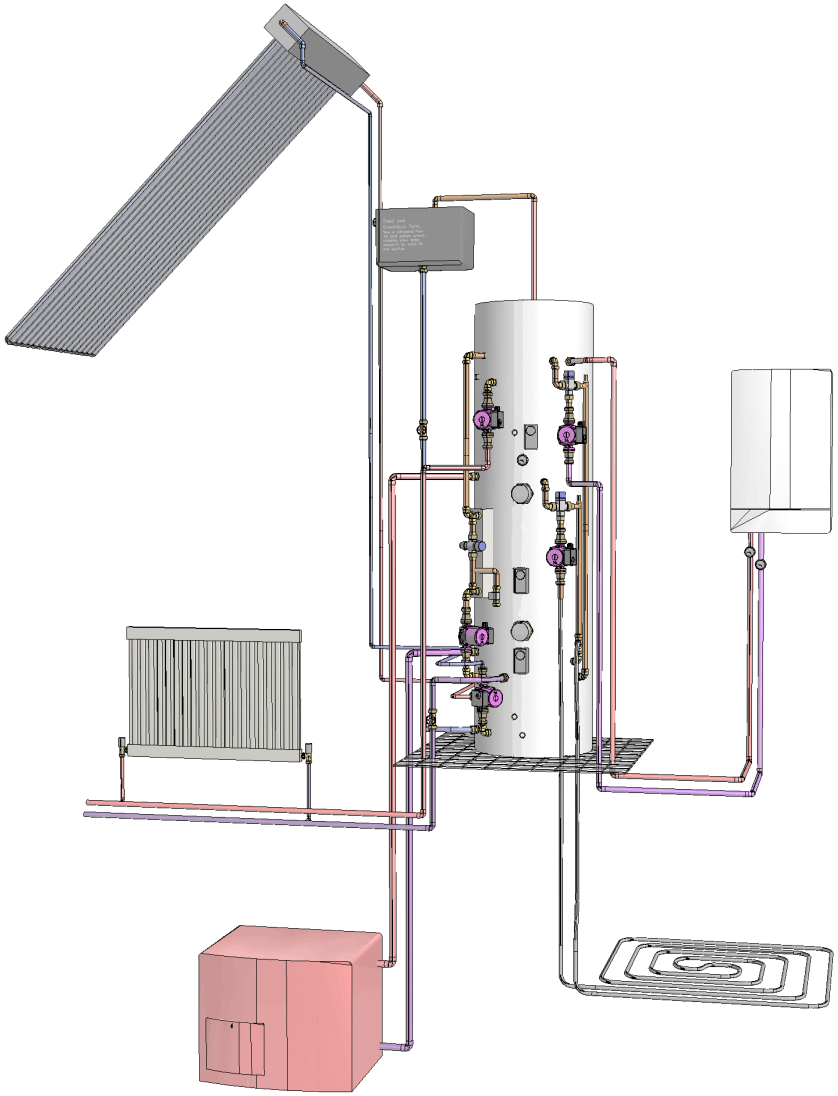
Multifuel Hot Water & Central Heating Systems



Richard Hanson-Graville
MA Mech Eng, FCIPHE
Technical Manager
Thermal Integration Ltd.

Why Now ?

Kyoto Agreement

75% of all household energy use must be renewably generated locally by 2020. This equates to more than one UK installation per second until 2020, or the UK faces hefty fines.

FIT, RHI Tariff and Green Deal

UK Government offering £ Billions to make this happen

Fuel Sources Available

- Gas Boilers
- Oil Boilers
- Biomass Boilers, Chip, Pellet & Log
- Wood Burners / Multifuel Stoves
- Heat Pumps, Air and Ground Source
- Solar Thermal
- Solar PV

Proposed Residential RHI Tariffs

Technology	Scale	Tariffs (pence/kWh)	Tariff lifetime (years)
Small installations			
Solid biomass	Up to 45kW	9	15
Biodiesel (restricted use)	Up to 45kW	6.5	15
Biogas on-site combustion	Up to 45kW	5.5	10
Ground source heat pumps	Up to 45kW	7	23
Air source heat pumps	Up to 45kW	7.5	18
Solar thermal	Up to 20kW	18	20
Medium installations			
Solid biomass	45kW-500kW	6.5	15
Biogas on-site combustion	45kW-200kW	5.5	10
Ground source heat pumps	45kW-350kW	5.5	20
Air source heat pumps	45kW-350kW	2	20
Solar thermal	20kW-100kW	17	20
Large installations			
Solid biomass	500kW and above	1.6-2.5	15
Ground source heat pumps	350kW and above	1.5	20
Biomethane injection	All scales	4	15

Green Deal to cover install costs

A Single Solution ?

The highest carbon savings can be provided with a mix of energy sources, balanced to match individual situations

A Renewable System

Pellet Boiler
or Heat Pump

Solar Panels
PV & Thermal

Wood Burner

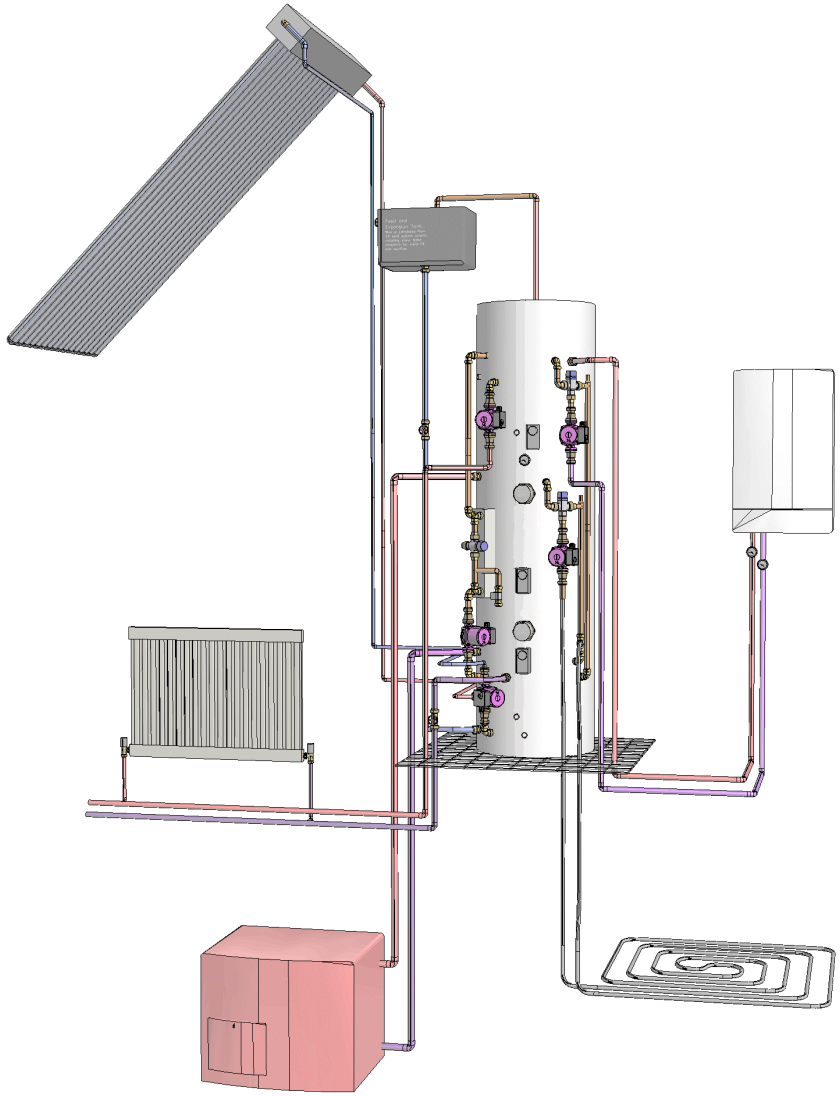
If suitable

80 - 100% Renewable
with 15-20 years of tariffs

The **Solar Panels** provide hot water in Summer

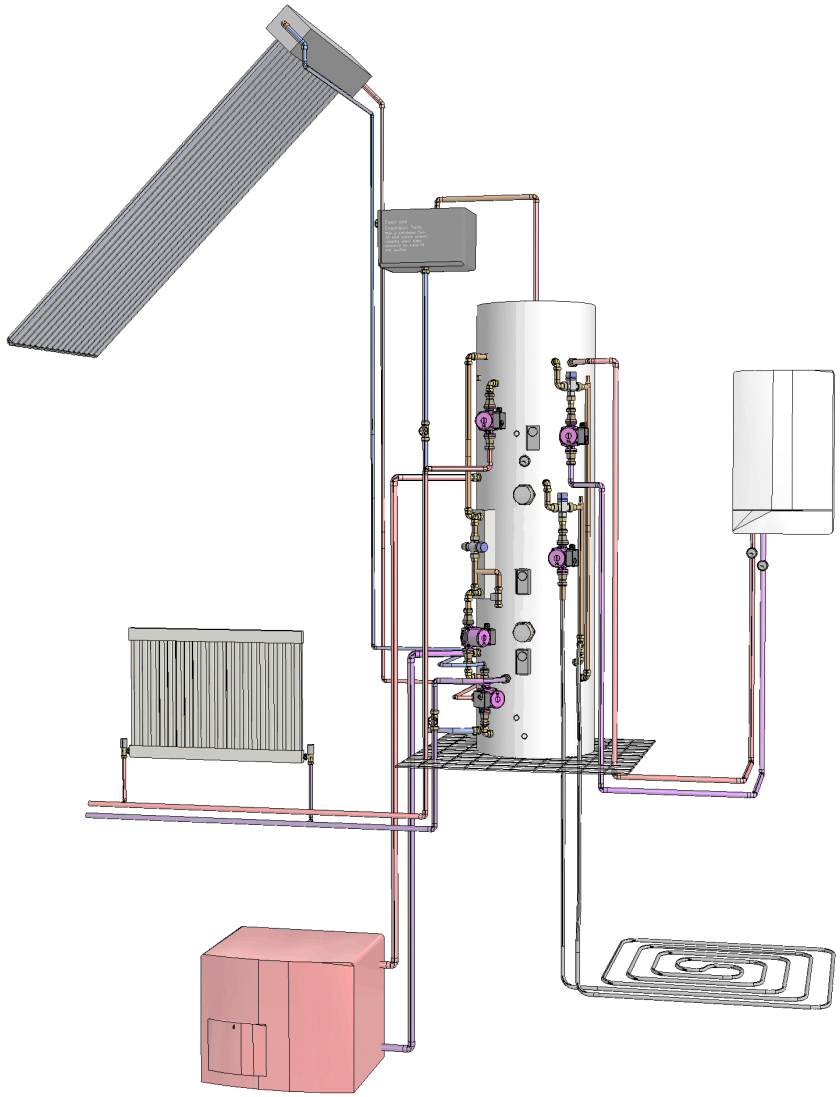
The **Wood burner** provides heat for central heating and hot water in Winter, using locally sourced wood at low cost.

The **Pellet Boiler** provides an easy to use backup heat source all year round. Fuel deliveries can be automated.



A **Thermal Store** allows the various heat sources to work in harmony with each other.

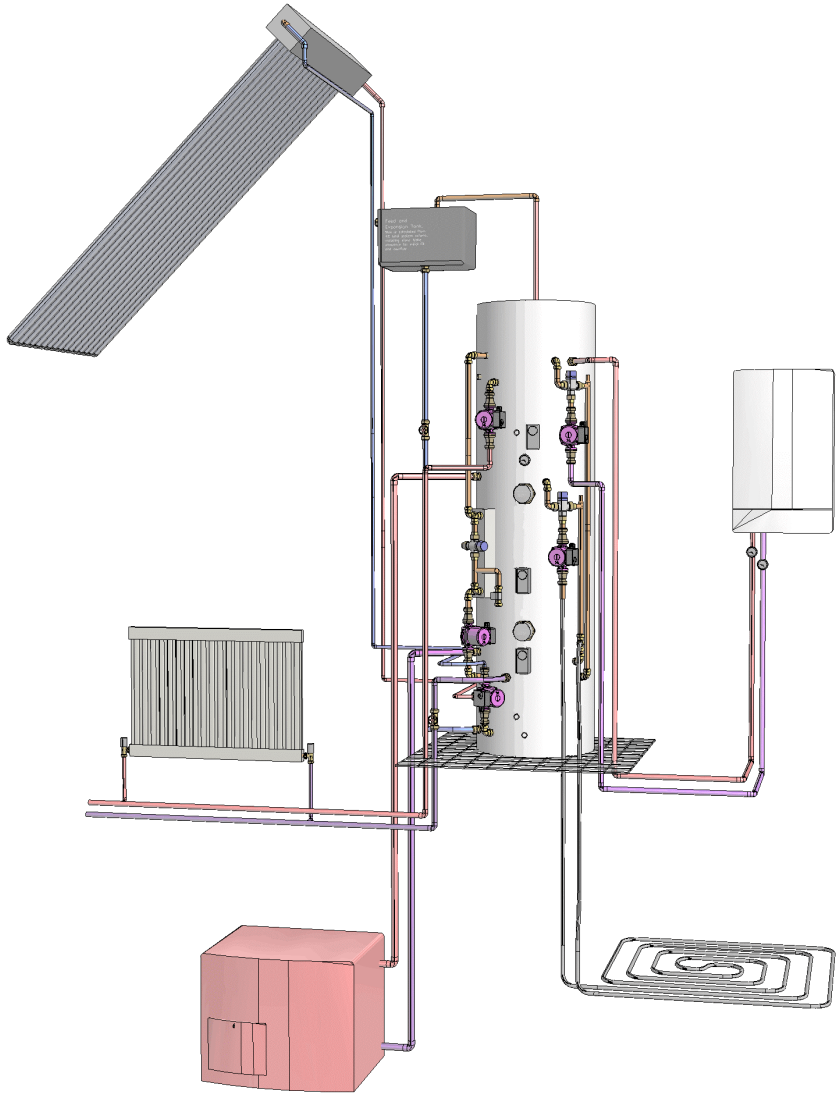
Storage is essential as the inputs from renewables will not perfectly match the demands for hot water and heating.

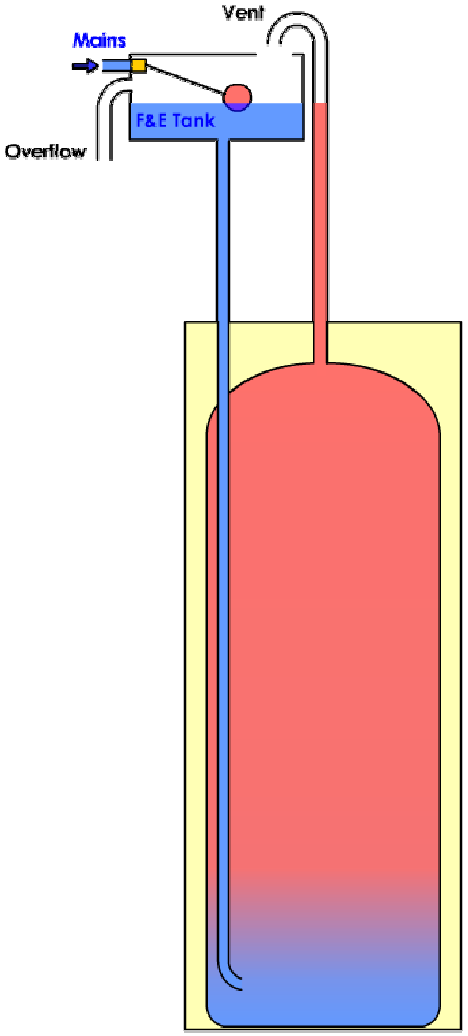


Solar input is highest during the middle of the day when hot water use is at the start and end of the day.

Wood burner input takes a while to get going, and can carry on into the night, when central heating is often required first thing in the morning.

Thermal Storage overcomes these timing issues.

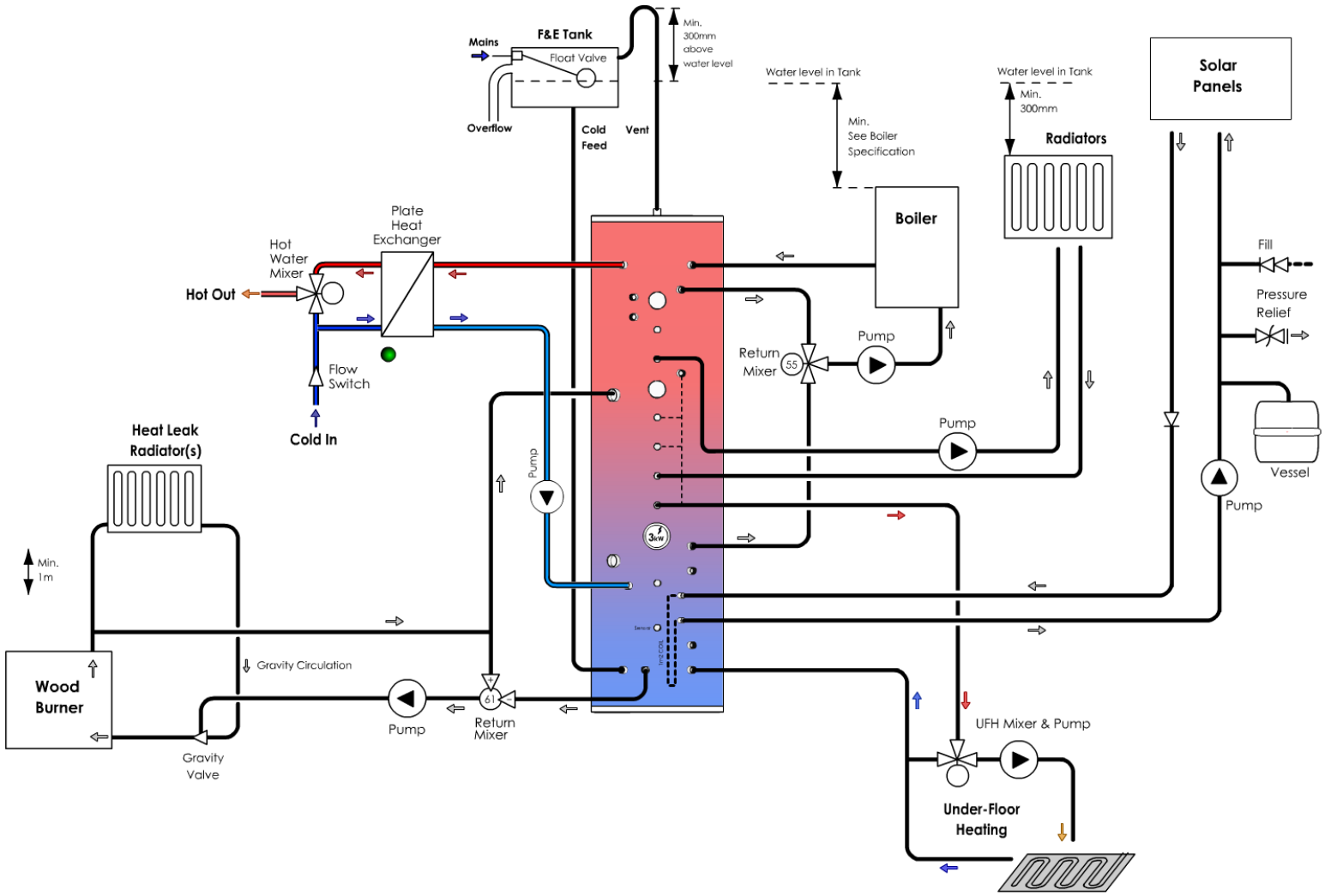




What is a Thermal Store ?

- Provides Heat Storage
- Typically Vented and filled by Feed and Expansion Tank
- Containing **Primary Water**
- Safe to use with wood burners
- Used to drive both hot water for taps, and central heating

Schematic Drawing



Online Design Tools

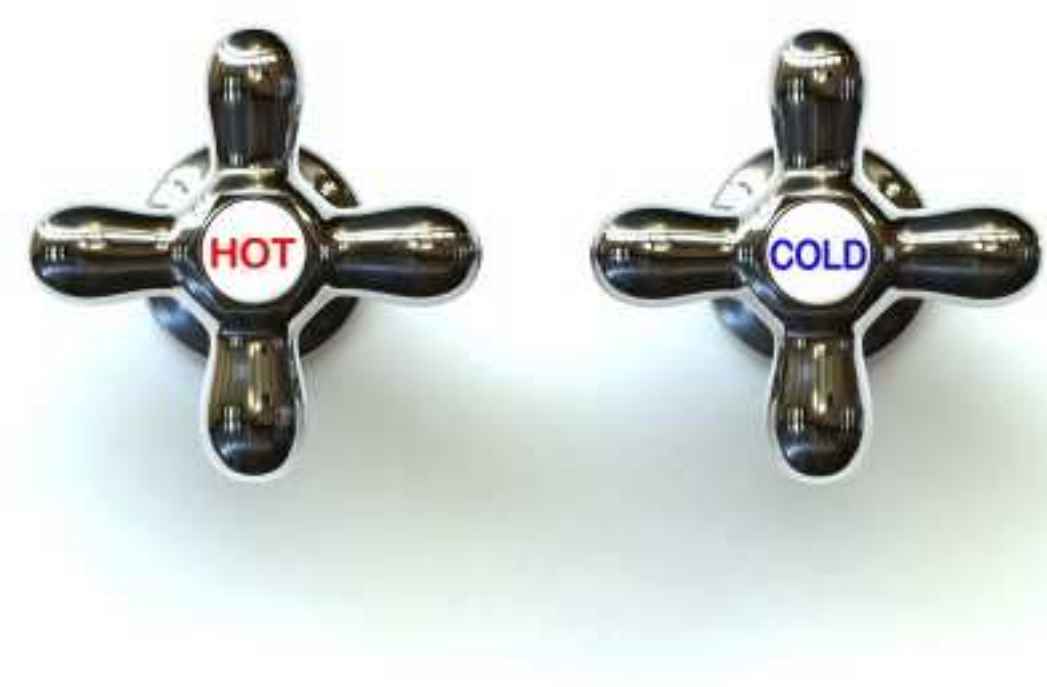
www.systemdesigner.co.uk

the SystemDesigner website
has been developed to
simplify the entire process of
designing a Multifuel hot
water system

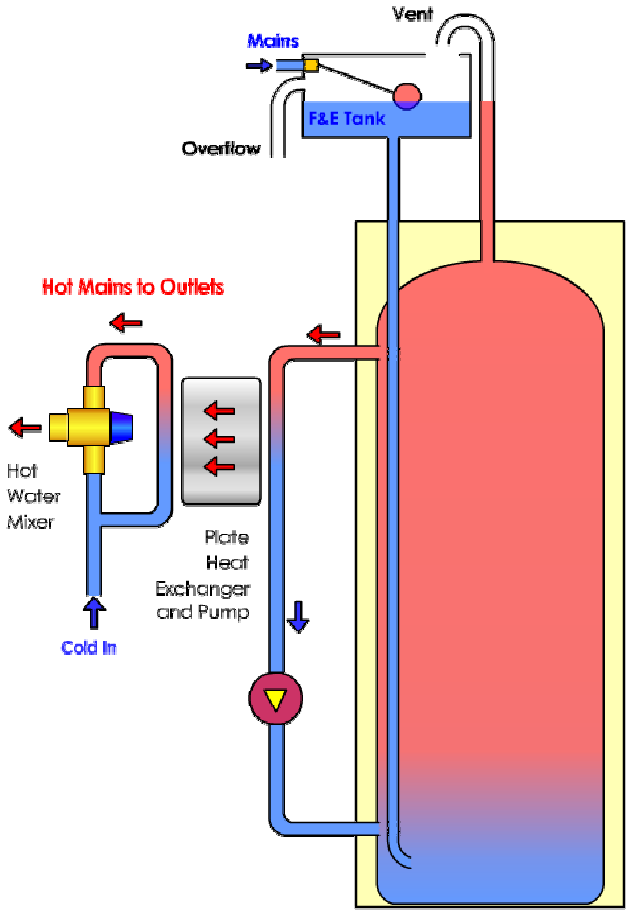
www.systemdesigner.co.uk

- Collects all relevant data in a central online resource that you can access and update anytime.
- Works out central heating losses, ventilation losses, and hot water demand.
- Works out running costs, carbon footprints, boiler sizes and pump sizes, highlighting potential problems.
- Works out savings that can be made from renewables and RHI payments you may receive.
- Generates schematic drawings.
- Generates parts lists and an estimate.
- Allows others to very quickly grasp the design.
- Takes as little as 5 minutes.

Domestic Hot Water



Domestic Hot Water



- **Hot water to taps is mains fed, and heated Instantaneously**
- Plate heat exchangers are used to transfer heat from the stored water into mains water
- Store remains unpressurised while water to taps is up to 10 bar pressure

Domestic Hot Water

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What type of project are you designing for ? Upgrading your own House

This helps us direct your enquiry to the correct technical agent.

When is equipment required on site ? Unknown

Would you like the system to provide domestic hot water to taps ? Yes

If you would like you system to provide hot water then click YES. Otherwise click NO.

More information...

How many people live in the house ? 2

This is the number of people we will design to provide for.

If there are many more bedrooms than people normally living in the house, you should enter the number of people you want the system to be capable of providing hot water for, i.e. a full house.

More information...

Domestic Hot Water

www.systemdesigner.co.uk

How many bath tubs are there ?

2

More information...

How many showers are there ?

1

Do not include showers that are integral to a bath listed above.

More information...

What is the maximum amount of hot water you want to run, at the same time ?

24 litres/minute

From your answers concerning numbers of baths and showers, the calculated flow rate with all outlets running is 46 litres/minute.

This is a measure of how much running hot water is required at the same time. Showers use approximately 8 litres per minute, while a bath can use from 18 to 30 litres per minute. To run a bath and a shower together will therefore need a minimum of 24 litres per minute. Care should be taken when using drench showers, body jets, or large bath taps, as they often need far higher flow rates. The following list gives some examples:

Basic shower = 8 lpm
Powerful shower = 12 lpm
Large shower rose = 20 lpm
Drench shower = 30 lpm
Standard bath tap = 18 lpm
Large bath tap = 30 lpm

More information...

Domestic Hot Water

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How good is your mains water supply ?

25 litres/minute

This is a measure of how much mains water is coming into the property. The minimum guaranteed by water authorities is typically 9 litres per minute, with the average being 24 litres per minute.

This is measured by filling a bucket of known volume and timing it with a stopwatch.

What level of hot water demand is there ?

Average (65 litres/person/day)

This is a measure of how much hot water is required by each person every day.

Do you need additional limescale protection ?

No

This is advisable in a hard water area. Fitted limescale protection prevents limescale from sticking to heat exchangers and pipework, however it does not remove scale - just keeps it in a non-stick form. If you desire for scale to be removed from your water supply then a chemical water softener will be needed.

If your hot water heat exchanger is not protected and if scales up, it can still be flushed.

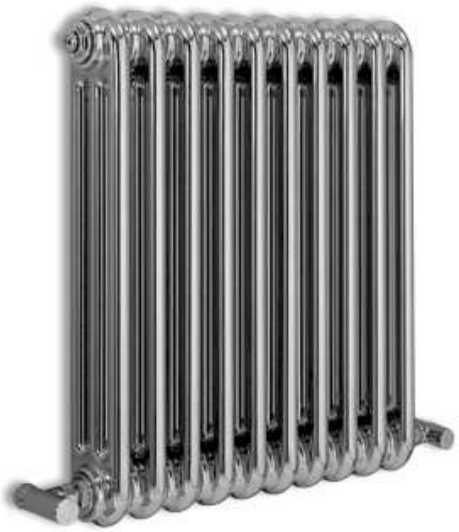
Are you fitting a pumped hot water circuit to taps ?

No

When pipe runs to taps are particularly long, the delay in running cold water out of pipes before hot water reaches the tap can be undesirably long. A pumped hot water circuit keeps the water in hot water supply pipes constantly recirculating and at a usable temperature. The system requires pipework to be installed in a loop. This option saves wastage of water, and also time waiting at a tap - however, keeping the circuit hot will use additional heat energy, so the circuits are usually timed to match hot water needs.

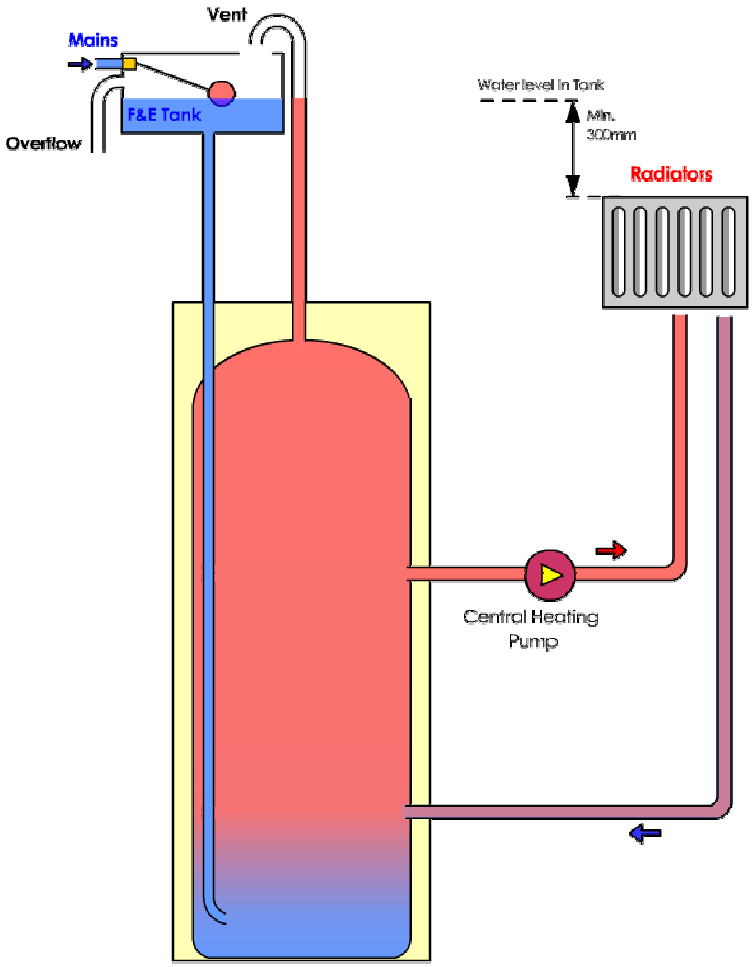
Central Heating

Radiators



Underfloor Heating

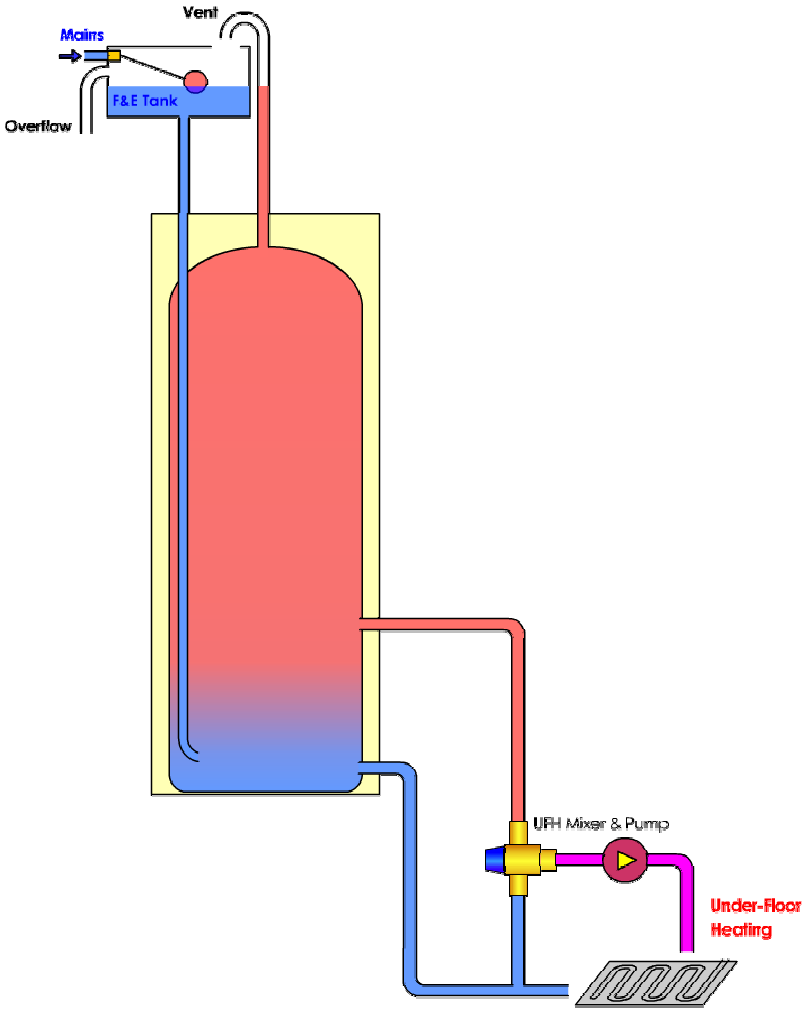
Central Heating, Radiators



- **Radiators are fed directly from the top section of the store**

- For multiple zones, more than one pumped circuit can be used,
or motorised valves can be used to zone.

Central Heating, Underfloor



- **Underfloor Heating is fed directly from the lower section of the store**

- Can be heated using low grade heat from solar or heat pumps, while top of store runs at higher temperatures

Central Heating

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Is the system to provide Central Heating ?

Yes

This is either using radiators or underfloor heating.

Area of Ground Floor ?

75m2

The area of a room can be roughly calculated from the width (in metres) multiplied by the length. For example: A house with a kitchen 3m x 5m, a living room 5m x 4m, and a hallway 2m x 6m, would have an area equal to 15 + 20 + 12, or 47 square metres.

Length of External Wall ?

20m

As heat is lost from a property through walls to outside, we need to know the length of exposed wall. Walls adjoining another property can be assumed to gain heat as much as they loose heat so can be discounted from these calculations (if next door property is occupied).

Room Height ?

2.4m

This is height between floors (floor to floor above, rather than floor to ceiling).

Number of Floors ?

1 Floor

Central Heating

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Average U Value of Property ?

Some Insulation, 1 W/m2K

This is a measure of how well insulated the property is. The lower the better.

More information...

Heating Degree Days in your location, for whole year ?

2500 Degree Days

This is a measure of how much heating is required to maintain the property at a desired temperature at a specific location. Use a value of 2500 for most calculations. The link below allows you to calculate alternative values.

More information...

Are you using Heat Recovery Ventilation

No

This is a system installed to allow air in a property to be refreshed without loosing valuable heat in the process. Warm air from within the property is pumped through a heat exchanger to outside, while at the same time fresh incoming air also passes through the heat exchanger, recovering the heat. As a great deal of heat can be lost through ventilation, such a system can have a large impact on a properties heating requirements.

Do you want to run an independent towel rail circuit

No

Enables a heated towel rail without the use of the main central heating circuit(s).

Central Heating

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How many square metres of floor area is heated by radiators ?

50m2

Floor area = 75 square metres (from your answers so far).

How many zones of radiators are there ?

1 Zone

It is usually beneficial to zone off the central heating system so that some rooms can be timed separately to others to reduce running costs. For example, bedrooms may not need heating during the day, and likewise, downstairs rooms may not need heating late at night.

How many square metres of floor area is heated by underfloor heating ?

25m2

Floor area = 75 square metres (from your answers so far).

How is underfloor heating temperature controlled ?

Controls on Manifold

Underfloor heating requires a lower temperature than radiators - if a floor gets too hot it can be dangerous to infants, and be uncomfortable to live with. It is usual for the underfloor heating manifold to be supplied with a temperature control valve, as well as a circulating pump. Alternatively, we can fit the valve and pump on the Heat Bank. Care should be taken not to 'double up'

Boilers

Gas and Oil

Biomass

Gas Boilers

Advantages

- Cheap Fuel
- Easy to Control
- High Grade Heat
- High Outputs from small compact boilers

Disadvantages

- Fossil Fuel
- Requires connection to Mains Gas Supplies
- No biomass RHI

Oil / LPG Boilers

Advantages

- No connection to mains gas supply
- Easy to Control
- High Grade Heat

Disadvantages

- Fossil Fuel
- On-site Fuel Storage
- Expensive Fuel Source
- No biomass RHI

Biomass Boilers

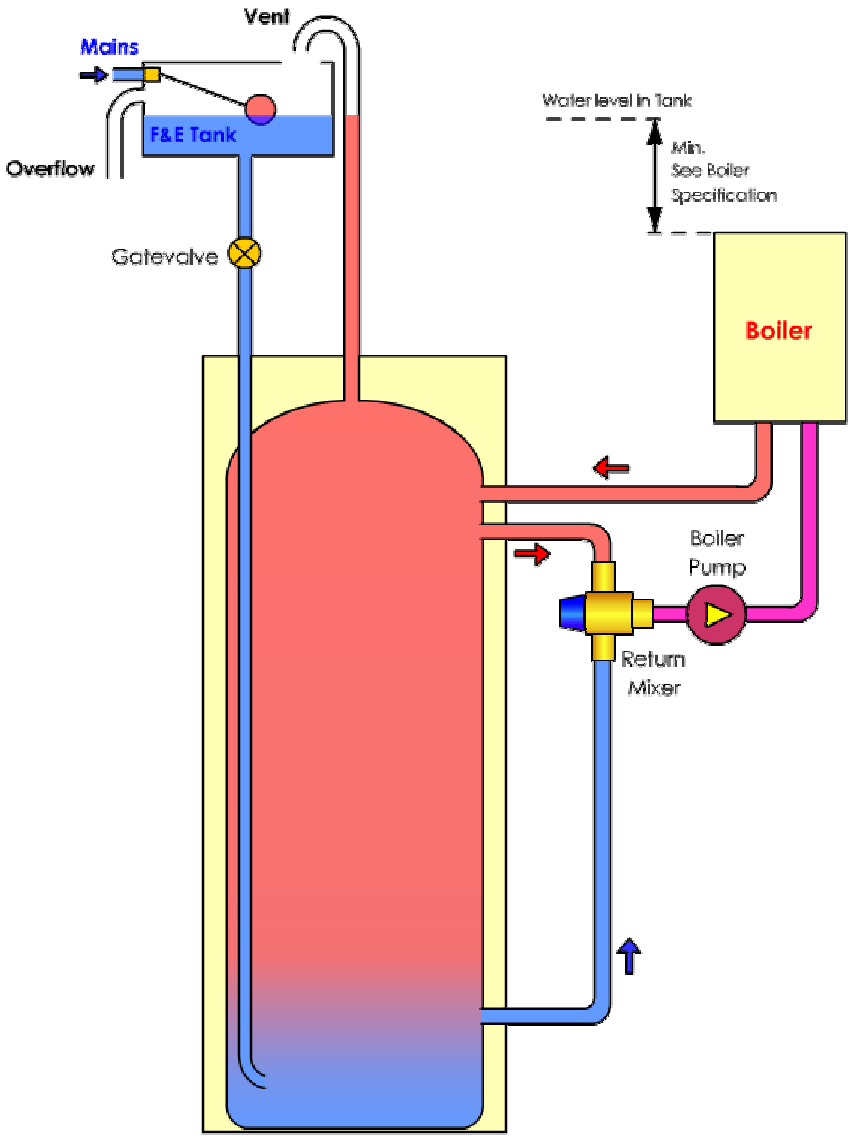
Advantages

- Low Carbon
- Low Cost Fuel
- High Grade Heat
- RHI payments

Disadvantages

- On-site Fuel Storage
- More hands-on than other boilers

Boilers



- **Connected Directly**
- Storage heated from the **top-down**
- Control over amount of store heated
- Return Temperature Control

Boilers

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Are you using a boiler ?

Yes

This can be gas or oil.

What type of Boiler are you using.

Regular Boiler

Are to tied to using a particular boiler - because you already own one for example.

What is the output of the boiler ?

15kW

This is used to size pumps and valves on the boiler circuit.

Boilers are typically sized to match peak central heating requirements, 3kW per person for hot water.

Estimated boiler output required is 14.045 kW

Wood Burners

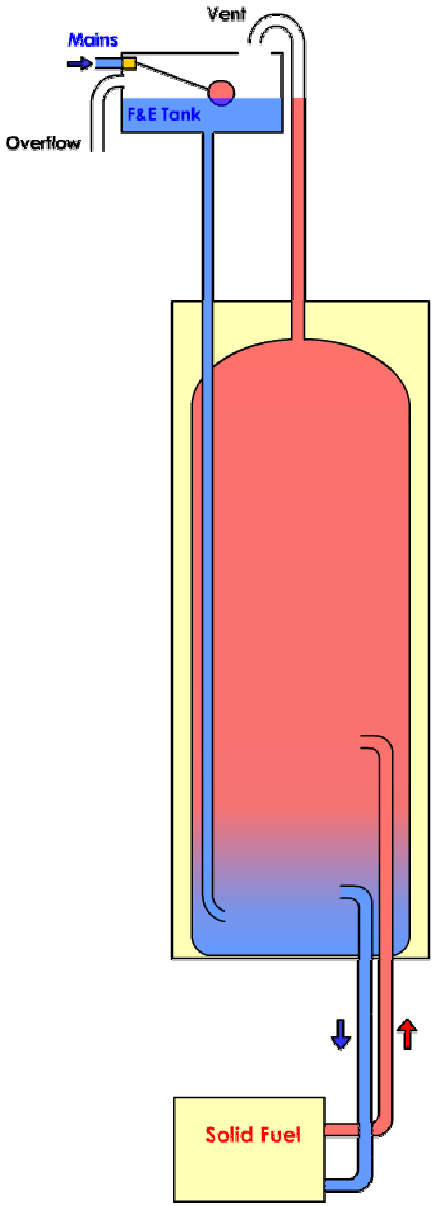
Wood Burners

Advantages

- **Zero Carbon**
- Can make use of locally sourced fuel
- High Grade Heat
- **Lowest Cost Fuel**
- Can operate without electrical supply

Disadvantages

- Uncontrollable
- Requires additional overheat protection
- Requires high level of user interaction
- No RHI but some form of “recognition” expected



Wood Burners

- Connected **Directly**
- No pump, uses **Gravity Circulation**
- Additional Overheat required (not shown)

Wood Burners

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Are you using a multifuel stove with a back boiler ?

Yes

Or any type of multifuel stove.

Where is the stove in relation to the hot water store ?

Directly Below (within 2m across)

This is important as it allows us to determine if gravity circulation (thermo-siphon) is possible, or whether a pumped wood burner system is necessary.

IT IS IMPORTANT THAT DURING ALL CONDITIONS (EVEN A POWER CUT OR PUMP FAILURE) THAT ALL HEAT GENERATED BY A WOOD BURNER IS REMOVED BY SOME FORM OF GRAVITY CIRCUIT. AT LEAST ONE PIPE MUST RISE CONTINUOUSLY FROM THE WOOD BURNER TO THE VENT PIPE.

With thermostatic wood burners, it may be necessary to install a heat leak radiator above the wood burner if pipework will not gravity the heat to the Xcel store. With manual wood burners a heat leak radiator may not be large enough, and we would offer a mains water heat exchanger to discharge hot water to drain.

What is the output of the stove to water ?

10kW to Water

Pick from selection.

What is the output of the stove to the room ?

5kW to Room

Pick from selection.

Wood Burners

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If you have selected a stove, does it throttle down its output when it gets hot ?

Manually Adjusted

Basic stoves will keep burning at the same rate even when they get very hot. More advanced models will shut down the air intake and reduce output when they get too hot.

Where will you source your logs ?

Free of Charge

How much do you intend to use the stove ?

Weekends

Heat Pumps

Air Source Heat Pumps

Advantages

- Easy to Install
- Easy to Control
- RHI Tariff

Disadvantages

- Electrical input required (20-90%)
- Low Grade Heat
- Less Efficient in Winter

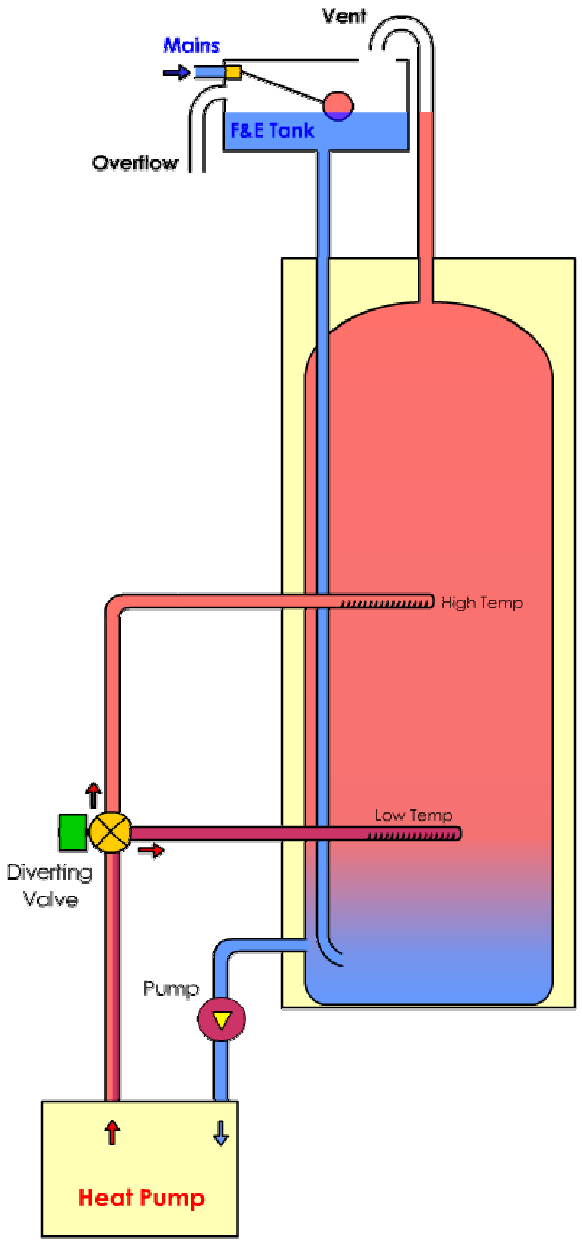
Ground Source Heat Pumps

Advantages

- Easy to Control
- Better Winter performance than Air Source
- RHI Tariff

Disadvantages

- Electrical input required (15-75%)
- Low Grade Heat
- Requires larger Electricity Supply
- Requires large Ground Area
- Major work



Heat Pumps

- Different levels of complexity
- Prefer direct connection, without anti-freeze
- Low temperature weather compensated heating
- High temperature hot water mode
- Diffuser tubes or baffle plates used to reduce mixing

Heat Pumps

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Are you using a heat pump ? Yes

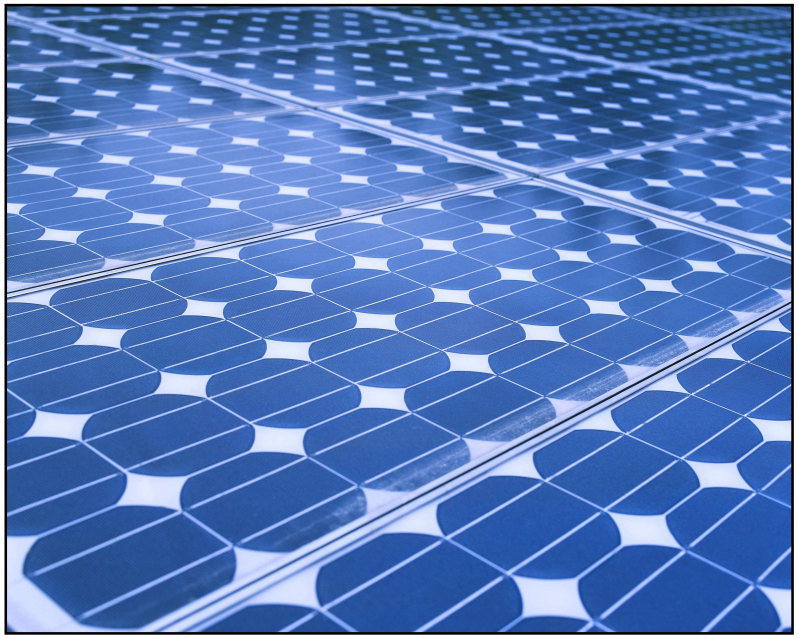
What type of Heat Pump ? Air Source

Pick from selection.

What size of Heat Pump ? 10kW

Pick the output in kW from the selection.

Solar Photovoltaic (Electricity)



Solar Photovoltaic (Electricity)

Advantages

- Free Energy
- Low Maintenance
- Feed In Tariff provides 10% return

Disadvantages

- Inefficient way of generating heat from the sun
- Expensive
- Limited by available Roof Space
- Highly Visible
  Permission often required

Solar Photovoltaic

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Are you using solar PV electric panels to generate electricity ? Yes

More information...

How many solar panels are you using ?
Please state total panel area. 16m2

What direction are the panels facing ? South

What elavation will the panels be ? 45°

More information...

Solar Thermal

Solar Thermal

Advantages

- Free Energy
- Low Maintenance
- RHI Tariff

Disadvantages

- Uncontrollable
- Seasonal Only 10% output in Winter
- Limited by available roof space
- Doesn’t cover central heating
- Highly Visible
  Permission often required

Solar Thermal

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Are you using solar thermal panels to heat water ? Yes

This refers to solar panels that generate heat (not electricity).

What type of solar panels are you using? Flat Plate (standard)

More information...

How many solar panels are you using ?
Please state total panel Aperture area. 4m2

If you have not yet sized your solar system, the required aperture area will be 0.6m2 and 1m2 per person, depending on the orientation and angle of the panel.

What direction are the panels facing ? South

What elavation will the panels be ? Pitched Roof

Extra Information

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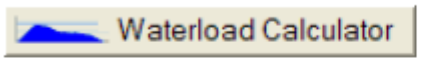
Size of store to be used ? 300 litre



The list here comprises of the standard units. Custom sizes are available on request.

Are their any particular size restrictions ? Maximum Width

Maximum Width ? 600mm

Is it possible to install a Feed and Expansion Tank ? Yes

Calculations

www.systemdesigner.co.uk

Calculations:

Hot Water:

Hot flow rate with all baths running = 36 litres/minute
Hot flow rate with all showers running = 10 litres/minute
Hot flow rate all outlets running = 46 litres/minute
Surplus of Mains Water Supply = 1 litres/minute
Allowance for Hot Water = 6 kW **HW kW**
Daily kWh (units) used for hot water = 7.6 kWh
Annual kWh used for hot water = 2774 kWh **HW kWh**

Heating Requirements:

Floor Area of Property = 75 m2
External Wall Area = 53 m2
Roof + Floor Area = 150 m2
U Value of Property = 1 W/m2K
Surface Area of Property = 203 m2
Heat losses through walls = 5.075 kW
Air Volume of property = 180 m3
Air changes each hour = 2
Ventilation Factor = 0.33 W/m3K
Heat losses from ventilation = 2.97 kW
Total Heat Input required for Heating = 8.045 kW **HTG kW**
Total Heating Area = 75 m2
Required Heat Emitter Density = 107 W/m2
Estimated Annual degree days for heating = 2500 degree days
Estimated Annual kWh heat losses = 12180 kWh
Estimated Annual kWh ventilation = 7128 kWh
Estimated Annual kWh used for heating = 19308 kWh **HTG kWh**

Heat Inputs:

Calculated Input required from heat sources = 14.045 kW **kW**
Input from Boiler = 15 kW
Input from Heat Pump = 10 kW
Input from Stove = 15 kW
Total Input from all switchable heat sources (boiler & heat pump) = 25 kW
Total Input from all heat sources (boiler, heat pump & stove) = 40 kW
Surplass input at full load central heating = 31.955 kW
Surplass input at full heating and hot water = 25.955 kW
Total kWh per year , hot water and heating = 22082 kW **kWh**

Wood:

kWh (Units) of Heat per Kg of wood, given 4.1kWh/Kg and 80% boiler efficiency = 3.28 kWh
Kg of wood burnt each hour at full output = 4.573 Kg
Kg wood required to supply daily hot water = 2.317 kg
Kg wood required to supply hot water for one year = 845 Kg
Kg wood required to supply heating for one year = 5886 Kg
Maximum daily wood use = 0.5 hours
Maximum daily wood use = 2.286 kg
Cost of wood per tonne = 0 £
Cost of wood per kWh = 0 £
Annual Cost of hot water using 50% wood, 50% solar = 0 £
Annual Cost of heating using 100% wood = 0 £

Gas:

Cost of mains gas per kWh, given 90% boiler efficiency = 0.039 £
Annual Cost of hot water using 50% gas, 50% solar = 54.093 £
Annual Cost of heating using 100% gas = 753 £
Annual Cost of DHW and heating using 100% gas = 861 £
Carbon Emmisions for Gas = 0.206 kg/kWh
Carbon Emmisions of DHW and heating using 100% gas = 4548 kg CO2/year

Solar:

Feed In Tariffs:

Payment per kWh generated though solid biomass (boilers only) = 0.09 £
Cash Paid for full years heating using biomass = 1737 £
Cash Paid for full years hot water using biomass = 249 £
Payment per kWh generated though solar thermal = 0.18 £
Cash Paid for 50% annual hot water using solar = 249 £
TOTAL ANUAL TARIFF PAMENT = 2235 £

The calculations are best estimates, and should be confirmed by alternative means.

Calculations

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The calculations highlight potential problems with the design

Hot Water:

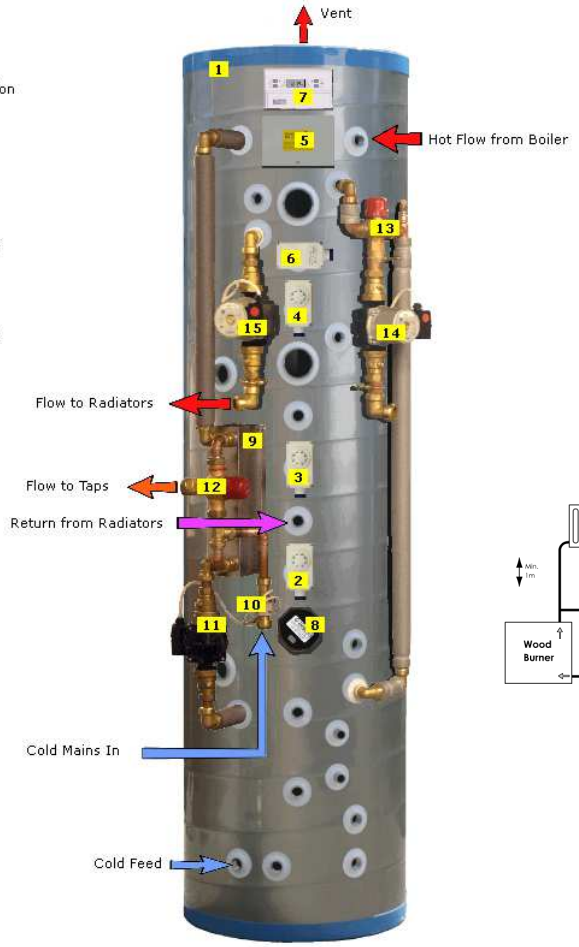
Hot flow rate with all baths running = 36 litres/minute
Hot flow rate with all showers running = 10 litres/minute
Hot flow rate all outlets running = 46 litres/minute
Surplus of Mains Water Supply = -15 litres/minute **Water Boosting Equipment Required**
Allowance for Hot Water = 6 kW **HW kW**
Daily kWh (units) used for hot water = 7.6 kWh
Annual kWh used for hot water = 2774 kWh **HW kWh**

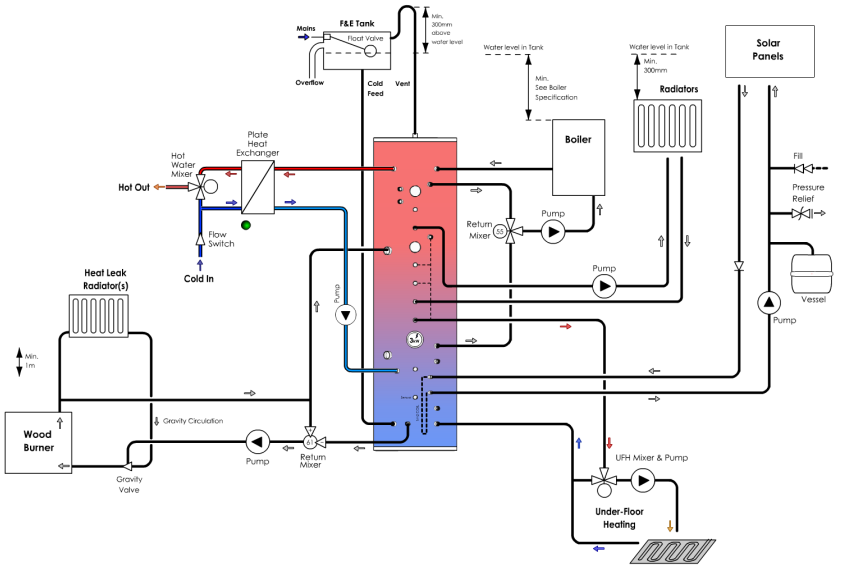
Heat Inputs:

Calculated Input required from heat sources = 28.03 kW **kW**
Input from Boiler = 15 kW
Input from Stove = 4 kW
Total Input from all switchable heat sources (boiler & heat pump) = 15 kW
Total Input from all heat sources (boiler, heat pump & stove) = 19 kW
Surplass input at full load central heating = -3.03 kW **You need more heat input to run central heating.**
Surplass input at full heating and hot water = -9.03 kW **You need more heat input to run full heating and hot water together.**
Total kWh per year , hot water and heating = 55646 kW **kWh**

X2009-1A:300 litre Xcel Thermal Store
X2009-2:For provision of hot water up to 45 l/min.
X2009-9:To provide overheat protection (90°C settable) by turning on radiators.
X2009-13:To provide (power-free) overheat protection (95°C locked) by discharge of hot water to drain.
X2009-5:Boiler temperature control valve.
X2009-11B:Standard pump for boiler circuit.
X2009-7:Second thermostat to provide buffered operation of boiler.
X2009-8:Economy thermostat to provide economy (summer) mode operation using boiler.
X2009-18A:Two channel programer to control summer/winter operation using boiler.
X2009-11A:Standard pump for towel rail or radiator circuit.
X2009-16A:3kW Electric Element.
X2009-10:Additional Sensor Pockets (for solar).
X2009-17:Temperature Gauge.
DELIVERY:Delivery Charges
FE450x450FIT:Feed and Expansion Tank, with fitted Float Valve and Copper Float.

1. Xcel Heat Bank Cylinder
2. Control Thermostat 65C
3. Buffer Control Thermostat 50C
4. Economy Control Thermostat
5. Wiring Centre
6. Overheat Thermostat 90C
7. Programmer, 2 Channel
8. Immersion Heater 3kW
9. Plate Heat Exchanger, IC8x40
10. Flow Switch
11. Heat Exchanger Pump, Wilo RS
12. Thermostatic Mixing Valve, 28mm
13. Thermostatic Boiler Valve, 28mm
14. Boiler Pump, Wilo RS
15. Radiator Pump, Wilo RS





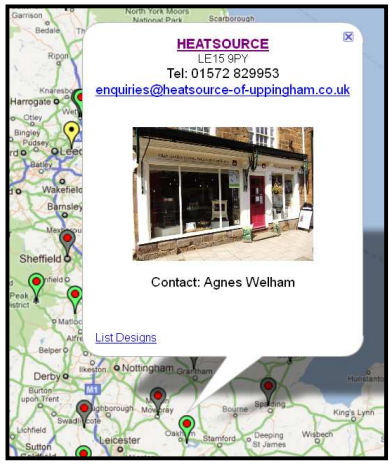
Prefabricated Design

Schematic Design

What to do next ?

Once you have a design finished, why not go and have a look at a fully working example ?

Over 30 Working Display Centres Nationwide



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