# Goal and scoping for the JRC detailed pilot studies

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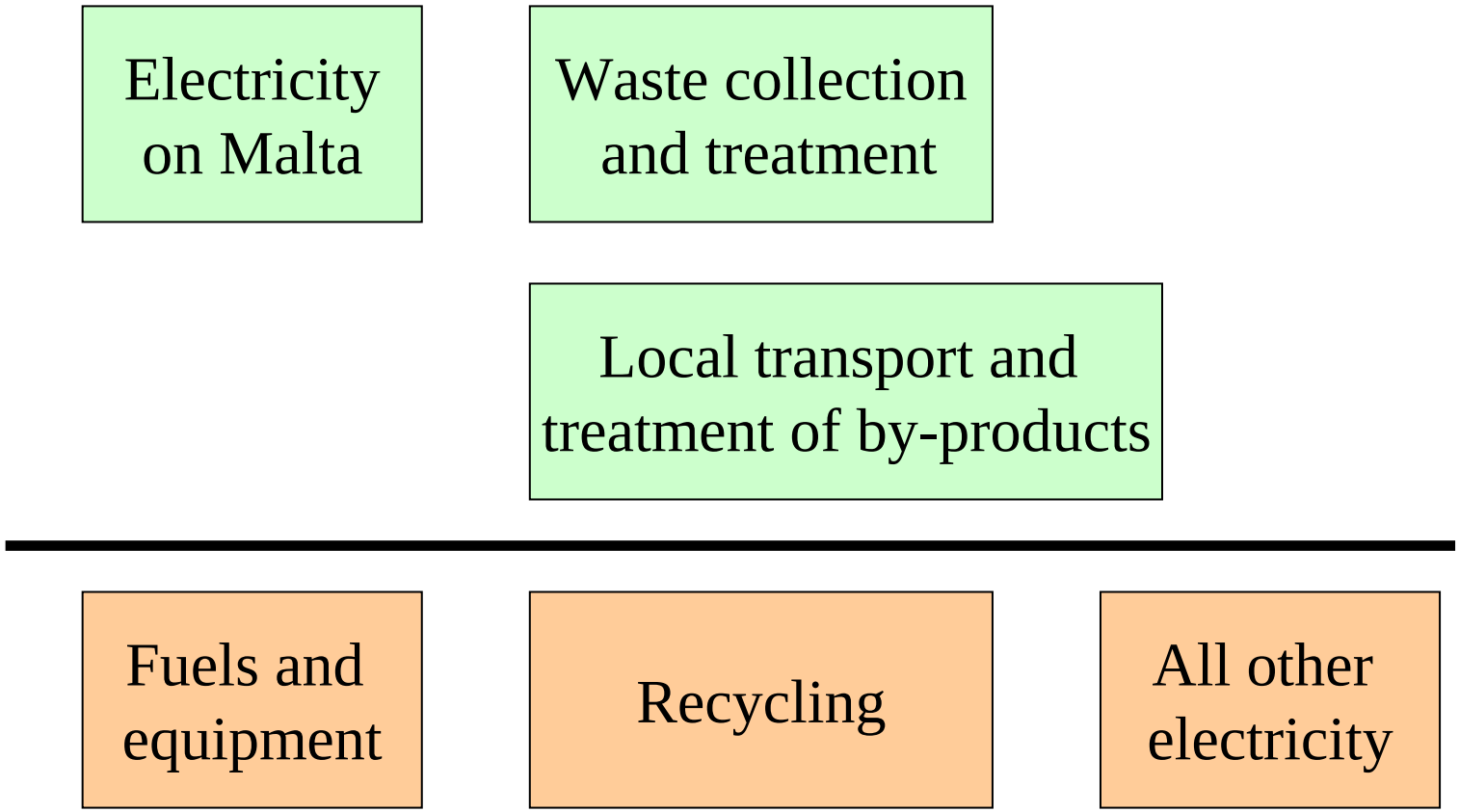
# Geographical system boundaries

- Malta & Krakow
- Site-specific versus generic data
- Differences in sensitivity of ecosystems

# Geographical system boundaries



# Temporal system boundaries

- In principle:
  - Infinite time horizon
  - All emissions assumed to take place at present (steady-state model)
  - Exception for emissions to groundwater:
    2 weeks, 100 years, 60’000 years…

# Functional unit

- 1 Mg (metric tonne) of municipal solid waste
  - at private households,
  - including waste from commercial operations when this is collected together with and in the same way as the household waste.

- Implications:
  - Waste prevention is not covered, e.g. reuse options

# Waste composition

- *Specific* waste compositions of Malta and Krakow
- *Current* waste composition
- Clean fractions, i.e. impurities follow main fraction
- Implications:
  - Results do not predict actual future emissions, as these will be influenced by possible changes in waste composition
  - Impurities may in reality end up in other places than predicted by the model (e.g. in wastewater)

# Waste fractions studied

- Wet biodegradable wastes
- Paper and cardboard wastes, subdivided in Cardboard wastes, Newsprint wastes and Other paper wastes
- Plastics wastes
- Glass wastes
- Iron and steel wastes
- Aluminium wastes
- Other wastes

# Substance composition of waste fractions

- Plastics assumed to be 60% PE, 20% PET, 10% PP, 5% PS, 4% PU and 1% PVC
- Wet biodegradable assumed to contain at least 15% parks and garden waste
- Elemental composition from Ecoinvent, supplemented with data from AWAST
- Example: Wet biodegradable wastes (g/Mg): O 126430; H 20000; C 162400; S 1500; N 4000; P 1130; B 10; Cl 4000; Br 6; F 200; I 0.055; As 2; Cd 0.138; Co 5; Cr 8; Cu 18; Hg 0.07; Mn 4.3; Mo 0.4; Ni 5.42; Pb 18.56; Se 0.5; Sn 8; V 3; Zn 58; Si 39980; Fe 600; Ca 21800; Al 10000; K 3500; Mg 2820; Na 1500

# Composition of “Other wastes”

- Textiles: 3.2% of household waste
- Batteries: 0.32 kg per capita
- Electronic goods: 0.4% of household waste
- Other hazardous: 2.12% of household waste
- Paper and plastic: Each 1.5% (Malta) and 4.5% (Krakow) of household waste
- Inert waste: 15% (Malta) and 26% (Krakow) of “Other wastes”

# Technologies studied

- Uncontrolled landfill
- Directive compliant landfill
- Directive compliant incineration with energy recovery, BAT, Semi-dry, non-catalytic $NO_xR$
- Home incineration
- Central composting with energy recovery, BAT
- Central composting without energy recovery
- Home composting
- Material recycling

# Scenarios studied

A. Baseline (2003) waste management infrastructure
B. Incineration scenario with increased recycling
C. Composting scenario with increased recycling
D. Economic optimum scenario
E. Environmental optimum scenario

Ultimate packaging recycling targets applied to entire MSW:

- 60 % for all glass and paper
- 50 % for all metal
- 22.5 % for all plastics
- Overall minimum of 55% for all these fractions

# Optimising economic performance within each scenario

- Maximum recycling attainable (Tucker & Speirs 2002):
  - 85% for cardboard, newspaper and glass
  - 80% for other fractions
- Marginal costs of recycling versus incineration:
  - (EUR/Mg): Alu -875, PET -103, Iron&steel -49, Glass -47, Cardboard -32, Newsprint -1.5, PE 7.5, Mixed paper 8.5, Wet biowaste 26

Assumptions: 5 EUR additional promotion costs; 24 EUR additional collection costs for separate fractions; 43 EUR for biowaste; excluding 29 EUR additional transport from Malta; 25% efficiency of electricity production from waste incineration; 0.08 EUR / kWh; Price of recycled materials from Sound Resources Management.

# Economic cost data

| Waste fraction | Incineration [EUR/Mg] | | Recycling [EUR/Mg] | |
|---|---|---|---|---|
| | Fixed cost of incineration | Economic value of electricity sold | Additional cost of collection | Economic value of material |
| Aluminium | 40 – 45 | 19 | 18 – 30 | 800 – 960 |
| PET | 40 – 45 | 121 | 18 – 30 | 190 – 230 |
| PE | 40 – 45 | 230 | 18 – 30 | 170 – 200 |
| Cardboard | 40 – 45 | 82 | 18 – 30 | 90 – 110 |
| Newsprint | 40 – 45 | 72 | 18 – 30 | 50 – 70 |
| Mixed paper | 40 – 45 | 72 | 18 – 30 | 45 – 55 |
| Iron & steel | 40 – 45 | 4 – 5 | 18 – 30 | 35 – 45 |
| Glass | 40 – 45 | -8 | 18 – 30 | 20 – 30 |
| Wet biowaste | 40 – 45 | 16 | 35 – 50 | -26 – 12 |

# A. Baseline 2003 (Malta)

| | Uncontrolled landfill | Central composting – no energy recovery | Sums |
|---|---|---|---|
| Wet biodegradable | 76 | 24 | 100 |
| Paper & board | 100 | | 100 |
| Plastics | 100 | | 100 |
| Glass | 100 | | 100 |
| Iron & steel | 100 | | 100 |
| Aluminium | 100 | | 100 |
| Other | 100 | | 100 |

# A. Baseline 2003 (Krakow)

| | Uncontrolled | Land-fill, dir. compl. | Incine-ration at home | Recycl | Central compost – no energy | Home compost | Sum |
|---|---|---|---|---|---|---|---|
| Wet biodegradable | | 78 | | | 7 | 15 | 100 |
| Paper & board | | 81 | 13 | 6 | | | 100 |
| Plastics | 9 | 90 | | 1 | | | 100 |
| Glass | 9 | 49 | | 42 | | | 100 |
| Iron & steel | 8 | 74 | | 18 | | | 100 |
| Aluminium | 8 | 76 | | 16 | | | 100 |
| Other | 9 | 91 | | | | | 100 |

# B. Incineration (Malta / Krakow)

| | Incineration | Recycling | Sums |
|---|---|---|---|
| Wet biodegradable | 100 | | 100 |
| Paper & board | 40 | 60 | 100 |
| - of which Newsp. | 43 | 57 | 100 |
| - of which Cardb. | 15 | 85 | 100 |
| - of which Other | 100 | | 100 |
| Plastics | 68 | 32 | 100 |
| - of which PE | 100 | | 100 |
| - of which Other | 20 | 80 | 100 |
| Glass | 28 / 36 | 72 / 64 | 100 |
| Iron & steel | 20 | 80 | 100 |
| Aluminium | 20 | 80 | 100 |
| Other | 100 | | 100 |

# C. Composting (Malta / Krakow)

| | Incineration | Composting / Recycling | Sums |
|---|---|---|---|
| Wet biodegradable | 46 / 59 | 54 / 41 | 100 |
| Paper & board | 40 | 60 | 100 |
| - of which Newsp. | 43 | 57 | 100 |
| - of which Cardb. | 15 | 85 | 100 |
| - of which Other | 100 | | 100 |
| Plastics | 53 / 60 | 47 / 40 | 100 |
| - of which PE | 75 / 86 | 25 / 14 | 100 |
| - of which Other | 20 | 80 | 100 |
| Glass | 40 | 60 | 100 |
| Iron & steel | 20 / 50 | 80 / 50 | 100 |
| Aluminium | 20 | 80 | 100 |
| Other | 100 | | 100 |

# D. Economic (Malta / Krakow)

| | Incineration | Composting / Recycling | Sums |
|---|---|---|---|
| Wet biodegradable | 100 | | 100 |
| Paper & board | 40 / 27 | 60 / 73 | 100 |
| - of which Newsp. | 43 / 15 | 57 / 85 | 100 |
| - of which Cardb. | 15 | 85 | 100 |
| - of which Other | 100 | | 100 |
| Plastics | 68 | 32 | 100 |
| - of which PE | 100 | | 100 |
| - of which Other | 20 | 80 | 100 |
| Glass | 15 | 85 | 100 |
| Iron & steel | 20 | 80 | 100 |
| Aluminium | 20 | 80 | 100 |
| Other | 100 | | 100 |