From Waste Management to Resources Management

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What is the most important resource?
Tulips?

Titelblad van 'Tooneel van Flora' uit 1637.
Price of a tulip in the year 1637:

3000 Gulden, equivalent to:
8 fat pigs + 4 fat oxen + 12 fat sheep
+24 tons wheat + 48 tons barley
+2 barrels wine + 4 barrels beer
+2000 kg butter + 500 kg cheese
+1 silver cup + 1 bale cloth
+1 bed including sheets and cover
+1 boat worths 500 Gulden!
The „most crazy speculation in history“?
Salt – the most important resource?

Salzbergwerk Wielicka, Polen
The environment – most limited resource?

*atmosphere* 4,200 [Mio. km³]

*hydrosphere* 1,400 [Mio. km³]

*pedosphere* 0,3 [Mio. km³]

*nach A. Nieman ergänzt durch G. Döberl*
Limited sinks: where to dispose of carbon?

Concentration of $\text{CO}_2$ and $\text{CH}_4$ in the atmosphere

$\text{CO}_2$ + 75 %

$\text{CH}_4$ + 300 %

Quelle: Beer, Baumgartner, 1995
Iron flows and stocks in Austria in Mio t/a

Iron the most important resource?

Primary production → Production → Waste management

Σ Import ~11
Σ Export ~7,8

stock 184 \( \Delta a \)

Lithosphere 140

*LAGER EISENERZ (Siderit) ohne Taubgestein

System "Eisenhaushalt Österreich"

Iron stock

[Mio. t]
Fuel – the most important resource?

Tesla Car

0-100 kmh in 3,9 sec. < 2 liter /100 km
Oil – the most important resource?

The stone age did not finish because of a scarcity of stones!
Biomass - the most important resource?

<table>
<thead>
<tr>
<th>sun -&gt; electron</th>
<th>Area needed to supply all electricity for phh</th>
<th>wastes due to biomass fuel</th>
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<td>utilization of biomass</td>
<td>7800 m²/capita</td>
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Is the sun the most important resource?

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</tr>
<tr>
<td>photovoltaic cells</td>
<td>80 m²/capita</td>
<td>0 kg/cap&amp;year</td>
</tr>
</tbody>
</table>
The most important resource!
What is the contribution of waste management to resources management?

**Precautionary principle:**

Waste of today’s generation may not impose any economic or ecological burden on future generations.

**Goals**

1. Protection of men and the environment
2. Conservation of resources
3. After-care-free waste management (landfills)

**Strategies to reach the goals:**

Prevention, recycling, disposal

→ EU: hierarchy!
How to reach the goals: 1. clean cycles 2. low emissions 3. safe final sinks
**Plastic waste management in Austria**

Source: R. Fehringer, 1998

**Diagram Description**

- **Raw Material**: 1,100 kt/y 1994
- **Duro- and Polymers**: 850 kt/y 1994
- **Product Manufacturing**:
  - Primary Processing: stock: 40
  - Production: stock: 50
  - Consumption: stock: 7,100 + 400
- **Collection, Transporting, Sorting**:
  - Recycling: stock: 0
  - Energy Recovery: stock: 0
  - Landfill: stock: 9,700 + 590

**Flowchart**

- IMPORT:
  - Raw Material: 1,100
  - Intermediate Products: 990
  - Plastic Products: 530
  - IMPORT: 990

- EXPORT:
  - Duro- and Polymers: 850
  - Plastic Products: 420
  - Intermediate Products: 210
  - EXPORT: 26

- **Regranulate**:
  - 17
  - 26

**Wastes**

- 720 wastes
- 28 wastes
- 590 wastes

**Stock Levels**

- 40 regranulate
- 42 regranulate
- 9700 + 590 landfill
- 7100 + 400 consumption

**Percentages**

- 80% of landfilled waste
- 7% of recycling waste
## Additives as the main problem

<table>
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<tr>
<th>Material &amp; additives</th>
<th>Total consumption [kt/yr]</th>
<th>% in packaging material [%]</th>
<th>Total stock [kt]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics</td>
<td>1,100</td>
<td>200</td>
<td>7,100</td>
</tr>
<tr>
<td>Softeners</td>
<td>14</td>
<td>0.2</td>
<td>140</td>
</tr>
<tr>
<td>Ba/Cd- stabilizers</td>
<td>0.27</td>
<td>0.0002</td>
<td>2.6</td>
</tr>
<tr>
<td>Pb-stabilizers</td>
<td>1.8</td>
<td>0.002</td>
<td>18</td>
</tr>
<tr>
<td>Fire retardants</td>
<td>2.3</td>
<td>0</td>
<td>22</td>
</tr>
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How to establish clean cycles?

Partitioning of cadmium contained in waste plastic by:

**Plastic recycling**
- Recycling plastic: 73%
- Residue I: 14%
- Residue II: 2%
- Sludge: 1%
- Residue III: 10%

**MSW incineration**
- Flue gas: <1%
- E-Filter dust: 92%
- Waste water: <1%
- Filter cake: <1%
- Bottom ash: 8%
The market sets limits for recycling! (example lead)

Source: Lohm et al., 1998
We need landfills

Reactor landfills versus final sinks

We need „final storage quality“
Final storage quality -> making „stones“

Döberl et al. (2001)
Thank you