# The ENERGY SHOWCASE Project

David Olivier

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## *Summary*

- The project is named after a 1980 project in Canada. To recognise the lead set by Canada - followed by USA, Sweden and Denmark - in work on energy-efficient and solar-heated buildings after the oil crises of 1973 and 1979.

- A 110 $m^2$ detached "cottage" on a rural 1,300 $m^2$ plot, constructed on a standard self-build budget. The site had detailed planning permission for a replacement dwelling. This consent was amended to permit the rear façade to face due south.

- The building will eventually produce all its energy from renewables, mostly solar, as follows:

  Passive solar space heating;
  An experimental solar water heating system;
  Solar electricity for ventilation, lights & appliances;
  Biofuels for cooking.

# View of the North Roof

A “catslide”. Clad in reclaimed, mostly purple Welsh slates. Fixed with Belgian stainless steel slate hooks and stainless steel screws. Gives a more secure fixing than nails in high winds. Permits the better re-use of very old but sound slates.

Two rooflights, of an experimental design. The larger one is above the house stairwell; the smaller one is above the porch.

The outer portion of both lights comprises a single pane of toughened glass, an oak frame and a stainless steel flashing.

# View of the South Roof

Clad in ten toughened glass panels:

(a) Four panels contain photovoltaic cells for electricity generation.

(b) Two panels are blank.

(c) Four panels will comprise part of the solar water heating system.

The glazing bars between the panes are stainless steel. This has a lower embodied energy than the more common aluminium bars.

The lean-to greenhouse adjacent to part of the ground floor is to be constructed.

# External View of the Windows

Made by Thermotech Ltd. of Ottawa, Canada, who have been producing very high-performance glazing since 1991-92. Krypton-filled, double low-emissivity, warm-edge triple glazing, in insulated pultruded fiberglass frames. Very low frame profile, seen in elevation. Higher passive solar gains than the majority of today's European-made energy-efficient windows.

# Some Views of the Interior

*Left* - The staircase, clad with green Lake District slate. The solid balustrade is topped with blue sandstone offcuts. The hall floor is clad with orthogneiss offcuts. *Right* - The kitchen floor, clad with granite offcuts from a kitchen worktop manufacturer. Had this material not been salvaged, it would have gone to landfill. So would another 70 $m^2$ of stone which is used elsewhere, internally and externally.

Note: Views of the construction site, which may not fully reflect the appearance of the finished house.

# Space Heating Energy Use

- House heated mainly by passive solar and internal gains. Minimal space heating system installed. Predicted standard of thermal comfort; e.g., hours below 20ºC, on a par with a normal UK home with a conventional heating system.
- Factors contributing towards this goal:

(a) High thermal insulation;

(b) Very draughtproof construction, around 0.4 air changes/hour at 50 Pascals;

(c) Mechanical ventilation with heat recovery, including an earth-buried tube to preheat fresh air in winter and precool it in summer, with novel techniques to augment the winter preheat;

(d) Windows on the south façade which gain more heat than they lose, even in a grey and gloomy southern English winter;

(e) Very high thermal capacity;

(f) Other site-specific techniques.

- Dynamic computer modelling used historic Kew weather data. Since cross-checked with other more local temperatures and solar radiation data in the Meteorological Office’s records.

# Water Heating Energy Use

- A novel, building-integrated solar water heating system on the second floor within the slope of the pitched roof. Directly-fed by pressurised water, with medium-term heat storage. Construction of the system is underway.

- System design based *inter alia* on pioneering work by solar engineer Norman B Saunders in Weston, Massachusetts, USA from 1965 to 1990. His research and practice was popularised by the physicist William A Shurcliff, of Harvard University, Cambridge, Massachusetts. Also informed by work on the Self-Sufficient Solar House at the Fraunhofer Institute, Freiburg, Germany from 1988 to 1996.

- Aims for a solar fraction in the 90s%, to avoid the need for major use of stored fuel; i.e., LPG or in future bio-DME. Hot baths in winter?

# Electricity Use for Lighting

- Extremely energy-efficient lighting.. House initially uses ~95% fluorescent lighting and 5% LEDs, concealed by appropriate shades / luminaires.
- Efficacy in lumens per watt (lm/W) including control gear = 100 lm/W for “eco” T5 fluorescent lamps, 40-75 lm/W for compact fluorescent lamps (CFLs) and 12-20 lm/W for GLS lamps and halogens. LEDs achieve 40-60 lm/W if they are sized to give adequate light near the end of their life.
- Appropriate shades/luminaires with efficiencies (LORs) in the range 70-90% instead of more commonly 30-70%.
- Overall target = Same visibility, lighting electricity consumption seven times less than the UK average of ~1,000 kWh/year in a dwelling this size.
- Contributes to the near-term imperative of “keeping the lights on”. Also helps a small PV system to supply as much electricity as a house needs, on an annual average basis.

# Energy Use for Cooking and Domestic Electrical Appliances

- With extremely energy-efficient electrical appliances and ventilation.
- Estimated electricity generation = 1,020 kWh/yr, estimated consumption = 900 kWh/yr. For instance, the fridge-freezer proposed for use in the house uses 129 kWh/year as opposed to a typical 500 kWh/year.
- The house is connected to the national grid. In the long term, PV as used here is expected to be just one of many different renewable electricity sources contributing to the UK national grid.
- Fossil propane for cooking, approx. 500 kWh/yr, until equivalent biofuels; e.g., DME, www.biodme.eu, are available in the UK. Residual $CO_2$ emissions offset by on-site $CO_2$ sequestration measures. Note that a combination of *clean* fossil fuel combustion and biomass $CO_2$ sequestration is less environmentally-damaging than small-scale wood combustion and is set to have lower net GHG emissions over the next 25 or 50 years.

# Electricity Use for Ventilation

- Mechanical ventilation and heat recovery (MVHR) system based on energy-efficient fans, a low pressure drop ductwork system, generously-sized silencers and particle filters. Estimated efficiency 84/92/96% at high/normal/low airflow.

- Site-built air-to-air heat exchanger of recycled glass tubes, formerly used in an East Anglian maltings. Very low pressure drop versus equipment on the market, including systems certified for “Passivhaus” buildings.

- Displacement ventilation, to give higher ventilation efficiency and higher internal air quality per unit of fresh air intake.

- Earth preheating tube for intake air, based on prior experience in, *inter alia*, Germany and Switzerland. Two novel features incorporated to give a higher level of winter preheating, especially in “coldwaves”, and improved summer cooling performance in heatwaves.

- Projected specific fanpower around 0.15 $Wh/m^3$ or one-third that of Passivhaus-certified MVHR systems (0.45 $Wh/m^3$) and one-tenth that of normal to poor UK systems (1.0-2.0 $Wh/m^3$).

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