GRENOL

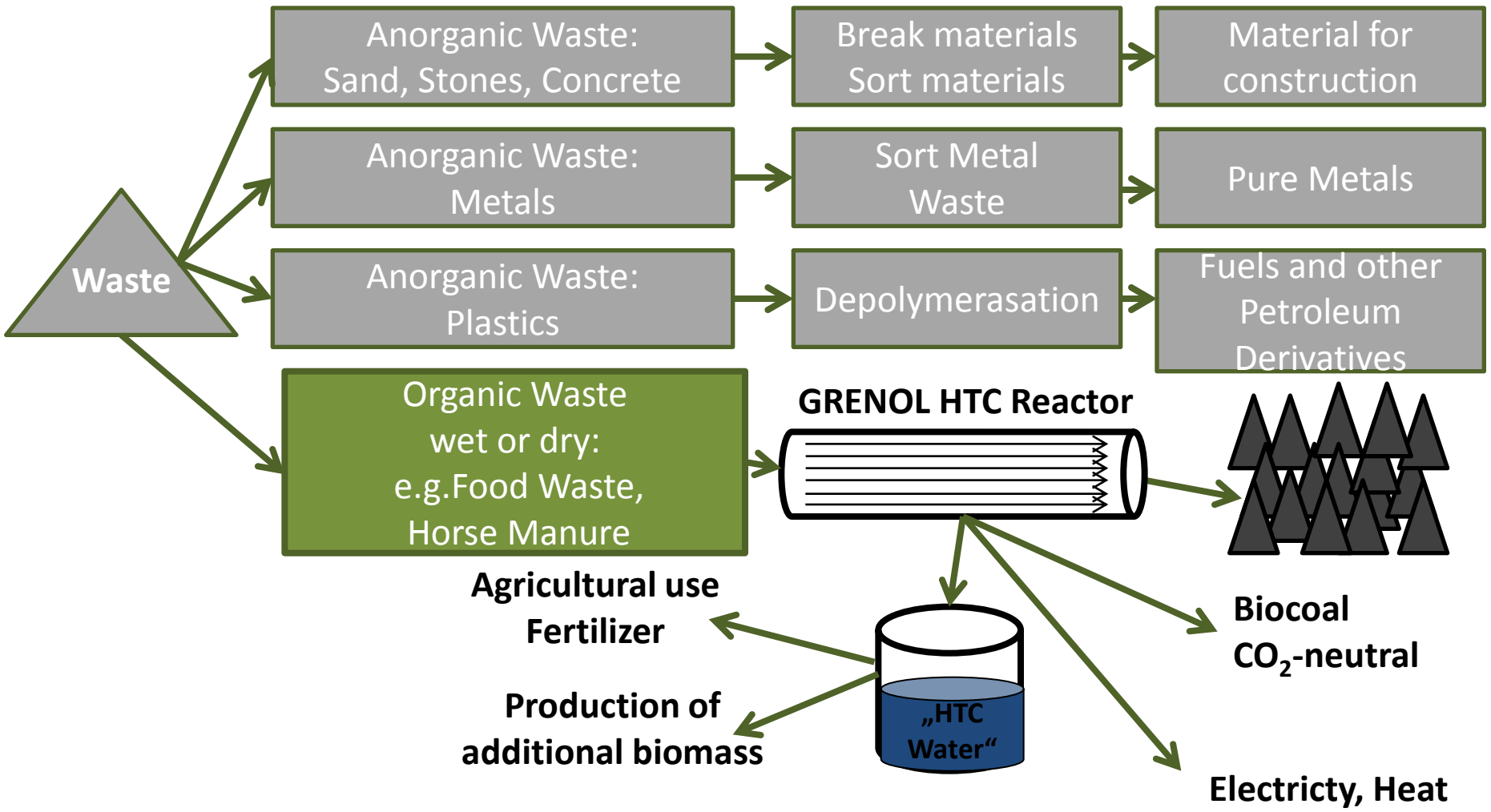
HYDROTHERMAL CARBONIZATION

Key Technology in Biomass Waste Treatment

Structure

1. Application of Hydrothermal Carbonization Technology: Closed cycle of organic waste management
2. Combined Plant: Continuous GRENOL HTC Process & Greenhouse system
3. Energy Balance of GRENOL HTC Technology
4. Benefits & challenges of GRENOL HTC Technology
5. Examples: food waste, horse manure
6. Conclusion

1. Application of HTC



1. Application of HTC

Traditional Treatment of Biomass Waste:

Combustion, Fermentation to alcohol,
bacterial Conversion into methane and carbon dioxide

GRENOL HTC Technology offers better solutions:

1. Waste of Energy/Insufficient use of energy is avoided
2. Economic damage caused by extravagance is avoided
3. Decentral solution for treatment of organic waste
4. Solution for hygienic problems
   (human pathogens, antibiotics, hormons)
5. Positive effects for environment
   (Better for climate, agriculture, nutrition)

1. Application of HTC

The GRENOL HTC-process is the industrial application of the natural conversion from organic material to coal and oil derivatives millions of years ago.

GRENOL
HTC Reactor

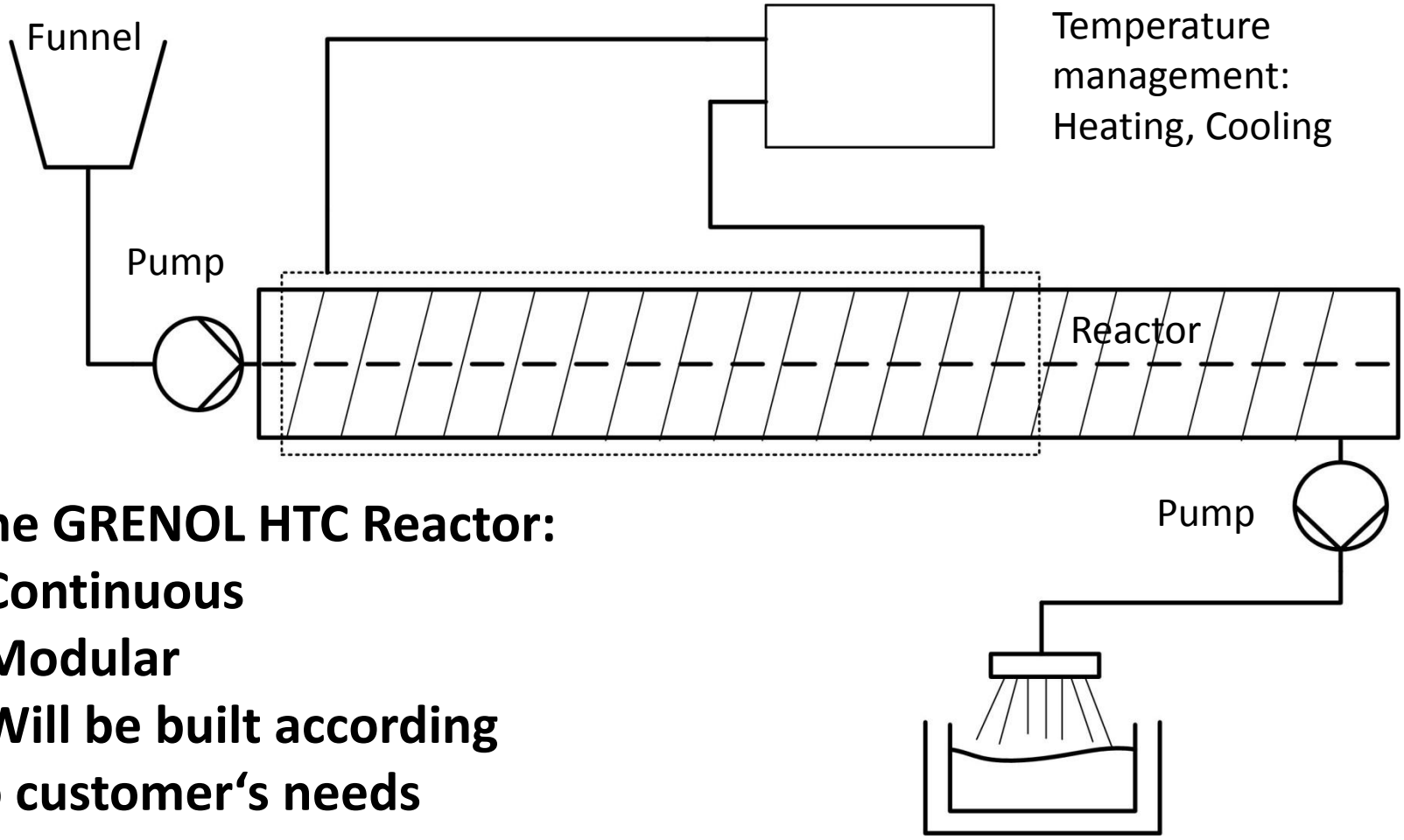
Humus soil, Coal,
Oil derivatives

Carbon Hydrates
e.g. sugar
$C_6 H_{12} O_6$

+ Temperature:
ca. 200 C
+ Pressure ca. 20 bar
(about 3-12 hours)

6 C + 6 H_2O

2. GRENOL HTC Reactor



The GRENOL HTC Reactor:

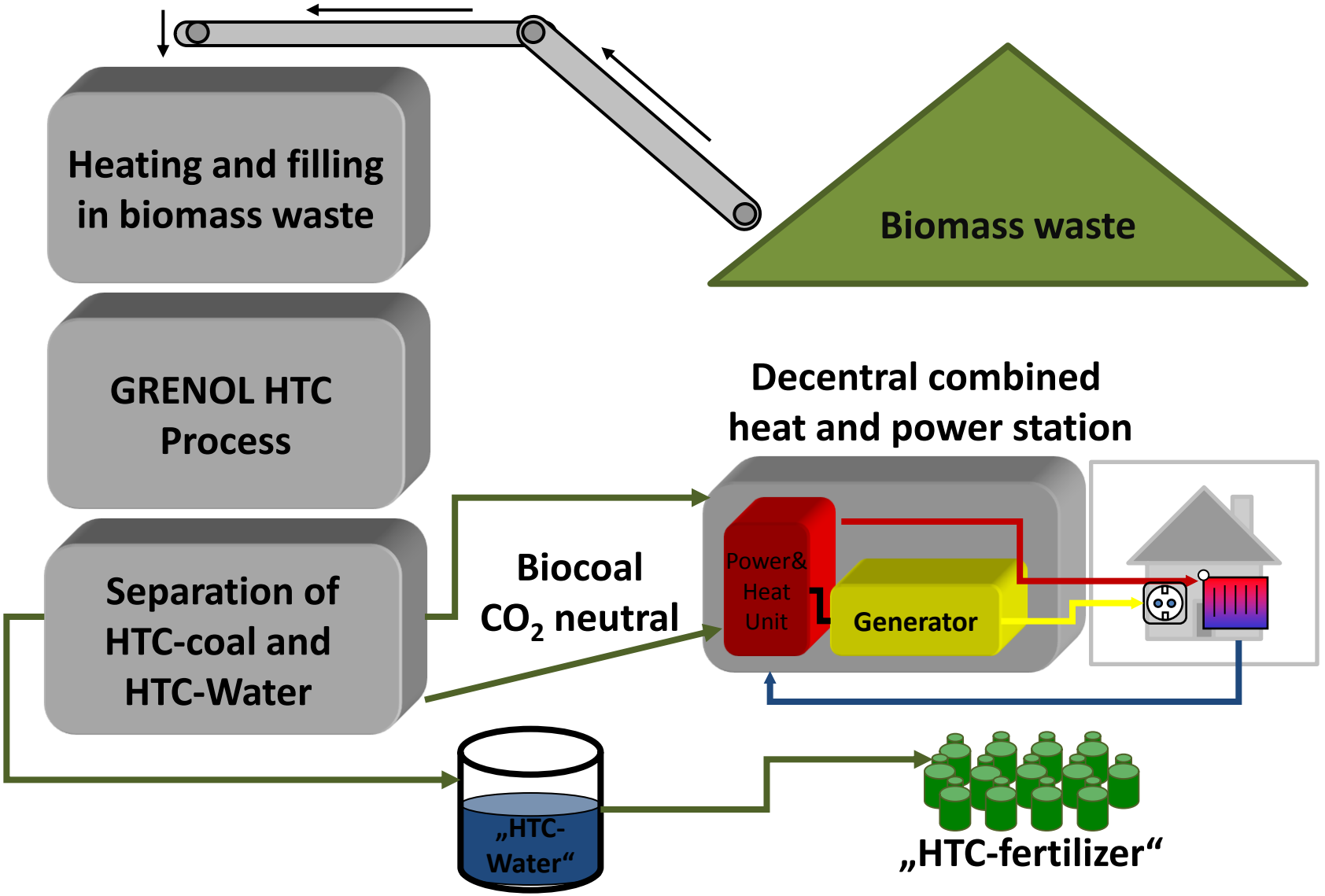
- **Continuous**
- **Modular**
- **Will be built according to customer‘s needs**

2. GRENOL HTC Reactor

Prototype of GRENOL HTC reactor in Kalkar/Germany.

Capacity : 1 ton of Biomass Waste per day

Usage: How HTC contributes to produce energy and heat from coal



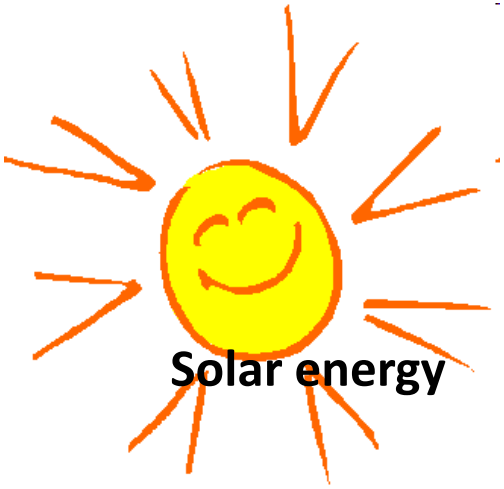
2. Greenhouse System

In the HTC process, Coal and HTC-Water is produced. If the HTC Water cannot be used in agriculture, we propose following solution: Greenhouse system.

Biorector:

- Indoor farming system for higher aquatic plants uses Water from GRENOL HTC process and purifies water. HTC water serves as substrate for higher aquatic plants. Additional biomass is produced.
- Space saving indoor farming system
- Removal of CO_2 from the atmosphere due to production of additional biomass.

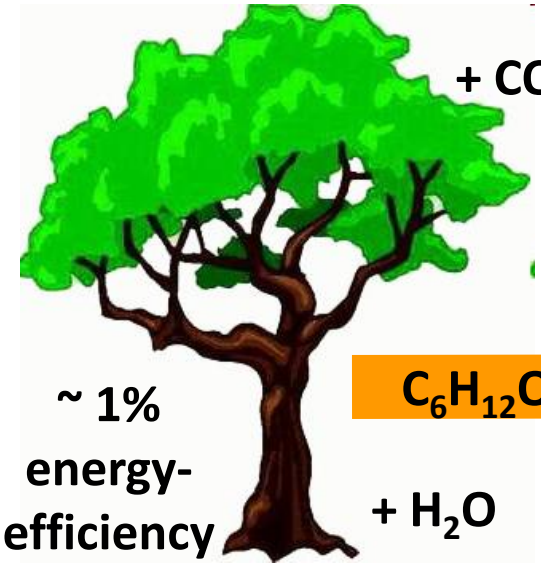
3. Energy Balance of HTC



33 % energy is produced in the process

Thermal Feedback of exotherm energy

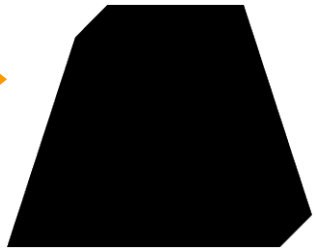
66 % of the energy is preserved in the HTC coal.



$C_6H_{12}O_6$

GRENOL HTC Technology

6 C + 6 H_2O



4. Benefits

- With GRENOL HTC Technology, the **cycle of municipal waste management is closed**. All types of Biomass waste can be processed. GRENOL HTC technology offers a decentral solution to waste management.
- **Carbon cycle is closed**: Grenol HTC Technology is climate friendly because of production of CO_2-neutral coal.
- **Storable energy:**
  Coal is a form of energy that can be stored.
- **Efficiency**: 100% of the carbon and 2/3 of the energy inside the biomass waste are preserved.
- **Machinery**: Closed system, simple mechanical handling.

4. Benefits

- **Ecological resources are preserved:** Use of biomass waste replaces consumption of fossile ressources (crude oil, gas, coal).
- **No competition with food industry**: No farmland is used. We only use organic waste.
- Contrary to combustion, fermentation or biogas, GRENOL HTC Technology **is a physio-chemical, not a biological process**. No greenhouse gases are emitted.
- **Hygienic advantage:** Large amounts of biomass waste may cause harmful deseases. Due to heat and pressure human pathogens and antibiotics are destroyed.

4. Challenges

- **Soil optimizing based on HTC Water:** Only additional biomass will remove CO_2 from the atmosphere and thus helps to close the carbon cycle. Research on fertilizing soil for cultivating barren lands using water from HTC process is underway.
- **International market introduction**: GRENOL group is ready to plan and build HTC reactors according to customers‘ specific needs when it comes to closing cycle of waste management. International market introduction is underway.

5. Examples: Horse Manure

- Manure from horse or other animal is a form of organic waste that does not necessarily need to be removed. Thus, there is no cost for removal of horse manure.
- Example: 10.000 tons of horse manure. Assume manure contains 30% dry substance. With HTC, 1.500 tons of coal will be produced. Coal from horse manure can be burned at 5,5 kWh/kg. This will produce 8.25 Mio. kWh energy. With state of the art technology this will produce 2.5 Mio. kWh electrical energy and 4.25 Mio. kWh thermal energy.
- Horse manure contains less energy than food waste.

5. Examples: Food Waste

- Food waste is a form of organic waste that has to be removed in a hygienic way. Removal of food waste costs money.
- Example: 10.000 tons of food waste. Assume food waste contains 30% dry substance. With HTC, 1.500 tons of coal will be produced. Coal from food waste can be burned at 7 kWh/kg. This will produce 10.5 Mio. kWh energy.
- With state of the art burner this will produce 3.15 Mio. kWh electrical energy and 5.25 Mio. kWh thermal energy. Moreover, zero cost for removal of food waste.

6. Conclusion

GRENOL HTC Technology

offers new alternative procedure

to process organic waste

in environmentally friendly way

and closes the cycle of waste management.

Contact

THANK YOU FOR

YOUR ATTENTION!

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