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UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Utilities Service

BULLETIN 1724D-104
RD-GD-2019-94

SUBJECT: **An Engineering Economics Computer Workbook Procedure**

TO: RUS Electric Borrowers and RUS Electric Staff

EFFECTIVE DATE: Date of approval.

OFFICE OF PRIMARY INTEREST: Engineering Standards Branch, Office of Customer Service and Technical Assistance

FILING INSTRUCTIONS: This is a revised bulletin. This bulletin can be accessed via the Internet on the RUS website:

https://www.rd.usda.gov/publications/regulations-guidelines/bulletins/electric

PURPOSE: This bulletin describes the 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

2/14/19

Date

TABLE OF CONTENTS

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 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 Microsoft Excel 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 Exhibits A through F at the end of this bulletin.

a. Workbook. 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] Microsoft, Excel, and Windows are registered trademarks of the Microsoft Corporation.

b. Evaluation Procedure. 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.

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

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.

Worksheet Printouts. 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 by downloading a copy off of the RUS website at https://www.rd.usda.gov/publications/regulations-guidelines/bulletins/electric.

4. EXPLANATION OF WORKSHEET CALCULATIONS

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

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

b. Worksheet "FCR" 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 Exhibit B). These factors are required for subsequent calculations.

(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.

(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.

c. Worksheet "INPUT" 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 Exhibit C).

(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.

(2) The user may enter alternative FCR or LsF factors if those calculated on Worksheet "FCR" are incomplete or unsatisfactory. Data has to be entered in all of the shaded cells so that the final calculated results are complete and meaningful.

d. Worksheet "PLAN 1" 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.

(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.

(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:

$$\text{Inflated Cost} = \text{Estimated Cost} \times (1 + \text{Inflation Rate})^{(Yn - Yo)}$$

where:

Yn = Year of Installation
Yo = 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.

(3) "PRESENT WORTH" Column: The present worth of each of the Inflated Cost calculated above is determined by using the following formula:

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

where:

Yn = Year of Installation
Yo = 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) "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."

(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.

(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 in Section 4d(5) in this bulletin, and the following formula:

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

The kWh (Accumulated) Losses for each year is the sum 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.

(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:

$$\text{Inflated Cost of Annual kW Losses} = \text{Monthly Av. kW Losses} \times 12 \text{ (mo/yr)} \times \text{Demand Cost} \times (1 + \text{Annual Cost Increase})^{(Yn-Yo)}$$

where:

Yn = Year of Installation
Yo = Present (first) year of plan

The Monthly Average of kW Losses is discussed above in Section 4d(5) in this bulletin. 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:

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

where:

Yn = Year of Installation
Yo = 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 kW Losses for the previous year. This accumulated total is displayed in bold font for each year in the Row "ACCUMULATED through Year End."

(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.

$$\text{Inflated Cost of Annual kWh Losses} = \text{kWh Losses (Annual)} \times \text{Energy Cost} \times (1 + \text{Annual Cost Increase})^{(Yn-Yo)}$$

where:

Yn = Year of Installation
Yo = Present (first) year of plan

The kWh Losses (Annual) is calculated as discussed in Section 4d(6) in this bulletin. 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:

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

where:

Yn = Year of Installation
Yo = 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."

(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.

e. Worksheet "PLAN 2" 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.

f. Worksheet "COMPARE" 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.

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 Form 7.
* 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.

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.

(Rev 8/2016)

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 6 (*b*)
E	554,980	DISTRIBUTION EXPENSE - MAINT.	Part A, Line 7 *(b)*
F	1,238,930	DEPRECIATION & AMORT. EXPENSE	Part A, Line 13 *(b)*
G	251,778	TAX EXPENSE - PROPERTY	Part A, Line 14 *(b)*
H	158,419	TAX EXPENSE - OTHER	Part A, Line 15 *(b)*

ENTER the following construction loan data.

Loan Source	Interest Rate	% of Total
RUS	4.50	70.00
CFC	4.75	30.00
Other		
Other		

J 4.58 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)

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

FIXED CHARGE RATE FACTORS

2.87	Cost of Debt (%)	= (**C** / (**B**+**C**)) x **J**
4.21	Cost of Equity (%)	= (**B** / (**B**+**C**)) x **M**
7.08	**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**
14.32	**FIXED CHARGE RATE (%)** (Sum of the above)	

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	**ANNUAL (purchased) ENERGY (kWh) -** (Circuit, Substation or System)
20,869	**ANNUAL PEAK DEMAND (kW) -** (Circuit, Substation or System)
60.16	**CALCULATED ANNUAL LOAD FACTOR (LdF) (%)**
0.400	**CALCULATED AREA LOSS FACTOR (LsF)**
	ENTER ABOVE LsF OR OTHER CALCULATED OR ASSUMED LsF TO BE USED.

FIXED CHARGE RATE

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

2.87	**COST OF DEBT RATE (%)** (May be Blended Interest Rate)
4.21	**COST OF EQUITY RATE (%)** (= 0 if Blended Interest Rate used above)
1.09	**TAX RATE (%)**
3.30	**DEPRECIATION RATE (%)**
2.85	**OPERATIONS & MAINTENANCE RATE (%)**
14.32	**CALCULATED FIXED CHARGE RATE (FCR)** (Sum of Above)
14.32	**ENTER ABOVE FCR OR OTHER CALCULATED OR ASSUMED FCR TO BE USED.**

AREA PEAK kW DEMAND LOSSES and GROWTH RATE

10.0	**CIRCUIT or AREA PEAK DEMAND LOSSES (kW)** (First year of Plan)
90.0	**MONTHLY DEMAND COINCIDENT FACTOR (%)**
	(Coincident factor x Peak Annual Demand Losses = Average monthly kW demand of losse
3.50	**CIRCUIT or AREA ANNUAL GROWTH RATE (%)**

DEMAND and ENERGY COSTS and ANNUAL INCREASES

8.00	**DEMAND COST ($/kW/MONTH)**
0.080	**ENERGY COST ($/kWh)**
5.00	**ANNUAL COST INCREASE FOR kW DEMAND (%)**
4.00	**ANNUAL COST INCREASE FOR kWH ENERGY (%)**

INFLATION and PRESENT WORTH RATES

3.50	**ANNUAL INCREASES of the COST OF NEW CONSTRUCTION (Inflation) (%)**
4.58	**PRESENT WORTH RATE for COST OF NEW CONSTRUCTION (%)**
6.50	**PRESENT WORTH RATE for COST OF LOSSES (%)**

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

WORKSHEET "PLAN 1" (ONLY SHOWING 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

COMPANY: Sample for Bulletin 1724D-104

DATE: 08/15/16

PLAN 1: Build 2 miles of 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: PRESENT YEAR EST. COST	INFLATED COST 3.50%	PRESENT WORTH 4.58%	FIXED CHARGES 14.32%	DEMAND and ENERGY LOSSES and COSTS: kW LOSSES Ann. Peak / Month Avg.	kWh LOSSES Annual / Accumulated	INFLATED COST OF: ANNUAL kW 5.00%	ANNUAL kWh 4.00%
2016							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
2017	Build 2 miles of new line		120,000	124,200	118,761	17,007	10.7 9.6	37,561 72,625	972	3,125
	20,853 TOTAL for Year		120,000	124,200	118,761	17,007			913	2,934
	24,523 ACCUM. thru Year		120,000			17,007			1,777	5,739
2018		-5.0					6.5 5.8	22,705 95,330	617	1,965
	18,538 TOTAL for Year					16,262			544	1,732
	43,060 ACCUM. thru Year		120,000			33,268			2,320	7,472
2019							6.9 6.2	24,322 119,652	694	2,189
	17,936 TOTAL for Year					15,550			574	1,812
	60,996 ACCUM. thru Year		120,000			48,818			2,895	9,284
2020							7.4 6.7	26,054 145,706	780	2,438
	17,371 TOTAL for Year					14,869			607	1,895
	78,367 ACCUM. thru Year		120,000			63,686			3,501	11,179
2021							8.0 7.2	27,910 173,616	878	2,717
	16,841 TOTAL for Year					14,217			641	1,983
	95,207 ACCUM. thru Year		120,000			77,904			4,142	13,162
2022							8.5 7.7	29,898 203,514	987	3,026
	16,346 TOTAL for Year					13,595			677	2,074
	111,553 ACCUM. thru Year		120,000			91,499			4,818	15,236
2023							9.1 8.2	32,027 235,541	1,110	3,372
	15,884 TOTAL for Year					12,999			715	2,170
	127,437 ACCUM. thru Year		120,000			104,498			5,533	17,405
2024							9.8 8.8	34,308 269,850	1,249	3,756
	15,454 TOTAL for Year					12,430			755	2,270
	142,891 ACCUM. thru Year		120,000			116,928			6,288	19,675
2025							10.5 9.4	36,752 306,602	1,405	4,185
	15,057 TOTAL for Year					11,886			797	2,374
	157,948 ACCUM. thru Year		120,000			128,814			7,085	22,049

WORKSHEET "PLAN 2" (ONLY SHOWING FIRST 9 OF 30 YEARS)

ANNUAL and ACCUMULATED COST TOTALS of CARRYING CHARGES and LOSSES

PRESENT WORTH of the INFLATED PRESENT ESTIMATED COSTS

ENGINEER:

COMPANY:

DATE: 08/15/16

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: PRESENT YEAR EST. COST	INFLATED COST 3.50%	PRESENT WORTH 4.58%	FIXED CHARGES 14.32%	DEMAND and ENERGY LOSSES and COSTS: kW LOSSES Ann. Peak / Month Avg.	kWh LOSSES Annual / Accumulated	INFLATED COST OF: ANNUAL kW 5.00%	ANNUAL kWh 4.00%
2016							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
2017	Install 3 new line voltage regulators		35,000	36,225	34,639	4,960	10.7 9.6	37,561 72,625	972	3,125
	8,807 TOTAL for Year		35,000	36,225	34,639	4,960			913	2,934
	12,476 ACCUMULATED thru Year		35,000			4,960			1,777	5,739
2018							11.5 10.3	40,237 112,862	1,093	3,482
	8,776 TOTAL for Year		0	0	0	4,743			964	3,070
	21,253 ACCUMULATED thru Year		35,000			9,703			2,740	8,809
2019							12.3 11.1	43,103 155,965	1,229	3,879
	8,764 TOTAL for Year		0	0	0	4,535			1,018	3,211
	30,017 ACCUMULATED thru Year		35,000			14,239			3,758	12,020
2020	Build 2 miles of new line, salvage regulators		120,000 (31,000)	137,703 (35,573)	115,119 (29,739)	16,485 (4,259)	13.2 11.9	46,173 202,137	1,383	4,321
	20,997 TOTAL for Year		89,000	102,130	85,380	16,563			1,075	3,359
	51,014 ACCUMULATED thru Year		124,000			30,802			4,833	15,379
2021		-5.1					9.0 8.1	31,579 233,716	993	3,074
	18,806 TOTAL for Year		0	0	0	15,838			725	2,243
	69,820 ACCUMULATED thru Year		124,000			46,639			5,558	17,622
2022							9.6 8.7	33,828 267,544	1,117	3,424
	18,256 TOTAL for Year		0	0	0	15,144			766	2,347
	88,076 ACCUMULATED thru Year		124,000			61,784			6,323	19,969
2023							10.3 9.3	36,237 303,781	1,256	3,815
	17,744 TOTAL for Year		0	0	0	14,481			809	2,455
	105,820 ACCUMULATED thru Year		124,000			76,264			7,132	22,424
2024							11.1 10.0	38,818 342,599	1,413	4,250
	17,269 TOTAL for Year		0	0	0	13,847			854	2,568
	123,089 ACCUMULATED thru Year		124,000			90,111			7,986	24,992
2025							11.9 10.7	41,583 384,182	1,590	4,735
	16,828 TOTAL for Year		0	0	0	13,240			902	2,686
	139,918 ACCUMULATED thru Year		124,000			103,352			8,888	27,678

WORKSHEET "COMPARE"

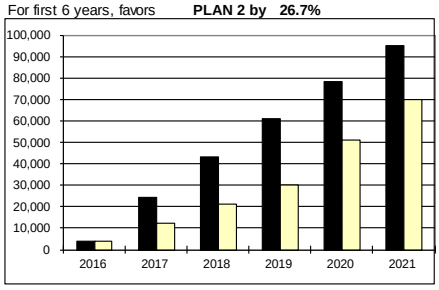
COMPARISON OF TOTAL ACCUMULATED COST and kWH LOSSES OF PLAN 1 vs PLAN 2

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

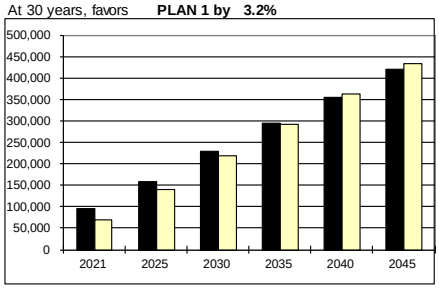
TOTAL COSTS ($)
(Capitalized Costs + Losses)

	PLAN 1	PLAN 2
2016	3,700	3,700
2017	24,500	12,500
2018	43,100	21,300
2019	61,000	30,000
2020	78,400	51,000
2021	95,200	69,800
2025	157,900	139,900
2030	228,300	218,600
2035	293,200	291,300
2040	356,000	361,700
2045	420,000	433,700

For first 6 years, favors **PLAN 2 by 26.7%**



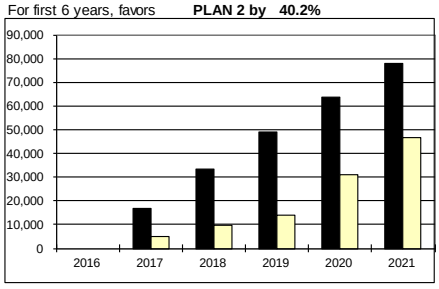
At 30 years, favors **PLAN 1 by 3.2%**



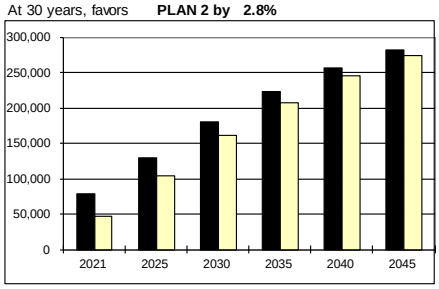
TOTAL CAPITALIZED COSTS ($)

	PLAN 1	PLAN 2
2016	0	0
2017	17,000	5,000
2018	33,300	9,700
2019	48,800	14,200
2020	63,700	30,800
2021	77,900	46,600
2025	128,800	103,400
2030	180,900	161,300
2035	222,500	207,700
2040	255,800	244,800
2045	282,400	274,400

For first 6 years, favors **PLAN 2 by 40.2%**



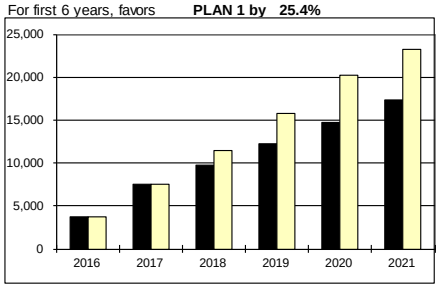
At 30 years, favors **PLAN 2 by 2.8%**



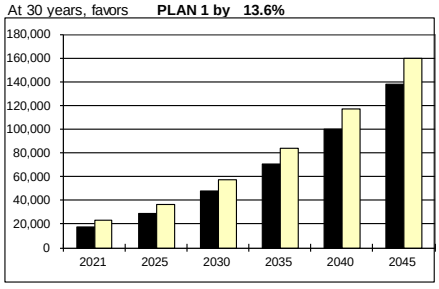
TOTAL COST OF LOSSES ($)

	PLAN 1	PLAN 2
2016	3,700	3,700
2017	7,500	7,500
2018	9,800	11,500
2019	12,200	15,800
2020	14,700	20,200
2021	17,300	23,200
2025	29,100	36,600
2030	47,500	57,300
2035	70,700	83,600
2040	100,200	117,000
2045	137,600	159,300

For first 6 years, favors **PLAN 1 by 25.4%**



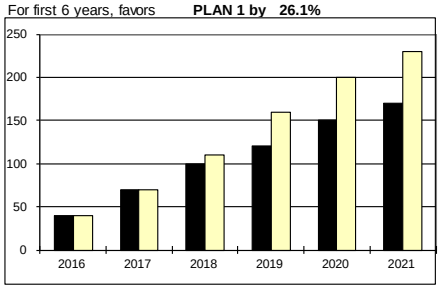
At 30 years, favors **PLAN 1 by 13.6%**



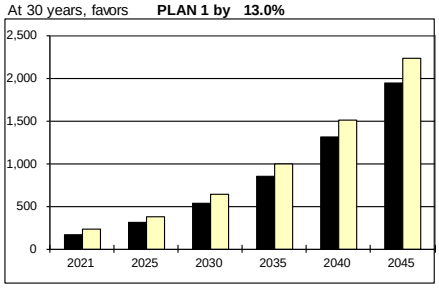
TOTAL ACCUMULATED LOSSES (MWh)

	PLAN 1	PLAN 2
2016	40	40
2017	70	70
2018	100	110
2019	120	160
2020	150	200
2021	170	230
2025	310	380
2030	530	640
2035	850	1,000
2040	1,310	1,510
2045	1,940	2,230

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



At 30 years, favors **PLAN 1 by 13.0%**



0.00% Fixed Charge Rate
3.50% Annual cost inflation rate - Construction
4.58% Annual present worth rate - Cost of construction
3.50% Annual growth rate - kW demand
4.00% Annual cost inflation rate of engergy - kWh
6.50% Annual present worth rate - Cost of kWh losses

PLAN 1 Build 2 miles of new line
PLAN 2 Install regulators, defer new line

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 Form 7.
* 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.

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.

(Rev 8/2016)