

Canadian Energy Research Institute

Relative Costs of Electricity Generation Technologies

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Prepared for:
Canadian Nuclear Association

September 2006



Relevant • Independent • Objective

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Basis of Cost Comparison

CERI was asked to update a graphical comparison of cost ranges for various generation technologies originally published in 2002 by Pollution Probe. As many of the original sources had not undertaken updates, CERI attempted instead to locate costs that to the extent possible had a common set of underlying assumptions. The updated comparison is presented in Figure 1; the basis and assumptions underlying the comparison are described below.

Internal studies by CERI provided levelized unit electricity cost (LUEC) estimates in 2003 Canadian dollars at 5% and 10% real discount rates for nuclear, coal and wind technology (depicted in red). These estimates were on a "Crown corporation" or public enterprise basis: not subject to income taxes. Operating life was taken as 25 years for wind, and 40 years for other technologies. Capacity factors were taken as 35% for wind, 93% for ACR-1000 and 90% for coal, gas and CANDU 6.

The levelized cost range for gas-fired generation as presented in Figure 1 (in black) was calculated on a very different basis from the range shown for all other technologies. Costed on the same basis as coal and nuclear, the range would have been very narrow - CAD 0.0815 to 0.0852 per kilowatt-hour. Being less capital-intensive than other technologies, it is less sensitive to the choice of discount rate. The key variable affecting the levelized cost of gas-fired electricity is the price of natural gas. A range of natural gas prices forecast by various organizations for the year 2010 was therefore incorporated into the range of levelized costs, whereas a single fuel price forecast was used for coal and nuclear.

To obtain reasonably comparable information for biomass, landfill, small hydro, large hydro, solar and geothermal (depicted in blue), CERI borrowed from levelized costs at 5% and 10% discount rates denominated in year 2003 U.S. funds as presented in an OECD/IEA/NEA document¹, and converted them into Canadian funds at the 2003 exchange rate of 1.3015 Canadian dollars per U.S. dollar. The range of costs taken from the OECD/IEA/NEA document was confined to those of North American and European countries excluding former centrally planned economies. If the levelized cost ranges for coal, nuclear and wind generation had been plotted on this basis rather than relying on CERI analyses, the resulting bars would have extended further upward and downward relative to those shown on the attached figure, reflecting the greater variety of circumstances. The bar for gas-fired generation, however, would have been lower (both top and bottom), reflecting the much lower real natural gas prices assumed in the OECD/IEA/NEA study. The CERI study projected a per gigajoule natural gas price of CAD 11.43 in the year 2010, whereas the per gigajoule range of year 2010 natural gas prices in the OECD/IEA/NEA document works out to CAD 4.84 – 7.44. All of these prices are expressed in constant 2003 dollars.

For biomass combustion, the range shown in Figure 1 pertains to the OECD/IEA/NEA's Combustible Renewable category. A more general definition of biomass combustion would extend the bar in both directions. At the low end, municipal waste incineration as costed out for

¹ OECD/IEA/NEA, Projected Costs of Generating Electricity: 2005 Update

a Netherlands plant at a 5% discount rate works out to a mere 0.6 cents per kilowatt-hour. The low number is attributable to a credit for avoided landfill costs. (In fact, the levelized costs of a similar plant in the Czech Republic turned out to be negative at a 5% discount rate.) At the high end, the levelized cost of a combined heat and power plant in Austria using biomass as fuel worked out to be 18.8 cents per kilowatt-hour at a 10% discount rate.

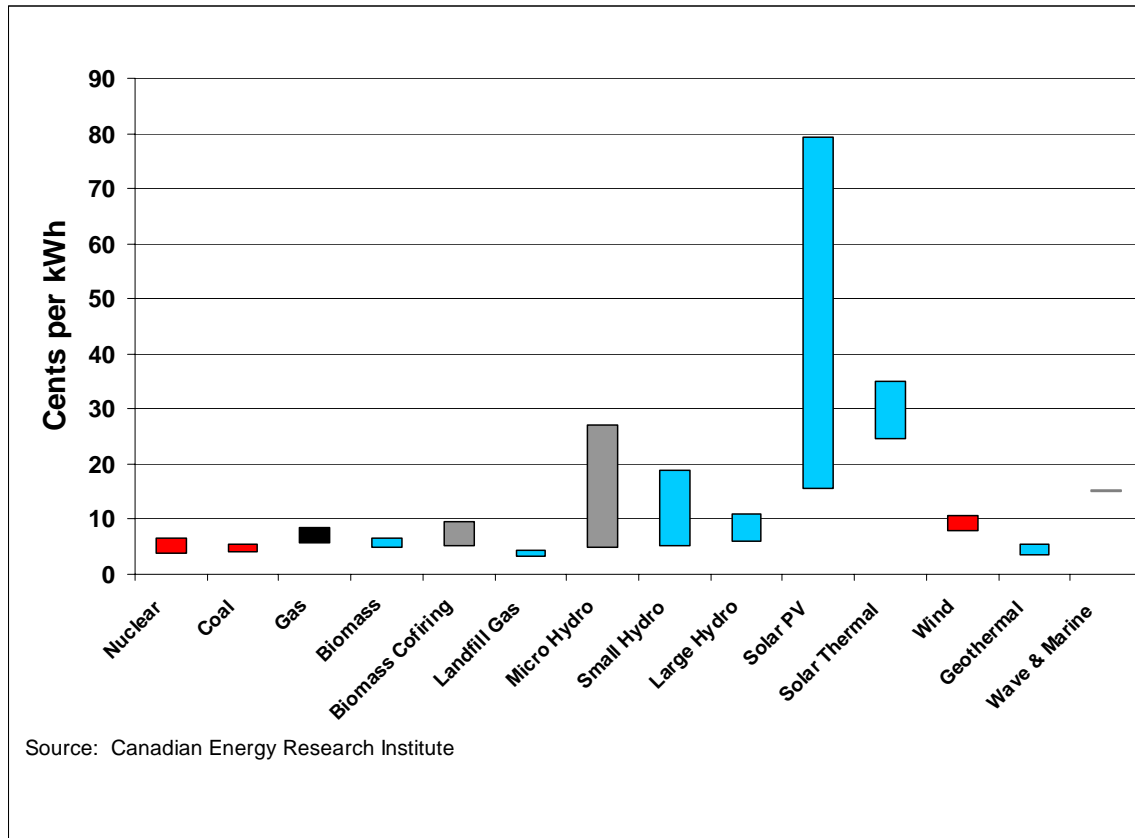
For co-firing of biomass, micro hydro and ocean technologies (depicted in gray) no data source could be found that offered a similar prospect of comparability. Incremental United States (Pennsylvania) costs of co-firing with biomass relative to the coal-only alternative were taken from documents prepared by Black & Veatch², converted to Canadian funds and added to the levelized costs shown for Canadian coal-fired generation. The range of levelized costs for micro hydro of 1 kW and 10 kW sizes was taken from a Compass Resource Management Ltd. study³ prepared in 2003. The sole figure for levelized cost of electricity from wave and tidal energy was taken from a 2003 study by PB Power⁴ in the United Kingdom that used a real discount rate of 7.5%. The levelized cost of 6.63 pence per kilowatt-hour calculated by PB Power was converted to Canadian funds at the 2003 exchange rate of 2.2883 Canadian dollars per U.K. pound.

² Black & Veatch, Renewable Energy 2004: Biomass Energy Projects Development, Specification and Financing, April 2004, prepared for the Council of Industrial Boiler Owners

³ Compass Management report to BC Hydro, 2003, cited in the BC Ministry of Agriculture and Lands' Energy Fact Sheet "On-Farm Hydroelectric Generation" dated May 2006

⁴ PB Power, The Cost of Generating Electricity, 2004, carried out for the Royal Academy of Engineering

Figure 1
Relative Costs of Electricity Generation Technologies
(2003 Canadian cents per kilowatt-hour)



About CERI

The Canadian Energy Research Institute (CERI) is a co-operative research organization established through an initiative of government, academia, and industry in 1975. The Institute's mission is to provide relevant, independent, objective economic research and education in energy and related environmental issues. Related objectives include reviewing emerging energy issues and policies as well as developing expertise in the analysis of questions related to energy and the environment.

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