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Value from Waste

Amsterdam's Vision on the 4th-generation Waste-2-Energy

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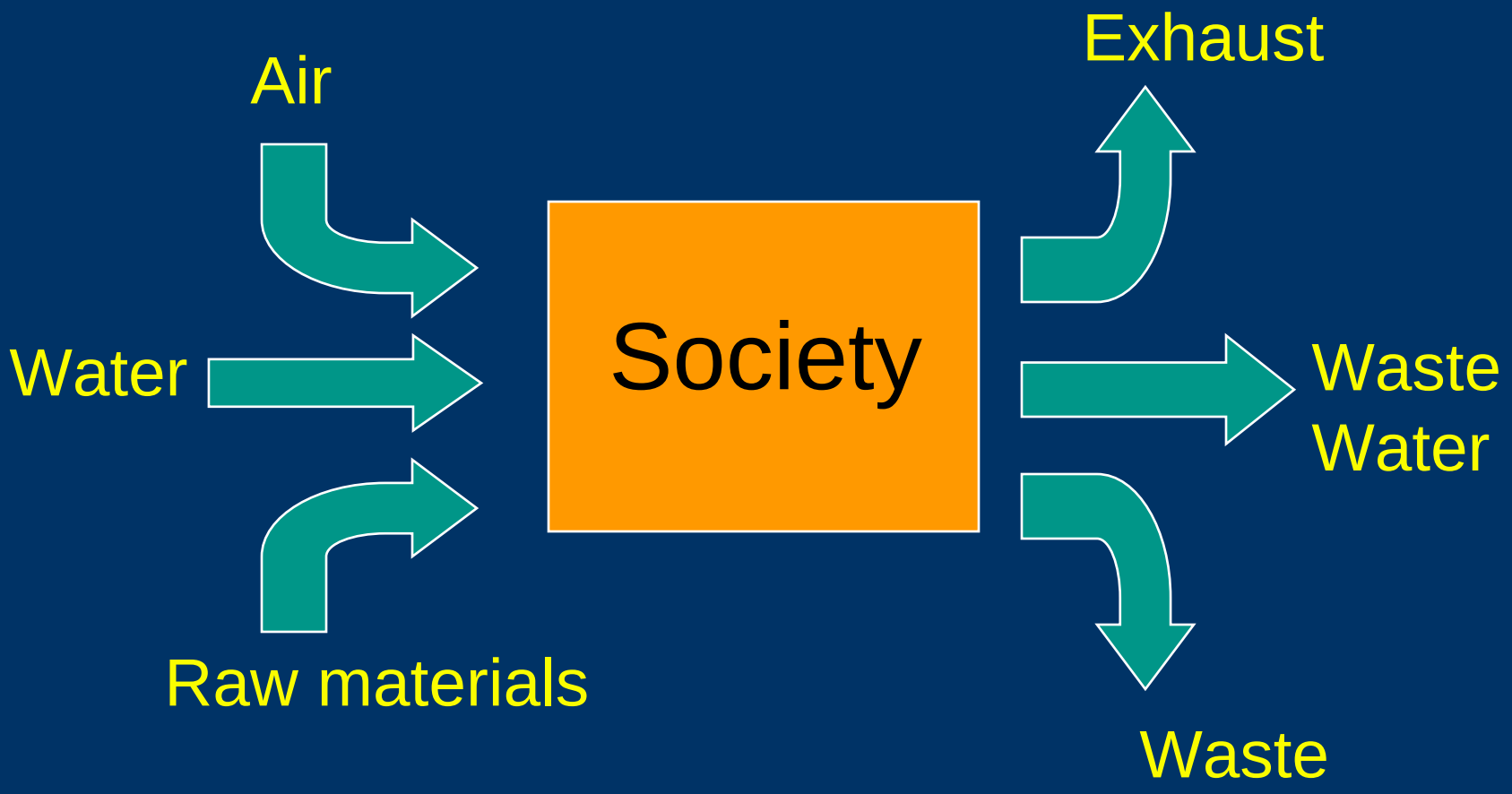
ISWA congress 2007
Plant Visit at Afvalenergiebedrijf

Amsterdam, 27 september 2007

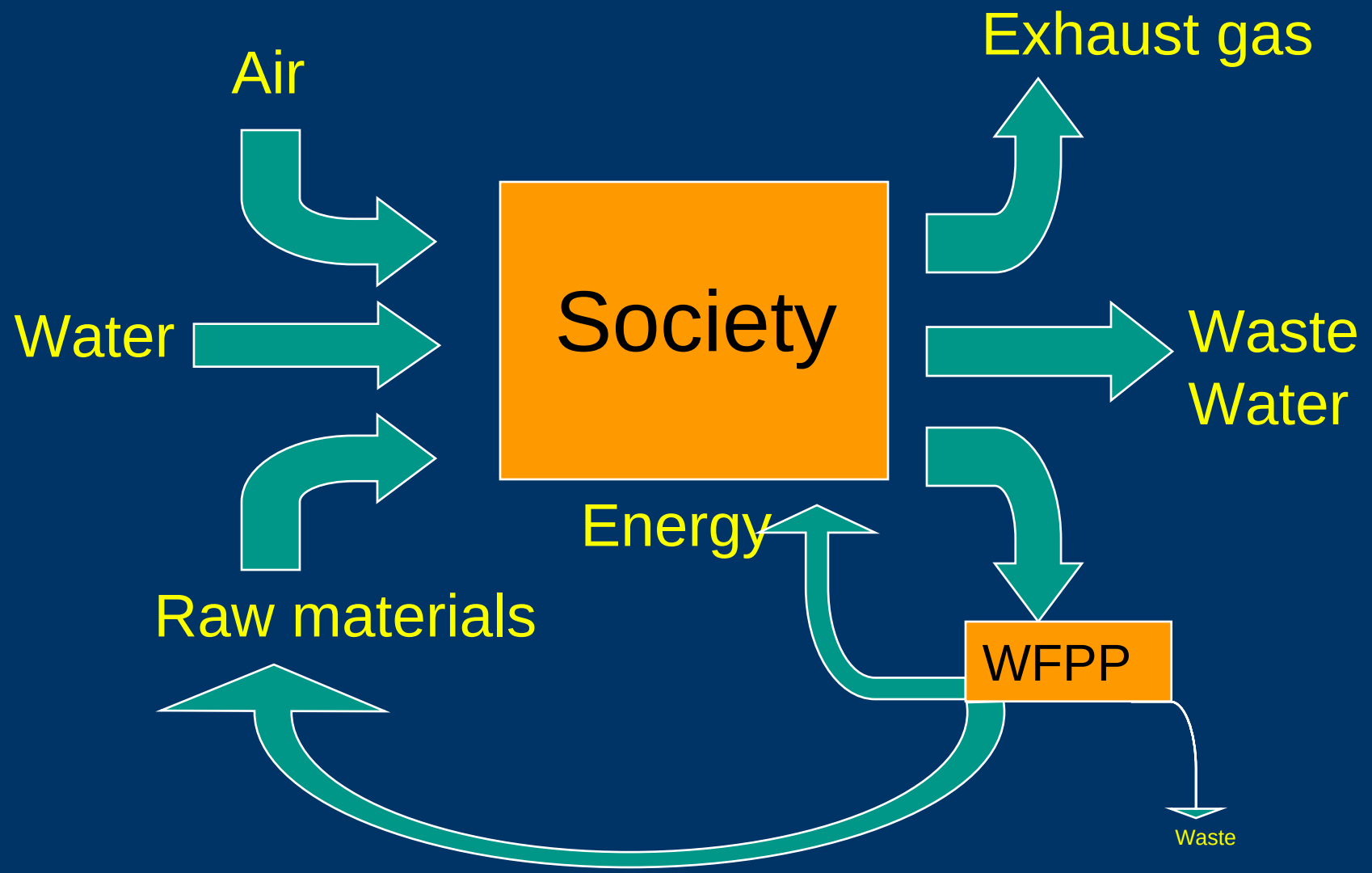
1. INTRODUCTION

1. Introduction
2. Scenarios for Recovery
3. Amsterdam
4. New generation of waste incineration
5. Conclusion

Society



Closing the loop



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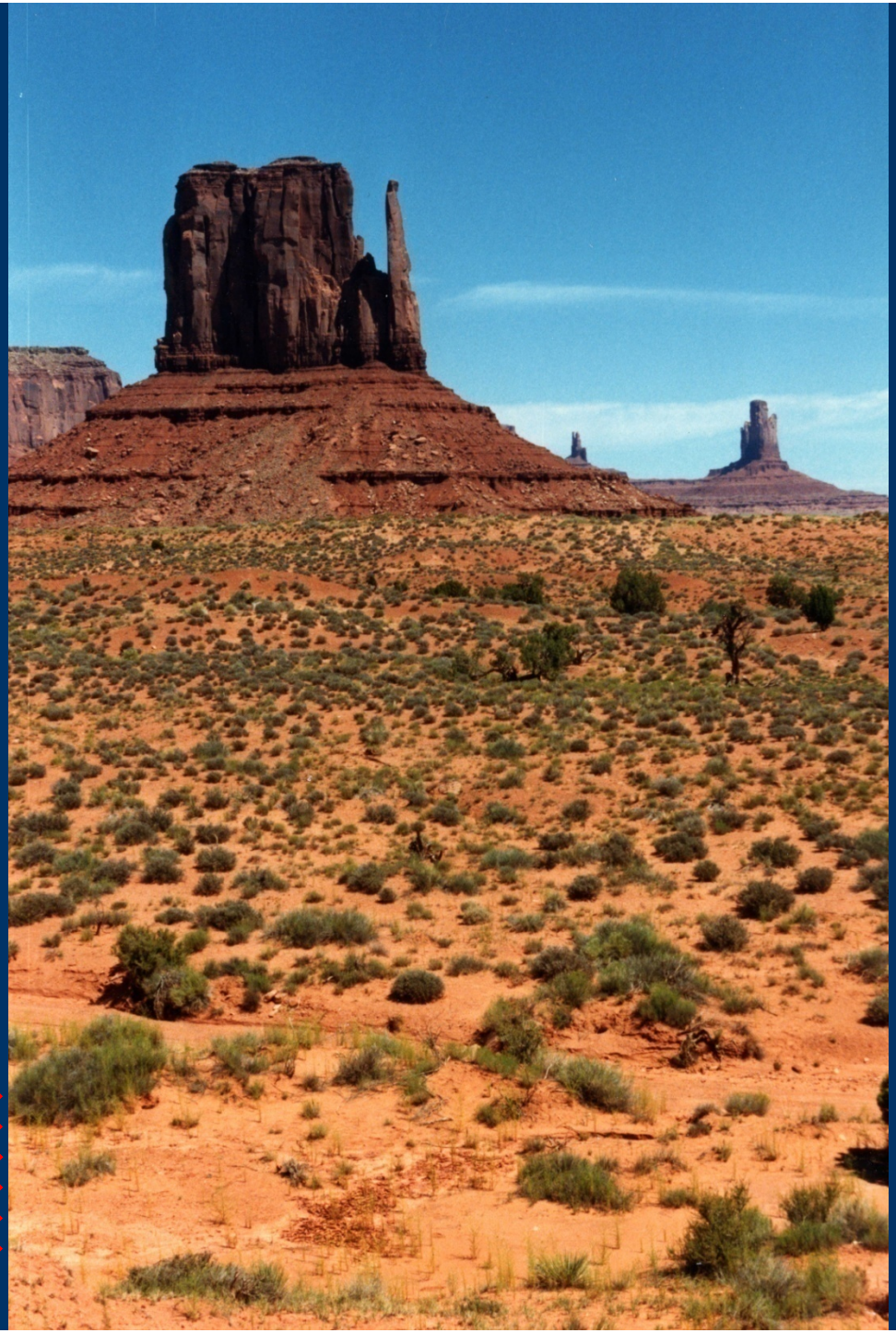
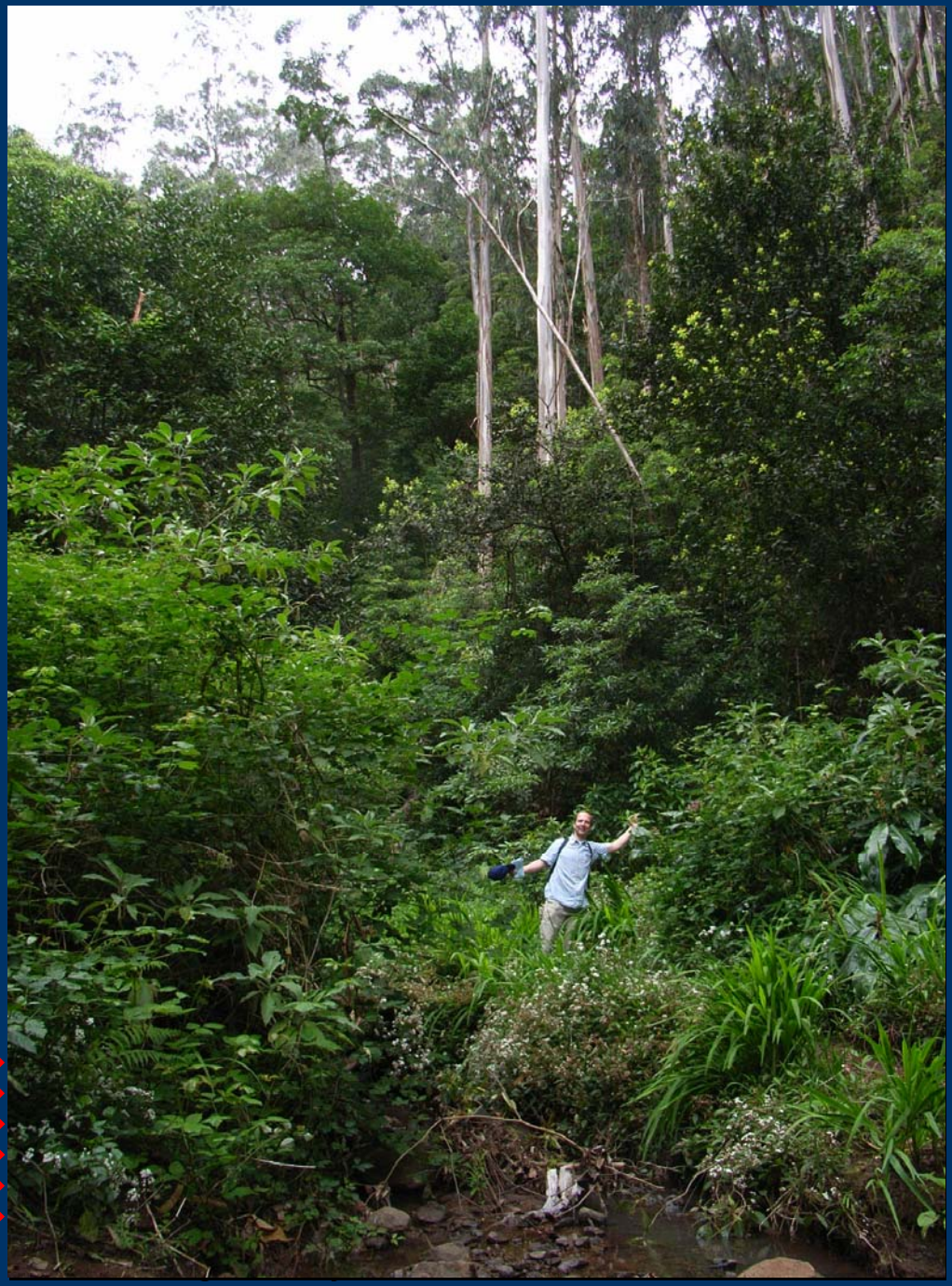


Desert

- Scarcity
- Survival
- Self supporting
- Deterrence
- Robustness
- Long live cycle
- Economical (=Zuinig)

- Waste prevention
- Residues remain



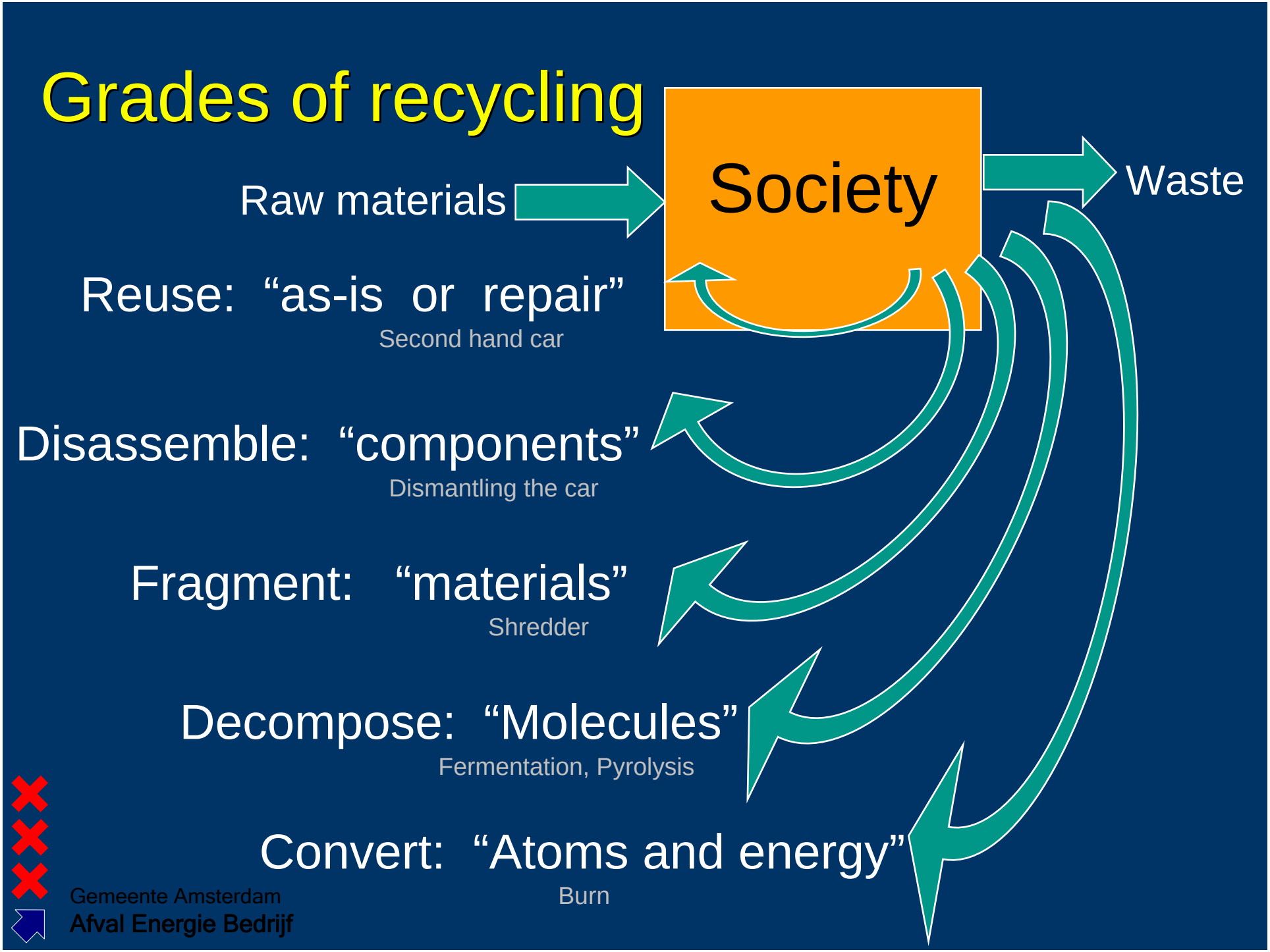
Tropical rain forest:

- Abundance
- Growth
- Competition
- Complexity
- Redundancy
- Short life-cycle
- Wasteful (=Verspillend)

- Massive disposal
- Massive recycling:

1. Eat-and-be-eaten = use the proteins
2. Down cycle = Molecular decomposition
3. Production = from residues

Grades of recycling



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Waste is a RENEWABLE !

- 100% Sustainable — Energy from an endless flow of waste
- 50% Renewable — CO_2-free energy from biomass

50% of waste is **BIOMASS** → **W**aste **F**ired **P**ower **P**lant → **Renewable** ENERGY

- Richer than most RAW MATERIALS

high concentration of valuable METALS

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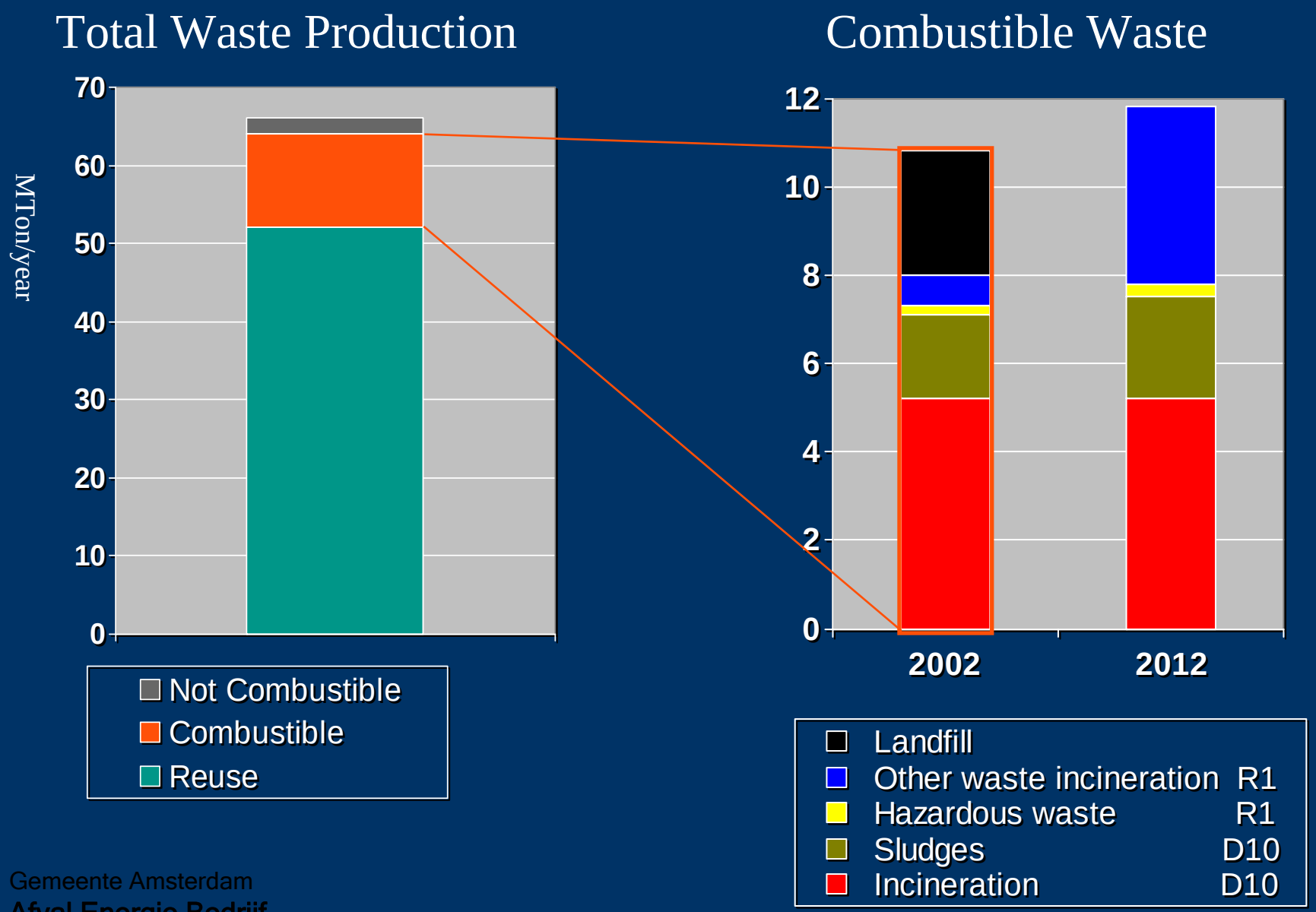
2. Dutch scenario 2012



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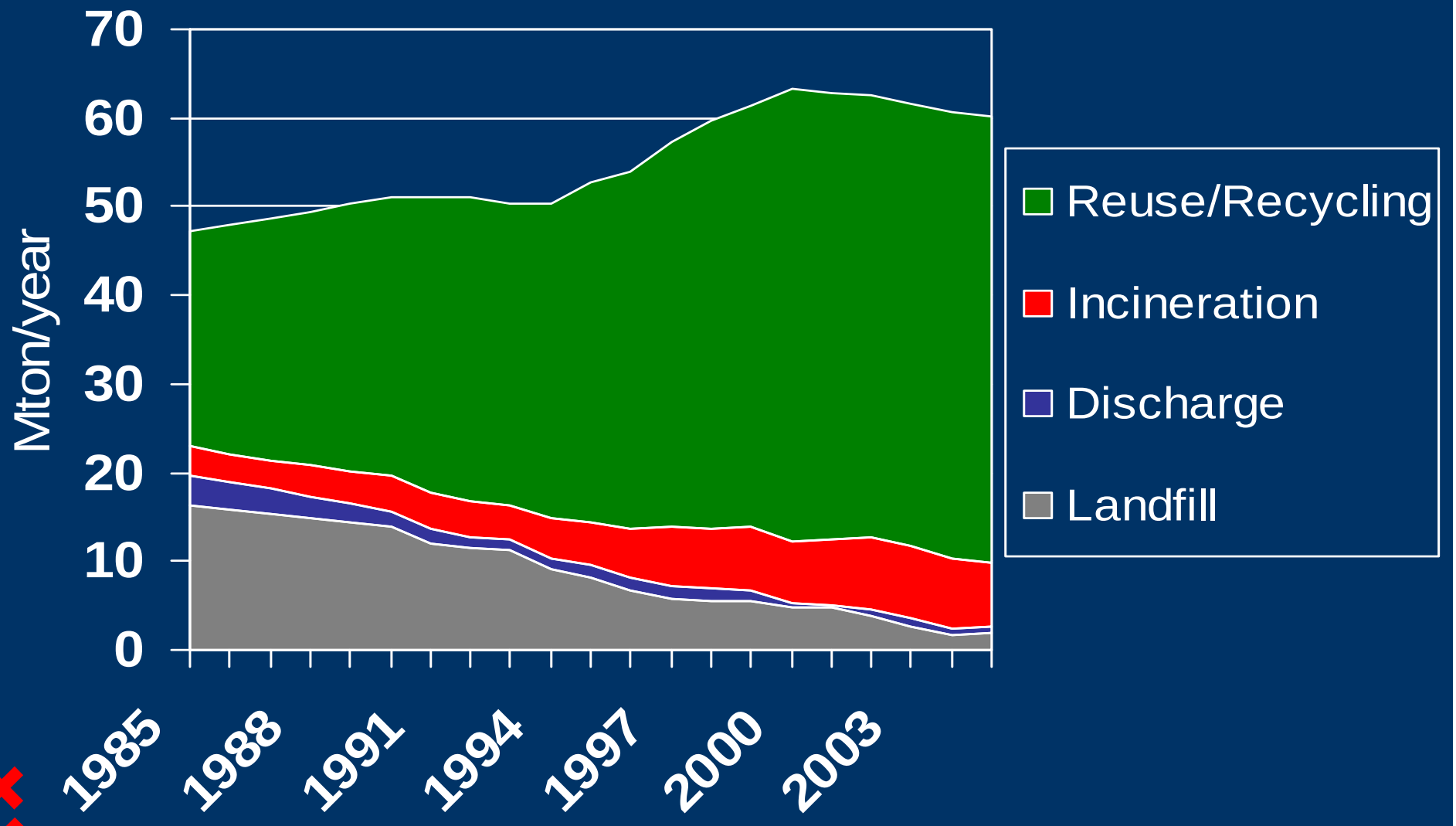
Dutch Results of policy



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Dutch waste policy

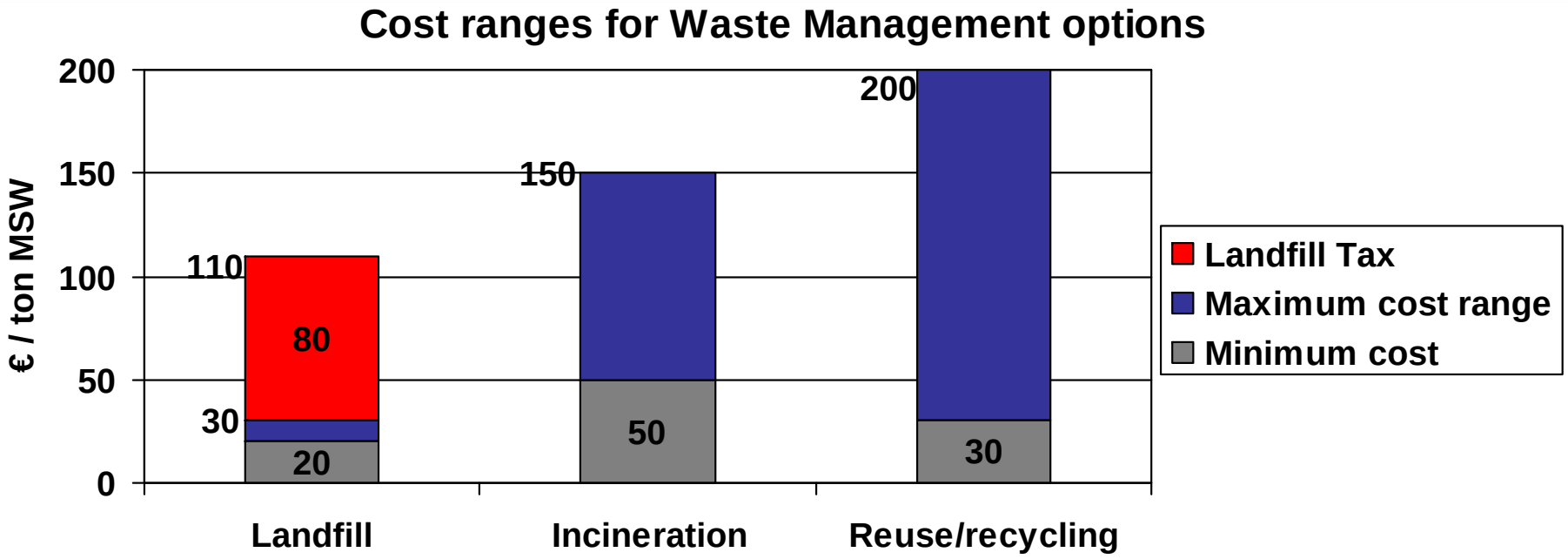
Preference order:

1. Prevention
2. Reuse and Recycling
3. Incineration/energy production
4. Landfill

Instruments for steering waste management:

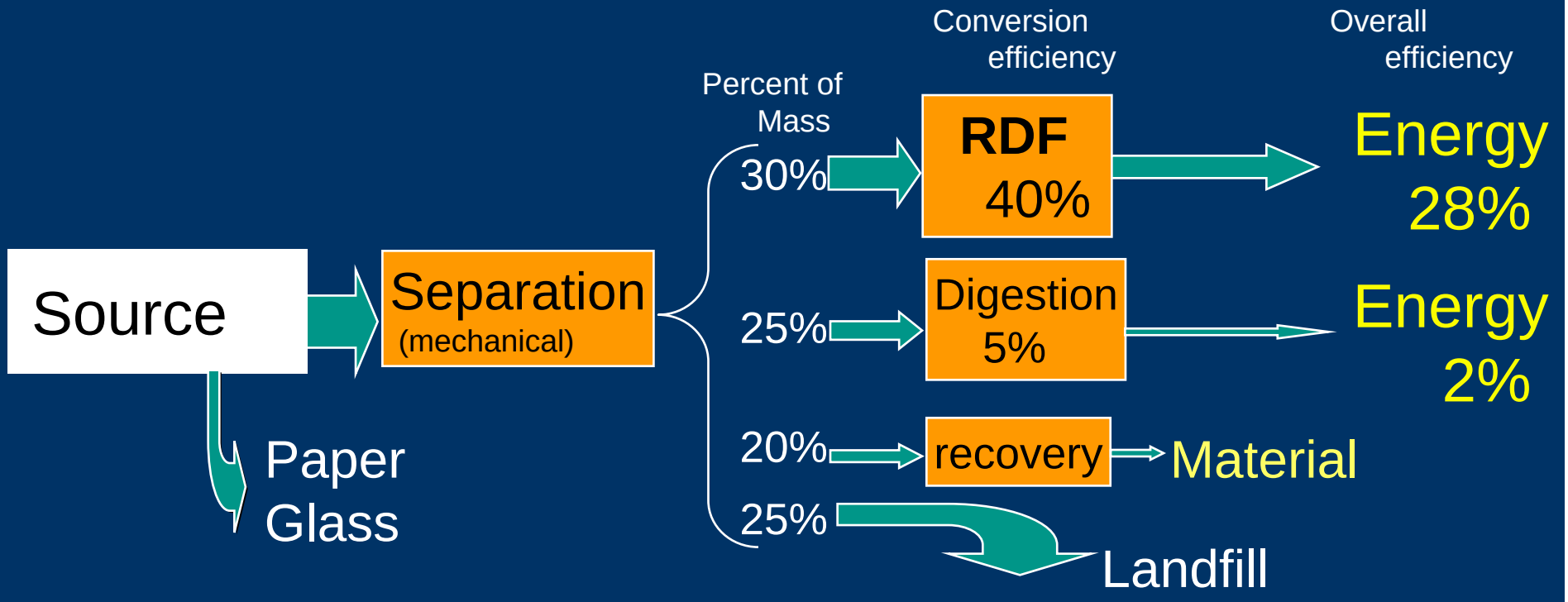
- Regulations on landfill (1980-90)
- Legislation
  - stringent emission limits incineration(1990)
  - directives and covenants (glass, paper, CFK)
- Ban on landfill and **landfill tax** for combustible waste (1995)
- Financial incentives (REB 1997, MEP 2005)

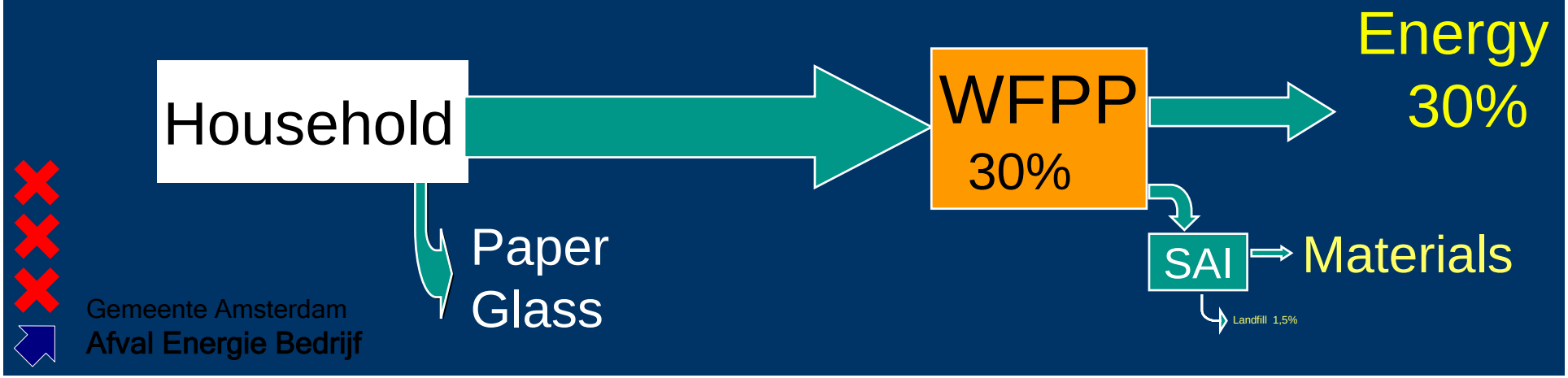
Price competition versus Preference order



- Cheap landfill beats every other option
- Landfill tax (or landfill ban) is needed to give reuse/recycling a fair chance
- WtE (as alternative for land filling) is needed to implement landfill taxes
- Prices of incineration are within range of reuse/recycling options
- Countries with high WtE percentage have much better reuse/recycling percentage

2. SCENARIOS: “Integral chain efficiency”





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The NEW Generation WtE

Third generation (1985-now) is

"designed to be CLEAN"

Fourth generation (now--> ….) is

"designed for RECOVERY"

of ENERGY and MATERIALS

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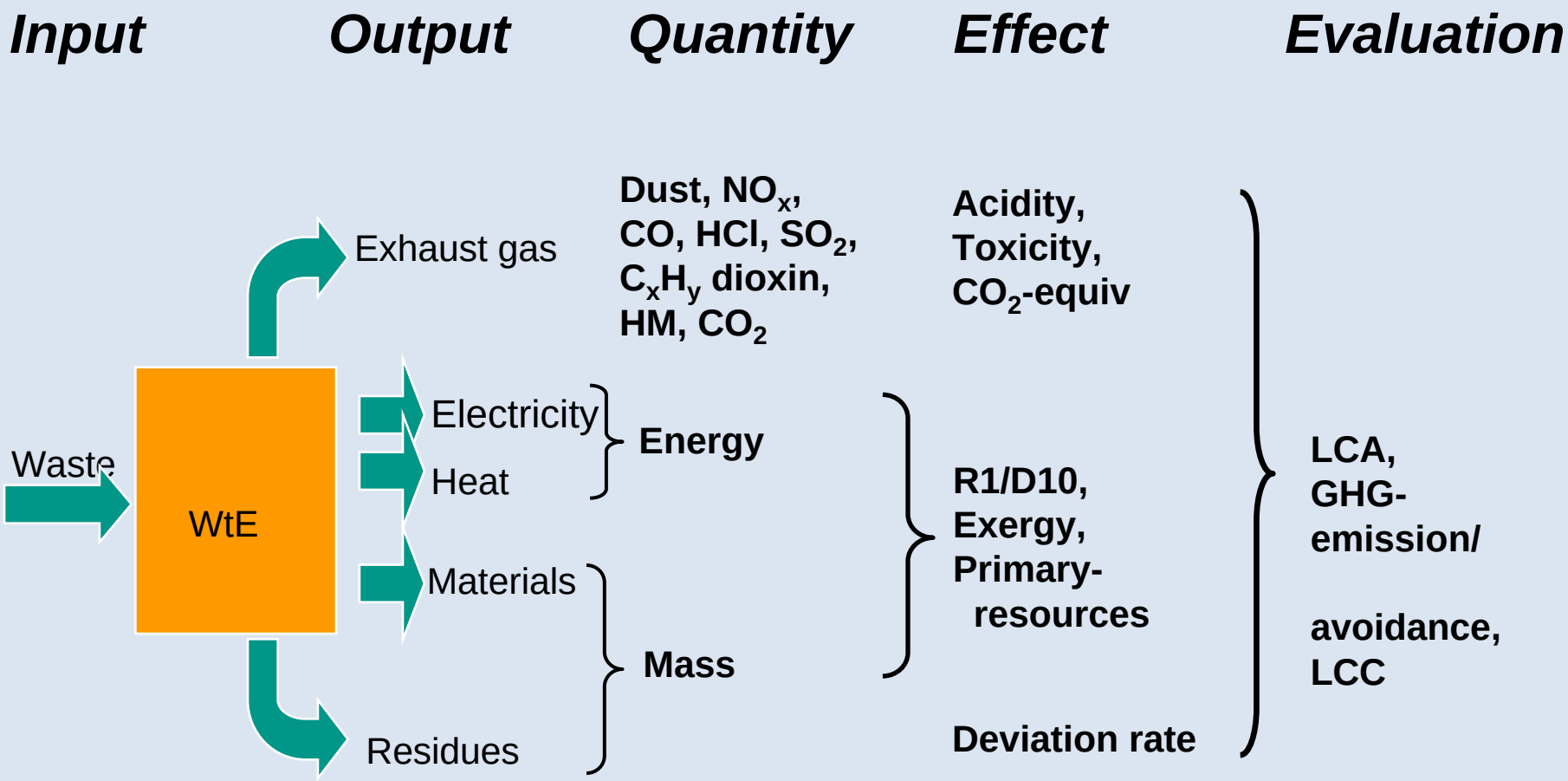
2. PERFORMANCE INDICATORS for WtE



RECOVERY is the new RULE !

It was	WI	Waste incineration	
It is	WTE	Waste To Energy	ca. 15%
It will be	WFPP	Waste Fired **Power Plant** →	**30%**

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Electrical Efficiency of Power Plants

Depends on fuel quality:

- Natural Gas 55 %
- Oil 50 %
- Coal 45 %
- Lignite 40 %
- Biomass 35 %
- Waste 15…22 %....30%

Current Average

Current:
State-of-the-Art

New:
Best Available Technology

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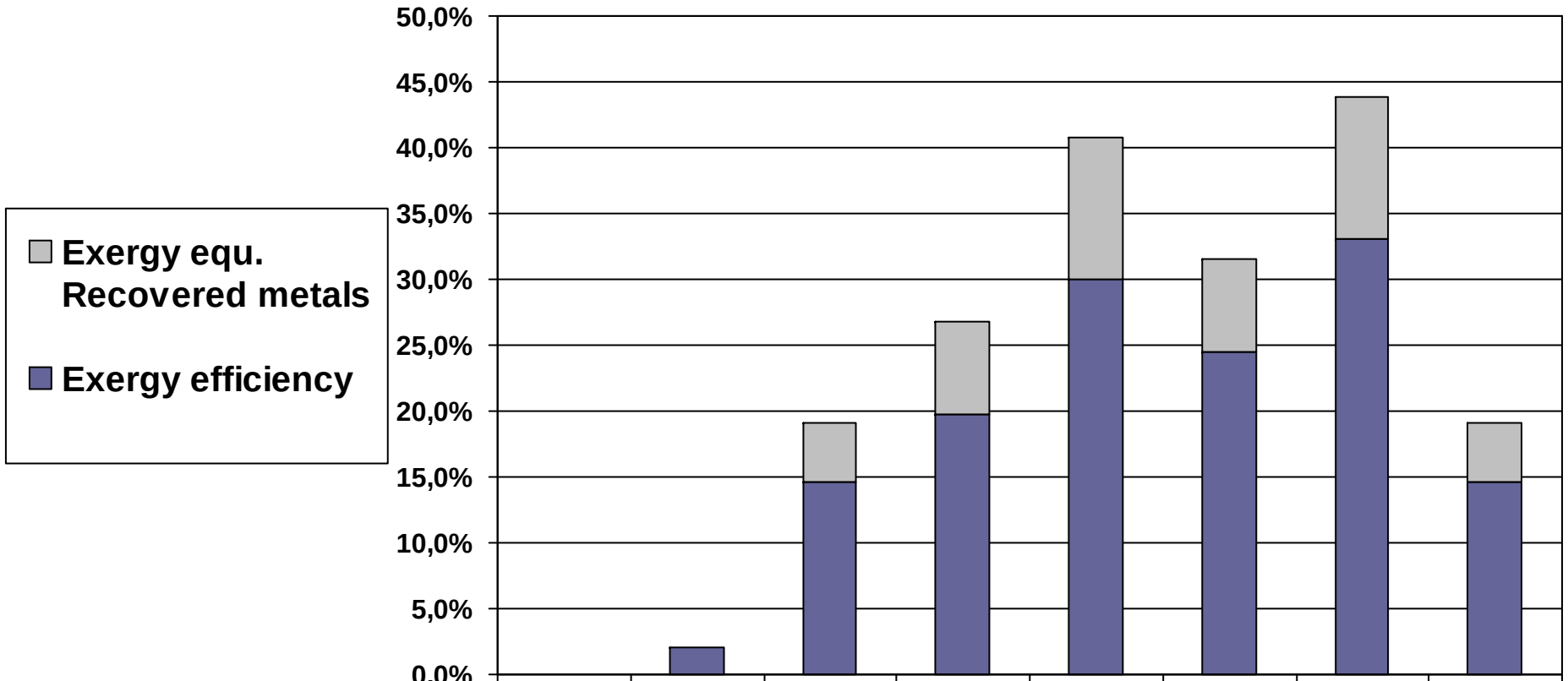
EXergy Production



	DUMPSITE	LANDFILL+ biogas engines	WtE Average NL	WtE Conventional	WtE Optimised	WtE Conv.+CHP	WtE Optim.+CHP	WtE heat only
Exergy equ. Recovered metals	0,0%	0,0%	4,5%	7,0%	10,8%	7,0%	10,8%	4,5%
Exergy efficiency	0,0%	2,0%	14,6%	19,8%	30,0%	24,5%	33,1%	14,6%

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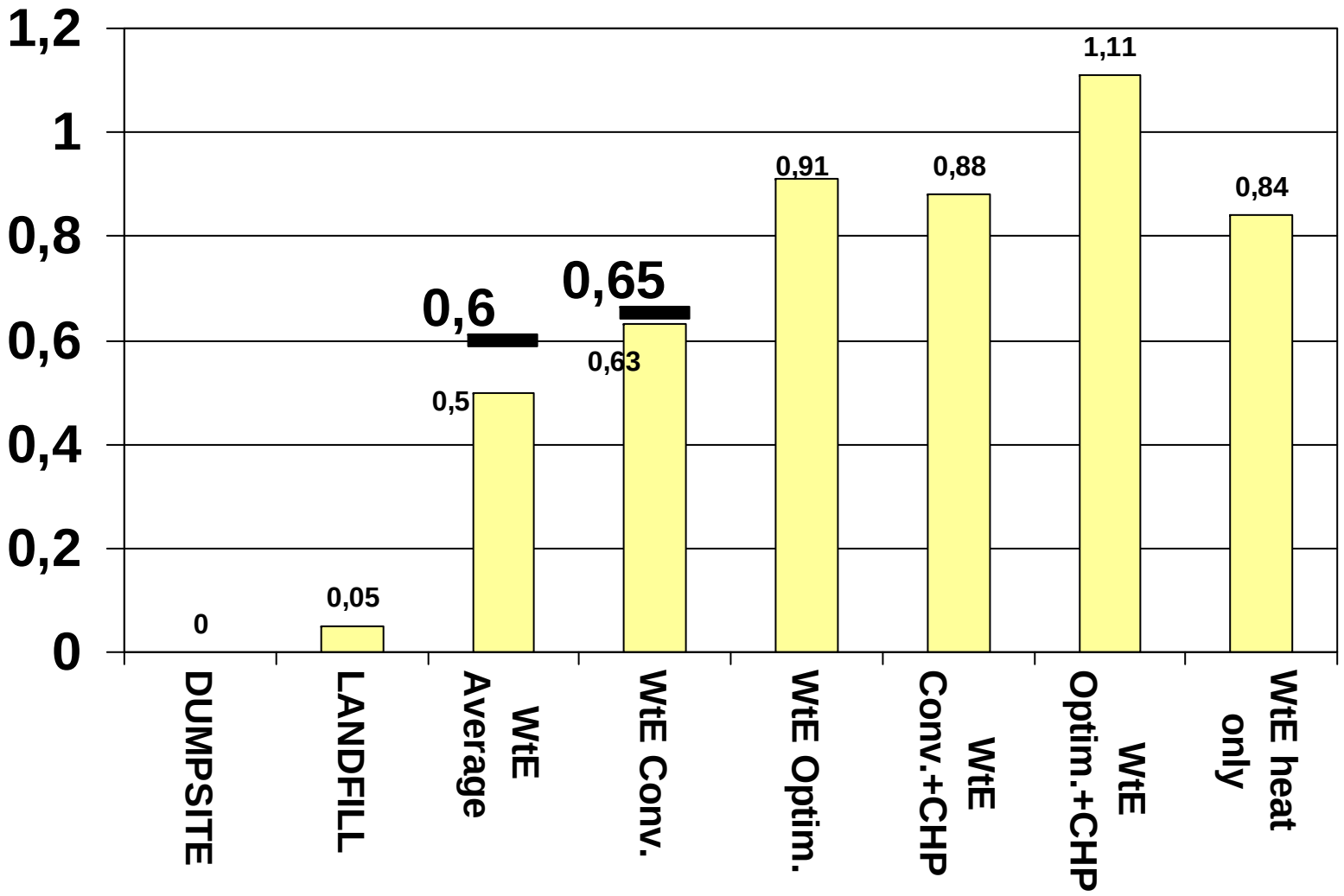
R1 / D10 (with proposed limits)



3. Amsterdam:
Waste & Energy Enterprise

- Owned by Local government
- Long term contracts
- Commercial operation: 70 €/ton of waste
- Capital intensive
- Industrial scale
- Mission: **Maximise the use of waste**
- Ambitious targets
  - Best environmental performance
  - Lowest cost

Generations in Waste incineration

Generation		Capacity [ton/year]	Operational paradigm
Start collection	1885	-	Open air incineration
1st	1917	150.000	Hygiene
2nd	1969	500.000	Flue gas de-dusting
3rd	1993	800.000	Chemical cleaning
4th	2006	+ 500.000	**RECOVERY** of ENERGY and MATERIALS

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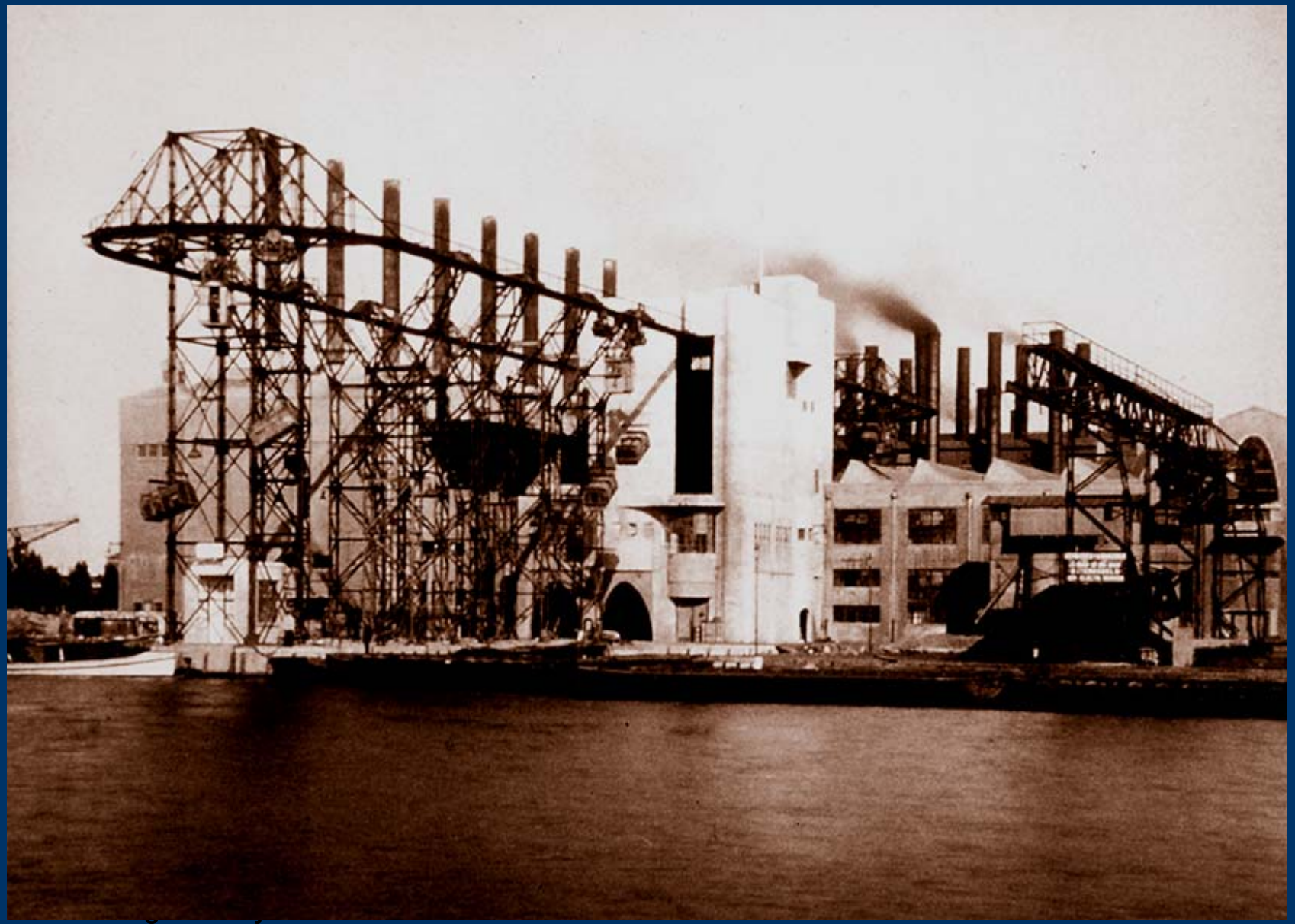
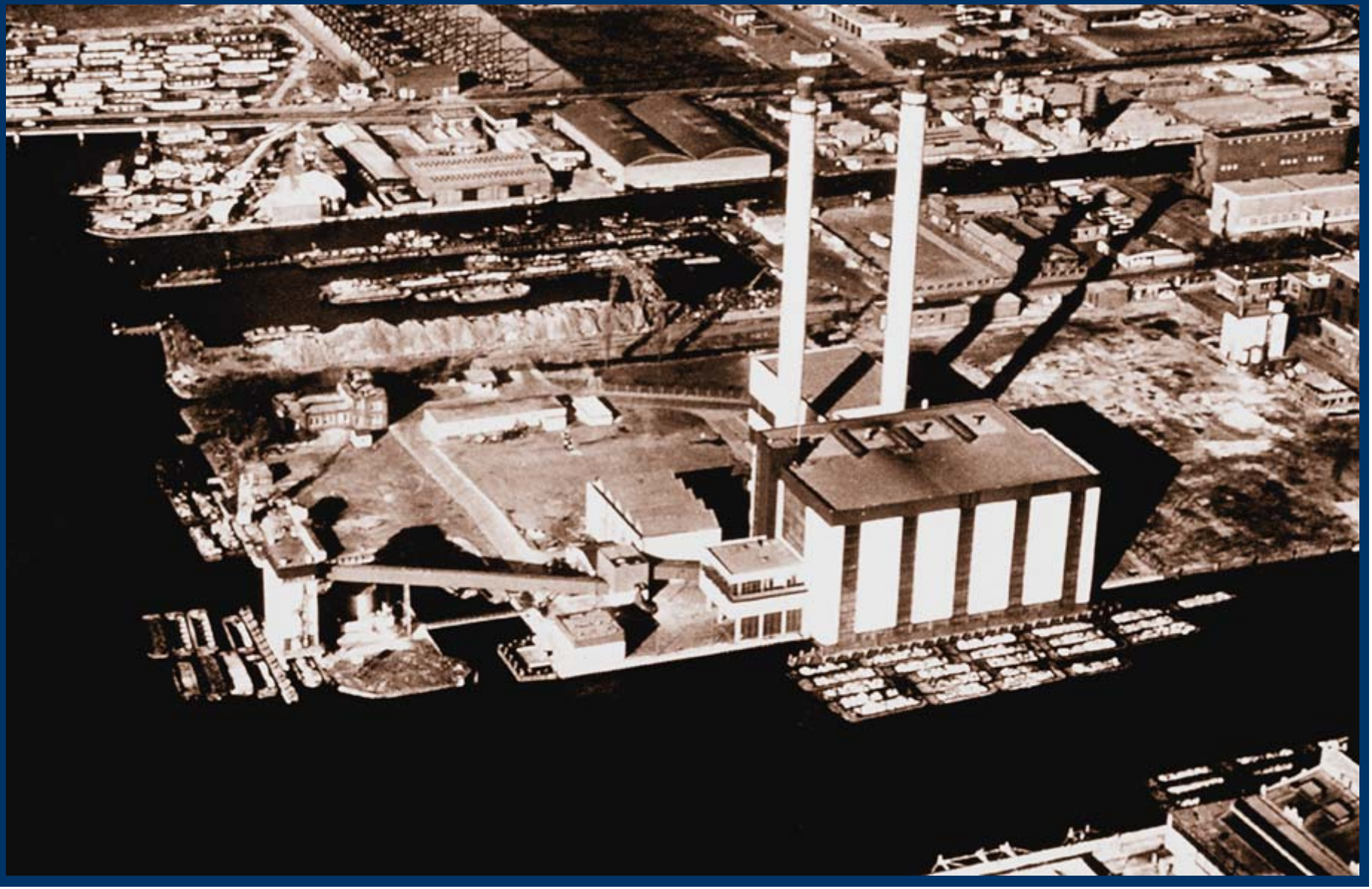
1st Incineration 1919-1969



AVI-Noord 1969-1993



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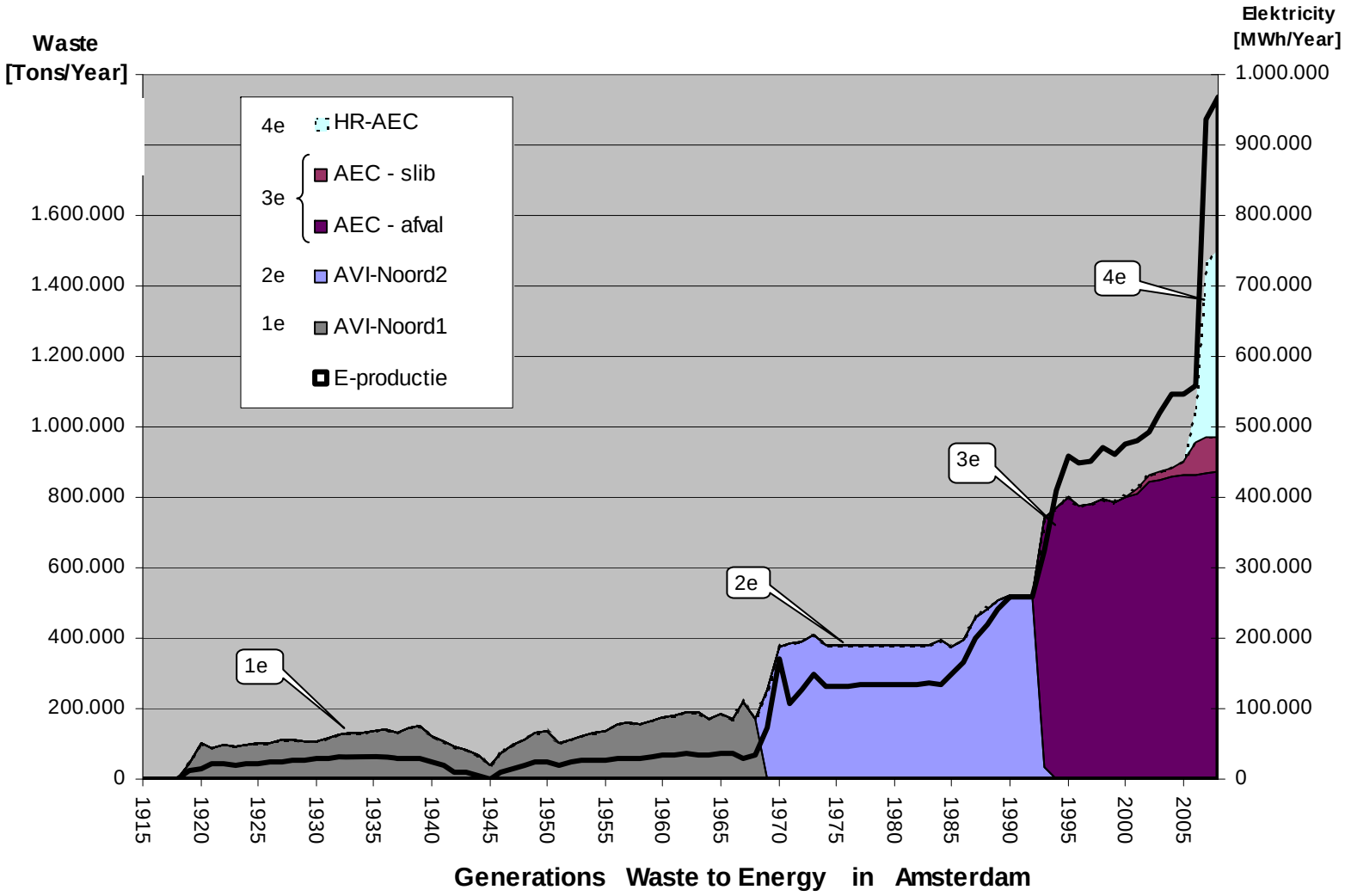
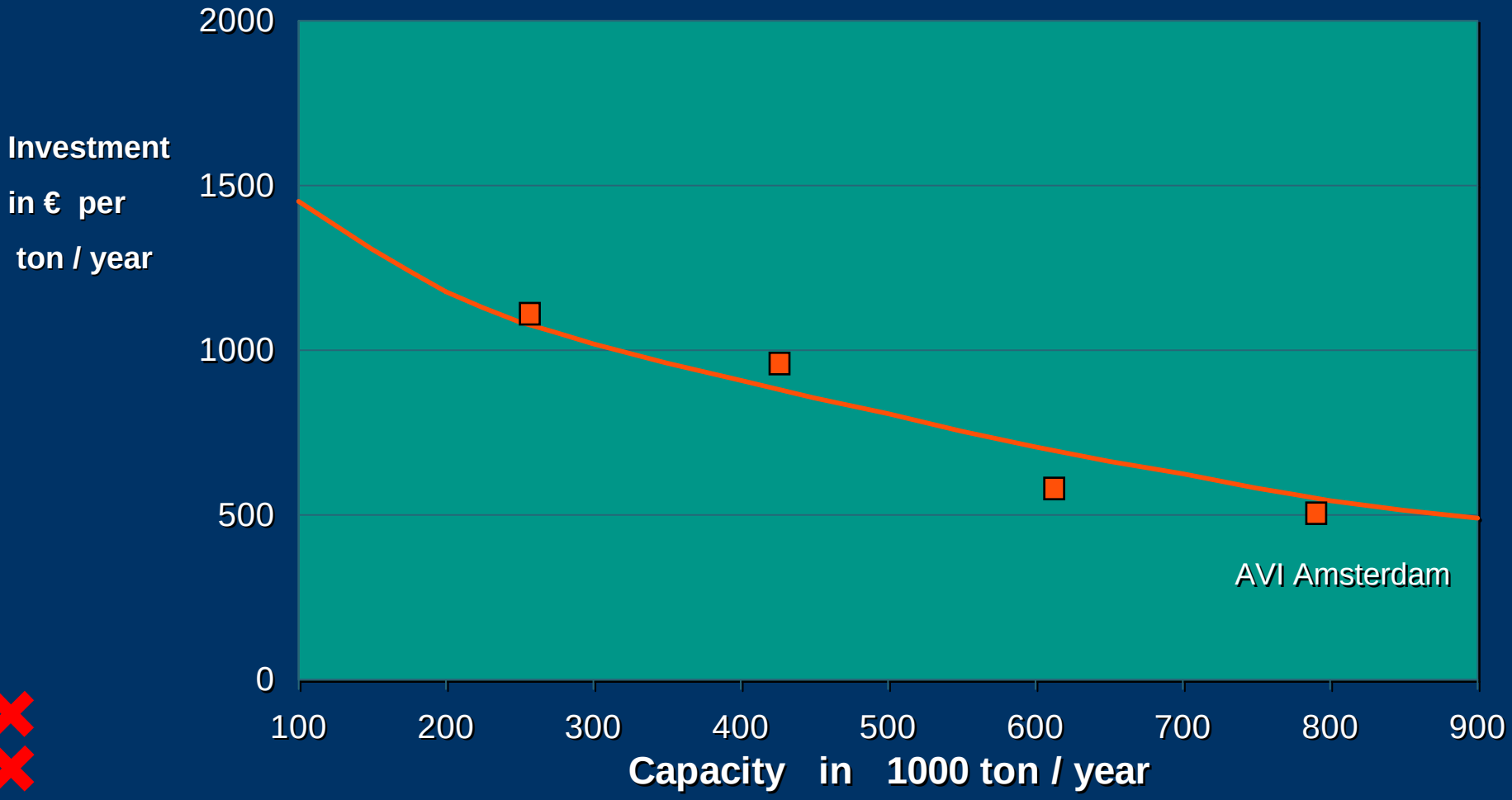
Construction of WFPP in Amsterdam

Amsterdam waste and Energy production



SIZE MATTERS

Investment in relation to the capacity of 4 Dutch AVI's



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4. New generation in Waste incineration

Historical waste incineration "generations":

- **0** **Open air incineration**
- **1st 1900** ***oven***
- **2nd 1960** ***dust removal*** **from flue gas**
- **3rd 1985** ***chemical cleaning*** **of flue gas**

In this presentation we outline a new step:

- **4th 2006** ***RECOVERY of energy and materials***

Why new generation ?

Historical development of public awareness:

A newly identified need leads to a new technical concept.

RECOVERY is the "next logical step".

The adapted installations will have additional lifetime because of social acceptability

4th-generation Incineration = WFPP

- Cost must go down
- Reliable, proven technology

- Energy Optimisation — to the max !!
  Leap from 22% — to >30%

- Material reuse — to the max !!
  Fe, Al, Cu, Gypsum, $CaCl_2$,
  Washed bottom ash = N1 quality building material
  Washed fly ash = inert

CONCEPT for RECOVERY

850 kWh/ton = **30 %** of energy in waste

Energy utilisation rate = 0,84

EU discussion on R1/D10

Chemicals 10 kg

Municipal Solid Waste

Incineration

Fluegass cleaning

Fluegass

SAI

Output per ton of waste:

Non Ferro	**5**	**kg**
Iron	**25**	**kg**
Sand	**100**	**kg**
Granulate	**100**	**kg**
Fines	20	kg

Salt	**7**	**kg**
Gypsum	**5**	**kg**
Fly-ash	**10**	**kg**
Residue	5	kg

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Sorting After Incineration

Washing water

Bottom ash

Sort

6-40mm

Magnet

Eddy current

Coarse granulate

Magnet

2-6mm

Density separation

Fine granulate

<2mm

Iron

Non-Fe

Cyclone

Clean sand

Dewatering

Sludge cake

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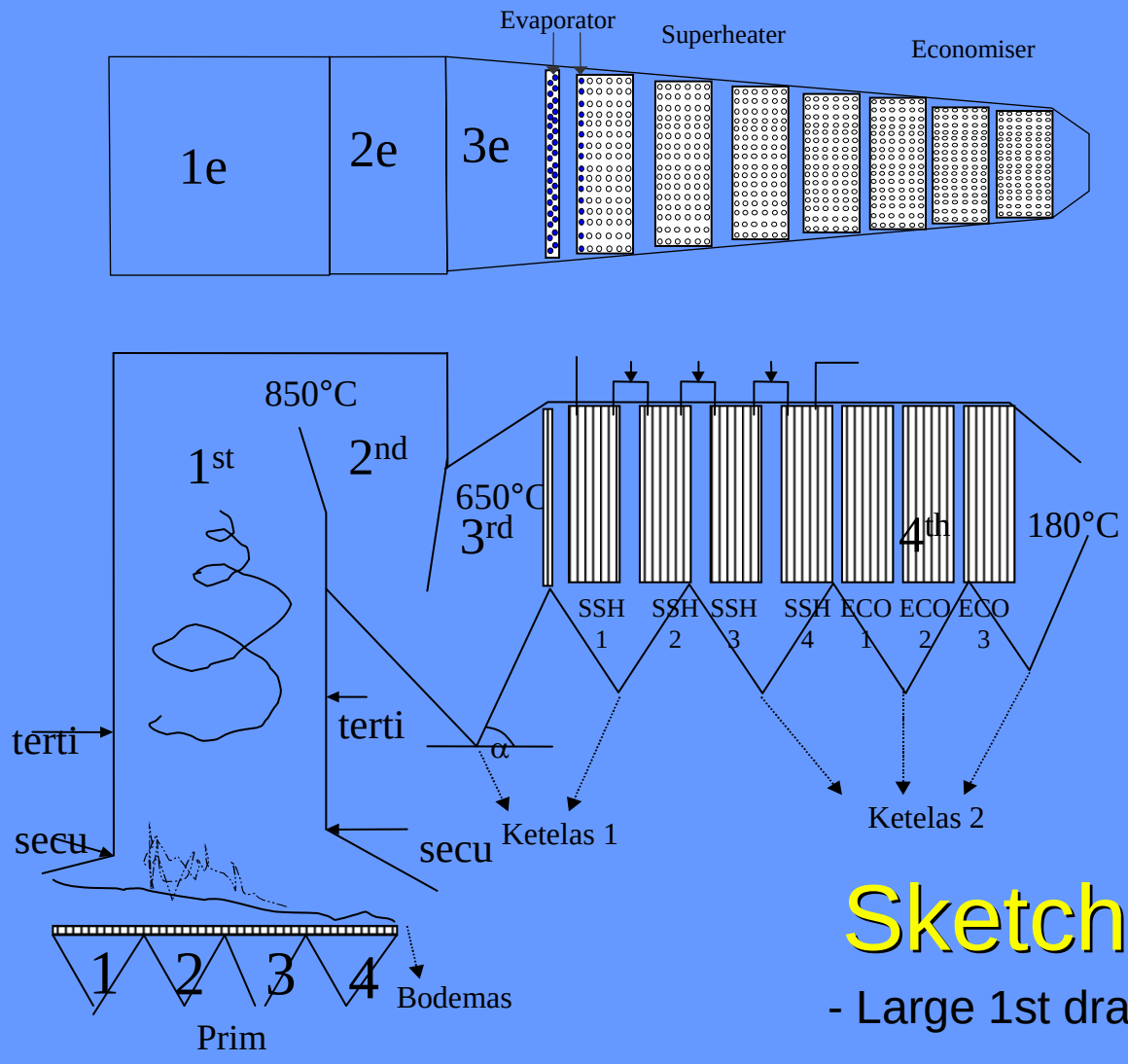
Bottomash treatmentplant

HR-AVI project = **WFPP**

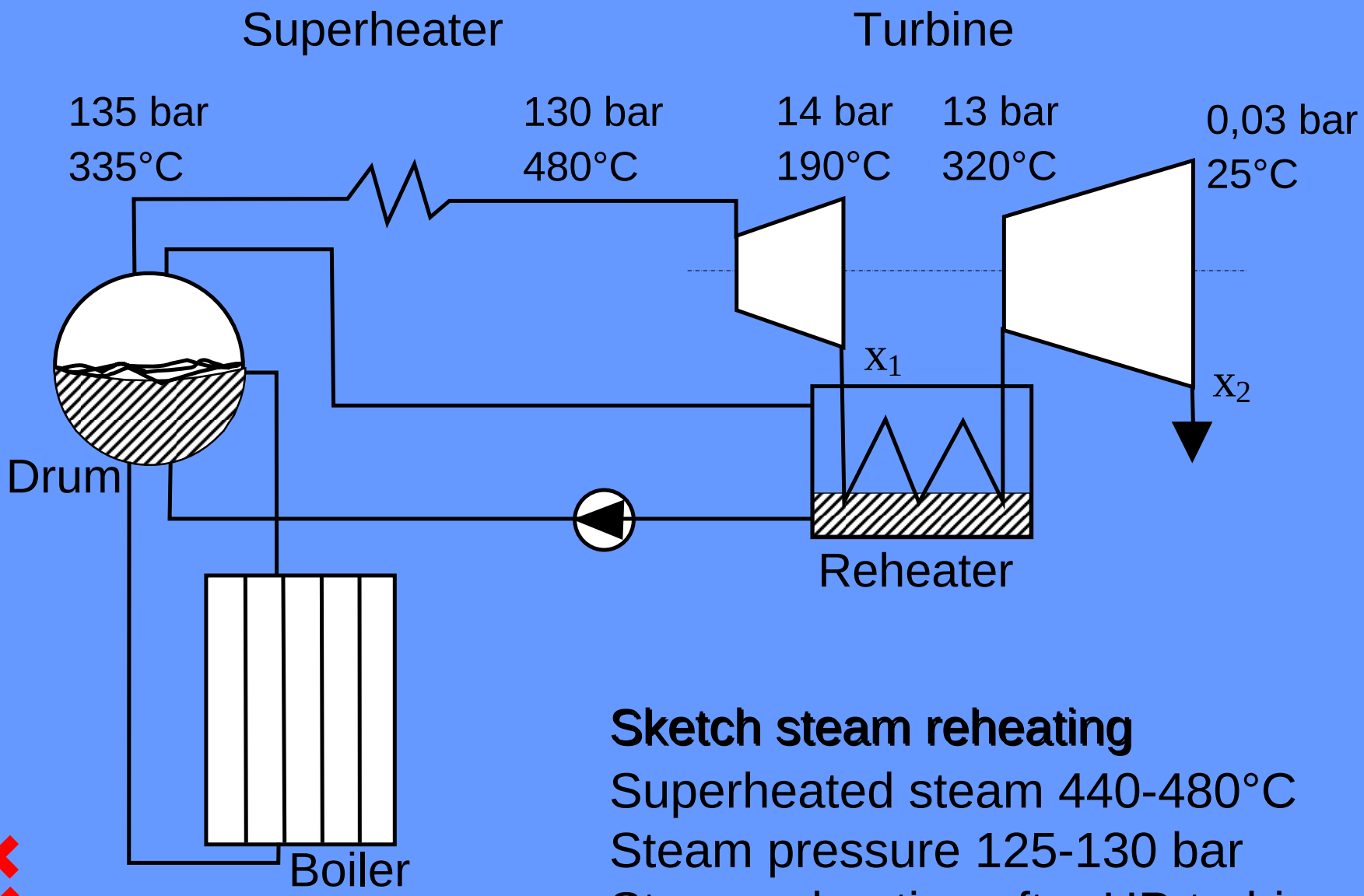
- Systematic approach to optimise recovery
- Using proven technologies in new combination
- Electrical efficiency >30%
- New logistic concept

- Budget: 400 M€
- Construction start: Begin 2004
- Completion: End 2006



Sketch boiler design

- Large 1st draw: Height >20m,
  Flue-gas velocity < 3m/s
- Large 2nd and 3rd-draw
- Super-heater: Flue-gas velocity < 2,5 m/s
- Second Economiser after fabric filter
- Flue-gas recirculation
  (primary and secondary air)



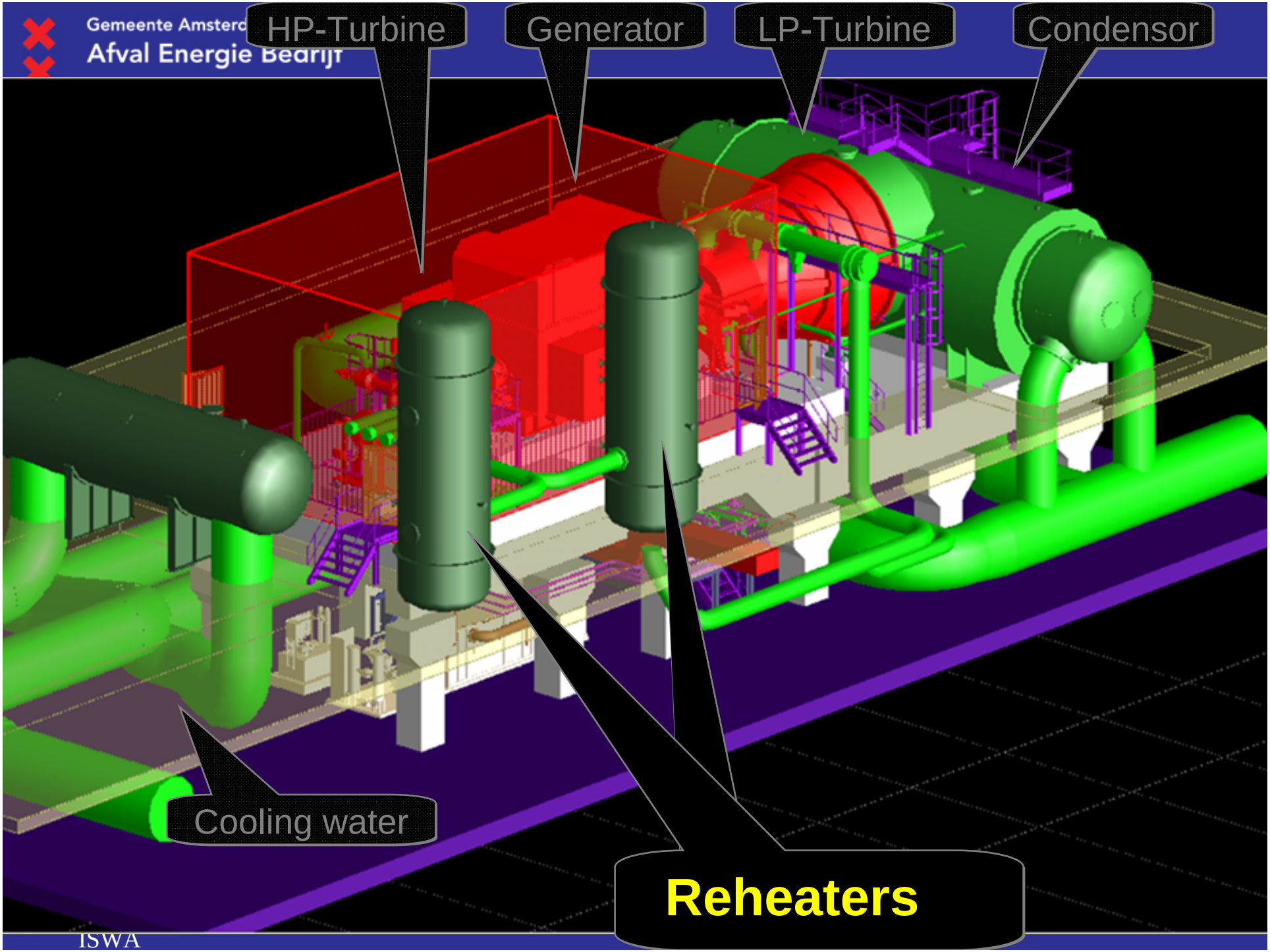
Sketch steam reheating

Superheated steam 440-480°C

Steam pressure 125-130 bar

Steam reheating after HP-turbine

Extra economiser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HP-Turbine
Generator
LP-Turbine
Condensor
Cooling water
Reheaters

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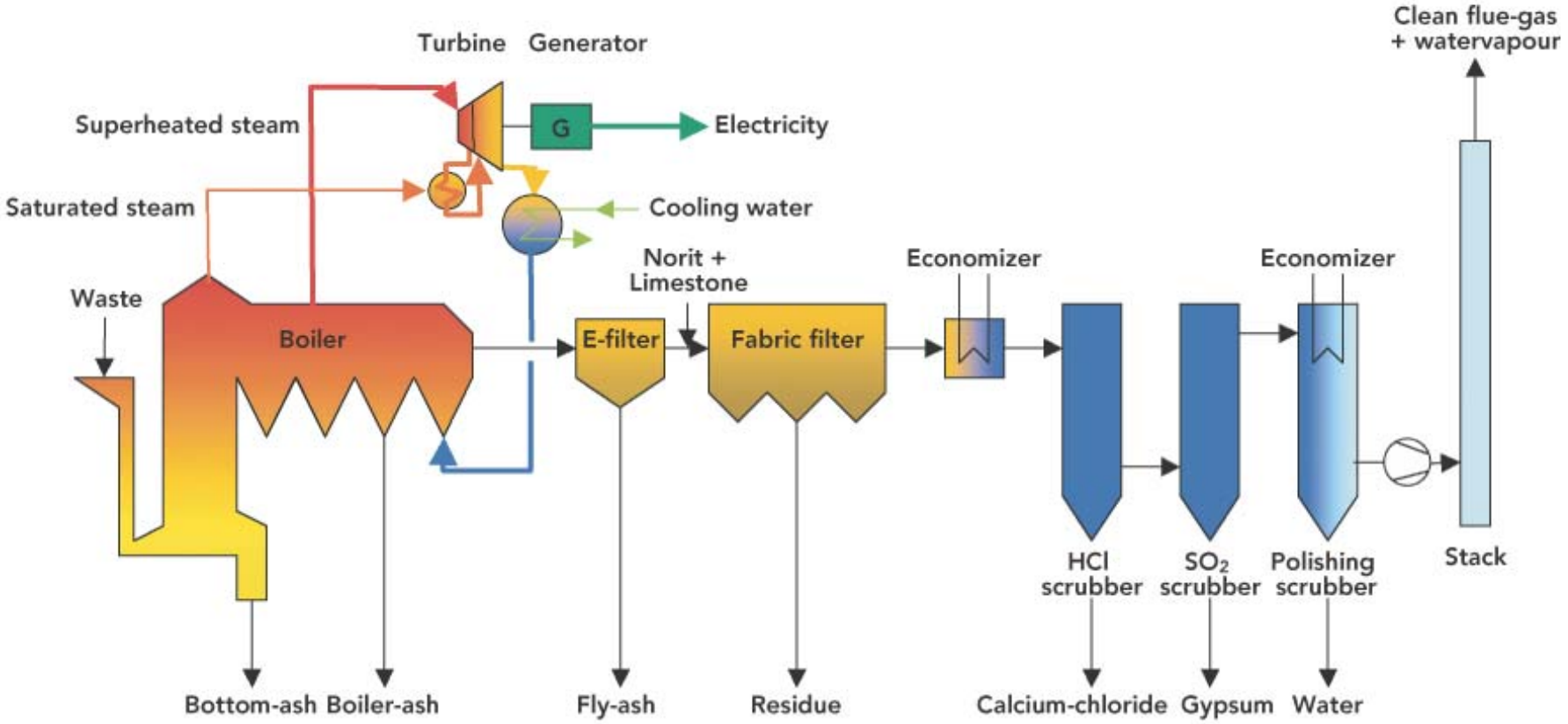
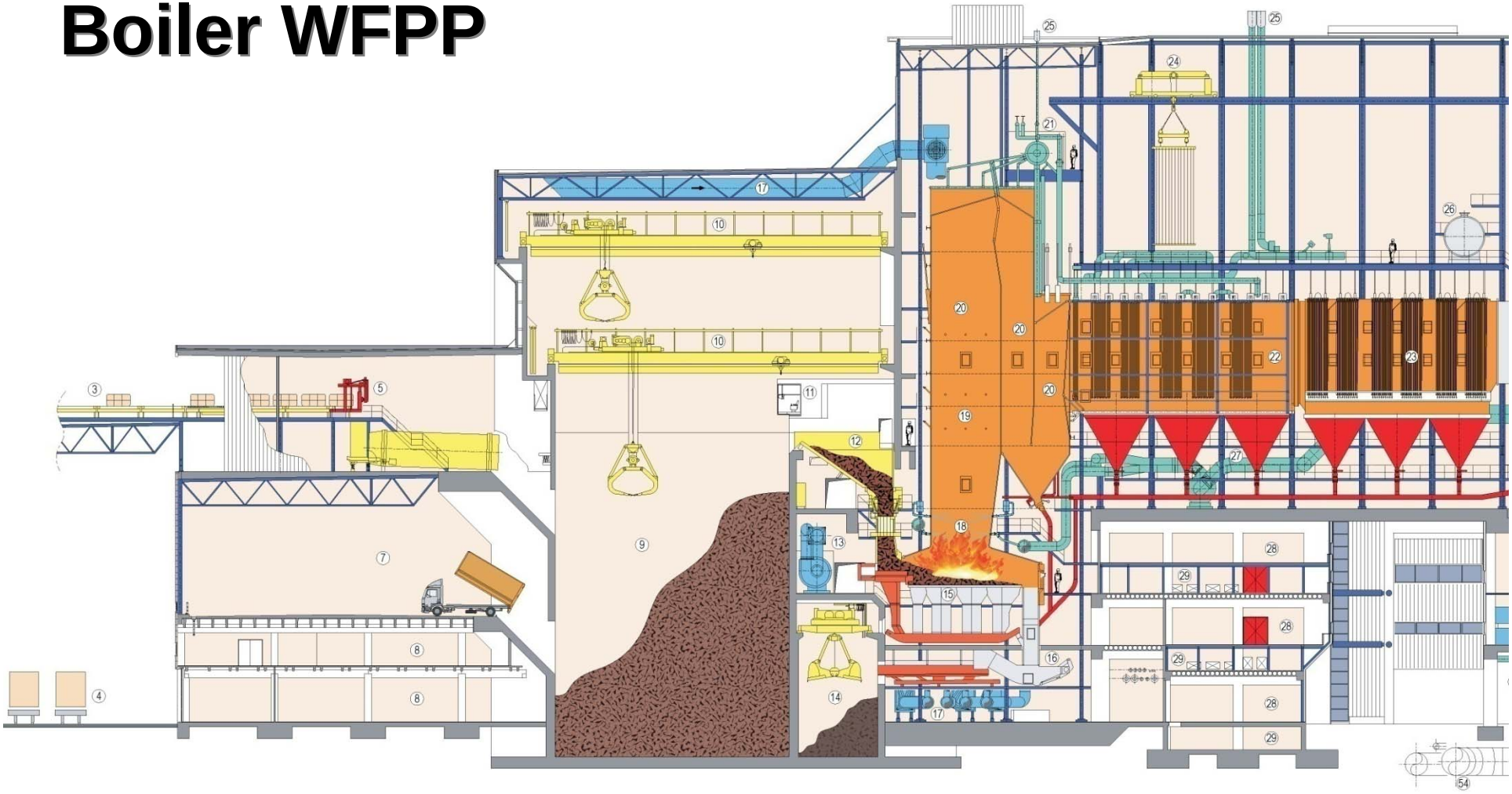
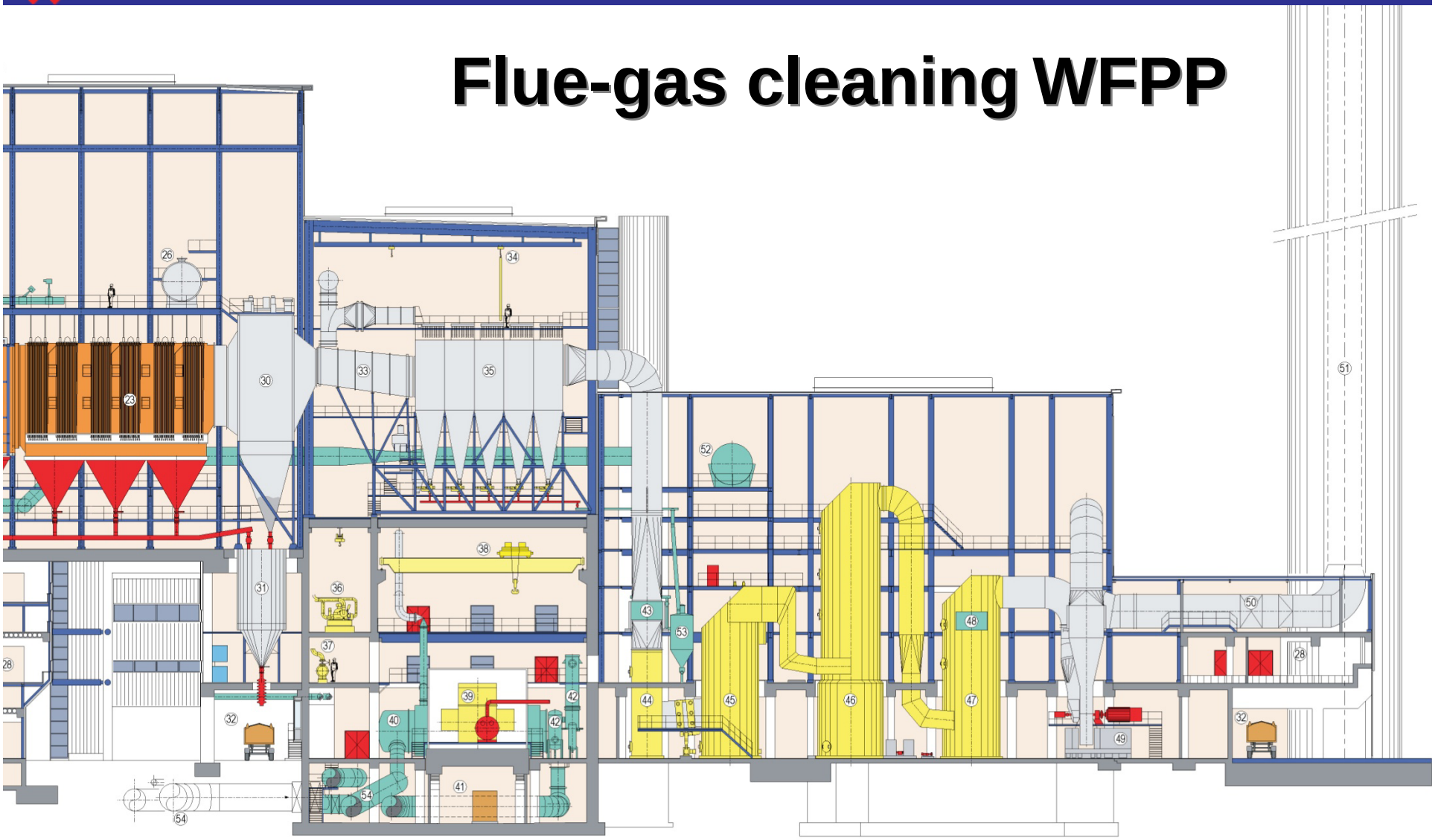
High Efficiency concept WFPP®



Boiler WFPP



Flue-gas cleaning WFPP



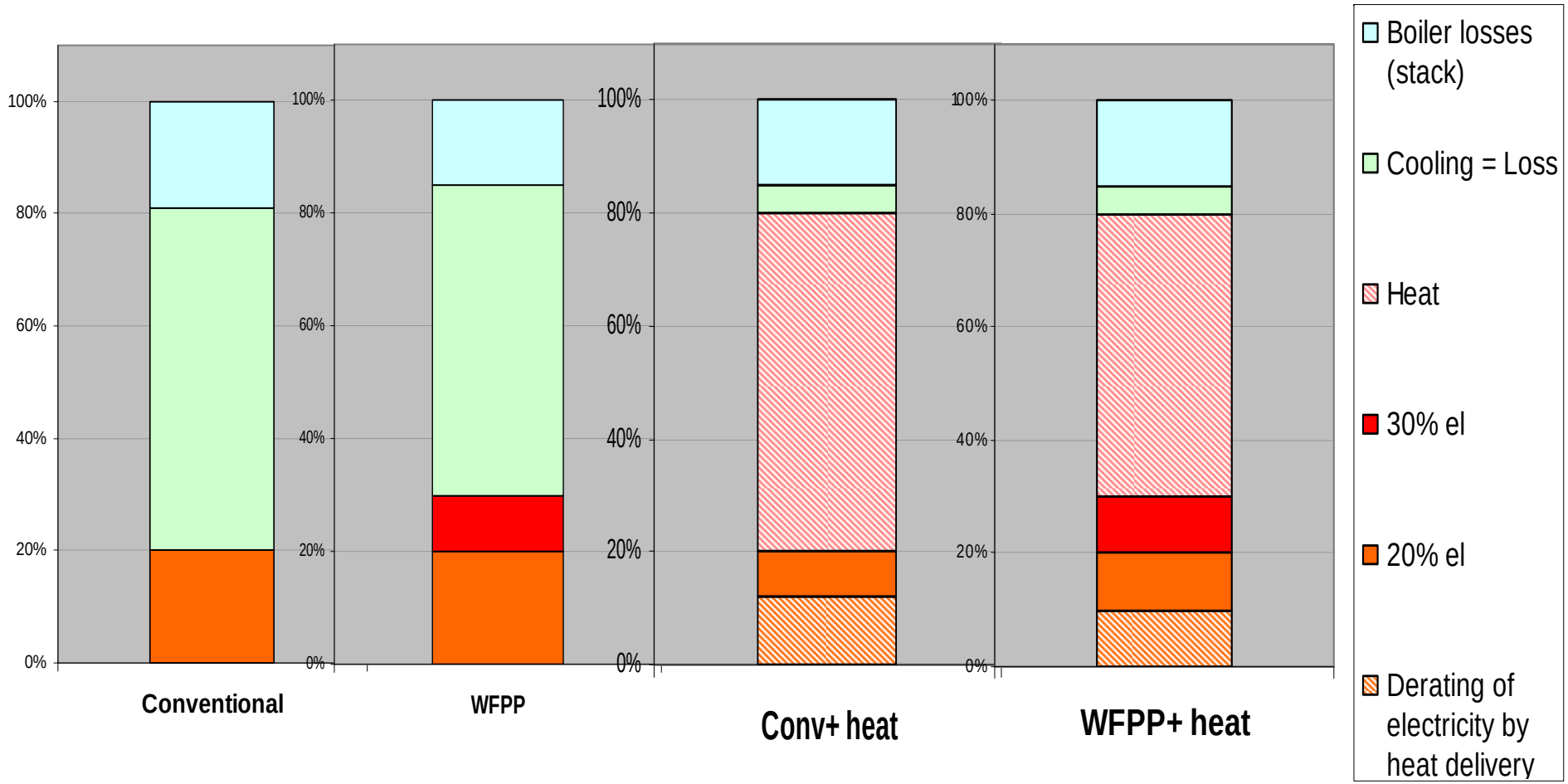
Energy-potential in Waste

Waste **in EU**: 182 MTon/year x 10 MJ/kg x 30%

Electricity: = 550 PJ / year
= 150 TWh / year
= 17.300 MW-continuous
= 8 % of total EU-production

Avoided CO_2 = 200 million tons per year

Efficiency breakdown



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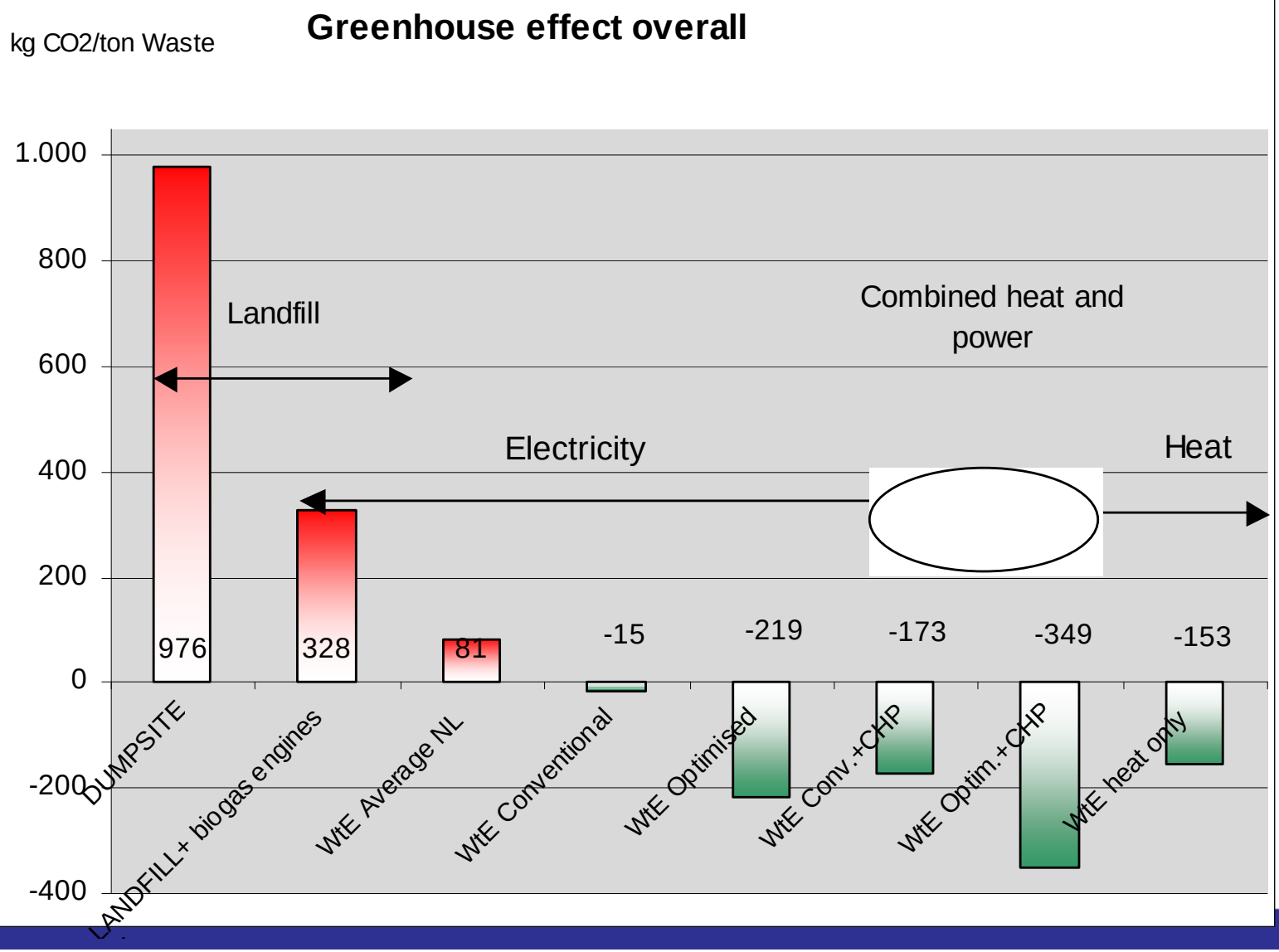
Greenhouse effect overall



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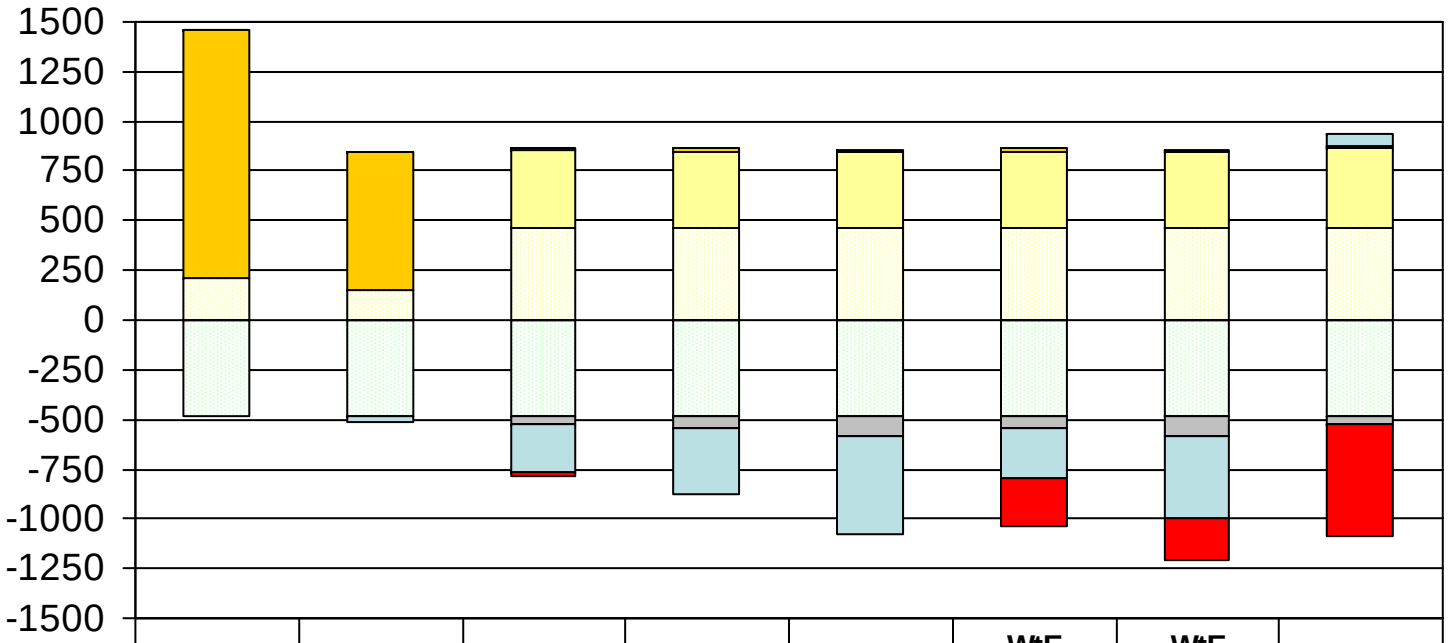
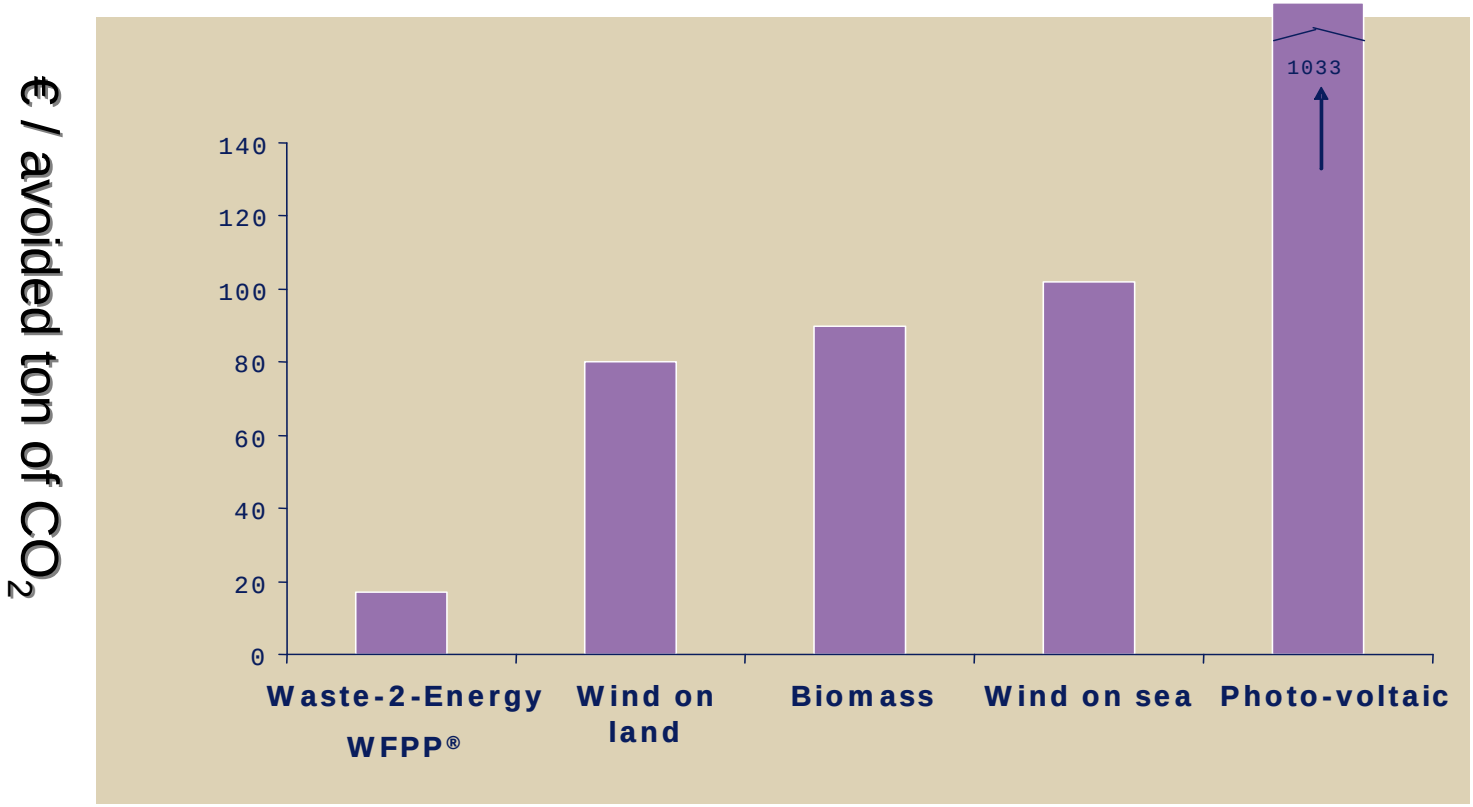
Greenhouse gas balance

[kg CO2 / ton Waste]



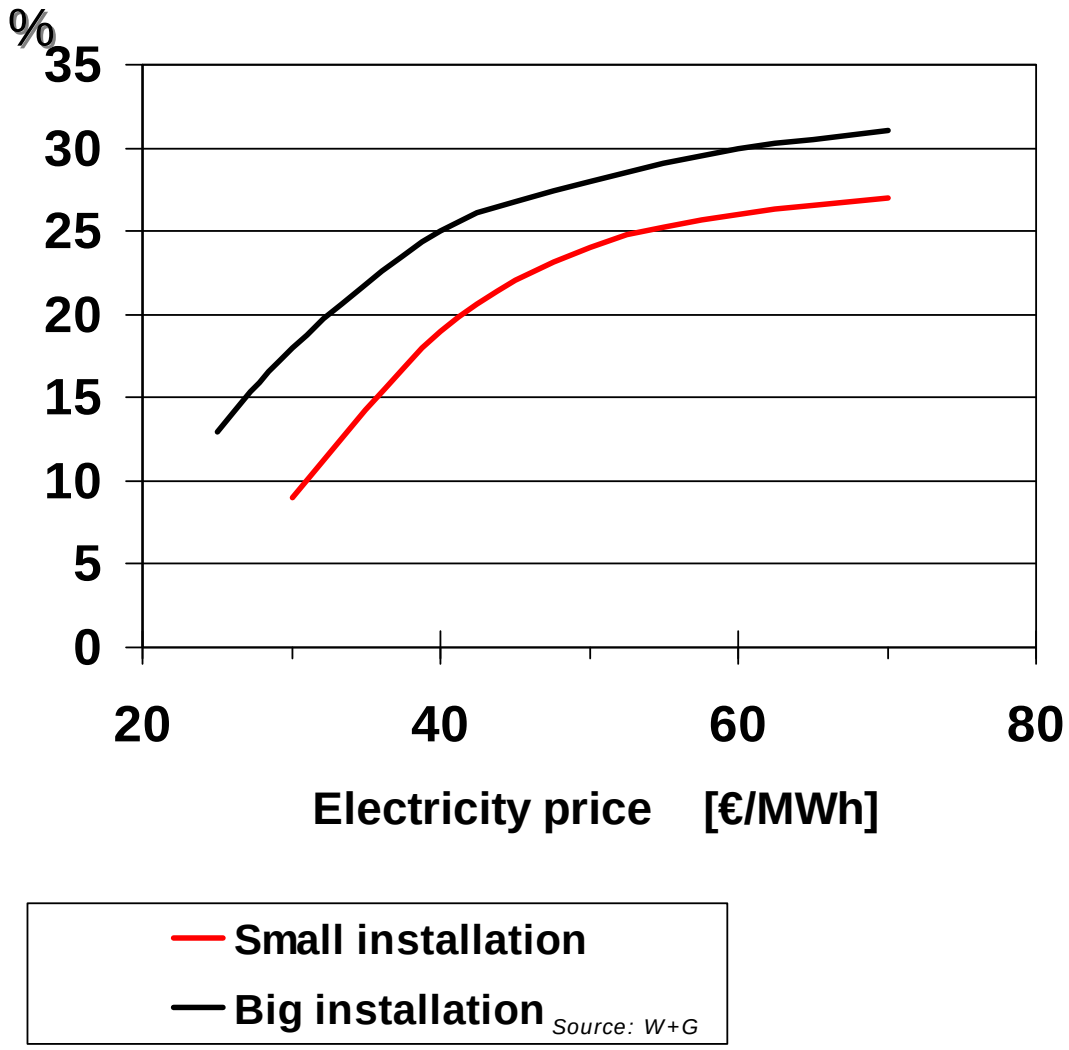
	DUMPSITE	LANDFILL	WtE Average	WtE Conv.	WtE Optim.	WtE Conv.+CHP	WtE Optim.+CHP	WtE heat only
Avoided CO2 by Heat delivery	0	0	-25	0	0	-241	-210	-563
Avoided CO2 by Electricity production	0	-33	-234	-332	-495	-248	-416	59
Avoided CO2 by metal recovery	0	0	-44	-65	-98	-65	-98	-44
Methane (CO2-equiv.)	1.251	693	15	15	15	15	15	15
CO2 emission Fos.orig.	0	0	383	381	374	381	374	394
CO2 emission Bio.orig.	208	151	468	468	468	468	468	468
CO2 used for biomass	-483	-483	-483	-483	-483	-483	-483	-483

WFPP® is the most cost-effective renewable option…



Sources: EZ, Regeling subsidiebedragen milieukwaliteit elektriciteitsproductie; VROM, personal communication, ECN, 2002, Duurzame Energie en Ruimte, M. Menkveld; analysis Deloitte

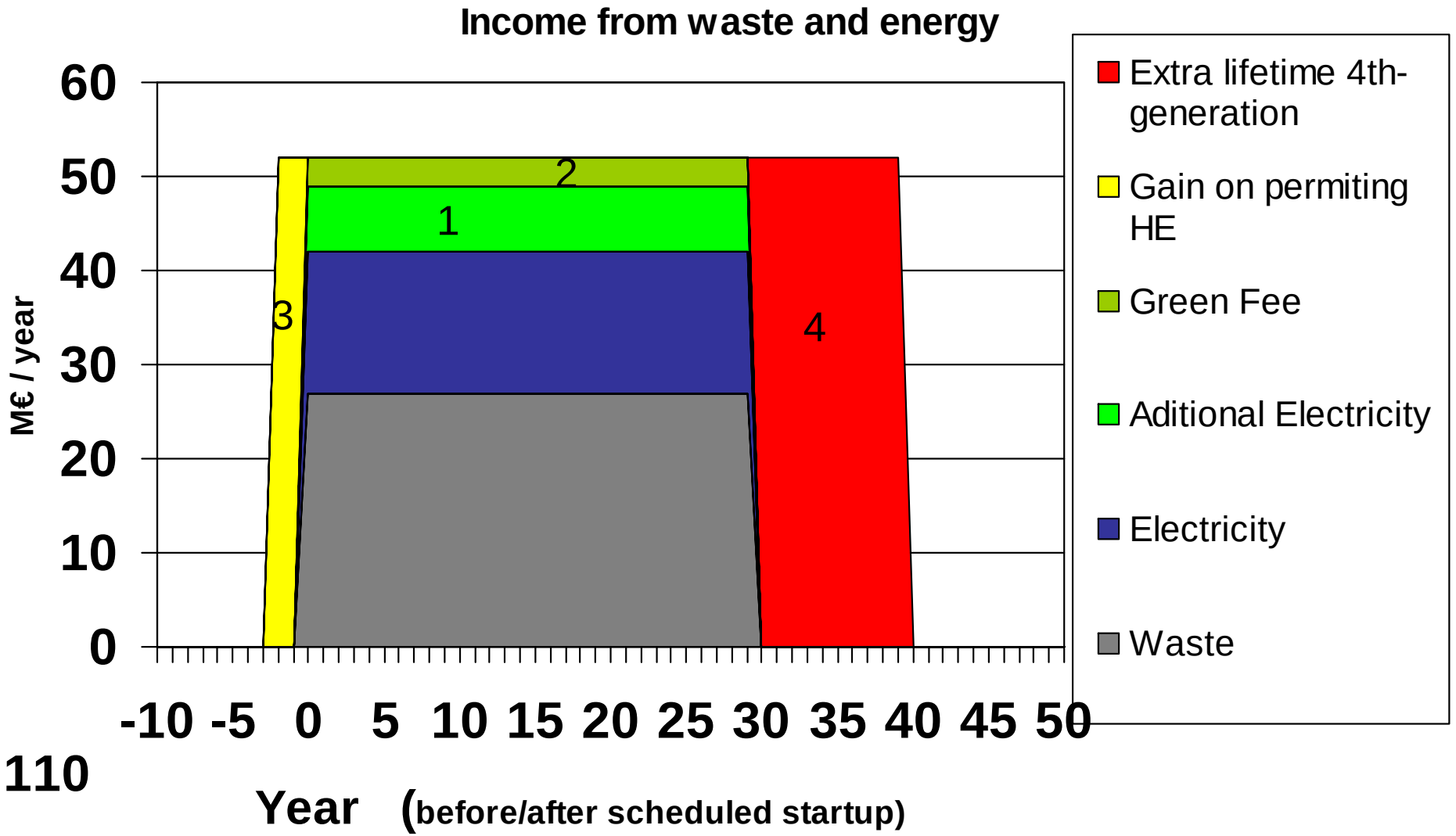
Optimal Electrical efficiency



OPTIMISATION:

- Local conditions
  - Cooling water
  - Type of waste
  - Size of installation
- Electricity price
- Depreciation time
- Subsidies
- Environmental profile
- Permit conditions

Business case for 4th-generation



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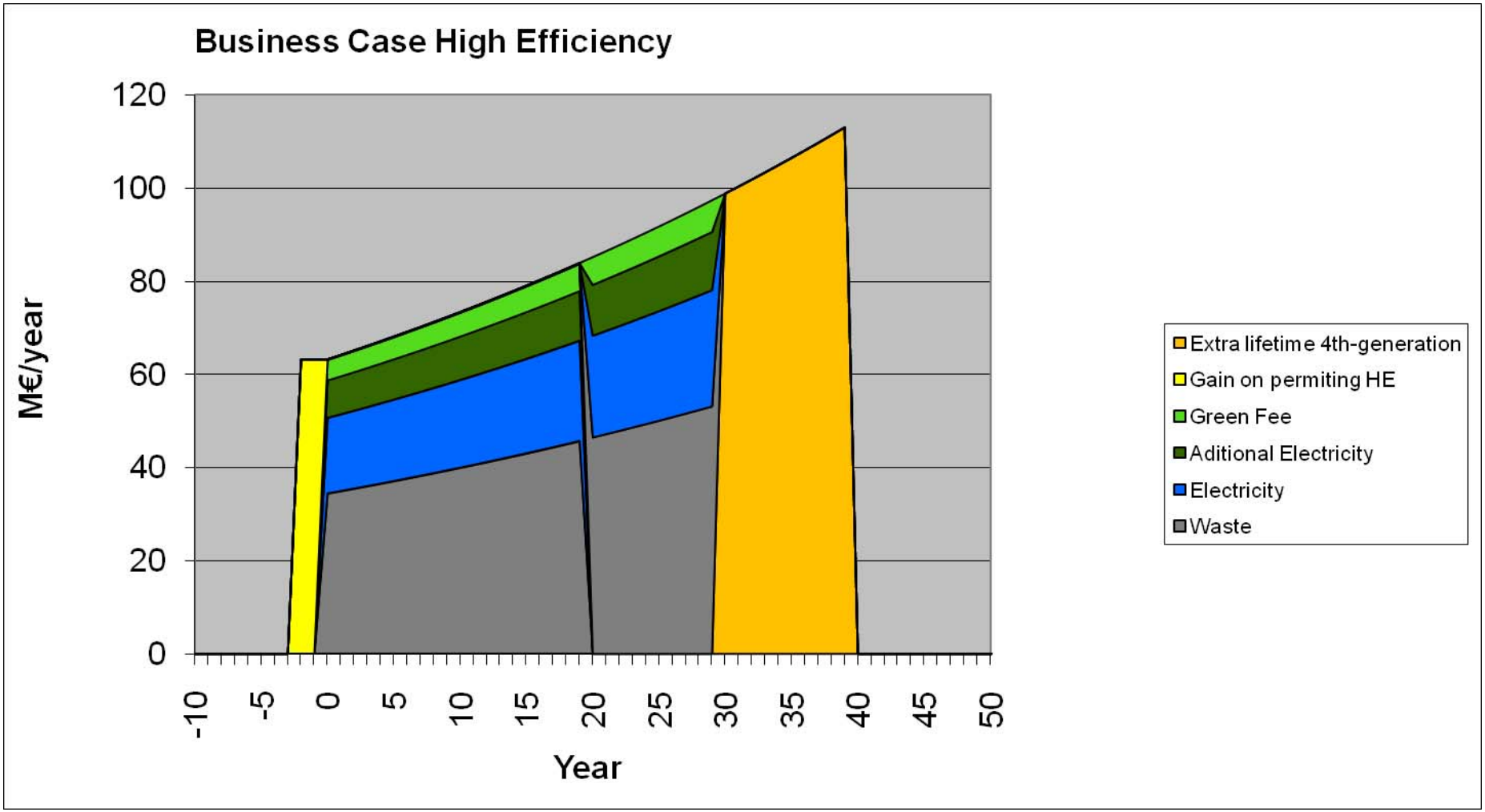
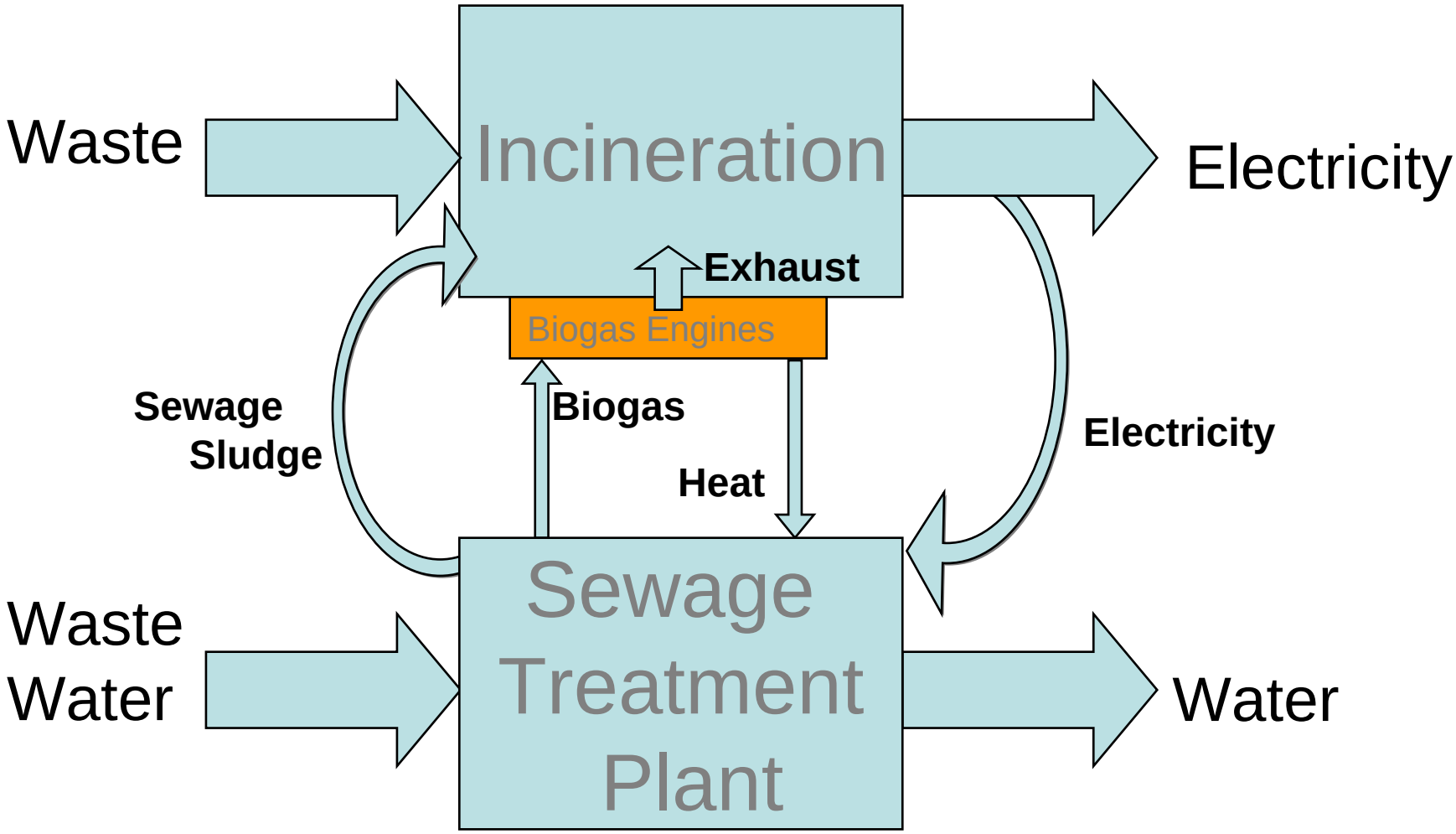
Business case for 4th-generation

3 4



SYNERGY


Waste
Incineration
Electricity
Exhaust
Biogas Engines
Sewage
Sludge
Biogas
Heat
Electricity
Waste
Water
Sewage
Treatment
Plant
Water

Patents for licensing

with support for implementation

Flue gas Cleaning

1. Dioxin removal in wet flue gas cleaning with detergents
2. Mercury removal in wet flue gas cleaning
3. Combining waste incineration and sewage treatment plant

Energy Recovery

4. High Efficiency - Waste Fired Power Plant
5. Flue gas recirculation to primary air
6. Steam super heater construction with screen pipes
7. Steam super heater with unround pipes

Material recovery

8. Salt fabrication from flue gas cleaning residue
9. Recovery of fine Non-Ferrous metals from bottom ash
10. Gravity Separation of Non-Ferrous metals from bottom ash

6. CONCLUSION

- COST can/must go DOWN
- SIMPLE process do it OPTIMAL
- Environmental efficiency use all SYNERGY
- Electrical Efficiency > 30%

Conclusion:

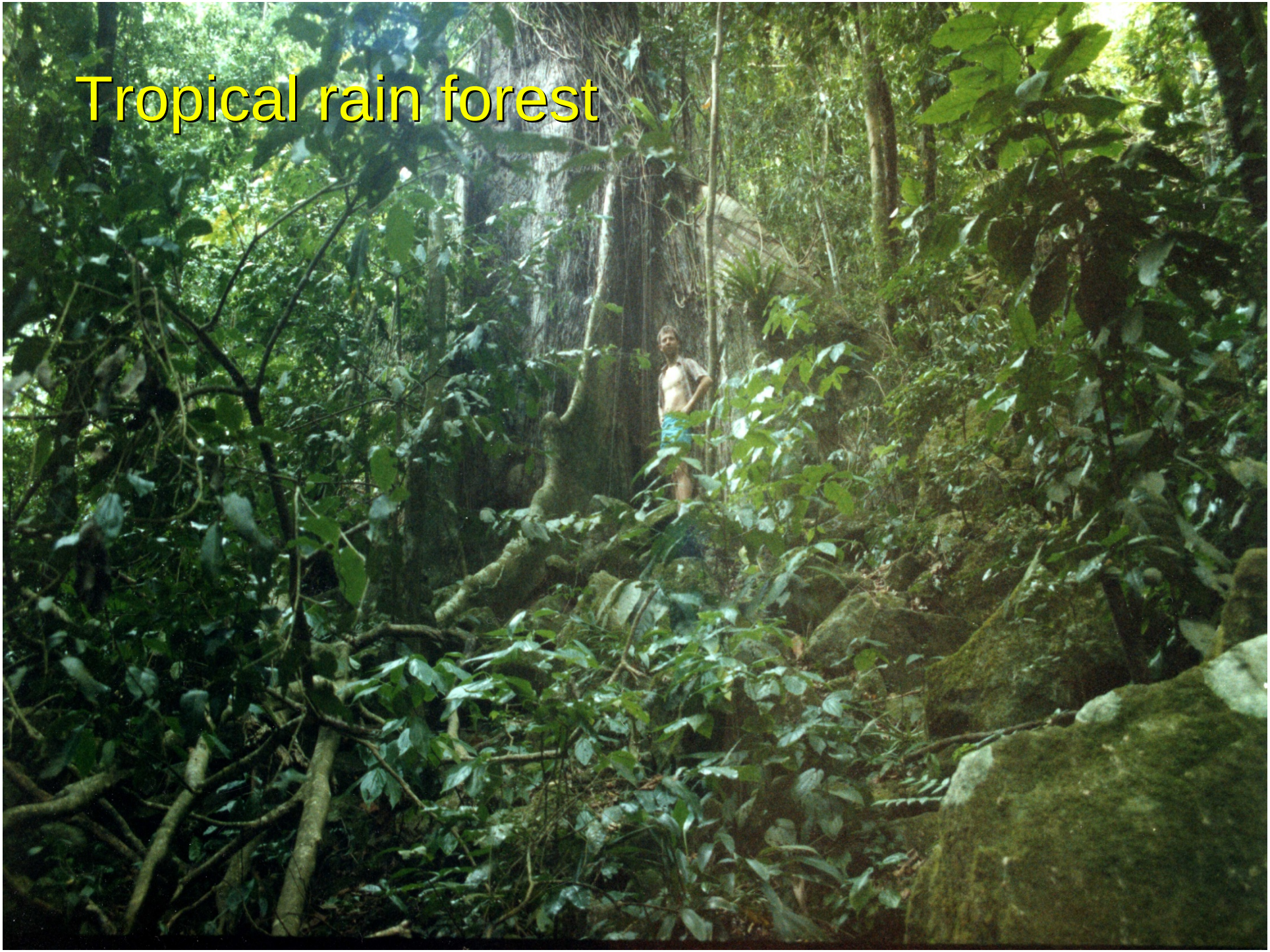
Waste is the directly available raw material for clean renewable energy and high quality building materials

Let’s explore together world’s most valuable mineral

Nothing is waste!

Nothing is to be wasted!

info@afvalenergiebedrijf.nl


Tropical rain forest

AEB Amsterdam