

UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Utilities Service

Bulletin 1724D-104

SUBJECT: An Engineering Economics Computer Workbook Procedure

TO: RUS Electric Borrowers and RUS Electric Staff

EFFECTIVE DATE: Date of Approval

OFFICE OF PRIMARY INTEREST: Distribution Branch, Electric Staff Division

FILING INSTRUCTIONS: This is a new bulletin. File hard copy along with 7 CFR 1724. This bulletin can be accessed via the Internet on the RUS website: <http://www.usda.gov/rus>

PURPOSE: This bulletin announces the availability of a Rural Utilities Service engineering economics computer application. This application offers users a planning tool for calculating the approximate "total owning" costs of planned construction projects. The application also compares annual costs of alternative construction projects. The bulletin explains the worksheets, formulas and results of this computer application.

Assistant Administrator
Electric Program

Date

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ABBREVIATIONS

FCR	Fixed Charge Rate, (an economics term)
kW	kilowatts (1,000 watts), (an amount of electrical power demand)
kWh	kilowatt-hours (1,000 watt-hours), (an amount of electrical energy)
LdF	Load Factor
LsF	Loss Factor
MWh	Megawatt-hours (1,000,000 watt-hours), (an amount of electrical energy)
RUS	Rural Utilities Service

1. GENERAL DESCRIPTION

This guide bulletin describes a computerized engineering economics procedure developed by the Rural Utilities Service (RUS) which can be used by RUS borrowers and others. This application was developed on Microsoft Excel 5.0 for Windows.¹ This guide bulletin details how the RUS application can be used and explains the calculations made within its worksheets. The bulletin does not derive the engineering economics methodology used.

The application consists of a 645 kilobyte workbook file, named “**ECONPLAN.XLS**” which contains the following 6 worksheets:

- “READ ME” is a written page of instructions for entering data.
- “FCR” is a form used to calculate the blended interest rate and the fixed charge rate factors from data found in RUS Form 7, “Financial and Statistical Report.”
- “INPUT” is a form used to calculate the annual load and loss factors. This form is also used to enter load losses, power costs, alternative fixed charge rate factors, inflation rates and present worth rates, all used in the engineering economics analysis.
- “PLAN 1” is a form in which proposed construction descriptions, costs and expected changes in kW losses are entered by year. The costs of construction and losses are calculated and displayed.
- “PLAN 2” is a form identical to “PLAN 1.” “PLAN 2” is used to calculate and display the costs of an alternative construction plan with the same economic factors as used in “PLAN 1.”
- “COMPARE” is a worksheet which displays and compares, in tables and bar graphs, the accumulated costs of construction and losses of the alternative plans entered.

Examples of these worksheets with sample data are included in Appendix A at the end of this bulletin.

1.1 The workbook associated with this bulletin determines the theoretical present cash required to finance a portion of a construction program, per year, for a period of up to 30 years. The workbook does the following:

- Provides instructions and forms for entering data and information;
- Inflates estimated construction costs to the year of installation, determines the present worth value of the inflated costs, and multiplies the results by the fixed charge rate;
- Calculates future demand and energy losses and their future and present worth costs;
- Totals and accumulates the above two sets of costs for each year for 30 years;
- Displays all of the input data and calculated results; and,
- Displays selected accumulated totals in tables and on bar graphs.

1.2 This evaluation procedure is widely used in the electric utility industry. RUS finds this methodology of engineering economic analysis acceptable for use by its borrowers in presenting construction project evaluations. Other methods are also acceptable to RUS.

1.3 Users should determine if this computer application is compatible for use on their own computer and printer.

¹ Microsoft, Excel and Windows are registered trademarks of the Microsoft Corporation

2. USES FOR THE WORKBOOK ANALYSIS

This computer application was developed as a planning tool for engineers, managers, and accountants. It can be used to:

- Determine the approximate “total owning cost” of a planned construction project or a partial construction plan;
- Compare construction requirements and the annual costs of two or more feasible plans that will each resolve an electric service problem. The most economically beneficial plan can be easily identified;
- Document, for reference purposes, engineering and planning work that has been performed; and,
- Display some of the details of a plan for presentation to others.

2.1 Worksheet printouts can also be used as documentation, and sometimes justification, for recommending a construction project. The application is especially useful when two alternative, feasible plans are under consideration. The printouts can be used for description and justification exhibits in Construction Work Plans and their amendments, Long-Range System Plans, and other studies. RUS generally prefers that only one or two such exhibits be included in such studies to serve as a sample of the economic analysis performed by the engineer for the entire study. However, for the more costly, complex, construction recommendations, the inclusion of additional exhibits is appropriate.

3. AVAILABILITY

A copy of the RUS Workbook program can be obtained free of charge by either of the following procedures:

3.1 Internet: Download the file from the Internet. The workbook file is available at the following Internet address:

<http://www.usda.gov/rus/electric/econplan.xls>

3.2 RUS Washington: Request a copy of the file from RUS by sending in a blank, DOS-formatted, 3 1/2 inch disk (high density) and a self-addressed mailer to:

Chief, Distribution Branch
Rural Utilities Service
STOP 1569
1400 Independence Avenue SW
Washington, DC 20250-1569

4. EXPLANATION OF WORKSHEET CALCULATIONS

The procedure and formulas used to calculate the displayed quantities on the worksheets in the workbook are explained below.

4.1 Worksheet “READ ME” is a page of written instructions for entering data. No calculations are performed on this spreadsheet.

4.2 Worksheet “FCR” is a form that can be used to calculate the blended interest rate of construction loans and the fixed charge rate (FCR) factors from data found on a borrower’s completed RUS Form 7. The formulas used to calculate the FCR factors and the FCR are shown on the worksheet. (See Appendix A, Exhibit 2). These factors are required for subsequent calculations.

4.2.1 The fixed charge rate is the sum of the following rates:

- Cost of capital (equals the cost of debt plus the cost of equity);
- Taxes;
- Depreciation;
- Operations; and,
- Maintenance.

4.2.2 The fixed charge rate, when multiplied by the cost of a new construction project, yields the annual “fixed charges.” Thus, the fixed charges are the annual interest expenses of the money borrowed to build, plus the annual costs to operate and maintain a new construction project.

4.3 Worksheet “INPUT” is a form with instructions and cells for entering certain economic, load and cost factors. This worksheet may also be used to calculate the annual load factor (LdF) and loss factor (LsF). The formulas used for all of the calculations are shown on the worksheet. (See Appendix A, Exhibit 3).

4.3.1 The LdF is used to determine the average hourly demand over a one year period from a given annual peak kW demand. The LsF, which is based on the LdF and empirical data, correlates demand and energy losses. The LsF is used to calculate energy losses from the annual peak kW demand of losses.

4.3.2 The user may enter alternative FCR factors if those calculated on Worksheet “FCR” are incomplete or unsatisfactory. If the user does not enter values for the LsF or the FCR, then the procedure automatically uses the values of 0.400 and 15.00, respectively. Any other data that is not known may be assumed. Data has to be entered in all of the shaded cells so that the final calculated results are complete and meaningful.

4.4 Worksheet “PLAN 1” is the form in which the user enters the descriptions and present estimated costs of proposed construction projects. The user also enters any anticipated changes in kW losses. All of the formulas used and the calculations performed on this worksheet are explained below, on a column by column basis, beginning at the left side of the worksheet.

4.4.1 “CHANGES PEAK kW LOSSES” Column: A planned future construction project will usually decrease, but sometimes increase, a circuit’s kW demand and kWh energy losses. If a future change in kW losses is anticipated, then the user enters the amount of the estimated or calculated annual peak kW losses change in the space provided to the right of the item description. If a reduction in kW losses is expected, a negative kW amount should be entered.

4.4.2 “INFLATED COST” Column: The present year estimated cost entered for each construction item is inflated to the year of construction by the using the following formula:

$$\text{Inflated Cost} = \text{Estimated Cost} \bullet (1 + \text{Inflation Rate})^{(Y_n - Y_o)}$$

where: Y_n = Year of Installation
 Y_o = Present (first) year of plan

The above estimated cost is entered by the user on Worksheet “PLAN 1.” The Inflation Rate is the “Annual Increases of the Cost of New Construction” entered on Worksheet “INPUT.” The Inflated Cost is displayed to the right of the present year estimated cost.

4.4.3 “PRESENT WORTH” Column: The present worth of each of the Inflated Cost calculated above is determined by using the following formula:

$$\text{Present Worth Cost} = \frac{\text{Inflated Cost}}{(1 + \text{Present Worth Rate})^{(Y_n - Y_o)}}$$

where: Y_n = Year of Installation
 Y_o = Present (first) year of plan

The Present Worth Rate (for the Cost of New Construction) is entered on Worksheet “INPUT.” The above Present Worth Costs are displayed to the right of the Inflated Cost of each construction item.

4.4.4 “FIXED CHARGES” Column: Each of the above calculated Present Worth Costs are multiplied by the fixed charge rate which is calculated on Worksheet “FCR” or alternatively entered on Worksheet “INPUT.” This product, which is the present worth of the Fixed Charges for each construction item, is displayed to the right of each calculated Present Worth Cost.

The Fixed Charges for the construction items are totaled for each year. Next, the previous year’s Accumulated Fixed Charges total is divided by the factor (1+ Present Worth Rate). These two present worth quantities are added together and displayed in bold fonts for each year in the Row “TOTAL COST for Year” in the “FIXED CHARGES” Column.

The above Total Cost of Fixed Charges for each year is added to the Accumulated Fixed Charges of the previous year and also displayed in bold fonts for each year in the Row “ACCUMULATED through Year End.”

4.4.5 “kW LOSSES” Column: The annual peak demand for the first year is the same as the value entered by the user on Worksheet “INPUT.” Each subsequent year is calculated by multiplying the previous year’s annual peak kW losses by the factor: (1+ Growth Rate)². To this product is added the positive or negative value of any changes in peak kW demand losses that has been entered for that year. The results are shown as “Ann. Peak” in this column.

The above annual peak kW demand of losses is assumed to occur during the one month of the year with the greatest total kW usage and demand losses. The demands for the other 11 months of the year are almost always less than the peak month. On Worksheet “INPUT” the user is instructed to enter a monthly demand coincidence factor. By definition, this factor, when multiplied by the annual peak demand, will yield an average monthly billing demand.

This coincidence factor varies greatly from system to system and area to area. The determination of this factor is left to the user.

The monthly average of kW losses is calculated by multiplying the annual peak of kW losses, ("Ann. Peak" discussed above), by the coincidence factor defined above. This monthly average is displayed as "Month Avg." for each year. The calculated monthly averages of kW demand losses are used later to calculate the annual cost of kW losses.

4.4.6 "kWh LOSSES" Column: The annual energy kWh losses are calculated for each year using the loss factor (LsF) calculated on Worksheet "INPUT", the annual peak kW losses discussed above in Section 4.4.5, and the following formula.

$$kWh \text{ Losses (Annual)} = kW \text{ Losses (Ann. Peak)} \bullet LsF \bullet 8766 \text{ (hrs / yr)}$$

The kWh (Accumulated) Losses for each year is the sum the of the above kWh Losses (Annual) for the year plus the kWh (Accumulated) Losses of the previous year. Both the Annual and the Accumulated kWh losses for each year are displayed in the "kWh LOSSES" Column.

4.4.7 "(INFLATED COST OF:) ANNUAL kW" Column: The cost of kW demand losses are increased each year by the "Annual Cost Increase for kW Demand" entered on Worksheet "INPUT." For each year, the cost of the kW demand losses are calculated according to the formulas:

Inflated Cost of Annual kW Losses =

$$\text{Monthly Ave. kW Losses} \bullet 12 \text{ (mo / yr)} \bullet \text{Demand Cost} \bullet (1 + \text{Ann. Cost Increase})^{(Y_n - Y_o)}$$

where: Y_n = Year of Installation

Y_o = Present (first) year of plan

The Monthly Average of kW Losses is discussed above in Section 4.4.5. The Demand Cost is entered on Worksheet "INPUT."

Then, for each year, the present worth of the above Inflated Cost of Annual kW losses is calculated using the following formula:

$$\text{Annual (Present Worth) Cost kW Losses} = \frac{\text{Inflated Cost of Annual kW Losses}}{(1 + \text{Present Worth Rate})^{(Y_n - Y_o)}}$$

where: Y_n = Year of Installation

Y_o = Present (first) year of plan

The above Present Worth Rate is entered on Worksheet "INPUT" as "Present Worth Rate for Cost of Losses (%)." The above Annual (Present Worth) Cost of kW Losses is displayed in bold fonts for each year on the worksheet in the "ANNUAL kW" Column and in the Row "TOTAL COST for Year."

The Accumulated (present worth of the inflated) Cost of Annual kW Losses is calculated for each year by adding the Annual Cost of kW Losses for the year to the Accumulated Cost of

kWh Losses for the previous year. This accumulated total is displayed in bold font for each year in the Row "ACCUMULATED through Year End."

4.4.8 "(INFLATED COST OF:) ANNUAL kWh" Column: The present worth of the inflated annual cost of kWh energy losses is calculated according to the following steps.

Inflated Cost of Annual kWh Losses =

$$kWh \text{ Losses (Annual)} \bullet \text{Energy Cost} \bullet (1 + \text{Ann. Cost Increase})^{(Y_n - Y_o)}$$

where: Y_n = Year of Installation

Y_o = Present (first) year of plan

The kWh Losses (Annual) is calculated as discussed in Section 4.4.6. The Energy Cost and Ann. Cost Increase (for energy) are entered on Worksheet "INPUT." The above calculated quantity is displayed in the "ANNUAL kWh" Column for each year.

Then, the present worth of the above Inflated Cost of Annual kWh Losses is calculated for each year using the following formula:

$$\text{Annual (Present Worth) Cost kWh Losses} = \frac{\text{Inflated Cost of Annual kWh Losses}}{(1 + \text{Present Worth Rate})^{(Y_n - Y_o)}}$$

where: Y_n = Year of Installation

Y_o = Present (first) year of plan

The Present Worth Rate (for the cost of losses) is entered on Worksheet "INPUT." The above present worth of the Inflated Cost of Annual kWh Losses are also displayed for each year, in bold fonts, on the worksheet in the "ANNUAL kWh" Column and in the Row "TOTAL COST for Year."

The Accumulated (present worth of the inflated) Cost of Annual kWh Losses is calculated for each year by adding the above Annual Cost of kWh Losses to the previous year's Accumulated Cost of kWh Losses. This accumulated total is displayed in bold fonts for each year in the Row "ACCUMULATED through Year End."

4.4.9 Year Cost Totals (Rows): Two cost totals are displayed for each year of the plans next to the year number. The top number is the total cost for the year and the bottom number is the accumulated yearly costs through the end of the year. Both totals are the sum of the yearly displayed cost of fixed charges plus the annual cost of the kW demand and the kWh energy losses. All of the totals, displayed in bold font, are present worth costs.

4.5 Worksheet "PLAN 2" is identical to "PLAN 1" in form and calculations. Both worksheets use the same economic and losses factors. This alternative plan can be used to compare the cost of construction and losses of two plans that each resolve the same electric system deficiency.

4.6 Worksheet "COMPARE" displays, in tables and bar graphs, the total accumulated costs and MWh energy losses from Worksheets "PLAN 1" and "PLAN 2" for the first 6 years and

every 5 years thereafter. The tables and graphs conveniently summarize and exhibit entered economic factors and the final results of the procedure used.

5. EXPLANATION OF RESULTS

The year by year, accumulated totals of the present worth of the inflated costs of the fixed charges plus losses are considered the final results of this procedure. The accumulated total cost for any given year is the theoretical present year cash required to finance the plan through that given year. It is assumed that a portion of the theoretical cash on hand is earning interest at the cost of capital rate; the remaining portion of the cash on hand is earning interest at the entered present worth rates. The present worth rates may be the blended interest rate, the rate of return on investments, the inflation rate or another rate and basis adopted at the discretion of the user.

6. SENSITIVITY ANALYSIS

Nearly all of the numerical data entered on the worksheets is either assumed or estimated. Thus, the calculated cost results are only accurate within some unknown range. The user can easily vary each of the input variables, individually or in combination, through reasonable ranges and monitor the new calculated cost totals. This sensitivity analysis will reveal total cost ranges and trends. This analysis may also give the user a perception of accuracy percentages and confidence levels of the final results. Performing this sensitivity analysis is a simple process and especially useful when comparing alternative plans whose calculated total costs nearly equal.

EXHIBIT 1: Worksheet "READ ME"

INSTRUCTIONS FOR ENTERING DATA

- * See RUS Bulletin 1724D-104 for additional details and sample data.
- * Enter data and information in the shaded (yellow) cells only.
- * Enter all numerical data in the format: XX.XX

WORKSHEET "FCR"

- * Use Worksheet "FCR" to calculate the blended interest rate, the fixed charge rate (FCR) and the FCR factors.
- * If these quantities are already known, then go directly to Worksheet "INPUT."
- * Copy required data from a recently completed "RUS Form 7" (Rev. 6-94).
- * Enter data in shaded cells as instructed.

WORKSHEET "INPUT"

- * Use Worksheet "INPUT" to calculate the area loss factor.
- * Enter data, as instructed, into all of the shaded cells for complete results.
- * If the fixed charge rate and its factors as calculated on Worksheet "FCR" are satisfactory, then skip section "FIXED CHARGE RATE."

WORKSHEETS "PLAN 1" and "PLAN 2" (if used)

- * Enter name of engineer, company and short plan description in shaded cells.

For each planned or proposed new construction item:

- * Enter brief description of planned construction in the shaded cell immediately to the right of the year in which the construction is planned.
(Up to 3 construction items and their costs may be entered per year.)
- * Enter the present year estimated cost of each new construction in the shaded cell immediately to the right of the construction description.
(Negative estimated costs (e.g. salvage) may be entered, however, negative costs are also capitalized and may be meaningless.)
- * Enter each expected future change in kW demand losses (+ or -) for each year that a change is expected.

EXHIBIT 2: Worksheet "FCR"

CALCULATE FIXED CHARGE RATE FACTORS

NOTES: If FCR factors are known, then go directly to Worksheet "INPUT"
Enter data in the shaded (yellow) cells only.

ENTER the following amounts from the most recent RUS Form 7.

A	37,516,724	NET UTILITY PLANT	Part C, Line 5
B	14,722,679	TOTAL MARGINS & EQUITIES	Part C, Line 36
C	24,705,644	TOTAL LONG-TERM DEBT	Part C, Line 41
D	513,600	DISTRIBUTION EXPENSE - OPER.	Part A, Line 5 (b)
E	554,980	DISTRIBUTION EXPENSE - MAINT.	Part A, Line 6 (b)
F	1,238,930	DEPRECIATION & AMORT. EXPENSE	Part A, Line 12 (b)
G	251,778	TAX EXPENSE - PROPERTY	Part A, Line 13 (b)
H	158,419	TAX EXPENSE - OTHER	Part A, Line 14 (b)

ENTER the following construction loan data.

Loan Source	Interest Rate	% of Total
RUS	7.75	70.00
CFC	8.25	30.00
Other		
Other		

J 7.90 Blended Interest Rate (%)

COST OF EQUITY FACTOR

K	12.0	ENTER the Capital Retirement Cycle. (Number of Years)
L	0.05	ENTER Utility Plant Growth Rate. (Format: 0.XX)
M	11.28	Calculated Cost of Equity Factor (%) (Goodwin Formula)

$$M = \frac{(1+L)^{(K+1)} - (1+L)^K}{(1+L)^K - 1} \times 100$$

FIXED CHARGE RATE FACTORS

4.95	Cost of Debt (%)	= (C / (B+C)) x J
4.21	Cost of Equity (%)	= (B / (B+C)) x M
9.16	TOTAL COST OF CAPITAL (%)	(= Cost of Debt + Cost of Equity)
1.09	TAX RATE (%)	= ((G + H) / A) x 100
3.30	DEPRECIATION RATE (%)	= (F / A) x 100
2.85	OPERATIONS and MAINTENANCE RATE (%)	= ((D + E) / A) x 100
16.41	FIXED CHARGE RATE (%)	(Sum of the above)

EXHIBIT 3: Worksheet "INPUT"

INPUT DATA for PRESENT WORTH ANALYSIS

Enter data in shaded (yellow) cells only. Enter all data below in the format: XX.XX

ANNUAL LOAD and LOSS FACTORS

LOAD FACTOR = LdF = Annual kWh Energy / (Peak kW Demand x 8766 hr./yr.)

LOSS FACTOR = LsF = .84 x (LdF)² + .16 x LdF

110,055,000
20,869
60.16
0.400

ANNUAL (purchased) ENERGY (kWh) - (Circuit, Substation or System)

ANNUAL PEAK DEMAND (kW) - (Circuit, Substation or System)

CALCULATED ANNUAL LOAD FACTOR (LdF) (%)

CALCULATED AREA LOSS FACTOR (LsF)

0.400

ENTER ABOVE LsF OR OTHER CALCULATED OR ASSUMED LsF TO BE USED.

Note: Loss Factor used = 0.400 (Default value = 0.40 when left blank)

FIXED CHARGE RATE

NOTE: If FCR and FCR factors on Worksheet "FCR" are satisfactory, then skip this section.

7.90
1.07
3.02
3.39
15.38

COST OF DEBT RATE (%) (May be Blended Interest Rate)

COST OF EQUITY RATE (%) (= 0 if Blended Interest Rate used above)

TAX RATE (%)

DEPRECIATION RATE (%)

OPERATIONS & MAINTENANCE RATE (%)

CALCULATED FIXED CHARGE RATE (FCR) (Sum of Above)

15.38

ENTER ABOVE FCR OR OTHER CALCULATED OR ASSUMED FCR TO BE USED

Note: FCR used = 15.38 (Default value = 15.00 when cell left blank)

AREA PEAK kW DEMAND LOSSES and GROWTH RATE

10.0
90.0

CIRCUIT or AREA PEAK DEMAND LOSSES (kW) (First year of Plan)

MONTHLY DEMAND COINCIDENT FACTOR (%)

(Coincident factor x Peak Annual Demand Losses = Average monthly kW demand of losses)

3.50

CIRCUIT or AREA ANNUAL GROWTH RATE (%)

DEMAND and ENERGY COSTS and ANNUAL INCREASES

8.00
0.080
5.00
4.00

DEMAND COST (\$/kW/MONTH)

ENERGY COST (\$/kWh)

ANNUAL COST INCREASE FOR kW DEMAND (%)

ANNUAL COST INCREASE FOR kWh ENERGY (%)

INFLATION and PRESENT WORTH RATES

3.50
7.90
8.50

ANNUAL INCREASES of the COST OF NEW CONSTRUCTION (Inflation) (%)

PRESENT WORTH RATE for COST OF NEW CONSTRUCTION (%)

PRESENT WORTH RATE for COST OF LOSSES (%)

(Present worth rates may be: rate of return on investments; blended interest rate; rate of inflation; or other assumed rate selected and explained by user)

EXHIBIT 4: Worksheet "PLAN 1" (First 9 of 30 years)

ANNUAL and ACCUMULATED COST TOTALS of CARRYING CHARGES and LOSSES

PRESENT WORTH of the INFLATED PRESENT ESTIMATED COSTS

ENGINEER: RUS/ESD/DB

DATE: 11/21/97

COMPANY: Sample for BULLETIN 1724D-104

PLAN 1: BUILD 5 KILOMETERS OF NEW LINE IN 1998

NOTE: Area (or circuit) growth rate given at 3.50%
Thus, losses increase annually at 7.12%

YEAR	DESCRIPTION of CONSTRUCTION	CHANGES PEAK kW LOSSES	ESTIMATED COST of NEW CONSTRUCTION				DEMAND and ENERGY LOSSES and COSTS			
			PRESENT YEAR EST. COST	INFLATED COST 3.50%	PRESENT WORTH 7.90%	FIXED CHARGES 15.38%	kW LOSSES	kWh LOSSES	INFLATED COST OF:	
							Ann. Peak Month Avg.	Annual Accumulated	ANNUAL kW 5.00%	ANNUAL kWh 4.00%
1997						10.0 9.0	35,064 35,064	864	2,805	
	\$ 3,669 TOTAL COST for Year				\$ 0			\$ 864	\$ 2,805	
	\$ 3,669 ACCUMULATED through Year End				\$ 0			\$ 864	\$ 2,805	
1998	Build 5 kilometers of new 3-phase line		120,000	124,200	115,107	17,703	10.7 9.6	37,561 72,625	972	3,125
	21,479 TOTAL for Year		120,000	124,200	115,107	17,703		896	2,880	
	25,148 ACCUM. thru Year		120,000			17,703		1,760	5,685	
1999		-5.0					6.5 5.8	22,705 95,330	617	1,965
	18,600 TOTAL for Year				16,407			524	1,669	
	43,748 ACCUM. thru Year		120,000		34,111			2,284	7,354	
2000							6.9 6.2	24,322 119,652	694	2,189
	17,463 TOTAL for Year				15,206			543	1,714	
	61,211 ACCUM. thru Year		120,000		49,317			2,827	9,068	
2001							7.4 6.7	26,054 145,706	780	2,438
	16,415 TOTAL for Year				14,093			563	1,759	
	77,626 ACCUM. thru Year		120,000		63,409			3,390	10,827	
2002							8.0 7.2	27,910 173,616	878	2,717
	15,451 TOTAL for Year				13,061			584	1,807	
	93,078 ACCUM. thru Year		120,000		76,470			3,974	12,634	
2003							8.5 7.7	29,898 203,514	987	3,026
	14,565 TOTAL for Year				12,105			605	1,855	
	107,642 ACCUM. thru Year		120,000		88,575			4,579	14,489	
2004							9.1 8.2	32,027 235,541	1,110	3,372
	13,750 TOTAL for Year				11,218			627	1,905	
	121,393 ACCUM. thru Year		120,000		99,793			5,206	16,394	
2005							9.8 8.8	34,308 269,850	1,249	3,756
	13,003 TOTAL for Year				10,397			650	1,956	
	134,396 ACCUM. thru Year		120,000		110,190			5,856	18,349	

EXHIBIT 5: Worksheet "PLAN 2" (First 9 of 30 years)

ANNUAL and ACCUMULATED COST TOTALS of CARRYING CHARGES and LOSSES

PRESENT WORTH of the INFLATED PRESENT ESTIMATED COSTS

ENGINEER: RUS/ESD/DB

DATE: 11/21/97

COMPANY: Sample for BULLETIN 1724D-104

PLAN 2: **INSTALL REGULATORS; DEFER NEW LINE**

NOTE: Area (or circuit) Growth Rate Given at 3.50%
Thus, losses increase annually at 7.12%

YEAR	DESCRIPTION of CONSTRUCTION	CHANGES PEAK kW LOSSES	ESTIMATED COST of NEW CONSTRUCTION				DEMAND and ENERGY LOSSES and COSTS			
			PRESENT YEAR EST. COST	INFLATED COST 3.50%	PRESENT WORTH 7.90%	FIXED CHARGES 15.38%	kW LOSSES	kWh LOSSES	INFLATED COST OF:	
							Ann. Peak	Annual	ANNUAL kW	ANNUAL kWh
							Month Avg.	Accumulated	5.00%	4.00%
1997						10.0 9.0	35,064 35,064	864	2,805	
	\$ 3,669 TOTAL COST for Year				\$ 0			\$ 864	\$ 2,805	
	\$ 3,669 ACCUMULATED through Year End				\$ 0			\$ 864	\$ 2,805	
1998	Install 3 line voltage regulators		35,000	36,225	33,573	5,163	10.7 9.6	37,561 72,625	972	3,125
	8,939 TOTAL for Year		35,000	36,225	33,573	5,163		896	2,880	
	12,609 ACCUMULATED thru Year		35,000			5,163		1,760	5,685	
1999							11.5 10.3	40,237 112,862	1,093	3,482
	8,671 TOTAL for Year		0	0	0	4,785		929	2,957	
	21,280 ACCUMULATED thru Year		35,000			9,949		2,688	8,643	
2000							12.3 11.1	43,103 155,965	1,229	3,879
	8,434 TOTAL for Year		0	0	0	4,435		963	3,037	
	29,714 ACCUMULATED thru Year		35,000			14,384		3,651	11,680	
2001	Build 5 kilometers of new 3-phase line Salvage 3 line regulators		120,000 (31,500)	137,703 (36,147)	101,591 (26,668)	15,625 (4,101)	13.2 11.9	46,173 202,137	1,383	4,321
	19,750 TOTAL for Year		88,500	101,556	74,924	15,634		998	3,118	
	49,464 ACCUMULATED thru Year		123,500			30,018		4,649	14,798	
2002		-6.1					8.0 7.2	27,910 230,047	878	2,717
	16,879 TOTAL for Year		0	0	0	14,489		584	1,807	
	66,343 ACCUMULATED thru Year		123,500			44,507		5,232	16,604	
2003							8.5 7.7	29,898 259,945	987	3,026
	15,888 TOTAL for Year		0	0	0	13,428		605	1,855	
	82,232 ACCUMULATED thru Year		123,500			57,935		5,838	18,459	
2004							9.1 8.2	32,027 291,972	1,110	3,372
	14,977 TOTAL for Year		0	0	0	12,445		627	1,905	
	97,209 ACCUMULATED thru Year		123,500			70,380		6,465	20,364	
2005							9.8 8.8	34,308 326,281	1,249	3,756
	14,140 TOTAL for Year		0	0	0	11,534		650	1,956	
	111,349 ACCUMULATED thru Year		123,500			81,914		7,115	22,320	

EXHIBIT 6: Worksheet "COMPARE"

COMPARISON OF TOTAL ACCUMULATED COST and kWh LOSSES OF PLAN 1 vs PLAN 2

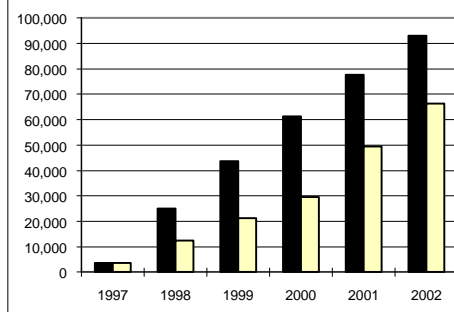
(All costs are the the accumulated present worth of the inflated cost)

TOTAL COSTS (\$)

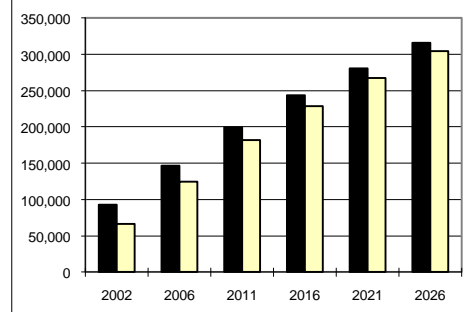
(Capitalized Costs + Losses)

	<u>PLAN 1</u>	<u>PLAN 2</u>
1997	3,700	3,700
1998	25,100	12,600
1999	43,700	21,300
2000	61,200	29,700
2001	77,600	49,500
2002	93,100	66,300
2006	146,700	124,700
2011	199,900	182,200
2016	243,200	228,300
2021	280,800	267,900
2026	315,800	304,200

For first 6 years, favors **PLAN 2 by 28.8%**



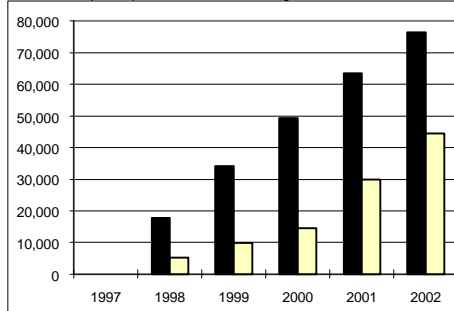
At 30 years, favors **PLAN 2 by 3.7%**



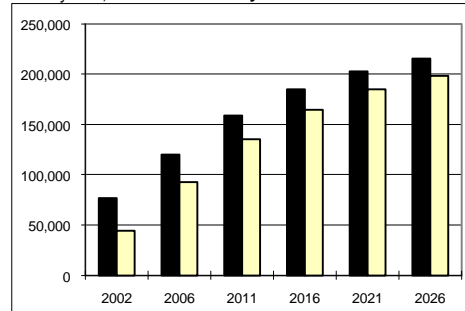
TOTAL CAPITALIZED COSTS (\$)

	<u>PLAN 1</u>	<u>PLAN 2</u>
1997	0	0
1998	17,700	5,200
1999	34,100	9,900
2000	49,300	14,400
2001	63,400	30,000
2002	76,500	44,500
2006	119,800	92,600
2011	158,400	135,400
2016	184,800	164,700
2021	202,800	184,700
2026	215,100	198,300

For first 6 years, favors **PLAN 2 by 41.8%**



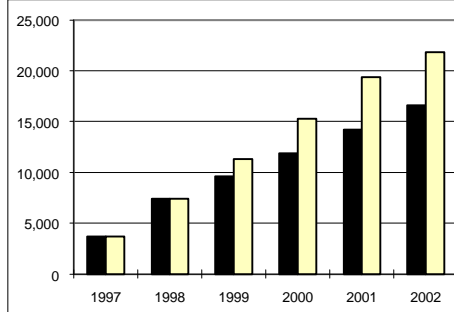
At 30 years, favors **PLAN 2 by 7.8%**



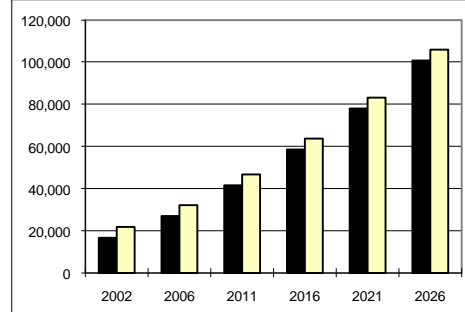
TOTAL COST OF LOSSES (\$)

	<u>PLAN 1</u>	<u>PLAN 2</u>
1997	3,700	3,700
1998	7,400	7,400
1999	9,600	11,300
2000	11,900	15,300
2001	14,200	19,400
2002	16,600	21,800
2006	26,900	32,100
2011	41,500	46,800
2016	58,400	63,700
2021	78,000	83,200
2026	100,600	105,900

For first 6 years, favors **PLAN 1 by 23.9%**



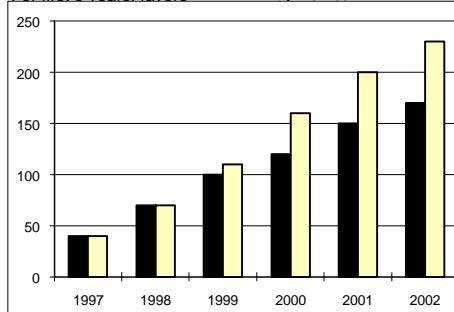
At 30 years, favors **PLAN 1 by 5.0%**



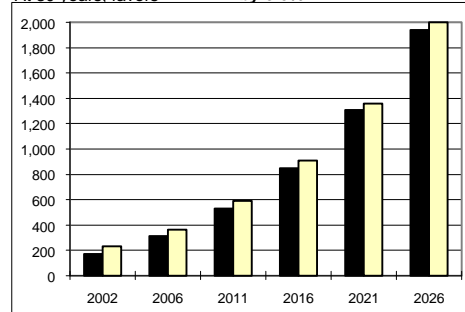
TOTAL ACCUM. LOSSES (MWh)

	<u>PLAN 1</u>	<u>PLAN 2</u>
1997	40	40
1998	70	70
1999	100	110
2000	120	160
2001	150	200
2002	170	230
2006	310	360
2011	530	590
2016	850	910
2021	1,310	1,360
2026	1,940	2,000

For first 6 years, favors **PLAN 1 by 26.1%**



At 30 years, favors **PLAN 1 by 3.0%**



15.38% Fixed Charge Rate

3.50% Annual cost inflation rate - Construction

7.90% Annual present worth rate - Cost of construction

3.50% Annual growth rate - kW demand

4.00% Annual cost inflation rate of engergy - kWh

■ **PLAN 1**
■ **PLAN 2**

BUILD 5 KILOMETERS OF NEW LINE IN 1998
INSTALL REGULATORS; DEFER NEW LINE