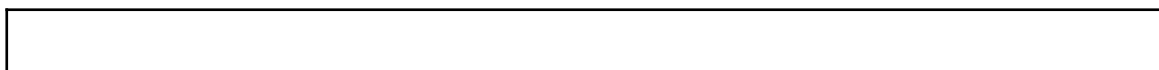
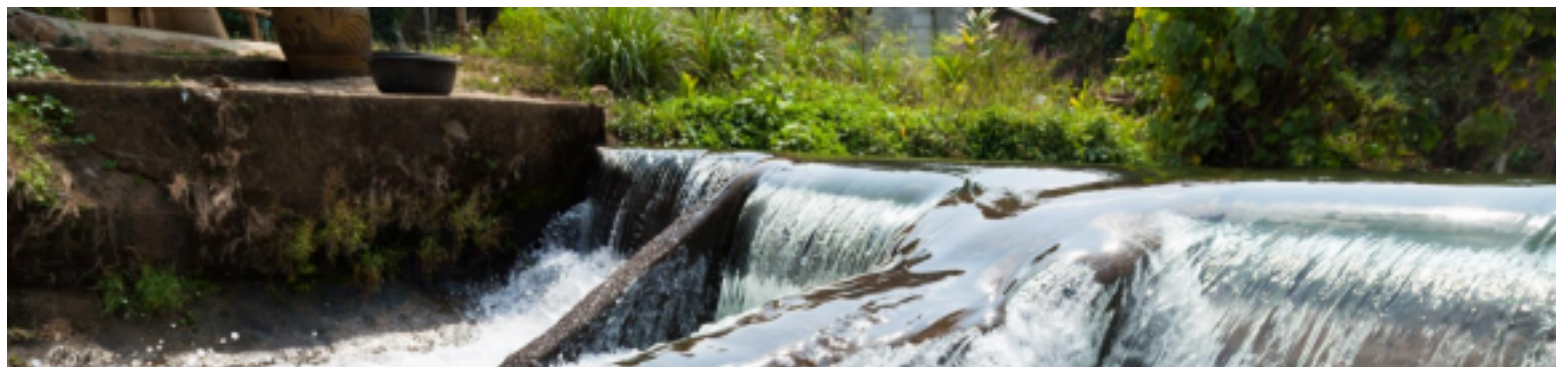


ANALYSIS OF COSTS OF SMALL-SCALE HYDRO AND IMPLIED FEED-IN TARIFFS

A report to British Hydropower Association

October 2015



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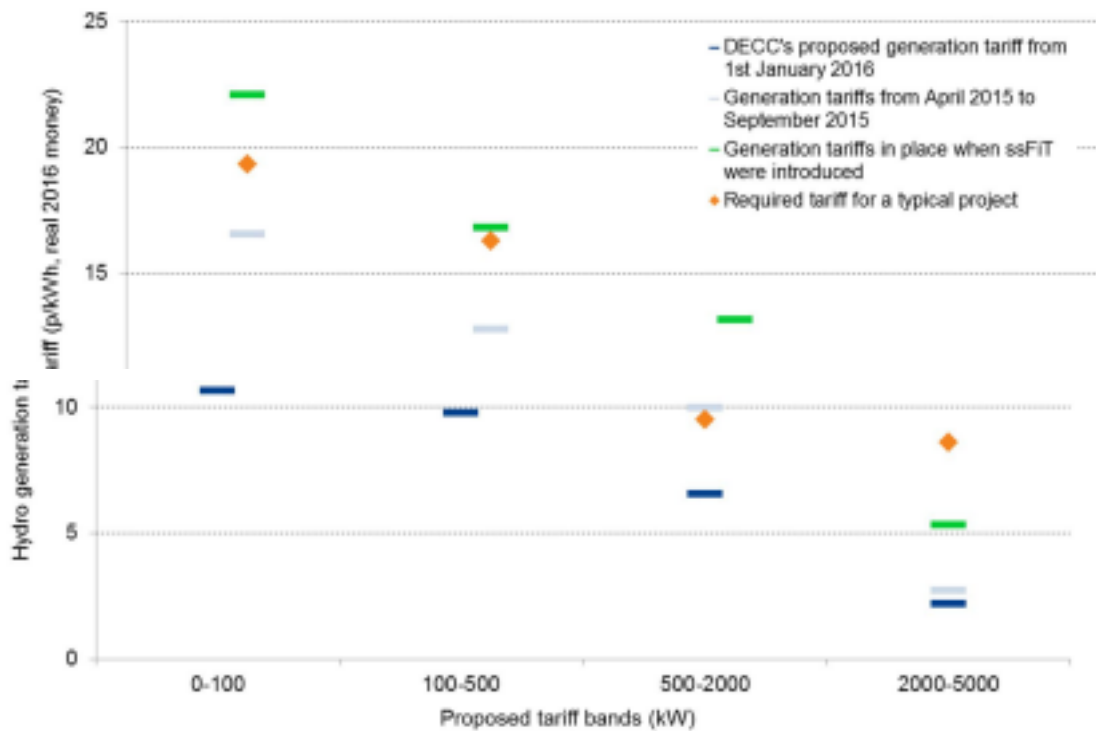
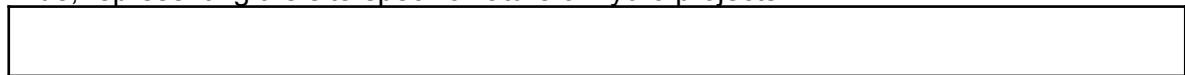
EXECUTIVE SUMMARY

The purpose of this report is to support the British Hydro Association's (BHA) response to

DECC's consultation proposing revised hydro generation tariffs to take effect from January 2016. It presents the required generation small-scale feed-in tariffs (ssFiT) for a hydro scheme to meet DECC's target rate of return for small scale hydro of 9%, based on project data collected from a BHA survey of its members. The report compares these required generation tariffs to DECC's proposed tariffs.

DECC's costs assumptions were based on a survey of ssFiT technology costs commissioned from Parsons Brinckerhoff (PB). A relatively low survey response for hydro meant that costs for some generation bands had to be inferred from other cost bands. The BHA survey resulted in around three times as many responses compared to the number received for PB's analysis. Given the response rate, the BHA data may be considered more representative than PB's (though the use of six capacity bands means that some bands do not have a large number of projects in the data set).

The main conclusion of our analysis is that the generation tariffs calculated from BHA survey data as being required by a 'typical hydro project' in each capacity band are significantly higher than those proposed in the consultation from 1 January 2016 (see Figure 1). The higher tariffs result from higher project costs reported in the BHA survey, partly due to the inclusion of all the project costs that need to be recovered to make a project viable. The range of costs (and hence required tariffs) within each size band was wide, representing the site-specific nature of hydro projects.



Source: Pöyry, DECC and Ofgem

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ANALYSIS OF THE COSTS OF SMALL-SCALE HYDRO AND IMPLIED FEED-IN TARIFFS

1. INTRODUCTION

1.1 Background

DECC published its 'Consultation on a review of the Feed-In Tariffs Scheme' on 27

August 2015. The consultation proposes a number of significant changes to the small scale feed-in tariff (ssFiT) scheme, primarily driven by a perceived need to control the costs of the scheme to stay within the Levy Control Framework cap on renewable electricity subsidies. The proposals include reductions in the generation tariffs for all technologies except Anaerobic Digestion (AD)¹, as well as changes to the tariff depression rules.

Alongside the consultation, DECC published a study by Parsons Brinckerhoff (PB) entitled 'Small-scale generations costs update'. This study presents PB's assessment of technology costs for small-scale hydro, wind and PV, at different installation sizes, based on a survey of stakeholders. The costs presented by PB were then used by DECC in its modelling to determine the proposed new generation tariffs to take effect from January 2016.

The response to the PB survey from hydro generators was relatively low, meaning that the costs for several capacity bands had to be inferred from the wider dataset. The costs requested in the survey also excluded costs that did not meet the definitions of the cost categories provided but nevertheless need to be recovered for the project to be viable.

To gain a stronger evidence base and ensure all costs were considered, British Hydro Association (BHA) undertook its own costs survey. Pöyry was commissioned to analyse the survey results and translate these into required generation tariffs to support BHA's consultation response. This report summarises the findings of this analysis, comparing it to the PB and DECC analysis that resulted in the proposed small-scale hydro tariffs from 1 January 2016.

As shown in Table 1, the BHA survey resulted in around three times as many responses compared to the number received for PB's analysis.

--

Installation size (kW) DECC/PB sample size BHA/Pöyry sample size 0-15 9 20 15-50 9 13 50-100 6 39 100-500 15 49 500-1000 6 16 1000-2000 8 12 2000-5000 0 5 **Total 53 154**

Source: DECC, PB and BHA

¹ Whilst no changes to the generation tariffs for AD were proposed in the consultation, a consultation on AD tariffs is scheduled before the end of 2015.

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ANALYSIS OF THE COSTS OF SMALL-SCALE HYDRO AND IMPLIED FEED-IN TARIFFS **1.2 Key**

findings

The main conclusion of our analysis is that the tariffs calculated from BHA survey data as being required by a 'typical hydro project' in each size band are significantly higher than those proposed in the consultation from 1 January 2016.

This is the result of higher project costs reported in the BHA survey, partly due to the inclusion of all the project costs that need to be recovered to make a project viable. The range of capex and opex costs within each installation size band was wide, representing the site-specific nature of hydro projects, and this presents a challenge in identifying a typical project.

Methodology and assumptions can also impact on the tariff required for a typical project that results from the analysis of data. Defining a methodology for deriving tariffs from the survey data collected involves some degree of judgment. In our view, some methodological decisions by DECC could have acted to dampen the tariffs calculated for a typical project – for example excluding outliers on the assumption of a normal distribution of costs and calculating tariffs from based on average cost parameters rather than average required tariff. Others appeared to have less no clear impact in either direction.

Pöyry used DECC’s assumptions for the construction period and economic lifetime (i.e. the time over which costs need to be recovered) for a project, at 1 year and 35 years respectively. It could be argued that a longer construction period and a shorter economic lifetime might be more realistic – both of which would imply an increased in required tariffs.

1.3 Report structure

The remainder of this report is structured as follows:

- ③ Chapter 2 presents the generation tariffs that would be required for a typical project based on BHA survey responses;
- ③ Chapter 3 explains our methodology and assumptions and how they compare to the methodology and assumptions used by PB and DECC; and
- ③ Chapter 4 summarises the results of the data collected from BHA surveys and how it compares to the PB survey data.

1.4 Conventions

All monetary values quoted in this report are in GB Pounds Sterling, in real 2016 money prices, unless otherwise stated.

Unless otherwise attributed the source for all tables, figures and charts is Pöyry Management Consulting.

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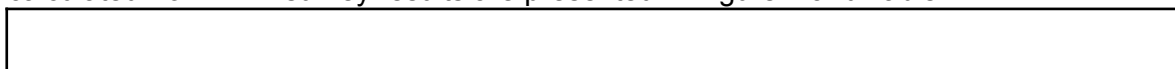
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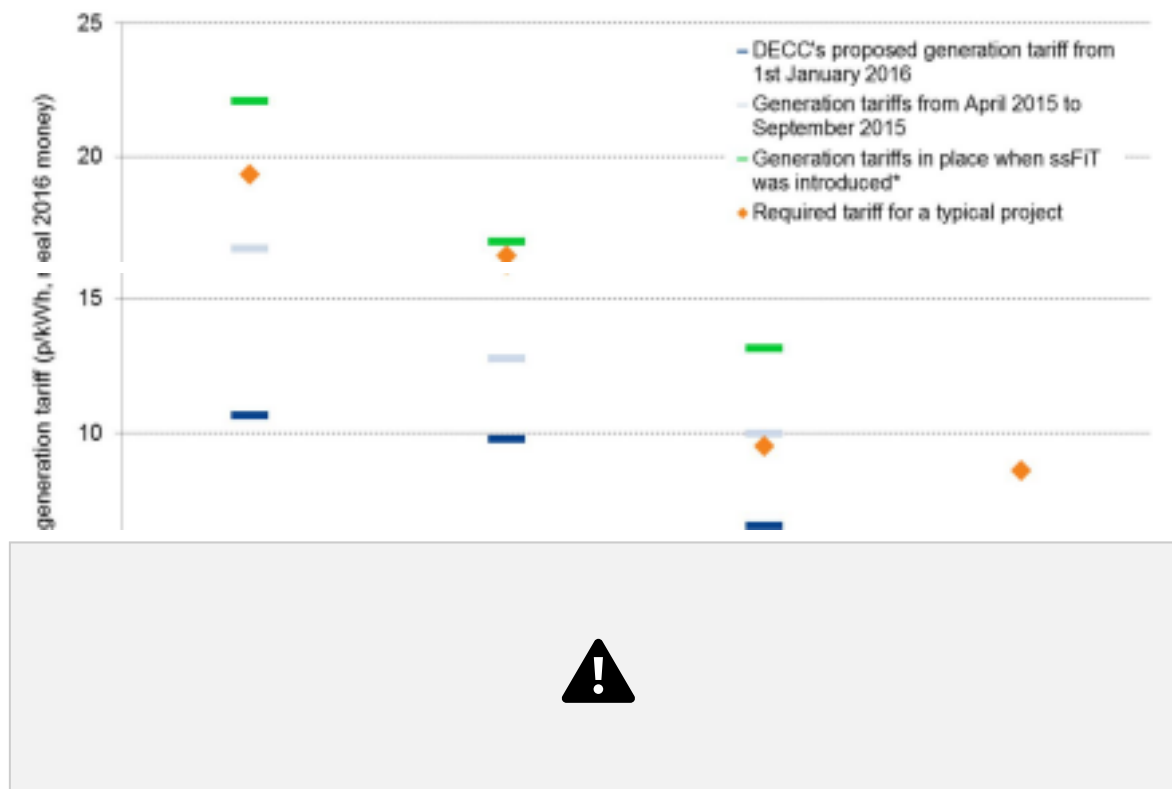


ANALYSIS OF THE COSTS OF SMALL-SCALE HYDRO AND IMPLIED FEED-IN TARIFFS

2. REQUIRED GENERATION TARIFFS FOR SMALL-SCALE HYDRO

The required generation tariffs for a typical hydro project, per proposed tariff band calculated from BHA survey results are presented in Figure 2 and Table 2.





The required generation tariffs, calculated from BHA survey data, are significantly higher than those proposed by DECC, and are closer to the tariffs in place prior to 1 October 2015. These higher tariffs are the result of higher reported costs, and partly a result of the inclusion of all project costs that need to be recovered to make a project viable (see section 3.2 and Chapter 0).

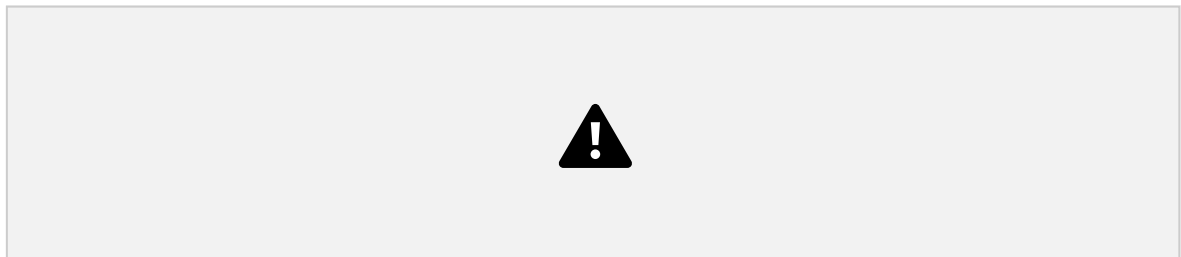
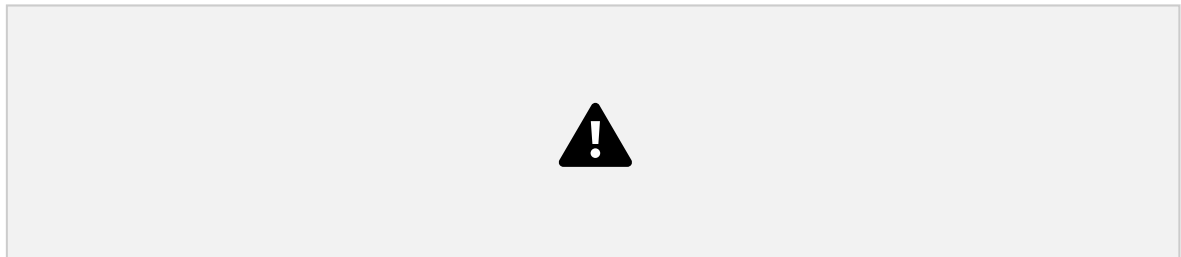
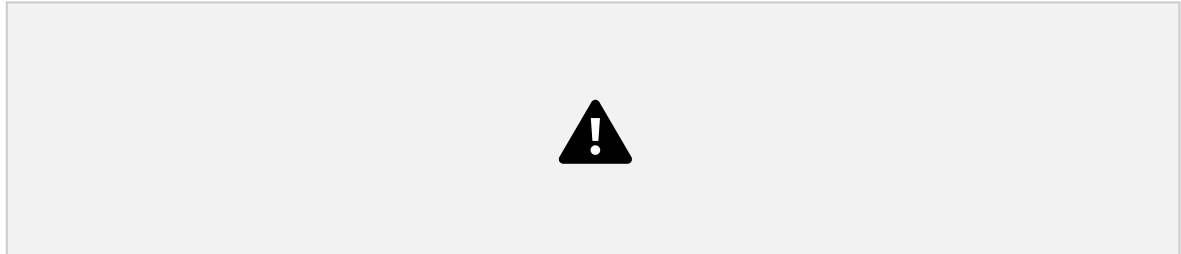
Installation size (kW)		was introduced*		September 2015		1st January 2016		typical project	
Generation tariffs in place when ssFiT		Generation tariffs from April 2015 to		DECC's proposed generation tariff from		Required tariff for a			
0-100	22.1 16.5 10.7 19.3	100-500	16.8 12.8 9.8 16.3	500-2000	13.1 10.0 6.6 9.5	2000-5000	5.3 2.7 2.2 8.6		

Source: Pöyry, DECC and Ofgem

Figure 3 shows the required tariffs broken down by the size categories used in PB's report on small-scale generation costs. The vertical bar represents the range of tariffs calculated for projects in the relevant size band. The orange diamonds represent a 'typical project', calculated by taking a simple average of the required tariffs for all projects in the size band (after exclusion of outliers).

It is clear that the tariff required for any particular project varies widely within an installation size band, reflecting the site-specific nature of hydro projects. So even at DECC's proposed tariffs some projects would be viable. However, these are projects on

the margin rather than a typical project, so a typical project would not appear to be sufficiently compensated under the proposed tariffs. It is also possible that the best-sited projects have already been developed and so it is not clear the extent to which such sites will be available in future. More detailed representations of the spread of project costs are given in Annex A.

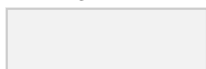


*The tariff shown for the 100-500kW band is the tariff that was introduced following the 2012 comprehensive ssFiT review.
Source: Pöyry, DECC and Ofgem

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3. METHODOLOGY AND ASSUMPTIONS

To calculate required hydro generation tariffs, we used BHA survey data and followed DECC/PB's methodology and assumptions where appropriate to provide as comparable results as possible. Our analysis differs from DECC's in the following respects:

1. We have used the data set collected by BHA, which is more comprehensive than that collected by PB.

2. We have taken account of any difference of opinion between DECC and BHA, for example on the definition of which costs to include.
3. The larger data set allows us to apply a consistent approach across all size bands, whereas PB had to use a different approach for some size bands where it had insufficient data.
4. Where the precise methodology used by PB/DECC is not clear we have made our own assumptions on the approach to use.

To test our model we also ran it using DECC's assumptions² and successfully reproduced DECC's proposed tariffs to a high degree of accuracy.

The key assumptions and methodologies behind the DECC/PB and Pöyry/BHA approaches are described in Section 3.1 and 3.2 below, and summarised in Table 3. The areas in which the Pöyry/BHA approach differed from DECC/PB's are highlighted in orange.

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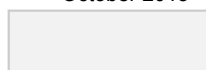
Assumptions DECC/PB approach BHA/Pöyry approach Cost source data PB survey BHA survey Costs included PB definition All costs Load factor 40% Survey data Hurdle Rate 9% 9% Commissioning time 1 year 1 year Project Lifetime 35 years 35 years DECC's export fraction PB survey BHA survey Outlier upper limit 75% of the median 75% of the median Outlier lower limit 25% of the median 25% of the median Cost outliers limits are applied to Capex and opex separately Capex and opex jointly Treatment of other costs if one is an outlier These costs can be considered Whole project excluded Tariff calculation approach Calculated from average parameters Average of project specific tariffs Weightings applied to cost data Yes No

3.1 Comparison of Pöyry and DECC/PB assumptions

The purpose of the project was to use updated cost source data with a greater sample size and for it to be based on all the project costs that need to be recovered to make a project viable. It therefore includes a wider definition of project costs than that in the PB report.

In the PB report capex was defined as including:

² As set out in its impact assessment for the periodic Feed-in Tariff review.



the design, procurement and construction (EPC) costs, equipment costs and civil works costs. It should not include owner's costs, grid connection costs or substation and/or transformer costs.

Opex was defined as including:

Labour, planned maintenance and lifecycle replacement costs. It should not include land costs, property and business rates tax costs, rental and community benefit payments. Variable Opex may also include water and/or chemical usage. Opex costs do not include feedstock or digestate disposal costs for AD.

PB requested costs for land purchase or rental, grid connection, and connection use of

system charges, but of these we understand only grid connection was included in DECC's calculation of its proposed tariffs.

In addition to the costs listed above the BHA survey requested:

- ③ development costs including environmental surveys, planning and licence applications (included as capex costs);
- ③ additional overheads including insurance costs, licence charges, monitoring fees, fish surveys, bank charges, audit and accountancy fees, property and business rates, tax costs and community benefit payments (included as opex costs); and
- ③ 'other' opex and capex costs incurred could also be provided.

We took a whole project approach to calculating tariffs (this is explained further in section 3.2) and so we used reported load factors from the survey data, rather than DECC's 40% assumption to maintain a consistent data set. We also used survey data for the export fraction for projects above 100kW³.

We used DECC's construction time assumption of 1 year for simplicity and consistency with DECC's approach, although our survey data suggests that a longer timeframe may be more appropriate. For consistency with DECC's approach we also used DECC's project lifetime assumption of 35 years and assumed this to also be the economic lifetime of the project.

We used a consistent hurdle rate assumption of 9%, given this is DECC's target return and we used DECC's assumptions for electricity price projections and the export tariff.

3.2 Comparison of Pöry and DECC/PB methodologies

Our general approach to determining required tariffs for each tariff band was the same as DECC's – to identify a tariff that would support a typical hydro project. The main difference in our methodology was that we were able to calculate all tariffs based on sample data due to the larger size, rather than it being necessary to infer results from changes in other size bands.

We also sought to improve internal consistency within the calculation by calculating a required tariff for each project and then averaging across projects in the band. This contrasts with the PB/DECC approach of first averaging input assumptions (such as

³ We assumed 75% of electricity was exported for projects below 100kW as this is a deemed figure. This is the same assumption that DECC used.

capex and opex) and performing a single tariff calculation for each band. Our approach meant that the characteristics of a particular project remain linked – for example some projects may have a higher capex but lower opex or vice versa, or some projects may have high capex and opex costs but also relatively high load factors.

Our general treatment of outliers for capex and opex was the same as PB's:

- ③ the median was found for each size band; and
- ③ projects with capex or opex greater than 75% of either side of the median were

discarded.

The benefit of excluding outliers when using medians, as DECC did in calculating its tariffs, is less clear than when calculating a mean as it doesn't impact on a calculated value just the which value falls in the middle. It is also not clear from the data that the distribution of hydro costs follows a normal distribution – it may be more skewed towards lower costs. In general, though not for every tariff band, exclusion of outliers led to lower tariffs under the BHA dataset than would have been the case if outliers were not excluded.

Where we differed from PB's approach was that, where a project was deemed an outlier due to its capex (or opex), the whole project was excluded from the tariff calculation. This meant that any relationship between capex and opex would be maintained in the remaining data set. This approach is easier to take with a larger dataset as it reduces the number of data points over the approach taken by PB (which was to just remove the single capex or opex figure).

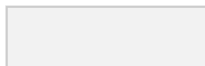
According to the PB report, 'weightings were applied to each number to adjust them based on Parsons Brinckerhoff's confidence'. However, as the specific weights themselves are not specified, we could not replicate this or make a judgement on its value to the dataset.

One further difference between the two approaches relates to treatment of 'extension projects' – that is projects which have added to existing capacity and the addition has moved them into a higher size band. In the BHA survey, this is treated as a single project (in the larger size band), and all costs associated with each build-stage are included in the capex and opex attributed to the project. This is to ensure the disproportionately high costs of the initial installation (with in many cases includes all the civil works) and disproportionately low cost of the extension (which may only include the turbine supply) did not skew the figures. As all schemes accredited in the 2-5MW range are extensions this methodology has provides a data set for this band.

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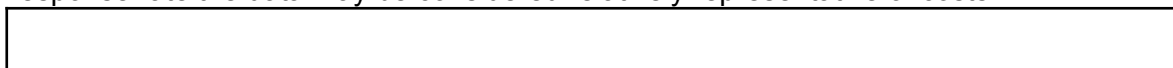
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ANALYSIS OF THE COSTS OF SMALL-SCALE HYDRO AND IMPLIED FEED-IN TARIFFS

4. SURVEY RESULTS

The BHA surveyed its members to collect data for both operational and proposed projects. Projects commissioned before 2010 were excluded. As shown in Table 4, the response rate to this survey was high across the majority of the size bands particularly for 50-100kW and 100-500kW projects with 39 and 49 responses respectively. Given the response rate the data may be considered relatively representative of costs.



Installation size (kW)		Sample size		Average		Export Fraction (%)		period		Capex (£/kW)		(£/kW/year)		Load																
		installation size (kW)		Commissioning				Opex				Factor (%)																		
0-15	20	9	47	1.9	12,400	190	55	15-50	13	34	80	1.0	7,000	60	46	50-100	39	91	90	1.4	7,500	170	54	100-500	49	408	97	1.3	5,300	160
42	500-1000	16	826	99	2.0	3,100	130	41	1000-2000	12	1,792	100	1.3	4,300	120	43	2000-5000	5	3,979	99	2.1	4,000	70	41						

Source: BHA members' survey, Pöyry analysis, costs shown are median figures, all other figures are means

Average installation sizes of the projects survey tended to be towards the higher end of the size category perhaps representing the lower costs of larger installations. Their construction periods were generally between 1 and 2 years.

In general capex and opex costs were lower (on a per kW basis) for larger projects, as might be expected due to economies of scale, though there were exceptions. Load factors were generally higher for installations below 100kW and below averaging 53%. Installations above 100kW had load factors just above 40%. Load factors from schemes greater than 100kW which are already operational averaged 40%.

For installations above 100kW virtually all electricity is exported, as may be expected from larger installations. These figures are in line with DECC assumptions so had little impact on the difference between DECC's proposed tariffs and the required tariffs calculated by Pöyry.

Table 5 compares the capex and opex costs resulting from the two surveys, along with the assumptions used by DECC (taken from PB's study) to calculate the proposed generation tariffs from January 2015. It also compares the resulting levelised cost of electricity. Capex and opex figures shaded blue are where PB did not have sufficient confidence to determine the figure from data for that installation size alone.

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Installation size (kW)										BHA DECC PB BHA DECC BHA												
Capex (£/kW)					Opex (£/kW/year)					LCOE (£/MWh)					DECC PB							
0-15	5,200	3,700	12,400	50	40	190	155	337	15-50	5,200	5,700	7,000	50	70	60	155	238	50-100	5,200	5,300	7,500	50
100	170	155	176	100-500	4,600	4,300	5,300	50	50	160	139	190	500-1000	3,700	3,400	3,100	20	20	130	106	141	
1000-2000	3,700	2,600	4,300	20	10	120	106	137	2000-5000	2,500	2,200	4,000	10	10	70	70	123					

Source: PB, BHA, Pöyry analysis. Costs shown are median figures. LCOE is the levelised cost of electricity generation.

The difference in reported capex and opex costs is the main driver of differences in the required tariffs calculated by DECC/PB and Pöyry. This was in part due to the inclusion of

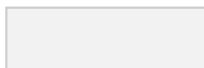
all project costs, as discussed in Section 3.1.

The greatest difference in costs is in the 0-15kW size band where we do not get the same result as PB of lower costs than the 15-50kW size band. In general, reported costs of projects below 100kW from BHA's were considerably higher than those from PB's analysis. However, this is somewhat offset by higher assumed load factors for this tariff band, meaning the difference in the required tariffs is proportionally less.

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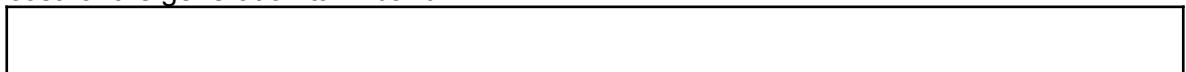
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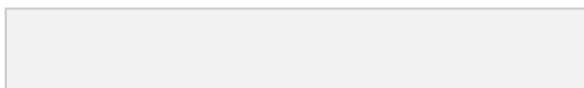
ANALYSIS OF THE COSTS OF SMALL-SCALE HYDRO AND IMPLIED FEED-IN TARIFFS **ANNEX**

A – PROJECT COST DATA

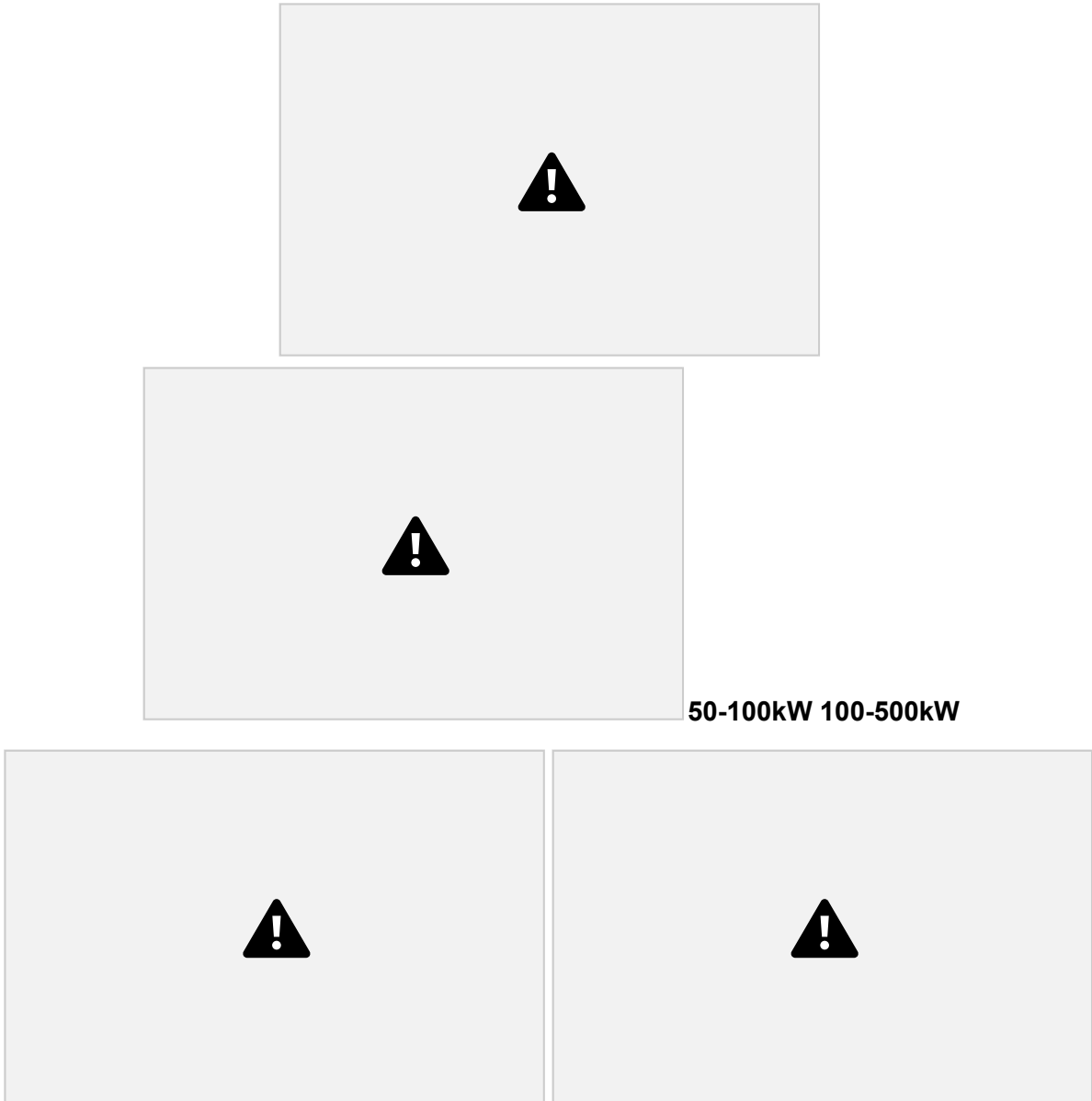
In this annex we show the reported capex and opex of the projects costs reported under the BHA's survey. Each point represents a project. The charts are broken down by the installation size categories reported in the PB report. The dotted line is DECC's assumed cost for the generation tariff band.



Legend



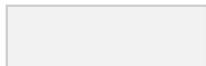
0-15kW 15-50kW



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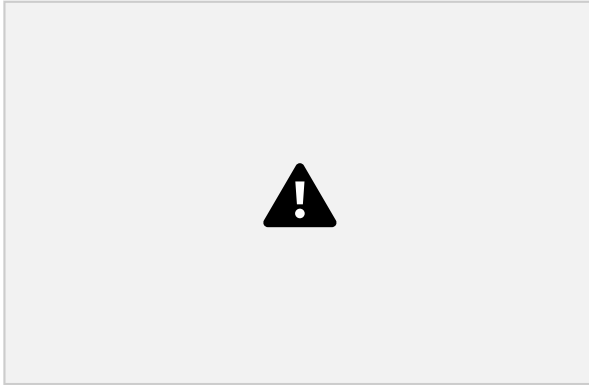
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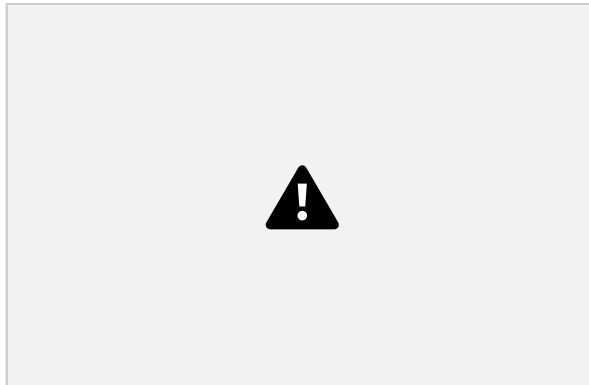
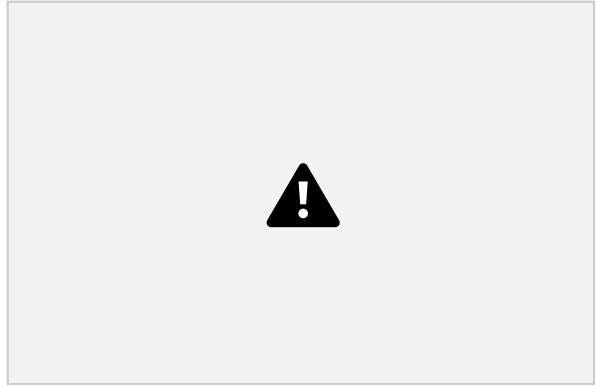


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500-1000kW 1000-2000kW



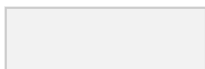
2000-5000kW



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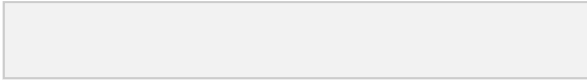
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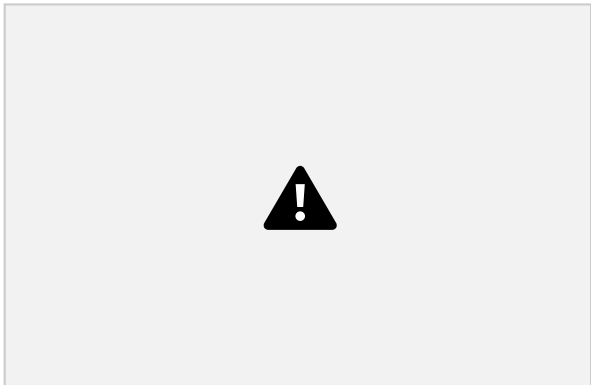
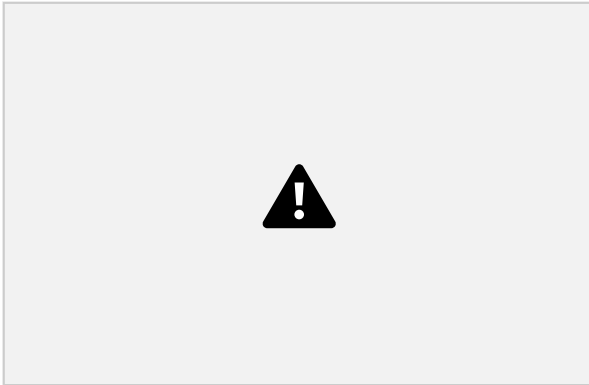
ANALYSIS OF THE COSTS OF SMALL-SCALE HYDRO AND IMPLIED FEED-IN TARIFFS



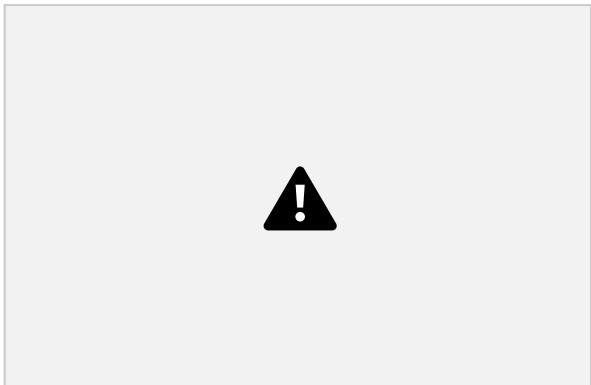
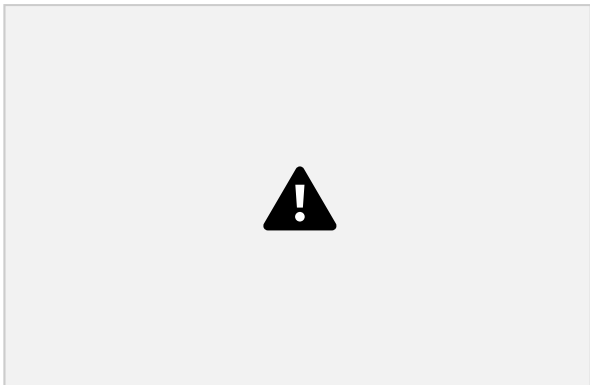
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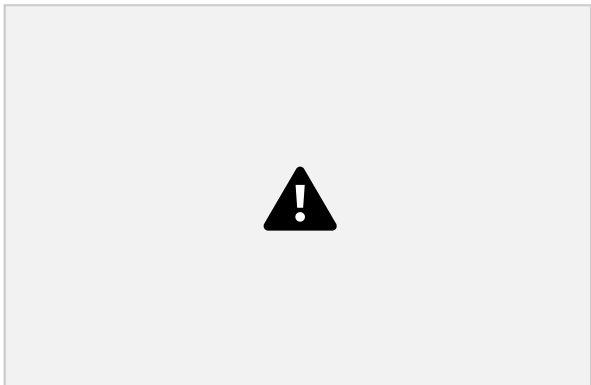
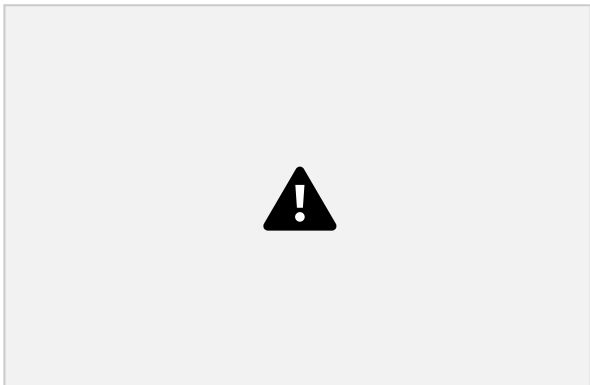
0-15kW 15-50kW



50-100kW 100-500kW

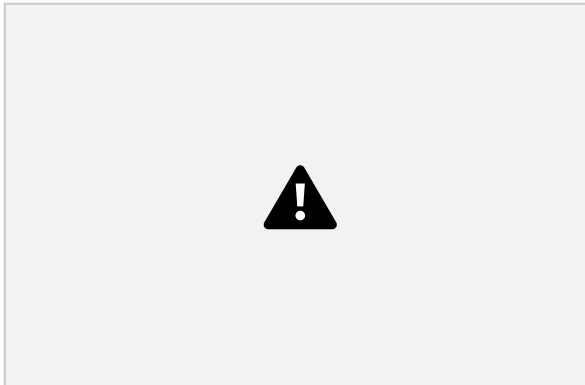


500-1000kW 1000-2000kW



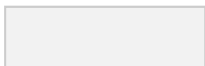


2000-5000kW



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AND DOCUMENT CONTROL

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