Attachment 2 - The Issue of Storage of Electrical Energy:

One can hardly open the news without finding another article about how the problem of intermittent renewable wind and solar generation has been solved by storage. In October a "Review of Ontario Interties" issued by the Independent Electricity System Operator and Ontario Power Authority led off saying, *"The province has now transitioned to a new resource supply mix, including shutting down coal-fired facilities, building modern natural gas facilities and increasing its reliance on renewable energy, conservation, storage and demand response."* The Ontario Long Term Energy Plan notes, *"Energy storage has significant potential to help Ontario modernize its electricity system."*

Even "The Economist" had a three page article in Dec. 2014 headed, "Grid-scale energy storage" and after a discussion of storage options concluded *"… cost of running a grid, and thus the price of electricity will fall."* It is not often that I find myself responding to an article in that prestigious journal, but that week I felt compelled. I include my comment to them here, as it summarizes the issue.

"Smooth operators" (The Economist Technological Quarterly Dec 6, 2014) glosses over fundamental issues leaving readers with unrealistic expectations.

The article speaks of grid-scale energy storage capabilities but describes storage capabilities in terms of 500 to 700 kWhr. That is about what a typical grid serving a population of 12 million consumes in one quarter-second. We read the battery plant "should be able to turn out 16.2 GWhr-worth" of batteries in a year. So, in slightly over 1000 years of full production they will be able to match one-tenth of the grid annual usage. (Not considering battery replacement needs.)

We read in the article that "the answer is to store surplus wind and solar on the grid." An example helps explain what this means. Today, 4135 MW of wind and solar (capability) in Ontario produce less than 4% of Ontario's electricity needs, even with contracts that guarantee access to the grid (and payment if not needed by the grid). In contrast, that amount of nuclear capability produces 20% of Ontario's electricity needs. (Total nuclear actually meets about 60% of needs). The difference is greater in that baseload generation is available 24/7, while wind and solar vary both daily and seasonally not matching need. To have enough wind and solar to supply both annual energy and system peak needs would require building the generating capability to have an instantaneous capability about 4 times what any day peak needs, and then to have a storage capability able to absorb nearly as much to store excess during grid low demand periods to be available to fill in the production valleys. That storage capability would need to be able to transfer the excess not just daily, but seasonally.

If we add in electric transportation, the needs increase further. We must be realistic as decision makers guided by your article would lead to commitments in generation and storage costs far exceeding GNP.