Biomass Steam Processing (BSP)

Conversion of Biomass to Coal by Steam Conditioning

Dr. George Francis
Presented by Thomas Hoffmann - BORDA

Live Energies: Mission and philosophy

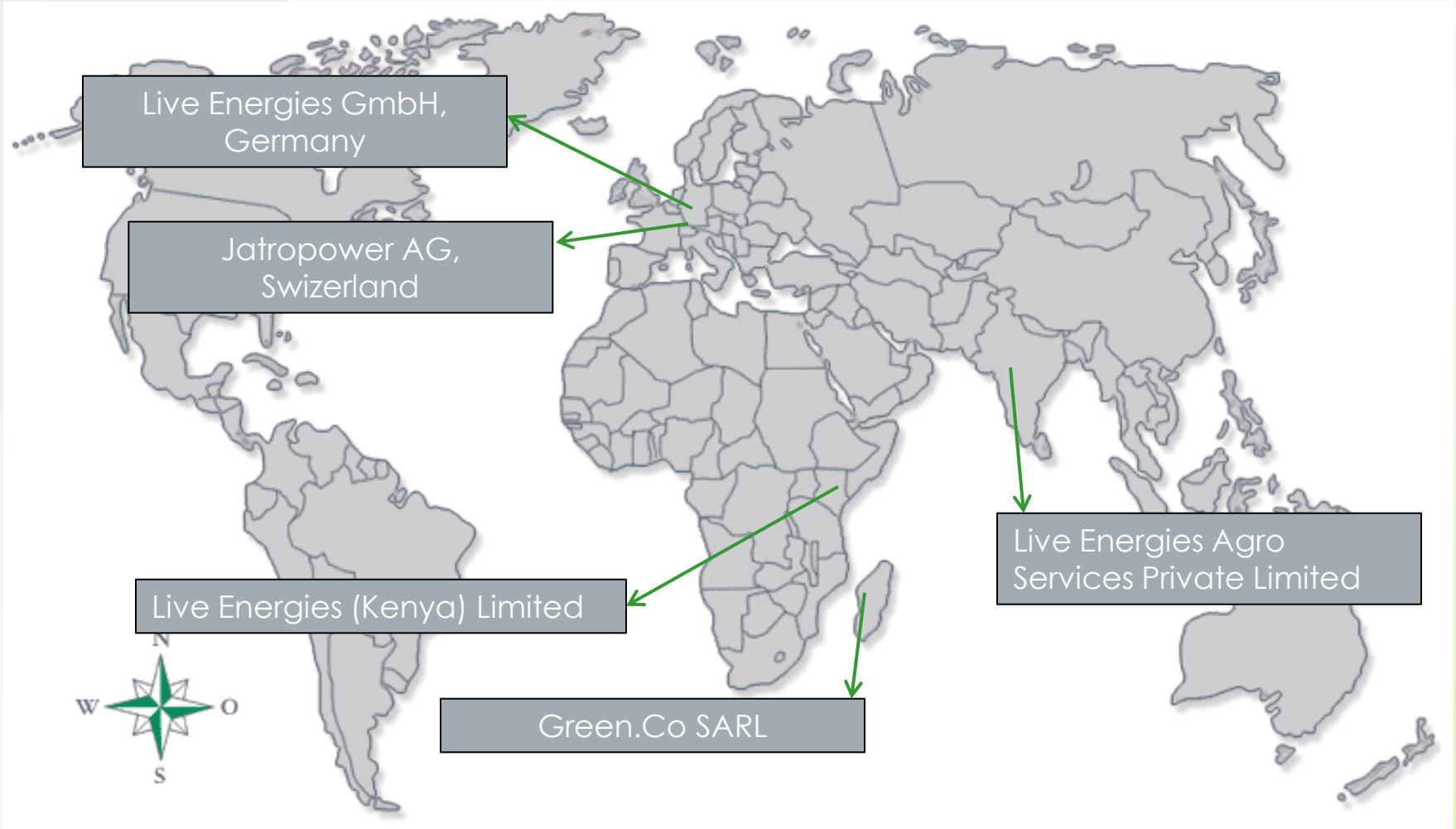
Play a constructive role in the bio-economy by:

- Generating „new“ industrial and bio-energy feedstocks
- Non-conventional activity areas
- Production from wasteland or underutilized land
- Use of by-products as resources

Multicultural projects:

- Conception
- Financing
- Consortium building
- Management of Implementation

Live Energies and its Partners



World-wide project experiences

- Biomass production from wasteland in Asia and Africa
- Expertise in evaluation and research in energy crops
  - Jatropha, Cassava, Opuntia, Euphorbia tirucalli
  - Product and by-product use strategies
- Wastes as a source of carbon enriched products
  - Biomass Steam Processing

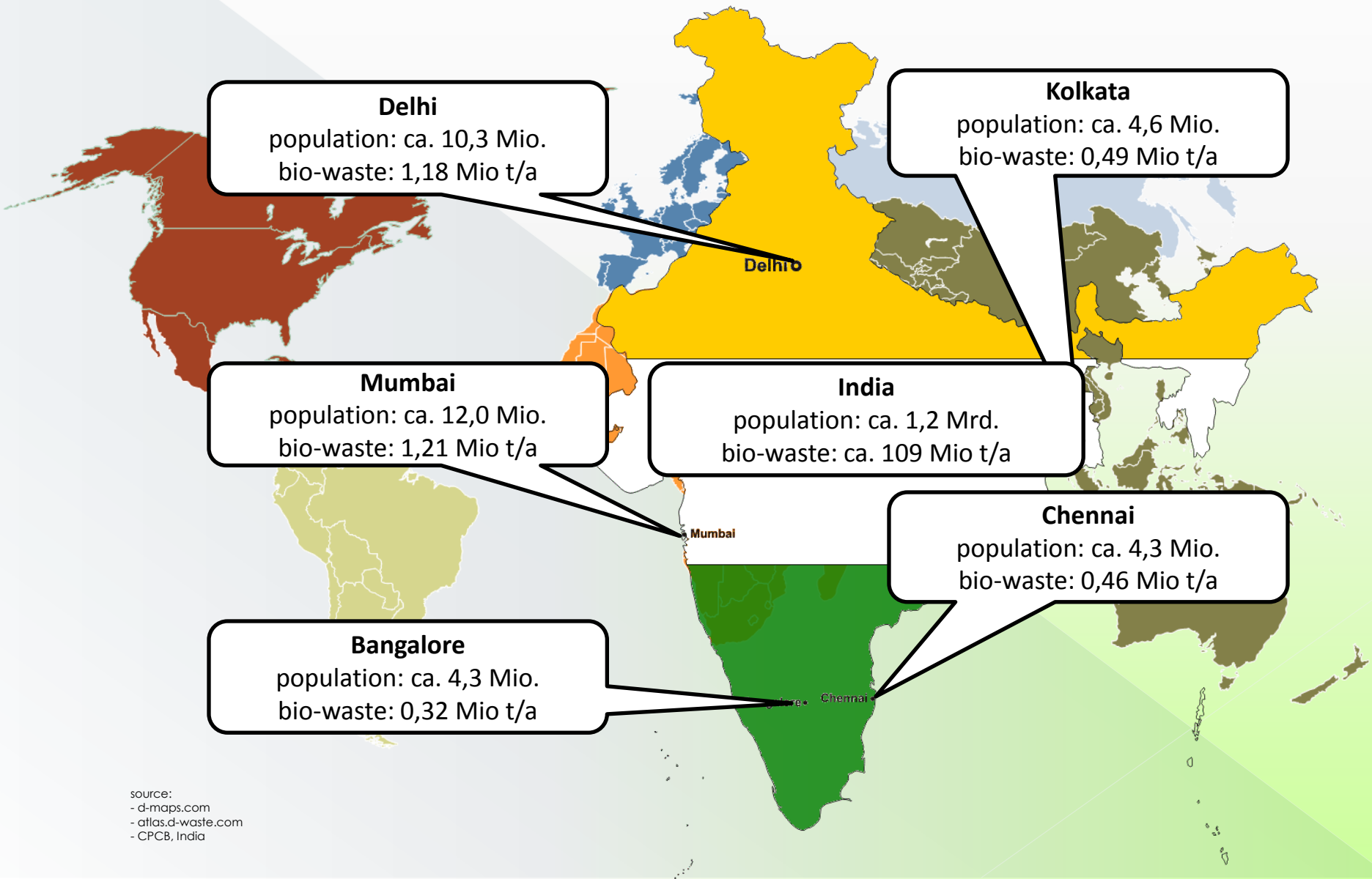
Biocoal from organic wastes – BSP project

- Partners:
  - EnBW Energie Baden-Würrttemberg AG, Germany (EnBW)
  - Karlsruhe Institute of Technology, Germany (KIT)
  - Live Energies GmbH, Germany (LE)
- The BSP process was invented at KIT (Prof. H. Bockhorn/ J. Steinbrueck) in a joint research project with EnBW. The process has been awarded a EU patent in 2016
- LE has been contracted by EnBW to establish a demonstration BSP plant
- The following slides show details on the relevance of BSP:
  - Bio-waste and issues
  - Biomass Steam Processing
  - Project

Bio-waste suitable for BSP

- Organic waste, mainly of vegetable origin
- Sources:
  - households, restaurants, markets, agriculture, food industries…

Bio-waste generation in India



source:
- d-maps.com
- atlas.d-waste.com
- CPCB, India

Challenges

- Huge and increasing urban bio-waste and sewage generation
- Disposal currently in empty lands in urban suburbs
- Problems:
  - lack of space
  - health risks, environmental issues, bad odour

Biomass Steam Processing

product:

- coal character ↑
- carbon fraction/-density ↑
- heating value ↑
- biological activity ↓
- homogenous, odorless, hydrophobic

advantages:

- transport costs ↓
- storability ↑
- range of applications ↑
  - incineration, gasification
  - activated carbon
  - fertilizer
  - CO_2-sink

BSP – process development

- Plant development from laboratory scale to pilot scale at KIT

lab reactor

up to 5 g

Batch - Discontinuous

small pilot reactor

up to 500 g/h

Semi - continuous

pilot plant

up to 50 kg/h

continuous

BSP can handle varied biomass

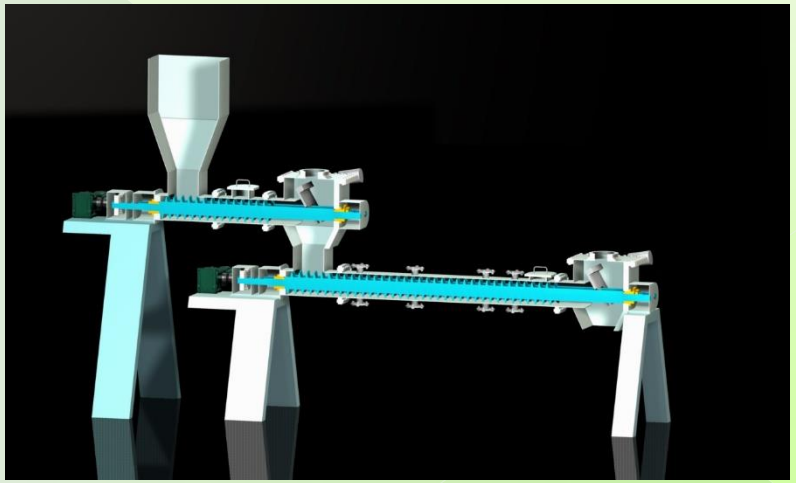
- Wide range of biomass inputs tested
- BSP imitates natural coalification but 3,5 x 10^{11} times faster

sample	temperature [°C]	HHV_{DM} [MJ/kg]	CR [%]
wood pellets	300	22,04	72,9
wood pellets	350	28,60	40,8
straw	300	21,45	47,9
straw	350	21,15	40,2
leaves	300	19,76	66,4
leaves	350	21,01	56,5
orange peels	300	24,24	56,3
bio-waste	325	25,79	53,1

BSP pilot plant tested with sewage – bio-waste mixtures

- Successful drying of the input and increase in HHV obtained

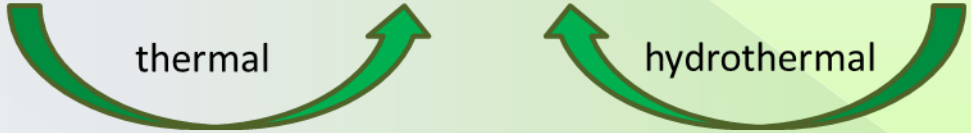
sample	dm [%]	HHV (as is) [MJ/kg]
sewage sludge	25	3.0
wood pellets	95	16.9
bio waste	10	2.2
$coal_{sludge+pellets}$	98	20.7
$coal_{sludge+bio\ waste}$	98	14.4



Process comparison

- BSP combines pyrolysis and HTC

	Slow Pyrolysis (SP)	Biomass Steam Processing (BSP)	Hydrothermal Carbonisation (HTC)
medium	inert gas (N_2)	superheated steam	pressurised water
temperature	300 – 500 °C	250 – 350 °C	180 – 250 °C
reaction time	long (t > 8 h)	short (t < 2 h)	long (t > 8 h)
pressure	increased (p > 1 bar)	atmospheric	high (p > 12 bar)
processing	continuous	continuous	semi-continuous



- BSP Advantages:
  - short reaction times, atmospheric pressure, continuous process, high moisture input, dry product

Demostration project and timeline

- **2017/18**
  - Establishment of a demonstration plant with 2000 t/y throughput capacity in Germany
  - Site: waste treatment/ composting site
  - Raw material: mixed gardening, landscaping and household wastes

- **2018/19**
  - Establishment of a plant with 2.000 t/y at a suitable site in India, subsequent upscaling to 20.000 t/y
  - Targeted raw material:
    - vegetable market wastes
    - sewage sludge

Important factors for success

- Availability of the required quantity of wastes on site
- Recognition of the fact that wastes present an environmental and health problem due to
  - Very low energy content
  - Bulk, high moisture content
  - High degradability, disposal problems in cities
  - Their disposal requires usually more energy than they contain
- Suitable valorisation of the intake of such wastes
- Marketability of the disposal products

Contact:

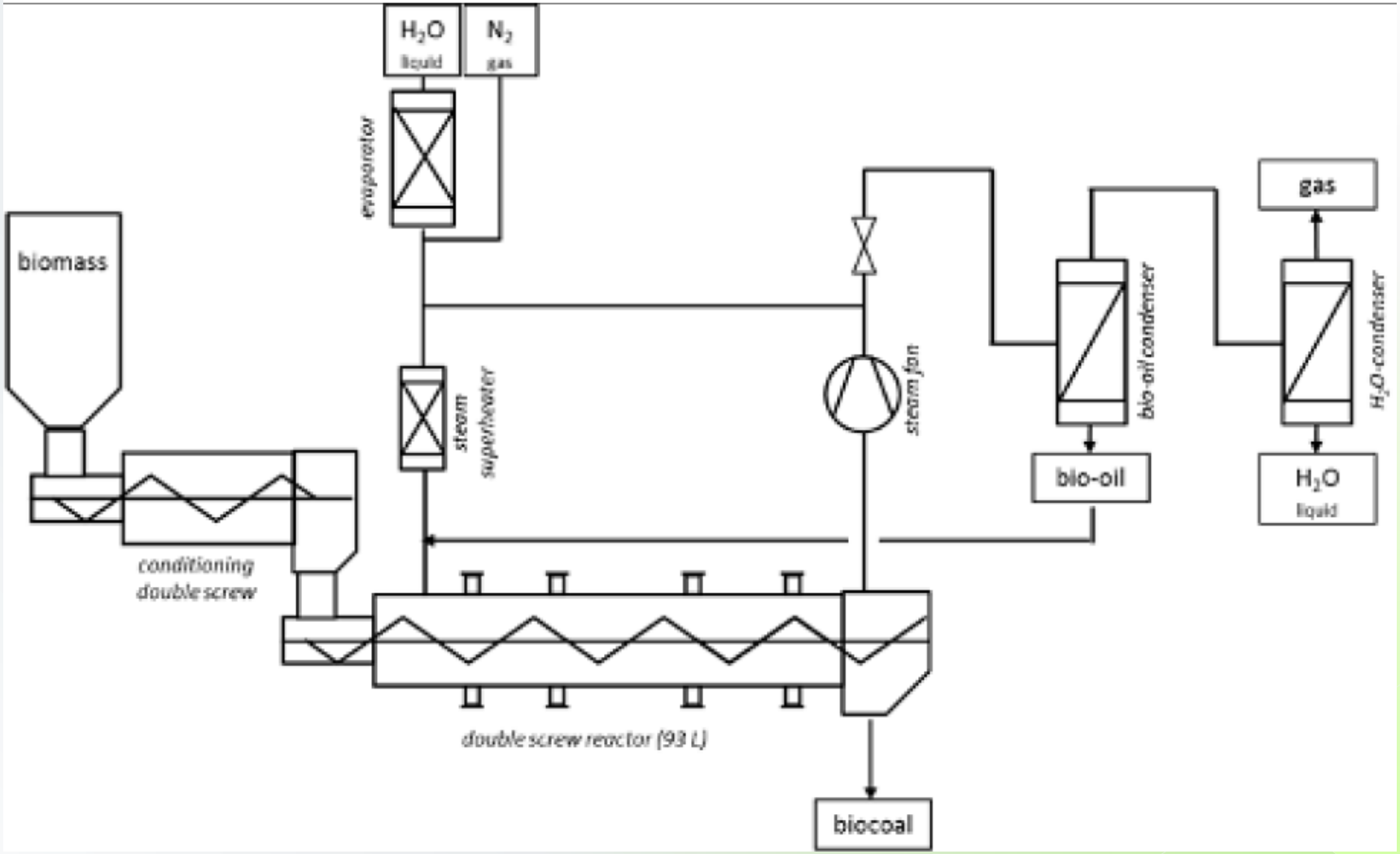
Live Energies GmbH

Scharnhauser Strasse 35
D-70599 Stuttgart, Germany
+49 711 94542744, office@liveenergies.de

Live Energies Agro Services

Private Limited, Chennai

Back-Up


H_2O
liquid
N_2
gas
evaporator
biomass
steam superheater
steam fan
bio-oil condenser
gas
H_2O-condenser
bio-oil
H_2O
liquid
conditioning double screw
double screw reactor (93 L)
biocoal