EB-2015-0166/0175 NEXUS pipeline 15 year approval
(Notice of intent to submit evidence)

In the transcript of the questions that I put to Enbridge I made numerous references to "exergy storage", all of which were converted to "energy storage" in the transcript. That indicates a failure on my part to adequately distinguish between the two terms. That difference is profound - it would be economically impossible for Ontario to use electricity to heat all of our buildings whereas they could very readily be heated using local sources of heat, employing a relatively small amount of electricity to drive heat pumps that would boost the exergy of the heat that is collected locally. The buildings can also be cooled with exergy stores, which also provide the heat for domestic hot water. Although descriptions of those extra capabilities are described in the science journal references that I had provided I had not explained them in my submissions to the Board.

The NEXUS project reflects a fundamental change in Ontario's energy supply. In the past we had relied on the Western Canada Sedimentary Basin for the conventional natural gas that we were (and at the moment still are) using but it is proposed that Ontario will switch to shale gas, primarily coming from the Marcellus/Uitica Basin in the US but with some shale gas also coming from Western Canada. Although it is poorly documented by the industry in its public reports the hydraulic fracturing process releases large amounts of methane that collects in the ground, creating a methane cloud that steadily increases in size and concentration over a period of decades (and centuries). If and when that methane cloud reaches the surface it could become the dominant source of GHG emissions attributable to Ontario's energy consumption. There is very little public information on the transport of the methane to the surface but it represents a significant risk that would be avoided if the OEB considers the safer and much less expensive option of using exergy stores to meet our needs for heating, peak power and supply/demand matching. Those are the purposes for which Ontario presently uses natural gas.

The problem is compounded by the fact that exergy stores concurrently meet two needs - the need to store both heat and electricity, so they impact the markets for both. Although the OEB is responsible for regulating both markets its hearings do not normally integrate their considerations. In this case, one of the LDC's (Hydro Ottawa) has applied to the Board for a revised price schedule so the exergy storage option has been proposed for that situation (see the OEB letter of comment below). The two technologies/markets are inextricably linked in this case.

I will try to present a more comprehensive explanation.

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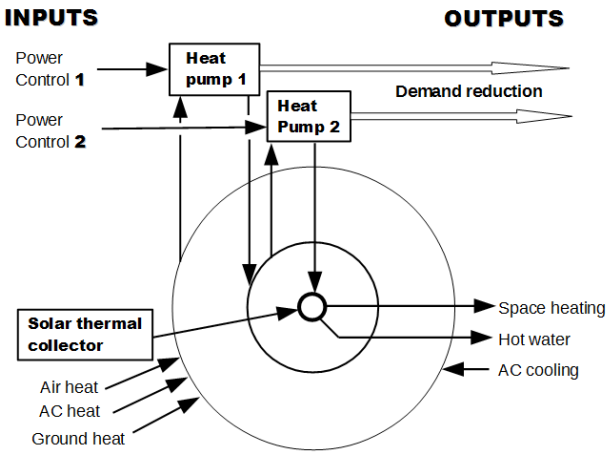
EB-2015-0004 How exergy storage could reduce energy costs

Hydro Ottawa has not responded to my letter to the OEB (added to the EB-2015-0004 database on July 20, 2015) so it appears that they are not interested in building exergy stores themselves. There is an alternative approach that could be used under which building owners would build the stores, thus achieving the same objectives of dramatically reducing the cost of electricity in Ontario, the level of capital spending, and the GHG emissions for which the Province is responsible.

Exergy stores are capable of inter-seasonally storing energy in two forms: heat and electricity. By storing heat (and cold) they could over time eliminate Ontario's dependency on fossil fuels for heating and cooling our buildings and for supplying their domestic hot water. Since the two annual electricity demand peaks are created by power used for those purposes the elimination of those demand peaks would reduce the peak power generation requirement by about 10,000 MW, setting up the potential for corresponding capital cost reductions. Since the buildings would primarily depend on local sources of thermal energy which would not need to be transmitted the transmission facilities for both electricity and natural gas could likewise be reduced, including the costs of new facilities like the proposed NEXUS pileline that is planned as a means of switching Ontario's gas supply from Western Canada to the Marcellus/Utica Basin in the US. (Such a switch will result in higher GHG emissions.)

The local thermal energy sources are the heat that can be extracted from the summer air, the heat that can be recovered from the ground throughout the year, the heat that is recovered from the building via cooling and solar heat that can be recovered with varying efficiency throughout the year. These sources of energy are almost completely neglected at the present time even though they are permanently capable of supplying 100% of the thermal needs of our buildings. For homes, that accounts for most of the energy consumption (88%). These energy sources are free, clean, stable and readily accessible but to utilize them you need to store the energy and you need to raise its temperature to a useful value (above 40 degrees C). Both tasks can be inexpensively and efficiently accomplished with an exergy store that consists of three circles of boreholes in the ground (Figure 1), using a pair of heat pumps to concentrate heat collected from the peripheral ring into the central ring. This form of concentration raises the temperature by boosting its exergy rather than by absorbing more energy so only a small amount of electricity is needed, thus ensuring that most of the energy delivered to the buildings comes from the local thermal sources, not the power grid.



Even though the amount of electricity that is needed is modest, the price of electricity has risen so rapidly in Ontario that such exergy storage systems are uneconomic, and since the price of electricity is projected to continue in its rapid growth pattern this unfortunate situation will just get worse. Fossil fuels are presently very cheap. Natural gas, for example, costs about 1.9 cents per kWh at source, so even though exergy stores extract most of their energy from free local sources the added cost of the electricity puts the total cost of the energy delivered to the buildings at a higher value. There are three linked solutions that could be implemented to deal with this problem:

1) Utilize the cheap power that is available during the middle of the night (but note that there is a caveat). The IESO price that the LDC's pay for electricity is always low and at some times of the year that price is negative (Figure 2). The price that consumers pay for electricity has two principal components: the charge for the amount of electricity consumed and the cost of delivering the service. The price set by the OEB for the nighttime power (8 cents per kWh) has no relationship to the cost of that electricity (which is essentially zero) so it is really just a tax that obstructs the potential to properly utilize the nighttime surplus.

2) Once the Energy Ministry and the OEB realize that the capital cost of new (and replacement) generation and distribution facilities is not needed the many billions of dollars that are currently being spent on such facilities will be saved. Note that this will happen quickly, resulting in a large cost reduction that is not dependent on a prior investment - all that is required is the grasp of the potential. The capital expenditures are predicated on the peak power expectation that determines how many reactors, power dams, wind turbines, etc. will be needed, and not on the MWh of energy consumed.

3) Use the storage potential to increase the MWh of energy that can be delivered by the existing generators. Ontario exports about 3800 MW of power at night at very low prices. This energy is virtually wasted at the present time but it could be put to good use in a system that provides storage. Moreover, the existing hydro dams (which are run-of-the-river dams that have little storage capacity) make poor use of the potential energy of the flowing water, which again would benefit from storage.

CAVEAT There are many systems available that can store nighttime power using either batteries or thermal storage but that are not capable of seasonal storage. Such systems do not reduce the seasonal peak power demands so they do not provide a useful solution, hence they should be excluded from any provision to use IESO pricing at night. Ontario does not produce enough electricity to support the widespread use of diurnal storage systems.

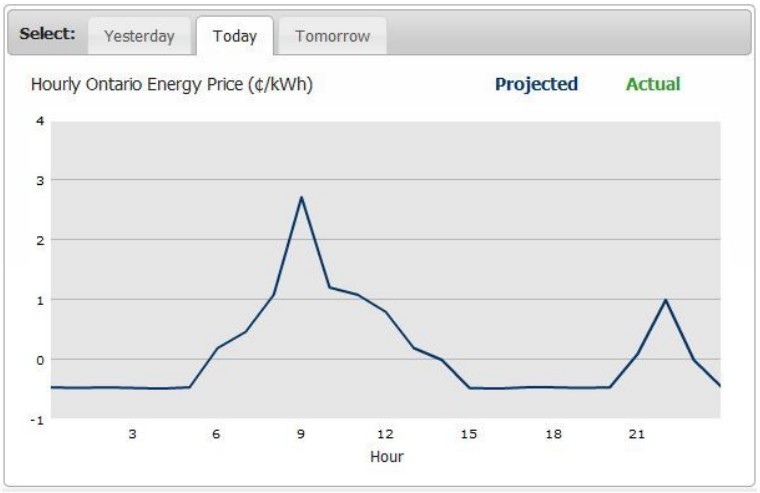


Figure 2

PROPOSAL

Hydro Ottawa and the OEB should provide a nighttime power rate equal to the IESO price for systems that are designed for minimal power consumption and that employ seasonal energy storage. The billings provide for separate cost recovery for the services provided by Hydro Ottawa (and the transmission companies) so there is no need for a markup on the electricity consumption price.

This proposal requires that Hydro Ottawa pre-approve the systems that would be eligible so there is a permanent means available for ensuring that the demand is kept within the bounds of the available nighttime supply capacity. The concept is scalable from a single building to covering all of Ontario's buildings, and exergy storage systems with their minimal power consumption could handle that entire range. They could even support an eventual phaseout of the nuclear power stations if some of the hydro dams installed turbines with higher ratings (to handle the high flow periods) and some use is made of the Hydro Quebec surplus of nighttime power.

The potential for both energy cost reductions and GHG emission reductions is very large, and the risks are very low.

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