

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



# SAMPLE OF A EMISSION CALCULATION WASTE TO ENERGY

(in the origin are more detailed infos . also for 21 years)

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



### GENERAL INFORMATION

Country:

Region:

Town:

Inhabitants: 1,500,00

$$\text{Baseline Emissions} = BE_y = (MB_y - MD_{reg,y}) * GWP_{CH_4} + BE_{EN,y}$$

AF: 0,00%

RATE<sub>compliance,y</sub> 0,00%

Quantity of waste per year:	200,000 tons
-----------------------------	--------------

#### 7 YEARS

##### WASTE QUANTITIES

Year	Quantity
1	140.274
2	200.000
3	204.000
4	208.080
5	212.242
6	216.486
7	220.816
8	62.313

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



Waste type j	Proportion	kj%	DOCj (% wet waste)	Proportion (proposed)
Pulp, paper and cardboard	16,80%	0,07	40,00%	16,80
Textiles	2,50%	0,07	24,00%	2,50
Wood and wood products	6,50%	0,035	43,00%	6,50
Garden, yard, park waste	6,50%	0,17	20,00%	6,50
Food, Food waste	43,40%	0,40	15,00%	43,40
Glas, plastic, metal, inert	24,30%	0,00	0,00%	10,00
<b>TOTAL</b>	<b>100,00%</b>			

IPCC	DEFAULT	DOCj % wet waste	DOCj % dry waste
Pulp, paper and cardboard		40	50
Textiles		24	30
Wood and wood products		43	50
Garden, yard and park waste		20	49
Food, Food waste		15	38
Glas, plastic, metal, other inert waste		0	0

Model correction factor to correct for the model-uncertainties:	90%
Fraction of methane captured at the SWDS and flared, combusted or used in another manner:	0%
Global warming Potential of methane (tCO <sub>2</sub> e/tCH <sub>4</sub> e)	21
Oxidation factor:	0%
Fraction of methane in the landfill gas:	50%
Fraction of degradable organic carbon that can decompose:	50%
Methane correction fraction:	80%

Avoided Methan Gas Factor:	5,04
----------------------------	------

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



### METHANE GENERATION FROM THE LANDFILL

Amount of waste treated (tons)	140.274	200.000	204.000	208.080	212.242	216.486	220.816	62.313
Year	2011	2012	2013	2014	2015	2016	2017	2018
	1	2	3	4	5	6	7	8
2011	1							9.235
2012	2						32.725	24.087
2013	3					32.083	23.615	17.773
2014	4				31.454	23.152	17.424	13.437
2015	5			30.837	22.698	17.082	13.174	10.423
2016	6		30.233	22.253	16.747	12.915	10.219	8.295
2017	7	29.640	21.817	16.419	12.662	10.018	8.132	6.764
2018	8	20.789	15.302	11.516	8.881	7.026	4.744	4.035
<b>BE<sub>CH4, WSDS, y</sub> (CO<sub>2</sub>)</b>	<b>20.789</b>	<b>44.941</b>	<b>63.565</b>	<b>78.390</b>	<b>90.588</b>	<b>100.955</b>	<b>110.033</b>	<b>94.049</b>

### AMOUNT OF ELECTRICITY GENERATED BY GASIFICATION

	2011	2012	2013	2014	2015	2016	2017	2018
Fresh waste delivered:	140.274	200.000	204.000	208.080	212.242	216.486	220.816	62.313
Dried and sorted	37.874	54.000	55.080	56.182	57.305	58.451	59.620	16.824
Theoretical H <sub>u</sub> TOTAL (GJ)	530.236	756.000	771.120	786.542	802.273	818.319	834.685	235.541
Theoretical MW TOTAL	147.288	210.000	214.200	218.484	222.854	227.311	231.857	65.428
MW <sub>th</sub> - TOTAL	19,64	28,00	28,56	29,13	29,71	30,31	30,91	8,72
70% Energy Content of Gas	13,75	19,60	19,99	20,39	20,80	21,22	21,64	6,11
Energy used for Drying	1,72	2,45	2,50	2,55	2,60	2,65	2,70	0,76
MW <sub>th</sub> - TOTAL - NET	12,03	17,15	17,49	17,84	18,20	18,56	18,93	5,34
MW <sub>e1</sub> - TOTAL - NET	4,57	6,52	6,65	6,78	6,92	7,06	7,20	2,03
<b>MWh</b>	<b>34.302</b>	<b>48.907</b>	<b>49.885</b>	<b>50.883</b>	<b>51.900</b>	<b>52.938</b>	<b>53.997</b>	<b>15.238</b>

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



### BASELINE EMISSIONS FROM GENERATION OF ENERGY DISPLACED BY THE PROJECT

Grid Emission Factor for:

Carbon Emission factor for the displace electricity source in the project scenario (tCO<sub>2</sub>/MWh):

**COUNTRY**

**0,6300**

Year	MWh	
	EG <sub>d,y</sub>	BE <sub>EN,y</sub>
2011	34.302	21.610
2012	48.907	30.811
2013	49.885	31.428
2014	50.883	32.056
2015	51.900	32.697
2016	52.938	33.351
2017	53.997	34.018
2018	15.238	9.600

### FUEL CONSUMPTION FOR WASTE COLLECTION

Type of vehicles	Number of vehicles	Power	Distance (km/day)	Consumption of diesel (l/100 km)	Consumption (liters/day)	Days of operation/ week	Total consumption (l/year)
Truck	1	13CV	150	12	18	6	5.616
Truck	5	11CV	100	10	10	6	15.600
Truck	1	12CV	200	11	22	6	6.864
Truck	2	08CV	300	9	27	6	16.848
Truck	1		300	13	39	6	12.168
Truck	1		200	14	28	6	8.736
<b>TOTAL</b>	<b>11</b>						<b>65.832</b>

= 180 l/day

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



### EMISSION FROM COMPOSTING

Share of waste degrades: 5,0

COMPOST QUANTITIES	
Year	Quantity
2011	70.137
2012	100.000
2013	102.000
2014	104.040
2015	106.121
2016	108.243
2017	110.408
2018	31.156
2018	112.616

Amount of waste treated (tons)	70.137	100.000	102.000	104.040	106.121	108.243	110.408	31.156
	2011	2012	2013	2014	2015	2016	2017	2018
Year	1	2	3	4	5	6	7	8
2011	1							4.617
2012	2						16.362	12.044
2013	3					16.042	11.808	8.886
2014	4				15.727	11.576	8.712	6.719
2015	5			15.419	11.349	8.541	6.587	5.211
2016	6		15.116	11.127	8.374	6.458	5.109	4.147
2017	7	14.820	10.908	8.210	6.331	5.009	4.066	3.382
2018	8	10.394	7.651	5.758	4.440	3.513	2.852	2.018
<b>BE<sub>CH4, WSDS, y</sub> (CO<sub>2</sub>)</b>	<b>10.394</b>	<b>22.471</b>	<b>31.783</b>	<b>39.195</b>	<b>45.294</b>	<b>50.477</b>	<b>55.016</b>	<b>47.024</b>

# EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



## PROJECT EMISSIONS

Emissions from waste water released ( $PE_{CH_4,w,y}$ )

$$PE_{CH_4,w,y} = Q_{COD,y} * P_{COD,y} * B_0 * MCF_p$$

$PE_{CH_4,w,y}$ tCO <sub>2</sub> e	$Q_{COD,y}$ m <sup>3</sup> /year	$P_{COD,y}$ tCOD/m <sup>3</sup>	$B_0$ kg CH <sub>4</sub> /kg COD	$MCF_p$ fraction
0	0,0	0,00	0,000	0,0
0	0,0	0,00	0,000	0,0
0	0,0	0,00	0,000	0,0
0	0,0	0,00	0,000	0,0
0	0,0	0,00	0,000	0,0
0	0,0	0,00	0,000	0,0
0	0,0	0,00	0,000	0,0
0	0,0	0,00	0,000	0,0

Emissions from anaerobic digestion ( $PE_{a,y}$ )

$PE_{a,1,y}$ tCO <sub>2</sub> e	$P_1$ Fraction	$M_{a,y}$ t CO <sub>2</sub>	$PE_{g,i,y}$ tCO <sub>2</sub> e	$P_2$ Fraction	$M_{g,y}$ t CO <sub>2</sub>	$PE_{a,s,y}$ tCO <sub>2</sub> e	$PE_{y,a} = PE_{a,1,y} + PE_{a,s,y}$												
							N <sub>2</sub> O emissions t CO <sub>2</sub>	CH <sub>4</sub> emissions t CO <sub>2</sub>	GWP N <sub>2</sub> O	GWP CH <sub>4</sub>	N <sub>2</sub> O emissions t N <sub>2</sub> O	EF N <sub>2</sub> O	CH <sub>4</sub> emissions t CH <sub>4</sub>	EF CH <sub>4</sub>	Energy TJ	NCV Biogas TJ/Gg of	Biogas tons	Methane density tCH <sub>4</sub> /m <sup>3</sup> CH <sub>4</sub>	Biogas m <sup>3</sup>
0	0%	51.481	0	0%	51.481	26	4,32	21,6	210	21	0,021	0,1	1,03	5,0	206	50,4	4.086	0,0007168	5.700.000
0	0%	68.641	0	0%	68.641	35	5,77	28,8	210	21	0,027	0,1	1,37	5,0	275	50,4	5.448	0,0007168	7.600.000
0	0%	102.961	0	0%	102.961	52	8,65	43,2	210	21	0,041	0,1	2,06	5,0	412	50,4	8.172	0,0007168	11.400.000
0	0%	102.961	0	0%	102.961	52	8,65	43,2	210	21	0,041	0,1	2,06	5,0	412	50,4	8.172	0,0007168	11.400.000
0	0%	102.961	0	0%	102.961	52	8,65	43,2	210	21	0,041	0,1	2,06	5,0	412	50,4	8.172	0,0007168	11.400.000
0	0%	102.961	0	0%	102.961	52	8,65	43,2	210	21	0,041	0,1	2,06	5,0	412	50,4	8.172	0,0007168	11.400.000
0	0%	25.740	0	0%	25.740	13	2,16	10,8	210	21	0,010	0,1	0,51	5,0	103	50,4	2.043	0,0007168	2.850.000

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



Emissions from fuel use on-site (PE <sub>FC,y</sub> )					Emissions from composting (PE <sub>c,y</sub> )						
PE <sub>FC,j,y</sub> = F <sub>cons,y</sub> * NCV <sub>fuel</sub> * EF <sub>fuel</sub>					PE <sub>c,y</sub> = PE <sub>c,N20</sub> + PE <sub>c,CH4,y</sub>						
PE <sub>FC,y</sub>	Fuel Cons	Fuel Dens	NCV <sub>fuel</sub>	EF <sub>fuel</sub>	PE <sub>c,N20,y</sub>	M <sub>compost,y</sub>	EF <sub>c,N20</sub>	PE <sub>c,CH4,y</sub>	MD <sub>compost,y</sub>	S <sub>a,y</sub>	
tCO <sub>2</sub>	l/year	t/l	TJ/t	tCO <sub>2</sub> /TJ	tCO <sub>2</sub>	tons/yr	t N <sub>2</sub> O/t comp	tCO <sub>2</sub> e	tCH <sub>4</sub>	%	
542	46.173	0,00088	0,043	74,1	1.143	935	70.137	0,000043	208	495	2%
773	65.832	0,00088	0,043	74,1	1.782	1.333	100.000	0,000043	449	1.070	2%
773	65.832	0,00088	0,043	74,1	1.995	1.360	102.000	0,000043	636	1.513	2%
773	65.832	0,00088	0,043	74,1	2.171	1.387	104.040	0,000043	784	1.866	2%
773	65.832	0,00088	0,043	74,1	2.320	1.415	106.121	0,000043	906	2.157	2%
773	65.832	0,00088	0,043	74,1	2.452	1.443	108.243	0,000043	1.010	2.404	2%
773	65.832	0,00088	0,043	74,1	2.572	1.472	110.408	0,000043	1.100	2.620	2%
218	18.577	0,00088	0,043	74,1	1.356	415	31.156	0,000043	940	2.239	2%
5.396					15.792	9.759			6.033		

## PROJECT EMISSIONS - TOTAL

Units	PE <sub>y</sub>	PE <sub>elec,y</sub>	PE <sub>FC,y</sub>	PE <sub>c,y</sub>	PE <sub>a,1,y</sub>	PE <sub>flare,y</sub>	PE <sub>w,CH4,y</sub>
	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e
2011	2.341	630	542	1.143	0	26	0
2012	2.590	0	773	1.782	0	35	0
2013	2.820	0	773	1.995	0	52	0
2014	2.995	0	773	2.171	0	52	0
2015	3.145	0	773	2.320	0	52	0
2016	3.277	0	773	2.452	0	52	0
2017	3.397	0	773	2.572	0	52	0
2018	1.587	0	218	1.356	0	13	0
<b>TOTAL 7 YEARS</b>	<b>22.151</b>	<b>630</b>	<b>5.396</b>	<b>15.792</b>	<b>0</b>	<b>333</b>	<b>0</b>

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



### LEAKAGE EMISSIONS FROM INCREASED TRANSPORT

Type of vehicles	Fuel consumption	NO <sub>vehicle,i,y</sub>	Distance	Daily	Annual
TRUCK	16,3	10	100	16,3	5.086
TRUCK	16,8	10	100	16,8	5.242
TRUCK	34,5	10	100	34,5	10.764
TRUCK	36,7	2	20	7,34	2.290
<b>TOTAL</b>		<b>32</b>			<b>23.381</b>

= 64 l/day

	L <sub>y</sub>	L <sub>t,y</sub>	L <sub>r,y</sub>	L <sub>s,y</sub>	L <sub>t,y</sub>	Fuel Cons.	Fuel Dens.	NCV <sub>fuel</sub>	EF <sub>fuel</sub>
Units	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> e	tCO <sub>2</sub> /year	l/year	t/L	TJ/t	TCO <sub>2</sub> /TJ
2011	192	192	0	0	192	16.399	0,00088	0,043	74,1
2012	274	274	0	0	274	23.381	0,00088	0,043	74,1
2013	274	274	0	0	274	23.381	0,00088	0,043	74,1
2014	274	274	0	0	274	23.381	0,00088	0,043	74,1
2015	274	274	0	0	274	23.381	0,00088	0,043	74,1
2016	274	274	0	0	274	23.381	0,00088	0,043	74,1
2017	274	274	0	0	274	23.381	0,00088	0,043	74,1
2018	77	77	0	0	77	6.598	0,00088	0,043	74,1
<b>TOTAL 7 YEARS</b>	<b>1.917</b>	<b>1.917</b>	<b>0</b>	<b>0</b>	<b>1.917</b>				

## EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



### EMISSION REDUCTION - SUMMARY

Baseline Emission			Project Emissions						Leakage		
BE <sub>y</sub>	M <sub>b,y</sub>	BE <sub>EN,y</sub>	PE <sub>elec,y</sub>	PE <sub>FC,y</sub>	PE <sub>c,y</sub>	PE <sub>a,1,y</sub>	PE <sub>a,s,y</sub>	PE <sub>w,CH4,y</sub>	L <sub>t,y</sub>	L <sub>r,y</sub>	L <sub>s,y</sub>
42.399	20.789	21.610	630	542	1.143	0	26	0	192	0	0
75.753	44.941	30.811	0	773	1.782	0	35	0	274	0	0
94.993	63.565	31.428	0	773	1.995	0	52	0	274	0	0
110.446	78.390	32.056	0	773	2.171	0	52	0	274	0	0
123.285	90.588	32.697	0	773	2.320	0	52	0	274	0	0
134.306	100.955	33.351	0	773	2.452	0	52	0	274	0	0
144.051	110.033	34.018	0	773	2.572	0	52	0	274	0	0
103.649	94.049	9.600	0	218	1.356	0	13	0	77	0	0
<b>828.881</b>	<b>603.310</b>	<b>225.571</b>	<b>630</b>	<b>5.396</b>	<b>15.792</b>	<b>0</b>	<b>333</b>	<b>0</b>	<b>1.917</b>	<b>0</b>	<b>0</b>

Year	ER <sub>y</sub>	BE <sub>y,a</sub>	PE <sub>y</sub>	L <sub>y</sub>
2011	39.865	42.399	2.341	192
2012	72.889	75.753	2.590	274
2013	91.898	94.993	2.820	274
2014	107.177	110.446	2.995	274
2015	119.866	123.285	3.145	274
2016	130.755	134.306	3.277	274
2017	140.380	144.051	3.397	274
2018	101.984	103.649	1.587	77
<b>TOTAL</b>	<b>804.814</b>	<b>828.881</b>	<b>22.151</b>	<b>1.917</b>
<b>ANNUAL AVERAGE</b>	<b>114.973</b>			

# EMISSION REDUCTION CALCULATION

Country:

Town:

© 2011, Change Energy Int.



<b>CREDITING PERIOD 7 YEARS</b>	<b>828.881 Baseline emissions (7 years)</b>
	<b>22.151 Project emissions (7 years)</b>
	<b>1.917 Leakage emissions (7 years)</b>
	<b>804.814 EMISSION REDUCTIONS 7 YEARS</b>

**€ 10,-- / CER = € 8,048,140,-- in 7 years**

