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THE POTENTIAL FOR ELECTRICITY CONSERVATION IN THE RAILBELT REGION OF ALASKA

DAVID A. TILLMAN
HARZA-EBASCO JOINT VENTURE
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1.0 Introduction

Energy conservation has numerous meanings including: (1) elimination of waste, (2) accomplishing the same tasks (or lifestyle) with less energy expenditure, and (3) simply using less energy. Conservation can be accomplished by a variety of means including technical adjustments (e.g., waste heat recovery, household insulation), and life style adjustments (e.g., lowering the setting on the thermostat). It can be accomplished in residential, commercial, industrial, and institutional economic sectors; and it can be accomplished with respect to all fuels and energy sources. Energy conservation can be effected by two means: (1) establishment of programs promoting or subsidizing conservation, and (2) relianace on economic forces associated with rising costs of energy. This report deals with energy conservation in its broadest sense, using less energy; and it includes technical and lifestyle changes in all sectors of the economy. Finally, it deals with both programatic and market driven energy conservation. However, this report deals specifically with electricity conservation rather than the reduction in use of all fuels.

In order to focus on electricity conservation, it is useful to examine the energy expenditures in Alaska as a whole, and in the Railbelt particularly. These are presented in Tables 1-3. It is significant to note that electricity accounts for only 6.1% of the total energy budget in Alaska; and that it has its highest use in industry (6×10^{12} Btu), with about equal amounts being used in residential and commercial applications.

Given the fact that much of the manufacturing base of Alaska (pulp mills, sawmills, canneries) is in the southeast region, it is necessary to examine more closely the distribution of energy usage in the Railbelt Region. This is shown in Table 3.

From Table 3, it can be seen that electricity is not used as much in the Railbelt Region as in Alaska as a whole. Electricty

accounts for 5.5% of the non-utility energy budgets within the region (electricity accounts fo 4.6% of thte total energy consumed in the region). From Table 3 it can also be seen that the dominant electricity consuming sectors are commercial (33.7%) and residential (32.8%), with the industrial sector accounting for 18.7% of electricity consumption and the military sector accounting for 14.8% of electricity usage.

The dominant electricity conservation potentials in the Railbelt Region, then, are in the residential and commercial economic sectors. Industrial and military uses of electricity in the Railbelt Region are far less important.

Because the residential sector is one of the two important electricity consuming groups in the Railbelt, it is important to examine, more closely, this sector's energy budgets. Tables 4 and 5 are presented to show the distribution of space and hot water heating in the Railbelt Region. Electricity has only 10% of the space heating market, while oil and gas combine to have nearly 83% of that market as is shown in Table 4. Electricity has captured only 22% of the hot water heating market in the Railbelt Region, while oil and gas combined have 73 percent of the hot water heating market as is shown in Table 5.

Electricity has captured a very small portion of the residential thermal market, as is shown in Tables 4 and 5. Further, the majority of megawatt hours consumed by the residential sector are not consumed to serve thermal applications. This distribution of electricity consumpion in the residential sector is shown in Table 6.

The commercial sector in the Railbelt Region is housed largely in the load centers of Anchorage and Fairbanks. Like the residential sector, it relies largely upon non-electic energy in thermal applications. In Anchorage, the dominant source of thermal energy is natural gas (Poray, 1983; also see A.D. Little, 1983). In Fairbanks, nearly 60% of the thermal energy is supplied by petroleum products (e.g., distillate oil).

Future demands are likely to continue the current distribution of thermal energy loads between non-electric and electric energy sources. In Anchorage, electrically heated homes are considered a drag on the market, and they are not being built at this time (Poray, 1983). Their share of the market is expected to decline over time (House, 1983). With electricity costing 8.5¢/kWh in

Fairbanks (Reaume, 1982), or $24.90/million Btu, it is difficult to forecast a rise in electric heat in that load center (particularly when distillate oil costs 85-90¢/gal or $6.30-$6.67/million Btu in that community). In the Anchorage area, the dominant load center, about 70% of the commercial office space has been built since 1970. Almost all of it (with one major development exception) is heated with natural gas (Poray, 1983). Poray expects this trend to extend into the future. In Fairbanks, where 21.2% of the commerical space is heated with electricity, 59.1% by fuel oil, and 19.7% by steam, the relative prices of distillate oil and electricity favor continuation of this distribution (Reaume, 1982).

Given those data concerning energy consumption in the Railbelt Region, certain conclusions can be drawn:

(1) The largest markets for energy conservation, the thermal markets, are served predominantly by non-electric energy sources. Therefore, the largest conservation potentials lie outside the electricity arena.

(2) The dominant uses of electricity are non-thermal applications (e.g., lighting) where conservation potentials are less significant and less important.

(3) The uses of electricity in industry, where process changes can effect energy conservation, are not particularly significant in the Railbelt Region of Alaska.

Given those limitations on electricity consumption in the Railbelt Region, it is important to examine the programatic and market potentials for reducing the use of electricity.

2.0 Programmatic Approaches to Energy Conservation

Energy conservation programs impacting upon electicity consumption have been developed and implemented both by the State of Alaska and by the various utilities within the Railbelt Region. Additional programs have been developed by the City of Anchorage. All of these programs have, to some extent, reduced the consumption of electricity in the Railbelt Region.

Virtually all of the programs have been directed at the residential sector. However, in Anchorage, some programs have impacted the governmental sector (including internal use of electricity by Anchorage Municipal Light and Power). Conservation in the commercial and industrial sectors has largely been left to marketplace driven actions.

2.1 The State (DEPD) Program

The DEPD energy program has been in place since 1981. This program has involved the following activities:

(1) Training of energy auditors;

(2) Performance of residential energy audits, which are physical inspections, including measurements of heat loss, upon request;[a/]

(3) Providing grants of up to $300/household, or loans, for energy conservation improvements based upon the audit;

(4) Providing retrofit (e.g. insulation, weatherization) for low income homes.

The key to the program is the audit, which is performed by private contractors. The forms employed are designed to show savings that can be achieved in the first year, the seventh year, and the tenth year after energy conservation measures have been implemented. The savings demonstrated provide the basis for qualifying for a grant or loan. The audits focus on major conservation opportunities such as insulation and reduction of infiltration (e.g., by weather stripping, caulking, and storm window application).

The DEPD program, overall, achieved a significant level of penetration into the conservation marketplace, as is shown in Table 7. Penetration in the state as a whole achieved 24%; and

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[a/] The state is charged for a portion of the cost of the audit, on a sliding scale, depending upon location in the state. The homeowner pays the difference between that price and the market price.

in the combined load centers of Anchorage and Fairbanks it also achieved 24%. It is useful to note that the audit program was more effective in high cost energy areas (e.g., Fairbanks) indicating that public participation was based upon market forces at least to some modest extent.

The DEPD program, according to its representative R. House, has achieved a 30 million Btu/house/yr or a 4.2% savings of energy in Alaska, of which 18% is electricity (House, 1983). Over 80 percent of the energy conserved has been in the area of fossil fuels. This is consistent with the direction of the program towards thermal energy savings (Brewer, 1983).

The DEPD program is currently being phased out, except for low income family assistance, particularly in the Bush Communities (Brewer, 1983). Even in those communities, only 13% of the homes will be treated (at a cost of $2000/house) in the next 3 years (Brewer, 1983). Educational efforts, however, will continue (House, 1983). If programs are constructed for the future, they will be directed at fossil fuel conservation. Particularly in the remote areas (House, 1983).

2.2 The City of Anchorage Program

The Anchorage Program is the other non-source-specific conservation program operated by the Energy Coordinator for the City of Anchorage. This program also involves audits, weatherization, and educational efforts. Cursory walk-through audits have been performed on city buildings and schools, and detailed audits have been performed on selected institutional buildings. According to energy coordinator P. Poray, few cost effective conservation measures were uncovered by the audits (Poray, 1983).

The weatherization program is applied in the case of low income personnel, and involves giving grants of up to $1600 for materials and incidental repairs. Labor is supplied from the Comprehensive Employment Training Act (CETA) program. It is designed to help those families hardest hit by rising energy costs including the elderly and the handicapped (ML&P, 1982).

The educational program has involved working with realtors, bankers, contractors and businessmen. It also has involved informal contacts with commercial building maintenance

personnel. Finally, it has involved contacts with the general public.

2.3 The Anchorage Municipal Light and Power (ML&P) Program

The ML&P program specifically addresses electricity conservation in both residential and institutional settings. It is a formal conservation program as mandated by the Powerplant and Industrial Fuel Use Act of 1978 (FUA).

The program of ML&P is designed to achieve a 10% reduction in electricity consumption from the base year, July 1, 1980 to June 30, 1981, as shown in Table 8. To achieve this level of conservation, ML&P provides information on available state and city programs (some employing Federal funds). Additionally, it has programs to:

(1) distribute hot water flow restrictors;

(2) insulate 1000 electric hot water heaters;

(3) heat the city water supply, increasing the temperature by 15°F (decreasing the thermal needs of hot water heaters); and

(4) convert two of its boiler feedwater pumps from electricity to steam.

(5) convert city street lights from mercury vapor lamps to high pressure sodium lamps; and

(6) convert the transmission system from 34.5 KV to 115 KV.

ML&P also supplies educational materials to its customers along with "Forget-me-not" stickers for light switches. It has a full time energy engineer devoted to energy conservation program development.

The projected impacts of specific ML&P energy conservation programs are detailed in Table 9. They are dominated by non-residential public sector programs such as street light conversion, transmission line conversion, and power plant boiler feed pump conversion. These three programs, for example,

provide 25,408 MWh of electricity conservation in 1987, or 72% of the total programmatic energy conservation. They are considered to be one-shot successess by AML&P (Keitch, 1983) that will peak in 1982.

The market driven conservation expectation of AML&P are compared to the programmatic efforts in Table 10. As can be seen, market driven conservation is the dominant force. If one further plots programmatic conservation programs impacting residential dwelling (weatherization, state programs, flow restrictors, and water heating) against market induced conservation, the dominance of that latter force is as follows:

Year	Market conservation as of a % of total private sector conservation
1981	77.8
1982	79.8
1983	82.5
1984	82.9
1985	83.6
1986	83.7
1987	83.9

The total conservation forecast by AML&P is shown in Table 11. It is clear that, after 1983, the rate of increase in conservation declines precipitously. The rate of improvement drops sufficiently that the observations of Keitch (1983), that realistic conservation reaches a maximum realistic level by 1983, can be reasonably documented. Beyond that time frame market driven conservation may be considered as the overwhelming contributor.

2.4 The Golden Valley Electric Association Program

Golden Valley Electric Assn., in Fairbanks, provides an education oriented approach to energy conservation programs. This utility, which serves all of the electric hest customers in Fairbanks (Colonell, 1983); La Marca, 1983), relies heavily upon the marketplace and provides its customers with information concerning how money can be saved. It uses heavy reliance on market forces due to the high cost of electricity in that city ($57.01/500 KWh in Fairbanks vs $28.08/500 KWh in Anchorage, Oct., 1982) and the high cost of electric energy vs other fuel as shown in Table 12.

To accomplish the education program, GVEA has adapted a plan pursuant to REA regulations. This utility employs an Energy Use Advisor who performs the following tasks:

(1) performs advisory (non-quantitative) audits;

(2) counsels customers on an individual basis on means to conserve electricity;

(3) provides group presentations and panel discussions; and

(4) provides printed material, including press releases and publications.

GVEA also eliminated its special rate for all electric homes, and placed a moratorium on electric home hook-ups in 1977. It has given out flow restrictors. It has prepared displays and presentations for the Fairbanks Home Show and the Tanana Valley State Fair. It coordinates its programs with the state (DEPD) program and with other programs.

The GVEA budget for conservation activities involves 1.8 man years of effort. In 1981, the last year for which data were available, it budgeted $102,733 for its conservation efforts.

The efforts of GVEA, combined with price increases and other socioeconomic phenomena, produced a conservation effect as shown in Table 13. It is impossible to attribute the entire reduction in energy use per household to the program as to price conservation per se, however the data do show a reduction from 17,332 KWh/house/yr in 1975 to a level of 9,303 KWh/house/yr in 1982. Electricity consumption per household has been cut nearly in half (by 47.6%).

The data in Table 13 also show a moderate upturn in electricity consumption per household in 1982, indicating that the practical limit of conservation may have been reached in the GVEA system. This is the belief of GVEA (Colonell, 1983).

2.5 Other Utility Programs

Other utility programs in the major load centers are represented by the Anchorage based Chugach Electric Association

(CEA) and the Fairbanks Municipal Utility System (FMVS). Both programs are aimed at getting information to the public concerning the dollar savings associated with electricity conservation. Both utilities rely on market forces, and aid in consumer recognition of those forces. Although their electrical rates are not as high as those associated with GVEA, they are sufficiently high to induce market driven conservation. (See Figure 1).

3.0 Price Induced Electricity Conservation

Price induced electricity conservation has been shown to be more important than programmatic conservation, and for several reasons.

(1) it already is having the dominant impact, particularly in the Anchorage area (see Table 9-11);

(2) programmatic efforts in the areas of subsidized audits and investments for residences are being phased out;

(3) programmatic efforts in the areas of institutional buildings and systems are approaching the practical limit of impact; and

(4) the dominant programs for the present and future, as implemented by electric utilities and government agencies, are educational programs designed to support, rather than supplement, price or market induced conservation.

The details of market induced conservation are covered elslewhere in this report. However, it is significant to conclude that the process has been going on for a sufficient length of time due to high prices that many opportunities are embedded in the existing building stock, and that further opportunities may be limited.

TABLE 1

END USE OF ENERGY IN ALASKA BY ECONOMIC SECTOR AND FUEL, 1981 (TRILLION BTU).

SECTOR	FUEL TYPE					
	Fuel Oil	Natural Gas	Coal	Electricity	Wood	Total[a/]
Residential	15.1	8.3	0.1	4.5	3.1	31.0
Commercial	3.3	7.6	1.1	4.4	-0-	16.4
Industrial	32.5	32.3	-0-	6.0	-0-	70.8
National Defense	15.4	4.6	5.9	1.7	-0-	27.5
Transportation	127.4	-0-	0.1	-0-	-0-	127.4
Total[a/]	193.6	52.7	7.2	16.6	3.1	273.2

Source: Arthur D. Little, 1983 (Appendix S).

TABLE 2

ENERGY USE DISTRIBUTION IN ALASKA, 1981 (PERCENT).

SECTOR	FUEL TYPE					
	Fuel Oil	Natural Gas	Coal	Electricity	Wood	Total[a/]
Residential	48.7	26.8	NEGL	14.5	10.0	100.0[b/]
Commercial	20.1	46.3	6.7	26.8	-0-	99.9[a/c/]
Industrial	45.9	45.6	-0-	8.5	-0-	100.0[d/]
National Defense	56.0	16.7	21.4	6.2	-0-	100.3[a/e/]
Transportation	100.0	-0-	0.1	-0-	-0-	100.1[a/e/]
Total[a/]	71.9	19.3	2.6	6.1	1.1	101.0[a/]

a/ Totals Do Not Add Due to Rounding
b/ 11.3% of Total Energy Consumed in Alaska
c/ 6.0% of Total Energy Consumed in Alaska
d/ 25.9% of Total Energy Consumed in Alaska
e/ 10.1% of Total Energy Consumed in Alaska
f/ 46.6% of Total Energy Consumed in Alaska

Source: Arthur D. Little, 1983 (Appendix S).

TABLE 3

RAILBELT ENERGY DISTRIBUTION FOR 1981, BY ECONOMIC SECTOR AND FUEL (VALUES IN TRILLION BTU)

ECONOMIC SECTOR	FUEL TYPE					
	Fuel Oil	Natural Gas	Coal	Electricity	Wood	Total
Utilities	2.15	5.41	29.65	-0-	2.90	-0-
Commercial	2.26	1.07	7.33	-0-	-0-	3.82
Industrial	13.26	-0-	31.44	-0-	-0-	2.13
Residential	9.65	0.15	8.11	1.56	-0-	3.75
Military	15.36	5.89	4.59	-0-	-0-	-0-
Other	95.08	0.07	-0-	-0-	-0-	-0-
Total	137.76	12.58	81.12	1.56	2.90	11.39

Source: Arthur D. Little, 1983 (Appendix S).

247.31 4.6
207.20 5.5

TABLE 4

DISTRIBUTION OF RESIDENTIAL SPACE HEAT IN THE RAILBELT REGION BY FUEL TYPE, 1981 (PERCENT).

COMMUNITY REGION	FUEL						
	Electricity	Natural Gas	Fuel Oil	Propane	Wood	Coal	Total
Anchorage	10[a/]	62	26	2	0	0	100
Fairbanks	5[b/]	0	70	5	17	3	100
Valdez/ Cordova	0	0	94	0	6	0	100
Kenai	18[c/]	28	48	0	6	0	100
Matanuska-Susitna	25[d/]	0	69	0	6	0	100
Southeast Fairbanks	0	0	94	0	6	0	100
Total	10.2	40.9	41.8	2.1	4.4	0.6	100

Source: Arthur D. Little, 1983 (Appendix S).

a/ Battelle placed this value at 16.1%.
b/ Battelle placed this value at 15.2%, the Fairbanks Consumer Advocacy Committee placed it at 9.6%, and the Interior Woodcutters Association placed it at 7.8%.
c/ Battelle placed this value at 20.6%.
d/ Battelle placed this value at 27.7%.

TABLE 5

DISTRIBUTION OF RESIDENTIAL HOT WATER HEATING IN THE RAILBELT REGION BY FUEL TYPE, 1981 (PERCENT).

COMMUNITY REGION	FUEL					
	Electricity	Natural Gas	Fuel Oil	Propane	Other	Total
Anchorage	12	55	21	4	0	100
Fairbanks	14	0	74	12	0	100
Valdez/ Cordova	13	0	75	12	0	100
Kenai	32	28	40	0	0	100
Matanuska-Susitna	53	0	35	12	0	100
Southeast Fairbanks	20	0	80	0	0	100
Total	21.6	36.8	36.0	5.6	0	100

Source: Arthur D. Little, 1983 (Appendix S).

TABLE 6

CONSUMPTION OF ELECTRICITY FOR RESIDENTIAL THERMAL APPLICATIONS AS A PERCENT OF TOTAL ELECTRICITY CONSUMED IN THE RAILBELT REGION, 1981.

ELECTRICITY CONSUMPTION SECTOR	MWH CONSUMED	% OF TIME
Space Heating	384,327	35.0
Water Heating	116,937	10.7
~~Total~~ Residential	1,097,725	~~10.0~~ 100.0

Source: Arthur D. Little, 1983 (Appendix S).

TABLE 7

MARKET PENETRATION OF THE DEPD AUDIT PROGRAM AS OF 1983.

COMMUNITY REGION	HOMES	AUDITS	MARKET PRODUCTION (%)
Kenai Peninsula	11,740	2,659	22.6
Anchorage	70,363	16,297	23.2
Matanuska-Susitna	10,198	2,801	17.7
Fairbanks	22,708	6,202	27.3
Southeast Fairbanks	2,490	734	29.5
Total	162,825	39,188	24.1

Source: Arthur D. Little, 1983 (Appendix S).

TABLE 8

BASE YEAR ENERGY GENERATION FOR ML&P

PERIOD	MI&P NET GEN. (KWH)	GEN. & PUR. (KWH)
Jul., '80	31410440	43419797
Aug., '80	31967600	42626788
Sep., '80	33371400	44974121
Oct., '80	41815000	49635210
Nov., '80	47803480	50876384
Dec., '80	59459560	64276503
Jan., '81	47741520	52873639
Feb., '81	42382280	49064429
Mar., '81	39289000	50301269
Apr., '81	38478600	47449439
May, '81	40496200	42789541
Jun., '81	38442120	43564710
Total Test Year:	492657200	581843030

Source: AML&P, 1982.

TABLE 9

PROGRAMATIC ENERGY CONSERVATION PROJECTIONS FOR AML&P
MWh/YR)

Program	Year						
	1981	1982	1983	1984	1985	1986	1987
Weatherization	586	762	938	1,114	1,290	1,466	1,641
State Programs	879	1,759	2,199	2,683	3,078	3,518	3,737
Water Flow Restrictions	200	464	464	464	464	464	464
Water Heat Injection	3,922	3,922	3,922	3,922	3,922	3,922	3,922
Hot Water Heater Wrap	NA	NA	249	249	249	249	249
Street Light Conversion	0	555	1,859	3,307	4,788	6,306	7,861
Transmission Conversion	0	0	4,119	8,732	9,256	9,811	10,399
Boiler Pump Conversion	7,148	7,148	7,148	7,148	7,148	7,148	7,148
TOTAL	12,735	14,609	20,896	27,619	30,195	32,614	35,421
% Change From Previous Year	NA	14.7	43.0	32.2	9.3	9.8	8.6

Source: AML&P, 1983

TABLE 10

PROGRAMATIC VS MARKET DRIVEN ENERGY CONSERVATION
PROJECTIONS IN THE AML&P SERVICE AREA

Year	Programatic Conservation (MWh)(% of total)		Market Driven Conservation (MWh)(%)		Total (MWH)(%)	
1981	12,735	39.5	19,558	60.5	32,294	100
1982	191,609	34.9	27,243	65.1	41,853	100
1983	20,896	37.1	35,374	62.9	56,289	100
1984	27,619	41.1	39,560	58.9	67,133	100
1985	30,195	40.4	44,536	59.6	74,730	100
1986	32,614	40.6	48,133	59.4	81,015	100
1987	35,421	41.0	50,940	59.0	86,363	100

Source: AML&P, 1983

TABLE 11

TOTAL PROJECTED ELECTRICITY CONSERVATION IN AML&P SERVICE AREA BY YEAR

Year	Projected Conservation (MWh)	% Change From Previous Year
1981	32,294	NA
1982	41,853	29.6
1983	56,269	34.4
1984	67,133	19.3
1985	74,360	10.8
1986	81,015	8.4
1987	86,363	6.6

Source: AML&P, 1983

TABLE 12

THE COST OF THERMAL ENERGY IN FAIRBANKS
1982

Dollars Per Million BTUs

Fuel	Unit of Measure	Heat Content (BTUs/Unit)	Cost Per Unit*	Typical Heating System Efficiency	Cost Per One Million BTU
Electricity	Kilowatt-Hour, KWh	3,414 Btu/KWh	8.37¢	100%	$24.52
#2 Heating Oil	Gallons, G	138,000 Btu/G	114.30¢	65%	12.74
Coal	Tons, T	17,400,000 Btu/T	$83.00	60%	7.95
Propane	Gallons, G	91,800 Btu/G	123.9¢	70%	19.28
Steam	Pounds, lbs.	970 Btu/lb.	0.65¢	100%	6.70
Wood					
Birch	Cords, C	21,500,000 Btu/C**	$100.00	52%***	8.46
Spruce	Cords, C	15,500,000 Btu/C**	92.50	52%***	10.85

* The cost per unit assumes bulk delivery of fuel: the cost for electricity is the MUS and GVEA average based on 2,000 KWh delivered; the cost of #2 heating oil assumes auto-delivery of 500 gallons; the cost of coal is for one ton of lump coal delivered; the propane cost is for bulk delivery of heating propane; and the cost of wood assumes delivery of one cord cut to length or split.

** Air-dried, moisture content of 20% and 80 cubic feet of wood per cord.

*** Assumes an airtight woodstove is used.

Note: This table deals only with the cost comparison between different fuel or energy sources. The initial cost of the individual heating system (furnace or stove andother hardware) is not included.

Source: Fairbanks North Star Borough Community Research Center, Oct. 1982.

TABLE 13

AVERAGE ANNUAL ELECTRICITY CONSUMPTION PER HOUSEHOLD ON THE GVEA SYSTEM, 1972-1982

Year	Annual Consumption (kwH)	Monthly Consumption (kwH)	Percent Change
1972	13,919	1,160	+5.6
1973	14,479	1,207	+4.0
1974	15,822	1,319	+9.3
1975	17,332	1,444	+9.5
1976	15,203	1,267	-12.3
1977	14,255	1,188	-6.2
1978	11,574	965	-18.8
1979	10,519	877	-9.1
1980	9,767	814	-7.1
1981	9,080	757	-7.0
1982	9,303	775	+2.5

Source: GVEA (Colonell, 1983)

Figure 12

PRICE OF 1,000 KILOWATT-HOURS OF RESIDENTIAL ELECTRICITY
For Selected Utilities
Fairbanks, Anchorage, and Seattle
1978-1982