NEWSPRINT
A LIFE CYCLE STUDY

AN INDEPENDENT ASSESSMENT OF THE ENVIRONMENTAL BENEFITS OF RECYCLING AT AYLESFORD NEWSPRINT COMPARED WITH INCINERATION

Consultant:

ECOBILAN GROUP
ECOBALANCE UK

Commissioned by:

Aylesford Newsprint
An SCA Graphic Paper and
Mondi Minorco Paper company

FOREWORD

Newspapers and magazines that have been read usually end up in one of three places; in a recycling bank, an incinerator or buried in a landfill site.

Instinctively, people believe that the best of these options is to recycle. The least attractive and most wasteful is to landfill it. If used newspapers and magazines cannot be recycled, surely the best thing is to incinerate them to recover the energy.

At Aylesford Newsprint where we produce 100% recycled newsprint from used newspapers and magazines, we have had these opinions tested fully by independent experts. Ecobalance has carried-out a detailed Life Cycle Assessment at our mill to establish the environmental impacts of both recycling and incineration on the environment.

Ecobalance has concluded that using Aylesford Newsprint's process, recycling is preferable to incineration.

The Study develops our understanding of the environmental advantages of recycling. More importantly, we feel the findings should add to the public's confidence in recycling. Other studies have, we believe, made the economic case for recycling over incineration.

However, we feel strongly that recycling and incineration with energy recovery can co-exist. It makes economic and environmental sense to recover energy by incineration where material is contaminated damaged or commercially exhausted.

Our view is that there is a natural progression from forest to fibre to recycling to incineration which is sustainable and environmentally valid.

Preference for recycling should not detract from the importance of incineration as an ultimate disposal option.

ALAN S McKENDRICK
Chief Executive
Aylesford Newsprint Limited

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THE STUDY

Aylesford Newsprint Limited (ANL) commissioned Ecobalance UK to prepare a study of the specific environmental impacts of recycling at Aylesford compared to incineration with energy recovery. A Life Cycle Assessment (LCA) approach has been used to investigate environmental inputs and outputs and associated environmental impacts of the alternative options for the disposal of one tonne of used newspapers and magazines. The options are:

i) Recycling of used newspapers and magazines into quality newsprint at Aylesford Newsprint Limited; and

ii) Incineration of used newspapers and magazines to produce electricity for the UK national grid.

A "gate to grave" system boundary was used for the Study as the alternatives have a common origin up to the point of disposal. Consistent with LCA best practice, an additive systems approach has been used requiring a balancing of the physical outputs. The following combinations are the basis for the Study (Figure 1):

Production of newsprint at ANL plus UK national grid plus equivalent electricity generation at other newsprint mills;

Production of newsprint at other newsprint mills plus incineration with energy recovery plus equivalent electricity generation at ANL.

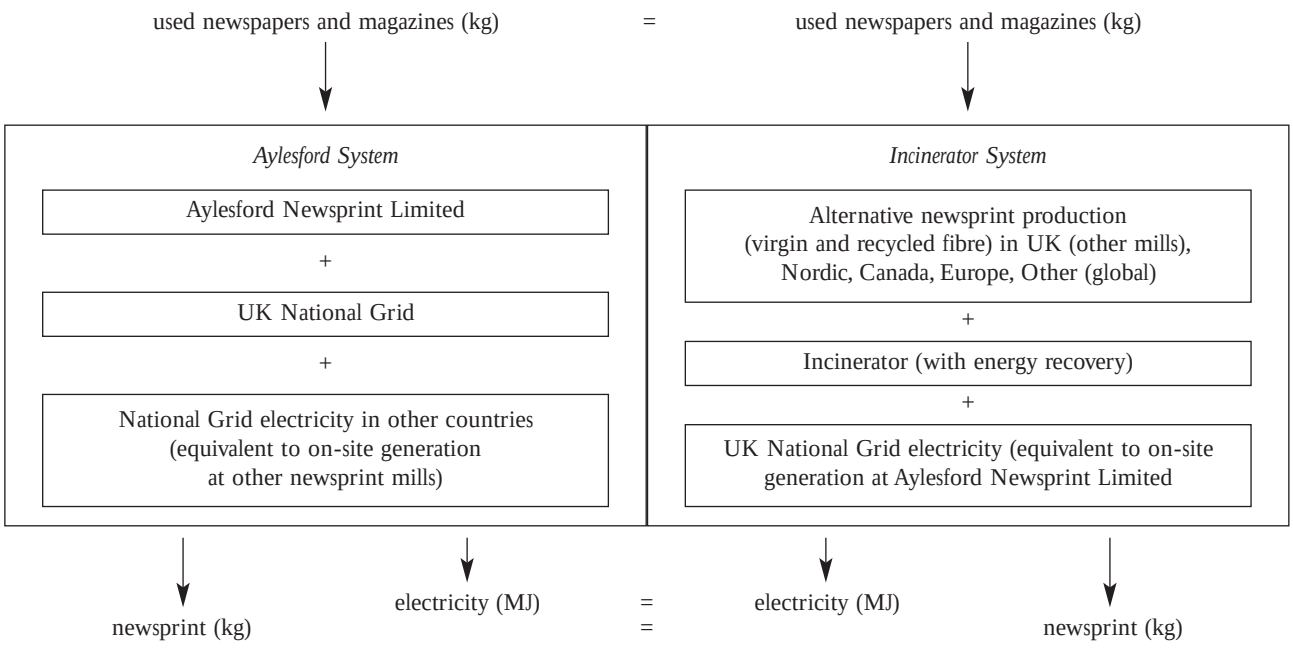
Both newsprint production and energy generation are therefore balanced and the production of newsprint at other mills has been set following an assessment of the current market. Production of electricity by the incinerator is balanced by equal electricity production for the UK national grid.

ANL generates electricity on site which offsets the need to obtain that electricity from the national grid. This is balanced by the equivalent electricity which would be obtained from the UK national grid. A similar assumption has been made of the other newsprint producers.

Proprietary data was collected using questionnaires as well as literary data all of which were assessed for quality prior to use in the LCA. Aggregated data were used from the Ecobilan Group DEAM (Data for Environmental Analysis and Management) Database.

Life Cycle inventories were generated and assessed using inventory analysis and problem oriented impact assessment. Additionally, Ecobalance UK has undertaken a separate analysis to look at the environmental impact of chemical use.

Figure 1 An Illustration of the Additive Systems Approach as used in this Study



CONCLUSION

The conclusions which can be made for the Study are:

Recycling of used newspapers and magazines at ANL is environmentally preferable to their incineration for energy recovery.

The emission of nitrogen oxides as a result of transport for recycling at ANL is less than the emission of nitrogen oxides emissions associated with transport to an incinerator plus material transportation (used paper and trees) to other newsprint mills;

Use of chemicals at ANL does not make a significant contribution to the environmental impact of newsprint production at ANL.

Recycling and incineration with energy recovery have a negligible impact on stratospheric ozone depletion.

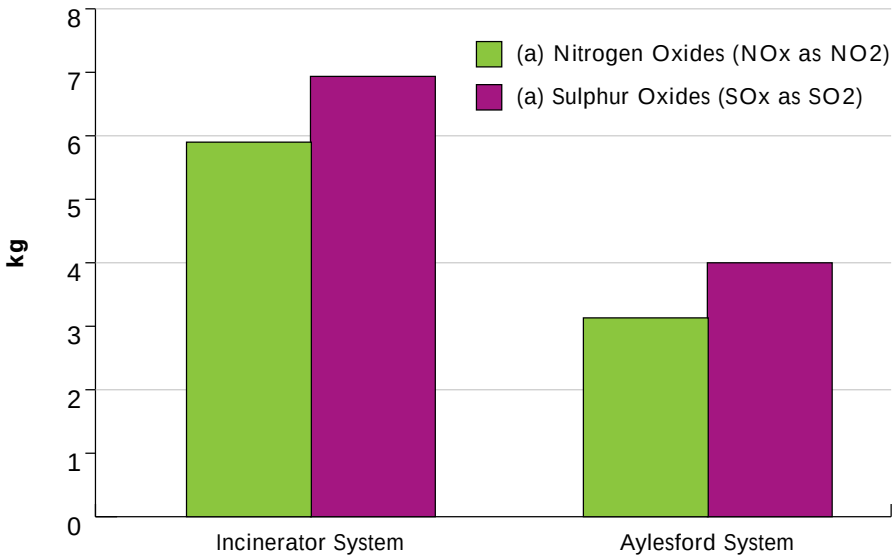
KEY FINDINGS

The main findings of the inventory analysis are as follows:

KEY FINDING 1

The Aylesford System releases less sulphur oxides and nitrogen oxides than the Incinerator System (Figure 2);

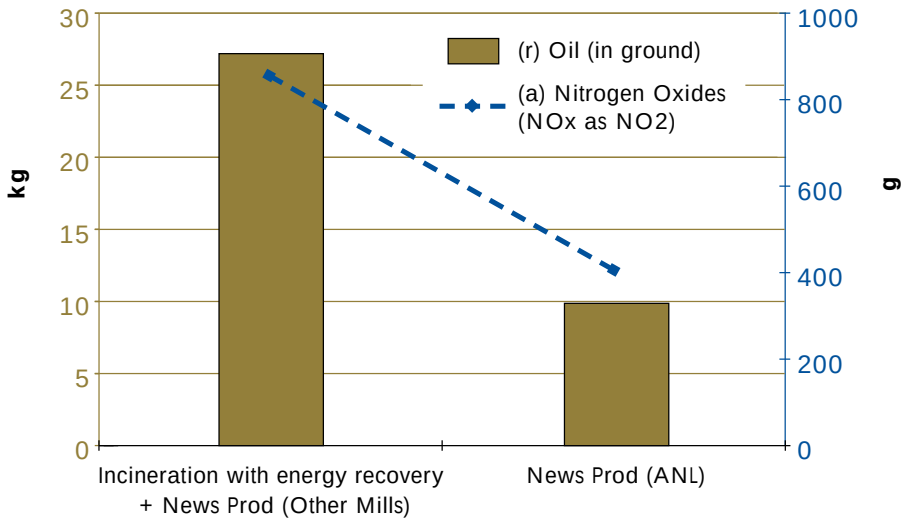
Figure 2 **Total Emissions of Sulphur Oxides and Nitrogen Oxides by the Incinerator and Aylesford Systems (kg)**



KEY FINDING 2

Recycling of newsprint at ANL generates less nitrogen oxides as a result of transport compared to the Incinerator System. The emissions of nitrogen oxides in the Incinerator System arise primarily from transport of raw material to the other newsprint mills (Figure 3);

Figure 3 **Comparison of Transport in the Aylesford System and Incinerator System for the Emission of Nitrogen Oxides (g) and Oil Depletion (kg)**



KEY FINDING 3

The Aylesford System releases less nitrogenous matter, suspended matter, and generates a smaller Chemical Oxygen Demand (COD) than the Incinerator System, but does produce more phosphates (Figures 4 and 5);

Figure 4 **COD and Emissions of Suspended Matter from the Components of the Incinerator and Aylesford Systems (kg)**

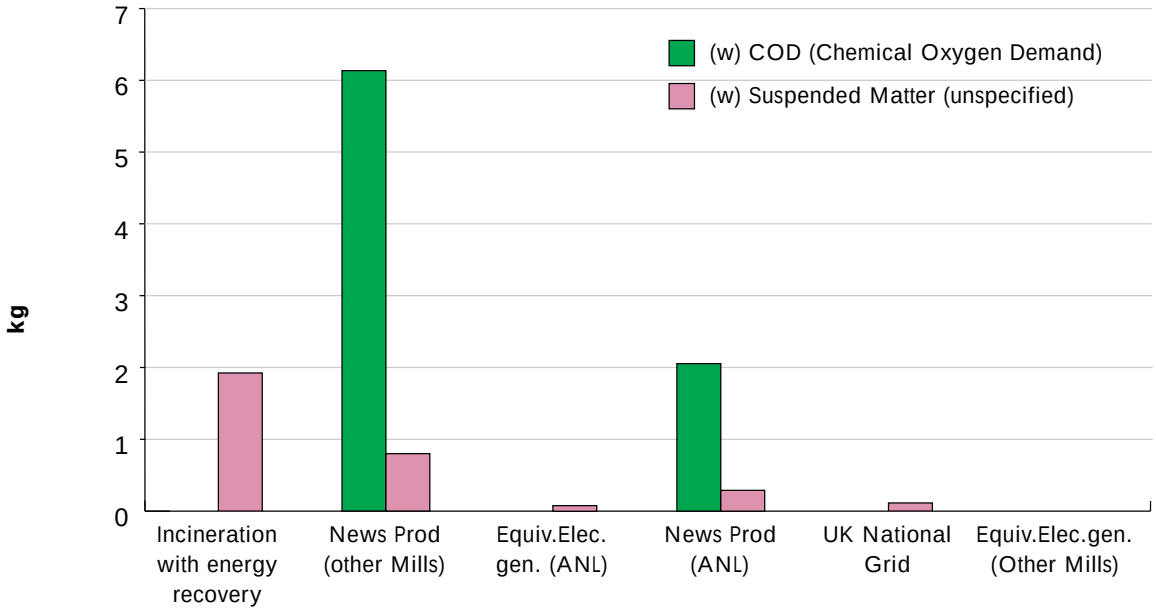
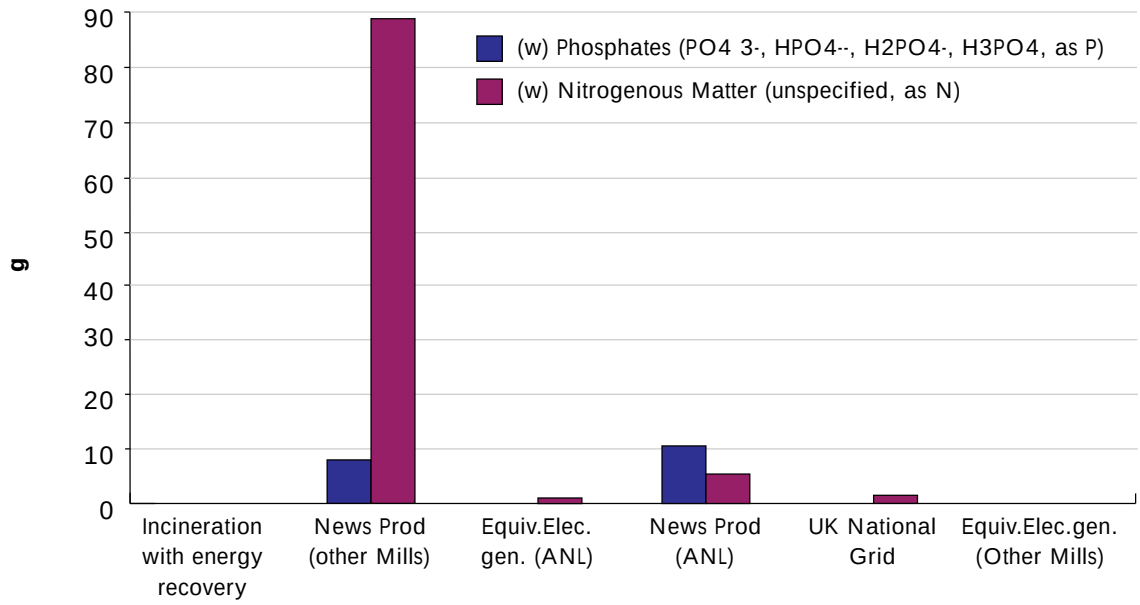


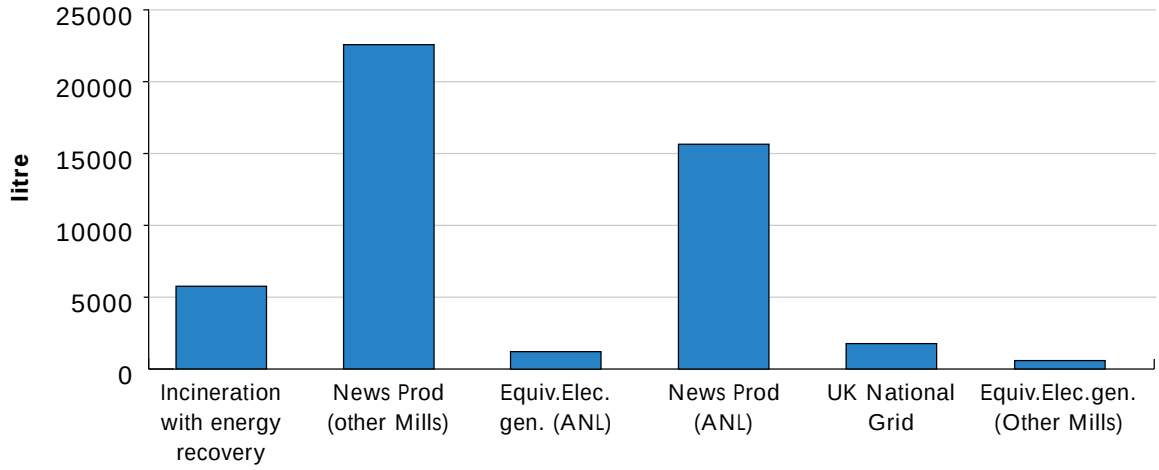
Figure 5 **Emissions of Phosphates and Nitrogenous Matter from the Components of the Incinerator and Aylesford Systems (kg)**



KEY FINDING 4

The Aylesford System uses less water than the Incinerator System (Figure 6).

Figure 6 **Water Use by Component Systems of the Incinerator System and Aylesford System (litres)**



KEY FINDING 5

The Aylesford System has a lower total primary energy than the Incinerator System (Table 1);

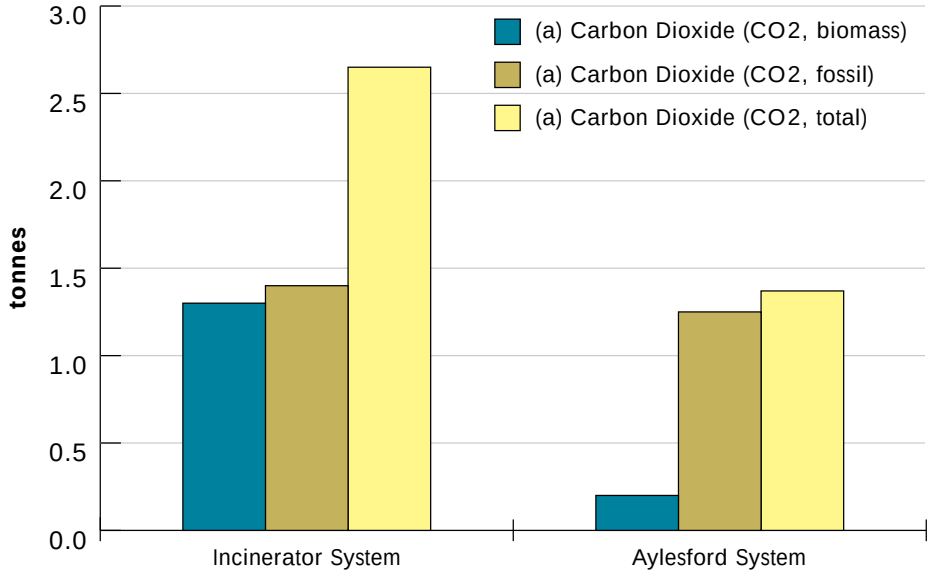
Table 1 **Division of Total Primary Energy (GJ)**

	Incinerator System	Aylesford System
E Feedstock Energy	16.5	16.0
E Fuel Energy	39.9	20.2
E Non Renewable Energy	23.9	21.0
E Renewable Energy	32.5	15.2
E Total Primary Energy	56.4	36.2

KEY FINDING 6

The Aylesford System generates less total carbon dioxide than the Incinerator System. Emissions of carbon dioxide from fossil fuel sources are less for the Aylesford System (11%);

Figure 7 **Carbon Dioxide Emissions to Atmosphere (tonnes)**



KEY FINDING 7

The Aylesford System consumes less resources (by mass) and specifically, less hydrocarbons (coal, lignite, oil and natural gas) (Table 2 and Figure 8);

Figure 8 **Unweighted Total Hydrocarbon Depletion (kg)**

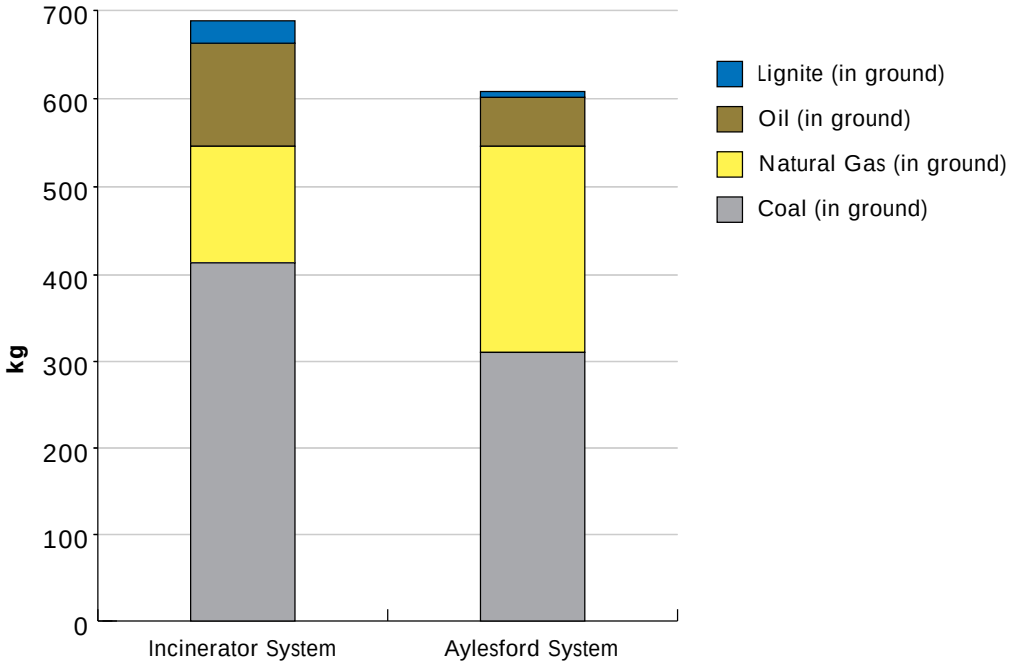


Table 2 **Unweighted Raw Material Depletion (kg)**

	Incinerator System	Aylesford System
Coal (in ground)	420	320
Natural Gas (in ground)	146	251
Oil (in ground)	97	36
Lignite (in ground)	32	4
Uranium (U, ore)	0.021	0.011
Iron (Fe, ore)	1.2	0.9
Limestone ($CaCO_3$, in ground)	80.4	55.9
Bauxite (Al_2O_3, ore)	0.5	0.3
Clay (in ground)	3.7	0.2

The main findings for the Problem Oriented Impact Assessment were as follows:

KEY FINDING 8

Recycling at ANL has less impact on the Greenhouse Effect (17% less over 20 years and 15% less over 100 years) (Figures 9 and 10);

Figure 9 **IPCC - Direct Impact on the Greenhouse Effect over a 20 year period (tonnes eq CO_2)**

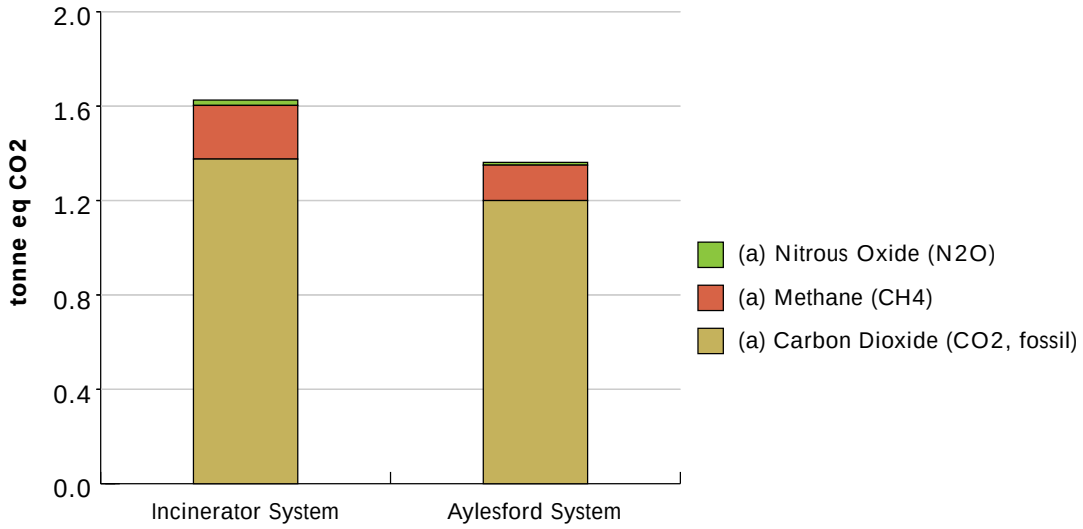
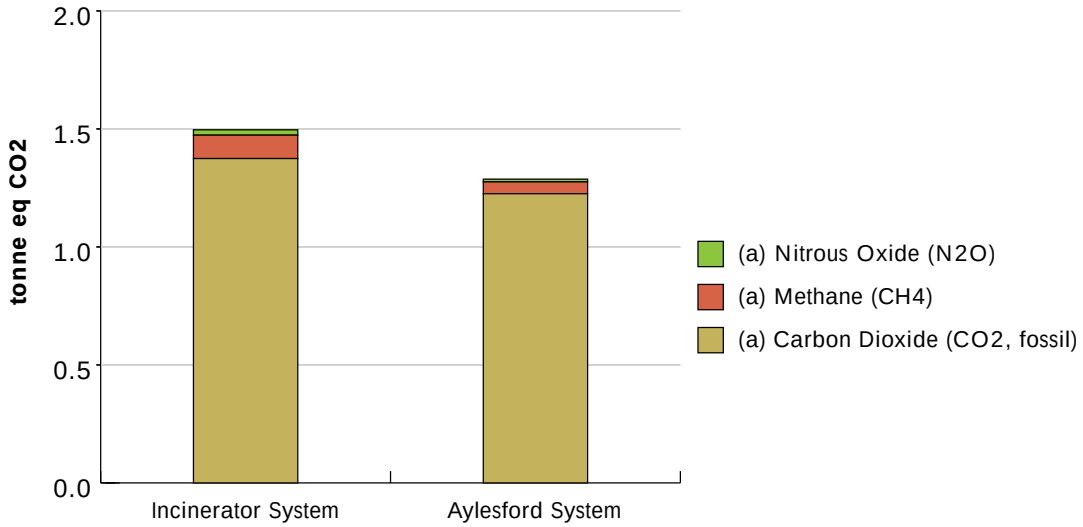


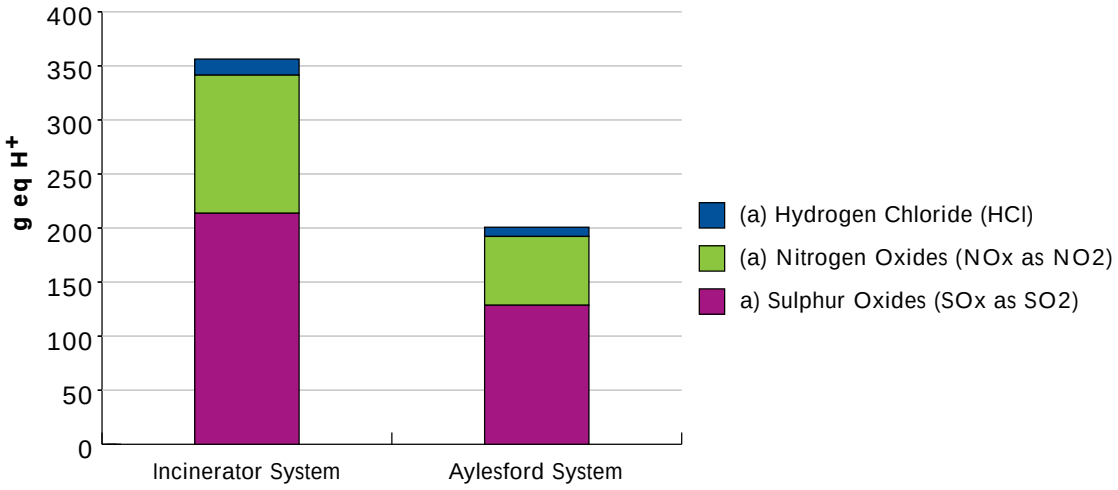
Figure 10 **IPCC - Direct Impact on the Greenhouse Effect over a 100 year period (tonnes eq CO_2)**



KEY FINDING 9

Recycling at ANL has less of an environmental impact and is therefore environmentally preferable in terms of impact on air acidification (Figure 11);

Figure 11 CML - Impact on Air Acidification (g eq H^+)



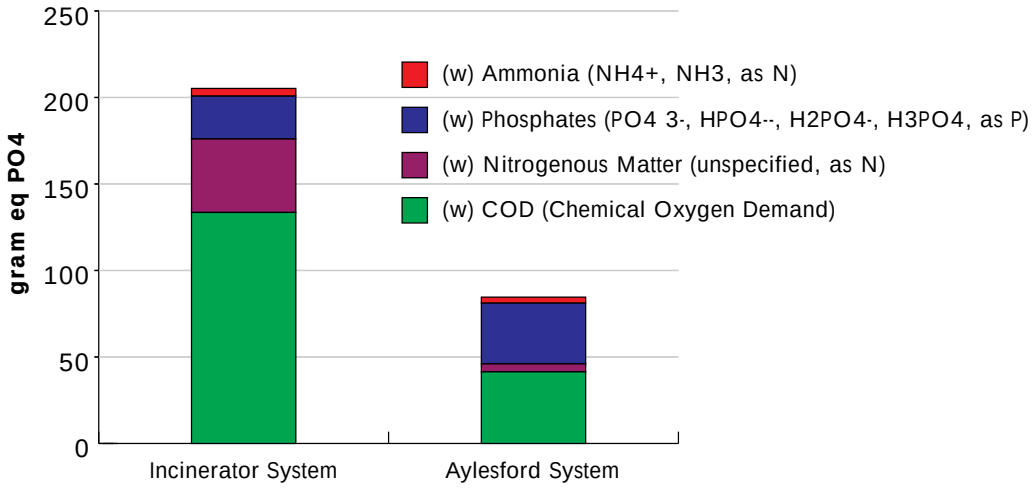
KEY FINDING 10

The impact of both systems is negligible when assessed for impact on stratospheric ozone depletion;

KEY FINDING 11

Recycling at ANL has less of an environmental impact and is therefore environmentally preferable in terms of impact on eutrophication of water (Figure 12);

Figure 12 CML - Eutrophication of Water (g eq PO_4^{3-})



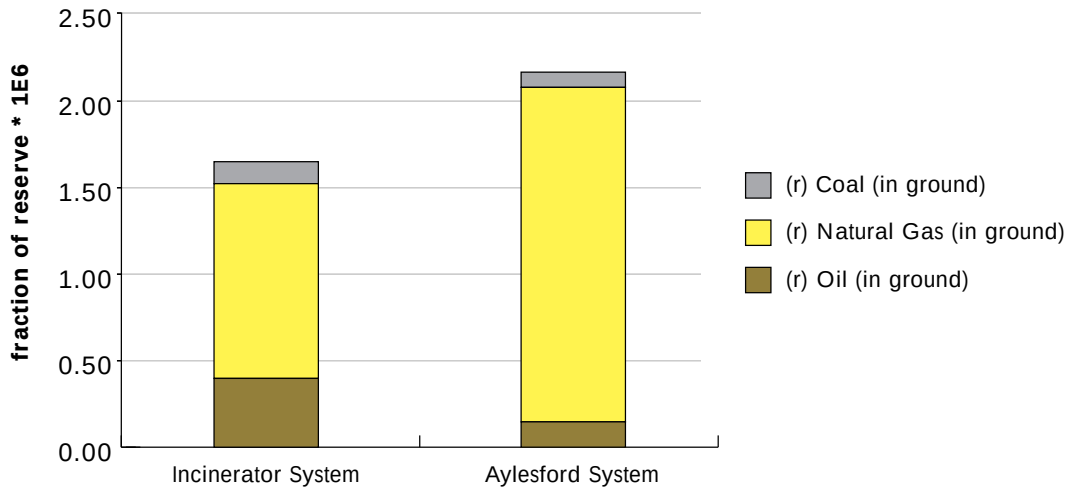
KEY FINDING 12

An impact assessment for non renewable resource depletion has been undertaken using two methodologies, these being fraction of reserve (which takes into account the size of the available reserve) and kg/yr (which takes into account the lifetime of the available reserve by incorporating global annually averaged extraction rates). Using a fraction of reserve methodology produces a smaller environmental impact for the Aylesford System in terms of total resources, but produces a less favourable result when the analysis is restricted to hydrocarbons only (due to the greater use of natural gas in the Aylesford System) (Table 3 and Figure 13 respectively)

Table 3 Ecobilan Group - Impact of Depletion of Non Renewable Resources (fraction of reserve x 10^6)

Main Contributors	Incinerator System		Aylesford System	
	Total	Relative	Total	Relative
Total	3.24		3.03	
(r) Uranium (U, ore)	1.53	47.3%	0.815	26.9%
(r) Natural Gas (in ground)	1.12	34.6%	1.94	63.9%
(r) Oil (in ground)	0.41	12.6%	0.15	5.0%
(r) Coal (in ground)	0.14	4.4%	0.11	3.5%
(r) Iron (Fe, ore)	0.018	0.5%	0.0098	0.3%
(r) Bauxite (Al_2O_3, ore)	0.012	0.4%	0.0091	0.3%

Figure 13 Ecobilan Group - Impact of Depletion of Hydrocarbon Reserves (fraction of reserve x 10^6)



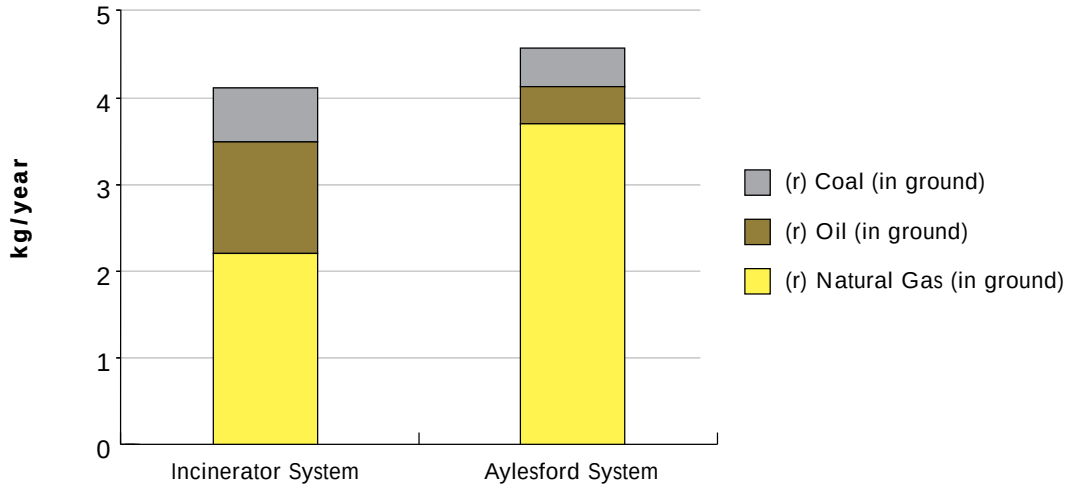
KEY FINDING 13

Using a kg/yr methodology, the Aylesford System is less favourable in terms of total resources used (Table 4) and hydrocarbons (Figure 14), due to its consumption of natural gas;

Table 4 Ecobilan Group - Impact of Depletion of Non Renewable Resources (kg/yr)

Main Contributors	Incinerator System		Aylesford System	
	Total	Relative	Total	Relative
Total	4.15		4.78	
(r) Natural Gas (in ground)	2.21	53.3%	3.81	79.7%
(r) Oil (in ground)	1.31	31.5%	0.48	10.0%
(r) Coal (in ground)	0.63	15.2%	0.48	10.0%
(r) Iron (Fe, ore)	0.0052	0.1%	0.0039	0.1%
(r) Bauxite (Al_2O_3, ore)	0.0019	0.0%	0.0011	0.0%
(r) Phosphate Rock (in ground)	0.0002	0.0%	N/A	0.0%
(r) Uranium (U, ore)	0.00005	0.0%	0.00003	0.0%

Figure 14 **Ecobilan Group - Impact of Depletion of Non Renewable Resources (kg/yr)**



KEY FINDING 14

The environmental impact of newsprint production at ANL is not significantly affected by use of chemicals for all impact methodologies used (Table 5). The largest contribution made by chemicals use is for air acidification (less than 30%) and the smallest for eutrophication of water (less than 2%)

Table 5 **Contribution of Chemical Use at ANL to the Newsprint Production at ANL System (kg eq CO_2)**

	News Prod (ANL)	Chemicals Used (ANL)	Relative contribution
IPCC-Greenhouse effect (direct, 100 years)			
Total	500	59	11.9%
(a) Carbon Dioxide (CO_2, fossil)	485	55	11.4%
(a) Methane (CH_4)	4	3	62.2%
(a) Nitrous Oxide (N_2O)	11	1	12.0%
IPCC-Greenhouse effect (direct, 20 years)			
Total	505	63	12.5%
(a) Carbon Dioxide (CO_2, fossil)	484	55	11.4%
(a) Methane (CH_4)	11	7	62.2%
(a) Nitrous Oxide (N_2O)	10	1	12.0%

KEY FINDING 15

The Aylesford System is environmentally preferable compared to the Incinerator System for the Environmental impact of Chemicals use.

Table 6 **Impact Assessment Results for the Incinerator and Aylesford Product Systems**

Impact Assessment	Unit	Incinerator System	Aylesford System
CML-Air Acidification	g eq H^+	15 .7	14 .9
CML-Eutrophication (water)	g eq PO_4^{3-}	2 .0	1 .2
Ecobilan - Depletion of non renewable resources	frac. of reserve*10^6	0 .14	0 .12
Ecobilan - Depletion of non renewable resources	kg/yr	0 .22	0 .19
IPCC-Greenhouse effect (direct, 100 years)	kg eq CO_2	61	59
IPCC-Greenhouse effect (direct, 20 years)	kg eq CO_2	65	63

ABOUT THE STUDY

The Study considers the environmental effects of recycling used newspapers and magazines at Aylesford Newsprint compared to incineration in a state-of-the-art plant to produce electricity as an alternative waste management strategy.

The environmental impacts of producing newsprint from different fibre sources due to a different levels of recycling and the associated energy changes have been included in the Study. The benefit of on-site electricity generating and the related UK national electricity changes in emission levels have also been evaluated. Apart from the common origin of used newspapers and magazines, the entire production processes have been considered, including extraction, processing, transport and material used, and disposal of waste both before and after the specific process.

To quantify the environmental impacts of the alternative disposal option, Ecobalance UK used the technique of Life Cycle Assessment (LCA). This involved compiling detailed inventories of environmental input and output data including use of energy and raw materials and releases to air, water and land respectively, for each process or operation which formed part of the comparison. From the inventories generated, five discrete environmental impact categories were used to examine the relative environmental implications of the system compared. A full description of the LCA methodology and further information regarding the Study can be found in the technical report.

The environmental impact categories investigated are:

GREENHOUSE EFFECT

An examination of those releases which contribute to the phenomenon known as global warming. That is, the potential for a global average increase in temperatures and, more generally, climate change to affect ecosystems, agricultural output and patterns of disease. Possible consequences include rising sea levels and flooding of many low-lying areas causing widespread damage, death and loss of habitat and productive land.

AIR ACIDIFICATION

An examination of the releases which contribute to acid rain. Acid rain can cause acidification of lakes, killing fish and other aquatic species as well as defoliation of trees.

EUTROPHICATION OF WATER

Pollution of water by increasing levels of compounds such as phosphates, ultimately rendering unsuitable for drinking or supporting aquatic life.

USE OF NON-RENEWABLE RESOURCES

Resources that are, by definition, finite in supply and therefore there is a need to minimise use as far as possible.

ABOUT LIFE CYCLE ASSESSMENT

Life Cycle Assessment (commonly referred to as 'LCA') is an environmental management tool which quantifies the use of raw materials and energy and releases to air, water and land across each stage of the 'life cycle" spanning extraction of raw materials from the ground/forestry through manufacture, distribution, use and final disposal. Using this information, the 'environmental inputs and outputs' are used as measures of environmental impact such as contribution to global warming, ozone layer depletion and acidification as well as parameters such as the depletion of renewable and non-renewable resources.

LCA methodology is currently the subject of standardisation with ISO (International Organisation for Standardisation) standards covering the different elements of the methodology. In addition, there are a number of reference documents which similarly aim to describe LCA methodology such as the Society

of Environmental Toxicology and Chemistry (SETAC) 'Code of Practice' for Life Cycle Assessment.

LCA is regarded by many as the most rigorous scientific discipline available for quantifying environmental impacts. In particular, one of LCA's main advantages is that it seeks to take into account a broad array of environmental aspects spanning the complete 'life cycle' associated with a given 'system' (ie., the activities to which the technique is applied). Moreover, its scope is not limited by single issues taken in isolation. Common to all research studies, both the results and conclusions of LCA determinations are specific to the methodology employed: the assumptions are clarified where appropriate, while the data sources are fully referenced. This means that where studies take generic data, resulting observations and conclusions are necessarily general.

To apply LCA methodology to the waste management options considered in this Study, it was assumed that the environmental inputs and outputs and impacts associated with those processes prior to the paper becoming waste were common in each case ñ and these were therefore not investigated as part of this Study. This is consistent with best practice LCA methodology.

Further, it was recognised in this Study that in order to compare the alternative 'systems', it was necessary to examine not only the final product of recycling, (in this case newsprint) but also the 'final product' of incineration with energy recovery where the 'output' is energy in the form of thermal heat used to generate electricity.

This means that to compare 'recycling' with 'incineration with energy recovery', it is necessary to ensure that the systems are always equivalent in respect of material and energy outputs; ie., each system examines the same amount of newsprint and energy, in this case, electricity.

Accordingly, to compare the environmental impacts associated with recycling a given quantity of used newspapers and magazines at Aylesford Newsprint with incinerating with energy recovery, it is necessary to render each system equivalent in terms of material and energy outputs. This is achieved by:

in the case of recycling used newspapers and magazines adding the environmental inputs and outputs associated with energy production from the UK national grid for that quantity of energy that would be generated by incinerating the used newspapers and magazines to the Aylesford Newsprint production of newsprint (in this Study, referred to as the 'Aylesford system'); and, in the case of the incineration with energy recovery system, adding the environmental inputs and outputs associated with newsprint production from an alternative source. This case is assumed to be a mix of mills from the UK and abroad which might provide newsprint to Aylesford Newsprint's existing customers if Aylesford Newsprint was not to have been built (in this case, referred to as the 'Incinerator system').

Data for this project were obtained from Aylesford Newsprint, SCA Graphic Paper, The Paper Federation of Great Britain and through use of the Ecobilan Group's own database. The assumptions concerning the 'mix of mills' for the incineration with energy recovery system were validated with a number of organisations in the pulp and paper industry and take account of both virgin and recycled newsprint production, 'local' fuel mixes including on-site energy generation and also transport to the UK to reach the same customers serviced by Aylesford Newsprint presently.

With regard to incineration with energy recovery, it was assumed that emissions were the same as those in force in Germany as these are the strictest within the European Union.

The reference value (ie., 'functional unit') using LCA terminology selected for the presentation of the results was 1000 kg of used paper disposed (where 'paper' refers to newspapers and magazines). This meant that when adding in environmental inputs and outputs associated with virgin production, account was taken of material losses through production occurring as a consequence of removal of ink particles as well as other residues such as staples. This approach served to ensure that production data were normalised in respect of environmental inputs and outputs and impacts required to produce an equivalent amount of newsprint from recycling 1000 kg of used newspapers and magazines.

For more detail concerning this aspect of LCA methodology, readers are referred to the full report describing the methodology and results of this study, available from Aylesford Newsprint.