

Table 4-8¹ Cost Comparison of transmission and generation alternatives needed to meet the LOLE reliability criterion for 2008

Economic Analysis of Alternatives 2002 Dollars	Alternative	1	2	3	4	5	6	7
	Item	Arrowhead-Weston Project	King-Weston Project	Combustion Turbine (CT) (160 MW)	Combined Cycle (CC) (250 MW)	Distributed Generation (1 MW)	Biomass Plant (100 MW)	Wind Plant (50 MW)
Capital cost (\$/kW) ²				423	554	998	1,823	1,037
Needed LOLE Generation Capacity (MW) ³				600	615	575	585	7,645
Total construction cost (millions) ⁴		\$379.2	\$310.6	\$271.5	\$358.6	\$591.5	\$1,084.2	\$7,947.3
Yearly capital cost (millions) ⁵	A	\$30.5	\$24.9	\$23.0	\$30.4	\$50.2	\$92.0	\$674.5
Yearly transmission cost to support new generation (millions) ⁶	B	N/A	N/A	\$2.31	\$2.40	\$0.00	\$2.22	\$14.82
Fixed O&M (millions) ⁷	C	\$0.49	\$0.37	\$6.32	\$7.77	\$8.17	\$27.68	\$205.52
Missed opportunity for LMP savings relative to A-W (mil.) ⁸	D	\$0.0	-\$3.5	\$56.9	\$45.4	\$60.9	\$53.8	-\$84.0
Super peak energy cost to meet the LOLE (millions) ⁹	E	\$2.2	\$2.2	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Total yearly costs (millions) F=A+B+C+D+E	F	\$33.1	\$24.0	\$88.6	\$86.0	\$119.2	\$175.7	\$810.9
Difference in PVRR relative to the A-W Alternative (mil.) ¹⁰ (King-Weston has costs due to a 4-year delay) ¹¹	G	\$0.0	\$188.3	\$889.8	\$849.2	\$1,382.0	\$2,288.9	\$12,480.3

¹ Similar format to Table 4-8, Chapter 4, Page 161, of the original Arrowhead-Weston Final Environmental Impact Statement (FEIS).

² These values are from Table 40, "Cost and Performance Characteristics of New Electricity Generation Technologies," on Page 73 of the "Energy Information Administration (EIA)/Assumptions to the Annual Energy Outlook 2003". The Public Service Commission of Wisconsin's (PSCW's) Ken Delmer suggested using this table for capital and operating cost estimates for new generation.

³ These values are based on Ron Harsevoort's Loss-of-Load Expectation (LOLE) analysis. The "Needed LOLE Generation Capacity" for the Distributed Generation has the lowest value. From a LOLE probabilistic perspective, smaller unit sizes (1 MW) result in less Distributed Generation being needed to meet the LOLE criterion than the other generation types. The incremental import capability benefit of A-W and K-W are each at least 1,190 MW. By comparing this value to the "Needed LOLE Generation Capacity" for alternatives 3 through 6 (which range from 575 to 615 MW), it is clear that the transmission line alternatives exceed the import capability necessary to meet the LOLE criterion by a wide margin, making for a more reliable system.

⁴ \$17.7 million has already been spent on the A-W project. These sunk costs were added to the total construction cost of the alternatives to A-W.

⁵ Jim Hodgson of ATC calculated a 8.5% real fixed charge rate for the generation alternatives and 8.0% for A-W and K-W. For consistency, a 40-year life was assumed for all of the alternatives. A 40-year life is optimistic for the generators (particularly gas-fired generation) and pessimistic for transmission lines. The economic analysis is for 2008 and beyond. Federal tax credits for renewable resources run out at the end of 2003 and as a result were not included. There is a possibility that they could be extended if the Federal Energy Act is passed this year.

⁶ In order not to bias the LMP analysis, the CTs, CCs and Biomass were equally distributed at 3 sites, with each site having 200, 205 and 195 MW, respectively. Using the transmission cost "power" regression equation ($y = 0.0035x^{1.4946}$), the additional transmission costs per site equals \$9.6, \$10.0 and \$9.3 million, respectively. Multiplying each of these by 3, for the 3 sites, results in totals of \$28.8, \$30.0 and \$27.9 million, respectively. Finally these values must be converted to yearly values by using the 8.0% fixed charge rate for transmission capital costs. Therefore, the resulting "Yearly transmission cost to support new generation" for the CTs, CCs and Biomass are \$2.31, \$2.40 and \$2.22 million, respectively. The transmission costs for the Wind generation were calculated in a slightly different manner. 7,645 MW of Wind generation is needed to meet the LOLE criterion, and at 50 MW per site, 153 sites would be needed. Using the regression equation and inputting 50 MW per site, the additional transmission costs per site equals \$1.2 million. Multiplying this by 153 sites equals \$185 million. Converting this to a yearly value by using the 8.0% fixed charge rate results in "Yearly transmission cost to support new generation" for the Wind generation of \$14.82 million.

⁷ Chris Dailey of ATC estimated total annual maintenance costs for the Arrowhead-Weston line at \$0.487 million. \$0.35 (or \$0.38 in 2002\$) million was used in the PSCW FEIS.

⁸ Locational Marginal Pricing (LMP) is the cost to serve the next MW of load at a specific location, using the lowest production cost of all available generation, while observing all transmission constraints. The MISO is preparing to implement LMP, which is a key component of the FERC's Standard Market Design (SMD). These values were provided by the MISO from the GE-MAPS model. Similar savings would accrue even if LMP is not implemented because Arrowhead Weston gives Wisconsin more access to lower cost power from the west. The analysis in the PSCW's FEIS included a credit that benefited the A-W project called "Energy credit for reducing losses on system". The LMP analysis captures most of this credit and is thus not included here. The values from the GE-MAPS model are in 2001 dollars and so one year of inflation at 3% was added to convert to 2002 dollars.

⁹ Ron Harsevoort estimated that the 600 MW of combustion turbines (CTs) in Alternative 3 would have to produce 17,942 MWh to meet the LOLE criterion. As noted in Table 4-8 of the FEIS, the needed capacity ("capacity equivalence") for transmission lines, like Arrowhead-Weston, is smaller than that necessary for generators, like CTs, due to the higher availability of transmission lines (790 MW versus 834 MW, respectively, in FEIS Table 4-8). Similarly in the new LOLE analysis, somewhat less transmission capacity would be needed to meet the LOLE criterion than the updated value of 600 MW of CT capacity. Being conservative, by not taking credit for this benefit of A-W over CT capacity and starting with the same super peak energy and capacity price as in the FEIS of \$120/MWh, the super peak cost works out to \$2.15 million ($\$120/\text{MWh} \times 17,942 \text{ MWh} = \$2,153,040$). The super peak energy and capacity price per MWh cost in the economic analysis is effectively closer to \$160/MWh ($120 + 40 = 160$). This is because the LMP analysis already includes some costs for the 17,942 MWh, probably about \$40/MWh, i.e. the variable costs for a combustion turbine. The \$40/MWh estimate is based on EIA's characterization of a full load heat rate of 10,450 BTU/kWh, \$3.33 per MBTU for natural gas fuel in 2001 dollars (\$3.43 per MWh in 2002 dollars) and \$4.09 per MWh in 2001 dollars (\$4.21 per MWh in 2002 dollars) for variable O&M. The actual calculation is $[(10,450 \times 3.43)/1000] + [4.21] = \40.06 per MWh in 2002 dollars. \$3.43 per MBTU is the average monthly natural gas fuel cost for the year from the GE-MAPS model. Natural gas fuel costs vary by month in the model, but are not listed here because they come from a GE subscription service.

¹⁰ Present Value Revenue Requirement (PVRR). The difference in the "Total yearly costs" between the A-W Alternative and each of the other alternatives is calculated. This yearly difference is discounted using a 5.5% real discount rate (the PSCW-approved value from Advance Plan 8) over 40 years. This is the same approach as used in the A-W FEIS, P. 160.

¹¹ The King-Weston alternative would involve a four-year delay relative to the A-W alternative and the associated costs can be captured in the PVRR calculation. Four years of "Missed opportunity for LMP savings relative to A-W" and costs for leasing enough diesel generation to meet the LOLE criterion were included.

Arrowhead Weston Cost Estimate

	2002	2003	2004	2005	2006	2007	2008	Total
Yearly Project Cost (Year of Expenditure Dollars)	26.5	7.0	60.2	101.3	113.8	78.6	33.0	420.3
Project Cost (2002 Dollars)	26.5	6.8	56.7	92.7	101.1	67.8	27.6	379.2

King Weston Option 10(1) Cost Estimate

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Yearly Project Cost (Year of Expenditure Dollars) ⁴	17.7	0.0	3.1	3.3	3.7	7.2	44.9	96.8	66.3	83.7	59.4	0.5	386.7
Project Cost (2002 Dollars) ⁴	17.7	0.0	2.9	3.1	3.3	6.2	37.6	78.7	52.3	64.2	44.2	0.4	310.6