August 31, 2016

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
PO Box 2319
Toronto M4P 1E4

Re: EB-2016-0152 OPG Inc. Application for Approval of 2017-2021 Payment Amounts

In its application OPA has requested that payments for its hydroelectric facilities should not be materially changed because they plan to stick with the status quo. However, a strong case can be made for adopting major technical changes to OPG's supply systems that would make those hydroelectric facilities much more productive, and such changes would as one consequence substantially reduce the need for nuclear power generation (or would alternatively generate surplus power that could be exported to the United States). We therefore agree with the Consumers Council of Canada that Issue 11.1 should read:

* is OPG's approach to IR for establishing the hydroelectric payment amounts appropriate?
* Is OPG's approach to IR for establishing the nuclear payment amounts appropriate?

We also agree with the Council's recommendation with respect to Issue 6.5:

* Are OPG's proposals related to the extended operations for Pickering and the impacts on the payment amounts appropriate?

and for Issue 11.3 the following question should be added:

* Are OPG's rate-smoothing proposals appropriate and in the public interest?

The OPG plans as they stand are deficient in considering Ontario's long term needs for power generation. Distributed energy supply systems would be capable of supplying the Province's energy needs at a much lower cost, would enable OPG (and Bruce Power) to reduce the number of expensive nuclear power stations, and would also eliminate the need for using fossil fuels to power peaking generators. While Bruce Power and the peaking plants may not fall directly under this application for regulated facilities the considerations are so completely interactive that they cannot be considered independently. For example, the target for power capacity is determined by the summer demand for power for air conditioning but that need would disappear almost entirely if distributed energy sources were used (see the Appendix for a technical explanation).

The use of a constant output supply system (the nuclear stations) creates a need for the peaking stations which could also be eliminated if we were to employ distributed energy supplies. Canada has undertaken to adopt whatever reasonable practices that are needed to meet the Paris Agreement objectives. Perpetuating the status quo for power would block that objective without offering any compensating advantages. In fact the staus quo cannot be maintained anyway because the traditional source of nutural gas is nearly exhausted and will soon need to be replaced by shale gas from the US, a supply that is likely to be curtailed in the future as explained in the Appendix.

All of Ontario's nuclear power stations are very old and will soon need to be retired. When that day comes Ontario will be in the same predicament as the UK is presently experiencing in selecting a new nuclear station design for Hinkley C - with a huge cost increment, a dearth of potential suppliers, a fundamentally new nuclear infrastructure, etc. We would suggest that OPG should be actively exploring the alternatives for both corporate and public reasons. Distributed sources such as exergy stores would enable them to start on a small scale and at very little cost and then expand the capacity at whatever rate proves to be needed. The is no upper limit in the energy supply capacity of exergy stores.

Yours truly,

Ron Tolmie
Sustainability-Journal.ca

Appendix

The following is a brief outline of exergy storage systems that was prepared for the Engineering Department of IESO.

Exergy storage: Suggested topics

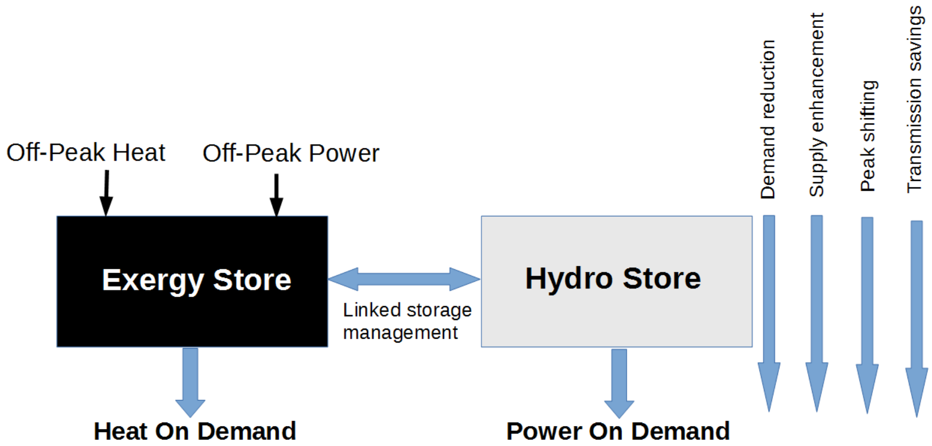
(1) Supply adequacy

This past summer has illustrated the potential for employing local energy storage very well. There have been many hot days for which the outer ring of a ground-based exergy store could have served as the heat sink for air conditioning systems, eliminating the present waste of electricity that drives air conditioning systems. For large buildings the heat extracted from the buildings in the summer could subsequently heat the buildings in the winter. For smaller buildings the substantial temperature difference between the local air temperature and that of the ground near the outer ring makes it easy to add whatever amount of additional heat is needed to provide heating during the winter. Both cooling and heating are scalable to handle any future population growth in Ontario.

Exergy stores provide a permanent solution for how we can heat and cool our buildings, and can be extended to provide domestic hot water as well. The total energy demand for those purposes in 2011 was 183,000 GWh for Residential and Commercial/Institutional buildings (NRCan Energy Database).

(2) "Black-box" performance

Exergy stores collect and store energy in the forms of both heat and electricity but the electricity is not recovered by converting heat back into electricity but rather by reducing the demand for electricity, by enhancing the output from existing power generators, by shifting the demand peaks and by re-purposing the existing storage capacity of the power dams. The "black-box" diagram illustrates how this can be accomplished:



The exergy store accumulates both heat and exergy (which contributes the power) at times when they are plentiful and the store returns both the heat and the electrical benefits according to the fluctuations in demand. The demand reduction and the supply enhancement (and the reduction in transmission losses) have the same effect on the power grid as might be achieved by expanding the power generation capacity - but no new generators need to be built.

For 365 days a year Ontario's electricity demand fluctuates in a consistent fashion, with a deep drop in power demand between the hours of midnight and 6 AM (the period during which the exergy store heat pumps operate). This fluctuation is presently mostly handled by employing ponding storage in Ontario's power stations but since the demand dip is reduced by the demand of the heat pumps and the peak demands are reduced by the reduction in the power demand for thermal applications the ponding storage can be rededicated to new applications. The system is thus capable of coping with varying supply from sources like wind turbines as well as varying demand, which would eliminate problems like excess nuclear power being generated at night.

This diurnal storage capability is accomplished along with the seasonal storage capacity that would enable Ontario to store summer heat for use in the winter and to store electricity generated during the spring river runoff. Intermittent energy sources such as those from windy or rainy days could likewise be stored for later use.

(3) Demand peak shift vs. providing over 30,000 MW of peak power

Ontario's current assumption is that the power generation system must meet the maximum potential demand, but a large part of that demand serves thermal needs (cooling, heating, DHW). If you relieve the thermal needs then the daily and annual demand fluctuations become much flatter, and that flattening can be further enhanced by controlling the timing of the demand. Instead of needing 30,000 MW of generation capacity that figure could be cut in half, with a consequent large reduction in the cost of the generating facilities.

(4) Exergy store costs

An exergy store basically consists of 8 boreholes with heat exchange tubes (identical to millions of existing ground heat exchangers used for GSHP’s) and conventional heat pumps that operate at conventional temperatures and power ratings. As noted they provide five large scale economic benefits for which the cost per MW (or MWh) is much smaller than the cost of the currently favoured alternative of adding new generation to meet demand. For the near future the nuclear generation stations exist and most are being considered for a last round of refurbishments so an alternative that might be considered would be for Canada to export electricity to the US, bearing in mind that Quebec and Manitoba would also make their generation facilities more efficient if they employed exergy stores. Exporting energy in the form of electricity might be just as profitable as the export of fossil fuels.

If Ontario used local thermal energy instead of natural gas then in addition to reducing the thermal demands for gas by 183,000 GWh the province would also reduce the peak electrical demands by about 31,000 GWh (2011 data).

The cost of expensive components like the NEXUS and Rover pipelines could be avoided. The 15 billion dollars in planned expenditures for transmission facilities would likewise be avoided, not to mention much of the 26 billion dollars in planned expenditures for reactor refurbishments.

The savings in electrical and gas transmission lines plus the savings from peak shifting would be much larger than the capital costs of the exergy stores so the benefits of the demand reduction, the enhanced generation and new electricity storage would all be gravy. Potentially residents could enjoy radical reductions in the costs of both power and heat, and Ontario's economy would be much stronger as a result.

(5) Obstructions

The primary costs of exergy stores are the operating cost, which consists mainly of the cost of the electricity needed to run the heat pumps, and the capital cost of the stores. The wholesale price of the nighttime electricity is virtually zero but that power is subject to a "tax" of about 14 cents per kWh. The merits of applying such a huge tax for nighttime power in the face of the extremely low prices for natural gas are highly questionable.

If a building owner were to build an exergy store that owner would get the thermal energy from the store but none of the five electrical benefits shown in the black-box diagram. All of those benefits would go to the various agencies that make up the regulated power generation system in Ontario. The obvious solution would be for the power companies to build the exergy stores and to leave the operating costs to the building owners (but with a more rational price for nighttime power).

These obstructions in both the operating costs and in the capital costs are the direct result of failures in Ontario policies. The province could readily provide all of its heat and power from local resources and at much lower costs if more rational policies are adopted.

(6) Environmental considerations

Exergy stores could quickly eliminate the need for peaking power stations (powered by natural gas and oil) and over a longer period the use of fossil fuels for heating could also be almost completely phased out. Ontario presently has no plan that is capable of meeting its 2050 target of an 80% reduction in GHG emissions. Some elements of such a plan will be very difficult to meet - there are no serious alternatives for airplanes and some industries need fossil fuels for chemical reactions or for high temperature applications - so the rational 2050 target for power and buildings should be as near zero as possible. The key points to be made are that such reductions for those two sectors are entirely feasible and that they offer the potential to save many tens of billions of dollars in the process.

Canada (and Ontario) have undertaken to adopt all reasonable measures that might contribute to holding the global climate change rise to as close to 1.5 degrees as possible. Ontario is in the process of switching to fracked gas that will release a large amount of unrecoverable methane that is presently just ignored by governments and the natural gas industry. That problem is compounded by the Ontario government's practice of also ignoring the upstream fugitive emissions from the stream of recovered gas plus the use of an incorrect GWP value for the methane in the gas. It would be impossible for Ontario to meet its obligations under the terms of the Paris Agreement if it continues its present practices (and would probably be impossible even if it continues to grant such huge loopholes in reporting to the gas industry).

The "too big to fail" argument applies not just to banks but to the shale gas industry as well, especially in the US. However, once it is realized that shale gas is not a viable source of energy it is likely that the US will restrict the production of such gas, particularly for non-US users. We can avoid the dangers of such a situation by using local thermal energy as an alternative, and as noted above that might also create a potential large export market for Canadian electricity.

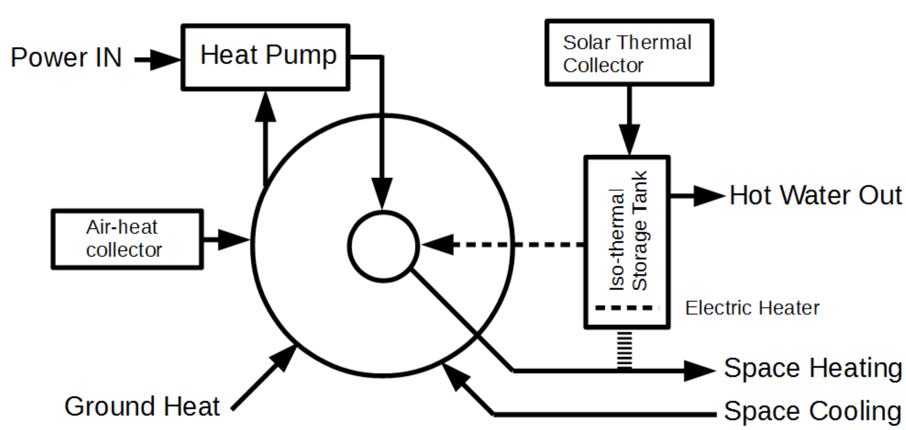
(7) Sustainability

Even supporters of natural gas refer to it as a "bridge" energy source - something that we will use only until something better comes along. Given some changes in government policies local thermal sources provide a better option, especially in Canada (where we need a lot of thermal energy and we already have a lot of complementary hydro power).

The sustainability of nuclear power in Canada is debatable. Canada as a whole already produces more than 60% of its electricity from hydro sources, and if it widely employed exergy stores then the five electricity supply features would enable the existing hydro stations to meet all of Canada's near term needs for electricity, with the potential for employing irregular sources like wind turbines being enhanced by the storage functions for the more distant future. We could certainly get along without any nuclear power. Considering the shift to nighttime power transmission such a change does not imply that Ontario might be vulnerable to problems arising from imports from Quebec and Manitoba.

System design

There are various designs that can be employed, depending on the size of the buildings, the local generation facilities, the comparative feasibility of installing the solar collectors, etc. The following is expected to be the most common configuration in Ontario:



The spacing between the rings must be great enough so that heat injected into the inner ring does not reach the outer ring until after the air conditioning season is over. The heat pumps operate only between midnight and 6 AM but power can be absorbed at any time as needed via the electric heater in the iso-thermal tank. Any excess energy (after the heat of fusion capacity has been met) is fed to the inner ring and this also handles any excess solar input. Some heat is withdrawn from the iso-thermal tank to regulate the building heating loop. The rings normally require only four boreholes per ring but more may be needed for high power applications. The storage capacity can be varied by altering the depth of the boreholes or by increasing the size of the inner ring while retaining the spacing between the rings. The diameter of the borehole field is about 5 metres. The heat pump operates in all four seasons: to acquire heat in the summer, to boost the exergy of the stored heat in the fall, to maintain the heating capacity in the winter and to recover to the starting temperatures in the spring. So long as the direction of heat flow around the periphery is towards the center no heat will be lost via the periphery. The solar thermal input (a conventional solar collector) compensates for the extra consumption of electricity, provides a higher temperature for hot water, regulates the heating loop and provides peak energy during the late winter period.

The design details are less significant than the evaluation of the potential of the general concept so the starting point should be the consideration of the black-box diagram.

Previous related papers by Ron Tolmie

1) with Dr. Marc A Rosen, **Exergy Storage in the Ground**, 3rd World Sustainability Forum (2013)
http://www.sciforum.net/conference/wsf3

2) with Dr. Marc A. Rosen, **A Dual Function Energy Store**, Sustainability, ISSN 2017-1050,
http://www.mdpi.com/journal/sustainability (2014)

3) with Dr. Marc A. Rosen, **Split Exergy Storage Systems**, The International Symposium on Energy Challenges and Mechanics, Inverness, UK, (July, 2016)

4) **Linking Hydro and Thermal Storage**, (in process) Journal of Modern Power Systems and Clean Energy (2016)

5) **Smart Grids vs. Storage Management**, Int. Journal of Process Systems Engineering (2015)
http://www.inderscienceonline.com/doi/abs/10.1504/IJPSE.2015.071433

6) with Dr. Marc A. Rosen, **Storing Energy in the Ground: An Effective Use of the Environment**, Research Journal of Environmental Sciences (2015)
http://scialert.net/current.php?issn-1819-3412

7) **Sustainable, Resilient Municipal Energy Systems**, 7th World Wind Energy Conference,
St. Lawrence College (2008)

8) **Concentric Ring Heat Exchangers**, GeoExchange Coalition/CANSIA workshop, University of Toronto, (January, 2013)

9) **Using Heat Storage for Electricity Demand Management**, Canadian GeoExchange Conference, Simon Fraser University, Burnaby, BC, (2013)