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Energy Savings At No Cost

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A case history of how a large manufacturer of sophisticated electron devices embarked on an energy conservation program which resulted in an overall reduction of 38 percent in annual energy used. Greatest savings of energy were realized from the projects that required essentially no capital dollars to incorporate.

Our plant is one of the Company's twenty-one manufacturing locations which operate throughout the country with national headquarters in New York. Operations at the Kansas City Works primarily consist of manufacturing electron devices for use in various components utilized in telephone central office switching equipment and also in the telephone handset itself. At this plant, microwave relay and amplifier equipment is also manufactured and assembled. The largest amount of energy is consumed or used in providing services to the electron device building. In fact, this building consumes energy at a ratio of approximately 3 to 1 to the energy used in other areas of the plant.

The total plant consists of 1.5 million square feet of floor space; approximately 600,000 square feet for electron device manufacture, 450,000 square feet for microwave work, and the remainder in office, storeroom and support facilities. Although the bulk of products manufactured is of the miniature type, such as transistors, diodes, varistors, and thick film circuits, their manufacturing processes consume considerable amounts of energy since they are largely of a chemical nature. Chemical operations require large amounts of exhausts, heated deionized water and during assembly of selected product, the environment must remain within fixed limits of temperature and cleanliness.

Present day usages of energy on an annual basis approximate:

Electricity	-	90 to 100 million KW hours
Natural Gas	-	360 billion cubic feet
Fuel Oil	-	150,000 - 500,000 gallons

We became concerned of our energy requirements in late 1972 as the shortage of fuel oil became apparent just preceding the Arab oil embargo. At that time, we were burning No. 2 fuel oil (9 cents/gallon) in our boilers at an average rate of 19,000 gallons per day (on typical 20^{o}F day). Concurrently, we were constructing a large storage tank for all types of oil (No. 2 through No. 6) and modifying three 70,000 pounds/hour boilers to burn any type fuel oil through No. 6.

Our organizational structure was ideal for having the capabilities of organizing and spearheading a concentrated energy conservation program. Our organization which includes Plant and Factory Engineering has the responsibility of providing all plant services, forecasting their uses, anticipated growth and budget requirements. This organization not only assures that facilities are adequate, but also is responsible for writing operating procedures for such apparatus as boilers, chillers, air compressors, and waste plant as well as specifying lighting levels and plant temperatures.

The first viable means of assessing the problem was to establish an Energy Conservation Committee, made up primarily of selected engineers, supervisors and operating engineers. The initial assignment of the committee was to identify areas where energy use could be reduced and categorically place them into: (1) no cost to implement, (2) minimal cost to implement, and (3) extensive cost items. Concentrated efforts were then placed on those areas where little or no costs would be involved and later much to our amazement these areas afforded us the majority of our energy savings. Our Headquarters organization at the same time was coordinating company efforts and disseminating information in the forms of "Energy Conservation Practices" and "Energy Conservation Bulletins." The practices were in the form of directives for implementation by all plants and the bulletins were ideas from both Headquarters and other plants on means of conserving energy.

The quickest response item was, of course, to change temperature within the plant by changing all thermostats. As previously noted, considerable concern is given to the environment in which many of our devices are manufactured, so in some areas it was required that fixed temperature and humidity be maintained. However, these areas were small in comparison to the overall plant. Rather than operate the plant year around at 76°F, the new settings are 65°F in the winter and 78°F in the summer. In between seasons (Fall and Spring), settings of 73°F are used when considerable outside air is used for conditioning purposes. With the changed thermostat settings, it was necessary to change the method of operating the air handling units--rather than operate all units uniformly, hot spots and cold spots within the plant were located and specific operating instructions were introduced for individual air handling units. Actually, the mixed air box temperature was raised in most cases which meant that the hot deck temperature was lowered while the cold deck temperature was raised and in essence this reduced the amount of fresh air that had to be treated. It is estimated that annually these changes resulted in savings of approximately 106 billion B.T.U.'s. While these changes were being made, a reduction in the static pressure differential of the building was reduced to a bare minimum. This was accomplished by reducing the number of air handling units in operation, and resulted in additional savings of 38 billion B.T.U.'s of energy.

Manufacturing electron devices requires many chemical operations and therefore involves considerable amounts of exhausts. The device manufacturing building normally exhausts 600,000 cubic feet of air each minute--all of which require makeup air that needs tempering. Previous operation of exhausts was convenient which meant that many exhausts operated around the clock when production was limited to first shift or first and second shifts. All exhaust systems had been identified in order to satisfy the State of Missouri emission control program. This identification proved most beneficial in assisting us in setting up a stringent exhaust control program. The Plant Engineering group polled all product organizations and had them verify their need for each exhaust and its period of operation. This information is retained on the computer and an updated list is periodically distributed to the Plant Protection personnel who in turn monitor the exhausts during their rounds. A typical listing is shown in Figure 1, Fan Shutdown Check Sheet. Upon finding an exhaust running, when not scheduled, a letter is initiated to the operating organization advising them of the condition that existed and also explaining the waste in energy and dollars if such action continues. With 450 exhausts, approximately four systems a week are found operating when scheduled down, however, this is such an improvement over allowing them to run indiscriminately, that an annual savings of 137 billion B.T.U.'s is realized--and essentially at little or no cost.

Even though the plant has a controlled atmosphere, investigation revealed that in most areas the relative humidity could vary. Fortunately, those products that are very sensitive to the environ-

FAN SHUT DOWN
CHECK SHEET
BY SHIFT

SYSTEM NO.	FAN/SW LOCATION	CFM	WED 3	WED 2	SUN 3	DOLLARS
1	30 E5 PH	3951.		–	–	2884
3	D5	172.		ON	–	86
4	E5	2384.		ON		1192
7	G5	1669.				1218
8	G5	1908.			–	1392
9	H5	874.				638
10	H5	9775.		ON	–	4888
11	H5	1272.		–	–	928
13	H5	378.		ON		189
15	J5	60.		ON		
16	J5	1864.		ON		932
21	M5	5382.	ON	ON		2691
23	N5	706.	ON	ON		190
26	P5	3394.	ON	ON		916

Figure 1.

ment had individual rooms for control of temperature, humidity and dust particles or a combination of these. With this information, we were able to allow the relative humidity to rise within the general plant area during the summer to approximately 50% by raising the chilled water temperature from 42°F to 47°F which resulted in additional energy savings of 11 billion B.T.U.'s annually.

As in most plants, lighting was more than sufficient for some of the required tasks. All lighting was reviewed to derive lighting levels required for the seeing tasks. First, aisle lights in most cases were removed since spill-over provided sufficient illumination. Storeroom lighting, where applicable, was reduced to every other fixture. Facade lighting, decorative lighting and cafeteria lighting were all reduced. And, in addition to all of this, lamp specifications were changed from 40 watts to 35 watts and 75 watts to 60 watts. Overall a savings of over 14 billion B.T.U.'s annually was realized. A point of caution, though, and that is all emergency light fixtures should be so identified in order that they remain lamped for use in case of emergencies.

Many smaller items were included in the energy conservation program. These included:

A. Domestic hot water temperature (except cafeterias) reduced from 140°F to 110°F.

B. Emergency diesel generators (1-500 KW and 1-250 KW) tested monthly in lieu of weekly.

C. Heated walkways restricted to use only on inclement weather days when temperatures are below freezing.

D. Receiving and shipping dock doors were kept shut when not in use.

E. Basement heating was turned off since machines, equipment, steam pipes and traps give off adequate heat to keep temperature above 50°F.

F. Some air handling units were converted by plant personnel to variable volume mode. This consisted of blanking off hot decks, shutting off steam and allowing the cold deck dampers to control space temperatures by utilizing internal heat gain (sensible heat) in the shop.

G. Eliminated firing of a standby boiler. Upon investigation it was found that normal operations can sustain a three-hour shutdown of steam in case of a boiler failure. Our particular boilers can be brought up to steam in approximately three hours, therefore, it was decided that there was no need to keep a standby boiler on line.

All of the preceding operations and procedures have two things in common; that is, they did not cost dollars (substantially) to implement and they all contributed in obtaining the bulk of the energy savings--you might say, "energy savings at no cost."

To achieve additional energy savings, other projects were initiated which involved spending investment dollars. These projects include: (1) incorporation of low voltage light controls so smaller areas of lamps may be controlled to coincide with the operations in the shop, (2) placement of "turn-off" stickers on all light switches throughout the plant and offices, (3) installation of a small packaged air conditioning unit for the computer room in order to eliminate running a plant 2500-ton chiller when not required for other than computer operations, and (4) installation of a flue gas recovery system on the power house boiler stack so that boiler water can be preheated by use of wasted stack gases.

Like any company, we like to receive dollars back for dollars invested. These last four projects were accomplished on cost reduction--that is, their investment cost is recovered in a fixed period of time. In these particular cases (except turn-off stickers) the pay-back period ranged from one to two years.

How much can you realize from a good energy conservation program? Shown in Figure 2, Energy Usage, is a comparison of our energy consumption by actual billings for the years 1972, through 1976. As noted, the consumption went from 1,086 X 10^9 B.T.U.'s to 668.5 X 10^9 B.T.U.'s in 1976, or a reduction of 38 percent. Figure 3, Annual Energy Saved, indicates how the energy use

ANNUAL ENERGY SAVED
(BILLION BTU'S)

YEAR	ENERGY TOTAL	FUEL USED	FUEL SAVINGS	ELECTRICITY USED	ELECTRICITY SAVINGS
1972	1086	761	–	325	–
1974	691	382	379(50%)	309	16(5%)
1975	679	377	5(1%)	302	7(2%)
1976	669	376	1(0%)	293	9(3%)

Figure 3.

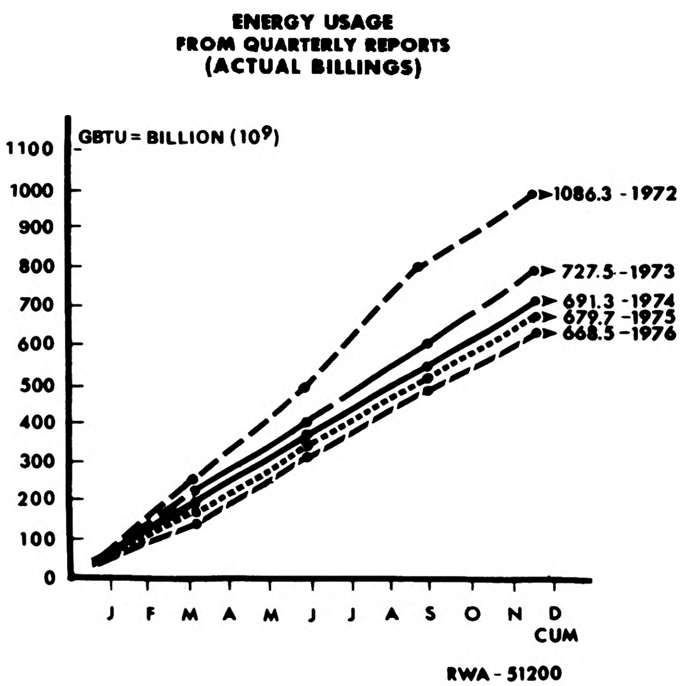

Figure 2.

is divided--that is, in 1972 there were 761 X 10^9 B.T.U.'s used as fuel and 325 X 10^9 B.T.U.'s as electricity. Also shown are the savings realized in the two categories of fuel and electricity. The projects that gave the significant amounts of savings are listed in Figure 4, Energy Saved By Category, and the majority of savings was from no cost items. As shown from these figures, the exhaust shutdown program (air we had previously ignored and threw away) resulted in approximately 37 percent of the total fuel savings, while thermostat changes and air handling unit operation changes all resulted in approximately 38.5 percent of the total fuel saved.

What does this really mean in dollars to the company in addition to the energy saved? At 1976 energy prices these savings are significant. The costs of one billion B.T.U.'s for various types

ENERGY SAVED BY CATEGORY FROM BASE YEAR 1972 THRU 1976 (BILLION BTU'S)

	FUEL	ELECTRICITY
(a) THERMOSTAT CHANGES	106.0	–
(b) AIR HANDLING UNITS	38.7	12.4
(c) EXHAUST SHUT DOWN	137.0	(b)
(d) CHILLED WATER TEMPERATURE	11.0	–
(e) REMOVE UNNECESSARY LIGHTING	–	7.4
(f) CHANGE TO LOW WATT LAMPS	Trade Off	7.1
(g) PACKAGED A/C UNIT	57.0	–
(h) MISCELLANEOUS	35.3	5.1
TOTAL	385.0	32.0

Figure 4.

ENERGY COSTS (1976 COSTS)

ONE (1) BILLION BTU EQUIVALENT

ENERGY TYPE	1976 PRICE (approx.)	EQUIVALENT to 1×10^9 BTU	1×10^9 BTU TOTAL COST
OIL	30¢ per GALLON	= 6.802 gallon of OIL	= $2,040
GAS	$1.00 per 1000 cu.ft.	= 1,000,000 cubic feet of GAS	= $1,000
ELECT.	1.8¢ per KWH	= 293,000 KWHR of ELECTRICITY	= $5,274

Figure 5.

of energy are shown in Figure 5, Energy Costs. Although the major portion of energy saved was in the less expensive type, the savings are still very substantial.

As to why the success or what the most significant changes were to accomplish these savings would be placed into three categories:

A. Implementation of an energy conservation committee which involves all functions; i.e., engineers, supervisors, and operating personnel.

B. Corporate headquarters' assistance by use of guideline implementation programs such as "Energy Conservation Practices" and "Energy Conservation Bulletins."

C. Feedback as to how it's working.

The latter function is most important. Again, through the headquarters organization, all pertinent information is placed in one format and then disseminated back to the locations. In this manner, we are able to compare our results with past performance as well as compare ourselves to like operations within the Company. A portion of this feedback is shown in Figure 6, Energy Usage Report,

WESTERN ELECTRIC COMPANY ENERGY USAGE REPORT

DEMAND RATIOS	1976	1975	1974	1973	1972
TOTAL USAGE (MEGA BTUS)	652,597	658,003	711,107	977,409	1,100,109
MBTU/SQ.FT. of FLOOR SPACE	408	412	446	612	689

Figure 6.

which makes comparisons of energy used for each square foot of floor space utilized. This latter form is used as a tool for making sure that programs initiated are continued and that their effectiveness does not dwindle.

For the future--we are presently working on plans to procure and implement an electrical energy management (EEM) system. Studies have been conducted for the last six months and now reveal that we may further enhance our energy conservation efforts by implementation of such a program. However, the costs will be substantial, particularly compared to the energy savings realized for little or no cost items. Incorporation of this system will allow further reductions in energy and should be paying its way in approximately 18 months.

With the amount of effort expended on energy conservation programs, it seems certain that American industry can enhance its operations while still conserving and minimizing energy used. As a result, these savings will benefit the end user, that is the customer by holding down overall costs even with the rapidly rising unit costs of all types of energy.