



Public acceptance and economic feasibility of Waste-to-Energy – Examples for Best Practice

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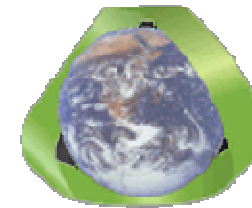
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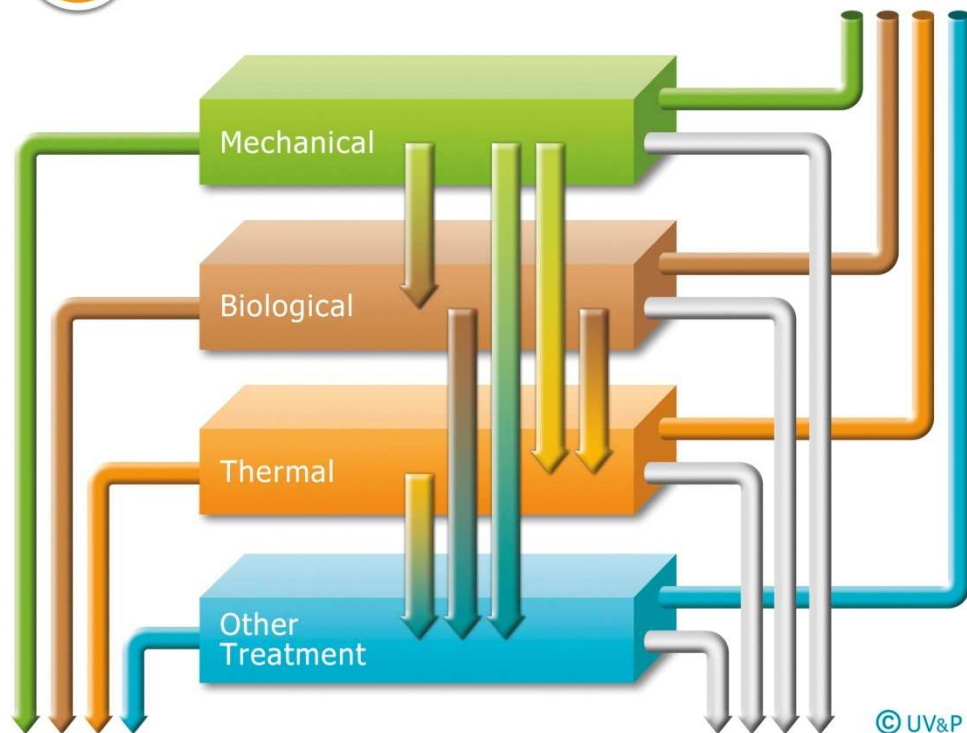




1

Priority Measures for
Prevention of Wastes

Source Separation
Collection of
Separated Wastes



2

Recovery incl.
Waste-to-Energy

3

Disposal
in Landfills

**Different technologies are
needed for specific
wastes in an integrated
treatment system.**

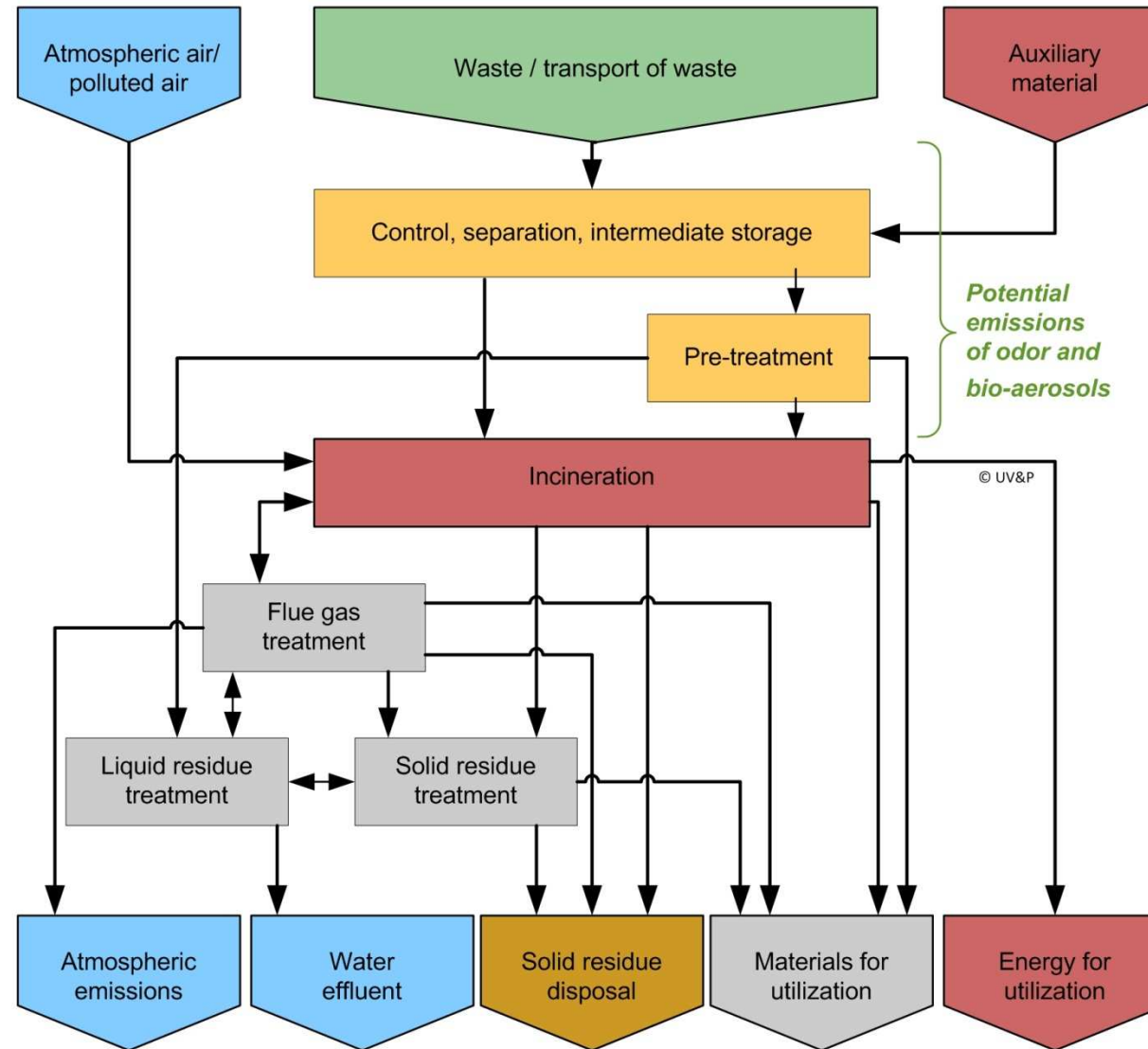
**Successful project
design must be based on
1st and 2nd Law of
Thermodynamics !**

**Our project designs are
profitable for our clients
and good for protection
of the environment.**

(UV&P, since 1991)

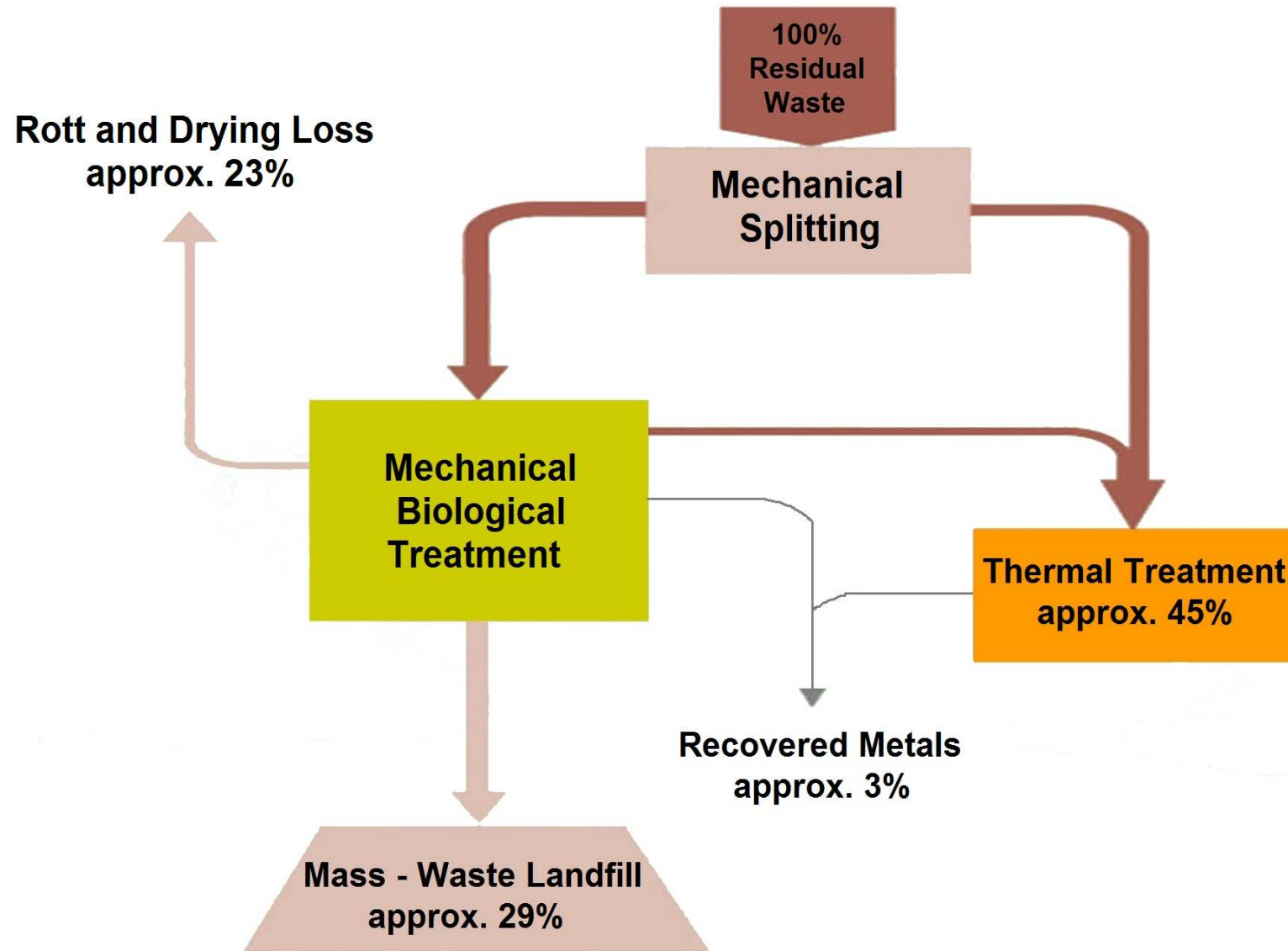


General Scheme for Pre-treatment and Incineration within complex Waste-to-Energy Plants





Average Mass Flows in Mechanical Biological Treatment (MBT) Plants for MSW in Austria



Source: White Book Waste-to-Energy, 2010



Atmospheric Emissions from waste incineration in Austria and Switzerland:

Values given in mg/m³_N (11% O₂, dry; for PCDD/F in ng/m³_N)

	Dust	Cd	HCl	SO ₂	NO _x	Hg	PCDD/F*
1970	100	0,2	1.000	500	300	0,5	50
1980	50	0,1	100	100	300	0,2	20
1990	1	0,005	5	20	100	0,01	0,05
2000	1	0,001	1	5	40	0,005	0,05

Source: Vogg (values for 1970 - 1990); RVL (values for 2000)

Legal Emission Standards for MSW 1994 in Austria compared to the September 2011 Emission Guidelines in British Columbia:

(**Bold numbers for 1/2-Hour Average**, *cursive numbers for Daily Average values*):

AT 1994	8	0,05	7	50	70	0,05	0,1
BC 2011	9	0,007	<i>10</i>	<i>50</i>	<i>190</i>	<i>0,02</i>	<i>0,08</i>



Municipal Waste-to-Energy: Example Waste Incineration Plant Spittelau, Vienna



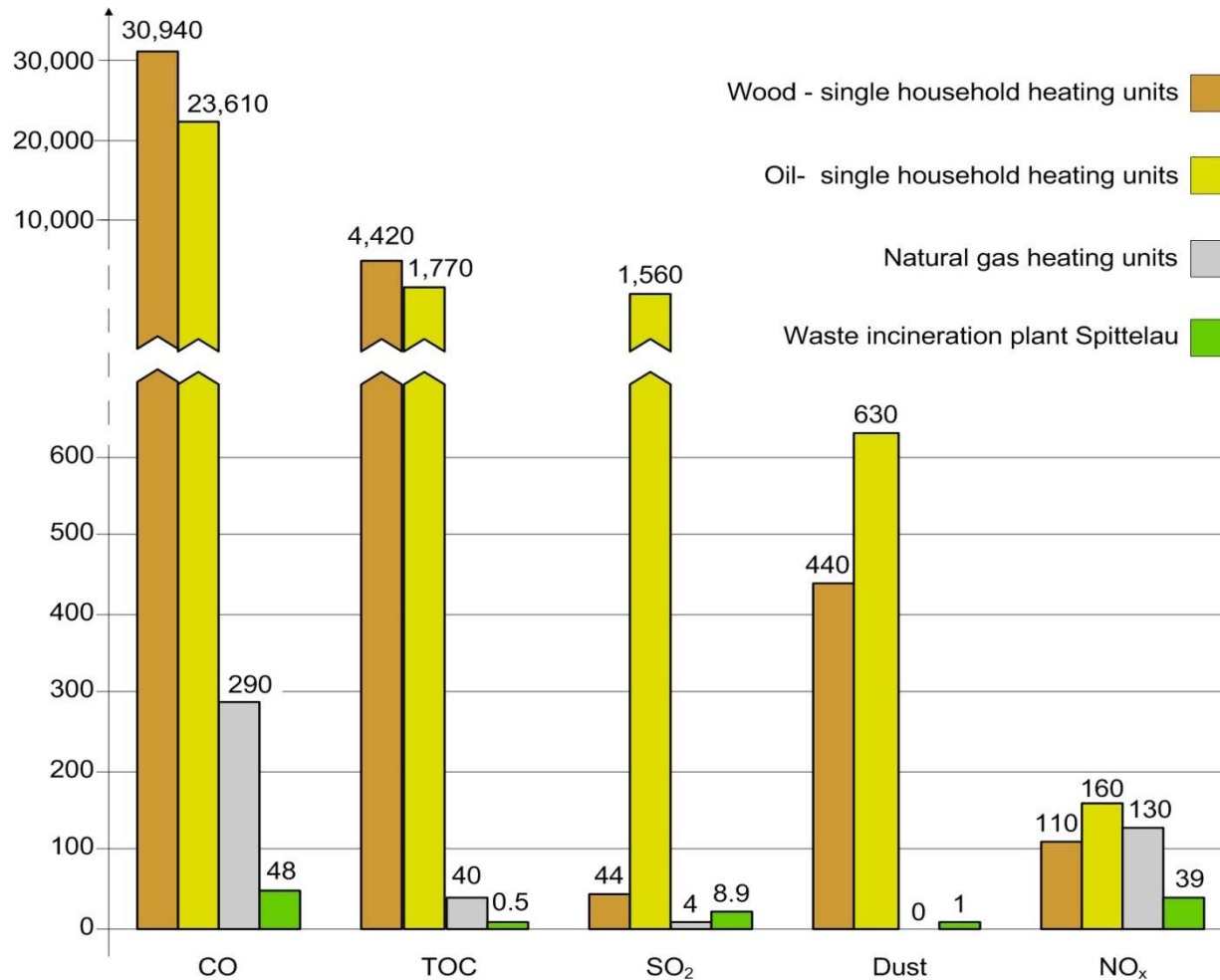
Start:	<u>1969</u>
(Re-) Start up:	1989
Re-vamping boilers:	<u>2013/15</u>
Site:	City of Vienna
Technology:	Grate firing
Fuel capacity:	85 MW
Efficiency:	up to 90 % (co-generation of electricity and district heat)
Steam production:	2 x 50 t / h (32 bar, 240°C)
Average waste throughput:	up to 780 t / d
Fuel:	municipal solid waste



Atmospheric Emissions from the Supply of Heat (Relevance for Air Quality in Vienna)



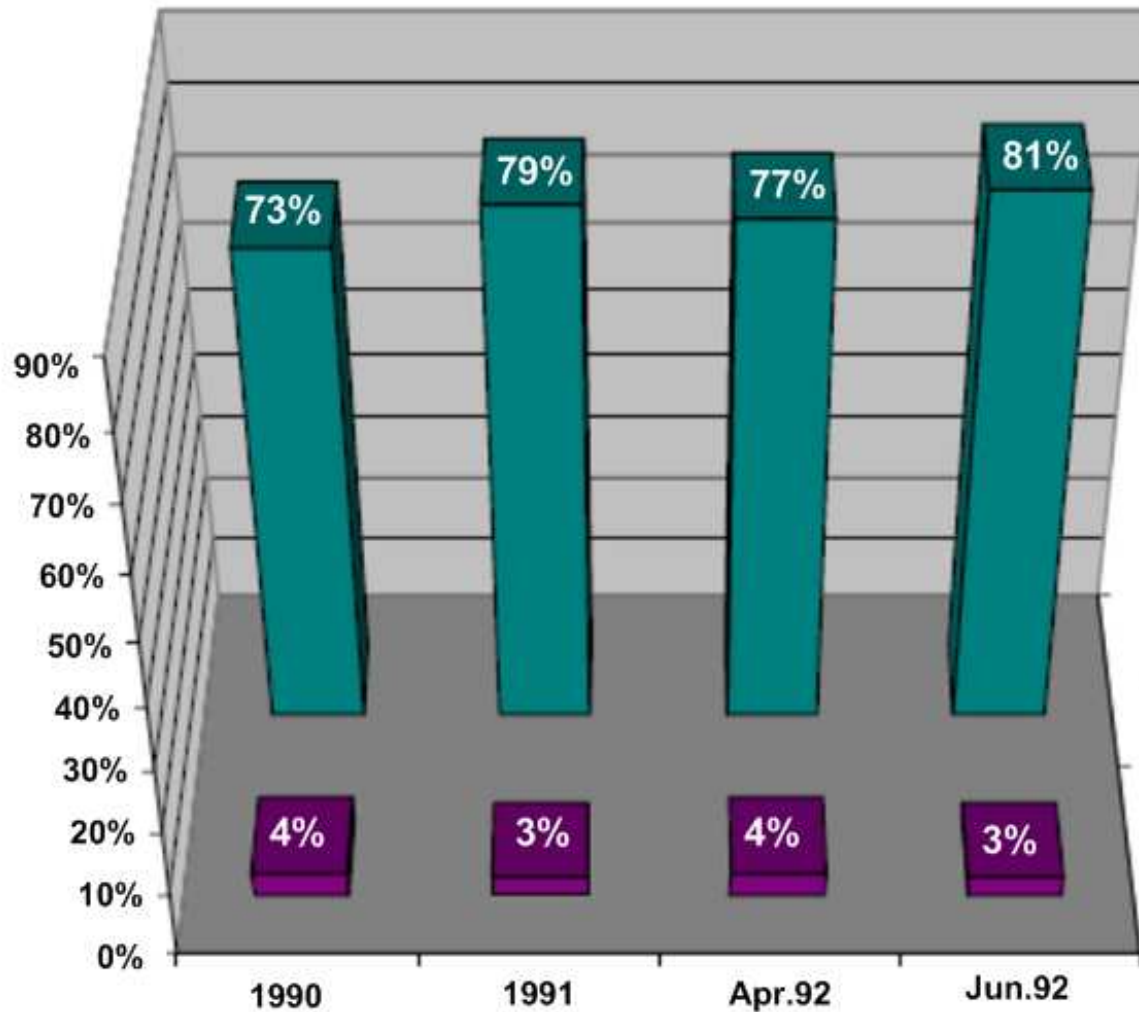
Air pollution in tons per year based on the same heating capacity



Source: Kirchner, IIR Conference: Efficient future Waste Treatment Technologies, 2008



Public acceptance of Waste-to-Energy in Vienna



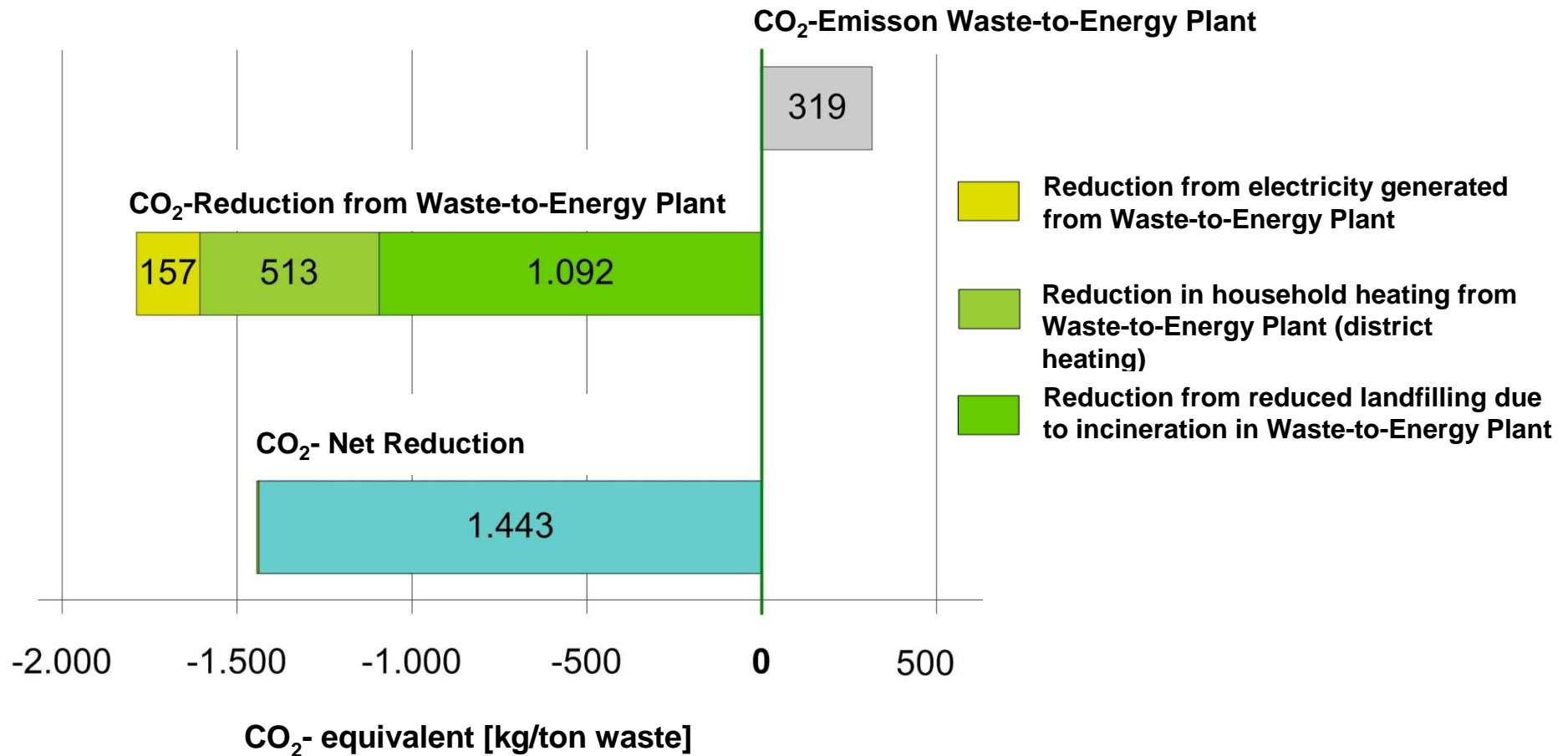
For Waste-to-Energy with district heating

Against incineration

Source: Löffler, MA22, Vienna



Reduction of Greenhouse - Gas Emissions by Municipal Waste Incineration in Vienna



Source: Kirchner, IIR Conference: Efficient future Waste Treatment Technologies, 2008



Waste Incineration Plant EVN in Zwentendorf, Lower Austria



Photo:EVN

Planning (UV&P):	1999/2001
Start up line 1+ 2:	2003
Start up line 3:	2009
Technology:	Grate firing
Fuel capacity:	2 x 60 MW 1 x 90 MW
Steam parameters:	50 bar, 380°C
Efficiency:	ca. 76 - 78 % (co-generation)
Average waste throughput:	approx. 500,000 t / a
Integrated option of steam supply to a turbine of coal-fired power plant (400 MW electricity).	
Project includes also a 31 km pipeline for district heating supply to St. Pölten.	



Waste-to-Energy Plant ENAGES Integrated within Site of Paper Industry in Niklasdorf, Styria

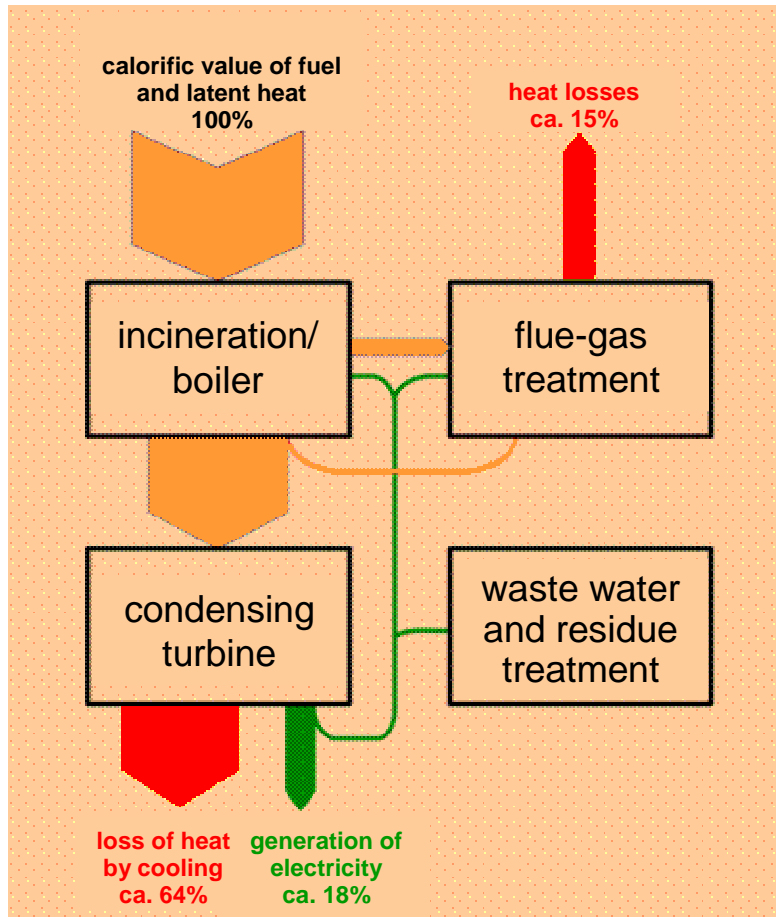


Source: <http://www.e-steiermark.com/enages/anlage.htm#>

Planning (UV&P):	1994/95
Start up:	2003
Technology:	Fluidized bed
Fuel capacity:	40 MW
Steam production:	46 t / h (40 bar, 400°C)
Average waste throughput:	approx. 100,000 t / a
Fuels:	RDF, municipal, commercial and production wastes, sewage sludge

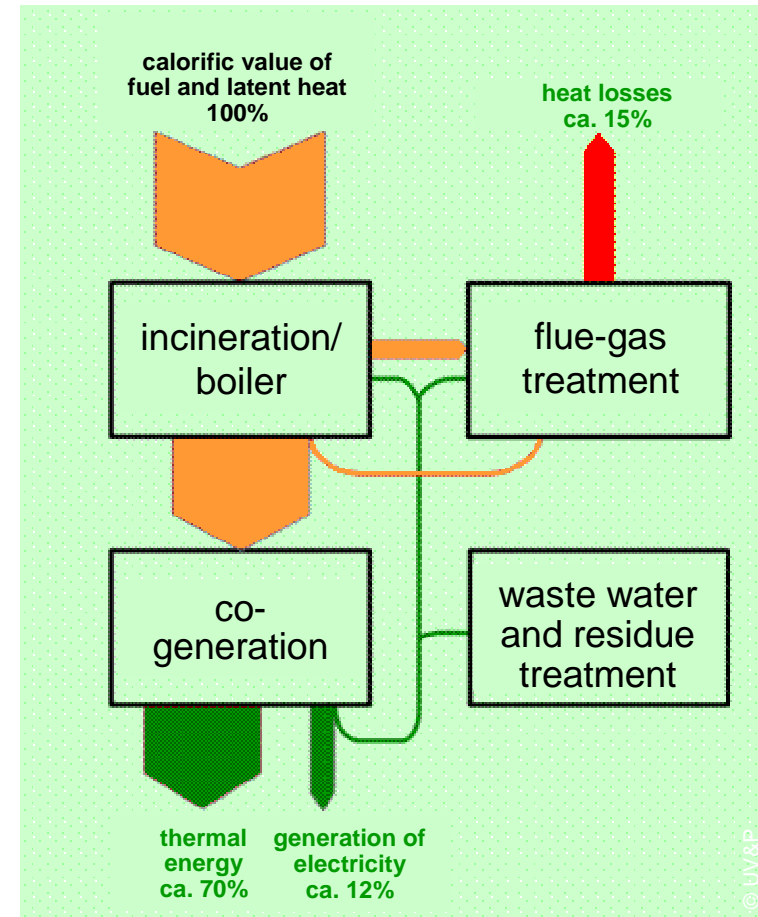


Condensing Turbine (electricity only)



Energy utilization approx. 20 %

Co-Generation (electricity + heat)

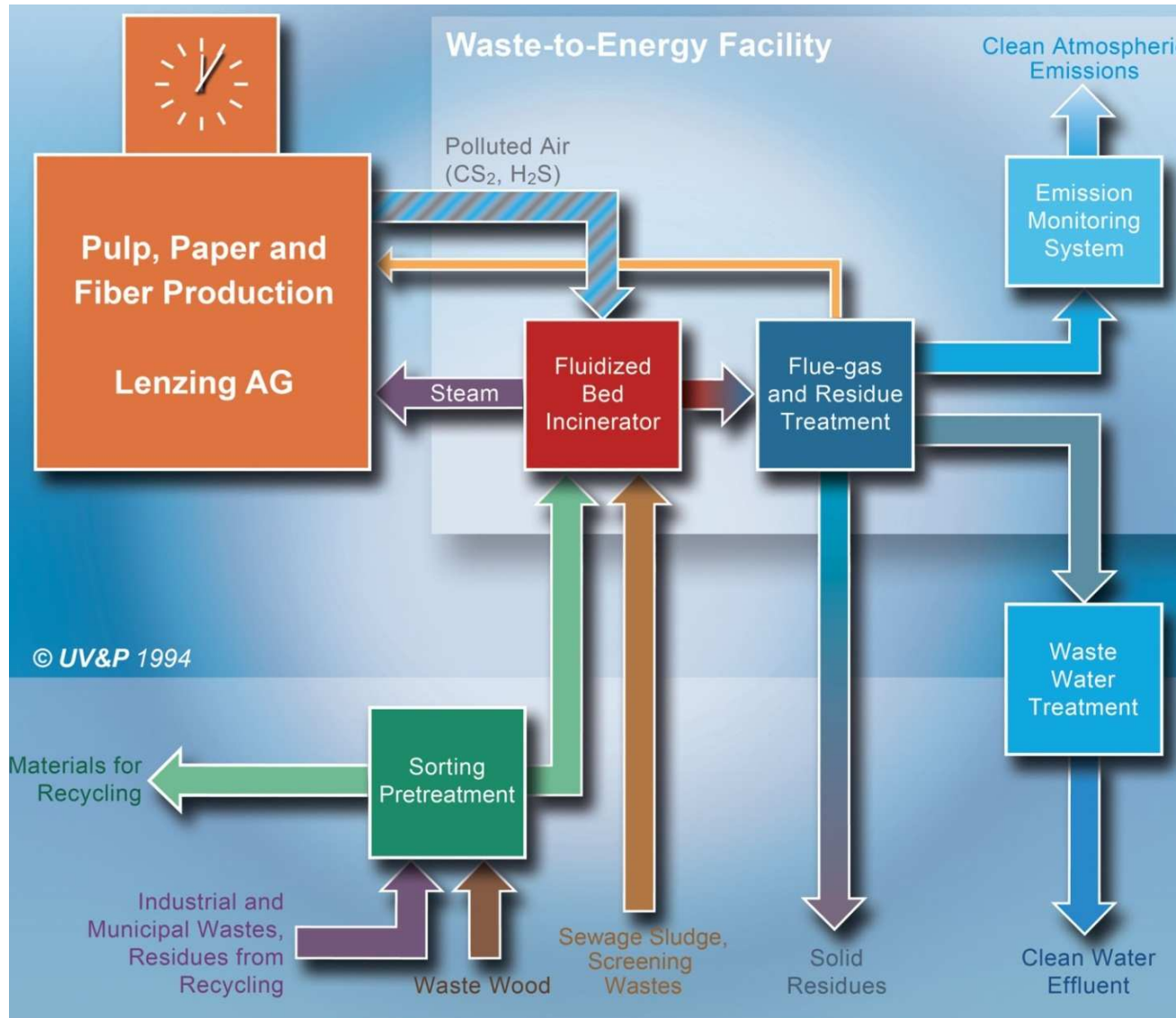


Energy utilization approx. 80 %



Integration of Waste-to-Energy in Industry

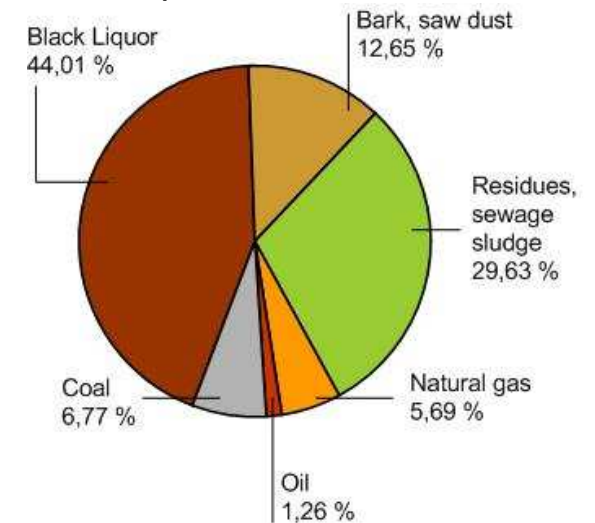
Example: RVL Lenzing, Upper Austria (1993)



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 2007 at Lenzing AG:

Fuel Input: 12.600.863 GJ / a





Industrial Site of Lenzing in the Salzkammergut, Upper Austria



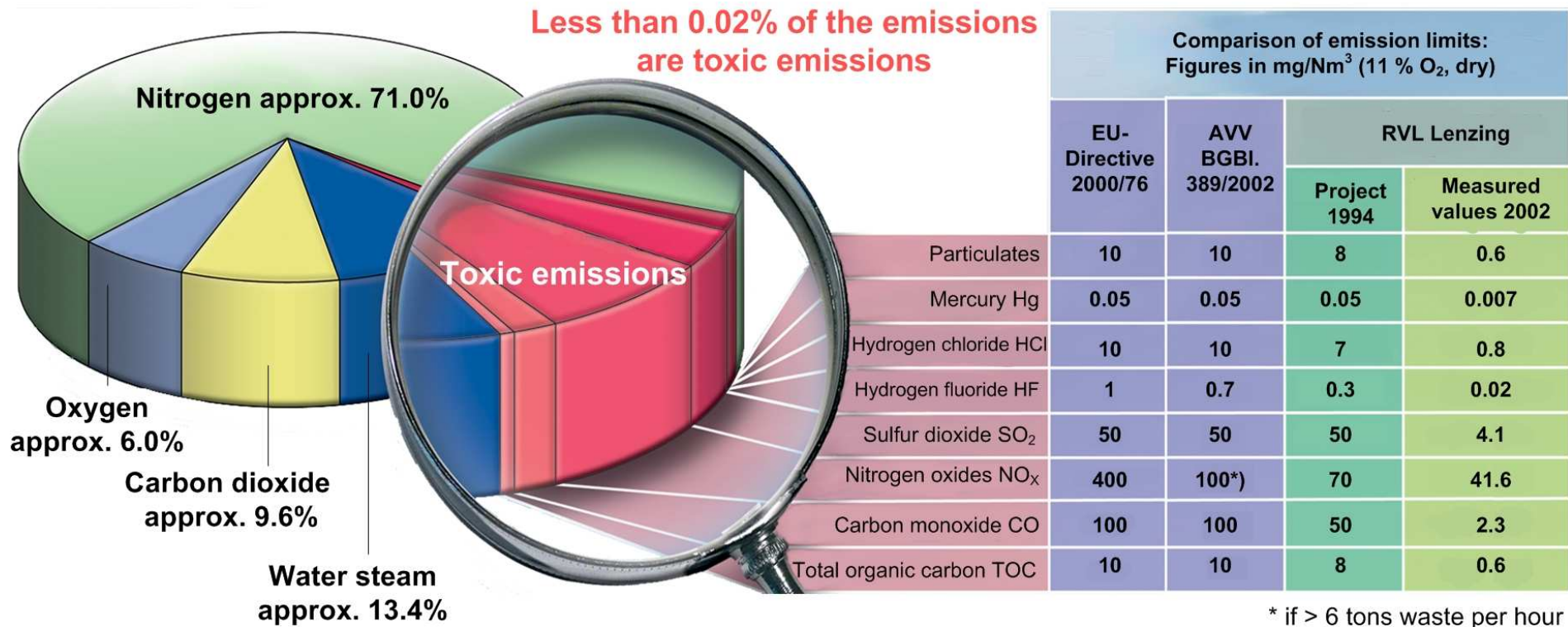
The waste-to-energy plant RVL is integrated in the industrial site of Lenzing, Austria – with advanced environmental technology to protect the natural environment (incl. organic farming) in the famous tourist region around Lake Attersee.

The 3 arguments in public discussions / acceptance:

- 1. Energy demand (90 MW)**
- 2. Reduction of odour (H_2S , CS_2)**
- 3. No landfilling (300.000 t / a)**



Control of Flue-Gas from Waste Incineration (Example: RVL Lenzing, in operation since 1998)





Comparison of organic compounds from incineration plant / cars on the road

Incineration plant

=

14 cars

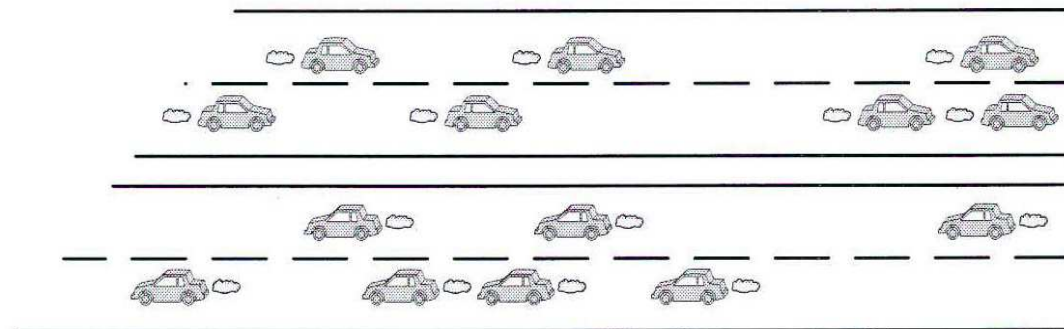
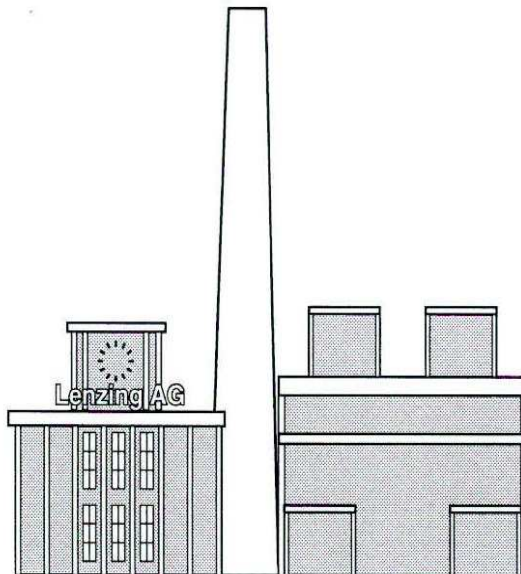
Calculation:

Car exhaust contains ca. 20 g C-org / kg fuel

(Source: Schopp G., Ö. Chemz. 1993/9)

Flue gas of the incineration plant with multi-stage flue gas cleaning contains less than 1.980 g C-org / h

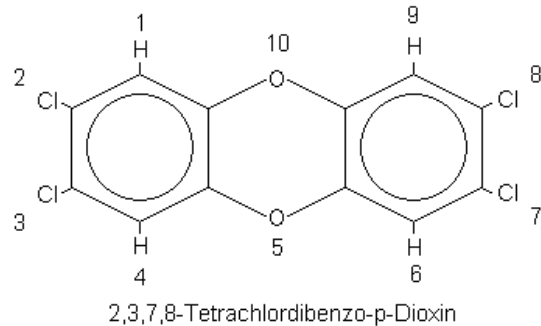
(Source: Expertise ZAMG, 22.12.1993)



Cleaned flue-gas of an incineration plant contains less organic compounds than the exhaust of 14 cars

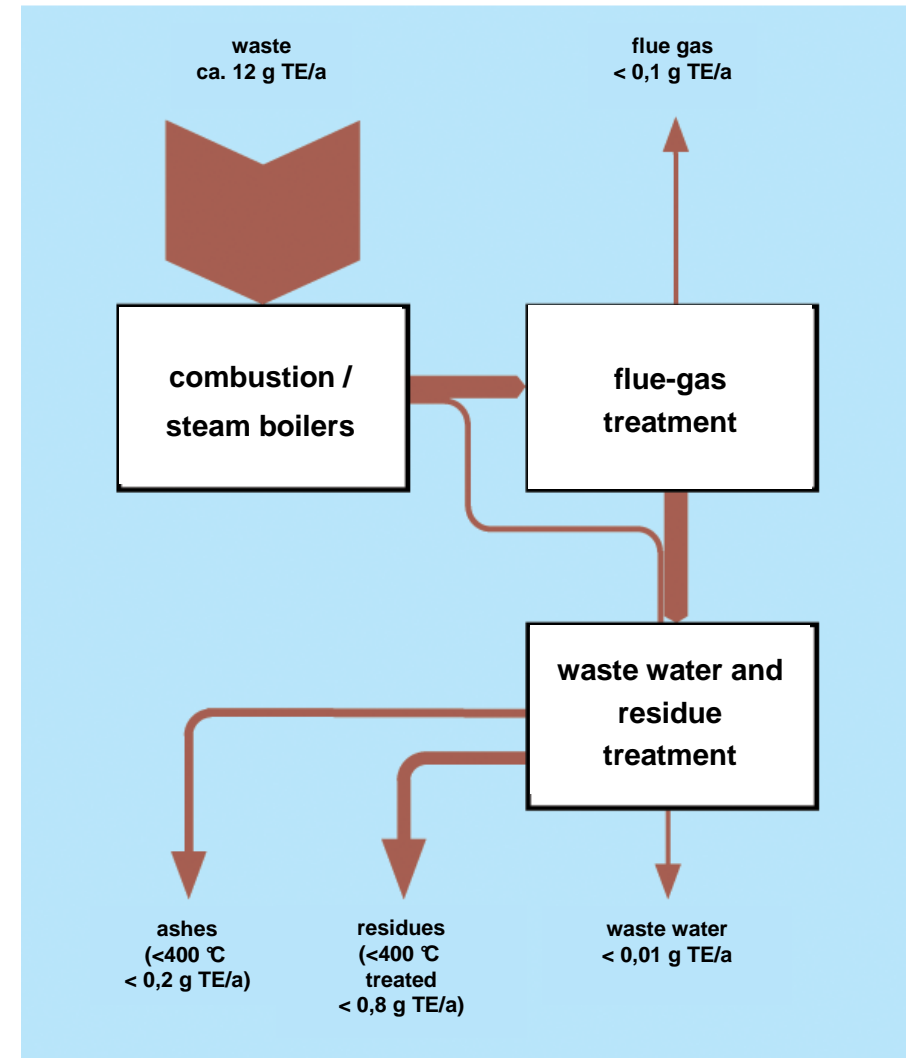
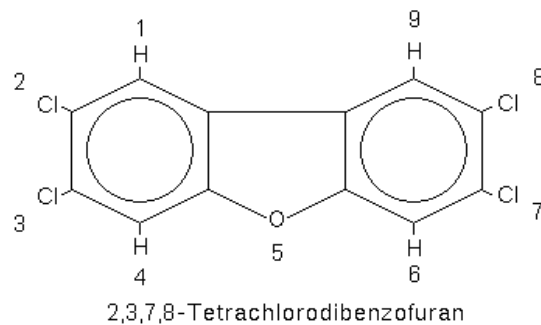


Balance of "Dioxins" in Waste Incineration according to State-of-the-Art Technology



The emission limit for "dioxins" is also the essential parameter for higher molecular halogenated organic substances and POPs persistent organic pollutant. The sum of "dioxin-emissions" of a thermal treatment plant according to state-of-the-art technology is significantly below the amount of dioxins already contained in waste prior to treatment.

g TE / a = g Toxicity Equivalent 2,3,7,8 TCDD per year



Calculation for an example of a waste incineration project: UV&P, 1996

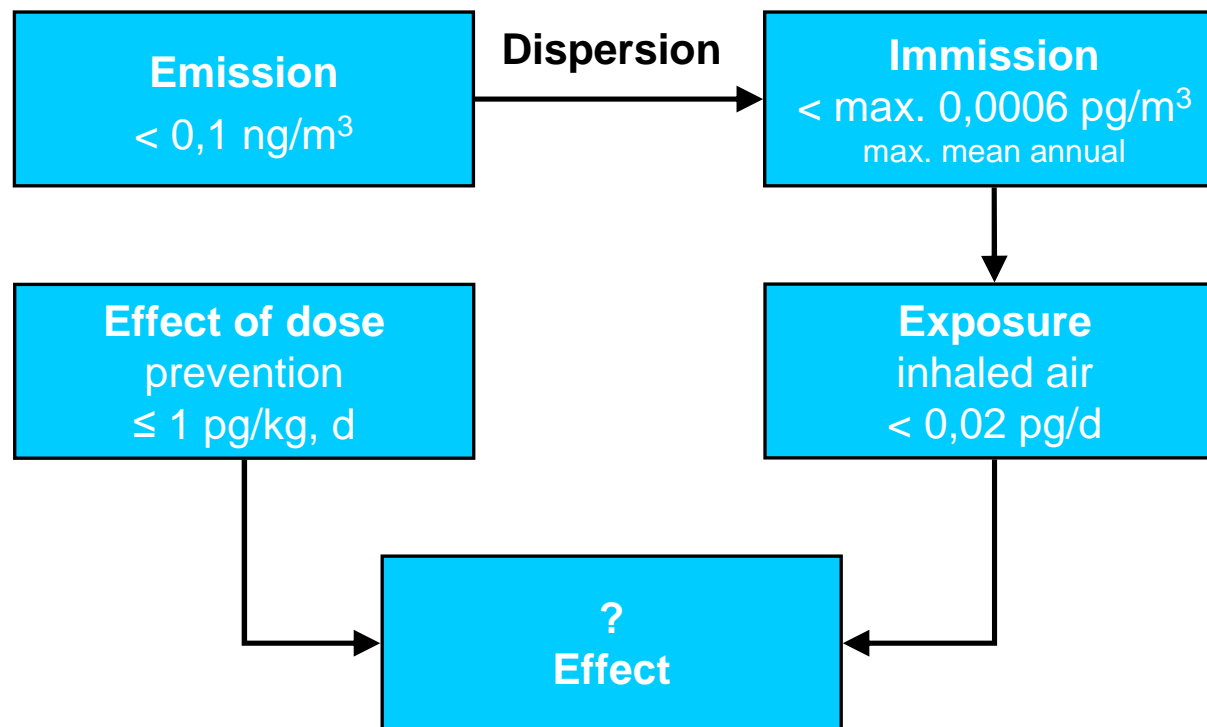


Risk Assessment for Atmospheric Emission of "Dioxins" (Example: RVL Lenzing 1994)



1 ng = 10^{-9} g = 0,000 000 001 g

1 pg = 10^{-12} g = 0,000 000 000 001 g



Risk assessment:

The precautionary protection standard (federal health bureau, Berlin) is 1 pg / kg weight and day (factor 1000 safety compared with NOEL - No Observable Effect Level). In the worst case a person inhales 0,012 pg dioxin with ca. 20m³ air per day. In comparison the protection standard for a 60 kg person is 60 pg/day. Therefore the inhaled maximum is less than $\frac{1}{1000}$ of the protection standard. Thus the additional risk can be considered irrelevant.

No increased health risk due to very small concentration of dioxins in the cleaned flue-gas of the waste incineration facility.



Illustration for Risk Assessment regarding “Dioxins” Example RVL, 1994



Assumption: **3 cigarettes per day** = marginal value of impact (no effect observable)

Thus the **precautious** protection standard (=1/1000) is equivalent to **1 cigarette per year**.



Conclusion : An incineration plant with multi-stage flue gas cleaning is factor 1000 below the (precautious) protection standard
thus = equivalent to 1 additional cigarette in 1000 years



Long-term monitoring of dioxins and furans near a municipal solid waste incinerator: human health risks

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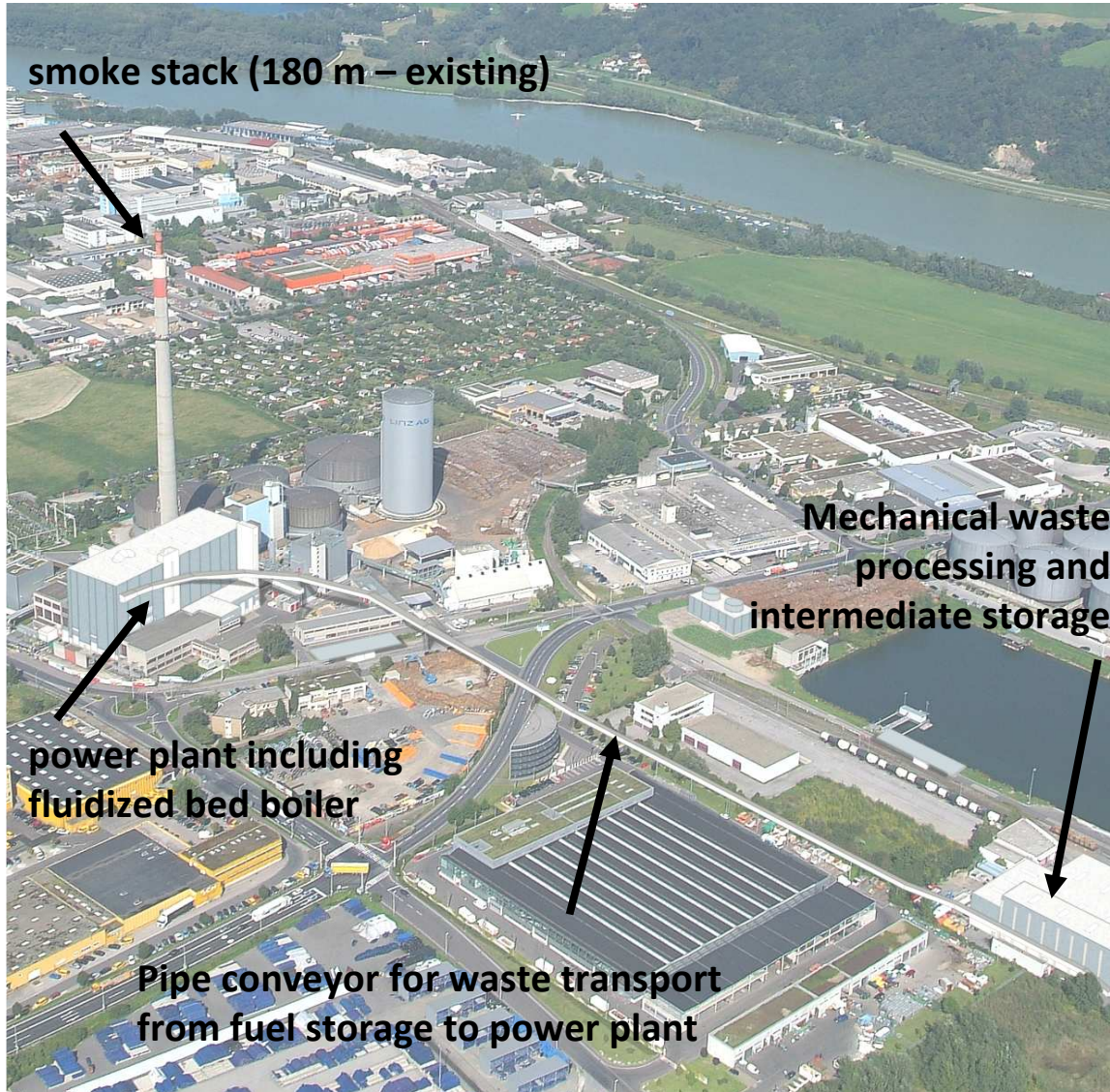
Lolita Vilavert¹, Martí Nadal¹, Marta Schuhmacher^{1,2} and José L Domingo¹

Abstract

Since 1996, a wide surveillance programme has been developed to get overall information on the impact of a municipal solid waste incinerator (MSWI) in Tarragona (Catalonia, Spain). The concentrations of polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) have been periodically measured in soil and vegetation samples collected at locations in the incinerator surroundings. Furthermore, air PCDD/F levels have been also monitored by using active and passive sampling devices, generating a huge amount of information regarding the environmental status of the zone. In the last survey (2009–2010), mean PCDD/F levels in vegetation, soil and air were 0.06 ng I-TEQ kg⁻¹, 0.58 ng I-TEQ kg⁻¹ and 10.5 fg WHO-TEQ m⁻³, respectively. Both soil and herbage showed a notable reduction in the PCDD/F concentrations in comparison with the baseline study, with this decrease only being significant for soils. In contrast, PCDD/F values in air remained similar during the whole assessment period. Human exposure to PCDD/Fs was evaluated under different scenarios, and the associated non-carcinogenic and carcinogenic risks were assessed. The hazard quotient was below unity in all cases, while cancer risks were under 10⁻⁶, which is lower than the maximum recommended guidelines. The current results clearly show that the MSWI of Tarragona does not produce additional health risks for the population living nearby.



RHKW Linz: Residual Waste Heat and Power Plant for Co-Generation / Electricity + District Heat



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 (+ 10%) (42 bar, 405°C)
Average waste throughput:	up to 800 t / d
Fuels:	Municipal and commercial waste, sewage sludge, screening wastes, shredder residues



Example for Future Perspectives: MMK Cardboard Industry / New Energy Center, Frohnleiten, Styria



Planning (UV&P):	2005/07
Technology:	Fluidized bed
Fuel capacity:	2 x 80 MW
Efficiency:	ca. 80 % (co-generation)
Steam production:	190 t / h (70 bar, 470°C)
Average RDF throughput:	up to 1.360 t / d
Fuels:	Refuse derived fuel, residues from paper recycling, waste wood, sludge from waste water treatment (biomass, coal)



**We have
calculated this
for you**



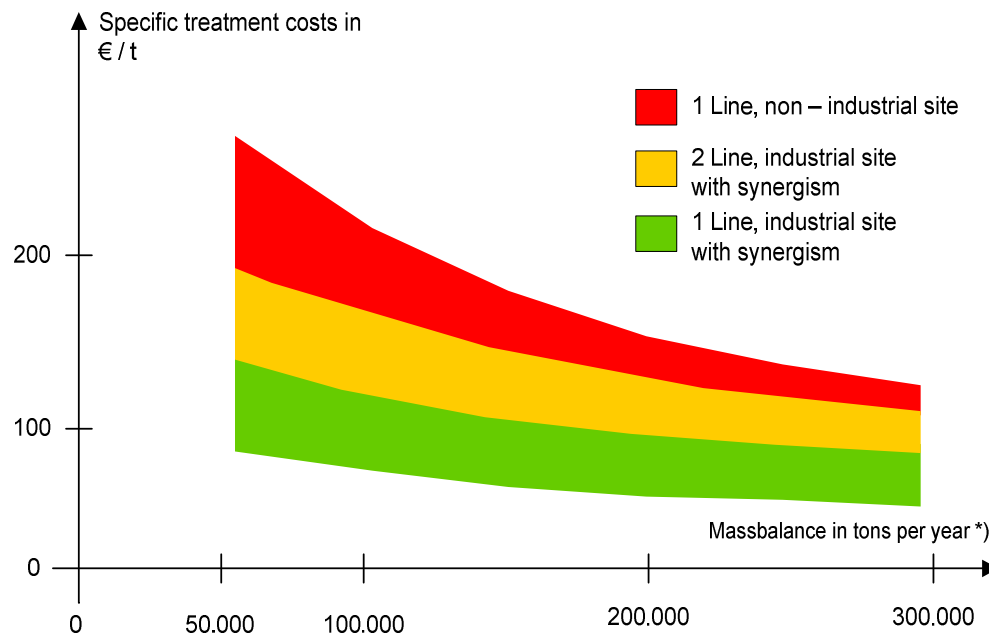
Source: Martin GmbH, SYNCOM presentation in Arnoldstein, 26-27 April 2006



Specific Treatment Costs and Composition of Costs for MSW Incinerators with Grate Systems in Austria

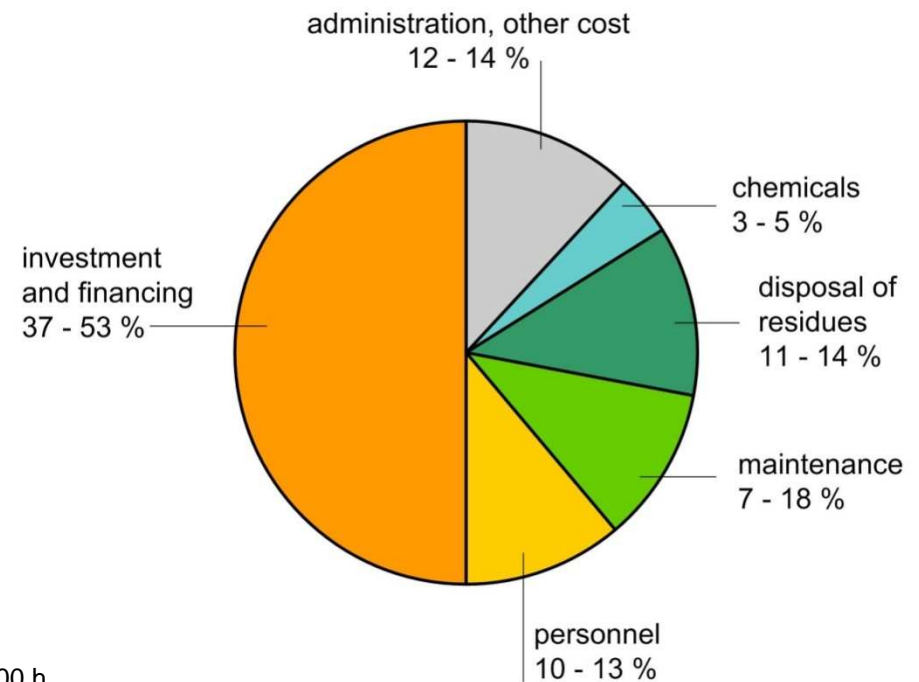


The specific investment costs depend on size (economies of scale), appropriate selection of site (available infrastructure, etc.) and competent design / competitive prices for supply of equipment



based on average calorific value of approx. 10 MJ / kg and annual operation of 8.000 h

Source: White Book „Waste-to-Energy in Austria“, 2010



Major revenues include production of steam (electricity and heat), revenues for waste treatment, and recovery of inorganic materials (in special cases)



Total investment for WtE-Plant incl. infrastructure → approx. 2 Mio €/MW (range 1 to 5 Mio €/MW)

Example for discussion:

WtE Plant with 100 MW fuel capacity → approx. 200 Mio € (100 to 500) investment for a technical life-time → 25 to 40 years of operation

- **Revenues for energy**

- Electricity export approx. 20 MW and 80 €/MWh (range 30 to 200) and 8,000 h/a → **12.8 Mio €/a** (up to 32 Mio €/a)
- If co-generation with export of 65 MW LP-steam (e.g. 20 €/MWh) but 5 MW less electricity (e.g. 80 €/MWh) → **additional 7.2 Mio €/a**

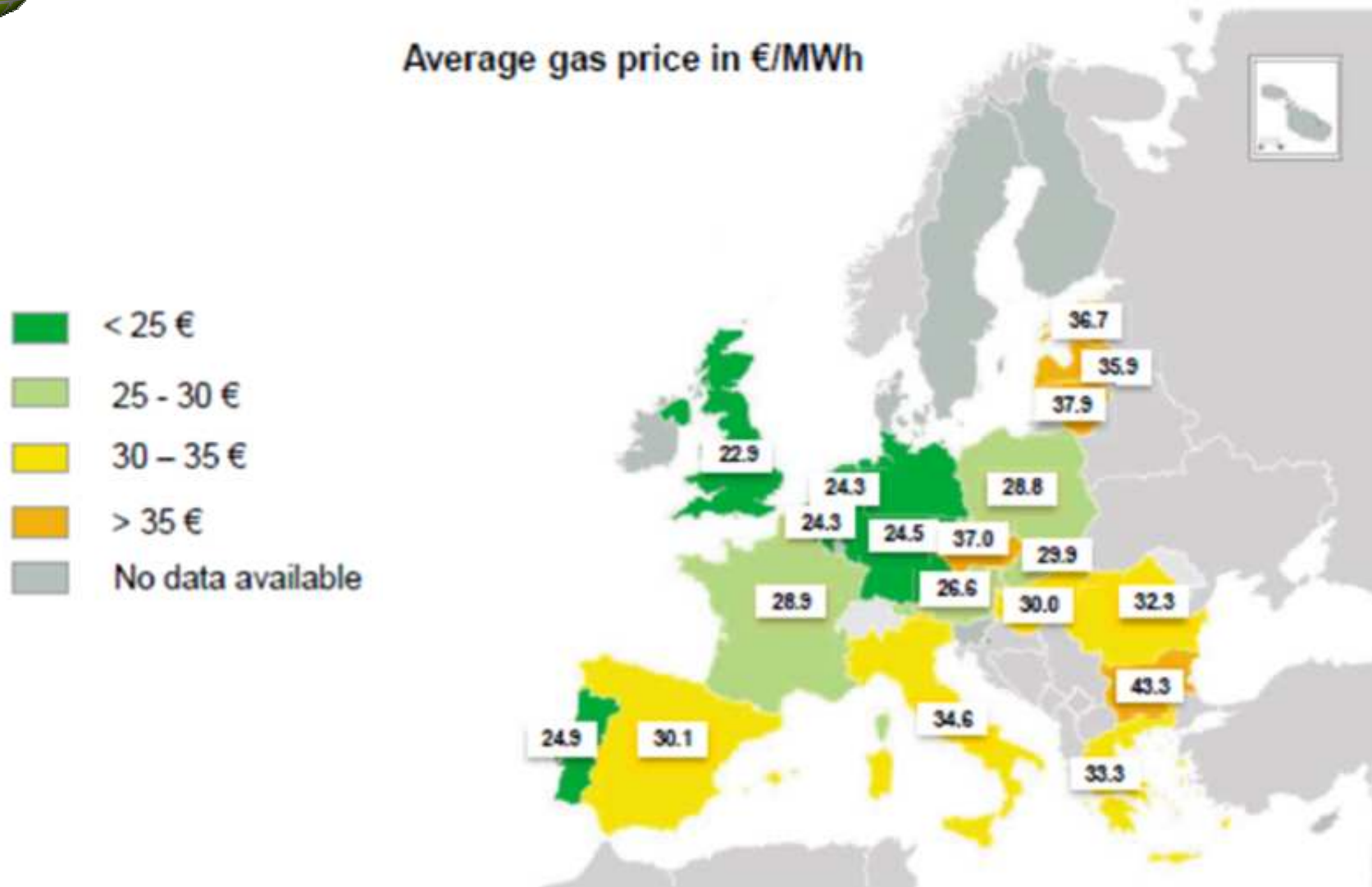
- **Revenues for waste treatment**

100 MW fuel capacity equals a waste treatment of approx. 300,000 t/a (average calorific value of 9 to 10 MJ/kg).

In case of 20 to 120 €/t for environmentally friendly waste treatment the revenues will be in the range of **6 to 36 Mio €/a**



Gas prices vary significantly across the EU depending on level of competition



Source: „Energy challenges and policy“, European Commission, May 2013



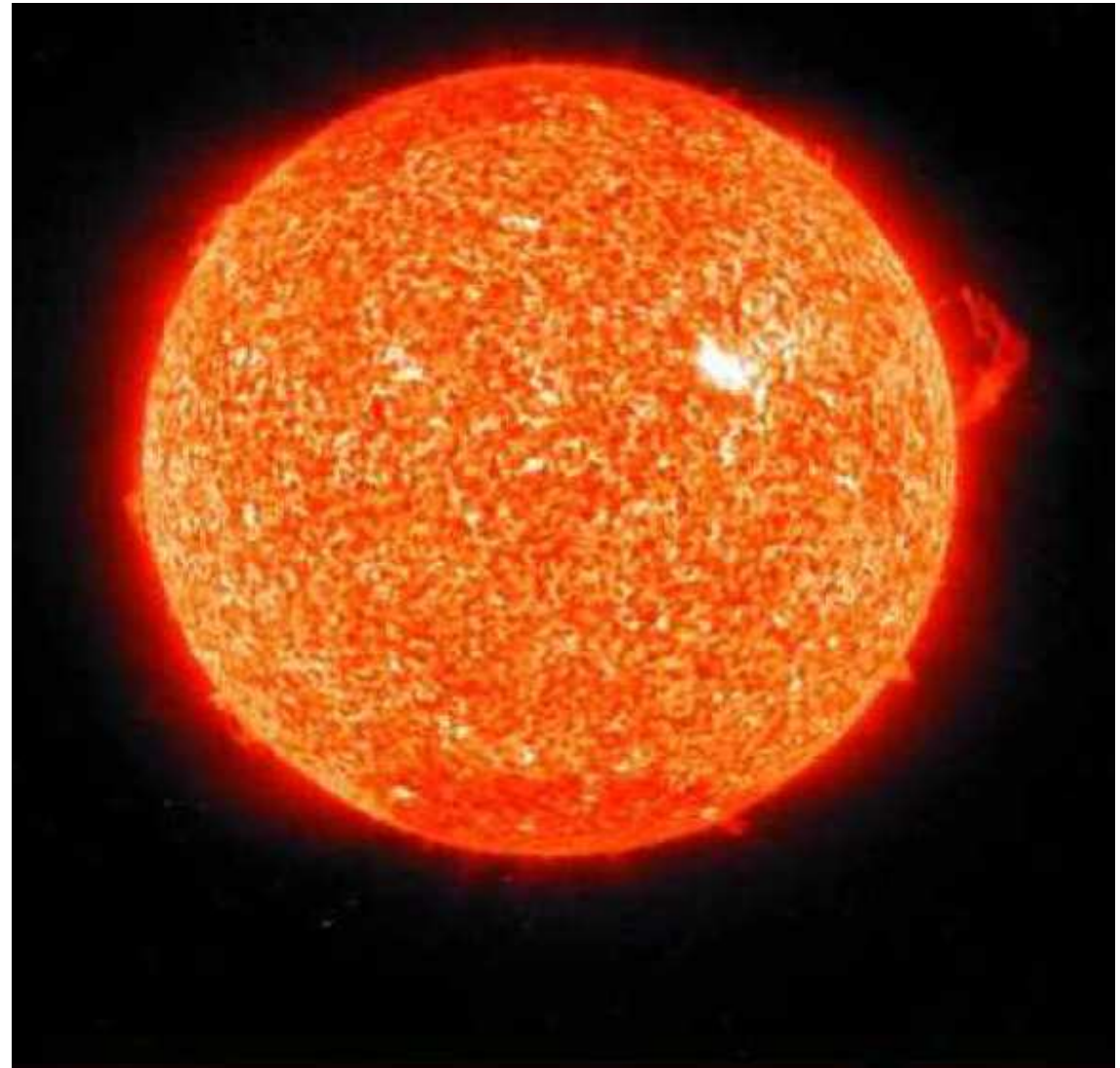
**Solar energy absorbed
by the earth in
1 hour**

**exceeds the world's
consumption of primary
energy in 1 year**

For Discussion:



**1 ton of
garbage per
year could
yield enough
electricity to
illuminate
7 LED-bulbs
(8 W - 638 LM)**



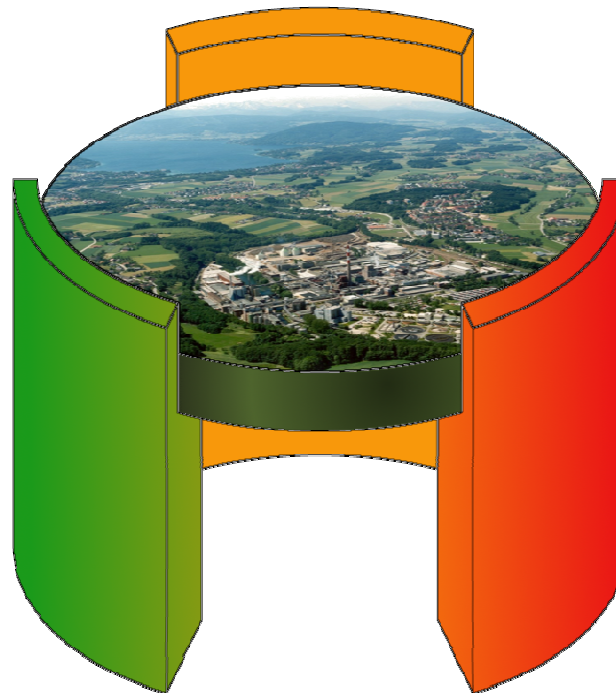
Source: Gohlke, O. (Martin GmbH), Waste & Climate Conference Copenhagen, Dec. 3-4, 2009



Example RVL Lenzing (110 MW)

legal & social acceptance

> 3,300 objections by citizens
11 years until final permit



ecological
requirements

economic
viability

Opposition by “green“
fundamentalists &
landfill profiteers &
“miraculous“ new
Technologies

Best environmental standard and economic performance since 1994/98

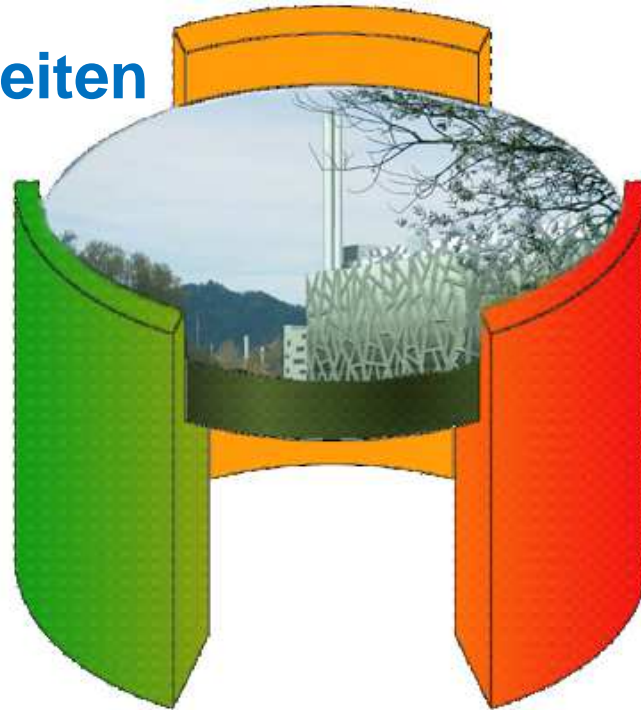


Example MMK Frohnleiten (160 MW)

legal & social acceptance

0 objections by citizens
1 year until final permit

**ecological
requirements**



**economic
viability**

**Price dumping (landfills
in neighbor regions) &
high taxation & lack of
funding & no green
tariffs and carbon
credits**

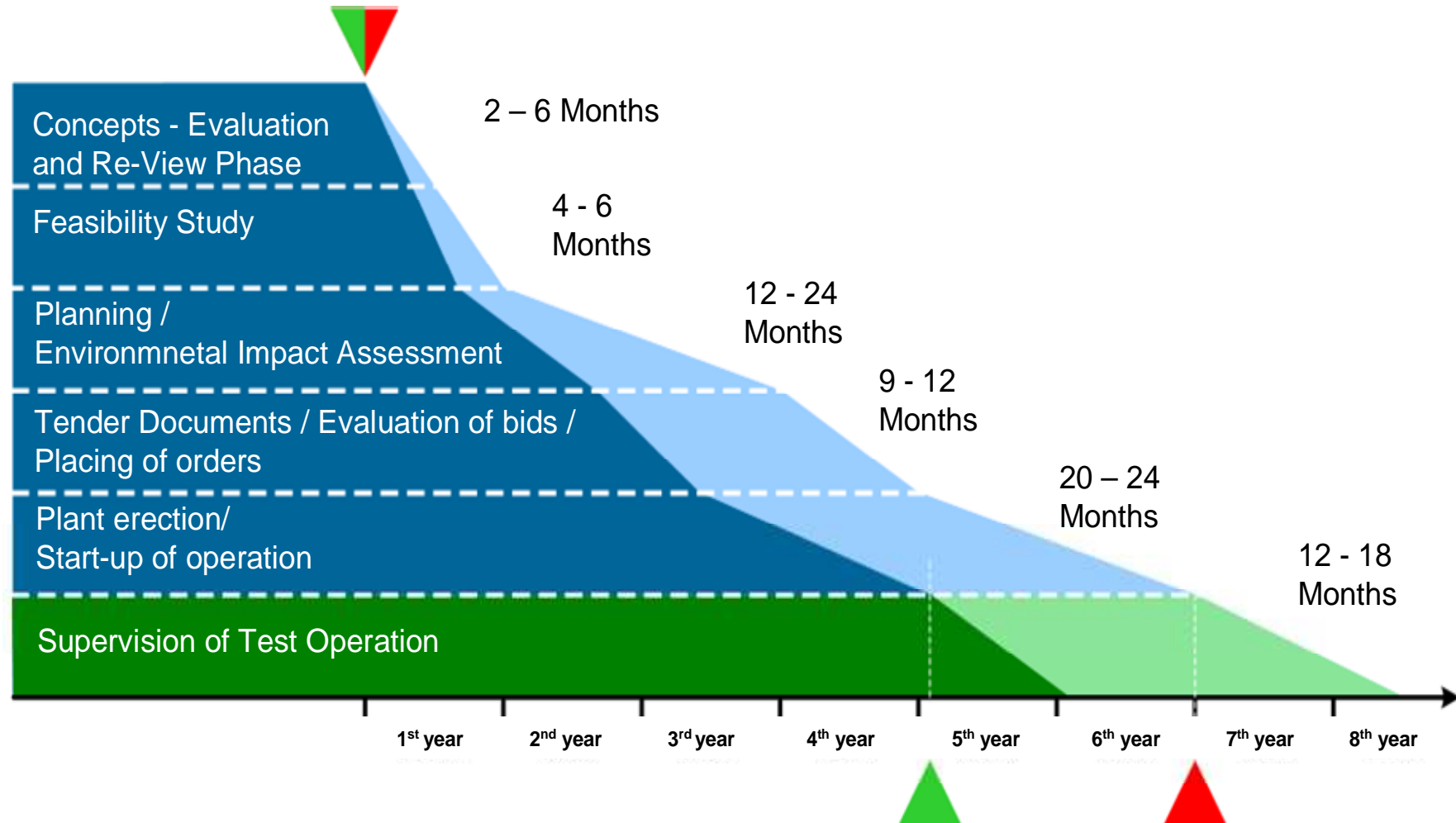
Proven environmental standard and expected least-cost, but....



Activities and Time Schedule for Project Implementation of large Waste-to-Energy Treatment Projects



Necessary time from project start until start-up of operation: min. 4 to approx. 6 years





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

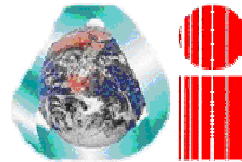


Waste Management
Supply of Waste Fuel /
Recovery / Disposal of Solid Residues



Thank you !
Comments & Questions ?

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www.wtert.org



ISWA Study Tour & Seminar WASTE-TO-ENERGY in Austria and Czech Republic, June 22-27, 2014





The **technical concept** should be based on:

- State-of-the-art technology (BAT) for such type of waste
- Proof of successful technical operation of a similar type and size of facility (e.g. > 80% of requested thermal capacity) over a minimum period of 3 years

The **financial risks** for installation of unproven technology are significant and have to be legally well-defined and financially secured.

The following scenarios must be considered:

1. Costs for immediate upgrading in case of insufficient performance
2. Costs for installation of a system according to state-of-the-art in case of a continuous failure
3. Costs for alternative treatment of waste during incomplete or malfunctioning of the overall system.



Typical Mistakes in the Development of Waste Management based on Experience in Europe



	Principle	Practical examples for violation of principles
1	Awareness	Ignorance may cause substantial economic losses to present and future generations, health hazards and general environmental degradation (e.g. waste dumps: out of sight – out of mind)
2	1st Law of Thermodynamics (balances of mass and energy)	Technologies with technically foreseeable faults (e.g. inappropriate selection of sites with lack for utilization of heat from waste incineration)
3	2nd Law of Thermodynamics (increase of entropy)	Technologies with technically foreseeable faults (e.g. stranded investments in waste sorting plants for recycling of municipal garbage)
4	Economic feasibility of project	Lack of consideration of waste markets, of economics of scale and of necessary cooperation
5	Public information and social acceptance of project	Lack of information and/or investment in public credibility of project applicants may prevent even environmentally friendly projects due to the “NIMBY-syndrome” (Not In My Back-Yard)
6	Civil law and civil conduct; Control and enforcement of law	Fraud, corruption, overregulation, ignorance, Laissez-faire in enforcement of environmental law and standards by governmental authorities
7	Foreseeable political development based on sustainability and legal justice	Increasing bureaucratic costs and stranded investments caused by unforeseen political changes with subsequent frequent changes of regulations and/or of enforcement (e.g. delay of enforcement action; permits for waste export)