From: Turton, Andrew
To: Hutchinson, Peter
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Subject: Draft technology assumptions
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100129 AECOM Renewable Heat Study Assumptions - V01c - issued.pdf

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Dear Peter,

I hope you are well.

Please find attached a draft assumptions document which can be distributed to the project advisory group (I think this is the term currently used!). This document contains cost and performance assumptions for the different technologies proposed, CO2 assumptions for the different fuels and electricity scenarios (based on the ARUP work), and energy cost projections.

We are still reviewing the values and format of the assumptions, but it would be useful for us to gain some initial thoughts on the current draft figures from the team. If there are any specific questions on certain values or technologies, we are happy to take calls. In particular there are a handful of values missing and we are still deciding on the best assumptions to use.

In general, work is progressing well on the project – I am aiming to send you a brief update report Monday or Tuesday next week.

Best wishes,

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Northern Ireland Renewable Heat Study

Project Assumptions

Andrew Turton, AECOM
Andrew Cripps, AECOM
John Cox, Pöyry

Introduction

This note summarises the assumptions being used in the heat model for Northern Ireland, to allow others to understand the basis of the model, and to provide input to improve the quality of the findings. Sources of information are identified; some data are estimated by the project team.

The note covers the following input assumptions:

1. Technologies
2. Carbon dioxide emissions factors for different fuels
3. Energy cost assumptions

For technologies, not all assumptions are included, to simplify this note, but it covers for alternative systems:

1. Efficiencies (heat and electric where appropriate)
2. Carbon factors
3. Capital costs (including variations where known)
4. Maintenance costs
5. Typical lifetime

Prices are expressed per installation for domestic scale systems, but per kW for larger systems.

Other elements that are not included in this draft set of assumptions, but will be included elsewhere are:

1. Availability of fuels in total
2. Availability of fuels in different locations
3. Acceptability of different solutions for different consumer types.

Existing heating technologies

Technology	Cost basis	Thermal efficiency	Proportion of heat load met	Proportion of hot water load	Load factor %	Fuel type	O&M per annum (£/kW) (£/per dwelling)
Gas boiler – domestic	dwelling	76%	100%	100%		gas	£160 - £200
Gas boiler – non domestic	kW	76%	100%	100%	10%	gas	£3
Oil boiler – domestic	dwelling	76%	100%	100%		oil	£160 - £200
Oil boiler – non domestic	kW	76%	100%	100%	10%	oil	£3
Coal boiler – domestic	dwelling	60%	100%	100%		coal	£160 - £200
Coal boiler – non domestic	kW	60%	100%	100%	10%	coal	£3
Electric resistance heating – domestic	kW	1	100%	100%	10%	electricity	£17
Electric resistance heating – non domestic	kW	1	100%	100%	10%	electricity	£11

Notes:

1. Domestic technologies are generally costed per dwelling. In general, the installation costs and equipment costs are relatively independent of the thermal capacity for fuel based technologies at a domestic scale.
2. For technologies costed on a thermal capacity basis, the load factor is used to determine the approximate thermal capacity of the system per customer type.

Building scale technologies

Technology	Cost basis	Electrical efficiency	Thermal efficiency	Proportion of heat load met	Proportion of hot water load	Load factor %	Fuel type	Fraction of capital for replacement	Lifetime (years)	Capital Cost (£/kW) (£/per dwelling)	O&M per annum (£/kW) (£/per dwelling)
Gas boiler – domestic	dwelling	0%	91%	100%	100%		gas	30%	15	£2,500	£160 - £200
Gas boiler – non domestic	kW	0%	91%	100%	100%	10%	gas	30%	15	£45	£3
Oil boiler – domestic	dwelling	0%	91%	100%	100%		oil	30%	15	£3,000	£160 - £200
Oil boiler – non domestic	kW	0%	91%	100%	100%	10%	oil	30%	15	£54	£3
Electric resistance heating – domestic	kW	0%	100%	100%	100%	10%	electricity	40%	15	£175	£17
Electric resistance heating – non domestic	kW	0%	100%	100%	100%	10%	electricity	40%	15	£221	£11

Non domestic scale technologies

Technology	Cost basis	Electrical efficiency	Thermal efficiency	Proportion of heat load met	Proportion of hot water load	Load factor %	Fuel type	Fraction of capital for replacement	Lifetime (years)	Capital Cost (£/kW) (£/per dwelling)	O&M per annum (£/kW) (£/per dwelling)
Biomass boiler – domestic	dwelling	0%	87%	100%	100%	20%	pellets	50%	15	£528	£18
Biomass boiler – non domestic	kW	0%	87%	80%	80%	20%	chip	50%	15	£368	£18
Air source heat pump – domestic	kW	0%	190%	100%	50%	20%	electricity	90%	20	£1,400	£44 - £100
Air source heat pump – non domestic	kW	0%	200%	100%	50%	20%	electricity	90%	20	£600	£9
Ground source heat pump – domestic	kW	0%	240%	100%	50%	20%	electricity	50%	20	£2,000	£44 - £275
Ground source heat pump – non domestic	kW	0%	250%	100%	50%	20%	electricity	50%	20	£1,000	£9
Solar thermal – domestic	dwelling			0%	50%		zero carbon	70%	20	£4,000	£25
Solar thermal – non domestic	kW			0%	50%		zero carbon	70%	20	£1,429	£4

Notes:

1. Where expressed as £ / kW, costs are based on thermal kW capacity.

Community and large commercial / industrial scale technologies

Technology	Cost basis	Electrical efficiency	Thermal efficiency	Proportion of heat load met	Proportion of hot water load	Load factor %	Fuel type	Fraction of capital for replacement	Lifetime (years)	Capital Cost (£/kW) (£/per dwelling)	O&M per annum (£/kW) (£/per dwelling)
Biomass CHP Air turbine (small)	kW	20%	50%	80%	80%	50%	chip	80%	15	£4,000	£180
Biomass Gasification CHP	kW	26%	34%	80%	80%	50%	chip	80%	15	XXX	XXX
Biomass CHP Steam turbine (Medium)	kW	17%	63%	80%	80%	50%	chip	90%	20	£3,500	£80
Biomass CHP Steam turbine (Large)	kW	24%	56%	80%	80%	50%	chip	90%	25	£1,780	£80
Biomass heating	kW	0%	87%	80%	80%	30%	chip	80%	15	£615	£15
Anaerobic digestion – CHP	kW	32%	48%	XXX	XXX			80%	20	£7,745	£775
Geothermal heat	kW	0%	XXX	XXX	XXX		zero carbon		15	£1,278	£47
Backup / Peak gas boilers	kW	0%	91%	variable	variable	20%	gas	80%	30	£60	£3

Notes:

1. For CHP technologies, the costs expressed as £ / kW are in terms of electrical capacity.
2. Where a technology is assumed to meet only a fraction of the thermal demand (typically 80% on a district heating system) additional backup / peak capacity is assumed to be gas boilers.

Biogas technologies

Technology	Cost basis	Electrical efficiency	Thermal efficiency	Proportion of heat load met	Proportion of hot water load	Fraction of capital for replacement	Lifetime (years)	Capital Cost (£/kW) (£/per dwelling)	O&M per annum (£/kW) (£/per dwelling)
Anaerobic digestion – BIOGAS CHP	kW	25%	55%	XXX	XXX	XXX	25	XXX	XXX
Agricultural AD – BIOGAS CHP	kW	27%	55%	XXX	XXX	XXX	25	£3,750	£121
Landfill gas – BIOGAS CHP	kW	32%	50%	XXX	XXX	XXX	25	£1,658	£71
Sewage Gas – BIOGAS CHP	kW	26%	54%	XXX	XXX	XXX	25	£2,958	£146

Biogas injection

Costs and output performance data currently being compiled. We are interested in obtaining information from the project advisory group alongside our other sources.

Carbon dioxide emissions factors- fuels

Fuel	Emissions factor (kg CO_2 / kWh)
Natural gas	0.194
Oil	0.265
Coal / solid	0.291
Biomass	0.025
LPG	0.234
Chip	0.025
Pellets	0.025

Carbon dioxide emissions factors – electricity

Scenario	Description	2010 kg / kWh	2015 kg / kWh	2020 kg / kWh
Counterfactual scenario - current build out of wind	Baseline / Business as usual	0.524	0.446	0.367
Low wind - 31% renewable electricity		0.524	0.421	0.318
Medium wind - 34% renewable electricity		0.524	0.415	0.307
High tidal - 37% renewable electricity		0.524	0.409	0.294
High wind - 43% renewable electricity		0.524	0.396	0.268
High Biomass - 47% renewable electricity	Maximum renewable electricity uptake	0.524	0.384	0.245
Marginal CCGT gas	Marginal CO_2 intensity	0.430	0.430	0.430

Notes:

1. Linear change is assumed between 2010 and 2020 as per Renewable Electricity Targets work by ARUP (Draft report)
2. CO_2 intensities are assumed level form 2020 onwards
3. The modelling will examine a number of intensity scenarios including the use of a marginal intensity figure.

Energy Costs – 2009 prices

Wholesale price: DECC Energy projections April 2009

High Scenario

Wholesale Costs		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gas price	p/kWh	2.43	2.52	2.62	2.71	2.80	2.90	2.99	3.08	3.18	3.27	3.36
Oil price	p/kWh	2.57	2.67	2.77	2.87	2.97	3.07	3.17	3.27	3.37	3.47	3.56
Coal price	p/kWh	0.94	0.91	0.88	0.85	0.82	0.78	0.78	0.78	0.78	0.78	0.78
Electricity price	p/kWh	8.20	8.49	8.57	8.83	9.08	9.32	9.57	9.86	10.09	10.34	10.54

Central Scenario

Wholesale Costs		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gas price	p/kWh	2.03	2.10	2.13	2.16	2.18	2.21	2.23	2.26	2.28	2.31	2.34
Oil price	p/kWh	2.15	2.23	2.26	2.28	2.31	2.34	2.37	2.39	2.42	2.45	2.48
Coal price	p/kWh	0.86	0.82	0.77	0.72	0.67	0.63	0.63	0.63	0.63	0.63	0.63
Electricity price	p/kWh	7.36	7.66	7.03	7.11	7.41	7.48	7.57	7.66	7.74	7.83	7.91

Low Scenario

Wholesale Costs		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gas price	p/kWh	1.14	1.14	1.15	1.15	1.15	1.16	1.16	1.16	1.17	1.17	1.17
Oil price	p/kWh	1.21	1.21	1.22	1.22	1.22	1.23	1.23	1.23	1.24	1.24	1.24
Coal price	p/kWh	0.63	0.58	0.53	0.49	0.44	0.39	0.39	0.39	0.39	0.39	0.39
Electricity price	p/kWh	5.73	4.98	4.31	4.09	4.05	4.06	4.08	4.11	4.13	4.15	4.17

Retail Prices:

Electricity – Interdepartmental Analyst group (Valuation of energy use and greenhouse gas emissions for appraisal and evaluation) January 2010

High Scenario

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic		p/KWh (2009)	14.74	15.40	15.73	16.28	16.83	17.49	18.04	18.92	19.58	20.13	20.79
Retail: commercial	Small	p/KWh (2009)	16.24	16.37	16.76	17.03	17.29	17.69	17.95	18.22	18.61	18.88	19.14
Retail: commercial	Medium	p/KWh (2009)	13.53	13.64	13.97	14.19	14.41	14.74	14.96	15.18	15.51	15.73	15.95
Retail: commercial	Large	p/KWh (2009)	10.15	10.23	10.48	10.64	10.81	11.06	11.22	11.39	11.63	11.80	11.96
Retail: industrial	Small	p/KWh (2009)	14.39	14.65	15.18	15.71	16.10	16.63	17.29	17.95	18.61	19.27	19.93
Retail: industrial	Medium	p/KWh (2009)	11.99	12.21	12.65	13.09	13.42	13.86	14.41	14.96	15.51	16.06	16.61
Retail: industrial	Large	p/KWh (2009)	8.99	9.16	9.49	9.82	10.07	10.40	10.81	11.22	11.63	12.05	12.46
Economy 7		p/KWh (2009)	5.50	5.75	5.87	6.07	6.28	6.53	6.73	7.06	7.31	7.51	7.76

Central Scenario

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic		p/KWh (2009)	13.53	14.19	14.41	14.74	15.29	15.62	16.06	16.94	17.38	17.71	18.15
Retail: commercial	Small	p/KWh (2009)	14.78	15.05	15.18	15.44	15.58	15.58	15.71	15.84	15.97	16.10	16.24
Retail: commercial	Medium	p/KWh (2009)	12.32	12.54	12.65	12.87	12.98	12.98	13.09	13.20	13.31	13.42	13.53
Retail: commercial	Large	p/KWh (2009)	9.24	9.41	9.49	9.65	9.74	9.74	9.82	9.90	9.98	10.07	10.15
Retail: industrial	Small	p/KWh (2009)	13.07	13.33	13.60	13.99	14.26	14.65	15.05	15.58	16.10	16.50	17.03
Retail: industrial	Medium	p/KWh (2009)	10.89	11.11	11.33	11.66	11.88	12.21	12.54	12.98	13.42	13.75	14.19

Retail: industrial	Large	p/KWh (2009)	8.17	8.33	8.50	8.75	8.91	9.16	9.41	9.74	10.07	10.31	10.64
Economy 7		p/KWh (2009)	5.50	5.77	5.86	5.99	6.22	6.35	6.53	6.89	7.07	7.20	7.38

Low Scenario

			2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Retail: domestic		p/KWh (2009)	11.11	11.55	11.66	11.99	12.43	12.76	13.09	13.86	14.30	14.63	14.96
Retail: commercial	Small	p/KWh (2009)	12.01	12.01	12.14	12.14	12.28	12.28	12.28	12.41	12.54	12.54	12.67
Retail: commercial	Medium	p/KWh (2009)	10.01	10.01	10.12	10.12	10.23	10.23	10.23	10.34	10.45	10.45	10.56
Retail: commercial	Large	p/KWh (2009)	7.51	7.51	7.59	7.59	7.67	7.67	7.67	7.76	7.84	7.84	7.92
Retail: industrial	Small	p/KWh (2009)	10.16	10.30	10.43	10.69	10.96	11.35	11.62	12.01	12.54	12.94	13.33
Retail: industrial	Medium	p/KWh (2009)	8.47	8.58	8.69	8.91	9.13	9.46	9.68	10.01	10.45	10.78	11.11
Retail: industrial	Large	p/KWh (2009)	6.35	6.44	6.52	6.68	6.85	7.10	7.26	7.51	7.84	8.09	8.33
Economy 7		p/KWh (2009)	5.50	5.72	5.77	5.94	6.15	6.32	6.48	6.86	7.08	7.24	7.41

Gas - Interdepartmental Analyst group (Valuation of energy use and greenhouse gas emissions for appraisal and evaluation) January 2010

High Scenario

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic		p/KWh (2009)	4.47	4.55	4.67	4.79	4.87	4.99	5.11	5.19	5.31	5.43	5.55
Retail: commercial	Small	p/KWh (2009)	4.59	4.68	4.81	4.94	5.03	5.16	5.29	5.38	5.51	5.64	5.77
Retail: commercial	Medium	p/KWh (2009)	3.99	4.07	4.18	4.30	4.37	4.49	4.60	4.68	4.79	4.91	5.02
Retail: commercial	Large	p/KWh (2009)	3.19	3.25	3.35	3.44	3.50	3.59	3.68	3.74	3.83	3.92	4.01
Retail: industrial	Small	p/KWh (2009)	3.79	3.88	4.01	4.15	4.24	4.37	4.51	4.60	4.74	4.87	5.00
Retail: industrial	Medium	p/KWh (2009)	3.29	3.37	3.49	3.61	3.69	3.80	3.92	4.00	4.12	4.23	4.35
Retail: industrial	Large	p/KWh (2009)	2.63	2.70	2.79	2.89	2.95	3.04	3.13	3.20	3.29	3.39	3.48

Central Scenario

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic		p/KWh (2009)	3.99	4.07	4.11	4.15	4.19	4.19	4.23	4.27	4.31	4.31	4.35
Retail: commercial	Small	p/KWh (2009)	4.07	4.15	4.20	4.24	4.28	4.28	4.33	4.37	4.42	4.42	4.46
Retail: commercial	Medium	p/KWh (2009)	3.54	3.61	3.65	3.69	3.72	3.72	3.76	3.80	3.84	3.84	3.88
Retail: commercial	Large	p/KWh (2009)	2.83	2.89	2.92	2.95	2.98	2.98	3.01	3.04	3.07	3.07	3.10
Retail: industrial	Small	p/KWh (2009)	3.25	3.34	3.38	3.43	3.47	3.47	3.51	3.56	3.60	3.60	3.65
Retail: industrial	Medium	p/KWh (2009)	2.82	2.90	2.94	2.98	3.02	3.02	3.06	3.10	3.13	3.13	3.18
Retail: industrial	Large	p/KWh (2009)	2.26	2.32	2.35	2.38	2.41	2.41	2.44	2.48	2.51	2.51	2.54

Low Scenario

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic		p/KWh (2009)	2.99	2.99	2.99	2.99	2.99	2.99	2.99	2.99	3.03	3.03	3.03
Retail: commercial	Small	p/KWh (2009)	2.97	2.97	2.97	2.97	2.97	2.97	2.97	2.97	3.01	3.01	3.01
Retail: commercial	Medium	p/KWh (2009)	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.62	2.62	2.62
Retail: commercial	Large	p/KWh (2009)	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.10	2.10	2.10
Retail: industrial	Small	p/KWh (2009)	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.16	2.16	2.16
Retail: industrial	Medium	p/KWh (2009)	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.88	1.88	1.88
Retail: industrial	Large	p/KWh (2009)	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.50	1.50	1.50

Coal - Interdepartmental Analyst group (Valuation of energy use and greenhouse gas emissions for appraisal and evaluation) January 2010

High Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	3.22	3.18	3.14	3.11	3.07	3.03	3.03	3.03	3.03	3.03	3.03
Retail: commercial	p/kWh	1.55	1.51	1.48	1.44	1.40	1.37	1.37	1.37	1.37	1.37	1.37
Retail: industrial	p/kWh	1.33	1.30	1.26	1.22	1.19	1.15	1.15	1.15	1.15	1.15	1.15

Central Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	3.12	3.07	3.01	2.95	2.89	2.84	2.84	2.84	2.84	2.84	3.12
Retail: commercial	p/kWh	1.46	1.40	1.35	1.29	1.24	1.18	1.18	1.18	1.18	1.18	1.46
Retail: industrial	p/kWh	1.24	1.19	1.13	1.08	1.02	0.97	0.97	0.97	0.97	0.97	1.24

Low Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55
Retail: commercial	p/kWh	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Retail: industrial	p/kWh	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

Heat Oil - Interdepartmental Analyst group (Valuation of energy use and greenhouse gas emissions for appraisal and evaluation) January 2010

High Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	4.51	4.63	4.79	4.94	5.06	5.21	5.32	5.47	5.62	5.73	5.88
Retail: commercial	p/kWh	4.29	4.41	4.56	4.71	4.82	4.96	5.06	5.21	5.35	5.45	5.60
Retail: industrial	p/kWh	4.28	4.41	4.58	4.75	4.87	5.03	5.15	5.32	5.48	5.60	5.76

Central Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	3.99	4.04	4.09	4.13	4.17	4.21	4.25	4.29	4.33	4.37	4.40
Retail: commercial	p/kWh	3.80	3.85	3.90	3.94	3.97	4.01	4.05	4.08	4.12	4.16	4.19
Retail: industrial	p/kWh	3.72	3.77	3.82	3.87	3.91	3.95	3.99	4.04	4.08	4.12	4.16

Low Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	3.26	3.27	3.35	3.43	3.51	3.59	3.66	3.66	3.67	3.67	3.67
Retail: commercial	p/kWh	3.10	3.12	3.19	3.27	3.34	3.42	3.49	3.49	3.49	3.49	3.49
Retail: industrial	p/kWh	2.92	2.93	3.02	3.11	3.19	3.27	3.35	3.36	3.36	3.36	3.36

Wholesale LPG – Reuters price for 2010, projections linked to wholesale Brent Oil price

High Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	3.50	3.63	3.77	3.90	4.04	4.17	4.31	4.44	4.58	4.71	4.85

Central Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	3.50	3.63	3.67	3.72	3.76	3.80	3.85	3.89	3.94	3.98	4.03

Low Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Retail: domestic	p/kWh	3.50	3.51	3.52	3.53	3.54	3.55	3.56	3.57	3.58	3.59	3.60

Carbon – DECC energy projections for traded carbon and shadow price of carbon (DECC / DEFRA)

High Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
UEP traded carbon	£/tonne CO2	27.0	27.4	27.8	28.2	28.6	29.1	29.5	29.9	30.4	30.8	31.3
Shadow price (2007 prices)	£/tonne CO2	27	27.6	28.1	28.7	29.2	29.8	30.4	31	31.6	32.3	32.9

Central Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
UEP traded carbon	£/tonne CO2	21.6	22.0	22.3	22.6	23.0	23.3	23.7	24.0	24.4	24.7	25.1
Shadow price (2007 prices)	£/tonne CO2	27	27.6	28.1	28.7	29.2	29.8	30.4	31	31.6	32.3	32.9

Low Scenario

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
UEP traded carbon	£/tonne CO2	12.3	12.4	12.6	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2
Shadow price (2007 prices)	£/tonne CO2	27	27.6	28.1	28.7	29.2	29.8	30.4	31	31.6	32.3	32.9

Biomass – E4Tech Biomass prices in the heat and electricity sector in the UK, (Supporting information for the Renewable Heat Incentive)

Pellet Prices – UK produced

£/MWh inc VAT	**2009**			**2020**		
	Bulk	**Bagged**	**Overall**	**Bulk**	**Bagged**	**Overall**
Low	37.7	45.7	43	36	43	40
Central	42.9	54.3	50	40	46	43
High	48	59.8	56	44	50	47

Pellet Prices – Imported

£/MWh inc VAT	**2020**		
	Bulk	**Bagged**	**Overall**
Low	41	48	45
Central	43	51	47
High	52	60	56

Chip Prices – UK produced

£/MWh inc VAT	**2009**	
	Domestic / Small Commercial	**Industrial / Commercial**
Low	21.3	16
Central	24	21.3
High	31.7	24

Chip Prices – UK produced

£/MWh inc VAT	**2020**	
	UK energy crops	**Imported**
Low	22	34
Central	25	41
High	28	44

International Marginal Biomass Costs

£/MWh inc VAT	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Low	15.41	15.41	15.41	15.41	15.41	8.39	8.39	8.39	8.39	8.39	6.37

Central	15.41	15.41	15.41	15.41	15.41	11.05	11.05	11.05	11.05	11.05	7.67
High	15.41	15.41	15.41	15.41	15.41	14.08	14.08	14.08	14.08	14.08	12.82
Very High											14.72

References

Ref number	Source	Year	
Technology assumptions			
1	The potential and costs of district Heating Networks	2009	DECC
2	OPTRES: Assessment and optimisation of renewable support schemes in the European Electricity market	2006	
3	Renewabble energy complience costs	2008	BERR
4	Renewable Heat and Heat from Combined Heat and Power Plants - Study and Analysis Report		Future Energy Solutions - AEA Technology plc
5	Potential for Microgeneration Study and Analysis - Final Report	2005	Energy Savings Trust, Econnect, Element Energy Limited
6	The growth potential for Microgeneration in England, Wales and Scotland - Final Appendix	2008	Element Energy Limited
7	The Role of Onsite Energy Generation in Delivering Zero Carbon Homes	2007	Element Energy Limited, Energy Savings Trust
8	Renewable Heat initial business case	2007	Ernst & Young
9	Barriers to renewable heat part 1: supply side	2008	Enviros Consulting
10	Buillding Regulations Part L, Approved Document		CLG
CO_2 assumptions			
1	Standard Assessment Procedure 2005 V9.82	2009	CLG
2	Establishment of Northern Ireland Renewable Electricity Targets to 2020 (Draft Report). ARUP.	2009	DETI