CIBSE Conference 2012

Review of Renewable Heating Systems
in a
Residential Retrofit Project

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The Plan

FRONT VIEW OF HOUSE : PRE-REFURBISHMENT

To install low-energy systems in an existing 1971 four-bedroom House in Killiney, Co. Dublin

The Challenge

REAR VIEW OF HOUSE : PRE-REFURBISHMENT

The existing house was poorly constructed, with hollow block external walls and a mixture of concrete block and timber stud partitions.

A single storey kitchen and garage was located to one side and a single storey extension to the rear.

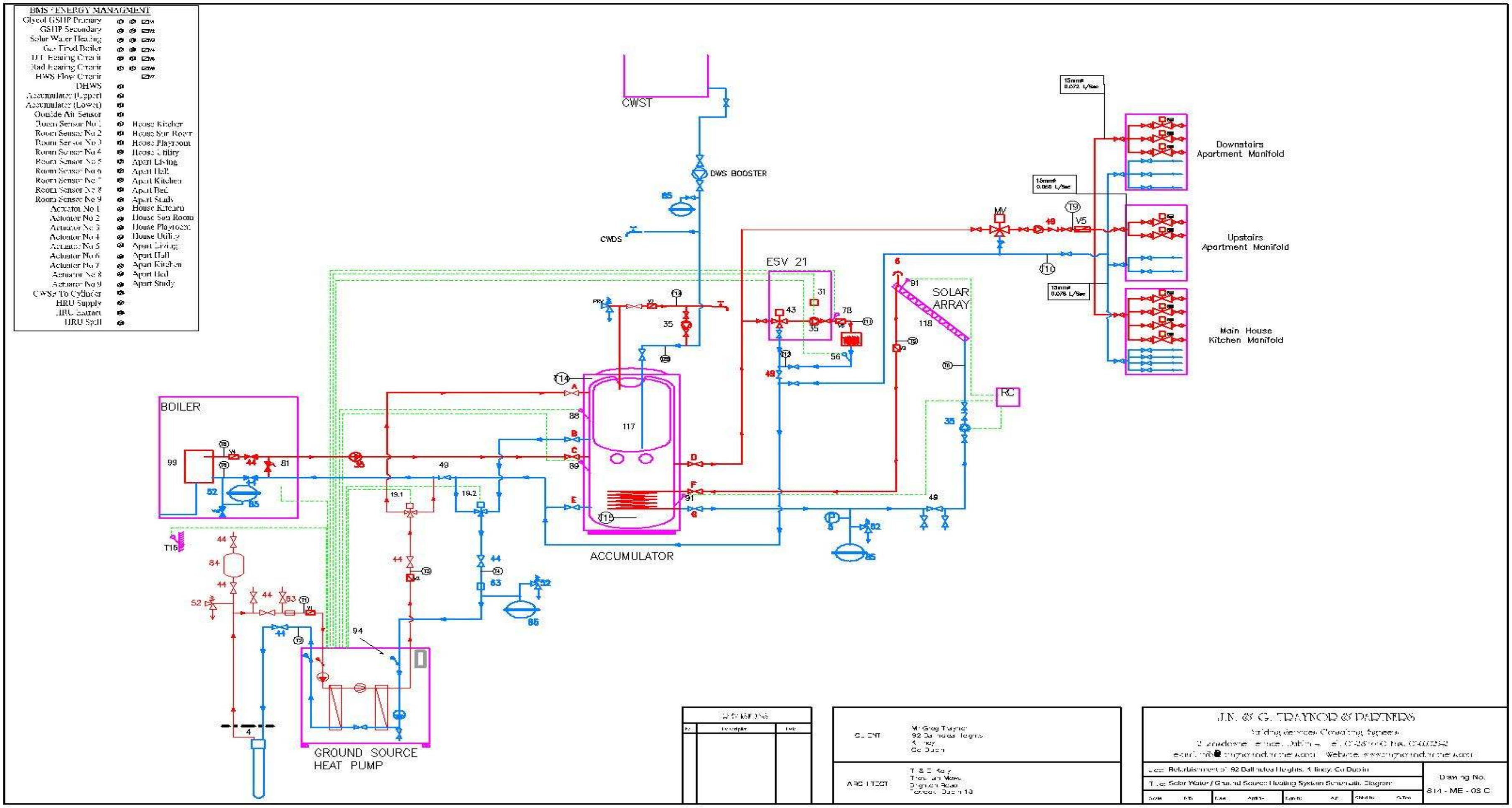
First: Insulate !

REAR VIEW OF HOUSE: POST CONSTRUCTION

Sun tunnels for internal shower room and walk-in wardrobe shown to left of solar panel array

- 300mm Rockwool in Attics
- 150mm external insulation First Floor rear
- 100mm external insulation on gable end wall
- 120mm /150mm rigid PIR on Ground Floor under u/f heating pipework
- 42.5mm & 37.5mm dry lining board to front and gable end walls. (Stairs had to be moved to facilitate!)

System Schematic



Equipment

PLANTROOM: Accumulator on left, heat pump and boiler on right, solar equipment upper centre

- 6 Sq. m. evacuated tube solar panel
- 8 kW single-phase heat pump
- 153 m bore hole
- Wall-mounted condensing gas boiler
- 750 litre accumulator (450l heating/300l DHW)
- MHRV (Mechanical Heat Recovery Ventilation)
- Meter on incoming electrical supply to panel
- Energy meters on brine, heat pump secondary, solar system, boiler circuit, underfloor heating system, LPHW (Low Pressure Hot Water) radiator system and DHWS (Domestic Hot Water Service)
- Cylon-based BMS installation

Active Low-Energy Strategies

- Additional area of solar panel (dry heat pipe evacuated tube). This has allowed the heating to run for long periods without calling in the heat pump. The normal solar glycol daily maximum temperature is between 60 °C and 70 °C and it has hit a high of 105 °C on one occasion.

- Installation of most of underfloor heating at 100mm centres. This allows for a much lower mean water heating flow temperature and utilises the resulting increased heat capacity of the accumulator. It allows the solar heating system to be activated at lower than normal temperatures. This lower temperature also improves the COP of the heat pump when that is called into service.

- Use of LED lamps in relatively inexpensive GU10 luminaires has proved to be very successful from the point of view of economical running and quality of light. The type of fitting allows us to change-over to a different lamp as technology improves.

Tweaking

- Pump speeds were reduced to the minimum settings. The resulting heating and hot water temperatures were assessed subjectively and found to be satisfactory.

- Time control of radiator heating. A contactor was installed on the circulating pump and another control block was added in to the BMS software to operate the contactor coil.

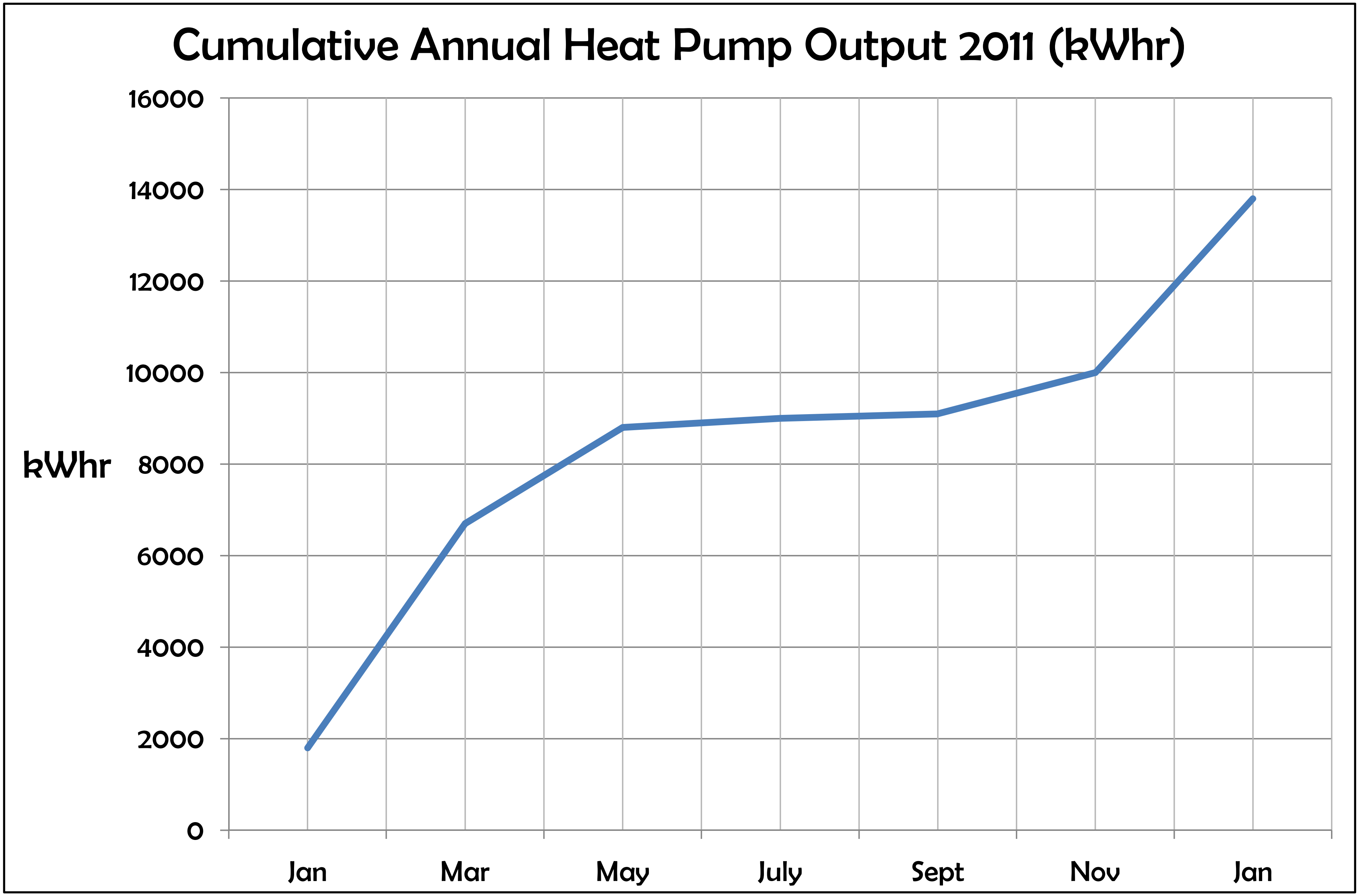
- Time control of underfloor heating through the BMS.

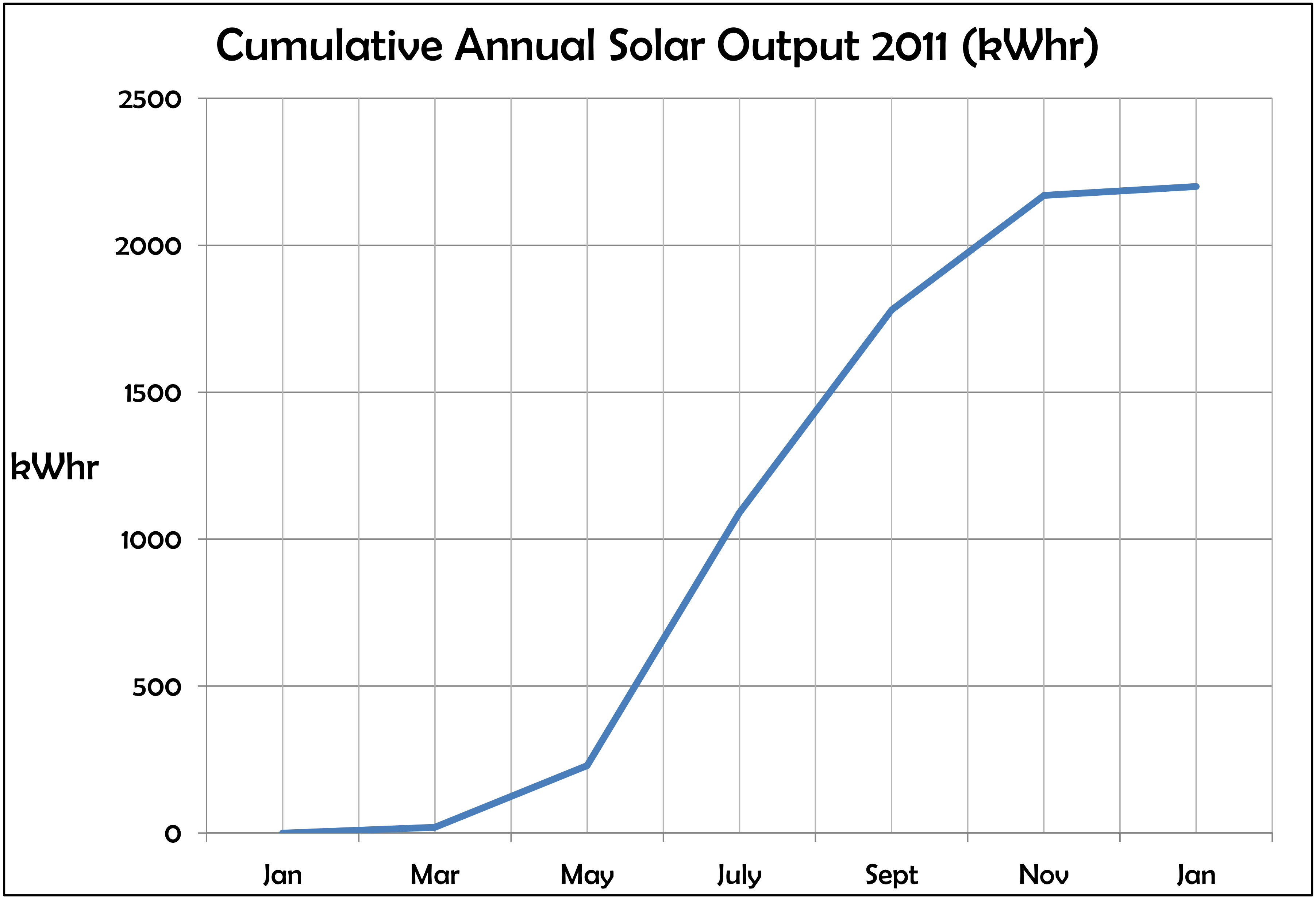
- Time control of MHRV through the BMS. The three-position speed control switch at the panel is normally set to the lowest speed and increased if there is temporary increased occupancy e.g., parties!! Initially it was decided to run it 24/7 at medium speed. However, it is now being run – under timed control – for just 7 hours every night at the slowest speed. One can open the windows on a mild day. Estimated savings of over € 80.00 p.a.

- The differential temperature between the solar panel and the bottom of the accumulator that activates the solar glycol pump was reduced from 8 °C to 6 °C. Cut-out temperature remains at 4 °C differential.

Operating Mode

- Underfloor heating operates at 27 °C
- LPHW serving radiator circuits is weather compensated and normally operates at between 30 °C and 40 °C
- Domestic Hot water is set to operate between 43 °C and 48 °C
- The anti-scald valve is set at 50 °C
- The condensing boiler operated during the commissioning stages– for a longer period than normal - due to a control anomaly. It has not been called into service since November 2010.


Cumulative Annual Heat Pump Output 2011 (kWhr)
kWhr
16000
14000
12000
10000
8000
6000
4000
2000
0
Jan
Mar
May
July
Sept
Nov
Jan


Cumulative Annual Solar Output 2011 (kWhr)
kWhr
2500
2000
1500
1000
500
0
Jan
Mar
May
July
Sept
Nov
Jan

Things we thought of doing, but didn’t:

- Fill the hollow block walls (1971 construction) with concrete, to increase the thermal wheel effect of the house. Considered too time-consuming and only partially effective, with unknown and dubious benefits.

- Use 4-way valves instead of 3-way priority valves between heat pump, accumulator and boiler in order to prevent parasitic flow through boiler. This WON’T WORK on the NIBE heat pump, as there has to be continuous flow through the heat pump to allow it to be able to monitor the heating water temperature. On a much larger (60kW heat pump) installation we have designed the boiler to act as a back-up stand-alone unit that feeds into a reheat cylinder, obviating the need to dock the boiler with the heat pump.

- Because the borehole temperature has been a few degrees lower than the 10°C to 12°C expected temperature in igneous rock, we figured that a substantial length of collector pipe is not in contact with the heat source. We considered filling the borehole with up to 8 cubic metres of bentonite, a heat conducting concrete, but the cost is high and there was no guarantee that it would work.

TIMBER FRAME EXTENSION IN MAIN HOUSE
(Yes, they *are* low-energy lamps!)

End Result

FRONT VIEW OF HOUSE : POST-CONSTRUCTION

Finished product:

New 3-bed house on left hand side. Granny flat on RHS.

Note triple-glazed windows and dummy chimney on right

A Few Lessons Learned

- The MHRV unit did not perform as expected, nor as advertised.
- Building sealing was not perfect. We achieved 4.4 cu.m/hr at 50 Pa on an initial pressure test and after subsequent best endeavours reduced that to 4.32 cu.m/hr. Where are the leaks? Are they important?
- The BER Cert achieved a provisional A3 certification. (Waiting for expected SEAI audit.)
- The necessity to provide ventilation to roof timbers can be at odds with the need to comprehensively insulate an attic.
- Solar heating provided most of the energy between the beginning of April 2011 to the end of August 2011 – principally for domestic hot water to a minimum of two showers and one bath per day.

Some Statistics

- The entire structure is just under 215 sq.metres in area.
- Running costs have been exceptionally low at under € 400.00 euro per annum, if one excludes standing charge, levy and VAT, especially considering that, in addition to heating, there is always plenty of domestic hot water for 3 adults and 2.5 children.
- Heat pump output for a calendar year was approximately 12,000 kWhr.
- Solar contribution for a calendar year was approximately 2,220 kWhr.
- Calculated Energy Consumption: 15,500kWhr/annum (DEAP formula)
- Measured Energy Consumption: 2,800kWhr/annum including heat pump, circulating pumps and MHRV system.
- The overall measured COP for the system is just over 5.0. This includes the heat pump and external motors, i.e., circulating pumps and MHRV fan.

Contented Customers

Payback Period

Do you want that in decades or centuries?

Acknowledgements

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