

Evaluating waste incineration as treatment and energy recovery method from an environmental point of view



Aim and scope

- ▶ Map the research field of systems analysis of waste management
- ▶ Describe the environmental performance of incineration with energy recovery in systems analysis studies
- ▶ Identify key factors that largely determines/affects the outcome from the studies
- ▶ Based on a set of key factors, discuss and draw conclusions on the environmental benefits and drawbacks from using waste incineration in Europe

Methodology

- ▶ Mapping through research networks etc (around 70 relevant studies)
- ▶ Brief examination (31 case studies)
- ▶ Detailed examination (12 case studies)
- ▶ Identification of key factors (12 case studies + 9 “key factor studies”)
- ▶ Scenario analysis

Main results

- ▶ Landfilling is the main treatment option in Europe. It is also clearly the worst environmental option according to the system studies.
- ▶ Material recycling, waste incineration and biological treatment are *complementary* options that all need to be expanded in order to replace landfilling.
- ▶ To reach the best environmental results for material recycling and biological treatment of organic combustible material, waste incineration is necessary for treating residues arising during pre-treatment and processing at the material recycling facilities and the biological treatment plants.
- ▶ Due to different local conditions and opportunities for development, the distribution of waste being treated by material recycling, waste incineration and biological treatment must be allowed to vary.
- ▶ Regional differences will lead to different distributions being optimal for different regions in Europe.

Results from the brief examination (31 case studies)

- ▶ Material recycling and biological treatment are normally compared with incineration for separate fractions. Very few studies examine how all parts of the mixed waste should be treated if incineration is replaced.
- ▶ For well source-separated and clean material fractions, material recycling generally leads to lower environmental impacts than incineration.
- ▶ For organic waste, the choice between incineration, composting and anaerobic digestion is not obvious.
- ▶ Landfilling is the worst option in almost all studies.

Detailed examination (12 case studies)



- ▶ 11 case studies for regional/national conditions in 7 different countries (see distribution on the map)
- ▶ 1 case study for Europe (EU-15)

Results from the detailed examination of the 12 case studies

Table 3.5: Incineration versus composting

| Ref. | Waste fractions | Alternatives | GWP | Acidification | Eutrophication | Photooxidants | Toxicity |
|------|-----------------------|-------------------------------------|--------|---------------|----------------|---------------|----------|
| 5 | Food waste | Composting | Green | Green | Green | White | Red |
| 23 | Easily bio-degradable | Composting | Yellow | Yellow | Green | Yellow | White |
| 25 | Food waste | Composting base | Red | Green | Red | Green | Green |
| | | Composting Natural gas ¹ | Green | Green | Red | Green | White |
| | | Composting GWP, 20 yr ² | Green | Green | Red | Green | White |
| | | Composting GWP, 500 yr | Green | Green | Red | Green | White |

¹ In the base scenario, biomass is the alternative fuel for district heating. Here, natural gas is the alternative.

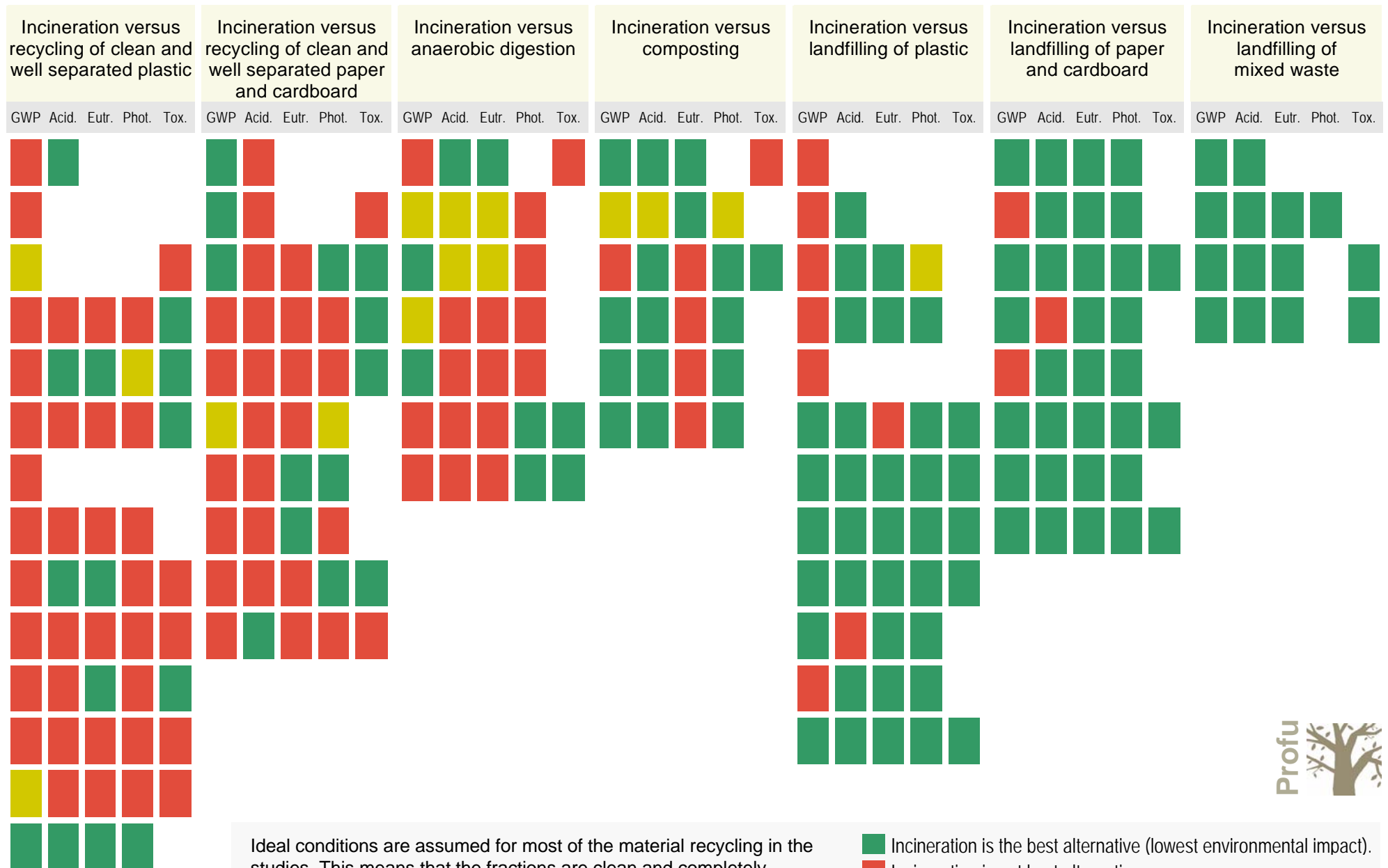
² In the base scenario, GWP factors for 100 years are used

■ Incineration is the best alternative (lowest environmental impact).

■ Incineration is not best alternative.

■ The difference between incineration and the alternative is small

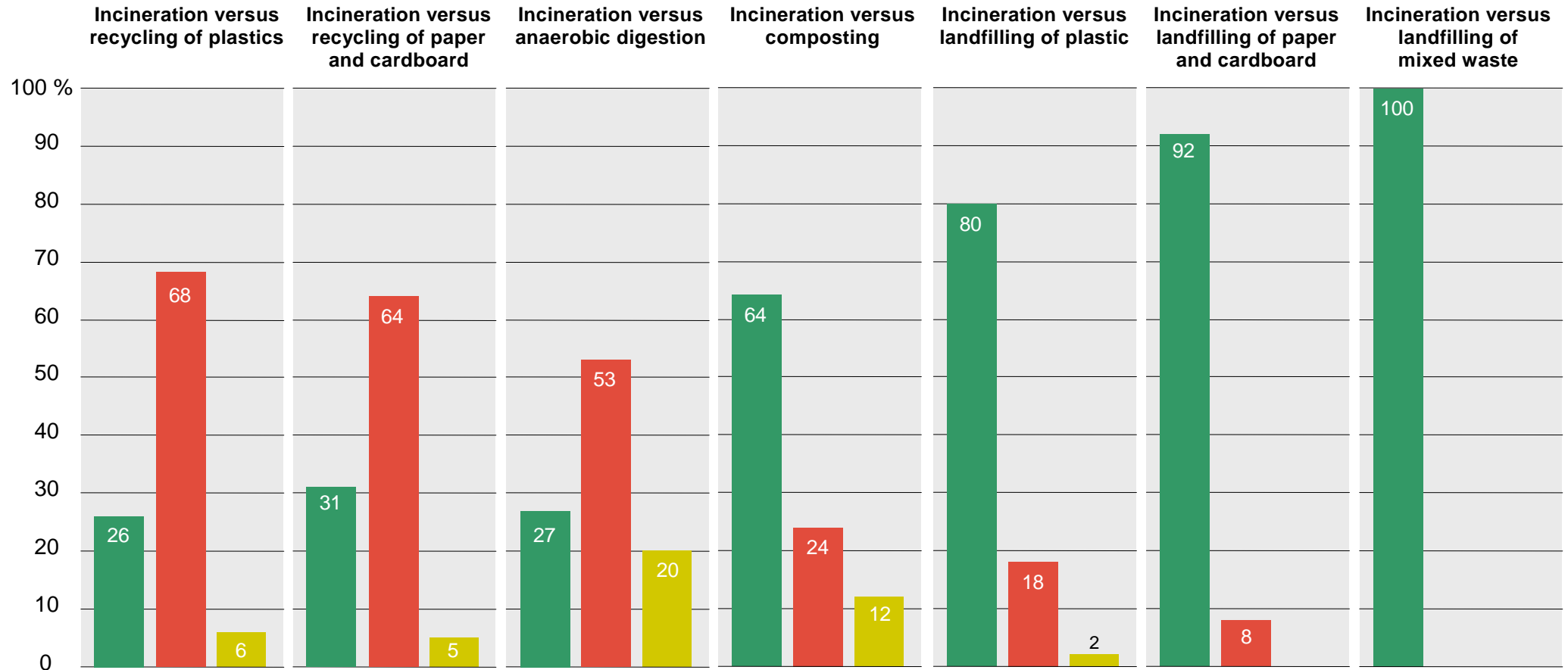
Results from the detailed examination of the 12 case studies



Ideal conditions are assumed for most of the material recycling in the studies. This means that the fractions are clean and completely separate and used for replacing virgin production of the same material.

- Green: Incineration is the best alternative (lowest environmental impact).
- Red: Incineration is not best alternative.
- Yellow: The difference between incineration and the alternative is small.

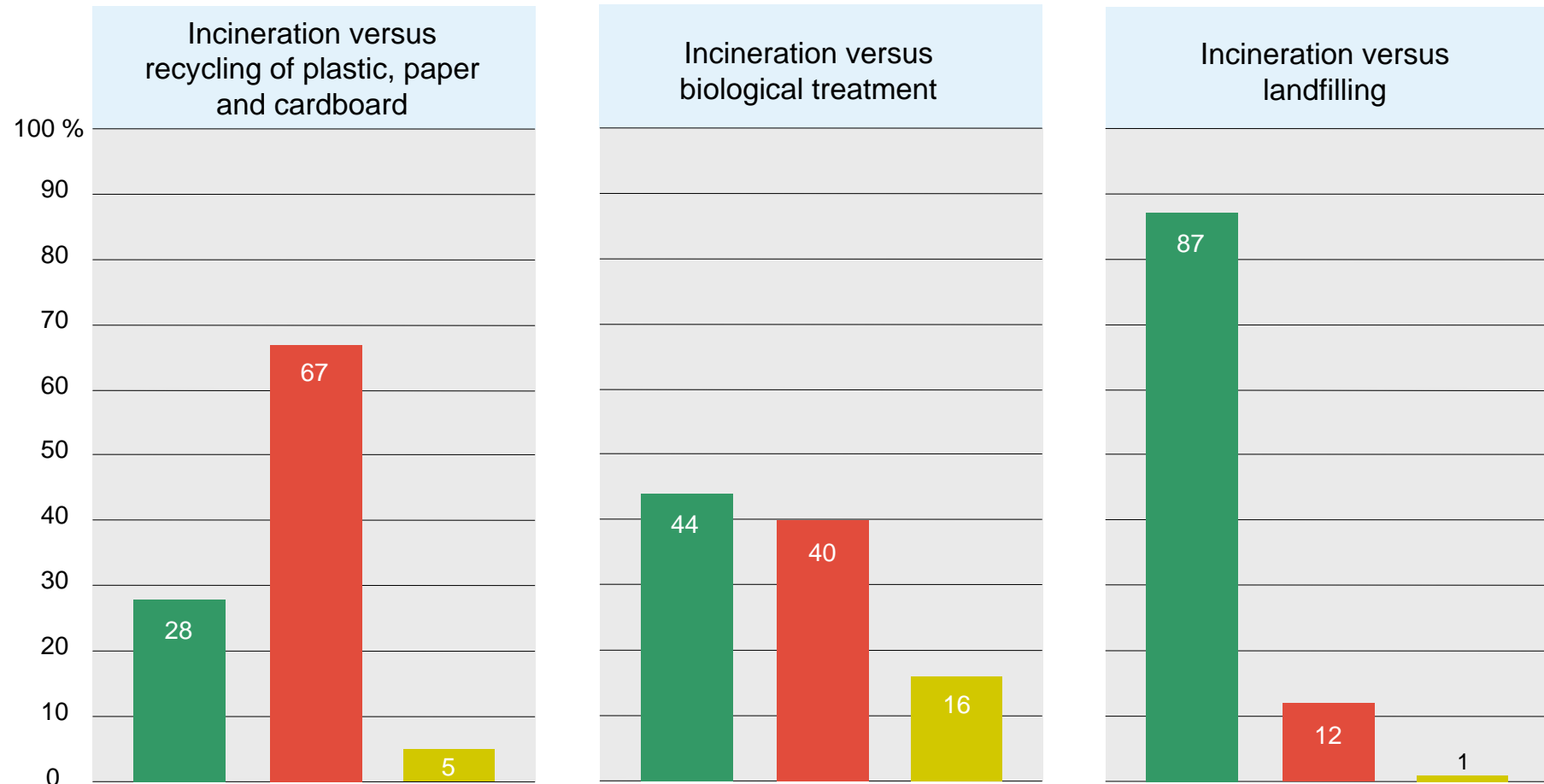
Results from the detailed examination of the 12 case studies – All impact categories



- Incineration is the best alternative (lowest environmental impact).
- Incineration is not best alternative.
- The difference between incineration and the alternative is small

NB! This slide shows the distribution of green, yellow and red in each comparison between incineration and an alternative treatment in slide 9. The slide is a **simplification of slide 9** since all impact categories are weighed the same. For full information, look at slide 9.

Results from the detailed examination of the 12 case studies – All impact categories

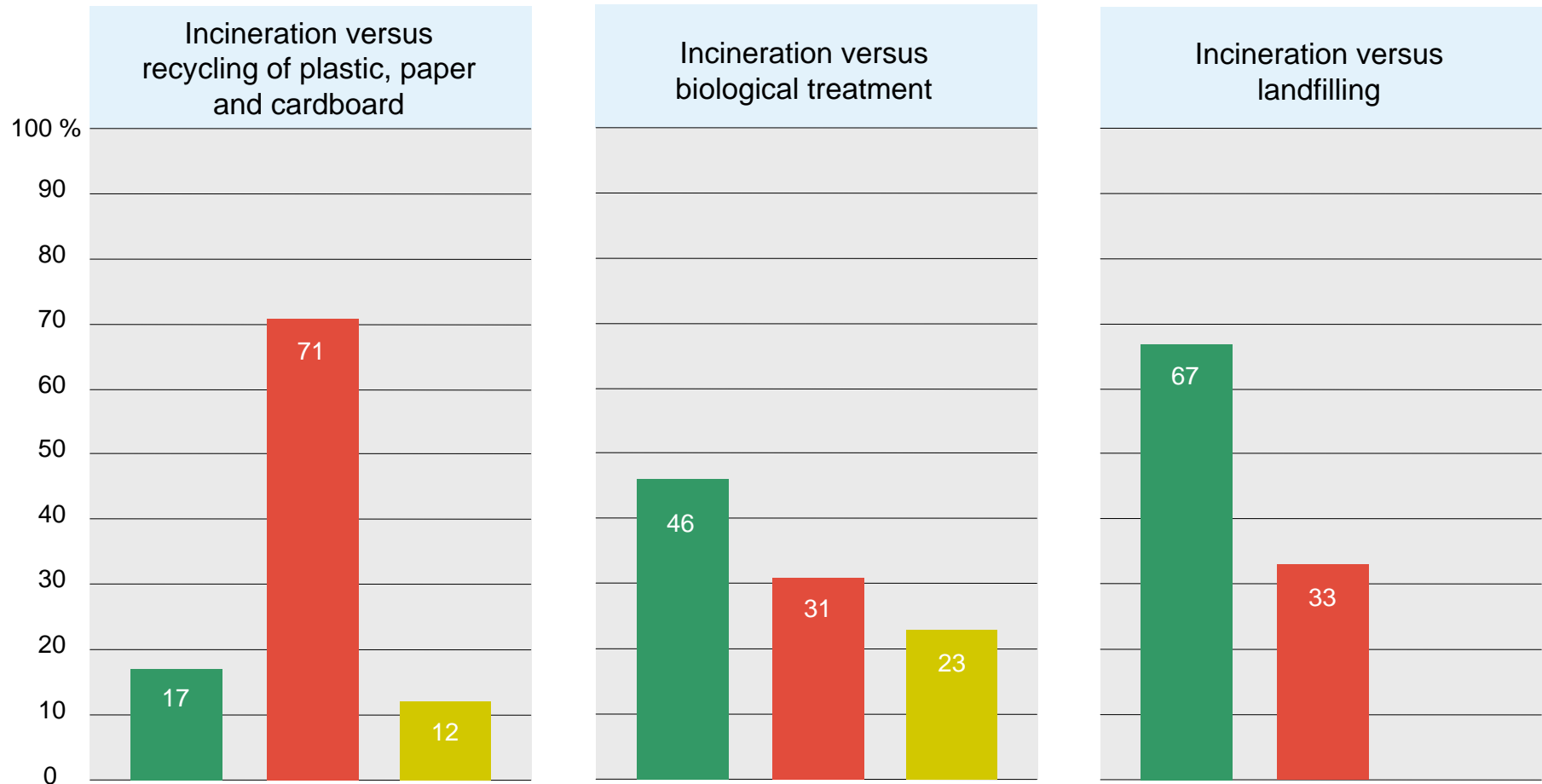


- Incineration is the best alternative (lowest environmental impact).
- Incineration is not best alternative.
- The difference between incineration and the alternative is small

NB! This slide is a **simplification of slide 10**. The results for incineration in comparison with recycling, biological treatment and landfilling in slide 10 have been added together. For full information, look at slide 9.



Results from the detailed examination of the 12 case studies – GWP results only



- Incineration is the best alternative (lowest environmental impact).
- Incineration is not best alternative.
- The difference between incineration and the alternative is small

NB! This slide is a **simplification of the GWP results in slide 9**. The distribution of green, yellow and red in each GWP-comparison in slide 9 have been summarized in three categories. For full information, look at slide 9.

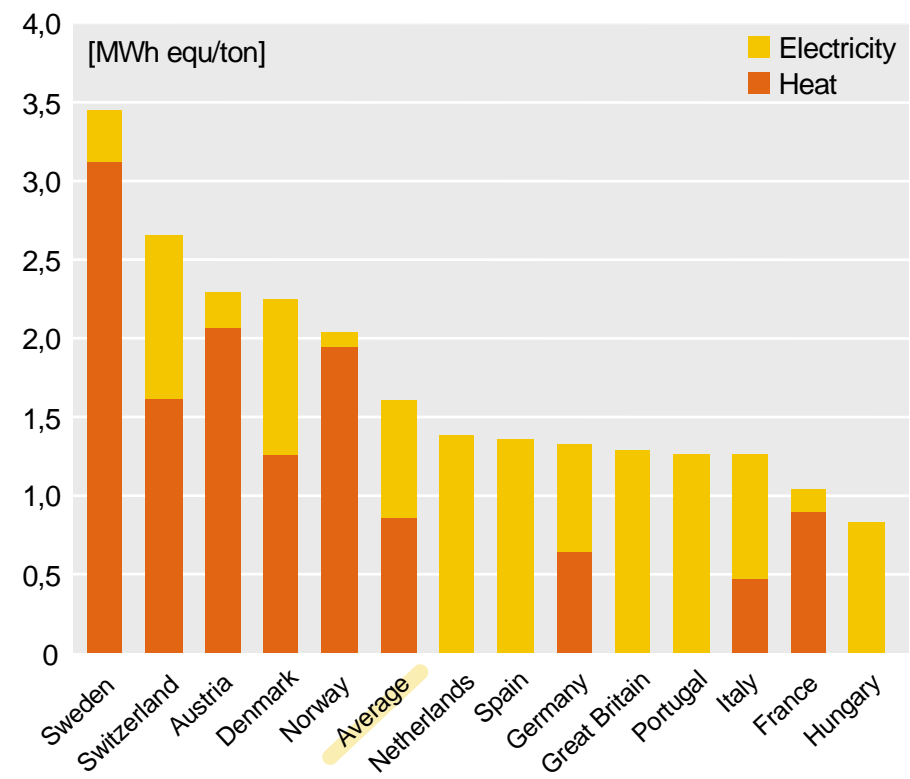
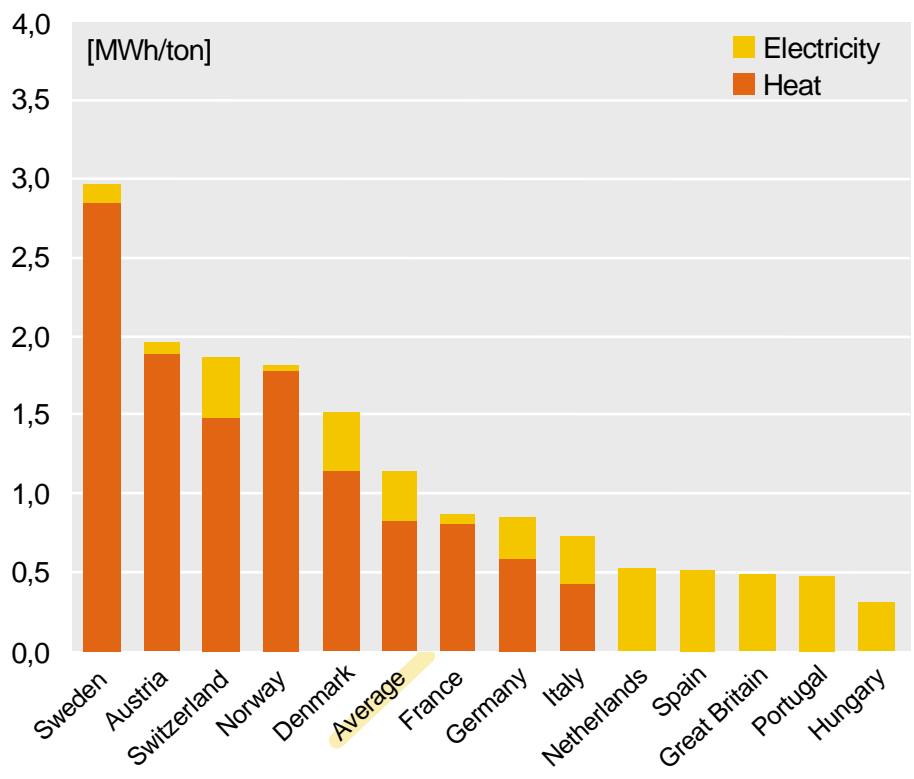


Scenario analysis

- ▶ We used five key factors to discuss the environmental performance of incineration in Europe today and in two scenarios for 2030.
- ▶ Key factors:
 - The time perspective
 - Energy recovery at incineration
 - Alternative electricity and heat generation
 - Material recycling efficiency
 - Biological treatment efficiency
- ▶ Scenarios 2030:
 1. Greenhouse gases of large importance
 2. Greenhouse gases of less importance

Energy recovery at incineration

BREF/BAT
 1 MWh el = 2,63 MWh equ.
 1 MWh heat = 1,1 MWh equ



Conclusions in scenario 1

- ▶ Material recycling is the best environmental option for well source-separated, “clean” materials.
- ▶ For the biodegradable part of waste that cannot be treated with a high material recycling efficiency, waste incineration and anaerobic digestion are the preferable alternatives from a GWP perspective.
- ▶ For the waste that cannot be treated by either material recycling or anaerobic digestion with a high efficiency, waste incineration is the preferable alternative from a GWP perspective.
- ▶ To efficiently reduce the GHG-emissions, a combination of material recycling, anaerobic digestion and incineration is the best strategy.

Conclusions in scenario 2

- ▶ Material recycling is the best environmental option for well source-separated, “clean” materials. In comparison with scenario 1, less waste fractions would be treated through material recycling due to less technology development.
- ▶ Waste incineration would generally be preferred over biological treatment from a GWP perspective.
- ▶ For the waste that cannot be treated by either material recycling or biologically with a high efficiency, waste incineration is the preferable alternative from a GWP perspective.
- ▶ To efficiently reduce the GHG-emissions, a combination of material recycling, anaerobic digestion and incineration is the best strategy.