

# Heat Output Tests

## Six Fuels on Three Appliances

Commissioned by  
HETAS (on behalf of DEFRA)

Report 101501/1

Compiled by allan wilson

14 February 2020



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# Heat Output Tests

## Six Fuels on Three Appliances

Carried out for: HETAS (on behalf of DEFRA)  
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Contract: Report 101501/1

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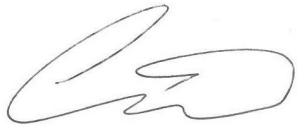
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## SUMMARY

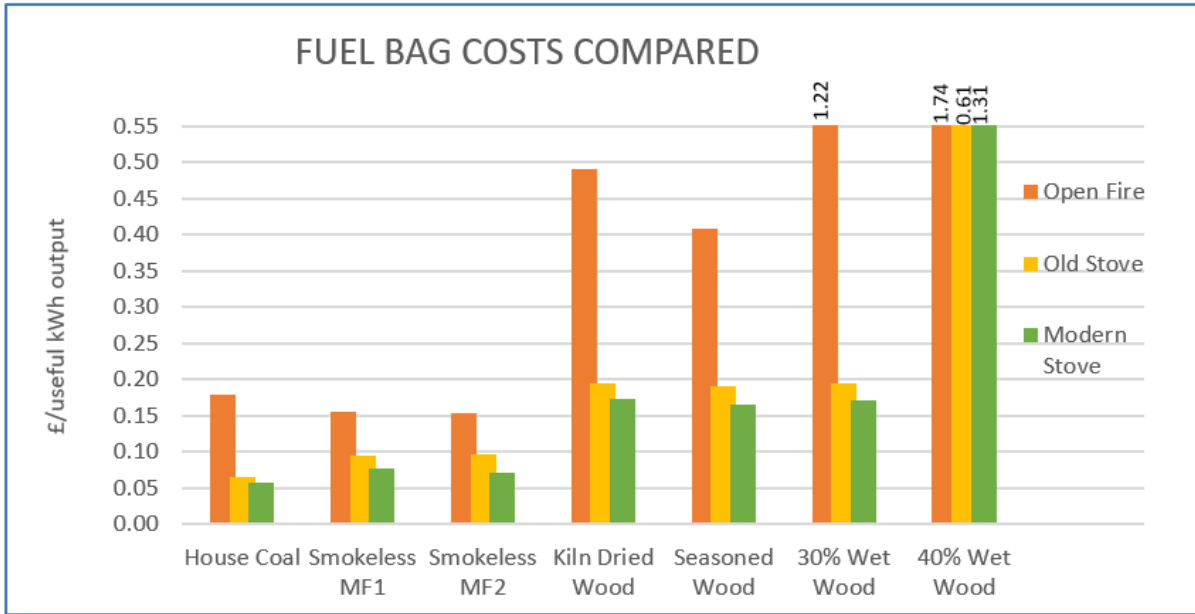
On behalf of DEFRA, Hetas Ltd. commissioned BSRIA to carry out a series of tests on three appliances (open fire, old stove and a modern stove) to identify the useful heat output of a series of solid fuels selected from typical fuels available to the public. Each fuel was tested on each of the appliances regardless of suitability for use on the respective appliances, to determine the effect where fuels are used without regard to manufacturers or industry recommendations for best practice. Figures 1 and Figure 2 are a graphic summary of Tables 25 & 26, and Tables 27 & 28 respectively.

A desk-based study was then carried out to identify the cost of each fuel type tested (house coal, two types of smokeless mineral fuel, kiln dried wood, seasoned wood and two sets of wet wood at approximately 30% and 40% moisture) in both bag and bulk quantities across five regions in England (North East, North West, Midlands, South East and South West).

The findings from the desk-based study along with the results of the testing were used to calculate costs of useful heat associated with operating each appliance with each type of fuel. Figure 1 and Figure 2 show the average cost across England per useful kilowatt-hour for each fuel and appliance tested. As it was not possible to burn wet wood with the high levels of moisture selected for these tests, additional methods were included in the test procedure, as described in Table 3 Section 6. As limited information was available regarding wet wood prices, the same price has been applied to unseasoned/wet wood at 30% and 40% moisture respectively shown in Figure 1 and Figure 2, and in Table 26 and Table 28, established from the average difference in prices between bags and bulk for kiln dried and seasoned wood in each region.

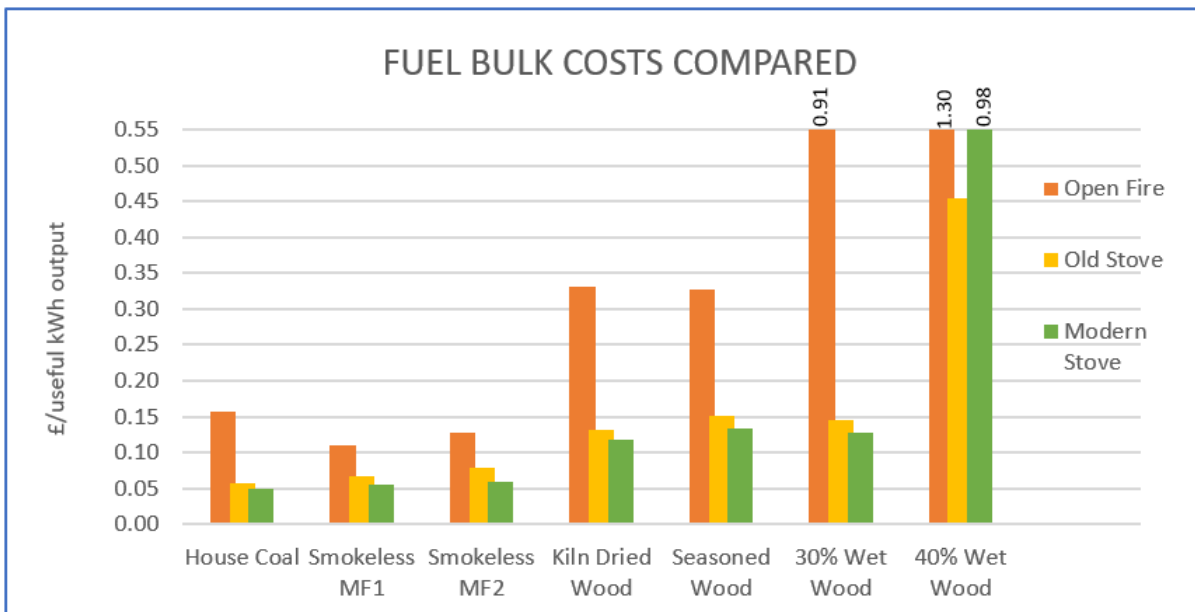
Full details of the objectives, test method used, and results are in the main body of this report.

**Figure 1 Cost per useful kWh – Bag prices (Graphic summary of Table 25 and Table 26)**



Cost/kWh for wet wood that are high above the scale of the chart are noted above respective bars

**Figure 2 Cost per useful kWh – Bulk prices (Graphic summary of Table 27 and Table 28)**



Cost/kWh for wet wood that are high above the scale of the chart are noted above respective bars

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## 1 INTRODUCTION

This report details a bespoke test procedure covering tests carried out on three different appliance types to identify the useful heat output of a series of solid fuels. The results of the testing were then used to calculate the costs associated with operating each appliance type with each fuel type across five pre-defined regions in England.

The general test procedures and practices set out in the standards listed in Section 6 were followed where relevant with deviations as noted to enable a practical application in achieving the objectives.

Testing was carried out on the BSRIA solid fuel appliance test rig in Bracknell, Berkshire during March, April and May 2019.

## 2 OBJECTIVES

The objectives of testing were to assess the heat output, and subsequent regional cost/useful kWh output from three solid fuel appliances consisting of an open fire, an old stove, and a modern Eco-design ready Clean Air Act compliant stove, using the following fuels:

- Bituminous house coal
- Smokeless manufactured solid fuel (MF 1) which meets 2% sulphur and 5g/hr smoke test
- Smokeless low cost manufactured solid fuel (MF 2) which meets 2% sulphur and 5g/hr smoke test
- Kiln dried wood (<20% moisture content)
- Seasoned wood (<25% moisture content)
- Wet wood (>30% moisture content)
- Wet wood (>40% moisture content)

Costings for the fuels listed above were to be researched in both bag and bulk quantities across the five following pre-defined regions in England:

- North East
- North West
- Midlands
- South East – including East of England
- South West



### 3 TEST FACILITY

The UKAS accredited test facility enables both the thermal performance and smoke tests to be carried out on free standing stoves, and inset appliances including open fires which are designed to burn wood and mineral fuels.

#### 3.1 EFFICIENCY AND HEAT OUTPUT TESTS

The efficiency of each appliance was determined from measurements made of the flue gas temperature, the CO<sub>2</sub> within the flue, the ambient temperature, and from the chemical analysis of the fuel used. The heat output of the appliance, as tested with each fuel in this investigation, was determined from a measurement of the efficiency, burning rate and lower or net calorific value of the fuel in accordance with BS EN 13240 and BS EN 13229 respectively.

For each fuel tested the following have been provided:

- For wood – details on fuel content, type of wood, moisture level and species.
- For coal and manufactured solid fuels – details on fuel content and type of coal.
- The fuel suppliers confirmed the products used were of UK origin.

### 4 INSTRUMENTATION

Table 1 details the instrumentation used during testing.

**Table 1 Instrumentation**

Instrument	Instrument No.	Calibration Expiry Date
High Temperature Sensors	1717	29/04/20
Tri-hedron Thermocouples	1701 - 1716	14/05/19
Flue Gas Analyser	1001	12/11/19
Static Pressure Indicator 3	1355	08/11/19
Scales for weighing test fuel	149	12/02/20
Moisture meter	211	13/09/20
Humidity Sensor and Ambient PRT	1495	09/10/19

## 5 TEST APPLIANCES AND FUELS

### 5.1 TEST APPLIANCES

Three appliances were used during testing, as shown in Figures 3 to 5

**Figure 3 Open Fire**



BSRIA Test open fireplace fitted with an 18" Solid Fuel Kit

**Figure 4 Old Stove**



Old Model 5kW Stove

**Figure 5 Modern Stove**



Modern Model 5kW Stove

## 5.2 TEST FUELS

Table 2 shows details of the fuel types used during testing.

The laboratory analyses of the fuels used are shown in Appendix B

The lower calorific values for wood fuels are adjusted according to the average moisture measured in the logs used at the time of testing (as fired).

**Table 2 Fuel types**

Fuel Type	Sample analysis reference	% Moisture (As fired)	Lower (Net) Calorific Value MJ/Kg (As fired)
House Coal	100174/1	7.5%	29.673
Smokeless (MF1) manufactured mineral fuel	100174/2	12.4%	28.021
Low cost smokeless (MF2) manufactured mineral fuel	100174/3	10.7%	27.828
Kiln dried wood logs (Beech)	100174/4	15.3%	15.008
Seasoned wood logs (Beech)	100174/5	15.0%	15.195
Wet wood logs (Ash)	100174/8	29.12%	12.155
Wet wood logs (Beech)	100174/7	39.06%	10.812

## 6 TEST SCHEDULE

**Table 3 Test Schedule Principles**

<p>Where appropriate the guidance and specifications given in the following standards will be adhered to.</p> <ul style="list-style-type: none"> <li>• BS EN 13240: “Room Heaters fired by solid fuel- Requirements and test methods” 2001 Incorporating amendment A2 :2004, and Corrigenda September 2003 and June 2006.</li> <li>• BS EN 13229: “Inset appliances including open fires fired by solid fuels - Requirements and test methods” 2001 Incorporating amendment A2 :2004, and Corrigenda September 2003, June 2006 and August 2007.</li> <li>• BS EN 16510-1:2018 (published 10<sup>th</sup> September 2018)</li> </ul> <p>The following deviations from the above standards have been implemented to facilitate more appropriate comparisons of the combustion characteristics of the respective fuels on the respective appliances.</p>	
<b>1</b>	All fuel loads have been standardised to a mass of 2kg with normal tolerances on start and finish weights, but no limit on test duration. i.e. The full fuel load was burnt on each test.
<b>2</b>	<p>Standard air control settings were used on each appliance across all fuel types, with exception for wet wood.</p> <p>Air settings were the same for all coal fuels across all appliance types at 100% primary air and 0% secondary air. The open fire only has a primary air control with free air above the grate.</p> <p>With wood fuels on the open fire the primary air control was closed, with exception for wet wood.</p> <p>Air settings for wood fuels on the closed appliances were as recommended by respective manufacturers i.e. 0% primary air on both, then 50% secondary air for the old stove and 60% secondary air for the modern stove.</p>
<b>3</b>	Wet wood with moisture levels outside the permissible limits listed in the standards will be used in the test programme.
<b>4</b>	<p>The wet wood would not burn without considerable assistances and the following agreed deviation to procedure has be employed to maintain a sustainable fire as follows;</p> <ol style="list-style-type: none"> <li>a) The 30% wet wood was placed on a fire bed of kiln dried wood and;             <ol style="list-style-type: none"> <li>i. The primary air control on the open fire was fully open, and the static pressure was increased to 24Pa±2Pa<sup>(1)</sup> in order to create sufficient draft to maintain a sustainable fire.</li> <li>ii. The primary air control on the old model stove was closed, with secondary air 50% open.</li> <li>iii. The primary air control on the modern stove was 100% open, with secondary air 60% open.</li> </ol> </li> <li>b) The 40% mc wet wood placed on a fire bed of smokeless (MF2) fuel and;             <ol style="list-style-type: none"> <li>i. The primary air control on the open fire was fully open</li> <li>ii. The primary air control on the old model stove was 50% open, with secondary air 50% open.</li> <li>iii. The primary air control on the modern stove was 50% open, with secondary air 60% open.</li> </ol> </li> </ol>
<b>Note 1</b>	The static pressure in the flue was maintained at 12Pa±2Pa for all tests with the exception when burning 30% mc wet wood on a kiln dried fire bed, where this was set to 24Pa±2Pa to create conditions for suitable combustion.
<b>Note 2</b>	All data was recorded every 30 seconds throughout each test period.

## 7 TEST RESULTS

### 7.1 HOUSE COAL

#### 7.1.1 Open Fire

**Table 4 House Coal Heat Output - Open fire**

Client: HETAS Stove Model: Open Fire				
Test Type: House Coal - AHK sample 100174/1				
Test Fuel: Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test	13/03/19	13/03/19	13/03/19	
Net Efficiency (%)	24.25	25.18	29.87	26.43
Measured Heat Output (kW)	3.00	2.90	3.48	3.13

#### 7.1.2 Old model stove

**Table 5 House Coal Heat Output - Old stove**

Client: HETAS Stove Model: Old Stove				
Test Type: House Coal - AHK sample 100174/1				
Test Fuel: Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test	18/03/19	18/03/19	18/03/19	
Net Efficiency (%)	77.26	71.99	70.52	73.26
Measured Heat Output (kW)	7.35	6.91	6.46	6.91

Note: House coal is not normally recommended for use in closed appliances.

#### 7.1.3 Modern model stove

**Table 6 House Coal Heat Output – Modern stove**

Client: HETAS Stove Model: Modern Stove				
Test Type: House Coal - AHK sample 100174/1				
Test Fuel: Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test	23/03/19	23/03/19	23/03/19	
Net Efficiency (%)	84.24	85.47	81.58	83.76
Measured Heat Output (kW)	7.51	8.63	8.32	8.15

Note: House coal is not normally recommended for use in closed appliances.

## 7.2 SMOKELESS MANUFACTURED COAL FUEL (MF1)

### 7.2.1 Open Fire

**Table 7 Smokeless MF1 Heat Output – Open fire**

Client:	HETAS	Stove Model:	Open Fire		
Test Type:	Smokeless MF1 - AHK sample 100174/2				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		15/03/19	15/03/19	15/03/19	
Net Efficiency (%)		42.17	43.18	37.73	41.02
Measured Heat Output (kW)		2.98	2.62	2.15	2.58

### 7.2.2 Old model stove

**Table 8 Smokeless MF1 Heat Output – Old stove**

Client:	HETAS	Stove Model:	Old Stove		
Test Type:	Smokeless MF1 - AHK sample 100174/2				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		16/03/19	16/03/19	16/03/19	
Net Efficiency (%)		66.84	69.68	66.26	67.59
Measured Heat Output (kW)		5.03	5.42	4.76	5.07

### 7.2.3 Modern model stove

**Table 9 Smokeless MF1 Heat Output – Modern stove**

Client:	HETAS	Stove Model:	Modern Stove		
Test Type:	Smokeless MF1 - AHK sample 100174/2				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		23/03/19	23/03/19	23/03/19	
Net Efficiency (%)		79.91	83.15	83.92	82.33
Measured Heat Output (kW)		5.45	5.28	6.03	5.59

## 7.3 SMOKELESS MANUFACTURED COAL FUEL (MF2)

### 7.3.1 Open Fire

**Table 10 Smokeless MF2 Heat Output – Open fire**

Client:	HETAS	Stove Model:	Open Fire		
Test Type:	Smokeless MF2 - AHK sample 100174/3				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		14/03/19	14/03/19	15/03/19	
Net Efficiency (%)		37.89	35.17	41.81	38.29
Measured Heat Output (kW)		2.07	1.85	2.59	2.17

### 7.3.2 Old model stove

**Table 11 Smokeless MF2 Heat Output – Old stove**

Client:	HETAS	Stove Model:	Old Stove		
Test Type:	Smokeless MF2 - AHK sample 100174/3				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		17/03/19	17/03/19	18/03/19	
Net Efficiency (%)		53.70	64.33	67.15	61.73
Measured Heat Output (kW)		3.69	3.93	4.02	3.88

### 7.3.3 Modern model stove

**Table 12 Smokeless MF2 Heat Output – Modern stove**

Client:	HETAS	Stove Model:	Modern Stove		
Test Type:	Smokeless MF2 - AHK sample 100174/3				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		22/03/19	22/03/19	22/03/19	
Net Efficiency (%)		82.94	83.22	82.83	83.00
Measured Heat Output (kW)		4.81	4.44	4.42	4.55

## 7.4 KILN DRIED WOOD LOGS

### 7.4.1 Open Fire

**Table 13 Kiln dried wood logs Heat Output – Open fire**

Client:	HETAS	Stove Model:	Open Fire		
Test Type:	Kiln dried wood logs - AHK sample 100174/4				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		26/03/19	26/03/19	26/03/19	
Net Efficiency (%)		34.79	24.99	19.87	26.55
Measured Heat Output (kW)		3.70	2.78	2.11	2.87

### 7.4.2 Old model stove

**Table 14 Kiln dried wood logs Heat Output – Old stove**

Client:	HETAS	Stove Model:	Old Stove		
Test Type:	Kiln dried wood logs - AHK sample 100174/4				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		19/03/19	19/03/19	19/03/19	
Net Efficiency (%)		68.39	66.76	65.95	67.03
Measured Heat Output (kW)		6.34	4.84	5.50	5.56

### 7.4.3 Modern model stove

**Table 15 Kiln dried wood logs Heat Output – Modern stove**

Client:	HETAS	Stove Model:	Modern Stove		
Test Type:	Kiln dried wood logs - AHK sample 100174/4				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		25/03/19	25/03/19	25/03/19	
Net Efficiency (%)		74.95	75.59	75.37	75.30
Measured Heat Output (kW)		5.21	6.30	5.98	5.83



## 7.5 SEASONED WOOD LOGS

### 7.5.1 Open Fire

**Table 16 Seasoned wood logs Heat Output – Open fire**

Client:	HETAS	Stove Model:	Open Fire		
Test Type:	Seasoned wood logs - AHK sample 100174/5				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		26/03/19	26/09/19	26/03/19	
Net Efficiency (%)		23.93	30.29	32.25	28.82
Measured Heat Output (kW)		2.02	2.65	3.03	2.56

### 7.5.2 Old model stove

**Table 17 Seasoned wood logs Heat Output – Old stove**

Client:	HETAS	Stove Model:	Old stove		
Test Type:	Seasoned wood logs - AHK sample 100174/5				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		19/03/19	19/03/19	19/03/19	
Net Efficiency (%)		60.13	60.76	65.06	61.99
Measured Heat Output (kW)		4.23	4.05	4.39	4.22

### 7.5.3 Modern model stove

**Table 18 Seasoned wood logs Heat Output – Modern stove**

Client:	HETAS	Stove Model:	Modern stove		
Test Type:	Seasoned wood logs - AHK sample 100174/5				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		25/03/19	25/03/19	25/03/19	
Net Efficiency (%)		75.60	72.86	64.64	71.03
Measured Heat Output (kW)		4.79	5.86	4.82	5.15

## 7.6 WET WOOD 30% MOISTURE (ON DRY WOOD BED)

### 7.6.1 Open Fire

**Table 19 30% Wet wood (on dry wood bed) Heat Output – Open fire**

Client:	HETAS	Stove Model:	Open Fire		
Test Type:	30% Wet Wood - AHK Sample 100174/8				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		09/05/19	09/05/19	09/05/19	
Net Efficiency (%)		6.67	7.38	7.99	7.34
Measured Heat Output (kW)		0.37	0.41	0.47	0.41

### 7.6.2 Old model stove

**Table 20 30% Wet wood (on dry wood bed) Heat Output – Old stove**

Client:	HETAS	Stove Model:	Old stove		
Test Type:	30% Wet Wood - AHK Sample 100174/8				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		07/05/19	07/05/19	07/05/19	
Net Efficiency (%)		45.08	47.99	46.02	46.36
Measured Heat Output (kW)		2.10	2.53	2.39	2.34

### 7.6.3 Modern model stove

**Table 21 30% Wet wood (on dry wood bed) Heat Output – Modern stove**

Client:	HETAS	Stove Model:	Modern stove		
Test Type:	30% Wet Wood - AHK Sample 100174/8				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		08/05/19	08/05/19	08/05/19	
Net Efficiency (%)		52.96	52.93	51.81	52.57
Measured Heat Output (kW)		2.38	2.94	2.88	2.73

## 7.7 WET WOOD 40% TM (ON COAL BED)

### 7.7.1 Open Fire

**Table 22 40% Wet wood (on coal bed) Heat Output – Open fire**

Client:	HETAS	Stove Model:	Open Fire		
Test Type:	40% Wet Wood - AHK Sample 100174/7				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		17/04/19	17/04/19	17/04/19	
Net Efficiency (%)		4.94	4.90	8.65	6.16
Measured Heat Output (kW)		0.18	0.13	0.23	0.18

### 7.7.2 Old model stove

**Table 23 40% Wet wood (on coal bed) Heat Output – Old stove**

Client:	HETAS	Stove Model:	Old stove		
Test Type:	40% Wet Wood - AHK Sample 100174/7				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		12/04/19	12/04/19	12/04/19	
Net Efficiency (%)		15.96	16.99	19.82	17.59
Measured Heat Output (kW)		0.85	0.69	0.93	0.83

### 7.7.3 Modern model stove

**Table 24 40% Wet wood (on coal bed) Heat Output – Modern stove**

Client:	HETAS	Stove Model:	Modern stove		
Test Type:	40% Wet Wood - AHK Sample 100174/7				
Test Fuel:	Heat Output	Test 1	Test 2	Test 3	Mean
Date of Test		16/04/19	16/04/19	16/04/19	
Net Efficiency (%)		7.31	5.93	11.29	8.18
Measured Heat Output (kW)		0.36	0.28	0.45	0.37

## 7.8 COMBINED RESULTS AND COSTING

Tables 25 to 28 show the cost per useful kWh of output for each fuel on each appliance, calculated from the calorific value as fired, the respective efficiency on each appliance, and the cost of the fuel type available in bags or bulk in each of following regions of England; North East, North West, Midlands, South East including East of England, and South West. The lowest (green) and highest (yellow) costs have been highlighted based on the figures reflected in this report.

The regional cost comparisons for the respective fuels are reflected in the Heat Maps, Figures 6 - 16.

Table 25 Summary coal bag prices and useful output costs

Summary Coal Bag Prices		£/kg			£/MJ	£/useful MJ output	£/useful kWh output	Average £/useful kWh output	
Lowest cost	Highest cost	Ave	Max	Min					
House Coal Sample 100174/1 Nett CV MJ/Kg (as fired) 29.673  Not recommended for use in closed appliances	Open Fire % Efficiency 26.43	NE	0.36	0.37	0.35	0.0122	0.0460	0.16571	0.17872
		NW	0.39	0.46	0.32	0.0131	0.0495	0.17802	
		M	0.37	0.39	0.35	0.0125	0.0474	0.17076	
		SE	0.45	0.50	0.40	0.0153	0.0580	0.20883	
		SW	0.37	0.37	0.37	0.0125	0.0473	0.17030	
	Old Stove % Efficiency 73.26	NE	0.36	0.37	0.35	0.0122	0.0166	0.05978	0.06448
		NW	0.39	0.46	0.32	0.0131	0.0178	0.06423	
		M	0.37	0.39	0.35	0.0125	0.0171	0.06161	
		SE	0.45	0.50	0.40	0.0153	0.0209	0.07534	
		SW	0.37	0.37	0.37	0.0125	0.0171	0.06144	
	Modern Stove % Efficiency 83.76	NE	0.36	0.37	0.35	0.0122	0.0145	0.05229	0.05640
		NW	0.39	0.46	0.32	0.0131	0.0156	0.05617	
		M	0.37	0.39	0.35	0.0125	0.0150	0.05388	
		SE	0.45	0.50	0.40	0.0153	0.0183	0.06589	
		SW	0.37	0.37	0.37	0.0125	0.0149	0.05374	
Smokeless MF1 Sample 100174/2 Nett CV MJ/Kg (as fired) 28.021	Open Fire % Efficiency 41.02	NE	0.56	0.73	0.31	0.0198	0.0484	0.17414	0.15486
		NW	0.46	0.60	0.31	0.0165	0.0403	0.14507	
		M	0.43	0.49	0.31	0.0152	0.0372	0.13382	
		SE	0.62	0.75	0.34	0.0222	0.0542	0.19519	
		SW	0.40	0.50	0.31	0.0144	0.0350	0.12606	
	Old Stove % Efficiency 67.59	NE	0.56	0.73	0.31	0.0198	0.0294	0.10568	0.09398
		NW	0.46	0.60	0.31	0.0165	0.0245	0.08804	
		M	0.43	0.49	0.31	0.0152	0.0226	0.08121	
		SE	0.62	0.75	0.34	0.0222	0.0329	0.11846	
		SW	0.40	0.50	0.31	0.0144	0.0213	0.07651	
	Modern Stove % Efficiency 82.33	NE	0.56	0.73	0.31	0.0198	0.0241	0.08676	0.07715
		NW	0.46	0.60	0.31	0.0165	0.0201	0.07228	
		M	0.43	0.49	0.31	0.0152	0.0185	0.06667	
		SE	0.62	0.75	0.34	0.0222	0.0270	0.09725	
		SW	0.40	0.50	0.31	0.0144	0.0174	0.06281	
Smokeless MF2 Sample 100174/3 Nett CV MJ/Kg (as fired) 27.829	Open Fire % Efficiency 38.29	NE	0.48	0.56	0.39	0.0172	0.0450	0.16193	0.15391
		NW	0.43	0.56	0.33	0.0153	0.0400	0.14386	
		M	0.44	0.54	0.39	0.0159	0.0414	0.14916	
		SE	0.54	0.64	0.42	0.0194	0.0508	0.18283	
		SW	0.39	0.39	0.39	0.0140	0.0366	0.13176	
	Old Stove % Efficiency 61.73	NE	0.48	0.56	0.39	0.0172	0.0279	0.10044	0.09547
		NW	0.43	0.56	0.33	0.0153	0.0248	0.08923	
		M	0.44	0.54	0.39	0.0159	0.0257	0.09252	
		SE	0.54	0.64	0.42	0.0194	0.0315	0.11340	
		SW	0.39	0.39	0.39	0.0140	0.0227	0.08173	
	Modern Stove % Efficiency 83.00	NE	0.48	0.56	0.39	0.0172	0.0208	0.07470	0.07100
		NW	0.43	0.56	0.33	0.0153	0.0184	0.06637	
		M	0.44	0.54	0.39	0.0159	0.0191	0.06881	
		SE	0.54	0.64	0.42	0.0194	0.0234	0.08434	
		SW	0.39	0.39	0.39	0.0140	0.0169	0.06078	

**Table 26 Summary wood bag prices and useful output costs**

Summary Wood Bag Prices			£/kg			£/MJ	£/useful MJ output	£/useful kWh output	Average £/useful kWh output
Lowest cost	Highest cost		Ave	Max	Min				
<b>Kiln Dried Wood</b> Sample 100174/4 Nett CV MJ/Kg (as fired) 15.008	Open Fire % Efficiency 26.55	NE	0.51	0.66	0.36	0.0339	0.1275	0.45914	0.49050
		NW	0.48	0.64	0.32	0.0319	0.1203	0.43312	
		M	0.39	0.45	0.33	0.0260	0.0979	0.35235	
		SE	0.66	0.70	0.55	0.0438	0.1649	0.59353	
		SW	0.68	0.68	0.68	0.0453	0.1707	0.61436	
	Old Stove % Efficiency 67.03	NE	0.51	0.66	0.36	0.0339	0.0505	0.18186	0.19428
		NW	0.48	0.64	0.32	0.0319	0.0477	0.17156	
		M	0.39	0.45	0.33	0.0260	0.0388	0.13956	
		SE	0.66	0.70	0.55	0.0438	0.0653	0.23509	
		SW	0.68	0.68	0.68	0.0453	0.0676	0.24334	
	Modern Stove % Efficiency 75.30	NE	0.51	0.66	0.36	0.0339	0.0450	0.16189	0.17295
		NW	0.48	0.64	0.32	0.0319	0.0424	0.15271	
		M	0.39	0.45	0.33	0.0260	0.0345	0.12424	
		SE	0.66	0.70	0.55	0.0438	0.0581	0.20927	
		SW	0.68	0.68	0.68	0.0453	0.0602	0.21662	
<b>Seasoned Wood</b> Sample 100174/5 Nett CV MJ/Kg (as fired) 15.195	Open Fire % Efficiency 28.82	NE	0.48	0.55	0.40	0.0313	0.1085	0.39048	0.40898
		NW	0.45	0.55	0.35	0.0296	0.1028	0.36993	
		M	0.42	0.55	0.30	0.0274	0.0951	0.34253	
		SE	0.73	0.90	0.55	0.0477	0.1656	0.59600	
		SW	0.42	0.55	0.21	0.0277	0.0961	0.34595	
	Old Stove % Efficiency 61.99	NE	0.48	0.55	0.40	0.0313	0.0504	0.18154	0.19014
		NW	0.45	0.55	0.35	0.0296	0.0478	0.17199	
		M	0.42	0.55	0.30	0.0274	0.0442	0.15925	
		SE	0.73	0.90	0.55	0.0477	0.0770	0.27709	
		SW	0.42	0.55	0.21	0.0277	0.0447	0.16084	
	Modern Stove % Efficiency 71.03	NE	0.48	0.55	0.40	0.0313	0.0440	0.15844	0.16594
		NW	0.45	0.55	0.35	0.0296	0.0417	0.15010	
		M	0.42	0.55	0.30	0.0274	0.0386	0.13898	
		SE	0.73	0.90	0.55	0.0477	0.0672	0.24182	
		SW	0.42	0.55	0.21	0.0277	0.0390	0.14037	
<b>30% Wet Wood</b> Sample 100174/8 Nett CV MJ/Kg (as fired) 12.155	Open Fire % Efficiency 7.34	NE	0.29	0.30	0.28	0.0240	0.3275	1.17912	1.22337
		NW	0.29	0.32	0.26	0.0237	0.3222	1.16007	
		M	0.24	0.25	0.23	0.0194	0.2645	0.95229	
		SE	0.36	0.40	0.32	0.0298	0.4063	1.46277	
		SW	0.34	0.39	0.29	0.0278	0.3785	1.36261	
	Old Stove % Efficiency 46.36	NE	0.29	0.30	0.28	0.0240	0.0519	0.18669	0.19369
		NW	0.29	0.32	0.26	0.0237	0.0510	0.18367	
		M	0.24	0.25	0.23	0.0194	0.0419	0.15077	
		SE	0.36	0.40	0.32	0.0298	0.0643	0.23159	
		SW	0.34	0.39	0.29	0.0278	0.0599	0.21574	
	Modern Stove % Efficiency 52.57	NE	0.29	0.30	0.28	0.0240	0.0457	0.16463	0.17081
		NW	0.29	0.32	0.26	0.0237	0.0450	0.16197	
		M	0.24	0.25	0.23	0.0194	0.0369	0.13296	
		SE	0.36	0.40	0.32	0.0298	0.0567	0.20424	
		SW	0.34	0.39	0.29	0.0278	0.0528	0.19025	

<b>40% Wet Wood</b> Sample 100174/7 Nett CV MJ/Kg (as fired) 10.182	Open Fire % Efficiency 6.16	NE	0.29	0.30	0.28	0.0287	0.4659	1.67724	1.74019
		NW	0.29	0.32	0.26	0.0282	0.4584	1.65015	
		M	0.24	0.25	0.23	0.0232	0.3763	1.35458	
		SE	0.36	0.40	0.32	0.0356	0.5780	2.08072	
		SW	0.34	0.39	0.29	0.0332	0.5384	1.93825	
	Old Stove % Efficiency 17.59	NE	0.29	0.30	0.28	0.0287	0.1632	0.58737	0.60941
		NW	0.29	0.32	0.26	0.0282	0.1605	0.57788	
		M	0.24	0.25	0.23	0.0232	0.1318	0.47437	
		SE	0.36	0.40	0.32	0.0356	0.2024	0.72867	
		SW	0.34	0.39	0.29	0.0332	0.1885	0.67877	
	Modern Stove % Efficiency 8.18	NE	0.29	0.30	0.28	0.0287	0.3508	1.26306	1.31046
		NW	0.29	0.32	0.26	0.0282	0.3452	1.24266	
		M	0.24	0.25	0.23	0.0232	0.2834	1.02008	
		SE	0.36	0.40	0.32	0.0356	0.4352	1.56690	
		SW	0.34	0.39	0.29	0.0332	0.4054	1.45961	

**Table 27 Summary coal bulk prices and useful output costs**

Summary Coal Bulk Prices			£/kg			£/MJ	£/useful MJ output	£/useful kWh output	Average £/useful kWh output	
Lowest cost	Highest cost		Ave	Max	Min					
<b>House Coal</b> Sample 100174/1 Nett CV MJ/Kg (as fired) 29.673  Not recommended for use in closed appliances	Open Fire % Efficiency 26.43	NE	0.33	0.34	0.32	0.0110	0.0417	0.15010	0.15719	
		NW	0.29	0.34	0.25	0.0098	0.0369	0.13296		
		M	0.36	0.38	0.34	0.0121	0.0456	0.16418		
		SE	0.40	0.43	0.37	0.0134	0.0509	0.18311		
		SW	0.34	0.34	0.34	0.0114	0.0432	0.15561		
	Old Stove % Efficiency 73.26	NE	0.33	0.34	0.32	0.0110	0.0150	0.05415	0.05671	
		NW	0.29	0.34	0.25	0.0098	0.0133	0.04797		
		M	0.36	0.38	0.34	0.0121	0.0165	0.05923		
		SE	0.40	0.43	0.37	0.0134	0.0183	0.06606		
	Modern Stove % Efficiency 83.76	NE	0.33	0.34	0.32	0.0110	0.0132	0.04736	0.04960	
		NW	0.29	0.34	0.25	0.0098	0.0117	0.04196		
		M	0.36	0.38	0.34	0.0121	0.0144	0.05181		
		SE	0.40	0.43	0.37	0.0134	0.0160	0.05778		
	<b>Smokeless MF1</b> Sample 100174/2 Nett CV MJ/Kg (as fired) 28.021	Open Fire % Efficiency 41.02	NE	0.33	0.38	0.28	0.0118	0.0288	0.10383	0.11063
			NW	0.31	0.34	0.28	0.0111	0.0271	0.09740	
M			0.39	0.47	0.28	0.0139	0.0338	0.12173		
SE			0.45	0.64	0.31	0.0161	0.0393	0.14157		
SW			0.28	0.28	0.28	0.0101	0.0246	0.08864		
Old Stove % Efficiency 67.59		NE	0.33	0.38	0.28	0.0118	0.0175	0.06301	0.06714	
		NW	0.31	0.34	0.28	0.0111	0.0164	0.05911		
		M	0.39	0.47	0.28	0.0139	0.0205	0.07388		
		SE	0.45	0.64	0.31	0.0161	0.0239	0.08592		
Modern Stove % Efficiency 82.33		NE	0.33	0.38	0.28	0.0118	0.0144	0.05173	0.05512	
		NW	0.31	0.34	0.28	0.0111	0.0135	0.04853		
		M	0.39	0.47	0.28	0.0139	0.0168	0.06065		
		SE	0.45	0.64	0.31	0.0161	0.0196	0.07053		
<b>Smokeless MF2</b> Sample 100174/3 Nett CV MJ/Kg (as fired) 27.829		Open Fire % Efficiency 38.29	NE	0.35	0.35	0.35	0.0126	0.0328	0.11825	0.12703
			NW	0.35	0.36	0.35	0.0128	0.0333	0.11993	
	M		0.37	0.40	0.35	0.0134	0.0350	0.12585		
	SE		0.45	0.53	0.38	0.0163	0.0425	0.15286		
	SW		0.35	0.35	0.35	0.0126	0.0328	0.11825		
	Old Stove % Efficiency 61.73	NE	0.35	0.35	0.35	0.0126	0.0204	0.07335	0.07879	
		NW	0.35	0.36	0.35	0.0128	0.0207	0.07439		
		M	0.37	0.40	0.35	0.0134	0.0217	0.07806		
		SE	0.45	0.53	0.38	0.0163	0.0263	0.09481		
	Modern Stove % Efficiency 83.00	NE	0.35	0.35	0.35	0.0126	0.0152	0.05455	0.05860	
		NW	0.35	0.36	0.35	0.0128	0.0154	0.05533		
		M	0.37	0.40	0.35	0.0134	0.0161	0.05806		
		SE	0.45	0.53	0.38	0.0163	0.0196	0.07052		
	SW	0.35	0.35	0.35	0.0126	0.0152	0.05455			



**Table 28 Summary wood bulk prices and useful output costs**

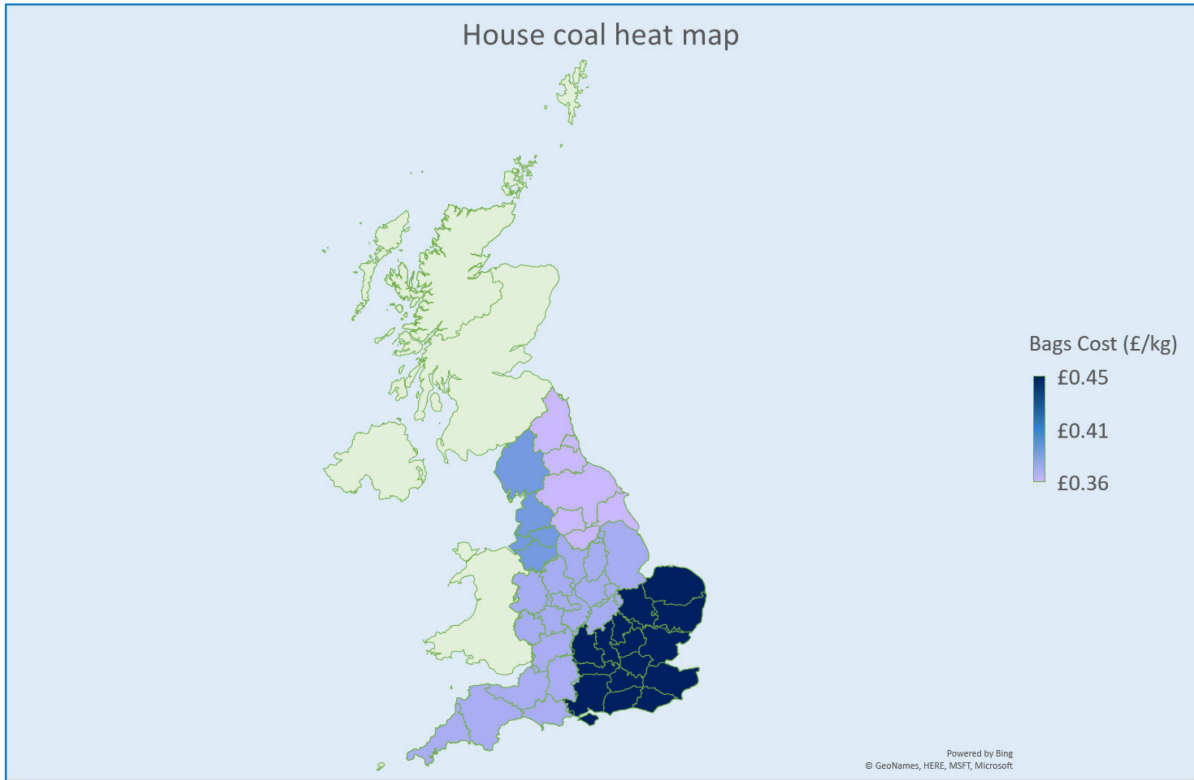
Summary Wood Bulk Prices		£/kg			£/MJ	£/useful MJ output	£/useful kWh output	Average £/useful kWh output	
Lowest cost	Highest cost	Ave	Max	Min					
Kiln Dried Wood Sample 100174/4 Nett CV MJ/Kg (as fired) 15.008	Open Fire % Efficiency 26.55	NE	0.37	0.44	0.26	0.0248	0.0933	0.33174	
		NW	0.36	0.42	0.29	0.0238	0.0895		
		M	0.32	0.36	0.27	0.0213	0.0802		0.28887
		SE	0.40	0.46	0.34	0.0267	0.1005		0.36166
		SW	0.39	0.39	0.39	0.0258	0.0972		0.35010
	Old Stove % Efficiency 67.03	NE	0.37	0.44	0.26	0.0248	0.0370	0.13307	0.13140
		NW	0.36	0.42	0.29	0.0238	0.0354	0.12759	
		M	0.32	0.36	0.27	0.0213	0.0318	0.11442	
		SE	0.40	0.46	0.34	0.0267	0.0398	0.14325	
		SW	0.39	0.39	0.39	0.0258	0.0385	0.13867	
	Modern Stove % Efficiency 75.30	NE	0.37	0.44	0.26	0.0248	0.0329	0.11846	0.11697
		NW	0.36	0.42	0.29	0.0238	0.0315	0.11357	
		M	0.32	0.36	0.27	0.0213	0.0283	0.10185	
		SE	0.40	0.46	0.34	0.0267	0.0354	0.12752	
		SW	0.39	0.39	0.39	0.0258	0.0343	0.12344	
	Seasoned Wood Sample 100174/5 Nett CV MJ/Kg (as fired) 15.195	Open Fire % Efficiency 28.82	NE	0.38	0.55	0.18	0.0247	0.0856	0.30828
NW			0.42	0.55	0.29	0.0275	0.0955	0.34367	
M			0.38	0.45	0.30	0.0247	0.0856	0.30828	
SE			0.55	0.55	0.55	0.0362	0.1256	0.45214	
SW			0.27	0.33	0.21	0.0177	0.0614	0.22093	
Old Stove % Efficiency 61.99		NE	0.38	0.55	0.18	0.0247	0.0398	0.14332	0.15187
		NW	0.42	0.55	0.29	0.0275	0.0444	0.15978	
		M	0.38	0.45	0.30	0.0247	0.0398	0.14332	
		SE	0.55	0.55	0.55	0.0362	0.0584	0.21020	
		SW	0.27	0.33	0.21	0.0177	0.0285	0.10271	
Modern Stove % Efficiency 71.03		NE	0.38	0.55	0.18	0.0247	0.0347	0.12508	0.13254
		NW	0.42	0.55	0.29	0.0275	0.0387	0.13944	
		M	0.38	0.45	0.30	0.0247	0.0347	0.12508	
		SE	0.55	0.55	0.55	0.0362	0.0510	0.18345	
		SW	0.27	0.33	0.21	0.0177	0.0249	0.08964	
30% Wet Wood Sample 100174/8 Nett CV MJ/Kg (as fired) 12.155		Open Fire % Efficiency 7.34	NE	0.22	0.25	0.20	0.0183	0.2494	0.89780
	NW		0.24	0.25	0.23	0.0195	0.2662	0.95833	
	M		0.20	0.25	0.16	0.0167	0.2270	0.81710	
	SE		0.25	0.25	0.25	0.0202	0.2746	0.98859	
	SW		0.22	0.25	0.20	0.0182	0.2482	0.89360	
	Old Stove % Efficiency 46.36	NE	0.22	0.25	0.20	0.0183	0.0395	0.14215	0.14425
		NW	0.24	0.25	0.23	0.0195	0.0421	0.15173	
		M	0.20	0.25	0.16	0.0167	0.0359	0.12937	
		SE	0.25	0.25	0.25	0.0202	0.0435	0.15652	
		SW	0.22	0.25	0.20	0.0182	0.0393	0.14148	
	Modern Stove % Efficiency 52.57	NE	0.22	0.25	0.20	0.0183	0.0348	0.12535	0.12721
		NW	0.24	0.25	0.23	0.0195	0.0372	0.13381	
		M	0.20	0.25	0.16	0.0167	0.0317	0.11409	
		SE	0.25	0.25	0.25	0.0202	0.0383	0.13803	
		SW	0.22	0.25	0.20	0.0182	0.0347	0.12477	

<b>40% Wet Wood Sample 100174/7 Nett CV MJ/Kg (as fired) 10.182</b>	Open Fire % Efficiency 6.16	NE	0.22	0.25	0.20	0.0219	0.3547	1.27708	1.29597
		NW	0.24	0.25	0.23	0.0233	0.3787	1.36318	
		M	0.20	0.25	0.16	0.0199	0.3229	1.16229	
		SE	0.25	0.25	0.25	0.0241	0.3906	1.40622	
		SW	0.22	0.25	0.20	0.0217	0.3531	1.27110	
	Old Stove % Efficiency 17.59	NE	0.22	0.25	0.20	0.0219	0.1242	0.44723	0.45385
		NW	0.24	0.25	0.23	0.0233	0.1326	0.47738	
		M	0.20	0.25	0.16	0.0199	0.1131	0.40703	
		SE	0.25	0.25	0.25	0.0241	0.1368	0.49246	
		SW	0.22	0.25	0.20	0.0217	0.1236	0.44514	
	Modern Stove % Efficiency 8.18	NE	0.22	0.25	0.20	0.0219	0.2671	0.96171	0.97594
		NW	0.24	0.25	0.23	0.0233	0.2852	1.02655	
		M	0.20	0.25	0.16	0.0199	0.2431	0.87527	
		SE	0.25	0.25	0.25	0.0241	0.2942	1.05897	
		SW	0.22	0.25	0.20	0.0217	0.2659	0.95721	

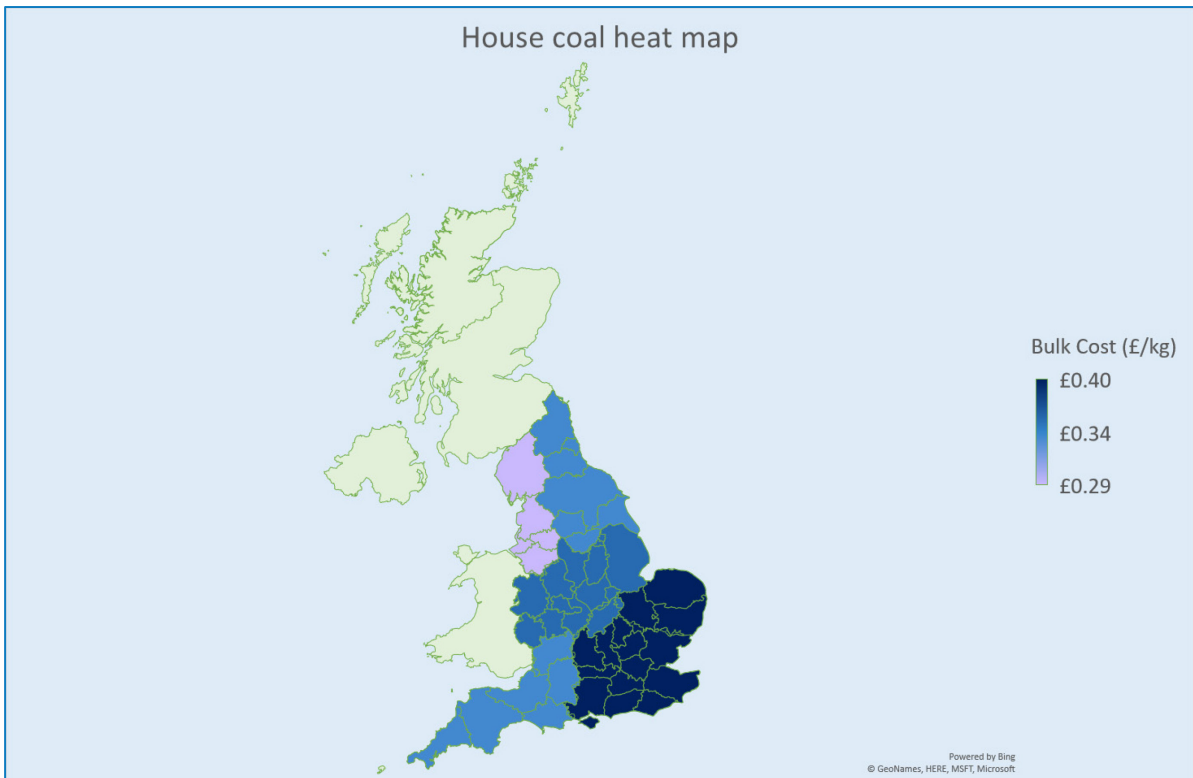
## APPENDIX A: SUMMARY OF FUEL PRICES

The resulting heat maps generated from the cost summaries shown in Section 7.8 follow:

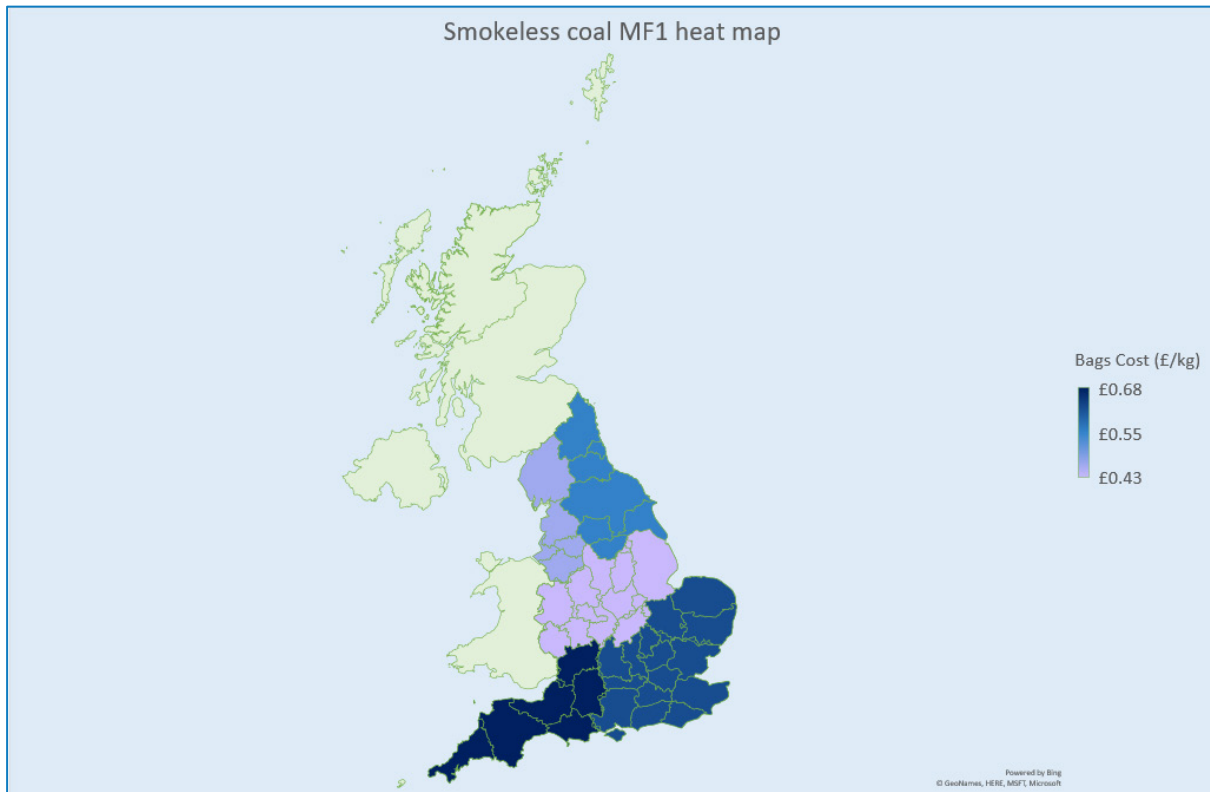
**Figure 6 House Coal Heat Map – Bag costs**



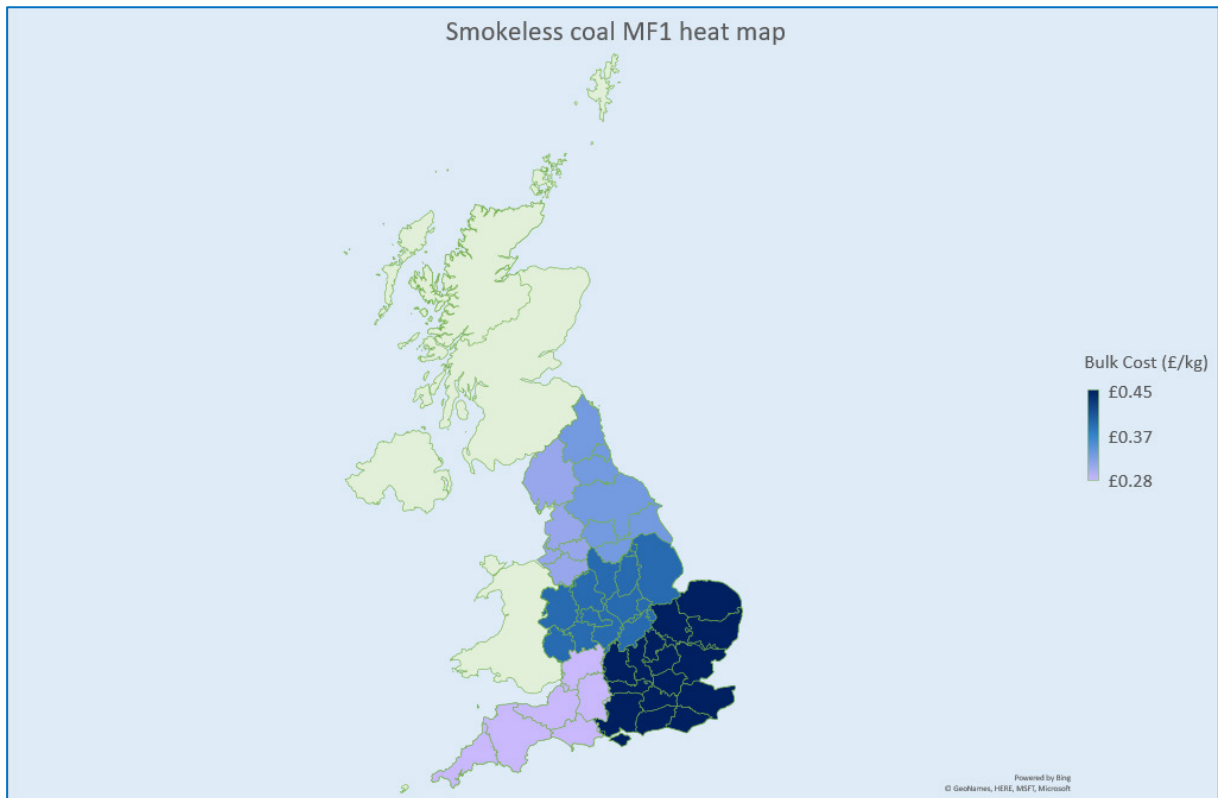
**Figure 7 House Coal Heat Maps – Bulk costs**



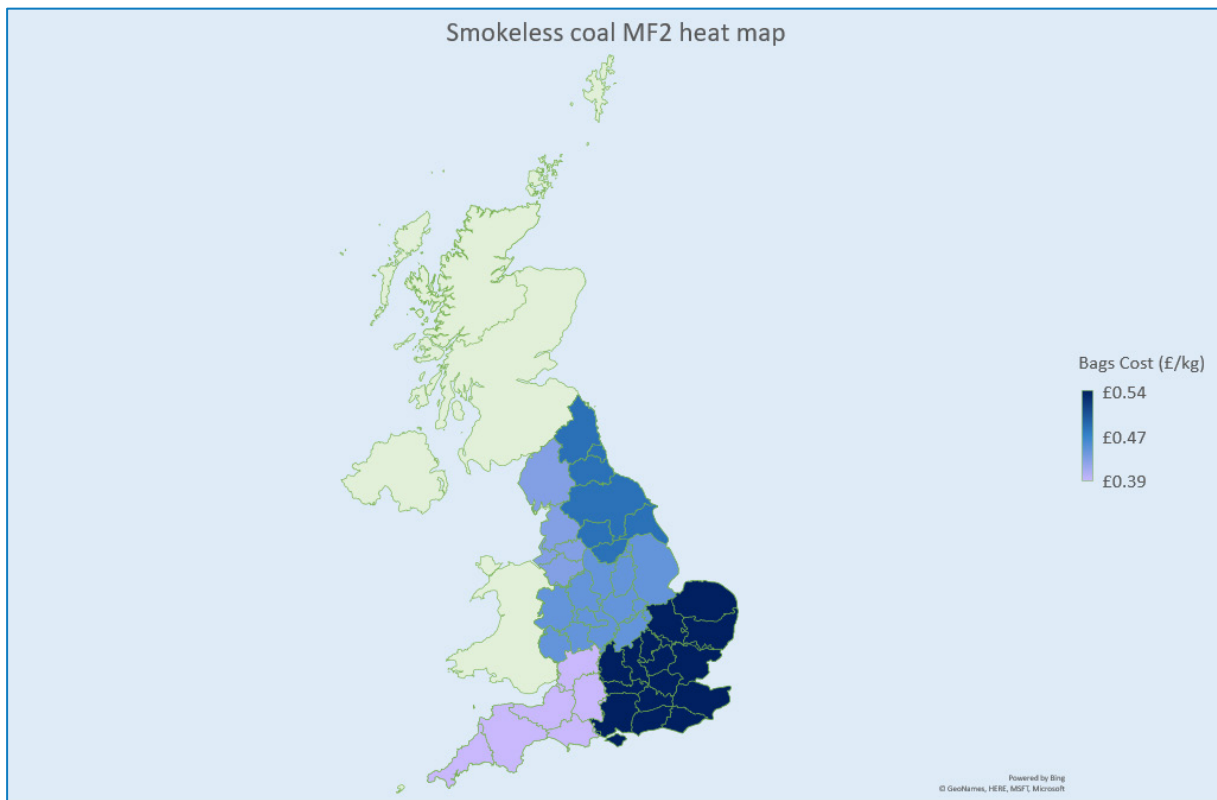
**Figure 8 Smokeless Coal MF1 Heat Map – Bag costs**



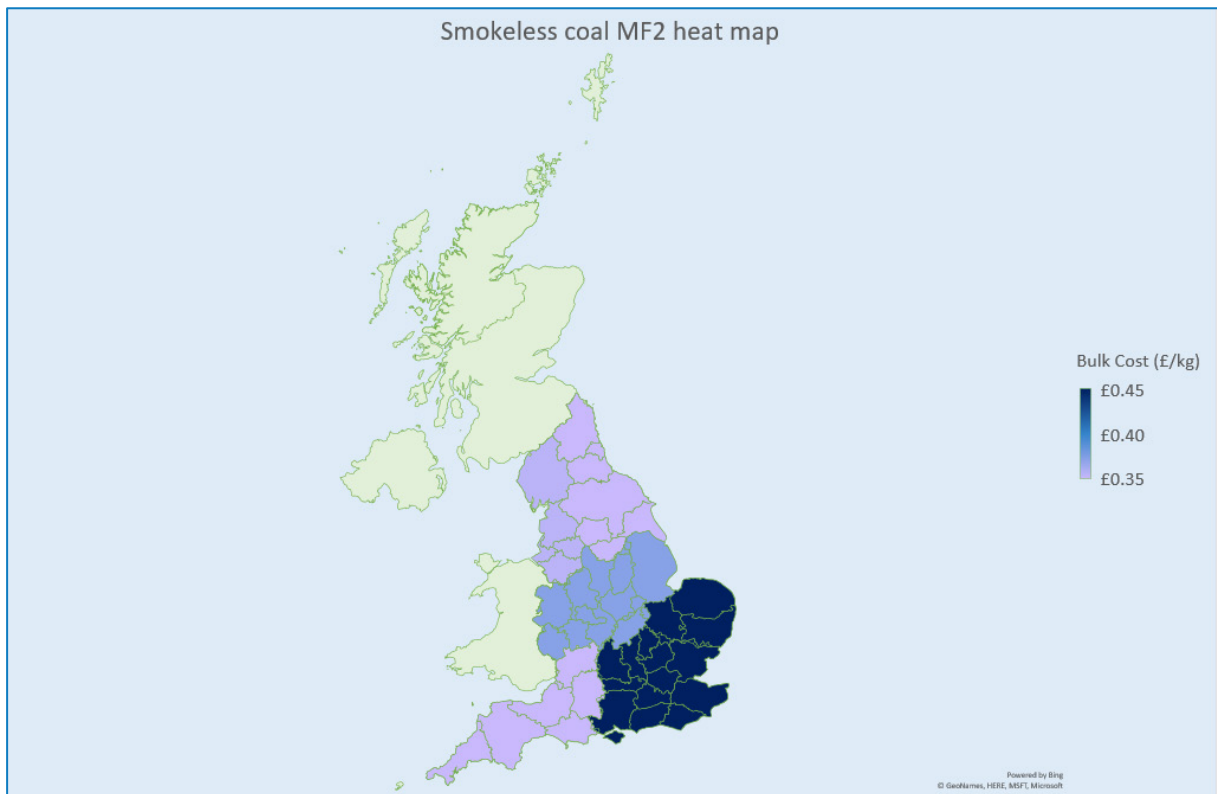
**Figure 9 Smokeless Coal MF1 Heat Map – Bulk costs**



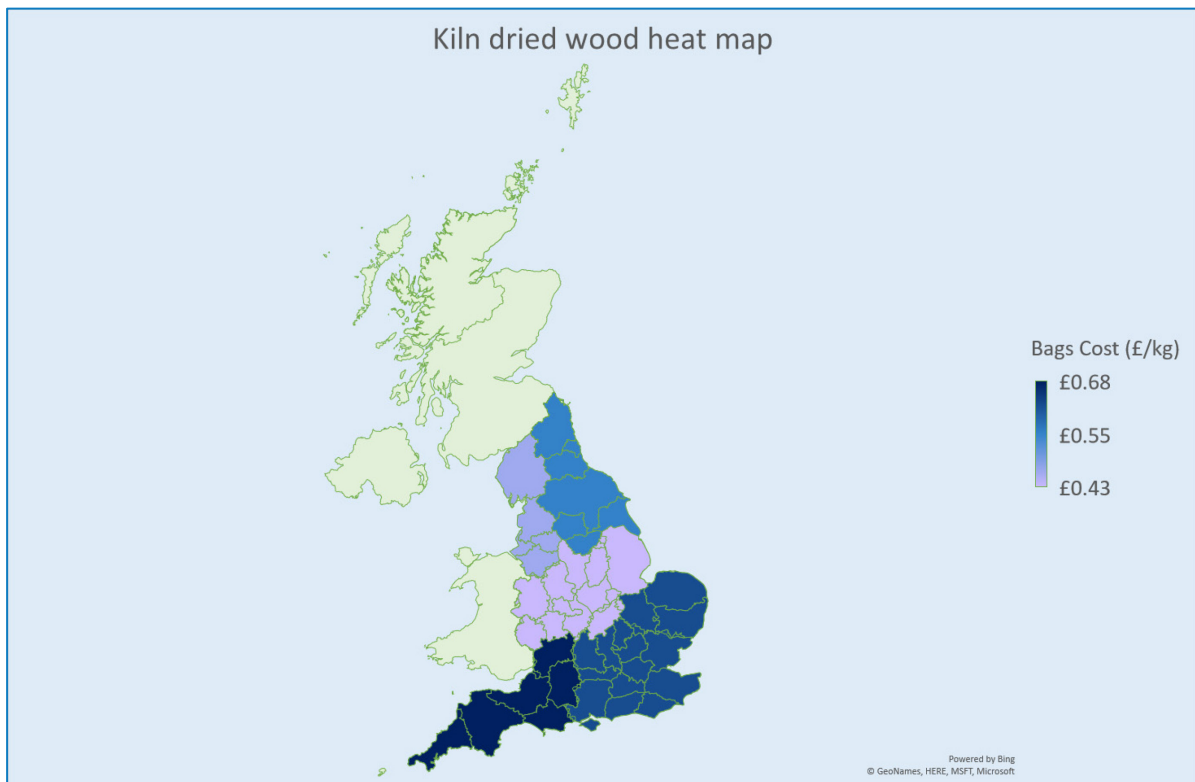
**Figure 10 Smokeless Coal MF2 Heat Map – Bag costs**



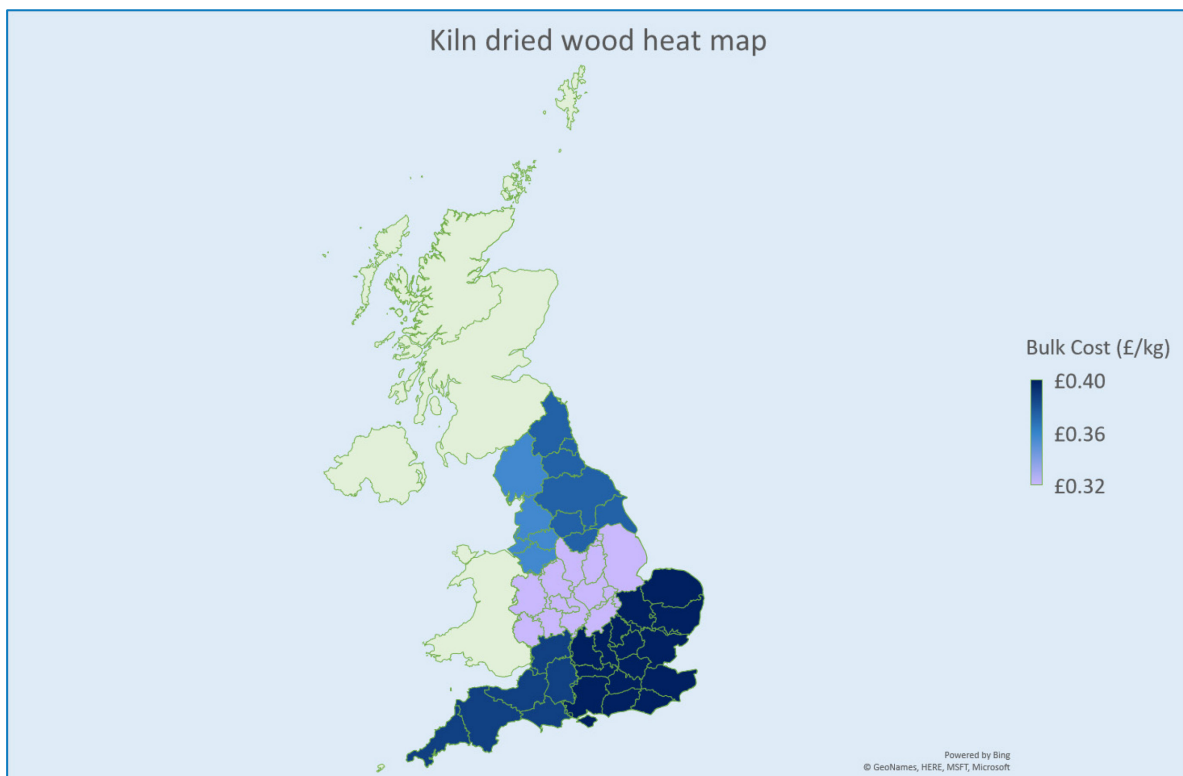
**Figure 11 Smokeless Coal MF2 Heat Maps – Bulk costs**



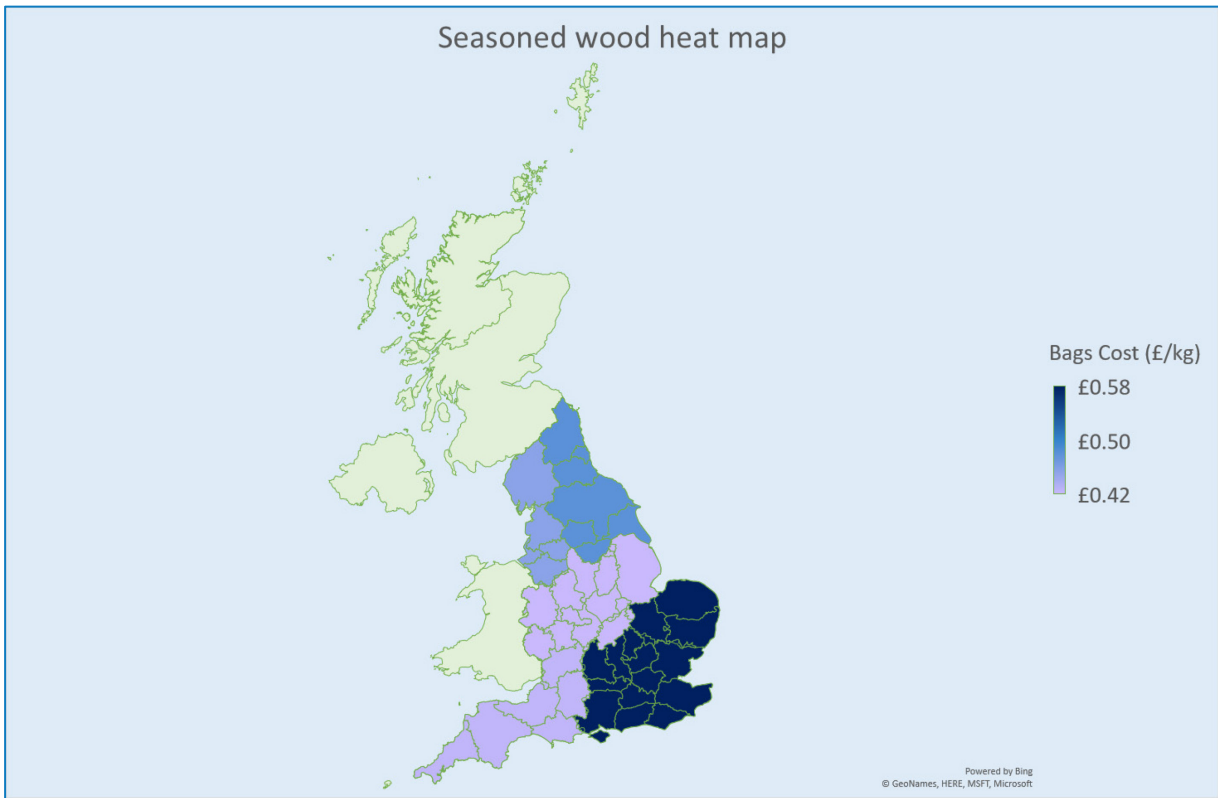
**Figure 12 Kiln Dried Wood Logs Heat Map – Bag costs**



**Figure 13 Kiln Dried Wood Logs Heat Map – Bulk costs**



**Figure 14** Seasoned Wood Logs Heat Map – Bag costs



**Figure 15** Seasoned Wood Logs Heat Map – Bulk costs

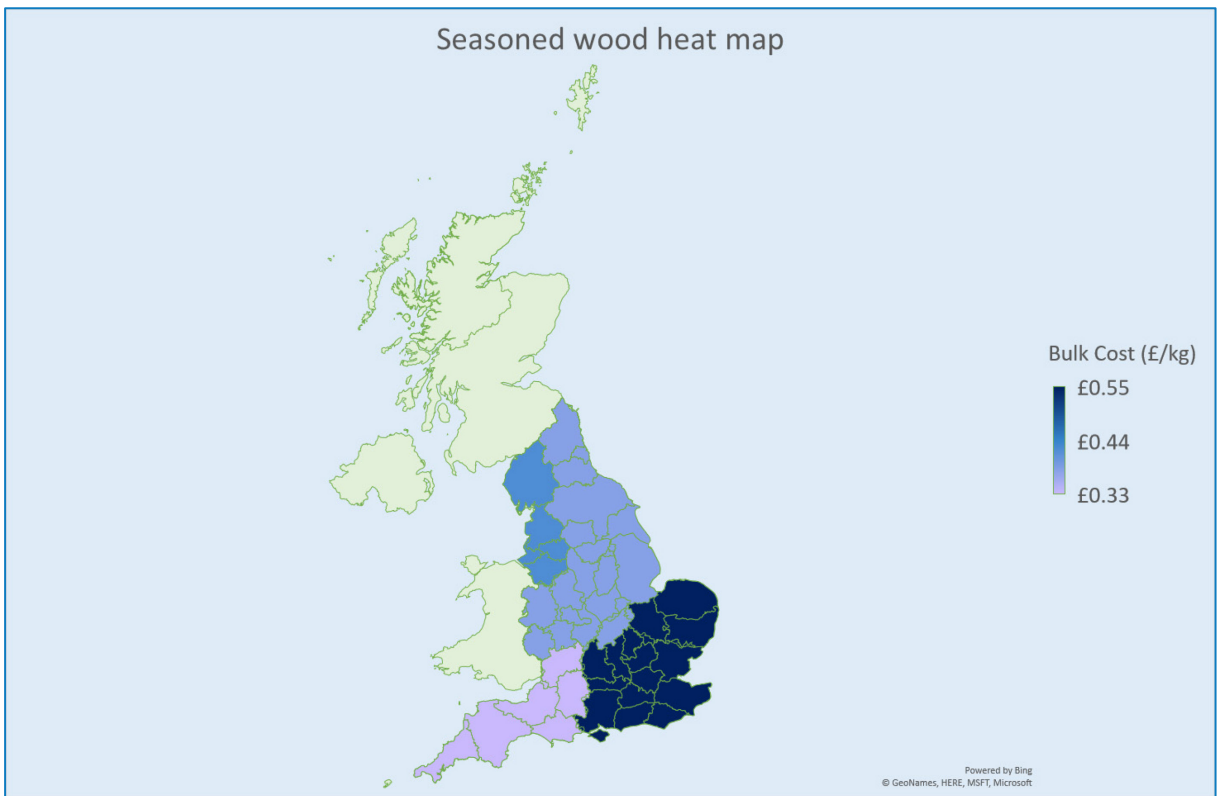
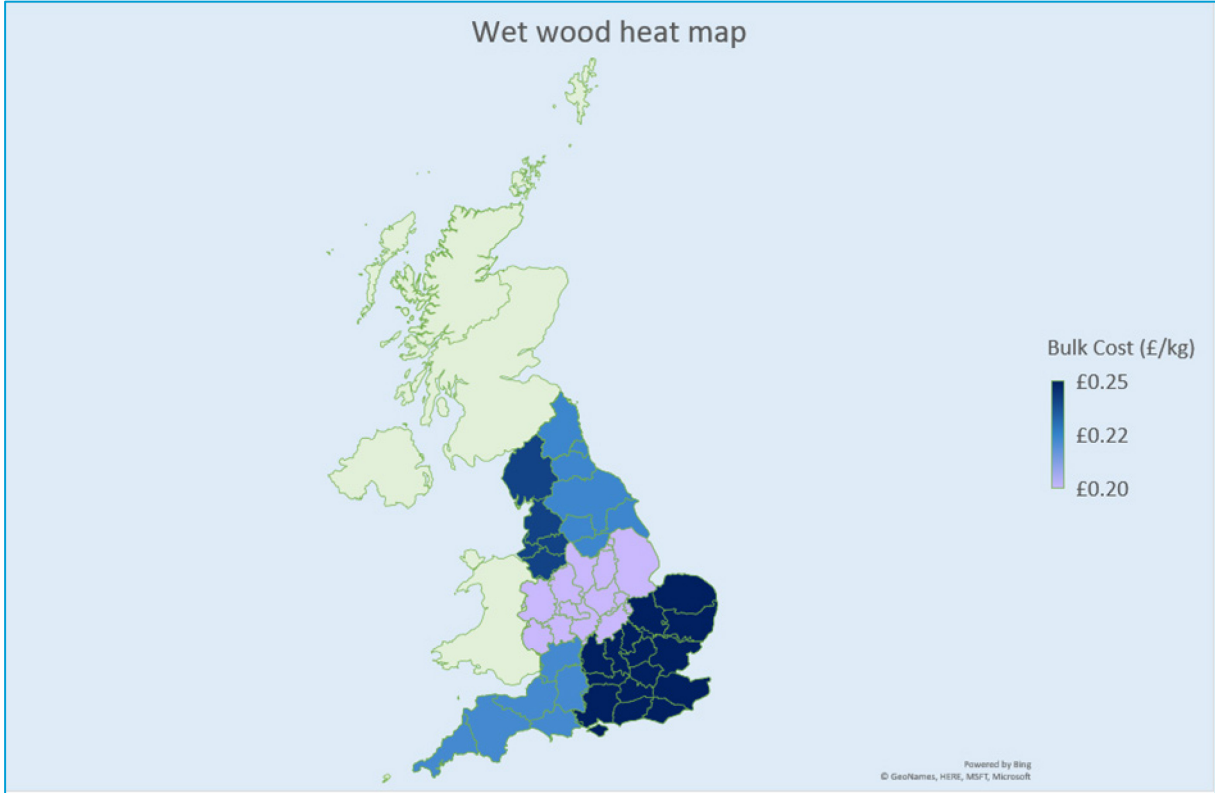


Figure 16 Wet Wood Logs Heat Map – Bulk costs





## APPENDIX B: LABORATORY ANALYSIS OF FUELS TESTED

## CERTIFICATE OF ANALYSIS



KNIGHT ENERGY  
SERVICES

ALLAN WILSON  
BSRIA LIMITED  
OLD BRACKNELL LANE WEST  
BRACKNELL  
BERKSHIRE  
RG12 7AH

Test Date(s): 22-Mar-2019 to 27-Mar-2019  
Date of Report: 27-Aug-2019

Date Received: 22-Mar-2019

AHK Ref: B/361070

Material Described As BITUMINOUS HOUSE COAL

Client Ref: TEST FUEL SAMPLE 100174/1

Client Ref.	Test	Unit	As Received	Dry Basis	Dry Ash-Free
<u>Test Fuel Sample 100174/1</u>					
	Total Moisture	%	7.5		
	Ash Content	%	3.1	3.3	
	Volatile Matter	%	32.5	35.1	36.3
	Fixed Carbon	%	57.0	61.6	63.7
	Total Sulphur	%	1.27	1.37	1.42
	Chlorine	%	0.02	0.02	0.02
	Carbon	%	74.7	80.8	83.6
	Hydrogen	%	4.54	4.91	5.08
	Nitrogen	%	1.78	1.92	1.99
	Oxygen By Difference	%	7.1	7.7	8.0
	Gross Calorific Value	MJ/Kg	30.827	33.326	34.463
	Net Calorific Value	MJ/Kg	29.673		

Client Ref.	Test	Unit	Result
<u>Test Fuel Sample 100174/1</u>			
	Carbon in Ash	%	< 0.1

## CERTIFICATE OF ANALYSIS



ALLAN WILSON  
BSRIA LIMITED  
OLD BRACKNELL LANE WEST  
BRACKNELL  
BERKSHIRE  
RG12 7AH

Test Date(s): 11-Mar-2019 to 19-Mar-2019  
Date of Report: 27-Aug-2019

Date Received: 11-Mar-2019

AHK Ref: B/360754

Material Described As: SMOKELESS M/F BRIQUETTES

Client Ref: SAMPLE 100174/2

Client Ref.	Test	Unit	As Received	Dry Basis	Dry Ash-Free
100174/2	Total Moisture	%	12.4		
	Ash Content	%	4.6	5.3	
	Volatile Matter	%	14.4	16.4	17.3
	Fixed Carbon	%	68.6	78.3	82.7
	Total Sulphur	%	1.26	1.44	1.52
	Chlorine	%	0.02	0.02	0.02
	Carbon	%	74.3	84.8	89.5
	Hydrogen	%	3.32	3.79	4.00
	Nitrogen	%	1.17	1.34	1.42
	Oxygen By Difference	%	2.9	3.3	3.5
	Gross Calorific Value	MJ/Kg	29.031	33.140	34.995
	Net Calorific Value	MJ/Kg	26.021		

Client Ref.	Test	Unit	Result
100174/2	Carbon in Ash	%	< 0.1

## CERTIFICATE OF ANALYSIS

KNIGHT ENERGY  
SERVICES

ALLAN WILSON  
BSRIA LIMITED  
OLD BRACKNELL LANE WEST  
BRACKNELL  
BERKSHIRE  
RG12 7AH

Test Date(s): ~~11-Mar-2019 to 19-Mar-2019~~  
Date of Report: ~~27-Aug-2019~~

Date Received: 11-Mar-2019

AHK Ref: B/360754

Material Described As: SMOKELESS M/F BRIQUETTES

Client Ref: ~~SAMPLE 100174/3~~

Client Ref.	Test	Unit	As Received	Dry Basis	Dry Ash-Free
<u>100174/3</u>	Total Moisture	%	10.7		
	Ash Content	%	4.8	5.4	
	Volatile Matter	%	16.0	17.9	18.9
	Fixed Carbon	%	68.5	76.7	81.1
	Total Sulphur	%	1.58	1.77	1.87
	Chlorine	%	0.11	0.12	0.13
	Carbon	%	74.1	83.0	87.7
	Hydrogen	%	3.21	3.59	3.79
	Nitrogen	%	1.20	1.34	1.42
	Oxygen By Difference	%	4.3	4.8	5.1
	Gross Calorific Value	MJ/Kg	28.774	32.222	34.061
	Net Calorific Value	MJ/Kg	27.829		

Client Ref.	Test	Unit	Result
<u>100174/3</u>	Carbon in Ash	%	< 0.1

## CERTIFICATE OF ANALYSIS



KNIGHT ENERGY  
SERVICES

ALLAN WILSON  
BSRIA LIMITED  
OLD BRACKNELL LANE WEST  
BRACKNELL  
BERKSHIRE  
RG12 7AH

Date of Report: 21-Mar-2019

AHK Ref: B/360873  
Client Ref: 100174/4, 5 & 7

Material Described As WOOD LOGS

Client Ref.	Test	Unit	As Received	Dry Basis	Dry Ash-Free
100174/4	Total Moisture	%	10.1		
	Ash Content	%	0.5	0.6	
	Volatile Matter	%	75.0	83.4	83.9
	Fixed Carbon	%	14.4	16.0	16.1
	Total Sulphur	%	< 0.01	< 0.01	< 0.01
	Chlorine	%	< 0.01	< 0.01	< 0.01
	Carbon	%	44.2	49.2	49.5
	Hydrogen	%	5.31	5.91	5.95
	Nitrogen	%	0.18	0.20	0.20
	Oxygen By Difference	%	39.6	44.1	44.4
	Gross Calorific Value	MJ/Kg	17.477	19.440	19.557
	Net Calorific Value	MJ/Kg	16.072		

Client Ref.	Test	Unit	Result
100174/4	Carbon in Ash	%	< 0.1

## CERTIFICATE OF ANALYSIS



KNIGHT ENERGY  
SERVICES

ALLAN WILSON  
BSRIA LIMITED  
OLD BRACKNELL LANE WEST  
BRACKNELL  
BERKSHIRE  
RG12 7AH

Date of Report: 21-Mar-2019

AHK Ref: B/360873  
Client Ref: 100174/4, 5 & 7

Material Described As WOOD LOGS

Client Ref.	Test	Unit	As Received	Dry Basis	Dry Ash-Free
100174/5	Total Moisture	%	17.2		
	Ash Content	%	0.2	0.3	
	Volatile Matter	%	69.9	84.4	84.7
	Fixed Carbon	%	12.7	15.3	15.3
	Total Sulphur	%	<0.01	<0.01	<0.01
	Chlorine	%	<0.01	<0.01	<0.01
	Carbon	%	42.1	50.8	51.0
	Hydrogen	%	4.79	5.78	5.80
	Nitrogen	%	0.17	0.21	0.21
	Oxygen By Difference	%	35.5	42.9	43.0
	Gross Calorific Value	MJ/Kg	16.206	19.572	19.631
	Net Calorific Value	MJ/Kg	14.742		

Client Ref.	Test	Unit	Result
100174/5	Carbon in Ash	%	<0.1



## CERTIFICATE OF ANALYSIS



KNIGHT ENERGY  
SERVICES

ALLAN WILSON  
BSRIA LIMITED  
OLD BRACKNELL LANE WEST  
BRACKNELL  
BERKSHIRE  
RG12 7AH

Date of Report: 19-Mar-2019

AHK Ref: B/360754

Material Described As BITUMINOUS HOUSE COAL

Client Ref: 100174/2,100174/3,100174/6

Client Ref.	Test	Unit	As Received	Dry Basis	Dry Ash-Free
100174/6	Total Moisture	%	7.2		
	Ash Content	%	4.0	4.3	
	Volatile Matter	%	32.6	35.1	36.7
	Fixed Carbon	%	56.2	60.6	63.3
	Total Sulphur	%	1.21	1.30	1.36
	Chlorine	%	0.03	0.03	0.03
	Carbon	%	74.9	80.7	84.3
	Hydrogen	%	4.70	5.06	5.29
	Nitrogen	%	1.66	1.79	1.87
	Oxygen By Difference	%	6.3	6.8	7.1
	Gross Calorific Value	MJ/Kg	30.621	32.997	34.480
	Net Calorific Value	MJ/Kg	29.443		

Client Ref.	Test	Unit	Result
100174/6	Carbon in Ash	%	< 0.1

## CERTIFICATE OF ANALYSIS



ALLAN WILSON  
BSRIA LIMITED  
OLD BRACKNELL LANE WEST  
BRACKNELL  
BERKSHIRE  
RG12 7AH

Date of Report: 21-Mar-2019

AHK Ref: B/360873  
Client Ref: 100174/4, 5 & 7

Material Described As WOOD LOGS

Client Ref.	Test	Unit	As Received	Dry Basis	Dry Ash-Free
<u>100174/7</u>	Total Moisture	%	45.3		
	Ash Content	%	0.1	0.2	
	Volatile Matter	%	46.8	85.6	85.8
	Fixed Carbon	%	7.8	14.2	14.2
	Total Sulphur	%	< 0.01	< 0.01	< 0.01
	Chlorine	%	< 0.01	< 0.01	< 0.01
	Carbon	%	27.6	50.5	50.6
	Hydrogen	%	3.22	5.89	5.90
	Nitrogen	%	0.07	0.13	0.13
	Oxygen By Difference	%	23.7	43.3	43.4
	Gross Calorific Value	MJ/Kg	10.698	19.557	19.596
	Net Calorific Value	MJ/Kg	8.889		

Client Ref.	Test	Unit	Result
<u>100174/7</u>	Carbon in Ash	%	< 0.1

## CERTIFICATE OF ANALYSIS



KNIGHT ENERGY  
SERVICES

ALLAN WILSON  
BSRIA LIMITED  
OLD BRACKNELL LANE WEST  
BRACKNELL  
BERKSHIRE  
RG12 7AH

Date of Report: 10-May-2019

AHK Ref: B/362026  
Client Ref: 100174/8

Material Described As: WOOD LOGS

Client Ref.	Test	Unit	As Received	Dry Basis	Dry Ash-Free
100174/8	Total Moisture	%	21.9		
	Ash Content	%	0.9	1.2	
	Volatile Matter	%	64.3	82.3	83.3
	Fixed Carbon	%	12.9	16.5	16.7
	Total Sulphur	%	0.02	0.02	0.02
	Chlorine	%	0.02	0.03	0.03
	Carbon	%	38.7	49.5	50.1
	Hydrogen	%	4.55	5.83	5.90
	Nitrogen	%	0.22	0.28	0.28
	Oxygen By Difference	%	33.7	43.2	43.7
	Gross Calorific Value	MJ/Kg	18,189	19,423	19,659
	Net Calorific Value	MJ/Kg	13,642		
	Carbon in Ash	%	2.1	2.7	2.7

  
Ken Hebburn  
Biomass Manager

For and on behalf of KNIGHT ENERGY SERVICES LIMITED

Doc Id: B/362026/1

KNIGHT ENERGY SERVICES LIMITED

Page 1 of 1

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