How many billions could be saved?

Previous reports on exergy storage have identified seven major ways in which economic savings could be achieved:

1) by replacing centralized energy sources (most notably natural gas) with local energy sources
2) by reducing the costs of delivering the energy
3) by making the existing electricity generation more productive
4) by shifting power demand from peak to off-peak periods
5) by reducing the capital expenditures on systems that boost the rate of generation
6) by reducing the costs of dealing with supply interruptions
7) by reducing the GHG consequential costs such as "carbon taxes"

The first of these is huge in its own right (657 PJ/year, or 178 TWh/year) but any of the other six types of savings would also be sufficient to justify the expense of adding exergy storage to Ontario's energy supply system. The province is presently consuming 88 TWh/year of electricity. Storage would not reduce the consumption of electrical energy but it would make an extra 42 TWh/year available to drive the exergy heat pumps that, together with the 40 TWh/year of solar thermal energy plus the heat extracted from the other local energy sources would generate the overall total of 178 TWh/year.

What would the savings amount to for these seven contributors?

1) Natural gas would no longer be needed for either heating buildings or for providing peak power generation. Ontario presently consumes 1 Tcf of natural gas annually, nearly all of it imported. Using the National Energy Board estimate for the near-term future price of natural gas that gas is costing us 6.82 billion dollars per year. It could be almost completely replaced by the four sources of local energy that don't cost anything.

2) Hydro One provides nearly all of the long distance power distribution in Ontario, with revenues of 5.7 billion dollars per year. Local distribution companies (LDC's) handle the distribution in most cities, with 2009 revenues of 11.8 billion dollars from nearly 80 LDC's. The $17.5 billion/year revenue total includes both the transmission costs and the power supply revenues. Hydro Ottawa bills indicate that the "Delivery"costs are about the same as their "Electricity charges" so for a rough estimate we could use half of the total revenue, or about $8.7 billion/year, for the transmission cost. Most of the energy delivered in Ontario comes from natural gas, not electricity, and that too has a substantial distribution cost, including the cost of providing large gas storage facilities. For lack of the relevant data we might start with a similar transmission cost for natural gas ($8.7 billion/year), bringing the total transmission costs to $17.5 billion per year. If exergy storage was fully deployed in Ontario the natural gas distribution costs would disappear and the electricity distribution costs would be cut approximately in half because they are proportional to the power capacity, not the amount of energy being distributed. That would bring the eventual distribution costs down from 17.5 $B/y to about 4.4 $B/y, for a saving of roughly 13.1 billion dollars per year.

3) The unused generation capacity would generate an extra 72 PJ/year of electricity (19.5 TWh). Ontario Power Generation states that the cost of power generated by their own facilities is 5.7 cents per kWh and that from the other suppliers is 9.9 cents per kWh. OPG claims that they generate 60% of Ontario's power so the blended cost is 7.38 cents per kWh, bringing the value of the extra power to $1.44 billion/year.

4) The IESO price for electricity is extremely volatile (for the current week it has ranged from $400 per MWh to -$140/MWh (i.e., Ontario pays other jurisdictions to take it away)). A reasonable estimate for the value of the demand shift is to price it at the same amount as the value of the electricity. At that price the 85 PJ/y of shift demand (23 TWh) is worth about $1.7 billion/year.

5) In 2006 Ontario's installed generation capacity was 31,000 MW. By 2025 the LTEP calls for that to be increased to 40,000 MW, with relatively larger increases in the grid's transmission capacity because of the increase in the use of intermittent energy sources like wind and solar PV generation. The overall government capital expenditures for the coming decade appear to be of the order of $3 billion per year (the LTEP and other government reports are decidedly unhelpful in defining these capital expenditures). However, the government agencies like the OPA purchase large amounts of power from private companies like Bruce Power, independent hydro companies, wind farms, solar arrays (under both the FIT and microFIT contracts), special arrangements like the Samsung deal, etc., at contracted prices that provide an incentive for the supplier to spend their own capital. This adds a guesstimated $4 billion per year to the actual capital expenditure. Moreover the three natural gas suppliers are presumably spending a comparable amount of capital in extending the gas distribution part of Ontario's energy network, including new pipelines that will be needed to handle the forthcoming switch from Alberta to US gas. That brings the overall capital expenditure to something like $14 billion per year.

Exergy storage would reduce the peak generation requirement by 10,000 MW or more. That means that there is no need whatsoever to increase the peak generation capacity and a reduced need to spend money on refurbishing the existing generation facilities. Those that are expensive or that have drawbacks like excessive GHG emissions, etc., could be phased out, leading to a system that is both cheaper and safer.

The net effect is that most of the planned $14 billion/year in capital expenditures would be eliminated Note that this saving would be achieved immediately. There is no need to wait until the exergy storage systems are in operation because the exergy systems can be put into service much more quickly than any of the power generation facilities. The result should be an almost immediate reduction in power costs (subject to the approvals processes) to be followed by more reductions as the exergy storage facilities are built.

6) Floods, ice storms and other weather-related power disruptions sometimes bring the productivity of the affected regions to a halt, and climate change is aggravating that problem. Local energy storage provides a means of dealing with that problem, particularly in residential areas, where about 88% of the energy demand is for thermal energy. Meeting the need to provide most of the energy demand reduces the requirement to make up the balance via local generation or battery storage that much simpler. Ontario's GDP is $647 billion so for each day of the avoidance of such interruptions the cost saving amounts to about $1.8 billion.

7) There are many consequences related to climate change. The most important ones relate to our fundamental desire to survive in a world that is experiencing rapid environmental deterioration. The economic consequences are also material: the costs of adapting to the changes, the costs of repairing the damages, the cost of imposing management fees such as "carbon taxes" or Cap & Trade, etc. If we lump these consequential costs into a single bundle and value it at $50 per tonne of GHG (which is less than some "carbon taxes" presently in effect) then the 105 million tonnes of GHG attributable to Ontario's use of natural gas is presently costing us $5.25 billion per year.

The grand total for these seven savings is $44.11 billion dollars per year, less the $0.5 billion per year cost of building the exergy stores, bringing the net savings to $43.6 billion per year. Note however that nearly one third of that saving could be achieved almost overnight if Ontario made the simple decision to switch to the use of storage instead of relying on additional generation to meet its peak loads. Exergy storage systems are inexpensive and they can be built very quickly so right from the outset they provide a viable alternative to the reliance on more generation and the decision immediately removes the need to spend $14 billion per year on generating systems (5).

Slides

23 Sept/14 note. This is a first draft that employs values that may be replaced by more accurate data. Anyone who can contribute such data should send it to tolmie129@rogers.com

Addendum (5 Oct/14)

An individual building owner could build an exergy store and it would make a contribution to societal savings in proportion to its share of the overall capacity. If there were one million buildings that are sharing the benefits then that building's share would amount to one millionth of the savings generated by the seven mechanisms. If all of the million buildings built such stores then they would all reap a handsome profit but if only one store is built then the building owner would be responsible for 100% of the cost but would reap only 0.0001% of the economic benefits. To make things worse, that building owner would be switching from a cheap energy source (natural gas) to reliance on electricity to drive the heat pumps, with the currently predicted rise in the price of electricity making that option extremely unattractive.

If our intent is to accelerate both the costs of energy and the rate of climate change then all three levels of government in Canada are doing the right thing. They are investing in the means of making fossil fuels more efficient: carbon capture, efficiency, conservation, pipelines, transport regulations, fossil fuel resource development, etc., all of which encourage the use of fossil fuels but none of which contribute to the seven mechanisms that will be needed to switch over to clean, inexpensive and permanently sustainable energy sources.

Planners from all three levels of government frequently argue that renewable energy sources are too expensive so their use should be deferred until the world is in such dire straits that it will be obliged to use them. **Such claims are false.** The above analysis shows how an investment of $0.5 billion per year could result in cost reductions of $43.6 billion. However, some of the seven mechanisms can be evaluated with a good level of confidence in predicting their benefits while others can only be roughly estimated. For the latter it will be instructive to either establish lower limits for the savings or defer their inclusion until such time as the appropriate numbers are available.

1) Eliminating natural gas. The primary uncertainty in this case is the price of natural gas, which in the past has abruptly increased by about a factor of four. The figure of $6.82 billion per year is not likely to be low but the figure could easily be several times higher.

2) Transmission costs. These costs are periodically examined by the Ontario Energy Board on a piecemeal basis so a detailed examination of the submissions made to the OEB by the electricity and gas transmission agencies should produce more reliable estimates. Until then the savings value of $13.1 billion per year should be considered to be only a very rough estimate.

3) Electricity productivity. The blended cost of 7.38 cents per kWh will increase sharply (according to the LTEP) so the savings estimate of $1.44 billion per year is likely to be on the low side.

4) Demand shift. The value of savings that could be realized is to a considerable extent determined by the confidential contractual agreements made with some of the principal electricity generation companies. This ($1.7 B/y) should perhaps be deferred until better data is available.

5) Capital expenditures. As with 2) this could be examined by looking at the OEB data for both the electricity and gas supply systems.

6) Supply interruptions. A literature search should produce values for this. Its inclusion ($1.8 B/y) could be deferred until such values are determined.

7) Consequential costs. The IPCC has produced many reports on this issue. Based on that data the consolidated value of $50 per tonne is not excessive so the estimated savings of $5.25 billions per year is reasonable.

That leaves us with a total of $3.5 B/y that might be deferred until better data is available (for 4 and 6), $13.51 B/y that should stand "as is" (for 1, 3 and 7) and a grey area of $27.1 B/y (for 2 and 5) for which we know the potential savings are very large but for which we lack accurate data. That leaves us with the conclusion that the savings will be at least 27 times the investment, with the expectation that the ratio might well be more than three times as much. We should certainly try to fill in the blanks but the outcome is not in doubt - we could both save a lot of money and eliminate this part of the GHG contribution by employing exergy storage, but that would require collective action. It won't happen under the existing provincial and municipal plans.

The reform that is required is neither complicated nor expensive. The stores should be built by the electricity supply industry, who stand to reap most of the economic benefits (lower capital costs, reduced transmission costs, more efficient operation). The building owners would ultimately pay for the facilities via their purchases of electricity but they should not fund the capital cost of the stores even though they reap some of the benefits via the heating/cooling supplied by the stores. The new ROI to the electricity supply industry is ample so their main concern should be to persuade the building owners to switch to the use of exergy stores. Making such a switch would be a substantial undertaking for the building owners so the incentives for them should be the opportunity to enjoy lower power rates plus heating and cooling without the burden of bearing the capital costs. The Ontario government already has three agencies that manage the supply: OPG, Hydro One and IESO, so it already has the tools needed to manage such a reform.

23/10/2014

Note that the primary beneficiary of all seven of the savings components is the Ontario electricity supply system. The generators and the distributors reap nearly all of the economic benefits even though under present Ontario practices they do not contribute anything at all to the costs of building or operating exergy stores.