Smart grids vs. storage management

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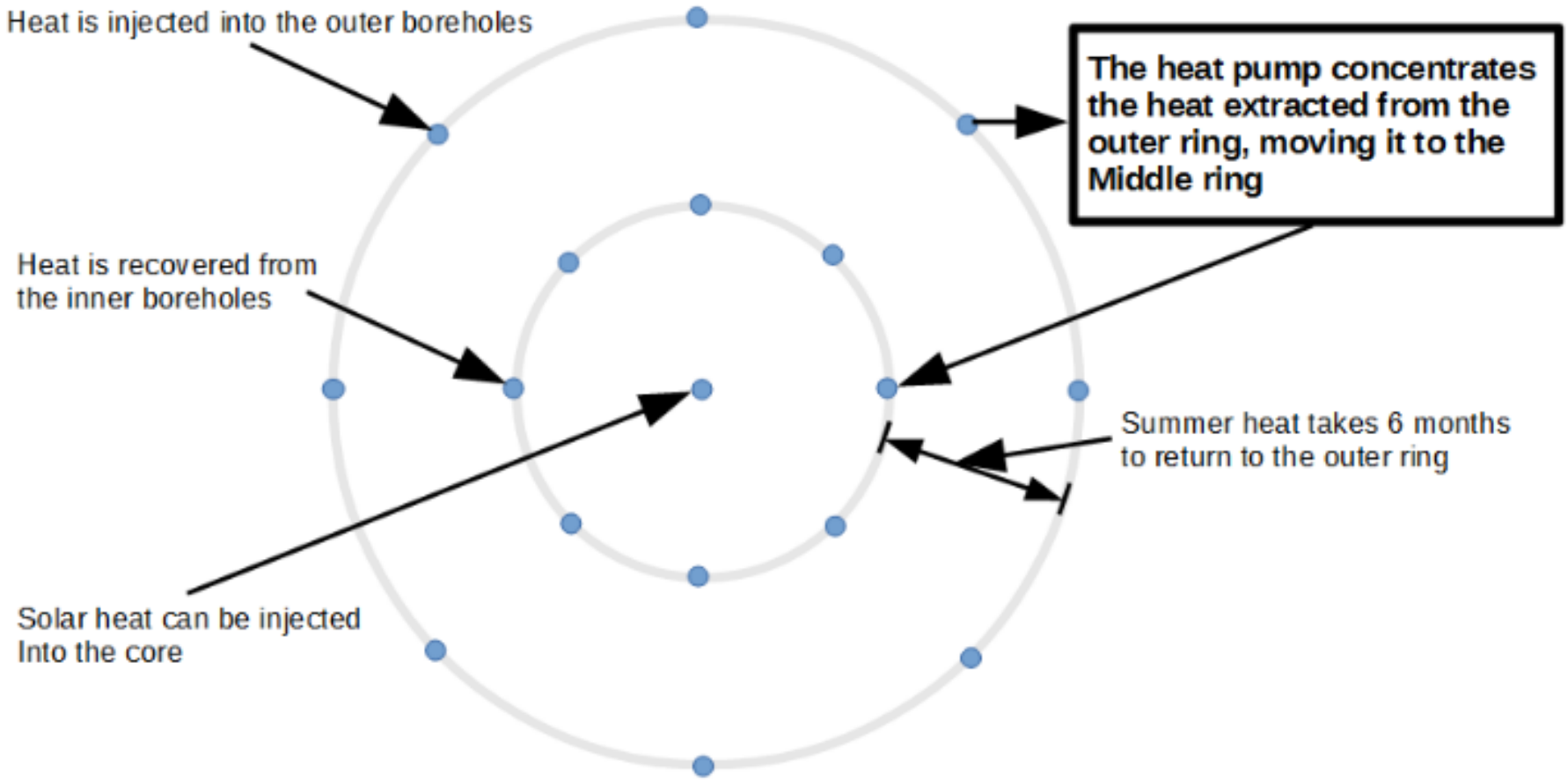
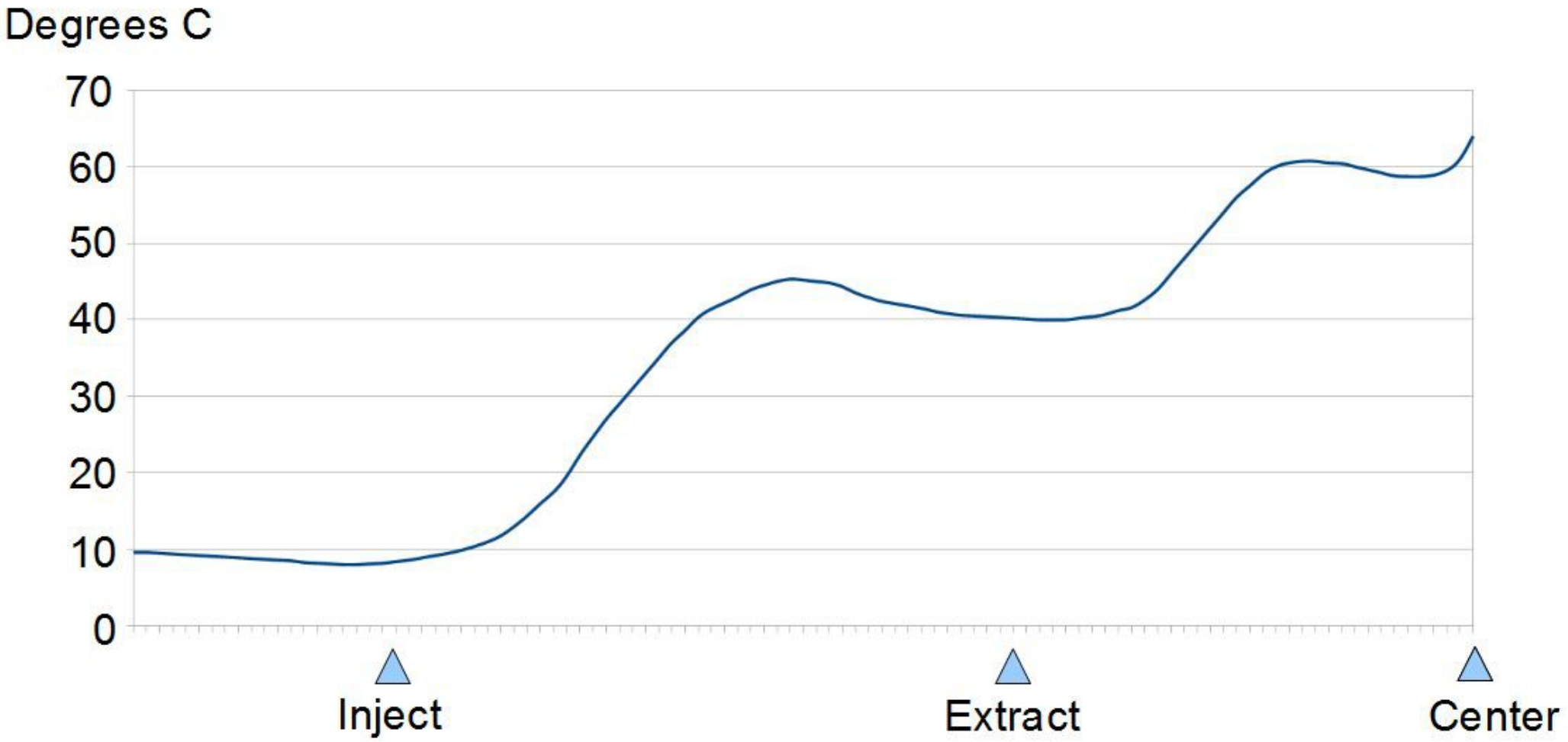
(1) Could storage replace peak generation?
(2) Are local energy sources adequate?
(3) Is the ground storage capacity adequate?
(4) Which choice is less expensive?
(5) Which produces less GHG?
(6) What are the barriers to the use of storage?

(*see the final slide for the answers*)

Figure 1 **Exergy Store. Two rings of boreholes surround the central (solar input) borehole. The heat pump concentrator extracts heat from the peripheral ring, and injects it at a higher temperature into the middle ring. Various sources of heat can be used to replace the heat that was extracted from the peripheral ring, setting up a cycle that can be repeated daily.**



Top view of a 17 borehole exergy store (typical dia. 24 m)


Degrees C
70
60
50
40
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Inject
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Figure 2 **Exergy stores shift the power demand away from peak demand periods to periods of excess supply (mostly at night). The stores can be designed to store heat at the temperatures that are needed for space heating and cooling and for DHW.**

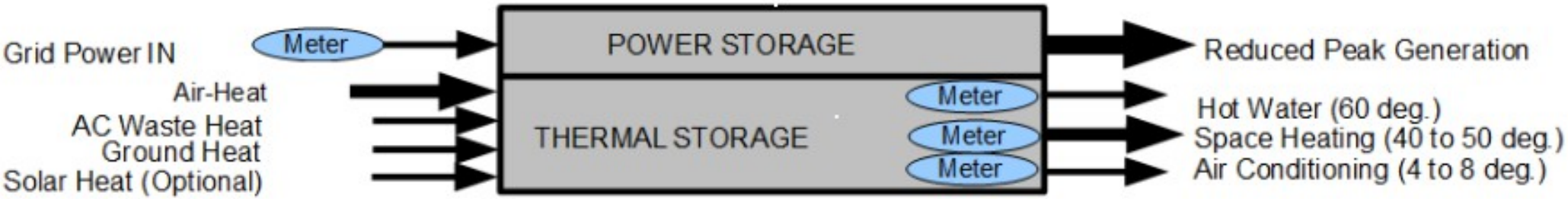


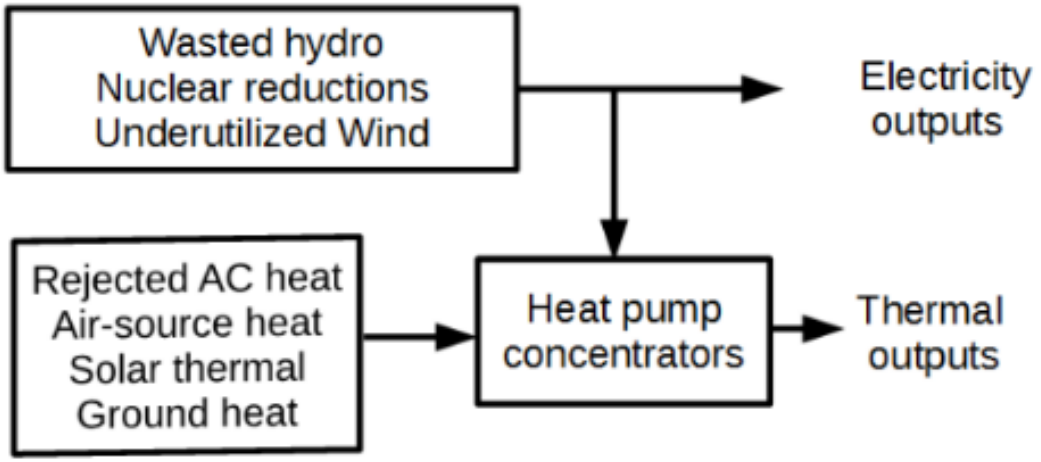
Table 1 ***The electricity consumption in Ontario in 2011 for thermal applications in the Residential and Commercial/Institutional Sectors***[8]

Application and building type	PJ/year
Electricity used for heating in residential sector	36.4
Electricity used for heating in commercial/institutional sector	14.5
Electricity used for cooling in residential sector	16.1
Electricity used for cooling in commercial/institutional sector	31.9
Electricity used for water heating in residential sector	9
Electricity used for water heating in commercial/institutional	2.3
Total electricity used for thermal applications in 2011	**110.2**

Note: The total electricity consumption for all applications was 326.6 PJ/year.

Table 2 ***The total energy consumption (including natural gas) in 2011 for the building sectors***

Application and building type	PJ/year
Total energy used for heating in residential sector	339.6
Total energy used for heating in commercial/institutional sector	119
Total energy used for cooling in residential sector	16.1
Total energy used for cooling in commercial/institutional sector	33.9
Total energy used for water heating in residential sector	110.2
Total energy used for water heating in commercial/institutional sector	38.3
Total energy used for thermal applications in 2011	**657.1**



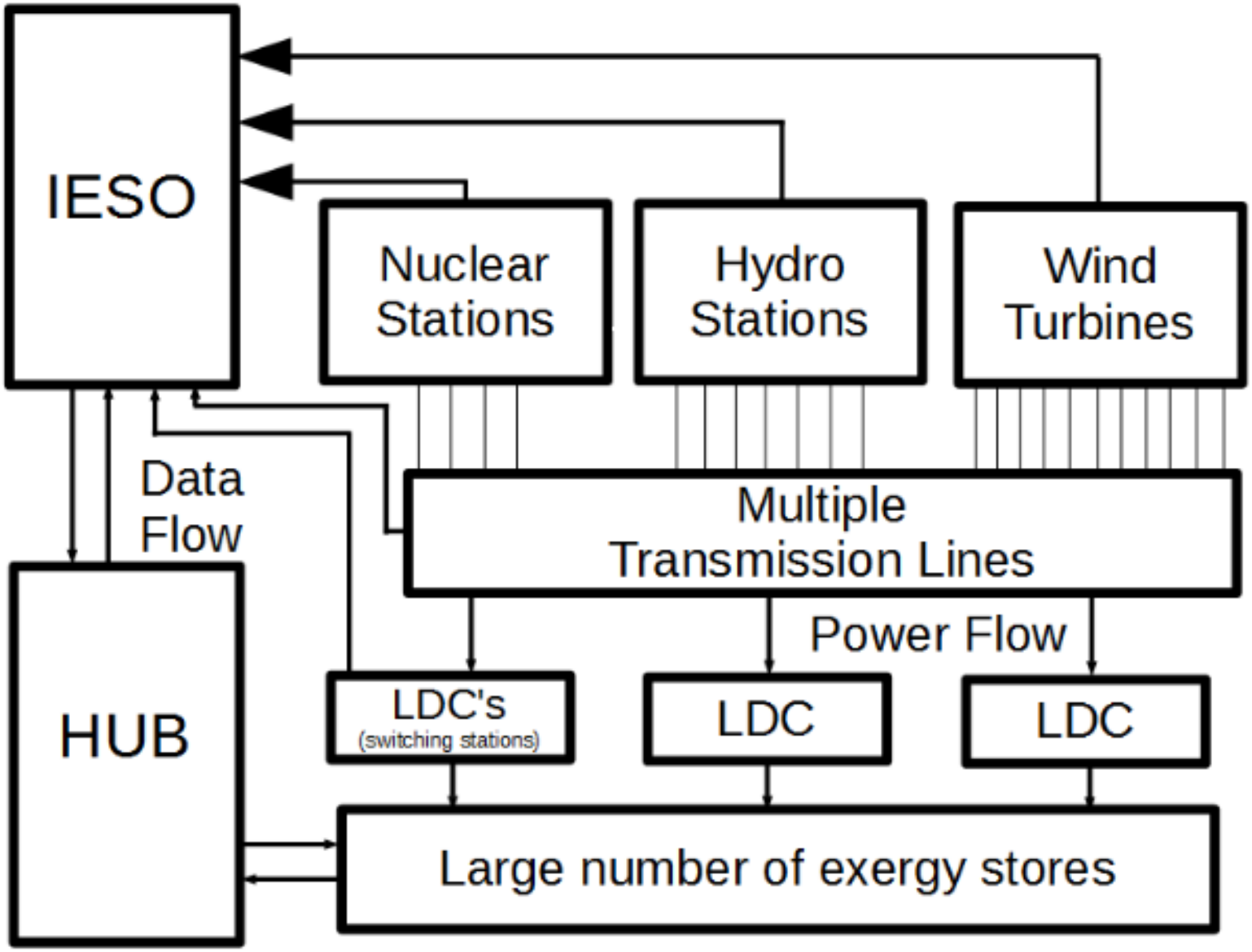
Unused electricity generation capacity in Ontario	**72 PJ/year**
Capacity that could be shifted from peak to low demand periods	**85 PJ/year**
Total	**157 PJ/year**

Residential and Commercial/Institutional thermal energy demand	**657 PJ/year**
less: solar heat used for DHW	**149 PJ/year**
less: solar heat redirected to space heating	**149 PJ/year**
Net heat to be pumped by heat pump	**359 PJ/year**

Minimum COP required for heat pumps = 359/157 = 2.3

The ground storage capacity in Ottawa is approx. 6,000 petajoules

Figure 4 **Block diagram of the power and data flows for a storage control system**



Smart grids vs. storage management - ANSWERS

(1) Yes, exergy storage could replace peak generation
(2) Yes, the local energy sources could provide sufficient thermal energy
(3) Yes, the storage capacity is more than adequate
(4) Probably, storage is arguably less expensive
(5) Yes, storage plus local energy would reduce GHG emissions
(6) The current barriers are substantial (knowledge, policies, support)