

Greener Power Ingredient: Coal

By Tom Adams*

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Many people debating greenhouse gas controls think they know that coal is our worst electricity source with respect to carbon dioxide emissions and that natural gas is about half as bad. Although replacing coal power with gas-fired power seems like an environmental winner, this simplistic generalization is often wrong. Eliminating coal-fired electricity will require replacing it with gas and because of the characteristics of our gas-fired stations, Ontario's carbon dioxide emissions will rise.

New rules for calculating the green house gas emissions footprint of transportation fuels introduced by the U.S. Environmental Protection Agency May 26th indicate that the U.S. is heading toward life-cycle assessment of emissions. Ontario needs to be ready when similar rules come to electricity.

During the Ontario election campaign of 2003, all the major political parties agreed that Ontario must phase out coal power, disagreeing only on the timing. The basis for this consensus was the idea that smog caused by coal power was killing hundreds of people every year. When it became clear that modern scrubbers, like those installed on two power big generators near Sarnia, allow coal power production without any significant contribution to smog, the McGuinty government shifted its justification for coal shutdown from health to climate protection. Although the McGuinty government slid the date for coal shutdown from 2007 to 2014, the government remains adamant about its shutdown policy, frequently citing it as the government's central climate change initiative.

Stopping coal makes for clean political messaging but overlooks the actual factors driving the environmental performance of our power system.

Primarily for environmental reasons, Ontario is contracting with developers to build many new wind farms. Although wind only contributed 0.9% of Ontario's electricity supply last year, soon it will make a more significant contribution. With new farms coming on, Ontario is hitting records. On May 16th, wind output supplied a 4.4% of Ontario's consumer demand, although that record will soon fall.

Notwithstanding its small market share, wind is already creating challenges for Ontario's power grid operators. Fortunately, sufficient operational flexibility has so far been available to provide a reliability cushion for customers. Wind-related problems have occurred this spring during periods where the combination of gentle weather, conservation programs, and a hurting economy have driven power usage to minimums not seen since 1997.

Grid operators must continuously exactly match power production and consumption. The mix of generating technologies used in Ontario makes the job particularly tough. Our nuclear generators have little capability to adjust their output up and down to match fluctuating usage. During high run-off, few of our hydro-electricity facilities can store any water and most are required to maintain high output to

prevent flooding. Our wind generators tend to be more productive during periods of low consumption than during periods of high consumption. All of this together can cause excess generation events.

During excess generation events, some of Ontario's electricity potential is wasted. Wind power has exacerbated now common events where our power system is being forced to dump nuclear generated steam and to spill water around hydro-electric generators. Wind power in Ontario has also contributed to U.S. power buyers actually getting paid for taking excess electricity off our over-supplied grid. For 21 hours during one day over the recent Easter weekend, neighbours taking power from the Ontario grid got paid for reducing our excess supply.

The generators most responsible for ramping up and down to reliably matching supply with demand are our fossil-fired generators.

Our growing wind fleet is creating additional ramping requirements on our fossil generators. Of all the technologies supplying Ontario's grid, wind output is by far the most fickle and the least predictable. Ontario's experience also proves that there is a high risk that all the wind generators can be rapidly becalmed at the same time.

To maintain reliability in the event of a rapid drop in wind, grid operators need generators able to quickly take up the slack. Coal power emits greenhouse gases at a much lower rate rather than Ontario's new mid-efficiency gas-fired generating units while providing essential reliability support for wind generation during high wind periods. Ontario's coal power stations are good at riding along at low power, often at 20% of full power, ready to quickly ramp up to full power when needed. However, our new gas plants have much higher minimum production requirements, typically at about 60% of full power. To match the upward generation flexibility of one large coal generator, about twice as much gas-fired generation capacity is required and four times as much carbon dioxide is emitted from the gas generators standing by to support wind power compared with coal generators doing the same job. For a 500 MW coal generator at 20% power or 100 MW, the CO₂ emission rate is typically about 100 t/hr while providing 400 MW of up ramp potential. To get the same 400 MW of up ramp potential, about 1000 MW of gas combined-cycle units are required, putting out 600 MW and emitting at a rate of approximately 400 t/hr.

The Ontario government's policies of maximizing wind power while phasing out coal power in favour of mid-efficiency gas plants are directly in conflict. Because our coal generators can operate at much lower minimum output levels than our gas-fired units, eliminating coal decreases the fraction of our power supply that can be safely and efficiently be met by wind power. In the example above, 500 MW of non-wind and non-fossil generation would have to be removed from the power system if gas is providing support for wind.

Although coal power has huge environmental advantages over Ontario's fleet of new gas-fired generators in supporting wind power during windy periods, gas-fired generators are much lower emitting when supporting wind generation when wind output is low. Since this is typically in summer when power usage peaks and we don't need gas for home heating, gas can play a useful role in supporting wind power.

Although low-efficiency, high-ramp gas units are an option for Ontario, cost is also a key consideration. Even with the recent North American natural gas supply glut and the resulting price crash, coal retains a drastic cost advantage over gas. Coal power ultimately costs Ontario consumers one half to one fifth what gas-fired power costs when provided from mid-efficiency gas generators. Lower efficiency gas generators have approximately two thirds the fuel efficiency of mid-efficiency units. Minimizing the cost of back-up power makes relatively costly wind power more socially acceptable.

One of the arguments prominent among environmental organizations promoting Ontario's Green Energy Act is that the gas-fired generation added in Ontario should be highly efficient co-generation. The operational flexibility of co-generation is roughly equivalent to that of Ontario's nuclear power generators. Any increase in co-generation will decrease the amount of wind power Ontario can safely and reliably integrate.

If environmental and consumer protection principles trumped sound-bite politics, Ontario would retain its mixed fleet of coal and gas-fired generation to best serve electricity consumers.

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