Table 6
Power System Losses, MW (2001 Summer)
at 825 MW Buffalo Ridge Area Generation Level compared to
425 MW generation level
(off-peak load condition)

Option	Description	Buffalo Ridge area Generation, MW	Losses, MW	Incremental Losses MW	%	Normalized
0	Existing System	425	10784.0	--	--	
1	Split Rock-Nobles-Lakefield Jct 345	825	10799.7	15.7	3.9	1.0
1D	Split Rk-Nobles-Lakefield Jct dbl ckt 345	825	10799.0	15.0	3.8	1.0
1E	Split Rock-Nobles-Lakefield Jct 500	825	10802.0	18.0	4.5	1.1
3	115 & 161 kV	825	10847.2	63.2	15.8	4.1
4	Lyon Co-Franklin-Ft Ridgely 115	825	10898.3	114.3	28.6	7.3
5	Reconductors only	825	10907.7	123.7	30.9	7.9
6	Chanarambie-Blue Lk HVDC	825	10758.0	-26.0	-6.5	-1.7

From Table 6 it is seen that during the off-peak condition analyzed, the most efficient transmission option is Option 6, which yields a loss reduction of 6.5%. The next-best transmission options are 1 and 1D, which lose less than 4% of the 400 MW incremental generation. Options 4 and 5 are approximately 7 and 8 times, respectively, more lossy than Option 1 or 1D.

5.3 Losses: Economic Evaluation

Losses were taken into account in the economic evaluation of the Options by computing an "equivalent capitalized value" of the loss differences between each option and the least-loss option. This equivalent capitalized value of the loss differences was then applied as an adjustment to the installed cost of each option to arrive at a loss-adjusted or "evaluated cost" for each option. The capitalized value of the losses has two components: Demand Losses, and Energy Losses. The following paragraphs describe

- the method by which cumulative present worth of each of these components was computed;
- how the resultant sum was converted to an equivalent capitalized value;
- the financial parameters applied (discount rate, energy & capacity values, fixed charge rates, etc.).

The economic value of losses was evaluated presuming a 20-year period for the duration of the loss differences, and a discount rate of 8.0%/yr. The 20-year study period was selected because loss differences change over time as transmission system additions are made and as use of the transmission system is modified due to both changes in generation pattern and changes in load levels and locations.

Demand losses (MW) were determined by performing powerflow simulations. The MW values used were those from the on-peak (100% load) condition series of simulations. Although MW losses are potentially higher during the off-peak condition, capacity is presumed to have no value during such periods due to the ample supply of generation resulting from the lower load-serving requirement during such intervals.

The demand loss differences computed from the powerflow simulations were then multiplied by a factor of 1.15 to account for the 15% generation reserve requirement which all MAPP members must maintain in excess of their total system demand (load + losses). It is these adjusted MW figures whose economic value was determined.

The demand losses' value was computed presuming that 50% of the capacity would consist of base-load capacity with an installed cost of $1,000/kW and the remaining 50% would consist of peaking capacity with an installed cost of $400/kW. These values are considered representative, respectively, of contemporary costs for a coal-fired steam plant and a gas-fired combustion turbine installation.

Referring to Table 7, the 20-year cumulative present value of the demand losses is $1,185,500 per on-peak MW.

Energy losses were evaluated based upon the off-peak MW loss figures, presuming a 30% annual loss factor (load factor of the losses). The resultant annual MWh figures were then converted to dollar values by multiplying by a presumed average annual energy cost of $22/MWh. This $22/MWh energy cost is based on an estimated cost of replacement energy from the "pool"; if the replacement energy were instead priced against purchasing additional wind-derived energy to compensate for the losses, the per-MWh cost would be considerably higher.

Referring to Table 7, the 20-year cumulative present value of the energy losses resulting from each (off-peak) MW loss difference is $567,600.

Table 7

Computation of Equivalent Capitalized value for losses
(based on 1.00 MW loss on -peak)
(pool reserve requirement of 15%)

Term of loss reduction	20 yrs		Present Value of annuity factor		9.82		
Assumed life, xmsn	35 yrs				11.65		
Discount rate	8 %/yr						
Energy value	$22 MWh						
Loss Factor	0.30						
FCR, xmsn	0.16					Levelized Annual Revenue Rqmt	Cum PW
Capacity value:					FCR		
	50 % peaking @		$400 /kW		0.15	$30,000	
	50 % baseload @		$1,000 /kW		0.15	$75,000	
					$	105,000	$
	add 15% reserve requirement:					120,750	1,185,541
Energy Value:	1.00	8760 hr/yr	0.30	$22 /MWh		57,816	$ 567,646
			Total annual cost, capacity & energy:		$	178,566	1,753,187
				Present Value factor		9.82	
				Cum PV	$	1,753,187	
				Equivalent investment	$	940,182	

For each option, the cumulative present value of the demand and energy losses was computed for each of the four Buffalo Ridge area generation levels for which powerflow simulations were performed (425, 525, 675, and 825 MW). The composite demand (MW) + energy loss (MWh) cost values were then converted to an equivalent capitalized value by the method described in the following paragraphs and in Table 7.

In order to determine the equivalent capitalized value of the losses, it is necessary to determine the amount of transmission investment which would cause a cumulative present worth cost (cumulative present worth of revenue requirements) equivalent to the cumulative present worth costs computed from the "pricing of the losses" exercise described in the preceding paragraphs. The following is a step-by-step example of the derivation of the equivalent capitalized value of losses.

Applying a 16% fixed charge rate, a $1,000,000 investment in transmission facilities yields a levelized annual revenue requirement of $160,000. Next applying a discount rate of 8.0% and a 35-year assumed life for transmission facilities, the "present value of annuity" factor is 11.65.

A $1,000,000 transmission investment, whose annual revenue requirement is $160,000 therefore has a 35-year cumulative present worth of revenue requirements of ($160,000)(11.65) = $1,864,000. Consequently, it can be observed that for transmission facilities the ratio between "cumulative present worth of annual revenue requirements" and "installed cost" is $1,864,000/$1,000,000 = 1.864. The reciprocal of this number (0.5365) is therefore the factor by which to multiply the "cumulative present worth of the losses" to obtain the "equivalent capitalized value of the losses".

Example: At the 825 MW generation level, Option 5 has losses that are higher than Option 1 (the lowest-loss option) by 60.1 MW on-peak and 108.0 MW off-peak.

Cumulative present value of the capacity is	(60.1 MW) ($1,185,500) =	$ 71,250,000
Cumulative present value of the energy is	(108.0 MW) ($567,600) =	61,300,000
Total cumulative present value of losses is	=	$ 132,550,000
Equivalent capitalized value of losses is	($132,550,000) (0.5365) =	$ 71,110,000
Installed cost of Option 5 at the 825 MW level	(value displayed on Graph 2)	$ 157,110,000
Evaluated cost of Option 5 at the 825 MW level	(value displayed on Graph 3)	$ 228,220,000