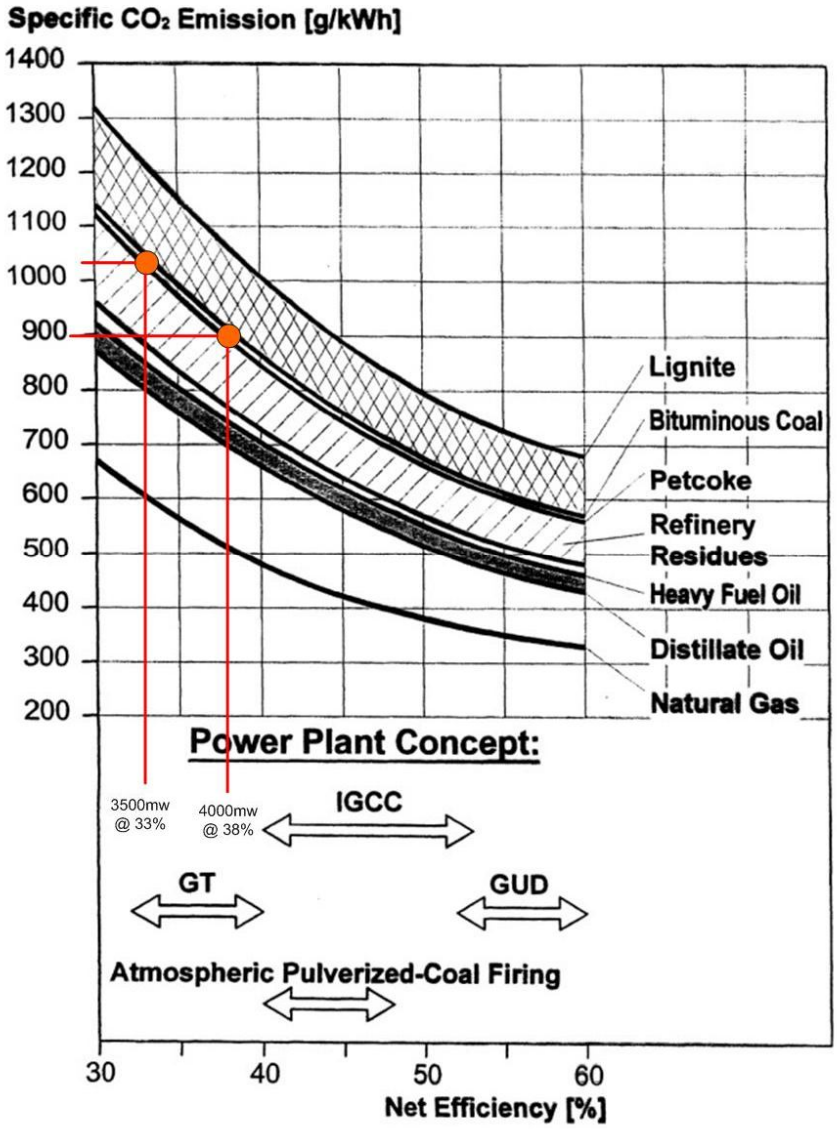
It seems counter-intuitive that extracting energy from wind may end up not saving very much in CO2 emissions. The fundamental reason for this is that wind energy, unlike all the other current major technologies, cannot be controlled in any meaningful fashion. The output for an entire farm can change dramatically in minutes, and has no relation whatever with demand – historically it has actually been negatively correlated. Because there is little prospect for storing the large amounts of energy involved, wind power requires a backup source that can be activated within seconds. Nuclear and coal are not suited for changing output this quickly, so that leaves us with gas fuel plants and maybe hydro, already running and synchronized with the rest of the grid. If there is an alternative to this, I have not yet found it, and would love to hear of it.

Perhaps you can start to see the nature of the problem. To get an idea of actual numbers, I've constructed a very simplified example. I'm sure someone can quibble about this example, maintaining that the grid would never encounter this specific case, and I'll agree. This example may be technologically feasible, but it is certainly not politically or economically feasible - those issues generate even more complexity, more than I have the ability to address. Still, this example is close enough to the real case to be instructive.

Let us say that Ontario needs 20,000 mw of power. Currently we supply that with the following mix: 10,000 mw nuclear, 4,000 mw hydro, 4,000 mw coal and 2,000 mw other (i.e. gas CCGT). Now we introduce 2,000 mw wind power into the mix and to get the best CO2 savings, we take a corresponding amount of coal offline. How much CO2 is saved by this?

The 2,000 mw of wind actually averages at maybe 25%, so the actual power put into the grid is 500 mw. So the coal production can drop by 500 mw, from 4,000 to 3,500 mw. But what does running a fossil fuel plant at less that full power do? The chart below, from Siemens, shows the relationship of efficiency vs. emissions. If we accept OPG's 900 g/kw-h, and if we assume they are using bituminous coal, we can infer they are running their coal plants at about 38% efficiency. If they lower the coal output to 3,500 mw, the efficiency drops to about 33% (3500/4000 ~=33/38). Following the curve, this means the new emission rate will be 1030 g/kw-h. So before wind we had 4,000 times 900 equals 3.6 tonnes/mw-h. After wind we have 3,500 times 1030 equals 3.605 tonnes/mw-h, **which is higher than before!**



As mentioned above, one can quibble with my assumptions and my numbers, but if there's any substantive problem with this example, I'd like to hear about it. You might say that CCGT is replaced, and that might make the numbers look better, but replacing coal with CCGT says more about the better efficiency of CCGT vs coal than anything about wind. As an aside, the standard wind industry CO2 savings numbers essentially assume that the curves above are horizontal straight lines, which is obviously not so.

The papers that I have seen, when they get into this level of analysis, all come to pretty much the same conclusion as I did - the reductions of CO2 from wind power are much less than advertised.