

# **RETROFIT FOR THE FUTURE**

Energy and CO<sub>2</sub> Modelling and  
Calculation using the Passivhaus  
Planning Package (PHPP)

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## Background to the Passivhaus energy standard

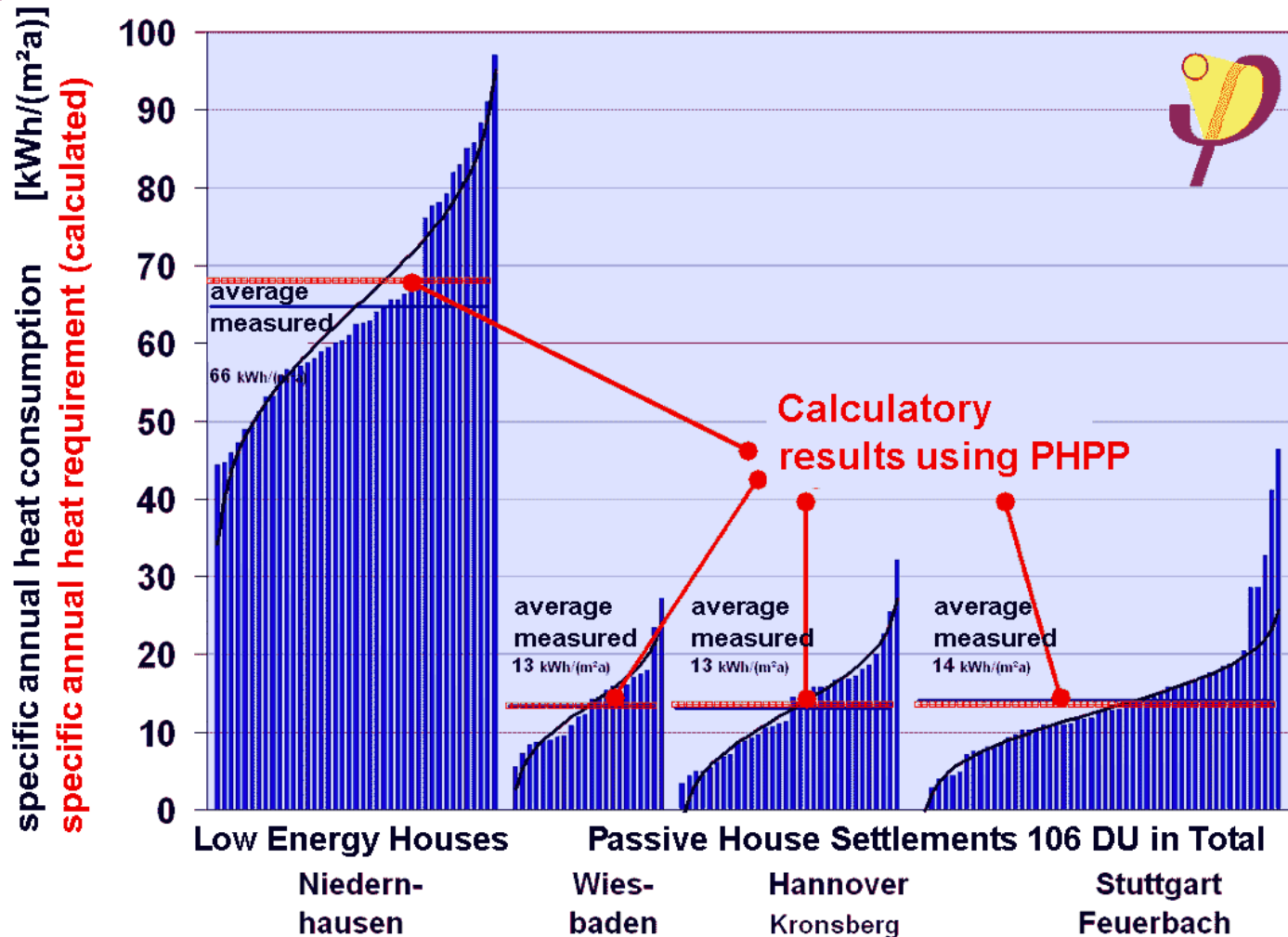
- The first four Passivhaus homes were built as a pilot project in Darmstadt in 1990-91
- The concept was developed in 1988 jointly by Dr Wolfgang Feist, Germany and by Bo Adamsson, Prof. of Building Science at Lund University, Sweden
- The homes were designed using sophisticated dynamic thermal modelling software which was generally only comprehensible to physicists
- Existing German Codes and Standards proved to be not up to the task. The same has since proved to be the case in Denmark, Belgium and the Netherlands.

## The key characteristics of PHPP

- A static model based on monthly degree-hours and which treats the building thermally as a single zone
- The utilisation efficiency of solar and internal gains depends on the building construction/thermal capacity and the ratio of gains to gross heat demand
- Calibrated using results of dynamic thermal simulations
- A whole-building model covering energy usage for lights, electrical appliances and cooking, heating and HVAC pumps/fans. Allows for all important phenomena; e.g. water evaporation and heating of liquid water
- Aims at a reasonable compromise between data entry requirements and the accuracy of the predictions

SAP is above all a compliance tool - PHPP is more of a design tool.

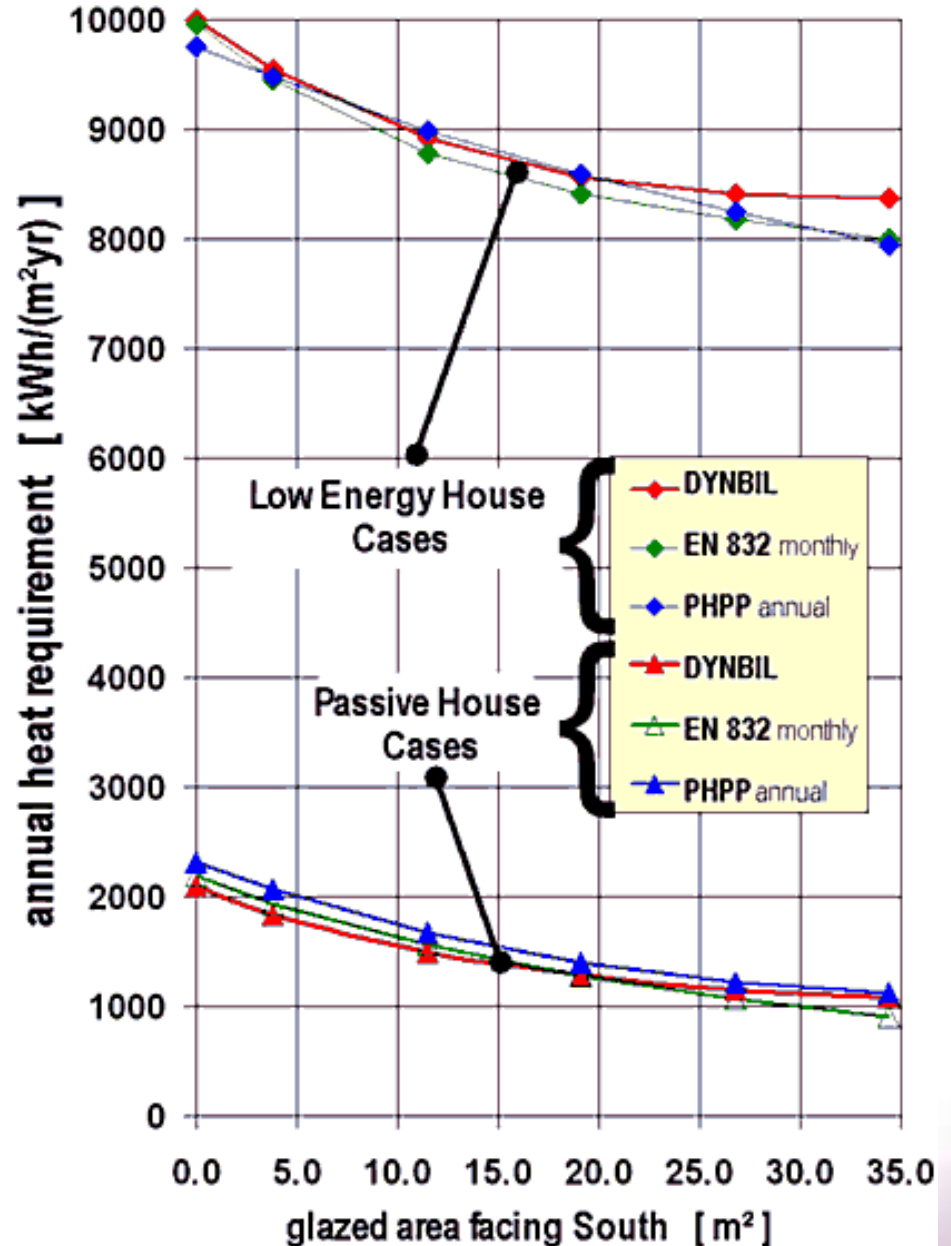
## PHPP Space heating useful energy - predictions versus measurements



## PHPP

How its predictions compare to the results of dynamic thermal simulations

## Comparison of Calculation Methods



## Using PHPP

Model dwelling(s) for standard occupancy conditions and average user habits - the same that would apply if your measures were replicated very widely:

- UK occupancy density, in persons per m<sup>2</sup>; equation in SAP-2005.
- Manchester weather data; i.e. close to UK population-weighted average.
- internal heat gains based on a future of more energy-efficient lighting and electrical appliances, most figures based on the *40% House Project 2005*.
- internal temperatures typical of future low-energy dwellings; typical temperatures maintained now in older dwellings reflect a major compromise between comfort and running costs

The energy monitoring of individual dwellings needs to allow for the above factors

PHPP2007 80 m2 urban semi rev DO 270509 with CHP [Compatibility Mode] - Microsoft Excel

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B C D E F G H I J K L M N O P Q R S V

Architect: \_\_\_\_\_  
Street: \_\_\_\_\_  
Postcode/City: \_\_\_\_\_

Mechanical System: \_\_\_\_\_  
Street: \_\_\_\_\_  
Postcode/City: \_\_\_\_\_

Year of Construction: 1920s

Number of Dwelling Units: 1 Interior Temperature: 21.0 °C

Enclosed Volume V<sub>e</sub>: 192.0 m<sup>3</sup> Internal Heat Gains: 2.1 W/m<sup>2</sup>

Number of Occupants: 2.3

### Calculation Electricity / Internal Heat Gains

Building Type: Residential

### Internal Heat Gains

Utilization Pattern: Duelling  
Type of Value Used: Standard

### Planned Number of Occupants:

3 Verification

### Verification:

Monthly Method	
Specific Space Heat Demand, Annual Method	69.6
Specific Space Heat Demand, Monthly Method	78.3

### Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 80.0 m<sup>2</sup>

Applied:	Monthly Method	PH Certificate:	Requirement fulfilled?
<b>Specific Space Heat Demand:</b>	<b>78 kWh/(m<sup>2</sup>a)</b>	15 kWh/(m <sup>2</sup> a)	No
<b>Pressurization Test Result:</b>	3.0 h <sup>-1</sup>	0.6 h <sup>-1</sup>	No
<b>Specific Primary Energy Demand (DHW, Heating, Auxiliary and Household Electricity):</b>	173 kWh/(m <sup>2</sup> a)	120 kWh/(m <sup>2</sup> a)	No
<b>Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):</b>	116 kWh/(m <sup>2</sup> a)		
<b>Specific Primary Energy Demand (Energy conservation by solar-generated electricity):</b>	0 kWh/(m <sup>2</sup> a)		
<b>Heating Load:</b>	25 W/m <sup>2</sup>		
<b>Frequency of Overheating:</b>	0 %	over 25 °C	
<b>Specific Useful Cooling Energy Demand:</b>	kWh/(m <sup>2</sup> a)	15 kWh/(m <sup>2</sup> a)	
<b>Cooling Load:</b>	2 W/m <sup>2</sup>		

confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The calculations

issued on: \_\_\_\_\_  
signed: \_\_\_\_\_

PHPP2007 75 m2 det bungalow 020509 rev DO 270509 with LPG and solar [Compatibility Mode] - Microsoft Excel

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B3

Passive House Planning  
ELECTRICITY DEMAND

Building: **Notional dwelling for TSB**

# Households	1	HH
Persons	2.4	P
Living Area	75	m <sup>2</sup>
Annual Heat Dema	21	kWh/(m <sup>2</sup> a)

Solar Fraction of DHW Wash&Dish	0%
Marginal Performance Ratio DHW	42%
Marginal Performance Ratio Heating	31%

Prim. Energy Factor: Electricity	2.7	kWh/kWh
Natural Gas	1.1	kWh/kWh
Energy Carrier for Space Heating/DHW:	2.7	kWh/kWh

Column Nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Application	Used ? (1/0)	Within the Thermal Envelope? (1/0)	Norm Demand	Utilization Factor	Frequency	Reference Quantity	Useful Energy (kWh/a)	Electric Fraction	Electric Demand (kWh/a)	Additional Demand	Marginal Performance Ratio	Solar Fraction	Non-Electric Demand (kWh/a)	Primary Energy Demand (kWh/a)	
Dishwashing DHW Coefficient	1	1	1.10 kWh/Use	1.00	65 f(P*a)	2.4 P	101	50%	51					137	
Clothes Washing DHW Coefficient	1	1	0.95 kWh/Use	1.00	57 f(P*a)	2.4 P	127	55%	70	(1+ 0.30)	0.42	(1- 0.00)	27	74	
Clothes Drying with Drying Coeff (incl. H) = 1	1	0	0.00 kWh/Use	0.75	57 f(P*a)	2.4 P	348	100%	348	(1+ 0.05)	0.42	(1- 0.00)	25	188	
Residual Demand 0.50							0	0%	0					67	
Corrosion caused by Exhaustion	1	0	0.00 kWh/Use	0.50	57 f(P*a)	2.4 P	0	100%	0	(1+ -0.10)	0.31	(1- 0.48)	0	0	
Refrigerating	0	1	0.28 kWh/d	1.00	365 d/a	1 HH	0	100%	0					0	
Freezing or Combined Unit	0	0	0.53 kWh/d	0.90	365 d/a	1 HH	0	100%	0					0	
Cooking with Electricity	1	1	0.39 kWh/Use	1.00	365 d/a	1 HH	141	100%	141					379	
Lighting	1	1	11 W	1.00	500 f(P*a)	2.4 P	224	100%	224					605	
Consumer Electron	1	1	11 W	1.00	2.90 kWh(P*a)	2.4 P	124	100%	124				0	0	
Small Appliances	1	1	310 W	1.00	0.55 kWh(P*a)	2.4 P	402	100%	402					335	
Total Aux. Electricity	1	1	50 kWh	1.00	1.00 f(P*a)	2.4 P	118	100%	118					1086	
Other:							185		185					319	
							0		0					0	
							0		0					0	
							0		0					0	
<b>Total</b>							<b>1770 kWh</b>		<b>1662 kWh</b>				<b>126 kWh</b>	<b>52 kWh</b>	<b>4629 kWh</b>

DHW Non-Electric Wash&Dish kWh

Non-Residual-Non-Electric DHW Wash&Dish kWh