Attachment 1.1

27th April 2016 Cork Theoretical Model for R1 Calculations for Various Scenarios

Cork Theoretical Model for R1 calculation for various senarios

Waste Stream	Tonnes	CV (MJ/kg)	R1
Municipal Waste	180,000	9.65	
Hazardous Aqueous Waste	8,500	0	
Hazardous Solids	11,500	13	
Hazardous Sludges	4,000	1	0.707
Non Hazardous sludges	6,000	1	
Other Industrial wastes	30,000	16	
Total	240,000	9.902	

Waste Stream	Tonnes	CV (MJ/kg)	R1
Municipal Waste	195,000	9.65	
Hazardous Aqueous Waste	8,500	0	
Hazardous Solids	11,500	13	
Hazardous Sludges	4,000	1	0.719
Non Hazardous sludges	6,000	1	
Other Industrial wastes	15,000	16	
Total	240,000	9.505	

Waste Stream	Tonnes	CV (MJ/kg)	R1
Municipal Waste	210,000	9.65	
Hazardous Aqueous Waste	8,500	0	
Hazardous Solids	11,500	13	
Hazardous Sludges	4,000	1	0.724
Non Hazardous sludges	6,000	1	
Other Industrial wastes	-	16	
Total	240,000	9.108	

Proposed Cork Facility Theoretical Calculation

Total waste treated	240,000	**Tonnes**
Total electricity produced	156,056	**MWh**

	Type of energy	Unit	Tonne	NCV (kJ/kg)	Energy (MWh)
1.1	Adjusted amount incinerated waste		240,000	9,108	607,222
1.2	Amount sewage sludge		-		
1.3	Amount used activated carbon		-	-	-
2	**E_w Energy input of waste**	**MWh**			**607,222**
2.1 + 2.2	Ef: Light fuel oil used for startup / keeping temperature	tonne	194	42,000	2,263
2.3	Ef: Natural gas used		-	-	-
3	**Ef: Energy input by imported energy with steam**	**MWh**			**2,263**
3.1	Ei: Light fuel oil used for startup / shutdown	tonne	194	42,000	2,263
3.2	Ei: Natural gas used	-	-	-	-
3.3	Ei: imported electricity (multiplied with equivalence factor 2.6)	-	-	-	
3.4	Ei: imported heat	-	-	-	-
4	**Ei: Energy input by imported energy without steam**	**MWh**			**2,263**
4.1	Ep: Adjusted electricity produced and internally used for incineration process	MWh	19,710	-	156,056
4.2	Ep: electricity delivered to a third party	MWh	136,346	-	
5	**Ep: Electricity produced**	**MWh**	**156,056.11**		**156,056.11**
5.1 + 5.2	Ep: Heat exported	MWh	-	-	-
6	**Ep: Heat exported**	**MWh**	**-**	**-**	**-**
6.1 to 6.3	Ep: heat used internally for steam driven pumps, backflow, heating flue gas, liquid APC residues		-	-	-
6.4	Ep: for soot blowing without backflow		-	-	
6.5 to 6.7	Ep: for heating buildings, deaeration, NH4OH injection		-	-	-
7	**Ep: Heat used internally**	**MWh**	**-**	**-**	**-**
	Ep	**MWh**			**405,746**
	R1				**0.679**
	R1 with Climate Correction				**0.724**

Assumptions		
Availability	90%	
MWe Produced	19.8	MWe
CV of waste	9.108	MJ/kg
Internal use	2.5	MWe
Export of elec	17.3	MWe

NOTE: **There is no allowance in these figures for curtailment and hence the calculation is conservative in the estimation of the R1**

$$\text{Energy efficiency} = \frac{E_p - (E_f + E_i)}{0.97 * (E_w + E_f)}$$

In which:

E_p *means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2.6 and heat produced for commercial use multiplied by 1.1 (GJ/year)*
E_f *means annual energy input to the system from fuels contributing to the production of steam (GJ/year)*
E_w *means annual energy contained in the treated waste calculated using the net calorific value of the waste (GJ/year)*
E_i *means annual energy imported excluding E_w and E_f (GJ/year)*
0.97 *is a factor accounting for energy losses due to bottom ash and radiation*

In addition, Annex II of the WFD highlights that this formula shall be applied in accordance with the Reference Document on Best Available Techniques for Waste Incineration (BREF WI).

Proposed Cork Facility Theoretical Calculation

Total waste treated	240,000	**Tonnes**
Total electricity produced	161,622	**MWh**

	Type of energy	Unit	Tonne	NCV (kJ/kg)	Energy (MWh)
1.1	Adjusted amount incinerated waste		240,000	9,505	633,681
1.2	Amount sewage sludge		-		
1.3	Amount used activated carbon		-	-	-
2	**E_w Energy input of waste**	**MWh**			**633,681**
2.1 + 2.2	Ef: Light fuel oil used for startup / keeping temperature	tonne	194	42,000	2,263
2.3	Ef: Natural gas used		-	-	-
3	**Ef: Energy input by imported energy with steam**	**MWh**			**2,263**
3.1	Ei: Light fuel oil used for startup / shutdown	tonne	194	42,000	2,263
3.2	Ei: Natural gas used	-	-	-	-
3.3	Ei: imported electricity (multiplied with equivalence factor 2.6)	-	-	-	
3.4	Ei: imported heat	-	-	-	-
4	**Ei: Energy input by imported energy without steam**	**MWh**			**2,263**
4.1	Ep: Adjusted electricity produced and internally used for incineration process	MWh	19,710	-	161,622
4.2	Ep: electricity delivered to a third party	MWh	141,912	-	
5	**Ep: Electricity produced**	**MWh**	**161,622.00**		**161,622.00**
5.1 + 5.2	Ep: Heat exported	MWh	-	-	-
6	**Ep: Heat exported**	**MWh**	**-**	**-**	**-**
6.1 to 6.3	Ep: heat used internally for steam driven pumps, backflow, heating flue gas, liquid APC residues		-	-	-
6.4	Ep: for soot blowing without backflow		-	-	
6.5 to 6.7	Ep: for heating buildings, deaeration, NH4OH injection		-	-	-
7	**Ep: Heat used internally**	**MWh**	**-**	**-**	**-**
	Ep	**MWh**			**420,217**
	R1				**0.674**
	R1 with Climate Correction				**0.719**

Assumptions		
Availability	90%	
MWe Produced	20.5	MWe
CV of waste	9.505	MJ/kg
Internal use	2.5	MWe
Export of elec	18	MWe

NOTE: **There is no allowance in these figures for curtailment and hence the calculation is conservative in the estimation of the R1**

$$\text{Energy efficiency} = \frac{E_p - (E_f + E_i)}{0.97 * (E_w + E_f)}$$

In which:

E_p *means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2.6 and heat produced for commercial use multiplied by 1.1 (GJ/year)*

E_f *means annual energy input to the system from fuels contributing to the production of steam (GJ/year)*

E_w *means annual energy contained in the treated waste calculated using the net calorific value of the waste (GJ/year)*

E_i *means annual energy imported excluding E_w and E_f (GJ/year)*

0.97 *is a factor accounting for energy losses due to bottom ash and radiation*

In addition, Annex II of the WFD highlights that this formula shall be applied in accordance with the Reference Document on Best Available Techniques for Waste Incineration (BREF WI).

Proposed Cork Facility Theoretical Calculation

Total waste treated	240,000	**Tonnes**
Total electricity produced	165,564	**MWh**

	Type of energy	Unit	Tonne	NCV (kJ/kg)	Energy (MWh)
1.1	Adjusted amount incinerated waste		240,000	9,902	660,139
1.2	Amount sewage sludge		-		
1.3	Amount used activated carbon		-	-	-
2	**E_w Energy input of waste**	**MWh**			**660,139**
2.1 + 2.2	Ef: Light fuel oil used for startup / keeping temperature	tonne	194	42,000	2,263
2.3	Ef: Natural gas used		-	-	-
3	**Ef: Energy input by imported energy with steam**	**MWh**			**2,263**
3.1	Ei: Light fuel oil used for startup / shutdown	tonne	194	42,000	2,263
3.2	Ei: Natural gas used	-	-	-	-
3.3	Ei: imported electricity (multiplied with equivalence factor 2.6)	-	-	-	
3.4	Ei: imported heat	-	-	-	-
4	**Ei: Energy input by imported energy without steam**	**MWh**			**2,263**
4.1	Ep: Adjusted electricity produced and internally used for incineration process	MWh	19,710	-	165,564
4.2	Ep: electricity delivered to a third party	MWh	145,854	-	
5	**Ep: Electricity produced**	**MWh**	**165,564.00**		**165,564.00**
5.1 + 5.2	Ep: Heat exported	MWh	-	-	-
6	**Ep: Heat exported**	**MWh**	**-**	**-**	**-**
6.1 to 6.3	Ep: heat used internally for steam driven pumps, backflow, heating flue gas, liquid APC residues		-	-	-
6.4	Ep: for soot blowing without backflow		-	-	
6.5 to 6.7	Ep: for heating buildings, deaeration, NH4OH injection		-	-	-
7	**Ep: Heat used internally**	**MWh**	**-**	**-**	**-**
	Ep	**MWh**			**430,466**
	R1				**0.663**
	R1 with Climate Correction				**0.707**

Assumptions		
Availability	90%	
MWe Produced	21	MWe
CV of waste	9.902	MJ/kg
Internal use	2.5	MWe
Export of elec	18.5	MWe

NOTE: **There is no allowance in these figures for curtailment and hence the calculation is conservative in the estimation of the R1**

$$\text{Energy efficiency} = \frac{E_p - (E_f + E_i)}{0.97 * (E_w + E_f)}$$

In which:

E_p *means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2.6 and heat produced for commercial use multiplied by 1.1 (GJ/year)*

E_f *means annual energy input to the system from fuels contributing to the production of steam (GJ/year)*

E_w *means annual energy contained in the treated waste calculated using the net calorific value of the waste (GJ/year)*

E_i *means annual energy imported excluding E_w and E_f (GJ/year)*

0.97 *is a factor accounting for energy losses due to bottom ash and radiation*

In addition, Annex II of the WFD highlights that this formula shall be applied in accordance with the Reference Document on Best Available Techniques for Waste Incineration (BREF WI).