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Energy Efficient Buildings Around the World

IEA Task XIII activities

Fourteen countries are designing, building and monitoring low-energy residential buildings as part of the International Energy Agency's Solar Heating and Cooling Program - Task XIII. Canada's study building is the Advanced House built in Brampton in 1989.

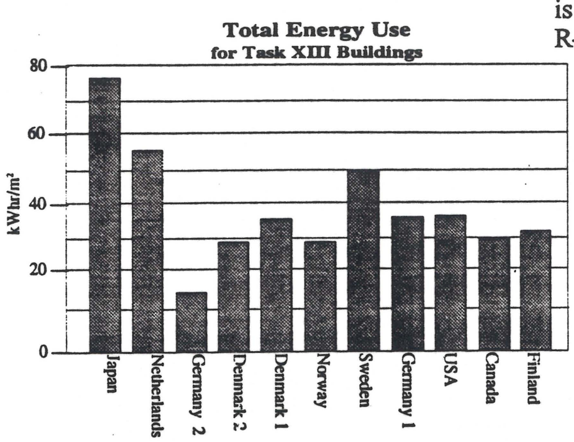
Although the houses are located in widely differing climates there are many similarities in design. All, except Canada's, are modestly sized with an average floor area of 130 m² (1400 sq.ft.). All except Japan's, are superinsulated. All use high performance windows mostly facing south. Air-tight building envelopes with mechanical heat recovery ventilation systems are common to all.

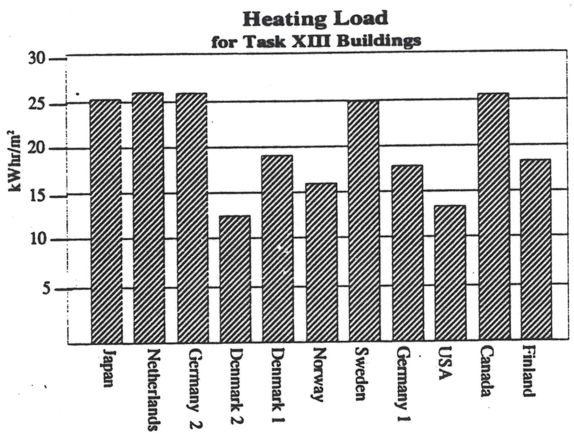
Many of the designs have small functional sunspaces. The Canadian and Dutch designs temper ventilation air in this space; the Norwegian design uses the sunspace as an entry airlock.

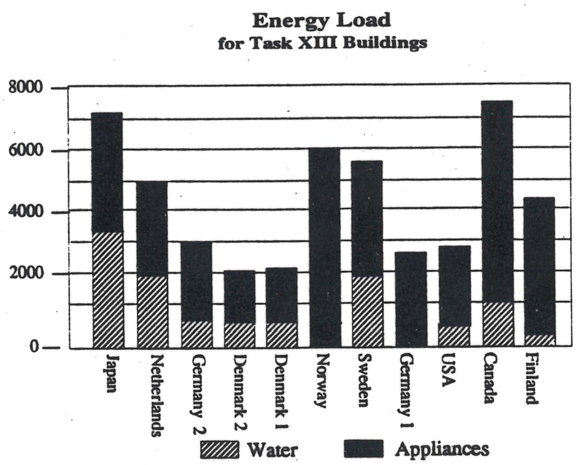
Heating systems vary with the predominant heating source. Most of the European buildings are connected to district heating systems; Canada, Finland, Japan and Norway use electrical heat pumps. Canada and Norway heat DHW with heat pumps; all other designs use solar DHW heating systems.

The total energy consumption, energy load, and heating load for the eleven buildings is summarized in the tables. Energy use is not climate dependent as one might expect. In addition, in very low energy houses the energy draw from pumps and fans is often a high proportion of total energy use (25% in the Canadian house).

The predicted total energy consumption of seven of the buildings falls within the 30 to 36 kWhr/m² range. The German *Ultra-Haus* uses an active solar heating system with seasonal storage to supply all the space and DHW heating load, to result in a predicted annual consumption of only 15 kWhr/m². The high







energy use of the Japanese house is due to a relatively high appliance energy use combined with the high DHW heating load - Japanese use twice as much hot water as Canadians. However, the average annual energy consumption of the IEA buildings is only 39 kWhr/m² which is one third the consumption of an average R-2000 home. The ten Canadian Advanced houses now nearing completion have an average consumption of 49 kWhr/m².

The energy use for hot water heating and appliances including lighting and fans in the Canadian house has an estimated load of 7200 kWhr. Though high in comparison to other buildings (except Japan's) this still is a significant reduction from the average Canadian home use of 13,000 kWhr (5,000 kWhr for hot water and 8,000 kWhr for other electric loads).

Innovations

The Norwegian row house has an integrated mechanical system with an air-to-air heat exchanger and a heat pump heat recovery unit. Recovered heat from exhaust air is used to heat DHW and meet space heating needs. A photovoltaic system supplies one third (2,000 kWhr) of the building's total electric load.

The Dutch building incorporates a 6 storey high, vented and shaded sunspace which connects three small apartment blocks. This sunspace preheats ventilation air for individual suites, virtually eliminating frosting in the heat exchanger. A high efficiency air to air heat exchanger provides extra heat for ventilation air tempering.

The German sunspace is fitted with sophisticated, water cooled, active solar shading blinds. The blinds are composed of tubular solar collector fins which are white on one side and selective surface on the other. Water is circulated through the tubes to supply DHW needs and to cool the blinds. At night the blinds are closed and heat loss is only 1.69 W/m² /°C (same as triple glazed windows with low-e coating). In summer the white side of the blinds is turned out to reflect most of the solar gain, water keeps blinds cool, and the inward facing selective surface reduces radiative heat gain to rooms. This system is superior to all other interior shading systems and has results similar to exterior venetian blinds without the associated problems.

The Swedish design incorporates hollow core floor slabs as a combined heating and cooling system. The home is slab on grade, insulated above and below the hollow core slab, with a low-temperature hydronic floor heating system in a thin slab on top of the insulated assembly. The hollow cores act as a 70% efficient air-to-air heat exchanger and carry supply and exhaust ventilation air. A hydronic coil tempers incoming supply air so it is always warmer than -4°C.

The flow pattern in the floor can be adjusted by the homeowner to control fresh air entering each room. No additional heat is required for supply air, since it never drops below 13°C. In the hydronic system, supply water at 30°C meets space heating needs. The water circuit is then split into two: one circuit for ventilation air preheating and one for domestic hot water heating. The low return temperature of 10°C can be supplied by a low-temperature source, such as active solar or industrial waste heat.

Innovative Housing '93

This international conference on energy efficient and environmentally responsible housing in Vancouver, B.C. June 21-25, 1993, co-sponsored by EMR and CMHC with the support of CHBA and the International Energy Agency (IEA) has attracted delegates from over 30 countries that include builders, manufacturers, researchers, planners, designers, policy makers and regulatory officials.

It will be the international forum for the exchange of new ideas about innovative residential building technologies.

Register for the conference by contacting:

Innovative Housing '93 Conference
c/o Events by Design
#601 - 325 Howe St.
Vancouver, B.C. V6C 1Z7
Tel: (604) 666-9193
Fax: (604) 669-7083

Letters to the Editor

Sir,

I was surprised, but not unhappy, to see an abstract of the CMHC report "Hard-Ducted Make-up Air for Ventilation" (SOLPLAN REVIEW No.47, Oct/Nov 1992). It obviously has stirred-up some discussion.

I would like to make it clear to your readers that I did not write the abstract nor have any knowledge of your intent to publish it prior to publication. There is always a danger of a reader misinterpreting statements that may be out of context because of the need for brevity when condensing a 47 page report to one page.

I would like to respond to Mr. Bowser's comments and HRAI's letter of endorsement, both published in SOLPLAN REVIEW No 48 (Dec/Jan 1992), as they are based upon misconceptions and significant errors.

One part of the project involved a field study of furnaces installed in 2 year old houses to see if hard connection of fresh air ducts to furnace return air systems were causing premature corrosion of heat exchangers on naturally aspirated furnaces. This study was conducted in the spring of 1991. At that time nearly all houses of that age were equipped with conventional naturally aspirated gas furnaces - the report and terms of reference refer to spillage susceptible furnaces with standing pilots. Mr. Bowser's criticism that now all new gas furnaces sold in B.C. and Ontario are mid efficiency types is true, but irrelevant, as the study was conducted in early 1991 when that was not the case.

Mr. Bowser criticizes the fact that the report discusses the 13°C return air temperature requirement to avoid condensation in ductwork and furnace heat exchanger rather than the 15.5°C limitation of one manufacturer of mid-efficiency furnaces - he calls it a glaring error.

Nonsense! The report did not address the 15.5°C limitation because it was not in the terms of reference and not an issue at that time. Mid-efficiency furnaces were very new. I believe Lennox was the first and only manufacturer to raise a concern, and that was not documented until early in 1992. Other manufacturers have been slow to follow Lennox's lead and add this limitation in their warranty and installation manual as has Lennox. Thus I do not believe the lack of a discussion of a limitation set by one manufacturer one year after the study was conducted is a "glaring omission". The terms of reference only related to concerns of rusting of conventional gas furnace heat exchangers due to condensation of water vapour contained in basement air.

Mr. Bowser states that the discussion of mixed air temperatures was based upon calculation only and that there were no measurements and no field observation is also incorrect. A reading of the complete report would plainly reveal this is not true.

The air flow in the fresh air duct was measured with a calibrated hot-wire anemometer and the total air flow through the system was determined using a temperature rise test and calculation similar to that provided by George Pinch of B.C. Hydro in the Dec/Jan 1993 issue. This is the standard and probably most accurate and practical method of measuring air flow in a large rectangular duct. Since we knew the return air temperature of the house, the only calculation that was required was the mixed air temperature in the return air duct based upon outdoor design temperature. The calculation is based upon accepted industry methods, also included in the HRAI Residential Air System Design Manual, and should provide very accurate indications of mixed air temperatures.

In addition, a special test house with temperature, pressure and flow sensors located throughout the ductwork and house, continually computer monitored for approximately two weeks was also used. This provided mixed and delivered air temperature information under a variety of conditions that would be expected to occur in a normal home. The results from the test house verified the accuracy of calculated mixed air temperatures, though that was not in the terms of reference. The air temperature at the air intake, all through the duct work, the furnace and at the register was recorded and reported, contrary to Mr. Bowser's letter.