Update of non-PV data for Feed In Tariff

Department of Energy & Climate Change

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PARSONS BRINCKERHOFF

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Prepared by
Parsons Brinckerhoff

www.pbworld.com

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Prepared by	**:**	**Andrew Price, Thomas Mills, James Munro**
Checked by	**:**	**Daniel Dufton, Kimberley Dewhirst .....**
Approved by	**:**	**Richard Wearmouth .....**

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1 INTRODUCTION

1.1 Context

The Department of Energy & Climate Change (DECC) appointed Parsons Brinckerhoff (PB) to update the cost and performance inputs for non-solar PV technologies used in DECC's model for the UK Feed-In Tariff (FIT), as part of the "Consultation on Comprehensive Review Phase 2B: Tariffs for non-PV technologies and scheme administration issues" [1]. These costs had been provided previously by PB in association with Cambridge Economic Policy Associates in November 2011. This report provides updated cost and performance data.

The technologies covered in this update are wind, micro CHP, anaerobic digestion (AD) and hydroelectric.

The project work and data gathering presented in this report took place between 23rd April and 18th May 2012.

1.2 Report structure

After this introduction and a description of the methodology used, this report is separated into sections for each individual technology. For each technology, we then discuss the updates that have been made to the following parameters (along with other additional factors relevant to each technology):

- Technology size
- Export fraction
- Capex
- Opex
- Load factor
- Technical Potential
- Lifetime

Appendices at the end of the report contain references, the updated cost and performance tables and an indication of the range of capex data used for each technology and size band.

[1], http://www.decc.gov.uk/en/content/cms/consultations/fits_rev_ph2b/fits_rev_ph2b.aspx

2 METHODOLOGY

2.1 General

PB used a number of different sources to update the cost and performance data provided in this report, including:

- market intelligence received from DECC (both formal responses to the consultation on Phase 2B of the FITs Comprehensive Review and data received through other channels);
- data on actual capital costs for recent installations, and recent quotes for proposed installations, sourced from a number of different companies;
- consultation with experts from the industry, including installers, manufacturers, and industry associations;
- PB's own recent project experience

The cost data sourced for this report is summarised in Appendix F. In a number of cases, data was provided on the basis that it would remain anonymous. Given that for some technologies and size bands there are a very limited number of installations and/or suppliers, we have not identified the individual data points used as this would not have assured anonymity. Appendix F therefore presents the number of sources and data points used and the range of data provided.

For each installation size band within each technology, we have derived central, low and high case values for current capex and opex. Where possible, we have used the median value to derive the central case, while the low and high values represent the 1st and 3rd quartiles of the data (i.e. 25 and 75% of the range respectively). In some cases, the nature of the data set available for each band meant that the use of median and/or quartile values was not appropriate and in such cases we have used judgement to derive representative central, low and high values.

For technologies and bands where MCS accreditation applies, only data for MCS accredited equipment was considered.

In all cases, the central value represents what we consider to be a typical value in the current market. It should be noted, however, that technologies such as hydro are highly site-specific and so a typical value simply represents a "middle-of-the-range" project, with both higher and lower values being equally valid.

We have also updated the future cost projections for capex and opex. For wind, AD and hydro, the industry views received indicated that costs would be broadly stable (in real terms) and we have therefore developed high, medium and low cases for future costs based on an assessment of these views and our own analysis. For micro CHP, which is a less mature technology where significant learning is expected in the future, we have used experience from more developed markets alongside industry views to derive future cost scenarios.

The current and future cost estimates have been used to provide three scenarios – central, high and low – as shown in the data in Appendices B to E.

In general, significantly more cost data has been available from industry for this update of the report and many of the changes in the cost and performance values presented here are a result of this more extensive data set.

Note that the data in our previous report expressed costs in 2010 prices. The data presented in this update is in 2012 prices. Where data from our previous report is quoted, this has been adjusted to 2012 prices[2]

[2] Conversion from 2010 to 2012 prices by increasing all values by 10% as agreed with DECC

3 WIND

3.1 Technology size

The typical system sizes for each band have not been altered in this update. We would however note the following points:

From our research for this update and feedback from industry, there are currently no turbines available in the UK in the <1.5kW band that are MCS accredited and thus eligible for the FIT. A number of industry consultees recommended that this band be amalgamated into the 1.5-15kW band.

We received a number of comments that using rated capacity to define the FIT bands was undesirable due to the incentive this provides to down-rate turbines to qualify for higher tariffs, possibly without adequate testing. To mitigate this risk, two alternative banding methods were suggested:

1) The use of the swept area of the turbine. This was considered a more representative indicator of potential power output than nameplate rated capacity.

2) The use of energy output over the course of a year. For example, the first 100,000 kWh is given the highest rate, and then the subsequent bands have a gradual digression of the tariff as more energy is generated.

3.2 Export fraction

Export fractions have not been changed as part of this review.

3.3 Capex

3.3.1 Current

The current capex data generally shows increases compared to our previous report, especially for the smaller bands.

Band	Previous report central case capex (£ 2012 / kW)	Current report central case capex (£ 2012 / kW)
1.5–15kW [3]	4,540	5,250
15–50kW	3,850	4,200
50–100kW	3,580	4,500
100–500kW	2,750	3,000
500–1,500kW	2,200	2,200
1,500-5,000kW	1,930	2,000

We believe that these changes are primarily a result of the larger data set available for this update of the report, resulting in costs that more accurately reflect current

[3] Note that in the detailed cost data in Appendix B we have divided costs for the 1.5-15kW band into a fixed £/installation element and a marginal £/kW element. See Appendix B for details.

market prices for available UK turbines. There are also some indications that cheaper, poorer performing small turbines are no longer on the market, raising the typical costs in the smaller size bands. There may also be an impact from increases in raw material prices.

The data gathered showed that capex on a £/kW basis is currently higher for the 50-100kW band than for the 15-50kW band. This is reflected in the capex values derived for this report. This appears to be a genuine difference based on actual prices for the limited number of turbine models currently available in these bands. Recent market analysis work by Renewable UK also showed some indications of a similar trend[4].

3.3.2 Future

Our medium scenario for future wind capex is for costs to remain flat in real terms. This is in agreement with the majority of industry views gathered during this update, although a number of stakeholders expressed concern on the impact of increasing costs for metals and other commodities. Our high future cost scenario shows an increase in capex over time, representing a situation where costs increase above general inflation as a result of increasing commodity prices. In our low future cost scenario, capex decreases slowly from 2017 onwards as a result of industry growth and some economies of scale being achieved.

These cost trends are slightly different to those in our previous report, where our medium scenario showed costs as initially flat, then declining slowly from 2016 onwards. This reduction now appears less likely and it is therefore represented by our low scenario in this report.

3.4 Opex

3.4.1 Current

Opex cost values have decreased compared to our previous report, with the exception of the 1.5-15kW and 100-500kW bands where costs are higher.

For the 1.5-15kW band, the evidence gathered for this update showed that more extensive maintenance is being carried out on installations of this size than previously assumed, and the updated costs reflect the significantly higher cost that this entails.

For the other size bands, our view is that the reduced values are likely to be as a result of the larger data set available for this report more accurately reflecting current costs. There may also be an impact from the growing number of FIT wind installations and resulting economies of scale in terms of O&M provision.

The data shows that opex in £/kW/yr is higher for the 100-500kW band than for the 50-100kW band, and this is reflected in the values derived for this report. This appears to be a real difference, with consistency across a number of different sources however there is a wide range in the data (reflected in our low/high opex values) for both these bands which implies a significant degree of variability.

3.4.2 Future

Our medium case scenario for future opex is for a slight decrease over time as the sector expands further and economies of scale and competition help to reduce costs.

[4] http://www.bwea.com/pdf/publications/RenewableUK_SMWMarketReport2012.pdf

This is in line with views expressed by industry. In our high future cost scenario, opex costs remain flat representing the case where there is less expansion of the market and so limited potential for cost reduction.

3.5 Load factor

There have been modifications to the load factor[5] since our last report. The table below shows the central case values for a 6 m/s wind speed at 45m AGL (above ground level) which we understand to be the data used by DECC in setting tariff levels. Unlike our previous report, actual turbine hub heights were used, rather than an assumed hub height for a particular turbine band. This provides a more accurate representation of the actual load factors that can be expected for different turbine sizes on a specific site. For the calculation of the high, low and central values, the upper and lower quartiles, and the median were used.

Band	Previous report central case load factor at 6 m/s, 45mAGL	Current report central case load factor at 6 m/s, 45 mAGL
1.5–15kW urban	13%	13%
1.5–15kW rural	17%	17%
15–50kW urban	13%	14%
15–50kW rural	16%	17%
50–100kW	16%	19%
100–500kW	18%	20%
500-1500kW	24%	22%
1500-5000kW	24%	25%

(data rounded to nearest 1%)

The load factors were calculated using the actual power curves for turbines which are available for installation in the UK in each band and for which cost data was available, thus providing a link between the cost and performance data in this report. The nominal wind speed bands in DECC's model (5.5m/s, 6m/s etc.) were taken to be the wind speeds at 45m AGL (metres above ground level). The wind speed for each band was then extrapolated to the actual hub height of each of the turbines assuming a wind shear coefficient of 1/7. Therefore the actual wind speeds used to calculate the load factors are different to the values of the bands in the model (i.e. lower for smaller turbines with hub height <45mAGL, higher for larger turbines with hub height >45mAGL). Loss factors were applied to the theoretical output from the power curves to account for wake effects, electrical losses, downtime for maintenance etc. These loss factors were:

- 0.88 for turbines above 500kW
- 0.82 for turbines 100-500kW
- 0.78 for turbines < 100kW

[5] Load factor for wind is more commonly described as capacity factor and is calculated as (actual output over a year)/(turbine capacity x 8760 hours per year). The term load factor is used here for consistency with the rest of the report.

The lower values for smaller turbines reflect the greater likelihood of nearby obstructions affecting the air flow and for the generally lower availability expected for the smaller machines.

Additional reductions were made for turbines in urban areas based on our judgement of likely further reductions in output for turbines located in urban areas. The difference between rural and urban load factors is the same as our previous report.

The main reason for the increase in capacity factors in most bands is that the turbines currently available for installation in the UK in each band have higher capacity factors compared to previous turbines considered. Additionally, more power curve data has been available than previously and therefore the results are based more on actual calculations and less on estimation.

The calculated load factors were checked against actual generation data for FIT wind installations. The most recent data available was from the DECC website[6] for generation in 2010/2011. Using the Ofgem register of FIT installations[7], we derived the average capacity of existing installations in each band and used this in combination with the DECC generation data to estimate average output for an average turbine in each band, i.e. a typical load factor[8]. This shows an average load factor of 16% for the 1.5-15kW turbines, close to our central case value at 6m/s. For 15-100kW turbines, the DECC data indicates a 17% load factor. As the majority of installed turbines in the 15-100kW range are < 50kW, we have considered this as being representative of turbines in the 15-50kW band where it is in line with our central case value.

There was insufficient generation data available to allow the same approach to be used for turbines above 100kW. The recent Renewable UK report for the small and medium wind market[3] provides expected total capacity and generation for a range of turbine size bands. This implies load factors of 17% for 15-100kW turbines and 20% for 100-500kW turbines, similar to our values.

Note that there are a very limited number of turbines available in the 50-100kW size range in the UK. The data received for these machines indicates that a relatively high level of performance (reflected in the load factor) in return for a relatively high cost, as described in section 3.3.1.

For the 100-500kW band, the available turbines appear to fall into two groups in terms of performance – one group with modelled load factors around 16-17% and the other with load factors in the 27-30% range. From analysis of the Ofgem FIT register, these groups appear to be equally represented in the population of currently installed turbines. We consider that a 20% load factor is a reasonable average value for this band.

3.6 Technical potential

The technical potential for wind has not been changed in this update.

[6] http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/source/fits/fits.aspx , table ET5.7
[7] Feed In Tariff Installation Report 31 March 2012, downloaded from http://www.ofgem.gov.uk/Sustainability/Environment/fits/Pages/fits.aspx
[8] Load factor = (total generation in that size band)/(number of turbines in that band x average turbine capacity in that band x 8760)

3.7 Lifetime

The installation lifetimes for wind have not been changed in this update.

3.8 Job creation

As part of this update, DECC requested that we provide indications of the UK employment potential in the small wind sector (turbines < 100kW capacity). The number of employees in companies we spoke to during this work ranged from 5 to approximately 250, and two thirds of the companies willing to discuss future employment figures believed that they would be employing new staff before the end of 2012 (none expected that they would have staff reductions). The sample of employers giving employment data currently employ 444 staff in total, which they expected to increase to approximately 522 by the end of the year, an increase of 18%. Most companies also anticipated employee numbers continuing to grow beyond the end of this year. It should be noted that the majority of employers indicated that this employment growth is dependant on the future of the FIT.

These roles include operation and maintenance, sales, installation and manufacturing. For every person employed directly within the wind industry, it was suggested that there were between 3 and 4 indirect jobs, for example in component supply and environmental and legal consultants.

These findings are in line with those of a recent Renewables UK study[4] on the future employment intentions of the small and medium wind industry in the UK.

According to a recent REA report[9], there were approximately 15,200 people working in the UK onshore wind sector in 2010/11. Although it was not possible to directly derive the proportion working in the small wind sector, their assumed annual growth of 15.7% is in line with our estimate above.

A number of manufacturers contacted during this study, who focus on turbines in the 1.5-100kW range, indicated that they want the UK to become their future base of operations for the EU. The reasoning behind this is that they have recently experienced an increase in the number of enquiries from the EU and North America, and believe that this indicates a strong export potential. Those that were consulted believed the reason for this is that the UK is seen as a market leader in the manufacture and installation of turbines within these size bands.

[9] REA, 2012, Renewable Energy: Made in Britain

4 MICRO-CHP

4.1 Technology size

The central technology size value of 1kWe has remained unchanged in this update. The low and high values have been adjusted (reducing the overall range for both fuel cell and Stirling engine mCHP) based on existing technology ranges.[11]

4.2 Export fraction

Based on feedback from industry stakeholders, the central and high case export fractions for both Stirling engines and fuel cells are unchanged compared to our previous report. The low case value has increased slightly (10% to 20%).

Stakeholders agreed that using a broad range of possible export fractions for Stirling engine mCHP is appropriate. As the technology is heat led, it may be generating at times when there is low electrical consumption, for example when the heating comes on early in the morning. As such, there could be a fairly large proportion of generation exported with Stirling engines, depending on the heating usage patterns of the household and the thermal efficiency of the dwelling. Alternatively, a household with a high level of daytime occupancy may generate a lot more electricity, but would export very little of it as a proportion of total generation.

For fuel cell mCHP, discussion with stakeholders suggested that, as fuel cell operation is electrically led, the export fraction should be linked to household electricity demand, i.e. the difference between generation and demand. This would lead to a lower range of export fractions than were previously used for fuel cells. Other stakeholders highlighted the fact that fuel cells are more efficient in the upper range of their generating capacity and, thus, a high level of modulation (i.e. to follow electrical demand) is unattractive. Furthermore, the ability to modulate varies with different technologies. While both PEMS and SOFC fuel cells can modulate, the higher operating temperature of SOFC units means modulation is likely to be slower, perhaps turning down for long periods of low demand, i.e. at night, but remaining at higher output levels when demand is more variable. As such, it is feasible that a larger (e.g. 2kWe) unit with low levels of modulation could export a very high proportion of generation. We have therefore maintained a wide range of possible export fractions, with a high case value of 90%.

4.3 Capex

4.3.1 Current

Capex for both Stirling engine and fuel cell mCHP have been increased in this update, based on more detailed data, actual prices paid and discussion with industry.

Band	Previous report central case capex (£ 2012 / kW)	Current report central case capex (£ 2012 / kW)
Domestic Stirling	6,050	7,500
Domestic fuel cell	12,320	20,000

[11] A 1kWe output may be higher than required by some households, however it is the electrical output of most available mCHP units for both Stirling engine and fuel cell technology

For fuel cells, manufacturers were not able to provide exact cost information for their units as they are not yet market ready; however, stakeholders were happy to discuss price ranges and provide evidence of costs in Japan, where the fuel cell market is more developed and we have used this to derive the updated fuel cell capex values.

4.3.2 Future

Future cost trends for were estimated based on discussion with stakeholders, stated cost aspirations from manufacturers, and implied from research conducted in academic papers[12].

For Stirling engines, we expect significant price falls in the next few years as the market expands and economies of scale are achieved. This rate of reduction would then taper off as the market matures.

For fuel cells, experience from the more developed Japanese market, as described in academic papers, was used to derive the potential rate of cost reduction for the UK market, alongside discussions with industry. The medium future capex scenario for this technology is for slow reductions in the short term, before more significant falls as the market develops and an eventual tapering off as it reaches maturity.

4.4 Opex

Opex for Stirling engines has been reduced slightly in this update. Our view is that Stirling engine opex is likely to be marginally higher than the equivalent gas boiler rates. We have therefore used the current British Gas annual boiler maintenance rate (including parts) as the low case opex. For the central and upper values, 20 and 50 percent uplifts were applied respectively. As maintenance is primarily a service cost, future costs are expected to remain flat.

For fuel cells, costs are slightly lower than our previous report. Given that this technology is still currently in the development phase, operating costs are difficult to establish. Following discussion with a manufacturer, the gas boiler maintenance rate was used as a starting point, with £30, £60 and £80 uplifts applied in the lower, central and upper cost scenarios respectively. While opex is expected to remain flat in the short and medium term, there is a possibility that the costs of parts may reduce in the longer term as the technology becomes more established. We have included a reduction in fuel cell opex from 2027 to allow for this.

4.5 Load factor

Load factors for Stirling engine mCHP have not changed in this update.

Load factors for fuel cell have been increased, following discussions with industry. Fuel cell mCHP is electrically led and is therefore expected to have much longer run hours than the Stirling engine equivalent. A broad range has been used to reflect the uncertainty associated with fuel cell mCHP and allowance has been made for the lower electrical demands of new build and efficient housing.

4.6 Technical potential

Technical potential has not been changed in this update.

[12] See reference list in Appendix A

4.7 Lifetime

Technology lifetime for Stirling engine mCHP has not been changed in this update.

Fuel cell lifetime has been increased based on discussion with industry, with the central case value now being 10 years.

4.8 Efficiency

For Stirling engine mCHP, electrical efficiency has been increased slightly based on discussion with stakeholders to provide heat to power ratios of 6:1. Overall system efficiency remains unchanged.

There is a wide range of efficiencies for the different fuel cell units available, with stated electrical efficiencies ranging from 32% to in excess of 50%. In discussion with industry, it was suggested that a central value of approximately 40% (HHV basis) would be reasonable, but it should be noted that there is considerable variation for this technology.

4.9 Gas boiler

As part of this update, DECC requested cost and performance data for condensing gas boilers (as being the alternative technology to mCHP). Efficiency data was sourced from the NHER (National Home Energy Rating) database. Capex ranges were sourced from online searches of installed costs for a condensing boiler and opex costs were as quoted on the British Gas website, with a variation applied for the upper and lower limit values.

5 ANAEROBIC DIGESTION

5.1 Technology size

The technology sizes in each AD band have been updated as part of this review, to reflect the typical sizes of systems being installed and proposed in the UK.

5.2 Export fraction

Export fractions for AD have not been altered as part of this review.

5.3 Capex

5.3.1 Current

The capex data for AD has been updated as part of this review. Central case values compared to our previous report are shown below.

Band	Previous report central case capex (£ 2012 / kW)	Current report central case capex (£ 2012 / kW)
>500kW	4,950	4,500
250 to 500kW	5,500	4,700
<250kW	6,600	6,000

The capex data ranges (high and low values) are similar to those provided in our previous report. The central values are slightly lower than our previous report. This is a result of the more detailed data now available. We do not believe that AD capex costs have changed significantly since our previous report, rather the data now available more accurately reflects the current market.

5.3.2 Future

The overall view of stakeholders consulted was that capex for AD is expected to rise in line with inflation over the next few years, i.e. that costs will remain flat in real terms.

There are a number of factors which will impact on the future capex of AD systems:

- The rate of change in pricing of materials such as steel, copper and concrete will impact on the capex with most materials costs expected to rise.
- The trend for the price of CHP units, which make up a significant part of the total capex, is expected to continue upwards.
- The majority of equipment for UK AD facilities is manufactured and supplied from Europe. Currently exchange rates have benefited UK projects, this is likely to change in the future. A number of stakeholders cited currency risk as a potential source of future price rises.

- A significant amount of equipment installed in the UK is manufactured in Germany. The German manufacturing industry is relatively buoyant at present and so the potential for price reductions here is limited.

- Several stakeholders suggested prices for equipment and services from overseas will typically attract a premium for businesses not familiar with the UK. This has potential to reduce as learning of and confidence in the UK market increases.

- An increase in the number of UK based equipment manufacturers has the potential to reduce costs in the future. One stakeholder stated they were able to reduce capex of one plant item by 20% through switching to a UK manufacturer.

- Smaller AD systems have more scope for efficiency improvements/innovation which could result in reduced capex in the future. There is a growing move towards modularisation and standardisation of AD plants at smaller scale, which could result in lower capex for these systems. There is less scope for such activity at larger scale where plants tend to be bespoke process facilities.

The majority of stakeholders suggested that implementation of a larger number of AD projects would enable cost reductions. Indications suggest that this 'critical mass' will need to be in the region of several hundred facilities over the next few years.

The factors above informed the development of our three future capex scenarios:

- Medium: capex remains constant in real terms;

- Low: capex in real terms remains constant for the next five years and shows a downwards trend after this as the industry grows and economies of scale start to apply;

- High: capex increases gradually in real terms as costs grow above general inflation

This represents a change compared to our previous report where capex was expected to decrease slowly in the medium case.

5.4 Opex

5.4.1 Current

The opex data for AD has been updated as part of this review.

Generally the opex values for the bands below 500kW are slightly higher than our previous report as a result of more detailed data being available. There is also likely to have been a degree of increase from cost inflation between 2010 and 2012.

Opex for the >500kW band is lower than our previous report, and is derived from the more detailed data available. This data shows, however, a wide range of values reflecting the different ways in which plants of this type operate, e.g. how much pre-treatment of waste is carried out on site, how much resource the operator puts in to

achieve higher load factor etc. The range of low to high values has therefore also increased.

5.4.2 Future

Future opex trends have not been changed in this update, i.e. they remain flat in current prices. This is in agreement with views expressed by industry that opex, which is mainly driven by labour and energy (and by feedstock costs in farm based systems), will rise in line with inflation.

5.5 Load factor

The load factor data for AD have not been changed in this update.

5.6 Technical potential

The technical potential for AD has not been altered as part of this review.

5.7 Lifetime

The AD lifetime data has not been altered as part of this review.

5.8 System definition

This section provides some discussion on how different AD systems are represented in the FIT scheme, and is presented here as a consistent theme which arose during discussion with stakeholders.

Historically in the UK AD systems[13] above 500kW installed capacity are either "post-consumer" systems processing food waste from municipalities, supermarkets or catering facilities or "pre-consumer systems" processing waste from the food and drinks industry such as by-products from beverage production, vegetable waste or abattoir waste. Systems below 500kW are primarily agricultural systems, sited on or near to farms, which use animal slurries and manures in combination with certain supplementary feedstocks such as vegetable trimmings, energy crops or glycerol.

On this basis, in this report systems above 500kW have been assumed to be food waste systems and systems below 500kW have been assumed to be agricultural systems to reflect the UK market and to fit with the banding structure.

Food waste and agricultural waste facilities have different capex, opex and operational characteristics. For example, food waste facilities generally have higher capital costs than an equivalent size agricultural system due to additional pre-processing plant for feedstock treatment (de-packaging, maceration, pasteurisation etc.). Food waste systems may receive a gate fee for the waste processed on behalf of a municipality for example, whereas agricultural systems may access slurry at no cost and buy in additional feedstocks to boost biogas production. Load factors are typically different with food facilities operating for more hours per year on a relatively consistent although aggressive (in terms of machinery wear) feedstock whereas agricultural systems typically have lower load factors due to less rigorous operation and maintenance regimes and seasonal feedstock which can result in lower output during certain times of the year. There is a wide range of opex for both food and

[13] Excluding landfill and sewage based systems

agricultural systems, depending on how they are design and operated, with a significant degree of overlap between the ranges.

Evidence gathered for this report showed that the division between large food waste and smaller agricultural systems in the UK is becoming less clear-cut, with a number of agricultural facilities larger than 500kW and a number of food waste facilities less than 500kW being implemented.

Several facilities are also processing a mixture of farm and food wastes. There are a number of reasons for this approach:

- Agricultural facilities may have access to animal slurries only while animals are housed and so need to bring in additional material to 'fill the gap' when animals are put out to graze, this material may be energy crops or food waste;
- Food waste may be added to agricultural facilities occasionally when it is available, for example vegetable trimming waste during the growing season;
- Food waste facilities may introduce animal slurry occasionally to maintain the health of the digester and boost the quantity of microbes present'.

There were a number of stakeholder comments received during this update on how the FIT tariff structure could reflect the differences between food and agricultural systems. Some stakeholders considered that the additional costs of operating a food waste facility are offset by the additional income received from gates fees when compared to agricultural systems, and it is therefore reasonable to consider the two systems under a single tariff structure. Others were keen to see a division of the tariff structure based on feedstock type, i.e. different tariffs for food and agricultural systems.

Although this report has continued to use the assumption that systems >500kW are food based and systems <500kW are agricultural, we did receive data on small food systems and large agricultural systems. This is summarised below:

5.8.1 Small food facilities

- Installed capacities 50kW to 490kW with median of 320kW (taken from five data points)
- Capex £4,211/kW to £9,646/kW with a median of £7,646/kW (taken from five data points)
- Opex of approximately £520/kW/y (single data point)

5.8.2 Large agricultural facilities

- Installed capacities 1,200kW to 7,500kW with median of 2,000kW (taken from four data points)
- Capex £3,333/kW to £7,500/kW with a median of £3,750/kW (taken from four data points)
- No opex data was available

6 HYDROELECTRIC

6.1 Technology size

The technology size bands for hydro have not been updated as part of this review.

6.2 Export fraction

The export fractions for the hydro bands have not been updated as part of this review.

6.3 Capex

6.3.1 Current

The current capex for hydro has been updated as part of this review.

Band	Previous report central case capex (£ 2012 / kW)	Current report central case capex (£ 2012 / kW)
<15kW [14]	8,090	9,500
15–50kW [14]	5,940	7,000
50–100kW	4,680	6,650
100–1,000kW	3,520	4,500
1,000–2,000kW	3,250	3,300
2,000–5,000kW	2,750	2,700

A much larger data set has been gathered for this review compared to previous work. Generally there has been an increase in capex other than for the largest size bands which are close to the previous values.

For systems above 1,000kW capacity there has been slight increase which appears likely to be related to general inflationary increases in costs since our previous data.

For the smaller size bands, capex values have increased more significantly compared to our previous report. While there may be some inflation elements in this, we consider that the primary reason is the more extensive data set providing a more accurate picture of costs of actual installation costs. This is in line with consultation comments that previous values were too low.

Note that, for the 1,000-2,000kW band, only two data points were available. Rather than relying on these data points to derive the capex for this band, we generated a cost vs. size correlation using the data gathered for 50 - 5,000kW systems and used this to provide the central case capex. Although this value is lower than the either of the two individual data points, we consider this to be a more appropriate means to derive a likely cost for installations in this band. The two individual data points lie within the range of the low/high capex values.

Note that hydro plants, as opposed to wind or solar PV, are bespoke installations with capex being very site dependent. This results in the wide low/high ranges provided in

[14] Note that in the detailed cost data in Appendix B we have divided costs for the <15 and 15-50kW bands into a fixed £/installation element and a marginal £/kW element. See Appendix E for details.

this report. These are genuine ranges that represent the range of costs for each size band (rather than, for example, reflecting uncertainty in the data).

6.3.2 Future

The overall view of stakeholders consulted was that capex for hydro is expected to rise in line with inflation over the next few years, i.e. that costs will remain flat in real terms.

Industry stakeholders expressed a number of views on factors likely to influence the future capex of hydro schemes:

- The main drivers for any capex increases in the future are the increasing prices of commodities like steel, aluminium, concrete and oil as well as labour, design and finance costs.
- The maturity of the hydro industry means there is limited scope for technical innovation to drive capex reductions. Each hydro development is bespoke to its setting, so there is limited scope for capex reduction through standardisation of design.
- Several stakeholders expressed concern over the increasing cost of environmental regulatory requirements, especially on a smaller scale where costs are a greater proportion of the overall capex.
- A number of stakeholders highlighted the fact that there is a fixed number of potential hydro sites in the UK. The sites with the most potential will be developed first leaving sites that require greater investment until some point in the future – effectively meaning capex of hydro in the future may increase.
- There was a consistent message from stakeholders that there is little prospect of reduction in capex, given the maturity of the industry and the bespoke nature of each installation.

The factors above informed the development of our three future capex scenarios:

- Medium: capex remains constant in real terms;
- Low: capex remains constant in real terms until 2017, with a slow decrease thereafter;
- High: capex increases in real terms as costs grow above general inflation, for example as more costly sites are developed

These are in line with our previous report, apart from the low scenario where our previous report showed costs decreasing slowly over time.

6.4 Opex

6.4.1 Current

Opex costs have been updated compared to our previous report. This is primarily due to having access to a larger dataset for this review compared to previous work.

The range of opex costs for systems below 100kW has been widened compared to the previous report, this is to reflect the range of opex between high head sites and low head sites. Low head sites potentially have higher operating costs due to increased channel and equipment maintenance, for example.

Opex data for systems in the 1,000 – 2,000kW range was limited, the opex for these systems has been assumed to be equivalent to systems in the 2,000 – 5,000kW band.

6.4.2 Future

Future opex trends have not been changed in this update, i.e. they remain flat in 2012 prices. This is in agreement with views expressed by industry that opex, which is mainly driven by labour costs, will rise in line with inflation. There is also some upward pressure on costs because of regulatory requirements for more and longer environmental monitoring.

6.5 Load factor

The load factor values for hydro have not been updated as part of this review.

6.6 Technical potential

The technical potential for hydro has not been updated as part of this review.

6.7 Lifetime

The lifetime values for hydro have not been updated as part of this review.

APPENDIX A – REFERENCE LIST

General:

- Consultation responses provided by DECC
- Discussions with industry associations (REA, BHA, MHA, CHPA, RenewableUK)
- Discussions with individual installers and manufacturers
- Ofgem's FIT register of installations (to March 31st 2012)

The following additional references were used for specific technologies:

Wind

- RenewableUK, 2012, "Small and Medium Wind UK Market Report", available at: http://www.bwea.com/pdf/publications/RenewableUK_SMWMarketReport2012.pdf
- REA, 2012, "Renewable Energy: Made in Britain"
- http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/source/fits/fits.aspx , table ET5.7

mCHP

- http://www.callux.net/application/files/medien/Callux_Standard_11-10-28_english.pdf - German field trials of fuel cell mCHP.
- http://www.osakagas.co.jp/company/press/pr_2012/1196121_5712.html - Osaka Gas press release for SOFC fuel cell.
- http://www.bhkw-forum.info/nachrichten/6441/2011-12-24-exklusiv-das-erste-brennstoffzellen-bhkw-ist-lieferbar/ - German article on CFCL fuel cell mCHP
- http://www.baxi-innotech.de/index.php?id=26&lang=1 – Baxi Innotech website.
- http://www.baxi.co.uk/ecogen - Baxi Ecogen website.
- http://www.chpa.co.uk/medialibrary/2011/05/18/fd8249cf/Micro-CHP%20Accelerator%20-%20Final%20Report%20-%20Mar11.pdf – mCHP Accelerator Final Report (2011).
- "Cost development of future technologies for power generation—A study based on experience curves and complementary bottom-up assessments" Neij, L. Energy Policy 36 (2008) 2200–2211
- "Estimating future prices for stationary fuel cells with empirically derived experience curves" Staffell, I and Green, I. International Journal of Hydrogen energy 34 (2009) 5617–5628

AD

- Discussions with NNFCC
- NNFCC AD Plant Map at http://biogas-info.co.uk/maps/index2.htm

APPENDIX B – UPDATED DATA TABLES - WIND

Technology Size (kW)

Band	Low	Central	High
1.5–15kW urban	5.0	6.0	10.0
1.5–15kW rural	5.0	6.0	10.0
15–50kW urban	15	20	30
15–50kW rural	15	20	30
50–100kW	55	60	75
100–500kW	200	350	450
500–1,500kW	800	1,300	1,400
1,500-5,000kW	1,500	2,000	2,500

Export fraction (% of output exported to the grid)

Band	Low	Central	High
1.5–15kW urban	20	30	75
1.5–15kW rural	50	50	75
15–50kW urban	20	50	80
15–50kW rural	50	75	90
50–100kW	50	80	90
100–500kW	50	90	95
500–1,500kW	50	90	99
1,500-5,000kW	50	90	99

Capex

Note that for the 1.5-15kW band we have divided costs between a fixed cost per installation and a marginal cost related to the capacity, on the basis that for systems of this size there will be some costs that are independent of scale. We have assumed these fixed costs to around a third of the total installed cost and used this to derive the fixed and marginal elements. This results in a central case fixed cost of £10,500 per system. A 2.5kW system would therefore have a total installed cost of £10,500 + (£3,500 x 2.5) = £19,250, while a 6kW system would have a total installed cost of £10,500 + (£3,500 x 6) = £31,500.

For larger size bands, costs will be more directly related to system size and it was not considered necessary to split costs into fixed and marginal components.

Low – fixed cost (£/installation)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£9,700	£9,700	£9,700	£9,700	£9,700	£9,652	£9,603	£9,555	£9,507	£9,460	£9,413	£9,366	£9,319	£9,272	£9,226	£9,180	£9,134	£9,088	£9,043	£8,997	£8,952
1.5–15kW rural	£9,700	£9,700	£9,700	£9,700	£9,700	£9,652	£9,603	£9,555	£9,507	£9,460	£9,413	£9,366	£9,319	£9,272	£9,226	£9,180	£9,134	£9,088	£9,043	£8,997	£8,952
15–50kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500–1,500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,500-5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Low – marginal cost (£/kW)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£3,200	£3,200	£3,200	£3,200	£3,200	£3,184	£3,168	£3,152	£3,136	£3,121	£3,105	£3,090	£3,074	£3,059	£3,044	£3,028	£3,013	£2,998	£2,983	£2,968	£2,953
1.5–15kW rural	£3,200	£3,200	£3,200	£3,200	£3,200	£3,184	£3,168	£3,152	£3,136	£3,121	£3,105	£3,090	£3,074	£3,059	£3,044	£3,028	£3,013	£2,998	£2,983	£2,968	£2,953
15–50kW urban	£4,000	£4,000	£4,000	£4,000	£4,000	£3,980	£3,960	£3,940	£3,921	£3,901	£3,881	£3,862	£3,843	£3,824	£3,804	£3,785	£3,766	£3,748	£3,729	£3,710	£3,692
15–50kW rural	£4,000	£4,000	£4,000	£4,000	£4,000	£3,980	£3,960	£3,940	£3,921	£3,901	£3,881	£3,862	£3,843	£3,824	£3,804	£3,785	£3,766	£3,748	£3,729	£3,710	£3,692
50–100kW	£2,900	£2,900	£2,900	£2,900	£2,900	£2,886	£2,871	£2,857	£2,842	£2,828	£2,814	£2,800	£2,786	£2,772	£2,758	£2,744	£2,731	£2,717	£2,703	£2,690	£2,677
100–500kW	£2,300	£2,300	£2,300	£2,300	£2,300	£2,289	£2,277	£2,266	£2,254	£2,243	£2,232	£2,221	£2,210	£2,199	£2,188	£2,177	£2,166	£2,155	£2,144	£2,133	£2,123
500–1,500kW	£1,800	£1,800	£1,800	£1,800	£1,800	£1,791	£1,782	£1,773	£1,764	£1,755	£1,747	£1,738	£1,729	£1,721	£1,712	£1,703	£1,695	£1,686	£1,678	£1,670	£1,661
1,500-5,000kW	£1,600	£1,600	£1,600	£1,600	£1,600	£1,592	£1,584	£1,576	£1,568	£1,560	£1,553	£1,545	£1,537	£1,529	£1,522	£1,514	£1,507	£1,499	£1,492	£1,484	£1,477

Central – fixed cost (£/installation)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500
1.5–15kW rural	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500	£10,500
15–50kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500–1,500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,500-5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Central – marginal cost (£/kW)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500
1.5–15kW rural	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500	£3,500
15–50kW urban	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200
15–50kW rural	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200	£4,200
50–100kW	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500
100–500kW	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000	£3,000
500–1,500kW	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200	£2,200
1,500-5,000kW	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000	£2,000

High – fixed cost (£/installation)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£17,100	£17,271	£17,444	£17,618	£11,400	£11,514	£11,629	£11,745	£11,863	£11,982	£12,101	£12,222	£12,345	£12,468	£12,593	£12,719	£12,846	£12,974	£13,104	£13,235	£13,367
1.5–15kW rural	£17,100	£17,271	£17,444	£17,618	£11,400	£11,514	£11,629	£11,745	£11,863	£11,982	£12,101	£12,222	£12,345	£12,468	£12,593	£12,719	£12,846	£12,974	£13,104	£13,235	£13,367
15–50kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500–1,500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,500-5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

High – marginal cost (£/kW)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£2,900	£2,929	£2,958	£2,988	£3,800	£3,838	£3,876	£3,915	£3,954	£3,994	£4,034	£4,074	£4,115	£4,156	£4,198	£4,240	£4,282	£4,325	£4,368	£4,412	£4,456
1.5–15kW rural	£2,900	£2,929	£2,958	£2,988	£3,800	£3,838	£3,876	£3,915	£3,954	£3,994	£4,034	£4,074	£4,115	£4,156	£4,198	£4,240	£4,282	£4,325	£4,368	£4,412	£4,456
15–50kW urban	£5,000	£5,050	£5,101	£5,152	£5,203	£5,255	£5,308	£5,361	£5,414	£5,468	£5,523	£5,578	£5,634	£5,690	£5,747	£5,805	£5,863	£5,922	£5,981	£6,041	£6,101
15–50kW rural	£5,000	£5,050	£5,101	£5,152	£5,203	£5,255	£5,308	£5,361	£5,414	£5,468	£5,523	£5,578	£5,634	£5,690	£5,747	£5,805	£5,863	£5,922	£5,981	£6,041	£6,101
50–100kW	£5,000	£5,050	£5,101	£5,152	£5,203	£5,255	£5,308	£5,361	£5,414	£5,468	£5,523	£5,578	£5,634	£5,690	£5,747	£5,805	£5,863	£5,922	£5,981	£6,041	£6,101
100–500kW	£3,600	£3,636	£3,672	£3,709	£3,746	£3,784	£3,821	£3,860	£3,898	£3,937	£3,977	£4,016	£4,057	£4,097	£4,138	£4,179	£4,221	£4,263	£4,306	£4,349	£4,393
500–1,500kW	£2,400	£2,424	£2,448	£2,473	£2,497	£2,522	£2,548	£2,573	£2,599	£2,625	£2,651	£2,678	£2,704	£2,731	£2,759	£2,786	£2,814	£2,842	£2,871	£2,899	£2,928
1,500-5,000kW	£2,300	£2,323	£2,346	£2,370	£2,393	£2,417	£2,441	£2,466	£2,491	£2,515	£2,541	£2,566	£2,592	£2,618	£2,644	£2,670	£2,697	£2,724	£2,751	£2,779	£2,806

Opex

Low – fixed cost (£/installation/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£350	£347	£343	£340	£336	£333	£330	£326	£323	£320	£317	£313	£310	£307	£304	£301	£298	£295	£292	£289	£286
1.5–15kW rural	£350	£347	£343	£340	£336	£333	£330	£326	£323	£320	£317	£313	£310	£307	£304	£301	£298	£295	£292	£289	£286
15–50kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500–1,500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,500-5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Low – marginal cost (£/kW/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.5–15kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW urban	£30	£30	£29	£29	£29	£29	£28	£28	£28	£27	£27	£27	£27	£26	£26	£26	£26	£25	£25	£25	£25
15–50kW rural	£30	£30	£29	£29	£29	£29	£28	£28	£28	£27	£27	£27	£27	£26	£26	£26	£26	£25	£25	£25	£25
50–100kW	£30	£30	£29	£29	£29	£29	£28	£28	£28	£27	£27	£27	£27	£26	£26	£26	£26	£25	£25	£25	£25
100–500kW	£45	£45	£44	£44	£43	£43	£42	£42	£42	£41	£41	£40	£40	£39	£39	£39	£38	£38	£38	£37	£37
500–1,500kW	£25	£25	£25	£24	£24	£24	£24	£23	£23	£23	£23	£22	£22	£22	£22	£22	£21	£21	£21	£21	£20
1,500-5,000kW	£25	£25	£25	£24	£24	£24	£24	£23	£23	£23	£23	£22	£22	£22	£22	£22	£21	£21	£21	£21	£20

Central – fixed cost (£/installation/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440
1.5–15kW rural	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440	£440
15–50kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500–1,500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,500-5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Central – marginal cost (£/kW/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.5–15kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW urban	£50	£50	£50	£49	£49	£49	£49	£48	£48	£48	£48	£47	£47	£47	£47	£46	£46	£46	£46	£45	£45
15–50kW rural	£50	£50	£50	£49	£49	£49	£49	£48	£48	£48	£48	£47	£47	£47	£47	£46	£46	£46	£46	£45	£45
50–100kW	£45	£45	£45	£44	£44	£44	£44	£43	£43	£43	£43	£43	£42	£42	£42	£42	£42	£41	£41	£41	£41
100–500kW	£60	£60	£59	£59	£59	£59	£58	£58	£58	£57	£57	£57	£56	£56	£56	£56	£55	£55	£55	£55	£54
500–1,500kW	£30	£30	£30	£30	£29	£29	£29	£29	£29	£29	£29	£28	£28	£28	£28	£28	£28	£28	£27	£27	£27
1,500-5,000kW	£30	£30	£30	£30	£29	£29	£29	£29	£29	£29	£29	£28	£28	£28	£28	£28	£28	£28	£27	£27	£27

High – fixed cost (£/installation/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850
1.5–15kW rural	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850
15–50kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
500–1,500kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,500-5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

High – marginal cost (£/kW/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1.5–15kW urban	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.5–15kW rural	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15–50kW urban	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60
15–50kW rural	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60	£60
50–100kW	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80	£80
100–500kW	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75	£75
500–1,500kW	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35
1,500-5,000kW	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35	£35

Load factor

	Size	Low	Central	High
Wind - 5.5 m/s	1.5–15kW urban	10%	11%	15%
Wind - 5.5 m/s	1.5–15kW rural	14%	14%	22%
Wind - 5.5 m/s	15–50kW urban	9%	12%	18%
Wind - 5.5 m/s	15–50kW rural	12%	13%	22%
Wind - 5.5 m/s	50–100kW	14%	16%	17%
Wind - 5.5 m/s	100–500kW	14%	16%	19%
Wind - 5.5 m/s	500–1,500kW	13%	18%	20%
Wind - 5.5 m/s	1,500-5,000kW	15%	21%	23%
Wind - 6 m/s	1.5–15kW urban	12%	13%	17%
Wind - 6 m/s	1.5–15kW rural	17%	17%	24%
Wind - 6 m/s	15–50kW urban	11%	14%	20%
Wind - 6 m/s	15–50kW rural	15%	17%	24%
Wind - 6 m/s	50–100kW	18%	19%	21%
Wind - 6 m/s	100–500kW	17%	20%	23%
Wind - 6 m/s	500–1,500kW	17%	22%	24%
Wind - 6 m/s	1,500-5,000kW	18%	25%	28%
Wind - 6.5 m/s	1.5–15kW urban	14%	15%	19%
Wind - 6.5 m/s	1.5–15kW rural	20%	21%	26%
Wind - 6.5 m/s	15–50kW urban	13%	16%	22%
Wind - 6.5 m/s	15–50kW rural	18%	21%	26%
Wind - 6.5 m/s	50–100kW	21%	22%	24%
Wind - 6.5 m/s	100–500kW	20%	24%	27%
Wind - 6.5 m/s	500–1,500kW	20%	26%	29%
Wind - 6.5 m/s	1,500-5,000kW	22%	29%	32%
Wind - 7 m/s	1.5–15kW urban	16%	17%	21%
Wind - 7 m/s	1.5–15kW rural	23%	24%	28%
Wind - 7 m/s	15–50kW urban	15%	18%	24%
Wind - 7 m/s	15–50kW rural	22%	24%	28%
Wind - 7 m/s	50–100kW	24%	25%	27%
Wind - 7 m/s	100–500kW	24%	28%	30%
Wind - 7 m/s	500–1,500kW	24%	30%	33%
Wind - 7 m/s	1,500-5,000kW	26%	33%	37%

	Size	Low	Central	High
Wind - 7.5 m/s	1.5–15kW urban	18%	19%	23%
Wind - 7.5 m/s	1.5–15kW rural	26%	27%	29%
Wind - 7.5 m/s	15–50kW urban	17%	20%	26%
Wind - 7.5 m/s	15–50kW rural	25%	28%	29%
Wind - 7.5 m/s	50–100kW	27%	28%	29%
Wind - 7.5 m/s	100–500kW	27%	32%	34%
Wind - 7.5 m/s	500–1,500kW	27%	34%	37%
Wind - 7.5 m/s	1,500-5,000kW	29%	37%	41%
Wind - >8.0 m/s	1.5–15kW urban	20%	21%	25%
Wind - >8.0 m/s	1.5–15kW rural	29%	29%	29%
Wind - >8.0 m/s	15–50kW urban	19%	22%	28%
Wind - >8.0 m/s	15–50kW rural	28%	29%	32%
Wind - >8.0 m/s	50–100kW	29%	30%	31%
Wind - >8.0 m/s	100–500kW	31%	35%	37%
Wind - >8.0 m/s	500–1,500kW	31%	38%	40%
Wind - >8.0 m/s	1,500-5,000kW	33%	41%	44%

Technical potential (total MWh/yr per site type)

	5.5 m/s	6 m/s	6.5 m/s	7 m/s	7.5 m/s	>8.0 m/s
1.5–15kW urban	0	0	0	0	0	0
1.5–15kW rural	867,576	413,834	179,828	80,606	38,665	29,445
15–50kW urban	0	0	0	0	0	0
15–50kW rural	793,998	286,741	135,999	83,768	33,270	17,739
50–100kW	325,767	163,120	58,221	26,354	3,553	2,943
100–500kW	1,264,974	599,117	287,356	100,147	4,797	3,974
500–1,500kW	431,422	174,660	100,971	56,044	35,493	15,617
1,500-5,000kW	3,967,218	1,606,114	928,498	515,363	326,381	143,612

Lifetime (years)

Size	Low	Central	High
1.5–15kW urban	15	20	25
1.5–15kW rural	15	20	25
15–50kW urban	15	20	25
15–50kW rural	15	20	25
50–100kW	15	20	25
100–500kW	15	20	25
500–1,500kW	15	20	25
1,500-5,000kW	15	20	25

APPENDIX C - UPDATED DATA TABLES – MICRO CHP

Technology Size (kWe)

Size	Low	Central	High
Domestic Stirling	0.8	1.0	1.2
Domestic Fuel Cell	0.7	1.0	2.0

Export fraction

Size	Low	Central	High
Domestic Stirling	20.0	50.0	90.0
Domestic Fuel Cell	20.0	50.0	90.0

Capex

Low (£/installation)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Domestic Stirling	£5,000	£4,750	£4,513	£4,287	£4,073	£3,869	£3,772	£3,678	£3,586	£3,550	£3,515	£3,479	£3,445	£3,410	£3,376	£3,376	£3,376	£3,376	£3,376	£3,376	£3,376
Domestic Fuel Cell	£15,000	£14,550	£14,114	£13,690	£13,006	£12,355	£11,738	£11,151	£10,593	£10,063	£9,560	£9,082	£8,628	£8,197	£7,787	£7,398	£7,028	£6,676	£6,476	£6,282	£6,093

Central (£/installation)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Domestic Stirling	£7,500	£6,938	£6,417	£5,936	£5,491	£5,079	£4,825	£4,584	£4,355	£4,137	£3,930	£3,733	£3,640	£3,549	£3,514	£3,514	£3,514	£3,514	£3,514	£3,514	£3,514
Domestic Fuel Cell	£20,000	£19,400	£18,818	£18,253	£17,341	£16,040	£14,837	£13,724	£12,695	£11,743	£10,862	£10,048	£9,294	£8,597	£7,952	£7,356	£6,988	£6,639	£6,439	£6,246	£6,059

High (£/installation)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Domestic Stirling	£10,000	£9,000	£8,100	£7,290	£6,743	£6,238	£5,770	£5,337	£4,937	£4,566	£4,338	£4,121	£4,018	£3,918	£3,879	£3,840	£3,801	£3,763	£3,726	£3,688	£3,652
Domestic Fuel Cell	£25,000	£24,250	£23,523	£22,817	£21,676	£20,050	£18,045	£16,241	£14,617	£13,155	£11,839	£10,656	£9,590	£8,631	£7,768	£6,991	£6,467	£6,143	£5,959	£5,780	£5,607

Opex

Low (£/installation/yr)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Domestic Stirling	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70	£70
Domestic Fuel Cell	£120	£120	£120	£120	£120	£120	£120	£120	£120	£120	£120	£120	£120	£120	£120	£100	£100	£100	£100	£100	£100

Central (£/installation/yr)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Domestic Stirling	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84	£84
Domestic Fuel Cell	£130	£130	£130	£130	£130	£130	£130	£130	£130	£130	£130	£130	£130	£130	£130	£110	£110	£110	£110	£110	£110

High (£/installation/yr)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Domestic Stirling	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105
Domestic Fuel Cell	£150	£150	£150	£150	£150	£150	£150	£150	£150	£150	£150	£150	£150	£150	£150	£130	£130	£130	£130	£130	£130

Load factor

Site type	Technology	Low	Central	High
CHP - Domestic New Build	Domestic Stirling	17%	23%	29%
CHP - Domestic New Build	Domestic Fuel Cell	50%	60%	70%
CHP - Existing Domestic (Energy Efficient)	Domestic Stirling	20%	26%	33%
CHP - Existing Domestic (Energy Efficient)	Domestic Fuel Cell	50%	60%	70%
CHP - Existing Domestic (Energy Inefficient)	Domestic Stirling	26%	34%	43%
CHP - Existing Domestic (Energy Inefficient)	Domestic Fuel Cell	50%	70%	90%
CHP - Stand-alone Commercial	Domestic Stirling	31%	39%	47%
CHP - Stand-alone Commercial	Domestic Fuel Cell	70%	80%	90%

Technical potential (total MWh/yr per site type)

	Domestic New Build	Existing Domestic (Energy Efficient)	Existing Domestic (Energy Inefficient)	Stand-alone Commercial
Domestic Stirling	0	6,244,992	53,298,648	6,988,925
Domestic Fuel Cell	0	693,888	5,922,072	776,547

Lifetime (years)

	Low	Central	High
Domestic Stirling	8	10	15
Domestic Fuel Cell	5	10	15

Efficiency

Technology	Heat to power ratio	Electrical efficiency	System efficiency
Domestic Stirling	6.0833	12%	85%
Domestic Fuel Cell	1.1250	40%	85%

Condensing gas boiler comparison data

	Low	Central	High
Seasonal efficiency	85%	89%	93%
Capex	£2,000	£2,500	£3,000
Opex	£65	£70	£80
Lifetime (years)	10	15	20

APPENDIX D – UPDATED DATA TABLES – ANAEROBIC DIGESTION (AD)

Technology Size (kWe)

	Low	Central	High
AD > 500kW	1,000	1,500	2,500
AD 250 - 500kW	280	340	480
AD < 250kW	60	100	140

Export fraction (% exported)

	Low	Central	High
AD > 500kW	85	87	90
AD 250 - 500kW	80	85	90
AD < 250kW	60	80	90

Capex

Low (£/kW)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
AD > 500kW	£3,000	£3,000	£3,000	£3,000	£3,000	£2,985	£2,970	£2,955	£2,940	£2,926	£2,911	£2,897	£2,882	£2,868	£2,853	£2,839	£2,825	£2,811	£2,797	£2,783	£2,769
AD 250 - 500kW	£3,000	£3,000	£3,000	£3,000	£3,000	£2,985	£2,970	£2,955	£2,940	£2,926	£2,911	£2,897	£2,882	£2,868	£2,853	£2,839	£2,825	£2,811	£2,797	£2,783	£2,769
AD < 250kW	£4,000	£4,000	£4,000	£4,000	£4,000	£3,980	£3,960	£3,940	£3,921	£3,901	£3,881	£3,862	£3,843	£3,824	£3,804	£3,785	£3,766	£3,748	£3,729	£3,710	£3,692

Central (£/kW)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
AD > 500kW	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500
AD 250 - 500kW	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700	£4,700
AD < 250kW	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000

High (£/kW)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
AD > 500kW	£6,000	£6,060	£6,121	£6,182	£6,244	£6,306	£6,369	£6,433	£6,497	£6,562	£6,628	£6,694	£6,761	£6,829	£6,897	£6,966	£7,035	£7,106	£7,177	£7,249	£7,321
AD 250 - 500kW	£7,000	£7,070	£7,141	£7,212	£7,284	£7,357	£7,431	£7,505	£7,580	£7,656	£7,732	£7,810	£7,888	£7,967	£8,046	£8,127	£8,208	£8,290	£8,373	£8,457	£8,541
AD < 250kW	£8,000	£8,080	£8,161	£8,242	£8,325	£8,408	£8,492	£8,577	£8,663	£8,749	£8,837	£8,925	£9,015	£9,105	£9,196	£9,288	£9,381	£9,474	£9,569	£9,665	£9,762

Opex

Low (£/kW/yr)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
AD > 500kW	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600	£600
AD 250 - 500kW	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750	£750
AD < 250kW	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800

Central (£/kW/yr)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
AD > 500kW	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800	£800
AD 250 - 500kW	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850	£850
AD < 250kW	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000

High (£/kW/yr)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
AD > 500kW	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200	£1,200
AD 250 - 500kW	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000
AD < 250kW	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500	£1,500

Load factor

Size	Low	Central	High
AD > 500kW	70%	80%	90%
AD 250 - 500kW	50%	65%	80%
AD < 250kW	30%	60%	80%

Technical potential (total MWh/yr)

Size	MWh/yr
AD > 500kW	1,600,000
AD 250 - 500kW	800,000
AD < 250kW	800,000

Lifetime

	Low	Central	High
AD > 500kW	15	20	25
AD 250 - 500kW	15	20	25
AD < 250kW	15	20	25

Efficiency

Technology	Heat to power ratio	Electrical efficiency	Overall efficiency
AD > 500kW	1.11	38%	80%
AD 250 - 500kW	1.08	36%	75%
AD < 250kW	1.32	31%	72%

APPENDIX E – UPDATED DATA TABLES - HYDRO

Technology Size (kWe)

	Low	Central	High
<15kW	3	5	8
15–50kW	20	23	30
50–100kW	55	60	75
100–1,000kW	350	500	650
1,000–2,000kW	1,250	1,500	1,750
2,000–5,000kW	2,500	3,500	4,500

Export fraction (% exported)

	Low	Central	High
<15kW	60	75	80
15–50kW	80	95	100
50–100kW	80	99	100
100–1,000kW	90	99	100
1,000–2,000kW	90	99	100
2,000–5,000kW	90	99	100

Capex

Note that for the <15kW and 15-50kW bands we have divided costs between a fixed cost per installation and a marginal cost related to the capacity, on the basis that for systems of this size there will be some costs that are independent of scale. In line with our previous report, we have assumed these fixed costs to be around 30% of the total installed cost of a typical <15kW system and around 10% of a typical 15-50kW system. This results in a central case fixed cost of £15,000 for <15kW installations and £19,000 for 15-50kW installations.

A 5kW system would therefore have a total installed cost of £15,000 + (£6,500 x 5) = £47,500, while a 23kW system would have a total installed cost of £19,000 + (£6,200 x 23) = £161,600.

For larger size bands, costs will be more directly related to system size and it was not considered necessary to split costs into fixed and marginal components.

Low – fixed cost (£/installation)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£11,000	£11,000	£11,000	£11,000	£11,000	£10,945	£10,890	£10,836	£10,782	£10,728	£10,674	£10,621	£10,568	£10,515	£10,462	£10,410	£10,358	£10,306	£10,255	£10,203	£10,152
15–50kW	£14,000	£14,000	£14,000	£14,000	£14,000	£13,930	£13,860	£13,791	£13,722	£13,653	£13,585	£13,517	£13,450	£13,382	£13,316	£13,249	£13,183	£13,117	£13,051	£12,986	£12,921
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–1,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,000–2,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,000–5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Low – marginal cost (£/kW)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£2,000	£2,000	£2,000	£2,000	£2,000	£1,990	£1,980	£1,970	£1,960	£1,950	£1,941	£1,931	£1,921	£1,912	£1,902	£1,893	£1,883	£1,874	£1,864	£1,855	£1,846
15–50kW	£2,500	£2,500	£2,500	£2,500	£2,500	£2,488	£2,475	£2,463	£2,450	£2,438	£2,426	£2,414	£2,402	£2,390	£2,378	£2,366	£2,354	£2,342	£2,331	£2,319	£2,307
50–100kW	£4,000	£4,000	£4,000	£4,000	£4,000	£3,980	£3,960	£3,940	£3,921	£3,901	£3,881	£3,862	£3,843	£3,824	£3,804	£3,785	£3,766	£3,748	£3,729	£3,710	£3,692
100–1,000kW	£2,500	£2,500	£2,500	£2,500	£2,500	£2,488	£2,475	£2,463	£2,450	£2,438	£2,426	£2,414	£2,402	£2,390	£2,378	£2,366	£2,354	£2,342	£2,331	£2,319	£2,307
1,000–2,000kW	£2,000	£2,000	£2,000	£2,000	£2,000	£1,990	£1,980	£1,970	£1,960	£1,950	£1,941	£1,931	£1,921	£1,912	£1,902	£1,893	£1,883	£1,874	£1,864	£1,855	£1,846
2,000–5,000kW	£2,000	£2,000	£2,000	£2,000	£2,000	£1,990	£1,980	£1,970	£1,960	£1,950	£1,941	£1,931	£1,921	£1,912	£1,902	£1,893	£1,883	£1,874	£1,864	£1,855	£1,846

Central – fixed cost (£/installation)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000
15–50kW	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000	£19,000
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–1,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,000–2,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,000–5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Central – marginal cost (£/kW)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500	£6,500
15–50kW	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200	£6,200
50–100kW	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650	£6,650
100–1,000kW	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500	£4,500
1,000–2,000kW	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300	£3,300
2,000–5,000kW	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700	£2,700

High – fixed cost (£/installation)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£32,000	£32,320	£32,643	£32,970	£33,299	£33,632	£33,969	£34,308	£34,651	£34,998	£35,348	£35,701	£36,058	£36,419	£36,783	£37,151	£37,523	£37,898	£38,277	£38,659	£39,046
15–50kW	£40,000	£40,400	£40,804	£41,212	£41,624	£42,040	£42,461	£42,885	£43,314	£43,747	£44,185	£44,627	£45,073	£45,524	£45,979	£46,439	£46,903	£47,372	£47,846	£48,324	£48,808
50–100kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100–1,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,000–2,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,000–5,000kW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

High – marginal cost (£/kW)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£15,000	£15,150	£15,302	£15,455	£15,609	£15,765	£15,923	£16,082	£16,243	£16,405	£16,569	£16,735	£16,902	£17,071	£17,242	£17,415	£17,589	£17,765	£17,942	£18,122	£18,303
15–50kW	£8,000	£8,080	£8,161	£8,242	£8,325	£8,408	£8,492	£8,577	£8,663	£8,749	£8,837	£8,925	£9,015	£9,105	£9,196	£9,288	£9,381	£9,474	£9,569	£9,665	£9,762
50–100kW	£10,000	£10,100	£10,201	£10,303	£10,406	£10,510	£10,615	£10,721	£10,829	£10,937	£11,046	£11,157	£11,268	£11,381	£11,495	£11,610	£11,726	£11,843	£11,961	£12,081	£12,202
100–1,000kW	£10,000	£10,100	£10,201	£10,303	£10,406	£10,510	£10,615	£10,721	£10,829	£10,937	£11,046	£11,157	£11,268	£11,381	£11,495	£11,610	£11,726	£11,843	£11,961	£12,081	£12,202
1,000–2,000kW	£9,000	£9,090	£9,181	£9,273	£9,365	£9,459	£9,554	£9,649	£9,746	£9,843	£9,942	£10,041	£10,141	£10,243	£10,345	£10,449	£10,553	£10,659	£10,765	£10,873	£10,982
2,000–5,000kW	£4,000	£4,040	£4,080	£4,121	£4,162	£4,204	£4,246	£4,289	£4,331	£4,375	£4,418	£4,463	£4,507	£4,552	£4,598	£4,644	£4,690	£4,737	£4,785	£4,832	£4,881

Opex

Low (£/installation/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£200	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300	£300
15–50kW	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000	£1,000
50–100kW	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000	£6,000
100–1,000kW	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000	£15,000
1,000–2,000kW	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000
2,000–5,000kW	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000

Central (£/installation/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550	£550
15–50kW	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000	£4,000
50–100kW	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000	£10,000
100–1,000kW	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000	£52,000
1,000–2,000kW	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000
2,000–5,000kW	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000	£120,000

High (£/installation/yr)

Size	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
<15kW	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000	£9,000
15–50kW	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000	£12,000
50–100kW	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000	£20,000
100–1,000kW	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000	£100,000
1,000–2,000kW	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000
2,000–5,000kW	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000	£150,000

Load factor

	Low	Central	High
<15kW	30%	35%	45%
15–50kW	30%	35%	45%
50–100kW	30%	35%	45%
100–1,000kW	30%	35%	45%
1,000–2,000kW	30%	35%	45%
2,000–5,000kW	30%	35%	45%

Technical potential (total MWh/yr)

	Total MWh/yr
<15kW	230,000
15–50kW	46,000
50–100kW	138,000
100–1,000kW	2,898,000
1,000–2,000kW	644,000
2,000–5,000kW	644,000

Lifetime (years)

	Low	Central	High
<15kW	25	25	25
15–50kW	25	25	25
50–100kW	25	25	25
100–1,000kW	25	25	25
1,000–2,000kW	25	25	25
2,000–5,000kW	25	25	25

APPENDIX F – SUMMARY OF RAW CAPEX DATA

Table F1 - Wind

Band	Number of data points	Number of sources	Range (£/kW)
1.5–15kW	30	12	4,000 - 7,000
15–50kW	6	4	3,650 - 5,000
50–100kW	12	6	2,650 - 6,360
100–500kW	26	8	1,800 - 4,780
500–1,500kW	9	3	1,830 - 2,420
1,500-5,000kW	18	3	1,420 - 2,500

Table F2 - mCHP

Band	Number of data points	Number of sources	Range (£/kW)
Stirling	13	7	5,000 - 10,000
Fuel Cell	11	7	15,000 - 25,000

Table F3 - AD

Band	Number of data points	Number of sources	Range (£/kW)
>500kW	5	5	2,880 - 6,250
250-500kW	8	5	3,150 - 8,000
<250kW	4	4	3,000 - 10,000

Table F4 - Hydro

Band	Number of data points	Number of sources[15]	Range (£/kW)
<15kW	35	3	2,800 - 40,000
15–50kW	13	2	2,800 - 9,500
50–100kW	15	3	3,900 - 9,500
100–1,000kW	10	2	1,700 - 12,000
1,000–2,000kW	2	1	confidential[16]
2,000–5,000kW	11	1	2,400 - 3,500

[15] Shows data gathered from multiple sources by industry associations as a single source
[16] Providing range would allow identification of individual data points.