Environmental Studies
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Waste : - Incinerate or Landfill?

In every country in Europe, waste production has increased every year for the last five years. In 2003, every individual in Western Europe produced 470 kg of municipal waste**.**

The majority of this waste was put in large holes in the ground (landfill) or was incinerated.

The problems with landfill and incineration

The European Union disposes of 60% of its waste in landfills because, by most economic measures, landfill is the 'cheapest' way of disposing of it (Table 1).

Table 1. Where does Europe's waste go?

Country	Landfill	Incineration	Composting	Recycling	Other
Belgium	39	52	2	7	-
Denmark	18	58	1	22	1
France	45	45	6	4	-
Germany	42	25	10	22	1
Greece	94	-	-	6	-
Ireland	99	-	-	1	-
Italy	85	7	-	4	4
Luxembourg	24	47	1	28	-
Netherlands	40	28	15	17	-
Portugal	35	-	10	1	54
Spain	83	6	10	1	-
UK	85	10	-	5	-
Total	58	22	5	10	5

So, there are large differences in the proportion of waste which is landfilled, incinerated and recycled within Europe. Equally, the composition of that waste also varies greatly (Table 2)

Table 2 What's in Europe's waste?

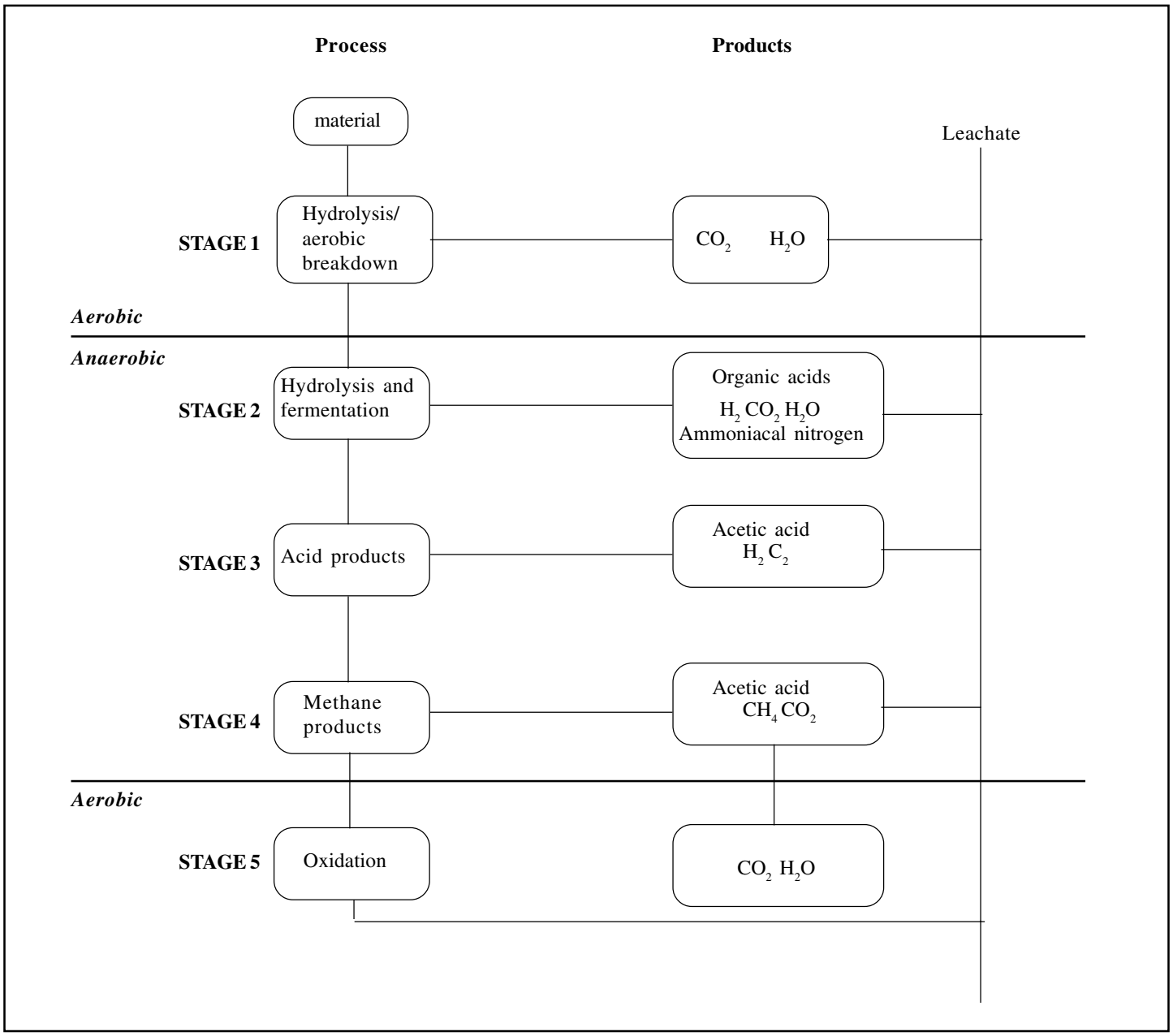
Country	Organics	Paper/Board	Glass	Metals	Plastics	Textiles	Other
Belgium	43	28	9	4	7	9	
Denmark	37	30	6	3	7	18	
Germany	32	24	8	5	9		22
France	21	27	7	4	11	2	28
Greece	49	20	5	4	9	13	
Ireland	42	15	6	4	11	8	14
Italy	32	27	8	4	7	3	19
Luxembourg	41	16	4	3	8	3	25
Netherlands	39	25	8	5	8	15	
Portugal	39	20	4	2	9	5	21
Spain	44	21	7	4	11	5	8
Uk	20	33	9	8	6	4	20

Landfill is only considered the cheapest approach because the economics of waste disposal do not yet fully take environmental costs into account. The major environmental problems associated with landfill are:

- When **biodegradable** matter (paper, food waste and garden waste) decomposes in anaerobic conditions i.e. without oxygen, as is the case in a landfill site, methane (CH_4) is given off. This is 21 times more powerful as a greenhouse gas than carbon dioxide. The methane may also seep into buildings where it represents a fire and explosive risk or into sewers or manholes where it may cause asphyxiation of workers.
- Some parts of the landfill site are not anaerobic so carbon dioxide is also given off- a greenhouse gas.
- Leachates from the landfill can contaminate aquifers (underground water stores). Unfortunately, the measures used to try to reduce the escape of gases and leachates (liner systems, waste compaction and capping) have also stopped oxygen entering and this has increased the generation of methane in landfill sites.
- Noise, smell and vermin

The breakdown of wastes in a landfill site is a complex process so the volumes and sequence of gas emissions can be difficult to predict. (Fig.1).

Fig 1. Breakdown of material in a landfill



In managed sites, the aim is to contain the methane and draw it off safely. This can be done by vertical wells or horizontal perforated pipes laid in gas permeable trenches distributed throughout the wastes. These wells or trenches are connected to a gas ring main and the gas is piped to a central blower/fan or gas compressor unit.

Once the gas is collected at a central point, it is then possible to burn the gas in a flare or use it for energy recovery, either through direct use of the gas or through electricity production.

So what about the alternative - incineration?

The major environmental problems are:

- Air pollution – carbon dioxide, sulphur dioxide, nitrogen dioxide, nitrous oxide, chlorine, dioxin and particulates. In turn, these lead to a host of other environmental problems – acid rain, smogs, lung disease etc.
- The volume of traffic generated – again leading to greater air pollution, noise, vibration and accidents
- The ash which results (usually equal to 20-30% of the mass of the original waste) is often toxic and still needs to be disposed of in landfill.
- High capital cost of building the incinerator

So both approaches have problems. However, if we assume, for the moment, that global warming represents the greatest environmental threat, then the release of methane from landfill is perhaps the crucial factor in determining whether we should incinerate or landfill.

All members of the EU have now agreed to significantly reduce the proportion of biodegradable waste that is landfilled. This will take 5-10 years to be effected.

How are they going to do this?

Through a variety of approaches, including:

1 waste reduction
2 increased re-use and recovery of organic wastes
3 pre-treatment of wastes to reduce the degradable organic fraction going to landfill, including:
   - composting
   - anaerobic digestion
   - incineration
   - recycling (paper, textiles)

All four options are already used to varying degrees throughout the EU but they will all become more important and this will affect every household in Europe. In other words, it will soon be compulsory to do more than throw our waste in the bin!

However, even if waste reduction, re-use and recovery becomes the norm, there will probably always be some waste that will require incineration or landfill either because a suitable recovery route has not been found, or because the waste is contaminated.

Environmentally, the priorities for the management of waste are:

- **Reduce** – both in production processes and in terms of what the consumer does with the product
- **Re-use**. There are two types of re-use. The first is where products are designed to be used a number of times before becoming obsolete, eg milk bottles. The second form of re-use occurs where new uses are found for items eg old tyres used as boat fenders.
- **Recycle or compost**. Recycling involves processing waste to produce a useable raw material or product.
- **Recovery of energy** –incineration or anaerobic digestion.
- **Dispose**

In terms of reducing methane production, **paper recycling** is crucial.

Huge volumes of waste paper are already used in paper and board manufacture throughout the European Union (Table 3).

Table 3. EU waste paper utilisation rates (2000)

Member State	Waste Paper Utilisation '000 tonnes	Utilisation Rate %
Austria	1,642.2	43.0
Belgium	448.0	30.1
Denmark	410.0	122.4
Finland	608.8	5.0
France	4,466.7	48.9
Germany	9,414.0	59.1
Greece	275.0	79.3
Ireland	54.0	124.4
Italy	3,657.5	48.6
Neverland	2,301.0	73.0
Portugal	322.0	29.8
Spain	3,032.0	76.4
Sweden	1,652.0	18.9
United Kingdom	4,618.1	71.5
Total EU	**32,901.5**	**43.7**

To summarise so far: Both landfill and incineration have environmental problems or costs. Both too, have benefits. **Cost – Benefit Analysis (CBA)** is an economic tool which can be used to help us choose between these two alternative ways of disposing of our waste. To do this we add up the:

- costs of incineration
- benefits of incineration

and take one from the other. This gives us the ***net cost or benefit***.
For example, let us assume that the total cost of all the types of pollution caused by incineration is £100million.
The benefits add up to £4 million.
So, the net cost is £96 million

We can now compare this to the net cost/benefit of landfill.
Let's assume that the total cost of all the types of pollution caused by landfill is £75million.
The benefits add up to £1million.
So, the net cost is £74 million

Comparing the two alternatives, the ***net cost*** of landfill is less than the ***net cost*** of incineration, so using this CBA, we would be better off choosing landfill.

> **NOTE:** These figures are completely made-up! As you will see, trying to calculate accurate CBA figures so that we can make the right decision is not easy

How do we work out what the costs and benefits of something like incineration are? We need to put a real price (in pounds sterling or Euros) on each advantage (benefit) or disadvantage (cost).

Table 4 lists some of the costs and benefits of both incineration and landfill. To get some idea of the problems we'll just concentrate on analysing landfill.

Table 4. Costs and benefits of incineration and landfill

Costs	**Incineration**	**Landfill**
	Capital cost	Capital cost
	CO_2	CO_2
	CH_4	CH_4
	CO	
	SO_2	
	N_2O	
	Cl_2	
	Dioxins	
	Particulates	
	Heavy metals	
	Transport emissions	Transport emissions
	Accidents	Accidents
	Noise	Noise
	Smell	Smell
	Visual	Visual
	Ash	Leachates
Benefits	Energy recovery	Energy recovery
	Heavy metal recovery	

Looking at the costs of landfill:

The first cost is that of the land itself and of the construction stage. The second cost is that caused by the CO_2 emitted. Why does this represent a cost? Because it adds to global warming. Global warming means coastal erosion, flooding and death of crops, soil salinisation, drought leading to crop death, displacement of species such as elephants leading to increased conflict with farmers, increased poaching…….

For each of these – and a dozen more - economists have to put a monetary value and work out what fraction of that cost is due to the extra global warming which arose from the CO_2 that came out of the landfill site……. Not easy.

The same has to be done for the methane, which is a much more powerful greenhouse gas, and for all the other costs. Adding all these up will give an estimate of the cost of building and using a new landfill site.

We than have to estimate the benefit (in terms of pounds sterling or Euros) of the new landfill site. For example, some of the methane that is collected can be used to heat buildings. This means they need less heating by whatever they used before –let's assume it was electricity from a coal-burning power station. So by building the landfill site, we end up using less coal, mining less coal, transporting less coal, releasing less CO_2 (from the power station), so reducing global warming and releasing less NO_2/SO_2(from the power station) so we get less acid rain, less acidification of fisheries, more fish, more profit etc etc. Every one of these has to be given a monetary value.

Once all of that is done, we can calculate the ***net benefit/cost*** of the landfill.

Then we have to the same for the incinerator.

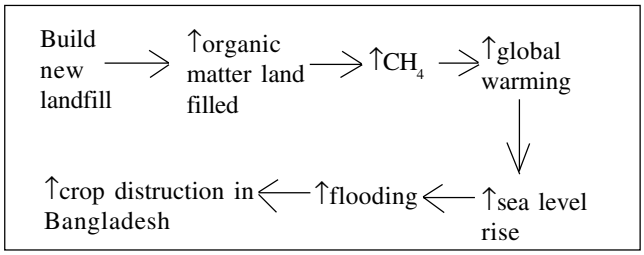
The whole situation is made worse because, as we have seen, the volume of CO_2.CH_4/NO_2 etc that is released from a landfill (and CO_2/Cl_2 etc from an incinerator) depends on many factors that keep changing. In the case of landfill, these factors include how much biodegradable material we put in it, the depth, temperature and moisture content of the material, how much is collected and burned and how much escapes. As EU legislation comes in, the proportion and nature of biodegradable material ending up in landfills will change.

So, one conclusion from all this is that if environmentalists are going to make the right decisions, they need to know some economics!

The exam

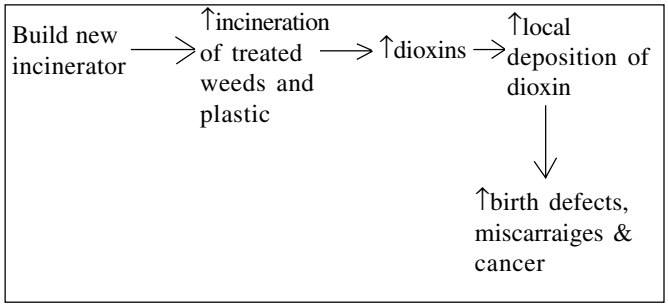
CBA will keep coming up in the exam! However, it will be pretty simple stuff. You will need to know the major advantages and disadvantages of, for example incineration and recycling (or, in a different context, wind farms versus a fossil-fuelled power station) and add up the costs and benefit figures that are provided. A decision to build a landfill site in Devon could lead to the death of a child from starvation in Bangladesh (Fig 4).

Fig 4.



Building an incinerator in Devon may not lead to the death of a child in Bangladesh, but it might lead to more children with birth defects in the local area (Fig 5). Appreciating that our decisions on what to do with our bin bags can have serious impacts thousands of miles away ***and*** on our own doorsteps is one of the useful skills ES gives us.

Fig 5.



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