EB-2016-0152 OPG 2017-2021 Payment Amounts
Dec. 16, 2016

In its Dec. 13 reply submissions to motions brought by Environmental Defence (ED), Green Energy Coalition (GEC) and School Energy Coalition (SEC) and to the Dec. 9 submission of the OEB staff OPG has made the assertion that "**The Cost and Availability of Alternative Generation Sources Is Not Relevant to Any Issue in This Proceeding**" (Page 5). The OPG argument is that only the Energy Ministry has the authority to choose what mix of energy sources are to be used in Ontario. The problem with that argument is that over the past decade the overwhelming thrust in the development of energy sources has been the shift to widely dispersed renewable energy sources. There have been no major developments in centralized power generation stations. Indeed the six Pickering reactors are scheduled to be permanently removed from service either in two years' time or over the coming seven years and there is a high probability that all of the Darlington reactors will be permanently taken out of service instead of being refurbished with the possible exception of Unit 2, which is currently being refurbished without waiting for the OEB to approve whatever payment rates might be appropriate. As the nuclear plants are taken out of service they will be replaced by local sources of energy that will be less expensive to buy and operate, are much safer, and are better with respect to their GHG emissions. Most of those local sources will be built by the energy users, not the Energy Ministry or its agencies. The OPG nuclear operations are likely to be phased out, and should be terminated as quickly as possible because their disadvantages outweigh their advantages. The OEB will not be called upon to decide what mix of sources will prove successful, but the Energy Ministry will not make that decision either. It will be made by the people and organizations that use the energy and build the local supply systems.

Sustainability-Journal.ca has been developing one of the candidates for that future role (described in the Appendix) so it provides one basis for comparison with older alternatives like the Pickering and Darlington stations. Nuclear stations cost tens of billions of dollars to build and billions of dollars to operate and refurbish thereafter. The payment rates per GWh for the S-J type of system are easy to define - they are zero. The consumer has to build the S-J system (called an exergy store) but the interest costs for such systems are substantially lower than the cost of purchasing natural gas and/or grid power so it is highly likely that the market will continue to shift towards such local facilities and away from nuclear power. OPG has not provided any comparative cost data so they have not provided the Board with a basis for anticipating future costs (and hence payment rates).

Barring any major failures like Chernobyl, Fukushima or NRX the existing nuclear stations will presumably continue to function for the next few years so the "need" for producing at least some power from Darlington is not in question. However, nuclear power is arguably not going to compete with the local energy technologies which suggests that the off ramp provisions of the OPG plans for Units 1, 3 and 4 should be assumed to be the basis for the payment amounts in this review. The question could be revisited as the end of the present term approaches (2021).

In the Conclusion of its Notice of Motion Environmental Defence cited a cost for Pickering through the test period of 7.5 billion dollars and suggested that the OEB-approved payment amounts might be capped at the cost of the least expensive alternative. Approximately 7,500 MW of power could be produced by exergy stores for that amount of money, providing more power than Pickering would deliver and for a period of many decades instead of just a few years. Exergy stores provide energy in two forms, thermal and electrical and they are designed so that they reduce both the building's electrical and thermal demands to zero (and they also provide for storing electricity to enhance hydro power sources).

Exergy stores can only save electricity in situations in which they also save heat. The two forms of energy are inherently linked. If the OEB approves the payment amounts that have been requested by OPG then the refurbishments will proceed, the public will pay the price, and the potential for utilizing options like exergy storage will be blocked. Ontario has undertaken to reduce its GHG emissions in accordance with the Paris Climate Change Agreement but that objective will be very expensive (and might be impossible) if the dual storage technology is blocked. While reducing GHG may not be a direct responsibility of the OEB in this application it is a priority issue in Ontario's energy policies.

Sustainability-Journal.ca supports the motions of ED, GEC and SEC.

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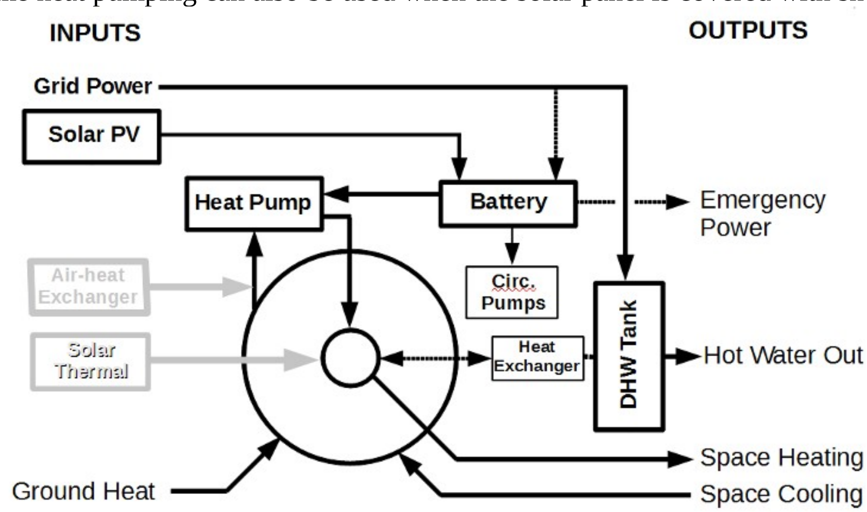
Appendix

Standard Exergy Store

It is anticipated that the most common configuration for exergy stores will be as shown in Figure 1. Since the core of an exergy store is trickle charged through all four seasons of the year and the charging process can be interrupted for many days if the sun isn't shining this is an ideal application for using a small solar PV panel to drive the heat pump, making the system independent of both natural gas lines and the power grid (with net metering). The power grid will still be used for non-building applications like cooking, laundry, etc. The exergy storage system is able to absorb and store excess electricity so it will make hydro, wind, solar and nuclear power supply systems much more efficient. Since the solar PV panel will deliver extra electricity during the summer the system can equalize the seasonal solar input by storing that extra energy and drawing some grid power during the winter. That both reduces the size of the store and provides a higher operating temperature for winter space heating. Exergy stores can be retrofitted to old buildings.

In some cases the solar input is not feasible so the heat pump can be run at night from grid power. In such cases there is still no consumption of peak power, no need to use electricity for air conditioning and there is still the enhancement of the capacity of hydro stations, etc., so such systems will still make big contributions to the power grid. Nighttime heat pumping can also be used when the solar panel is covered with snow.



Fully Off Grid Systems Systems that need to operate completely off grid will look like Figure 2 (our Testbed system in Kingston) with both solar PV and solar thermal collectors on the roof. Solar thermal collectors have much higher efficiencies than solar PV collectors so in this type of system they enhance the electricity supply capacity by more than solar PV collectors would. However, off grid systems will require large electricity storage batteries so they will be relatively expensive to build.

Enhancements Systems that have very high thermal loads or that need to handle grid power spikes can utilize isothermal buffers that use paraffin wax for heat of fusion storage. Similarly, buildings that need high cooling capacity in the summer can utilize buffers that use water as the heat of fusion storage medium. Applications that extract excessive amounts of heat from the ground can use summer air-heat exchangers to replenish the ground heat. By starting from a standard system design the various models will generally share the same components and will share the same design procedures. The physical size of the components will vary according to the required system capacity.

How does it work?

An exergy store has three basic components: an inner and outer ring of boreholes containing heat exchange tubes and a heat pump that extracts heat at a low temperature from the large outer ring and concentrates the heat in the smaller inner ring. Moving the heat adds only a small amount of energy. The central zone will be at a much higher temperature because it contains the same amount of energy in a smaller volume - in physics terms its exergy has been raised, hence the name 'exergy store'. The velocity of heat flow out of the core is slow so the outflow does not reach the outer ring until the fall, making it possible to use the outer ring for cooling in the summer. The heat pump operates in all four seasons, collecting heat in the summer, boosting the temperature of the stored heat in the fall, replenishing some of the heat that is extracted from the core in the winter, and bringing the temperatures back to their starting point in the spring. The stored heat and cold are used directly for space heating and cooling without assistance from a heat pump.

Conceptually this provides a means for cooling buildings in the summer, heating them in the winter and providing domestic hot water throughout the year. In practice the system may need some help - in the summer the temperature of the heat pump's input loop can be stabilized by adding heat extracted from the air and throughout the year heat can be injected into the core via a solar thermal panel to reduce the power demand of the heat pump. Since the heat pump operates whenever power is available throughout the year and its power demand is very low compared to that of a GSHP a small solar PV panel can provide the power. The panel will generate more power than is needed in the summer and that excess electricity can be fed to the grid via net metering. In the winter the grid will supply the needed power but the heat pump runs only at night so it never draws any power from the grid during high grid demand periods.

The results for homeowners (and commercial/institutional buildings) are:

***   the net power demand can be reduced to zero**
***   the system does not require any fossil fuels or produce any GHG**
***   the system can provide 100% of the heating, cooling and DHW of the buildings it serves**
***   the cost of the heat and of the electricity that the system itself draws is zero (but the buildings will use electricity for other applications so they will continue to draw power for those needs)**
***   the capital cost (per MWh) of such systems is much less than the costs of existing gas and grid power systems but there is a need to establish procedures that assign these capital costs to the relevant authorities (i.e. not to put the funding burden on homeowners)**

Exergy stores also provide major benefits to the electricity supply systems:

***   the power demand could be cut in half because much of the grid demand is used for heating, cooling and DHW**
***   the exergy systems draw no power at all during peak demand periods but they can optionally draw large amounts of power at night, thus flattening the daily demand graph**
***   the exergy stores can optionally utilize excess power produced by the spring runoff, after rainfalls, or on windy days to increase the energy production of exiting power generation systems**
***   the pond storage capacity of existing hydro power stations can be reassigned to serve the other power applications**
***   the losses and the costs of the energy distribution systems can be reduced**

Individual exergy stores provide these benefits but they are all shared by the collective energy users so the store builders realize only a tiny fraction of these collective benefits. There is thus a need to establish a procedure to assign both the capital and operating costs to the appropriate beneficiaries. For example, the local power distribution companies (LDC's) or the IESO might build the stores and the OEB/IESO might reduce the Global Adjustment rate to exergy store users to recognize the benefits to the grid. As an interim measure each City might utilize the existing provisions for Local Improvement Charges (LIC's) to spread out the capital expenditures for the homeowners. The reduction in gas and grid power costs and a reduction in the Global Adjustment would immediately reduce the existing annual costs for homeowners even though they would still over time be paying for the capital costs of the installations.

Potentially exergy stores could be using local thermal energy sources on a scale that would enable all of Canada to rely on just the existing hydro power generation facilities for many decades to come, without having to rely on nuclear power, expensive building changes, carbon taxes, subsidies or elaborate national and provincial Climate Change plans. More details on the system design are available in the paper "Compact Exergy Storage Systems".

Exergy storage solves two problems - eliminating GHG and reducing energy costs