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PETROLEUM CONSERVATION MEASURES ASSESSMENT

Volume II

Final Report

for

Iowa Energy Policy Council

January 15, 1980

PETROLEUM CONSERVATION

MEASURES ASSESSMENT

VOLUME II

FINAL REPORT

Submitted to the

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by

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PETROLEUM CONSERVATION MEASURES ASSESSMENT

1.0 INTRODUCTION

Less than 5% of the energy consumed in Iowa is from resources derived from within the State (1)*. Thus, because of federal price control on energy resources, the State finds itself in the difficult position of developing an energy conservation plan. The three primary energy resources used in Iowa are petroleum products (41%), natural gas (37%), and coal (19%). These resources are used almost equally for environmental control in residential and commercial buildings (40%), for industrial purposes (30%), and for transportation (30%). These relationships are shown in Tables 1.1 and 1.2.

To cope with shortages in these resources, which have occured during the past five years, two conservation philosophies have evolved:

- Preventive Conservation
- Reactive Conservation

Preventative conservation may be described as a relatively long-term management program designed to reduce depletion of natural resources. Preventative conservation can be implemented without adverse impact to the economy or deleterious impact to residents. A successful preventive conservation program requires a comprehensive impact analysis to provide assurance that a proposed conservation opportunity will result in its intended effect without unwanted interactive effects (2). Examples of preventive energy conservation programs in Iowa are the $8,000,000 appropriated by the Legislature in 1979 for implementing conservation programs in state buildings, and the Life-Cycle Cost Bill that was passed by the Legislature last year. Both of these programs inherently require economic, environmental and health impact analyses.

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*Numbers in parenthesis refer to references identified in Section 9.0.

Reactive conservation may be described as a relatively short-term management program designed to reduce depletion of a particular natural resource during a period of shortfall. Reactive conservation must be implemented without deleterious impact to residents, but adverse impact to the economy may result. A successful reactive conservation program requires an impact analysis to provide assurance that a proposed conservation opportunity will result in its intended effect, and any anticipated interactive effects should be identified. An example of a reactive conservation program which was implemented last year is the odd-even gasoline rationing that occured in some states. Another example is the Emergency Building Temperature Restriction which was imposed by the Department of Energy to reduce depletion of heating oil throughout the U.S. so it would be available to the Northeast sector of the U.S. (3). The limited success of these programs may be attributed to insufficient investment in program analysis.

1.1 Objective

The objective of the project reported herein was to provide an initial analysis of expected fuel savings that should result from specific reactive conservation measures proposed by the staff of the Iowa Energy Policy Council (EPC) in a May 31, 1979 draft document entitled "Iowa Energy Emergency Management Plan." A further objective of this project was to provide a review of the current methods used by EPC to access the state energy emergency plan.

1.2 Scope

The scope of this project was limited to an assessment of reactive conservation measures to be taken during, or in anticipation of, supply shortages of petroleum products. Fuel savings for voluntary and mandatory measures, proposed by EPC and ISU, were to be analyzed based on monthly petroleum use profiles which were to be developed from available data.

1.3 Limitations

Several other limitations were imposed on this project:

- A two and one half month schedule and an $8,000 level-of-effort were specified by the EPC. ISU agreed to undertake this study on a best effort approach so that an initial plan could be considered during January, 1980.
- The scope of the project was limited to assessment of conservation measures for petroleum shortages only, although the draft of the Iowa Energy Emergency Management Plan is comprehensive regarding the State's energy resources.
- Assessments of social and economic factors associated with the proposed measures were excluded from the project scope by EPC. Thus, only potential fuel savings could be addressed.

Therefore, the results reported herein must be interpreted as initial estimates only. They have been quantified only to provide some guide to authorities who must make difficult decisions under periods of stress. A re-evaluation of these reactive conservation measures should be made as time allows, and in no way should the measures be considered for preventive conservation without further analysis.

Table 1.1. 1975 ENERGY RESOURCE UTILIZATION PATTERNS IN IOWA[1,2]

Resource	Residential		Commercial		Total[3]	
	10^{12} Btu	%	10^{12} Btu	%	10^{12} Btu	%
Natural gas	107.5	52	76.7	51	334.4	37
Petroleum	42.7	21	28.0	19	361.7	41
Coal	44.5	22	39.0	26	171.9	19
Nuclear	7.2	3	3.7	3	17.6	2
Hydro	3.9	2	2.0	1	9.6	1
TOTAL	205.8	100	149.4	100	895.2	100

[1]Data from Second Annual Report of the Iowa Energy Policy Council, 1976.

[2]Values shown are for direct use and as electricity produced by conversion of that resource.

[3]Totals include industrial and transportation consumption.

Table 1.2. 1975 ENERGY CONSUMPTION PATTERNS IN IOWA[1]

Sector	Direct Consumption		Electric Consumption[2]		Total Consumption	
	10^{12} Btu	% Direct	10^{12} Btu	% Electric	10^{12} Btu	% Total
Residential	141.1	20	64.7	34	205.8	23
Commercial	91.7	13	57.7[4]	30	149.4	17
Industrial	195.6	28	69.6	36	265.2	30
Transportation	275.2[3]	39	-	-	275.2	30
TOTAL	703.6	100	191.0	100	895.2	100

[1]Data from Second Annual Report of the Iowa Energy Policy Council, 1976.

[2]Includes average conversion efficiency of 27% for power plant and transmission losses.

[3]Includes 2% fuel used for agricultural construction.

[4]Includes 3% electricity sold to cities and other miscellaneous consumers.

2.0 REVIEW OF MAY 31, 1979 DRAFT: "IOWA ENERGY EMERGENCY MANAGEMENT PLAN"

To obtain a perspective of the current thinking of the Energy Policy Council regarding emergency plans, the May 31, 1979 draft document entitled: "Iowa Energy Emergency Management Plan" was reviewed in accordance with paragraph 4.1 of the contract. The following comments are offered as constructive criticism to strengthen the final document.

The overall philosophy of the draft document is excellent. Implementation of the plan through three stages of emergency should minimize adverse impact to the economy of the State. Application of voluntary measures through the first two stages seems appropriate. The possibility of enforcement of mandatory measures in the third stage should be expressed to the citizens of the State to encourage adoption of the less stringent voluntary measures during the first two stages.

The Shortfall Index (SI), as defined in the draft, is on an absolute scale and does not reflect normal monthly deviations between supply and demand. As an alternative approach, we have proposed in Section 4.0 that the SI be redefined as the difference between the normal change in storage and the actual deviation:

$$SI = \left(\frac{\text{Supply - consumption}}{\text{consumption}}\right)_{\text{normal}} - \left(\frac{\text{Supply - consumption}}{\text{consumption}}\right)_{\text{actual}}$$

The energy data base presented in the draft document does not provide sufficient information to distinguish between supply and consumption values. Moreover, most of the information is presented on an annual basis in the appendix. We have re-analyzed the sources of the data presented in the draft and include in Section 4.0 monthly projections of supply and consumption rates for 1980. Monthly data for the last five years are presented in Appendix 10.1 of this report together with a description of the methodology used to obtain the projections.

The draft document is a comprehensive plan which includes considerations of shortages that might occur in any or all of the major resources used in Iowa. However, some of the measures proposed in the draft to offset shortages might be contraproductive for reactive conservation even though they might be appropriate as preventive conservation measures. An example is the proposal to reduce electrical consumption during fuel oil shortages. Since all but 3% of electricity is produced by resources other than oil, the consumption of electricity would tend to alleviate the demand for oil although electricity would be a more expensive heating medium than oil.

Updating of energy data during shortages must be done frequently. The Quarterly Energy Reporting Procedure, referred to on page 12 of the draft, may not provide sufficient updating information to properly manage a reactive conservation program. The "ideal" monthly reporting procedure described on pages 12 and 13 seems more appropriate. We suggest that this latter method be used and that monthly information regarding storage levels and their changes be added to this data base.

Compilation of major inventory holding capability, discussed on page 22 of the draft, should be instituted immediately. This information is vital to managing a reactive conservation program.

Comments of information found in the Appendices of the draft are as follows:

- <u>Emergency Response Measures</u>. This Appendix was reviewed in detail and is the subject of Sections 5.0 - 6.0 of this report.

- Enforcement of Mandatory Emergency Measures. This Appendix was reviewed, but evaluation of the methods proposed was considered to be outside the scope of our present contract.

- Emergency Data Base. This Appendix was used as a basis for developing the monthly projections contained in this report. However, the data, as they appear in the draft, were not sufficient for this purpose and re-evaluation of the sources was necessary. It is suggested that this Appendix be expanded to include monthly profiles of supply and consumption data.

- Federal Plans. Only Plan #2, Emergency Building Temperature Restriction, has been enacted. However, this program has not been enforced by authorities in Iowa; enforcement has been left to DOE.

- State Set-Aside Program. This program has been a model effort toward managing petroleum consumption on a dynamic basis and implies that storage is an important element in the program. The recommendations we have presented in this report are intended to be consistent with the philosophy established in the Set-Aside Program.

3.0 INTRODUCTION OF DYNAMIC MODEL

Most simple steady-state petroleum models only involve supply and demand. When supply does not equal demand a surplus or shortage exists. On a long-term basis, this is true. However, on a short-term basis, supply seldom matches demand and changes in storage must be considered. This variable, storage change, implies that a non-steady system must be managed. A model that describes this non-steady system may be called a "dynamic model."

Storage not only absorbs the normal fluctuations between supply and demand, it provides a time lag between the actual onset of a supply shortage and its impact on the consumer. If appropriate measures are taken during this time lag, a potential shortage at the consumer level can be avoided. Since this is the goal of the Iowa Emergency Management Plan, the petroleum model to be used should be a dynamic one which includes measures of storage and its changes.

The general model used in this study included storage at the various levels of distribution and is shown in Fig. 3.1. It included the gross input to the state, exports, and any "through" storage such as pipeline capacity, truck capacity, etc. No information was available for storage at this point of the model so this storage location was ignored throughout the remainder of the study. Information was obtained for the utility sector of the model which indicated that #2 fuel oil is the only petroleum product currently reported as used for electrical generation (4). Insufficient data were obtained for utility storage so it could not be treated separately. Data were also unavailable for "main" and "distribution" storage, shown in Fig. 3.1, so all three (utility, main, and distribution) levels of storage had to be treated as a lumped sum which must be assumed to include error terms. Local storage was defined as fuel stored by the consumer such as automobile gaoline tanks, farm storage, etc., but it also had to be ignored due to insufficient data. Monthly data were obtained for the net input to the State, for some distribution (sales from distributors) uses and for some end uses. Other monthly values were calculated from annual data. These data are described in Section 4.0. As new storage data become available, they should be incorporated into this model to obtain greater sensitivity to changes which occur either in supply or consumption.

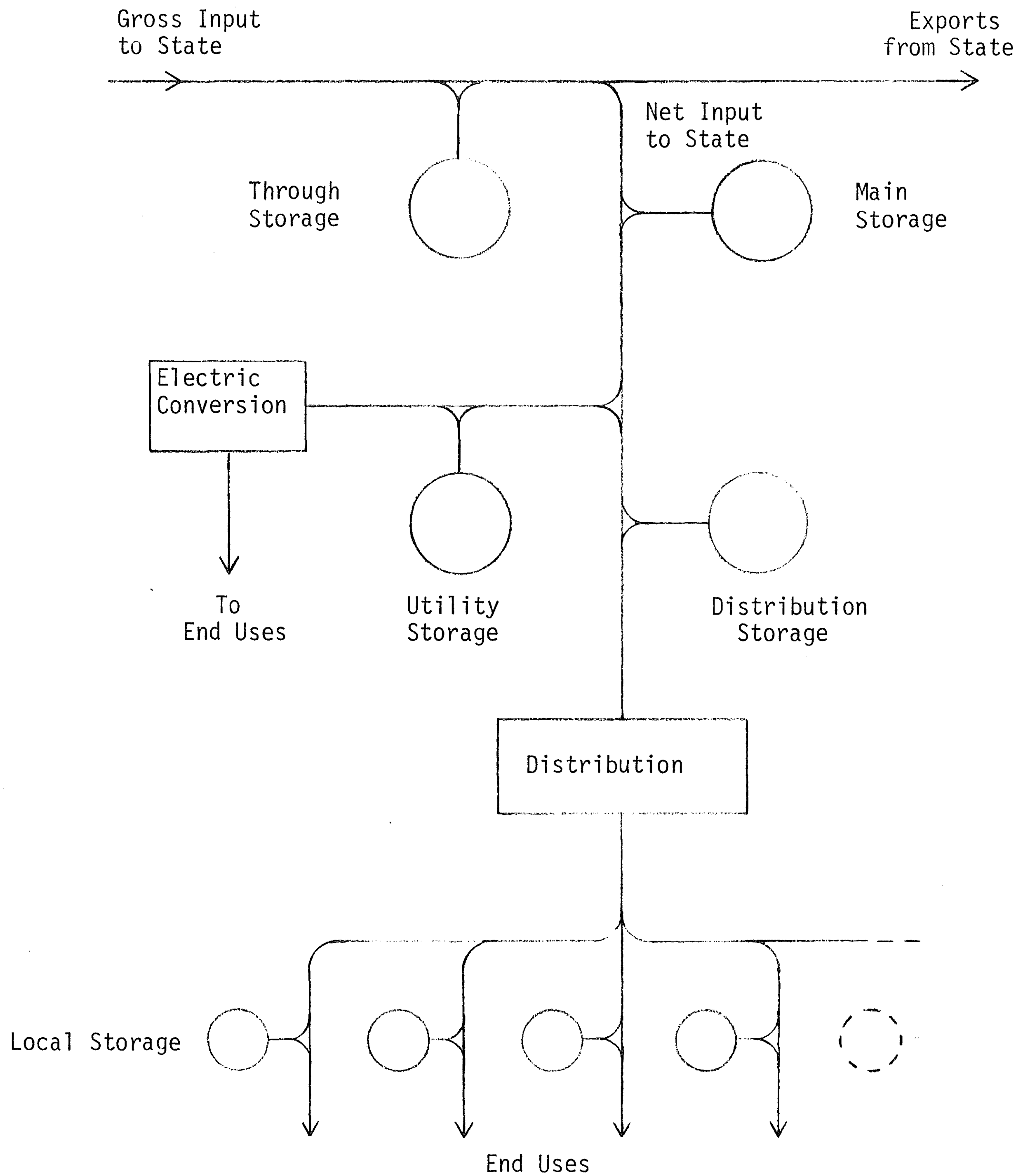


Fig. 3.1 GENERALIZED DYNAMIC MODEL OF ENERGY UTILIZATION IN IOWA

4.0 DEVELOPMENT OF BASELINE DATA

4.1 Description of Methodology

The success of the dynamic model in predicting potential petroleum shortages and assessing the impacts of the various reactive conservation measures is dependent upon the accuracy and detail of that data upon which the model is based. Ideally, this data base would include the supply to the State and the final consumption by all economic sectors for each distinct fuel type. In addition, the data base would include the amounts of storage at all levels of distribution. Finally, these data would indicate the supply, storage, and consumption trends during the year as well as from year to year.

Due to the limitations of the presently available data, it was decided to attempt to collect monthly data on supply, storage, and consumption for as many different end uses and fuel types as possible. The period of interest was limited from 1974 to the present due to changes in petroleum use patterns caused by the oil shortage of 1973. Numerous sources of data were obtained from the Iowa Energy Policy Council and other outside agencies. With these data, the model was exercised.

Many restrictions were put on the model due to the data available at the time of this study. Fuel types could only be separated into six categories which are defined below.

1. Gasoline - not including aviation gasoline
2. Diesel fuel
3. Distillates - kerosene, #1 and #2 fuel oil
4. Residuals - #5 and #6 fuel oil
5. Liquified petroleum gas (LP)
6. Aviation fuel - aviation gasoline, jet fuel

Monthly data for the net input (see Fig. 3.1) of the six fuel categories to the State were obtained from reports submitted to DOE by suppliers to the State (5).

Monthly data were obtained for fuel supplied to and consumed by the electrical utilities in the State from data compiled by the Iowa Energy Policy Council (EPC) staff (4). Annual utility consumption data from DOE (6) and the Iowa Commerce Commission (7) were consistent with the annualized utility consumption data from EPC, but the DOE and ICC annual supply data were inconsistent with annualized utility supply data provided by EPC. Therefore, the monthly utility supply data compiled by EPC were not used in the model and the ability of the model to treat utility storage separately was lost.

Some monthly data for gasoline, diesel fuel, and LP distributed to other users than utilities, were obtained from the Iowa Department of Revenue (8). Although the Department of Revenue obtained its data at the point where fuel is drawn from main storage (9), these values were assumed to be the final consumption due to a lack of available storage data. These data were in good agreement with the input data (5) to the State. Data were reported separately for government, custom commercial (stationary engines), and other miscellaneous non-highway uses from tax refund data. The difference between these data were assumed to be highway use. Monthly refund data for agricultural gasoline use were also reported, but were found to be approximately fifty percent lower than annual values obtained from the "Farm Fuel Use" survey (10). This difference was probably due to some farmers not collecting the full refund for gasoline to which they were entitled. Therefore, the annual "Farm Fuel Use" data were used and monthly values were calculated in proportion to the profile indicated by the Department of Revenue monthly gasoline data.

The Department of Revenue data also included monthly highway use of diesel fuel. Annual diesel consumption for agriculture was obtained from the "Farm Fuel Use" surveys. Monthly values were calculated in the same manner as the agricultural gasoline use. The sum of the annual highway and agricultural use, which was assumed to be the total consumption, was approximately twenty percent higher than the input data for each year observed in this study.

The monthly Department of Revenue liquified petroleum gas (LP) for highway use was less than one percent of the total input to the State and is ignored in this study. Annual LP consumption data were obtained from a DOE survey (11) which included categories for heating, industry, internal combustion, and miscellaneous uses. The miscellaneous category was a significant fraction of the total (twenty to forty percent) and the survey indicated that it could be accounted for, at least partially, by agricultural uses. Therefore, the LP data from the "Farm Fuel Use" survey were deducted from the miscellaneous and internal combustion use and added as another category. The remaining miscellaneous use was classified as "other." The resulting annual totals for LP consumption ranged from twenty to forty percent higher than the input with most of the fluctuations occuring in the remaining miscellaneous use. Due to a lack of monthly data for LP, the annual heating use was indexed with the Des Moines Degree Days (12) for the respective periods. All other annual uses were divided by twelve to obtain monthly values.

Annual distillate consumption was obtained from a DOE survey (6) similar to the one used for LP. The end use categories were heating, railroad, industry, utility, military, oil company, vessel bunkering, and miscellaneous. The four latter categories were combined as "other" since they only comprised five percent of the total. The annual heating data was indexed monthly with degree days. All other categories were divided by twelve to obtain monthly values. The total annual consumption data ranged from ten to twenty percent higher than the corresponding input data. Because these data for distillates and the data for diesel fuel contained large discrepancies, and because uses of these products are somewhat interchangeable, consideration by EPC should be given to combining these data bases.

Annual residuals data were obtained from the same DOE survey (6) as the distillates data. The main uses were heating, industrial, and railroad. These values fluctuated significantly from year to year. The total annual consumption values were about twice the input values for each year. Again, the annual values were profiled by monthly degree days for heating, and divided by twelve for the other categories to obtain monthly values.

Monthly aviation gasoline use was obtained from the Department of Revenue (8). However, no data, annual or monthly, were available at the time of this report. The input data from the EPC (5) is the sum of aviation gasoline and jet fuel. Therefore, the monthly aviation gasoline values were subtracted from the total input to obtain monthly jet fuel data.

4.2 Presentation of results

The annual consumption data, which served as a basis for projections to 1980 values, are summarized in Tables 4.1 to 4.6. Monthly consumption data that were available to the contractor or derived from annual data as described in Section 4.1, and used in this report are included in Appendix 10.1 together with the monthly input to the State data. These data were used in the model to obtain the results reported in this study.

To predict the supply and consumption for 1980, a least-squares exponential curve fit was used. The details of the exponential projection are described in Appendix 10.2. For data which did not have any observable trends, a simple arithmatic mean was used for the projections.

Whenever possible, the 1980 monthly data were projected separately and summed to obtain the 1980 annual projection. When no monthly data were available, the annual data were projected. Results of the 1980 annual consumption projections are summarized in Table 4.7.

Tables 4.8 - 4.14 show the predicted flow patterns within the State for the various fuel types. Each table also contains a drawing of the model used to obtain the relationship between supply, storage, and consumption. The monthly change in storage (ΔS_m) is the difference between the monthly input (IN_m) and consumption (CD_m). The monthly storage index (ST_m) is defined as $\Delta S_m/CD_m$. Cumulative changes in storage (ΔS_c) are also shown and are calculated by subtracting the cumulative consumption (CD_c) for the year from the cumulative input (IN_c). A cumulative storage index ($ST_c = \Delta S_c/CD_c$) is also listed. The predicted trends for the monthly and cumulative storage indices for each fuel type are shown in Fig. 4.1 - 4.6. The zero change in storage values for aviation fuel (Table 4.13 and Fig. 4.5) are due to a lack of data for jet fuel consumption which required that the jet fuel consumption be calculated by subtracting aviation gasoline use from the total aviation fuel input to the State.

The expected trand for the storage index is a monthly fluctuation about zero with an annual cumulative change of almost zero. This is the trend indicated for gasoline (Fig. 4.1) in 1980 where the monthly storage index ranges from -10 to +10% and the annual change in storage is less than 1% of the amount consumed. However, diesel fuel, distillates (fuel oil), LP, and residual oil show a predicted annual change of -29, 43, -12, and -41%, respectively, of the annual consumption. These unexpectedly large values may be due to input sources or end uses which are not accounted for, or some significant amount of unknown storage in the State from which fuel is continually being added or depleted. That explanations for these values are not apparent is further incentive to obtain more information on the four levels of storage indicated in Fig. 3.1.

The monthly and cumulative storage indices can be used to help manage the State energy resources. For example, the gasoline data indicate that up to a ten percent monthly supply shortage could occur with no reason for alarm as long as this trend does not continue over an extended period. The cumulative storage index indicates what the trend is over a longer period of time and is a better indicator of potential shortages. Since the data indicate that significantly positive or negative cumulative storage indices may occur normally, a better indicator for potential fuel shortages might be a comparison of the actual cumulative storage index to the predicted index. If the actual value begins to fall significantly below the predicted value, a potential shortage condition may exist. Then the reactive conservation measures proposed in the next section will have to be implemented to bring these two values back together. Although the data for other fuel categories were not as well behaved as gasoline, the storage indices shown in Fig. 4.2 - 4.7 can be used in their present form. However, as new data become available, all of these values should be continuously updated.

Table 4.1. ANNUAL DATA FOR GASOLINE CONSUMED IN IOWA, 1975 - 1978

Annual consumption	1975		1976		1977		1978	
	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%
1. Highway[1]	32756	82.4	34533	83.1	35571	84.7	35107	83.1
2. Agriculture[2]	6876	17.3	6914	16.6	6360	15.1	6748	16.0
3. Other[3]	139	0.3	109	0.3	104	0.2	382	0.9
TOTAL[4]	39762	100.0	41556	100.0	42035	100.0	42237	100.0

Sources: 1. Calculated by subtracting "Agriculture" and "Other" from "Total."

2. "Farm Fuel Use" reports (1974 data unavailable).

3. Department of Revenue ("Government Refunds", "Custom Commercial", and "Miscellaneous") reports.

4. Department of Revenue ("Imports" minus "Exports") reports.

Table 4.2. ANNUAL DATA FOR DIESEL FUEL CONSUMED IN IOWA, 1975 - 1978

Annual consumption	1975		1976		1977		1978	
	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%
1. Highway[1]	5449	60.6	6293	63.1	6685	64.0	6565	61.7
2. Agriculture[2,3]	3545	39.4	3686	36.9	3764	36.0	4071	38.3
TOTAL	8994	100.0	9979	100.0	10499	100.0	10636	100.0

Sources: 1. Department of Revenue reports.

2. "Farm Fuel Use" reports.

3. 1974 data unavailable.

Table 4.3. ANNUAL DATA FOR DISTILLATES CONSUMED IN IOWA, 1974 - 1978

Annual consumption	1974		1975		1976		1977		1978	
	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%
1. Heating [1]	5705	64.5	5052	59.4	4987	58.4	5032	57.3	5650	57.8
2. Railroads [1]	1601	18.1	1744	20.6	1440	16.9	1477	16.8	1319	13.5
3. Industrial [1]	598	6.8	708	8.3	928	10.9	966	11.0	1216	12.5
4. Utilities [2]	472	5.3	710	8.4	844	9.9	893	10.2	1131	11.6
5. Others [1,3]	469	5.3	283	3.3	334	3.9	416	4.7	451	4.6
TOTAL	8845	100.0	8497	100.0	8533	100.0	8784	100.0	9767	100.0

Sources: 1. DOE "Sales of Fuel Oil and Kerosene" report

2. DOE data compiled by EPC staff.

3. Includes "Military", "Oil Company", "Vessel Bunkering", and "Miscellaneous" data from DOE reports

Table 4.4. ANNUAL DATA FOR LIQUIFIED PETROLEUM GAS CONSUMED IN IOWA, 1975 - 1978

Annual consumption	1975		1976		1977		1978	
	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%
1. Heating[1,2]	8296	71.4	8785	53.2	8353	53.0	7534	55.7
2. Agriculture[3,4]	2424	20.8	2819	17.1	2955	18.8	3173	23.5
3. Industrial[1]	794	6.8	847	5.1	859	5.4	1132	8.4
4. Other[5]	116	1.0	4066	24.6	3593	22.8	1674	12.4
TOTAL	11630	100.0	16517	100.0	15760	100.0	13513	100.0

Sources:

1. DOE "Sales of Liquified Petroleum Gases and Ethane" reports.
2. Sum of "Residential & Commercial" and "Utility Gas" data from DOE reports.
3. "Farm Fuel Use" reports.
4. 1974 data unavailable.
5. Difference between "Miscellaneous" column of DOE and "Farm Use" column of "Farm Fuel Use" reports.
6. These totals do not include chemical uses for liquified petroleum due to industrial secrecy.

Table 4.5. ANNUAL DATA FOR AVIATION FUEL CONSUMED IN IOWA, 1975 - 1978

Annual consumption	1975		1976		1977		1978	
	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%
1. Jet fuel [1]	1694	91.9	1536	89.6	835	83.1	791	81.8
2. Aviation gasoline [2,3]	150	8.1	178	10.4	170	16.9	176	18.2
TOTAL [4]	1844	100.0	1714	100.0	1005	100.0	967	100.0

Sources: 1. Calculated by subtracting "Aviation gasoline" from "Total."

2. Department of Revenue reports.

3. 1974 data unavailable.

4. EIA - 25 reports.

Table 4.6. ANNUAL DATA FOR RESIDUALS CONSUMED IN IOWA, 1974 - 1978

Annual consumption	1974		1975		1976		1977		1978	
	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%	10^3 bbls	%
1. Heating[1]	445	70.9	325	80.2	528	89.8	661	86.5	559	93.3
2. Industrial[1]	137	21.8	76	18.8	40	6.8	33	4.3	18	3.0
3. Railroads[1]	0	0.0	0	0.0	19	3.2	13	1.7	7	1.2
4. Other[1,2]	46	7.3	4	1.0	1	0.2	57	7.5	15	2.5
TOTAL	628	100.0	405	100.0	588	100.0	764	100.0	599	100.0

Sources: 1. DOE "Sales of Fuel Oil and Kerosene" reports.

2. Includes "Utilities" (1974), "Oil Companies" (1975 - 1978), and "Miscellaneous Data" from DOE report.

Table 4.7. 1980 ANNUAL PETROLEUM CONSUMPTION PROJECTIONS (10^3 bbls)

	Gasoline	Diesel Fuel	Aviation Fuels	Liquified Petroleum	Distillates	Residuals
Highway	36466[3]	7409[1]	--	--	--	--
Agriculture	6400[2]	4381[2]	--	3816[2]	--	--
Jet fuel	--	--	683[3]	--	--	--
Aviation gasoline	--	--	180[1]	--	--	--
Heating	--	--	--	7740[1]	5266[1]	781[2]
Railroads	--	--	--	--	1210[2]	3[2]
Industrial	--	--	--	1311[2]	1712[2]	7[2]
Utilities	--	--	--	--	1559[1]	--
Other	598[1]	--	--	767[2]	434[2]	13[2]
TOTAL	43464[1]	11790[4]	863[5]	13634[4]	10181[4]	804[4]

1. Sum of monthly exponential projections.
2. Annual exponential projection.
3. Difference between total and all other uses.
4. Sum of all uses.
5. Sum of the averages of 1977-1979 monthly data.

Table 4.8 LEGEND FOR TABLES 4.9 - 4.14

IN = Net input (supply) to State

S = Storage

CD = Consumption demand (total)

$\Delta S_m = IN_m - CD_m$ (monthly difference)

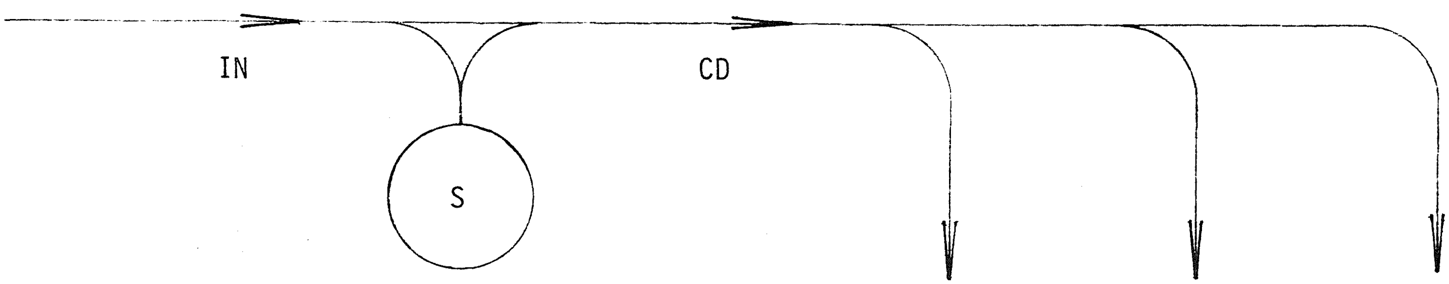
$\Delta S_c = IN_c - CD_c$ (cumulative difference)

ST = Storage index

$$ST_m = \left(\frac{IN_m - CD_m}{CD_m}\right) X\ 100\% \quad \text{(monthly)}$$

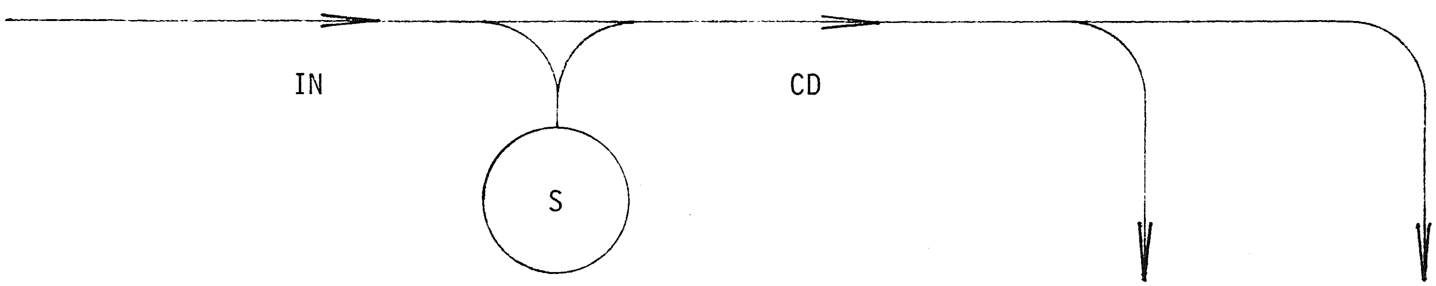
$$ST_c = \left(\frac{IN_c - CD_c}{CD_c}\right) X\ 100\% \quad \text{(cumulative)}$$

Table 4.9. 1980 MONTHLY PROJECTION FOR GASOLINE USAGE IN IOWA



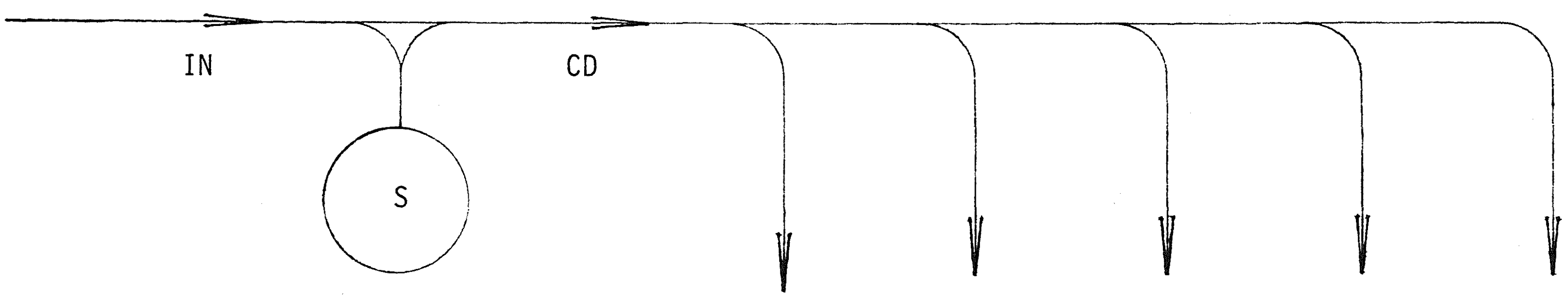
1980	IN		ΔS_m	ST_m	CD		Highway		Agriculture		Others		S_c	ST_c
	10^3 bbls	% of IN	10^3 bbls	% of CD_m	10^3 bbls	% of CD_a	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_c
Jan.	3338	8	-243	-7	3581	8	3448	96	132	4	1	0	-243	-7
Feb.	3333	8	-24	-1	3357	8	3037	90	287	9	33	1	-267	-4
Mar.	3688	8	161	5	3527	8	3249	92	234	7	44	1	-106	-1
Apr.	3527	8	39	1	3488	8	3013	86	348	10	127	4	-67	0
May	3767	9	-50	-1	3817	9	3295	86	484	13	38	1	-117	-1
June	3955	9	353	10	3602	8	2920	81	642	18	40	1	236	1
July	3420	8	-2	0	3422	8	3123	91	295	9	4	0	234	1
Aug.	3818	9	-26	-1	3844	9	3241	84	518	14	85	2	208	1
Sept.	3517	8	-376	-10	3893	9	3706	95	181	5	6	0	-168	0
Oct.	3964	9	247	7	3717	8	1864	50	1840	50	13	0	79	0
Nov.	3733	8	-184	-5	3917	9	2762	71	1069	27	86	2	-105	0
Dec.	3356	8	57	2	3299	8	2808	85	370	11	121	4	-48	0
TOTAL	43416	100	-48	0	43464	100	36466	84	6400	15	598	1	-48	0

Table 4.10. 1980 MONTHLY PROJECTION FOR DIESEL FUEL USAGE IN IOWA



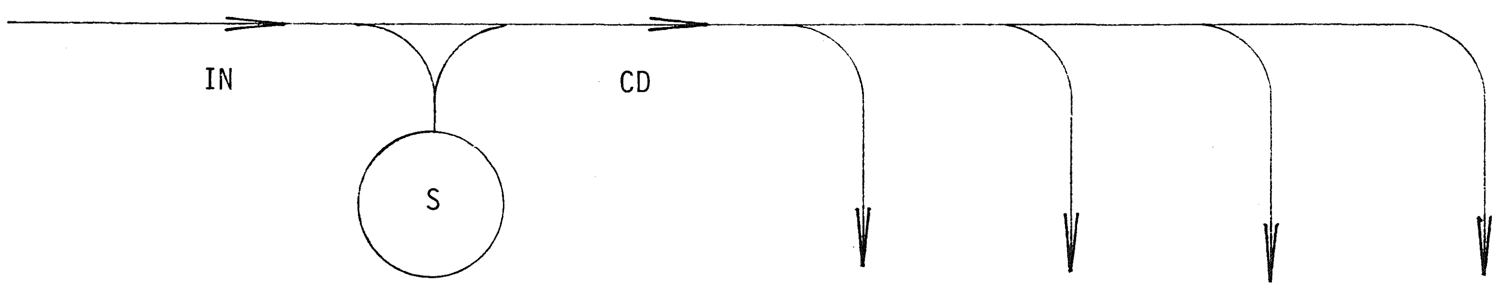
1980	IN		ΔS_m	ST_m	CD		Highway		Agriculture		ΔS_c	ST_c
	10^3 bbls	% of IN	10^3 bbls	% of CD_m	10^3 bbls	% of CD_a	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_c
Jan.	536	6	-226	-30	762	7	672	88	90	12	-226	-30
Feb.	486	6	-258	-35	744	6	547	74	197	26	-484	-32
Mar.	773	9	-59	-7	832	7	672	80	160	20	-543	-23
Apr.	819	10	-37	-4	856	8	618	72	238	28	-580	-18
May	1036	12	53	5	983	8	652	66	331	34	-527	-13
June	728	9	-241	-25	969	8	529	55	440	45	-768	-15
July	503	6	-201	-29	704	6	502	71	202	29	-969	-17
Aug.	658	8	-424	-39	1082	9	728	67	354	33	-1393	-20
Sept.	709	8	-77	-10	786	7	662	84	124	16	-1470	-19
Oct.	922	11	-983	-52	1905	16	645	34	1260	66	-2453	-25
Nov.	710	9	-709	-50	1419	12	687	48	732	52	-3162	-29
Dec.	503	6	-215	-30	718	6	465	65	253	35	-3377	-29
TOTAL	8383	100	-3377	-29	11790	100	7409	63	4381	37	-3377	-29

Table 4.11. 1980 PROJECTION FOR DISTILLATES USAGE IN IOWA



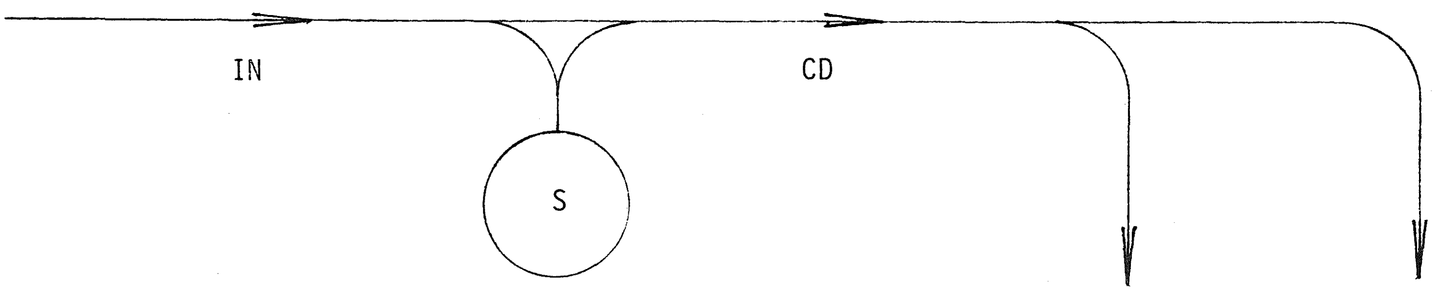
1980	IN		ΔS_m	ST_m	CD		Heating		Railroads		Industrial		Utilities		Others		ΔS_c	ST_c
	10^3 bbls	% of IN_a	10^3 bbls	% of CD_m	10^3 bbls	% of CD_a	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_c
Jan.	1999	14	-16	-1	2015	20	1366	68	101	5	142	7	370	18	36	2	-16	-1
Feb.	1762	12	212	14	1550	15	967	62	101	7	142	9	304	20	36	2	196	6
Mar.	1211	8	257	27	954	10	595	62	101	11	143	15	79	8	36	4	453	10
Apr.	781	6	190	32	591	6	214	36	101	17	143	24	97	17	36	6	643	13
May	1045	7	678	185	367	4	46	13	101	28	143	39	41	11	36	10	1321	24
June	936	6	609	186	327	3	2	1	100	31	143	44	45	74	37	11	1930	33
July	661	5	345	109	316	3	0	0	100	32	143	45	36	11	37	12	2275	37
Aug.	788	5	443	128	345	3	0	0	101	29	143	42	65	19	36	10	2718	42
Sept.	691	5	303	78	388	4	12	3	101	26	143	37	96	25	36	9	3021	44
Oct.	1275	9	517	68	758	7	372	49	101	13	143	19	106	14	36	5	3538	47
Nov.	1755	12	717	69	1038	10	625	60	101	10	142	14	134	13	36	3	4255	49
Dec.	1637	11	107	7	1530	15	1067	70	101	7	142	9	184	12	36	2	4362	43
TOTAL	14541	100	4362	43	10181	100	5266	52	1210	12	1712	17	1559	15	434	4	4362	43

Table 4.12. 1980 MONTHLY PROJECTION FOR LIQUIFIED PETROLEUM GAS (LP) USAGE IN IOWA



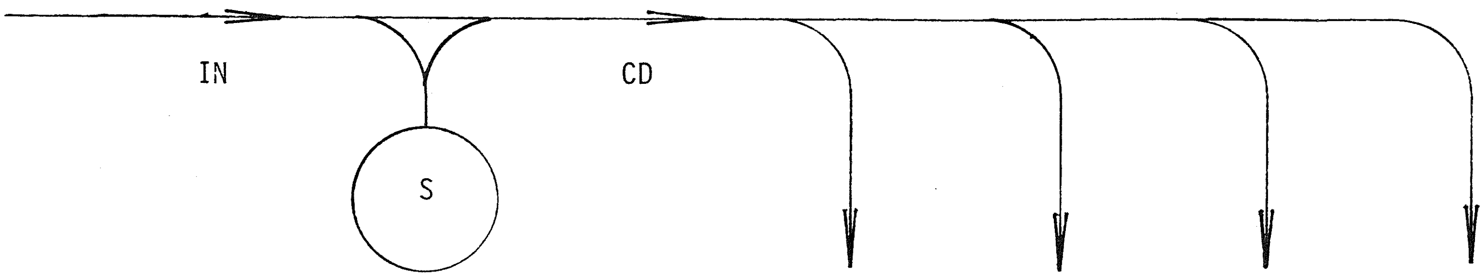
1980	IN		ΔS_m	ST_m	CD		Heating		Agriculture		Industrial		Others		ΔS_c	ST_c
	10^3 bbls	% of IN	10^3 bbls	% of CD_m	10^3 bbls	% of CD_a	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m
Jan.	2370	20	-129	-5	2499	18	2008	80	318	13	109	4	64	3	-129	-5
Feb.	1765	15	-148	-8	1913	13	1422	74	318	17	109	6	64	3	-277	-6
Mar.	945	8	-420	-31	1365	10	874	64	318	23	109	8	64	5	-697	-12
Apr.	454	4	-352	-44	806	6	315	39	318	39	109	14	64	8	-1040	-16
May	337	3	-221	-40	558	4	67	12	318	57	109	20	64	11	-1271	-18
June	344	3	-149	-30	493	4	2	0	318	65	109	22	64	13	-1420	-19
July	364	3	-127	-26	491	4	0	0	318	65	109	22	64	13	-1547	-19
Aug.	521	4	30	6	491	4	0	0	318	65	109	22	64	13	-1517	-18
Sept.	580	5	71	14	509	4	18	4	318	63	109	21	64	12	-1446	-16
Oct.	1915	15	877	84	1038	8	547	53	318	31	109	10	64	6	-570	-5
Nov.	809	6	-599	-42	1408	10	917	65	318	23	109	8	64	4	-1169	-10
Dec.	1624	13	-437	-21	2061	15	1570	76	318	16	109	5	64	3	-1606	-12
TOTAL	12028	100	-1606	-12	13634	100	7740	56	3816	28	1311	10	767	6	-1606	-12

Table 4.13. 1980 MONTHLY PROJECTION FOR AVIATION FUEL USAGE IN IOWA



1980	IN: 10^3 bbls	IN: % of IN	ΔS_m: 10^3 bbls	ST_m: % of CD_m	CD: 10^3 bbls	CD: % of CD_a	Jet Fuel: 10^3 bbls	Jet Fuel: % of CD_m	Aviation Gasoline: 10^3 bbls	Aviation Gasoline: % of CD_m	ΔS_c: 10^3 bbls	ST_c: % of CD_m
Jan.	45	5	0	0	45	5	39	87	6	13	0	0
Feb.	45	5	0	0	45	5	33	73	12	27	0	0
Mar.	67	8	0	0	67	8	53	79	14	21	0	0
Apr.	59	7	0	0	59	7	45	76	14	24	0	0
May	73	9	0	0	73	9	53	73	20	27	0	0
June	97	11	0	0	97	11	81	83	16	17	0	0
July	92	11	0	0	92	11	71	77	21	23	0	0
Aug.	102	12	0	0	102	12	81	79	21	21	0	0
Sept.	73	8	0	0	73	8	57	78	16	22	0	0
Oct.	82	9	0	0	82	9	66	80	16	20	0	0
Nov.	83	10	0	0	83	10	68	82	15	18	0	0
Dec.	45	5	0	0	45	5	36	80	9	20	0	0
TOTAL	863	100	0	0	863	100	683	79	180	21	0	0

Table 4.14. 1980 MONTHLY PROJECTION FOR RESIDUALS USAGE IN IOWA



1980	IN		S_m	ST_m	CD		Heating		Industrial		Railroads		Others		S_c	ST_c
	10^3 bbls	% of IN	10^3 bbls	% of CD_m	10^3 bbls	% of CD_a	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m	10^3 bbls	% of CD_m
Jan.	32	7	-135	-81	167	21	165	99	0.5	0.4	0.2	0.2	1.0	0.6	-135	-81
Feb.	53	11	-82	-61	135	17	133	99	0.6	0.4	0.3	0.2	1.1	0.8	-216	-72
Mar.	14	3	-100	-88	114	14	112	98	0.6	0.5	0.2	0.3	1.1	0.9	-316	-76
Apr.	13	3	-43	-77	56	7	54	9	0.6	1.0	0.3	0.5	1.1	1.9	-359	-76
May	20	4	-4	-15	24	3	22	92	0.6	2.5	0.2	1.1	1.1	4.6	-363	-73
June	17	4	-12	24	5	0.6	3	61	0.6	11.9	0.3	5.1	1.1	22.0	-351	-70
July	1	0	-1	-47	2	0.2	0	0	0.6	30.4	0.2	13.0	1.1	56.5	-352	-70
Aug.	1	0	-2	-71	3	0.4	2	44	0.6	17.1	0.3	7.3	1.1	31.7	-354	-70
Sept.	4	1	-9	-69	13	2	11	85	0.6	4.6	0.2	2.0	1.1	8.4	-363	-70
Oct.	210	44	167	393	43	5	41	96	0.6	1.4	0.3	0.6	1.1	2.5	-196	-35
Nov.	57	12	48	-41	97	12	95	98	0.6	0.6	0.2	0.3	1.1	1.1	-235	-36
Dec.	54	11	-92	-63	146	18	144	99	0.5	0.4	0.3	0.2	1.0	0.7	-328	-41
TOTAL	476	100	-328	-41	804	100	781	97	7.0	0.9	3.0	0.4	13.0	1.6	-328	-41

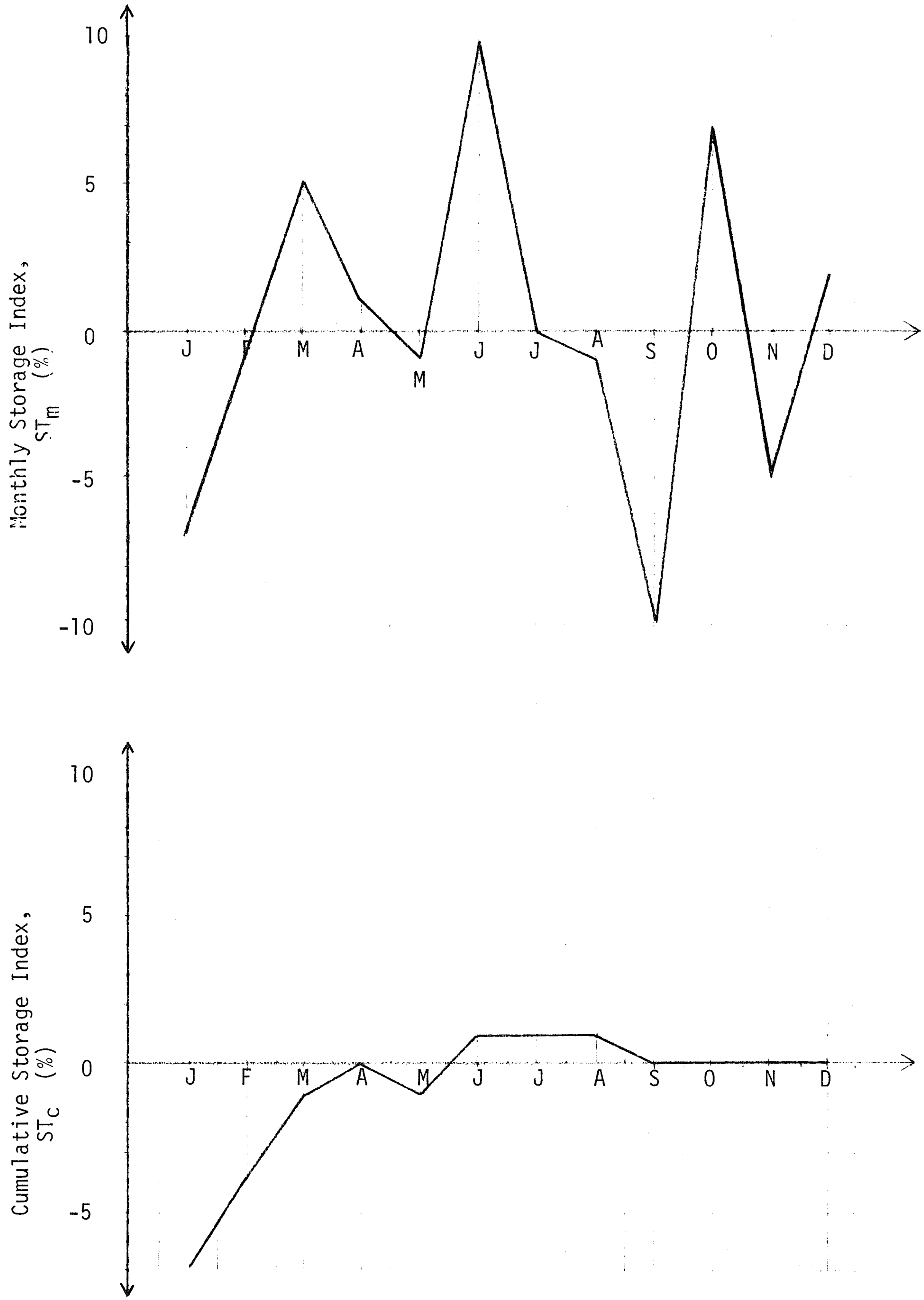
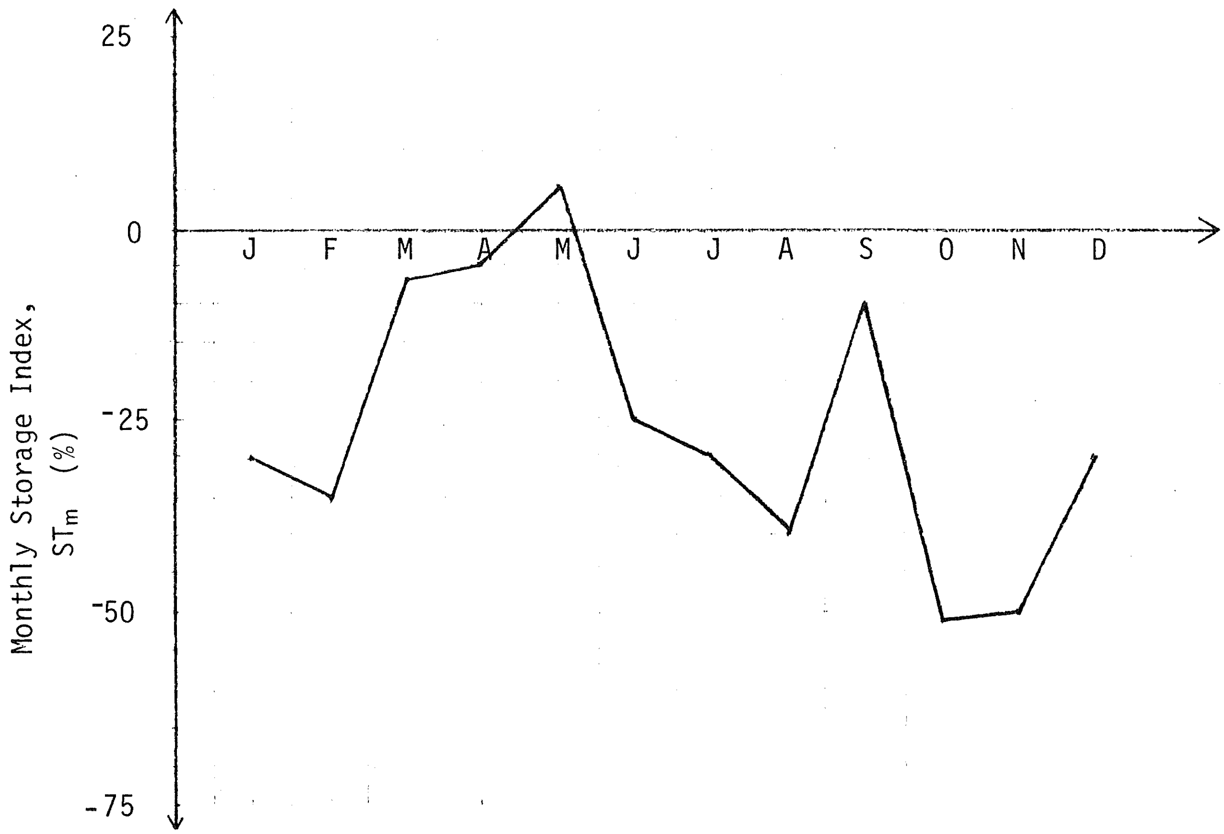


Fig. 4.1. PROJECTED MONTHLY AND CUMULATIVE STORAGE INDICES FOR GASOLINE IN 1980



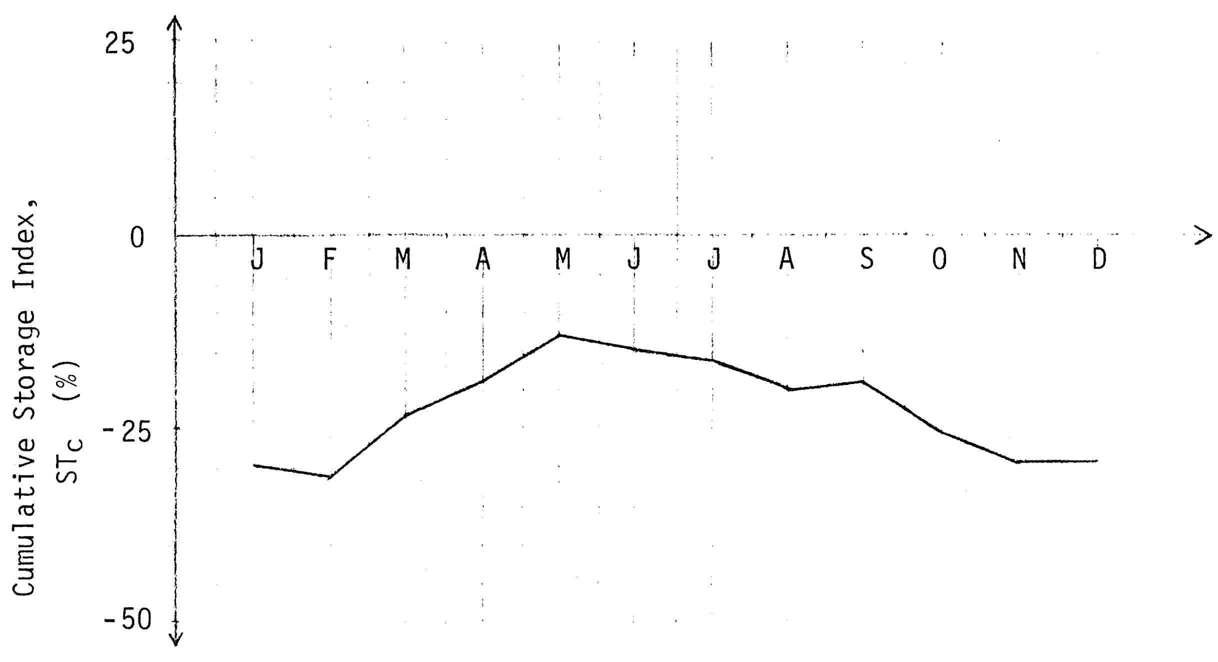


Fig. 4.2. PROJECTED MONTHLY AND CUMULATIVE STORAGE INDICES FOR DIESEL FUEL IN 1980

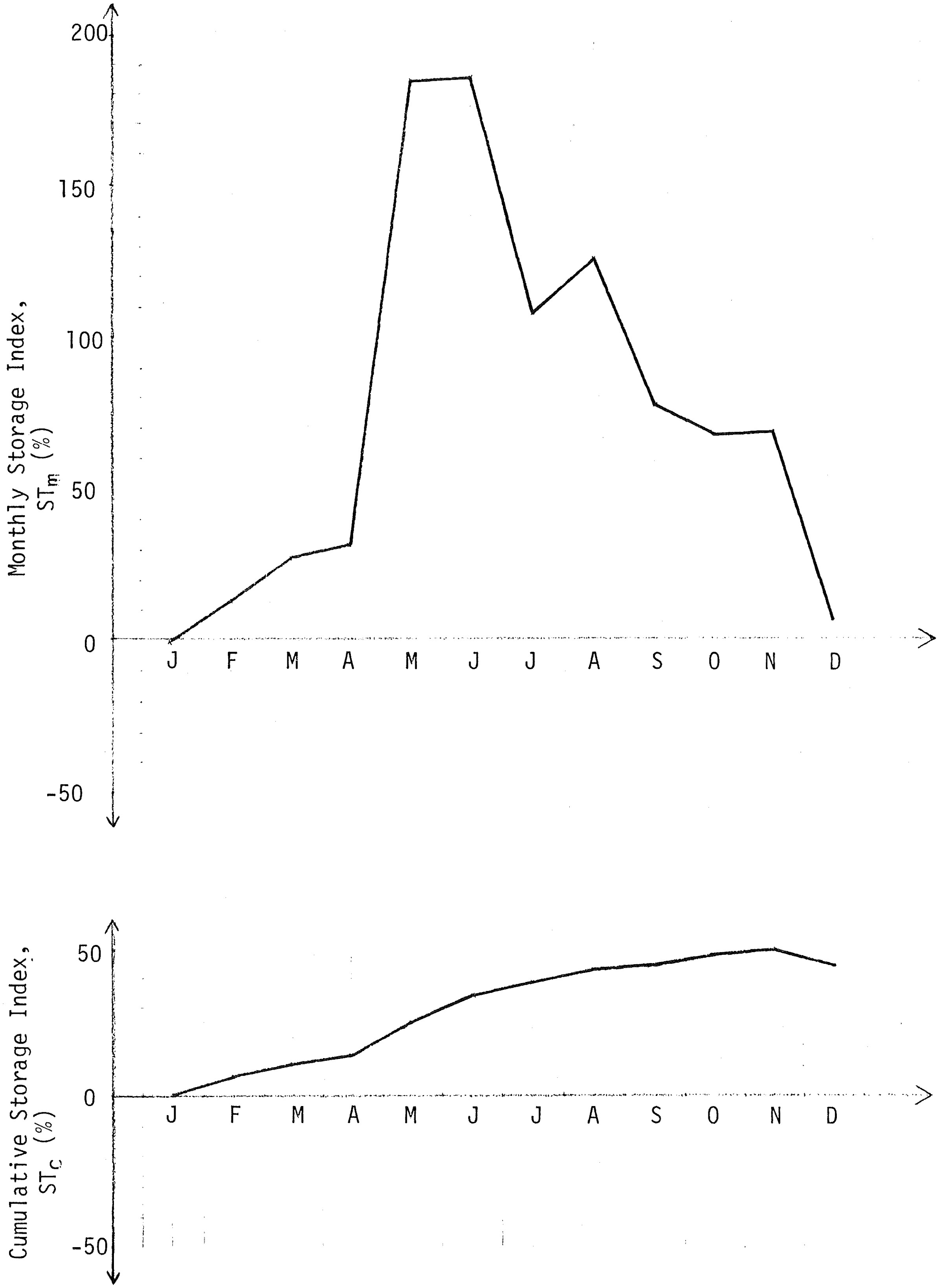


Fig. 4.3. PROJECTED MONTHLY AND CUMULATIVE STORAGE INDICES FOR DISTILLATES IN 1980

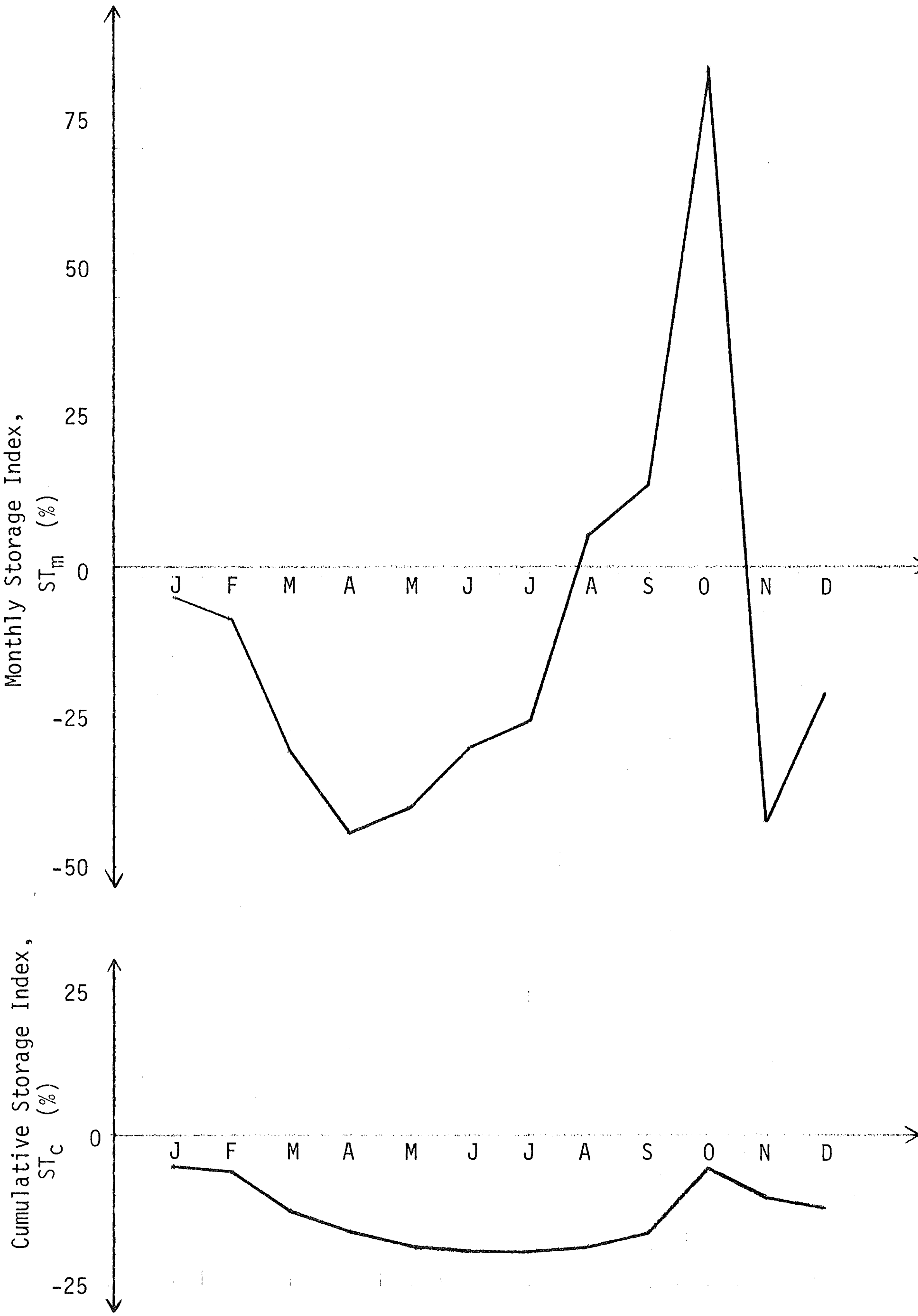


Fig. 4.4. PROJECTED MONTHLY AND CUMULATIVE STORAGE INDICES FOR LIQUIFIED PETROLEUM GAS IN 1980

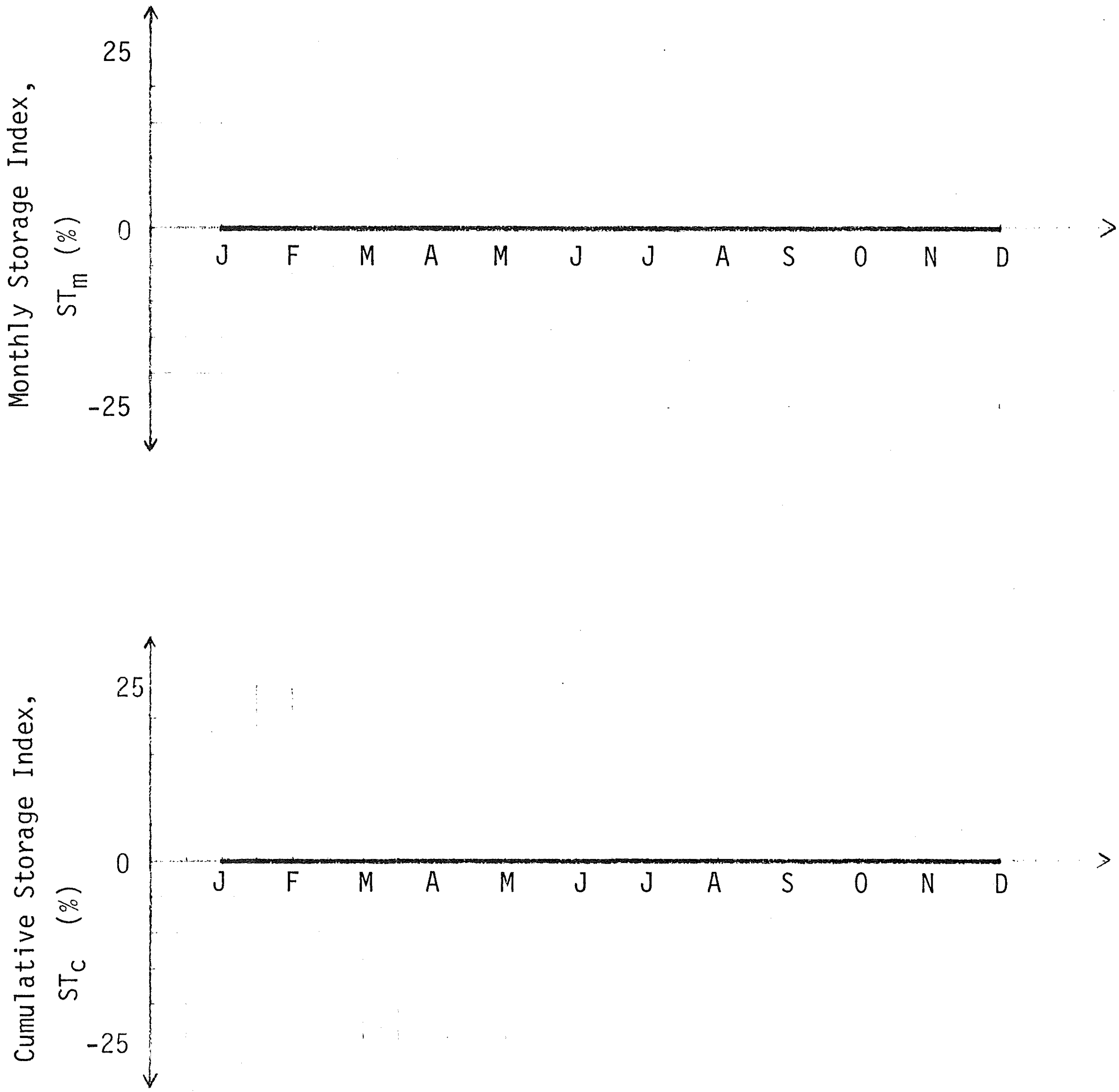


Fig. 4.5. PROJECTED MONTHLY AND CUMULATIVE STORAGE INDICES FOR AVIATION FUEL IN 1980

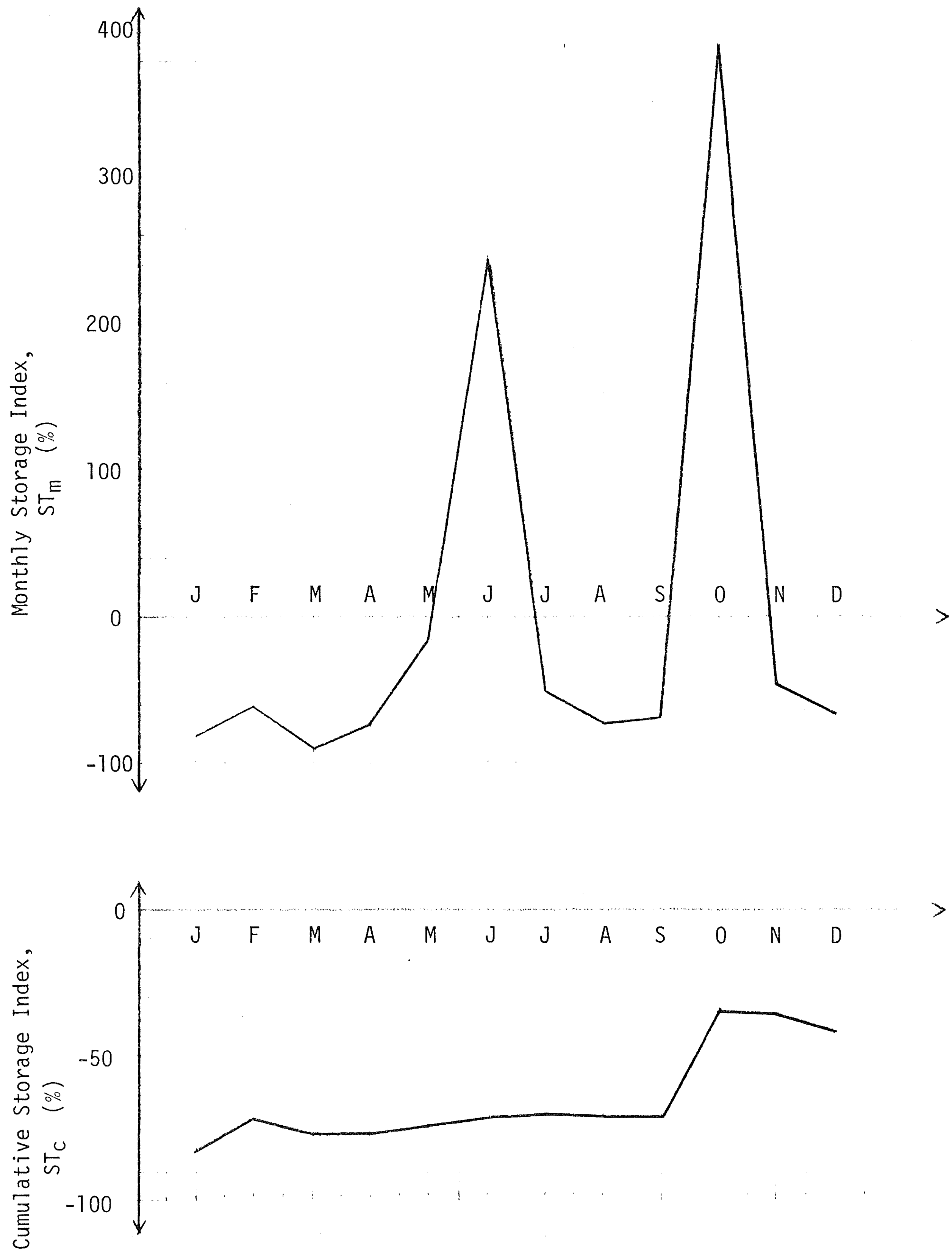


Fig. 4.6. PROJECTED MONTHLY AND CUMULATIVE STORAGE INDICES FOR RESIDUALS IN 1980

5.0 ASSESSMENT OF REACTIVE CONSERVATION MEASURES

Included in the May 31, 1979 draft of the "Iowa Energy Emergency Plan" were two lists of proposed measures: Voluntary and Mandatory. The voluntary measures would be implemented during a Stage I Alert, (Emergency not declared). During a Stage II Alert (Emergency declared), voluntary measures would be further emphasized and mandatory measures would be readied for implementation. If a Stage III Emergency were declared, mandatory measures would be put into effect. The technical feasibility of implementing the voluntary and mandatory measures is considered in this section. Also, questions regarding compliance of mandatory measures with federal and state authority are addressed.

The measures listed in the two tables of the draft are shown in Tables 5.1 to 5.6 according to the types of fuel to which they apply. The definitions of these measures are as cited in the May 31, 1979 draft of the Iowa Energy Emergency Management Plan. In addition to those originally identified by EPC, some other measures are shown which have been proposed by the contractor. These measures are briefly described in Table 5.7.

5.1 Technical Feasibility

All of the measures shown in Tables 5.1 to 5.6 were considered by the contractor to be technically feasible in theory. However, degree of compliance could not be assessed, thus the magnitude of energy savings is expected to vary considerably among measures. Comments on these factors are included in the next section, "Energy Savings."

Two of the voluntary measures shown in the draft document were deleted from further consideration as they were considered to be contraproductive to the objective of reducing specific shortages through reactive conservation. These were:

- Prohibit unnecessary electrical use.
- Conserve alternate fuels.

Although both of these measures are technically feasible and worthwhile preventive conservation measures, they could actually aggravate the problem of an acute heating fuel shortage. Since only 3% of the State's electrical use is derived from fuel oil, substitution of electrical heating for fuel oil heating will reduce depletion of fuel oil in the short term.

This same argument is also valid for the second deleted measure. Although conservation of all resources is desirable in the long term, consumption of alternate fuels to those in immediate short supply may be necessary during an emergency. For example, the use of natural gas, which may at other times be under control of interruptible contracts, could alleviate a fuel oil or LP shortfall. Other examples would be the use of fireplaces or electrical heat to substitute for fuel oil or LP residential heating sources. It should be noted that to substitute electric heat would be a reactive conservation measure which would reduce the shortage in fuel oil, but the cost of the heat to the consumer could increase.

Two other measures were deleted from further consideration as reactive measures although they were not considered to be contraproductive. They were:

- Conservation targets
- Reverse the school year

The conservation targets are not prescriptive measures and therefore did not require further analysis. If a 10% target is set, a 10% fuel savings should be realized. Prescriptive measures, which relate to this measure, and which have been included for further analysis consist of partial closings of facilities, 10 miles per week less driving, improved farm efficiencies, etc.

To reverse the school year was considered a preventive conservation measure which would have long-term (i.e. several years) impact to communities. A related measure which has been included for further analysis is partial school closings. This measure was assumed to mean a partial closure during the time of the shortfall and hence would occur only once. The time to make up for the closure was not specified.

5.2 Compliance with Federal and State Authorities

Compliance of mandatory measures with federal and state authorities was the other major factor to be considered in this section. Table 5.8 lists the measures and relevant precedents for their enforcement. Those measures which have been indicated as not having precedent should be studied carefully before enforcement. However, those studies should be prioritized based on energy savings that might be expected from the measures. Since reviews are being conducted by the Attorney General's office, no recommendations are being made in this report.

Table 5.1 REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN GASOLINE

Measure	Proposed by		Type of measure	
	EPC	ISU (added)	Voluntary	Mandatory
Public appeal	X		X	
Improved farm efficiency	X		X	X
State Government example	X		X	X
Drive 10 miles/wk less	X		X	
Prohibit sales when tank is more than half full	X		X	X
Limit travel by state employees	X		X	X
Prohibit single occupant cars	X			X
Weekend closing of service stations	X			X
Carpool incentive	X			X
Partial school closing	X			X
Partial commercial closure	X			X
Partial industrial closure	X			X
Partial government closure		X		X
Prohibit parking at meters	X			X
Restrict driving to public schools	X			X
Restrict after school activities		X		X
Prohibit free parking for state employees	X			X
Speed enforcement	X			X
Augment gas with alcohol	X			X
Odd-even sales	X			X
Highway speed reduction	X			X
State set aside	X			X
Restrict driving	X			X
Vehicle inspections		X	X	X

Table 5.2 REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN DIESEL FUEL

Measure	Proposed by		Type of measure	
	EPC	ISU (added)	Voluntary	Mandatory
Public appeal	X		X	
Improve farm efficiency	X		X	X
Improve truck efficiency	X		X	X
State Government example	X		X	
Limit road maintenance		X		X
Limit highway grass cutting		X		X
Limit snow removal		X		X
Prohibit deadheading	X		X	
Prohibit sales when tank is half full	X		X	
Increase payloads	X		X	X
Reduce construction	X			X
Reduce mining	X			X
Speed enforcement	X			X
Odd-even sales of fuel	X			X
Weekend closing of service stations		X		X
Highway speed reduction	X			X
State set aside	X			X
Restrict driving		X		X
Vehicle inspection		X		X

Table 5.3 REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN DISTILLATES

Measure	Proposed by		Type of measure	
	EPC	ISU (added)	Voluntary	Mandatory
Reduce hot water set point	(Residential)	(Other sectors)	X	X
Reduce hot water consumption	(Residential)	(Other sectors)	X	X
Space heating thermostat set back	(Residential & commercial)	(Other sectors)	X	X
Furnace tune-up	(Residential)	(Other sectors)	X	
Heat with alternate energy resources (electricity, wood, coal, etc.)		(All sectors)	X	X
Reduce ventilation to minimum acceptable levels		(All sectors)	X	X
Insure that "interruptible clauses" are not exercised		(Non-residential)	X	X
Load level electrical use				
•Minimize peak loading	(All sectors)		X	X
•Shift loads to minimize start ups		(All sectors)	X	X
•Purchase out of state electricity to replace that produced by oil		(All sectors)	X	X
Industrial - shift work to processes not requiring fuel oil	X		X	X
Agricultural - reduce drying or convert to other energy sources		X	X	
Partial school closures	X			X
Partial commercial closures	X			X
Partial industrial closures	X			X
Partial government closures	X			X
Operate buildings at night	X	(summer)		X
Restrict smoking in buildings	X		X	X

Table 5.4 REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN LIQUIFIED PETROLEUM GAS

Measure	Proposed by		Type of measure	
	EPC	ISU (added)	Voluntary	Mandatory
Reduce domestic hot water set points	(Residential)	(Other sectors)	X	X
Reduce domestic hot water consumption	(Residential)	(Other sectors)	X	X
Space heating thermostat set back	(Residential & commercial)	(Other sectors)	X	X
Furnace tune-up		(All sectors)	X	
Heat with alternate energy resources		(All sectors)	X	X
Reduce ventilation to minimum acceptable levels		(All sectors)	X	X
Insure "interruptible "clauses" are not exercised		(Non-residential)	X	X
Agricultural - reduce drying or convert to other energy sources		X	X	X
Partial school closing	X			X
Partial commercial closing	X			X
Partial industrial closing	X			X
Partial government closing	X			X
Operate building at night	X	(summer)		X
Restrict smoking	X			X

Table 5.5 REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN AVIATION FUELS

Measure	Proposed by		Type of measure	
	EPC	ISU (added)	Voluntary	Mandatory
Reduce aircraft operation	X		X	X
State government example	X		X	
Limit recreational flying		X	X	
Limit travel by state employees		X	X	
Limit Air National Guard maneuvers		X	X	
Limit crop dusting		X	X	
Limit number of commercial take-offs		X		X
Require commercial aircraft to operate at least 3/4 full	X			X

Table 5.6 REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN RESIDUALS

Measure	Proposed by		Type of measure	
	EPC	ISU (added)	Voluntary	Mandatory
Industry efficiency improvement	X		X	
Four day work week	X		X	
Partial industry closure	X			X
Use alternate sources		X	X	X

Table 5.7 ADDITIONAL REACTIVE CONSERVATION MEASURES PROPOSED BY ISU

Measure	Description
Partial government closure	Various offices could be closed on a priority basis to a limit where most essential remain open.
Restrict after school activities	Minimize the school operational hours.
Vehicle inspections	Priority cars to be tuned to the manufacturer's specifications.
Limit road maintenance Limit highway grass cutting Limit snow removal	Postpone operations on a priority basis.
Weekend closing of service stations Restrict driving	Could apply to diesel fuel as well.
Limit recreational flying Limit travel by state employees Limit Air National Guard maneuvers Limit crop dusting Limit number of commercial take-offs	Within the limits of reducing aircraft operation, but setting some priorities.
Reduce hot water set point Reduce hot water consumption Space heating thermostat set back	These measures could be applied to other sectors besides residential and commercial.
Furnace tune-ups	In other sectors in addition to residential.
Heat with alternate energy sources	Users of LPG or fuel oil switch to alternate sources such as natural gas.
Reduce ventilation to minimum acceptable levels	Maximize recirculation air.
Insure that "interruptible "clauses" are not exercised	Prevent shifting to fuel oil or LPG.
Shift loads to minimize start-ups	Have only necessary activities carried on during peak consumption hours.
Purchase out-of-state electricity to replace that produced by oil Agricultural - reduce drying or convert to other energy resources	Self explanatory

Table 5.8 PRECEDENTS FOR MANDATORY MEASURES

Measure	Precedent	Sources of Authority and Comments
Hot water temperature set back	Emergency Building Temperature Restriction (EBTR)	Residences and hospitals excluded.
Hot water flow restriction	Iowa State Energy Code	New buildings only.
Thermostat set back	EBTR	Residences, hospitals, and certain other buildings excluded.
Residential furnace tune-up		May require legislation.
General industry improvement		May require legislation.
Improve farm efficiency		May require legislation. May conflict with USDA & IDA established practices.
Improve truck efficiency		May require legislation. May conflict with ICC regulations.
Reduce aircraft operations		IEPC, special emergency powers. Iowa Code 93.8 (1977). May conflict with FAA regulations.
Four-day work week		IEPC, special emergency powers.
State Government example		Executive powers.
Reduce evening events		IEPC, special emergency powers.
Reduce dead-heading		Under jurisdiction of ICC.
Fill tanks only when less than 1/2 full		This measure may not be legal.
Restrict driving		IEPC, special emergency powers.
Prohibit single occupant cars		IEPC, special emergency powers.

Table 5.8 (cont.)

Measures	Precedent	Sources of Authority and Comments
Weekend closing of service stations		IEPC, special emergency powers.
Partial school closing		IEPC, special emergency powers.
Partial mining closing		IEPC, special emergency powers.
Partial construction closing		IEPC, special emergency powers.
Partial commercial closing		IEPC, special emergency powers.
Partial industrial closing		IEPC, special emergency powers.
Partial government closing		IECP, special emergency powers.
State enforcement of 55 mph speed limit	State Law	
Restrict driving to schools		IEPC, special emergency powers.
Restrict parking at meters		May require legislation.
Free mass transit		May require legislation.
No free parking for gov't employees		Executive powers.
Night office hours		IEPC, special emergency powers.
Restrict smoking		May require legislation.
Restrict aircraft to greater than 3/4 full		May be under jurisdiction of FAA.
Require use of gasohol		May require legislation.
Odd/even gasoline sales		IEPC, special emergency powers.
Speed limit reduction to 50 mph		May require legislation.

Table 5.8 (cont.)

Measure	Precedent	Sources of Authority and Comments
State Set-aside	State Law	
Limit aircraft take-offs		IEPC, special emergency powers.
Institute vehicle inspection		May require legislation.
Restrict road maintenance		Executive powers.
Restrict highway grass cutting	In effect	Executive powers.
Restrict highway snow removal		Executive powers.
Use alternate heating sources		May require legislation.
Reduce ventilation in non-residential buildings	State Energy Code	Based on ASHRAE Std. 62-73.
Restrict grain drying		May require legislation. May conflict with USDA & IDA.
Industrial shift in labor		May require legislation.
Electrical load-leveling		May require legislation.
Restrict aircraft operations		IEPC, special emergency powers.
Limit state employees travel		Executive powers.
Limit Air National Guard operations		Executive powers.
Limit crop dusting		IEPC, special emergency powers.

6.0 ESTIMATES OF ENERGY SAVINGS FOR REACTIVE CONSERVATION MEASURES

The reactive conservation measures, described in the previous section, are evaluated in this section for their potential energy savings. Where data were available, physical interactive effects have been addressed, but in most cases, these effects could not be analyzed. Information was not available regarding social or economic impact of the measures. The results of those effects must be left to a future study. Thus, the levels of acceptance or compliance for the measures could not be quantified at this time, and the results of ranking of the measures reported in this section were based on the potential for energy savings.

To rank the reactive measures, potential energy savings were estimated as a function of a consumption rate for an economic sector such as residential or for a process such as heating. These savings were then evaluated on a monthly basis using the projected energy consumption profiles described in Section 4.0. The measures were then evaluated in terms of total energy savings across all economic sectors (10^9 Btu), in terms of energy savings by economic sector (10^9 Btu) and in terms of energy savings by fuel type (10^3 bbls). Finally, the measures were ranked from the most to the least energy savings across all economic sectors, within each economic sector and within each fuel type.

6.1 Potential Energy Savings

Reactive conservation measures for six categories of petroleum products are shown in Tables 6.1 - 6.6 together with estimates of their potential energy savings. Comments on the methods of estimation are also included in these tables. Where detailed explanations were required, these have been included in Appendix 10.3. Note that the energy savings are shown as a fixed amount per month or as a percentage of specified values. The former values are seasonally independent while the latter values reflect seasonal adjustments.

Results of projected monthly and annual energy savings for each measure are shown in terms of total energy savings across all economic sectors and fuel categories, Table 6.7, in terms of total energy savings for all fuel categories within each economic sector, Tables 6.8 - 6.11, and in terms of each type of fuel category, Tables 6.12 - 6.17.

The results shown in Table 6.7 may be used to evaluate the relative merits of the measures in terms of energy equivalency. These values may be of assistance in public relations associated with implementing reactive measures. They also may be of assistance in evaluating the impact of the measures on a preventive conservation program. However, since the fuel type cannot be identified in this classification, reactive measures should not be chosen based on this table. The other use of the table is in cross references of the measure identification number shown in the left hand column. These numbers are used for measure identification in the subsequent tables in this section.

Tables 6.8 - 6.11 also are presented in terms of equivalent energy units with fuel types combined. Therefore, they should not be used to select reactive measures. Their basic value may be to provide guidance in comparing energy savings by economic sector. For example, Table 6.9 indicates an annual savings of 480 x 10^9 Btu for partial school closing. This value consists of energy equivalents for distillates and LP. If, in addition, data for gasoline savings could have been quantified for this measure, then some guidance toward the relative impact of this measure might have been indicated. Future efforts to complete these evaluations are necessary.

For purposes of choosing reactive measures to meet an anticipated shortfall of a particular fuel, Tables 6.12 - 6.17 should provide primary guidance. However, care must be exercised, here, as data upon which these savings were estimated still require validation.

6.2 Ranking of Reactive Conservation Measures

The reactive conservation measures were ranked according to their energy saving potentials as described in Tables 6.18 - 6.23. The ranking of measures according to total energy savings across all economic categories and fuel categories is shown in Table 6.18. Note that all 24 reactive measures that were quantified and listed in Table 6.7 are shown in Table 6.18. The rankings of measures according to total energy savings for all fuel categories within each economic sector are shown in Table 6.19. These rankings correspond to the measures shown in Tables 6.8 to 6.11. The rankings of measures according to specific fuel savings for all economic sectors are shown in Tables 6.20 - 6.23 and correspond to Tables 6.12 to 6.17.

The energy savings for reactive measures shown in Tables 6.7 - 6.17 are not completely independent and it is expected that one measure will have some effect on others. However, for purposes of this report, it is reasonable to assume that they are essentially independent as listed in the tables. Thus, the savings may be assumed as additive unless otherwise noted.

Results of these analyses indicate that the potential energy savings of the voluntary and mandatory reactive conservation measures, so far identified, are significant. The additive savings possible range from approximately 10% for diesel and aviation fuels, to about 25% for distillates and LP, and to approximately 44% for gasoline. It must be remembered, however, that these are potential savings and that 100% achievement of these potentials is not likely.

Table 6.1 POTENTIAL FUEL SAVINGS FOR REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN GASOLINE

Measure	Type	Savings	Comments
Public appeal	V	152×10^3 bbls/month	See EPC draft page 44. See Appendix 10.3, note #1.
Improved farm efficiency	V/M	10% of monthly agriculture values	See EPC draft page 50.
State Government example	V/M	Not quantified	Data unavailable. Also see Appendix 10.3, note #2.
Drive 10 miles/wk less	V	113×10^3 bbls/month	See Appendix 10.3, note #3.
No sales when tank greater than 1/2 full	V/M	Not quantified	Data unavailable.
Limit travel by State employees	V/M	Not quantified	See Appendix 10.3, note #2.
Prohibit single occupant cars	M	36% of monthly highway values	See Appendix 10.3, note #4.
Weekend closing of service stations	M	4% of monthly highway values	See EPC draft page 68.
Carpool incentive	M	4% of monthly highway values	See EPC draft page 68.
Partial school closing	M	Not quantified	Data unavailable. See Appendix 10.3, note #5.
Partial commercial closing	M	Not quantified	Data unavailable.
Partial industrial closing	M	< 1% of monthly highway values	See EPC draft page 79. See Appendix 10.3, note #6.
Partial government closing	M	Not quantified	See Appendix 10.3, note #2.
Prohibit parking at meters	M	Not quantified	Data unavailable.
Restrict driving to public schools	M	Not quantified	Data unavailable. See Appendix 10.3, note #5.

Table 6.1 (cont.)

Measure	Type	Savings	Comment
Restrict after school activities	M	Not quantified	Data unavailable. See Appendix 10.3, note #5.
Prohibit free parking for State employees	M	Not quantified	Related to carpool incentive.
Speed enforcement	M	1.7% of monthly highway values	See Appendix 10.3, note #7.
Augment with alcohol (gasohol)	M	Not quantified	See EPC draft page 92.
Odd/even sales	M	Not quantified	Data unavailable.
Highway speed reduction	M	2% of monthly highway values	See Appendix 10.3, note #8.
State Set-aside	M	Not quantified	Data unavailable.
Restrict driving	M	Not quantified	Included in other measures.
Vehicle inspection	M	2.5% of monthly highway values	See Appendix 10.3, note #9.

Table 6.2 POTENTIAL FUEL SAVINGS FOR REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN DIESEL FUEL

Measure	Type	Savings	Comments
Public appeal	V	Negligible	See EPC draft page 55.
Improved farm efficiency	V/M	10% of monthly agriculture values	See EPC draft page 50.
Improved truck efficiency	V/M	3.4% of monthly highway values	See EPC draft page 55.
State Government example	V/M	Not quantified	Data unavailable. Also see Appendix 10.3, note #2.
Limit road maintenance	M	Not quantified	Data unavailable.
Limit highway grass cutting	M	Not quantified	Data unavailable.
Limit snow removal	M	Not quantified	Data unavailable.
Prohibit dead-heading	M	Not quantified	Data unavailable.
No sales when tanks greater than 1/2 full	M	Not quantified.	Data unavailable.
Increase payloads	M	Not quantified	See EPC draft page 55. (part of improved truck efficiency)
Partial construction closure	M	Negligible	See EPC draft page 74.
Partial mining closure	M	0.5% of monthly total diesel values reduction in mining	See EPC draft page 73.
Speed enforcement	M	2.3% of monthly highway values	See Appendix 10.3, note #10.
Odd/even sales	M	Negligible	See EPC draft page 91.
Weekend closing of service stations	M	None	See EPC draft page 95.

Table 6.2 (cont.)

Measure	Type	Savings	Comments
Highway speed reduction	M	2.2% of monthly highway values	See Appendix 10.3, note #11.
State Set-aside	M	Not quantified	Data unavailable.
Restrict driving	M	Not quantified	Included in other measures.
Vehicle inspection	M	2.5% of monthly highway values	See Appendix 10.3, note #2.

Table 6.3 POTENTIAL FUEL SAVINGS FOR REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN DISTILLATES

Measure	Type	Savings	Comments
Reduce hot water temperature set point	V/M	892 bbls/month (residential)	Not quantified for non-residential. See Appendix 10.3, note #12.
Reduce hot water consumption	V/M	140 bbls/month (residential)	Not quantified for non-residential. See Appendix 10.3, note #13.
Thermostat set back	V/M	12% of monthly heating values	See Appendix 10.3, note #14.
Furnace tune-up	V	5% of monthly heating values	See EPC draft page 46.
Use alternate fuel	V/M	17% of monthly total values	See Appendix 10.3, note #15.
Reduce ventilation	V/M	5% of monthly heating values	See Appendix 10.3, note #16.
Prevent use of interrruptible clauses	V/M	Not quantified	Included in considering alternate fuels.
Load-level electricity	V/M	10% of monthly utility values	Assumed values are consistent with several reports.
Industrial labor shift	V/M	5% of monthly industrial values for 10% shift	See EPC draft page 79.
Restrict grain drying	V/M	Not quantified	Data unavailable.
Partial school closing	M	1.8% of monthly heating values for 5% closing	See Appendix 10.3, note #17.
Partial commercial closing	M	2.5% of monthly heating values for 5% closing	See EPC draft page 76.
Partial industrial closing	M	Not quantified	See EPC draft page 79 and (Assumed as part of labor shift).
Partial government closing	M	Negligible (i.e. 0.8% of monthly heating values for 50% closing)	See Appendix 10.3, note #18.

Table 6.3 (cont.)

Measure	Type	Savings	Comments
Operate buildings at night	M	Not quantified	Data unavailable.
Prohibit smoking	M	Not quantified	Assumed as with reduced ventilation.

Table 6.4 POTENTIAL FUEL SAVINGS FOR REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN LIQUIFIED PETROLEUM GAS

Measures	Type	Savings	Comments
Reduce hot water set point	V/M	16.4×10^3 bbls/month residential. Not quantified for non-residential	See Appendix 10.3, note #12. Data not available.
Reduce hot water consumption	V/M	2.58×10^3 bbls/month residential. Not quantified for non-residential	See Appendix 10.3, note #13. Data unavailable.
Thermostat set back	V/M	12% reduction in heating consumption	See Appendix 10.3, note #14.
Furnace tune-up	V	5% of monthly heating consumption	See EPC draft page 46.
Use alternative sources	V/M	17% of monthly heating consumption	See Appendix 10.3, note #15.
Reduce ventilation	V/M	5% of monthly heating consumption	See Appendix 10.3, note #16.
Prevent use of interruptible clauses	V/M	Included in considering alternate fuels	
Restrict grain drying	V/M	Not quantified	Data unavailable.
Partial school closing	V/M	Negligible	See Appendix 10.3, note #17.
Partial commercial closing	V/M	Negligible	See Appendix 10.3, note #19.
Partial industrial closing	V/M	5% savings for 10% shutdown	See Appendix 10.3, note #20.
Partial government closing	V/M	Negligible	See Appendix 10.3, note #18.
Prohibit smoking	V/M	Required for reduced ventilation	

Table 6.5 POTENTIAL FUEL SAVINGS FOR REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN AVIATION FUELS

Measures	Type	Savings	Comments
Reduce air operations	V/M	Not quantified	Data unavailable.
State Government example	V/M	Not quantified	Data unavailable.
Limit State employee travel	V/M	Not quantified	Data unavailable.
Limit Air National Guard operations	V/M	Not quantified	Data unavailable.
Limit crop dusting	M	Not quantified	Data unavailable.
Limit number of commercial take-offs	M	Target 10% of monthly fuel supply	See EPC draft page 56.
Limit take-off when less than 3/4 full	M	Not quantified	Data unavailable.

Table 6.6 POTENTIAL FUEL SAVINGS FOR REACTIVE CONSERVATION MEASURES FOR SHORTAGES IN RESIDUALS

Measure	Type	Savings	Comments
Industrial efficiency improvement	V/M	Assume 10% reduction of industrial use	See EPC draft page 47.
Four-day work week	V/M	Not quantified	Data unavailable.
Partial industrial closing	V/M	Assume 10% reduction of industrial use	See EPC draft page 47.
Use alternate sources	V/M	Assume 50% reduction in heating	Residuals used as secondary.

Table 6.7 EVALUATION OF MEASURES BY TOTAL ENERGY SAVINGS (10^9 Btu)

	Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	Res. hot water temp. set back	V/M	67	67	67	67	67	67	67	67	67	67	67	67	804
2	Hot water flow reduction	V/M	12	12	12	12	12	12	12	12	12	12	12	12	144
3	Thermostat set back	V/M	1959	1392	853	310	67	0	0	0	8	263	879	1501	7232
4	Pub. appeal to save gasoline	V	793	793	793	793	793	793	793	793	793	793	793	793	9516
5	Res. furnace tune-up	V/M	798	565	351	128	24	0	0	0	7	219	365	622	3079
6	Improve farm efficiency	V/M	119	265	211	319	437	583	265	470	162	1674	972	335	5812
7	Improve truck efficiency	V/M	130	107	130	119	125	102	96	142	125	125	130	91	1422
8	Drive 10 miles less per week	V	590	590	590	590	590	590	590	590	590	590	590	590	7080
9	Prohibit 1 occupancy cars	M	6476	5703	6105	5661	6189	5484	5865	6090	6961	3501	5187	5276	68498
10	Weekend closings	M	720	631	678	631	689	611	652	678	772	391	574	584	7611
11	Commuter parking	M	720	631	678	631	689	611	652	678	772	391	574	584	7611

Table 6.7 (cont.)

	Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
12	Partial school closing *	M	142	96	62	11	4	0	0	0	1	23	34	107	480 *
13	Partial mining closure	M	193	153	193	176	187	147	142	204	187	181	193	130	2086
14	Partial commercial closure *	M	198	140	88	23	6	0	0	0	1	58	93	152	759 *
15	Partial industry closure *	M	140	130	135	130	140	124	135	135	156	88	119	119	1551 *
16	Partial gov't closure *	M	56	40	24	8	2	0	0	0	0	16	24	44	214 *
17	Strict 55 mph	M	393	339	372	345	372	329	339	370	414	246	330	307	4156
18	Speed reduction	M	445	386	424	392	424	376	386	430	556	278	372	349	4818
19	Limit take-offs	M	22	22	40	34	40	57	51	57	40	45	45	22	475
20	Vehicle inspection	M	550	476	519	476	519	460	481	525	582	336	456	438	5818
21	Use alternate source for heating	V/M	3246	2349	1545	599	161	0	0	0	56	868	1551	2587	12962
22	Reduce ventilation	V/M	798	565	352	128	24	0	0	0	8	219	365	622	3081

* Traffic savings not quantified

Table 6.7 (cont.)

	Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
23	Industrial shift in labor	V/M	41	41	41	41	41	41	41	41	41	41	41	41	492
24	Elec. load level	V/M	216	175	47	58	23	23	23	35	58	64	76	105	903
25	Restrict driving	M					SEE OTHERS								
26	Prohibit elec. use	V/M					NOT A REACTIVE MEASURE								
27	Conserve alternate fuels	V/M					NOT A REACTIVE MEASURE								
28	Conservation targets	M					NOT A REACTIVE MEASURE								
29	Reverse school year	M					NOT A REACTIVE MEASURE								
30	General industry improvement	V/M					NOT QUANTIFIED								
31	Reduce air operations	V/M					NOT QUANTIFIED								
32	4-day work week	V/M					NOT QUANTIFIED								
33	State Gov't Example	V/M					NOT QUANTIFIED								
34	Reduce evening events	V/M					NOT QUANTIFIED								
35	Reduce dead-heading	V/M					NOT QUANTIFIED								
36	Tank less than 1/2 full	V/M					NOT QUANTIFIED								
37	Partial construction closure	M					NOT QUANTIFIED								

Table 6.7 (cont.)

	Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
38	No driving to schools	M					NOT QUANTIFIED								
39	No meter parking	M					NOT QUANTIFIED								
40	Free mass transit	M					NOT QUANTIFIED								
41	No free parking	M					NOT QUANTIFIED								
42	Night operations	M					NOT QUANTIFIED								
43	3/4 full aircraft	M					NOT QUANTIFIED								
44	Odd/even sales	M					NOT QUANTIFIED								
45	State Set-aside	M					NOT QUANTIFIED								
46	Restrict road maintenance	M					NOT QUANTIFIED								
47	Restrict highway grass cutting	M					NOT QUANTIFIED								
48	Restrict snow removal	M					NOT QUANTIFIED								
49	Agriculture drying	V/M					NOT QUANTIFIED								
50	Reduce air operations	V/M					NOT QUANTIFIED								
51	Limit state employee travel	M					NOT QUANTIFIED								

Table 6.7 (cont.)

	Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
52	Limit Air National Guard operations	V/M					NOT QUANTIFIED								
53	Limit crop dusting	V/M					NOT QUANTIFIED								
54	No smoking	M				PART OF VENTILATION									
55	Gasohol	M					NEGLIGIBLE								

Table 6.8 EVALUATION OF MEASURES IN THE RESIDENTIAL SECTOR (10^9 Btu)

	Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	Hot water temp. set back	V/M	67	67	67	67	67	67	67	67	67	67	67	67	804
2	Hot water flow reduction	V/M	12	12	12	12	12	12	12	12	12	12	12	12	144
3	Thermostat set back *	V/M	1156	819	502	182	39	0	0	0	5	155	517	883	4258
4	Furnace tune-up	V/M	798	565	351	128	24	0	0	0	7	219	365	622	3079
5	Use alternate energy sources *	V/M	1910	1382	909	352	95	0	0	0	33	511	913	1522	7627
	Total		3943	2845	1841	741	237	79	79	79	124	964	1874	3106	15912

*Residential fractions of savings estimated in proportion to total fraction of consumption (i.e. 10/17 of savings; see Appendix 10.3, note #15).

Table 6.9 EVALUATION OF MEASURES IN THE COMMERCIAL SECTOR (10^9 Btu)

	Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
3	Thermostat set back*	V/M	803	573	351	128	28	0	0	0	3	108	362	618	2974
12	Partial school closing	M	142	96	62	11	4	0	0	0	1	23	34	107	480
14	Partial commercial closing	M	198	140	88	23	6	0	0	0	1	58	93	152	759
21	Use alternate sources of heating*	V/M	1336	967	636	247	66	0	0	0	23	357	638	1065	5335
22	Reduce ventilation	V/M	798	565	352	128	24	0	0	0	8	219	365	622	3081
	Total		3277	2341	1489	537	128	0	0	0	36	765	1492	2564	12629

*Commercial fractions of savings estimated in proportion to total fraction of consumption (i.e. 7/17 of savings; see Appendix 10.3, note #15).

Table 6.10 EVALUATION OF MEASURES IN THE TRANSPORTATION SECTOR (10^9 Btu)

	Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
4	Public appeal to save gasoline	V	793	793	793	793	793	793	793	793	793	793	793	793	9516
7	Improve truck efficiency	V/M	130	107	130	119	125	102	96	142	125	125	130	91	1422
8	Drive 10 miles less	V	590	590	590	590	590	590	590	590	590	590	590	590	7080
9	Prohibit 1 occupancy cars	M	6476	5703	6105	5661	6189	5484	5865	6090	6961	3501	5187	5278	68498
10	Weekend closings of service stations	M	720	631	678	631	689	611	652	678	772	391	574	584	7611
11	Commuter parking	M	720	631	678	631	689	611	652	678	772	391	574	584	7611
17	Strict 55 mph	M	393	339	372	345	372	329	339	370	414	246	330	307	4156
18	Speed reduction	M	445	386	424	392	424	376	386	430	556	278	372	349	4818
19	Limit take-offs	M	22	22	40	34	40	57	51	57	40	45	45	22	475
20	Vehicle inspection	M	550	476	519	476	519	460	481	525	582	336	456	438	5818
	Total		10839	9678	10329	9672	10430	9413	9905	10353	11605	6696	9051	9036	117007

Table 6.11 EVALUATION OF MEASURES IN OTHER ECONOMIC SECTORS (10^9 Btu)

Measures	Type (V/M)	J	F	M	A	M	J	J	A	S	O	N	D	Total
Utilities														
24 Load level	V/M	216	175	47	58	23	23	23	35	58	64	76	105	903
Industrial														
15 Partial closure	M	140	130	135	130	140	124	135	135	156	88	119	119	1551
23 Labor shift	V/M	41	41	41	41	41	41	41	41	41	41	41	41	492
Total		181	171	176	171	181	165	176	176	197	129	160	160	2043
Agricultural														
6 Improve efficiency	V/M	119	265	211	319	437	538	265	470	162	1674	972	335	5812
Mining														
13 Partial closure	M	193	153	193	176	187	147	142	204	187	181	193	130	2086
Government														
16 Partial closure	M	56	40	24	8	2	0	0	0	0	16	24	44	214

Table 6.12 POTENTIAL GASOLINE SAVINGS IN 1980 FROM REACTIVE CONSERVATION MEASURES (10^3 bbls)

	Measure	J	F	M	A	M	J	J	A	S	O	N	D	Total
4	Public appeal	152	152	152	152	152	152	152	152	152	152	152	152	1824
6	Farm efficiency	13	29	23	35	48	64	29	52	18	184	107	37	639
8	10 miles less	113	113	113	113	113	113	113	113	113	113	113	113	1356
9	2 occupant cars	1241	1093	1170	1085	1186	1051	1124	1167	1334	671	994	1011	13128
10	Weekend closing	138	121	130	121	132	117	125	130	148	75	110	112	1459
11	Carpool incentive	138	121	130	121	132	117	125	130	148	75	110	112	1459
15	10% industry closing	23	21	22	21	23	20	22	22	26	13	19	19	251
17	Speed enforcement	59	52	55	51	56	50	53	55	63	32	47	48	620
18	Speed reduction	69	61	65	60	66	59	62	65	74	38	55	56	729
20	Vehicle inspection	87	76	81	75	82	74	78	81	93	47	69	71	912
	Total less #4 & #8	1768	1574	1789	1569	1725	1552	1618	1702	1811	1088	1511	1466	19173

Table 6.13 ESTIMATED POTENTIAL DIESEL FUEL SAVINGS IN 1980 FROM REACTIVE CONSERVATION MEASURES (10^3 bbls)

	Measures	J	F	M	A	M	J	J	A	S	O	N	D	Total
4	Improve farm	9	20	16	24	33	44	20	35	12	126	73	25	437
6	Improve truck	23	19	23	21	22	18	17	25	22	22	23	16	251
13	Mining	34	27	34	31	33	26	25	36	33	32	34	23	368
17	Speed enforcement	15	12	15	14	14	12	11	16	15	14	15	10	163
18	Speed reduction	15	12	15	14	14	12	11	16	15	14	15	10	163
20	Vehicle inspection	17	14	17	15	16	13	13	18	17	16	17	12	185
	Total less #13	79	77	86	88	99	99	72	110	81	192	143	73	1199

Table 6.14 ESTIMATED POTENTIAL DISTILLATES SAVINGS IN 1980 FROM REACTIVE CONSERVATION MEASURES (10^3 bbls)

	Measure	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	Reduce hot water temp.	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	10.8
2	Reduce hot water flow	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2
5	Furnace	68	48	30	11	2	0.1	0	0	0.6	19	31	53	263
21	Alternate sources	232	164	101	36	8	0.3	0.2	0.2	2	63	106	181	893
22	Reduce ventilation	68	48	30	11	2	0.1	0	0	0.6	19	31	53	263
24	Load level	37	30	8	10	4	4	4	6	10	11	13	18	155
23	Industry shift	7	7	7	7	7	7	7	7	7	7	7	7	84
12	5% schools close	25	17	11	4	0.8	0	0	0	0.2	7	11	19	95
14	5% commercial close	34	24	15	6	1	0	0	0	0.3	10	16	26	132
16	5% gov't closing	14	10	6	2	0.4	0	0	0	0.1	4	6	11	53
3	Thermostat set back	170	121	74	27	6	0	0	0	0	45	75	128	646
	Total	656	470	283	115	32	12	12	14	22	186	297	497	2596

Table 6.15 ESTIMATED POTENTIAL LIQUIFIED PETROLEUM GAS SAVINGS IN 1980 FROM REACTIVE CONSERVATION MEASURES (10^3bbls)

	Measure	J	F	M	A	M	J	J	A	S	O	N	D	Total
1	Reduce hot water	16	16	16	16	16	16	16	16	16	16	16	16	192
2	Reduce hot water consumption	3	3	3	3	3	3	3	3	3	3	3	3	36
3	Thermostat set back	241	171	105	38	8	0	0	0	2	66	110	188	929
5	Furnace tune-up	100	71	44	16	3	0	0	0	1	27	46	78	386
21	Alternate sources	341	242	149	54	11	0	0	0	3	93	156	267	1316
22	Reduce ventilation	100	71	44	16	3	0	0	0	1	27	46	78	386
15	Partial industry closing	5	5	5	5	5	5	5	5	5	5	5	5	60
	Total	806	579	366	148	49	24	24	24	31	237	382	635	3305

Table 6.16 ESTIMATED POTENTIAL AVIATION FUEL SAVINGS IN 1980 FROM REACTIVE CONSERVATION MEASURES (10^3bbls)

	Measure	J	F	M	A	M	J	J	A	S	O	N	D	Total
43	Limit take-offs	4	4	7	6	7	10	9	10	7	8	8	4	84
	Total	4	4	7	6	7	10	9	10	7	8	8	4	84

Table 6.17 ESTIMATED POTENTIAL RESIDUALS SAVINGS IN 1980 FROM REACTIVE CONSERVATION MEASURES (10^3bbls)

	Measure	J	F	M	A	M	J	J	A	S	O	N	D	Total
21	Use alternate sources	82	66	56	27	11	1	0	1	5	20	48	72	389
	Total	82	66	56	27	11	1	0	1	5	20	48	72	389

Table 6.18 RANKING OF MEASURES[1] BY TOTAL ENERGY SAVINGS IN 1980

	Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
	Rank													
Most	1	9	9	9	9	9	9	9	9	9	9	9	9	9
Savings	2	21	21	21	4	4	4	4	4	4	6	21	21	21
↓	3	3	3	3	10	10	10	10	10	10	21	6	3	4
	4	22	4	4	11 *	11 *	11 *	11 *	11 *	11 *	4	3	4	10
	5	5 *	10	10	21	8	8	8	8	8	8	4	5	11 *
	6	4	11 *	11 *	8	20	6	20	20	20	10	8	22 *	3
	7	10	8	8	20	6	20	18	6	18	11 *	10	8	8
	8	11 *	5	20	18	18	18	17	18	17	20	11 *	10	20
	9	8	22 *	18	17	17	17	6	17	6	18	20	11 *	6
	10	20	20	17	6	13	13	13	13	13	3	18	20	18
	11	18	18	22	3	21	15	15	7	15	17	22	18	17
	12	17	17	5	13	15	7	7	15	7	5	5 *	6	22
	13	24	6	6	15	7	1	1	1	1	22 *	17	17	5
	14	14	24	13	5	1	19	19	19	21	13	13	14	13
	15	13	13	15	22 *	3 *	23	23	23	23	7	7	13	15
	16	12	14	7	7	23	24	24	24	19	15	15	15	7

Continued

Table 6.13 (cont.)

	Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
↓	Rank													
	17	15	15	14	1	19	2	2	2	24	1	14	12	24
	18	7	7	1	24	5	3 *	3 *	3 *	2	14	1	24	1
	19	6	12	12	23	22 *	5 *	5 *	5 *	3	24 *	24	7	14
	20	1	1	24	19	24	12 *	12 *	12 *	22 *	19	19	1	23
	21	16 *	23	23	14	2	14 *	14 *	14 *	5	23	23	16	12
	22	24	16	19	2	14	16 *	16 *	16 *	12	12	12	23	19
Least	23	19	19	16	12	12	21 *	21 *	21 *	14 *	16	16	19	16
savings	24	2	2	2	16	16	22 *	22 *	22 *	16	2	2	2	2

[1] Measures are indicated by a number key from Table 6.7.
* Indicates a measure with the same savings as the previous measure.

Table 6.19 RANKING OF MEASURE[1] BY ECONOMIC SECTOR IN 1980

		Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
		Rank													
Most		1	9	9	9	9	9	9	9	9	9	9	9	9	9
savings	Transportation	2	4	4	4	4	4	4	4	4	4	4	4	4	4
↓		3	11	11	11	11	11	11	11	11	11	11	11	11	11
		4	10 *	10 *	10 *	10 *	10 *	10 *	10 *	10 *	10 *	10 *	10 *	10 *	10 *
		5	8	8	8	8	8	8	8	8	8	8	8	8	8
		6	20	20	20	20	20	20	20	20	20	20	20	20	20
		7	18	18	18	18	18	18	18	18	18	18	18	18	18
		8	17	17	17	17	17	17	17	17	17	17	17	17	17
Least		9	7	7	7	7	7	7	7	7	7	7	7	7	7
savings		10	19	19	19	19	19	19	19	19	19	19	19	19	19
Most	Commercial	1	21	21	21	21	21	-	-	-	21	21	21	21	21
savings		2	3	3	22	22	3	-	-	-	22	22	22	22	22
↓		3	22	22	3	3 *	22	-	-	-	3	3	3	3	3
Least		4	14	14	14	14	14	-	-	-	14	14	14	14	14
savings		5	12	12	12	12	12	-	-	-	12 *	12	12	12	12

Continued

Table 6.19 (cont.)

	Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
	Rank													
Most / Residential	1	21	21	21	21	21	1	1	1	1	21	21	21	21
savings	2	3	3	3	3	1	2	2	2	21	5	3	3	3
↓	3	5	5	5	5	3	-	-	-	2	3	5	5	5
Least	4	1	1	1	1	5	-	-	-	5	1	1	1	1
savings	5	2	2	2	2	2	-	-	-	3	2	2	2	2

[1] Measures are indicated by a number key from Table 6.7.

[2] Other sectors had insufficient measures to rank.

* Indicates a measure with the same savings as the previous measure.

Table 6.20 RANKING OF REACTIVE CONSERVATION MEASURES[1] FOR GASOLINE IN 1980

	Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
	Rank													
Most	1	9	9	9	9	9	9	9	9	9	9	9	9	9
savings	2	4	4	4	4	4	4	4	4	4	6	4	4	4
↓	3	10	10	10	10	10	10	10	10	10	4	8	8	10
	4	11 *	11 *	11 *	11 *	11 *	11 *	11 *	11 *	11 *	8 *	10	10	11
	5	8	8	8	8	8	8	8	8	8	10	11 *	11 *	8
	6	20	20	20	20	20	20	20	20	20	11 *	6	6	20
	7	18	18	18	18	18	18	18	18	18	20	20	20	18
	8	17	17	17	17	17	17	17	17	17	18	18	18	6
Least	9	15	6	6	6	6	6	6	6	15	17	17	17	17
savings	10	6	15	15	15	15	15	15	15	6	15	15	15	15

[1] Measures are indicated by a number key from Table 6.7.

* Indicates a measure with the same savings as the previous measure.

Table 6.21 RANKING OF REACTIVE CONSERVATION MEASURES[1] FOR DIESEL FUEL IN 1980

	Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
	Rank													
Most	1	13	13	13	13	13	6	13	13	13	6	6	6	6
savings	2	7	6	7	6	6 *	13	6	6	7	13	13	13	13
↓	3	20	7	20	7	7	7	7	7	20	7	7	7	7
	4	17	20	6	20	20	20	20	20	17	20	20	20	20
Least	5	18 *	17	17	17	17	17	17	17	18 *	17	17	17	17
savings	6	6	18 *	18 *	18 *	18 *	18 *	18 *	18 *	6	18 *	18 *	18 *	18 *

[1] Measures are indicated by a number key from Table 6.7.

* Indicates a measure with the same savings as the previous measure.

Table 6.22 RANKING OF REACTIVE CONSERVATION MEASURES[1] FOR DISTILLATES IN 1980

	Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
	Rank													
Most savings	1	21	21	21	21	21	23	23	23	24	21	21	21	21
↓	2	3	3	3	3	23	24	24	24	23	3	3	3	3
	3	5	5	5	5	3	1	1	1	21	5	5	5	5
	4	22 *	22 *	22 *	22 *	24	21	21	21	1	22 *	22 *	22 *	22
	5	24	24	14	24	5	2	2	2	5	24	14	14	24
	6	14	14	12	23	22 *	5 *	5	5	22 *	14	24	12	14
	7	12	12	24	14	14	22 *	22 *	22 *	14	23	12	24	12
	8	16	16	23	12	1	12	12 *	12 *	12 *	12	23	16	23
	9	23	23	16	16	12 *	14 *	14 *	14	2	16	16	23	16
Least savings	10	1	1	1	1	16 *	16 *	16 *	16 *	16 *	1	1	1	1
	11	2	2	2	2	2	3 *	3 *	3 *	3	2	2	2	2

[1] Measures are indicated by a number key from Table 6.7.

* Indicates a measure with the same savings as previous measure.

Table 6.23 RANKING OF REACTIVE CONSERVATION MEASURES[1] FOR LIQUIFIED PETROLEUM GAS IN 1980

	Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
	Rank													
Most	1	21	21	21	21	1	1	1	1	1	21	21	21	21
savings	2	3	3	3	3	21	15	15	15	15	3	3	3	3
↓	3	5	5	5	5	3	2	2	2	2	5	5	5	5
	4	22 *	22 *	22 *	22 *	15	3	3	3	21 *	22 *	22 *	22 *	22 *
	5	1	1	1	1 *	2	5 *	5 *	5 *	3	1	1	1	1
Least	6	15	15	15	15	5 *	21 *	21 *	21 *	5	15	15	15	15
savings	7	2	2	2	2	22 *	22 *	22 *	22 *	22 *	2	2	2	2

[1] Measures are indicated by a number key from Table 6.7.

* Indicates a measure with the same savings as the previous measure.

7.0 CONCLUSIONS

The present form of the Iowa Energy Emergency Plan contains a good workable philosophy which should not need any major changes. The study reported herein addressed several of the problems identified in the plan, solved some of them, revealed other problems, and left several unresolved.

The present plan of implementing voluntary conservation measures followed by mandatory ones, is considered a good course of action in the event of a shortage.

A difference in conservation measures was identified: Preventive conservation measures and Reactive conservation measures. The reactive and preventive conservation measures discussed in this report are not necessarily compatible, but can be, if used properly. Most of the conservation measures listed in the plan were found to be reactive in nature, technically feasible, and in compliance with federal and state authority. These measures were quantified for potential energy saving when sufficient information was available. When data were unavailable, the measures were identified, assessed for feasibility and compliance, but not quantified for potential energy savings. Since the social, economic, and environmental impact of the conservation measures was beyond the scope of this study, confidence intervals for the potential energy savings could not be established.

The most serious deficiency of the plan is in the present fuel data base which the EPC must use to assess its energy emergency plan. Major inconsistencies were found between data banks, especially supply and demand. Moreover, storage data were not available. The most consistent data obtained were for gasoline, and these data indicate that the model developed in this study is valid. However, a better data base is needed before the model can be used to reliably assess conservation measures and predict potential shortages.

Management concepts, based on dynamic models, have been used to develop a monthly storage index and a cumulative storage index which should allow EPC to more accurately track the dynamics of petroleum utilization in the State. These indices should also provide a feedback mechanism to evaluate the effectiveness of both reactive and preventive conservation measures.

8.0 RECOMMENDATIONS

8.1 It is recommended that a comprehensive data base for supply, consumption, and storage of energy resources be developed and maintained on a monthly basis. Input and output data at intermediate steps in the model also should be obtained. From surveys of the oil industry, data should be obtained on storage capacity at all levels in the model, including distributor storage and farm storage capacity. It is recommended that the EPC use all means available to collect these data, including powers granted in paragraph 93.7(3) of the Iowa Code (1977).

8.2 It is necessary that inconsistencies between various sources of data be studied and corrected (e.g. between DOE/EIA - 25 input data (5) and DOE/EIA - 0113 consumption data (6)). Further, it is recommended that non-linear trand analysis be more frequently utilized to project energy patterns.

8.3 Where reactive conservation measures have been identified as having insufficient data to quantify, studies should be commissioned to obtain the required information and to quantify the measures.

8.4 Since the transportation sector of the economy is the most intensive consumer of petroleum energy resources, it is recommended that EPC work with DOE to obtain monthly data for use in energy management and planning. Specific data to be obtained should include:

- Supply and consumption rates.
- Storage capacities and changes in them.
- Subdivision of data by economic sector and fuel type.

8.5 Expansion of this study should be commissioned to include the other primary energy sources used in the State (i.e. coal and natural gas). The model described in this report should be expanded to include all resources and fuel types. In addition, electrical consumption should be evaluated as an energy alternative to a shortfall in different fuel types.

8.6 Similarities and differences in reactive and preventative conservation measures should be studied. The effect of long-term preventative measures on various reactive measures should be studied with regard to whether they would be complimentary or conflicting.

8.7 Results of the initial study should be re-evaluated as more data become available. This re-evaluation should include social, economic, and environmental assessments so confidence intervals can be established for the projected fuel savings. Environmental trade-offs should be studied for short-term and long-term effects. Time intervals for which environmental considerations may be suspended should also be studied.

8.8 It is recommended that the Iowa Energy Emergency Management Plan be completed and published as soon as possible, even if this means publishing the information in separate documents for each fuel type.

9.0 REFERENCES

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10.0 APPENDICES

10.1 Summary of Baseline Data

10.1.1 Gasoline Data

FUEL TYPE: Gasoline USE: Input to State UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	2867	2922	2954	3094	3079	3327	3338
FEB	2363	2436	2747	2909	2808	3199	3333
MAR	2783	2880	3427	3355	3448	3344	3688
APR	3517	3211	3519	3631	3476	3452	3527
MAY	3626	4068	3588	3796	3900	3670	3767
JUN	3056	3474	3751	3699	4021	3457	3955
JUL	3589	3655	3578	3515	3631	3354	3420
AUG	3552	3582	3618	3767	4017	3547	3818
SEP	3249	3422	3601	3558	3548	3318	3517
OCT	3828	3994	3818	3716	4072		3964
NOV	3527	3109	3520	3513	3650		3733
DEC	3510	3308	3513	3366	3400		3356
TOTAL	39467	40061	41634	41919	43050		43416

SOURCES— 1974: EIA-25 forms compiled by EPC staff
1975: " " " " " "
1976: " " " " " "
1977: " " " " " "
1978: " " " " " "
1979: " " " " " "

NOTES—

GS/IN

FUEL TYPE: Gasoline USE: Consumption Demand (CD) UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	2796	2929	2975	3135	3038	3664	3581
FEB	2496	2574	2758	2890	3002	3215	3357
MAR	2958	2811	3349	3371	3416	3230	3527
APR	3384	3214	3544	3627	3413	3374	3488
MAY	3454*	3699*	3616*	3647*	3930	3620	3817
JUN	3454*	3699*	3616*	3647*	3922	3323	3602
JUL	3539	3676	3749	3597	3657	3274	3422
AUG	3477	3512	3580	3701	3881	3646	3844
SEP	3156	3357	3499	3633	3549		3893
OCT	3775	3932	3866	3770	3733		3717
NOV	3346	3072	3500	3532	3694		3917
DEC	3258	3287	3504	3487	3002		3299
TOTAL	39093	39762	41556	42035	42237		43464

SOURCES—
1974: Iowa Department of Revenue
1975: " " " "
1976: " " " "
1977: " " " "
1978: " " " "
1979: " " " "

NOTES— *May and June values are averaged 1980 values are projected exponentially
Calculated by subtracting exports from gross input
Data is listed by sales month which is one month before tax month

GS/CD

FUEL TYPE: Gasoline USE: Other UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN		19	0	6	1	3	1
FEB		5	16	13	10	31	33
MAR		12	3	5	0	50	44
APR		7	6	11	10	184	127
MAY		8	11	4	4	106	38
JUN	17	7	8	10	11	94	40
JUL	22	10	11	14	6	5	4
AUG	3	23	14	2	0	135	85
SEP	29	6	14	12	0		6
OCT	8	6	8	10	24		13
NOV	21	23	12	10	152		86
DEC	9	13	6	7	164		121
TOTAL		139	109	104	382		598

SOURCES—
1974: Other= Govt Refunds + Custom Commercial + Miscellaneous Refunds
1975: " " " " " " "
1976: " " " " " " "
1977: " " " " " " "
1978: " " " " " " "
1979: " " " " " " "

NOTES—
Refund data from Iowa Department of Revenue
1980 values are projected exponentially

GS/Other

FUEL TYPE: Gasoline USE: Agricultural Refunds UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN		483	0	146	36	112	35
FEB		101	247	84	156	63	76
MAR		211	60	122	0	79	62
APR		88	120	194	151	57	92
MAY		200	288	118	175	148	128
JUN	255	380	252	327	167	184	170
JUL	653	134	245	225	191	79	78
AUG	150	699	309	144	0	147	137
SEP	553	178	283	147	97		48
OCT	191	200	241	229	420		487
NOV	555	652	431	384	385		283
DEC	276	368	252	205	126		98
TOTAL		3694	2728	2325	1904		1694

SOURCES—
1974: Iowa Department of Revenue
1975: " " " "
1976: " " " "
1977: " " " "
1978: " " " "
1979: " " " "

NOTES—
1980 values are projected exponentially
These data were used to index the projected annual diesel fuel and gasoline data from the "Farm Fuel Use" report to obtain monthly values.
Data is listed by sales month which is one month before tax month

10.1.2 Diesel Fuel Data

FUEL TYPE: Diesel Fuel USE: Input to State UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	560	564	507	525	473	613	536
FEB	516	492	448	529	478	496	486
MAR	530	484	783	782	659	648	773
APR	811	639	840	884	889	709	819
MAY	818	1036	808	872	1179	924	1036
JUN	624	637	679	664	824	628	728
JUL	666	670	537	617	534	538	503
AUG	550	578	517	721	650	584	658
SEP	574	715	670	760	755	598	709
OCT	761	935	765	854	896		922
NOV	688	725	933	729	652		710
DEC	614	581	640	565	519		503
TOTAL	7711	8056	8127	8502	8508		8383

SOURCES— 1974: EIA-25 forms compiled by EPC staff
1975: " " " " " "
1976: " " " " " "
1977: " " " " " "
1978: " " " " " "
1979: " " " " " "

NOTES— 1980 values are projected exponentially

DF/IN

FUEL TYPE: Diesel Fuel USE: Highway Use UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN		425	474	521	510	649	672
FEB		417	463	517	485	512	547
MAR		436	537	577	637	566	672
APR		437	524	581	566	545	618
MAY		433*	527*	544*	574	586	652
JUN	741	433*	527*	544*	657	511	529
JUL	447	438	493	520	483	468	502
AUG	211	459	522	568	545	500	728
SEP	459	493	547	585	560		662
OCT	517	549	578	620	572		645
NOV	457	464	550	569	582		687
DEC	432	465	551	539	394		465
TOTAL		5449	6293	6685	6565		7409

SOURCES— 1974: Iowa Department of Revenue
1975: " " " "
1976: " " " "
1977: " " " "
1978: " " " "
1979: " " " "

NOTES— *May and June values are averaged.
Data is listed by sales month which is one month before tax month.
1980 values are projected exponentially

10.1.3 Distillates

(Kerosene, #1 and #2 Fuel Oil) Data

FUEL TYPE: Distillates USE: Input to state UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	1415	1420	1521	2053	1631	1841	1999
FEB	1040	1257	1013	1490	1547	1566	1762
MAR	833	997	948	870	1099	1209	1211
APR	726	801	707	757	630	899	781
MAY	547	634	769	623	846	1006	1045
JUN	312	428	625	606	604	778	936
JUL	503	523	544	642	490	700	661
AUG	500	566	709	680	582	779	788
SEP	775	747	844	666	712	724	691
OCT	897	827	1016	835	1277		1275
NOV	877	896	1549	1103	1371		1755
DEC	1424	1413	1909	1567	1455		1637
TOTAL	9849	10509	12154	11892	12244		14541

SOURCES— 1974: EIA-25 forms compiled by EPC
1975: " " " " "
1976: " " " " "
1977: " " " " "
1978: " " " " "
1979: " " " " "

NOTES— 1980 values are projected exponentially

DIS/IN

FUEL TYPE: Distillate USE: Consumption Demand UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	
JAN	1614	1400	1375	1876	1706		
FEB	1207	1286	993	1130	1550		
MAR	956	1138	906	814	1073		
APR	574	686	480	470	648		
MAY	405	329	364	318	428		
JUN	255	285	240	283	349		
JUL	284	296	265	375	319		
AUG	255	284	274	272	303		
SEP	399	376	317	282	402		
OCT	536	465	759	600	616		
NOV	965	773	1114	935	947		
DEC	1394	1180	1448	1429	1426		
TOTAL	8845	8497	8533	8784	9767		

SOURCES— 1974: Sum of all end uses

1975: " " " " "

1976: " " " " "

1977: " " " " "

1978: " " " " "

1979: " " " " "

NOTES—

DIS/CD

FUEL TYPE: Distillate USE: Utility Consumption (UC) UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	89	133	128	223	153	372	370
FEB	27	115	66	75	173	227	304
MAR	15	43	67	59	50	48	79
APR	15	29	17	36	65	138	97
MAY	9	37	13	58	37	19	41
JUN	14	48	12	43	93	18	45
JUL	62	68	40	137	70	20	36
AUG	22	56	47	32	54		65
SEP	21	30	32	15	115		96
OCT	30	25	119	39	66		106
NOV	44	38	130	57	90		134
DEC	124	88	173	119	165		184
TOTAL	472	710	844	893	1131		1559

SOURCES—
1974: FPC Monthly News Releases compiled by EPC staff
1975: " " " " " " " "
1976: " " " " " " " "
1977: " " " " " " " "
1978: " " " " " " " "
1979: " " " " " " " "

NOTES— 1980 values are projected exponentially

DIS/UC

FUEL TYPE: Distillate USE: Heating UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	1302	1040	1021	1414	1305		1366
FEB	957	943	701	816	1129		967
MAR	718	867	614	519	774		595
APR	336	429	238	195	334		214
MAY	175	64	126	21	142		46
JUN	19	9	3	2	7		2
JUL	0	0	0	0	0		0
AUG	11	0	1	2	0		0
SEP	156	118	60	29	38		12
OCT	284	212	415	323	301		372
NOV	699	507	759	640	608		625
DEC	1048	863	1050	1072	1012		1067
TOTAL	5705	5052	4987	5032	5650		5266

SOURCES—
1974: Annual: DOE/EIA-0113 Monthly: Indexed by degree days
1975: " " " " "
1976: " " " " "
1977: " " " " "
1978: " " " " "
1979: " " " " "

NOTES— 1980 values are projected exponentially

10.1.4 Liquified Petroleum Gas Data

FUEL TYPE: Liquified Petroleum Gas USE: Input to State UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	931	1403	1465	1886	1781	1878	2370
FEB	595	1029	970	1208	1416	1443	1765
MAR	427	907	720	576	818	873	945
APR	410	623	344	435	336	592	454
MAY	216	249	255	257	286	326	337
JUN	214	225	223	268	243	366	344
JUL	282	309	331	277	316	385	364
AUG	352	461	419	505	508	441	521
SEP	436	604	822	725	599	438	580
OCT	1206	1161	1354	1318	1761		1915
NOV	2605	891	1519	1282	1112		809
DEC	1418	1312	1717	1736	1363		1624
TOTAL	9092	9174	10139	10473	10539		12028

SOURCES— 1974: EIA-25 forms compiled by EPC staff
1975: " " " " " "
1976: " " " " " "
1977: " " " " " "
1978: " " " " " "
1979: " " " " " "

NOTES— 1980 values are projected exponentially

LP/IN

FUEL TYPE: Liquified Petroleum Gas USE: Consumption Demand (CD) UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	2117	1986	2444	2965	2239		
FEB	1619	1825	1879	1972	2005		
MAR	1274	1702	1727	1480	1531		
APR	723	982	1064	940	944		
MAY	490	384	866	652	687		
JUN	264	292	650	620	507		
JUL	237	278	644	617	498		
AUG	253	278	645	621	498		
SEP	462	471	749	665	548		
OCT	648	627	1375	1153	900		
NOV	1247	1110	1981	1678	1308		
DEC	1750	1695	2493	2397	1848		
TOTAL	11084	11630	16517	15760	13513		

SOURCES— 1974: Sum of all end uses
1975: " " " " "
1976: " " " " "
1977: " " " " "
1978: " " " " "
1979: " " " " "

NOTES—

LP/CD

FUEL TYPE: Liquified Petroleum Gas   USE: Heating   UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	1880	1709	1799	2347	1740		2008
FEB	1382	1548	1234	1354	1506		1422
MAR	1037	1424	1082	862	1032		874
APR	486	704	419	323	446		315
MAY	253	106	222	35	189		67
JUN	27	14	6	3	9		2
JUL	0	0	0	0	0		0
AUG	16	0	1	4	0		0
SEP	225	193	105	48	50		18
OCT	411	349	731	536	402		547
NOV	1010	832	1337	1061	810		917
DEC	1513	1417	1849	1780	1350		1570
TOTAL	8240	8296	8785	8353	7534		7740

SOURCES—
1974: annual: DOE/EIA-0115 Sum of Utility gas and Residential & Commercial; monthly is indexed by Des Moines degree days
1975: " " " " " " " " " " " " " "
1976: " " " " " " " " " " " " " "
1977: " " " " " " " " " " " " " "
1978: " " " " " " " " " " " " " "
1979: " " " " " " " " " " " " " "

NOTES—

LP/heating

10.1.5 Aviation Fuel Data

FUEL TYPE: Aviation Fuel USE: Input to State UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80*
JAN	127	90	168	50	75	10	45
FEB	46	148	167	52	77	6	45
MAR	53	150	179	60	88	54	67
APR	49	147	162	52	76	50	59
MAY	57	153	163	75	90	53	73
JUN	94	156	179	146	95	49	97
JUL	151	160	198	131	90	55	92
AUG	164	178	197	121	98	86	102
SEP	127	158	83	82	93	45	73
OCT	164	194	81	76	88		82
NOV	144	152	71	79	88		83
DEC	124	157	66	80	9		45
TOTAL	1299	1844	1714	1005	967		863

SOURCES— 1974: EIA-25 forms compiled by EPC staff
1975: " " " " " "
1976: " " " " " "
1977: " " " " " "
1978: " " " " " "
1979: " " " " " "

NOTES— *Due to discontinuity in trend from 76 to 77, projections are made by averaging 77-79 data.

AF/IN

FUEL TYPE: Aviation Fuel USE: Aviation Gasoline UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN		11	13	8	8	7	6
FEB		7	12	11	10	11	12
MAR		8	11	15	13	11	14
APR		10	15	12	12	13	14
MAY		12*	15*	17*	18	17	20
JUN	27	12*	15*	17*	19	17	16
JUL	15	21	20	20	20	19	21
AUG	20	19	19	20	20	22	21
SEP	15	15	19	16	14		16
OCT	16	11	13	12	19		16
NOV	12	14	13	12	16		15
DEC	10	10	13	10	8		9
TOTAL		150	178	170	176		180

SOURCES— 1974: Iowa Department of Revenue

1975: " " " "

1976: " " " "

1977: " " " "

1978: " " " "

1979: " " " "

NOTES— *May and June values are averaged

Data is listed by sales month which is one month before tax month

1980 values are projected exponentially

AF/Aviation Gas

10.1.6 Residuals Data

FUEL TYPE: Residual USE: Input to State UNITS: 10^3 bbls

	1974	1975	1976	1977	1978	1979	Projected 80
JAN	87	37	33	14	52	54	32
FEB	40	24	12	26	26	100	53
MAR	26	16	0	4	30	27	14
APR	14	19	0	3	30	14	13
MAY	4	1	0	0	22	8	20
JUN	3	11	61	10	12	10	17
JUL	8	7	1	0	7	1	1
AUG	5	0	12	0	5	1	1
SEP	28	1	7	14	4	0	4
OCT	16	9	22	67	74		210
NOV	22	14	13	68	29		57
DEC	26	22	2	98	40		54
TOTAL	279	161	163	304	331		476

SOURCES— 1974: EIA-25 forms compiled by EPC staff

1975: " " " " " "

1976: " " " " " "

1977: " " " " " "

1978: " " " " " "

1979: " " " " " "

NOTES— 1980 values are projected exponentially

RES/IN

10.1.7 Heating Degree Days Data

Des Moines — Heating Degree Days — UNITS: Base 65 F

	1974	1975	1976	1977	1978	1979	Normal*
JAN	1406	1308	1297	1700	1667	1779	1414
FEB	1033	1185	890	981	1442	1433	1142
MAR	775	1090	780	624	988	912	964
APR	363	539	302	234	427	532	465
MAY	189	81	160	25	181	163	186
JUN	20	11	4	2	9	13	26
JUL	0	0	0	0	0	1	0
AUG	12	0	1	3	0	10	13
SEP	168	148	76	35	48	57	94
OCT	307	267	527	388	385	339	350
NOV	755	637	964	769	776		816
DEC	1131	1085	1333	1289	1293		1240
TOTAL	6159	6351	6334	6050	7216		6710

SOURCES— 1974: US Department of Commerce Local Climatological Data
1975: " " " " " " "
1976: " " " " " " "
1977: " " " " " " "
1978: " " " " " " "
1979: " " " " " " "

NOTES— *Based on 1941-70 data

10.2 Exponential Projection Method

The form of the equation used to make the projections is

$$Y = c \cdot \exp(dX) \qquad [1]$$

where Y is the amount of fuel supplied or consumed in year X. An alternate form of Eq. 1 is

$$\ln Y = a + bX \qquad [2]$$

which is linear in lnY and X. The constants (a and b) can be determined from a data set using the method of least squares (12). The solution for a set of m points of the form (Xi, Yi) is

$$a = \frac{\Sigma X_i \Sigma \ln Y_i - \Sigma X_i \Sigma X_i \ln Y_i}{m \Sigma X_i^2 - (\Sigma X_i)^2} \qquad [3]$$

$$b = \frac{m \Sigma X_i \ln Y_i - \Sigma X_i \Sigma Y_i}{m \Sigma X_i^2 - (\Sigma X_i)^2} \qquad [4]$$

Once a and b are known, Eq. 2 can be used to project the 1980 value. A sample set of calculations using the January gasoline consumption data is shown below.

Data for gasoline consumption demand (CD) from Appendix 10.1

X_i = Year

Y_i = Barrels of gasoline consumed in January of year X_i

X_i	Y_i	X_i	$\ln Y_i$	$X_i \ln Y_i$
74	2796	5476	7.9359451	587.25994
75	2929	5625	7.9824163	598.68123
76	2975	5776	7.9979993	607.84795
77	3135	5929	8.0503845	619.87960
78	3038	6084	8.0189547	625.47847
79	3664	6241	8.2063107	648.29855
459	18537	35131	48.1920106	3687.44573

$$a = \frac{(35131)(48.1920106) - (459)(3687.44573)}{(6)(35131) - (459)^2} = 4.7232$$

$$b = \frac{(6)(3687.44573) - (459)(48.1920106)}{(6)(35131) - (459)^2} = 0.043252$$

$$\ln Y = 4.7232 + 0.043252X$$

$$Y = \exp\,(4.7232 + 0.043252X)$$

when $X = 80$, $Y = 3581$ (1980 projection)

These data are shown in Fig. 10.1.

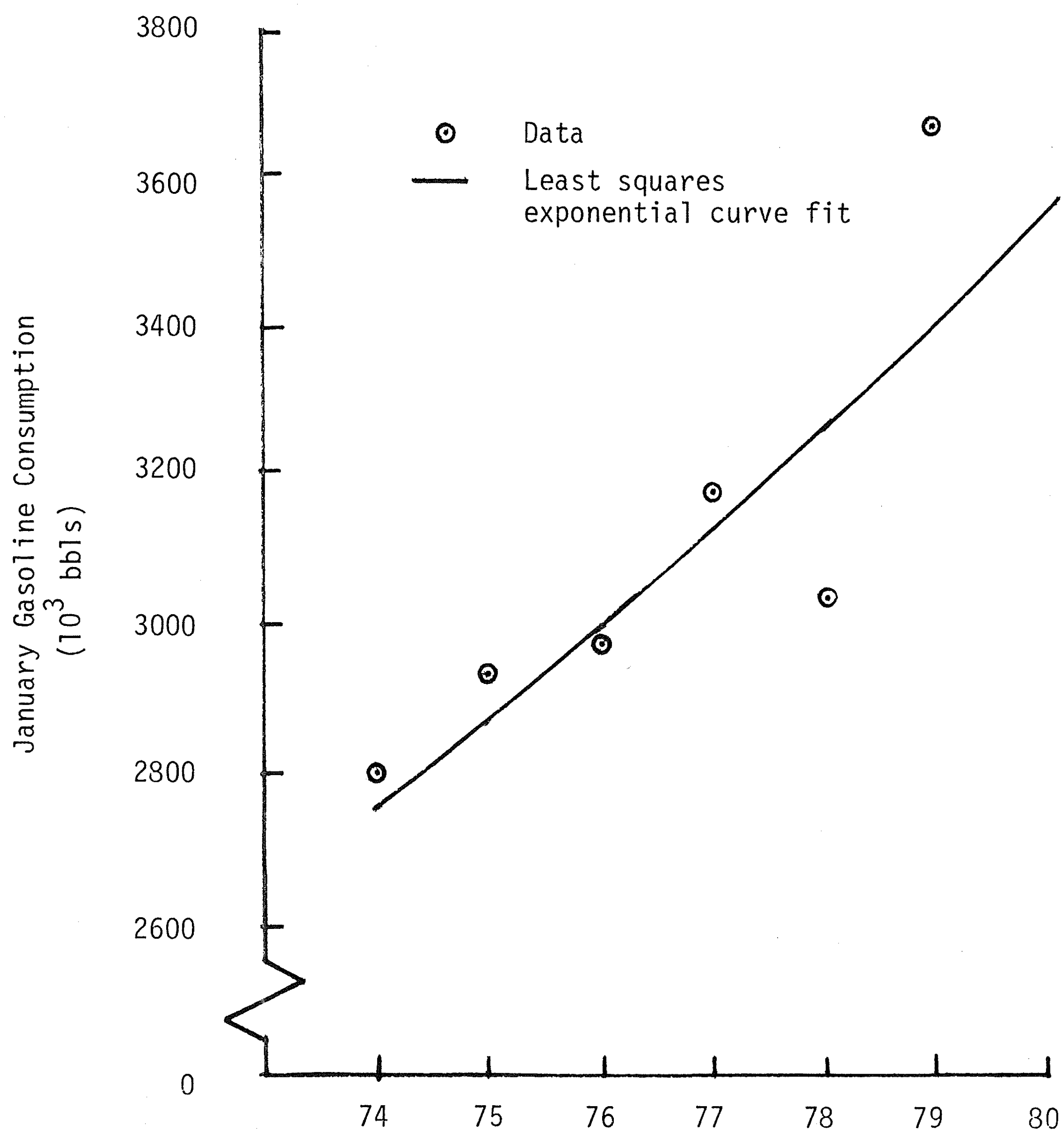


Fig. 10.1 LEAST-SQUARE EXPONENTIAL CURVE FIT FOR JANUARY GASOLINE CONSUMPTION DATA

10.3 Quantification of Potential Energy Savings for Reactive Conservation Measures

The following rates were developed to support the energy savings quantification assumed for the Reactive Conservation measures proposed by EPC and ISU.

Note #1. Public appeal can be assumed to result in gasoline savings of about one gallon per car per week. Approximately 1.6×10^6 cars are registered in the State. Therefore, the potential savings are estimated as:

$$\text{Gasoline Savings} = \frac{1 \text{ gal.}}{\text{car} \cdot \text{week}} \times \frac{4 \text{ weeks}}{\text{month}} \times 1.6 \times 10^6 \text{ cars} \times \frac{\text{bbl}}{42 \text{ gal.}}$$

$$\text{Gasoline Savings} = 152 \times 10^3 \text{ bbls/month}$$

Note #2. State Government Example. Less than 1% of gasoline consumption is consumed by state cars according to tax refund and exemption figures, so no significant savings are apparent. However, personal cars are often driven on state business. Since the owners are reimbursed for their expenses and tax is paid on the gasoline consumed, the miles traveled would be more difficult to estimate. It is possible that analysis of comptroller records would provide a basis for an estimate, however, these data were not available at this time.

Note #3. Drive 10 miles less per week. This can be another result of public appeal. Average mileage has been estimated for automobiles in the State at 13.5 mpg (See EPC draft, p. 50) and DOT references.

$$\text{Gasoline Savings} = \frac{10\ \text{miles}}{\text{week}\cdot\text{car}} \times \frac{4\ \text{weeks}}{\text{month}} \times 1.6 \times 10^6\ \text{cars} \times \frac{\text{gal.}}{13.5\text{miles}} \times \frac{\text{bbl}}{42\ \text{gals.}}$$

$$\text{Gasoline Savings} = 113 \times 10^3\ \text{bbls/month}$$

Note #4. Prohibit single occupant cars. To estimate the potential savings, the following relationship was developed:

$$\left(\frac{\text{gallon}}{\text{month}}\right)_{new} = \left(\frac{\text{gallon}}{\text{month}}\right)_{old} \left[\frac{\left(\frac{\text{occupants}}{\text{car}}\right)_{old}}{\left(\frac{\text{occupants}}{\text{car}}\right)_{new}}\right] \left(\frac{(\text{occ}\cdot\text{mi/mo})_{new}}{(\text{occ}\cdot\text{mi/mo})_{old}}\right) \left(\frac{(\text{mi/gal})_{old}}{(\text{mi/gal})_{new}}\right) \qquad [10.3.1]$$

From the EPC draft p. 43 and from DOT records (14), the average number of occupants per car is 1.3 and mpg is reduced by 1.5% per 100 lbs. additional load (EPC draft, p.43). Thus, if another passenger is added, the average number of occupants should increase to 2.3. If the average weight of the additional occupant is 150 lbs., mileage would be expected to decrease by 2.25%. It is also assumed that the additional passenger would require about 10% more travel for the car per month. Then from Eq. 10.3.1, the gasoline savings are estimated as:

$$\frac{(\text{gal/mo})_{old} - (\text{gal/mo})_{new}}{(\text{gal/mo})_{old}} = 1 - \left(\frac{1.3}{2.3}\right)\left(\frac{1.10}{1.0}\right)\left(\frac{1.025}{1.0}\right)$$

Therefore, % savings = 3.6%

Note #5. Partial school closing would result in some reduction in passenger car transportation of students and faculty, but data are unavailable at this time. Needed information would include average travel at each school and how driving habits would be altered. Would they drive somewhere else if school were closed?

Note #6. Partial industrial closing. EPC draft p. 79 estimates 1.31×10^{12} Btu gasoline savings for a 10% closing. Therefore, savings can be estimated as:

$$\text{Gasoline Savings} = \frac{1.31 \times 10^{12} \text{ Btu}}{124{,}240 \text{ Btu/gal}} \times \frac{\text{bbls}}{42 \text{ gal}} = 251 \times 10^{3} \text{ bbls}$$

$$\text{Annual Savings} = \frac{251 \times 10^{3} \text{ bbls}}{36466 \times 10^{3} \text{ bbls}} = 0.7\%$$

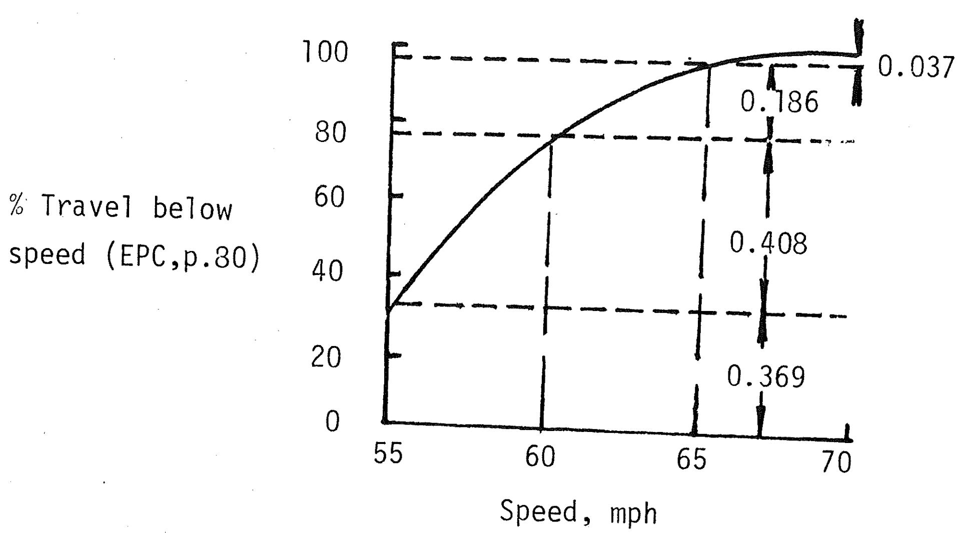
Note #7. 55 mph speed enforcement. From DOT statistics (14), the projected number of miles traveled in 1980 will be 19.99×10^{9} miles (Projection from method descrived in Appendix 10.2). The projected number of autos, trucks and motorcycles for 1980 is 2.63×10^{6} vehicles. Therefore, the average miles per vehicle will be:

$$\frac{\text{miles}}{\text{vehicle}} = \frac{19.99 \times 10^{9} \text{ miles}}{2.63 \times 10^{6} \text{ vehicles}} = 7601 \text{ miles/vehicle}$$

The average mileage will be:

$$\frac{19.99 \times 10^{9} \text{ miles}}{36.46 \times 10^{6} \text{ bbls}} \times \frac{\text{bbls}}{42 \text{ gals}} = 13.0 \frac{\text{miles}}{\text{gal}}$$

Approximately 47% of auto travel is for more than 21 miles (see EPC draft, p. 96). So assume highway travel at 55 mph = $0.47 \times 19.99 \times 10^{9}$ = 9.39×10^{9} miles. By 1980, assume the average car will be 3 years old, so use 1977 mileage data.



Average mileage = (0.369)(17.38 @ 55) + (0.408)(16.85 @ 57.5) + (0.186)(14.73 @ 62.5) + (0.037)(14.2 @ 70)

Average mileage = 16.55 mi/gal

Mileage at enforced 55 mph = 17.38 mi/gal

Difference = 0.83 mi/gal

$$\text{Fuel saved} = \left(\frac{9.39 \times 10^9 \text{ mi}}{16.55 \text{ mi/gal}} - \frac{9.39 \times 10^9 \text{ mi}}{17.38 \text{ mi/gal}}\right)\left(\frac{\text{bbls}}{42 \text{ gal}}\right)$$

Fuel saved = 0.645×10^6 bbls

$$\% = \frac{0.645 \times 10^6 \text{ bbls}}{3.647 \times 10^6 \text{ bbls}} = 1.7\%$$

Note #8. Highway speed reduction from 55 to 50 mph. From the same information used in note #7,

$$\text{Savings from 55 to 50} = 9.39 \times 10^9 \text{ mi}\left(\frac{1}{17.38} - \frac{1}{18.42}\right)\frac{\text{gal}}{\text{mi}} \times \frac{\text{bbls}}{42 \text{ gal}}$$

$$= 0.727 \times 10^6 \text{ bbls}$$

$$\% = \frac{0.727 \times 10^6 \text{ bbls}}{(36.47 - 0.645) \times 10^6 \text{ bbls}} = 2.03\%$$

Note #9. Vehicle inspection. Establish a vehicle inspection policy for all priority vehicles. Inspection should include tune-up to obtain rated performance of manufacturer. A 10% reduction in fuel consumption should be expected for the same reasons used to estimate the reductions due to farm and truck improvements. Savings would also depend on the number of authorized priority vehicles. For estimating purposes, assume this number as 25% of normal traffic. Therefore, savings would be 2.5%

Note #10. Speed enforcement for motor carriers. From DOT statistics (14), the mileage projected for motor freight carriers and liquid motor carriers in 1980 is 6.38 miles/gal (see Appendix 10.2 for projection method). Assuming that the percent fuel savings from 57.5 to 55 is the same as for automobiles (i.e. 5.2%), then expected mileage at the 55 mph limit should be (1.052)(6.38) = 6.7 mpg. To estimate fuel savings:

1. Total gals = 7409×10^3 bbls X $\frac{42 \text{ gal}}{\text{bbls}}$ = 3.11×10^6 gals
2. Total miles = 3.11×10^6 gals X 6.38 mi/gal = 2.0×10^9 miles
3. Diesel fuel saved = $\underbrace{0.474}_{\text{highway \%}}(2.0 \times 10^9 \text{ miles})\left(\frac{1}{6.38} - \frac{1}{6.7}\right)\frac{\text{gal}}{\text{mile}}$

(items 1–3: from Table 4.10)

$$= \frac{7.09 \times 10^6 \text{ gals}}{42 \text{ gal/bbl}} = 169 \times 10^3 \text{ bbls}$$

4. % of highway = $\frac{169 \times 10^3 \text{ bbls}}{7409 \times 10^3 \text{ bbls}} = 2.3\%$

Note #11. Motor carrier reduction from 55 to 50 mph. Assume the percent fuel savings for diesels is the same as for automobiles (i.e. 5.2%). So diesel savings is:

$$\text{Savings} = \frac{0.474(2 \times 10^9 \text{ miles})}{42 \text{ gal/bbls}}\left(\frac{1}{6.7} - \frac{1}{6.7(1.052)}\right)\frac{\text{gal}}{\text{mile}}$$

$$= 166 \times 10^3 \text{ bbls}$$

$$\% \text{ savings} = \frac{166 \times 10^3 \text{ bbls}}{7409 \times 10^3 \text{ bbls}} = 2.2\%$$

Note #12. Reduce hot water temperature set point. Assume hot water temperature will be controlled at 105° F rather than the more conventional set point of 140° F. Typically, domestic water is supplied to residences at a temperature of 50° F to 60° F. (assume 50° F). Energy required to heat the water is estimated at

$$Q = \dot{m} c_p \Delta t$$

= Energy consumption rate

where $\dot{m}$ = Flow rate

c_p = Specific heat

Δt = Temperature difference

For purposes of this estimation, assume four occupants per residence, a hot water consumption rate of 20 gallons per day per occupant (15), and that 7500 residences use fuel oil hot water heaters (EPC draft, p. 37). Then energy savings are estimated as:

$$Q = \frac{4 \text{ occupants}}{\text{residence}} \times \frac{20 \text{ gal}}{\text{occ}\cdot\text{day}} \times \frac{8.33 \text{ lbs water}}{\text{gal}} \times \frac{1 \text{ Btu}}{\text{lb water }^\circ\text{F}} (90^\circ \text{ F} - 55^\circ \text{ F})$$

$$= \frac{23324 \text{ Btu}}{\text{day}\cdot\text{residence}} \times \frac{30 \text{ days}}{\text{month}} \times 7500 \text{ residences} \times \frac{\text{gal oil}}{140000 \text{ Btu}}$$

$$= 37485 \frac{\text{gal}}{\text{mo}} \times \frac{\text{bbl}}{42 \text{ gal}}$$

$$Q = 892 \text{ bbls/month}$$

Note #13. Reduce hot water consumption. Assume consumption rate is reduced 10% or 2 gal/occupant·day. The estimated energy savings after temperature has been set back to 105° F is:

$$Q = \frac{4 \text{ occ}}{\text{res}} \times \frac{(20 - 18) \text{ gal water}}{\text{occ}\cdot\text{day}} \times \frac{8.33 \text{ lbs water}}{\text{gal}} \times \frac{1 \text{ Btu}}{\text{lb water }^\circ\text{F}} (55^\circ\text{F})$$

$$Q = \frac{3665 \text{ Btu}}{\text{day}\cdot\text{res}} \times \frac{30 \text{ day}}{\text{month}} \times 7500 \text{ res} \times \frac{\text{gal}}{140{,}000 \text{ Btu}} \times \frac{\text{bbl}}{42 \text{ gal}}$$

$$Q = 140 \text{ bbl/month}$$

Note #14. Thermostat set-back. The method described by Dubin (15, p.101) was used for this estimation. Average energy consumption rates for domiciles, educational facility, offices and public assembly buildings were assumed from data obtained through Preliminary Energy Audit Analyses, Tables 10.3.1 & 10.3.2:

$$\overline{EUI}_{ave} = \frac{142 + 139 + 176 + 160}{4} = 154 \times 10^3 \frac{Btu}{ft^2 yr}$$

Assume heating energy for these buildings as 80% of EUI:

$$\overline{EUI}_H = (0.8)(154 \times 10^3 \frac{Btu}{ft^2 yr}) = 123 \times 10^3 \frac{Btu}{ft^2 yr}$$

Assume average yearly degree days = 6500.

Assume thermostat set back from 95° F to 65° F (EBTR requirements), therefore t = 10° F.

From nomograph (15, p. 101), annual savings = $32 \times 10^3 \frac{Btu}{ft^2 yr}$

So estimated potential fuel savings for these buildings is 25%.

Assume these buildings represent 50% of the buildings heated in the State (others such as hospitals are exempt from compliance).

Therefore, estimated savings = (0.5)(.25) = 12%

Note # 15. Alternate fuels. Approximately 20% of the State's energy resources are consumed directly in residences, 13% in commercial sector and 28% in industrial sector (Table 1.2).

Assume that 50% of the residences can be heated by alternate fuels in an emergency (i.e. fireplaces, electric heaters, etc.), and that 50% of the commercial facilities could find a standby fuel (or not have to exercise interruptible clauses). No industrial savings are assumed in this estimate. So potential energy savings are:

Savings = 0.5(0.20 + 0.13) = 17% of heating values

Note #16. Reduced ventilation. Commercial buildings consume about 13% of the State's petroleum (Table 1.2) directly; about 40% of this is consumed for ventilation. If minimum ventilation rates are maintained, the consumption of fuel oil in 1980 is 10181×10^3 bbls. Therefore estimated energy savings is:

FO_2 savings = $(0.5)(0.4)(0.13)(10181 \times 10^3$ bbls)

$= 2.65 \times 10^5$ bbls

and savings as percent of heating values (Table 4.11) is:

$2.65 \times 10^5 / 5268 \times 10^3 = 5.7\%$

From Table 4.12, the projected consumption of LP in 1980 is 13634×10^3 bbls. Therefore, savings due to ventilation are estimated as:

LP savings = $(0.5)(0.4)(0.13)(13634 \times 10^3$ bbls)

$= 354 \times 10^3$ bbls

and savings as a percent of heating values is estimated as:

% savings (LP) = 354/7740 = .046 or 5%

Note #17. Partial school closings. PEA surveys indicated that 5% of schools used FO_2 as a primary source of fuel with natural gas used as secondary. The surveys also indicated that 14% of the total EUI for schools was for FO_2 (see Table 10.3.2). Assume that secondary sources in the 5% of buildings can become primary sources, or alternate sources can be used rather than FO_2. Where FO_2 is used as secondary source assume that its use can be minimized by assuring that interruptible clauses will not be exercised. Thus, only 5% shutdown might be required because alternatives are not available.

$$\text{Savings} = (0.05)(2068 \text{ schools})\left(\frac{28300 \times 10^3 \text{ft}^2}{621 \text{ schools}}\right)(0.84)\left(139000 \frac{\text{Btu}}{\text{ft}^2\text{yr}}\right)$$

$$= \frac{0.55 \times 10^{12} \text{ Btu}}{(140000 \text{ Btu/gal})(42 \text{ gal/bbl})}$$

Savings = 93×10^3 bbls or as a percent

$$\text{percent of heating} = \frac{93}{5268} = 1.8\%$$

PEA surveys also identified 7 of 621 schools as using LP as primary fuel and 29 as secondary fuel. Projecting to 2068 schools, it is estimated that 23 would use LP as primary and 90 as secondary. If an LP shortage occurs, assume primary source to the 90 schools and transfer as many of the 23 as possible to secondary sources.

If the 23 could not be transferred to alternate sources and had to be closed, the estimated savings would be:

$$\text{Savings} = 23 \text{ schools X } \frac{139 \times 10^3 \text{ Btu}}{\text{ft}^2\text{yr}} \text{ X } \frac{28300 \times 10^3 \text{ft}^2}{621 \text{ schools}} \text{ X } \frac{\text{gal}}{95,500 \text{ Btu}}$$

$$\text{Savings} = \frac{1.526 \times 10^6 \text{ gal}}{42 \text{ gal/bbl}}$$

$\text{Savings} = 36 \times 10^3$ bbls/yr, or as a percent of heating values:

$$\text{Savings} = \frac{36}{7740} = 0.5\% \Longrightarrow \text{negligible}$$

Note #18. PEA surveys indicate that there are 1302 local government buildings. Previous ISU studies indicated that 2776 buildings are either owned or operated by the State. The average size of local government buildings is 17,500 ft^2 (from Table 10.3.1) and 5925 ft^2 for State buildings. The average EUI's are 199×10^3 and 218×10^3 Btu/ft^2yr, respectively. So total energy consumption is estimated at 4.53×10^{12} and 3.58×10^{12} Btu/ft^2yr, respectively. Both types of buildings require about 80% of the EUI for heating (Tables 10.3.1 and 10.3.2), and both required about 7.5% of heating from fuel oil and 2% from LP.

Total fuel oil consumed for government buildings is estimated as:

$$FO_2 = (0.075)(0.80)(4.53 + 3.58)10^{12} \text{ Btu} = 0.487 \times 10^{12} \text{ Btu}$$

$$= \frac{0.487 \times 10^{12} \text{ Btu}}{(140,000 \text{ Btu/gal})(42 \text{ gal/bbl})} = 82.8 \times 10^3 \text{ bbls}$$

As a percent of annual heating consumption:

$$FO_2 = \frac{82.8}{5268} = 1.6\%$$

Thus, to obtain a 1% reduction in fuel oil consumption, more than 50% closure would be required. This would seem unacceptable.

Total LP consumed for government buildings is estimated as:

$$LP = (0.02)(0.8)(4.53 + 3.58)10^{12} \text{ Btu} = 0.130 \times 10^{12} \text{ Btu}$$

$$= \frac{0.130 \times 10^{12} \text{ Btu}}{(95{,}500 \text{ Btu/gal})(42 \text{ gal/bbl})} = 32 \times 10^3 \text{ bbls}$$

As a percent of annual heating consumption:

$$LP = \frac{32}{7740} = 0.4\% \Rightarrow \text{negligible}$$

<u>Note #19</u>. <u>Partial commercial closing</u> of the 89 offices and 3 laboratories surveyed, no significant LP was consumed. Liquor stores represented a significant number of public assembly buildings and this category required 5% of heating as LP. Assuming as average floor area = 4113 ft^2 (Table 10.3.2), then energy for public assembly buildings is estimated as:

$$LP = (0.05)(212 \text{ Liq. Stores})(160 \times \frac{10^3 \text{ Btu}}{ft^2 yr})(4113 \text{ ft}^2)$$

$$= (6.97 \times \frac{10^9 \text{ Btu}}{yr})(\frac{gal}{95{,}500 \text{ Btu}})(\frac{bbl}{42 \text{ gal}})$$

$$LP = 1.7 \times 10^3 \text{ bbls}$$

As percent of heating value:

$$LP = \frac{1.7 \times 10^3}{7740 \times 10^3} = 0.02\% \quad \text{negligible}$$

<u>Note #20</u>. <u>Partial industrial closing</u>. A 10% shutdown in operations was assumed. From p. 79 of the EPC draft, the estimated annual savings for LP was 1.3 x 10^{12} Btu. Thus, savings are estimated as:

$$\text{Savings} = \frac{1.3 \times 10^{12} \text{ Btu}}{(95{,}500 \text{ Btu/gal})(42 \text{ gal/bbl})} = 324 \times 10^3 \text{ bbls}$$

or as a percent savings of industrial:

$$\text{Savings} = \frac{324 \times 10^3 \text{ bbls}}{1311 \times 10^3 \text{ bbls}} = 25\% \Longrightarrow$$ seems too high as industry consumes 10% of total LP

Use 5% savings of industrial and recommend re-evaluation.

Table 10.3.1 SUMMARY OF ENERGY CONSUMPTION IN BUILDINGS LISTED BY DOE CATEGORIES[1]

Category	Total No. of Bldgs. in data set	Total area in data set (10^3 ft^2)	Mean ± SD EUI[2] in data set (10^3 Btu/ft^2·yr)		% of Total Energy in Category						
					Heating					Elec.	Total
					NG	FO_2	LP	Other	Total		
Hospitals	33	4430	339 ± 154	Primary	70	0	0	0	70	18	
				Secondary	0	5	7	0	12	0	
				Total	70	5	7	0	82	18	100
Care Facilities	35	1010	200 ± 101	Primary	42	23	6	0	71	25	
				Secondary	1	2	1	0	4	0	
				Total	43	25	7	0	75	25	100
County (non-care) Facilities	76	1330	199 ± 228	Primary	62	3	1	11	77	18	
				Secondary	0	5	0	0	5	0	
				Total	62	8	1	11	82	18	100
State Buildings	427	2530	218 ± 407	Primary	70	6	2	2	80	19	
				Secondary	0	1	0	0	0	0	
				Total	70	7	2	2	80	19	100
Schools	673	28700	143 ± 67	Primary	67	7	1	2	77	16	
				Secondary	1	6	0	0	7	0	
				Total	68	13	1	2	84	16	100

1. Summarized from other ISU studies.
2. EUI, Energy Utilization Index.

Table 10.3.2 SUMMARY OF ENERGY CONSUMPTION IN BUILDINGS LISTED BY ISU CATEGORIES[1]

ISU Category	Total No. of Bldgs. in data set	Total area in data set (10^3 ft^2)	Mean ± SD EUI in data set (10^3 Btu/ft^2·yr)		% of Total Energy in Category						
					Heating					Elec.	Total
					NG	FO_2	LP	Other	Total		
Domicile	24	294	142 ± 66	Primary	17	40	5	0	62	29	
				Secondary	8	0	1	0	9	0	
				Total	25	40	6	0	71	29	100
Education	621	28300	139 ± 53	Primary	67	8	0	2	77	16	
				Secondary	1	6	0	0	7	0	
				Total	68	14	0	2	84	16	100
Office	89	1770	176 ± 106	Primary	64	1	0	0	75	22	
				Secondary	0	3	0	0	3	0	
				Total	64	4	0	0	78	22	100
Laboratory	3	46	185 ± 229	Primary	45	0	0	0	45	55	
				Secondary	0	0	0	0	0	0	
				Total	45	0	0	0	45	55	100
Medical	47	4930	313 ± 146	Primary	70	1	0	0	71	19	
				Secondary	0	4	6	0	10	0	
				Total	70	5	6	0	81	19	100
Public Assembly	230	946	160 ± 143	Primary	61	9	5	0	75	25	
				Secondary	0	0	0	0	0	0	
				Total	61	9	5	0	75	25	100

Table 10.3.2 (cont.)

ISU Category	Total No. of Bldgs. in data set	Total area in data set (10^3 ft^2)	Mean ± SD EUI in data set (10^3 Btu/ft^2·yr)		% of Total Energy in Category						
					Heating					Elec.	Total
					NG	FO_2	LP	Other	Total		
Rehabilitation	5	103	86 ± 60	Primary	36	26	13	0	75	25	
				Secondary	0	0	0	0	0	0	
				Total	36	26	13	0	75	25	100
Warehouse	217	1530	287 ± 551	Primary	77	10	2	0	89	9	
				Secondary	0	1	1	0	2	0	
				Total	77	11	3	0	91	9	100
Industrial	8	92	381 ± 500	Primary	78	2	12	0	92	8	
				Secondary	0	0	0	0	0	0	
				Total	78	2	12	0	92	8	100

1. Summarized from other ISU studies.

10.4 Conversion Factors

Fuel	Heating Value Btu/gal	Heating Value 10^6 Btu/bbls*
Gasoline	124,240	5.2181
Fuel Oil #2	138,000	5.8380
Fuel Oil #6	152,000	6.3840
Liquified Petroleum	95,500	4.0110
Aviation Gasoline	120,200	5.0484
Jet Fuel	135,000	5.6700
Diesel Fuel	135,000	5.6700

*1 bbl (barrel) = 42 gal.