Implementing a Biowaste Strategy for Bulgaria

Energy Recovery from Residual Municipal Wastes and Residues from Sewage Treatment (incl. significant „Bio-wastes“)

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- Experience in Austria and Know-how transfer
Shareholders:
• Franz Neubacher
• Herbert Beywinkler
• Peter Seybert
• Helen Neubacher

Turnover:
Approx. 1 Mio. € / a
Value of our projects exceeds 1,000 Mio € investments

Senior expert teams with interdisciplinary competence for implementation of best available waste treatment technologies

We cooperate with local partners!
Integrated waste management began in Austria about 30 years ago with increasing public awareness, environmental regulations and subsidies:

- Technical guidelines for control of waste dumps, 1977
- **Hazardous and Special Waste Management Act, 1983**
- Federal legislation on the **Environmental Protection Fund, 1983**
- **Guidelines for Waste Management in Austria, 1988**
- Federal legislation on clean-up of landfills and contaminated sites, 1993 (including a **disposal tax on landfill operations** for clean-up activities)
- **Ban on disposal of hazardous wastes in landfills** (except of inorganic wastes encapsulated in closed salt formations) by July 2001
- Decree on landfills including the **ban on disposal of wastes exceeding 5 % TOC (Total Organic Carbon)** for new landfills by the beginning of 1997 and limitation for existing landfills until beginning of 2004 (limited legal exemptions until end of 2008, and limited exemptions for stabilized residues from MBT Mechanical Biological Treatment).
Please note:
Today, less than 50 of those landfills are still in operation (with control of waste input, collection and treatment of gas and leachate).
The development of waste management in Austria towards reduction of landfilled waste as well as recycling and recovery has been very effectively supported by a special landfill tax.

**Development of the Special Landfill Tax in Austria**

**Landfill tax in € / ton of waste**
(e. g. municipal waste)

**Revenue from landfill tax in Mio. € / a**
(total revenue per year)

3 criteria:
- Foreseeable for at least 10 years
- Environmental standard of the landfill
- Quality of waste to be landfilled

€ / ton

Mio € / a

87 (= US $ 120)

+ 29 Euro/ton, if no collection and treatment of landfill gas
+ 29 Euro/ton, if no encapsulation or base lining with collection and treatment of leachate
Different technologies are needed for specific wastes in an integrated treatment system, also taking into consideration specific regional conditions.

Successful project design must be based on the 1st and 2nd Law of Thermodynamics!

Our project designs are profitable for our clients and protect the environment.

(UV&P, since 1991)
Example for Public Education in Prevention: “The Beautiful Danube starts here ...”

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### Source Separation and Sorting of Municipal Wastes for Recovery of Materials and Energy

**Separated collection of**

- **specific hazardous wastes**
- **mixed municipal waste**
- **bulky waste**
- **green waste**
- **food and kitchen waste**
- **recyclable materials**
- **construction waste**

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<table>
<thead>
<tr>
<th>Type of waste fraction</th>
<th>Incineration in % weight</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper, Cardboard</td>
<td>approx. 5 – 15</td>
<td>Sorting and processing</td>
</tr>
<tr>
<td>Plastics, Composites</td>
<td>approx. 30 – 70</td>
<td>„Plastic Packaging Bag“, „Oekobox“</td>
</tr>
<tr>
<td>Packaging glass, Laminated glass</td>
<td>approx. 2 – 10</td>
<td>Plastics, Composite films</td>
</tr>
<tr>
<td>Construction waste</td>
<td>approx. 10 – 40</td>
<td>Wood, shavings, plastic pipes, foils, packaging, carpeting</td>
</tr>
<tr>
<td>Biological waste</td>
<td>approx. 5 – 10</td>
<td>Plastics, non-biodegradable materials</td>
</tr>
<tr>
<td>Bulky waste, scrap tires</td>
<td>approx. 70 – 90</td>
<td>without metals and recyclable fractions</td>
</tr>
<tr>
<td>Non-recyclable garbage</td>
<td>approx. 45 – 98</td>
<td>without metals, due to biological processes (MBT)</td>
</tr>
</tbody>
</table>

**Separate collection and recycling must be complemented by waste-to-energy**
Comparison of Calorific Values of different Fuels and Wastes

E = m \cdot c^2

1 t SKE = 30 GJ

1 t ROE = 40 GJ
Development of Atmospheric Emissions from Waste Incineration according to State-of-the-Art (in Austria and Switzerland)

### Values given in mg/m$^3_N$ (11% O$_2$, dry):

<table>
<thead>
<tr>
<th>Year</th>
<th>Dust</th>
<th>Cd</th>
<th>HCl</th>
<th>SO$_2$</th>
<th>NO$_x$</th>
<th>Hg</th>
<th>PCDD/F*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>100</td>
<td>0,2</td>
<td>1.000</td>
<td>500</td>
<td>300</td>
<td>0,5</td>
<td>50</td>
</tr>
<tr>
<td>1980</td>
<td>50</td>
<td>0,1</td>
<td>100</td>
<td>100</td>
<td>300</td>
<td>0,2</td>
<td>20</td>
</tr>
<tr>
<td>1990</td>
<td>1</td>
<td>0,005</td>
<td>5</td>
<td>20</td>
<td>100</td>
<td>0,01</td>
<td>0,05</td>
</tr>
<tr>
<td>2000</td>
<td>1</td>
<td>0,001</td>
<td>1</td>
<td>5</td>
<td>40</td>
<td>0,005</td>
<td>0,05</td>
</tr>
</tbody>
</table>

* Values in ng/m$^3_N$ = 10$^{-6}$ mg/m$^3$

Source: Vogg (values for 1970 - 1990); RVL (values for 2000)
DIRECTIVE 2008/98/EC of 19 November 2008 on waste:
… that waste prevention should be the first priority of waste management, and that re-use and material recycling should be preferred to energy recovery from waste, where and insofar as they are the best ecological options.

Reduction of biodegradable wastes according to Council Directive 1999/31/EC Art. 5 on the Landfill of Waste
Complexity of the 20-20-20 Goals by the EU in 2020: 
+ 20 % Energy Efficiency / - 20 % CO2-Emissions / 20 % Renewable

Example for the Efficiency in Use of Non-renewable Resources: Mineral Oil

Higher efficiency in the use of crude oil for production of valuable materials, including recycling of plastics and the recovery of energy from waste

100 kg difference in weight of a vehicle may change fuel consumption by 0,3 l / 100 km

Zero disposal! (despite Landfill Directive 1999/31/EC)
Restrictions on Disposal of Wastes in Treatment of End-of-life Products: e.g. Vehicles

EU environmental policy:
Increasingly oriented towards mandatory requirements for take-back of all sorts of specific products by the producers (referred to as “producer’s responsibility”).

End-of-life vehicles (in Austria):
1. Reuse of parts in approx. 4,000 automobile workshops and do-it-yourself activities
2. Pre-treatment to recover hazardous and special materials (approx. 200 sites)
3. Mechanical shredding and material separation (6 sites)
4. Treatment of shredder residues for recovery

EU Targets for 2015:
85 % Reuse and recycling
95 % Recovery (by weight!)
Specific Residues from Municipal Waste Water Treatment

- waste water
- screen
- sand and fat trap
- settling tank
- aerated tank
- pre-thickener
- post-thickener
- mechanical sludge dewatering
- digester
- biogas tank
- sewage sludge

- screening waste
- contaminated sand
- cleaned water
Example of Sewage Screening Residues: Limits for Prevention and Recycling - Need for Treatment

© UV&P, 1999
Layout of the Wastewater Treatment Plant in the Region of Linz-Asten

Legend:

01 Influent building
11 Screw pump plant
12 Screening station
13 Grit chamber
14 Distribution building, primary settling tanks
15 Combined sewer overflow building
16 Discharge channel mechanical stage
18 Exhaust air treatment mechanical stage
19 Exhaust air treatment sludge reservoir
20 Aeration tanks 1,2
21 Aeration tanks 3,4
22 Aeration tanks 5-8
23 Secondary clarifiers 1-4
24 Secondary clarifiers 5-8
25 Quality control, outlet of biological stage
29 Iron sulphate dissolving station
31 Pre-thickener
32 Digester tank
33 Sludge pump house
40 Natural gas pressure reducing station
41 Gas tank
42 Gas flare and biomethane plant
44 Machine house I
45 Machine house II
48 Heating and boiler house
50 Sludge reservoir
51 Buffer tank
53 Sludge dewatering
54 Filtrate settling tank, biofilter
56 Excess sludge thickening
70 Electricity distributor
71 Biofilter
80 Office building
81 Workshops and garage
Humanity has not changed, but the technical methods have become increasingly effective.

New chemical, biochemical, nano, and nuclear technologies provide new opportunities as well as significant new risks.

Example municipal waste and sewage: Environmental and health risks due to various hazardous organic substances (e.g. pharmaceuticals, medicines, household chemicals, biocides, etc.) as well as micro-biological hazards.
Examples for Waste Incineration Plants in Austria: Site-specific Options for Utilization of Energy

**Condensing Turbine** *(electricity only)*

- Calorific value of fuel and latent heat: 100%
- Heat losses ca. 15%
- Incineration/boiler
- Flue-gas treatment
- Condensing turbine
- Loss of heat by cooling ca. 64%
- Generation of electricity ca. 18%

*Energy utilization approx. 20%*

**Co-Generation** *(electricity + heat)*

- Calorific value of fuel and latent heat: 100%
- Heat losses ca. 15%
- Incineration/boiler
- Flue-gas treatment
- Co-generation
- Thermal energy ca. 70%
- Generation of electricity ca. 12%
- Waste water and residue treatment

*Energy utilization approx. 80%*
Integrated Waste-to-Energy in the Industrial Site of Lenzing in Salzkammergut, Austria

The waste-to-energy plant RVL is integrated in the industrial site of Lenzing Austria – with advanced environmental technology to protect the natural environment in the famous tourist region around Lake Attersee.

The 3 arguments:
1. Energy demand
2. Reduction of odour
3. No landfilling

Planning (UV&P): 1993/94  
Start Up: 1998  
Technology: fluidized bed  
Fuel capacity: 110 MW  
Steam production: 120 t / h  
(80 bar, 500°C)  
Waste throughput: up to 1.000 t / d

Fuel mix in 2010 at Lenzing AG:

Fuel Input: 12.600.863 GJ / a

- Black Liquor: 47,4 %
- Bark, saw dust: 11,7 %
- Residues, sewage sludge: 27,6 %
- Coal: 6,3 %
- Natural gas: 5,2 %
- Oil: 1,8 %
Control of Cleaned Flue-Gas from Co-combustion and Incineration of Waste (Example: RVL Lenzing, in operation since 1998)

Less than 0.02% of the emissions are toxic emissions

<table>
<thead>
<tr>
<th></th>
<th>Comparison of emission limits: Figures in mg/Nm³ (11 % O₂, dry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulates</td>
<td>10</td>
</tr>
<tr>
<td>Mercury Hg</td>
<td>0.05</td>
</tr>
<tr>
<td>Hydrogen chloride HCl</td>
<td>10</td>
</tr>
<tr>
<td>Hydrogen fluoride HF</td>
<td>1</td>
</tr>
<tr>
<td>Sulfur dioxide SO₂</td>
<td>50</td>
</tr>
<tr>
<td>Nitrogen oxides NOₓ</td>
<td>400</td>
</tr>
<tr>
<td>Carbon monoxide CO</td>
<td>100</td>
</tr>
<tr>
<td>Total organic carbon TOC</td>
<td>10</td>
</tr>
</tbody>
</table>

* if > 6 tons waste per hour
Fundamentals: 1\textsuperscript{st} and 2\textsuperscript{nd} Law of Thermodynamics!

Austrian Standard ÖNORM S 2108-1 (2006-05-01)

Thermal Treatment of Wastes - Part 1

Requirements and boundary conditions:

- Logical mass balances / emissions at minimum for S, Cl, F, Cr, Cd, Hg; which is fundamental for treatment of flue-gas and options for recovery and treatment of residues
- Necessary flue-gas treatment (for different wastes according to waste code) i.e., fine particulates, SO\textsubscript{x}, Halogens, POP, Hg, NO\textsubscript{x}
- Suggestion for utilization in specific production processes (e.g. main burner cement clinker kiln)
- Suggestions for recovery of (inorganic) material from thermal treatment process (e.g., recovery of metal from shredder residues)
Concept Phase in (successful) Project Development: Example for a Waste-to-Energy plant in the Region of Linz


The three most important criteria (in real-estate) are: site, site, site

Parameters for evaluation of potential waste-to-energy sites in the region included:

- Continuous heat demand
- Area for plant construction
- Industrial infrastructure
- Road and rail connection
- Electrical grid connection
- Polluted air / combustion
- Operation & maintenance
- Ambient air quality requests
- Local residents, land use
- Commercial conditions.
Example RHKW Residual Waste Heat and Power Plant Linz: Co-Generation based on Waste Derived Fuel

Planning (UV&P): 2006/07
Start Up: 2011
Technology: Fluidized bed
Fuel capacity: 66 MW (+10%)
Efficiency: ca. 80 % (co-generation)
Steam production: 78 t / h (42 bar, 405°C)
Average waste throughput: up to 800 t / d
Fuels: Municipal and commercial wastes, sewage sludge, screening wastes, shredder residues
Concept for the Waste-to-Energy Plant in Linz with a Fluidized Bed System and Multistage Treatment of Flue-gas and Residues
Discussion on Mechanical - Biological Treatment (MBT) vs. Mechanical Processing (MP) and Recovery (Austria, 2007)
Decision for a Mechanical Processing Plant (instead of planned MBT) in the Central Region of Tirol for 116,000 tons of solid waste per year
Model Calculation for Potential GHG – Emissions from Treatment of Residual Municipal Solid Waste for the Year 2013 in Austria

Total emissions (10^6 tons of CO_2-equivalent for 2013)

Proportion of residual waste treatment for waste incineration [%] (based on the total quantity waste incineration + mechanical biological treatment)

Forecasted residual waste generation for 2013: 1,310,580 t, 1,456,200 t, 1,601,820 t

Source: Gerd Mauschitz, Klimarelevanz der Abfallwirtschaft IV, Studie im Auftrag des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, TU Wien, 2009
Treatment of Residual Municipal Solid Waste Development from 1980 to 2013 in Austria

Figures expressed in tons per year

Source: Gerd Mauschitz, Klimarelevanz der Abfallwirtschaft IV, Studie im Auftrag des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft
Know-how Transfer: Necessary Capacities in large Waste-to-Energy Facilities in Austria and Bulgaria

Austria (approx. 8 Mio. people)  Bulgaria (approx. 8 Mio. people)

Large facilities for thermal treatment of waste in Austria:

- 16 fluidized bed incinerators
- 14 grate systems
- 3 rotary kilns (for hazardous wastes)
- 9 cement kilns with co-firing of waste fuels

Subtotal: **42 facilities in operation**

Planned projects:

- 4 fluidized bed incinerators
- 1 grate system

Subtotal: **5 facilities planned**

**Total: 47 large waste incineration facilities in Austria**
Potential for Recycling and Recovery: Look into a Garbage Container in Sofia filled with Mixed Wastes (Example, March 31, 2012)
Necessary Cooperation for Successful Implementation of Waste-to-Energy Projects

Financing (co-Financing incl. Subsidies)
Project Development, Planning, Investments of Equipment and Infrastructure

Know-how
for Project- Development and -Management, Engineering, Erection incl. Supervision, Operation incl. Maintenance, Environmental Audit

Energy Efficiency
Combined Heat and Power / Continuous Heat Demand (e.g. for Industrial Process)

Waste Management
Collection & Supply of Waste Fuel / Recovery / Disposal of Solid Residues
Activities and time schedule for project implementation

Necessary time from project start until start-up: Minimum 5 to approx. 7 years*

* Based on competent experience made in Germany, Switzerland and Austria
Overall Costs for Project Development, Implementation and Operation of large Plants

Typical Cash-flow of large Waste-to-Energy Plants over Lifetime (e.g. RVL Lenzing, EVN Lower Austria, RHKW Linz)

- Concept- and Feasibility Studies approx. 0.2 – 0.5 Mio. Euro
- Management, Consulting & Engineering approx. 10 Mio. Euro
- Supply and Construction approx. 100 – 200 Mio. Euro
- Operation & Maintenance of Waste-to-Energy Plant (e.g. 40 years) approx. 600 – 1,600 Mio. Euro

Recommendation:
The determining factor for future success is the competent development and systematic evaluation of technical alternatives and feasibility studies by independent expert teams in cooperation with local partners.
Specific Treatment Costs and Composition of Costs per Ton of Waste for Typical Municipal Waste Incineration Plants in Austria

The specific investment costs depend on the size (economies of scale), optimum site selection (available infrastructure, etc.) and competent technical design / competitive prices for supply of plant.

Major revenues include steam (electricity and heat), gate fee for waste treatment, and recovery of inorganic materials (special cases). Subsidies (Co-Financing) for necessary investment (e.g. by EU-funds), revenues for CO$_2$-reduction credits, and substitution for necessary alternative boiler investment can significantly improve economic feasibility / reduce fees for waste treatment service.

Calorific value of 1 bale of RDF equals 2 to 3 barrels of crude oil.
State-of-the-art: cylindrical bales with approx. 1,2 m diameter and 1,2 m height
Capacity per packing machine approx. 30 bales/h, 3,000 to 4,000 h/a ⇒ ca. 60,000 to 120,000 t/a
Storage amount dependent on height of pile: up to 60,000 t/ha storage area
Short-term Alternative for Improvement in Recovery from Mixed Municipal Waste in the “Transient Phase”

Separation of mixed municipal waste into:

- **Metal scrap for recycling**

- **Fine fraction for available landfills / bio-reactor with recovery of biogas**

- **Refuse-derived fuel for waste-to-energy plants** (Option: Intermediate storage)
Renewable Resources with Recycling and Recovery for Sustainable Development

UV&P Environmental Management and Engineering

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