CARBON COMPLIANCE

Setting an appropriate limit for zero carbon new homes

Technical Modelling Assumptions

Published February 2011

'2016' carbon emission factors

Fuel	2016 carbon emissions factor ($kgCO_{2(eq)}$/kWh)
Grid electricity	0.527
Electricity generated on-site	0.527
Mains gas	0.227
Wood pellets	0.037
Wood chips	0.015
Biomass community heating	0.019

Fabric specification 'FEES' (minimum Fabric Energy Efficiency Standard for 2016)

	[East Pennines Location]	Small apartment	Large apartment	Mid terrace house	End terrace house	Detached house
U-values	Ext. Walls (W/m²K)	0.18	0.18	0.18	0.18	0.15
	Party Walls (W/m²K)	0	0	0	0	n/a
	Semi exposed walls, inc adjustment (W/m²K)	0.17	0.17	n/a	n/a	n/a
	Floor (W/m²K)	0.15	0.15	0.17	0.18	0.15
	Roof (W/m²K)	0.13	0.13	0.13	0.13	0.13
	Windows (W/m²K) whole window u-value	1.4 (double glazed)	1.4 (double glazed)	1.4 (double glazed)	1.4 (double glazed)	1.4 (double glazed)
	Doors (W/m²K)	1.0	1.0	1.0	1.0	1.0
	Window g-value	0.63	0.63	0.63	0.63	0.63
	Airtightness (m³/hr/m²)	5	5	5	5	3.1
	Thermal bridging y-value (W/m²K)	0.04	0.04	0.04	0.04	0.04
	Ventilation type	Natural	Natural	Natural	Natural	Natural
	Number of extract fans	2	3	4	4	4
	Low energy lighting	100%	100%	100%	100%	100%

Fabric specification 'Spec C'

		Small apartment	Large apartment	Mid terrace house	End terrace house	Detached house
U-values	Ext. Walls (W/m²K)	0.15	0.15	0.15	0.15	0.15
	Party Walls (W/m²K)	0	0	0	0	n/a
	Semi exposed walls, inc adjustment (W/m²K)	0.14	0.14	n/a	n/a	n/a
	Floor (W/m²K)	0.15	0.15	0.15	0.15	0.15
	Roof (W/m²K)	0.11	0.11	0.11	0.11	0.11
	Windows (W/m²K) whole window u-value	0.8 (triple glazed)	0.8 (triple glazed)	0.8 (triple glazed)	0.8 (triple glazed)	0.8 (triple glazed)
	Doors (W/m²K)	1.0	1.0	1.0	1.0	1.0
	Window g-value	0.57	0.57	0.57	0.57	0.57
	Airtightness (m³/hr/m²)	1	1	1	1	1
	Thermal bridging y-value (W/m²K)	0.04	0.04	0.04	0.04	0.04
	Ventilation type	MVHR	MVHR	MVHR	MVHR	MVHR
	Low energy lighting	100%	100%	100%	100%	100%

Additional technologies modelled for sensitivity analysis

Individual

Gas boiler + SHW (+PV)

ASHP + SHW (+ PV)

GSHP (+PV)

GSHP + SHW (+ PV)

GSHP + biomass back boiler (+ PV)

Biomass boiler (+ PV)

Communal

Gas boiler + SHW (+PV) [Apartment block]

Biomass CHP + gas boiler (+ PV)

Gas CHP + biomass boiler (+ PV)

Gas CHP + gas boiler (+PV), CHP fraction 0.7 or less

Gas CHP + gas boiler (+PV), no tank in dwelling

Technology performance efficiencies used in modelling

Technology	Specification	Notes
Gas condensing boiler (individual)	95% efficient	Assuming an integrated flue gas heat recovery system - i.e. 91% for condensing boiler + 4% for FGHR. Note that SAP already has an in-use factor for boilers contained in it.
Gas condensing combi boiler (individual)	95% efficient	Assuming an integrated flue gas heat recovery system - i.e. 91% for condensing boiler + 4% for FGHR. Note that SAP already has an in-use factor for boilers contained in it.
ASHP (individual)	250% efficient	Use current SAP default. HP trials said 80% performed worse than expected, however much of this was put down to poor installation. Assumption that by 2016 improvements in installation will bring performance up. So considered reasonable to assume current SAP default - no justification to assume anything different.
GSHP (individual)	320% efficient	Use current SAP default. HP trials said 80% performed worse than expected, however much of this was put down to poor installation. Assumption that by 2016 improvements in installation will bring performance up. So considered reasonable to assume current SAP default - no justification to assume anything different.
GSHP (communal)	300% efficient	Use current SAP default. HP trials said 80% performed worse than expected, however much of this was put down to poor installation. Assumption that by 2016 improvements in installation will bring performance up. So considered reasonable to assume current SAP default - no justification to assume anything different.
Gas boiler (communal)	86% efficient	Limit for non-condensing boilers.
Biomass boiler (communal)	86% efficient	Limit for non-condensing boilers.
Gas CHP (communal)	37% elec efficiency 47% heat efficiency	Confirmed by CHPA, based on 250kWe
Biomass CHP (communal)	17% elec efficiency 60% heat efficiency	Adjusted data from CHPA
Solar hot water	Zero loss collector efficiency = 0.81; heat loss coefficient = 3.9	Confirmed by REA
Photovoltaics	7m²/kWp assumed	Confirmed by REA
Biomass boiler (individual)	85% efficient	
Biomass back boiler (individual)	75% efficient	
MVHR	Specific Fan Power = 0.5 Heat recovery efficiency = 90%	Good practice 2010

Other modelling assumptions

Item	Specification	Notes
DHW cylinder size	Apartments: 120 litre Mid & End terrace: 150 litre Detached: 200 litre	Declared loss factors of 0.96, 1.14 and 1.44 respectively. Water use less than or equal to 125 litres/person/day.
Space heating controls (individual system)	Time & temperature zone control	As proxy for well controlled heating system. To be used in all dwelling types.
Space heating controls (communal system)	Programmer + TRV, charging linked to use	Gives best performance in SAP
Compensator (where applicable)	Weather compensator	Weather and Enhanced Load compensators give same performance boost in SAP.
Communal heating type (where applicable)	100degC or below full control variable system	
Hot water storage for communal heating options	Cylinder in dwelling	It was considered more likely that developers will want to include cylinder in dwelling to help ameliorate occupant concerns over connection to a communal system which is not under their direct control.
Fraction of heat from CHP (where applicable)	To be equivalent to hot water demand	Ratio of hot water demand to total heat demand calculated for each dwelling modelled.
Heat pump (individual)	Use immersion	Use deemed to be likely
Solar hot water	Orientation = South Collector tilt = 30deg Overshading = none/ very little	Optimum performance assumed
Photovoltaics	Orientation = SE/SW Collector tilt = 45deg Overshading = none/ very little	Not quite optimum orientation & tilt. Sensitivity analysis also carried out for all orientation, tilt and overshading combinations.

Technology lifetimes for whole life costing

Item	Lifecycle (years)
Combi boiler	12 (CERT figure)
Boiler	12 (CERT figure)
Communal boiler	20
Cylinder	30
ASHP: Heat pump	18 (RHI figure)
GSHP: Heat pump	23 (RHI figure)
GSHP: Replace glycol	5
GSHP: Borehole pipework	60
Gas CHP (medium 200kW)	15
Gas CHP (large 1MW)	20
Solar hot water: panels	20 (assuming direct flow)
PV: Panels	30
PV: Inverter	12
Exhaust heat recovery unit	18
MVHR heat recovery unit	20

Annual solar radiation, kWh/m²

	Location							
	East Pennines		Borders		South West England		Thames	
Tilt of collector	South	SE/SW	South	SE/SW	South	SE/SW	South	SE/SW
30°	1096	1040	1005	951	1196	1138	1140	1084
45°	1083	1013	999	931	1173	1103	1120	1052