Methane emissions from solid waste disposal sites

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Summary

Norway has developed a new national model for calculating methane emissions from solid waste disposal sites (SWDS). This model has been used to recalculate the emissions for 2002. They are 45.6 % lower than they would have been using the old model. The reasons for this substantial reduction are:

A. Plastics are no longer considered to be degradable/dissimilatable materials.
B. The fraction of methane in generated landfill gas has been lowered to the IPCC default value of 50 %.
C. The FOD (First Order Decay) calculating equation has been corrected.
D. Due to new knowledge especially about the dissimilating part of wood, DOCf (The part of DOC (Degradable Organic Carbon) that dissimilates under anaerobic conditions), has been substantially lowered.

The new calculating model is in full compliance with the *Revised IPCC 1996 Guidelines for National Greenhouse Gas inventories* and the *IPCC Good Practice Guidance and Uncertainty management in National Greenhouse Gas Inventories* as approved by the UNFCC, with the mathematics of the first order reaction corrected. The model consists of a very simple Excel workbook. Yearly calculations are being done in single lines in 6 worksheets. To make it comply with the new material-based waste statistics from Statistics Norway, the new model too is material-based (food waste, paper, wood and textiles).

The new model is very simple to use, also for prognosis-making.

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1 Introduction

The former Norwegian model for calculating methane emissions from solid waste disposal sites (SWDS) is from 1999. It was a pioneer work, mainly built on the IPCC (Intergovernmental Panel on Climate Change) Guidelines from 1996. Data for landfilled waste was established back to 1945, and an Excel workbook model was developed to do the yearly calculations.

When doing the calculations for 2002, it became apparent that the model needed revising. The main reasons were:

a. The model was based on landfill data for three different waste categories. After 1999, Statistics Norway had changed its waste statistics from waste category to material. Hence, Statistics Norway had to rearrange data to make them fit the model
b. The model counted plastics in as degradable materials.
c. Based on analysis of landfill gas, the methane fraction had been set to 55 %. The amount of CO_2 being absorbed in the seepage water had not been taken into account.
d. The rate of reaction equation (Equation 16, page 53, SFT report 99:16) had not been integrated for calculating mass over the time period, and therefore gave erroneous emission calculations.
e. The workbook model was very complicated, with a poor view of the actual calculations in the model.

At a late stage of the work with the model, it was also realized that there was a need to change the parameter DOCf (the part of DOC that will dissimilate under anaerobic conditions). New knowledge, especially about dissimilation of wood, has shown that DOCf set at 0.7 would be too high.

As a part of the review of the model, a new and much simpler worksheet model has been developed. It is being used for the calculations of the 2003 methane emissions, with recalculations back to 1945.

This report documents the changes and recalculations that have been made. Section 2 is about the recalculations from waste category to materials. Section 3 is about the changes made to parameters and section 4 deals with the mathematics of the First Order Decay (FOD) model. In section 5 the new worksheet model is described.

2 Recalculation from waste categories to materials

2.1 General

The Norwegian model is documented in an SFT report (SFT 99:16 (not translated to English)). Tables 2 and 4, pages 29 and 30, contain information about the material composition for household waste and business waste. The material composition was used to calculate the average TOC (Total Organic Carbon) for the two waste categories. The third waste category, industrial waste, consists almost entirely of wood and bark.

For the new model the information from tables 2 and 4 is being used to calculate waste material amounts from the waste category amounts in the original model. These recalculations are quite straight forward, but some adjustments had to be made. The term DOC (Degradable Organic Carbon) is in this report also being used also where SFT report 99:16 uses TOC (Total Organic Carbon).

2.2 Textiles

An SFT report from 1996 (SFT 96:16) estimates the part of plastics in textiles to be 50 %. Hence, half the amount of textiles is subtracted and added to plastics. In tables 2 and 4, DOC for textiles is set at 0.500 (gram DOC/gram material). This too is only possible with a large part of synthetic polymers. For the recalculations, DOC = 0.400 is used for textiles.

2.3 Wood

Wood has not been consistently reported as wood through the entire time series. Paper, food waste, textiles and plastics are reported, and wood partly, and there is a fraction named “burnable”. As the other burnable materials are specifically reported, this fraction is considered to be all wood. The “burnable” has been given a lower DOC than wood. This is being solved by recalculating the amount of material with low DOC into a smaller amount of material with the higher DOC of wood (0.400). The same applies for the industrial wood and bark fillings, and a small fraction of “fine particles” in household waste. They have also been recalculated into smaller amounts of wood with the higher DOC.

There is a special problem with the industrial wood and bark landfills. While the same MCF (Methane Correction Factor. MCF varies with the condition of landfills) has been used for all categories of waste from 1945 to 1980, MCF has been kept at 0.8 for the industrial landfills, while it was increased to 1 for the SWDS for household and business waste from 1980. Therefore a weighted average MCF has been calculated for wood from 1980 to 2002. This weighted average has been close to 0.95 for the last few years, and for material landfilled from 2003, MCF is set at 1 for all wood.

2.4 Worksheet

The recalculations from waste category into materials are to be found in Workbook “Materialrecalc”.

3 Parameters

3.1 Plastics

The amounts of plastics landfilled are kept in the worksheets, but DOCf (The dissimilating part of DOC) is set at 0. In the workbook, the yearly amount of plastics being landfilled, is used to calculate the amount of plastics accumulated in SWDS.

3.2 The methane content in generated landfill gas

In the former Norwegian model, the methane content in generated landfill gas had been set to 55 %, based on analysis of landfill gas. Then the CO_2 absorption in the seepage water is not accounted for. In the dump there is ½ atm driving force for CO_2 absorption due to the atmosphere containing 50 % CO_2, and the landfill is at a neutral state favoring forming of bicarbonate. Seepage water from landfills often foams vigorously.

Without running a full CO_2 mass balance, results from landfill gas analysis should not be used. Not far from 90 % of the degradable material in the landfill is cellulose/hemicellulose, giving a theoretical composition of the generated landfill gas of 50 % CH_4 / 50 % CO_2. To move the generated gas composition considerably away from this 50/50 condition, there would have to be considerable amounts of fat in the dump.

Also IPCC has 50 % methane in generated landfill gas as the default value. The reviewed Norwegian model has accepted the IPCC default value, meaning F = 0.5.

References: 1. HBergman, Teniska høgskolan i Luleå, Licentiatuppsats 1995:14L. (in Swedish) 2. Fischer, Albrecht and Kämpfe in Kämpfer and Weissenfels, Biologische Behandlung organischer Abfälle Springer 2001 (in German). 3. IPCC 1996 Guidelines, Reference Manual, part 6.2.2. 4. M Barlaz, ncasi Technical Bulletin no 872, March 2004.

3.3 Half-life times

Half-life times for the different waste categories were based on half-life times for different materials, reported in SFT-report 96:16. With the new model we revert to the half-life time for materials from that report. As of now, we have little new information about half-life times. Hence, the half-life times we use in the new material based model are:

Food waste:	2.8 years
Paper:	8.4 years
Wood	10.5 years
Textiles	10.5 years

3.4 Methane Correction Factor (MCF)

In unmanaged and shallow landfills, a larger part of the landfilled materials is degraded under aerobic conditions. MCF is the part left to degrade under anaerobic conditions. It has not been altered in the historic calculations. It was set at 0.4 from 1945 to 1969 and at 0.8 from 1970 to

1979 for all waste categories. From 1980 it has been 1.0 for household and business waste, and 0.8 for industrial waste (see section 2.3). From 2003 MCF is set at 1 for all materials.

3.5 Other factors

The former model recalculated mass DOC dissimilated to volume landfill gas, and recalculated volume landfill gas to mass CH_4 emitted at the end. These recalculations are not necessary, and are omitted from the new model. The factor transforming dissimilated DOC to methane gas produced, will then be F*16/12, where F is the fraction of methane in generated landfill gas and 16/12 is the mole weight ratio between methane and carbon.

4 The mathematics of the new model

4.1 Basic FOD theory

Here a new term is introduced: DDOC. DDOC stands for Dissimilatable Organic Carbon, and is the DOC (Degradable Organic Carbon) that actually will degrade (dissimilates) under anaerobic conditions.

The basis for a FOD reaction is a reaction starting with the full amount of reactant, going with a constant reaction rate, -k, related to the amount of the reactant, here DDOCm (DDOC mass). The amount of DDOCm, dDDOCm, reacted over a period of time dt is then described by this differential equation:

(1) dDDOCm = -k * DDOCm *dt

Solved between 0 and t for time, and DDOCmo (DDOCm at time 0) and DDOCm for the amount of DDOCm, the solution to the differential equation is:

(2) DDOCm = DDOCmo * e^-kt

This is the basic first order reaction equation.

The amount of DDOCm dissimilated into CH_4 and CO_2 can easily be found just by analyzing equation (2). It states that from a reaction start with a full amount of DDOCm, DDOCmo at point 0 when e^-kt = 1, the amount is decreased to DDOCmo * e^-k(*1) after one year. This means the amount of DDOCm dissimilated is DDOCmo * (1- e^-k), or as the general equation:

(3) DDOCmdiss(t) = DDOCmo (e^-k(t-1) - e^-kt)

It can be of interest to note that equation (2) is analogous to the compound interest equation, with negative interest rate.

4.2 The rate of reaction approach

The most common way of looking at the mass transformation in a chemical reaction, is starting with the rate of reaction equation. As the amount of reactant DOCm is known, the rate of reaction equation can easily be formed:

(4) DDOCmdiss reaction rate = k * DDOCmo * e^-kt

The rate of reaction equation shows the rate of reaction at any time. But, as the rate of reaction follows the e^-kt curve, the rate of reaction equation has to be integrated to find the amount of reacted DOCm over a period of time. (DDOCmdiss reaction rate = dDDOCmdiss/dt)

However, there is one minor obstacle to the integration in this case. We want to find the amount of DDOCm dissimilated into CH_4 and CO_2 per calender year. The start is year number 1 going from point 0 to point 1 on the time axis. Year number 1 is associated to point

1 on the time axis. Therefore the integration has to be performed from t-1 to t, and the correct form of the integrated rate of reaction equation (4) is:

(5) = (3) DDOCmdiss(t) = DDOCmo * (e^-k(t-1) - e^-kt)

Equations (1) to (5) are all related to reaction start on January 1 in the year after landfilling. However, equations (4) and (5) can also easily be transformed to meet the requirements for start of reaction in the year of landfilling. It is done by moving the e^-kt curve along the time axis. For reaction start on the first of October, equation (5) will be transformed into this:

(6) DDOCmdiss reaction rate = k * DDOCmo * e^-k(t+0,25)

Then there will be two integrated solutions, one for the year of landfilling and one for the rest of the years:

(7) DDOCmdi = DDOCmo * (1 - e^-0,25k)
(8) DDOCmdiss(t) = DDOCmo * (e^-k(t-0,75) - e^-k(t+0,25))

Where:

t = year, referring to point t on the time axis where year 1 is the year after landfilling.
DDOCmdi = DDOC mass dissimilated in year of landfilling
DDOCmdiss(t) = DDOC mass dissimilated in year t.

4.3 k and half-life time

To find half-life time, $t_{1/2}$ and DDOCm = ½DDOCmo are put into equation (2)

$$½ \text{ DDOCmo} = \text{DDOCmo} * e^{-kt_{1/2}}$$

Solving this equation, one finds:

$$t_{1/2} = \ln(2)/k \quad \text{or} \quad k = \ln(2)/t_{1/2}$$

4.4 Equation 16, SFT report 99:16

In SFT report 99:16, equation 16 is used for methane production calculations to calculate the amount of DDOCm dissimilating in one year. In a simplified basic form equation 16 looks like this:

(9) DDOCmdiss(t) = k * DDOCmo * e^-kt

However, this is the rate of reaction equation, and the annual methane production is calculated from the rate of reaction at the end of the year. This means that the calculations are too low. With a half-life time of 10 years the former Norwegian model calculates results that are close to 3.5 % too low.

As equation 16 in the Norwegian model is equivalent to equation 4, chapter 6 in the annex of the IPCC Guidelines from 1996, this also means that the IPCC 1996 model calculates methane emissions that are close to 3,5 % too low with a half-life time of 10 years.

4.5 New model versus exact model

Both the former and the new model work as if the full amount of DDOCm, DDOCmo is being landfilled at the same time. This is not correct. Landfilling starts at the beginning of the year and recording stops at the end. With a linear landfilling rate, the average holding time in the landfill is half a year before reaction is set to start.

However, the model presented here can also be used to run day-by-day calculations on DDOCm dissimilated and DDOCm accumulated in the landfill. This has been done for the year of landfilling. Those calculations show that with a half-life time of 10 years, the day-by-day calculations give the same results as using the model presented here with reaction start set only 1 day away from midyear. With a half-life time of 3 years our chosen model is 3.5 days away from the model giving exact calculations.

One main advantage of the model presented here, is its simplicity. Then an accuracy of 1 to 3.5 days can easily be sacrificed to keep the simplicity of the worksheets. This will especially be true because there is a process delay time from landfilling to full rate of methane production. We have little exact knowledge about this delay time. For Norway it is set at half a year, with a full reaction start on January 1 the year after landfilling. This is also as recommended by IPCC. But the uncertainty level of this delay time is at least ± 2 months.

5 The new worksheet model

5.1 Model basics

The new model starts with the calculation of the amount of dissimilating DDOC mass contained in the amount of landfilled material (DDOCmd). Calculations are the same as in the former model. This amount feeds the "motor" of the new model.

As this is a first order reaction, the amount of product formed will always be proportional to the amount of reactant. This means that it is of no concern to the process when the DDOC came into the landfill. In so far as we know the amount of DDOC mass in the landfill at the start of the year, all years can be considered to be the first calculating year. This simplifies calculations. With reaction start set at January 1 the year after landfilling, the "motor" of the new calculating model has been made out of these two very simple equations:

(I) DDOCmdiss = (DDOCma(ly) + DDOCmd) * (1- e^-k)
(II) DDOCma = (DDOCma(ly) + DDOCmd) * e^-k

Equation (I) calculates DDOCm dissimilating, from not dissimilated DDOC mass accumulated from last year, plus DDOC mass landfilled last year. Equation (II) calculates the DDOC mass accumulated as not dissimilated for next year's calculations, from the same basis as equation (I).

If the reaction is set to start in the year of landfilling, separate calculations have to be made for that year, and two extra calculating equations will have to be added. For these, see section 5.2.

After the amount of dissimilated DDOCm is found, CH_4 produced and CH_4 emitted is found using the same set of procedures and factors as the former model.

By doing it this way, one year's calculations can be done in single lines in worksheets in an Excel workbook. One sheet is used for each material, and one sheet for inventory input and the final methane emission calculation. (Workbook: "N2003CH4emission")

The full set of equations is to be found in section 5.2 below and in the workbook. The figure in appendix 1 illustrates how the model works with reaction start on January 1st in the year after landfilling. Equations number I and II in the figure refer to equations I and II above, while equations A, F and G refer to A, F and G below.

5.2 Equations

To calculate DDOCmd from the amount of material

(A) DDOCmd = W * MCF * DOC * DOCf

To calculate DDOCm accumulated in the SWDS

(B) DDOCml = DDOCmd * e^-k*((13-M)/12)
(C) DDOCma = DDOCma(ly) * e^-k + DDOCml

To calculate DDOCm dissimilated

(D) DDOCmdi = DDOCmd * (1-e^-k*((13-M)/12))
(E) DDOCmdiss = DDOCma(ly) * (1-e^-k) + DDOCmdi

To calculate methane produced from DDOC dissimilated

(F) CH_4 prod = DDOCmdiss (m/c) * F * 16/12

To calculate methane emitted

(G) CH_4 emitted in year T = ($\sum$ CH_4 prod (T)) - R(T)) * (1-OX)

Where:

W = amount landfilled
MCF = Methane Correction Factor
M = Month number for reaction start. (January 1, year after landfilling, M=13)
DOC = Degradable Organic Carbon
DOCf = Fraction of DOC dissimilating under anaerobic conditions
DDOC = Dissimilatable Organic Carbon, anaerobic conditions
DDOCmd = DDOC mass landfilled
DDOCml = DDOC mass left not dissimilated from DDOCm landfilled, year of landfilling
DDOCma = DDOC mass left not dissimilated at end of year
DDOCma(ly) = DDOC mass accumulated from last year
DDOCmdi = DDOC mass dissimilated from DDOCm landfilled, year of landfilling
DDOCmdiss = DDOC mass dissimilated in calculation year
CH_4 prod = CH_4 produced
F = Fraction of CH_4 by volume in generated landfill gas
16/12 = Conversion factor from C to CH_4
R(T) = Recovered CH_4 in year of calculation
OX = Oxidation factor (fraction)
CH4 emitted in year T - Mg/year

In spreadsheet 11 the amount of plastics accumulated in the SWDSs is calculated:

Pm = Wp * TOCp/TOCdcp

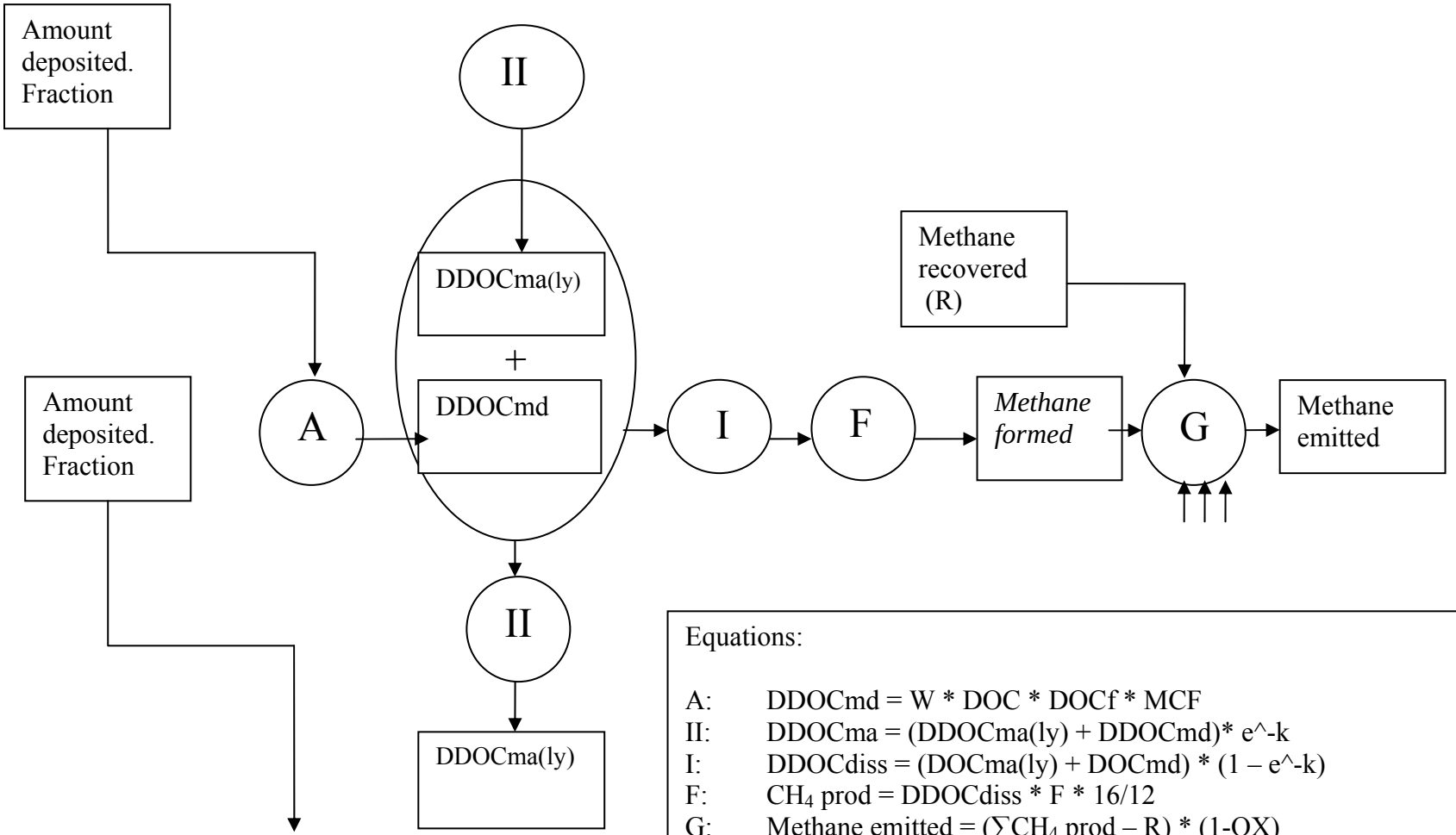
where
Pm = Amount of dry, clean plastics into the landfill
Wp = Reported amount of plastics landfilled
TOCp = TOC in reported plastics
TOCdcp = TOC in dry, clean plastics

6 Results

A new, simplified worksheet model for calculating methane emissions from SWDS (Solid Waste Disposal Sites) has been developed. The model is especially well suited for prognosis-making. An Excel copy has been made available on internet together with this report. Organisations and individuals who wish to do so, will then be able to make methane emission prognoses based on their own scenarios of materials being landfilled. Other countries are welcome to evaluate and eventually use the model.

The new model for calculating methane emissions lowers the emissions for 2002 by 45.6 % compared to the former calculating model. In metric tons the drop is from 183 844 tons according to the former model, to 99 975 tons calculated by the new model (Sheet 4 in the workbook "N2003CH4emission"). The new model also shows a more rapid decline in methane emissions from SWDS after 1990, than the former model did.

For year 2003 the methane emission from SWDS has been calculated to 97 584 tons.



Equations:

A: DDOCmd = W * DOC * DOCf * MCF
II: DDOCma = (DDOCma(ly) + DDOCmd)* e^-k
I: DDOCdiss = (DOCma(ly) + DOCmd) * (1 – e^-k)
F: CH_4 prod = DDOCdiss * F * 16/12
G: Methane emitted = ($\sum CH_4$ prod – R) * (1-OX)

Appendix 1. Calculating method illustrated graphically.

Methane emissions from solide waste disposal sites

Norway

1945 to 2003

Contents:

Sheet 2: The mathematics of the model, equations
Sheet 3: Parameters
Sheet 4: Input of material amounts and final result
Sheet 5: Food waste calculations
Sheet 6: Paper calculations
Sheet 7: Wood calculations
Sheet 8 Testile calculations
Sheet 9: Accumulation of plastics
Sheet 10: Comparing results from former and new model

The mathematics of the spreadsheets

The equations used in these spreadsheets are:

To calculate DDOCmd from amount of material
(A) DDOCmd = W * MCF * DOC * DOCf
To calculate DDOCm accumulated in the SWD
(B) DDOCml = DDOCmd * e^-k*((13-M)/12)
(C) DDOCma = DDOCma(ly) * e^-k + DDOCml
To calculate DDOCm dissimilated
(D) DDOCmdi = DDOCmd * (1-e^-k*((13-M)/12))
(E) DDOCmdiss = DDOCma(ly) * (1-e^-k) + DDOCmdi
To calculate methane produced form DDOC dissimilated
(F) CH4 prod = DDOCmdiss * F * 16/12
To calculate methane emitted
(G) CH4 emitted in year T = (∑ CH4 prod (T)) - R(T)) * (1-OX)
Where:

W = amount deposited
MCF = Methane Correction Factor
M = Month number for reaction start. (January 1, year after deposition, M=13)
DOC = Degradable Organic Carbon
DDOC = Dissimilatable Organic Carbon, anaerobic conditions
DOCf = Fraction of DOC dissimilatable, anaerobic conditions
DDOCmd = DDOC mass deposited
DDOCml = DDOC mass left not dissimilated from DDOCm deposited, year of deposition
DDOCma = DDOC mass left not dissimilated at end of year
DDOCma(ly) = DDOC mass accumulated from last year
DDOCmdi = DDOC mass dissimilated from DDOCm deposited, year of deposition
DDOCmdiss = DDOC mass dissimilated in calculation year
CH4 prod = CH4 produced
F = Fraction CH4 by volume in generated landfill gas
16/12 = Conversion factor from C to CH4
R(T) = Recovered CH4 in year of calculation
OX = Oxidation factor (fraction)
CH4 emitted in year T - Mg/year

In spreadsheet 11 the amount of plastics accumulated in the SWDSs is calculated:

Pm = Wp * TOCp/TOCdcp

where

Pm = Amount of dry, clean plastics deposited
Wp = Reported amount of plastics deposited
TOCp = TOC in reported plastics
TOCdcp = TOC in dry, clean plastics

Parameters:	IPCC default/recc.		National parameters	
			Value	Remarks
MCF(x) - Methane Corr Factor	Unmanaged, shallow	0,4	0,4	1945-1969
	Unmanaged, deep	0,8	0,8	1970-1979
	Managed	1	1	1980-
	Uncategorized	0,6		
DOC				
Food waste			0,17	
Paper			0,385	
Wood			0,4	
Textile			0,4	
Plastics, TOC			0,57	
DOCf		0,5-0,7		
Food Waste			0,5	
Paper			0,5	
Wood			0,5	
Textiles			0,5	
Half-life time				
Food waste			2,8	
Paper			8,4	
Wood			10,5	
Textiles			10,5	
Reaction start. First of month number		13	13	
F - Fraction of methane in developed gas		0,5	0,5	
Conversion factor, C to CH_4		1,33	1,33	

OX - Part of methane oxidized in the top layer		0	0,1	
TOC in dry, clean plastics			0,8	

Input and result

Parameter	
OX- oxidation factor	0,10

	Amounts deposited						
Year	Food	Paper	Wood	Textile	Plastics	Methane recovery	Methane emission
	Mg	Mg	Mg	Mg	Mg	Mg	Mg
1945	65 632	135 532	216 566	3 460	16 033		0
1946	67 725	139 854	223 999	3 571	16 544		1 464
1947	69 901	144 348	231 708	3 685	17 076		2 830
1948	72 062	148 811	239 366	3 799	17 604		4 114
1949	74 190	153 205	246 915	3 912	18 124		5 329
1950	101 269	209 123	336 440	5 339	24 739		6 484
1951	103 629	213 996	344 938	5 464	25 315		8 141
1952	106 041	218 977	353 420	5 591	25 904		9 704
1953	108 532	224 121	362 162	5 722	26 513		11 184
1954	111 057	229 336	371 018	5 855	27 130		12 594
1955	113 631	234 651	380 033	5 991	27 759		13 943
1956	116 188	239 931	388 991	6 126	28 383		15 239
1957	118 724	245 169	397 882	6 260	29 003		16 489
1958	121 284	250 454	406 849	6 395	29 628		17 695
1959	123 828	255 708	415 766	6 529	30 250		18 864
1960	148 372	306 392	496 964	7 823	36 245		19 998
1961	151 096	312 016	506 471	7 966	36 911		21 591
1962	153 867	317 740	516 135	8 113	37 588		23 110
1963	156 600	323 383	525 671	8 257	38 256		24 566
1964	159 364	329 090	535 310	8 402	38 931		25 964
1965	223 341	378 981	486 424	8 552	70 694		27 312
1966	227 336	385 761	495 465	8 705	71 958		28 871
1967	223 481	382 686	500 351	8 525	71 579		30 335
1968	219 661	379 669	505 309	8 347	71 210		31 636
1969	223 880	386 829	514 826	8 509	72 546		32 798
1970	240 623	415 239	536 415	9 150	77 845		33 930
1971	244 722	422 195	543 976	9 307	79 143		39 477
1972	249 035	429 513	551 773	9 472	80 508		44 577
1973	253 222	436 619	559 431	9 632	81 834		49 304
1974	258 040	448 150	572 003	9 786	84 173		53 708
1975	263 312	459 695	584 125	9 964	86 472		57 903
1976	268 469	471 021	596 090	10 138	88 729		61 921
1977	273 536	482 214	607 979	10 309	90 962		65 782
1978	280 241	495 103	620 313	10 552	93 451		69 506
1979	287 810	508 863	632 850	10 833	96 069		73 139
1980	295 352	522 590	645 374	11 113	98 682		76 707
1981	303 757	539 354	660 825	11 412	101 949		82 391
1982	311 932	555 978	676 338	11 700	105 204		87 882
1983	316 221	568 539	690 750	11 816	107 843		93 209
1984	314 874	573 081	700 893	11 702	109 073		98 309
1985	305 099	566 254	705 433	11 239	108 346		103 045
1986	279 300	530 422	690 030	10 178	102 107		107 223
1987	275 752	523 947	688 593	10 047	100 874		110 315
1988	281 404	522 026	683 393	10 368	99 871	480	112 651
1989	288 040	523 194	681 061	10 715	99 523	606	115 128
1990	333 025	520 203	624 170	17 169	153 882	946	117 296

1991	352 315	450 063	645 512	17 299	161 492	4 482	116 487
1992	311 890	458 357	648 153	14 745	152 600	8 831	114 428
1993	309 337	416 466	630 063	14 252	150 211	9 834	114 778
1994	329 017	448 495	564 576	15 159	162 643	10 357	114 908
1995	354 786	525 088	550 319	17 659	190 075	12 250	113 885
1996	344 565	481 122	477 080	16 037	187 540	13 691	114 185
1997	315 079	414 962	416 024	16 146	174 949	15 030	113 400
1998	345 631	505 156	436 985	18 300	192 366	20 051	107 820
1999	276 771	403 253	261 739	16 024	162 048	22 302	106 158
2000	260 266	407 442	246 805	15 379	159 229	18 821	106 631
2001	275 569	442 633	321 487	14 006	169 570	20 582	102 387
2002	222 716	389 054	259 755	12 224	142 570	21 787	99 975
2003						21 384	97 584

Methane calculation from type of material

Food waste

	National values
Half-life time ($t_{1/2}$):	2,8
e^-k*1	0,78
Process start in deposition year. Month M	13,00
e^-k*(13-M/12)	1,00
DOC	0,170
DOCf	0,500

Year	Amount deposited	MCF	DDOCmd	DDOCm not reacted. Deposition year	DDOCm to methane. Deposition year	DDOCma, accumulated in dump, end of year	DDOC to methane	Methane formed (Qf)
	Mg		Mg	Mg	Mg	Mg	Mg	Mg
1945	65 632	0,40	2 231	2 231	0	2 231	0	0
1946	67 725	0,40	2 303	2 303	0	4 045	489	326
1947	69 901	0,40	2 377	2 377	0	5 534	887	591
1948	72 062	0,40	2 450	2 450	0	6 771	1 214	809
1949	74 190	0,40	2 522	2 522	0	7 809	1 485	990
1950	101 269	0,40	3 443	3 443	0	9 539	1 712	1 142
1951	103 629	0,40	3 523	3 523	0	10 971	2 092	1 395
1952	106 041	0,40	3 605	3 605	0	12 170	2 406	1 604
1953	108 532	0,40	3 690	3 690	0	13 192	2 669	1 779
1954	111 057	0,40	3 776	3 776	0	14 075	2 893	1 929
1955	113 631	0,40	3 863	3 863	0	14 852	3 086	2 058
1956	116 188	0,40	3 950	3 950	0	15 545	3 257	2 171
1957	118 724	0,40	4 037	4 037	0	16 173	3 409	2 273
1958	121 284	0,40	4 124	4 124	0	16 750	3 547	2 364
1959	123 828	0,40	4 210	4 210	0	17 287	3 673	2 449
1960	148 372	0,40	5 045	5 045	0	18 541	3 791	2 527
1961	151 096	0,40	5 137	5 137	0	19 612	4 066	2 711
1962	153 867	0,40	5 231	5 231	0	20 543	4 301	2 867
1963	156 600	0,40	5 324	5 324	0	21 362	4 505	3 003
1964	159 364	0,40	5 418	5 418	0	22 096	4 685	3 123
1965	223 341	0,40	7 594	7 594	0	24 844	4 846	3 230
1966	227 336	0,40	7 729	7 729	0	27 126	5 448	3 632
1967	223 481	0,40	7 598	7 598	0	28 776	5 948	3 966
1968	219 661	0,40	7 468	7 468	0	29 934	6 310	4 207
1969	223 880	0,40	7 612	7 612	0	30 982	6 564	4 376
1970	240 623	0,80	16 362	16 362	0	40 550	6 794	4 529
1971	244 722	0,80	16 641	16 641	0	48 299	8 892	5 928
1972	249 035	0,80	16 934	16 934	0	54 642	10 591	7 061
1973	253 222	0,80	17 219	17 219	0	59 878	11 982	7 988
1974	258 040	0,80	17 547	17 547	0	64 294	13 131	8 754
1975	263 312	0,80	17 905	17 905	0	68 100	14 099	9 399
1976	268 469	0,80	18 256	18 256	0	71 422	14 934	9 956
1977	273 536	0,80	18 600	18 600	0	74 361	15 662	10 442
1978	280 241	0,80	19 056	19 056	0	77 110	16 307	10 871
1979	287 810	0,80	19 571	19 571	0	79 772	16 910	11 273

1980	295 352	1,00	25 105	25 105	0	87 384	17 493	11 662
1981	303 757	1,00	25 819	25 819	0	94 041	19 162	12 775
1982	311 932	1,00	26 514	26 514	0	99 933	20 622	13 748
1983	316 221	1,00	26 879	26 879	0	104 897	21 914	14 610
1984	314 874	1,00	26 764	26 764	0	108 658	23 003	15 335
1985	305 099	1,00	25 933	25 933	0	110 764	23 828	15 885
1986	279 300	1,00	23 741	23 741	0	110 215	24 290	16 193
1987	275 752	1,00	23 439	23 439	0	109 485	24 169	16 113
1988	281 404	1,00	23 919	23 919	0	109 395	24 009	16 006
1989	288 040	1,00	24 483	24 483	0	109 889	23 989	15 993
1990	333 025	1,00	28 307	28 307	0	114 099	24 098	16 065
1991	352 315	1,00	29 947	29 947	0	119 025	25 021	16 681
1992	311 890	1,00	26 511	26 511	0	119 434	26 101	17 401
1993	309 337	1,00	26 294	26 294	0	119 537	26 191	17 461
1994	329 017	1,00	27 966	27 966	0	121 290	26 213	17 476
1995	354 786	1,00	30 157	30 157	0	124 849	26 598	17 732
1996	344 565	1,00	29 288	29 288	0	126 759	27 378	18 252
1997	315 079	1,00	26 782	26 782	0	125 743	27 797	18 531
1998	345 631	1,00	29 379	29 379	0	127 548	27 574	18 383
1999	276 771	1,00	23 526	23 526	0	123 103	27 970	18 647
2000	260 266	1,00	22 123	22 123	0	118 230	26 995	17 997
2001	275 569	1,00	23 423	23 423	0	115 727	25 927	17 285
2002	222 716	1,00	18 931	18 931	0	109 280	25 378	16 919
2003	0	1,00	0	0	0	85 316	23 964	15 976

Methane calculation from type of material

Paper

	National values
Half-life time ($t_{1/2}$):	8,4
e^-k*1	0,92
Process start in deposition year. Month M	13,00
e^-k*(13-M/12)	1,00
DOC	0,385
DOCf	0,500

Year	Amount deposited	MCF	DDOCmd	DDOCm not reacted. Deposition year	DDOCm to methane. Deposition year	DDOCma, accumulated in dump, end of year	DDOC to methane	Methane formed (Qf)
	Mg		Mg	Mg	Mg	Mg	Mg	Mg
1945	135 532	0,40	10 436	10 436	0	10 436	0	0
1946	139 854	0,40	10 769	10 769	0	20 378	827	551
1947	144 348	0,40	11 115	11 115	0	29 879	1 614	1 076
1948	148 811	0,40	11 458	11 458	0	38 971	2 367	1 578
1949	153 205	0,40	11 797	11 797	0	47 681	3 087	2 058
1950	209 123	0,40	16 102	16 102	0	60 007	3 777	2 518
1951	213 996	0,40	16 478	16 478	0	71 732	4 753	3 169
1952	218 977	0,40	16 861	16 861	0	82 911	5 681	3 788
1953	224 121	0,40	17 257	17 257	0	93 602	6 567	4 378
1954	229 336	0,40	17 659	17 659	0	103 847	7 414	4 942
1955	234 651	0,40	18 068	18 068	0	113 690	8 225	5 483
1956	239 931	0,40	18 475	18 475	0	123 160	9 005	6 003
1957	245 169	0,40	18 878	18 878	0	132 283	9 755	6 503
1958	250 454	0,40	19 285	19 285	0	141 091	10 477	6 985
1959	255 708	0,40	19 689	19 689	0	149 605	11 175	7 450
1960	306 392	0,40	23 592	23 592	0	161 348	11 849	7 900
1961	312 016	0,40	24 025	24 025	0	172 593	12 779	8 520
1962	317 740	0,40	24 466	24 466	0	183 389	13 670	9 113
1963	323 383	0,40	24 900	24 900	0	193 764	14 525	9 684
1964	329 090	0,40	25 340	25 340	0	203 757	15 347	10 231
1965	378 981	0,40	29 182	29 182	0	216 800	16 139	10 759
1966	385 761	0,40	29 704	29 704	0	229 332	17 172	11 448
1967	382 686	0,40	29 467	29 467	0	240 635	18 164	12 109
1968	379 669	0,40	29 234	29 234	0	250 810	19 059	12 706
1969	386 829	0,40	29 786	29 786	0	260 730	19 865	13 244
1970	415 239	0,80	63 947	63 947	0	304 026	20 651	13 767
1971	422 195	0,80	65 018	65 018	0	344 964	24 080	16 054
1972	429 513	0,80	66 145	66 145	0	383 786	27 323	18 215
1973	436 619	0,80	67 239	67 239	0	420 628	30 398	20 265
1974	448 150	0,80	69 015	69 015	0	456 327	33 316	22 210
1975	459 695	0,80	70 793	70 793	0	490 977	36 143	24 096
1976	471 021	0,80	72 537	72 537	0	524 626	38 888	25 925
1977	482 214	0,80	74 261	74 261	0	557 335	41 553	27 702
1978	495 103	0,80	76 246	76 246	0	589 437	44 144	29 429
1979	508 863	0,80	78 365	78 365	0	621 116	46 686	31 124

1980	522 590	1,00	100 599	100 599	0	672 519	49 195	32 797
1981	539 354	1,00	103 826	103 826	0	723 078	53 267	35 511
1982	555 978	1,00	107 026	107 026	0	772 832	57 271	38 181
1983	568 539	1,00	109 444	109 444	0	821 064	61 212	40 808
1984	573 081	1,00	110 318	110 318	0	866 350	65 032	43 355
1985	566 254	1,00	109 004	109 004	0	906 735	68 619	45 746
1986	530 422	1,00	102 106	102 106	0	937 024	71 818	47 878
1987	523 947	1,00	100 860	100 860	0	963 667	74 217	49 478
1988	522 026	1,00	100 490	100 490	0	987 830	76 327	50 885
1989	523 194	1,00	100 715	100 715	0	1 010 304	78 241	52 161
1990	520 203	1,00	100 139	100 139	0	1 030 422	80 021	53 347
1991	450 063	1,00	86 637	86 637	0	1 035 445	81 614	54 410
1992	458 357	1,00	88 234	88 234	0	1 041 667	82 012	54 675
1993	416 466	1,00	80 170	80 170	0	1 039 331	82 505	55 003
1994	448 495	1,00	86 335	86 335	0	1 043 347	82 320	54 880
1995	525 088	1,00	101 079	101 079	0	1 061 788	82 638	55 092
1996	481 122	1,00	92 616	92 616	0	1 070 306	84 099	56 066
1997	414 962	1,00	79 880	79 880	0	1 065 413	84 773	56 515
1998	505 156	1,00	97 243	97 243	0	1 078 269	84 386	56 257
1999	403 253	1,00	77 626	77 626	0	1 070 492	85 404	56 936
2000	407 442	1,00	78 433	78 433	0	1 064 136	84 788	56 525
2001	442 633	1,00	85 207	85 207	0	1 065 058	84 285	56 190
2002	389 054	1,00	74 893	74 893	0	1 055 594	84 358	56 238
2003	0	1,00	0	0	0	971 986	83 608	55 739

Methane calculation from type of material

Wood

	National values
Half-life time ($t_{1/2}$):	10,5
e^-k*1	0,94
Process start in deposition year. Month M	13,00
e^-k*(13-M/12)	1,00
DOC	0,400
DOCf	0,500

Year	Amount deposited	MCF	DDOCmd	DDOCm not reacted. Deposition year	DDOCm to methane. Deposition year	DDOCma, accumulated in dump, end of year	DDOC to methane	Methane formed (Qf)
	Mg		Mg	Mg	Mg	Mg	Mg	Mg
1945	216 566	0,40	17 325	17 325	0	17 325	0	0
1946	223 999	0,40	17 920	17 920	0	34 138	1 107	738
1947	231 708	0,40	18 537	18 537	0	50 494	2 181	1 454
1948	239 366	0,40	19 149	19 149	0	66 418	3 226	2 150
1949	246 915	0,40	19 753	19 753	0	81 928	4 243	2 829
1950	336 440	0,40	26 915	26 915	0	103 610	5 234	3 489
1951	344 938	0,40	27 595	27 595	0	124 586	6 619	4 413
1952	353 420	0,40	28 274	28 274	0	144 901	7 959	5 306
1953	362 162	0,40	28 973	28 973	0	164 617	9 257	6 171
1954	371 018	0,40	29 681	29 681	0	183 782	10 516	7 011
1955	380 033	0,40	30 403	30 403	0	202 444	11 740	7 827
1956	388 991	0,40	31 119	31 119	0	220 631	12 933	8 622
1957	397 882	0,40	31 831	31 831	0	238 367	14 094	9 396
1958	406 849	0,40	32 548	32 548	0	255 688	15 227	10 152
1959	415 766	0,40	33 261	33 261	0	272 615	16 334	10 889
1960	496 964	0,40	39 757	39 757	0	294 957	17 415	11 610
1961	506 471	0,40	40 518	40 518	0	316 632	18 843	12 562
1962	516 135	0,40	41 291	41 291	0	337 696	20 227	13 485
1963	525 671	0,40	42 054	42 054	0	358 177	21 573	14 382
1964	535 310	0,40	42 825	42 825	0	378 120	22 881	15 254
1965	486 424	0,40	38 914	38 914	0	392 879	24 155	16 103
1966	495 465	0,40	39 637	39 637	0	407 418	25 098	16 732
1967	500 351	0,40	40 028	40 028	0	421 420	26 027	17 351
1968	505 309	0,40	40 425	40 425	0	434 923	26 921	17 947
1969	514 826	0,40	41 186	41 186	0	448 325	27 784	18 523
1970	536 415	0,80	85 826	85 826	0	505 512	28 640	19 093
1971	543 976	0,80	87 036	87 036	0	560 255	32 293	21 529
1972	551 773	0,80	88 284	88 284	0	612 748	35 790	23 860
1973	559 431	0,80	89 509	89 509	0	663 113	39 144	26 096
1974	572 003	0,80	91 521	91 521	0	712 272	42 361	28 241
1975	584 125	0,80	93 460	93 460	0	760 231	45 502	30 334
1976	596 090	0,80	95 374	95 374	0	807 040	48 565	32 377
1977	607 979	0,80	97 277	97 277	0	852 761	51 556	34 370
1978	620 313	0,80	99 250	99 250	0	897 535	54 476	36 318
1979	632 850	0,80	101 256	101 256	0	941 454	57 337	38 224

1980	645 374	0,91	117 358	117 358	0	998 670	60 142	40 095
1981	660 825	0,91	120 326	120 326	0	1 055 198	63 797	42 532
1982	676 338	0,91	123 307	123 307	0	1 111 097	67 408	44 939
1983	690 750	0,91	126 068	126 068	0	1 166 185	70 979	47 320
1984	700 893	0,91	127 974	127 974	0	1 219 661	74 499	49 666
1985	705 433	0,91	128 761	128 761	0	1 270 507	77 915	51 943
1986	690 030	0,91	125 558	125 558	0	1 314 902	81 163	54 109
1987	688 593	0,91	125 149	125 149	0	1 356 052	83 999	55 999
1988	683 393	0,91	123 987	123 987	0	1 393 412	86 628	57 752
1989	681 061	0,91	123 399	123 399	0	1 427 797	89 014	59 343
1990	624 170	0,90	111 899	111 899	0	1 448 486	91 211	60 807
1991	645 512	0,90	116 046	116 046	0	1 471 999	92 533	61 688
1992	648 153	0,90	116 452	116 452	0	1 494 417	94 035	62 690
1993	630 063	0,89	112 713	112 713	0	1 511 663	95 467	63 644
1994	564 576	0,91	102 240	102 240	0	1 517 335	96 568	64 379
1995	550 319	0,93	102 014	102 014	0	1 522 418	96 931	64 621
1996	477 080	0,94	89 991	89 991	0	1 515 153	97 255	64 837
1997	416 024	0,93	77 608	77 608	0	1 495 970	96 791	64 528
1998	436 985	0,93	81 531	81 531	0	1 481 935	95 566	63 711
1999	261 739	0,94	49 303	49 303	0	1 436 569	94 669	63 113
2000	246 805	0,94	46 316	46 316	0	1 391 113	91 771	61 181
2001	321 487	0,95	61 322	61 322	0	1 363 568	88 867	59 245
2002	259 755	0,95	49 151	49 151	0	1 325 612	87 108	58 072
2003	0	1,00	0	0	0	1 240 928	84 683	56 455

Methane calculation from type of material

Textiles

	National values
Half-life time ($t_{1/2}$):	10,5
e^-k*1	0,94
Process start in deposition year. Month M	13,00
e^-k*(13-M/12)	1,00
DOC	0,400
DOCf	0,500

Year	Amount deposited	MCF	DDOCmd	DDOCm not reacted. Deposition year	DDOCm to methane. Deposition year	DDOCma, accumulated in dump, end of year	DDOC to methane	Methane formed (Qf)
	Mg		Mg	Mg	Mg	Mg	Mg	Mg
1945	3 460	0,40	277	277	0	277	0	0
1946	3 571	0,40	286	286	0	545	18	12
1947	3 685	0,40	295	295	0	805	35	23
1948	3 799	0,40	304	304	0	1 057	51	34
1949	3 912	0,40	313	313	0	1 303	68	45
1950	5 339	0,40	427	427	0	1 647	83	55
1951	5 464	0,40	437	437	0	1 979	105	70
1952	5 591	0,40	447	447	0	2 299	126	84
1953	5 722	0,40	458	458	0	2 610	147	98
1954	5 855	0,40	468	468	0	2 912	167	111
1955	5 991	0,40	479	479	0	3 205	186	124
1956	6 126	0,40	490	490	0	3 491	205	137
1957	6 260	0,40	501	501	0	3 768	223	149
1958	6 395	0,40	512	512	0	4 039	241	160
1959	6 529	0,40	522	522	0	4 303	258	172
1960	7 823	0,40	626	626	0	4 654	275	183
1961	7 966	0,40	637	637	0	4 994	297	198
1962	8 113	0,40	649	649	0	5 324	319	213
1963	8 257	0,40	661	661	0	5 645	340	227
1964	8 402	0,40	672	672	0	5 956	361	240
1965	8 552	0,40	684	684	0	6 260	381	254
1966	8 705	0,40	696	696	0	6 556	400	267
1967	8 525	0,40	682	682	0	6 820	419	279
1968	8 347	0,40	668	668	0	7 052	436	290
1969	8 509	0,40	681	681	0	7 282	450	300
1970	9 150	0,80	1 464	1 464	0	8 281	465	310
1971	9 307	0,80	1 489	1 489	0	9 241	529	353
1972	9 472	0,80	1 516	1 516	0	10 166	590	394
1973	9 632	0,80	1 541	1 541	0	11 058	649	433
1974	9 786	0,80	1 566	1 566	0	11 917	706	471
1975	9 964	0,80	1 594	1 594	0	12 750	761	508
1976	10 138	0,80	1 622	1 622	0	13 558	815	543
1977	10 309	0,80	1 649	1 649	0	14 341	866	577
1978	10 552	0,80	1 688	1 688	0	15 113	916	611
1979	10 833	0,80	1 733	1 733	0	15 881	965	644

1980	11 113	1,00	2 223	2 223	0	17 089	1 015	676
1981	11 412	1,00	2 282	2 282	0	18 280	1 092	728
1982	11 700	1,00	2 340	2 340	0	19 452	1 168	779
1983	11 816	1,00	2 363	2 363	0	20 573	1 243	828
1984	11 702	1,00	2 340	2 340	0	21 599	1 314	876
1985	11 239	1,00	2 248	2 248	0	22 467	1 380	920
1986	10 178	1,00	2 036	2 036	0	23 067	1 435	957
1987	10 047	1,00	2 009	2 009	0	23 603	1 474	982
1988	10 368	1,00	2 074	2 074	0	24 169	1 508	1 005
1989	10 715	1,00	2 143	2 143	0	24 768	1 544	1 029
1990	17 169	1,00	3 434	3 434	0	26 620	1 582	1 055
1991	17 299	1,00	3 460	3 460	0	28 379	1 701	1 134
1992	14 745	1,00	2 949	2 949	0	29 515	1 813	1 209
1993	14 252	1,00	2 850	2 850	0	30 480	1 885	1 257
1994	15 159	1,00	3 032	3 032	0	31 565	1 947	1 298
1995	17 659	1,00	3 532	3 532	0	33 080	2 016	1 344
1996	16 037	1,00	3 207	3 207	0	34 174	2 113	1 409
1997	16 146	1,00	3 229	3 229	0	35 220	2 183	1 455
1998	18 300	1,00	3 660	3 660	0	36 630	2 250	1 500
1999	16 024	1,00	3 205	3 205	0	37 495	2 340	1 560
2000	15 379	1,00	3 076	3 076	0	38 176	2 395	1 597
2001	14 006	1,00	2 801	2 801	0	38 538	2 439	1 626
2002	12 224	1,00	2 445	2 445	0	38 521	2 462	1 641
2003	0	1,00	0	0	0	36 060	2 461	1 641

Plastics accumulated in SWDS

Parameters	
TOC in plastics reported	0,57
TOC in dry, clean plastics	0,8

	Plastics.	
Year	Plastics reported	Plastics accumulated
	Mg	Mg
1945	16 033	11 424
1946	16 544	23 212
1947	17 076	35 378
1948	17 604	47 921
1949	18 124	60 834
1950	24 739	78 461
1951	25 315	96 498
1952	25 904	114 955
1953	26 513	133 845
1954	27 130	153 175
1955	27 759	172 954
1956	28 383	193 177
1957	29 003	213 841
1958	29 628	234 951
1959	30 250	256 504
1960	36 245	282 329
1961	36 911	308 628
1962	37 588	335 410
1963	38 256	362 667
1964	38 931	390 405
1965	70 694	440 774
1966	71 958	492 044
1967	71 579	543 044
1968	71 210	593 782
1969	72 546	645 471
1970	77 845	700 936
1971	79 143	757 325
1972	80 508	814 687
1973	81 834	872 994
1974	84 173	932 966
1975	86 472	994 578
1976	88 729	1 057 797
1977	90 962	1 122 607
1978	93 451	1 189 191
1979	96 069	1 257 640
1980	98 682	1 327 951
1981	101 949	1 400 590
1982	105 204	1 475 548
1983	107 843	1 552 386
1984	109 073	1 630 100
1985	108 346	1 707 297
1986	102 107	1 780 048
1987	100 874	1 851 921
1988	99 871	1 923 079

1989	99 523	1 993 989
1990	153 882	2 103 630
1991	161 492	2 218 693
1992	152 600	2 327 420
1993	150 211	2 434 446
1994	162 643	2 550 330
1995	190 075	2 685 758
1996	187 540	2 819 380
1997	174 949	2 944 032
1998	192 366	3 081 092
1999	162 048	3 196 551
2000	159 229	3 310 002
2001	169 570	3 430 821
2002	142 570	3 532 402
2003	0	3 532 402

Comparing results from the former Norwegian model to the new one

Historic data. Former model calculations just until year 2002.

Year	Former model	New model	Deviation
	Mg	Mg	%
1945	0	0	
1946	1 837	1 464	-20,3
1947	3 616	2 830	-21,7
1948	5 343	4 114	-23,0
1949	7 020	5 329	-24,1
1950	8 651	6 484	-25,1
1951	10 936	8 141	-25,6
1952	13 141	9 704	-26,2
1953	15 274	11 184	-26,8
1954	17 341	12 594	-27,4
1955	19 347	13 943	-27,9
1956	21 297	15 239	-28,4
1957	23 196	16 489	-28,9
1958	25 045	17 695	-29,3
1959	26 849	18 864	-29,7
1960	28 610	19 998	-30,1
1961	30 945	21 591	-30,2
1962	33 207	23 110	-30,4
1963	35 404	24 566	-30,6
1964	37 537	25 964	-30,8
1965	39 612	27 312	-31,1
1966	41 910	28 871	-31,1
1967	44 147	30 335	-31,3
1968	46 230	31 636	-31,6
1969	48 171	32 798	-31,9
1970	50 080	33 930	-32,2
1971	57 493	39 477	-31,3
1972	64 593	44 577	-31,0
1973	71 409	49 304	-31,0
1974	77 953	53 708	-31,1
1975	84 342	57 903	-31,3
1976	90 584	61 921	-31,6
1977	96 685	65 782	-32,0
1978	102 651	69 506	-32,3
1979	108 524	73 139	-32,6
1980	114 326	76 707	-32,9
1981	122 745	82 391	-32,9
1982	131 077	87 882	-33,0
1983	139 326	93 209	-33,1
1984	147 400	98 309	-33,3
1985	155 111	103 045	-33,6
1986	162 199	107 223	-33,9
1987	167 961	110 315	-34,3
1988	173 215	112 651	-35,0
1989	178 082	115 128	-35,4
1990	181 700	117 296	-35,4

1991	184 118	116 487	-36,7
1992	183 982	114 428	-37,8
1993	186 749	114 778	-38,5
1994	187 854	114 908	-38,8
1995	189 302	113 885	-39,8
1996	191 359	114 185	-40,3
1997	190 229	113 400	-40,4
1998	186 749	107 820	-42,3
1999	187 039	106 158	-43,2
2000	185 940	106 631	-42,7
2001	185 547	102 387	-44,8
2002	183 844	99 975	-45,6

Recalculation from waste category to waste material

Basis. Deposited amounts

Year	Household waste	Business waste	Industrial waste
	Mg	Mg	Mg
1945	230 694	265 298	106 500
1946	238 049	273 756	110 500
1947	245 699	282 554	114 634
1948	253 295	291 289	118 744
1949	260 775	299 891	122 800
1950	355 953	409 346	166 939
1951	364 249	418 887	171 581
1952	372 726	428 635	176 093
1953	381 482	438 704	180 732
1954	390 359	448 913	185 427
1955	399 407	459 318	190 200
1956	408 394	469 653	194 945
1957	417 308	479 905	199 658
1958	426 304	490 250	204 407
1959	435 247	500 534	209 132
1960	521 518	599 746	249 199
1961	531 092	610 756	254 213
1962	540 834	621 959	259 303
1963	550 439	633 005	264 331
1964	560 154	644 177	269 409
1965	570 110	655 626	274 597
1966	580 309	667 356	279 896
1967	568 359	671 988	285 355
1968	556 495	676 719	290 854
1969	567 266	689 106	296 415
1970	610 004	738 255	300 000
1971	620 468	750 288	303 478
1972	631 477	762 948	306 956
1973	642 166	775 241	310 434
1974	652 420	804 825	313 912
1975	664 294	832 260	317 390
1976	675 889	859 250	320 868
1977	687 246	886 057	324 346
1978	703 440	912 696	327 824
1979	722 203	939 133	331 302
1980	740 889	965 549	334 780
1981	760 823	1 001 726	338 258
1982	780 015	1 038 385	341 736
1983	787 746	1 075 284	345 214
1984	780 148	1 102 747	348 692
1985	749 253	1 118 954	352 170
1986	678 560	1 079 774	355 648
1987	669 778	1 067 273	359 126
1988	691 216	1 030 900	362 604
1989	714 301	1 003 944	366 082
1990	736 971	971 939	369 560
1991	745 255	957 406	373 038

1992	596 842	1 003 911	376 516
1993	581 219	934 770	380 000
1994	606 496	1 009 744	305 000
1995	601 493	1 274 941	230 000
1996	570 454	1 162 330	155 000
1997	520 933	1 041 016	159 900
1998	566 343	1 191 528	167 603
1999	488 058	867 519	87 000
2000	448 660	864 210	87 000
2001	332 093	1 012 992	85 000
2002	318 516	889 391	80 000

Recalculation from waste category to waste material

Food waste

	Household waste		Business waste		Sum
Year	%	Amount	%	Amount	
		Mg		Mg	Mg
1945	25	57 673	3	7 959	65 632
1946		59 512		8 213	67 725
1947		61 425		8 477	69 901
1948		63 324		8 739	72 062
1949		65 194		8 997	74 190
1950		88 988		12 280	101 269
1951		91 062		12 567	103 629
1952		93 182		12 859	106 041
1953		95 370		13 161	108 532
1954		97 590		13 467	111 057
1955		99 852		13 780	113 631
1956		102 098		14 090	116 188
1957		104 327		14 397	118 724
1958		106 576		14 707	121 284
1959		108 812		15 016	123 828
1960		130 379		17 992	148 372
1961		132 773		18 323	151 096
1962		135 209		18 659	153 867
1963		137 610		18 990	156 600
1964		140 038		19 325	159 364
1965	34	193 837	4,5	29 503	223 341
1966		197 305		30 031	227 336
1967		193 242		30 239	223 481
1968		189 208		30 452	219 661
1969		192 871		31 010	223 880
1970		207 401		33 221	240 623
1971		210 959		33 763	244 722
1972		214 702		34 333	249 035
1973		218 337		34 886	253 222
1974		221 823		36 217	258 040
1975		225 860		37 452	263 312
1976		229 802		38 666	268 469
1977		233 664		39 873	273 536
1978		239 170		41 071	280 241
1979		245 549		42 261	287 810
1980		251 902		43 450	295 352
1981		258 680		45 078	303 757
1982		265 205		46 727	311 932
1983		267 834		48 388	316 221
1984		265 250		49 624	314 874
1985		254 746		50 353	305 099
1986		230 710		48 590	279 300
1987		227 725		48 027	275 752
1988		235 013		46 390	281 404
1989		242 862		45 177	288 040
1990	32	235 831	10	97 194	333 025

1991	33,4	248 915	10,8	103 400	352 315
1992	35,1	209 492	10,2	102 399	311 890
1993	37,3	216 795	9,9	92 542	309 337
1994	37,6	228 042	10	100 974	329 017
1995	38	228 567	9,9	126 219	354 786
1996	38,6	220 195	10,7	124 369	344 565
1997	40,3	209 936	10,1	105 143	315 079
1998	40,2	227 670	9,9	117 961	345 631
1999	41,6	203 032	8,5	73 739	276 771
2000	42,6	191 129	8	69 137	260 266
2001	41,8	138 815	13,5	136 754	275 569
2002	42	133 777	10	88 939	222 716

Recalculation from waste category to waste material

Paper

	Household waste		Business waste		Sum
Year	%	Mengde	%	Mengde	
		Mg		Mg	Mg
1945	30	69 208	25	66 324	135 532
1946		71 415		68 439	139 854
1947		73 710		70 638	144 348
1948		75 989		72 822	148 811
1949		78 232		74 973	153 205
1950		106 786		102 337	209 123
1951		109 275		104 722	213 996
1952		111 818		107 159	218 977
1953		114 445		109 676	224 121
1954		117 108		112 228	229 336
1955		119 822		114 829	234 651
1956		122 518		117 413	239 931
1957		125 193		119 976	245 169
1958		127 891		122 562	250 454
1959		130 574		125 133	255 708
1960		156 455		149 936	306 392
1961		159 328		152 689	312 016
1962		162 250		155 490	317 740
1963		165 132		158 251	323 383
1964		168 046		161 044	329 090
1965	36	205 240	26,5	173 741	378 981
1966		208 911		176 849	385 761
1967		204 609		178 077	382 686
1968		200 338		179 331	379 669
1969		204 216		182 613	386 829
1970		219 601		195 637	415 239
1971		223 369		198 826	422 195
1972		227 332		202 181	429 513
1973		231 180		205 439	436 619
1974		234 871		213 278	448 150
1975		239 146		220 549	459 695
1976		243 320		227 701	471 021
1977		247 409		234 805	482 214
1978		253 238		241 865	495 103
1979		259 993		248 870	508 863
1980		266 720		255 870	522 590
1981		273 896		265 457	539 354
1982		280 805		275 172	555 978
1983		283 589		284 950	568 539
1984		280 853		292 228	573 081
1985		269 731		296 523	566 254
1986		244 282		286 140	530 422
1987		241 120		282 827	523 947
1988		248 838		273 188	522 026
1989		257 148		266 045	523 194
1990	33	243 200	28,5	277 003	520 203

1991	31,1	231 774	22,8	218 289	450 063
1992	29,7	177 262	28	281 095	458 357
1993	26,3	152 861	28,2	263 605	416 466
1994	26	157 689	28,8	290 806	448 495
1995	27,1	163 005	28,4	362 083	525 088
1996	27,9	159 157	27,7	321 965	481 122
1997	27,5	143 257	26,1	271 705	414 962
1998	26,5	150 081	29,8	355 075	505 156
1999	24,5	119 574	32,7	283 679	403 253
2000	25,9	116 203	33,7	291 239	407 442
2001	31,1	103 281	33,5	339 352	442 633
2002	30	95 555	33	293 499	389 054

Recalculation from waste category to waste material

Wood **All calculated as wood, TOC = 400**

	Household waste				Business waste				Industry
	Fine m TOC =95		Burnable TOC=370		Wood TOC=400		Burnable TOC=370		TOC=350
Year	%	Amount	%	Amount	%	Amount	%	Amount	Amount
		Mg		Mg		Mg		Mg	Mg
1945	10	5 479	15	32 009	0		35	85 890	93 188
1946		5 654		33 029				88 628	96 687
1947		5 835		34 091				91 477	100 305
1948		6 016		35 145				94 305	103 901
1949		6 193		36 182				97 090	107 450
1950		8 454		49 389				132 526	146 071
1951		8 651		50 540				135 615	150 133
1952		8 852		51 716				138 771	154 081
1953		9 060		52 931				142 030	158 141
1954		9 271		54 162				145 336	162 249
1955		9 486		55 418				148 704	166 425
1956		9 699		56 665				152 050	170 577
1957		9 911		57 902				155 369	174 700
1958		10 125		59 150				158 718	178 856
1959		10 337		60 390				162 048	182 990
1960		12 386		72 361				194 168	218 049
1961		12 613		73 689				197 732	222 436
1962		12 845		75 041				201 359	226 890
1963		13 073		76 373				204 935	231 289
1964		13 304		77 721				208 552	235 733
1965	4	5 416	10	52 735	0		31	188 001	240 272
1966		5 513		53 679				191 364	244 909
1967		5 399		52 573				192 692	249 686
1968		5 287		51 476				194 049	254 498
1969		5 389		52 472				197 601	259 363
1970		5 795		56 425				211 694	262 500
1971		5 894		57 393				215 145	265 543
1972		5 999		58 412				218 775	268 587
1973		6 101		59 400				222 300	271 630
1974		6 198		60 349				230 783	274 673
1975		6 311		61 447				238 651	277 716
1976		6 421		62 520				246 390	280 760
1977		6 529		63 570				254 077	283 803
1978		6 683		65 068				261 716	286 846
1979		6 861		66 804				269 296	289 889
1980		7 038		68 532				276 871	292 933
1981		7 228		70 376				287 245	295 976
1982		7 410		72 151				297 757	299 019
1983		7 484		72 867				308 338	302 062
1984		7 411		72 164				316 213	305 106
1985		7 118		69 306				320 860	308 149
1986		6 446		62 767				309 625	311 192
1987		6 363		61 954				306 040	314 235
1988		6 567		63 937				295 610	317 279
1989		6 786		66 073				287 881	320 322
1990	5	8 752	8	54 536	17,5	170 089	7,5	67 428	323 365
1991	5,2	9 204	8,3	57 217	18,9	180 950	8,1	71 734	326 408

1992	5,5	7 796	8,7	48 031	18,6	186 727	8,2	76 147	329 452
1993	5,8	8 006	9	48 386	18,4	171 998	8	69 173	332 500
1994	5,9	8 499	8,7	48 808	16,5	166 608	7,9	73 787	266 875
1995	6,2	8 857	6,1	33 939	16,9	215 465	7,7	90 808	201 250
1996	6,7	9 077	4,6	24 273	19,2	223 167	7,9	84 937	135 625
1997	7,3	9 032	1,8	8 674	17,7	184 260	7,7	74 146	139 913
1998	7,5	10 088	2,2	11 525	15,8	188 261	7,3	80 458	146 653
1999	8	9 273	0,1	451	13,8	119 718	7	56 172	76 125
2000	8,3	8 844	-2,6	-10 790	13,5	116 668	7	55 958	76 125
2001	9	7 098	-4,3	-13 209	15,1	152 962	10,7	100 261	74 375
2002	8,5	6 430	-4	-11 785	15	133 409	7,5	61 702	70 000

Sum	New MCF
Mg	
216 566	
223 999	
231 708	
239 366	
246 915	
336 440	
344 938	
353 420	
362 162	
371 018	
380 033	
388 991	
397 882	
406 849	
415 766	
496 964	
506 471	
516 135	
525 671	
535 310	
486 424	
495 465	
500 351	
505 309	
514 826	
536 415	
543 976	
551 773	
559 431	
572 003	
584 125	
596 090	
607 979	
620 313	
632 850	
645 374	0,91
660 825	0,91
676 338	0,91
690 750	0,91
700 893	0,91
705 433	0,91
690 030	0,91
688 593	0,91
683 393	0,91
681 061	0,91
624 170	0,90
645 512	0,90

648 153	0,90
630 063	0,89
564 576	0,91
550 319	0,93
477 080	0,94
416 024	0,93
436 985	0,93
261 739	0,94
246 805	0,94
321 487	0,95
259 755	0,95

Recalculation from waste category to waste material

Textiles

New TOC = 400
0,50 : Part plastics in textiles

	Household waste		Business waste		Sum
Year	%	Amount	%	Amount	
		Mg		Mg	Mg
1945	3	3 460	0	0	3 460
1946		3 571		0	3 571
1947		3 685		0	3 685
1948		3 799		0	3 799
1949		3 912		0	3 912
1950		5 339		0	5 339
1951		5 464		0	5 464
1952		5 591		0	5 591
1953		5 722		0	5 722
1954		5 855		0	5 855
1955		5 991		0	5 991
1956		6 126		0	6 126
1957		6 260		0	6 260
1958		6 395		0	6 395
1959		6 529		0	6 529
1960		7 823		0	7 823
1961		7 966		0	7 966
1962		8 113		0	8 113
1963		8 257		0	8 257
1964		8 402		0	8 402
1965	3	8 552		0	8 552
1966		8 705		0	8 705
1967		8 525		0	8 525
1968		8 347		0	8 347
1969		8 509		0	8 509
1970		9 150		0	9 150
1971		9 307		0	9 307
1972		9 472		0	9 472
1973		9 632		0	9 632
1974		9 786		0	9 786
1975		9 964		0	9 964
1976		10 138		0	10 138
1977		10 309		0	10 309
1978		10 552		0	10 552
1979		10 833		0	10 833
1980		11 113		0	11 113
1981		11 412		0	11 412
1982		11 700		0	11 700
1983		11 816		0	11 816
1984		11 702		0	11 702
1985		11 239		0	11 239
1986		10 178		0	10 178
1987		10 047		0	10 047
1988		10 368		0	10 368
1989		10 715		0	10 715
1990	4	14 739	0,5	2 430	17 169
1991	4	14 905	0,5	2 394	17 299

1992	4,1	12 235	0,5	2 510	14 745
1993	4,1	11 915	0,5	2 337	14 252
1994	4	12 130	0,6	3 029	15 159
1995	4,6	13 834	0,6	3 825	17 659
1996	4,4	12 550	0,6	3 487	16 037
1997	5	13 023	0,6	3 123	16 146
1998	5,2	14 725	0,6	3 575	18 300
1999	5,5	13 422	0,6	2 603	16 024
2000	5,7	12 787	0,6	2 593	15 379
2001	6,3	10 461	0,7	3 545	14 006
2002	6	9 555	0,6	2 668	12 224

Recalculation from waste category to waste material

Plastics

	Household waste		Business waste		Textiles	Sum
Year	%	Amount	%	Amount	Amount	
		Mg		Mg	Mg	Mg
1945	2	4 614	3	7 959	3 460	16 033
1946		4 761		8 213	3 571	16 544
1947		4 914		8 477	3 685	17 076
1948		5 066		8 739	3 799	17 604
1949		5 215		8 997	3 912	18 124
1950		7 119		12 280	5 339	24 739
1951		7 285		12 567	5 464	25 315
1952		7 455		12 859	5 591	25 904
1953		7 630		13 161	5 722	26 513
1954		7 807		13 467	5 855	27 130
1955		7 988		13 780	5 991	27 759
1956		8 168		14 090	6 126	28 383
1957		8 346		14 397	6 260	29 003
1958		8 526		14 707	6 395	29 628
1959		8 705		15 016	6 529	30 250
1960		10 430		17 992	7 823	36 245
1961		10 622		18 323	7 966	36 911
1962		10 817		18 659	8 113	37 588
1963		11 009		18 990	8 257	38 256
1964		11 203		19 325	8 402	38 931
1965	4	22 804	6	39 338	8 552	70 694
1966		23 212		40 041	8 705	71 958
1967		22 734		40 319	8 525	71 579
1968		22 260		40 603	8 347	71 210
1969		22 691		41 346	8 509	72 546
1970		24 400		44 295	9 150	77 845
1971		24 819		45 017	9 307	79 143
1972		25 259		45 777	9 472	80 508
1973		25 687		46 514	9 632	81 834
1974		26 097		48 289	9 786	84 173
1975		26 572		49 936	9 964	86 472
1976		27 036		51 555	10 138	88 729
1977		27 490		53 163	10 309	90 962
1978		28 138		54 762	10 552	93 451
1979		28 888		56 348	10 833	96 069
1980		29 636		57 933	11 113	98 682
1981		30 433		60 104	11 412	101 949
1982		31 201		62 303	11 700	105 204
1983		31 510		64 517	11 816	107 843
1984		31 206		66 165	11 702	109 073
1985		29 970		67 137	11 239	108 346
1986		27 142		64 786	10 178	102 107
1987		26 791		64 036	10 047	100 874
1988		27 649		61 854	10 368	99 871
1989		28 572		60 237	10 715	99 523
1990	8	58 958	8	77 755	17 169	153 882

1991	8,3	61 856	8,6	82 337	17 299	161 492
1992	8,8	52 522	8,5	85 332	14 745	152 600
1993	9,4	54 635	8,7	81 325	14 252	150 211
1994	9,5	57 617	8,9	89 867	15 159	162 643
1995	9,8	58 946	8,9	113 470	17 659	190 075
1996	10,3	58 757	9,7	112 746	16 037	187 540
1997	11,3	58 865	9,6	99 938	16 146	174 949
1998	11,8	66 828	9	107 238	18 300	192 366
1999	12,5	61 007	9,8	85 017	16 024	162 048
2000	12,8	57 428	10	86 421	15 379	159 229
2001	13,9	46 161	10,8	109 403	14 006	169 570
2002	13	41 407	10	88 939	12 224	142 570