HOSP-TUBR)
   - [ ] OTHER (HOSP-OTHR)

C — ENERGY REPORT CHECK-OFF

Check the type of reports which were completed prior to this maxi-audit report form.

- [X] Energy Report
  - [ ] Elementary School Energy Report (form no. ED-00444-02)
  - [ ] Secondary School Energy Report (form no. ED-00445-02)
  - [X] Existing Building Energy Report (form no. EN-00041-01)
- [X] Mini-Audit Report (form no. EN-00065-01)

If no energy report was completed before this maxi-audit report, include one with this report. Elementary school administrators should use form no. ED-00444-02. Secondary and vocational school administrators should use form no. ED-00445-02. All other building owners should use form no. EN-00041-01. All building auditors are to use the mini-audit form EN-00065-01 after completion of one of the first three above.

D — ENERGY REPORT AND MINI-AUDIT REPORT SUMMARY

Instructions: Complete this section with a summary of what was accomplished as a result of the energy report and the mini-audit report.

ENERGY REPORT:

Energy Report (form EN-00041-01) resulted in the Mini-Audit (Form EN-00065-01) and showed good potentials for energy savings. Equipment adjustment between the Energy Report and Mini-Audit have greatly reduced energy use. This reduction would not show in report figures as format is presented. Gas consumption was reduced to one-third the previous usage.

MINI-AUDIT REPORT:

Maintenance items listed in audit are being accomplished with 25-30% additional items that have been implemented. Large cost maintenance and capital expenditures have not been addressed. A specific energy program on a continuing basis would help promote some projects started and later dropped. Energy recordkeeping is excellent under the new format.

E

Instructions: This section is to be completed and signed by a registered architect, a registered mechanical engineer, or a registered electrical engineer. This section should be completed after this maxi-audit report is completed. All blanks must be filled in.

I have reviewed the building energy report and/or the mini-audit report for this building. I found all information contained therein to be correct, to the best of my knowledge, or I have corrected any misinformation on the reports, which will be resubmitted with the maxi-audit report to the Minnesota Energy Agency.

I am not directly responsible for the day-to-day operation of this building being audited.

I have fully disclosed my financial interests relating to this maxi-audit and any energy conservation measures considered by this audit.

Referring to section G, I have included an analysis that assumes all energy savings obtained from energy conservation operation and maintenance procedures have been realized.

I have calculated the total energy cost savings, by fuel type, expected to result from the acquisition and installation of all recommended energy conservation measures, taking into account the interaction among the various measures.

The energy prices used in the maxi-audit report are the current prices based on the institution's most recent purchase.

Included in the maxi-audit report is a solar analysis for: (check one or more)

- ☒ a domestic hot water heating system
- ☒ a space heating system
- ☐ an electrical generation system
- ☐ an attached solar greenhouse
- ☐ other: (specify)________

I recommend that this building should not undergo a solar installation.
(should, should not)

Included in the maxi-audit report is a list of local zoning ordinances or building codes that will restrict the utilization of solar energy ☐ YES ☒ NO (A no answer indicates that there are no local zoning ordinances or building codes to my knowledge that will restrict the use of solar energy systems.)

I recommend that this building should not undergo a waste, wind, or wood installation.
(should, should not) (circle which one(s))

I hereby certify that this audit was prepared by me or under my direct supervision and all information contained herein is correct to the best of my knowledge. I am a duly registered mechanical engineer, electrical engineer, or architect under the laws of the State of Minnesota. (only one signature is required)

Architect	Engineer Paul Martinsen
Signature	Signature Paul Martinsen
Registration no.	Registration no. 9597
Firm	Firm Rieke Carroll Muller Associates, Inc.
Address	Address P.O. Box 130, Hopkins, MN 55343
Phone	Phone 612/935-6901
Date	Date 6-18-81

MAX-AUDITOR STATEMENTS

F REMAINING USEFUL LIFE OF THE BUILDING

Instructions: For determining the remaining useful life of the building, list each addition of the building and describe the addition, its condition, its age, and its gross square footage. Then for the building as a whole enter the remaining useful life in years. Enter the gross floor area of the building. Some of this information can be found in the energy report.

Building Unit Condition	Age	Sq. Ft.
1963 offices - remodeled 1970	18 years	32,892
1975 addition	6	23,688
1975 offices remodeled	6	32,892

Remaining Useful Life of the Building 79 Yrs	Gross Floor Area of the Building 56,580 Sq. Ft.

G ESTIMATED ENERGY INDEX

Instructions: Enter the energy consumption of the building by fuel type in MMBTU's/year when the building is at optimum efficiency. Enter the energy index in MBTU's/square foot/year.

	Fuel 1	Fuel 2	Electricity	Total
MMBTU/Year	1499.7	not recorded	10,739,3	12,239.0
MBTU/sq. ft./Yr.	26.51	not recorded	189.81	216.32

NOTE: For the conversion of fuel quantity to BTU's, use the following conversion factors *for this section only.*

Electricity—11,600 BTU per kilowatt-hour
Natural gas—1,030 BTU per cubic foot
Distillate fuel oil—138,690 BTU per gallon
Residual fuel oil—149,690 BTU per gallon
Coal—24.5 million BTU per standard short ton
Liquefied petroleum gases including propane and butane—95,475 BTU per gallon
Steam—1,390 BTU per pound

The above conversion factors are stipulated in the federal requirements for the Institutional Buildings Grants Program. These source conversion factors are to be used in this section only. Conversion factors may be taken from engineering reference manuals for fuels not listed.

H

ECO REPORT SUMMARY

Instructions: Read through the list of energy conservation opportunities provided in the Maxi-Audit Manual. Upon completion of a thorough engineering and economic analysis enter all the energy conservation opportunities in this section. Enter the results of the engineering and economic analysis for each energy conservation opportunity as indicated on the "Energy Conservation Measure Development Sheet" and/or "Energy Conservation Operations and Mainenance Procedure Development Sheet" or other format in the appropriate boxes The classification numbers, major and subclass, should be taken from the classification scheme for energy conservation opportunities. Use the fuel codes as listed. The fuel codes indicate the type and the unit of measure. If the fuel comes under OTHER convert the units of measure to MBTU and describe the fuel saved in the description. Enter yes or no in the box entitled "Funding Requested" to indicate whether funding is being applied for through the Institutional Buildings Grants Program. The "Funding Requested" and "Implementation Date" boxes are the only boxes that are not required to be filled upon completion of the maxi-audit report. See page 14 for important detailed instructions.

Electricity, kwh	10	No. 2 fuel oil, gallons	31	Street steam, Mlbs	51
Natural gas, therms	21	No. 4 fuel oil, gallons	32	Solar, hours	52
Natural gas, CCF	22	No. 5 fuel oil, gallons	33	Wind, kwh	53
Natural gas, MCF	23	No. 6 fuel oil, gallons	34	Wood, tons	54
Natural gas, CF	24	Hard coal, tons	41	Other (specify), MBTU	55
LPG, gallons	25	Soft coal, tons	42		

Fuel 1 Code	Quantity of 1 Saved Units	Fuel 1 Cost Savings $	Item No	Classification Major	Classification Sub	Description
24	166,395FT^3	417.65	1	2	2	
Fuel 2 Code	**Quantity of 2 Saved Units**	**Fuel 2 Cost Savings $**	**Funding Requested**	**Implem Date**		

	Total Fuel Savings MMBTU	Total Fuel Cost Savings $	Acquisition Cost $	Installation Cost $	Design Cost $	Total Modification Cost $	Simple Payback Period Yrs
TOTAL FUEL	466.4	417.65	1440.00	525.00	-	1965.00	4.7
ELECT CODE	**Quantity Saved - KWH**	**Elect Cost Savings - $**	**Increase In O & M Cost $**	**Salvage Value $**	**Useful Life - Yrs**	**Total Energy Cost Savings $**	**Alternate Payback Yrs**
10			-	-	50	417.65	- (optional)

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description
			2	4	3	Replace 40 watt fluorescent lights with 35 watt-miser fluorescent lights.
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs
TOTAL FUEL			5244.00	-	-	5244.00	5.32
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs.**
10	27,383.7	985.45	-	-	7½	985.45	- (optional)

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description.
24	68,803CF	167.54	3	2	10	Install storm sash on north facing windows.
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		
			no			

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs.
TOTAL FUEL	66.803	167.54	2743.00	977.00	-	3720.00	21.13
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs.**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs.**
10	235.05	8.51	-	-	50	176.05	- (optional)

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description:
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs.
TOTAL FUEL							
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs.**
10							(optional)

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FUEL AND ELECTRIC CONSUMPTION REPORT

NOV 04 1981

A Instructions: Enter the organization name, date, building name, building address, city, and zip code as used on the prior report, mini-audit report, and/or maxi-audit report.

BUILDING NAME		NAME OF ORGANIZATION	DATE
City Hall		City of Bloomington	6-18-81
BUILDING ADDRESS		ADDRESS	
2215 West Old Shakopee Road		2215 West Old Shakopee Road	
CITY	ZIP CODE	CITY	ZIP CODE
Bloomington, MN	55431	Bloomington, MN	55431
PERSON COMPLETING FORM	TELEPHONE	CONTACT PERSON	TELEPHONE
P.R. Wilcox	612/935-6901	Arthur W. Jensen	612/881-5811

CONTACT DATA

B Instructions: Complete this section of fuel consumption as accurately as possible. Indicate the fuel types used by the fuel code as listed. The fuel code number describes the fuel type and the units of measure.

Electricity, kwh 10
Natural gas, therms 21
Natural gas, CCF 22
Natural gas, MCF 23
Natural gas, CF 24
LPG, gallons 25
No. 2 fuel oil, gallons 31
No. 4 fuel oil, gallons 32
No. 5 fuel oil, gallons 33
No. 6 fuel oil, gallons 34
Hard coal, tons 41
Soft coal, tons 42
Street steam, Mlbs 51
Solar, hours 52
Wind, kwh 53
Wood, tons 54
Other (specify), MBTU 55

If the fuel used comes under the heading of OTHER, enter the code number 55 and specify the fuel type. For the units of measure convert the units as stipulated from the supplier to MBTU using the conversion factors as listed in the Maxi-Audit Manual or other engineering reference text. Enter the storage capacities of each fuel type for the building. Enter the year the data is being completed for. Enter the monthly quantities used, if it is measured, and the cost corresponding with the quality used. Otherwise enter the purchased quantities and costs. If more than two fuels are used make additional copies of this form.

		FUEL TYPE	UNIT OF MEASURE	FUEL TYPE	UNIT OF MEASURE
		natural gas	CCF	#2 fuel oil	gallon
		FUEL CODE	STORAGE CAPACITY	FUEL CODE	STORAGE CAPACITY
		23	-	31	-
Month	Year	Quantity Used	Cost	Quantity Used	Cost
July	1979	60	$ 39.38	*0	
August	1979	40	34.64	0	
September	1979	30	31.40	0	
October	1979	80	41.53	0	
November	1979	1300	310.37	0	
December	1979	2160	99.28	0	
January	1980	2770	649.97	0	
February	1980	2760	678.82	0	
March	1980	2790	683.54	0	
April	1980	1960	477.80	0	
May	1980	490	157.37	0	
June	1980	120	47.45	0	
Year Total		14,560	$3651.55	0	

FUEL CONSUMPTION

Minnesota Energy Agency
EN-00078-01 December 1979

*Oil standby - none used.

C Instructions: Complete this section on electrical consumption as accurately as possible. Enter the electrical utility name supplying electrical power to the building and the rate classification utilized. Enter the year that the data is being completed for. Use the same months and year for this section as were used in the fuel consumption section. Enter the electrical energy consumed in kilowatt-hours. Enter the total electric bill for each month. If the building has a demand meter, enter the maximum kilowatt demand for each month. Enter the power factor also, if it is included in the utility metering.

Utility Name: Northern States Power Company

Rate Classification: Commercial

ELECTRICAL CONSUMPTION

Month	Year	Energy Kilowatt-Hours	Maximum Demand Kilowatts	Power Factor	Cost ($)
July	1979	116,200		91.68	3745.48
August	1979	81,800		91.28	3973.19
September	1979	91,800		92.61	3344.16
October	1979	68,200		95.33	2245.62
November	1979	61,800		97.46	2180.19
December	1979	72,200		97.16	2442.86
January	1980	68.000		97.15	2408.81
February	1980	67,600		97.31	2355.11
March	1980	68,800		94.94	2406.35
April	1980	70,400		96.37	2506.99
May	1980	67,600		95.40	2527.62
June	1980	91,400		93.41	3389.32
Year Total		925,800			33,525.70

Upon completion of the Fuel and Electrical Consumption Report Form mail it to:

Minnesota Energy Agency
Conservation Research and Development
Conservation Division
980 American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101

Minnesota Energy Agency
EN-00078-01 December 1979

RENEWABLE RESOURCES REPORT

The most practical renewable resource area for the City Hall is solar. The building was analyzed for application of a solar collector system for both the domestic hot water system and the building heating system. The results are tabulated below.

	Domestic Hot Water-50%	Building Heating-48%
Cost	$4000.00	$180,000.00
Energy Savings	$ 76.04/year	$ 1,752.74/year
Payback Time	52.6 years	102.2 years

Based on the above data, the systems would not be practical to install, because the payback time is excessive or will probably exceed the life of the building. Also, the building has a steam heating system which would require costly modifications to be compatible with a solar collector heating system.

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING (GIVEN DATA)

Month	D_o Work days/mo.	N_d (Days per month)	T_a (^0F)	H_t (Btu/day ft^2)
January	23	31	12.2	1124
February	21	28	15.8	1363
March	21	31	28.4	1433
April	22	30	44.6	1442
May	22	31	57.2	1475
June	21	30	66.2	1522
July	23	31	71.6	1588
August	21	31	69.8	1581
September	22	30	60.8	1519
October	23	31	50.0	1484
November	20	30	32.0	1004
December	23	31	19.4	897

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(CALCULATED DATA)

Month	L_w (Btu/Month)	N_f (Ft^3/mo)	X/A ($1/ft^2$)	Y/A ($1/ft^2$)	X	Y	f	f x L_w (Btu/Month)
January	3,300,138	5,340	.041	.006	4.1	0.6	.30	990,041.40
February	3,013,169	4,876	.039	.007	3.9	0.7	.39	1,175,135.90
March	3,013,169	4,876	.038	.009	3.8	0.9	.53	1,749,073.10
April	3,156,654	5,108	.029	.008	2.9	0.8	.50	1,578,327.00
May	3,156,654	5,108	.026	.009	2.6	0.9	.60	1,893,992.40
June	3,013,169	4,876	.023	.009	2.3	0.9	.60	1,980,082.80
July	3,300,138	5,340	.021	.009	2.1	0.9	.61	2,013,084.20
August	3,013,169	4,876	.023	.010	2.3	1.0	.60	1,980,082.80
September	3,156,654	5,108	.024	.009	2.4	0.9	.66	2,083,391.60
October	3,300,138	5,340	.027	.008	2.7	0.8	.52	1,716,071.80
November	2,869,685	4,644	.037	.006	3.7	0.6	.33	946,996.05
December	3,300,138	5,340	.038	.005	3.8	0.5	.24	792,033.12
	37,592,875	6,003						18,898,312.17

$L_w = 8.33 \times N \times Z \times D_o \times (T_w - 52)$

$N_f = \dfrac{L_w}{H_f \times E_f}$

$X/A = 16.8 \times \dfrac{N_d}{L_w} \times (212 - T_a) \times \boxed{1 + 0.006(60 - T_a)}$

$Y/A = 0.59 \times H_T \times \dfrac{N_d}{L_w}$

$X = X/A \times A$

$Y = Y/A \times A$

$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$

N = No. of bldg. occupants = 325

Z = Daily water consump/occupant = 1 gal.

D_o = No. of days per mo. bldg. is occupied

T_w = Water temperature (^oF) = 105^o

H_f = Fuel heating value = 1030 BTU/ft^3

E_f = Avg. heating efficiency = 60%

A = Solar collector plate area = 8.0 Ft^2

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_w}{\sum L_w}$$

$$= \frac{18,898,312}{37,592,875}$$

$$= 0.50 \text{ or } 50\%$$

2. System Cost (Cs)

$$C_s = \$40.00/Ft^2 \times \text{Area}$$

$$= \$40.00/Ft^2 \times 100 \text{ sq. ft.}$$

$$= \$4,000.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \sum N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.50 \times 60,832 \text{ Ft}^3/\text{yr} \times \$0.0025/\text{Ft3}$$

$$= \$76.04/\text{year}$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$4,000.00}{\$\ 76.04}$$

$$= 52.6 \text{ years}$$

SOLAR ASSISTANCE TO BUILDING HEATING
(GIVEN DATA)

Month	N_d (Days per month)	T_a (^0F)	H_t (Btu/day ft^2)	N_f (ft^3/month)
January	31	12.2	1124	277,000
February	28	15.8	1363	276,000
March	31	28.4	1433	279,000
April	30	44.6	1442	196,000
May	31	57.2	1475	49,000
June	30	66.2	1522	12,000
July	31	71.6	1588	6,000
August	31	69.8	1581	4,000
September	30	60.8	1519	3,000
October	31	50.0	1484	8,000
November	30	32.0	1004	130,000
December	31	19.4	897	216,000

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

N_f = number of fuel units consumed per month (ft^3/month)

SOLAR ASSISTANCE TO BUILDING HEATING
(CALCULATED DATA)

Month	L_T (Btu/Month)	X/A $1/ft^2$	Y/A $1/ft^2$	X	Y	f	$f \times L_T$ (Btu/Month)
January	171,186,000	00.61×10^{-3}	00.12×10^{-3}	002.75	00.540	0.32	54,779.52
February	170,568,000	00.54×10^{-3}	00.13×10^{-3}	002.43	00.590	0.39	66,521.52
March	172,422,000	00.56×10^{-3}	00.15×10^{-3}	002.52	00.680	0.48	82,762.56
April	121,128,000	00.70×10^{-3}	00.22×10^{-3}	003.15	00.990	0.60	72,676.80
May	30,282,000	02.66×10^{-3}	00.89×10^{-3}	011.97	04.010	1.00	30,282.00
June	7,416,000	09.91×10^{-3}	03.63×10^{-3}	044.60	16.335	1.00	7,416.00
July	3,708,000	19.72×10^{-3}	07.93×10^{-3}	088.74	35.240	1.00	3,708.00
August	2,472,000	29.96×10^{-3}	11.70×10^{-3}	134.82	52.650	1.00	2,472.00
September	1,854,000	41.10×10^{-3}	14.50×10^{-3}	184.95	65.250	1.00	1,854.00
October	4,944,000	17.07×10^{-3}	05.49×10^{-3}	076.82	24.710	1.00	4,944.00
November	80,340,000	01.13×10^{-3}	00.22×10^{-3}	005.09	00.990	0.61	49,007.40
December	133,488,000	00.75×10^{-3}	00.12×10^{-3}	003.48	00.540	0.40	53,395.20
	899,808,000						429,819.00

$$L_T = N_f \times H_f \times E_f$$

H_f = fuel heating value = 140,000 BTU/ft^3

E_f = average furnace efficiency = 60%

$$X/A = 16.8 \times \frac{N_d}{L_T} \times (212 - T_a)$$

$$Y/A = 0.59 \times H_T \times \frac{N_d}{L_T}$$

A = solar collector plate area = 4500 Ft^2

$X = X/A \times A$

$Y = Y/A \times A$

$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$

SOLAR ASSISTANCE TO BUILDING HEATING
COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_T}{\sum L_T}$$

$$= \frac{429,819}{899,808}$$

$$= 0.48 \text{ or } 48\%$$

2. System Cost (Cs)

$$C_s = \$40.00/Ft^2 \times Area$$

$$= \$40.00Ft^2 \times 4,500.00$$

$$= \$180,000.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \sum N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.48 \times 1,456,000Ft^3/yr \times \$0.0025/Ft3$$

$$= \$1,752.74/year$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$180,000.00}{\$\ 1,752.74}$$

$$= 102.7 \text{ years}$$

LOGGED

ENERGY CONSERVATION MEASURE DEVELOPMENT SHEET

Building: City Hall
2215 West Old Shakopee Road
Bloomington, MN 55431

Date 6-18-81
Item No. 1
Major Class 2
Sub. Class 2

Energy Conservation Measure

Description of existing equipment:

The existing 3 garage doors (old ones) on the south side of the building are wood panel and have no insulation and have an overall "U" value of 0.87 and an infiltration rate of 3.20 CFM per foot of crack. The doors are 120"x108".

Description of energy conservation measure:

Replace the 3 garage doors with insulated ones having a "U" value of 0.16 and an infiltration rate of 1.00 CFM per foot of crack. This will reduce the building heat loss.

Useful life 50 years

Engineering Analysis:

(Per 1976 ASHRAE Systems Handbook)

Annual heating degree days 8159
Annual cooling degree days 523
Fuel 1 gas units of Measure MCF
Fuel 2 ______ units of Measure ______

H_L =Design Heat Loss (Btu/hr)
U =Heat Transfer Coeff. ($Btu/hr x Ft^2 x {}^oF$)
A =Area (Ft^2)
Δt =Inside-Outside Temp (^oF)
D =Degree Days
η =Equipment Efficiency
V =Fuel Heating Value (Btu/Ft^3)
C_D =Correction Factor
C_F =Load Correction Factor

$$\text{*Energy Consumption} = E = \frac{H_L x D x 24}{\Delta t x \eta x V} \; x \; C_D x C_F$$

$$\text{Since Energy Savings} = \Delta E \& H_L = (U x A x \Delta t)+(1.09 x CFM x \Delta t)$$ i.e. Transmission Loss + Infiltration Loss

$$\text{Then Energy Savings} = \Delta E = \frac{(\Delta U x A x \Delta t)+(1.09 x CFM x \Delta t) \; x D x 24}{\Delta t x \eta x V} \; x \; C_D x C_F$$

$$\Delta E = \frac{(0.71x270x70-(-12))+(1.09x2.20x204x70-(-12)) \; x8159x24}{70-(-12)x0.80x1000} \; x0.64x1.56$$

$$\Delta E = 166{,}395 \; FT^3/year$$

electrical savings 0 kwh/year
fuel 1 savings 166,395 FT^3 /year
fuel 2 savings 0 /year
Total Fuel Savings 166.4 MMBTU/Year

Economic Analysis

(1) Design cost: $ 0

(2) Acquisition cost: $ 1440.00

*(3) 108"x120" insulated metal doors @ $480.00 each

(3) Installation cost: $ 525.00

(3) 108"x120" doors - 2 persons, 5 hrs @ $17.50/hr = $175.00 each

Total Modification Cost = (1) + (2) + (3): $ 1965.00

Increased operation and maintenance costs: $ 0

Salvage or disposal costs: $ 0

Energy Cost Savings

Electrical and/or fuel cost savings:

$$\text{Gas} = 166{,}395\ \frac{\text{Ft}^3}{\text{year}} \times \frac{\$2.51}{1000\ \text{Ft}^3} = \$417.65/\text{year}$$

Electrical $	0	/year
fuel 1 $	417.65	/year
fuel 2 $	0	/year
Total Fuel (1 + 2) $	417.65	/year

Payback Period

Simple and alternate payback period:

$$\frac{\$1465.00}{\$\ 417.65} = 4.7\ \text{years}$$

*Costs from 1980 Means Building Construction Cost Data-including overhead and profit.

Simple 4.7 years
Alternate ______ years

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

Building: City Hall
2215 West Old Shakopee Road
Bloomington, MN 55431

Date 6-18-81
Item No. 2
Major Class 4
Sub. Class 3

Energy Conservation Measure

Description of existing equipment:

All fluorescent lights show age on the bulbs and lens. Many areas are overlit. Average of 70 lumes per sq ft should be sufficient.

Description of energy conservation measure:

Replace all 40 watt old fluorescent bulbs (2622) with new watt-miser fluorescent units. Clean lens and reflectors. Watt-miser bulbs are rated at 35 watts.

Useful life $7\frac{1}{2}$ years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days 523
Fuel 1 ______ units of Measure ______
Fuel 2 ______ units of Measure ______

2622 bulbs (4') at 40 watts = 104,880 watts

2622 watt-miser at 35 watts = 91,770 watts
13,110 watt/hr savings

$$\frac{13{,}110 \text{ w/h} \times 8 \text{ hrs} \times 261 \text{ days}}{1000 \text{ watts/kw}} = 27{,}373.7 \text{ KW/year}$$

electrical savings 27,373.7 kwh/year
fuel 1 savings ______ /year
fuel 2 savings ______ /year
Total Fuel Savings ______ MMBTU/Year

Economic Analysis

(1) Design cost: $ 0

(2) Acquisition cost: $ 5244.00

400-four ft watt-miser fluorescent tubes @ $2.00 ea (1980 local cost)

(3) Installation cost: $ -

Total Modification Cost = (1) + (2) + (3): $ 5244.00

Increased operation and maintenance costs: $ ______

Decreased maintenance costs as entire building is relamped rather than individual replacement.

Salvage or disposal costs: $ ______

Energy Cost Savings

Electrical and/or fuel cost savings:

27,373.7 KW/year x $.036/KW = $985.45/year

Electrical $ 985.45 /year
fuel 1 $ ______ /year
fuel 2 $ ______ /year
Total Fuel (1 + 2) $ ______ /year

Payback Period

Simple and alternate payback period:

$$\frac{\$5244.00 \text{ cost}}{\$\ 985.45/\text{year}} = 5.32 \text{ years}$$

Simple 5.32 years
Alternate ______ years

ENERGY CONSERVATION MEASURE

DEVELOPMENT SHEET

Building: City Hall
2215 West Old Shakopee Road
Bloomington, MN 55431

Date 6-18-81
Item No. 3
Major Class 2
Sub. Class 10

Energy Conservation Measure

Description of existing equipment:
Most of the windows are single pane, fixed units. Metal framing appears to be compatible for storm sash mounting.

Description of energy conservation measure:
Install single glaze storm sash on existing windows for the north side of the building.

Useful life 50 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days 523
Fuel 1 gas units of Measure CF
Fuel 2 elec. units of Measure KW

Single glaze windows - 575 Ft^2

575x187,362 BTU/Ft^2/yr = 107,733,150 BTU

With storm sash

575x94,419BTU/Ft^2/yr = 54,290,925 BTU

Heating savings= 53,442,225 BTU/yr

575FT^2x36,579 BTU/Ft^2/yr = 21,032,925 BTU
575FT^2x33,089 BTU/Ft^2/yr = 19,026,175 BTU
Cooling savings = 2,006,750 BTU

$$\frac{53,422,225}{0.8 \times 1000} = 66,803 \text{ cu ft gas}$$

$$\frac{2,006,750}{2.5 \times 3415} = 235.05 \text{ KW}$$

All figures for BTU/Ft^2/yr are listed in DOE/CS-0132
Energy Conservation for Existing Buildings

electrical savings 235.05 kwh/year
fuel 1 savings 66,803 CF /year
fuel 2 savings /year
Total Fuel Savings 55.5 MMBTU/Year

Economic Analysis

(1) Design cost: $ 0

(2) Acquisition cost: $ 2743.00

* 16 windows 2'-6 x 10 - @ $136.00 ea = $2176.00
  7 windows 2'-6 x 2'-6 @ $ 81.00 ea = $ 567.00

(3) Installation cost: $ 977.00

* 16 windows 2'-6 x 10' @ $44.00 ea = $ 704.00
  7 windows 2'-6 x 2'6 @ $39.00 ea = $ 273.00

Total Modification Cost = (1) + (2) + (3): $ 3720.00

Increased operation and maintenance costs: $ 0

Salvage or disposal costs: $ 0

Energy Cost Savings

Electrical and/or fuel cost savings:

$\frac{66,803}{1000}$ x $2.51/MCF = $167.54/year

235.05 x $.0362/KW = $8.51/yr

Electrical $	8.51	/year
fuel 1 $	167.54	/year
fuel 2 $		/year
Total Fuel (1 + 2) $	176.05	/year

Payback Period

Simple and alternate payback period:

$\frac{\$\ 3720.00}{\$\ 176.05/\text{year}}$ = 21.13 years

* 1980 Means Cost Data

Simple	21.13	years
Alternate		years

Building Characteristics

A. Description

The City Hall was built in 1963, was remodeled in 1970 and remodeled with an addition in 1975. The building is used for City offices, police station, and meeting rooms. The building is concrete block, with 4" brick face, insulated windows, flat roof pitch and gravel with insulation on steel corrugated decking and drop ceilings.

B. Envelope Characteristics

1. Walls

	"R"
Outside Air Film	0.17
4" Brick	0.39
Cement Mortar	0.10
Concrete Block	1.11
Air Space	0.97
Plaster Board	0.41
Inside Air Film	0.68
	3.83

U = 1/3.83 = 0.26

2. Roof

Outside Air Film	0.17
Builtup Roof	0.33
Roof Insulation	4.17
Metal Deck	0.00
Air Space	1.23
3/4" Ceiling Tile	0.10
Inside Air Film	0.92
	7.00

U = 1/7.00 = 0.14

C. Building Heat Loss

Walls	$0.26 \times 13{,}498 FT^2 \times 82^o \Delta t$	= 287,77 BTUH
Roof	$0.14 \times 29{,}050 FT^2 \times 82^o \Delta t$	= 333,494 BTUH
Glass	$0.58 \times 3095 FT^2 \times 82^o \Delta t$	= 147,198 BTUH
Infil.	$0.15 \times 16{,}593 FT^2 \times 82^o \Delta t$	= 204,093 BTUH
Edge Loss	45x694Ft	= 31,222 BTUH
	Total	=1,003,784 BTUH

D. Building Energy Using Systems

1. Heating System

The building is heated with interruptable gas-oil fired boilers (2) producing low pressure steam. Air handlers with steam coils and A/C coils distribute to office space. Hot water baseboard handles outside wall losses. Unit heaters and cabinet unit heaters handle some areas.

2. Ventilation System

Centralized exhaust duct systems handle required ventilation.

3. Lighting

Low wattage fluorescent tubes with high efficiency ballasts are used throughout the building.

E. Building Equipment

Boiler Room

1. Boilers
two-Kewanee boilers - 15 P.S.I. steam
gross output - 3060 MBH
gas/oil combination

2. Pumps
2-H.W. circulators - B & G - 3 HP
1-condenser water pump - 5 HP
2-condensate pumps - 1/3 HP
1-H.W. baseboard pump - 1½ HP
1-condensate pump - Demming - 1½ HP
dual condensat pumps 3/4 HP

3. Air Handlers
2-McQuay Air Handlers
15,800 CFM-7½ HP

4. Chillers
Trane Chiller - model 2E5048
60 HP - 147 rated amps

Trane Chiller - model 2F-5C-88
50 HP - 126 rated amps

5. Air Compressor
1 HP air compressor with 12 gallon storage tank and controls

6. Emergency Generator
Stewart & Stevenson 150 KW
208 volts-120 volts
oil-diesel fuel

D. Building Equipment (continued)

7. Exhaust Fan
   2 HP unit

Penthouse

1. Air Handlers
   1-Trane-5 HP blower-11,620 CFM
   1-Trane-5 HP blower-7379 CFM

2. Condensing Unit
   60 HP-171-Full load amp
   6 fans-1½ HP each

3. Water Cooling Tower
   5 HP - closed tower

Computer Room

1. Air Condenser
   Carrier Unit - 1½ HP comp. - 40.2 F.L.A.

2. Air Handler
   Carrier Unit-1½ HP fan

Police Area

1. Air Conditioner
   Trane - 2 compressors - 29.6 F.L.A. ea
   2 fans - ½ HP each

   Trane - 3 HP air handler - type 6

2. Exhausters
   1-3/4 HP exhauster
   8-fractional HP exhausters

3. Water Heater
   State Vulcraft - gas fired
   75,000 BTUH input
   60,000 BTUH output
   100 gallon capacity - 63 G.P.H. recovery

Lighting

2622-40 watt fluorescent lights
61 - 150 watt incandescent
16 - 45 watt incandescent

Development Sheet Supplement A

Yearly heat loss of single and double glaze windows - BTU/Ft^2/year

North	Yearly - Act. Reduction
single - 187,362 double - 94,419 BTUH -	50% reduction-92,943 BTUH
East & West	
single - 161,707 double - 84,936 BTUH	47% reduction-76,771 BTUH
South	
single - 140,428 double - 74,865 BTUH	47% reduction-65,563 BTUH

Yearly heat gain/sq ft of single and double glaze

North	
single - 36,579 double - 33,089 BTUH	10% reduction-3,490 BTUH
East & West	
single - 98,158 double - 88,200 BTUH	10% reduction-9,958 BTUH
South	
single - 82,597 double - 70,729 BTUH	14% reduction-11,868 BTUH

North Elevation

Present single glaze windows (heating)

575 Ft^2 x 187,362 BTU/Ft^2/yr = 107,733,150 BTU

Proposed double glaze windows (heating)

575 Ft^2 x 94,419 BTU/Ft^2/yr = 54,290,925 BTU

53,442,225 BTU savings

Development Sheet Supplement A

Present single glaze windows (cooling)

$575 \text{ Ft}^2 \times 36{,}579 \text{ BTU/Ft}^2\text{/yr} = 21{,}032{,}925 \text{ BTU}$

Proposed double glaze windows (cooling)

$575 \text{ Ft}^2 \times 33{,}089 \text{ BTU/Ft}^2\text{/yr} = \underline{19{,}026{,}175 \text{ BTU}}$

$2{,}006{,}750 \text{ BTU}$ savings

$$\frac{53{,}442{,}225}{0.8 \times 1000} = 66{,}803 \text{ cu ft gas}$$

$$\frac{2{,}006{,}750}{2.5 \times 3415} = 235.05 \text{ KW}$$

$$\frac{66{,}803}{1000} \times \$2.51\text{/MCF} = \$167.54\text{/year}$$

$$235.05 \times \$.0362\text{/KW} = \underline{\$\ \ 8.51\text{/year}}$$

$$\$176.05\text{/year}$$

MAXI AUDIT

OF THE

COMMUNITY ICE GARDEN

FOR

BLOOMINGTON, MINNESOTA

TABLE OF CONTENTS

Introduction

This Maxi-Audit Report is a detailed engineering analysis, of the Community Ice Garden Building, to identify possible energy conservation measures. These items are shown along with their costs, yearly energy savings and payback times.

SUMMARY

The Community Ice Garden was built in 1970 with a second ice rink added in 1976 on the east side of the structure. The west ice rink is used eleven months per year and the east ice rink is used six months per year for ice activities. The east rink is used for dry floor activities during the summer months. The energy saving proposals are calculated accordingly. Summer cooling loads for the east rink are not considered because of their variability.

Due to the specialized use of this building, it is difficult to analyze its energy use without separate electrical metering for compressors, lighting, air conditioning, etc. Industry average for ice rink operations were applied, as most ice facilities are of a standard size. The coefficient of performance (COP) for a direct refrigeration system (3.4) was applied to these calculations for determining simple payback.

Meters and monitoring for the two ice rinks can produce many energy reduction procedures which may change the operating methods for managing energy usage. Examples of energy reduction, if monitoring were instituteed, are as follows:

1. Establishing best night time shut-down of compressors and morning start-up.
2. Highest optimum compressor suction temperature, day and night.
3. Lowest temperature of resurfacing water.
4. Lowest lighting level for each activity.
5. Maximum outside air usage during winter months.

Energy saving possibilities on the above items cannot be calculated without continuous monitoring equipment. The following energy savings are based on industry standards and should be tempered with other in-house conditions.

ENERGY SAVING ITEMS

Item	Cost	Savings	Payback Time
Use low-emissivity paint on ceiling, west rink	$ 16,348.00	$ 8,807.95	1.85 yrs
Use condenser heat for space	$ 24,000.00	$ 6,668.03	3.60 yrs
Use low-emissivity paint for east rink	$ 16,348.00	$ 4,407.05	3.71 yrs
Solar domestic water system	$ 4,400.00	$ 89.59	49.11 yrs
Solar building heat system	$ 540,000.00	$ 8,080.77	66.80 yrs

LOGGED

MAXI-AUDIT REPORT

NOV 04 1981

A — CONTACT DATA

BUILDING NAME		NAME OF ORGANIZATION	DATE
Community Ice Garden		City of Bloomington	6-16-81
BUILDING ADDRESS		ADDRESS	
3600 West 98th Street		2215 West Old Shakopee Road	
CITY	ZIP CODE	CITY	ZIP CODE
Bloomington, MN	55431	Bloomington, MN	55431
PERSON COMPLETING FORM	TELEPHONE	CONTACT PERSON	TELEPHONE
P. R. Wilcox	935-6901	Arthur W. Jensen	881-5811

B — BUILDING ELIGIBILITY CODE

Instructions: For blocks 1 and 2 check the box which best fits the building ownership conditions. For block 3 determine which of the four categories describes the building type and then within the category check off the sub category befitting the building function.

1. OWNERSHIP TYPE
   - [X] Public (PUB)
   - [ ] Non-Profit Association (NAP)

2. ULTIMATE OWNER
   - [ ] County (CNTY)
   - [X] City (CITY)
   - [ ] Township (TOWN)
   - [ ] State (STAT)
   - [ ] Public School (PUSC)
   - [ ] Private School (PRSC)
   - [ ] Non-Profit Association (NPAP)
   - [ ] Indian Tribe (INDN)

3a. SCHOOLS
   - [ ] Elementary (SCHL-ELM)
   - [ ] Secondary (SCHL-SECD)
   - [ ] Coll. or Univ. (SCHL-POST)
   - [ ] Vocational (SCHL-VOCL)
   - [ ] Education Agency (SCHL-ADMN)
   - [ ] Administration (SCHL-ADMN)
   - [ ] OTHER (SCHL-OTHR)

b. PUBLIC CARE
   - [ ] Nursing Home (PBCR-NURS)
   - [ ] Long Term Care (PBCR-TERM)
   - [ ] Rehab. Facility (PBCR-RHAB)
   - [ ] Public Health Ctr. (PBCR-HCTR)
   - [ ] Res. Child Care Ctr. (PBCR-RCCC)

c. LOCAL GOVERNMENT
   - [ ] Office (LOCG-OFFC)
   - [ ] Storage (LOCG-STRG)
   - [X] Service (LOCG-SERV)
   - [ ] Library (LOCG-LBRY)
   - [ ] Police (LOCG-PLCE)
   - [ ] Fire (LOCG-FIRE)
   - [ ] OTHER (LOCG-OTHR)

d. HOSPITALS
   - [ ] General (HOSP-GENL)
   - [ ] Tuberculosis (HOSP-TUBR)
   - [ ] OTHER (HOSP-OTHR)

C — ENERGY REPORT CHECK-OFF

Check the type of reports which were completed prior to this maxi-audit report form.

- [X] Energy Report
  - [ ] Elementary School Energy Report (form no. ED-00444-02)
  - [ ] Secondary School Energy Report (form no. ED-00445-02)
  - [X] Existing Building Energy Report (form no. EN-00041-01)
- [X] Mini-Audit Report (form no. EN-00065-01)

If no energy report was completed before this maxi-audit report, include one with this report. Elementary school administrators should use form no. ED-00444-02. Secondary and vocational school administrators should use form no. ED-00445-02. All other building owners should use form no. EN-00041-01. All building auditors are to use the mini-audit form EN-00065-01 after completion of one of the first three above.

D — ENERGY REPORT AND MINI-AUDIT REPORT SUMMARY

Instructions: Complete this section with a summary of what was accomplished as a result of the energy report and the mini-audit report.

ENERGY REPORT:

The Energy Report (form #EN-00041-01) resulted in the Mini-Audit Report (form #EN-00065-01). Some equipment adjustments completed between energy report and Mini-Audit.

MINI-AUDIT REPORT:

Approximately 25-30% of 40 energy opportunities are completed. Most maintenance items completed. Budget for capital improvements and equipment changes pending Maxi-Audit.

E

Instructions: This section is to be completed and signed by a registered architect, a registered mechanical engineer, or a registered electrical engineer. This section should be completed after this maxi-audit report is completed. All blanks must be filled in.

I have reviewed the building energy report and/or the mini-audit report for this building. I found all information contained therein to be correct, to the best of my knowledge, or I have corrected any misinformation on the reports, which will be resubmitted with the maxi-audit report to the Minnesota Energy Agency.

I am not directly responsible for the day-to-day operation of this building being audited.

I have fully disclosed my financial interests relating to this maxi-audit and any energy conservation measures considered by this audit.

Referring to section G, I have included an analysis that assumes all energy savings obtained from energy conservation operation and maintenance procedures have been realized.

I have calculated the total energy cost savings, by fuel type, expected to result from the acquisition and installation of all recommended energy conservation measures, taking into account the interaction among the various measures.

The energy prices used in the maxi-audit report are the current prices based on the institution's most recent purchase.

Included in the maxi-audit report is a solar analysis for: (check one or more)

- ☒ a domestic hot water heating system
- ☒ a space heating system
- ☐ an electrical generation system
- ☐ an attached solar greenhouse
- ☐ other: (specify)________

I recommend that this building should not undergo a solar installation.
(should, should not)

Included in the maxi-audit report is a list of local zoning ordinances or building codes that will restrict the utilization of solar energy ☐ YES ☒ NO (A no answer indicates that there are no local zoning ordinances or building codes to my knowledge that will restrict the use of solar energy systems.)

I recommend that this building should not undergo a waste, wind, or wood installation
(should, should not) (circle which one(s))

I hereby certify that this audit was prepared by me or under my direct supervision and all information contained herein is correct to the best of my knowledge. I am a duly registered mechanical engineer, electrical engineer, or architect under the laws of the State of Minnesota. (only one signature is required)

Architect	Engineer Paul Martinsen
Signature	Signature Paul B. Martinsen
Registration no.	Registration no. 9597
Firm	Firm Rieke Carroll Muller Associates, Inc.
Address	Address 1011 1st Street South, Hopkins, MN
Phone	Phone 612/935-6901
Date	Date 23 September 1981

MAX-AUDITOR STATEMENTS

F

REMAINING USEFUL LIFE OF THE BUILDING

Instructions: For determining the remaining useful life of the building, list each addition of the building and describe the addition, its condition, its age, and its gross square footage. Then for the building as a whole enter the remaining useful life in years. Enter the gross floor area of the building. Some of this information can be found in the energy report.

Building Unit	Condition	Age	Sq. Ft.
1970 - Ice Skating Rink		11	34,088
1976 - Addition		5	28,574

Remaining Useful Life of the Building	97	Yrs	Gross Floor Area of the Building	62,662	Sq. Ft.

G

ESTIMATED ENERGY INDEX

Instructions: Enter the energy consumption of the building by fuel type in MMBTU's/year when the building is at optimum efficiency. Enter the energy index in MBTU's/square foot/year.

	Fuel 1	Fuel 2	Electricity	Total
MMBTU/Year	5,397.11		16,474.02	21,871.13
MBTU/sq. ft./Yr.	86.13		262.90	349.03

NOTE: For the conversion of fuel quantity to BTU's, use the following conversion factors *for this section only.*

Electricity—11,600 BTU per kilowatt-hour
Natural gas—1,030 BTU per cubic foot
Distillate fuel oil—138,690 BTU per gallon
Residual fuel oil—149,690 BTU per gallon
Coal—24.5 million BTU per standard short ton
Liquefied petroleum gases including propane and butane—95,475 BTU per gallon
Steam—1,390 BTU per pound

The above conversion factors are stipulated in the federal requirements for the Institutional Buildings Grants Program. These source conversion factors are to be used in this section only. Conversion factors may be taken from engineering reference manuals for fuels not listed.

H

Instructions: Read through the list of energy conservation opportunities provided in the Maxi-Audit Manual. Upon completion of a thorough engineering and economic analysis enter all the energy conservation opportunities in this section. Enter the results of the engineering and economic analysis for each energy conservation opportunity as indicated on the "Energy Conservation Measure Development Sheet" and/or "Energy Conservation Operations and Mainenance Procedure Development Sheet" or other format in the appropriate boxes The classification numbers, major and subclass, should be taken from the classification scheme for energy conservation opportunities. Use the fuel codes as listed. The fuel codes indicate the type and the unit of measure. If the fuel comes under OTHER convert the units of measure to MBTU and describe the fuel saved in the description. Enter yes or no in the box entitled "Funding Requested" to indicate whether funding is being applied for through the Institutional Buildings Grants Program. The "Funding Requested" and "Implementation Date" boxes are the only boxes that are not required to be filled upon completion of the maxi-audit report. See page 14 for important detailed instructions.

ECO REPORT SUMMARY

Electricity, kwh	10	No. 2 fuel oil, gallons	31	Street steam, Mlbs	51
Natural gas, therms	21	No. 4 fuel oil, gallons	32	Solar, hours	52
Natural gas, CCF	22	No 5 fuel oil, gallons	33	Wind, kwh	53
Natural gas, MCF	23	No. 6 fuel oil, gallons	34	Wood, tons	54
Natural gas, CF	24	Hard coal, tons	41	Other (specify), MBTU	55
LPG, gallons	25	Soft coal, tons	42		

Fuel 1 Code	Quantity of 1 Saved Units	Fuel 1 Cost Savings $	Item No	Classification Major	Classification Sub	Description
24	1,547,000	4139.80	1	2	6	Paint ceiling with low-emissivity aluminum paint on west rink.

Fuel 2 Code	Quantity of 2 Saved Units	Fuel 2 Cost Savings $	Funding Requested	Implem Date

	Total Fuel Savings MMBTU	Total Fuel Cost Savings $	Acquisition Cost $	Installation Cost $	Design Cost $	Total Modification Cost $	Simple Payback Period Yrs
TOTAL FUEL	1,547.0	4139.80	5362	10,986	---	16,348	1.86

ELECT CODE	Quantity Saved - KWH	Elect Cost Savings $	Increase In O & M Cost $	Salvage Value $	Useful Life - Yrs	Total Energy Cost Savings $	Alternate Payback Yrs (optional)
10	172,894.44	4668.15	---	---	20	8807.95	---

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No	Classification Major	Classification Sub	Description
24	2.4×10^6 Ft^3	6668.03	2	6	4	Utilize condenser heat to heat space in east rink.

Fuel 2 Code	Quantity of 2 Saved—Units	Fuel 2 Cost Savings—$	Funding Requested	Implem. Date

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs
TOTAL FUEL	2488.0	6668.03	No breakdown	No breakdown		24,000	3.6

ELECT CODE	Quantity Saved—KWH	Elect. Cost Savings—$	Increase In O & M Cost—$	Salvage Value—$	Useful Life—Yrs	Total Energy Cost Savings—$	Alternate Payback—Yrs (optional)
10			---	---	20	6668.03	---

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description
24	773,500 Ft^3	2072.98	3	2	6	Paint ceiling with low-emissivity aluminum paint on east rink.

Fuel 2 Code	Quantity of 2 Saved—Units	Fuel 2 Cost Savings—$	Funding Requested	Implem. Date

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs.
TOTAL FUEL	773.5	2072.98	5362	10,986	---	16,348	3.71

ELECT. CODE	Quantity Saved—KWH	Elect. Cost Savings—$	Increase In O & M Cost—$	Salvage Value—$	Useful Life—Yrs.	Total Energy Cost Savings—$	Alternate Payback—Yrs. (optional)
10	86,447.22	2334.07	---	---	20	4407.05	---

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description:

Fuel 2 Code	Quantity of 2 Saved—Units	Fuel 2 Cost Savings—$	Funding Requested	Implem. Date

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs.
TOTAL FUEL							

ELECT. CODE	Quantity Saved—KWH	Elect. Cost Savings—$	Increase In O & M Cost—$	Salvage Value—$	Useful Life—Yrs	Total Energy Cost Savings—$	Alternate Payback—Yrs. (optional)
10							

LOGGED

FUEL AND ELECTRIC CONSUMPTION REPORT

NOV 04 1981

A

Instructions: Enter the organization name, date, building name, building address, city, and zip code as used on the prior report, mini-audit report, and/or maxi-audit report.

BUILDING NAME		NAME OF ORGANIZATION	DATE
Community Ice Garden		City of Bloomington	6-16-81
BUILDING ADDRESS		ADDRESS	
3600 West 98th Street		2215 West Old Shakopee Road	
CITY	ZIP CODE	CITY	ZIP CODE
Bloomington, MN	55431	Bloomington, MN	55431
PERSON COMPLETING FORM	TELEPHONE	CONTACT PERSON	TELEPHONE
P. R. Wilcox	935-6901	Arthur W. Jensen	881-5811

CONTACT DATA

B

Instructions: Complete this section of fuel consumption as accurately as possible. Indicate the fuel types used by the fuel code as listed. The fuel code number describes the fuel type and the units of measure.

- Electricity, kwh 10
- Natural gas, therms 21
- Natural gas, CCF 22
- Natural gas, MCF 23
- Natural gas, CF 24
- LPG, gallons 25
- No. 2 fuel oil, gallons 31
- No. 4 fuel oil, gallons 32
- No. 5 fuel oil, gallons 33
- No. 6 fuel oil, gallons 34
- Hard coal, tons 41
- Soft coal, tons 42
- Street steam, Mlbs 51
- Solar, hours 52
- Wind, kwh 53
- Wood, tons 54
- Other (specify), MBTU 55

If the fuel used comes under the heading of OTHER, enter the code number 55 and specify the fuel type. For the units of measure convert the units as stipulated from the supplier to MBTU using the conversion factors as listed in the Maxi-Audit Manual or other engineering reference text. Enter the storage capacities of each fuel type for the building. Enter the year the data is being completed for. Enter the monthly quantities used, if it is measured, and the cost corresponding with the quality used. Otherwise enter the purchased quantities and costs. If more than two fuels are used make additional copies of this form.

		FUEL TYPE: Nat. Gas	UNIT OF MEASURE: CCF	FUEL TYPE	UNIT OF MEASURE
		FUEL CODE: 22	STORAGE CAPACITY	FUEL CODE	STORAGE CAPACITY
Month	Year	Quantity Used	Cost	Quantity Used	Cost
July	1979	1348	349.68		
August	1979	2624	702.64		
September	1979	3166	832.09		
October	1979	3484	915.27		
November	1979	5556	1457.22		
December	1979	5779	1515.55		
January	1980	13,766	3661.93		
February	1980	4075	1120.75		
March	1980	7785	2131.31		
April	1980	7495	2036.49		
May	1980	1578	431.52		
June	1980	1546	420.51		
Year Total		58,202	15,574.96		

FUEL CONSUMPTION

Minnesota Energy Agency
EN-00078-01 December 1979

C

Instructions: Complete this section on electrical consumption as accurately as possible. Enter the electrical utility name supplying electrical power to the building and the rate classification utilized. Enter the year that the data is being completed for. Use the same months and year for this section as were used in the fuel consumption section. Enter the electrical energy consumed in kilowatt-hours. Enter the total electric bill for each month. If the building has a demand meter, enter the maximum kilowatt demand for each month. Enter the power factor also, if it is included in the utility metering.

Utility Name: Northern States Power Company

Rate Classification:

Month	Year	Energy Kilowatt-Hours	Maximum Demand Kilowatts	Power Factor	Cost ($)
July	1979	140320		Metered by N.S.P.	4,210.45
August	1979	137920			3,991.46
September	1979	18,8640			5,528.74
October	1979	122,560			3,794.52
November	1979	112,480			3,365.01
December	1979	148,960			4,171.93
January	1980	159,520			4,572.71
February	1980	179,920			4,840.21
March	1980	118,720			3,356.66
April	1980	120,160			3,774.10
May	1980	85,920			2,989.29
June	1980	157,440			4,744.97
Year Total		1,672,560			45,195.12

CONSUMPTION

Upon completion of the Fuel and Electrical Consumption Report Form mail it to:

Minnesota Energy Agency
Conservation Research and Development
Conservation Division
980 American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101

nnesota Energy Agency
1-00078-01 December 1979

RENEWABLE RESOURCES REPORT

The most practical renewable resource area for the Community Ice Garden is solar. The building was analyzed for application of a solar collector system for both the domestic hot water system and the building heating system. The results are tabulated below.

	Domestic Hot Water-51%	Building Heating-52%
Cost	$4,400.00	$540,000.00
Energy Savings	$89.59/year	$8,080.77/year
Payback Time	49.11 years	66.8 years

Based on the above data, the systems would not be practical to install, because the payback time is excessive or will probably exceed thelife of the building.

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(GIVEN DATA)

Month	D_o Work days/mo.	N_d (Days per month)	T_a (^oF)	H_t (Btu/day ft^2)
January	26	31	12.2	1124
February	25	28	15.8	1363
March	26	31	28.4	1433
April	26	30	44.6	1442
May	26	31	57.2	1475
June	25	30	66.2	1522
July	26	31	71.6	1588
August	26	31	69.8	1581
September	25	30	60.8	1519
October	27	31	50.0	1484
November	23	30	32.0	1004
December	26	31	19.4	897

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(CALCULATED DATA)

Month	L_w (Btu/Month)	N_f Ft^3/mo.	X/A $1/ft^2$	Y/A $1/ft^2$	X	Y	f	$f \times L_w$ (Btu/Month)
January	3,443,622	5,572.20	0.039	0.006	4.29	0.66	0.36	1,239,703.90
February	3,311,175	5,357.89	0.035	0.007	3.85	0.77	0.44	1,456,917.00
March	3,443,622	5,572.20	0.033	0.008	3.63	0.88	0.52	1,790,683.40
April	3,443,622	5,572.20	0.027	0.008	2.97	0.88	0.57	1,962,864.50
May	3,443,622	5,572.20	0.024	0.008	2.64	0.88	0.58	1,997,300.80
June	3,311,175	5,357.89	0.021	0.008	2.31	0.88	0.59	1,195,593.30
July	3,443,622	5,572.20	0.020	0.008	2.20	0.88	0.60	2,066,173.20
August	3,433,622	5,572.20	0.020	0.008	2.20	0.88	0.60	2,066,173.20
September	3,311,175	5,357.89	0.023	0.008	2.53	0.88	0.58	1,920,481.50
October	3,576,069	5,786.52	0.025	0.008	2.75	0.88	0.57	2,038,359.30
November	3,046,281	4,929.26	0.035	0.006	3.85	0.66	0.36	1,096,661.20
December	3,443,622	5,572.20	0.036	0.005	3.96	0.55	0.29	998,650.38
	40,661,229	65,794.65						20,587,562

$$L_w = 8.33 \times N \times Z \times D. \times (T_w - 52)$$

$$N_f = \frac{L_w}{H_f \times E_f}$$

$$X/A = 16.8 \times \frac{N_d}{L_w} \times (212 - T_a) \times 1 + 0.006(60 - T_a)$$

$$Y/A = 0.59 \times H_T \times \frac{N_d}{L_w}$$

$$X = X/A \times A$$

$$Y = Y/A \times A$$

$$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$$

N = No. of bldg. occupants = 300

Z = Daily water consumption/occupant = 1

D_o = No. of days per mo. bldg. is occupied

T_w = Water temperature (^oF) 105

H_f = Fuel heating value = 1030BTU /Ft^3

E_f = Avg. heating efficiency = 60%

A = Solar collector plate area = 110 Ft^2

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_w}{\sum L_w}$$

$$= \frac{20,587,562}{40,661,229}$$

$$= 0.51 \text{ or } 51\%$$

2. System Cost (Cs)

$$C_s = \$40.00/Ft^2 \times Area$$

$$= \$40.00Ft^2 \times 110 \text{ sq. ft.}$$

$$= \$4,400.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \sum N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.51 \times 65,794.65\ Ft^3/yr \times \$0.00267/Ft^3$$

$$= \$89.59/year$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$4,400.00}{\$\ 89.59}$$

$$= 49.11 \text{ years}$$

SOLAR ASSISTANCE TO BUILDING HEATING
(GIVEN DATA)

Month	N_d (Days per month)	T_a (^0F)	H_t (Btu/day ft^2)	N_f (ft^3/month)
January	31	12.2	1124	1,376,600
February	28	15.8	1363	407,500
March	31	28.4	1433	778,500
April	30	44.6	1442	749,500
May	31	57.2	1475	157,800
June	30	66.2	1522	154,600
July	31	71.6	1588	134,800
August	31	69.8	1581	262,400
September	30	60.8	1519	316,600
October	31	50.0	1484	348,400
November	30	32.0	1004	555,600
December	31	19.4	897	577,900

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

N_f = number of fuel units consumed per month (ft^3/month)

SOLAR ASSISTANCE TO BUILDING HEATING
(CALCULATED DATA)

Month	L_T (Btu/Month)	X/A $1/ft^2$	Y/A $1/ft^2$	X	Y	f	$f \times L_T$ (Btu/Month)
January	850,738,800	0.122×10^{-3}	0.024×10^{-3}	01.65	0.32	0.22	187,162,540
February	251,835,000	0.366×10^{-3}	0.089×10^{-3}	04.94	1.20	0.65	163,692,750
March	481,113,000	0.199×10^{-3}	0.055×10^{-3}	02.69	0.74	0.48	230,934,240
April	463,191,000	0.182×10^{-3}	0.057×10^{-3}	02.46	0.77	0.05	231,595,500
May	97,520,400	0.827×10^{-3}	0.277×10^{-3}	11.16	3.74	1.00	97,520,400
June	95,542,800	0.769×10^{-3}	0.282×10^{-3}	10.38	3.81	1.00	95,542,800
July	83,306,400	0.878×10^{-3}	0.349×10^{-3}	11.85	4.71	1.00	83,306,400
August	162,163,200	0.457×10^{-3}	0.178×10^{-3}	06.17	2.40	1.00	162,163,200
September	195,658,800	0.390×10^{-3}	0.137×10^{-3}	05.27	1.85	0.92	180,006,100
October	215,311,200	0.392×10^{-3}	0.126×10^{-3}	05.29	1.70	0.86	185,167,630
November	343,360,800	0.264×10^{-3}	0.520×10^{-3}	03.56	0.70	0.40	137,344,320
December	357,142,200	0.281×10^{-3}	0.460×10^{-3}	03.79	0.62	0.33	117,856,930
	3,596,883,600						1,872,292,800

$L_T = N_f \times H_f \times E_f$

H_f = fuel heating value = 1 ,000 BTU /ft^3

E_f = average furnace efficiency = 60%

$$X/A = \frac{16.8 \times N_d \times (212 - T_a)}{L_T}$$

$$Y/A = 0.59 \times H_T \times \frac{N_d}{L_T}$$

A = solar collector plate area = 13500 Ft^2

X = X/A x A

Y = Y/A x A

$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$

SOLAR ASSISTANCE TO BUILDING HEATING
COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_T}{\sum L_T}$$

$$= \frac{1,872,292,800}{3,596,883,600}$$

$$= 0.52 \text{ or } 52\%$$

2. System Cost (Cs)

$$C_s = \$40.00/Ft^2 \times \text{Area}$$

$$= \$40.00Ft^2 \times 13500 \text{ sq. ft.}$$

$$= \$540,000.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \sum N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.52 \times 5,820,200 \ Ft^3/yr \times \$0.00267$$

$$= \$8,0808.77/year$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$540,000.00}{\$8,080.77}$$

$$= 66.8 \text{ years}$$

LOGGED

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

Building: Community Ice Gardens
3600 West 18th
Bloomington, MN 55431

Date 6-16-81
Item No. 1
Major Class 2
Sub. Class 6

Energy Conservation Measure

Description of existing equipment:

Ceiling is currently painted a neutral color. The beams, equipment, and ductwork are various colors..

West rink is used year around (365 days).

Description of energy conservation measure:

Paint the ceiling, beams and ducts with low emissivity aluminum-base paint. This will decrease the infrared radiation from the ceiling and reduce water vapor forming on the ceiling. The ceiling temperature will stay above the wet bulb temperature of the air.

Useful life 20 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days 523
Fuel 1 Nat. Gas units of Measure CF
Fuel 2 ______ units of Measure ______

Area = L x W

A = 250 x 120 = 30,000 Ft^2

Radiant heat load reduction = 1,547 x 10^6 BTU/year*

$$\frac{1{,}547 \times 10^6}{1000\ \text{BTU/CF}} = 1{,}547{,}000\ \text{CF Gas/year}$$

Cost of refrigeration = $5,473/year*

$$\$5{,}473 \times \frac{2.0\ \text{COP}}{3.4\ \text{COP}} = \$4{,}668.15/\text{year}$$

$$\frac{\$4{,}668.15/\text{year}}{\$0.027/\text{kw}} = 172{,}894.44\ \text{kw}$$

electrical savings 172,894.44 kwh/year
fuel 1 savings 1,547,000 CF /year
fuel 2 savings ______ /year
Total Fuel Savings 1,547.00 MMBTU/Year

*U.S. DOE Energy Conservation in Ice Skating Rinks. DOE/TIC 10289

Economic Analysis

(1) Design cost: $ ---

(2) Acquisition cost: $ 5,362

Paint - $\$.06/Ft^2 \times 30,000\ Ft^2 =$ 1,600

Scaffold $\$12.54/100\ Ft^2 \times 30,000\ Ft^2 =$ 3,762

5,362

(3) Installation cost: $ 10,986

Painting - $\$.11/Ft^2 \times 30,000\ Ft^2 =$ 3,300

Scaffold $\$25.62/100\ Ft^2 \times 30,000\ Ft^2 =$ 7,686

10,986

Total Modification Cost = (1) + (2) + (3): $ 16,348

Increased operation and maintenance costs: $ ---

Salvage or disposal costs: $ ---

Energy Cost Savings

Electrical and/or fuel cost savings:

Electrical cost = $4,669.15/year

1,547,000 CF Gas x $2.58/1000 CF = $4,139.80/year

Electrical $	4,668.15	/year
fuel 1 $	4,139.80	/year
fuel 2 $		/year
Total Fuel (1 + 2) $	8,807.95	/year

Payback Period

Simple and alternate payback period:

$$\frac{\$16,348.09}{8,807.95} = 1.86 \text{ years}$$

Simple	1.86	years
Alternate		years

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

Building: Community Ice Garden
3600 West 98th Street
Bloomington, MN 55431

Date 6-16-81
Item No. 2
Major Class 6
Sub. Class 4

Energy Conservation Measure

Description of existing equipment:

Ice making condenser is presently heating west ice rink. Additional capacity is available as the cooling tower is running during heating season.

Description of energy conservation measure:

Utilize the excess heat for a similar system for the east rink.

Useful life 25 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days
Fuel 1 Gas units of Measure CF
Fuel 2 units of Measure

1) Actual electrical use for winter months (Oct. thru March) is 842,150 kwh.

$842{,}160 \times \frac{2}{365} = 4{,}614.58$ kwh/24 hr. day

Direct Freon C.O.P. = 3.2; Compressor C.O.P. = 3.4
Compressor use percentage of buildinguse = 92%

2) BTU/day = kwh/Day x .92 x 3412 (BTU/kwh) x 3.2 $\left(1 + \frac{1}{3.4}\right)$

BTU/day = 4614.58 x 0.92 x 3412 x 3.2 $\left(1 + \frac{1}{3.4}\right)$ = 13,633,272 BTU/D

$\frac{13{,}633{,}272 \text{ BTU/D}}{24 \text{ hr.}} = 568{,}053$ BTUH.

$\frac{568{,}053 \text{ BTUH}}{1000 \text{ BTU/Ft}^3 \times 0.8 \text{ (EFF.)}} \times 4{,}380 \text{ Hr.} = 2{,}488.072 \text{ Ft}^3$ Nat. Gas

1) See suppliment #1 for details

2) Energy Conservation in Ice Skating Rinks - 1980 - Dietrick & McQuoy

electrical savings kwh/year
fuel 1 savings 2,488,072 Ft^3 /year
fuel 2 savings /year
Total Fuel Savings 2,488.072 MMBTU/Year

Economic Analysis

(1) Design cost: $ ______

(2) Acquisition cost: $ ______

No breakdown of materials and labor available

(3) Installation cost: $ ______

Total Modification Cost = (1) + (2) + (3): $ 24,000

$21,000	quoted from page 17 - DOE/TIC 10289
3,000	increased cost for labor & material
$24,000	"Energy Conservation in Ice Skating Rinks"

Increased operation and maintenance costs: $ ---

Salvage or disposal costs: $ ---

Energy Cost Savings

Electrical and/or fuel cost savings:

2,488,072 Ft^3 Gas x 2.68/1000 Ft^3 = $6,668.03 (6 month winter only)

Additional cost savings will be realized but a complexity of building heating and use has too many variables. Approximately an additional $3,000-$,300 may be realized per Energy Conservation manual for the other 6 months.

Electrical $		/year
fuel 1 $	6,668.03	/year
fuel 2 $		/year
Total Fuel (1 + 2) $	6,668.03	/year

Payback Period

Simple and alternate payback period:

$$\frac{\$24,000}{6,668.03} = 3.6 \text{ years}$$

Simple	3.6	years
Alternate		years

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

Building: Community Ice Gardens
3600 West 18th
Bloomington, MN 55431

Date 6-16-81
Item No. 3
Major Class 2
Sub. Class 6

Energy Conservation Measure

Description of existing equipment:

Ceiling is currently painted a neutral color. The beams, equipment, and ductwork are various colors.

East rink is used 168 days/year.

Description of energy conservation measure:

Paint the ceiling, beams and ducts with low emissivity aluminum-base paint. This will decrease the infrared radiation from the ceiling and reduce water vapor forming on the ceiling. The ceiling temperature will stay above the wet bulb temperature of the air.

Useful life 20 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days 523
Fuel 1 Nat. Gas units of Measure CF
Fuel 2 ______ units of Measure ______

Area = L x W

$A = 250 \times 120 = 30{,}000\ Ft^2$

Radiant heat load reduction = $1{,}547 \times 10^6$ BTU/year $\times 0.5 = 773.5 \times 10^6$*

$$\frac{773.5 \times 10^6}{1000\ BTU/CF} = 773{,}500\ CF\ Gas/year$$

Cost of refrigeration = \$2,736.50/year*

$$\$2{,}736.50 \times \frac{2.9\ C.O.P.}{3.4\ C.O.P.} = \$2{,}334.07/year$$

$$\frac{\$2{,}334.07/year}{\$0.027/kw} = 86{,}447.22\ kw$$

electrical savings 86,447.22 kwh/year
fuel 1 savings 773,500 CF /year
fuel 2 savings ______ /year
Total Fuel Savings 773.5 MMBTU/Year

*U.S. DOE Energy Conservation in Ice Skating Rinks. DOE/TIC 10289

Economic Analysis

(1) Design cost: $ ---

(2) Acquisition cost: $ 5,362

Paint - $\$.06/Ft^2 \times 30{,}000\ Ft^2 =$ 1,600

Scaffold $\$12.54/100\ Ft^2 \times 30{,}000\ Ft^2 =$ 3,762

5,362

(3) Installation cost: $ 10,986

Painting - $\$.11/Ft^2 \times 30{,}000\ Ft^2 =$ 3,300

Scaffold $\$25.62/100\ Ft^2$ - 39m999 Ft^2 = 7,686

10,986

Total Modification Cost = (1) + (2) + (3): $ 16,348

Increased operation and maintenance costs: $ ---

Salvage or disposal costs: $ ---

Energy Cost Savings

Electrical and/or fuel cost savings:

Electrical Cost = $2,334.07/year

773,500 CF Gas x $2.68/1000 CF = $2,072.98/year

Electrical $	2,334.07	/year
fuel 1 $	2,072.98	/year
fuel 2 $		/year
Total Fuel (1 + 2) $	4,407.05	/year

Payback Period

Simple and alternate payback period:

$$\frac{\$16{,}348.00}{\$4{,}407.05} = 3.71 \text{ years}$$

Simple	3.71	years
Alternate		years

BUILDING CHARACTERISTICS

A. Description

The Community Ice Garden was built in 1970 with a second rink addition in 1976. It is used for hockey, general skating, shows, and commercial rental use. The west rink has insulated upper walls and ceiling, while the east rink has insulated ceiling only. The west rink normally has June through April use, and the east rink is used October through April for ice activities and non-ice occasional use from April to October. This accounts for uneven energy loads and energy use timing.

B. Envelope Characteristics

1. West Rink Walls (upper)

	"R"
Outside Air Film	0.17
3/4" Stucco	0.32
Metal Studs and Air Space	0.97
3/4" Rigid Insulation	3.00
Inside Air Film	0.68
	5.14

"U" = 1/5.14 = 0.19

2. West Rink Lower Walls

Outside Air Film	0.17
4" Face Brick	0.44
8" Concrete Block	1.11
Inside Air Film	0.68
	2.40

"U" = 1/2.40 = 0.42

3. East Rink Upper Walls

Outside Air Film	0.17
7/8" Stucco on Metal Lath	0.34
2" Air Space	0.97
1" Rigid Insulation	4.00
Inside Air Film	0.68
	6.16

"U" = 1/6.16 = 0.16

4. East Rink Lower Walls

Outside Air Film	0.17
4" Face Brick	0.44
8" Concrete Block	1.11
½" Plaster	0.09
Inside Air Surface	0.68
	2.49

"U" = 1/2.49 = 0.40

5. Roof

Outside Air Film	0.17
Built Up Roofing	0.33
Insulation - 2"	5.56
Metal Decking	0.00
Inside Air Film	0.68
	6.74

"U" = 1/6.74 = 0.15

C. Building Heat Loss

Upper West Walls	0.19 x 3,200 Ft^2 x 60^o Δt	=	36,480 BTUH
Lower West Walls	0.42 x 4,800 Ft^2 x 60^o Δt	=	120,960 BTUH
Upper East Walls	0.16 x 2,832 Ft^2 x 60^o Δt	=	27,187 BTUH
Lower East Walls	0.40 x 4,249 Ft^2 x 60^o Δt	=	101,976 BTUH
Windows	1.13 x 1,329 Ft^2 x 60^o Δt	=	90,106 BTUH
Doors	1.09 x 524 Ft^2 x 60^o Δt	=	34,270 BTUH
Walls Below Grade	0.1 BTUH x 5560 Ft^2x60^o Δt	=	33,360 BTUH
Edge Loss	0.81 x 1,112 Ft^2 x 60^o Δt	=	54,043 BTUH
Floors	0.10 x 28,262 Ft^2 x 60^o Δt	=	169,572 BTUH
Ice Rinks	0.88 x 34,400 Ft^2	=	30,272 BTUH
	TOTAL		698,226 BTUH

D. Building Energy Using Systems

Heating Building #1

Unit #1	S.W. Corner	535,000	Input
	Natural Gas	428,000	Output
Unit #2	N.W. Corner	535,000	Input
	Natural Gas	410,000	Output
Unit #3	S.E. Corner	512,000	Input
	Natural Gas	428,000	Output
Unit #4	N.E. Corner	512,000	Input
	Natural Gas	410,000	Output

Lobby heat low pressure boiler - Natural Gas	625,000 500,000	Input Output
Zamboni Room Rink #1 Unit Heater - Natural Gas	50,000 40,000	Input Output
Locker Room Rink #1 Unit Heater - Natural Gas	150,000 112,000	Input Output
Pumper Room Rink #1 Unit Heater - Natural Gas	50,000 40,000	Input Output
Water Heater west end Rink #1	199,000	Input
Water Heater east end Rink #1 - Natural Gas	312,000 250,000	Input Output

4 - 130,000 BTUH Air Conditioners - Rink #1 - Main Arena

89,000 BTUH Lobby Air Conditioner - Rink #1

3 Ton Air Condition - Office - Rink #1

Rink #2 heat

Unit #5 east end - Natural gas	869,000	Input
Unit #6 west end - Natural gas	869,000	Input
Locker Room Rink #2 Natural gas	160,000 128,000	Input Output
Office heat Rink #2 Natural gas	160,000 128,000	Input Output
Zamboni Room Unit Heater Rink #2 - Natural Gas	175,000 140,000	Input Output

6 - Electric Unit Heaters - 10 KW

2 - 25 Ton Air Conditioner Units in Main Arena Rink #2

100 Tons refrigeration for ice rinks

SUPPLEMENT #1

Electric Use for Winter Months

October	122,560 kwh
November	112,480 kwh
December	148,960 kwh
January	159,520 kwh
February	179,920 kwh
March	118,720 kwh
	842,160 kwh

$$842{,}160 \times \frac{2}{365} = 4{,}614.58 \text{ kwh/24 hour day}$$

$$\text{BTU/day} = \text{kwh/day} \times .92 \times 3{,}412 \text{ (BTU/kwh)} \times \text{overall C.O.P. } (1 + \frac{1}{\text{comp C.O.P.}}$$

Direct Freon C.O.P. = 3.20

Comp. C.O.P. = 3.40

Comp. use of total = .092

$$\text{BTU/day} = 4{,}614.58 \times 0.92 \times 3{,}412 \times 3.2 \ (1 + \frac{1}{3.4}$$

BTU/day = 13,633,272

$$\frac{13{,}633{,}272}{24 \text{ hr}} = 568{,}053 \text{ BTUH average}$$

MAXI AUDIT

OF THE

RYAN BUILDING

FOR

BLOOMINGTON, MINNESOTA

TABLE OF CONTENTS

Introduction

This Maxi-Audit Report is a detailed engineering analysis, of the Ryan Building, to identify possible energy conservation measures. These items are shown along with their costs, yearly energy savings and payback times.

SUMMARY

The Ryan Building was purchased by the City of Bloomington in 1980 and is approximately 12 years old. The building serves three basic functions. The office area, which has been partially remodeled, will serve as a city engineering office space. The second area is a storage area for records and equipment and is kept at reduced temperature. The third and largest area is for vehicle storage and maintenance.

The energy saving possibilities are in the storage and maintenance area rather than in the office or record storage area. Excessive infiltration losses exist in the maintenance garage, along with outer shell losses, offer the best opportunity for savings. The high air change rate of the heating and ventilation systems necessitates frequent cleaning of light fixtures. Lighting might be improved by more frequent cleaning but, to avoid crane operation, these fixtures are at a height which makes this possibility an expensive one.

Below are tabulated potential energy saving ideas, along with their costs, savings and payback time. More details of these items are contained within this report.

Energy Saving Items

Item	Cost	Savings	Payback Time
Waste Heat Recovery	$ 7,500	$2,616.94	2.87 yrs
Add Gas Radiant Heaters-Garage Area	$ 22,000	$3,604.45	6.10 yrs
Solar Domestic Hot Water Heating	$ 2,000	$ 42.04	47.50 yrs
Install Insulated	$ 141,050	$1,888.64	66.20 yrs

There may be additional energy savings on items listed in the mini-audit that could not be instituted previously, due to building modifications and the change in use of some spaces.

Note the unusually high BTU per square foot consumption of this ubilding, listed elsewhere in this report.

LOGGED

MAXI-AUDIT REPORT

NOV 04 1981

A CONTACT DATA

BUILDING NAME		NAME OF ORGANIZATION	DATE
Ryan Building		City of Bloomington	6-18-81
BUILDING ADDRESS		ADDRESS	
9750 James Avenue South		2215 West Old Shakopee Road	
CITY	ZIP CODE	CITY	ZIP CODE
Bloomington, MN	55431	Bloomington, MN	55431
PERSON COMPLETING FORM	TELEPHONE	CONTACT PERSON	TELEPHONE
P.R. Wilcox	612/935-6901	Arthur W. Jensen	612/421-8064

B BUILDING ELIGIBILITY CODE

Instructions: For blocks 1 and 2 check the box which best fits the building ownership conditions. For block 3 determine which of the four categories describes the building type and then within the category check off the sub category befitting the building function.

1. OWNERSHIP TYPE
   - [X] Public (PUB)
   - [ ] Non-Profit Association (NAP)

2. ULTIMATE OWNER
   - [ ] County (CNTY)
   - [X] City (CITY)
   - [ ] Township (TOWN)
   - [ ] State (STAT)
   - [ ] Public School (PUSC)
   - [ ] Private School (PRSC)
   - [ ] Non-Profit Association (NPAP)
   - [ ] Indian Tribe (INDN)

3a. SCHOOLS
   - [ ] Elementary (SCHL-ELM)
   - [ ] Secondary (SCHL-SECD)
   - [ ] Coll. or Univ. (SCHL-POST)
   - [ ] Vocational (SCHL-VOCL)
   - [ ] Education Agency (SCHL-ADMN)
   - [ ] Administration (SCHL-ADMN)
   - [ ] OTHER (SCHL-OTHR)

b. PUBLIC CARE
   - [ ] Nursing Home (PBCR-NURS)
   - [ ] Long Term Care (PBCR-TERM)
   - [ ] Rehab. Facility (PBCR-RHAB)
   - [ ] Public Health Ctr. (PBCR-HCTR)
   - [ ] Res. Child Care Ctr. (PBCR-RCCC)

c. LOCAL GOVERNMENT
   - [X] Office (LOCG-OFFC)
   - [ ] Storage (LOCG-STRG)
   - [ ] Service (LOCG-SERV)
   - [ ] Library (LOCG-LBRY)
   - [ ] Police (LOCG-PLCE)
   - [ ] Fire (LOCG-FIRE)
   - [ ] OTHER (LOCG-OTHR)

d. HOSPITALS
   - [ ] General (HOSP-GENL)
   - [ ] Tuberculosis (HOSP-TUBR)
   - [ ] OTHER (HOSP-OTHR)

C ENERGY REPORT CHECK-OFF

Check the type of reports which were completed prior to this maxi-audit report form.

- [X] Energy Report
  - [ ] Elementary School Energy Report (form no. ED-00444-02)
  - [ ] Secondary School Energy Report (form no. ED-00445-02)
  - [X] Existing Building Energy Report (form no. EN-00041-01)
- [X] Mini-Audit Report (form no. EN-00065-01)

If no energy report was completed before this maxi-audit report, include one with this report. Elementary school administrators should use form no. ED-00444-02. Secondary and vocational school administrators should use form no. ED-00445-02. All other building owners should use form no. EN-00041-01. All building auditors are to use the mini-audit form EN-00065-01 after completion of one of the first three above.

D ENERGY REPORT AND MINI-AUDIT REPORT SUMMARY

Instructions: Complete this section with a summary of what was accomplished as a result of the energy report and the mini-audit report.

ENERGY REPORT:

Energy report complete, analysis justified Mini-Audit. Maintenance Supervisor used report to implement energy savings.

MINI-AUDIT REPORT:

Mini-Audit completed and used as guide for remodel. Insulation added to walls and ceiling of remodeled areas. Fresh air to horizontal furnace in shop and rooftop A/C unit reduced. Heat temp. reduced in office areas. Dampers reset. Furnace in paint shop left off.

E

MAXI-AUDITOR STATEMENTS

Instructions: This section is to be completed and signed by a registered architect, a registered mechanical engineer, or a registered electrical engineer. This section should be completed after this maxi-audit report is completed. All blanks must be filled in.

I have reviewed the building energy report and/or the mini-audit report for this building. I found all information contained therein to be correct, to the best of my knowledge, or I have corrected any misinformation on the reports, which will be resubmitted with the maxi-audit report to the Minnesota Energy Agency.

I am not directly responsible for the day-to-day operation of this building being audited.

I have fully disclosed my financial interests relating to this maxi-audit and any energy conservation measures considered by this audit.

Referring to section G, I have included an analysis that assumes all energy savings obtained from energy conservation operation and maintenance procedures have been realized.

I have calculated the total energy cost savings, by fuel type, expected to result from the acquisition and installation of all recommended energy conservation measures, taking into account the interaction among the various measures.

The energy prices used in the maxi-audit report are the current prices based on the institution's most recent purchase.

Included in the maxi-audit report is a solar analysis for: (check one or more)

- ☒ a domestic hot water heating system
- ☐ a space heating system
- ☐ an electrical generation system
- ☐ an attached solar greenhouse
- ☐ other: (specify)________

I recommend that this building should not undergo a solar installation.
(should, should not)

Included in the maxi-audit report is a list of local zoning ordinances or building codes that will restrict the utilization of solar energy ☐ YES ☒ NO (A no answer indicates that there are no local zoning ordinances or building codes to my knowledge that will restrict the use of solar energy systems.)

I recommend that this building should not undergo a waste, wind, or wood installation.
(should, should not) (circle which one(s))

I hereby certify that this audit was prepared by me or under my direct supervision and all information contained herein is correct to the best of my knowledge. I am a duly registered mechanical engineer, electrical engineer, or architect under the laws of the State of Minnesota. (only one signature is required)

Architect	Engineer Paul Martinsen
Signature	Signature Paul B Martinsen
Registration no.	Registration no. 9597
Firm	Firm Rieke Carroll Muller Associates, Inc.
Address	Address 1011 1st St. S., Hopkins, MN
Phone	Phone 612/935-3421
Date	Date 14 September 1981

F

REMAINING USEFUL LIFE OF THE BUILDING

Instructions: For determining the remaining useful life of the building, list each addition of the building and describe the addition, its condition, its age, and its gross square footage. Then for the building as a whole enter the remaining useful life in years. Enter the gross floor area of the building. Some of this information can be found in the energy report.

Building Unit	Condition	Age	Sq. Ft.
1967 Warehouse		14	9,000
1967 Garage		14	9,228
1967 Office		14	10,323
1967 Paint Shop		14	2,220

Remaining Useful Life of the Building	81	Yrs	Gross Floor Area of the Building	30,771	Sq. Ft.

G

ESTIMATED ENERGY INDEX

Instructions: Enter the energy consumption of the building by fuel type in MMBTU's/year when the building is at optimum efficiency. Enter the energy index in MBTU's/square foot/year.

	Fuel 1	Fuel 2	Electricity	Total
MMBTU/Year	8,141.9		2,666.07	10,807.97
MBTU/sq. ft./Yr.	264.6		86.64	351.24

NOTE: For the conversion of fuel quantity to BTU's, use the following conversion factors *for this section only.*

Electricity—11,600 BTU per kilowatt-hour
Natural gas—1,030 BTU per cubic foot
Distillate fuel oil—138,690 BTU per gallon
Residual fuel oil—149,690 BTU per gallon
Coal—24.5 million BTU per standard short ton
Liquefied petroleum gases including propane and butane—95,475 BTU per gallon
Steam—1,390 BTU per pound

The above conversion factors are stipulated in the federal requirements for the Institutional Buildings Grants Program. These source conversion factors are to be used in this section only. Conversion factors may be taken from engineering reference manuals for fuels not listed.

H

ECO REPORT SUMMARY

Instructions: Read through the list of energy conservation opportunities provided in the Maxi-Audit Manual. Upon completion of a thorough engineering and economic analysis enter all the energy conservation opportunities in this section. Enter the results of the engineering and economic analysis for each energy conservation opportunity as indicated on the "Energy Conservation Measure Development Sheet" and/or "Energy Conservation Operations and Mainenance Procedure Development Sheet" or other format in the appropriate boxes The classification numbers, major and subclass, should be taken from the classification scheme for energy conservation opportunities. Use the fuel codes as listed. The fuel codes indicate the type and the unit of measure. If the fuel comes under OTHER convert the units of measure to MBTU and describe the fuel saved in the description. Enter yes or no in the box entitled "Funding Requested" to indicate whether funding is being applied for through the Institutional Buildings Grants Program. The "Funding Requested" and "Implementation Date" boxes are the only boxes that are not required to be filled upon completion of the maxi-audit report. See page 14 for important detailed instructions.

Electricity, kwh	10	No. 2 fuel oil, gallons	31	Street steam, Mlbs	51
Natural gas, therms	21	No. 4 fuel oil, gallons	32	Solar, hours	52
Natural gas, CCF	22	No. 5 fuel oil, gallons	33	Wind, kwh	53
Natural gas, MCF	23	No. 6 fuel oil, gallons	34	Wood, tons	54
Natural gas, CF	24	Hard coal, tons	41	Other (specify), MBTU	55
LPG, gallons	25	Soft coal, tons	42		

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description
24	911,825	2616.94	1	6	4	Add waste heat recovery air-to-air heat exchanger. Use heat to preheat combustion air.
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		
			No			

TOTAL FUEL	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs
	911.825	2616.94	3,000	4,500	---	7,500	2.87
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs (optional)**
10			---	---	18	2616.94	---

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description
24	1,255.906	3604.45	2	7	7	Add gas radiant heaters to high bay shop area.
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		
			No			

TOTAL FUEL	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs
	1,255.906	3604.45	12,000	10,000	---	22,000	6.10
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs (optional)**
10					20	3,604.45	---

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description
24	658.052	1888.64	3	2	2	Replace 8 steel roll up doors with 8 insulated roll up doors.
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		
			No			

TOTAL FUEL	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs.
	658.052	1888.64	47,050	94,000	---	141,050	66.21
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs.**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs. (optional)**
10				16,000	71	1888.64	

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description:
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		

TOTAL FUEL	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs.
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs.**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs. (optional)**
10							

LOGGED

FUEL AND ELECTRIC CONSUMPTION REPORT

NOV 04 1981

A Instructions: Enter the organization name, date, building name, building address, city, and zip code as used on the prior report, mini-audit report, and/or maxi-audit report.

CONTACT DATA

BUILDING NAME		NAME OF ORGANIZATION	DATE
Ryan Building		City of Bloomington	6-18-81
BUILDING ADDRESS		ADDRESS	
9750 James Avenue South		2215 West Old Shakopee Road	
CITY	ZIP CODE	CITY	ZIP CODE
Bloomington, MN	55431	Bloomington, MN	55431
PERSON COMPLETING FORM	TELEPHONE	CONTACT PERSON	TELEPHONE
P.R. Weber	612/935-6901	Arthur W. Jensen	612/881-5811

B Instructions: Complete this section of fuel consumption as accurately as possible. Indicate the fuel types used by the fuel code as listed. The fuel code number describes the fuel type and the units of measure.

Electricity, kwh 10
Natural gas, therms 21
Natural gas, CCF 22
Natural gas, MCF 23
Natural gas, CF 24
LPG, gallons 25
No. 2 fuel oil, gallons 31
No. 4 fuel oil, gallons 32
No. 5 fuel oil, gallons 33
No. 6 fuel oil, gallons 34
Hard coal, tons 41
Soft coal, tons 42
Street steam, Mlbs 51
Solar, hours 52
Wind, kwh 53
Wood, tons 54
Other (specify), MBTU 55

If the fuel used comes under the heading of OTHER, enter the code number 55 and specify the fuel type. For the units of measure convert the units as stipulated from the supplier to MBTU using the conversion factors as listed in the Maxi-Audit Manual or other engineering reference text. Enter the storage capacities of each fuel type for the building. Enter the year the data is being completed for. Enter the monthly quantities used, if it is measured, and the cost corresponding with the quality used. Otherwise enter the purchased quantities and costs. If more than two fuels are used make additional copies of this form.

FUEL CONSUMPTION

		FUEL TYPE: Nat. Gas	UNIT OF MEASURE: CCF	FUEL TYPE	UNIT OF MEASURE
		FUEL CODE: 22	STORAGE CAPACITY: ---	FUEL CODE	STORAGE CAPACITY
Month	Year	Quantity Used	Cost	Quantity Used	Cost
July	1979	204	62.67		
August	1979	389	167.30		
September	1979	244	74.67		
October	1979	686	194.91		
November	1979	6288	1718.77		
December	1979	7017	1915.72		
January	1980	14792	4080.87		
February	1980	15099	4311.70		
March	1980	11401	3249.46		
April	1980	7817	2212.91		
May	1980	2007	573.92		
June	1980	90	30.60		
Year Total		66034	18593.50		

Minnesota Energy Agency
EN-00078-01 December 1979

C

Instructions: Complete this section on electrical consumption as accurately as possible. Enter the electrical utility name supplying electrical power to the building and the rate classification utilized. Enter the year that the data is being completed for. Use the same months and year for this section as were used in the fuel consumption section. Enter the electrical energy consumed in kilowatt-hours. Enter the total electric bill for each month. If the building has a demand meter, enter the maximum kilowatt demand for each month. Enter the power factor also, if it is included in the utility metering.

Utility Name: Northern States Power Company

Rate Classification: Commercial

ELECTRICAL CONSUMPTION

Month	Year	Energy Kilowatt-Hours	Maximum Demand Kilowatts	Power Factor	Cost ($)
July	1979	16000			899.58
August	1979	16400			1162.58
September	1979	17800			947.67
October	1979	14600			685.84
November	1979	18200			784.22
December	1979	25200			995.30
January	1980	28600			1125.45
February	1980	28200			1069.11
March	1980	24800			985.63
April	1980	22400			943.72
May	1980	15200			733.20
June	1980	1660			906.72
Year Total		229060			11241.02

Upon completion of the Fuel and Electrical Consumption Report Form mail it to:

Minnesota Energy Agency
Conservation Research and Development
Conservation Division
980 American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101

Minnesota Energy Agency
EN-00078-01 December 1979

RENEWABLE RESOURCES REPORT

The most practical renewable resource area for the Ryan Garage is solar. The building's domestic hot water requirements are small, and this water is heated by the building gas water heater.

An analysis of a solar collector system, which would handle 50% of the building heating loads, shows the following:

Cost	$2,000.00
Energy Savings	$ 42.09
Payback Time	47.52 years

Based on this data, the system would not be practical to install, because the payback tiem will exceed the life of the building.

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(GIVEN DATA)

Month	D_o Work days/mo.	N_d (Days per month)	T_a (^0F)	H_t (Btu/day ft^2)
January	23	31	12.2	1124
February	21	28	15.8	1363
March	21	31	28.4	1433
April	22	30	44.6	1442
May	22	31	57.2	1475
June	21	30	66.2	1522
July	23	31	71.6	1588
August	21	31	69.8	1581
September	22	30	60.8	1519
October	23	31	50.0	1484
November	20	30	32.0	1004
December	23	31	19.4	897

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(CALCULATED DATA)

Month	L_w (Btu/Month)	N_f (Ft^3/mo)	X/A ($1/ft^2$)	Y/A ($1/ft^2$)	X	Y	f	$f \times L_w$ (Btu/Month)
January	1,624,683.2	2,628.94	0.082	0.0127	4.10	0.64	0.35	568,639.12
February	1,483,406.4	2,400.33	0.079	0.0152	3.95	0.76	0.41	623,030.69
March	1,483,406.4	2,400.33	0.077	0.0177	3.85	0.89	0.52	771,371.33
April	1,554,044.8	2,514.64	0.059	0.0170	2.95	0.85	0.55	854,724.64
May	1,554,044.8	2,514.64	0.053	0.0173	2.65	0.87	0.58	901,345.98
June	1,483,406.4	2,400.33	0.048	0.0182	2.40	0.91	0.60	890,043.84
July	1,624,683.2	2,628.94	0.042	0.0179	2.10	0.90	0.61	991,056.75
August	1,483,406.4	2,400.33	0.047	0.0195	2.35	0.98	0.66	979,048.22
September	1,554,044.8	2,514.64	0.049	0.0173	2.45	0.87	0.57	885,805.54
October	1,624,683.2	2,628.94	0.055	0.0167	2.75	0.84	0.53	861,082.10
November	1,412,768.0	2,400.33	0.075	0.0126	3.75	0.63	0.34	480,341.12
December	1,624,683.2	2,628.94	0.077	0.0101	3.85	0.51	0.25	406,170.80
	18,507,261.8	30,061.33						9,212,660.10

$$L_w = 8.33 \times N \times Z \times D_o \times (T_w - 52)$$

$$N_f = \frac{L_w}{H_f \times E_f}$$

$$X/A = \frac{16.8 \times N_d \times (212 - T_a) \times 1 + 0.006(60 - T_a)}{L_w}$$

$$Y/A = \frac{0.59 \times H_T \times N_d}{L_w}$$

$$X = X/A \times A$$

$$Y = Y/A \times A$$

$$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$$

N = No. of bldg. occupants = 80

Z = Daily water consump/occupant = 2 gal.

D_o = No. of days per mo. bldg. is occupied

T_w = Water temperature (^oF) = 105^o

H_f = Fuel heating value = 1030 BTU /ft^3

E_f = Avg. heating efficiency = 60%

A = Solar collector plate area = 50 Ft^2

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_w}{\sum L_w}$$

$$= \frac{9{,}212{,}600.1}{18{,}507{,}261}$$

$$= 0.50 \text{ or } 50\%$$

2. System Cost (Cs)

$$C_s = \$40.00/\text{Ft}^2 \times \text{Area}$$

$$= \$40.00/\text{Ft}^2 \times 0.50/\text{Ft}^2$$

$$= \$2{,}000.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \sum N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.50 \times 30{,}061.33 \text{ Ft}^3/\text{yr} \times \$\ .0028/\text{Ft}^3$$

$$= \$42.09/\text{year}$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$2{,}000.00}{\$\ 42.09}$$

$$= 47.52 \text{ years}$$

LOGGED

ENERGY CONSERVATION MEASURE DEVELOPMENT SHEET

Building:

Ryan Building
9750 James Avenue South
Bloomington, MN 55431

Date 6-18-81
Item No. 1
Major Class 6
Sub. Class 4

Energy Conservation Measure

Description of existing equipment:

Overhead horizontal furnace - 8,000,000 BTUH input rising combustion air and draft divester air from heated space. Creates negative space pressure.

Description of energy conservation measure:

Add waste heat recovery air-to-air heat exchanger on roof tied to power flue. Duct preheated combustion air and draft divester air direct to furnace.

Useful life 18 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days ____
Fuel 1 Gas units of Measure CF
Fuel 2 ____ units of Measure ____

Assume: 29°F=average winter temp.- ASHRAE
53% heat exchanger efficiency
65°F - indoor
29°F - outdoor average
36°F - Δ t

$$\frac{8{,}000{,}000 \text{ BTUH input}}{1{,}000 \text{ BTU/Ft}^3} \times \text{ID (cu. ft. air for combustion)} = 80{,}000 \text{ cu. ft. (combustion air)}$$

80,000 cu. ft. air
80,000 cu. ft. draft diverter
160,000 cu. ft.

160,000 x 0.53 x 0.33 (cycle) = 279,840 BTU

$$^{*}E = \left(\frac{H_L \times D \times 24}{t \times n \times V}\right)(C_P)(C_F) \quad \left(\frac{279{,}840 \times 8159 \times 24}{75 \times .8 \times 1{,}000}\right)(.64) \times (1.56) = 911{,}825 \text{ cu.ft.gas}$$

2% heating combustion efficiency outlined in ASHRAE guide not included in above calculations.

electrical savings ____ kwh/year
fuel 1 savings 911,825 /year
fuel 2 savings ____ /year
Total Fuel Savings 911.825 MMBTU/Year

*see explanation elsewhere in report

Economic Analysis

(1) Design cost: $ ______

(2) Acquisition cost: $ 3,000

Rooftop air-to-air heat exchanger 1,600,000 BTU input - 0.53 efficient - Supplier quote.

(3) Installation cost: $ 4,500

Mount on roof and duct to burner and draft diverter - Supplier quote.

Total Modification Cost = (1) + (2) + (3): $ 7,500

Increased operation and maintenance costs: $ ---

Salvage or disposal costs: $ ---

Energy Cost Savings

Electrical and/or fuel cost savings:

911825 cu. ft. x $2.87/1,000 Ft^3 = $3,626.94

Electrical $		/year
fuel 1 $	2,616.94	/year
fuel 2 $		/year
Total Fuel (1 + 2) $		/year

Payback Period

Simple and alternate payback period:

$$\frac{\$7500}{2616.94} = 2.87 \text{ years}$$

Simple	2.87	years
Alternate		years

Local supplier quote on material & labor.

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

Building: Ryan Building
9750 James Avenue South
Bloomington, MN 55431

Date 6-18-81
Item No. 2
Major Class 7
Sub. Class 7

Energy Conservation Measure

Description of existing equipment:

Present horizontal furnace in shop area is 8,000,000 Btuh input, 6,4000,000 Btuh output. Heat loss for this area is 770,878 Btuh. Excessive infiltration and high ceilings.

Description of energy conservation measure:

Change over to gas fired radiant heating in garage high bay area. Keep horizontal furnace for summer ventilation and supplimentary heating.

Useful life 20 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days
Fuel 1 Gas units of Measure CF
Fuel 2 units of Measure

$$*E = \left(\frac{770{,}878 \times 8159 \times 24}{75 \times .8 \times 1000}\right)(.64) \times 1.56 = 2{,}511{,}812 \text{ CF}$$

$$.5 \times 2{,}511{,}812 = 1{,}255{,}906 \text{ CF}$$

Vendor quotes reduction of 50% over furnace method.

electrical savings kwh/year
fuel 1 savings 1,255,906 /year
fuel 2 savings /year
Total Fuel Savings 1,255,906 MMBTU/Year

*See Pride Development Sheet for formula.

Economic Analysis

(1) Design cost: $ ---

(2) Acquisition cost: $ 12,000

Mfg. quote on equipment from building inspection

(3) Installation cost: $ 10,000

Mfg. quote on labor, overhead, and profit from building inspection

Total Modification Cost = (1) + (2) + (3): $ 22,000

Vendor quote

Increased operation and maintenance costs: $ ---

Salvage or disposal costs: $ ---

Energy Cost Savings

Electrical and/or fuel cost savings:

$2.87/MCF = Gas rate

$$a,255,906 \text{ CF} \times \frac{\$2.87}{1000 \text{ Ft}^3} = \$3,604.45/\text{Year}$$

Electrical $		/year
fuel 1 $	3,604.45	/year
fuel 2 $		/year
Total Fuel (1 + 2) $		/year

Payback Period

Simple and alternate payback period:

$$\frac{\$22,000}{3,604.45/\text{Yr}} = 6.10 \text{ Years}$$

Simple	6.10	years
Alternate		years

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

Building: Ryan Building
9750 James Avenue South
Bloomington, MN 55431

Date 6-18-81
Item No. 3
Major Class 2
Sub. Class 2

Energy Conservation Measure

Description of existing equipment:

Existing steel roll up doors are loos fitting and cannot be insulated or weatherstripped. These are in garage area in daily use, door heat loss accounts for 36% of building heat loss. "U" value of 1.28.

Description of energy conservation measure:

Replace 8 roll up doors with thermal insulated roll up doors. "U" value of 0.20

Useful life 71 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days
Fuel 1 gas units of Measure CF
Fuel 2 units of Measure

Per A.S.H.R.A.E. -

$$E = \left(\frac{H_t \times D \times 24}{t \times \quad \times V}\right)(C_D)(C_F)$$

where

E = fuel or energy consumption
H_t = design heat loss, including infiltration, Btu per hour
D = number of 65 F degree days
Δ_t = design temp. difference (^oF)
n = rated full load efficiency
V = heating value of fuel
C_D = interim correction factor for heating effect vs. degree days
C_F = interim part-load correction factor

Garage Doors - 1 - 30' x 18' = 360 Ft^2
7 - 16' x 18' = 2016 Ft^2
2376 Ft^2

$1.28 \times 2376 \times 75^oF\ \Delta t_2 =$ 228,096 Btuh
Inf. $2376 \times 6\text{-Btuh}/Ft^2 =$ 14,256 Btuh
242,352 Btuh - Existing

$0.20 \times 2376 \times 75^oF\ \Delta t =$ 35,640 Btuh
Inf. $2376\ Ft^2 \times 2\text{-Btuh}/Ft^2 =$ 4,752 Btuh
40,392 Btuh - New Doors

242,352 Btuh - 40,392 Btuh = 201,960 Btuh - Savings

$$*E = \left(\frac{201{,}960 \times 8159 \times 24}{75 \times .80 \times 1000}\right)(.64)(1.56) = 658{,}062 \text{ cu. ft. gas}$$

electrical savings kwh/year
fuel 1 savings 658,062 cu. ft /year
fuel 2 savings /year
Total Fuel Savings 658,062 MMBTU/Year

*See prior sheet

Economic Analysis

(1) Design cost: $ ____________

(2) Acquisition cost: $ 47,050

1 - 20H x 18W thermal door - $6,800
7 - 16H x 18W thermal doors - $5,750 ea - $40,250
$6,800 + $80,500 = $47,050

(3) Installation cost: $ 94,000

1 - 20 x 18 - $13,500
7 - 16 x 18 - $11,500 ea. - $80,500
$13,500 + $80,500 = $94,000

Total Modification Cost = (1) + (2) + (3): $ 141,050

Increased operation and maintenance costs: $ ____________

Salvage or ~~disposal~~ costs: $ -16,000

$ 125,050 Net

Energy Cost Savings

Electrical and/or fuel cost savings:

$2.87/MCF - Nat. Gas

$$\frac{658{,}062}{1{,}000} \times 2.87 = \$1{,}888.64$$

Electrical $	____________	/year
fuel 1 $	1,888.64	/year
fuel 2 $	____________	/year
Total Fuel (1 + 2) $	____________	/year

Payback Period

Simple and alternate payback period:

$$\frac{125{,}050}{1{,}888.64} = 66.21$$

Simple	66.21	years
Alternate	____________	years

(2) & (3) - Local Door Supplier

BUILDING CHARACTERISTICS

A. Description

The Ryan Building was acquired by the City of Bloomington in 1980. Estimated to be about 12 years old, the building is in good condition. It was remodeled in 1981 with insulation, dry ceiling and some space rearrangement. Overall use is similar as designed. Basic construction is concrete block on grade; flat roof, pitch and gravel, rigid insulation, corrugated steel deck over trusses. There are numerous large corrugated steel roll-up service doors.

B. Envelope Characteristics

1. Office Walls

	"R"
Outside Air Film	0.17
4" Face Brick	0.43
8" Concrete Block	1.11
2" Insulation	5.00
1/4" Plywood	0.59
Inside Air Film	0.61
	7.91

"U" = 1/7.91 = 0.13

2. Garage Walls

Outside Air Film	0.17
8" Concrete Block	1.11
Inside Air Film	0.61
	1.95

"U" = 1/1.95 = 0.51

3. Office Ceiling

Outside Air Film	0.17
Built Up Roof	0.33
Insulation	4.17
Steel Deck	0.00
Air Space	1.23
3/4" Ins. Ceiling Tile	1.68
Inside Air Space	0.68
	8.26

"U" = 1/8.26 = 0.12

C. Building Heat Loss

Office Walls	0.13 x 3,552 Ft^2 x 82^oF Δt	= 37,865 Btuh
Garage Walls	0.51 x 14,054 Ft^2 x 75^oF Δt	= 54,700 Btuh
Office Glass	0.55 x 1,308 Ft^2 x 82^oF Δt	= 58,990 Btuh
Garage Glass	1.13 x 514 Ft^2 x 75^oF Δt	= 43,562 Btuh
Office Doors	1.40 x 24 Ft^2 x 82^oF Δt	= 2,755 Btuh
Garage Doors	1.28 x 3,764 Ft^2 x 75^oF Δt	= 361,344 Btuh
Office Ceiling	0.12 x 8,508 Ft^2 x 82^oF Δt	= 83,719 Btuh
Garage Ceiling	0.21 x 18,340 Ft^2 x 75^oF Δt	= 288,855 Btuh
Office Infiltration	0.55 x 4,884 Ft^2	= 2,686 Btuh
Garage Infiltration	0.70 x 18,332 Ft^2	= 12,832 Btuh
Door Infiltration	6 Btuh x 3,764 Ft^2	= 22,584 Btuh
Edge Loss	45 Btuh/Ft. x 916 Ft.	= 41,220 Btuh
		1,011,112 Btuh

D. Building Energy Using Systems

1. Heating Systems

   The three sections of the building are heated separately with three different systems as follows:

   A. Office Area - roof top combination gas fired air handler and air conditioning unit with ducted air diffusers to each area.

   B. Storage Area - overhead separate gas fired unit heaters, five units total.

   C. Garage Repair Area - single gas fired horizontal furnace with ducted overhead distribution system.

2. Ventilation Systems

   A. Office Area - as needed exhaust systems for toilet areas; manual switching and time clock operation.

   B. Storage Area - no ventilation system in storage area; gas fired unit heaters depend on infiltration for combustion air, creating negative pressure in area.

   C. Garage Repair Area - timed high and low power exhaust system ducted throughout area; manual switching optional.

3. Lighting

   A. <u>Office Area</u> - fluorescent lighting throughout

   B. <u>Storage Area</u> - fluorescent lighting in entire area as well as dock lighting

   C. <u>Garage Repair Area</u> - H.I.D. lighting in high bay area fluorescent in a few side repair and storage areas.

4. Compressed Air Systems

   A. High pressure shop air system piped throughout garage area only for equipment operation.

   B. Control air system operating heat - A/C control valves and thermostats.

E. Building Components

1. Office Area

   A. Heat-Cool Rooftop Air Handler
   Mammoth Industries Unit
   Model CEHB-251-6-415 M25
   520,000 input natural gas max.
   260,000 input natural gas min.
   415,000 output Btuh modulating burner with
   1/3 H.P. burner blower, 1/4 H.P. induced draft
   7-1/2 H.P. blower - 208/60/3
   30 H.P. compressor - 208/60/3
   3 H.P. condenser - 208/60/1
   Low ambient lock out on compressor

2. Storage Area

   5 - Bryant gas fired unit heaters
   120,000 Btuh input

3. Garage Area

   A. Mammoth Industires Horizontal Gas-Fired Furnace
   8,000,000 Btu input
   30 H.P. blower
   Adjustable fresh air intake

   B. Air Compressors
      1. Westinghouse - 100# air, 10 H.P. - 208/60/3
      2. Buckeye Boiler Co. - Air Compressor for control air - 3/4 H.P., 115/60/1

4. Paint Shop - not previously listed - unused. Ambient Storage only at present

   A. Mammoth Nu Air Direct Fired Make Up Furnace
      Mode T-3680
      10,400,000 BTUH input
      80,000 CFM - 40 H.P. blower, 208/6/3

   B. Malsbory Steam Jenny
      1,000,000 BTU input, natural gas

   C. Air Compressor - shop air
      Est. 40 H.P. compressor

   D. Explosion-proof fluorescent lighting.

   Above equipment list for reference only. Not included in audit report.

MAXI AUDIT

OF THE

WATER TREATMENT PLANT

FOR

BLOOMINGTON, MINNESOTA

TABLE OF CONTENTS

Introduction

This Maxi-Audit Report is a detailed engineering analysis, of the Water Treatment Plant, to identify possible energy conservation measures. These items are shown along with their costs, yearly energy savings and payback times.

Summary

The Water Treatment Plant is a 7-year-old building, used for softening, purifying, clarifying and adding chemicals to the water system for the City of Bloomington.

This facility uses the largest amount of energy of all of Bloomington's public properties. Therefore, it might stand to reason that, because of the number of processes, methods, equipment, structural features and operating procedures, there might be an opportunity for extensive savings. This does not appear to be the case; most energy demands are consistent with this type of industrial operation.

The potential for additional energy savings exists, but would require a study of the processes, equipment, pumping and tank design that is beyond the scope of this report. In this type of plant, a high energy use exists that is directly related to gallons per minute pumped and is independent of the total building design criteria.
A cursory examination of power factors listed elsewhere in this report showed them to be satisfactory, after which we examined the heating, building shell, and efficient heat usage. These last three areas offer the best immediate energy saving opportunities, as follows:

Energy Saving Items

Item	Cost	Savings	Payback Time
Snow Melt Controls	$ 600.00	$10,122.67	.06 years
New Boiler Controls	$1,218.00	$ 3,309.54	0.37 years
Add Capacitors	See Appendix II		
Domestic Solar Water Heating	$1,400.00	$ 25.15	55.60 years
Building Solar Heating	$290,000.00	$ 3,603.21	80.50 years

There are several additional items to consider which were outlined in the mini-audit and fall under the classification of maintenance and operation. These may be expense items with no immediate energy savings, but a long-term operating savings may be realized. The corrosion of unit heaters, thermostats, valves, registers, piping, heat exchangers, air conditioning equipment, etc. reduces useful life and operating efficiency, due to chemical oxidation. This corrosion can be impeded by adding ventilation which will reduce humidity, dust and chemical fumes, perhaps better than an expensive dehumidification process. All air conditioning equipment is reaching its saturation point of moisture removal (approximately 25% of coil capacity).

LOGGED

MAXI-AUDIT REPORT

NOV 04 1981

A — CONTACT DATA

BUILDING NAME	NAME OF ORGANIZATION	DATE
Water Treatment Plant	City of Bloomington	6-4-81

BUILDING ADDRESS	ADDRESS
9304 Poplar Bridge Road	2215 West Old Shakopee Road

CITY	ZIP CODE	CITY	ZIP CODE
Bloomington, MN	55437	Bloomington, MN	55431

PERSON COMPLETING FORM	TELEPHONE	CONTACT PERSON	TELEPHONE
P.R. Wilcox	612/935-6901	Arthur W. Jensen	612/881-5811

B — BUILDING ELIGIBILITY CODE

Instructions: For blocks 1 and 2 check the box which best fits the building ownership conditions. For block 3 determine which of the four categories describes the building type and then within the category check off the sub category befitting the building function.

1. OWNERSHIP TYPE
   - [X] Public (PUB)
   - [ ] Non-Profit Association (NAP)

2. ULTIMATE OWNER
   - [ ] County (CNTY)
   - [X] City (CITY)
   - [ ] Township (TOWN)
   - [ ] State (STAT)
   - [ ] Public School (PUSC)
   - [ ] Private School (PRSC)
   - [ ] Non-Profit Association (NPAP)
   - [ ] Indian Tribe (INDN)

3a. SCHOOLS
   - [ ] Elementary (SCHL-ELM)
   - [ ] Secondary (SCHL-SECD)
   - [ ] Coll. or Univ. (SCHL-POST)
   - [ ] Vocational (SCHL-VOCL)
   - [ ] Education Agency (SCHL-ADMN)
   - [ ] Administration (SCHL-ADMN)
   - [ ] OTHER (SCHL-OTHR)

b. PUBLIC CARE
   - [ ] Nursing Home (PBCR-NURS)
   - [ ] Long Term Care (PBCR-TERM)
   - [ ] Rehab. Facility (PBCR-RHAB)
   - [ ] Public Health Ctr. (PBCR-HCTR)
   - [ ] Res. Child Care Ctr. (PBCR-RCCC)

c. LOCAL GOVERNMENT
   - [ ] Office (LOCG-OFFC)
   - [ ] Storage (LOCG-STRG)
   - [X] Service (LOCG-SERV)
   - [ ] Library (LOCG-LBRY)
   - [ ] Police (LOCG-PLCE)
   - [ ] Fire (LOCG-FIRE)
   - [ ] OTHER (LOCG-OTHR)

d. HOSPITALS
   - [ ] General (HOSP-GENL)
   - [ ] Tuberculosis (HOSP-TUBR)
   - [ ] OTHER (HOSP-OTHR)

C — ENERGY REPORT CHECK-OFF

Check the type of reports which were completed prior to this maxi-audit report form.

- [X] Energy Report
  - [ ] Elementary School Energy Report (form no. ED-00444-02)
  - [ ] Secondary School Energy Report (form no. ED-00445-02)
  - [X] Existing Building Energy Report (form no. EN-00041-01)
- [X] Mini-Audit Report (form no. EN-00065-01)

If no energy report was completed before this maxi-audit report, include one with this report. Elementary school administrators should use form no. ED-00444-02. Secondary and vocational school administrators should use form no. ED-00445-02. All other building owners should use form no. EN-00041-01. All building auditors are to use the mini-audit form EN-00065-01 after completion of one of the first three above.

D — ENERGY REPORT AND MINI-AUDIT REPORT SUMMARY

Instructions: Complete this section with a summary of what was accomplished as a result of the energy report and the mini-audit report.

ENERGY REPORT:

The City administration authorized the mini-audit as a result of the energy report. The report indicates high energy usage, but a review shows most use for process application.

MINI-AUDIT REPORT:

The mini-audit outlined 32 separate considerations, some that oculd be done on an immediate basis, and others requiring budget expenditures. Additional details were supplies on several listings. The City classified most for maxi-audit, which this report will cover. Capital expenditures for some improvements are being determined for upcoming budgets. Example - lighting replacements.

E

Instructions: This section is to be completed and signed by a registered architect, a registered mechanical engineer, or a registered electrical engineer. This section should be completed after this maxi-audit report is completed. All blanks must be filled in.

I have reviewed the building energy report and/or the mini-audit report for this building. I found all information contained therein to be correct, to the best of my knowledge, or I have corrected any misinformation on the reports, which will be resubmitted with the maxi-audit report to the Minnesota Energy Agency.

I am not directly responsible for the day-to-day operation of this building being audited.

I have fully disclosed my financial interests relating to this maxi-audit and any energy conservation measures considered by this audit.

Referring to section G, I have included an analysis that assumes all energy savings obtained from energy conservation operation and maintenance procedures have been realized.

I have calculated the total energy cost savings, by fuel type, expected to result from the acquisition and installation of all recommended energy conservation measures, taking into account the interaction among the various measures.

The energy prices used in the maxi-audit report are the current prices based on the institution's most recent purchase.

Included in the maxi-audit report is a solar analysis for: (check one or more)

- ☒ a domestic hot water heating system
- ☒ a space heating system
- ☐ an electrical generation system
- ☐ an attached solar greenhouse
- ☐ other: (specify)__________

I recommend that this building should not undergo a solar installation.
(should, should not)

Included in the maxi-audit report is a list of local zoning ordinances or building codes that will restrict the utilization of solar energy ☐ YES ☒ NO (A no answer indicates that there are no local zoning ordinances or building codes to my knowledge that will restrict the use of solar energy systems.)

I recommend that this building ~~should not~~ undergo a waste, wind, or wood installation.
(should, should not) (circle which one(s))

I hereby certify that this audit was prepared by me or under my direct supervision and all information contained herein is correct to the best of my knowledge. I am a duly registered mechanical engineer, electrical engineer, or architect under the laws of the State of Minnesota. (only one signature is required)

Architect	Engineer Paul Martinsen
Signature	Signature Paul B. Martinsen
Registration no.	Registration no. 9597
Firm	Firm Rieke Carroll Muller Associates, Inc.
Address	Address P.O. Box 130, Hopkins, MN 55343
Phone	Phone 612/935-6901
Date	Date 6-4-81

MAX-AUDITOR STATEMENTS

F

Instructions: For determining the remaining useful life of the building, list each addition of the building and describe the addition, its condition, its age, and its gross square footage. Then for the building as a whole enter the remaining useful life in years. Enter the gross floor area of the building. Some of this information can be found in the energy report.

REMAINING USEFUL LIFE OF THE BUILDING

Building Unit	Condition	Age	Sq. Ft.
1974 Water Treatment Plant		7 years	32,696

Remaining Useful Life of the Building	88 Yrs	Gross Floor Area of the Building	32,696 Sq. Ft.

G

Instructions: Enter the energy consumption of the building by fuel type in MMBTU's/year when the building is at optimum efficiency. Enter the energy index in MBTU's/square foot/year.

ESTIMATED ENERGY INDEX

	Fuel 1	Fuel 2	Electricity	Total
MMBTU/Year	2615.2	693.45	40,330.24	43,638.89
MBTU/sq. ft./Yr.	79.9	21.21	1,233.49	1,334.69

NOTE: For the conversion of fuel quantity to BTU's, use the following conversion factors *for this section only.*

Electricity—11,600 BTU per kilowatt-hour
Natural gas—1,030 BTU per cubic foot
Distillate fuel oil—138,690 BTU per gallon
Residual fuel oil—149,690 BTU per gallon
Coal—24.5 million BTU per standard short ton
Liquefied petroleum gases including propane and butane—95,475 BTU per gallon
Steam—1,390 BTU per pound

The above conversion factors are stipulated in the federal requirements for the Institutional Buildings Grants Program. These source conversion factors are to be used in this section only. Conversion factors may be taken from engineering reference manuals for fuels not listed.

H

ECO REPORT SUMMARY

Instructions: Read through the list of energy conservation opportunities provided in the Maxi-Audit Manual. Upon completion of a thorough engineering and economic analysis enter all the energy conservation opportunities in this section. Enter the results of the engineering and economic analysis for each energy conservation opportunity as indicated on the "Energy Conservation Measure Development Sheet" and/or "Energy Conservation Operations and Mainenance Procedure Development Sheet" or other format in the appropriate boxes The classification numbers, major and subclass, should be taken from the classification scheme for energy conservation opportunities. Use the fuel codes as listed. The fuel codes indicate the type and the unit of measure. If the fuel comes under OTHER convert the units of measure to MBTU and describe the fuel saved in the description. Enter yes or no in the box entitled "Funding Requested" to indicate whether funding is being applied for through the Institutional Buildings Grants Program. The "Funding Requested" and "Implementation Date" boxes are the only boxes that are not required to be filled upon completion of the maxi-audit report. See page 14 for important detailed instructions.

Electricity, kwh	10	No. 2 fuel oil, gallons	31	Street steam, Mlbs	51
Natural gas, therms	21	No. 4 fuel oil, gallons	32	Solar, hours	52
Natural gas, CCF	22	No. 5 fuel oil, gallons	33	Wind, kwh	53
Natural gas, MCF	23	No. 6 fuel oil, gallons	34	Wood, tons	54
Natural gas, CF	24	Hard coal, tons	41	Other (specify), MBTU	55
LPG, gallons	25	Soft coal, tons	42		

Fuel 1 Code	Quantity of 1 Saved Units	Fuel 1 Cost Savings $	Item No	Classification Major	Classification Sub	Description
24	3,917,061	9870.99	1	6	3	Install snow sensor or under concrete snow melt system. Regulate temperature for use periods only.

Fuel 2 Code	Quantity of 2 Saved Units	Fuel 2 Cost Savings $	Funding Requested	Implem Date
			no	

	Total Fuel Savings MMBTU	Total Fuel Cost Savings $	Acquisition Cost $	Installation Cost $	Design Cost $	Total Modification Cost $	Simple Payback Period Yrs
TOTAL FUEL	3,197.06	9870.99	200.00	400.00	-	600.00	.06

ELECT CODE	Quantity Saved - KWH	Elect Cost Savings $	Increase In O & M Cost $	Salvage Value $	Useful Life - Yrs	Total Energy Cost Savings $	Alternate Payback Yrs (optional)
10	9253	251.68	-	-	18	10,122.67	

Fuel 1 Code	Quantity of 1 Saved – Units	Fuel 1 Cost Savings – $	Item No	Classification Major	Classification Sub	Description
24	897,151	2260.82	2	7	4	Add automatic controls to modulate boiler temperature with outdoor sensor. Use only one circulating pump.

Fuel 2 Code	Quantity of 2 Saved – Units	Fuel 2 Cost Savings – $	Funding Requested	Implem. Date
			no	

	Total Fuel Savings – MMBTU	Total Fuel Cost Savings $	Acquisition Cost – $	Installation Cost – $	Design Cost – $	Total Modification Cost $	Simple Payback Period – Yrs
TOTAL FUEL	897.15	2260.82	865.00	253.00	100.00	1218.00	0.37

ELECT CODE	Quantity Saved – KWH	Elect. Cost Savings – $	Increase In O & M Cost – $	Salvage Value – $	Useful Life – Yrs	Total Energy Cost Savings – $	Alternate Payback – Yrs. (optional)
10	42,840	1048.72	-	-	17	3309.54	

Fuel 1 Code	Quantity of 1 Saved – Units	Fuel 1 Cost Savings – $	Item No.	Classification Major	Classification Sub	Description
			3	1	3	Utilize capacitors where needed on motor to raise power factor to 0.90. (See Appendix II)

Fuel 2 Code	Quantity of 2 Saved – Units	Fuel 2 Cost Savings – $	Funding Requested	Implem. Date
			no	

	Total Fuel Savings – MMBTU	Total Fuel Cost Savings $	Acquisition Cost – $	Installation Cost – $	Design Cost – $	Total Modification Cost – $	Simple Payback Period – Yrs.
TOTAL FUEL				Appendix II		Appendix II	Appendix II

ELECT. CODE	Quantity Saved – KWH	Elect. Cost Savings – $	Increase In O & M Cost – $	Salvage Value – $	Useful Life – Yrs.	Total Energy Cost Savings – $	Alternate Payback – Yrs. (optional)
10		AppendixII	-	-		Appendix II	

Fuel 1 Code	Quantity of 1 Saved – Units	Fuel 1 Cost Savings – $	Item No.	Classification Major	Classification Sub	Description:

Fuel 2 Code	Quantity of 2 Saved – Units	Fuel 2 Cost Savings – $	Funding Requested	Implem. Date

	Total Fuel Savings – MMBTU	Total Fuel Cost Savings $	Acquisition Cost – $	Installation Cost – $	Design Cost – $	Total Modification Cost – $	Simple Payback Period – Yrs.
TOTAL FUEL							

ELECT. CODE	Quantity Saved – KWH	Elect. Cost Savings – $	Increase In O & M Cost – $	Salvage Value – $	Useful Life – Yrs.	Total Energy Cost Savings – $	Alternate Payback – Yrs. (optional)
10							

LOGGED

FUEL AND ELECTRIC CONSUMPTION REPORT

NOV 04 1981

A Instructions: Enter the organization name, date, building name, building address, city, and zip code as used on the prior report, mini-audit report, and/or maxi-audit report.

BUILDING NAME: Water Treatment Plant		NAME OF ORGANIZATION: City of Bloomington	DATE: 6-4-81
BUILDING ADDRESS: 9304 Poplar Bridge Road		ADDRESS: 2215 West Old Shakopee Road	
CITY: Bloomington, MN	ZIP CODE: 55437	CITY: Bloomington, MN	ZIP CODE: 55431
PERSON COMPLETING FORM: P.E. Wilcox	TELEPHONE: 612/935-6901	CONTACT PERSON: Arthur W. Jensen	TELEPHONE: 612/881-5811

CONTACT DATA

B Instructions: Complete this section of fuel consumption as accurately as possible. Indicate the fuel types used by the fuel code as listed. The fuel code number describes the fuel type and the units of measure.

- Electricity, kwh 10
- Natural gas, therms 21
- Natural gas, CCF 22
- Natural gas, MCF 23
- Natural gas, CF 24
- LPG, gallons 25
- No. 2 fuel oil, gallons 31
- No. 4 fuel oil, gallons 32
- No. 5 fuel oil, gallons 33
- No. 6 fuel oil, gallons 34
- Hard coal, tons 41
- Soft coal, tons 42
- Street steam, Mlbs 51
- Solar, hours 52
- Wind, kwh 53
- Wood, tons 54
- Other (specify), MBTU 55

If the fuel used comes under the heading of OTHER, enter the code number 55 and specify the fuel type. For the units of measure convert the units as stipulated from the supplier to MBTU using the conversion factors as listed in the Maxi-Audit Manual or other engineering reference text. Enter the storage capacities of each fuel type for the building. Enter the year the data is being completed for. Enter the monthly quantities used, if it is measured, and the cost corresponding with the quality used. Otherwise enter the purchased quantities and costs. If more than two fuels are used make additional copies of this form.

		FUEL TYPE: Natural Gas	UNIT OF MEASURE: CCF	FUEL TYPE: #2 Fuel Oil	UNIT OF MEASURE: Gallons
		FUEL CODE:	STORAGE CAPACITY:	FUEL CODE: 31	STORAGE CAPACITY:
Month	Year	Quantity Used	Cost	Quantity Used	Cost
July	1979	810	231.71	0	
August	1979	860	252.58	0	
September	1979	810	235.86	0	
October	1979	1300	342.23	0	
November	1979	2360	543.21	0	
December	1979	3270	756.11	0	
January	1980	4670	1097.77	0	
February	1980	4510	1113.65	0	
March	1980	4380	1080.52	0	
April	1980	3750	919.82	0	
May	1980	1400	351.33	0	
June	1980	600	162.63	0	
Year Total		28,720	7087.42	0	

FUEL CONSUMPTION

Minnesota Energy Agency
EN-00078-01 December 1979

C

Instructions: Complete this section on electrical consumption as accurately as possible. Enter the electrical utility name supplying electrical power to the building and the rate classification utilized. Enter the year that the data is being completed for. Use the same months and year for this section as were used in the fuel consumption section. Enter the electrical energy consumed in kilowatt-hours. Enter the total electric bill for each month. If the building has a demand meter, enter the maximum kilowatt demand for each month. Enter the power factor also, if it is included in the utility metering.

Utility Name: Northern States Power Company

Rate Classification: Commercial-Water & Sewer Pumping Rate

ELECTRICAL CONSUMPTION

Month	Year	Energy Kilowatt-Hours	Maximum Demand Kilowatts	Power Factor	Cost ($)
July	1979	364,183			9383.24
August	1979	348,560			9031.74
September	1979	370,829			9963.68
October	1979	328,271			7617.58
November	1979	313,197			7023.34
December	1979	266,057			6137.91
January	1980	235,095			5683.93
February	1980	194,157			4552.01
March	1980	207,291			4925.57
April	1980	222,160			5593.93
May	1980	199,349			4907.41
June	1980	337,452			9244.20
Year Total		3,386,601			84,064.54

Upon completion of the Fuel and Electrical Consumption Report Form mail it to:

Minnesota Energy Agency
Conservation Research and Development
Conservation Division
980 American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101

RENEWABLE RESOURCES REPORT

The most practical renewabel resource area for the Water Treatment Plant is solar. The building was analyzed for application of a solar collector system for both the domestic hot water system and the building heating system. The results are tabulated below.

	Domestic Hot Water-49%	Building Heating-51%
Cost	$1400.00	$290,000.00
Energy Savings	$ 25.15	$ 3,603.21
Payback Time	55.6 years	80.5 years

Based on the above data, the systems would not be practical to install, because the payback time is excessive or will probably exceed the life of the building. Also, the building has a hot water heating system which would require costly modifications to be compatible with a solar collector heating system.

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(GIVEN DATA)

Month	D_o Work days/mo.	N_d (Days per month)	T_a (^0F)	H_t (Btu/day ft^2)
January	31	31	12.2	1124
February	28	28	15.8	1363
March	31	31	28.4	1433
April	30	30	44.6	1442
May	31	31	57.2	1475
June	30	30	66.2	1522
July	31	31	71.6	1588
August	31	31	69.8	1581
September	30	30	60.8	1519
October	31	31	50.0	1484
November	30	30	32.0	1004
December	31	31	19.4	897

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(CALCULATED DATA)

Month	L_w (Btu/Month)	N_f (Ft^3/mo)	X/A ($1/ft^2$)	Y/A ($1/ft^2$)	X	Y	f	f x L_w (Btu/Month)
January	1,094,895	1,772	0.122	0.019	4.27	0.67	0.32	350,366
February	988,938	1,600	0.118	0.023	4.13	0.81	0.45	445,022
March	1,094,895	1,772	0.104	0.024	3.64	0.84	0.50	547,447
April	1,059,576	1,715	0.087	0.025	3.05	0.88	0.54	572,171
May	1,094,895	1,772	0.075	0.025	2.63	0.88	0.56	613,141
June	1,059,576	1,715	0.067	0.025	2.35	0.88	0.58	614,554
July	1,094,895	1,772	0.062	0.027	2.17	0.95	0.62	678,834
August	1,094,895	1,772	0.064	0.026	2.24	0.91	0.61	667,885
September	1,059,576	1,715	0.072	0.025	2.52	0.88	0.58	614,554
October	1,094,895	1,772	0.082	0.025	2.87	0.88	0.57	624,090
November	1,059,576	1,715	0.100	0.017	3.50	0.56	0.30	317,872
December	1,094,895	1,772	0.114	0.015	3.99	0.53	0.26	284,672
	602,950	974						286,525

$$L_w = 8.33 \times N \times Z \times D_o \times (T_w - 52)$$

$$N_f = \frac{L_w}{H_f \times E_f}$$

$$X/A = 16.8 \times \frac{N_d}{L_w} \times (212 - T_a) \times 1 + 0.006(60 - T_a)$$

$$Y/A = 0.59 \times H_T \times \frac{N_d}{L_w}$$

$$X = X/A \times A$$

$$Y = Y/A \times A$$

$$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$$

N = No. of bldg. occupants = 4

Z = Daily water consump/occupant = 20 gal.

D_o = No. of days per mo. bldg. is occupied

T_w = Water temperature (^oF) = 105^o

H_f = Fuel heating value = 1030 BTU / Ft^3

E_f = Avg. heating efficiency = 60%

A = Solar collector plate area = 35 Ft^2

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_w}{\sum L_w}$$

$$= \frac{6{,}330{,}608}{12{,}891{,}507}$$

$$= .49 \text{ or } 49\%$$

2. System Cost (Cs)

$$C_s = \$40.00/Ft^2 \times \text{Area}$$

$$= \$40.00/Ft^2 \times 35 \text{ sq. ft.}$$

$$= \$1{,}400.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \sum N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.49 \times 20{,}864\ Ft^3/yr \times \$0.00246/Ft^3$$

$$= \$25.15 \text{ per year}$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$1{,}400.00}{\$\ 25.15}$$

$$= 55.6 \text{ years}$$

SOLAR ASSISTANCE TO BUILDING HEATING
(GIVEN DATA)

Month	N_d (Days per month)	T_a (^0F)	H_t (Btu/day ft^2)	N_f (ft^3/month)
January	31	12.2	1124	4,670
February	28	15.8	1363	4,510
March	31	28.4	1433	4,380
April	30	44.6	1442	3,750
May	31	57.2	1475	1,400
June	30	66.2	1522	600
July	31	71.6	1588	810
August	31	69.8	1581	860
September	30	60.8	1519	810
October	31	50.0	1484	1,300
November	30	32.0	1004	2,360
December	31	19.4	897	3,270

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

N_f = number of fuel units consumed per month (ft^3/month)

SOLAR ASSISTANCE TO BUILDING HEATING
(CALCULATED DATA)

Month	L_T (Btu/Month)	X/A $1/ft^2$	Y/A $1/ft^2$	X	Y	f	$f \times L_T$ (Btu/Month)
January	288,606,000	0.36×10^{-3}	0.07×10^{-3}	02.61	0.51	0.30	86,581,800
February	278,718,000	0.33×10^{-3}	0.08×10^{-3}	02.39	0.58	0.36	100,338,480
March	270,684,000	0.35×10^{-3}	0.10×10^{-3}	02.54	0.73	0.47	127,221,480
April	231,750,000	0.36×10^{-3}	0.11×10^{-3}	02.61	0.80	0.51	118,192,500
May	86,520,000	0.93×10^{-3}	0.31×10^{-3}	06.74	2.25	0.93	80,463,600
June	37,080,000	1.98×10^{-3}	0.73×10^{-3}	14.36	5.29	1.00	37,080,000
July	50,058,000	1.46×10^{-3}	0.58×10^{-3}	10.59	4.21	1.00	50,058,000
August	53,148,000	1.39×10^{-3}	0.54×10^{-3}	10.08	3.92	1.00	53,148,000
September	50,058,000	1.52×10^{-3}	0.54×10^{-3}	11.02	3.92	1.00	50,058,000
October	80,340,000	1.05×10^{-3}	0.34×10^{-3}	07.61	2.47	0.95	76,323,000
November	145,848,000	0.62×10^{-3}	0.12×10^{-3}	04.50	0.87	0.47	68,548,560
December	202,086,000	0.50×10^{-3}	0.08×10^{-3}	03.63	0.58	0.30	60,625,800
	1,774,895,600						908,639,220

$$L_T = N_f \times H_f \times E_f$$

H_f = fuel heating value = 1,000 BTU $/ft^3$

E_f = average furnace efficiency = 60%

$$X/A = 16.8 \times \frac{N_d \times (212 - T_a)}{L_T}$$

$$Y/A = 0.59 \times H_T \times \frac{N_d}{L_T}$$

A = solar collector plate area = 7250 Ft^2

$X = X/A \times A$

$Y = Y/A \times A$

$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$

SOLAR ASSISTANCE TO BUILDING HEATING
COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_T}{\sum L_T}$$

$$= \frac{908,639,220}{1,774,896,000}$$

$$= 0.51 \text{ or } 51\%$$

2. System Cost (Cs)

$$C_s = \$40.00/Ft^2 \times \text{Area}$$

$$= \$40.00Ft^2 \times 7,250 \text{ sq. ft.}$$

$$= \$290,000.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \sum N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.51 \times 28,720\ Ft^3/yr \times \$0.00246\ /Ft^3$$

$$= \$3,603.21/\text{year}$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$290,000.00}{\$\ 3,603.21}$$

$$= 80.5 \text{ years}$$

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

LOGGED

Building: Water Treatment Plant
9310 Poplar Bridge Road
Bloomington, MN 55437

Date 6-4-81
Item No. 1
Major Class 6
Sub. Class 8

Energy Conservation Measure

Description of existing equipment:

Present mechanical system is using a snow melting system to keep approach apron to the garage area free of snow. This system is connected to a heat exchanger from the plant boiler. Manual switch with temp. regulating valve. All winter operation manual.

Description of energy conservation measure:

Install snow sensor to activate system only when snow is present. Nov. 1 to March 31, total of 3630 hours, ASHRAE guide shows an average of 203 hours per year of snow, or 5.6% of the total hours. Present temperature regulator resets on fluid temperature all winter.

Useful life 18 years

Engineering Analysis:

Annual heating degree days 8382
Annual cooling degree days 523
Fuel 1 gas units of Measure CF
Fuel 2 electricity units of Measure KW

System designed for Class III industrial use allowing 254 BTU/Ft^2/hr.

Actual ramp area is 3600 Ft^2.

$3600 \times 254 \times 203 = 186 \times 10^6$ BTU/Year

$\frac{186 \times 10^6}{0.8 \times 1000} = 232{,}029$ CF gas (snow time only)

$\frac{3600 \times 254 \times 3630}{0.8 \times 1000} = 4{,}149{,}090$ CF gas (all winter use)

4,149,090 - 232,029 = 3,917,061 CF gas

203 x 1.5 HP x 1.8 = 548 KW (snow use-circulator)

3630 x 1.5 HP x 1.8 = 9801 KW (all winter circulator)

9801 - 548 = 9253 KW savings

Minor efficiency losses not included in calculations and do not affect comparisons.

See Snowfall Data - Page 41

electrical savings 9253 kwh/year
fuel 1 savings 3,917,061 CF /year
fuel 2 savings ______ /year
Total Fuel Savings 3817.061 MMBTU/Year

Economic Analysis

(1) Design cost: $ 0

(2) Acquisition cost: $ 200.00

* 1 - snow sensor (several models available)

/

(3) Installation cost: $ 400.00

* Labor - 1 person - 2 days

Total Modification Cost = (1) + (2) + (3): $ 600.00

Increased operation and maintenance costs: $ 0

Salvage or disposal costs: $ 0

Energy Cost Savings

Electrical and/or fuel cost savings:

9253KWH x $.0272/KWH = $251.68

3,917,061 CF x $ .00252/FT^3 = $9870.99

Electrical $	251.68	/year
fuel 1 $	9870.99	/year
fuel 2 $		/year
Total Fuel (1 + 2) $	10,122.67	/year

Payback Period

Simple and alternate payback period:

$$\frac{\$600.00}{\$10,122.67/\text{year}} = 0.06 \text{ years}$$

*Honeywell Factory Quote

Simple	.06	years
Alternate		years

Minneapolis Snowfall Data Sheet

856.68 hrs over 32^{0}F - no snow	23.6%
2570.04 hrs below 32^{0}F - no snow	70.8%
203 hrs snowfall	5.6%

3630 total hours - Nov. 1 to March 31

254 BTU/sq ft - Design - Class III Industrial

98 x 36 + 70 = 3598.00 ft^2

3600 x 254 = 914,400 BTU/hr

914,400 x 203 = 185,623,200 BTU/hr

$$\frac{186 \times 10^6}{0.8 \times 1000} = 232{,}029 \ ft^3 \text{ gas}$$

232,029 x .00252 = $584.71/year cost - gas

203 x 1.5HP x 1.8KW/HP = 548 KW

548 x .0272 = $14.91/year electricity

$584.71 + $14.91 = $599.62/year cost, $2.95/hr

$2.95 x 3630 hr = $10,722.24 cost/total winter use

10,722.24 - 599.62 = $10,122.62 savings

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

Building: Water Treatment Plant
9310 Poplar Bridge Road
Bloomington, MN 55437

Date 6-4-81
Item No. 2
Major Class 7
Sub. Class 4

Energy Conservation Measure

Description of existing equipment:

Boiler and pumps running when outside air temperature is above $65^{O}F$.

Description of energy conservation measure:

Connect boiler on outdoor anticipator.
Run only one 5 HP circulator.
Pump on low demand. Run second pump on temperatures below $10^{O}F$.

Useful life 17 years

Engineering Analysis:

Annual heating degree days 8382
Annual cooling degree days 523
Fuel 1 gas units of Measure CF
Fuel 2 ______ units of Measure ______

Assume: 6120 hours running time/year
$.0272/KW - electric rate
$2.52/MCF - gas rate

6120 x 5 HP x 1.4 = 42,840 KW/year

Actual gas usage: 2,872,000 CF

April through October degree days = 1739

$$\frac{1739}{8382} = \frac{X}{2{,}872{,}000}$$

x = 595,849

Use: April through October = 1,493,000 (from plant records)

1,493,000 - 595,849 = 897,151 CF

electrical savings 42,840 kwh/year
fuel 1 savings 897,151 CF /year
fuel 2 savings ______ /year
Total Fuel Savings 1043.36 MMBTU/Year

Economic Analysis

(1) Design cost: $ 100.00

(2) Acquisition cost: $ 865.00

1 - outdoor ant. controller	$385.00
1 - aquastat controller	280.00
wiring	200.00
	$865.00

(3) Installation cost: $ 253.00

1 - outdoor controller	$129.00
1 - aquastat controller	124.00
	$253.00

Total Modification Cost = (1) + (2) + (3): $ 1,218.00

Increased operation and maintenance costs: $ --------

Salvage or disposal costs: $ --------

Energy Cost Savings

Electrical and/or fuel cost savings:

Electricity rate = $0.0272/kW
Gas rate = $2.52/MCF

$$42{,}840 \text{ kWH} \times \frac{0.0272}{\text{kWH}} \times .9 = \$1{,}048.72 = \text{Electricity}$$

$$897{,}151 \text{ CF} \times 0.00252 = \$2{,}260.82 = \text{Gas}$$

Electrical $ 1,048.72 /year
fuel 1 $ 2,260.82 /year
fuel 2 $ ______ /year
Total Fuel (1 + 2) $ 3,309.54 /year

Payback Period

Simple and alternate payback period:

$$\frac{1{,}218}{3{,}310/\text{yr}} = 0.37/\text{yr}$$

Simple 0.37 years
Alternate ______ years

Building Characteristics

A. Description

The Water Treatment Plant was built in 1974 of concrete block and face brick walls. Ceiling is concrete with insulated pitch and gravel covering. Additional insulation has been added to the underside of ceiling in some areas. Large glass areas identify the modern building. A portion of the wall areas are below grade as this is a multi-level structure.

B. Enevelope Characteristics

1. Walls

	"R"
Outside Air Film	0.17
4" Face Brick	0.44
Cement Mortar - ½"	0.10
Concrete Block	1.24
Inside Air Film	0.68
	2.63

U = 1/2.63 = 0.38

2. Roof

Outside Air Film	0.17
Built-up Roofing	0.33
Insulation	6.76
Concrete Decking	3.24
Inside Air Film	0.61
	11.11

U = 1/11.11 = 0.09

3. Building Heat Loss

Walls	$0.38 \times 19,838\ FT^2 \times 75^o \Delta t$	=	565,383 BTUH
Glass & Doors	$0.55 \times 2520\ FT^2 \times\ 75^o \Delta t$	=	103,950 BTUH
Roof	$0.09 \times 19,445\ FT^2 \times 75^o \Delta t$	=	131,254 BTUH
Edge Loss	45 BTU/FT x 1056 lin.ft.	=	47,520 BTUH
Infiltration	$3,72 \times 456 FT^2 \times 75^o \Delta t$	=	127,216 BTUH
			975,323 BTUH

D. Building Energy Using Systems

1. Water Pumping Systems and Process

   Appendix I lists the major pump motors and their uses. Numberous smaller fractional motors are used throughout the plant, however they are not continous operation. For this reason, it is not feasible to determine daily energy use. All electric power is combined to total plant uses, as this is the largest single electric energy use facility in Bloomington. Programmed panel board operation is in use.

2. Heating System

   The majority of the building is heated with a hot water boiler, gas-oil combination. Unit heater and baseboard radiation are the heating elements. Office areas and lab have hot water coils in the combination heating/air conditioning units.

3. Air Conditioning Systems

   Office areas use air conditioning units that dispells its heat into adjacent room space. Laboratory areas use a split system with a/c on the roof and a heating coil from the boiler hot water system.

4. Dehumidification System

   Dehumidification of select areas is accomplished with a water cooled electric unit.

5. Exhaust Systems

   Several small exhaust air systems throughout the plant. Manual operation for most systems except chemical exhausts, which are on automatic sensors.

6. Snow Melting System

   Under the concrete system for snow melt; operates on glycol-water from heat exchanger. Boiler heat and pump operation are manual.

7. Lighting

   Most of the plant is fluorescent lighting. Outdoor lighting is the only unit on automatic photocell switching. Incandescent lighting in some process areas.

D. Building Energy Using Systems (continued)

8. Security System

Total plant operation is monitored from the master switchboard system. Door security uses magnetic sensors for indicating door position.

E. Building Equipment

1. Boiler

Gas-oil hot water boiler unit
720,000 BTUH input
dual - 5 HP circulating pumps - B & G

2. Heat-Cool Units

Singer Incremental heater in office.
Trane Split System in lab.

3. Process Equipment

See Appendix III

4. Water Heater

Gas fired water heater for summer use.
Circulator used continuous. 1/12 HP - B & G

5. Lights

Fluorescent and incandescent

APPENDIX I

ELECTRIC MOTOR POWER FACTOR RATINGS

Water Treatment Plant
9310 Poplar Bridge Road
Bloomington, MN 55437

Location	Equipment	H.P.	Phase	Amps	Power Factor
High Service Pump Room	Circ. Pump #1	100	460/3	100A	0.88
High Service Pump Room	Circ. Pump #2	200	460/3	200A	0.90
High Service Pump Room	Circ. Pump #3	200	460/3	200A	0.90
High Service Pump Room	Circ. Pump #4	100	460/3	95A	0.90
Pump Room	Booster	20	475/2	25A	0.87
Vac. Pump Room	Vac. Pump #50	50	475/3	51A	0.87
Vac. Pump Room	Vap. Pump #48	50	475/3	54A	0.87
Pump Station 82nd St.	Pump #5	400	480/3	425A	0.87

APPENDIX II

Item 3 Major Class - 1, Sub - 3

Electric Motor Energy Savings Chart

(adding capacitators to existing equipment)

H.P.	Capacitator Cost 240V (2)	Capacitator Cost 480V (2)	Est. Dollar Savings/Yr (1)	Simple Payback 240V	Simple Payback 480V
5	$135.00	$260.00	-	-	-
10	$265.00	$325.00	$55.20	4.8	5.89
20	$275.00	$350.00	$110.00	2.5	3.18
50	$350.00	$440.00	$276.00	1.27	1.59
100	$480.00	$780.00	$552.00	0.87	1.4
200	$780.00	$1500.00	$1104.00	0.71	1.36

(1) Based on demand charge of $5.00/KW/mo. and assuming we raise power factor from 0.8 to 0.9.

(2) Furnished and installed prices estimated including overhead and profit.

(3) At the water plant, we observed power factors higher than the 0.8 assumed in the appendix. As a result, the annual saving may be significantly less.

APPENDIX III

	H.P.	Nameplate Current at 480V	Current Observed
Pebble Lime Blower (Lincoln Motor)	20	25	16.0/14.0/15.0
Filtrate Pumps* (G.E. Motor)	5	7.5	6.5A
D.A. 100	1.5	5.4	2.4/3.0/3.0
Screw Conveyor (both sides the same)	2	3.0	2.8/3.0/3.0
Flash Mixer No. 1** (G.E.)	2	3.1	3.5/3.5/3.5
Flash Mixer No. 2** (G.E.)	2	3.1	4.4/4.0/4.4
Sludge Gate Hydraulic Pump (Lincoln)	10	13	7.8/8.1/8.1
Sludge Gate Hydraulic Pump (Lincoln)	10	13	7.0/7.0/6.8
Thickening Tower Scraper (Reliance)	2	3.2	2.1/2.1/2.3
Clarifier Rake Drive (G.E.)	½	2.9	.4/.4/.4
Lime Slaker Torque Mtr. #1	½	2.0	less than .5
Silo Lime Blower (Louisalls)	100	120	54/58
Vacuum Pump #1* (U.S.)	50	59.5	50A
Vacuum Pump #2* (U.S.)	50	59.5	48A
Sludge Thickener *	2	3.2	2.6A
Sludge Pump #1* (Reliance)	10	13.1	7.5A
Sludge Pump #2* (Reliance)	10	13.1	8A
Backwash Pump* (Westinghouse)	100	120	80A
High Service Pump #1*(Westinghouse)	100	114	84A
High Service Pump #2*(Westinghouse)	200	220	186A
High Service Pump #3*(Westinghouse)	200	220	184A
High Service Pump #4*	100	114	88A
Booster Pump #1* (Reliance)	75	92	62A
Booster Pump #2* (Reliance)	75	92	60A
Booster Pump #4* (Reliance)	30	37	37A
Well Pump #1 (out of service)			
Well Pump #2 (U.S.)	150	180	150A
Well Pump #3 (Westinghouse)	125	142	128A

* Observed current from 1-23-79 report

** Overloaded motor - starter contains B6.90 thermal unit rated at 4.44 amps minimum and 4.96 amps maximum. Unit 2 had a loose wire in terminal strip.

MAXI AUDIT

OF THE

PUBLIC WORKS-WESTERN MAINTENANCE

FOR

BLOOMINGTON, MINNESOTA

TABLE OF CONTENTS

Introduction

This Maxi-Audit Report is a detailed engineering analysis, of the Public Works-Western Maintenance Building, to identify possible energy conservation measures. These items are shown along with their costs, yearly energy savings and payback times.

Summary

The Public Works-Western Maintenance Garage is an 8 year old building. Insulation in the built-up flat roof, and no insulation in the walls, makes this structure a high energy use facility during winter months. The high ventilation rate due to its use for vehicle repair mandates close operating conditions to conserve on fuel and electric usage.

Although this report outlines some energy saving opportunities, the largest savings can be realized in the operation of the heating equipment, lighting use and schedule hours. With only a few hours occupancy per day, five days a week, or approximately 15 hours per week, it is hard to identify the best capital improvements for energy management. Other judgement factors not covered in this report should be applied to the following energy saving items.

Energy Saving Items

Item	Cost	Energy Savings/Year	Payback Time
Add Wall Insulation	$5558.08	$1032.30	5.38 years
Install Radiant Heat	$7058.00	$1236.00	5.71 years
Add Storm Windows	$ 678.72	$ 70.72	9.6 years
Solar Domestic Water Heat	$ 128.00	$ 7.35	17.4 years
Solar Building Heat	$114,800.00	$1529.39	75.1 years

LOGGED

MAXI-AUDIT REPORT

NOV 04 1981

A — CONTACT DATA

BUILDING NAME Public Works-Western Maintenance Garage		NAME OF ORGANIZATION City of Bloomington	DATE 6-16-81
BUILDING ADDRESS 10500 Hampshire Avenue South		ADDRESS 2215 West Old Shakopee Road	
CITY Bloomington, MN	ZIP CODE 55431	CITY Bloomington, MN	ZIP CODE 55431
PERSON COMPLETING FORM P.R. Wilcox	TELEPHONE 612/935-6901	CONTACT PERSON Arthur W. Jensen	TELEPHONE 612/881-5811

B — BUILDING ELIGIBILITY CODE

Instructions: For blocks 1 and 2 check the box which best fits the building ownership conditions. For block 3 determine which of the four categories describes the building type and then within the category check off the sub category befitting the building function.

1. OWNERSHIP TYPE
   - [X] Public (PUB)
   - [ ] Non-Profit Association (NAP)

2. ULTIMATE OWNER
   - [ ] County (CNTY)
   - [X] City (CITY)
   - [ ] Township (TOWN)
   - [ ] State (STAT)
   - [ ] Public School (PUSC)
   - [ ] Private School (PRSC)
   - [ ] Non-Profit Association (NPAP)
   - [ ] Indian Tribe (INDN)

3a. SCHOOLS
   - [ ] Elementary (SCHL-ELM)
   - [ ] Secondary (SCHL-SECD)
   - [ ] Coll. or Univ. (SCHL-POST)
   - [ ] Vocational (SCHL-VOCL)
   - [ ] Education Agency (SCHL-ADMN)
   - [ ] Administration (SCHL-ADMN)
   - [ ] OTHER (SCHL-OTHR)

b. PUBLIC CARE
   - [ ] Nursing Home (PBCR-NURS)
   - [ ] Long Term Care (PBCR-TERM)
   - [ ] Rehab. Facility (PBCR-RHAB)
   - [ ] Public Health Ctr. (PBCR-HCTR)
   - [ ] Res. Child Care Ctr. (PBCR-RCCC)

c. LOCAL GOVERNMENT
   - [ ] Office (LOCG-OFFC)
   - [ ] Storage (LOCG-STRG)
   - [X] Service (LOCG-SERV)
   - [ ] Library (LOCG-LBRY)
   - [ ] Police (LOCG-PLCE)
   - [ ] Fire (LOCG-FIRE)
   - [ ] OTHER (LOCG-OTHR)

d. HOSPITALS
   - [ ] General (HOSP-GENL)
   - [ ] Tuberculosis (HOSP-TUBR)
   - [ ] OTHER (HOSP-OTHR)

C — ENERGY REPORT CHECK-OFF

Check the type of reports which were completed prior to this maxi-audit report form.

- [X] Energy Report
  - [ ] Elementary School Energy Report (form no. ED-00444-02)
  - [ ] Secondary School Energy Report (form no. ED-00445-02)
  - [X] Existing Building Energy Report (form no. EN-00041-01)
- [X] Mini-Audit Report (form no. EN-00065-01)

If no energy report was completed before this maxi-audit report, include one with this report. Elementary school administrators should use form no. ED-00444-02. Secondary and vocational school administrators should use form no. ED-00445-02. All other building owners should use form no. EN-00041-01. All building auditors are to use the mini-audit form EN-00065-01 after completion of one of the first three above.

D — ENERGY REPORT AND MINI-AUDIT REPORT SUMMARY

Instructions: Complete this section with a summary of what was accomplished as a result of the energy report and the mini-audit report.

ENERGY REPORT:

The Energy Report (Form EN-00041-01) indicated potential savings. The mini-audit was instituted. Seven energy conservation actions taken after report, with one-third reduction on natural gas use.

MINI-AUDIT REPORT:

Approximately 50-55% of the 30 listed energy opportunities are completed. The new energy records will help identify and manage the use. Most items are maintenance and equipment adjustments. Capital expenditure items will be considered after the Maxi-Audit.

E

Instructions: This section is to be completed and signed by a registered architect, a registered mechanical engineer, or a registered electrical engineer. This section should be completed after this maxi-audit report is completed. All blanks must be filled in.

I have reviewed the building energy report and/or the mini-audit report for this building. I found all information contained therein to be correct, to the best of my knowledge, or I have corrected any misinformation on the reports, which will be resubmitted with the maxi-audit report to the Minnesota Energy Agency.

I am not directly responsible for the day-to-day operation of this building being audited.

I have fully disclosed my financial interests relating to this maxi-audit and any energy conservation measures considered by this audit.

Referring to section G, I have included an analysis that assumes all energy savings obtained from energy conservation operation and maintenance procedures have been realized.

I have calculated the total energy cost savings, by fuel type, expected to result from the acquisition and installation of all recommended energy conservation measures, taking into account the interaction among the various measures.

The energy prices used in the maxi-audit report are the current prices based on the institution's most recent purchase.

Included in the maxi-audit report is a solar analysis for: (check one or more)

- [x] a domestic hot water heating system
- [x] a space heating system
- [ ] an electrical generation system
- [ ] an attached solar greenhouse
- [ ] other: (specify)__________

I recommend that this building should not undergo a solar installation.
(should, should not)

Included in the maxi-audit report is a list of local zoning ordinances or building codes that will restrict the utilization of solar energy ☐ YES ☒ NO (A no answer indicates that there are no local zoning ordinances or building codes to my knowledge that will restrict the use of solar energy systems.)

I recommend that this building should not undergo a waste, wind, or wood installation.
(should, should not) (circle which one(s))

I hereby certify that this audit was prepared by me or under my direct supervision and all information contained herein is correct to the best of my knowledge. I am a duly registered mechanical engineer, electrical engineer, or architect under the laws of the State of Minnesota. (only one signature is required)

Architect	Engineer Paul Martinsen
Signature	Signature Paul B. Martinsen
Registration no.	Registration no. 9597
Firm	Firm Rieke Carroll Muller Associates, Inc.
Address	Address P.O. Box 130, Hopkins, MN 55343
Phone	Phone 612/935-6901
Date	Date 6-16-81

MAX-AUDITOR STATEMENTS

F

Instructions: For determining the remaining useful life of the building, list each addition of the building and describe the addition, its condition, its age, and its gross square footage. Then for the building as a whole enter the remaining useful life in years. Enter the gross floor area of the building. Some of this information can be found in the energy report.

Building Unit	Condition	Age	Sq. Ft.
1973 Maintenance Garage	Normal	8 years	6440

Remaining Useful Life of the Building	87 Yrs	Gross Floor Area of the Building	6440 Sq. Ft.

REMAINING USEFUL LIFE OF THE BUILDING

G

Instructions: Enter the energy consumption of the building by fuel type in MMBTU's/year when the building is at optimum efficiency. Enter the energy index in MBTU's/square foot/year.

	Fuel 1	Fuel 2	Electricity	Total
MMBTU/Year	1283.74		323.77	1607.51
MBTU/sq. ft./Yr.	199.34		50.27	249.61

NOTE: For the conversion of fuel quantity to BTU's, use the following conversion factors *for this section only.*

Electricity—11,600 BTU per kilowatt-hour
Natural gas—1,030 BTU per cubic foot
Distillate fuel oil—138,690 BTU per gallon
Residual fuel oil—149,690 BTU per gallon
Coal—24.5 million BTU per standard short ton
Liquefied petroleum gases including propane and butane—95,475 BTU per gallon
Steam—1,390 BTU per pound

The above conversion factors are stipulated in the federal requirements for the Institutional Buildings Grants Program. These source conversion factors are to be used in this section only. Conversion factors may be taken from engineering reference manuals for fuels not listed.

ESTIMATED ENERGY INDEX

H — ECO REPORT SUMMARY

Instructions: Read through the list of energy conservation opportunities provided in the Maxi-Audit Manual. Upon completion of a thorough engineering and economic analysis enter all the energy conservation opportunities in this section. Enter the results of the engineering and economic analysis for each energy conservation opportunity as indicated on the "Energy Conservation Measure Development Sheet" and/or "Energy Conservation Operations and Mainenance Procedure Development Sheet" or other format in the appropriate boxes The classification numbers, major and subclass, should be taken from the classification scheme for energy conservation opportunities. Use the fuel codes as listed. The fuel codes indicate the type and the unit of measure. If the fuel comes under OTHER convert the units of measure to MBTU and describe the fuel saved in the description. Enter yes or no in the box entitled "Funding Requested" to indicate whether funding is being applied for through the Institutional Buildings Grants Program. The "Funding Requested" and "Implementation Date" boxes are the only boxes that are not required to be filled upon completion of the maxi-audit report. See page 14 for important detailed instructions.

Electricity, kwh	10	No. 2 fuel oil, gallons	31	Street steam, Mlbs	51
Natural gas, therms	21	No. 4 fuel oil, gallons	32	Solar, hours	52
Natural gas, CCF	22	No. 5 fuel oil, gallons	33	Wind, kwh	53
Natural gas, MCF	23	No. 6 fuel oil, gallons	34	Wood, tons	54
Natural gas, CF	24	Hard coal, tons	41	Other (specify), MBTU	55
LPG, gallons	25	Soft coal, tons	42		

Fuel 1 Code	Quantity of 1 Saved Units	Fuel 1 Cost Savings $	Item No	Classification Major	Classification Sub	Description
24	347,574CFM	1032.30	1	2	8	Add styrofoam insluation to walls.
Fuel 2 Code	**Quantity of 2 Saved Units**	**Fuel 2 Cost Savings $**	**Funding Requested**	**Implem Date**		

	Total Fuel Savings MMBTU	Total Fuel Cost Savings $	Acquisition Cost $	Installation Cost $	Design Cost $	Total Modification Cost $	Simple Payback Period Yrs
TOTAL FUEL	347.574	1032.30	1934.56	3623.52	-	5558.08	5.38
ELECT CODE	**Quantity Saved KWH**	**Elect Cost Savings $**	**Increase In O & M Cost $**	**Salvage Value $**	**Useful Life Yrs**	**Total Energy Cost Savings $**	**Alternate Payback Yrs (optional)**
10			-	-	50	1032.30	-

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description
24	520.200	1236.00	2	3	2	Add radian heat.
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs
TOTAL FUEL	520.2	1236.00	5040.00	2016.00	0	7056.00	5.71
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs (optional)**
10			-	-	20	1236.00	—

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description
24	23,812CF	70.72	3	2	10	Install plexiglass storms to overhead doors.
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs.
TOTAL FUEL	23.812	70.72	384.72	294.00	-	678.72	9.6
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs.**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs. (optional)**
10			-	-	20	70.72	

Fuel 1 Code	Quantity of 1 Saved—Units	Fuel 1 Cost Savings—$	Item No.	Classification Major	Classification Sub	Description:
Fuel 2 Code	**Quantity of 2 Saved—Units**	**Fuel 2 Cost Savings—$**	**Funding Requested**	**Implem. Date**		

	Total Fuel Savings—MMBTU	Total Fuel Cost Savings $	Acquisition Cost—$	Installation Cost—$	Design Cost—$	Total Modification Cost—$	Simple Payback Period—Yrs.
TOTAL FUEL							
ELECT. CODE	**Quantity Saved—KWH**	**Elect. Cost Savings—$**	**Increase In O & M Cost—$**	**Salvage Value—$**	**Useful Life—Yrs.**	**Total Energy Cost Savings—$**	**Alternate Payback—Yrs. (optional)**
10							

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FUEL AND ELECTRIC CONSUMPTION REPORT

NOV 04 1981

A Instructions: Enter the organization name, date, building name, building address, city, and zip code as used on the prior report, mini-audit report, and/or maxi-audit report.

CONTACT DATA

BUILDING NAME		NAME OF ORGANIZATION	DATE
Public Works-Western Maintenance Garage		City of Bloomington	6-16-81
BUILDING ADDRESS		ADDRESS	
10500 Hampshire Avenue South		2215 West Old Shakopee Road	
CITY	ZIP CODE	CITY	ZIP CODE
Bloomington, MN	55431	Bloomington, MN	55431
PERSON COMPLETING FORM	TELEPHONE	CONTACT PERSON	TELEPHONE
P.R. Wilcox	612/935-6901	Arthur W. Jensen	612/881-5811

B Instructions: Complete this section of fuel consumption as accurately as possible. Indicate the fuel types used by the fuel code as listed. The fuel code number describes the fuel type and the units of measure.

Electricity, kwh 10	No. 6 fuel oil, gallons 34
Natural gas, therms 21	Hard coal, tons 41
Natural gas, CCF 22	Soft coal, tons 42
Natural gas, MCF 23	Street steam, Mlbs 51
Natural gas, CF 24	Solar, hours 52
LPG, gallons 25	Wind, kwh 53
No. 2 fuel oil, gallons 31	Wood, tons 54
No. 4 fuel oil, gallons 32	Other (specify), MBTU 55
No. 5 fuel oil, gallons 33	

If the fuel used comes under the heading of OTHER, enter the code number 55 and specify the fuel type. For the units of measure convert the units as stipulated from the supplier to MBTU using the conversion factors as listed in the Maxi-Audit Manual or other engineering reference text. Enter the storage capacities of each fuel type for the building. Enter the year the data is being completed for. Enter the monthly quantities used, if it is measured, and the cost corresponding with the quality used. Otherwise enter the purchased quantities and costs. If more than two fuels are used make additional copies of this form.

FUEL CONSUMPTION

		FUEL TYPE natural gas	UNIT OF MEASURE CCF	FUEL TYPE	UNIT OF MEASURE
		FUEL CODE 22	STORAGE CAPACITY	FUEL CODE	STORAGE CAPACITY
Month	Year	Quantity Used	Cost	Quantity Used	Cost
July	19 79	571	154.32		
August	19 79	0	0		
September	19 79	0	6.34		
October	19 79	272	75.14		
November	19 79	1127	298.77		
December	19 79	99	29.89		
January	19 80	1789	475.98		
February	19 80	1956	540.03		
March	19 80	2993	823.63		
April	19 80	737	203.85		
May	19 80	688	190.51		
June	19 80	172	286.55		
Year Total		10,404	3085.01		

Minnesota Energy Agency
EN-00078-01 December 1979

C

Instructions: Complete this section on electrical consumption as accurately as possible. Enter the electrical utility name supplying electrical power to the building and the rate classification utilized. Enter the year that the data is being completed for. Use the same months and year for this section as were used in the fuel consumption section. Enter the electrical energy consumed in kilowatt-hours. Enter the total electric bill for each month. If the building has a demand meter, enter the maximum kilowatt demand for each month. Enter the power factor also, if it is included in the utility metering.

Utility Name: Northern States Power Company

Rate Classification: Commercial

ELECTRICAL CONSUMPTION

Month	Year	Energy Kilowatt-Hours	Maximum Demand Kilowatts	Power Factor	Cost ($)
July	1979	1520			79.97
August	1979	1520			80.17
September	1979	1240			64.22
October	1979	1600			73.86
November	1979	2800			101.99
December	1979	1960			81.37
January	1980	4360			160.67
February	1980	2040			73.22
March	1980	2080			74.86
April	1980	2560			98.25
May	1980	1400			74.90
June	1980	1480			81.50
Year Total		24,560			1044.98

Upon completion of the Fuel and Electrical Consumption Report Form mail it to:

Minnesota Energy Agency
Conservation Research and Development
Conservation Division
980 American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101

RENEWABLE RESOURCES REPORT

The most practical renewable resource are for the Public Works-Western Maintenance Building is solar. The building was analyzed for application of a solar collector system for both the domestic hot water system and the building heating system. The results are tabulated below.

	Domestic Hot Water-51%	Building Heating-49%
Cost	$ 128.00	$ 114,800.00
Energy Savings	$ 7.35/year	$ 1,529.39
Payback Time	17.4 years	75.1 years

Based on the above data, the systems would not be practical to install, bacuse the payback time is excessive or will probably exceed the life of the building.

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(GIVEN DATA)

Month	D_o Work days/mo.	N_d (Days per month)	T_a (^0F)	H_t (Btu/day ft^2)
January	23	31	12.2	1124
February	21	28	15.8	1363
March	21	31	28.4	1433
April	22	30	44.6	1442
May	22	31	57.2	1475
June	21	30	66.2	1522
July	23	31	71.6	1588
August	21	31	69.8	1581
September	22	30	60.8	1519
October	23	31	50.0	1484
November	20	30	32.0	1004
December	23	31	19.4	897

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
(CALCULATED DATA)

Month	L_w (Btu/Month)	N_f (KWH/mo)	X/A ($1/ft^2$)	Y/A ($1/ft^2$)	X	Y	f	$f \times L_w$ (Btu/Month)
January	101,542.7	29.75	1.319	0.203	4.22	0.65	0.33	33,509.09
February	92,712.9	27.16	1.259	0.243	4.03	0.78	0.42	38,939.42
March	92,712.9	27.16	1.227	0.283	3.93	0.91	0.54	50,064.97
April	97,127.8	28.46	0.949	0.272	3.04	0.87	0.53	51,477.73
May	97,127.8	28.46	0.844	0.278	2.70	0.89	0.57	55,362.85
June	92,712.9	27.16	0.763	0.291	2.44	0.93	0.62	57,482.00
July	101,542.7	29.75	0.670	0.286	2.14	0.92	0.64	64,987.33
August	92,712.9	27.16	0.752	0.312	2.41	1.00	0.66	61,190.50
September	97,127.8	28.46	0.781	0.279	2.50	0.89	0.59	57,305.40
October	101,542.7	29.75	0.881	0.267	2.82	0.85	0.55	55,848.49
November	88,298.0	25.87	1.200	0.201	3.84	0.64	0.35	30,904.30
December	101,542.7	29.75	1.228	0.162	3.93	0.52	0.27	27,416.53
	1,156,703.8	338.89						584,488.61

$L_w = 8.33 \times N \times Z \times D_o \times (T_w - 52)$

$N_f = \dfrac{L_w}{H_f \times E_f}$

$X/A = 16.8 \times \dfrac{N_d}{L_w} \times (212 - T_a) \times 1 + 0.006(60 - T_a)$

$Y/A = 0.59 \times H_T \times \dfrac{N_d}{L_w}$

$X = X/A \times A$

$Y = Y/A \times A$

$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$

N = No. of bldg. occupants = 5

Z = Daily water consump/occupant = 2 gal

D_o = No. of days per mo. bldg. is occupied

T_w = Water temperature (^oF) = 105^o

H_f = Fuel heating value = 3413 BTU / KWH

E_f = Avg. heating efficiency = 1.0

A = Solar collector plate area = 3.2 Ft^2

SOLAR ASSISTANCE TO DOMESTIC WATER HEATING
COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_w}{\sum L_w}$$

$$= \frac{584,588.61}{1,156,703.8}$$

$$= 0.51 \text{ or } 51\%$$

2. System Cost (Cs)

$$C_s = \$40.00/Ft^2 \times \text{Area}$$

$$= \$40.00/Ft^2 \times 3.2 \text{ sq. ft.}$$

$$= \$128.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \Sigma N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.51 \times 338.89 \text{KWH/yr} \times \$0.0425 \text{ KWH}$$

$$= \$7.35/\text{year}$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$128.00}{\$7.35/\text{year}}$$

$$= 17.4 \text{ years}$$

SOLAR ASSISTANCE TO BUILDING HEATING
(GIVEN DATA)

Month	N_d (Days per month)	T_a (^0F)	H_t (Btu/day ft^2)	N_f (ft^3/month)
January	31	12.2	1124	178,900
February	28	15.8	1363	195,600
March	31	28.4	1433	299,300
April	30	44.6	1442	73,700
May	31	57.2	1475	68,800
June	30	66.2	1522	17,200
July	31	71.6	1588	57,100
August	31	69.8	1581	0
September	30	60.8	1519	0
October	31	50.0	1484	27,200
November	30	32.0	1004	112,700
December	31	19.4	897	9,900

T_a = monthly average ambient temperature (^oF)

H_T = daily average radiation incident on the collector surface (Btu/day ft^2)

N_f = number of fuel units consumed per month (ft^3/month)

SOLAR ASSISTANCE TO BUILDING HEATING
(CALCULATED DATA)

Month	L_T (Btu/Month)	X/A $1/ft^2$	Y/A $1/ft^2$	X	Y	f	$f \times L_T$ (Btu/Month)
January	110,560,200	00.94×10^{-3}	0.19×10^{-3}	02.70	0.55	0.34	37,590,468
February	120,880,800	00.76×10^{-3}	0.19×10^{-3}	02.18	0.55	0.37	44,725,896
March	184,967,400	00.52×10^{-3}	0.14×10^{-3}	01.49	0.40	0.30	55,490,220
April	45,546,600	01.85×10^{-3}	0.58×10^{-3}	05.31	1.67	0.85	38,714,610
May	42,518,400	01.90×10^{-3}	0.63×10^{-3}	05.45	1.81	0.89	37,841,376
June	10,629,600	06.91×10^{-3}	2.50×10^{-3}	19.83	7.18	1.00	10,629,600
July	35,287,800	02.07×10^{-3}	0.82×10^{-3}	05.94	2.35	1.00	35,287,800
August	0	0×10^{-3}	0×10^{-3}	0	0	0	0
September	0	0×10^{-3}	0×10^{-3}	0	0	0	0
October	16,809,600	05.02×10^{-3}	1.61×10^{-3}	14.41	4.62	1.00	16,809,600
November	69,648,600	01.30×10^{-3}	0.26×10^{-3}	03.73	0.75	0.44	30,645,384
December	6,118,200	16.39×10^{-3}	2.68×10^{-3}	47.04	7.69	1.00	6,118,200
	642,967,200						

$L_T = N_f \times H_f \times E_f$

H_f = fuel heating value = 1,000 BTU/ft^3

E_f = average furnace efficiency = 60%

$$X/A = \frac{16.8 \times N_d \times (212 - T_a)}{L_T}$$

$$Y/A = \frac{0.59 \times H_T \times N_d}{L_T}$$

A = solar collector plate area = 2870 Ft^2

X = X/A x A

Y = Y/A x A

$f = 1.029Y - 0.065X - 0.245Y^2 + 0.0018X^2 + 0.0215Y^3$

SOLAR ASSISTANCE TO BUILDING HEATING
COLLECTOR SYSTEM CALCULATIONS

1. System Contribution (F)

$$F = \frac{\sum f \times L_T}{\sum L_T}$$

$$= \frac{313,853,150}{642,967,200}$$

$$= 0.49 \text{ or } 49\%$$

2. System Cost (Cs)

$$C_s = \$40.00/Ft^2 \times \text{Area}$$

$$= \$40.00Ft^2 \times 2870 \text{ sq. ft.}$$

$$= \$114,800.00$$

3. System Energy Savings (S_s)

$$S_s = F \times \sum N_f \times C_f$$

$$C_f = \text{fuel cost per unit}$$

$$= 0.49 \times 1,040,400 \ Ft^3/yr \times \$0.0003/Ft^3$$

$$= \$1,529.39/year$$

4. System Payback Time (t)

$$t = \frac{C_s}{S_s}$$

$$= \frac{\$114,800.00}{\$1,529.39}$$

$$= 75.1 \text{ years}$$

LOGGED

ENERGY CONSERVATION MEASURE DEVELOPMENT SHEET

Building: Public Works-Western Maintenance Garage
10500 Hampshire Avenue South
Bloomington, MN 55431

Date 6-16-81
Item No. 1
Major Class 2
Sub. Class 8

Energy Conservation Measure

Description of existing equipment:
Brick-concrete block walls have no insulation and have an overall "R" value of 2.45 or a "U" value of 0.41.
4588 FT^2 wall area

Description of energy conservation measure:

Add 1½" of styrofoam insulation to the interior surfaces of the wall to decrease the overall "U" value from 0.41 to 0.10. This includes furring the walls, attaching the insulation and covering with ½" sheetrock. This will reduce the heat loss through the wall.

Useful life 50 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days 523
Fuel 1 gas units of Measure CF
Fuel 2 ______ units of Measure ______

(Per 1976 ASHRAE Systems Handbook)

$$\text{Energy Consumption} = E = \left(\frac{H_L x D x 24}{\Delta t x \eta x V}\right) x\ C_D x C_F$$

$$\text{Since Energy Savings} = \Delta E \& H_L = U A \Delta t$$

$$\text{Then Energy Savings} = \Delta E = \left(\frac{\Delta U x A x \Delta t x D x 24}{\Delta t x \eta x V}\right) x\ C_D x C_F$$

$$\Delta E = \left(\frac{0.31x4588x60-(-10)x8159x24}{60-(-0)x0.80x1000}\right) x\ 0.64x1.56$$

$$\Delta E = 347{,}574\ FT^3/\text{year}$$

H_L = Design Heat Loss (Btu/hr)
U = Heat Transfer Coeff. ($Btu/hr x ft^2 x {}^oF$)
A = Area (Ft^2)
Δt = Inside-outside temp (${}^oF$)
D = Degree Days
η = Equipment Efficiency
V = Fuel Heating Value (Btu/FT^3)
C_D = Correction Factor
C_F = Load Correction Factor

electrical savings 0 kwh/year
fuel 1 savings 347,574 FT^3 /year
fuel 2 savings 0 /year
Total Fuel Savings 347.574 MMBTU/Year

Economic Analysis

(1) Design cost: $ 0

(2) Acquisition cost: $ 1934.56

Furring	2963FTx$0.08/FT		$237.00
Insulation	$4588FT^2 x \$0.20/FT^2$		917.60
Sheetrock	$4588FT^2 x \$0.17/FT^2$	=	779.96
			$1934.56

(3) Installation cost: $ 3623.52

Furring	2963FTx$0.65/FT	=	$1925.96
Insulation	$4588FT^2 x \$0.20/FT^2$	=	917.60
Sheetrock	$4588FT^2 x \$0.17/FT^2$	=	779.96
			$3632.52

Total Modification Cost = (1) + (2) + (3): $ 5558.08

Increased operation and maintenance costs: $ 0

Salvage or disposal costs: $ 0

Energy Cost Savings

Electrical and/or fuel cost savings:

$$\text{Gas: } \frac{347{,}574 FT^3}{Yr.} \times \frac{\$2.97}{1000 FT^3} = \$1032.30/\text{year}$$

Electrical $		/year
fuel 1 $	1032.30	/year
fuel 2 $		/year
Total Fuel (1 + 2) $	1032.30	/year

Payback Period

Simple and alternate payback period:

$$\frac{\$5558.08}{\$1032.30/\text{year}} = 5.38 \text{ years}$$

Costs from 1980 Means Building Construction Cost Data

Simple	5.38	years
Alternate		years

ENERGY CONSERVATION MEASURE

DEVELOPMENT SHEET

Building: Public Works-Western Maintenance Garage
10500 Hampshire Avenue South
Bloomington, MN 55431

Date 6-16-81
Item No. 2
Major Class 3
Sub. Class 2

Energy Conservation Measure

Description of existing equipment:

812,500 input horizontal furnace presently being used for garage area heating. Heat loss of area is only 306,874 BTUH. Building uses 1,040,400 cu.ft.of gas annually.

Description of energy conservation measure:

Leave furnace for summer ventilation and install gas fired radiant heat units.

Useful life 20 years

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days 523
Fuel 1 natural gas units of Measure CF
Fuel 2 ______ units of Measure ______

1,040,400 cu ft gas x 0.50 (efficiency reduction) = 520,200 CF gas

Calculated gas usage is slightly higher than actual usage.
Use of lower figure gives slightly more conservative analysis.

$$*E = \left(\frac{383{,}593 \times 8159 D.D \times 24 hr}{75 \times .8 \times 1000}\right) 0.64 \times 1.56 = 1{,}249{,}891 \text{ CF per season average use}$$

.5x1,249,891 = 624,945 CF (calculated savings)

electrical savings 0 kwh/year
fuel 1 savings 520,200 /year
fuel 2 savings ______ /year
Total Fuel Savings 520.2 MMBTU/Year

*Per 1976 ASHRAE Systems Handbook
See page 33 for symbol clarification

Economic Analysis

(1) Design cost: $ 0

(2) Acquisition cost: $ 5040.00

$5040FT^2 x \$1.00/FT^2 = \$5040.00$

$\$1.00/FT^2$-manufacturers quoted estimate for materials

(3) Installation cost: $ 2016.00

$5040FT^2 x \$0.40/FT^2 = \$2016.00$

$\$0.40/FT^2$-based on local contractors labor market.

Total Modification Cost = (1) + (2) + (3): $ 7056.00

Increased operation and maintenance costs: $ 0

Salvage or disposal costs: $ 0

Energy Cost Savings

Electrical and/or fuel cost savings:

$$520{,}200CF \times \frac{\$2.97}{1000CF} \times 0.8 = \$1236/year$$

0.8 = % building area and per cost of actual gas consumption listed under analysis. Other 20% of building has separate heating system.

Electrical $		/year
fuel 1 $	1236	/year
fuel 2 $		/year
Total Fuel (1 + 2) $	1236	/year

Payback Period

Simple and alternate payback period:

$$\frac{\$7056.00 \text{ total cost}}{\$1236.99 \text{ per year}} = 5.71 \text{ years}$$

Local contractors cost quote
materials cost from manufacturer

Simple	5.71	years
Alternate		years

ENERGY CONSERVATION MEASURE
DEVELOPMENT SHEET

Building: Public Works-Western Maintenance Garage
10500 Hampshire Avenue South
Bloomington, MN 55431

Date 6-16-81
Item No. 3
Major Class 2
Sub. Class 10

Energy Conservation Measure

Description of existing equipment:

Maintenance garage doors have single glaze windows.
Windows have "U" value of 1.13.
168 FT^2 of glass for 6 doors.

Description of energy conservation measure:

Add plexiglass storm windows to the existing frames.
Double glaze windows have "U" value of 0.55.

Useful life 20 years

(Per 1976 ASHRAE Systems Handbook)

H_L=Design Heat Loss (Btu/hr)
U =Heat Transfer Coeff. ($Btu/hr \times ft^2 \times {}^oF$)
A =Area (Ft^2)
Δt=Inside-outside temp (^oF)
D =Degree Days
η =Equipment Efficiency
V =Fuel Heating Value (Btu/FT^3)
C_D=Correction Factor
C_F=Load Correction Factor

Engineering Analysis:

Annual heating degree days 8159
Annual cooling degree days 523
Fuel 1 gas units of Measure CF
Fuel 2 ______ units of Measure ______

$168FT^2 \times 1.13 \times 82 \Delta t = 15{,}567$ BTUH

$168FT^2 \times 0.55 \times 82 \Delta t = 7{,}577$ BTUH
Energy Savings = 7,990 BTUH

$$E = \left(\frac{H_L \times D \times 24}{\Delta t \times \eta \times V}\right) \times C_D \times C_F$$

$$E = \left(\frac{7990 \times 8159 \times 24}{82, .8 \times 1000}\right) \times 0.64 \times 1.56 = 23{,}812 \text{ CF}$$

electrical savings ______ kwh/year
fuel 1 savings 23,812 /year
fuel 2 savings ______ /year
Total Fuel Savings 23.8 MMBTU/Year

Economic Analysis

(1) Design cost: $ 0

(2) Acquisition cost: $ 384.72

*Plexiglass material = $\$2.29/FT^2$

$168FT^2 x \$2.29$ = #384.72

(3) Installation cost: $ 294.00

*Labor = $\$1.75/FT^2$

168x$1.75 = $294.00

Total Modification Cost = (1) + (2) + (3): $ 678.72

Increased operation and maintenance costs: $ 0

Salvage or disposal costs: $ 0

Energy Cost Savings

Electrical and/or fuel cost savings:

$$23,812 \text{ CF} \times \frac{\$2.97}{1000\text{CF}} = \$70.72/\text{year}$$

Electrical $		/year
fuel 1 $	70.72	/year
fuel 2 $		/year
Total Fuel (1 + 2) $		/year

Payback Period

Simple and alternate payback period:

$$\frac{\$678.72}{\$\ 70.72} = 9.6 \text{ years}$$

Simple 9.6 years

Alternate ______ years

* Means Estimating Manual-1980

Building Characteristics

A. Description

The Public Works-Western Maintenance building was built in 1973 and is used as a maintenance garage and office space.

The walls are concrete block and 4" face block. The roof is built up pitch and gravel over 1½" rigid insulation on 1½" corregated steel decking. Open bar joist in garage area and upper mezzanine. Wood joist and gypsum board ceiling in lower mezzanine. Floor at grade on concrete slab.

B. Enevelope Characteristics

1. Walls

	"R"
Outside Air Film	0.17
4" Blcok	0.39
3/4" Mortar	0.10
8" Concrete Block	1.11
Inside Air Film	0.68
	2.45

U=1/2.45 = 0.41

2. Roof

Outside Air FIlm	0.17
Built-up Roofing	0.33
1½" rigid insulation	4.17
Metal Decking	0.00
Inside Air Film	0.92
	5.59

U=1/5.59 = 0.18

C. Building Heat Loss

Walls	$0.41 \times 5205 FT^2 \times 82^o$ t	= 174,992 BTUH
Roof	$0.18 \times 6300 FT^2 \times 82^o$ t	= 92,988 BTUH
Edge Loss	45x360 FT	= 16,200 BTUH
Inf.	0.15x267,980 BTU	= 40,198 BTUH
Glass	$1.13 \times 36 FT^2 \times 82^o$ t	= 3,336 BTUH
Doors	$0.55 \times 1239 FT^2 \times 82^o$ t	= 55,879 BTUH
	TOTAL	= 383,593 BTUH

D. Building Energy Using Systems

1. Heating System

The building has 2 furnaces, gas fired; one counterflow and one horizontal unit. Ducted warm air systems with fresh air intake.

2. Ventilation System

One system handles garage area to include fume exhaust. Operated as needed. Second system handles toilet exhausts on a continuous basis.

3. Lighting System

Fluorescent lighting - minimum use

4. Water Heater

30 gallon H.R. electric

E. Building Equipment

1. Furnaces

a. Repair Area - natural gas furnace
Rheem National
812,500 BTUH input
650,000 BTUH output

b. Office Area - natural gas counterflow furnace
Lennox Counterflow - single stage
165,000 BTUH input
132,000 BTUH output

2. Water Heater

High Recovery 30 gallon electric water heater; no recirculating line.

3. Lighting

Entire building has watt-miser fluorescent fixtures.