Notes re. The Role of AE systems

Data from the Office of Energy Efficiency tables (NRCan)
2006 Ontario Energy sources for residences:

Electricity	30.3%
Natural gas	60.5%
Heating Oil	3.9%
Other	5.3%

Ontario Ministry of Energy and Infrastructure (Nov/08 web site news)
Ontario supply mix for electricity

Nuclear	14,000 MW
Hydro	7,795
Coal	6,434
Oil & gas	5,103
Wind & other	593
Total	33,930

The Ontario Power Authority Application to the Ontario Energy Board (Aug. 29, 2007) can be found here. The proceedings have been stayed for a period of six months at the request of George Smitherman, the Minister of Energy and Infrastructure for Ontario.

A report prepared for the OPA concerning Ontario's wind power potential is available here. It shows a total capacity for the Province of 628,000 MW, but most of that is located north of the 50th parallel. The usable amount depends on many factors, most notably the ability to store the collected energy. Storage methods include pumped storage, heat storage, hydrogen storage and chemical storage. The method assumed for the figures below is to use short term thermal storage (less than one hour) combined with hydro power to effectively achieve the equivalent to pumped storage. That also increases the "live" utilization factor to a value greater than 17% and makes long distance transmission more practical. An unknown factor is the potential for large scale use of solar energy (PV or concentrating collectors) which are also subject to developments in the means of storing the energy. (Note. It is often forgotten that mostly we use energy in the form of low grade heat – the subject of this review - which can easily be stored for long periods)

Data for Graph A (Ontario residential energy sources)

Natural gas & heating oil for heating	64.4%
Natural gas & coal for electricity	10.3%
Nuclear	12.4%
Hydro	7.0%
Wind	1.5%
Other	4.4%
AE systems	0
*AE load levelling, conservation	0
*Wind (southern Ontario)	0
*Wind (northern Ontario)	0
*New imports (hydro sources)	0
*New hydro (northern Ontario)	0
*Stored wind & solar	0
*Recovered from waste products	0

Data for Graph B (Ontario residential energy sources)

Natural gas & heating oil for heating	0
Natural gas & coal for electricity	0
Nuclear	12.4%
Hydro	7.0% (consolidated 11.3%)
Wind	1.5% (consolidated 4.5%)
Other	4.4%
AE systems	64.4% (consolidated 67.4%)
*AE load levelling, conservation	3%
*New Wind (southern Ontario)	2%
*New Wind (northern Ontario)	1%
*New imports (hydro sources)	2.3%
*New hydro (northern Ontario)	2%
*Stored wind & solar	0
*Recovered from waste products	0

Data for Graph C (Ontario residential energy sources)

Natural gas & heating oil for heating	0
Natural gas & coal for electricity	0
Nuclear	0
Hydro	7.0% (consolidated 13.3%)
Wind	1.5% (consolidated 13.9%)
Other	4.4% (consolidated 5.4%)
AE systems	64.4% (consolidated 67.4%)
*AE load levelling, conservation	3%
*New Wind (southern Ontario)	4%
*New Wind (northern Ontario)	4%
*New imports (hydro sources)	2.3%
*New hydro (northern Ontario)	4%
*Stored wind & solar	4.4%
*Recovered from waste products	1%

Ontario Energy Association
Comments re. OPA IPSP Paper 4

New hydro potential (northern Ontario)	2,200 MW
New wind potential (see caveats)	5,000 MW
Available wind capacity	17%
Existing natural gas & oil power gen	5,103 MW
Planned natural gas & oil	11,000 MW
Existing coal	6,434 MW
Planned coal	0
Future Imports	1,250 MW

Graph A shows the present energy sources for residences
Graph B shows the sources if fossil fuels are phased out for both home heating and power generation
Graph C shows the sources if nuclear power is also phased out

The values for Graphs B and C show what is potentially achievable and are not predictions of the actual utilization which will depend on factors like government policies, the cost of oil and natural gas (which

is currently plummeting) and the emergence of manufacturers and installers for AE systems. There is therefore no time scale associated with those graphs. The energy consumption for buildings used for commercial, industrial and institutional purposes should follow a comparable pattern.

Ontario's population has been growing at the rate of 1.32% per year. By the year 2050 the population will be 2.2 times larger than in 1990 (the reference point for dealing with CO2). If we want to meet a target of a reduction to 20% of the per capita greenhouse gas production then we will need to reduce the overall per capita CO2 production to 7% of its present (2008) value. It is easier to make large reductions in the buildings sector of the economy than in industry or transportation so the implication is that we really need to think in terms of eliminating CO2 production altogether in this sector, not just reducing it by some average factor..

Using stored wind power enables the wind generators to deliver more power immediately and also to deliver constant stored power as an additional energy source

AE system both remove most of the demand peak load for air conditioning and provide for demand shifting (load levelling) on both a seasonal and diurnal basis, reducing the peak demands

If both new hydro and new wind resources in the north are utilized then they can balance one another and they will share a power trunk line to the south.

The solar contribution is hard to predict but might be more substantial

New agreements for hydro power have been signed with Manitoba and Quebec since the OEA submission.

Since cases B and C both use power sources that do not generate CO2 or air pollution the indirect generation of pollution by systems that use the ground as a source or store for heat is eliminated for those cases..

The broad intent for AE systems is to provide systems that can be used anywhere (given a seasonal temperature difference), for any type of building, and for any density of population. That requires the design to be tailored for various applications and for various ground types. For example, the ground may have water flowing through it, in which case some or even all of any injected heat may be carried away by the water. In that case, the water is also bringing heat TO the boreholes so the system will continue to meet the heating objectives. The systems can in fact utilize up to seven sources of heat:

(1) heat collected in the summer and stored
(2) heat extracted from the air and used immediately. This is useful in areas having mild climates, like Vancouver or the southern US, where the system can operate like an air-source heat pump and needs only minimal ground storage
(3) heat collected from ground water, including “half and half” situations
(4) heat collected from the ground, as with a conventional GSHP, again in combinations
(5) heat stored in aquifers, in which case the system becomes an ATES
(6) electric heat injected into the ground. Useful for systems that have been installed too late in the year to inject summer heat. Off peak electric power will soon cost 2.7 cents per kWh vs. 9.3 cents for daytime power. An inexpensive fix for unanticipated problems.
(7) waste heat from wind-thermal generators that store heat seasonally, and can also store energy for short periods to maintain continuous power, and that can deliver both heat and electric power on demand and without interruption. Particularly attractive for the far north

Since the homeowner can control the amount of heat injected in the summer it is easy to adapt to such unexpected ground conditions by adjusting either the amount of heat injected or the timing of the injection if the thermal conductivity is unusual. In exceptional cases off peak electric heat can be used, although that is primarily intended to make it possible to install such systems at any time of the year.

The end result is that AE systems can be used almost anywhere.

In 2006 Canadian homes used 1072 petajoules of energy for space heating, cooling and hot water (OEE) and commercial/institutional buildings used 709 petajoules, for a total of 1781 PJ for those two sectors. At a price of 10 cents per kWh that works out to $50 billion per year, providing an estimate of the value of the heat that could be delivered by AE systems.