Sewage sludge → energy + product!

Sewage sludge from not contaminated waste water systems is a huge energy source.

Our rotary kiln thermolysis systems offer a highly effective economical conversion of supposed 'waste material' into high efficient energy and their various recyclings.

The following presentation gives an overview of individual capabilities.

Different preparation of input material in connection with DGE-rotary kilns, varying from 300 kg/h up to 2,000 kg/h material throughput, allows customised construction of our facilities.

Additional possible finishings of generated products increase the profitability considerably.

Just choose components according to your requirements and we create a solution!

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Fundamentals of recycling

Composting is the most commonly used method for biomass-recycling. The CO_2 which is released during aerobic composting has to be seen as CO_2 off-balance.

During anaerobic decomposition (**putrescene**) methane is generated which is up to 21-times as harmful to the climate as CO_2 .

During CO_2-neutral **combustion** a lot of fine dust may be generated. And, depending on the composition of the biomass, new pollutants are generated during combustion.
(Dioxines & heavy metal oxydes)

During **torrefication** at low temperartures (i.e. 250-300°C) a portion of the volatile ingridients will cast expelled. As a result you receive a product with a higher heating value at reduced volume. Depending on process control energy has to be added.

In the **thermolysis** all volatiles are driven off and the organic structures (most) broken up in order to get a very high propotion of process gas. As a result one receives mineralized coke as a solid matter, which can be used, among other things, as a soil conditioner to reduce CO_2.

During **gasification** all carbon containing compounds are cracked and only in an ideal case a pure gaseous mixture consisting of H_2 und CO is generated. However, having biomasses with a low ash melting point, gasification may be critical.

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CO_2-Equivalent

Treatment	Conversion of carbon	CO_2-Equivalent	
Rotting	50% CO_2 50% CH_4	6,25	
Combustion	100 % CO_2	1,00	
Gasification	100 % CO	1,00	
Thermolysis	30 % CO_2 70 % C_{fix}	0,30	When using C_{fix} as Soil conditioner, colourant, raw material,energy source

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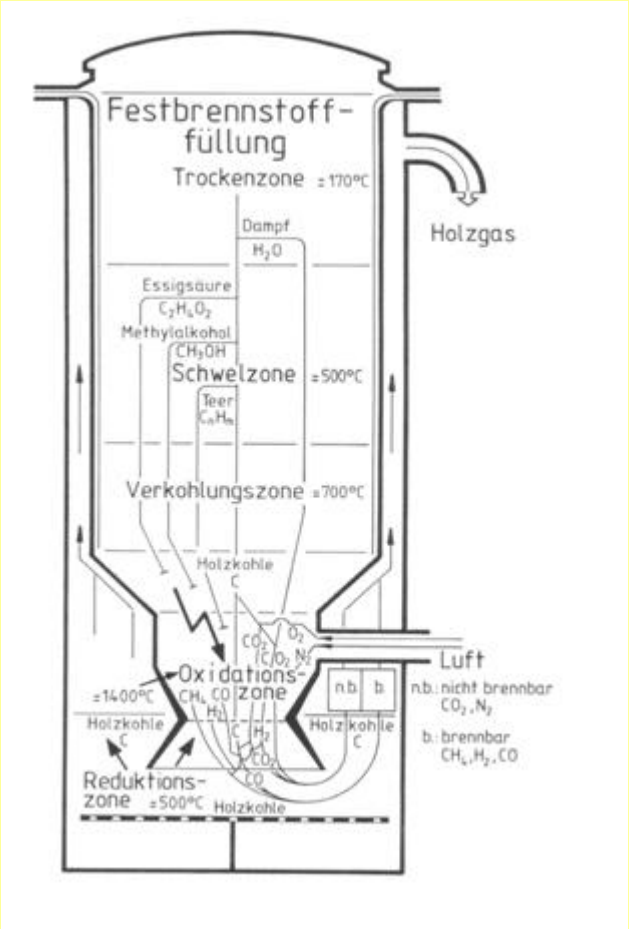
Fundamentals of thermal recycling



Imbert Holzvergaser
Taken from: www.holzgibtgas.com

Preferably oxygene and steam are led over a firebed during (wood-)**gasification**. As a result a gas consisting of H2 und CO is generated.
However, in most of the reaction vessels air is used. The process gas therefore contains a high ratio of nitrogen. For this reason it has a comparatively low heating value.

During **Flash Pyrolysis** the input material is often abruptly heated up to 300-500°C in a fluidized bed.
The residence time is typically only seconds.

During **Rotary Kiln Thermolysis** the input material is continuously heated up to 500-750°C but in **absence of oxygen!** During this process organical material decomposes in several stages and a high-heating-value gas is generated.
The residence time in the continuous rotary kiln is typically 30 – 60 minutes.

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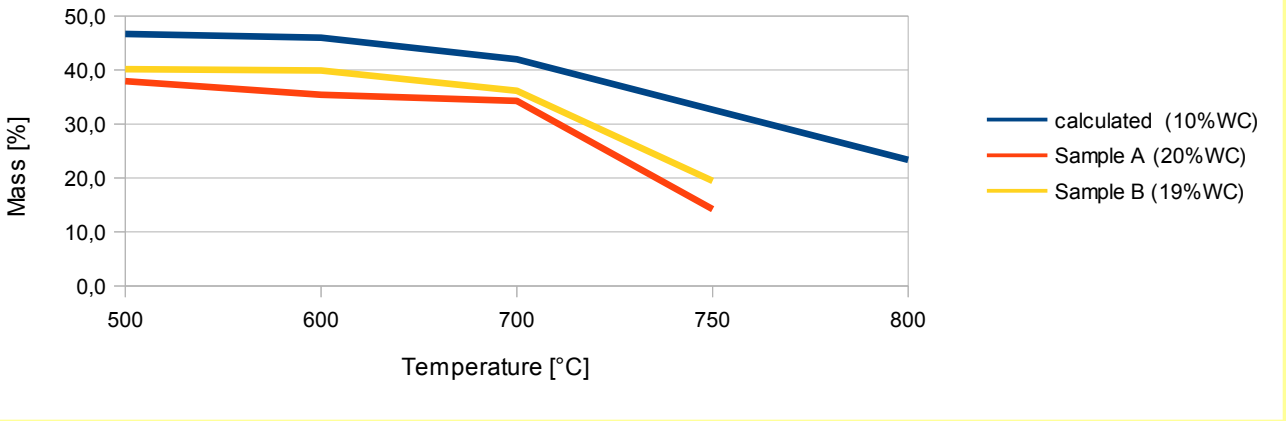
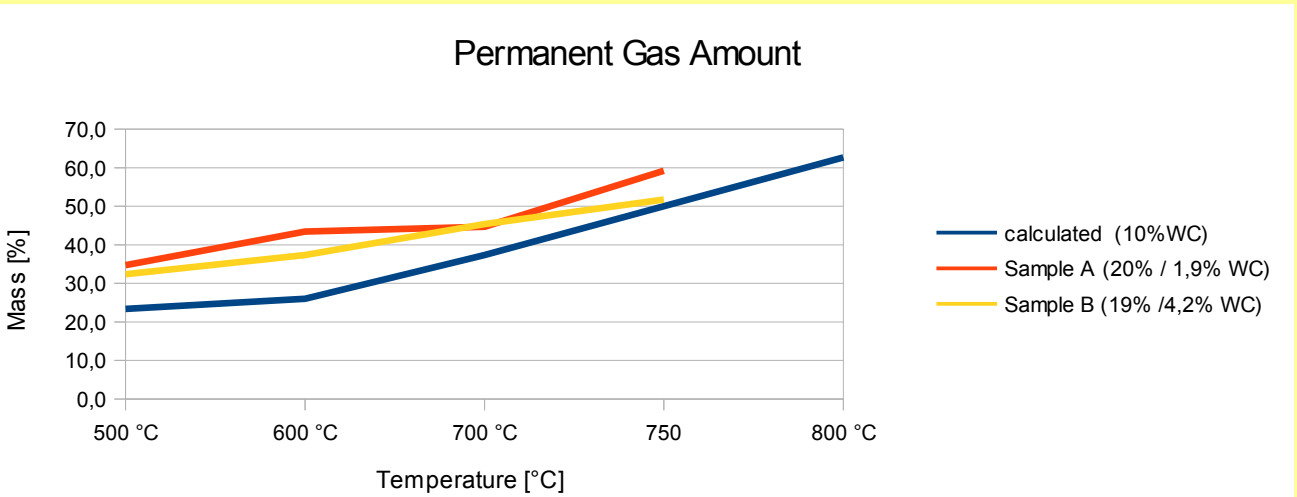
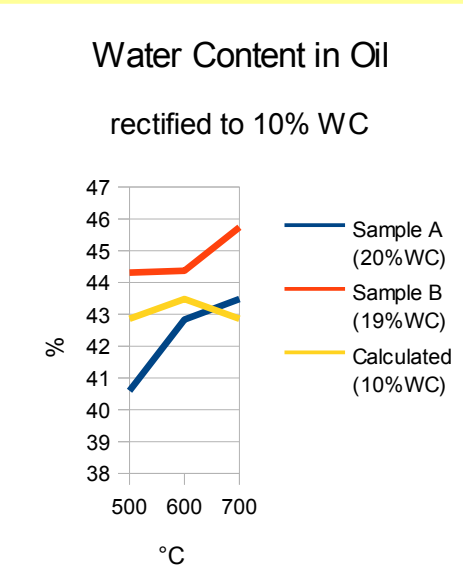
Testing results biomass







Please note:
Even trees of the same genus show different values according to place of location and year !

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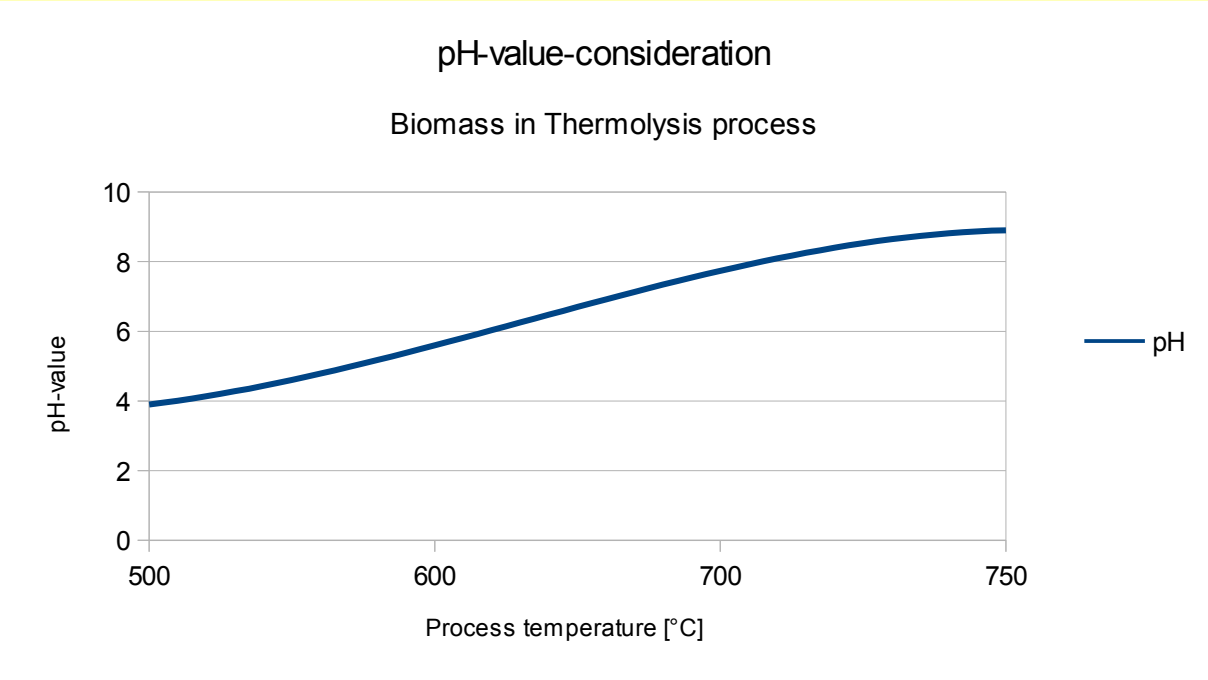
Pyrolysis oil = causing corrosion?



Please note:
The often quoted „nameless“ pyrolysis oil derives from Flash-Pyrolysis tests, which take place clearly below 500°C!

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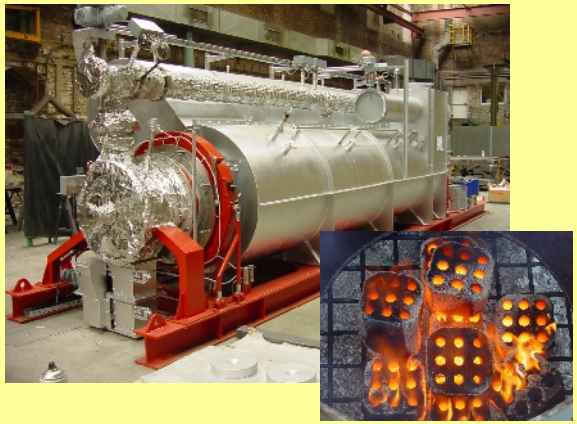
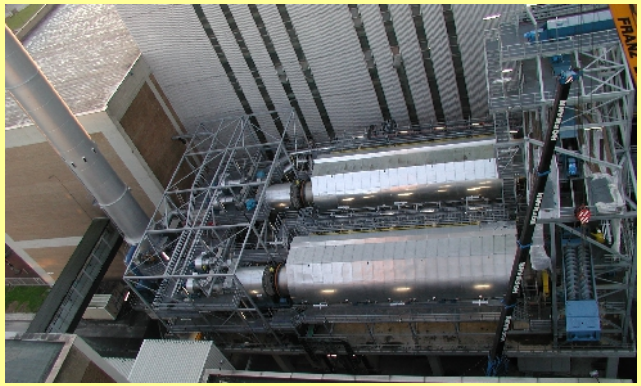
Rotary kiln thermolysis facilities

Rotary kiln-thermolysis is a proven and tested technology!





Cleaning of contaminated grounds, waste disposal, brown coal treatment, matured wood recycling, sewage sludge disposal, activated carbon regeneration, Alu-Fluff-Recycling, scrap tire disposal

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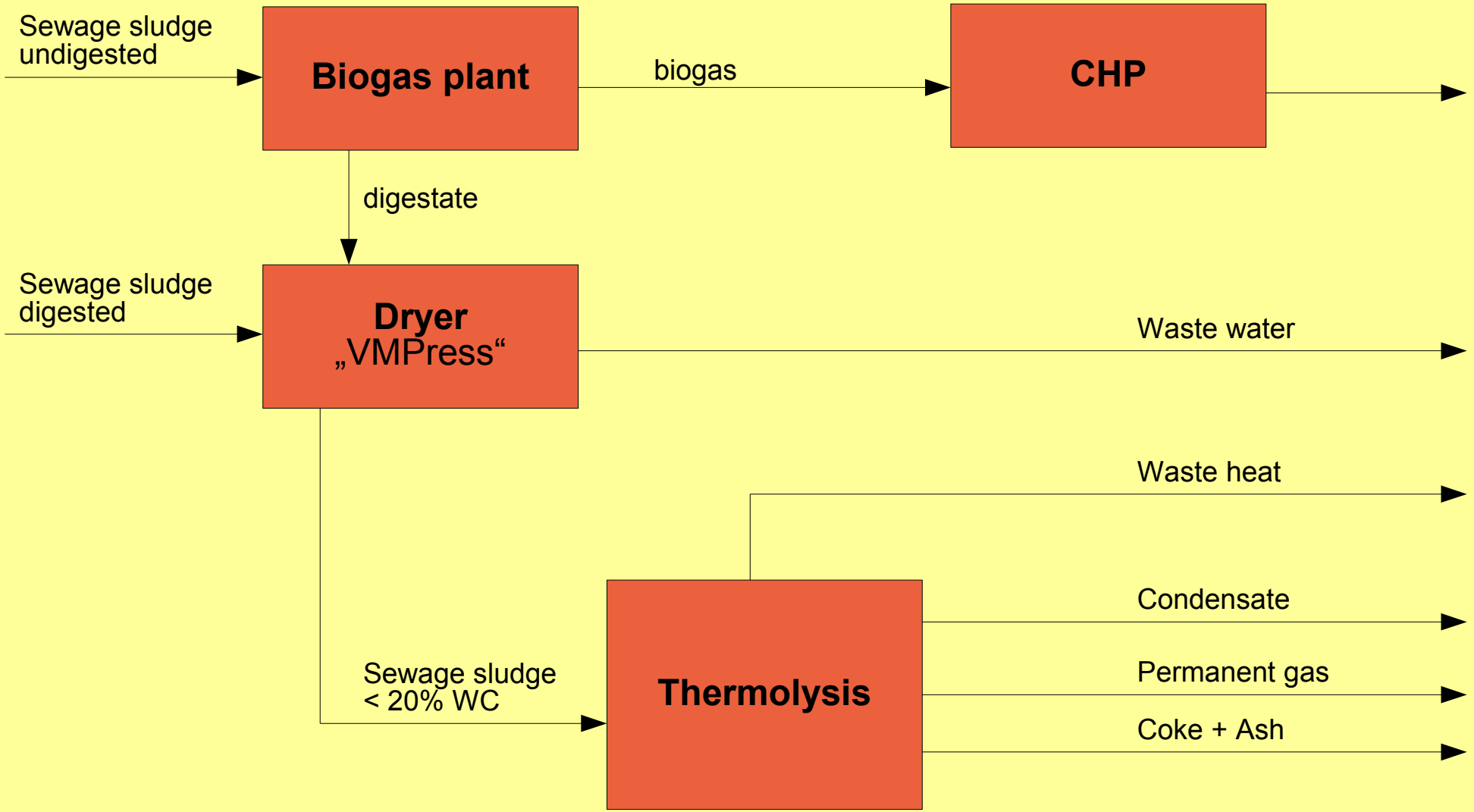
Sewage sludge recycling



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Drying facility „Backnang“

Data

Type	Bundled tubes-steam-dryer
Input	700 kg/h 60% WC
Vaporisation	400 kg/h
Medium	Sewage sludge
Energy demand	ca. 800 kW (Natural gas) **ca. 2.000 $kW_{thermal}$/t**
Space demand	200 m² (Container)
Commissioning	1995

Advantages:

- Closed steam cicuit
- Alternative for air-cooled condenser

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Dryer „Riela“

Data

Type	Feed-and-turn-dryer
Input	700 kg/h < 50% WC
Vaporisation	250 kg/h
Medium	various
Energy demand	ca. 400 kW Warmwater/Turbine off-gas **ca. 1.600 $kW_{thermal}$/t**
Space demand	trailer

Tested products:

Eggshells, fermentation residue, cereals, wood chips, sewage sludge, corn, bark mulch,clay, peat, pulp, sugar-beets shred

Advantages:

- Stationary: Use of the process waste heat
- Mobile: Use of the waste heat of an integrated CHP

By means of on-site drying reduction of transport weight of the recycling goods!

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Dryer „VMPress“

Data

Type	
Input	1.000 kg/h < 60% WC
Vaporisation	none
Medium	any (with structure)
Energy demand	**ca. 16 $kW_{electrical}$/t**
Space demand	40“ Container

Tested products:

Brown coal, domestic waste, sewage sludge (< 60%WC), food leftovers, plastic waste

Advantages:

Very little energy demand

Organical press sludge generally very suitable for biofermenter!

Drying down beneath 10% WC (plastics) and 20%WC (domestic waste) possible.

Organic bonded water can not be pressed out!
It is advisable to use a (partial) bio fermentation for cracking the cell structure, which besides generates enough bio gas …

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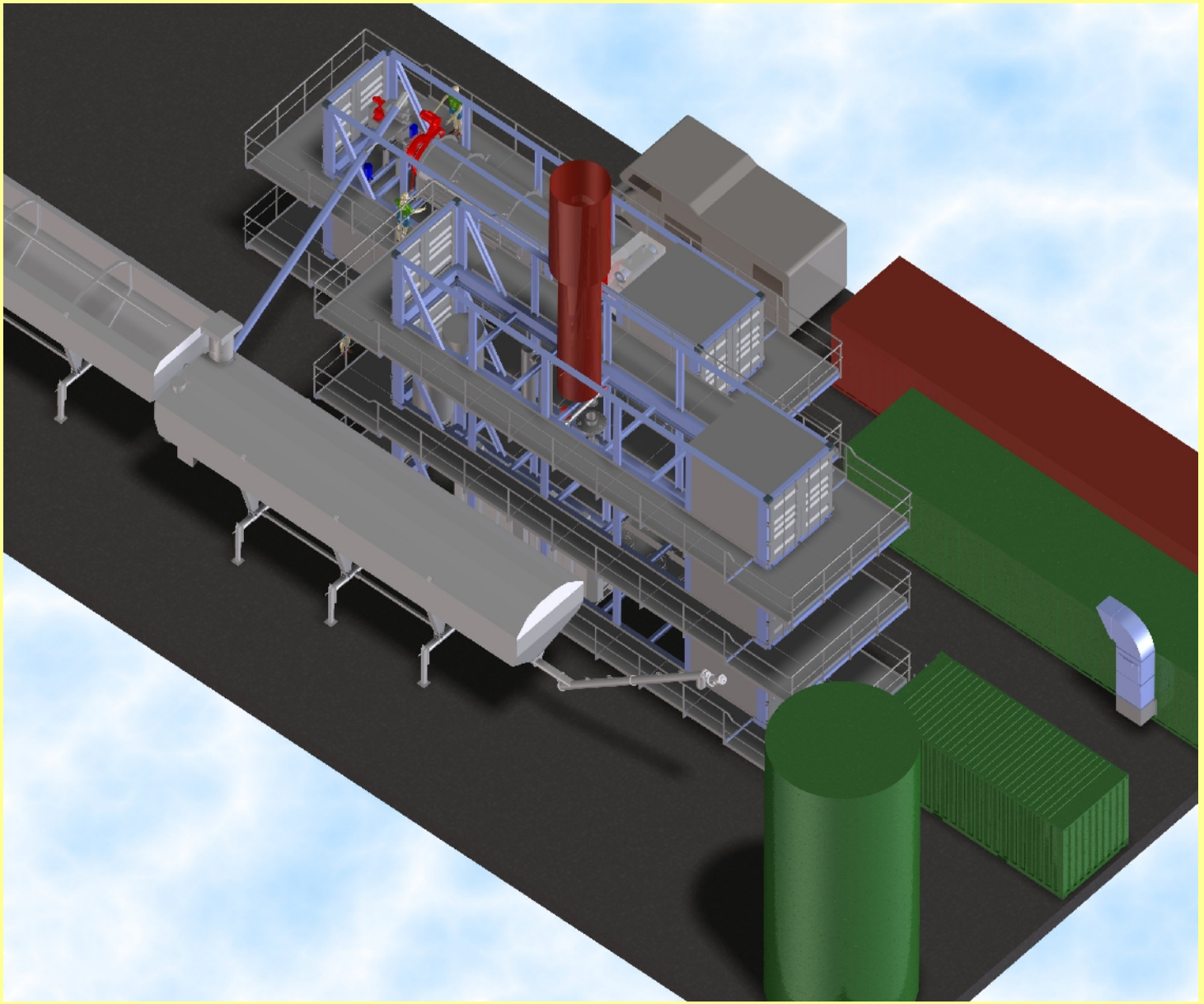
Plant type MINI-05



Data

completely mounted, Turnkey
EX WORKS

Throughput nom. 300 kg/h

Grain size < 20 mm
Spreading variable

Semimobile:
→ transposition within two-weeks'-time
→ for standard trucks

Remote control
Unmanned operation possible

Outdoor installation on a paved area respectively strip footings

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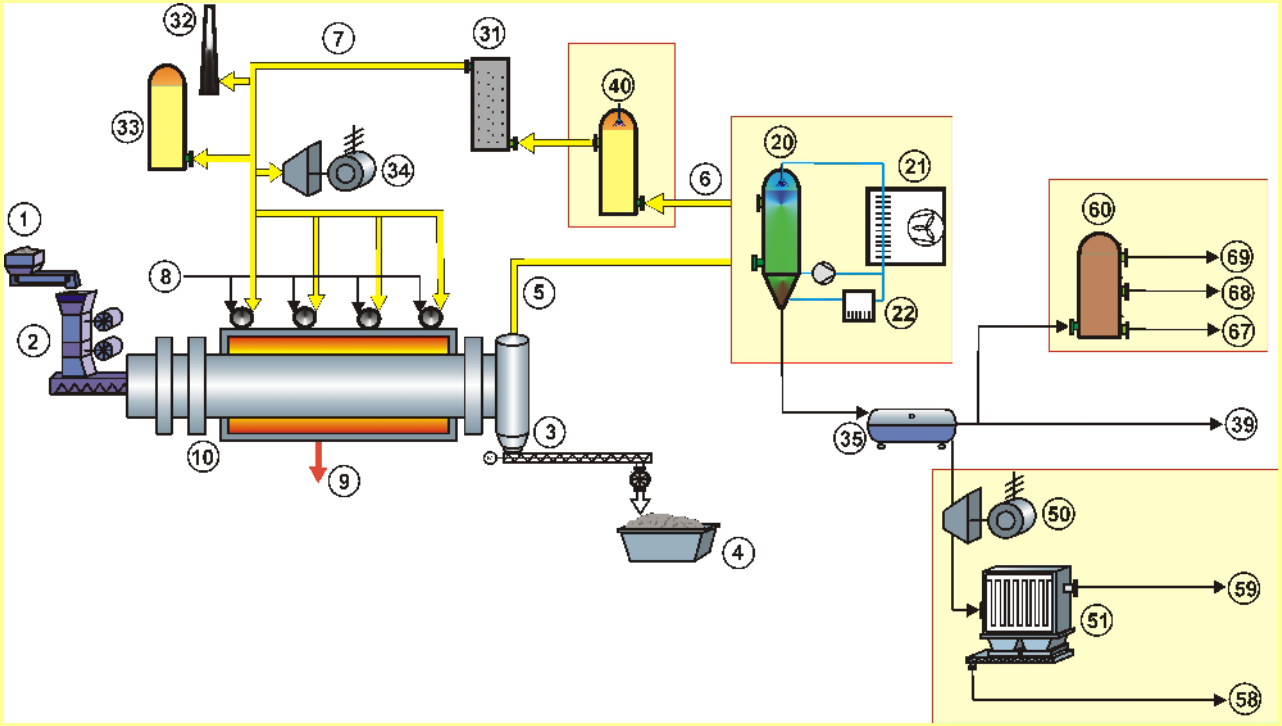
Flow diagram DGE-Process



1 Hopper
2 Input Sluice
3 Thermolyis coke hot
4 Thermolysis coke cold
5 Thermolysis raw gas
6 Permanent gas
7 Permanent gas, cleaned
8 GPL / natural gas
9 Off gas

10 Rotary Kiln Unit

20 Condensation
21 Cooler
22 Filter

31 Activated Carbon Filter
32 Emergency Flare
33 Gasometer
34 CHP

35 Raw oil tank
39 Thermolysis raw oil

40 De-sulphuring

50 Oil-bhpp
51 Off-gas filter
58 (Filter dust)
59 Off-gas

60 Distillation

67 Super fraction
68 Light oil fraction
69 Heavy oil fraction

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Impacts on the thermolysis process

Throughput

The rotary kiln dimensions limit the input quantity within the kiln.
But: By reducing the residence time, throughput can be increased!

Water content

"The dryer the better!"
Our rotary kiln plant achieves the highest efficiency with a totally dry input material.

Process parameters:

Temperatures
Atmosphere
Rotation speed
Filling level

Ratio Gas - Oil - Coke

Higher process temperatures generate a higher gas/oil-ratio.
Lower temperatures increase solid output.

Input quality

Hydrocarbons are cracked due to temperature.
Contained minerals and heavy metals remain unchanged.
(Exception Hg, Cd)

Product quality

The product obtained has process-related a higher percentage of minerals and heavy metals, as the product contained in the task.

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Advantages of rotary kiln thermolysis

Technical reasons

- Reactor temperature is clearly below slag melting point
- No nitrogen ballast (→ high calorofic value)
- Continuous mixing of the product
- Broad range of grain size
- Due to external gas utilisation the rotary kiln-reactor is „free adjustable“
- Due to process elimination of dioxines and furans
- Heavy metals remain predominantly in solids (→ less air emissions)

Economical reasons

- Any (dry) organic material can be used
- No problems with antibiotics (→ biogas plants)
- Withdrawal of potential CO2 from the cycle (→ CO2-certificates)

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Products instead of waste destruction!

Permanent gas
- Process heat for thermolysis process
- Process heat for drying processes
- Heat for cooling unit, sufficient for hotels (approx. 100 beds)
- Turbine fuel (→ power generation)

Condensate oil
- Fuel (→ power generation)
- Fuel for own devices
- Raw material for chemical industry

Solid /Coke + Minerals
- Soil conditioner (Terra Preta)
- Source for phosphate

CO2-Certificate (currently 15 €/to CO2)

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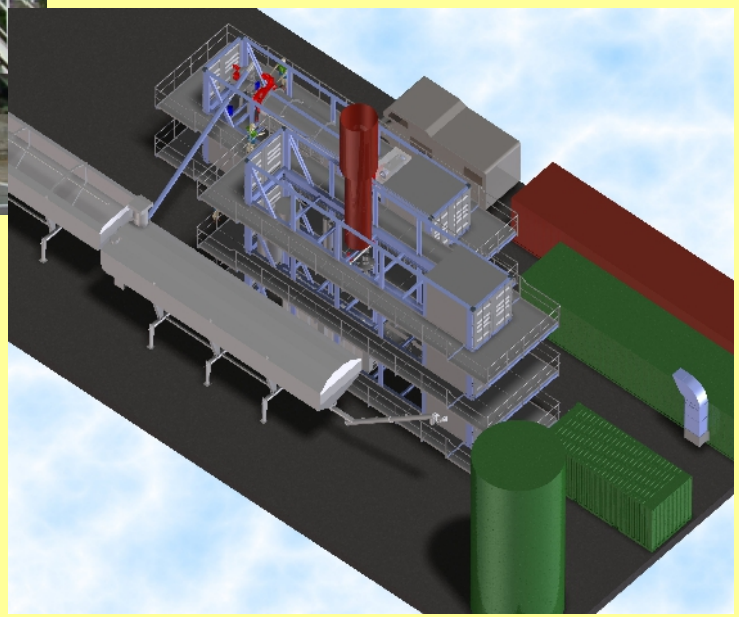
Generating products instead of waste destruction!

DGE-plant “MINI-05“

Data

Type	MINI-05
Input	< 300 kg/h < 10% WC
Medium	not sticky
Energy	ca. 50 $kW_{el.}$
Space demand	15 m x 25 m



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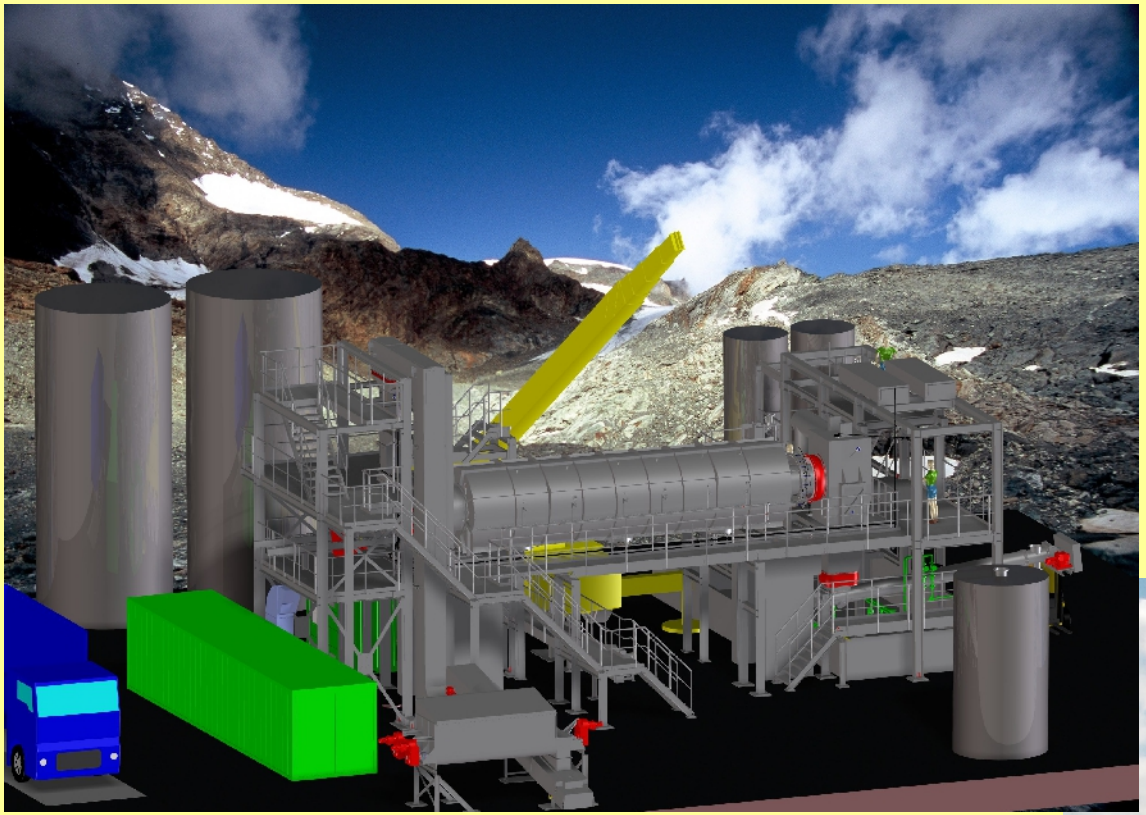
DGE-plant “MAXI-09“



Data

Type	MAXI-09
Input	1.000 kg/h < 10% WC
Medium	not sticky
Energie	ca. 300 $kW_{el.}$
Space demand	30 m x 50 m

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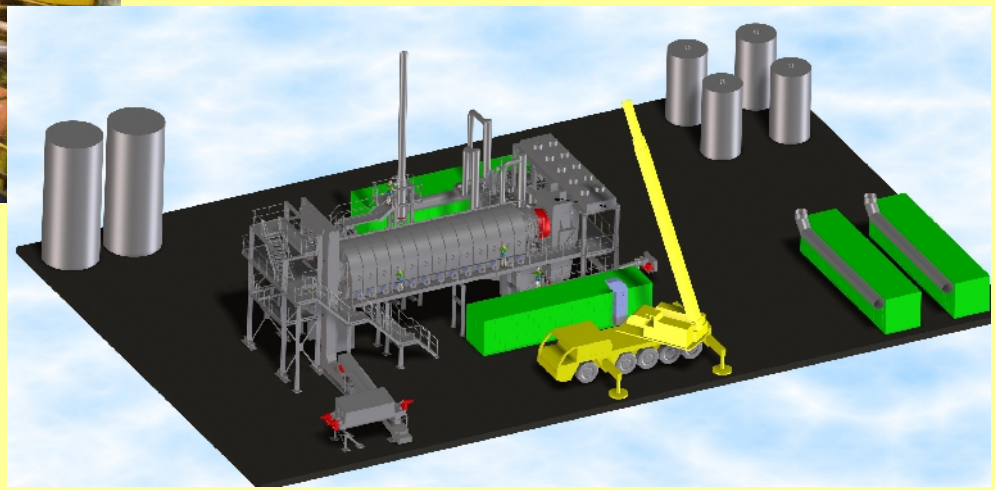
DGE-plant “MASTER-12“

Data

Type	MASTER-12
Input	2,000 kg/h < 10% WC
Medium	not sticky
Energy	ca. 400 $kW_{el.}$
Space demand	30 m x 60 m



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Power generation 1

Multi-fuel engines can use condensate oils of (almost) every quality.

Specification MTU 837 BA 500
- Manufacturer: MTU Mercedes Benz Manufacture
- Design: V-shape 90 Type
- Mode of operation: Four stroke precombustion chamber with mechanical charging
- Number of cylinders: 8
- Total cylinder capacity: 29900 ccm
- Nominal power: 460 bis 485 kW according to DIN at 2200/ min
- Max. torque: 2206 Nm at 1750/ min
- Idle-running speed: 600 bis 630 / min (motor at operating temperature)
- Full load speed: 2200/ min (nominal speed)
- Cooling type: watercirculation cooling
- Cooling liquid: 115 liter up to -20 °C frost-proof
- Engine oil pressure at operating temperature 6 bis 8 bar at 2200/ min
- Consumption 240g/KW at full load ca. 108 kg/h
- electrical effectiveness ca. 39%

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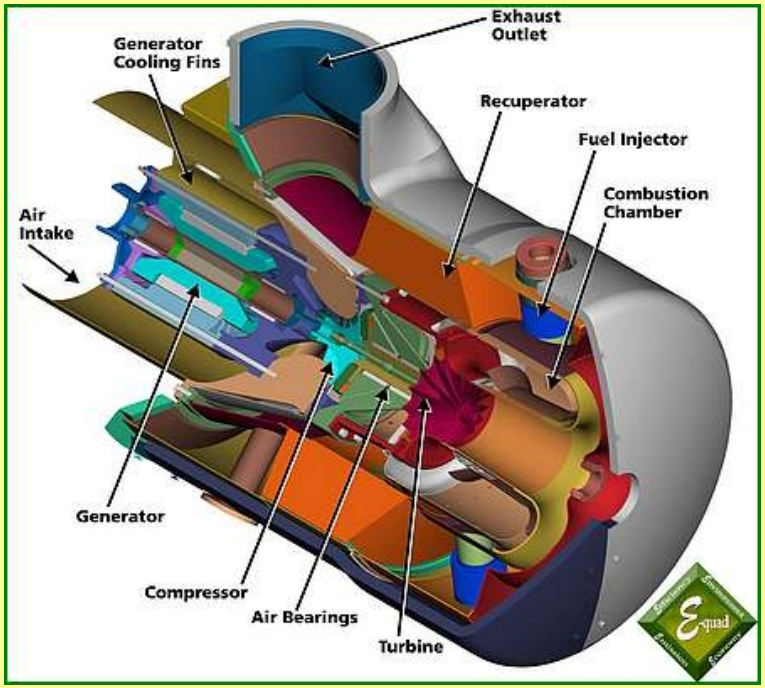
Power generation 2



In cooperation with the German distributor of Capstone, DGEngineering is developing the micro-turbine application for the use of condensate oil and permanent gas.

The following points are advantages of this technology:
- No lubricating oils that need to be replaced regularly
- Air bearings for wear-free, long life
- No pistons or abrasive components
- High control range from 10 – 100% which allows an energy generation on demand
- High off gas temperature (280°C), can be used for generating steam and drying

E-quad Power Systems

Specification C1000 (5x C200)

- Manufacturer: Capstone
- Type: Gas turbine
- Nominal power: 5x 200 $kW_{el.}$
- Full load speed: 61.000 rpm (Nominal speed)
- Cooling type: air
- Off-gas temperature: 280°C
- Cooling liquid: -
- Consumption ca. 300g/KW at full load ca. 300 kg/h
- electrical efectiveness ca. 33%

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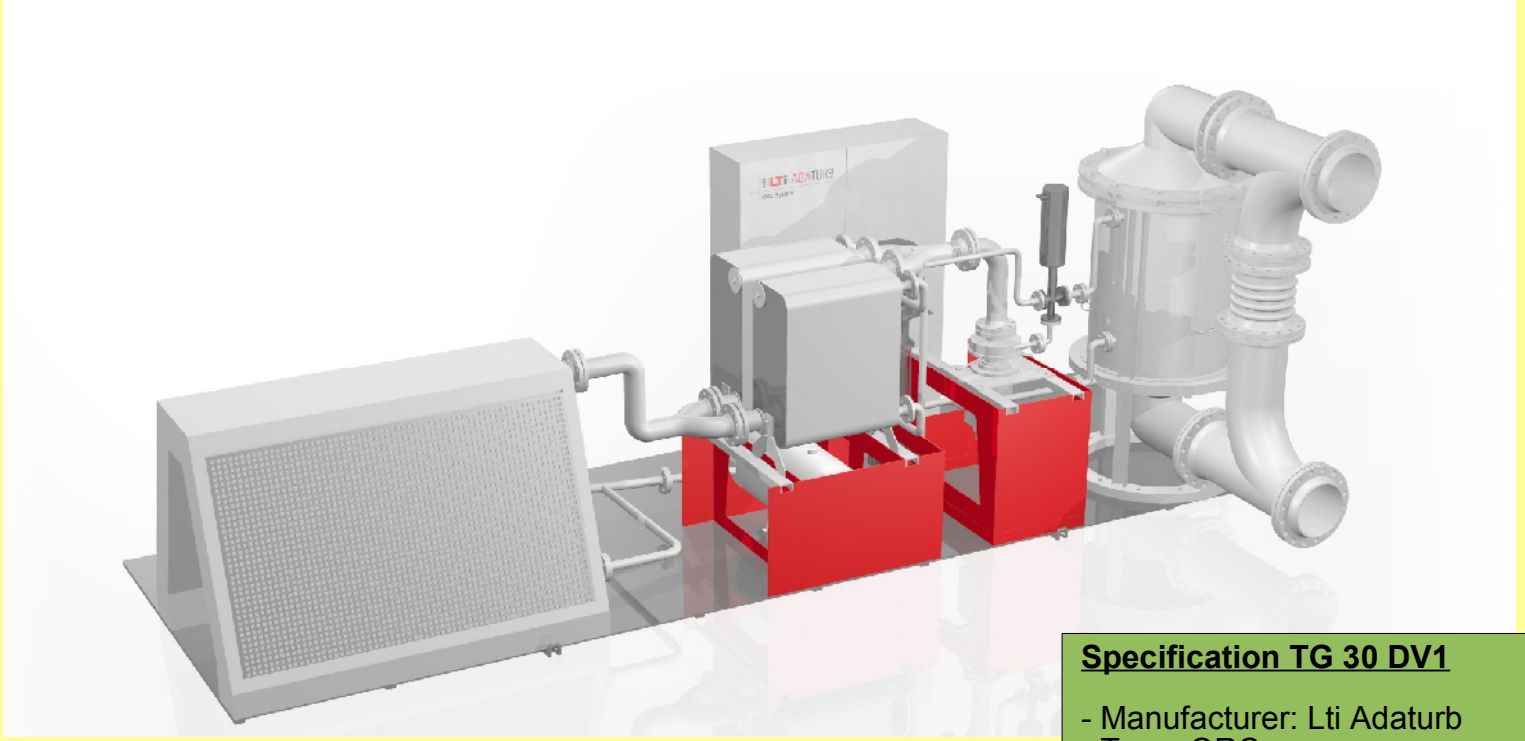
Power generation 3

By using a ORC-unit e.g. from company LTi Adaturb the off-heat of the process can also be used for power generation.

The cogeneration-of-heat-and-power-bonus is granted for plants with thermal and electrical usage, therewith you can receive this bonus for the completely used off-heat.



Specification TG 30 DV1

- Manufacturer: Lti Adaturb
- Type: ORC
- Nominal power: 30 $kW_{el.}$
- Cooling type: air
- Consumption off-gas min. 180 kW at 470°C
- Electrical effectiveness: ca. 17%

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Scope of power generation

MINI-05		example	digested sludge		undigested sludge	
		11.0 MJ/kg	9.0 MJ/kg	12.0 MJ/kg	11.0 MJ/kg	17.0 MJ/kg
Input	300 kg/h	3,300 MJ/h	2,700 MJ/h	3,600 MJ/h	3,300 MJ/h	5,100 MJ/h
Thermolysis gas energy	78%	715 kW	585 kW	780 kW	715 kW	1,105 kW
Required process energy		200 kW	200 kW	200 kW	200 kW	200 kW
Usable energy		515 kW	385 kW	580 kW	515 kW	905 kW
max. poss. electr. en.	**33%**	**170 kW**	**127 kW**	**191 kW**	**170 kW**	**299 kW**

MAXI-09		example	digested sludge		undigested sludge	
		11.0 MJ/kg	9.0 MJ/kg	12.0 MJ/kg	11.0 MJ/kg	17.0 MJ/kg
Input	1,000 kg/h	11,000 MJ/h	9,000 MJ/h	12,000 MJ/h	11,000 MJ/h	17,000 MJ/h
Thermolysis gas energy	78%	2,383 kW	1,950 kW	2,600 kW	2,383 kW	3,683 kW
Required process energy		1,000 kW	1,000 kW	1,000 kW	1,000 kW	1,000 kW
Usable energy		1,383 kW	950 kW	1,600 kW	1,383 kW	2,683 kW
max.poss. electr. en.	**33%**	**457 kW**	**314 kW**	**528 kW**	**457 kW**	**886 kW**

MASTER-12		example	digested sludge		undigested sludge	
		11.0 MJ/kg	9.0 MJ/kg	12.0 MJ/kg	11.0 MJ/kg	17.0 MJ/kg
Input	2,000 kg/h	22,000 MJ/h	18,000 MJ/h	24,000 MJ/h	22,000 MJ/h	34,000 MJ/h
Thermolysis gas energy	78%	4,767 kW	3,900 kW	5,200 kW	4,767 kW	7,367 kW
Required process energy		1,500 kW	1,500 kW	1,500 kW	1,500 kW	1,500 kW
Usable energy		3,267 kW	2,400 kW	3,700 kW	3,267 kW	5,867 kW
max. poss. electr. en.	**33%**	**1,078 kW**	**792 kW**	**1,221 kW**	**1,078 kW**	**1,936 kW**

Important: The actual generated energy depends on the input material, the equipment used and the operated process parameters!

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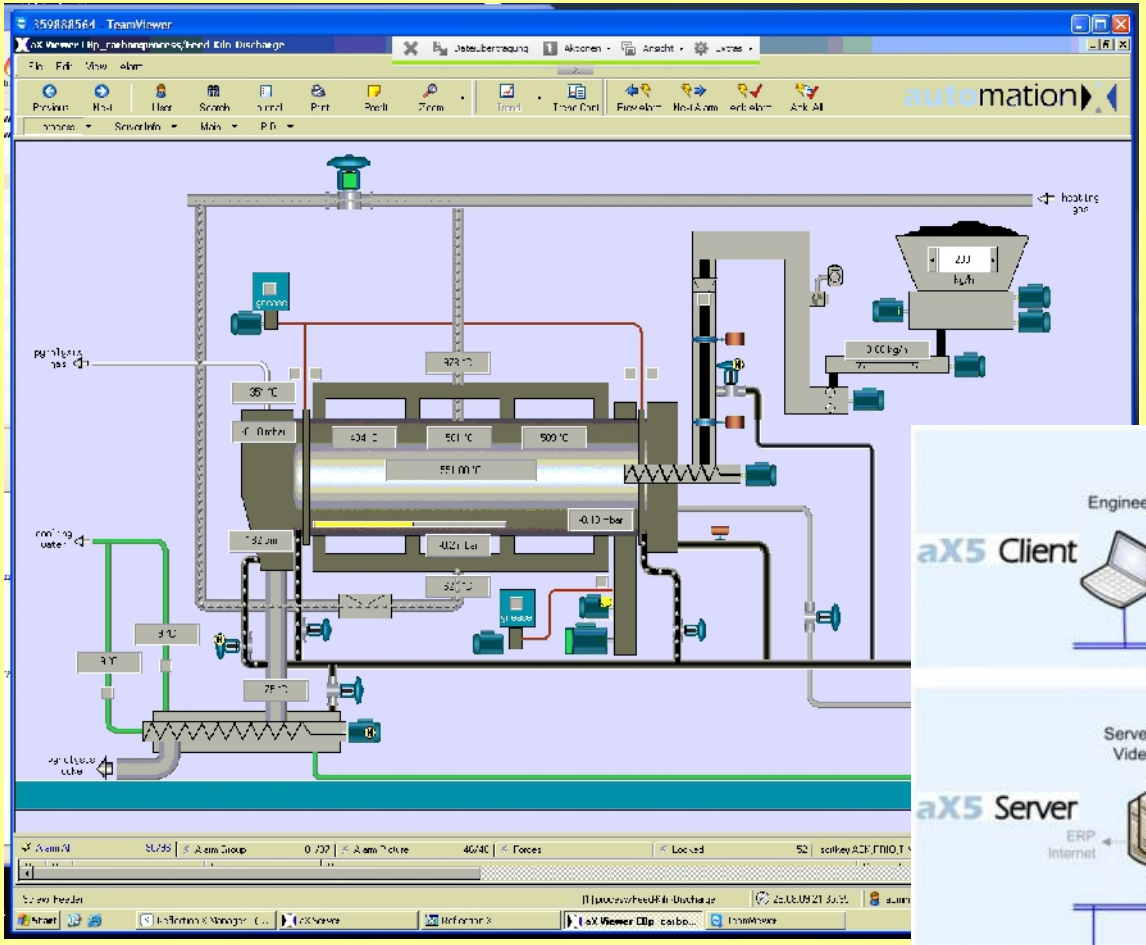
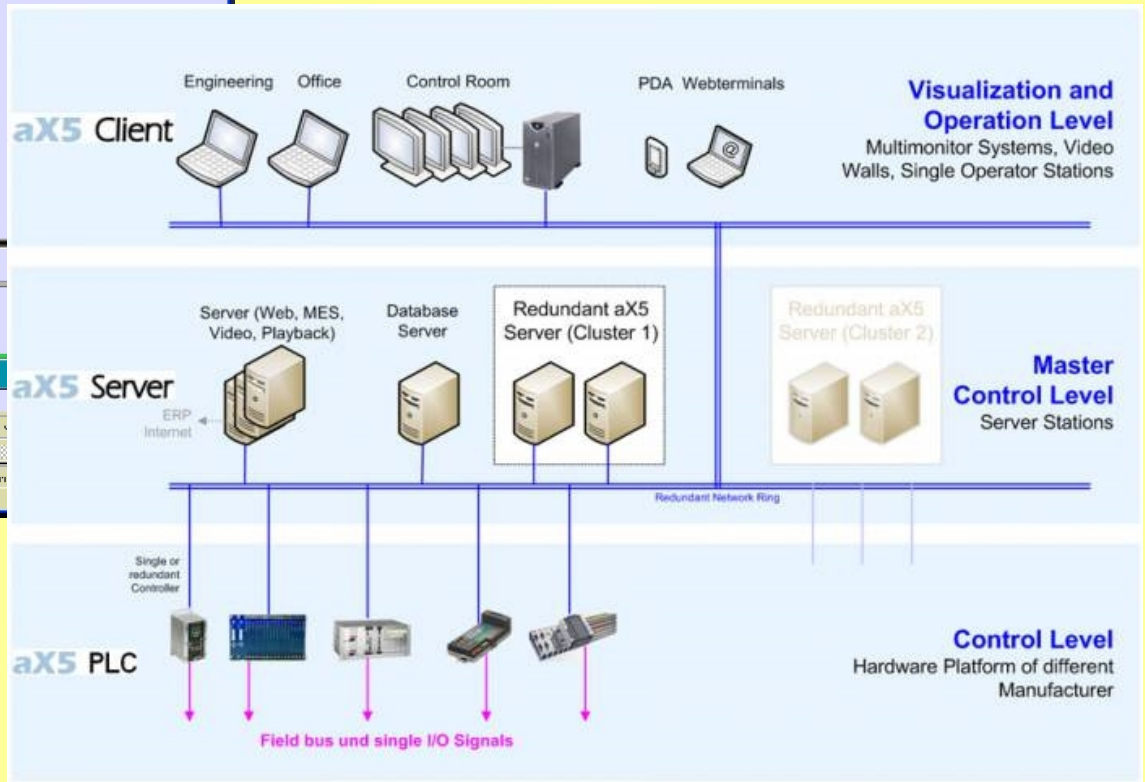
Prozeß-Leit-System



The AutomationX is an industrially successful management and control system.

The plants are operated usually by local staff.

For optimising or troubleshooting a remote access via a secure VPN-line via Internet.



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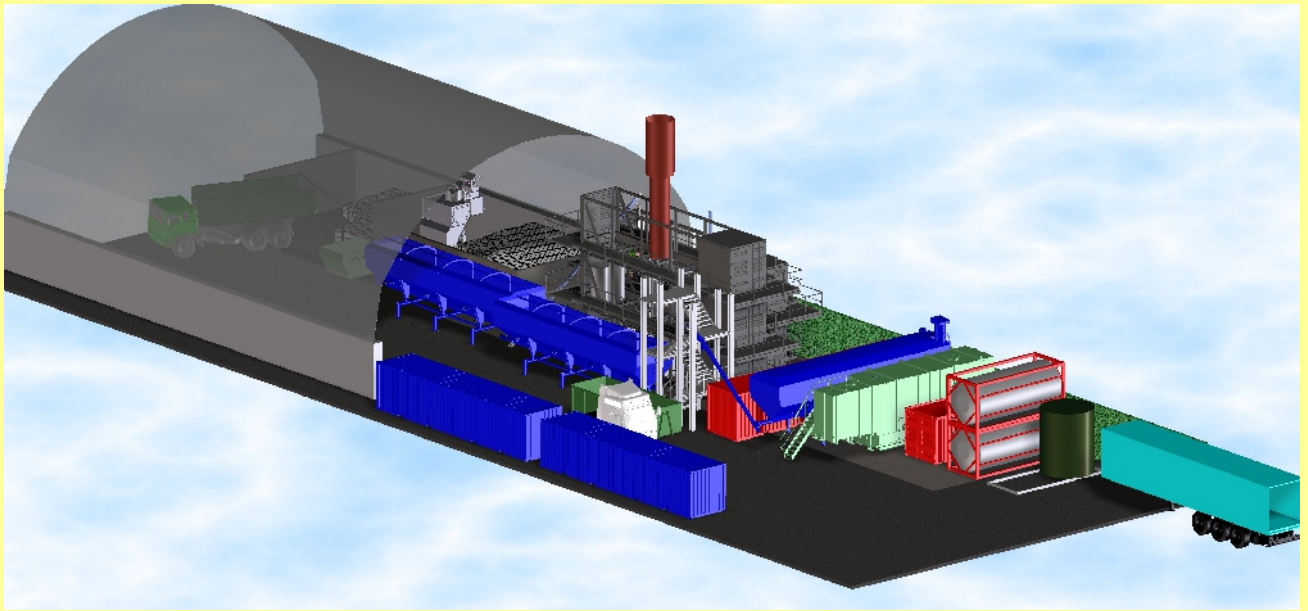
Possible applications for MINI-05



The semi-mobile plant MINI-05 can be used reasonable in cases where integrated heating concepts are needed.

We see possible following appliances:

- Drying wood chips (about 5,000 metric tons W50)
- Leisure
- Food industry (about 500kg / h steam)
- Villages (about 80 - 100 residential units)
- Greenhouses (warm air quantity 800 kW)

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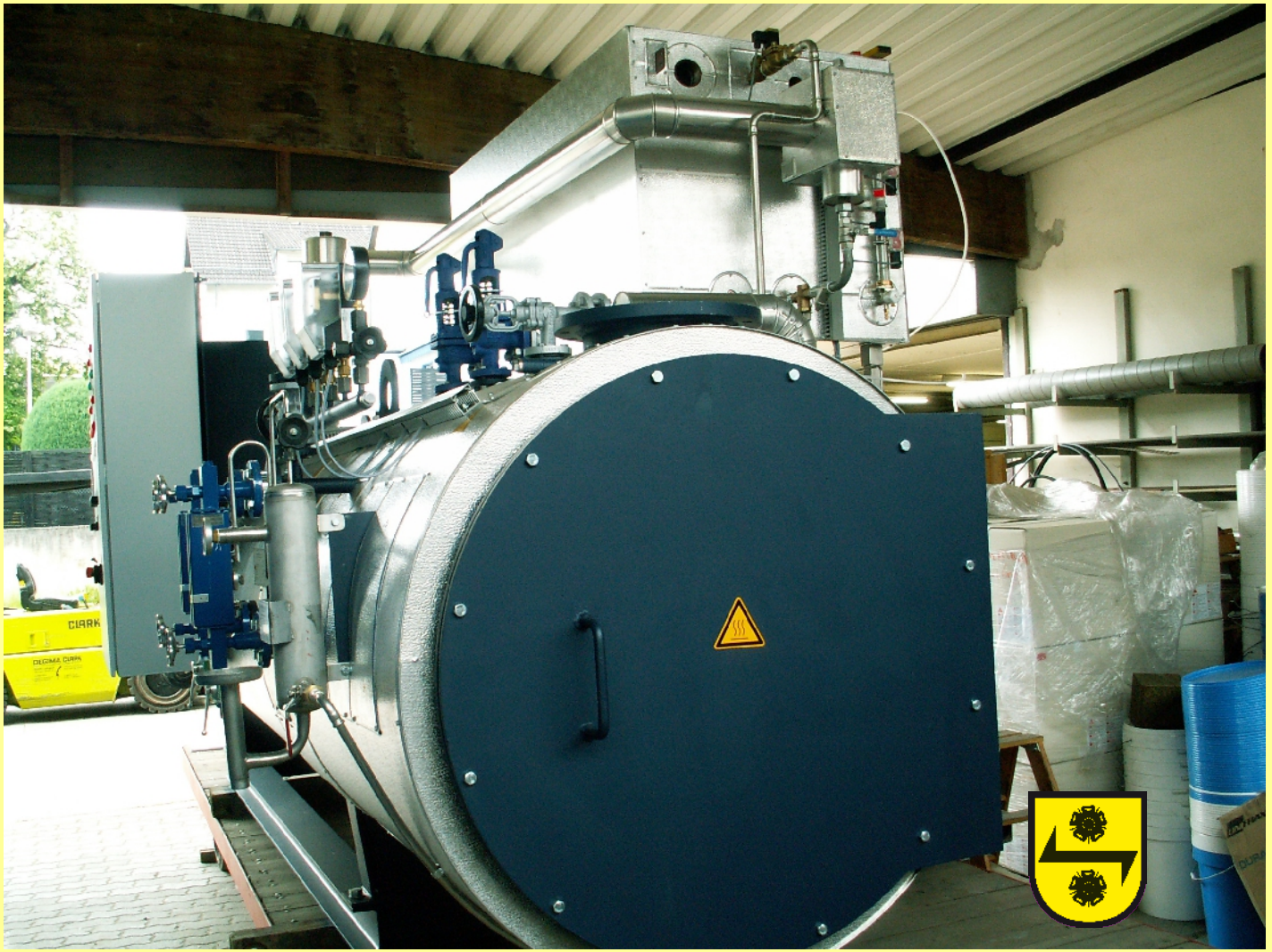
T-Kit: steam / warm water



Off-heat usage for steam- respectively warm water generation.

Food industry, laundry

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T-Kit: Cooling

Photo by Katharina Wieland Müller @ PIXELIO

Off-heat usage for air conditioning of buildings.
With MIN-05I: hotels with 100 beds or cold store up to -4°C

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T-Kit: Cool-Churns

Regenerationsequipment
Regeneration equipment

Heizmanschette
2-3 CoolChurns / Batch

Heating Collar
2-3 CoolChurns / Batch

Gasbetriebener oder elektrischer Ofen
15-32 CoolChurns / Batch

Gas driven or electrical oven
15-32 CoolChurns / Batch

Regenerationsequipment
Regeneration equipment

Kontinuierlicher gasbetriebener Ofen
60-120 CoolChurns / h

Continuous gas driven oven
60-120 CoolChurns / h

Cool-System KEG GmbH
Flössaustr. 7
D - 90763 Fürth / Bayern
Tel.: +49 911 25 30 160
Fax: +49 911 25 30 159
http://www.coolsystem.de
http://www.coolchurn.com
Email: info@coolsystem.de

CoolChurn® is a registered brandname of COOLSYSTEM®

CoolChurn®

- die erste selbstkühlende Kanne / Container
- the first selfchilling churn / container

- **Inhalt: 7,5 - 20,0l**
  Content: 7,5 – 20,0l
- **Kühlkapazität: t max. 25°K**
  Cooling capacity: t max. 25°K
- **Dauer der Kühlung: bis zu 24 h**
  Duration of cooling: up to 24h
- **Stahlqualität: 1.4301**
  Steel quality: AISI 304

Off-heat usage for regeneration of selfchilling barrels & churns

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More applications...

- Wood
  Wood chips
  Wood pellets
- Strawpellets
- Bamboo
- Miscanthus
- Pet manure
  Camel manure
- Hazelnut shells
  Cococnut shells
  Palmoil shells
- Waste wood
- Plastic Chips
- Sewage sludge
- Oil sludge
  (gives clean soil
  from contaminated areas)
- Tetra Pack Fluff
  (generates aluminium chips)
- Scrap tires

Mixing of the products is generally possible!

But economically rarely reasonable!

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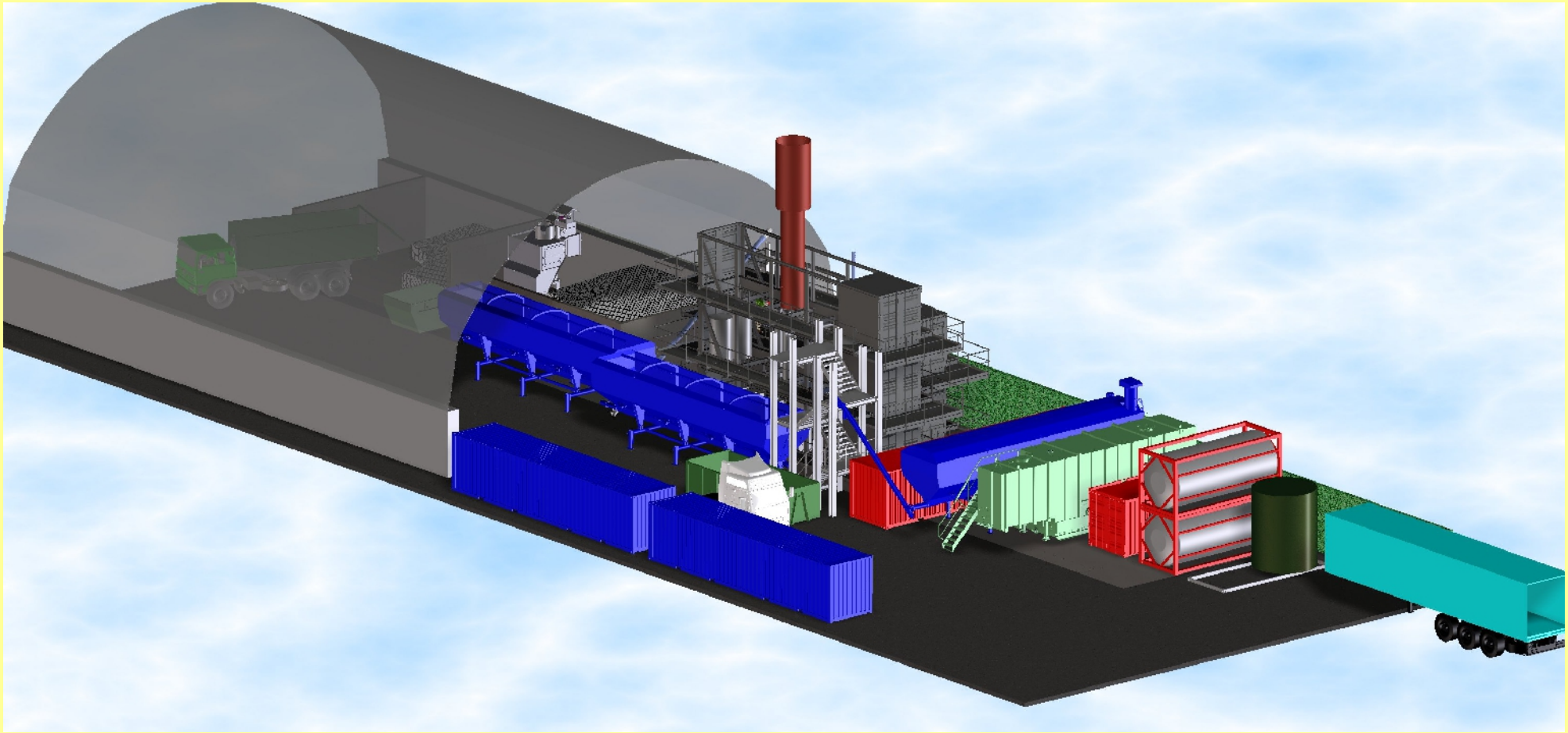
Thank you!



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