Assess options for maximising the net renewable energy production from the Energy from Waste facility

1. EXECUTIVE SUMMARY

1.1. This work stream considers the contribution made by the Island's Energy from Waste Facility (EfW) in providing renewable electricity on Island for the Island. It reviews the options for increasing net energy production, and for reducing the net carbon footprint of the EfW. In 2018 the EfW total footprint CO_2 emission was 7,500 tonnes per annum, taking into account other fuel uses, removal of CO_2 from biogenic sources (considered short cycle carbon) and carbon savings from electricity generation. The total Process Carbon Emissions was 50,000 tonnes per annum of CO_2. This is stack emissions through the processing of the waste, and takes into account the calorific value of the waste and fuel used by the burners.

1.2. The EfW is primarily a facility for disposing of the Islands combustible wastes. It has two incinerators. The primary waste incinerator (PWI) has capacity to process up to 60,000 tonnes of mixed household and commercial waste a year. The secondary waste incinerator (SWI) is a high temperature facility for the disposal of clinical wastes.

1.3. On average the Isle of Man delivers 50,000 tonnes pa of waste to the EfW, subsequently exporting circa 25,000 MWh electricity (2017) to the National Grid. A percentage of the electricity is able to be counted as renewable as it is produced through the combustion of biogenic waste. However the EfW has the capacity to produce more electricity if it burns more combustible waste. This increase in electricity could also be achieved by removing the non-combustible fraction of the waste stream (metals). In addition, were the waste feedstock to increase, this would prevent an unscheduled non-maintenance EfW shutdown which is caused due to the lower waste tonnages, and requires the use of virgin oil. Oil use could also be reduced through a change in SWI technology.

1.4. There are two possible sources of additional combustible waste feedstock: waste material not delivered to the EfW but disposed of by unregulated means, and biomass. The Isle of Man does not have legislation prohibiting unregulated burning of wastes in the open air, the only exceptions being on licenced waste disposal sites or where the burning is determined to be a statutory nuisance. The open burning of waste is known to occur across the Island, albeit there is no data on exact tonnages or waste types. Were legislation to be introduced to prohibit or restrict open burning of waste (akin to the UK Clean Air Act 1993) this would divert combustible wastes via the EfW increasing the tonnage.

1.5. The Department of Environment Food and Agriculture (DEFA) produces biomass which could be used throughout the year to supplement the EfW waste feedstock.

The cost of biomass procurement and transportation would need to take account of the impact of this on reducing Island wide carbon emissions.

1.6. As a means for reducing territorial carbon emissions the report will also consider options for closing the EfW, redirecting the organic fraction of the waste stream via an anaerobic digestion facility, and exporting the remain wastes as refuse derived fuel to the UK for disposal.

1.7. The report does not consider the embedded carbon in materials and goods imported and goods and wastes exported.

2. THE CHALLENGE

2.1. The Isle of Man is seeking ways to reduce its Greenhouse Gas Emissions to achieve a target of net zero emissions by 2050.

2.2. In 2018 the Isle of Man Energy from Waste Facility (EfW) total footprint CO_2 emission was 3,594 tpa (Suez 2019 extract Annex A, full report Annex B). Total Process Carbon Emissions in 2018 were 50,110 tpa of CO_2.

- Total process carbon emissions are the stack emissions, i.e. from the processing of the waste; this takes into account the calorific value of the waste and includes fuel used by the burners.
- The total footprint emissions are the carbon footprint of the EfW, taking into account other fuel uses, removal of CO_2 from biogenic sources (considered short cycle carbon) and carbon savings from electricity generation.

2.3. The primary function of the EfW is to dispose of residual combustible wastes produced from all sectors on the island. The secondary function is to produce electricity. It is this function which allows the EfW to be classified as a recovery facility and to have its electricity classified as renewable energy (Environment Agency, 2016). The EfW exports circa 25,000 MWh of electricity per year to the National Grid. Carbon Balance Calculations by SUEZ (2019) indicate that a percentage of this electricity can be counted as 'renewable' (Eunomia, 2019). Data analysis, including consideration of the biogenic component of the waste feedstock (e.g. food waste, paper), is on-going and once completed will confirm the EfW renewable energy contribution.

2.4. At present waste heat is not recovered from the EfW for export. This option for recovery of heat is being considered under work package Work Package 33.

2.5. The EfW, commissioned in 2003, is operated by Suez under a 25 year contract. As a strategic part of the Isle of Man National Waste Infrastructure the EfW is expected to remain the main disposal facility for combustible wastes on Island for the next 15-20 years, as reflected in the 2018 Waste Strategy Policy (Isle of Man Government,

2018). The capital investment in the EfW (circa £44m) will be paid off in 2028.

Primary Waste Incinerator (PWI)

2.6. The design capacity of the PWI EfW is 60,000 tpa of wastes, burning at a temperature of 850 degrees C. The current tonnage processed via the PWI is 50,000 tpa. The EfW is required to dispose of mixed waste arising on the Island (household, commercial industrial). Legislation prohibits both the export and import of waste for disposal, although it does allow for the export of waste for recovery (Environment Angency, 2014) (Tynwald.org.im, 2019). The EfW needs therefore to retain capacity to allow for fluctuations in waste arising (change in population size, economic activity etc.) and types. This means that, unlike its UK counterparts, the EfW does not operate at 100% capacity allowing it to maximise net electricity production.

2.7. At current waste tonnages the EfW operates at about 80% capacity, and requires one additional unscheduled shutdown per year due to lack of waste. Each additional shutdown requires consumption of gas oil for PWI shutdown and start up, burning an addition of 30,000 litres of oil and adding to the EfW greenhouse gas (GHG) emissions.

Secondary Waste Incinerator (SWI)

2.8. The design capacity of the SWI is 5,000 tpa of animal and clinical waste, burning at a temperature of 1000 degrees C. Since 2008 the SWI has only processed clinical waste. The SWI currently requires circa 45,000L per annum virgin oil for incineration. This is due to the very low tonnages of clinical waste processed (average 250 tonnes pa) and the high temperatures required for the destruction of volatile gasses (Suez, 2019). Waste mineral oil (estimated 440 tonnes per annum) is also disposed of in the SWI, and is used to maintain the minimum temperature required for the incineration process. Work is underway to replace this SWI with a less fuel intensive facility for processing clinical waste, waste oil and other wastes for which disposal on Island is proving problematic (eg hydrocarbon contaminated soils).

Focus for the Work Program

2.9. This main focus for this GHG reduction work programme is therefore to:

i. reduce virgin oil consumption by preventing any unscheduled shutdowns.
ii. maximise the net renewable energy production from the EfW.

It is acknowledged that there are other potential work streams associated with the objective of decarbonising the EfW. These relate to:

iii. decarbonising the EfW feedstock (waste stream) by:
    a. removing fossil fuel based wastes (essentially plastics)
    b. removing high carbon wastes such as organics/food/green waste.
iv. decommissioning the EfW and exporting residual wastes for incineration as refuse derived fuel in another jurisdiction.

2.10. Potential work stream iii (b) would require the calculation of carbon based on embedded carbon and allow consideration of carbon impacts for goods imported and exported (Department of Energy & Climate Change, 2015). As this work stream focuses on territorial GHG emissions this cannot be progressed. This issue is discussed further in Annex B.

2.11. Potential work stream iii (b) will also require a review of Anaerobic Digestion (AD) (wet and dry) as a process, and whether this could form part of the Island's strategic waste management/disposal infrastructure. Biogenic/organic waste types include:

- Agricultural manure and slurry (not a controlled waste under the terms of the Public Health Act 1990).
- Sewage sludge (managed by Manx Utilities through drying and controlled incineration).
- Commercial wastes such as bakery, creamery and brewery waste.
- Household wastes – food and green waste (currently managed via home composing, centralised compositing, in-sink disposal units, and EfW).

2.12. It is known that some of these commercial waste streams have already been subject to review for AD processing. However as these have been private studies they are not at present available.

2.13. Isle of Man household food and garden waste was the focus for study in 2008. The resulting Organics Waste Strategy – Options and Appraisal included a review of options for managing the organic element of household waste. The preferred option was for alternate week collection of commingled household garden and kitchen waste, for 'dry' anaerobic digestion, at a collection cost of £700k pa (2008 figure). To note the focus for this study was performance and cost, not GHG emissions.

2.14. As a means for reducing territorial carbon emissions this work stream will also consider options for decommissioning the EfW, constructing a primary treatment facility (Materials Recovery Facility) for removing potentially recyclable materials from the residual waste stream, baling and then exporting the wastes as refuse derived fuel to the UK for incineration.

2.15. At present the Isle of Man is not permitted under international legislation to export wastes for disposal unless these have prior authorisation by the receiving jurisdiction (for the Island this is tends to be the UK) (Environment Angency, 2014). The carbon cost of pre-treatment prior to export would need to be considered as part the carbon calculation of waste export as opposed to on island disposal.

3. THE OPPORTUNITY

3.1. The IoM Energy from Waste Facility (EfW) was designed to produce electricity, converting the heat generated through incineration of waste materials into steam and then to electricity. Some of this electricity (Suez, 2019) is used on site (the

'parasitic load' in 2018 was 817MWh, or 0.015MWh/tonne of waste) and the remainder is exported to the electricity grid. Electricity export in 2018 was 25,000MWh. The EfW meets the design criteria for classification as a recovery plant (Chartered Institution of Wastes Management, 2019) in accordance with the Waste Framework Directive (WFD) Article 3. The electricity produced by the EfW is therefore presently classified as renewable energy.

3.2. There are two separate but linked opportunities for reducing EfW CO_2 and CO_2e, by:

- Reducing the amount of GHG emitted from the EfW stack, and
- Producing less carbon intensive electricity ('replacing' power generated from the Pulrose Power Station generated by burning gas)

3.3. These can be achieved by:

Reducing PWI virgin oil consumption

3.4. Reducing Primary Waste Incinerator unscheduled shutdowns by:

- Preventing un-regulated burning of waste in the open.

3.5. The Isle of Man does not have legislation prohibiting unregulated burning of wastes in the open air, the only exceptions being on licenced waste disposal sites or where the burning is determined to be a statutory nuisance. The open burning of waste is known to occur across the Island, albeit there is no data on exact tonnages or waste types. Were legislation to be introduced to prohibit or restrict open burning of waste (akin to the UK Clean Air Act 1993) this would divert combustible wastes via the EfW increasing the tonnage.

- Supplementing the feedstock by burning biomass.

3.6. To prevent a shutdown due to lack of waste would require 4,000 tpa biomass at a net cost to Department of Infrastructure (DOI) of £151k (based on £40/tonne (Infrastructure, 2018)). This would generate an additional 1660 MWh electricity, save 30,000L EfW oil use, replace GHG emissions from the gas fired power station and possibly contribute to Isle of Man CO_2 reductions though sustainable forestry planting replacement biomass.

3.7. To operate the EfW at near maximum capacity would require an additional 10 kt biomass pa at a net cost to DOI of £219k pa. This would generate an additional 13,835 MWh electricity.

3.8. Issues to be resolved:

- Cost of procuring biomass from DEFA
- Availability of biomass

- Type of biomass (size, length of chips etc.)
- Cost paid to DOI/Suez by Manx Utilities for EfW electricity. Current MU buys at £25.65/MWh but sells at £124/MWh

Changing the design and operation of the SWI

3.9. The need to replace the current SWI has been accepted. The technology being considered could reduce virgin oil consumption from the current 199,000 litres/pa (£109k pa) to as low as 10,000 litres/pa. This will take place within the next 2 year timeframe effecting a reduction in EfW stack GHG emissions.

Increasing the Calorific Value (CV) of Waste Feedstock

3.10. Increasing the net renewable energy production from the PWI can also be achieved by increasing the calorific value of EfW feedstock. Waste made from non-combustible material such as metal (ferrous and non-ferrous), electrical items and glass absorb energy during the incineration process. This reduces the CV, energy produced and consequently electricity produced.

3.11. The most recent EfW feedstock analysis (M.E.L., 2019) identified 11.5% of non-combustible waste in the EfW feedstock. The EfW design criteria (Isle of Man Government , 2016) is for combustion of waste between 9.5 MJ/kg and 10.7 MJ/kg. In 2018 the average CV was 10.2 MJ/kg. There are schemes on Island for recovering glass, metal and some WEEE from the waste stream and these should be promoted to increase participation and material capture. The proposed 2020 household baseline waste composition audit will provide contemporary data. Household waste is circa 72% of the PWI feedstock.

4. THE ACTIONS

4.1. Progress the design and development of the replacement SWI. This will effect a significant reduction in stack GHG emissions.

4.2. Investigate the logistics and cost of procuring biomass with DEFA.

4.3. Progress legislation to prohibit the unregulated burning of waste in the open air.

4.4. Promote schemes for recovery of metal, glass and other non-combustible waste materials from the residual waste stream.

4.5. Agree the fraction of energy classified as renewable energy produced by the EfW.

4.6. Discuss with regulatory bodies the option of exporting residual waste for incineration in the UK or elsewhere.

4.7. Undertake a high level review of Anaerobic Digestion as a waste management process on Island, including waste types, use for methane gases, collection systems and disposal of residues.

5. THE RISKS

5.1. There are no risks associated with the actions outlined in section 3. The actions will provide enhanced data and information to allow the Isle of Man to determine how best to manage its residual waste in the context of its aim for a net zero carbon emission by 2050.

6. CONCLUSION

6.1. The EfW Facility is a key part of the Island's National Waste Infrastructure. Its primary function is the safe disposal of residual household, commercial, industrial and clinical waste. The Island needs to maintain a strategic waste disposal capacity which meets the needs of the local industry and the population. This capacity needs to be flexible to accommodate fluctuations in economic activity and population and waste type.

6.2. Whilst in 2018 the Total Process Carbon Emission was 50,110 tpa CO_2, the total environmental impact/EfW footprint was only 3,594 tpa CO_2.

6.3. There are options in the short term for increasing the net electricity production of the EfW. Whilst technically not all of this electricity will be classified as renewable, practically, it will replace reliance upon electricity generated from combustion of fossil fuel via the power station.

6.4. Replacing the SWI will reduce GHG stack emissions.

6.5. There are other options for managing specific elements of the mixed waste stream (waste plastics and paper exported as refuse derived fuel, organic waste digested etc). Each of these options will incur associated carbon emissions which will need to be taken into account.

6.6. The current EfW contract expires in 2029. However it is extremely improbable that waste arisings by that time will have reduced to the extent the EfW as a method for disposing of mixed residual waste will not be required for 10-15 years beyond that date. Even taking account of the impact of any increased promotion of waste reduction; a wholesale move away from plastic packaging by the food and retail sector, with fossil fuel based plastics being replaced by, for example, PLA; promotion of recycling and increased access to household recycling schemes, including waste electrical and electronic equipment (WEEE) goods, there will remain a residual waste

within the household, commercial, industrial and clinical waste sectors that will require controlled disposal on Island.

6.7. A recent study into waste management on Islands acknowledged that "*Municipal solid waste (MSW) management is a controversial aspect of isolated environments, not only because the production of waste grows exponentially, but also because in these isolated regions the difficulties are accentuated in comparison with the mainland territories*" (Uche-Soria & Rodríguez-Monroy, 2019). It concluded that, in this context, "*use of a solution based on a waste to energy plant contributes to reducing GHG emissions, increases the rate of recycling and treats waste in a sustainable manner"*.

7. REFERENCES

Chartered Institution of Wastes Management. (2019). *The R1 Energy Efficiency Formula*. Retrieved 2019, from Chartered Institution of Wastes Management: https://www.ciwm.co.uk/ciwm/knowledge/the-r1-energy-efficiency-formula.aspx

Department of Energy & Climate Change. (2015). *Alternative approaches to reporting UK Greenhouse Gas Emissions.* Department of Energy & Climate Change.

Environment Agency. (2016). *Waste incinerator plant: apply for R1 status*. Retrieved 2019, from GOV.UK: https://www.gov.uk/guidance/waste-incinerator-plant-apply-for-ri-status

Environment Angency. (2014). *Waste: import and export*. Retrieved 2019, from Gov.uk: https://www.gov.uk/guidance/importing-and-exporting-waste

Isle of Man Government . (2016). *Isle of Man Government* . Retrieved 2019, from Department's Requirements Richmond Hill's Incinerator: https://www.gov.im/media/1364232/efw-departments-requirements-conformed-copy-september-2016.pdf

Isle of Man Government . (2018). *Isle of Man Government: Waste Strategy*. Retrieved 2019, from Isle of Man Government : https://www.gov.im/media/1362121/2018-approved-waste-strategy.pdf

Suez. (2019). *Isle of Man annual public report .* Suez.

Tynwald.org.im. (2019). *THE IMPORT AND EXPORT OF WASTE REGULATIONS 2000* . Retrieved 2019, from Tynwald.org.im: http://www.tynwald.org.im/links/tls/SD/2000/2000-SD-0695.PDF#search="import export waste"

Uche-Soria, M., & Rodríguez-Monroy, C. (2019). An Efficient Waste-To-Energy Model in Isolated Environments. Case Study: La Gomera (Canary Islands). *Sustainability*.

8. BIBLIOGRAPHY

Camilleri-Fenech, M et al	2019	'Where do islands put their waste? – A material flow and carbon footprint analysis of municipal waste management in the Maltese Islands' in Journal of Cleaner Production Volume 195, 10 September 2018, Pages 1609-1619	Available on line at:	https://www.sciencedirect.com/science/article/pii/S0959652617314853
Chartered Institution of Wastes Management	2019	On line Journal 'The R1 Energy Efficiency Formula'	Available on line at:	https://www.ciwm.co.uk/ciwm/knowledge/the-r1-energy-efficiency-formula.aspx
DEFRA	2019	Guidance 'Waste incinerator plant: apply for R1 status'	Available on line at:	https://www.gov.uk/guidance/waste-incinerator-plant-apply-for-ri-status Energy from Waste plants
DEFRA	2014	Guidance 'Waste: import and export'	Available on line at:	https://www.gov.uk/guidance/importing-and-exporting-waste
Department of Energy and Climate Change	2015	Alternative approaches to reporting UK Greenhouse Gas Emissions	Available on line at:	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/450542/Alternative_approaches_to_reporting_greenhouse_gas_emissions_report.pdf
Department of Infrastructure	2018	Waste Strategy	Available on line at:	https://www.gov.im/media/1362121/2018-approved-waste-strategy.pdf
Department of Infrastructure	2018	Pers Comm. Meeting with IOM DEFA re: the procurement of biomass as a supplementary feedstock		
Enviros Consulting	2008	Report: 'Isle of Man Organics Waste Strategy – Options Appraisal		
Enviros Consulting Limited	2007	Report 'Isle Of Man Government Two Season Waste Composition Survey July 2007'		
Eunomia	2019	'Initial Review of Isle of Man Documentation on Energy from Waste' WP 13(b) WP32		Email: 10 0ctober 2019
Isle of Man Government	2001	Public Health Act 1990, Import and Export of Waste Regulations Staturoty Document 51/01	Available on line at:	http://www.tynwald.org.im/links/tls/SD/2000/2000-SD-0695.PDF#search="import export waste"
Isle of Man Government	2000	Department's Requirements Richmond Hill Incinertor	Available on line at:	https://www.gov.im/media/1364232/efw-departments-requirements-conformed-copy-september-2016.pdf
M.E.L Research	2019	Report: 'Analysis of Isle of Man EfW Feedstock Summary Report February 2019'		
Suez Isle of Man Ltd	2018	2018 Annual Public Report	Available on line at:	http://www.suez.co.im/wp-content/uploads/2019/05/SUEZIOM-AnnualPublicReport-2018-web.pdf page 15
Uche-Soria, Manuel	2019	'An Efficient Waste-To-Energy Model in Isolated Environments. Case Study: La Gomera Canary Islands' Article in Sustainability 2019, 11(11), 3198;	Available on line at:	https://doi.org/10.3390/su11113198

Annex A

1. DATA PROVIDED TO THE CARBON TRUST AS PART OF SUEZ ACCREDITATION TO THE CARBON TRUST STANDARD.

OUTPUTS

	2016	2017	2018	
Total Process Carbon Emissions i.e. Total stack emission	49872	50927	49792	t_{CO2} p.a.
Total Process Non-Biogenic Carbon Emissions	15037	15280	15064	t_{CO2} p.a.
Total Process Carbon Equivalent Emissions	17684	18219	17545	t_{CO2} p.a.
Total Carbon Savings	10204	10438	10014	t_{CO2} p.a.
Total Footprint Emissions i.e. Total environmental impact	7480	7781	7530	tCO2 p.a.

Annex B

1. DECARBONISING THE WASTE FEEDSTOCK

1.1. The EfW contains a significant amount of combustible carbon rich feedstock (waste audit 2007 and 2019), much of which could have the potential to be recovered for recycling i.e. turned into a usable raw material or product.

1.2. However the potential for segregation of wastes for recycling is contingent upon a number of factor which are unique to the Isle of Man both as an island and as an independent jurisdiction and which have both carbon and fiscal considerations, for example:

- if, and where (Far East, Europe or UK etc.), recycling facilities are available for all material types (specifically plastics)
- the cost and carbon impact of transporting the waste material for recycling
- the gate fee for reprocessing
- the material specification for that material i.e. levels of contamination permitted
- the carbon impact and fiscal cost (local) of collecting the source segregated material for recycling, and preparing for recycling (mainly off island)
- the likely participation of the local population in a recycling scheme and level of capture of potentially recyclable material in that scheme
- the carbon impact and fiscal cost (local) of composting or digesting organic/food/green waste
- use on island for any composted organic product (mindful of stringent Animal By product Regulations)
- the Island cannot access the schemes in the UK for waste goods and packaging free take back, producer responsibility, or claim packaging recovery notes (PRN) or ePRNs for goods exported for recycling

1.3. The Isle of Man imports the majority of its goods. The Isle of Man has no control over how those goods are designed or packaged. To facilitate both a review of the waste stream composition over the next 10+ years, and an assessment of the need for, and carbon reduction benefit of, new schemes to remove wastes for recycling, an assumption needs to be made about the nature of that waste stream. Taking extremes, there will be:

- status quo in terms of waste composition/packaging types etc., and Isle of Man will therefore need to invest heavily to decarbonise by setting up new schemes to remove organics, plastics, paper waste from the waste stream for recycling; or
- a sea change in packaging/products with a move away from fossil fuel based plastics to a more sustainable combustible alternative, with a change in consumer demand leading to naturally lower carbon waste stream. This work is high on the agenda through Circular Economy/ EU legislation etc.

The Isle of Man will benefit by proxy from this change in product and packaging composition.