Pilgrims Barn South Elevation (Photo J Harrall)

Pilgrim's Barn

Pilgrim's Barn is an exceptionally energy efficient **CLASS Q** [i] residential development in the heart of Suffolk.

The former chicken shed benefitted from Permitted Development Rights (Class Q) allowing a change of use (Planning Ref: DC/21/01912) to a 465m^2 five-bedroom residential dwelling.

Completed in October 2022, Pilgrim's Barn achieved an exceptionally high SAP Rating of 134A at a time when the average UK new dwelling SAP Rating was 83B **English Housing Survey** The SAP (Standard Assessment Procedure) is the UK's methodology for predicting a home's energy efficiency and carbon mitigation, its output being the Energy Performance Certificate (EPC) The higher the SAP Rating, the higher the degree of energy efficiency and generally the lower the CO2 emissions in occupation.

Another exceptional performance characteristic of this barn conversion is its exceptionally low Air Pressure Test (APT) of **1.9m^3/h.m^2 @ 50Pascals.** The UK **Average APT** for new homes is **5m^3/h.m^2** for compliance with Building Regulations under Approved Document Part L1A (England and Wales) An APT measures the air permeability of the building's fabric, the more air leakage, the more potential heat loss.

DESIGN PRINCIPLES

The home owners, Nick and Saffy Woolley, engaged design consultants **Hockerton Housing Project** (HHP) to assist in the detailed design of Pilgrim's conversion. The HHP design team have a collective experience and

knowledge from self-building HHP and twenty-seven years of living a near autonomous lifestyle in the UK's largest collection of earth-sheltered dwellings.

The design principles used at Pilgrim's Barn are the same design principles applied at HHP by its Architects, Professor's Brenda and Robert Vale, **The Vale's**. The Vales work was first published in their 1975 book, 'The Autonomous House' and later implemented at their former Nottinghamshire home, **'The New Autonomous House'**

Pilgrim's Barn utilises selective passive solar design principles pioneered by The Vale's as delivered at HHP. These design principles include;

- Southerly orientated glazing – *triple glazing* ***8W/m²K***
- Thermal mass superstructure – *concrete floor and block walls*
- Super-insulated envelope – *better than Part L minimum requirements*
- Renewable energy – ***27KWpeak*** *Roof Mounted (75no. panels) pv's*
- Energy Storage – *Tesla Powerwall2 batteries*

Pilgrims Barn West Elevation (Photo J. Harrall)

CONSTRUCTION SPECIFICATION

Enhanced fabric insulation levels are a key characteristic of Pilgrim's Barn performance in reducing heating demand and tempering internal air temperature variation. Allied with roof mounted photovoltaics (pv's) and energy storage (batteries) Pilgrim's energy consumption for the 12months May 2023 to April 2024 were 10,800KWhrs (home) and 7,000KWhrs (EV cars)
Pilgrim's building fabric comprises;

Floor – *300mm Jablite, 300mm reinforced concrete slab, resin bonded laminate floor finish*

Wall – *Black painted vertical timber cladding, 100mm thermalite, 300mm Rockwall cavity fill, 100mm dense concrete, sand/cement render & skim*

Roof – *Profile* steel roof cladding, 440mm Celotex, plasterboard & skim ceilings

Windows – *Rationale external doors and windows, triple glazed 0.8 U-Value*

Space heating is provided by two sources but;

Space Heating

- Electric underfloor heating &
- MVHR Vent Axia 190W rating

Renewable Energy:

- 27KWpeak Roof Mounted (75no. panels) PV's *[58W/m² Gross Floor Area]*
- Tesla Powerwall2 Batteries,
- 8KW SolarEdge Invertors
- Zappy EV Chargers

Essential Resources

Pilgrim's utility connections include, the National Grid and mains water supply.

Additional on-site resources include, rainwater harvesting and grey water harvesting, while waste water from Pilgrim's is managed by an on-site Sewerage Treatment Plant, with filtering via a reedbed pond.

PILGRIM'S BARN VS UK BUILDING REGULATIONS NOTIONAL BUILDING					
Minimum Standards for Fabric Performance			**Notional Building**	**PILGRIM'S BARN**	**% Difference**
	Part L 2013	**Part L 2021**	**Part L 2021**		
External walls	0.3 w/m²k	0.26 w/m²k	0.18 w/m²k	**0.1 w/m²k**	**+40**
Floors	0.25 w/m²k	0.18 w/m²k	0.13 w/m²k	**0.09 w/m²k**	**+30**
Roofs	0.2 w/m²k	0.16 w/m²k	0.11 w/m²k	**0.06 w/m²k**	**+44**
Windows	2 w/m²k	2.2 w/m²k	1.2 w/m²k	**0.78 w/m²k**	**+35**
Doors	2 w/m²k	1.6 w/m²k	1.0 w/m²k	**0.9 w/m²k**	**+10**
Air Permeability	10 m³/m²/hr @ 50Pa	8.0 m³/m²/hr @ 50Pa	5.0 m³/m²/hr @ 50Pa	**1.9m³/m²/hr @50Pa**	**+62**

Figure 1 Notional Building Comparison (J. Harrall)

Notional Building Comparisons

Pilgrim's building element specification significantly out performs the UK Building Regulations 'Notional Building' (See Figure 1.)

Favourable comparisons in fabric heat transmittance (U-Values) to the Notional Building are up by 40% for its walls (0.1W/m²K) up 30% for its floors (0.09W/m²K) and up 35% for the roof (0.06W/m²K)

The most significant improvement against the Notional Building is Pilgrim's Air Pressure Test (APT) which recorded 1.9m3@50Pascals, recording a 62% reduced fabric air infiltration rate.

CONSTRUCTION COST

The reported build cost by the owners is £1,650 m² excluding the reedbed pond and wider landscape environs. This compares favourably with £2,000 m² for a conventional dwelling and £2,200m² for a Passive House.

BUILDING PERFORMANCE STATISTICS FOR 2023

Total solar pv generation for the 12months of 2023 was 26MWhr, the equivalent of 963KWhrs/KW/year, an exceptionally high annually pv generation rate for the UK.

The total home (including two EV cars) energy consumption was 18.5MWhr, circa 40KWhrs/m^2 across gross building floor area.

The total energy imported during 2023 from the Grid was 8MWhr, the equivalent of 17KWhrs/m^2, nearly double the total export to the Grid at 15.5MWhr.

The balance of energy exchange with the Grid was a surplus exported of 7.5MWhr, enough to power another similar home.

SUMMARY

Pilgrim's Barn offers a valuable insight in to how existing buildings can be upgraded to exceptional levels of energy efficiency at a commensurate cost to more conventional building specifications. Essential to that performance is an understanding of passive solar design techniques, the role of thermal mass and fenestration arrangements. By encouraging solar gains in to the home and providing the means to conduct and store that ubiquitous heat source, reduces the requirement for primary heating systems.

Pilgrim's design solution was informed by over three decades of Hockerton Housing Project's first-hand experience, building and living a near autonomous lifestyle. Such is the legacy of its Architects, the Vales, a growing number of new and existing homes are now adopting the virtues of passive solar design principles.

[i] *UK Government. 2015. The Town and Country Planning (General Permitted Development) (England) Order 2015*