

The Real Cost of Wind Energy

Joseph F. DeCarolus and David W. Keith

Science Volume 294, Number 5544 Issue of 2 Nov 2001, pp. 1000 - 1001

©2001 by The American Association for the Advancement of Science.

The cost of electricity from wind is about 4 ¢ per kilowatt-hour (kWh) according to M. Z. Jacobson and G. M. Masters' estimate in their Policy Forum "Exploiting wind versus coal" (*Science's* Compass, 24 Aug., p. 1438), making wind energy competitive with new coal-fired generation. There is a 1.5-¢/kWh federal credit for wind energy producers, and, in addition, consumers are willing to pay a premium for wind. Given this credit, and a conservative 0.5-¢/kWh green power premium (1), one might expect wind producers to break even at ~6 ¢/kWh. If their costs are 4 ¢/kWh, producers should make large profits and wind should dominate new electric capacity. No such boom is observed; wind generates only 0.1% of U.S. electricity and accounts for only 1% of capacity additions in the last 5 years (2). Two factors--transmission and intermittency--raise the real cost of wind and explain the discrepancy between simple estimates of cost and observed installation of capacity.

Jacobson and Masters propose replacing ~60% of coal capacity with wind farms in North Dakota that have an average power of ~130 GW. At this scale, wind is a significant fraction of capacity, and its intermittency must be addressed. To derive a conservative estimate for the cost of backup generation under suboptimal wind conditions, suppose that 130 GW of gas turbine capacity is installed. Wind power generated beyond the mean output can be sold, roughly compensating for fuel costs when backup generation is used. The amortized cost of the gas capacity is ~1 ¢/kWh. In addition, Jacobson and Masters dismiss transmission costs, suggesting that they "can be offset with turbine mass production." We are unconvinced. The best sites for wind farms are in the Great Plains, far from demand centers concentrated on the coasts, so transmission costs must be included if wind is to supply a significant fraction of national demand. Using modern HVDC (high-voltage direct current) technology, transmission costs are ~1.5 ¢/kWh for 2000-km lines (3). Therefore, combining the cost of backup and transmission adds 2 to 3 ¢/kWh to the cost of wind, partially explaining the discrepancy between simple cost estimates and observed behavior.

We believe that the challenges posed by remoteness and intermittency are surmountable, but it is an exaggeration to say that wind is now competitive with coal.

References and Notes

1. See U.S. Department of Energy, "Green certificate marketers," *Green Power Network* (updated 18 Oct. 2001) (http://www.eren.doe.gov/greenpower/mkt_gcert.html)
2. Energy Information Administration, "Annual energy review" (modified Oct. 2001) (<http://www.eia.doe.gov/emeu/aer/contents.html>)
3. Calculation based on *HVDC Power Transmission Technology Assessment Report ORNL/Sub/95-SR893/1* (Oak Ridge National Laboratory, Oak Ridge, TN, April 1997).