# Sustainable communities

A previous note summarized the energy needs of a typical Ontario home that consumes 30,000 kWh of energy per year. Natural sources of energy could provide 25,340 kWh, inviting the question: "Could our homes be completely energy self-sufficient?"

Ontario has 4.6 million residences that consume 528.1 PJ of energy (of all types) per year so the average is 31,900 kWh per residence. The application breakdown is as follows:

| | |
|---|---|
| Space heating | 20,097 kWh |
| DHW | 5,902 kWh |
| Cooling | 670 kWh |
| Other | 5,231 kWh |
| TOTAL | 31,900 kWh |

**Home totals** In Ontario the residential consumption of energy is (Stats Canada data for 2009):

| | |
|---|---|
| Space heating | 63.0% |
| DHW | 18.5% |
| Cooling | 2.1% |
| Other | 16.4% |

Let us choose a solar thermal panel that delivers 1.5 times as much power (15 kW) as a standard microFIT Solar PV panel and the proportional amount of energy (12,000 kWh) and design the heat store so that 20% of the space heat comes from natural ground heat (i.e. 4,019 kWh) bearing in mind that the ability to trap the heat is dependent on ensuring that the direction of heat flow is always towards the collectors. The air-source provides the balance of the heat: 25,999 kWh total heat less the ground heat contribution (4,019 kWh) the solar heat contribution (12,000 - 5,550 kWh = 6,450 kWh) and the heat pump's drive consumption at an assumed COP of 4.0 (6,500 kWh) for a net contribution of 9,030 kWh. That results in a total annual energy collection of:

| | |
|---|---|
| Ground heat | 4,019 kWh |
| Solar heat | 12,000 kWh |
| Air-source heat | 9,030 kWh |
| Solar PV energy | 8,000 kWh |
| TOTAL | 33,049 kWh |

Technically the 8,000 kWh from the Solar PV installation would be fed to the grid in order to collect the microFIT fee and the power for the house would be drawn back from the grid, but for this calculation we are only concerned about the net energy flow.

The "other" category for energy consumption accounts for 5,231 kWh (mostly electrical). If the heat pump drive energy is 6,500 kWh then the total power consumption is 11,821 kWh, or 3,821 kWh more than the 8,000 kWh provided by the Solar PV generation. Homeowners should do what they can to reduce their power consumption in this "other" category but in any event it should always be possible to completely eliminate the residential consumption of fossil fuels and also reduce the consumption of electricity in homes.

Many homes use electricity for nearly all energy needs, including home heating and DHW. In those cases the reduction in electricity consumption will amount to a whopping 31,900 kWh - 3,821 kWh = 28,079 kWh. In Ontario only about 23% of homes use electricity as the only energy source with the balance using natural gas (or heating oil) together with some electricity but the savings in electricity for those homes is so large that it more than compensates for the incremental electricity used in homes that switch from natural gas to the stored energy option. Moreover, the reductions occur during the periods of maximum electricity demand in Ontario so they would make it possible to close down the coal and gas-fired power generators, thus eliminating the buildings-sector GHG emissions altogether. In Canada as a whole hydro power is our principle source of electricity so there is no point in reducing our reliance on that source below the existing hydro capacity.

**Other considerations:**

**Large buildings** Large buildings primarily need cooling rather than heating so if they switch to the use of storage for heating and cooling that frees up a huge amount of electricity for other uses. Some buildings employ absorption cooling, but such systems consume a large amount of natural gas and they also pose a hazard (Legionnaires' disease from that source has claimed eight lives and made 106 people sick in Quebec in the past week).

**Energy from garbage** Plasma systems can convert garbage to power and a glass-like waste so they could be an effective source of renewable energy in the form of electricity.

**Electricity imports** 68% of the homes in Quebec use electricity for space heating and DHW. Most of that power comes from Northern Quebec and Labrador, which means that the power transmission capacity is restricted by the long transmission lines. By flattening the demand peaks and increasing the nighttime electricity consumption the existing facilities would be able to handle millions of additional customers.

**Design considerations** Since the primary loads for both heating and electricity are caused by the space heating requirements there is room for major improvements. For example, if the ground store is held at a high temperature the heat pump "lift" can be reduced with a corresponding reduction in power consumption. Theoretically that component could even be reduced to zero (as in the Okotoks example) but that would entail some major tradeoffs in other factors like system costs. The heat pumps themselves can be improved. The use of buffers to stabilize the operating temperate can improve the efficiency, etc.

**Size considerations** A house that is substantially larger or smaller than average will primarily differ in its heating requirements. If the heating demand is 50% larger then the annual residual energy (electricity) demand will rise from 3,821 kWh to about 6,320 kWh. If it is 50% smaller then the residual would fall to about 1,320 kWh.

**Choice of energy source** Many homes are shaded by trees or other buildings or are precluded from using solar PV and thermal collectors for various other reasons. For those homes the air-source becomes the primary source of renewable energy. Systems that call for storing cold rather than heat will also rely on air-source collectors. In many such circumstances large nearby buildings provide a useful alternative for heat, and in some cases for cooling as well.

**Geographic variations**

Most Canadians live in a narrow latitude belt close to 45 degrees latitude so the above values provide a good starting point for calculating the loads for all Provinces.

As you move further North the advantages of using stored heat become progressively greater because the heating demand rises while the cooling demand is smaller. In that case systems that utilize large storage fields become particularly attractive because the ground temperature can be close to to "room temperature", minimizing the power demand of the heat pumps.

Similarly, as you move South you reach a region where the optimum design injects cold into the ground in the winter, again reducing the power load during the season that has the greatest power demand (the summer).

**Note that in geographic locations that have relatively uniform temperatures throughout the whole year thermal storage systems do not provide a useful solution.**

Return to Index
http://sustainability-journal.ca