

WASTE RECOVERY WITH


 **DuplexTEC-Process®**

An innovative solution for municipal
and industrial waste streams

TCP Energies GmbH & Co. KG
Dr. Hartwig Streitenberger
(Managing Director and process developer)
Jena



Inhalt

- Company introduction
- Waste
-  **DuplexTEC-Process**[®]
- Performance data
- Economic analysis
- Project and schedule

TCP Energies GmbH & Co. KG

- Company location is Jena / Thuringia, Germany
- Well-known science site in Germany
- Development of the innovative "waste to energy" procedure **DuplexTEC-Process**
- Inventor Mr. Dr. Streitenberger
- Worldwide plant locations of holistic waste management planning
- Marketing/sales of technology as a holistic solution



HISTORY

EuroTherm Technologies AG

Development and construction of a pilot plant at the scale of 1:1 for the thermal treatment of highly calorific waste

Operation of the pilot plant in test campaigns

Development of the technology up to series production

Completion of the test series in 2011



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The Duplex TEC-Process® as new process development

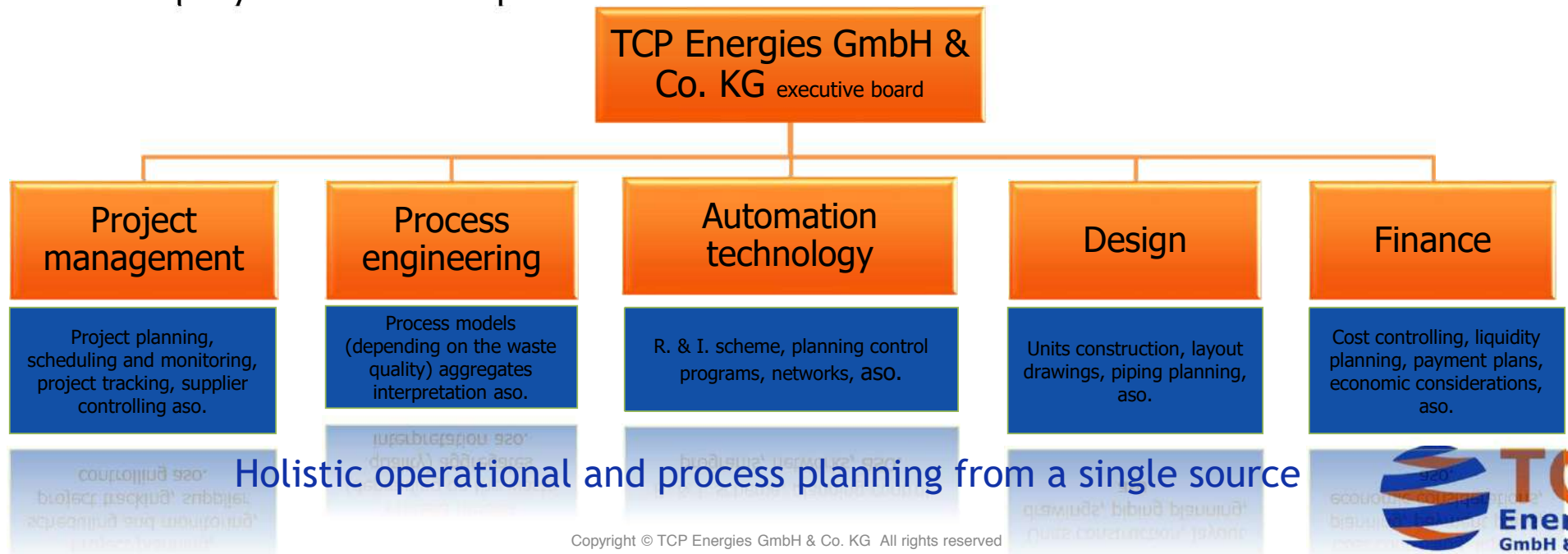
Development, marketing, planning and implementation of projects

TCP Energies GmbH & Co. KG

Planning, development and construction of innovative power plant technologies

Performance areas:

- ❖ Development of Duplex TEC-Process® (aggregate - and process-technical development)
- ❖ Integrated process planning of all major and minor components
- ❖ Implementation of the latest technologies
- ❖ Planning of all relevant material flows (supply - and disposal streams)
- ❖ Preparation of approval documentation and documentation
- ❖ Flat company structure with specialists



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WASTES AS RAW MATERIALS

HOW WE GET INPUT MATERIAL/ RECYCLABLES FROM MUNICIPAL AND INDUSTRIAL WASTE?



www.nabu.de

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Problem

- Amount of waste is increasing!
- Increase of the living standards leads to more waste
- Unsolved disposal problem of not rotting ingredients
- Limited availability of landfill space
- Movement in landfills not permanently safe (risk of contamination of groundwater and deeper layers of the Earth)



Solution

- ❖ Waste as a unsorted group = recyclables/raw material
- ❖ Separation of waste according to material groups
- ❖ Repatriation in recycling circuits
- ❖ Thermal utilisation of calorific waste to the Duplex TEC-Process®
- ❖ Generation of electricity from waste

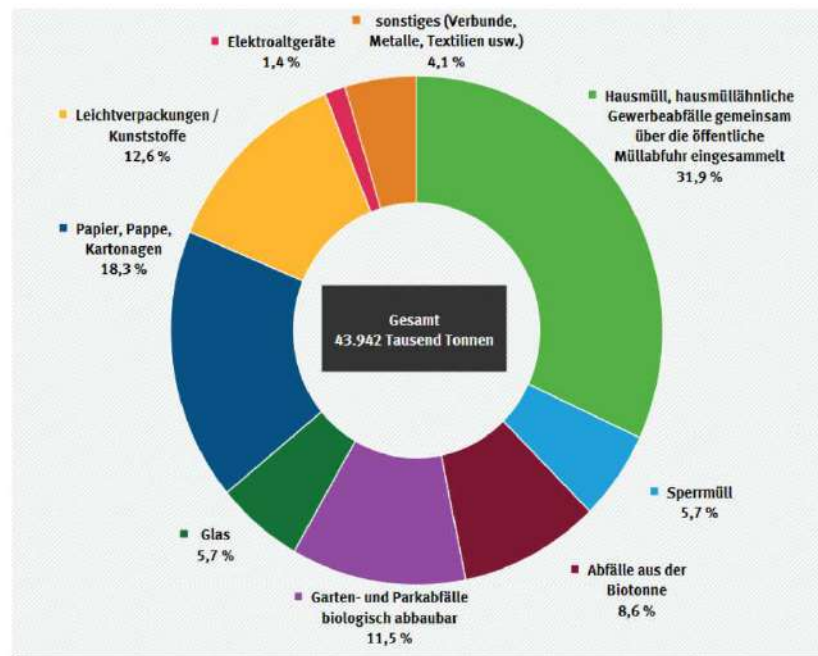


Waste streams

- From municipal and industrial sources (typical values)

Waste composition Germany

Zusammensetzung der haushaltstypischen Siedlungsabfälle 2013



Quelle: Statistisches Bundesamt, Abfallbilanz 2013, Wiesbaden 2015

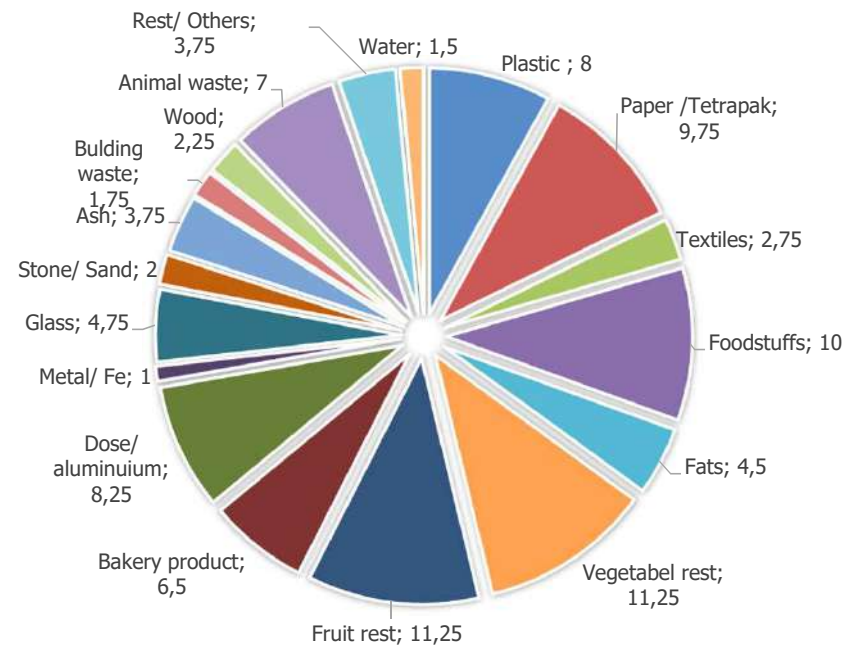
thermally high caloric valuable part:

ca. 40 %

(Plastics, paper/Pape, bulky waste and percentage of public waste collection)

Waste composition Turkey

Waste composition Turkey

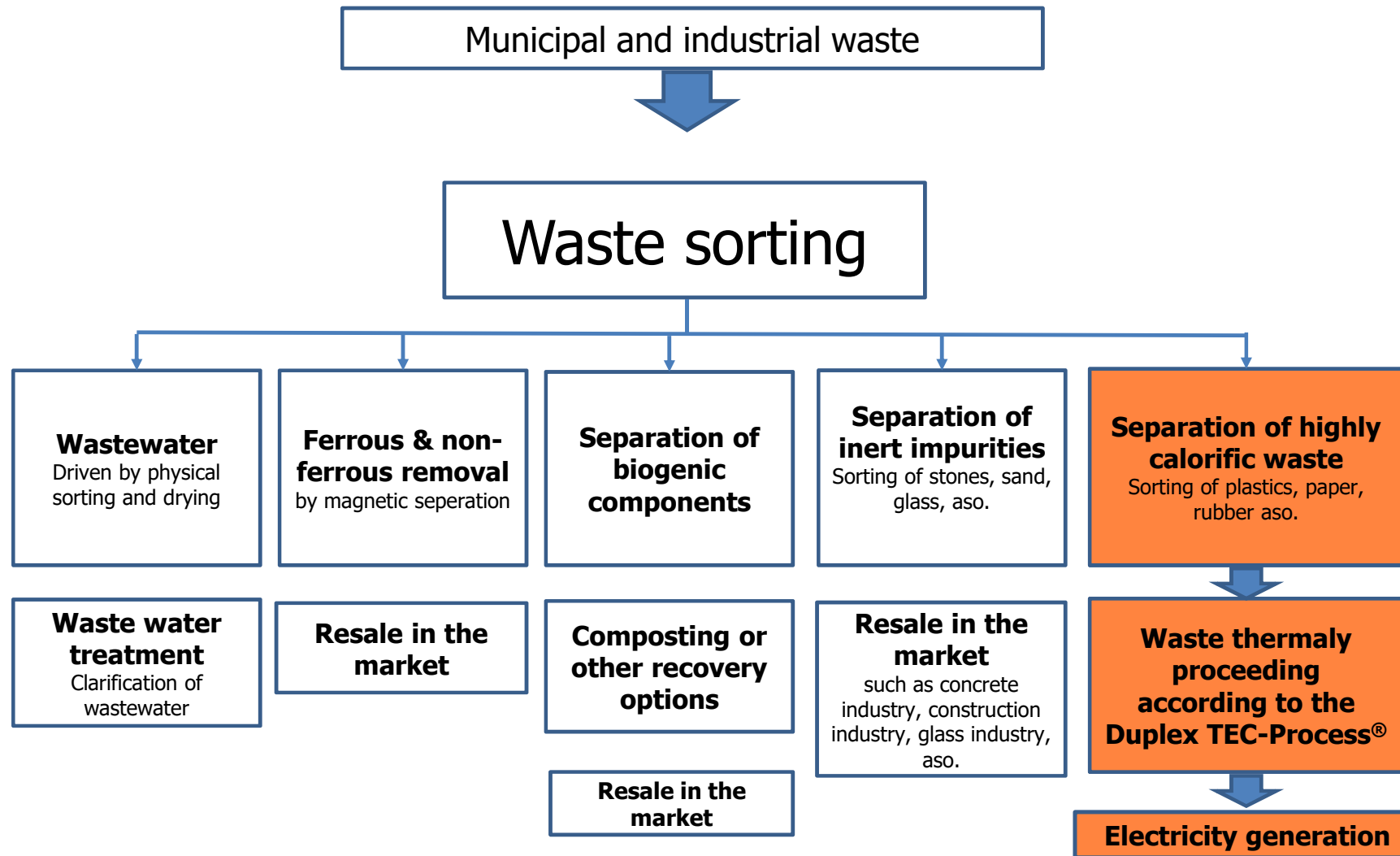


thermally high caloric valuable part:

ca. 30 %

(Plastics, paper/Pape, wood, fats, textiles)

Waste sorting of TCP Energies GmbH & Co. KG



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What kind of waste can using thermally processed with the

DuplexTEC-Process®

- Sorting of the waste stream into usable streams
- All high-caloric organic wastes from municipal and industrial sources (calorific value-rich carbon-containing wastes)
- Plastics, wood, paper & cardboard, scrap tires, paints & coatings, textiles & leather, aso.
- A specific input material for thermal recovery in our facilities, resulting in the integral part of the process of waste sorting and waste packaging (product: **R**efuse **D**erived **F**uel: **RDF**)
- Sorting residues can be conveyed to the existing recycling system such as metals and glass scraps

Characteristics of the input materials for the thermal area

❖ physical and chemical properties

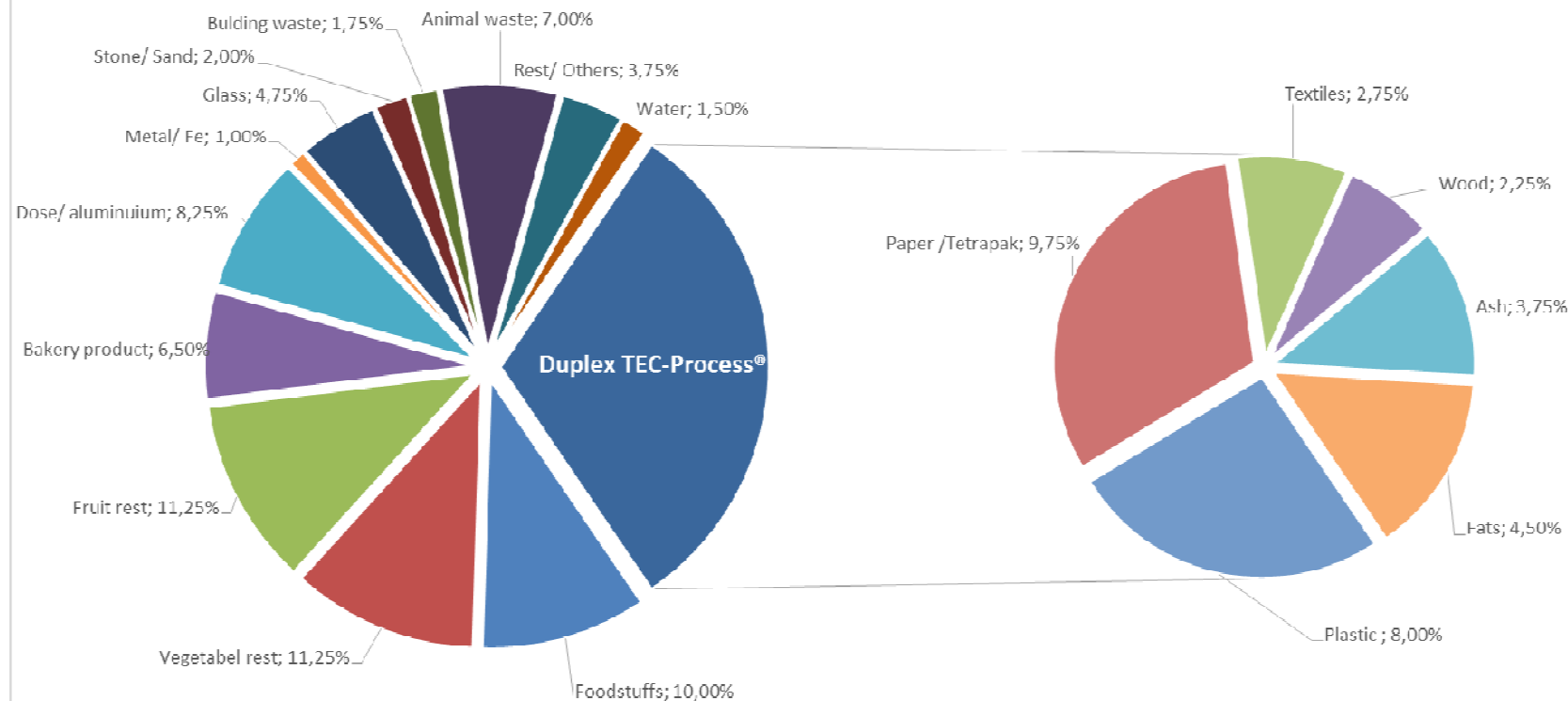
Input	before preparation	before thermal processing
Structure * (granulation size) (solid)	<1.3 m	approximately 2 to 35 mm edge length
Structure (granulation size) (films, fluff)	variable	up to max. 30 mm edge length
Heating value:		approximately 15 to 30 MJ / kg
Water content, free flowing, muddy, pasty	variable	about 10 Ma % after drying
Inert portion / ash content	Conditioned, not fluid	approximately 1 to 7%
Bulk density		0.35 t / m ³
Contaminants	variable	Stones: up to 15 mm edge length Glass: up to 15 mm edge length FE / NE: up to 10 mm edge length
Chemical parameter / heavy metals	see specification: Input materials	

Chemical limits	
Parameter	Weighting %
Ash	≤20
C	≥30
N	≤3
S _{gas}	≤5
Cl _{gas}	≤10
P	≤5
F	≤3
Br	≤3
Water content	10
Organic Cl	> 1 (according to substance configuration)
Lower HW (MJ / kg)	11 ... 20 (max. 30)
Bulk density (t / m ³)	<0.3
Parameter	mg / kg
As	<1000
Pb	<2,500
Cd	<400
Cr	<2000
Cu	<5000
Ni	<2000
Hg	<10
Zn	<100,000
Tl	<20
Mn	<500
V	<500
Co	<1000
SE	<10
Sn	<1000
Sb	<500
Te	<500
PCB	<5
PCP	<5
PAK	No limit
PCDD / F	<50 [µg TE/kg TS]

Waste for thermaly proceeding according to the

DuplexTEC-Process®

Waste composition Turkey



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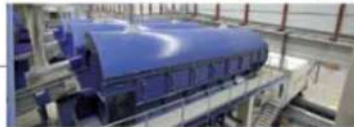
The Waste Treatment

→ Acquisition of commercial components from well-known plant manufacturers such as Fa. Stadler, Ventilex

- Bag opener
- Shredder



- Manual pre-sorting
- Screening drum



- Ballistic separator
- Air classifier



- Magnetic separator
- Eddy current separator



- Near-infrared separator



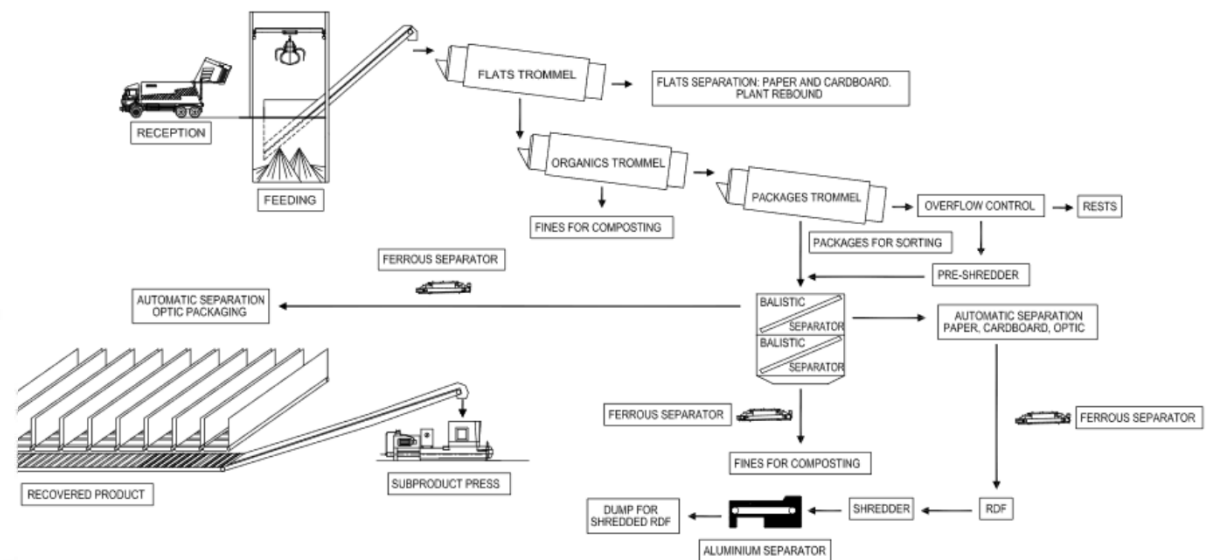
- Bunker conveyors



- Baling press
- Shredder (RDF)



DRAWING OF AN AUTOMATIC PLANT



Broschüre der Firma Stadler: Hausmüllsortierung; www.stadler.com

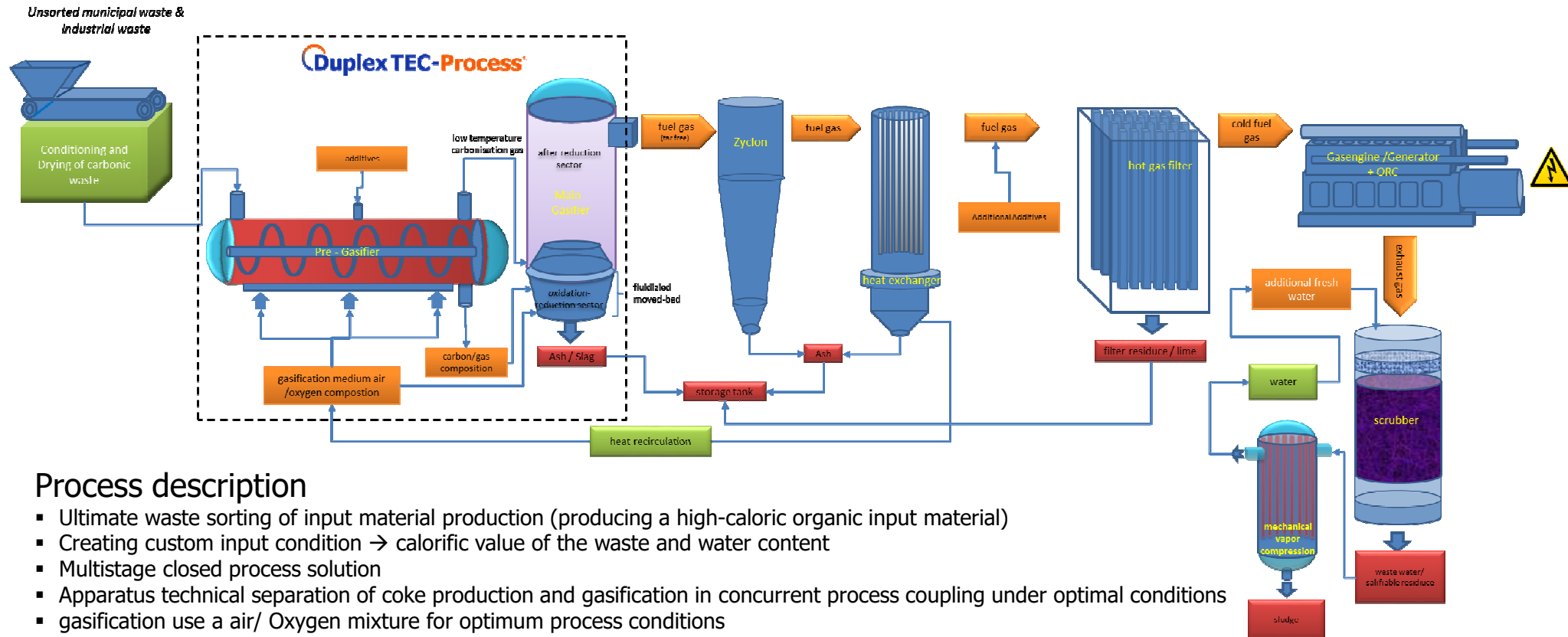
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WASTE TO POWER



How is the basic components of the thermal area?

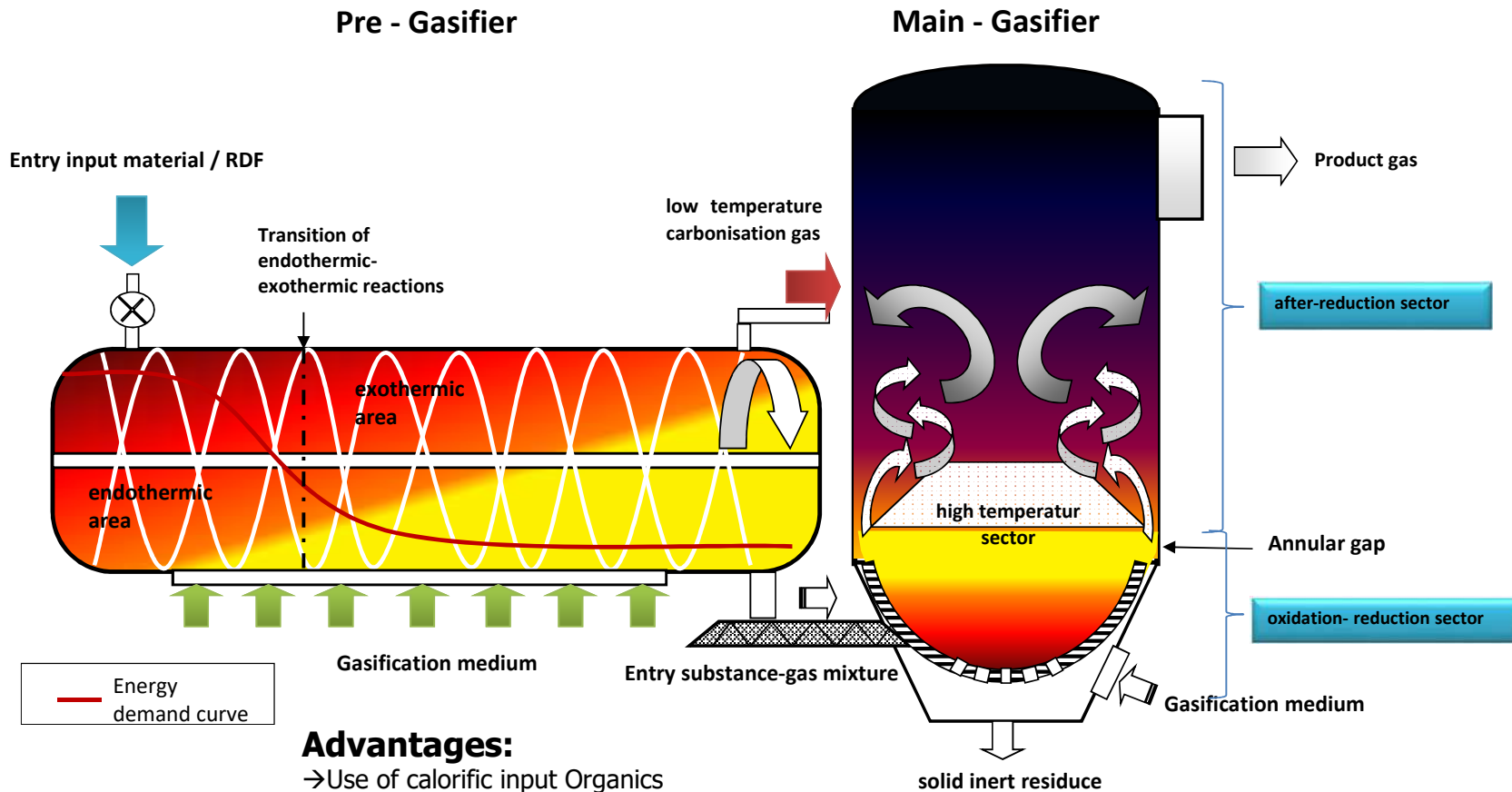
- New innovative plant technology with patented process and construction according to the Duplex TEC-Process®



Process description

- Ultimate waste sorting of input material production (producing a high-caloric organic input material)
- Creating custom input condition → calorific value of the waste and water content
- Multistage closed process solution
- Apparatus technical separation of coke production and gasification in concurrent process coupling under optimal conditions
- gasification use a air/ Oxygen mixture for optimum process conditions
- optimal process conditions and unit design ensures a usable, almost tar-free product gas
- Aggregate technical design on 3,3 t/h (incl. 10% H₂O)
- Modular plant design (no scaling risk through capacity increase in the occurrence of waste)
- Use of process waste heat for drying of the input material

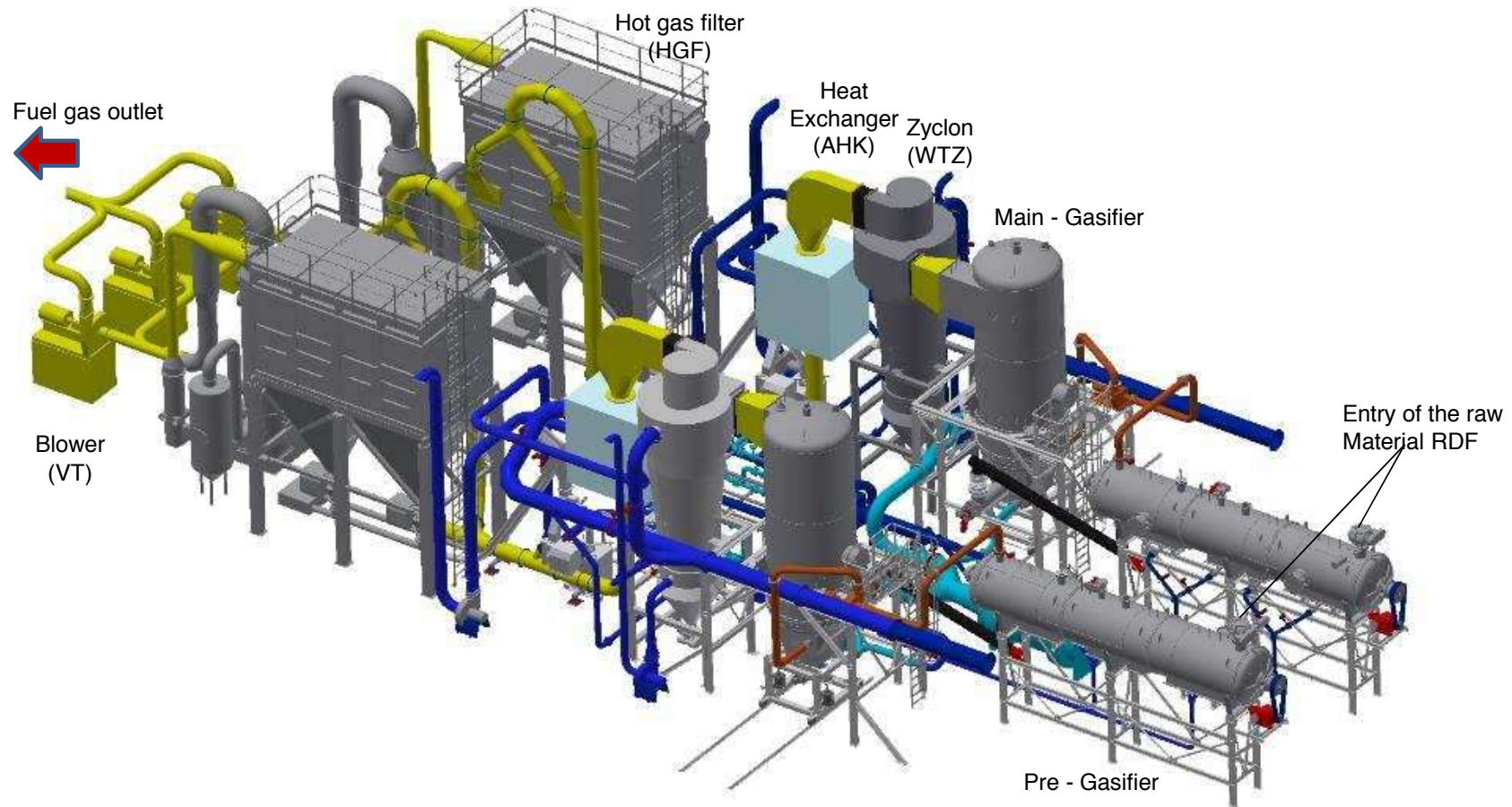
Function and advantages of the Duplex TEC-Process®



Advantages:

- Use of calorific input Organics
- Autothermal process control
- Multi-stage fuel gas processing
- Supply the means of gasification with oxygen enrichment
- High commercial yield
- High efficiency of carbon turnover >99 %

Layout thermal area

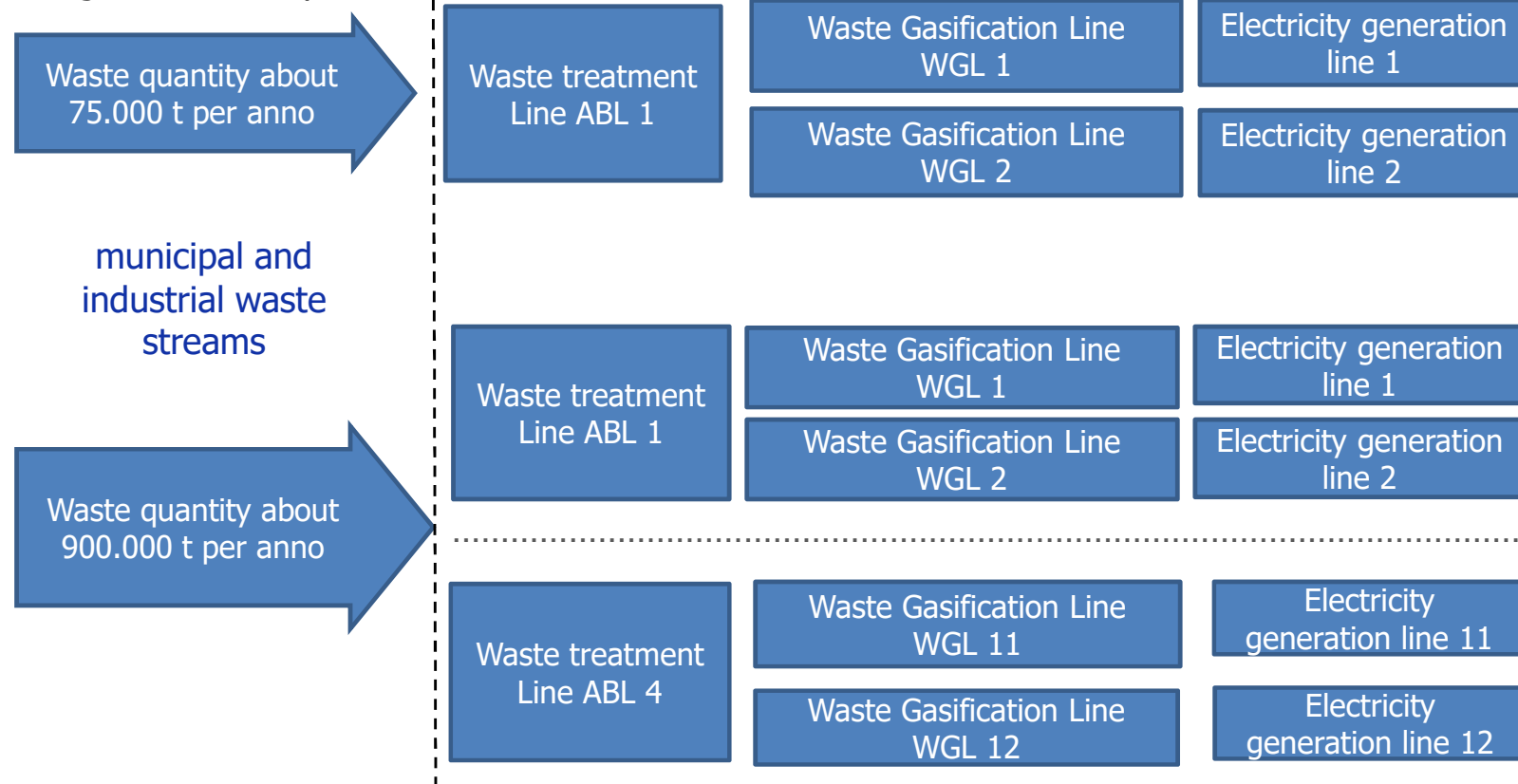


System sizing to individual customer needs

→ Modular plants build up in lines (ABL: Waste Treatment Line; WGL[®]: Waste Gasification Line; VSL: Electricity Generation line)

Configuration example:

DuplexTEC-Process[®]



Power parameters ($H_u = 20.0 \text{ MJ / kg}$)

Waste treatment	Plant description	ABL 1-30	ABL 1-50	ABL 3-150	ABL 4-300
	Material	homogeneous, high-caloric, miscible in shredder	homogeneous, high-caloric, miscible in shredder	homogeneous, high-caloric, miscible in shredder	homogeneous, high-caloric, miscible in shredder
	Sludge (blendable)	concentrated	concentrated	concentrated	concentrated
	Input flow (amount) 0 to 40 Ma% of H ₂ O	3.0 to 4.6 t/h 24 -36.8 kt / a	6 to 9.2 t / h 49.5 to 75.9 kt / a	18 to 27.6 t / h 148.5 -227.7 kt/a	36 to 55.2 t / h 297 -455.4 kt/a
	Consistency	Bed material load	Bed material load	Bed material load	Bed material load
	Edge length	<30 mm	<30 mm	<30 mm	<30 mm
	Input with 10 Ma%	3.3 t / h	6.6 t / h	19.8 t / h	39.6 t / h
	Calorific value of the input material approx	20.0 MJ / kg	20.0 MJ / kg	20.0 MJ / kg	20.0 MJ / kg
Duplex TEC- Process®	Plant description	WGL 1-25	WGL 2-50	WGL 6-150	WGL 12-300
	Energy content input approx	20.19 MWh/h	40.83 MWh/h	121.14 MWh/h	242.28 MWh/h
	efficiency of cold gas	83 %	83 %	83 %	83 %
	Material inert and process-related residues	3 to 7 %	3 to 7 %	3 to 7 %	3 to 7 %
	Pure gas supply	6150 Nm ³ /h	12,300 Nm ³ /h	36,900 Nm ³ /h	73,800 Nm ³ /h
Power generation	Chemical energy Pure gas supply	17.10 MWh/h	34.20 MWh/h	102.60 MWh/h	205.20 MWh/h
	Plant description	VSL 1	VSL 2	VSL 6	VSL 12
	Power generation (Gas motor or ORC)	8.89 MWh/h	17.78 MWh/h	53.35 MWh/h	106.7 MWh/h
	Power supply (Reduction by self-consumption and transformation losses)	7.18 MWh/h	14.36 MWh/h	43.09 MWh/h	86.18 MWh/h

Fuel gas-fired power generation

- ❖ Customization of the engine configuration on the Duplex TEC Process® (in terms of quantity of gas and gas quality)
- ❖ Use of very robust marine engine technology
- ❖ Use of engines with low speed
- ❖ Consumption lubrication allows very long service life
- ❖ Proven technology with very low risk
- ❖ Each thermal line has exactly a gas engine with generator and its subsequent ORC Process

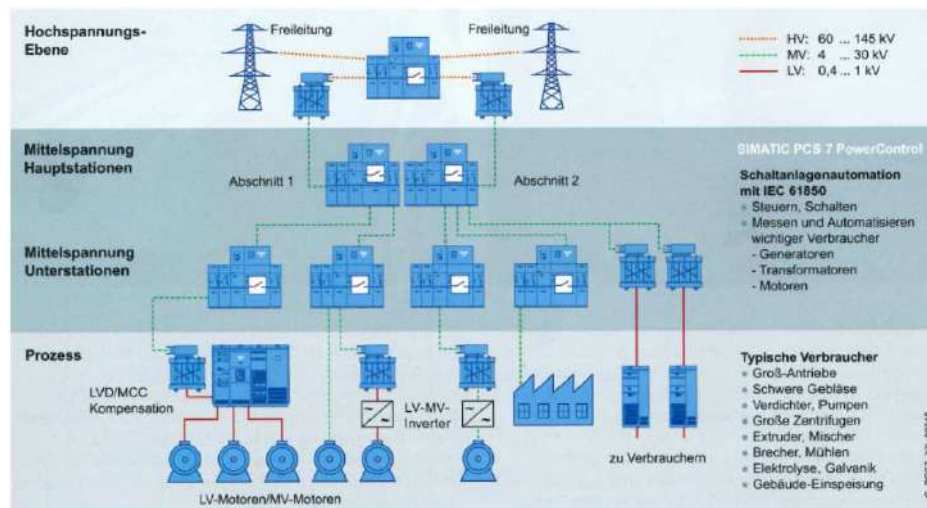
Technical Data

Characteristics	Unit	2 x18V 32/40 PGI
Engine Power	KW mechanic	8100
Power Generator	KW electric	7865
Heat Rate Generator	(kJ/kWh) / (BTU/kWh)	7972 / 7566
Net power of Plant	KW electric	15000
Heat Rate Plant	(kJ/kWh) / (BTU/kWh)	8210 / 7782
Plant Efficiency	%	43.8
Engine Efficiency	%	45.2
Generator Efficiency	%	97

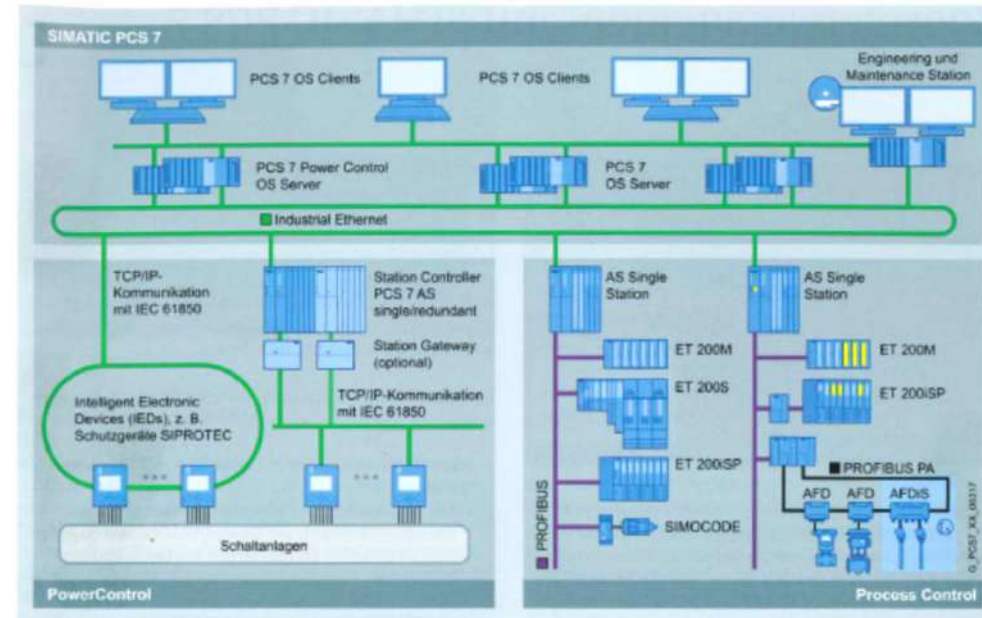


Process control and visualisation by means of Siemens Simatic PCS 7

- ❖ Safe process and system management
- ❖ High scalability, flexibility and consistency
- ❖ High reliability and partially redundant dimensioning in critical process areas
- ❖ Process breakdown with control room and all relevant information
- ❖ Data recording and archiving
- ❖ Central source of information for planned maintenance
- ❖ Defence in depth architecture to avoid security risks
- ❖ Remote maintenance access to any worldwide location



Automatisierungsebenen der Energieversorgung- und -verteilung



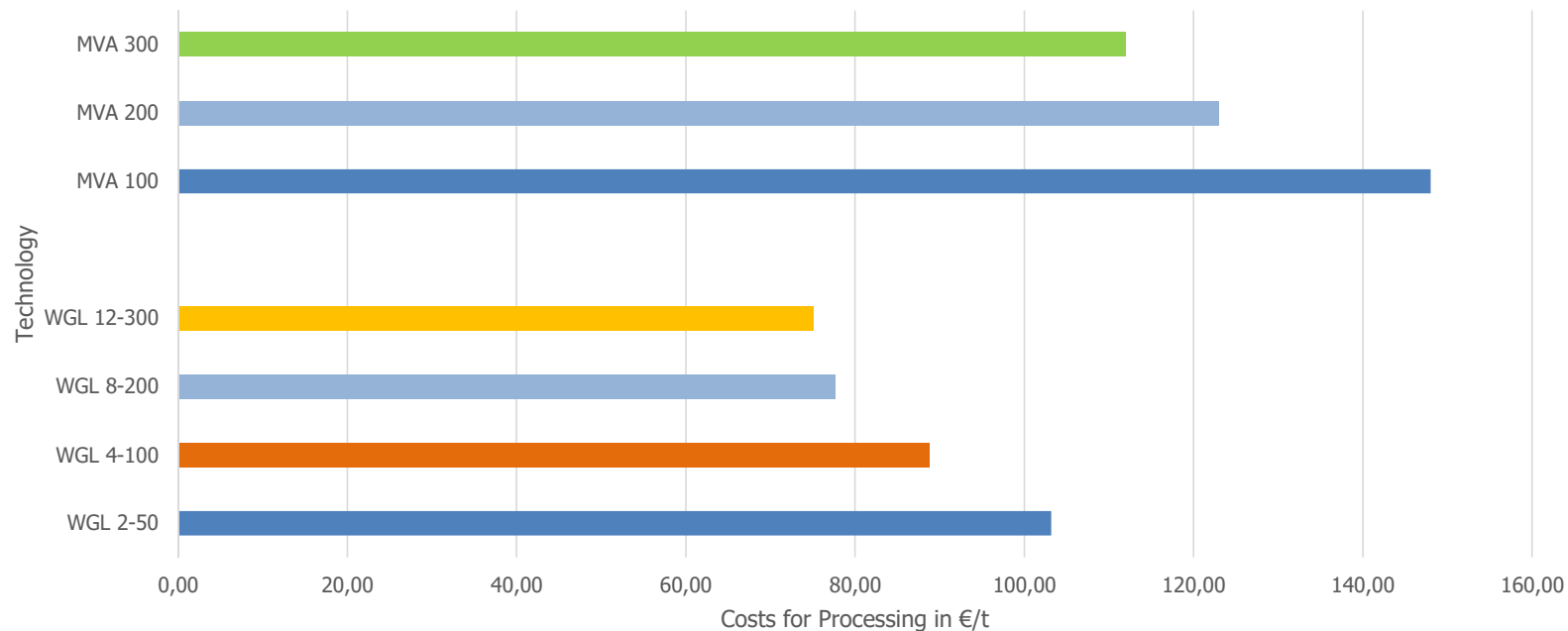
Integrationsmöglichkeiten für die Automation von Mittelspannungsschaltanlagen

Business viewing

- Duplex TEC-Process® in comparison with other methods

Comparison of waste incineration plant and Duplex TEC-Process®

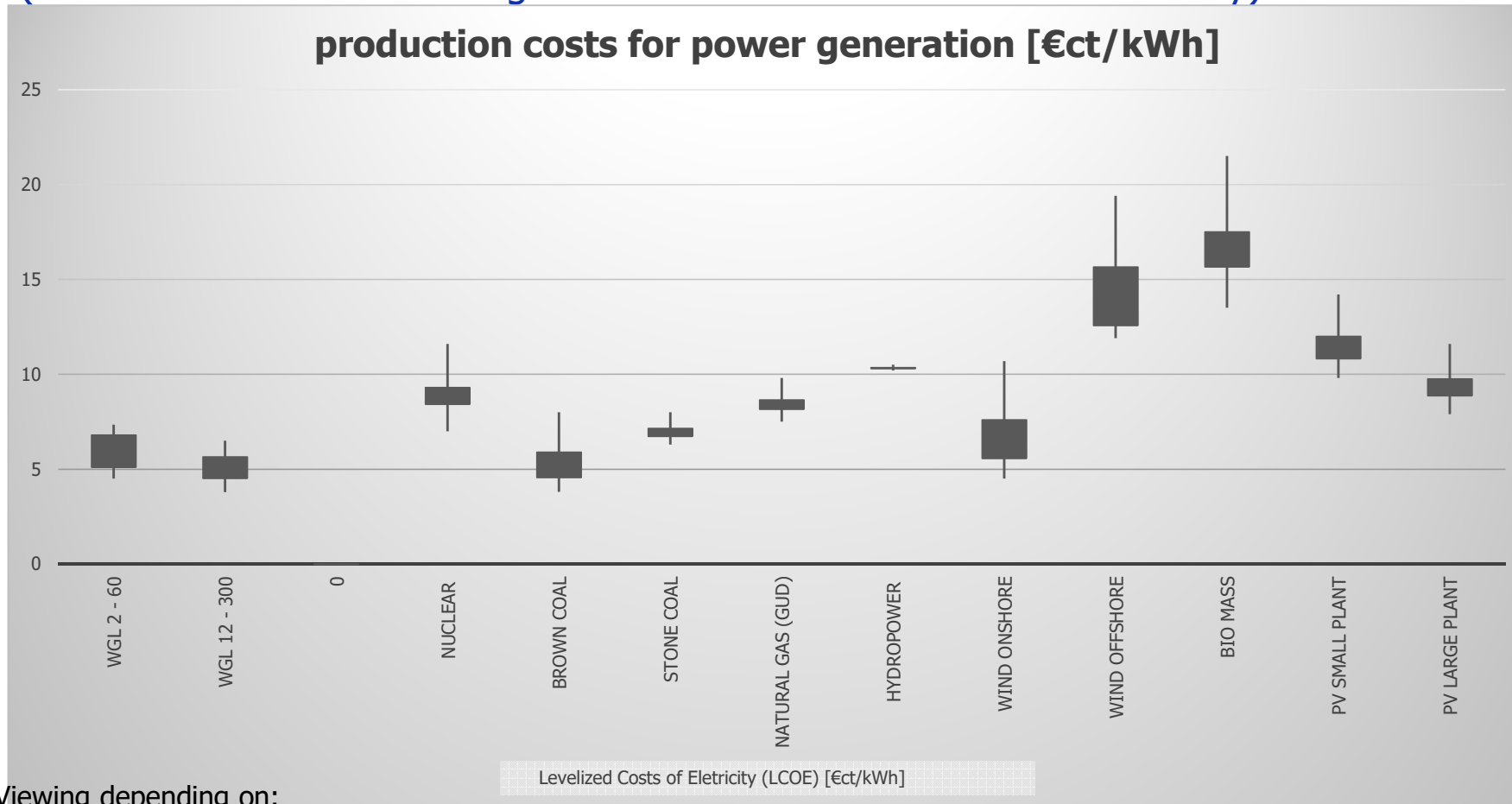
Comparison of the specific cost [€/t] between waste incineration (MVA)
[in thousand tones per year] and the Duplex TEC-Process®



- Waste treatment costs with the Duplex TEC-Process® are significantly lower than with waste incineration technology
- Electricity generation with the Duplex TEC-Process® about 1,8 – 2,2 MW_{el}/t_{RDF}
(based on the calorific value of the input material)

Economic characteristics

(Researchs of the TCP Energies GmbH & Co. KG → Location Germany)



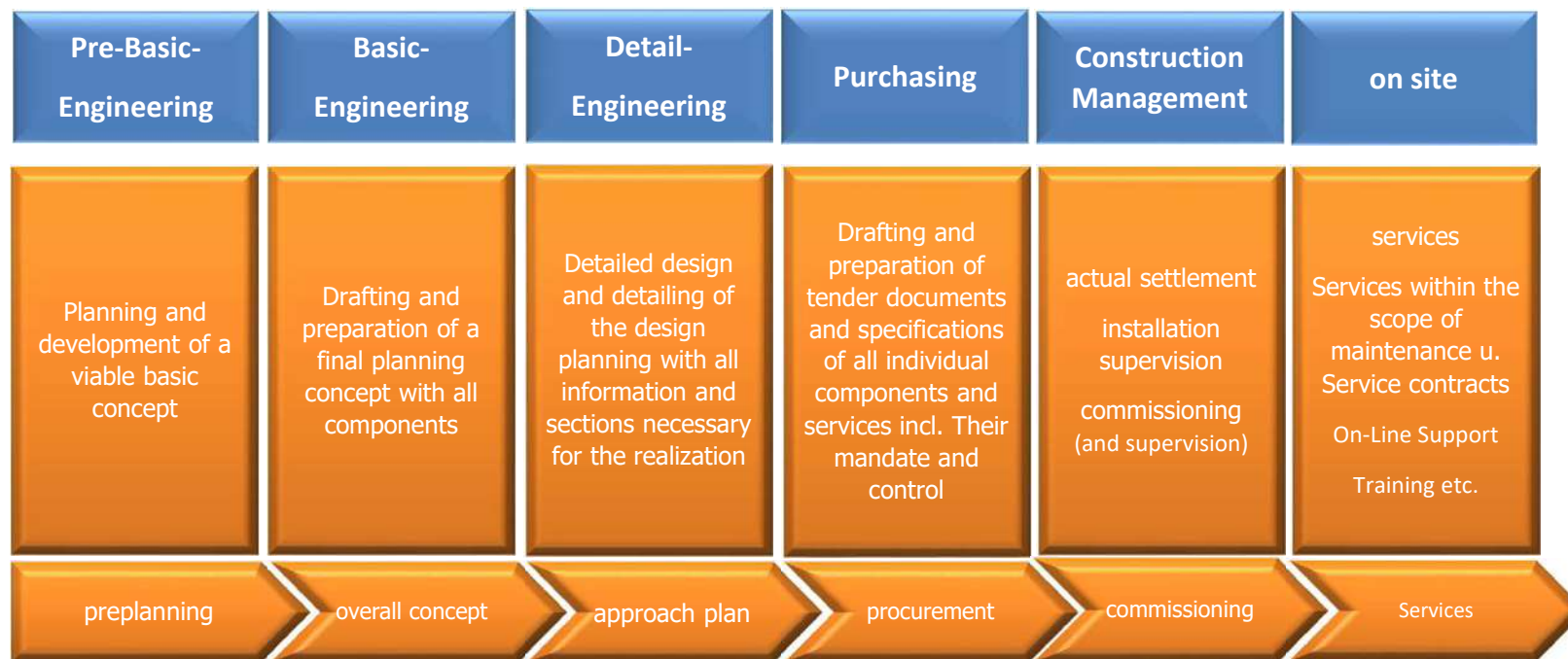
Viewing depending on:

Amortization period, invest-sum, foreign funding, asset utilization, efficiency, "Fuel costs" /-compensation, fuel costs, employee usage, input material quality, logistics

PROJECT RUNTIME

Project operations

Basic division of engineering services and content for the construction of plants for the Duplex TEC- Process®



Time schedule



- ❖ Individual adjustment of the investment areas to the local conditions
- ❖ Preparation of approval documents
- ❖ Production of extensive documentation
- ❖ Training employees
- ❖ Holistic care range with online service
- ❖ Project realization time approx. 27-36 months

Unique Features

- Modular system configuration depending on the waste generation and composition
- Highly efficient procedures in the area of "Waste to Energy"
- Continuous high throughput rates of 3.3 tons / h incl. 10 Ma% H₂O (per thermal line)
- Closed multilevel process solution with process coupling before Pre - Gasifier and Main- Gasifier in the thermal area
- Use of oxygen-enriched gasification agent for constant high fabric implementation
- Direct-fired power generation in modified high efficient gas engines with high electrical efficiencies (cold gas efficiency > 88%; Efficiency of gas engines > 42%)
- Patented and property rights secure the technology
- Testing on a 1:1 scale (without scaling risk)
- Low electricity production costs
- CO₂ neutral balance
- Compliance with all applicable rules and regulations (Germany & European Union)
- Best German technology - with TÜV expertise

There is currently no comparable technology and process solution!

TCP Energies GmbH & Co. KG

Group of companies



HS Techtransfer UG &
Co. KG

Holder of rights at the patents and
brands

Licenses

Project companies

Patents / property rights

- Deutsche Patente
 - DE 10 2008 058 602.1 Vorrichtung in Form eines Bewegt-Bett-Vergasers und Verfahren...
 - DE 10 2009 007 768.5 Vorrichtung in Form eines Thermolysereaktors und Verfahrens...
 - DE 10 2012 124 204.2 Thermolyse-Rotations-Reaktor
 - DE 10 2016 121 046.3 Duplex-TEK-Mehrstufen-Vergaser
 - DE 20 2016 106 184.9 Duplex-TEK-Mehrstufen-Vergaser
- International
 - EP 0979949.3 Vorrichtung in Form eines Bewegt-Bett-Vergasers und Verfahren...
 - EP 10707201.09 Vorrichtung in Form eines Thermolyse-reaktors und Verfahrens
 - EP 13826992.3 Thermolyse-Rotations-Reaktor
 - US 14/649,742 Thermolyse-Rotations-Reaktor
 - JP 2015-545665 Thermolyse-Rotations-Reaktor
 - CN 105026521; HK 16 Thermolyse-Rotations-Reaktor
 - CA 2,893,790 Thermolyse-Rotations-Reaktor
 - 2015126860 Thermolyse-Rotations-Reaktor



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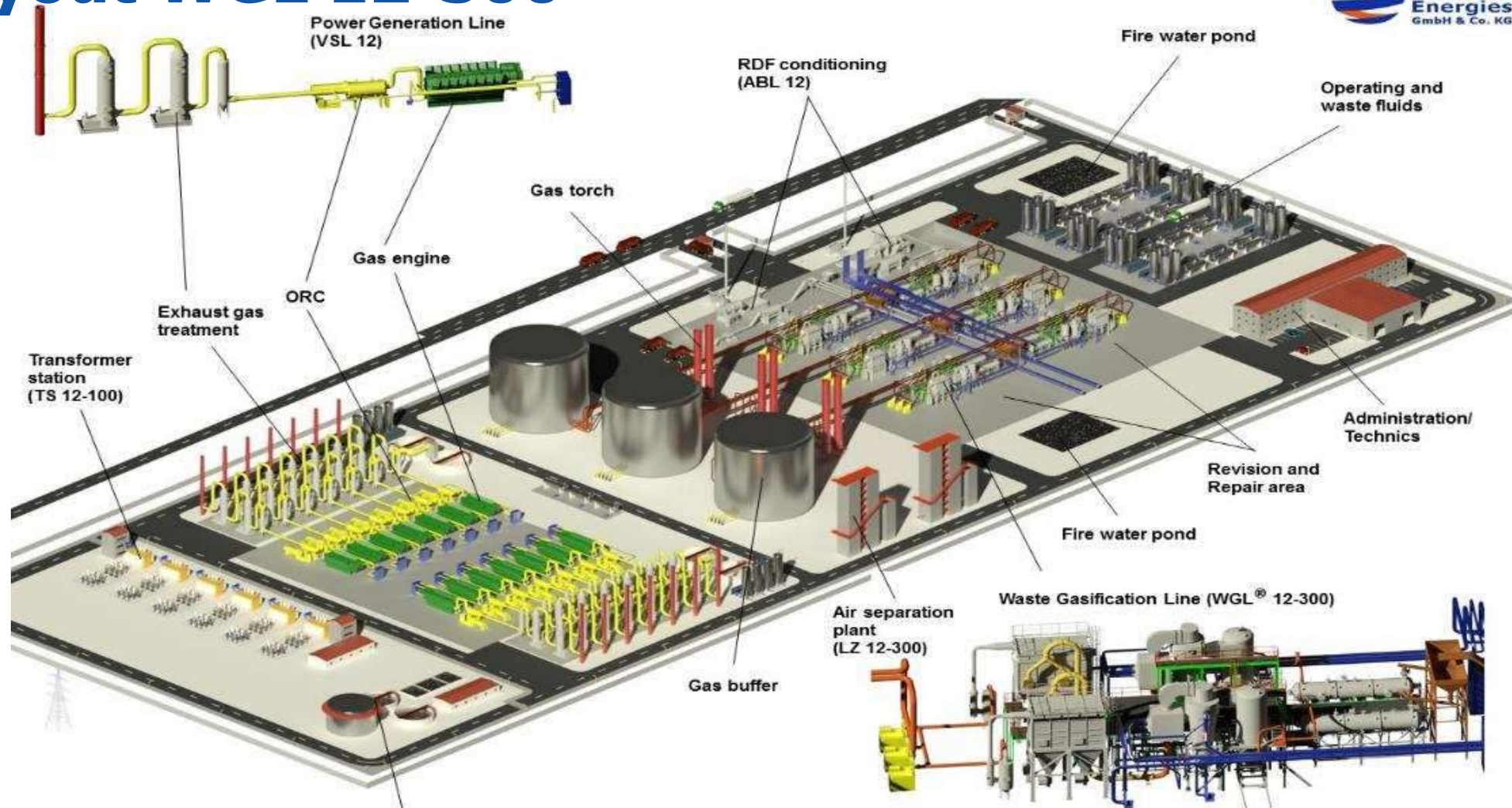
APPEDIX

Layout WGL 2-50



TCP Energies GmbH & Co. KG
WGL 2-50
Waste to Energy System
Requ. Area: app. 360m x 100m
GmbH & Co. KG

Layout WGL 12-300



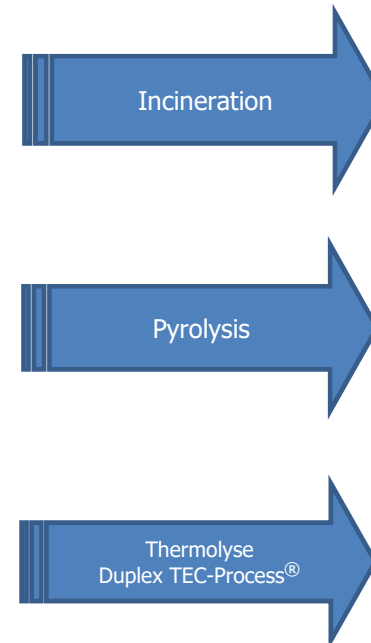
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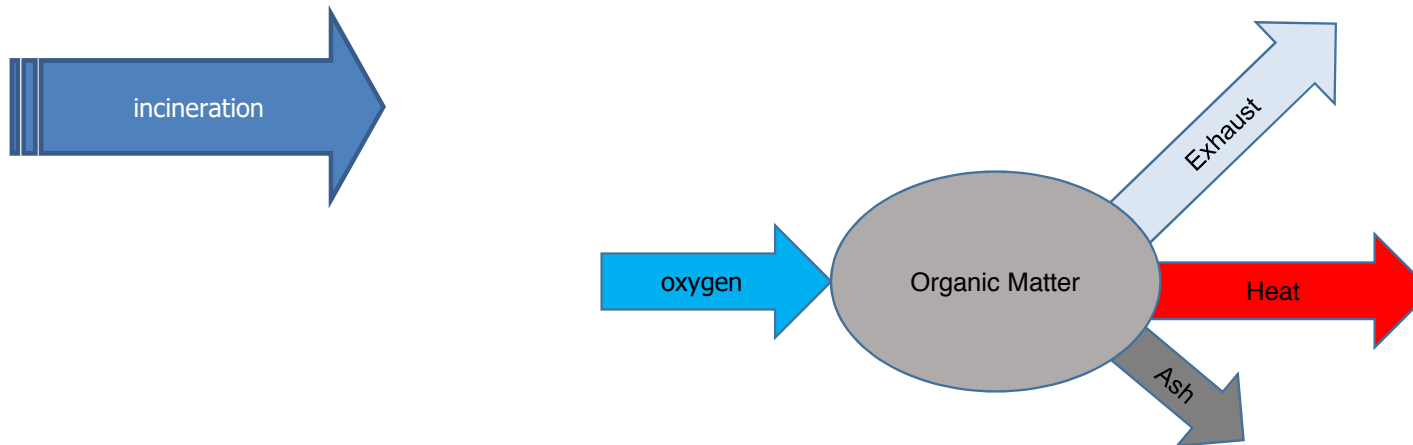
WGL® 12-300
Waste to Energy System
Requ. Area. app. 505m x 210m

Delineation of existing waste recovery operations

- Waste Incineration vs. waste Pyrolysis vs. Duplex TEC-Process®

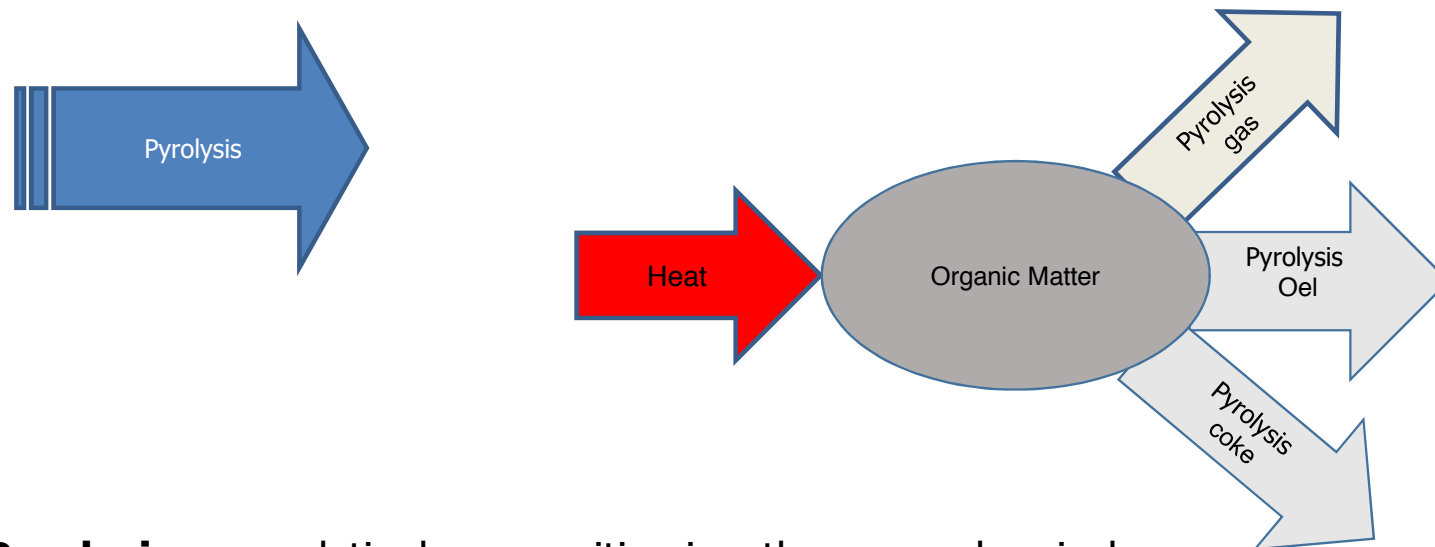
Teilschritte der Verbrennung			
Teilschritt	Prozess	Temperatur	Energie
1. Trocknung	Verdampfung des Wassers im Abfall	Bis 150°C	Braucht Energie
2. Pyrolyse (Entgasung)	Thermische Zersetzung in brennbare Gase und Kohle $\text{CH}_{1,4}\text{O}_{0,7} \rightarrow \text{CH}_4, \text{CO}, \text{H}_2 + \text{C}$	150°- 600°C	Braucht Energie
3. Reduktion (Vergasung)	Abgase aus der Oxidation (4. Schritt) werden an Kohle zu brennbaren Gasen reduziert $\text{C} + \text{CO}_2 \rightarrow 2\text{CO}$ $\text{C} + \text{H}_2\text{O} \rightarrow \text{CO} + \text{H}_2$	400°-1000°C	Braucht wenig Energie
4. Oxidation	Reaktion der brennbaren Gase und der Kohle mit Sauerstoff $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ $\text{H}_2 + 0,5 \text{O}_2 \rightarrow \text{H}_2\text{O}$	400°-1300°C	Liefert Energie





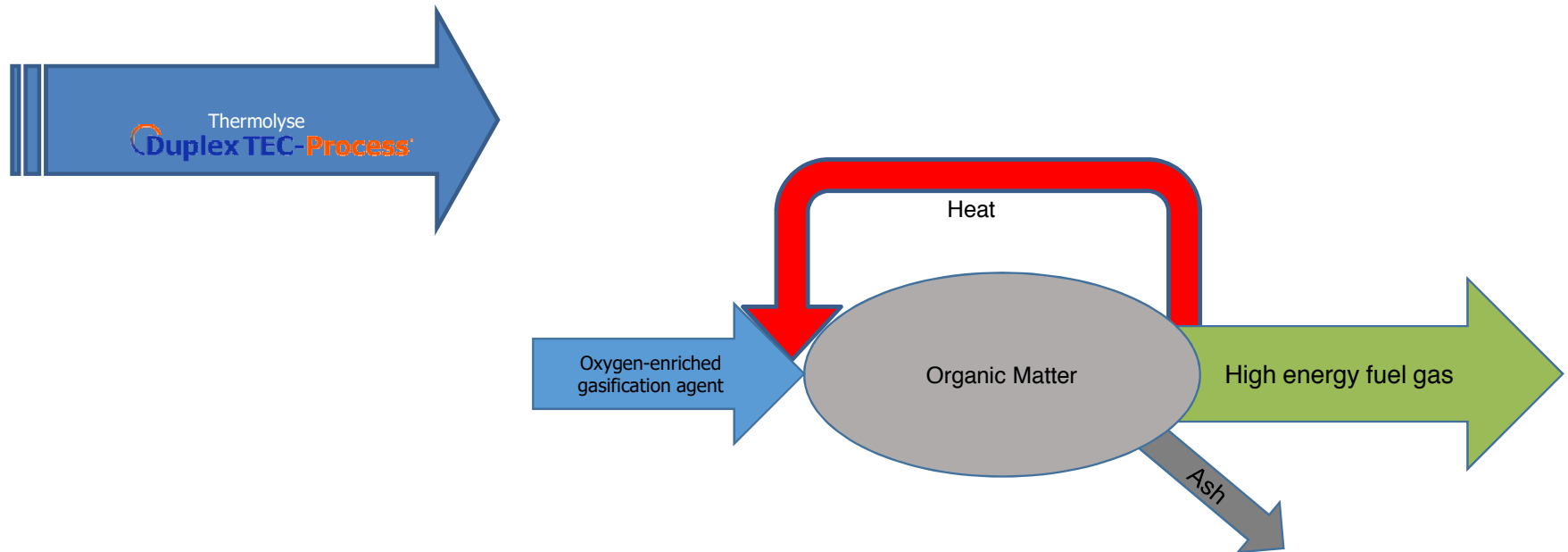
A **combustion** is a chemical reaction in which a flammable substance is oxidized by oxygen in the air. The combustion is known as stöchiometrisch when this exact amount of oxygen is supplied, which is mathematically necessary for complete combustion.

❖ **The combustion air ratio is then lambda $\lambda > 1$.**



The **Pyrolysis** or pyrolytic decomposition is a thermos - chemical Division of organic compounds with high temperatures (200-900 °C) enforces a bond breaking within large molecules into smaller ones.

❖The pyrolysis air ratio is then $\lambda = 0$



The **Gasification** is the incomplete combustion (i.e., lack of oxygen in the presence of water) of organic compounds to the so-called fuel gas or product gas. In the crack and partial oxidation split long-chain hydrocarbons into shorter chains in a radical reaction.

❖ Combustion Gasification air ratio $\lambda < 1$

back