Aberdeen City Council

Addendum to Energy from Waste Business Case

November 2015

Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

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Document revisions

No.	Details	Date
1	Draft Report	October 2015
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1. Introduction

This section outlines the purpose and context for this report, the scope of work and the various options that are appraised.

1.1 Purpose of Report

Amec Foster Wheeler Environment & Infrastructure UK Limited (hereafter 'Amec Foster Wheeler') was appointed by Aberdeen City Council (ACC) in November 2013 to provide a Business Case (referred to as 2013 Business Case in this report) for the development of an Energy from Waste (EfW) facility as a waste treatment solution for the City's residual municipal solid waste (rMSW). The Council had previously produced an Outline Business Case for Waste Facilities in October 2012.

This Addendum addresses the changes to the modelling inputs since the 2013 Business Case, and sets out the overall results. It is not a stand-alone business case and should be read in conjunction with both the 2012 Outline Business Case and 2013 Business Case.

1.2 Context

The 2013 Business Case considered a series of options for the development including the development of a stand-alone plant sized for ACC alone, a larger EfW which could also accept rMSW from a neighbouring authority, or with a pre-treatment facility with all rMSW exported to an existing facility in Northern Europe. The recommendations arising from this study were primarily;

- Secure support for a Large EfW
- Secure site for new EfW
- Develop procurement strategy
- Research and develop RDF contingency arrangements
- Keep a watching brief on potential changes in law and policy

Since the Energy from Waste Business Case was issued, discussions have been ongoing between ACC and Aberdeenshire and Moray Councils and in principle the Authorities have decided to work together to progress a joint solution. A site within East Tullos Industrial Estate has been identified for the development and is now in the process of being purchased from SGN by ACC prior to an application for planning permission.

The 2013 Business Case now requires to be updated to reflect the recent activities and test the joint working option against the other original options to ensure it remains the preferred solution and offers all three Authorities value for money.

1.3 Scope of Work

As defined in Amec Foster Wheeler's proposal (e-mailed to the Council on 1st July 2015), the scope of works comprises modelling of waste flows and cost base for three options:

- EfW sized for Aberdeen City Council only
- The continued use of RDF export for Aberdeen City Council through use of the Altens RDF Facility post SITA contract.
- A joint Authority EfW for Aberdeen City Council, Aberdeenshire Council and Moray Council

The Private-Public Partnership (PPP) variants on these options have not been refreshed as the current preference is for a Council funded option (albeit the previous general findings in terms of differential factors between the various funding options would still apply).

Ernst and Young was appointed by the Council to undertake financial modelling, based on the mass flow and cost assumptions provided by Amec Foster Wheeler. Their report is provided in **Appendix 2.**

1.4 Outline of Options

The modelling of waste flows and costs undertaken for the 2012 Outline Business Case and 2013 Business Case, provided detail on five options. Three of these have been updated within this Addendum as set out below.

Option One (Small EfW, Council financed):

To develop a facility on a site identified within the Council's boundary with the purpose of treating Aberdeen's residual waste arisings. The capital investment to provide this facility would be funded directly by the Council, and a partner waste contractor engaged to manage the facility's operational activities on the Council's behalf. It offers the potential benefit of renewable energy generation within the City. It would not include front end mechanical treatment (MT) due to the potential for exemption under the Thermal Treatment Guidelines.

Option Two (Small EfW, PPP financed):

NOT REMODELLED

Option Three (Large EfW, Council financed):

As option 1, with a larger EfW facility that is sized to take other residual waste. This other waste is assumed to be Aberdeenshire Council (70 ktpa) and Moray Council (20 ktpa), but could also include some commercial and industrial wastes. With this option the MT facility need not be co-located with the EfW, as this could take place at the waste source, with the EfW being constructed at a suitable central site. As above, exemption from further pre-treatment of residual waste could be obtained by all three Councils. The capital investment to provide this facility would be funded directly by the Council and a partner waste contractor engaged to manage operations;

Option Four (Large EfW, PPP financed):

NOT REMODELLED

Option Five (RDF offtake):

The Council has been progressing an interim treatment solution comprising the preparation of waste as Refuse Derived Fuel (RDF) prior to export to European EfW facilities. The business case considers this waste treatment option also as a long term solution, assessing whether the cost of this waste management practice would provide better value for money.

2. Technical Modelling

This section considers updated costings for each of the Options using the outputs from mass flow modelling to inform an outline financial appraisal.

2.1 Mass Flow Modelling

The previous technical note on the underlying modelling undertaken by Amec Foster Wheeler has been updated (see **Appendix 1)** and includes a summary of key inputs.

The required EfW facility size for Option 1 is 60,000 tonnes per year, and a similar tonnage from ACC requires pre-treatment and RDF offtake in Option 5.

For Options 3 the rMSW inputs are;

- **Aberdeen City Council** – annual tonnages with waste growth and changes in recycling rates etc as previously modelled (e.g. no major updates to the detailed mass flow model ACC Profile Model V11 – 20130918)
- **Moray Council -** a fixed 20ktpa. Note that their underlying consultant's report has slightly more total residual waste arisings, but it will not all be suitable for thermal treatment hence the difference.
- **Aberdeenshire Council** - a fixed 70ktpa

The previous modelling assumed a generic additional input of 62,000 tonnes per year in addition to ACCs rMSW, resulting in a total EfW facility size of 109,000 tonnes per year. Amec Foster Wheeler not developed detailed mass flow models for the other two partner Councils and have utilised fixed annual tonnage based on their stated requirements. The updated tonnages result in a larger EfW solution would accept up to **150,000 tpa**, and this is what the planning application is being based upon. Any surplus capacity within a 150ktpa plant would be taken up by third party waste, but no revenue from this is assumed in order to test the option is still viable without reliance on income from third parties.

2.2 Project Timetable

The timing assumptions for the options appraisal were updated from the 2013 Business Case to reflect the intervening period, and are as follows:

- Whilst SITA are contracted to provide services until 2025 the Council has the option to take out residual waste at any time. Purely for the purposes of this assessment, all options have been assumed to commence full operations in the year 2022, and have been assessed over a 25 year period to 2047;
- Options 1 and 3 –. New EfW procured and constructed by 2022;
- Option 5 –Long term export of RDF from 2022. It is assumed that a new offtake contract would be entered into on equivalent terms.

The project timescales will be driven by 4 principal drivers:

- The Waste (Scotland) Regulations 2012 requirement banning biodegradable waste going directly to landfill from 2020;
- The level and capability of resourcing within the Council's project team and governance structure;
- The programme and timescales set out for the procurement process; and

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- The time taken to physically deliver each option. The highest uncertainty and risk is associated with construction of a new EfW.

3. Financial Appraisal

This section considers updated costings for each of the Options using the outputs from mass flow modelling to inform an outline financial appraisal.

3.1 Approach

Ernst and Young was appointed by the Council to undertake financial modelling, based on the mass flow and cost assumptions provided by Amec Foster Wheeler.

A recent report for Aberdeenshire on waste management options (SLR, May 2015) utilised WRAP gate fees which helped inform the case for joint working. This addendum applies the previous approach of bespoke financial modelling for a new facility, allowing the generation of a project specific gatefee by the financial advisors.

Each of the three options has been refreshed using updated reference data held by Amec Foster Wheeler on Capex, Opex, Income and Lifecycle costs, plus any site specific data available on site purchase/ development costs. A summary of the cost assumptions is provided in the section below. The costs exclude fees for investigations into site specific costs with utility providers, and site specific bills of quantities for a new facility. It is recommended that parallel research is undertaken into these elements in order to utilise better base data in the financial modelling, or that a further refresh of the business case is undertaken in 2016 once these items have been fully costed.

The financial modelling assumes a revenue from an electricity only output i.e. the Council would not elect to make use of heat produced from any EfW plant by feeding it to a CHP. The benefits of CHP are discussed in the 2013 Business Case. No costs for a CHP pipeline have been included in the modelling as any additional capital expenditure would typically be expected to be covered by the heat income.

There are also a number of “one off” costs that could also apply to Options 1 relating to the particular site. Pending further site studies, it has been assumed that the grid connection and site preparation costs are similar to other UK plants within Amec Foster Wheeler’s cost database, and are therefore included in the modelling.

3.2 Revised Design and Cost Assumptions

The design and cost assumptions regarding the subsequent EfW or RDF export outlet are set out in Table 3.2.

Table 3.1 Key EfW Input Assumptions

Item	Assumption
Option 1 & 2 - Small EfW	
Long term residual Waste throughput (Tonnes)	55,733
Design Throughput of Facility (Tonnes)	60,000
Capital Expenditure	£55,729,143 (excludes inflation and financing costs)
Maintenance per annum	£3.62 per tonne
LifeCycle per annum	£2.79 per tonne
Operating Cost Variable per annum	£19 per tonne
Operating Cost Fixed per annum	£21 per tonne

Item	Assumption
Calorific value of rMSW	7.7 MJ/kg
Option 3 & 4 - Large EfW	
Maximum residual Waste (Tonnes)	145,733
Design Throughput of Facility (Tonnes)	150,000
Capital Expenditure	£138,861,985 (excludes inflation and financing costs)
Maintenance per annum	£6.46 per tonne
LifeCycle per annum	£4.97 per tonne
Operating Cost Variable per annum	£19.08 per tonne
Operating Cost Fixed per annum	£9.91 per tonne
Calorific value of rMSW	7.7 MJ/kg
Option 5 – RDF offtake	
Capital Expenditure (RDF Mechanical Treatment plant)	£? (excludes inflation and financing costs)
Baling and Wrapping	£10 per tonne
Gate Fee at Swedish plant	£82 per tonne (Free on board)
Sea transport & handling	£0 per tonne (assumes no backload available for free)
Licensing (TFS)	£4,000 per year

Note: Costs are quoted at 2015 prices (e.g. excluding future inflation), and represent underlying inputs to the financial modelling

3.3 Sensitivity Modelling

A number of financial sensitivities have been generated for E&Y the financial advisor;

- Capex -10% and +30%
- Opex -10% and +10%
- RDF offtake +50%

Within the last Business Case another 2 sensitivities were undertaken on Waste Growth (-10%, +10%) and Recycling (65%). These only affect the annual facility throughputs. It is not considered that they would affect the relative ranking of the options, and for the purpose of this high level refresh have not been remodelled.

The key technical sensitivity model for the original Business Case was the inclusion or exclusion of a Mechanical Treatment (MT) facility before the residual waste was thermally treated in a new EfW. The general findings of this still stand, and due to the evolving policy context the use of MT has not been utilised for this refresh of the EfW cases (Option 1 & 3), but is included in the RDF case (Option 5)

The 2013 Business Case discussed the options available and the related risks to make a recommendation on a way forward for the next 25 years. Background information, Procurement routes, Management Structures and a projected Timetable were also provided so that the document could form the basis of a Descriptive Document. This wider analysis has not been updated as part of this Addendum.

3.4 Revised Financial Modelling

The financial assumptions and results are set out in **Appendix B** together with supporting comments.

Key assumptions on third party income are:

- Third party Waste has been priced at £65/t for spare capacity.

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- Electricity has been priced at £47/MWh and indexed at 2.5%. This is slightly more aggressive than typical bank funding but comfortable for the current market placement on power price.

Key assumptions on indexation and funding terms are:

- Treasury Green Book advice has been applied where appropriate
- The project has been costed on a operating life of 25 years, in line with other waste project financial models currently in the market
- Inflation at 2.5% in line with Treasury Green Book, unless specific aspects of the project suggest using a higher rate e.g. capital costs at 4.5%, RDF export at 3%.
  - Risk / Optimism Bias has been based on the financial consultants experience with similar waste related projects as per the 2013 Business Case.

The total net present value (NPV) of each option uses a standard 3.5% discount rate.

The summary results are set out below. The sensitivity results are shown in **Appendix B.**

Table 3.2 Results – Base Case

Item	Option 1 - 60 kpta EfW	Option 3 - 150 kpta EfW	Option 5 - MT & RDF
	£000	**£000**	**£000**
Total Nominal Price	290,710	247,967	283,880
Total NPV	**98,818**	**84,793**	**84,411**
	£	£	£
Gate fee per tonne (year 1 operations)	187	161	143

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4. Conclusions

The financial assessment of options re-confirms the previous conclusion that a larger EfW delivers the best value for money solution in the long term.

The analysis broadly follows the expected convention that a larger EfW facility gives a lower nominal price than a small one, with Option 3 having a 15% lower NPV over 25 years than Option 1, based on the stated assumptions.

In the event that a larger EfW was not deemed deliverable, the next ranked option in terms of total NPV is Option 5 (MT & RDF), with total NPV comparable to Option 3 (3% higher). RDF export is a competitive option for the Council in the short to medium term. However following the end of the current RDF contract there will be an unquantifiable risk of increases in gate fee (as more waste producers seek to access a fixed number of energy from waste outlets). In contrast Option 1 and 2 will allow a stable gate fee price over the length of the contract following the construction phase.

A smaller scale EfW facility (Option 1) would be the most expensive option in NPV terms. However with both Options 1 and 3, once the borrowing has been re-paid the EfW facility would benefit from a step-down in the price per tonne for ongoing operations. The Council would be in ownership of a strategic asset which could offer a continued service at much reduced rates, in a similar way that other UK authorities are currently benefiting from operating older EfW facilities.

The 25 year NPV of the options tends to hide the relative changes in future costs over time, due to discounting effects on payments in later years. In those later years the budgetary impacts of high prices could place added financial burdens on the Council, albeit the overall 25 year project cost is still value for money. In terms of annual gate fees, Option 5 RDF offtake could be lower than Option 3 until about the year 2028, and lower than Option 1 until around the year 2036. After these points the respective EfW options have lower gate fees than RDF offtake. The RDF offtake price and the future inflation assumptions have a key influence on the cross over point between the options.

A number of critical documents will emerge during any procurement this could impact upon final designs and costs of the new EfW, including EU Best Available Techniques reference documents due in 2016. The legislation and guidance controlling the pre-treatment and export of RDF is also likely to evolve over coming years. Finally any future introduction of EU incineration taxes or other changes in law could impact upon the deliverability and costs of each option.

Appendix A
Waste Flow Model Assumptions 2015

1. Aberdeen Waste Flow Model

This paper sets out the modelling assumptions made by Amec Foster Wheeler in support of the options assessment.

The basis of the Waste Flow Model (WFM) is the data by Aberdeen City Council provided in "*ACC Profile Model V11 - 20130918.xlsx".*

The waste flow model was developed to replicate the tonnages projected by ACC, and we have not attempted to check the appropriateness of the underlying capture assumptions. No time was allowed to look at the sensitivity of waste composition versus participation and recognition. The ACC projected capture rates appear challenging. Given the absence of a waste sort composition for Aberdeen further work is recommended as the project proceeds.

2014 data was the starting point for the WFM. We have replicated the entire model and provide comments below. Modelled waste arisings match those provided by Aberdeen City.

The data provided by ACC indicates 54% in 2025 for ACC recycling and 7.4% from further "picking" operations totalling 61.4%. ACC have modelled 65.7% diversion rate for the HWRC as a new HWRC is commissioned and/or improvements to other HWRCs are achieved. There is no HWRC picking line modelled in the WFM from 2016 onwards when the new HWRC is commissioned.

Post issuance of the ACC data it was decided to route the HWRC residual waste to the MT plant in Option 5. Further instructions were to minimise the cost of the MT plant and capture metals and dense plastics (as per SITA proposal for the interim SRF market solution).

The projected recycling & composting rate including the MT plant in the WFM is 56.4% (2025), which is below the ACC modelled rates. This rate does not include IBA metals (which are expected to be minimal as metals are captured at the MT plant). Excluding the MT plant contribution, the recycling & composting performance in the WFM is 53.6% (2025).

2. Housing Types

For modelling purposes we have extracted data from http://www.gro-scotland.gov.uk/files2/stats/household-estimates/he-12/2012-estimates-households-dllings-Scotland.pdf.

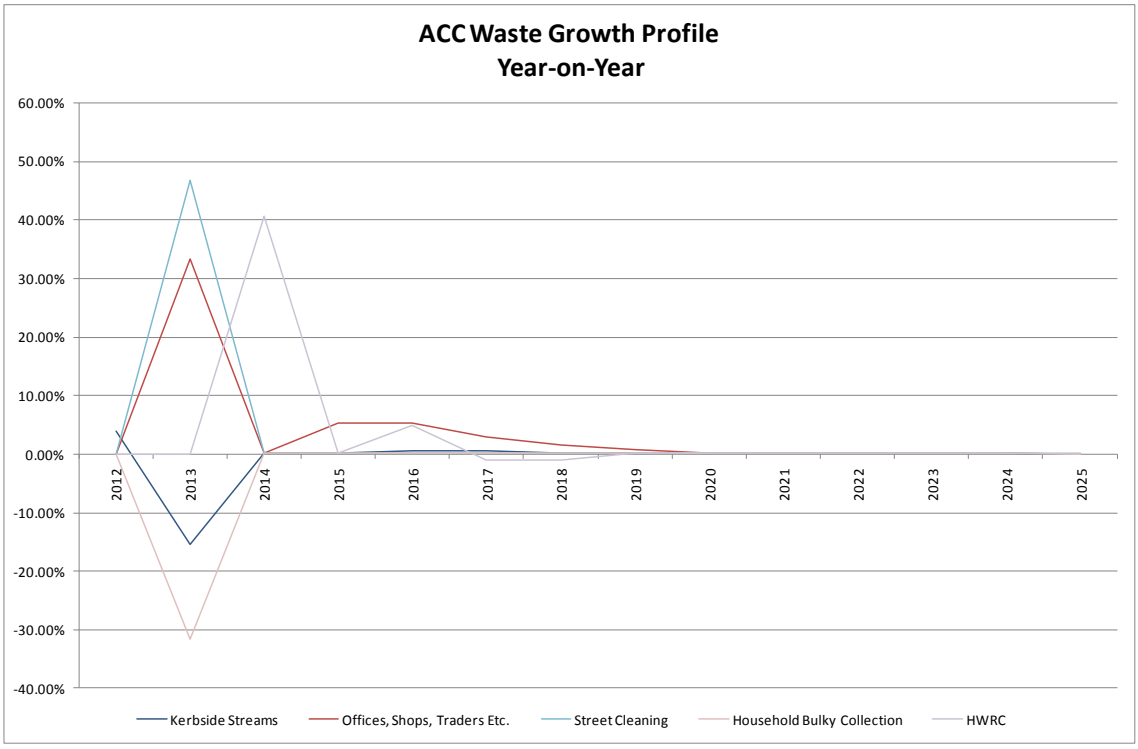
	Aberdeen City		AMEC model
Flats	55%	HG1(gardened properties)	27%
Terraced	18%	HG2 (garden flats)	5.4%
Semi-detached	17%	HG3 (flats without gardens)	49%
Detached	11%	HG4 (Terraced properties without gardens)	17.8%

We have assumed that 10% of the flats have gardens.

3. Growth

For kerbside household waste this is 3.9% growth in 2013, (minus) -15.38% growth in 2014, 0.15% (2015), 0.2% (2016), 0.6% (2017), 0.61% (2018) and 0.25% from 2019 to 2025 and 0% from 2026 onwards as provided by Aberdeen City "ACC Profile Model V11 - 20130918.xlsx".

The non-kerbside streams have different growth profiles.



4. Composition

We have used Edinburgh kerbside waste composition, with adjustments to cater for the current garden waste capture and the projected dry recyclables capture, i.e. we increased the relative concentrations of the targeted dry recyclables over that in Edinburgh (45.6% versus 38.3%). This suggests that either the composition data is incorrect or the capture rates in the ACC model are overly ambitious.

We have assumed that all housing types generate the same quantities of waste (except garden waste) tpa/household.

Assumed waste composition

Waste component	Sub-component	HOUSING GROUP 1 & 2	HOUSING GROUP 3 & 4
Paper	Newspapers	8.07%	11.25%
Paper	Magazines	5.19%	7.84%
Paper	Other Recyclable Paper	1.73%	2.61%
Paper	Paper Packaging	0.00%	0.00%
Paper	Non-recyclable Paper	2.89%	4.36%
Card	Liquid Cartons	0.24%	0.36%
Card	Board Packaging	1.87%	2.82%
Card	Card Packaging	1.74%	2.63%
Card	Other Card	0.21%	0.32%
Dense Plastic	Plastic Bottles	2.85%	4.31%
Dense Plastic	Other Dense Plastic Packaging	1.47%	2.22%
Dense Plastic	Other Dense Plastic	0.71%	1.07%
Plastic Film	Other plastic film	0.36%	0.54%
Plastic Film	Packaging film	1.41%	2.12%

Waste component	Sub-component	HOUSING GROUP 1 & 2	HOUSING GROUP 3 & 4
Textiles	Textiles	1.34%	2.03%
Textiles	Shoes	0.23%	0.35%
Glass	Glass Bottles	9.14%	13.79%
Glass	Glass Jars	0.00%	0.00%
Glass	Other Glass	0.14%	0.22%
Miscellaneous Combustibles	Treated Wood	0.14%	0.21%
Miscellaneous Combustibles	Untreated Wood	0.02%	0.03%
Miscellaneous Combustibles	Furniture	0.90%	1.36%
Miscellaneous Combustibles	Disposable Nappies	1.44%	2.17%
Miscellaneous Combustibles	Other Miscellaneous Combustibles	2.35%	3.54%
Miscellaneous Combustibles	Carpet and Underlay	1.44%	2.18%
Miscellaneous Non-combustibles	Construction and Demolition	1.33%	2.01%
Miscellaneous Non-combustibles	Other Miscellaneous Non-combustibles	0.46%	0.70%
Ferrous Metal	Ferrous food	0.79%	1.19%
Ferrous Metal	Ferrous beverage cans	0.00%	0.00%
Ferrous Metal	other ferrous metal	0.40%	0.61%
Non-ferrous metal	Non-ferrous food	0.20%	0.30%
Non-ferrous metal	Non-ferrous beverage cans	0.00%	0.00%
Non-ferrous metal	Other non ferrous metal	0.40%	0.61%
WEEE	white goods	0.00%	0.00%
WEEE	Large electronic goods	0.00%	0.00%
WEEE	TV's and monitors	0.00%	0.00%
WEEE	Other WEEE	0.00%	0.00%
Hazardous	Household Batteries	0.00%	0.00%
Hazardous	Car Batteries	0.00%	0.00%
Hazardous	Engine Oil	0.00%	0.00%
Hazardous	Other potentially hazardous	0.00%	0.00%
Hazardous	Identifiable clinical waste	0.00%	0.00%
Organic non-catering	Garden Waste	32.95%	0.00%
Organic non-catering	Soil	0.00%	0.00%
Organic non-catering	Other Organic	0.18%	0.00%
Organic catering	Home compostable Kitchen Waste	8.47%	12.78%
Organic catering	Non-home compostable Kitchen Waste	7.75%	11.69%
Fines	Fines	1.18%	1.78%
		100.0%	100.0%

5. Kerbside Recycling

5.1 Dry Recycling

Current System coverage & participation– kerbside sort

HG1 2012 to 2015

- Coverage 100%
- Participation 32% to 32.6%

HG2 2012 to 2015

- Coverage 100%
- Participation 32% to 32.6%

HG3 2012 to 2014

- Coverage 100%
- Participation 56.5% to 30.9%

HG4 2012 to 2014

- Coverage 100%
- Participation 56.5% to 30.9%

Future System coverage & participation– kerbside comingled

HG1 2016 onwards

- Coverage 100%
- Participation rising to 56.9%

HG2 2016 onwards

- Coverage 100%
- Participation 56.9%

HG3 2015 onwards

- Coverage 100%
- Participation rising to 33.3%

HG4 2015 onwards

- Coverage 100%
- Participation rising to 33.3%

Targeting & Recognition of kerbside Dry Recyclables

Targeted Dry Recyclables	2012 - 2014	2015	2017 onwards
Newspapers	100%	100%	100%
Magazines	100%	100%	100%
Other Recyclable Paper	100%	0%	100%
Paper Packaging	100%	0%	0%
Liquid Cartons	100%	100%	100%
Board Packaging	100%	100%	100%
Card Packaging	100%	100%	100%
Other Card	100%	0%	100%
Plastic Bottles	100%	100%	100%
Other Dense Plastic Packaging	0%	100%	100%
Other Dense Plastic	0%	100%	100%
Textiles	0%	100%	100%
Shoes	0%	100%	100%
Glass Bottles	100%	100%	100%
Glass Jars	100%	100%	100%
Ferrous food	100%	100%	100%
Ferrous beverage cans	100%	100%	100%
Non-ferrous food	100%	100%	100%
Non-ferrous beverage cans	100%	100%	100%

Dry Recyclables Recognition	**2025**
Newspapers	94%
Magazines	95%
Other Recyclable Paper	50%
Liquid Cartons	80%
Board Packaging	53%
Card Packaging	53%
Other Card	44%
Plastic Bottles	90%
Other Dense Plastic Packaging	52%
Other Dense Plastic	25%
Textiles	59%
Shoes	59%
Glass Bottles	90%
Glass Jars	90%
Ferrous food	85%
Ferrous beverage cans	90%
Non-ferrous food	85%
Non-ferrous beverage cans	90%

5.2 Garden & Food waste

HG1 2012 to 2015:

- 100% coverage
- 90.1% to 94.3% Participation
- Recognition garden waste 95%
- Recognition food waste 63%

5.3 Garden

HG1 2016 onwards

- 100% coverage
- Participation 78.9% rising to 79.1%
- Recognition garden waste 95%

HG2 2016 onwards

- 100% coverage
- Participation 72% rising to 75%
- Recognition garden waste 95%

5.4 Food waste

HG1 2016 onwards:

- 100% coverage
- Participation 78.9% to 79.1%%
- Recognition food waste 63%

HG2 2014 onwards:

- 100% coverage
- Participation 78.9% to 79.1%%
- Recognition food waste 63%

HG3 2014 onwards:

- 100% coverage
- Participation 30%
- Recognition food waste 63%

HG1 2014 onwards:

- 100% coverage
- Participation 30%
- Recognition food waste 63%

5.5 Overall performance

Recycling & composting rate including MT plant is 56.4% (2025). This does not include IBA metals (which are expected to be minimal as metals are captured at the MT plant).

Without the MT plant, the recycling & composting performance is 53.6% (2025).

Note: These rates are below the performance data provided by Aberdeen City "ACC Profile Model V11-20130918.xlsx" which indicates 54% in 2025 for ACC recycling and 7.4% from further "picking" operations totalling 61.4%. This is because post issuance of the ACC data it was decided to route the HWRC residual waste to the MT plant. Further instructions were to minimise the cost of the MT plant and capture metals and dense plastics (as per SITA proposal for the interim SRF market solution). This means that the MT plant performance is NOT as good as the ACC modelled "picking line".

6. Residual Waste Management

Three residual waste management options have been modelled:

- **Option 1:** EfW sized for Aberdeen City Council only.

  To develop a facility on a site identified within the Council's boundary with the purpose of treating Aberdeen's residual waste arisings. This would include front end mechanical treatment (MT) to recycle plastics and metals, and remove inert fraction, as preparation for an Energy from Waste (EfW) facility in line with Scottish Government requirements. The capital investment to provide this facility would be funded directly by the Council, and a partner waste contractor engaged to manage the facility's operational activities on the Council's behalf. It offers the potential benefit of renewable energy generation within the City.

- **Option 3:** A joint Authority EfW for Aberdeen City Council, Aberdeenshire Council and Moray Council Option 1 EfW (Aberdeen County Council).

  As Option 1, with a larger EfW facility that is sized to take other residual waste. This other waste could be sourced from other public sector bodies or commercial and industrial wastes. With this option the MT facility need not be co-located with the EfW, as this could take place at the waste source, with the EfW being constructed at a suitable central site. The capital investment to provide this facility would be funded directly by the Council and a partner waste contractor engaged to manage operations.

- **Option 5:** The continued use of RDF export for Aberdeen City Council through use of the Altens RDF Facility post SITA contract.

  The Council is currently progressing an interim treatment solution comprising the preparation of waste as Refuse Derived Fuel (RDF) prior to export to European EfW facilities. The business case considers this waste treatment option also as a long term solution, assessing whether the cost of this waste management practice would provide better value for money.

Projected arisings of residual waste are 73,292 tpa (2015) falling to 55,733tpa as kerbside performance improves.

For Option 3 we have assumed the additional residual waste tonnages:

- Moray Council 20,000 tpa; and
- Aberdeenshire Council 70,000 tpa.

6.1 Option 5 MT (Mechanical Treatment) + RDF

A 75,000 tpa capacity MT plant is assumed to have been already provided under the current contract with SITA from 2022. The overall performance of the MT plant as modelled is:

- 6.2% recycling (2025)
- 83.3% RDF (2025)

- 10.5 % landfill (2025) (overall 5.4% of MSW to landfill)

This is based on the following material captures (metals):

- Plastic Bottles 70%
- Other Dense Plastic Packaging 10%
- Other Dense Plastic 10%
- Ferrous 83%
- Non-ferrous 80%

RDF output is 46,452 tpa.

Modelling Notes: In the tab "Model Data MT RDF" of the workbook ACC WFM AMEC V8 RDF rev 0 the MBT model facility is used as a surrogate for the Residual Waste MT in this model because the MT model facility was previously allocated to a HWRC Residual Waste MT plant. In the EfW options there is NO Residual Waste MT facility modelled.

6.2 Option 1 and 3 EfW (Energy from Waste)

For modelling purposes as the bottom ash and APC residues are treated off-site by a 3rd Party. The EfW performance is assumed to be:

- % Combusted 71%
- % Fly Ash 4%, of which;
  - Fly Ash recycled 100% (to remove landfill costs associated with ash from the model as a "gate-fee" for ash handling is assumed in the EfW cost model.
  - Fly Ash landfilled 0% (to remove landfill costs associated with ash from the model as a "gate-fee" for ash handling is assumed in the EfW cost model.
- Bottom Ash 25%, of which
  - Bottom Ash recycled 100% (to remove landfill costs associated with ash from the model as a "gate-fee" for ash handling is assumed in the EfW cost model.
  - Bottom Ash landfilled 0% (to remove landfill costs associated with ash from the model as a "gate-fee" for ash handling is assumed in the EfW cost model.
- Electricity Production (output):
  - 323 kWh(e) / te (for 60ktpa EfW based on NCV of 7.74MJ/kg and net electrical efficiency of 15%)
  - 430 kWh(e) / te (for 60ktpa EfW based on NCV of 7.74MJ/kg, and net electrical efficiency of 20%)

7. Other Facilities

7.1 Windrow

- 12,000 tpa (All costing data removed from the model)

7.2 IVC (food)

- 13,000 tpa (All costing data removed from the model)

7.3 MRF

- 25,000 tpa (All costing data removed from the model)

8. Basis of Costs

8.1 Treatment Facilities

60,000 tpa EfW

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EFW COSTS ESTIMATION
Energy Services
Valid for EfW projects 50 - 120ktpa

Project	Aberdeen CC				
Reference	34149-02				
For	Steve Blackburn				
By	Brendan Sharpe				
Date	09 July 2015				

CAPEX ESTIMATE

Waste Stream	MSW				
Waste CV	7.74	MJ/kg			
Capacity	60,000	tonnes/year			
Location	North East Scotland				
Location Costing Factor	95%	Costing Factor (relative to Base Case data)			
Tonnage Rating	7.5	tonnes per hour	8,000.00	Operating hours per year	
Thermal Capacity	16	MW(th) @	91%	Load Factor	
Electrical Output	2.4	MW(e) @	15%	Net Electrical Efficiency	
Electrical Output	19,362	MWh per year =	**323**	kWh(e) per tonne of waste	
Estimated EFW EPC Capex					
Thermal Element	£ 19	M			
Tonnage Element	£ 33	M			
Total EFW EPC Cost Estimate	**£ 52**	**M**	**£ 870**	**per tonne/year capacity**	

Capex extimates are accurate to +/- 50%
Capex estimates do not include contingency margins

MAINTENANCE ESTIMATE

Lifecycle Replacement Costs	£ 0.2	M per year	£ 2.79		
Other Routine Maintenance Costs	£ 0.2	M per year (Annual Average over Lifetime)	£ 3.62		
Total Annual Average Maintenance Costs	**£ 0.4**	M per year =	**£ 6**	per tonne of waste feed	

OPEX ESTIMATE

VARIABLE OPERATING COSTS (Purchase of consumables and disposal of residues)

Consumables					
Lime	15.0	kg/tonne	188.07	per tonne	£ 169,267
Activated Carbon	1.0	kg/tonne	675.14	per tonne	£ 40,508
Ammonia (30% Solution)	4.0	kg/tonne	184.46	per tonne	£ 44,270
Process Water	0.6	m3/tonne	0.96	per m3	£ 34,721
Sodium Bicarbonate		kg/tonne	241.12	per tonne	£ -
Urea		kg/tonne	397.85	per tonne	£ -
By-Products Disposal					
Bottom Ash	25%	of Waste Feed @	24.18	per tonne	£ 362,699
FGT Residues	4%	of Waste Feed @	205.53	per tonne	£ 493,271
Total Variable Costs	**£ 1,144,737**	=	**19.08**	per tonne	

FIXED OPERATING COSTS (Staffing, environmental compliance, office admin costs, excludes insurance)

Staffing	£ 1,051,828	per year		
Environmental Compliance	£ 120,900	per year		
Office Expenses	£ 48,360	per year		
Other Unspecified	£ 60,450	per year		
	£ 1,281,537	per year	**21.36**	per tonne of waste
	Excludes insurances			

SUMMARY OF O&M COSTS

Variable Opex Estimate	19.08	per tonne of waste feed
Fixed Opex Estimate	21.36	per tonne of waste feed
	40.44	per tonne of waste feed
Esimated Maintenance Cost Estimate	6.41	per tonne of waste feed
Total O&M Cost Estimate	**46.85**	per tonne of waste feed

REVENUES ESTIMATE

Electricity Production	19,362	MWh per year		
Electricty Sale Price	£ 47	per MWh		
Electricity Sales Revenue	**£ 910,014**	per year =	**15.17**	per tonne of waste

The NCV of the rMSW is on the low side, however this is estimated from the waste flow model and reflects the relatively high public recognition rate of paper and plastics (high calorific value) versus the lower recognition of food waste.

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150,000 tpa EfW

EFW COSTS ESTIMATION						
Energy Services						
Valid for EfW projects > 120ktpa						
Project	Aberdeen CC					
Reference	34149-02					
For	Steve Blackburn					
By	Brendan Sharpe					
Date	09 July 2015					
CAPEX ESTIMATE						
Waste Stream	MSW					
Waste CV	7.74	MJ/kg				
Capacity	150,000	tonnes/year				
Location	North East Scotland					
Location Costing Factor	95%	Costing Factor (relative to Base Case data)				
Tonnage Rating	18.8	tonnes per hour	8,000.00	Operating hours per year		
Thermal Capacity	40	MW(th) @	91%	Load Factor		
Electrical Output	8	MW(e) @	20%	Net Electrical Efficiency		
Electrical Output	64,540	MWh per year =	**430**	kWh(e) per tonne of waste		
Estimated EFW EPC Capex						
Thermal Element	£ 48	M				
Tonnage Element	£ 87	M				
Total Final Capex Estimate	**£ 135**	**M**	**£ 902**	**per tonne/year capacity**		
Capex extimates are accurate to +/- 50%						
Capex estimates do not include contingency margins						
MAINTENANCE ESTIMATE						
Lifecycle Replacement Costs	£ 0.7	M per year	£ 4.97			
Other Routine Maintenance Costs	£ 1.0	M per year (Annua	£ 6.46			
Total Annual Average Maintenance Costs	**£ 1.7**	M per year =	**£ 11**	per tonne of waste feed		
OPEX ESTIMATE						
VARIABLE OPERATING COSTS	(Purchase of consumables and disposal of residues)					
Consumables						
Lime	15.0	kg/tonne	£ 188	per tonne	£ 423,168	
Activated Carbon	1.0	kg/tonne	£ 675	per tonne	£ 101,271	
Ammonia (30% Solution)	4.0	kg/tonne	£ 184	per tonne	£ 110,675	
Process Water	0.6	m3/tonne	£ 0.96	per m3	£ 86,804	
Sodium Bicarbonate		kg/tonne	£ 241	per tonne	£ -	
Urea		kg/tonne	£ 398	per tonne	£ -	
By-Products Disposal						
Bottom Ash	25%	of Waste Feed @	£ 24	per tonne	£ 906,748	
FGT Residues	4%	of Waste Feed @	£ 206	per tonne	£ 1,233,177	
Total Variable Costs	**£ 2,861,843**	=	**£ 19**	per tonne		
FIXED OPERATING COSTS	(Staffing, environmental compliance, office admin costs, excludes insurance)					
Staffing	£ 1,257,357	per year				
Environmental Compliance	£ 120,900	per year				
Office Expenses	£ 48,360	per year				
Other Unspecified	£ 60,450	per year				
	£ 1,487,067	per year	**£ 10**	per tonne of waste		
	Excludes insurances					
SUMMARY OF O&M COSTS						
Variable Opex Estimate			£ 19	per tonne of waste feed		
Fixed Opex Estimate			£ 10	per tonne of waste feed		
			£ 29	per tonne of waste feed		
Esimated Maintenance Cost Estimate			£ 11	per tonne of waste feed		
Total O&M Cost Estimate			**£ 40**	per tonne of waste feed		
REVENUES ESTIMATE						
Electricity Production	64,540	MWh per year				
Electricty Sale Price	£ 47	per MWh				
Electricity Sales Revenue	**£ 3,033,380**	per year =	**£ 20.22**	per tonne of waste		

The NCV of the rMSW is on the low side, however this is estimated from the waste flow model and reflects the relatively high public recognition rates of paper and plastics (high calorific value) versus the lower recognition of food waste.

Price basis is 2009 to which RPI inflation for EfW capex has been added. Benchmarked against more recent information.

For operating costs the inflation is based on Reagent Base Prices April 2008 (RPI from April 2008 to April 2015 20.6%). Note RPI all items is 20.9% from 2009 to 2015.

9. Other Costs

- Allowance for Grid connection £1,000,000.
- Allowance for Site purchase £2,200,000
- Allowance for relocation of culvert £500,000.
- Landfill Gate Fee £41.4/t : MT reject waste modelled to landfill. No wastes direct to landfill in EfW options.
- Special Waste Landfill Gate Fee £200/t – no waste modelled to Landfill.
- Landfill tax £82.6/t from 2015 remaining stable
- No transport costs modelled.

10. Income

- Electricity Sale Price £47/MWh. This is increased from the OBC 2013 and assumes a council funded option. It is note that a more conservative approach may be taken by bank/external sponsors.
- 3rd Party income for EfW headroom –none modelled by Amec Foster Wheeler.
- Income from recyclates modelled based on unit costs provided by ACC "'[ACC Profile Model V7a.xlsm] tab Unit Costs. – All income from recyclables removed from the model.
- All paper and card £5/t income. – All income from recyclables removed from the model.
- All textiles £250/t income. – All income from recyclables removed from the model.
- All glass wood £5/t income. – All income from recyclables removed from the model.
- All metals (ferrous & non-ferrous) £250/t income – All income from recyclables removed from the model.

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Appendix B
EY Value for Money Report

See separate report submitted to the Council by Ernst & Young LLP on 7 August 2015 *"Aberdeen Waste Project VFM – Business Case update".*

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