Strategies and Measures for Promoting MFA applications for RM and EM in Industries

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Incentives for industry to use MFA

1. Direct economic benefit
2. Comparative advantage in a competitive market
3. Leadership
4. Regulations
5. Improve knowledge base

No incentive:
*MFA studies “per se” without economic or problem solving purpose*
1. Economic benefits: MFA and greenhouse gas emission assessment
Concept of Balance Method

Material data of waste input
- Biogenic matter: C, H, O, N, S, Cl
- Fossil matter: C, H, O, N, S, Cl

Balance equations

Operating data from WTE plant
- Waste input, flue gas volume, CO2, O2, steam production

Graphs showing:
- CO2 emissions (kg CO2 eq./t waste)
- Ratio of energy from biogenic sources (%)

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### Balance Equation

**Mass balance**

\[ m_B + m_F + m_I + m_w = 1 \]

**“Ash”-balance**

\[ c_B \cdot m_B + c_F \cdot m_F = m_I \]

**Carbon-balance**

\[ H_{2}V_B \cdot m_B + H_{2}V_F \cdot m_F - 2.45 \cdot m_w \]

**Energy-balance**

\[ O_2^{C,B} \cdot m_B + O_2^{C,F} \cdot m_F \]

**O₂-consumption**

\[ d_{O_2-CO_2} \cdot m_B + d_{O_2-CO_2} \cdot m_F \]

**Difference of O₂-cons. + CO₂-prod.**

\[ d_{O_2-CO_2, waste} \]

**Coefficients** (given by the chemical composition of biogenic and fossil matter)

Derived from operating data

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Results (annual values)

Sources of CO₂-emissions

- Fossil fuels: 72,7 ± 3,1
- Biogenic: 81,9 ± 3,9

Sources of energy

- Fossil fuels (plastics): 52.7±2.0%
- Biomass (paper, ...): 46.5±2.0%
- Auxiliary fuels (fuel oil, natural gas): 0.8%
Comparison with radiocarbon method

![Comparison with radiocarbon method](chart)

Fellner et al., 2007
2. Comparative advantage in a competitive market (V.EFB)
3. Leadership: regional lead flows to air from smelter

Import: 340 t/y
Stock: ~1000 + 60 t
Export: 280 t/y

- Atmosphere: 0.5 t/y
- Forest soil: 150 + 0.6 t/y
- Agricultural soil: 240 + 0.9 t/y
- Urban soil: 30 + 0.2 t/y
- River: 0.2 t/y
- STP: 0.14 t/y
- Landfill: ~600 + 60 t
- Industry: >270 t
- Municipal solid waste: 0.6 t
- Consumer goods: 7 t
- Used cars: 330 t
- Household: 0.15 t

Surface water: 0.6 t/y
Filter dust: 60 t

Regional boundary: 60 t
4. Regulations: MFA to cut costs from railway maintenance
The problem: high costs for landfilling spent gravel from RR

Quality criteria:
- Landfill ordinance
- Anthropogenic Cu
- Recycling
- Geogenic Cu

Cu-content [mg/kg] vs. time [t]
The method: MFA of Cu in track ballast
Result: brake system and contact line as main anthropogenic sources

\[ +1.9 \text{ kg/y} \]

\[ +1.8 \text{ kg/y} \]

Import = 12±3.5
Stock = +2.6±0.85
Export = 9.7±1.6

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Solution: new material for brake pads, contact line (?), and low Cu gravel

Quality criteria:

- Cu-content [mg/kg]
- Time [t]
- Landfill ordinance
- Recycling
- Anthropogenic Cu
- Geogenic Cu
Solution: new material for brake pads, contact line (?), and low Cu gravel

Quality criteria:

- landfills ordinance
- recycling
- anthropogenic Cu
- geogenic Cu

Cu-content [mg/kg] vs. time [t]
5. Improve knowledge base: case of lead recycling

lead stocks in networks and buildings of Vienna

pipes

in-house cables

out-of-house cables

other networks

water- and waste-water systems

in-house energy- and information grid

out-of-house energy- and information grid

other networks

n.b.

lead flows in Mg/a
lead stocks in Mg
n.b. not determined

Source: Möslinger, J., 1998

System Boundary "Vienna"
5. Improve knowledge base: case of waste management

Systemgrance “Status Quo (A0), Steiermark 2006” 
Laner et al., 2009

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5. Improve knowledge base

Issue:
Struggle between private and public waste management: Who should collect wastes from industry, business and trade?

Questions:
Where are additional potentials for waste collection and treatment?
What is the “best” solution: private or public?

Procedure:
1. Assessment of waste amounts, 2. MFA of various scenarios, and 3. evaluation of scenarios

Solution:
1. Insufficient information to answer the question (->scenarios)
2. Separate collection and treatment has advantages, no matter if public or private
3. Amount in question relatively small (~ 20%) when compared to rest
Conclusion

Industry will apply MFA if:
• MFA is known to industry
• MFA is instrumental to solve relevant industrial problems
• MFA is economic (benefit > cost)
• MFA is mandated by law

Strategy to promote MFA in industry:
• Identify key industries and apply MFA for problem solving
• Make economically successful MFA results known to industry
• Educate engineers and practitioners in MFA methodology
• Standardize MFA as an instrument for RM, WM and EM
• Incorporate MFA into selected legislation (EIA, SEIA)
• Incorporate MFA in national planning (RM, WM, EM)
  -> framework for industrial activities