# Technical Note

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| cc | | File reference | |
| Prepared by | [redacted] | Date | 14 August 2019 |
| Subject | NESS Energy from Waste facility - Cost Benefit Analysis of CHP Heat Offtake | | |

# 1 Introduction

This technical note is to support the Cost Benefit Analysis for the installation located on the East Tullos Industrial Estate, Aberdeen (National Grid Ref. NJ953040). It was produced by Arup for Acciona Industrial to form part of the permit authorising the incineration or co-incineration of waste under the Pollution Prevention and Control (Scotland) regulations 2012.

This technical note should be read alongside the Cost Benefit Analysis (CBA) cashflow spreadsheet filled in using the Environment Agency's Cost-benefit Assessment for combustion installations guidance[1]. This note discusses the methodology and boundaries taken when assessing the financial implications of the Aberdeen Energy from Waste (EfW) plant providing heat offtake for district heating.

This paper focuses on the financial aspects of heat offtake and does not go into any detail about the technical aspects of the heat offtake. For this information, please see the heat and power plan that is issued alongside this paper.

# 2 Methodology

## 2.1 Boundaries of the CBA

This work evaluates the implications of providing heat to the heat network but omits the construction of the heat network itself. Further to this as it is now a regulatory requirement to ensure all EfW plants are combined heat and power (CHP) ready, the related turbine design costs have also been omitted. The aspects included and excluded are shown in Table 1 below.

[1] Environment Agency, Cost-benefit assessment for combustion installations V0.9 April 2015. [Available from: https://consult.environment-agency.gov.uk/psc/mcp-and-sg-regulations/supporting_documents/Draft%20Article%2014%20guidance%20April%202015%20V0.9.pdf]

Table 1: Indicates the scope of this CBA and the corresponding inputs

| Consideration | Included in this CBA? | Justification | Value used |
|---|---|---|---|
| Onsite heat exchanger | Yes | This equipment will be paid for and maintained by the EfW plant operator and would not be needed without heat offtake.<br><br>The EfW plant operator will recover these costs with a small margin to cover the risk. | £80k CAPEX<br>£4k annual OPEX (5% of CAPEX) |
| Turbine design alterations for heat offtake | No | All EfW plants in the UK need to be CHP ready. | £0 |
| Heat revenues | No | The heat network operator will receive the heat for free. This is a condition of the waste treatment contract between the EfW plant operator and the Waste Authority.<br>This will be provided up to a maximum of 10MWth which will be made available for the duration of the EfW contract. | £0/MWh |
| Heat network and standby boilers | No | The EfW plant operator is not required to develop and operate standby boilers, the energy centre or the heat network. These aspects will not represent a cost for the EfW plant operator. It is assumed that the standby boilers do not diminish the heat requirement from the EfW, so the % of heat provided by them is assessed as zero within this assessment. The CBA guidance[1] states that CAPEX and OPEX for the heat network infrastructure should be included, however this CBA is being undertaken on behalf of the EfW plant operator who will get no revenue from the heat network and will have no expenditure for the heat network. | CAPEX £0<br>OPEX £0<br>Pipeline 7.3 km<br>% of heat provided by Standby Boiler 0% |
| Lost electricity revenues | Yes | The supply of heat to the heat network will reduce the generation of electrical power.<br>The EfW plant operator will therefore sacrifice electrical revenues to be able to provide the heat to the network. | z-factor = 6.4 (ratio of electricity sacrificed for heat generated)<br>£50.034/MWh electricity sacrificed<br>1.3% inflation due to predicted electricity wholesale increase |

## 2.2 Approach

In accordance with the Environment Agency 2015 publication "Guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive" the scenario modelled is: **Scenario 1 – "power generating installation** (Heat Source) that, by becoming a cogeneration installation, supplies heat but still **uses the same amount of fuel".**

The spreadsheet was populated using the numbers identified above.

The district heat scheme is in development and is expected to have the following demand/growth profile:

- 3 MWth by year 2025
- 6 MWth by year 2030
- 10 MWth by year 2035

To find the "Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)" the 2035 value was used and multiplied by the operational hours of the EfW plant. This was opted for because from day one, the EfW plant operator will be able to produce 10MWth of heat and make it available to the heat network. This is independent of the requirement of heat from the heat network.

## 3 Results

Due to there being no revenue associated with the heat offtake, the IRR is negative and therefore cannot be calculated.

The 31 year NPV (before financing and tax) associated with the heat offtake will be -£3.42m. The inputs and key outputs from the CBA tool can be found on the next page.

**DOCUMENT CHECKING (not mandatory for File Note)**

| | Prepared by | Checked by | Approved by |
|---|---|---|---|
| Name | [redacted] | [redacted] | [redacted] |
| Signature | | [redacted] | |

# INPUTS — Version Jan 2015

## Scenario Choice (dropdown box): 1 — Power generator (Heat Source) same fuel amount

### Technical solution features

| | |
|---|---|
| Heat carrying medium (hot water, steam or other) (dropdown box) | Hot water |
| Total length of supply pipework (kms) | 7.3 |
| Peak heat demand from Heat User(s) (MWth) | 10 |
| Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) (MWh) | *Lines 49 & 79* |

**Key**

| | |
|---|---|
| 2 | Participant to define |
| 2 | Regulatory prescribed |
| 2 | Calculated |
| 2 | Prescribed - but possibility to change if make a case |

### DCF Model Parameters

| | |
|---|---|
| Discount rate (pre-tax pre-financing) (%) - 17% suggested rate | 17% |
| Project lifespan (yrs) | 30 |
| **Exceptional** shorter lifespan (yrs) | 0 |

### Cost and revenue streams

**Construction costs and build up of operating costs and revenues during construction phase**

| | % operating costs and revenues during construction phase | Heat Supply Infrastructure - used in Scenarios 1, 2, 3 and 5 | Heat Station - used in Scenarios 1, 2 and 3 | Standby boilers (only if needed for Scenarios 1, 2 and 3) | Industrial CHP - used in Scenario 4 * |
|---|---|---|---|---|---|
| Project asset lifespan (yrs) | | 30 | 30 | 30 | 20 |
| **Exceptional** reason for shorter lifespan of Heat Supply Infrastructure, Standby Boiler and/ or Heat Station (yrs) | | | | | |
| Construction length before system operational and at steady state (yrs) | 1 | | | | |
| Number of years to build | | 1 | 0 | 1 | 0 |
| | % (ONLY IF APPLICABLE) | £m | £m | £m | £m |
| Year 1 costs (£m) and build up of operating costs and revenues (%) | | 0.08 | | 0 | |
| Year 2 costs (£m) and build up of operating costs and revenues (%) | | | | | |
| Year 3 costs (£m) and build up of operating costs and revenues (%) | | | | | |
| Year 4 costs (£m) and build up of operating costs and revenues (%) | | | | | |
| Year 5 costs (£m) and build up of operating costs and revenues (%) | | | | | |

**Non-power related operations**

| | |
|---|---|
| OPEX for full steady state Heat Supply Infrastructure on price basis of first year of operations (partial or steady state) (£m) | 0.0 |
| OPEX for full steady state Heat Station on price basis of first year of operations (partial or steady state) (£m) | 0.0 |
| OPEX for full steady state Standby Boilers on price basis of first year of operations (partial or steady state) (£m) | 0.0 |
| OPEX for full steady state Industrial CHP on price basis of first year of operations (partial or steady state) (£m) * | 0.0 |
| Additional equivalent OPEX to pay for a major Industrial CHP overall spread over the life of the asset (£m) on price basis of first year of operations (partial or steady state) (£m) * | 0.0 |
| Other 1 - Participant to define (£m) | 0.0 |
| Other 2 - Participant to define (£m) | 0.0 |
| **Total non-power related operations** | **0.0** |
| Annual inflation for all non-power related OPEX from first year of operations (full or partial) (%) | 2.0% |

### Unit Energy Prices, Energy Balance, Fuel Related Operational costs and Revenue Stream

| | Scenario used | 1 Power generator (Heat Source) same fuel amount | 2 Power generator (Heat Source) same electrical output | 3 Industrial installation (Heat Source) - use waste heat | 4 Industrial installation (Heat Source) - CHP set to thermal input | 5 District heating (Heat User) |
|---|---|---|---|---|---|---|
| Heat sale price (£/ MWh) at first year of operations (partial or full) | 0.00 | 0.00 | 50.00 | 50.00 | | |
| Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh) | 80,000 | 80,000 | 1,000,000 | 250,000 | | |
| Equivalent heat sales if first year of operations is steady state (£ m) | 0.0 | | | | | |
| Heat sale price inflation from first year of operations (full or partial) (% per year) | 3.0% | 3.0% | 3.0% | 3.0% | | |
| Percentage of heat supplied by Standby Boiler (if relevant) | 0% | 0% | 20% | 20% | | |
| 'Lost' electricity sale price (£/ MWh) at first year of operations | 50.03 | 50.03 | | | | |
| Z-ratio (commonly in the range 3.5 - 8.5) | 6.40 | 6.40 | | | | |
| Power generation lost at steady state (MWh) | 12,500 | 12,500 | | | | |
| Equivalent 'lost' revenue from power generation if first year of operations is steady state (£ m) | 0.63 | | | | | |
| Electricity sale price inflation from first year of operations (full or partial) (% per year) | 1.3% | 1.3% | | | | |
| Industrial CHP electricity sale price (£/ MWh) at first year of operations (full or partial) | 0.00 | | | | 110.00 | |
| Industrial CHP electrical generation in steady state (MWh) | 0 | | | | * 285,714 | |
| Equivalent revenue from power generation if first year of operations is steady state (£ m) | 0.00 | | | | | |
| Industrial CHP electricity price inflation from first year of operations (full or partial) (% per year) | 0.0% | | | | 2.0% | |
| Fuel price for larger power generator/ CHP at first year of operations (full or partial) (£ / MWh) | 0.00 | | 40.00 | | 40.00 | |
| Z-ratio (commonly in the range 3.5 - 8.5) | 0 | | 3.50 | | | |
| Power efficiency in cogeneration mode (%) | 0 | | 30% | | | |
| Additional fuel required per year for larger power generator / CHP in steady state (MWh) | 0 | | 761,905 | | * 300,000 | |
| Equivalent additional fuel costs if first year of operations is steady state (£ m) | 0.00 | | | | | |
| Fuel price inflation from first year of operations (full or partial) (% per year) | 0.0% | | 3.0% | | 5.0% | |
| Fuel price for Standby Boiler at first year of operations (£ / MWh) | 0.00 | 0.00 | 40.00 | 40.00 | | |
| Boiler efficiency of Standby Boiler (%) | 80% | 80% | 80% | 80% | | |
| Additional fuel required per year for Standby Boiler in steady state (MWh) | - | - | 250,000 | 62,500 | | |
| Equivalent additional fuel costs if first year of operations is steady state (£m) | - | | | | | |
| Fuel price inflation for Standby Boiler from first year of operations (full or partial) (% per year) | 0.00% | 0.0% | 3.0% | 3.0% | | |
| Heat purchase price (£/ MWh) at first year of operations (partial or full) | 0.00 | | | | | 35.00 |
| Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh) | 0 | | | | | 200,000 |
| Equivalent cost of heat purchased if first year of operations is steady state (£ m) | 0.0 | | | | | |
| Heat purchase price inflation from first year of operations (full or partial) (% per year) | 0.0% | | | | | 3.0% |
| Fuel price (£ / MWh) at first year of operations (partial or full) | 0.00 | | | | | 40.00 |
| Boiler efficiency of district heating plant | 0% | | | | | 80% |
| Fuel avoided per year in steady state (MWh) | 0 | | | | | 250,000 |
| Equivalent fuel savings if first year of operations is steady state (£m) | 0.0 | | | | | |
| Fuel price inflation from first year of operations (full or partial) (% per year) | 0.0% | | | | | 4.0% |
| Fiscal benefits (£m) in first year of operations assuming it is at steady state ** | 0.00 | 0.00 | 2.50 | | 2.50 | |
| Fiscal benefits inflation rate from first year of opeations (full or partial) (%) ** | 0.0% | 0.0% | 1.0% | | 1.0% | |

* In the case of Industrial CHP a separate model template is available for typical indicative CAPEX, non-power related OPEX, additional equivalent OPEX to pay for a major overall, MWh of electricity generated in the steady state and the additional fuel required.

** Operator only needs to enter a value for fiscal benefits (£m) and the annual fiscal benefit inflation rate (%) if the NPV without fiscal benefits is negative at the specified discount rate

# OUTPUTS

| | |
|---|---|
| Nominal Project IRR (before financing and tax) over 31 years | #NUM! |
| Nominal NPV (before financing and tax) (£m) over 31 years | -3.42 |