Annex 1 – Input Assumptions

In setting tariffs DECC has used a large dataset of performance and cost data for a large number of building types. This data is disclosed in full in the accompanying spreadsheet to this IA, and these annexes are intended as a guide to that data and how it is used. Throughout, a single example has been provided.

Property Types

Firstly industrial, commercial and public sector dwellings are split over the following characteristics:

Counterfactual Fuel	Sector Sub-Segment	Location	Building Age & Insulation Type
Electricity Gas Non net bound	Large private Dry Large private Wet Large public Dry Large public Wet Large high temperature process Dry Large high temperature process Wet Large low temperature process Wet Large, space Dry Large, space Wet Small private Wet Small public Wet Small high temperature process Dry Small high temperature process Wet Small low temperature process Wet Small, space Dry Small, space Wet	Urban Rural Suburban	Solid Wall (insulated) Solid Wall (uninsulated) Pre 1990 (insulated) Post 1990 (uninsulated) Pre 1990 (insulated) Post 1990 (uninsulated) New Build

Example: Here we present the example of an insulated pre-1990 commercial, large, private property which is in an urban setting. The commercial building has gas as the counterfactual fuel and wants to install an air to water heat pump in 2013.

Input Data

For each technology and for each of the combinations of characteristics listed above, the spreadsheets list DECC's assumptions (for both the renewable technology and the existing 'counterfactual' technology).

These assumptions are largely taken from work carried out for DECC by AEA. The input assumptions in the accompanying spreadsheet are labelled by source. The majority are taken directly or derived from AEA data, however in places adjustments have been made such as a review of efficiency assumptions by DECC. For more information on how data was derived see the AEA report. The assumptions provided are:

- Capex per kW
- Fixed Opex per MWh
- Efficiency
- Capacity

- Lifetime
- Annual heat output
- Technical Potential

In addition to these the spreadsheet details, again for each technology and combination of building characteristics, the following estimates:

- Fuel Cost per MWh
- Upfront Risk (implicit) Barriers per MWh
- Upfront Hassle (explicit) Barriers per MWh
- Ongoing Hassle (explicit) Barriers per MWh

These costs are shown as levelised values (the present value divided by the lifetime output of the technology).

The levelised fuel cost has been generated according to the profile of energy use and DECC carbon and fuel price projections over the lifetime of the technology. These fuel and carbon values can be found on DECC's website.

Also shown as an input assumption is the technical potential of each technology for each combination of building type. This has been generated using DECCs Updated Energy Projections (UEP) data, English Housing Survey Data and AEA's assessment of suitability [which will be published separately shortly]. These have been used to generate an estimate of the number of buildings of each type, the amount of heat used in those buildings over time, and the percentage of each building type which is suitable for each technology.

Finally, as costs and performance are being considered over a 20 year period, and DECC projects building energy to fall over this period, an adjustment factor has been calculated which adjusts down the average energy use of the building, to reflect that insulation standards are expected to rise over the 20 year period.

<u>Example:</u> For a pre-1990, commercial, large private property which is in an urban setting has gas as the counterfactual fuel and wants to install an air-to-water air source heat pump in 2013, the following data is used (all costs are in 2012 prices).

Characteristics of Air-to-Air Air Source Heat Pump	
Capex (£/kW)	619.65
Opex per (£/MWh)	1.55
Efficiency	320%
Capacity of heat pump (kW)	300
Lifetime of heat pump (years)	20
Annual heat output (MWh)	919.80
Fuel Cost (£/MWh)	47.68
Characteristics of Existing Gas System	
Capex (£/kW)	73.63
Opex per (£/MWh)	0.79
Efficiency	90%
Capacity of existing system (kW)	525
Lifetime of existing system (years)	20
Annual heat output (MWh)	919.80
Fuel Cost (£/MWh)	53.51

Net Cost of Barriers	
Net Levelised Upfront Implicit Barriers (£/MWh)	0
Net levelised upfront explicit barriers (£/MWh)	0.41
Ongoing Hassle (explicit) Barriers (£/MWh)	0.08
Additional Inputs	
Efficiency factor	0.93

Annex 2 – Tariff setting methodology

The methodology that DECC has used to calculate tariffs is to identify the amount of subsidy per kWh required to compensate for the difference between the lifetime costs of renewable heating technologies and the lifetimes costs of counterfactual technologies. We have carried this calculation for each technology and each building type, which can be found in the accompanying spreadsheet. These calculations are described in detail and worked through using our example of an air-to-air air source heat pump below. This can be followed in row 108 of the accompanying spreadsheet (published alongside this IA on the DECC website).

Please Note: there are some exceptions where this methodology is slightly different for example for Solar Thermal, no counterfactual capex is considered. For electric heating the cost of water heating is added to the counterfactual. These differences are shown in the spreadsheet calculations.

1. <u>Calculating a levelised cost</u>

In setting tariffs DECC has calculated the levelised cost, and the tariff required to offset additional costs, for each technology in each building type.

The spreadsheet shows these calculations.

The levelised cost of a renewable technology is the present value of all costs and benefits of the renewable technology divided by the lifetime energy output of that technology. This gives a cost figure expressed in £/MWh, which essentially demonstrates the cost of producing a unit of energy using that technology, by spreading out all the associated costs across all the heat produced.

The net levelised cost of a renewable technology is the levelised cost of the renewable technology minus the levelised cost of the counterfactual technology.

In calculating RHI tariffs we have examined this net levelised cost as we aim to compensate for the additional costs of installing renewable heat only, for properties that need to replace their existing heating equipment.

In calculating a levelised cost DECC has assumed an average cost of capital 12%.

The spreadsheet, and the example below, detail the calculation further.

<u>Example:</u> For the air source heat pump, using the values in the table in Annex 1, the levelised cost is calculated as follows:

First the heat output of the heat pump is adjusted to account for increases in efficiencies of the property (e.g. insulation) over time. This is shown below:

(1)

(2)

Following this the annuitised capital expenditure is calculated over the lifetime of technology using equation 3 and a rate of return equal to the cost of capital, 12%.

(3)

$= \pounds 82.96/kW$ (4)

From this the levelised capital expenditure (capex) of the heat pump can be calculated.

(5)

(6)

The same calculations are carried out to calculate the capital expenditure of the counterfactual technology.

(7)

(8)

(9)

If the technology had a counterfactual fuel of electricity additional calculations would need to be carried out relating to the introduction of a wet heating system and because modelling in some instances assumes that if, for example, electric heating could be replaced by an air source heat pump, it could also have been replaced with a gas or oil boiler, and as such, these should form the counterfactual cost. These steps can be found in the “Upfront CF Capex” sheet of the spreadsheet.

Using the values from the table in Annex 1, the total costs of the heat pump and the counterfactual (CF) technology, per MWh, are calculated below.

(10)

(11)

(12)

2. Calculating the required tariff

We then need to calculate the net cost which is the difference between the total costs. In calculating the net costs we also need to consider the non-financial barriers associated with installing the renewable heat technology and the counterfactual.

For the air source heat pump the net upfront explicit barriers (e.g. admin burdens, demand side barriers and inconvenience to the property owner/occupier) are calculated to be £0.41/MWh. The upfront implicit barriers (e.g. perceived risk barriers) are zero for air source heat pumps. These have been calculated using a rate of return of zero, as they are non-financial costs and as such, no cost of capital should apply to them. More detail on how these have been calculated can be found in annex 3.

The ongoing explicit barriers for the renewable technology are the recurring admin and demand side barriers. For an air source heat pump in this specific building type this is estimated to be £0.08/MWh.

The net cost is then calculated as follows:

(13)

(14)

The non-domestic scheme differs from the domestic scheme, as the subsidy is paid over the lifetime of the property. In the domestic scheme a shorter payment period is used to overcome some of the barriers that cause home owners to demand high future compensation in order to make early capital investments.

The net cost is also the *required tariff* for that technology.

3. Establishing a Cost Curve

Having established the net cost for each property type, the next step is to establish a cost curve for 2013. For this we use the technical potential of the renewable technology. The technical potential is the number of the dwellings of each property type which will be replacing their heating system in 2013 for each building type, multiplied by the proportion of that property type which is considered suitable for that technology and the average heat use of each property.

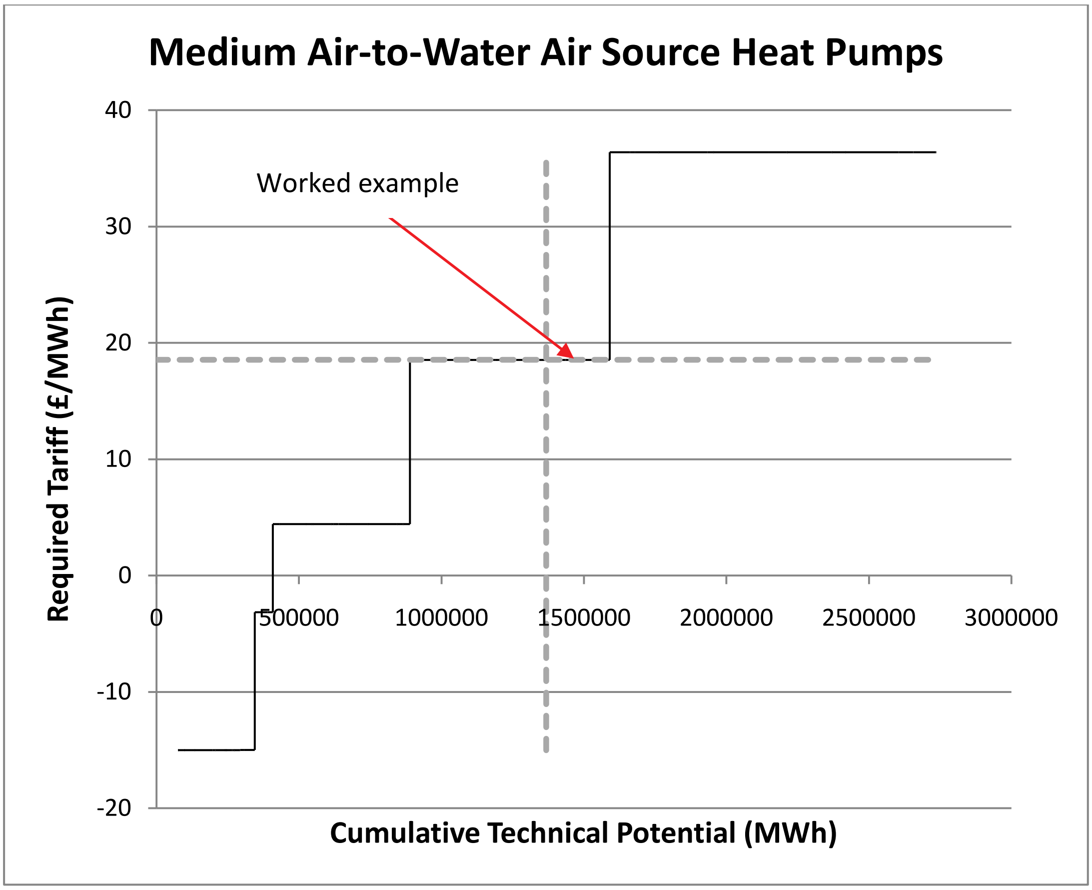
For each technology, we take all the *required tariff* data, for all the different property types, and match them with the technical potential for that property type[1].

We order this data by the net cost, so the lowest cost opportunities are first, and plot this with the cumulative technical potential to form a cost curve.

Example: For air-to-air air source heat pumps we take the net cost in 2013 and technical potentials for all property types which could install a medium size air source heat pump. We then order the data in terms of net cost, with the lowest net cost (and therefore the most cost effective) technology first and the highest net cost last. The technical potential is then converted to cumulative figures by considering the technical potential of all the property types which have a lower cost.

The cost curve for all medium air source heat pump is shown below.

[1] This is a slight simplification to the more detailed methodology which excludes barrier costs when deriving the cost curve and adds them back in for the final tariff calculation. For this worked example we have not included these steps, but it makes only a very marginal difference.



The steps in the curve are different building types. The length of the step is how much renewable heat could be produced by that property type and the height of the step indicates it's cost per MWh.

The arrow on the graph indicates where our worked example is on the curve. For medium air-to-air air source heat pumps, the required tariff is also at around 0.97p/kWh.

4. Setting the Final Tariff

The tariff is then taken as the median cost opportunity. This is the net cost half way along cost curve which refers to the cost associated with half the technical potential of that technology.

For the medium air source heat pump curve, the 50th percentile is at 1,368GWh which corresponds to £18.5/MWh. This is shown of the graph above by the dashed lines.

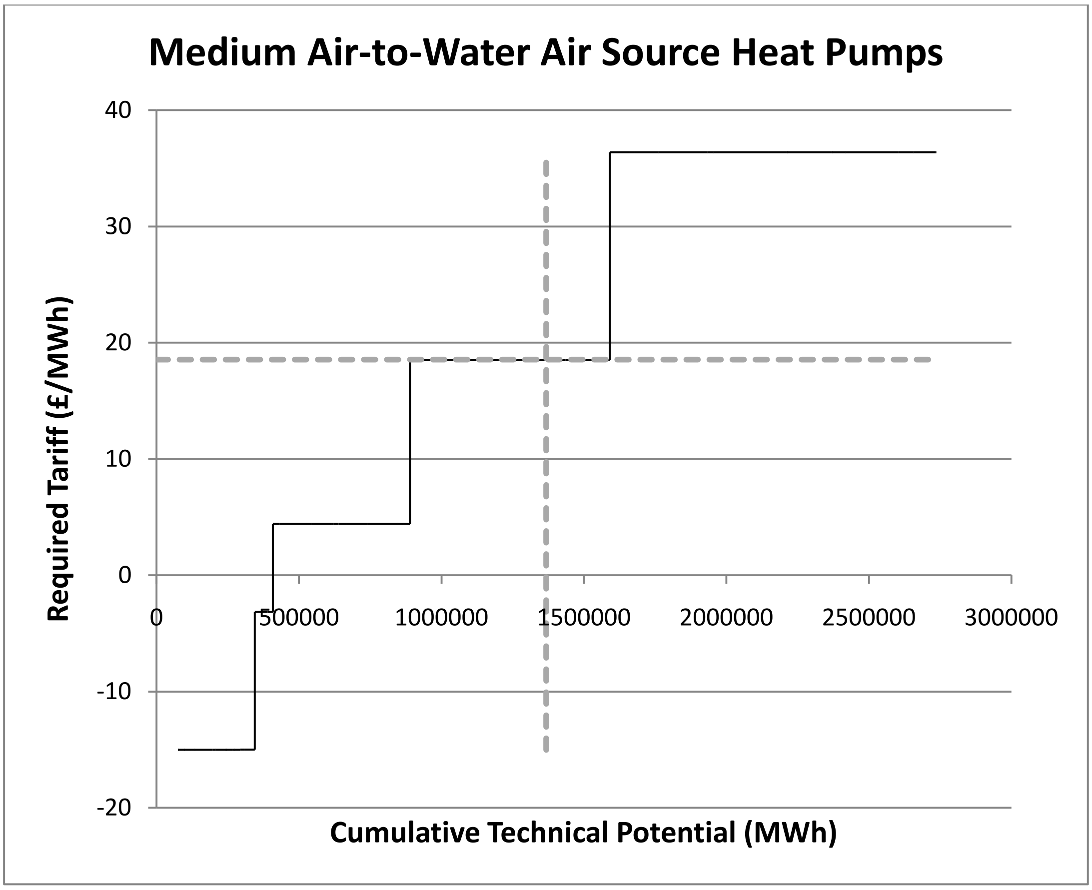
The maximum subsidy rate is capped which is equal to the levelised cost off-shore wind (£89/MWh). If the median net cost (the point halfway up the cost curve) is greater than this levelised cost then the capped subsidy is used. In this instance the tariff is lower than the capped subsidy so we use this is the tariff for all medium air-to-air air source heat pumps.

For our example, the air source heat pump is at the same net costs as the median point on the cost curve, which means that all of the additional costs of installing the air source heat pump in that property type will be compensated by the proposed subsidy.

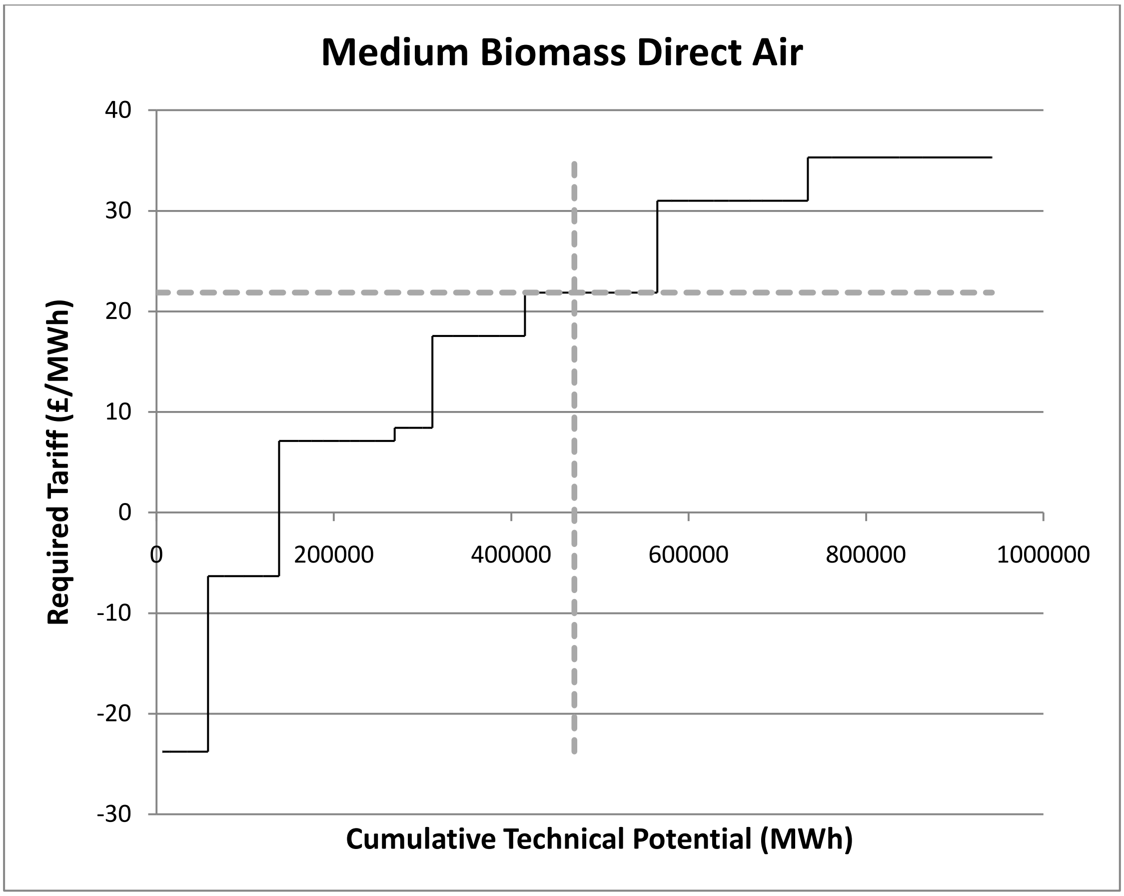
Annex 3 – Cost Curves

The following are the estimated cost curves for air-to-water heat pumps and biomass direct air all opportunities, with costs displayed as tariffs.[2]

Each graph represents the cumulative potential (MWh) of renewable heat that could be incentivised at each price in 2013 (first year of the scheme). The dotted lines show the cost and position on the cost curve of the 50th percentile (the median cost opportunity) for the full UK non-domestic potential.



[2] The Air to Air cost curve is currently not available.



Medium Biomass Direct Air
Required Tariff (£/MWh)
40
30
20
10
0
-10
-20
-30
0
200000
400000
600000
800000
1000000
Cumulative Technical Potential (MWh)