Sustainable newbuild and refurbishment

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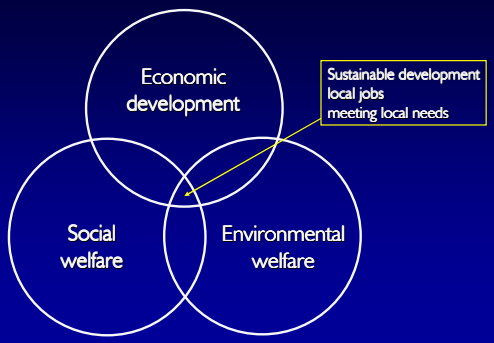
Energy and Environmental Design Consultant

Promoting Sustainable Economic Development

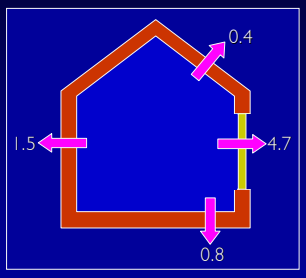


- Reducing carbon dioxide emissions for the typical UK house
- Designing new buildings for zero emissions

Typical UK House

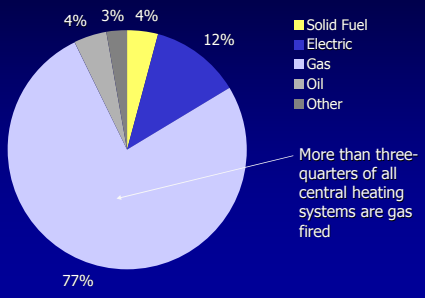
- Semi detached
- Three bedroom
- Approximately 90 m^2 floor area
- Built around 1935
- Masonry construction

Typical UK House



Central heating types

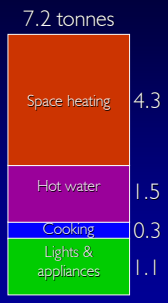
GB 1996



Typical 3 bed semi

7.2 Tonnes of CO_2

Typical 3 bed semi



Energy white paper 60% reduction = 2.9 tonnes

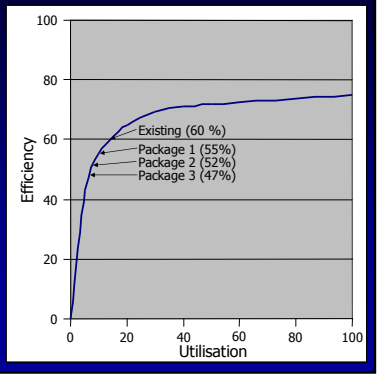
Improvement measures - insulation

Package	Walls	Roof	Floor	Windows	Ventilation
Existing	cavity	100 mm	suspended timber	Single glazing	None
Package 1	Cavity wall insulation	Extra 100 mm		Double glazing	None
Package 2 (B Regs)	cwi + 40 mm	Extra 150 mm	150 mm	Double glazing with lowE + Ar	2 extract fans
Package 3 (super)	cwi + 100 mm	Extra 200 mm	200 mm	Double glazing with super lowE + Ar	7ac/h @ 50Pa seal chimney PSV

CO_2 savings - insulation

Package	CO_2 tonnes/yr	% saved	Total fuel cost	Heat loss
Base case	7.2		£652	7 kW
Package 1	5.3	26%	£506	4.4 kW
Package 2 (B Regs)	4.3	41%	£436	3.1 kW
Package 3 (super)	3.5	51%	£379	2.2 kW

Boiler Efficiency v Utilisation



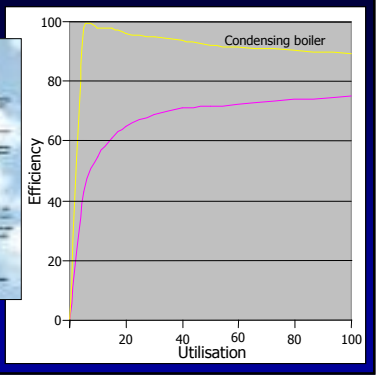
'Real' CO_2 savings

Package	CO_2 tonnes/yr	% saved
Base case	7.2	
Package 1	5.3	26%
Package 2 (B Regs)	4.3	41%
Package 3 (super)	3.5	51%

'Real' CO_2 savings

Package	CO_2 tonnes/yr		% saved	
Base case	7.2			
Package 1	~~5.3~~	5.7	~~26%~~	21%
Package 2 (B Regs)	~~4.3~~	4.8	~~41%~~	33%
Package 3 (super)	~~3.5~~	4.1	~~51%~~	43%

Boiler Efficiency v Utilisation



Improvement measures

Insulation and existing htg

Package	CO_2 tonnes/yr	% saved
Base case	7.2	
Package 1	5.7	21%
Package 2 (B Regs)	4.8	33%
Package 3 (super)	4.1	43%

Insulation and new heating

Package	CO_2 tonnes/yr	% saved
Base case	7.2	
Base case + heating	4.9	32%
Package 1 + heating	3.6	50%
Package 2 (B Regs) + htg	3.0	58%
Package 3 (super) + htg	2.4	67%

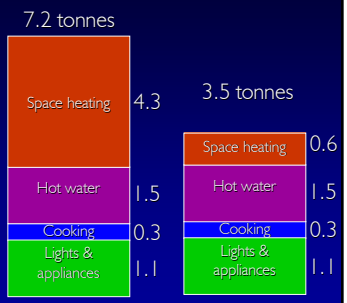
CO_2 Savings

To make significant CO_2 savings, needs attention to the fabric *and* the heating system

Improvement measures

Improvement option	Capital cost	£ spent per tonne CO_2 saved
Building Regs Package	£ 7000	£3000
New boiler and controls	£1500	£650

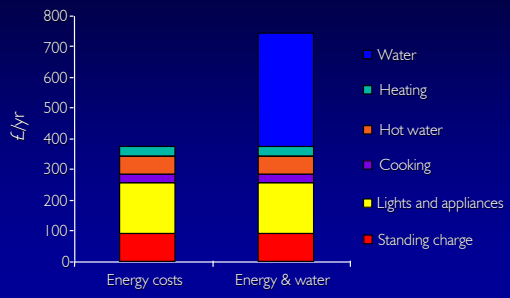
Hot Water



Water conservation

Flow control

Water and Energy Costs Compared

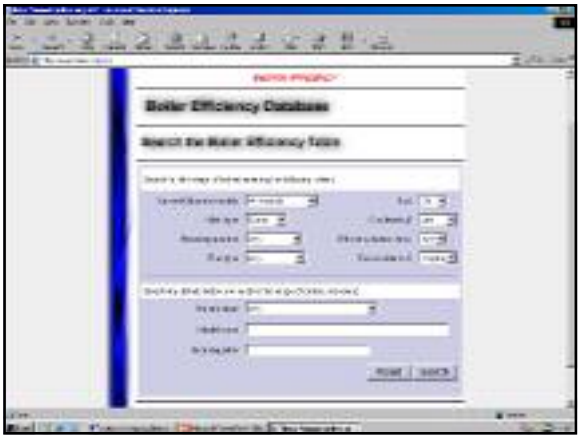


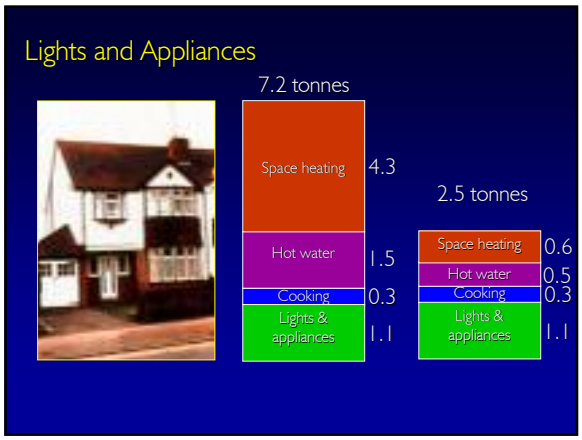
Combi boilers

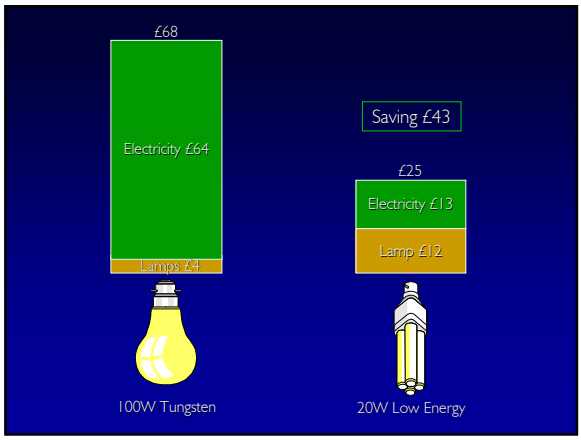
Typical combi output	7 – 25 kW
Hot water flow at 35K temperature rise	10 litres/min
Time taken to fill a bath	8 minutes
Typical output of new combis	7 – 35 kW
Hot water flow at 35K temperature rise	14 litres/min
Time taken to fill a bath	6 minutes

SEDBUK

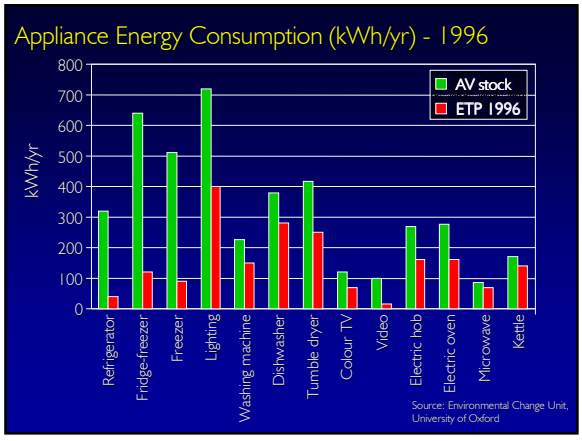
- Seasonal Efficiency of Domestic Boilers in the UK

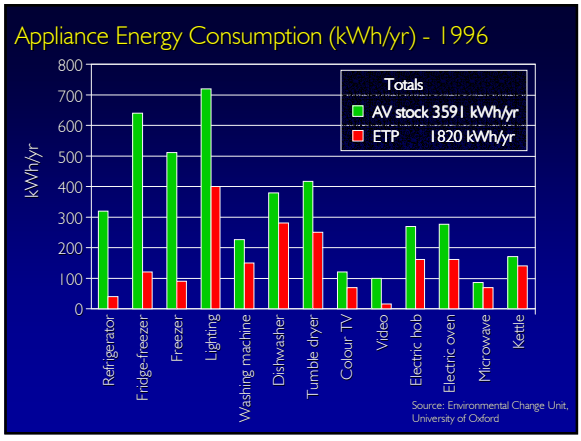



Lights and Appliances
7.2 tonnes
Space heating
4.3
Hot water
1.5
Cooking
0.3
Lights & appliances
1.1
2.5 tonnes
Space heating
0.6
Hot water
0.5
Cooking
0.3
Lights & appliances
1.1

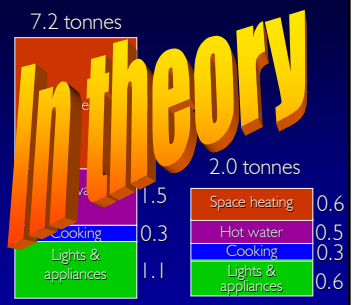

£68
Electricity £64
Lamps £4
Saving £43
£25
Electricity £13
Lamp £12
100W Tungsten
20W Low Energy


£429.95


Appliance Energy Consumption (kWh/yr) - 1996
AV stock
ETP 1996
kWh/yr
800
700
600
500
400
300
200
100
0
Refrigerator
Fridge-freezer
Freezer
Lighting
Washing machine
Dishwasher
Tumble dryer
Colour TV
Video
Electric hob
Electric oven
Microwave
Kettle
Source: Environmental Change Unit, University of Oxford


Appliance Energy Consumption (kWh/yr) - 1996
Totals
AV stock 3591 kWh/yr
ETP 1820 kWh/yr
kWh/yr
800
700
600
500
400
300
200
100
0
Refrigerator
Fridge-freezer
Freezer
Lighting
Washing machine
Dishwasher
Tumble dryer
Colour TV
Video
Electric hob
Electric oven
Microwave
Kettle
Source: Environmental Change Unit, University of Oxford

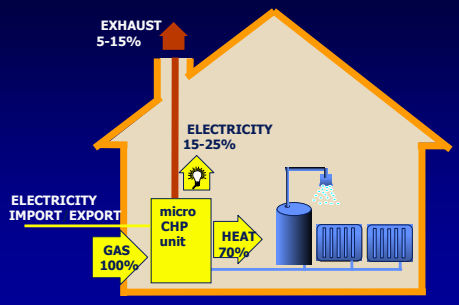
Lights and Appliances



New and Renewable Energy

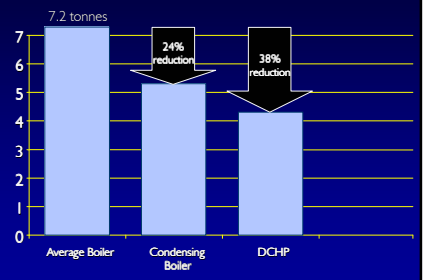
- Domestic Combined Heat and Power (DCHP)
- Wood heating
- Solar hot water
- Photovoltaics
- Wind

Micro CHP system concept



Courtesy EA Technology

Carbon dioxide emissions are reduced by the home is reduced by over 1.5 tonnes per year with DCHP



Powergen

Powergen
1kWe, 6kWt

- Taken over WhisperTech
- 0.8 kWe
- 6 kWt
- Plan 400 installations this winter

MicroGen

- Part of BG Group
- 1.1 kWe
- Plan 24 – 36 kWt using condensing regular or combi boiler

Baxi

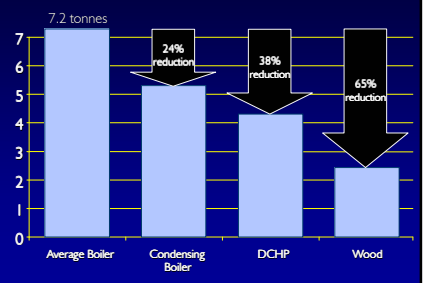
Baxi
5.5kWe, 12.5kWt

Renewables – biomass

Courtesy Welsh Biofuels

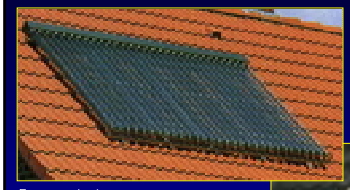
Wood burning?

Carbon dioxide emissions are reduced by the home is reduced by over 1.5 tonnes per year with DCHP



NB: Power generation mix, efficiency & emissions factors from DUKES 2000

Renewables – solar hot water



Evacuated tubes

Flat plate

Renewables – solar hot water

Improvement option	Capital cost	£ spent per tonne CO_2 saved
Flat plate	£ 2500	£8300
Evacuated tube	£3500	£9000

Renewables – solar photovoltaics

Lights and appliances 15 m^2

All CO_2 emissions 50 m^2

Renewables – photovoltaics

Improvement option	Capital cost	£ spent per tonne CO_2 saved
Lights and appliances only	£ 10 000	£16 500
To offset all CO_2	£25 000	£12 000

Renewables – wind

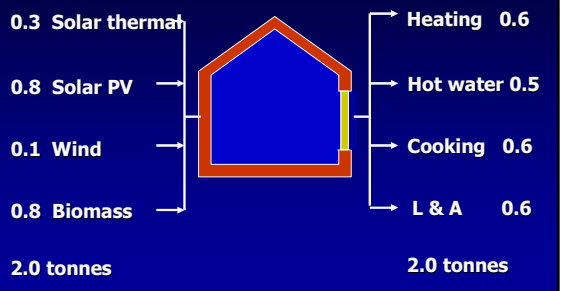
225 kW Wind turbine at Woodgreen Animal Centre

1.5 MW wind turbine at Ecotech Centre

Renewables – wind

Improvement option	Capital cost	£ spent per tonne CO_2 saved
400 W turbine	£ 1500	£10 000
6 kW turbine	£20 000	£4000
75 kW turbine	£120 000	£2000

Renewables



Conclusions

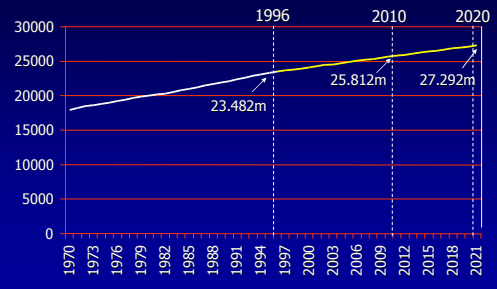
- 60% reductions in CO2 is possible on easy-to-insulate houses (cavity walls, loft space, suspended timber floors)
- Cost in the order of £12 000 (£3000 / tonne saved)
- For easy-to-insulate dwellings we need to go further
- Renewables can contribute
- Cost in the order of £25 000 (£12,000 / tonne)
- We need to investigate this in practice

Monitored Local Exemplars

New dwellings

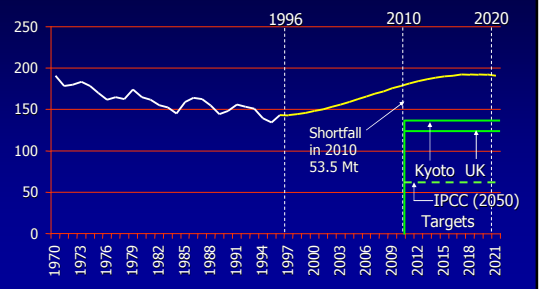
Projected households

GB 1970-2021 (thousands)



Projected CO_2 emissions

GB domestic sector 1970-2021 (Mt)



New dwellings
A strong case for zero emissions?

Energy Use – Building Regulations

	kWh/yr
Heating	40 000
Hot water	20 000
Electricity	30 000
	90 000

Energy Use – Building Regulations

	kWh/yr	tonne CO2
Heating	40 000	16
Hot water	20 000	
Electricity	30 000	12
	90 000	**28**

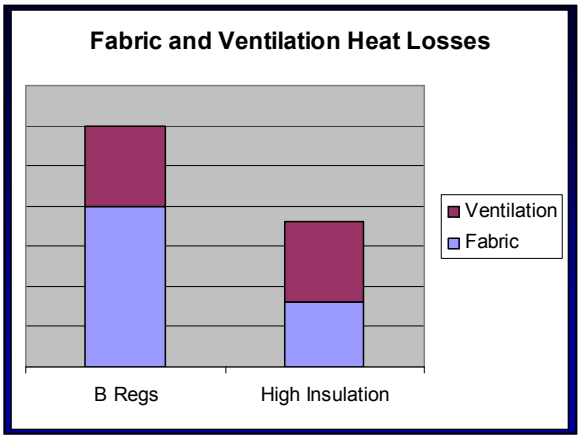
Heating

Lots of insulation – 300 mm all round

High performance windows

Passive solar gains

40 000 → 10 000 kWh/yr



Heating

Lots of insulation – 300 mm all round

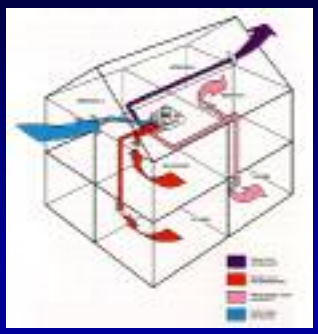
High performance windows

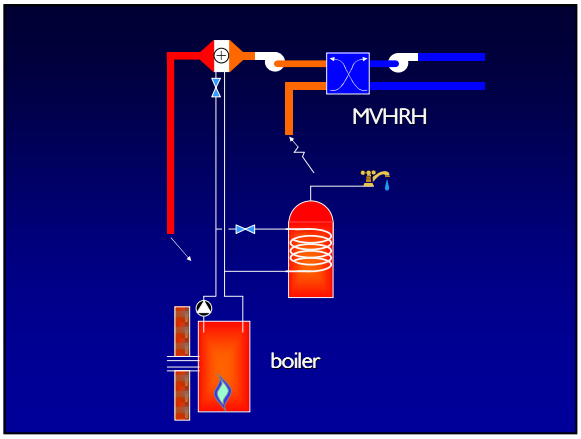
Passive solar gains

And airtightness

40 000 → 5 000 kWh/yr

Whole house heat recovery ventilation





Energy Use – Building Regulations

	kWh/yr	tonne CO2
Heating	40 000	16
Hot water	20 000	
Electricity	30 000	12
	90 000	**28**

Hot water

Low water use appliances

Low flow showers and taps

20 000 → 15 000 kWh/yr

Energy Use – Building Regulations

	kWh/yr	tonne CO2
Heating	40 000	16
Hot water	20 000	
Electricity	30 000	12
	90 000	**28**

Electricity

Selection of the most energy efficient appliances

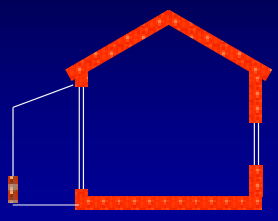
Low energy lights

30 000 → 15 000 kWh/yr

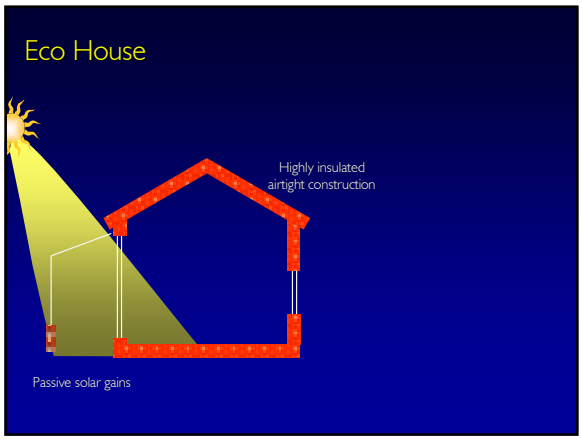
Energy Use

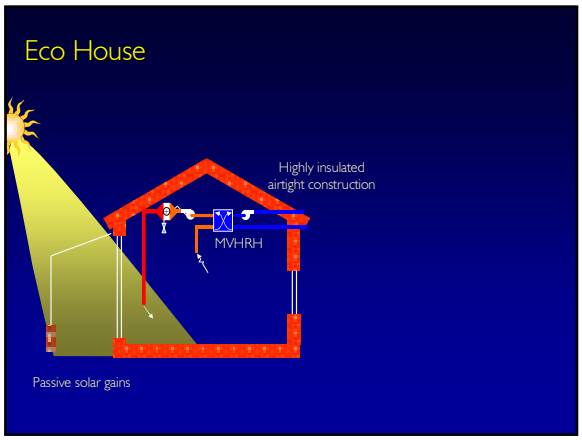
	~~kWh/yr~~	kWh/yr	tonne CO2
Heating	~~40 000~~	5 000	10
Hot water	~~20 000~~	15 000	
Electricity	~~30 000~~	15 000	6
	~~**90 000**~~	**35 000**	**16**

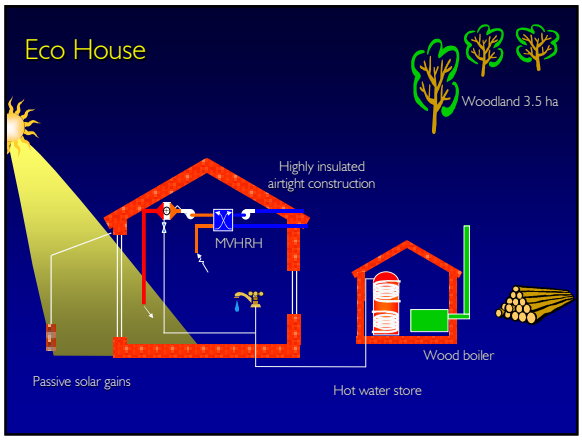
Eco House

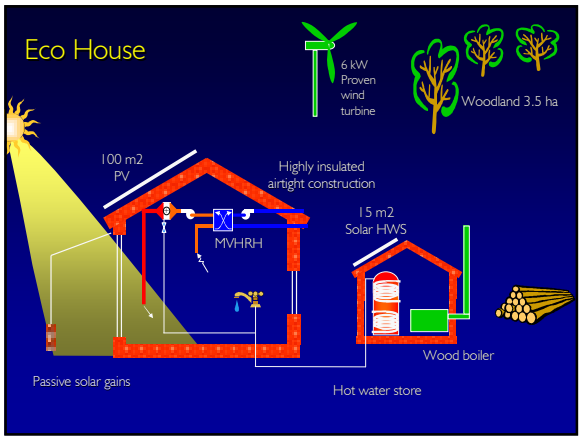


Highly insulated heavyweight airtight construction


Eco House
Highly insulated
airtight construction
Passive solar gains


Eco House
Highly insulated
airtight construction
MVHRH
Passive solar gains


Eco House
Woodland 3.5 ha
Highly insulated
airtight construction
MVHRH
Wood boiler
Passive solar gains
Hot water store


Eco House
6 kW
Proven
wind
turbine
Woodland 3.5 ha
100 m2
PV
Highly insulated
airtight construction
15 m2
Solar HWS
MVHRH
Wood boiler
Passive solar gains
Hot water store