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Our thermolysis technology converts biomass into (storable) energy!

Biomass = waste ?

ENERGY EFFICIENCY made in Germany

Photo: by Helga @ PIXELIO

Our thermolysis technology converts biomass into (storable) energy!

Biomass → Energy + Product!

Today biomass is an important resource. Therefore it should be used reasonably and should not just be composted or burnt.

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 operation of our standardised plant concepts.

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 biomass-recycling

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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.
(Straw → Dioxine)

During **torrefication** parts of volatile components are driven off at low temperartures (i.e. 250-300°C). As a result you receive a product with a higher heating value at reduced volume. Depending on process control energy has to be added.

During **thermolysis** all volatile compounds are driven off and most of the organic structures are set out, to get a preferably high ratio 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.

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, feedstock,energy source

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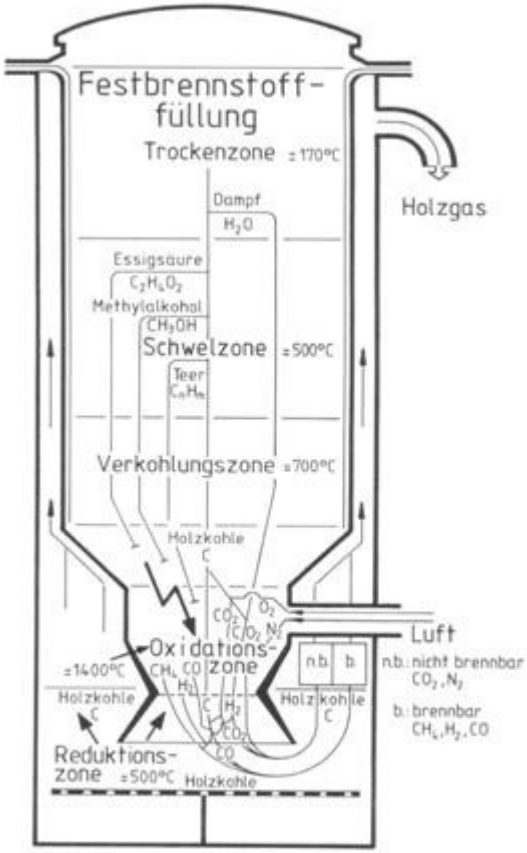
Fundamentals



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

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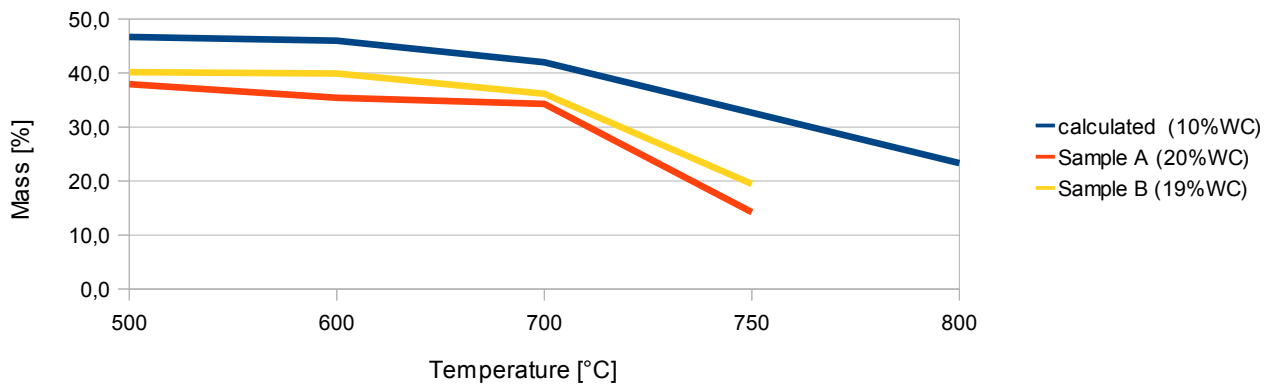
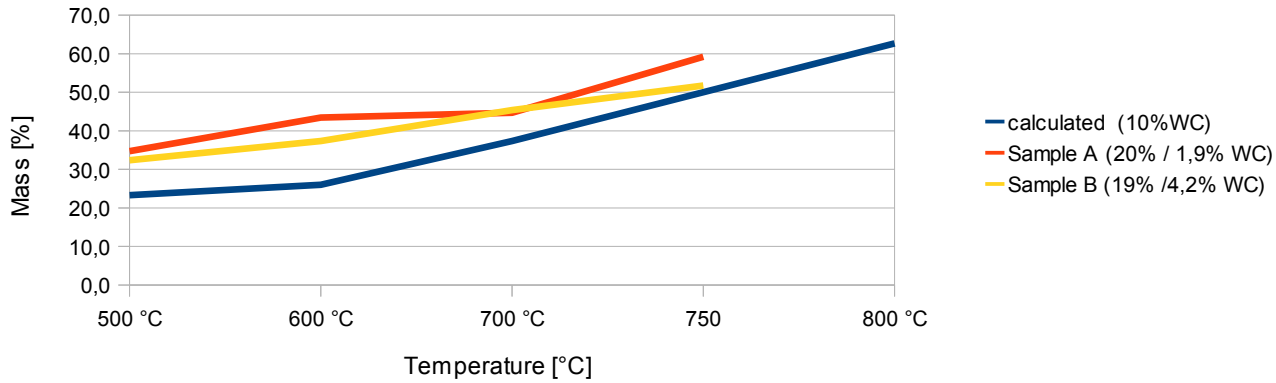
Oil (+water) amount

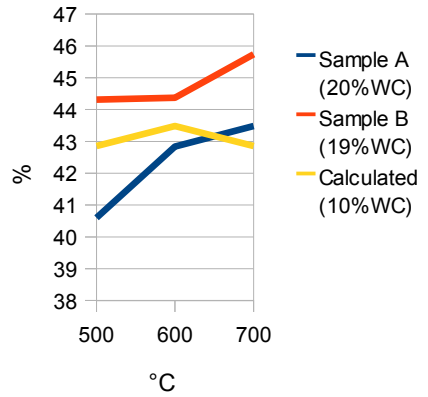


Permanent Gas Amount



Water Content in Oil

rectified to 10% WC



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

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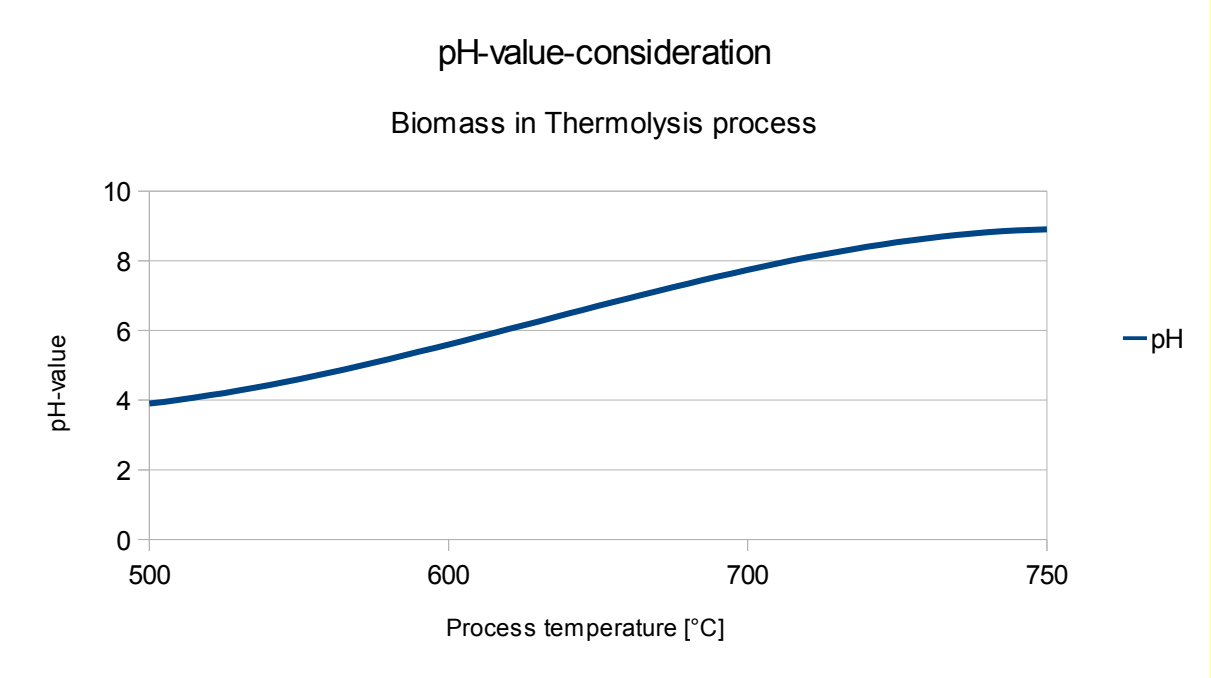
Pyrolysis oil = causing corrosion?



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 plants

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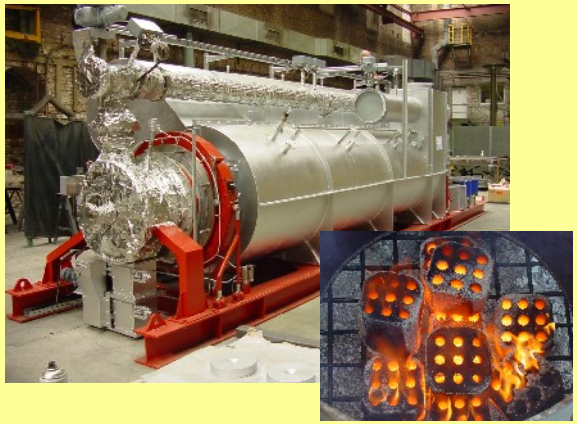
Rotary kiln-thermolysis is a proven and tested technology!



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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Clean Coal Project - Philippines

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Carbonisation with MINI-05

Input:	brown coal	25% WC
Output:	coke	10% VM

Target:

- ✓ Smokeless cooking
- ✓ Simple ignition with a pocket lighter
- ✓ Heat for 2 to 3 hours

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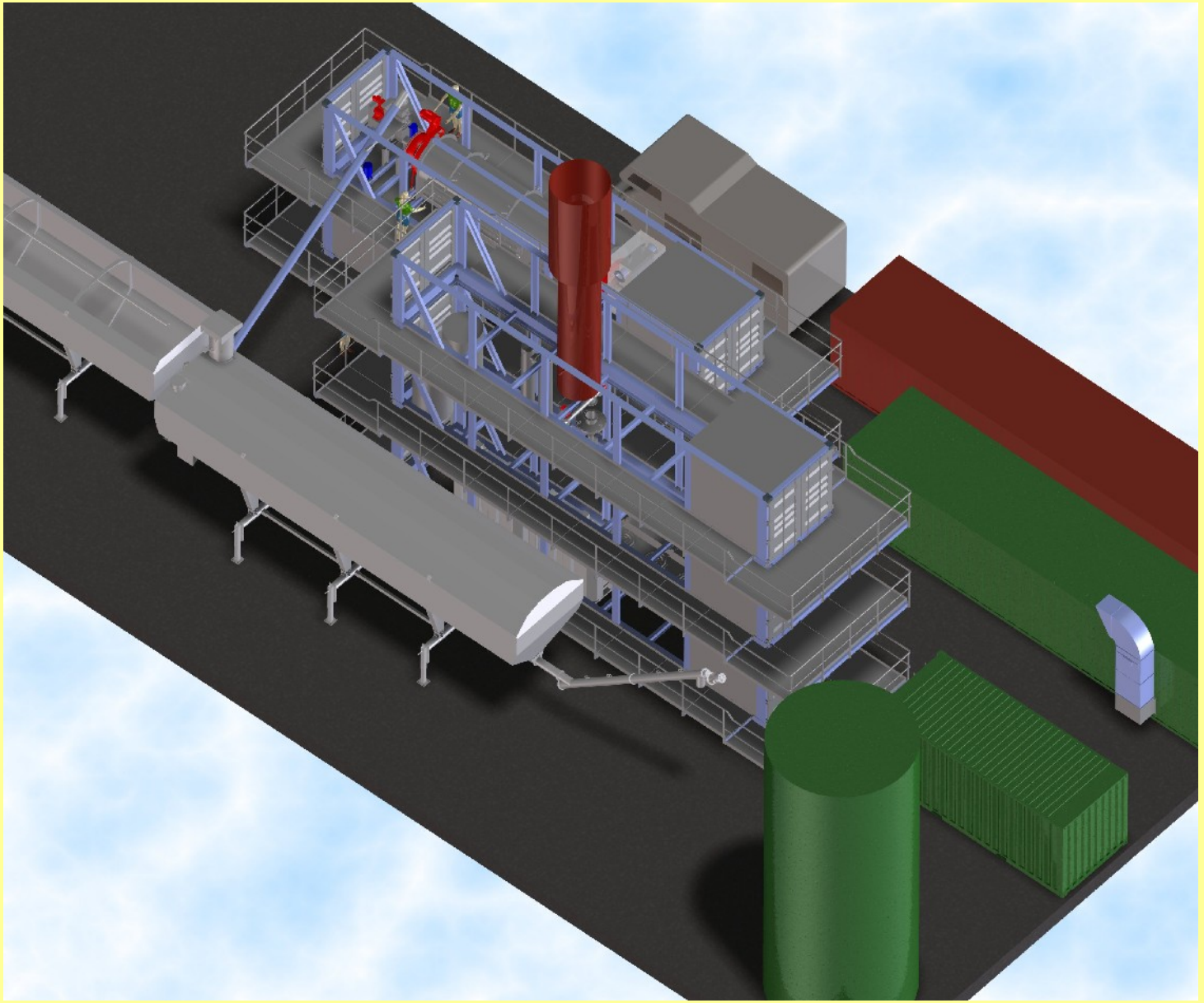
Plant type MINI-05



Data

Completely assembled, turnkey EXW

Throughput nominal 300 kg/h

Grain size < 20 mm
spreading variable

Semimobile:
→ Removal within 2 weeks
→ for standard trucks

Remote controllable
Operation without personell possible

Outdoor erection on concrete ground respectively, strip foundation

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Biomass recycling

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Biomass

Pre-dryer
(mobile)
e.g. “Riela”

Waste heat

Turbine
“C200”

Biomass

dryer
(local)
e.g. „GGM“

Waste heat

ORC

Biomass <10%
WC

Thermolysis plant

Condensate oil

Permanent gas

Activation

Active coal

Coke + Ashes

Briquetting

Briquettes

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Mobile dryer „Riela“

Data

Type	Feed-and-turn-dryer
Input	700 kg/h < 50% WC
Vaporisation	250 kg/h
Medium	different
Energy demand	approx. 400 kW Warm water/Turbine off-gas
Required space	trailer

Tested products:

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

Advantages:

- Stationary: Using of thermolysis waste heat
- Mobile: Using of waste heat from an integrated Oil-Micro-Turbine

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

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Dryer „GGM“

Data

Type	CDT 500
Input	700 kg/h < 50% WC
Vaporization	440 kg/h
Medium	wood chip
Energy demand	approx. 500 kW Hot water / turbine exhaust
Required space	2 x 40“ Container

Advantages:

- Utilisation of the thermolysis waste-heat
- Especially for wood-chip drying

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Dryer „VMPress“

Tested products:

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

Data

Type	
Input	1.000 kg/h < 60% WC
Vaporization	no
Medium	any (with structure)
Energy demand	approx.16 $kW_{electrical}$/t
Required space	40“ Container

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 sufficient bio gas …

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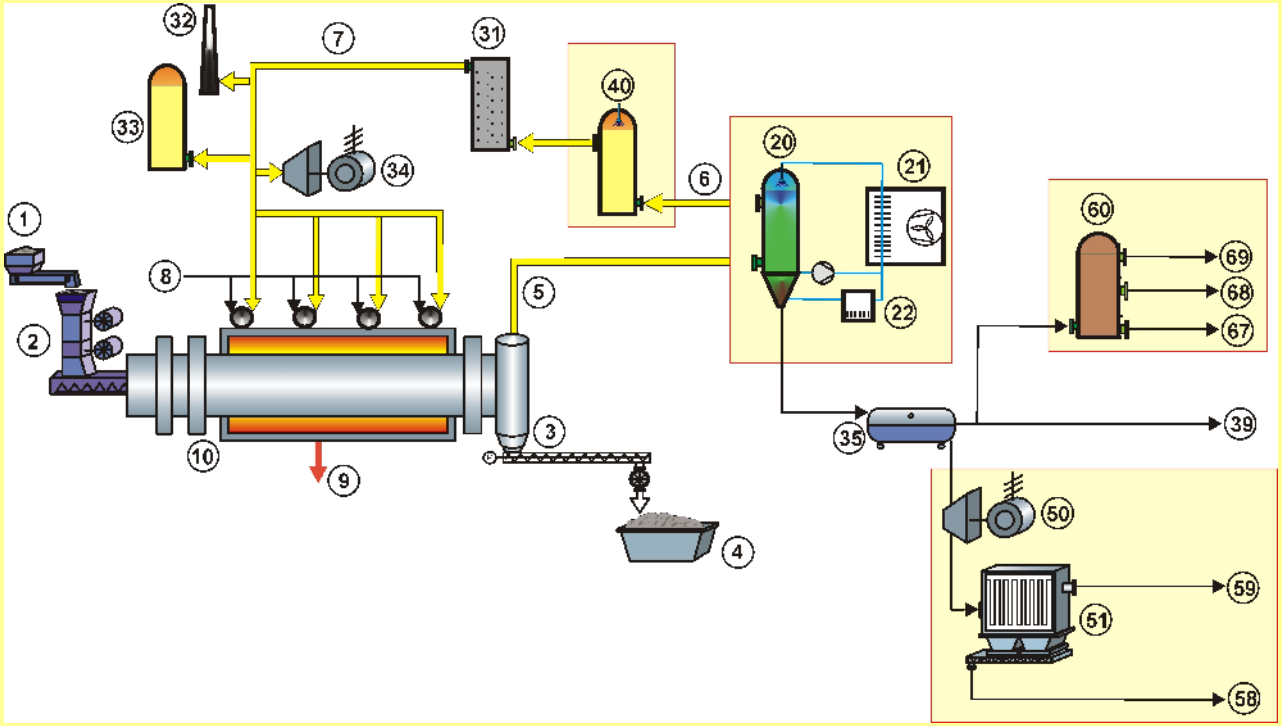
DGE – Flow diagram thermolysis



1 Hopper
2 Input sluice
3 Thermolysis-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 oil, raw

40 Desulphuring

50 Oil-CHP
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

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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)

Output 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 heating 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

Economical reasons

- Any (dry) organic material can be used
- No problems with antibiotics (→ biogas plants)
- Disposal of problematical biomasses (e.g. horse manure, mouldy)
- Withdrawal of potential CO2 from the cycle (→ CO2-certificates)

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Products instead of waste

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

Condensate oil (current price for raw oil 500 €/to)
- Fuel (→ power generation)
- Fuel for own devices
- Feddstock for chemical industry

Coke (due to quality 150 – 2.500 €/to)
- Colourant for the cement industry (150 €/to)
- Substitute for carbon black in chemical industry (powdered approx. 500 €/to)
- Substitue for coke in metallurgical industry
- Basis for activated carbon production (activated 700 €/to and more)
- Soil conditioner (Terra Preta)
- Bio barbecue coal

CO2-Certificate (current price 15 €/to CO2)

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MINI-05 with biomass

input: biomass 300kg/h = 1.440 kW

Permanent gas
- 100 kW process heat for own process
- 100 kW process heat for drying processes or
- heat for cooling unit
- 30 kW fuel (→ power generation)

Condensate oil (460 kW / 80 kg/h)
- Fuel (→ power generation)
- Fuel for own devices
- Chemical industry

Coke (750 kW / 90 kg/h
- Substitute for carbon black in the chemical industry
- Substitue for coke in the metallurgical industry
- Basis for activated carbon production
- Soil conditioner (→ Terra Preta)
- Bio-barbeque coal

CO2-certificate (CO2-reduction 1.800 to/a)
Equates to approx. 160 average citizens

Please note: Especially biomasses have wild variations!

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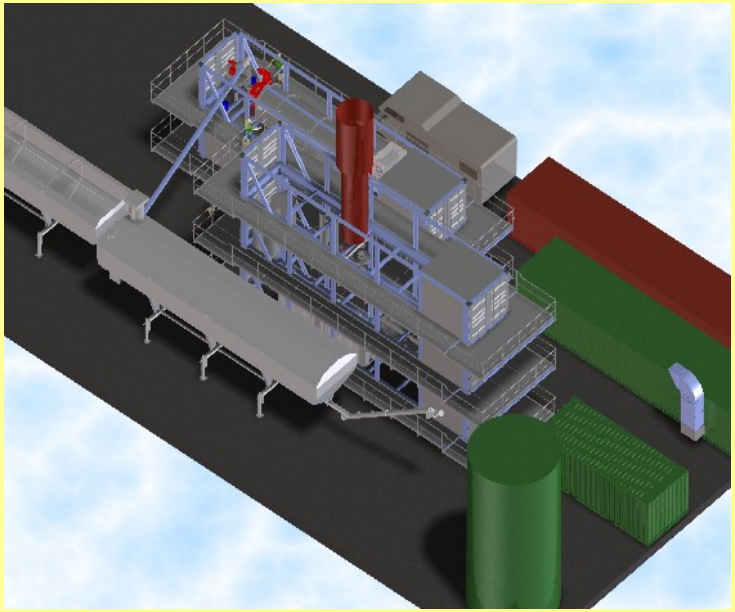
DGE-plant „MINI-05“

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



MINI-05 throughput		300 kg/h	13.20 MJ/kg	3,960 MJ/h	1,100 kW
Permanent gas	39%	117 kg/h	*11.20 MJ/kg*	*1,310 MJ/h*	364 kW
Pyrolyseöl	39%	117 kg/h	16.00 MJ/kg	1,872 MJ/h	520 kW
Pyrolysekoks	22%	66 kg/h	11.79 MJ/kg	778 MJ/h	216 kW

The ratio oil / gas has to be checked!
The values will vary due to input material!

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DGE-plant „MAXI-09“

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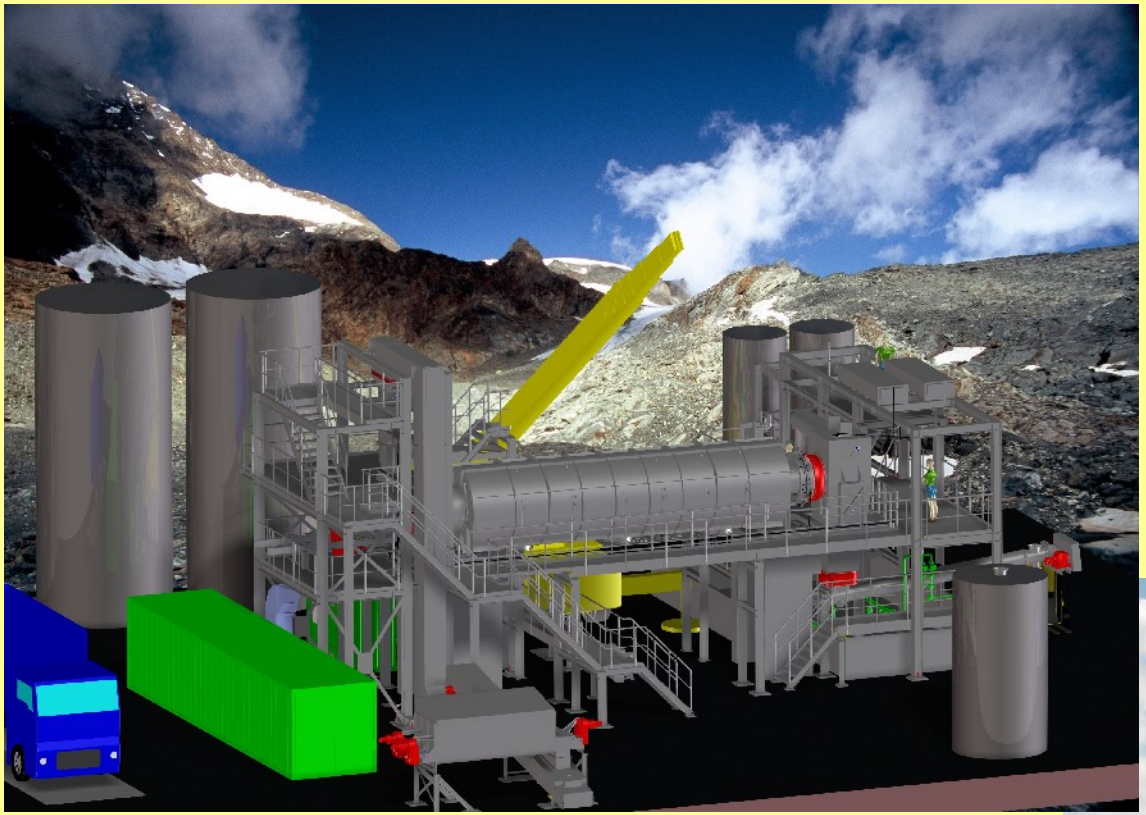

Data

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

MAXI-09 throughput		1,000 kg/h	13.20 MJ/kg	13,200 MJ/h	3,667 kW
Permanentgas	39%	390 kg/h	*11.20 MJ/kg*	*4,366 MJ/h*	1,213 kW
Pyrolyseöl	39%	390 kg/h	16.00 MJ/kg	6,240 MJ/h	1,733 kW
Pyrolysekoks	22%	220 kg/h	11.79 MJ/kg	2,594 MJ/h	721 kW

The ratio oil / gas has to be checked!
The values will vary due to input material!

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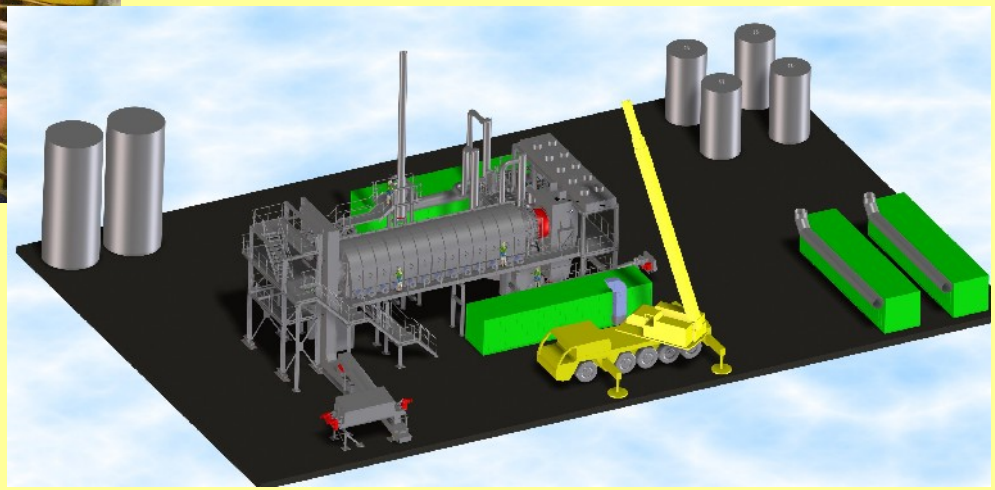
DGE-plant „MASTER-12“

ENERGY EFFICIENCY made in Germany

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



MASTER-12 throughput		2,000 kg/h	13.20 MJ/kg	26,400 MJ/h	7,333 kW
Permanentgas	39%	780 kg/h	*11.20 MJ/kg*	*8,732 MJ/h*	2,426 kW
Pyrolyseöl	39%	780 kg/h	16.00 MJ/kg	12,480 MJ/h	3,467 kW
Pyrolysekoks	22%	440 kg/h	11.79 MJ/kg	5,188 MJ/h	1,441 kW

The ratio oil / gas has to be checked!
The values will vary due to input material!

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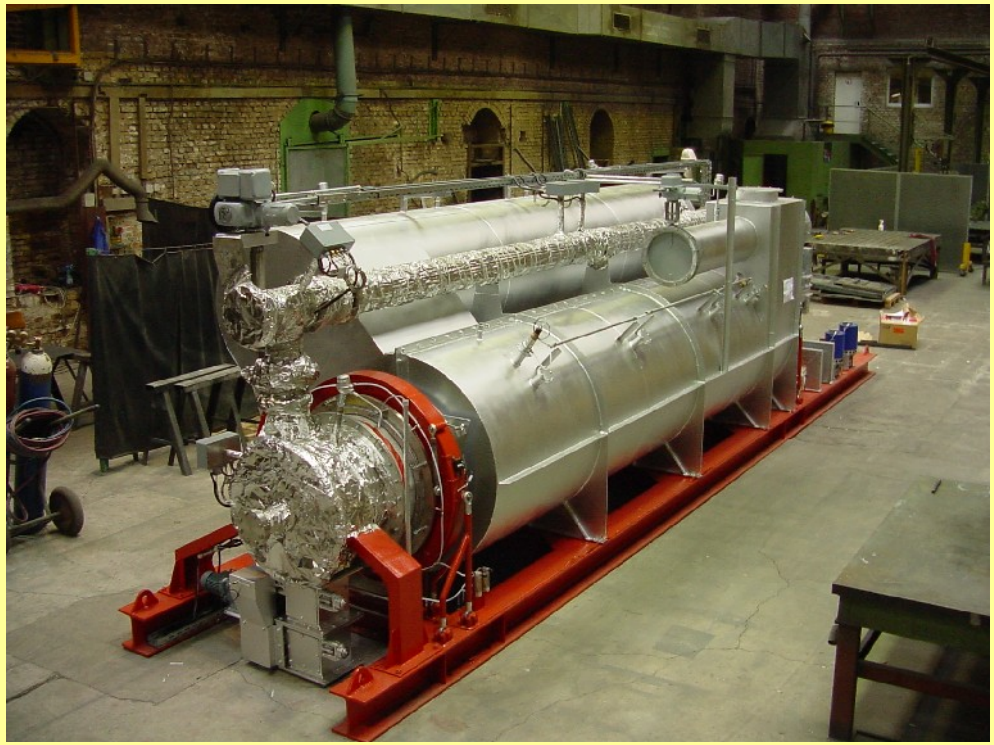
Activation unit „MINI-05“

ENERGY EFFICIENCY made in Germany



Based on the standard plant type MINI-05 the activation unit includes some modifications:

- High temperature kiln shell and housings
- Better insulation for higher temperatures
- Burner-cooler-system for more safe operation

MINI throughput		200.0	129.6	1,555.2
		[kg/h]	[Tons/Month]	[Tons/Year]
Active coal	66%	132.0	85.5	1,026.4
Syngas	34%	68.0	44.1	528.8

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Flexibility Activation Output/Quality

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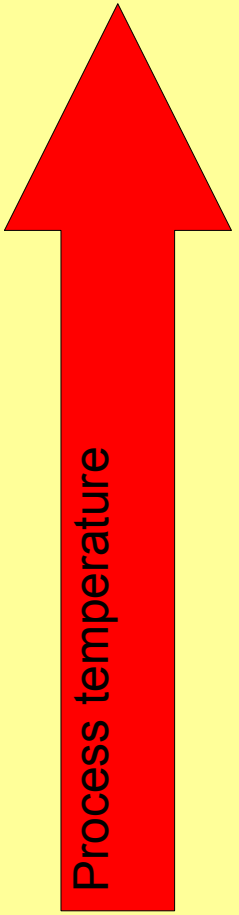
450 m²/gr.

Achieves in laboratory rotary kiln...



300 m²/gr.

MINI throughput		200.0	129.6	1,555.2
		[kg/h]	[Tons/Month]	[Tons/Year]
Active coal	66%	132.0	85.5	1,026.4
Syngas	34%	68.0	44.1	528.8

< 50 m²/gr.

MINI throughput		200.0	129.6	1,555.2
		[kg/h]	[Tons/Month]	[Tons/Year]
Active coal	95%	190.0	123.1	1,477.4
Syngas	5%	10.0	6.5	77.8

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Briquetting of carbon black

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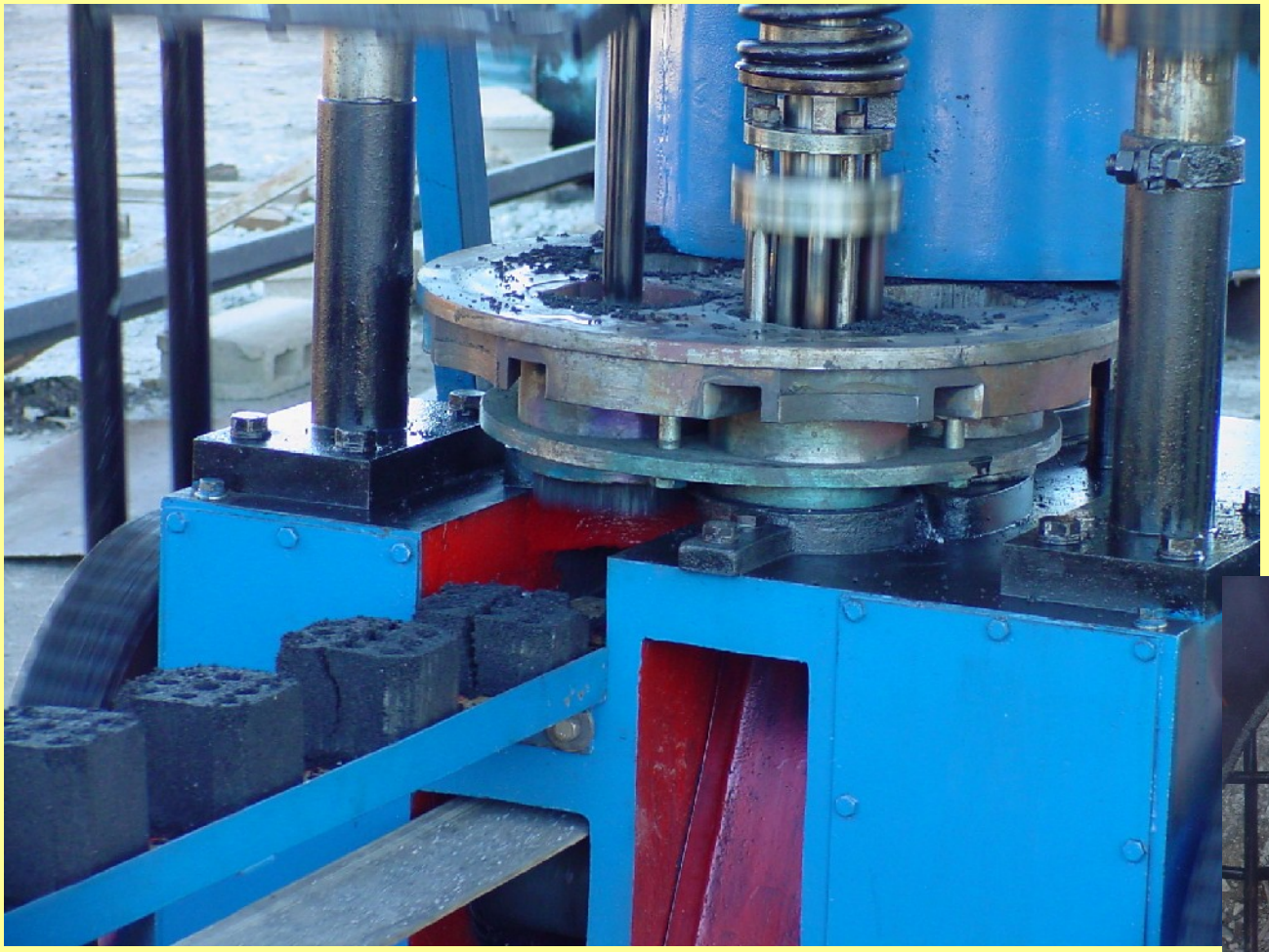

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Power generation 1

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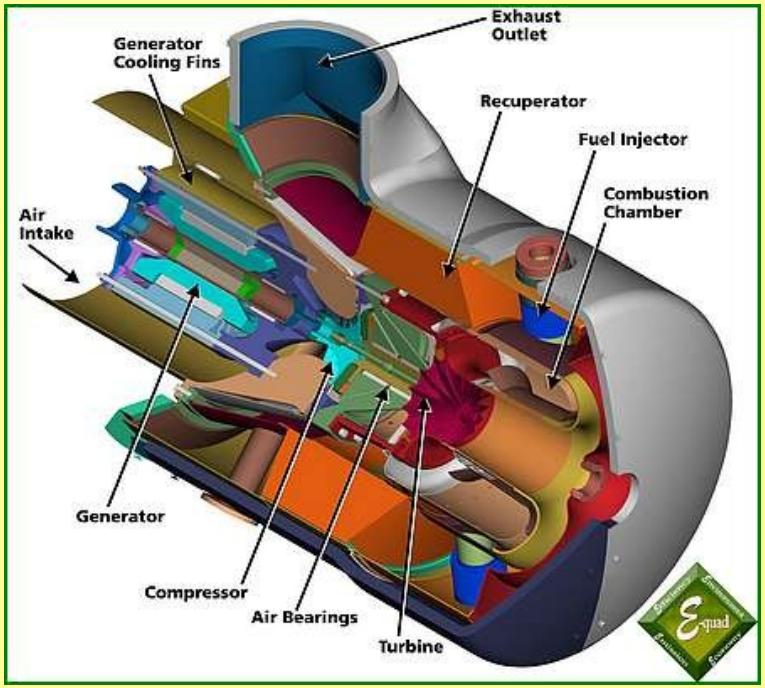

In cooperation with the German distributor of Capstone DGEngineering is developing the micro-turbine application for the use of condensate oil and permanent gas.

These are the advantages of this technology:

- No lubrication oil, which must be replaced
- Air supporting for long life time
- No pistons or other rubbing parts, which need maintenance
- High control range from 10 - 100% which allows energy generationon demand
- High off gas temperature (280°C), useful for additional boilers

E-quad Power Systems

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Power generation 2

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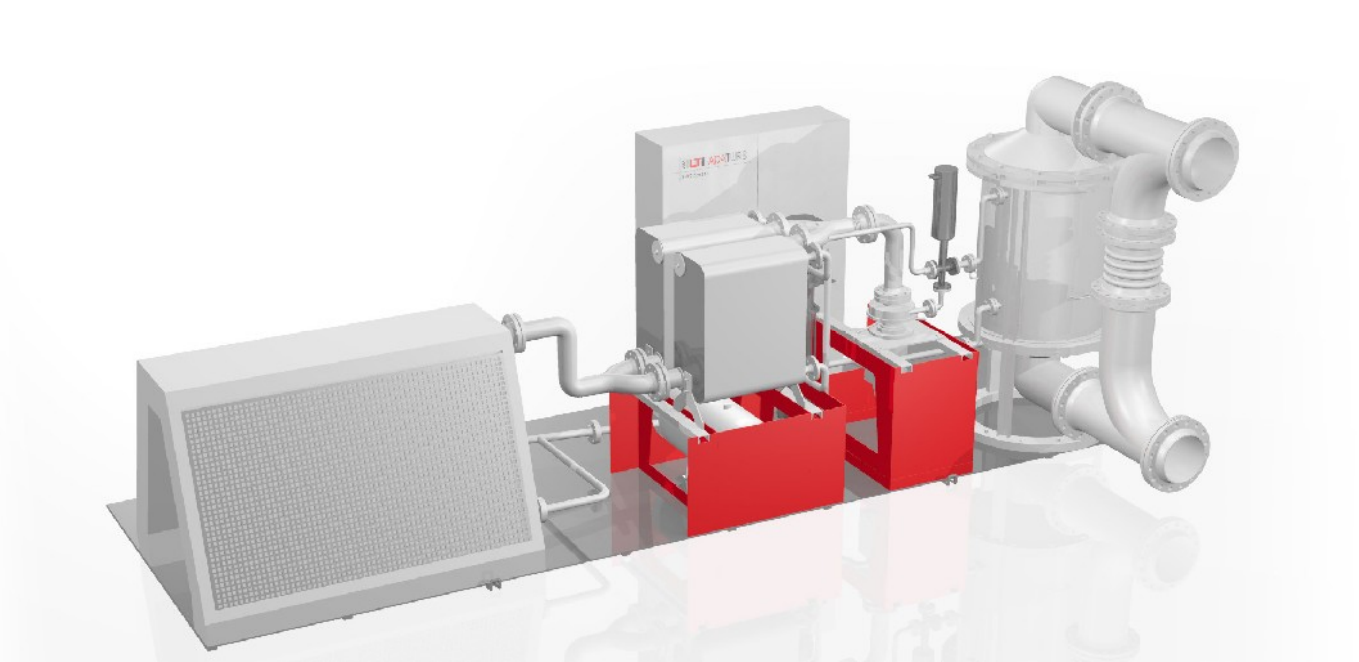
With an ORC unit of the company LTi Adaturb, the waste heat of the process can be used to generate electricity.

The CHP bonus is granted for plants with thermal and electrical use.

So for the complete waste heat the CHP bonus can be safed.



Data

Type	TG 30 DV1
Energy	net ca. 30 $kW_{el.}$
Space demand	20“ Container

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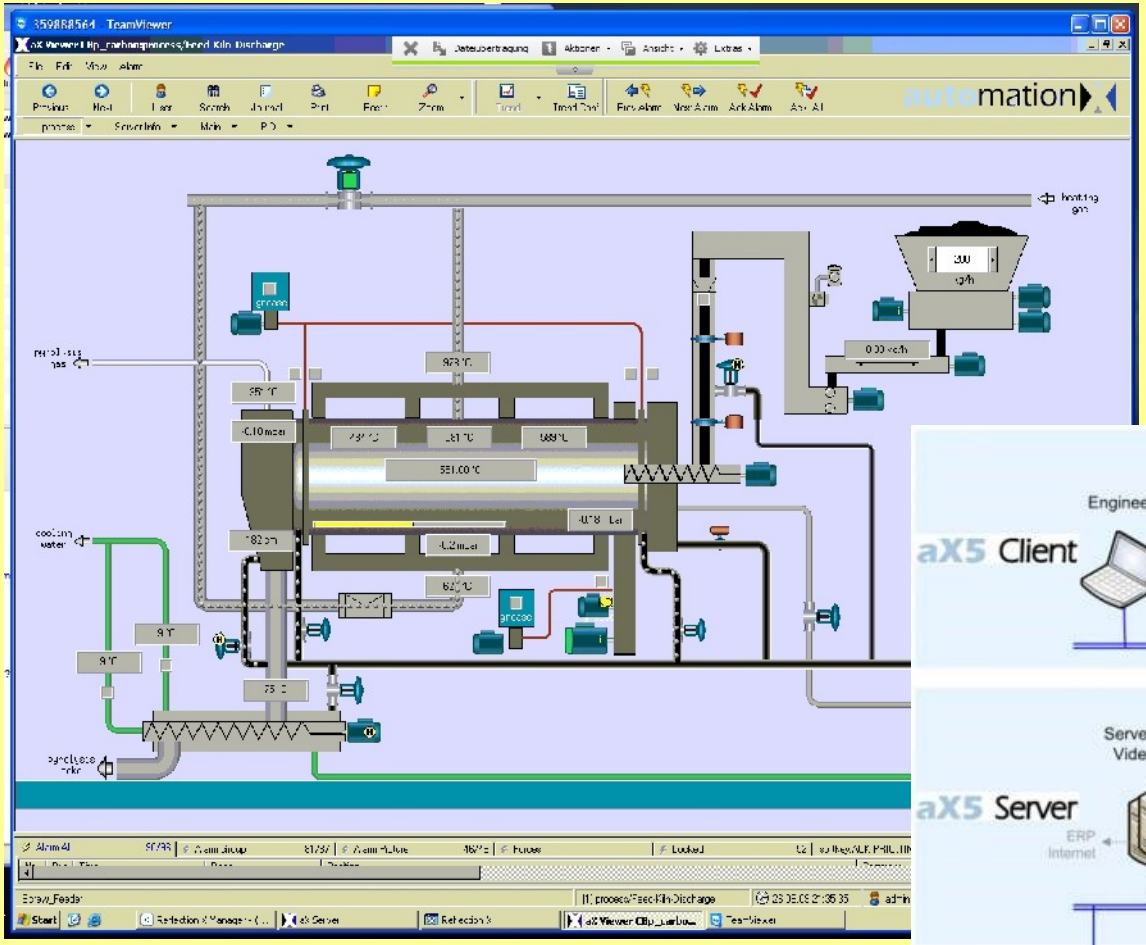
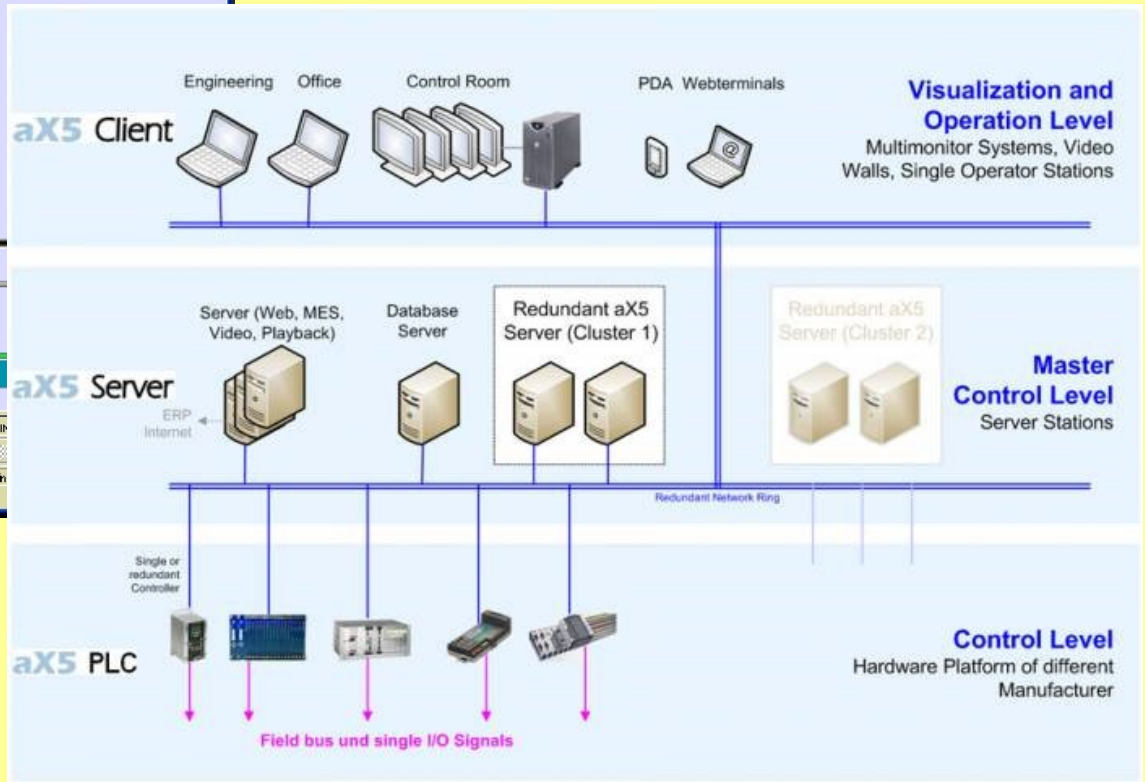
Process control system



The AutomationX process control system is a fully industrial approved control system.

The plant normally will be controlled by the local site engineer.

For maintenance or consulting a remote control via internet is possible only on demand.



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Required personnel

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	Engineer per shift	Technician per shift	Helper per shift	shifts	**total**
Mobile Pre-drying	0	0	0,5	5	**2.5**
Stationary pre-drying	0	0	0.5	5	**2.5**
Thermolysis	1	0	1	5	**10**
Briquetting	0	1	1	1	**2**
Power generation	0	0	0	0	**0**
total	**5**	**1**	**11**		**17**

The table shows the required staff for Germany.

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Possibilities for subvention
(Germany 2011)

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Not all biogenic resources get subventions for renewable resources

Renewable resources bonus
- Miscanthus
- Corn chaff
- Hay, silage
- Horse manure
- Pellet wastage
- Faulty or bug infested wood,forest residues
- Bark
- Cereal wastage

Negative list
- Cereal
- Domestic animal manure
- Saw dust & wood shavings
- Mash
- Vegetable leftovers
- Rejected vegetables
- Rejected potatoes

Not all thermal uses get the bonus according to EEG (Renewable Energy Sources Act)

Positive list
- Heating of buildings
- Feed-in
- Utilisatin as process heat
- Heating of barns
- Heating of Unterglasanlagen

Negative list
- Heating of buildings
- Charging of heat reservoirs
- Utilisation of off-heat ORC

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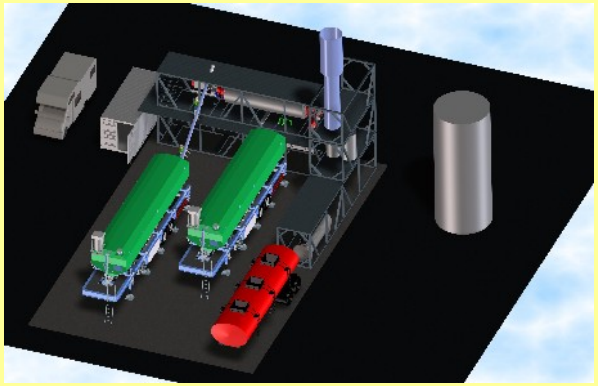
Capabilities of the MINI-05



The semimobile plant MINI-05 is designed for cases where integrated heating concepts are required as well as where biomasses incur,either free of charge or which have to be recycled expensively.

Our plant can possibly be used in the following:

- Wood chip drying (ca. 5.000 t/a W50)
- Horse property (ca. 300 – 400 horses)
- Leisure
- Food industry (ca. 500kg/h steam)
- Villages (ca. 80 - 100 residential units)
- Greenhouses (warm air quantity ca. 800 kW)
- Energy hosts (farm size 100 – 150 ha)

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T-Kit: Steam / Hot water

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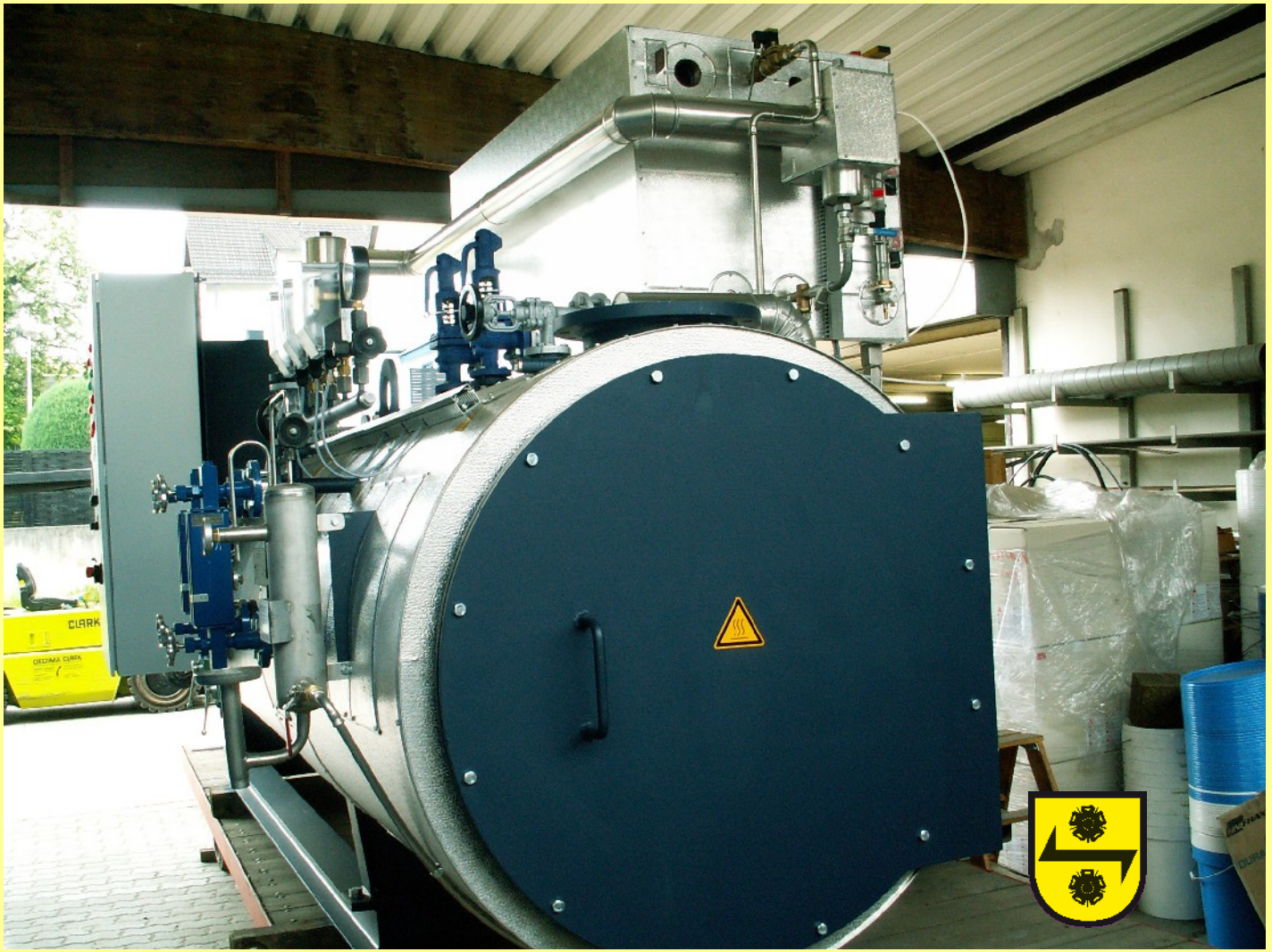

Off-heat utilisation for steam or hot water generation.

Food production, laundry etc.

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T-Kit: Cooling

ENERGY EFFICIENCY made in Germany

Photo by Katharina Wieland Müller @ PIXELIO

Off-heat utilisation for air conditioning.

With MINI: hotels with 100 beds or cold store up to -4°C

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T-Kit: Cool-Churns

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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 utilisation for regeneration of selfchilling barrels & churns

DGEngineering
www.dgengineering.de

More applications...

ENERGY EFFICIENCY made in Germany

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

Mixing of the products is generally possible!

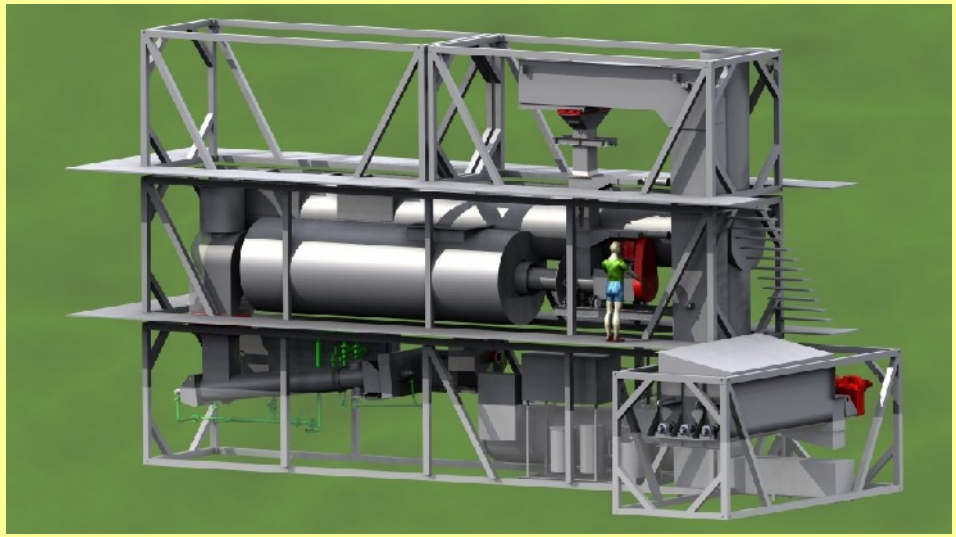
DGEngineering

www.dgengineering.de

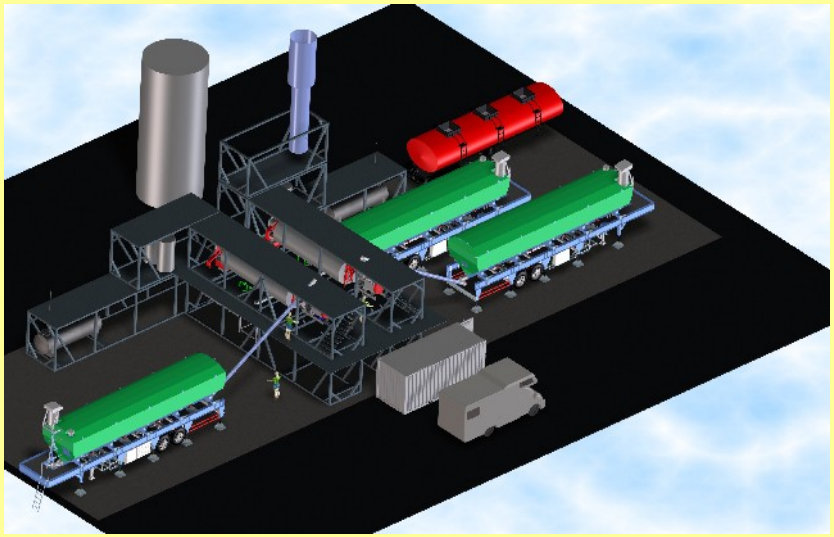
Our thermolysis technology converts biomass into (storable) energy!

Thank you for your attention!

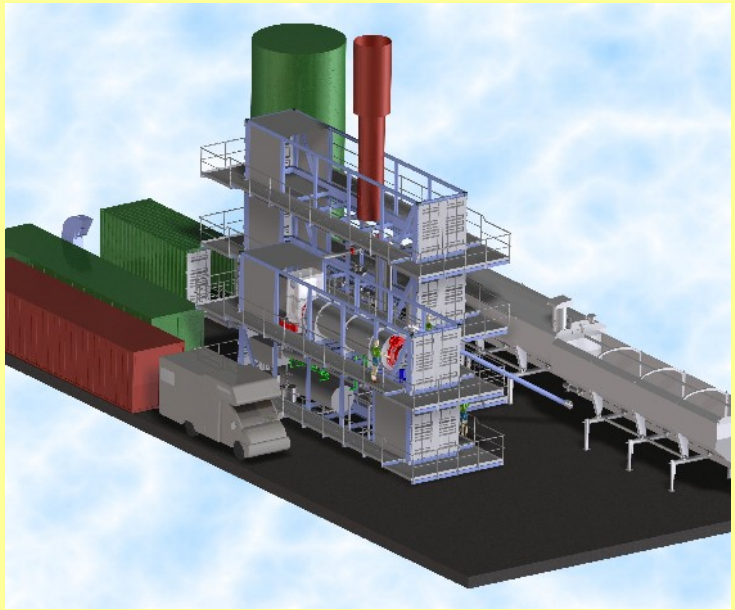
ENERGY EFFICIENCY made in Germany



MINI-05 Anlagenansicht (system view 2009)



MINI-05-Duo (system view 2010)



MINI-05 (system view 2011)