LAMBION Energy Solutions

< ENERGY FROM BIOMASS >
COMPANY: LAMBION designs and builds custom-made biomass incineration plants of $1-30 \text{ MW}_{\text{th}}$

USP: Comprehensive project partner and fuel specialist with a focus on decentralized energy concepts

LAMBION FUEL ARCHIVE: Experience with over 100 different biofuels

TECHNOLOGY AND RANGE OF SERVICE: Concept & construction of the entire plant, in-house production of know-how supporting components

HOLISTIC PROJECT PLANNING: Ecologically meaningful processing of bio residues from one source

CALCULATION OF PROFITABILITY: Example for power-led operation of the power plant

BIOMASS POWER PLANT AND HEATING PLANT TECHNOLOGY: Carefully coordinated components for optimum efficiency

REFERENCES: Over 3,400 biomass plants in 72 countries

EXAMPLE PROJECTS (1) - (4)

CONTACT
COMPANY: Lambion designs and builds custom-made biomass incineration plants of 1 - 30 Mw<sub>th</sub>
USP: Comprehensive project partner and fuel specialist with a focus on decentralized energy concepts

**FUEL RESIDUE NOT RAW MATERIALS**

- Fuel specialist for sophisticated and low-grade biomasses and mixes
- Robust, durable and maintenance/repair-free, but still providing 8000 h of energy production

**AN ALL-IN-ONE SOLUTION NOT A PUZZLE**

- Consideration of the energy problem, from economic efficiency via the technically-optimized concept to the operational/business model

**DECENTRALISED ENERGY CONCEPTS**

- A focus on practical capacities for decentralized fuel quantities and energy consumption
- Avoidance of fuel tourism and additional required energy infrastructure

**LIFE TIME CYCLE VIEWING**

- Consideration of the customer benefit and economic efficiency throughout the operating phase, instead of only investment minimization
LAMBION FUEL ARCHIVE: Experience with over 100 different biofuels

- Analysis and testing in consideration of chemical and physical properties
- Evaluation of the analysis values and fuel performance
TECHNOLOGY & RANGE OF SERVICE: Concept & construction of the entire plant, in-house production of know-how supporting components

<table>
<thead>
<tr>
<th>FUEL UNLOADING &amp; CARRYING EQUIPMENT</th>
<th>INFEED AND FIRING</th>
<th>BOILER SYSTEM</th>
<th>ASH REMOVAL AND FLUE GAS CLEANING</th>
<th>MSR-ANLAGEN</th>
<th>PLANT CIRCUMFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pushbutton systems</td>
<td>Multiple infeed system</td>
<td>Flue-/ Fire-tube boiler</td>
<td>Wet ash extractor</td>
<td>Low-voltage circuitry</td>
<td>Electrical installation</td>
</tr>
<tr>
<td>Unloading screw</td>
<td>Hydr. infeed system</td>
<td>Hybrid-prechamber fire-tube boiler</td>
<td>Ash screw conveyor</td>
<td>PLC system control</td>
<td>Pipeline construction</td>
</tr>
<tr>
<td>Drag chain conveyor</td>
<td>Air-cooled moving-grate firing</td>
<td>Water tube boiler</td>
<td>Multi-cyclone deduster</td>
<td>Process visualization</td>
<td>Water treatment</td>
</tr>
<tr>
<td>Screw conveyors</td>
<td>Ring burner firing (Dusts)</td>
<td>Thermal oil boiler</td>
<td>Induced draft fan and ducts</td>
<td>Process control</td>
<td>Plant steel structure</td>
</tr>
<tr>
<td>Pneumatic conveyor systems</td>
<td>Injection firing, special fuels (p.e. coffee, cleaning sludge)</td>
<td></td>
<td>Electrostatic precipiator</td>
<td></td>
<td>Turbine, Steam motor</td>
</tr>
<tr>
<td></td>
<td>Underfeed firing for export and smaller units</td>
<td></td>
<td>Bag filter (incl. additive systems)</td>
<td></td>
<td>Re-cooling systems</td>
</tr>
</tbody>
</table>

- Own technology, in-house production
- Own technology, Manufacturing partner
- Purchase from partner
HOLISTIC PROJECT PLANNING: Ecologically meaningful processing of bio residues from one source

- Lambion's core competence is the construction of combustion plants
- A wealth of experience allows for turnkey takeover of the biomass project
CALCULATION OF PROFITABILITY: Example for power-led operation of the power plant

**INPUT**

- **FUEL (e. g.)**
  - Landscape conversation-cut with approx. 3 kWh/kg
  - Input 18.500 t/year,
  - Price approx. 14 €/t
  - Fuel costs approx. 255 T€/year

- **CO2-SAVING**
  - compared to fuel oil EL 11.800 t/year

**BIOMASS POWER PLANT**

- **PERFORMANCE DATA**
  - Steam boiler 30 bar, 400 °C
  - thermal output approx. 6 MW
  - Extraction condensing turbine exhaust steam pressure 0,1 bar
  - el. power max. 1,4 MW

- **INVESTMENT & ADDITIONAL COSTS**
  - Plant 4.900 T€
  - Periphery 1.000 T€
  - Bank / DD 250 T€
  - Working Capital 200 T€
  - Sum 6.350 T€
  - Equity capital (40 %) 2.540 T€

**OUTPUT (Mix)**

- **ENERGYMIX OF POWER, STEAM, HEAT (EXAMPLE)**
  - Energymix is based on the max. current efficiency, the required heat quantity of the industrial enterprise is decoupled (power-led operation).
  - Annual amount approx. 8.450 MWh power
  - approx. 20.000 MWh steam
  - Compensation
    - Ø 140 €/MWh power
    - Ø 42 € MWh heat
  - Revenues p.a.
    - 1.183 T€/a power
    - 840 T€/a heat

**ECONOMY**

- **PROFITABILITY**
  - Cur. proceeds 2.023 T€/a
  - Cur. cost of fuel 255 T€/a
  - Cur. operation 365 T€/a

- **EBITA**
  - Writedown (12 y.) 530 T€/year
  - Ø Interest of 60 % outside capital (Basis 7 %) 133 T€/year

- **RESULTS FROM ORDINARY BUSINESS ACTIVITY**
  - TAX 26,4 %
  - 221 T€/year

- **ANNUAL SURPLUS**
  - Ø Equity return 20,4 %

- **GOING CONCERN**
  - approx. 3 E (TZ 20 h/ W)
  - 8000 operating hours/year
  - Operating costs 365 T€/year
BIOMASS POWER PLANT AND HEATING SYSTEMS: Coordinated product range for optimum efficiency

- Design of all components individually in term of their use, energy efficiency and profitability
- Modularized
- Optimized for assembly, transport and commissioning
COMPONENTS OF A BIOMASS PLANT: Unlimited functionality when all key components are taken into account

FUEL SUPPLY
- Storage system
- Delivery system
- Fuel transport

ENERGY PRODUCTION
- Feeding
- Combustion
- Boiler
- Plant control

HEAT DISTRIBUTION + CHP
- Decentralized energy supply
- Heat grids

ASH AND WASTE GASES
- Constant metering of emissions
CORE COMPONENTS OF THE BIOMASS PLANT: Careful coordination of core components ensures efficient operation of the plant.

**FUEL FEEDING**
- Underfeed stoker
- Multiple shaft screws
- Flap-gate locks
- Hydraulic fuel feed
- Pneumatic blow-in equipment

**COMBUSTION SYSTEMS**
- Infeed grate
- Underfeed combustion
- Blow-in combustion
- Ring burner

**BOILER SYSTEMS**
- Fire-tube boilers
- Water-tube boilers
- ORC

**PLANT CONTROL**
- Contactor technology and PLCs
- Component testing
- Monitoring, documenting and archiving
LAMBION COMPETENCE: Lambion is a specialist in the development and design of tailor-made combustion technology

The following combustion technologies can be distinguished:

- **INFEED GRATE COMBUSTION**
  - **FUEL**: Coarse biomasses (wet or dry)
  - **POWER RANGE**: 1 to 30 MW\textsubscript{th}

- **RING BURNER COMBUSTION**
  - **FUEL**: Fine and grainy biomasses or dust to 100%
  - **POWER RANGE**: 1 to 5 MW\textsubscript{th}

- **UNDERFEED COMBUSTION**
  - **FUEL**: Simple biomasses with a low ash content
  - **POWER RANGE**: 1 to 5 MW\textsubscript{th}
REFERENCES: Over 3,400 biomass plants in 72 countries

OUR CUSTOMERS INCLUDE:

- Manufacturing industry
- Counties, communes, public services
- Forestry and market-garden enterprises
- Energy providers
- Waste management companies
EXAMPLE PROJECT (1) NOBILIA: Processing of grainy biofuels and dusts in an arbitrary mix, according to availability

TECHNOLOGY
Hot-water boiler system with 2 x 4400 kW, ring burner infeed grate combustion with water-cooled combustion chamber, flame-tube/fire-tube boiler

FUEL
Chipboard waste with 50 - 100% dust content

INCLUDED IN DELIVERY
Complete plant technology including fuel supply and flue gas cleaning

SCOPE OF SERVICE
Plant concept and dimensioning, planning, construction

SPECIFICS
Sharp seasonal variation in fuel and heat demands
EXAMPLE PROJECT (2) AVIKO: Processing of potato residues in mix with waste wood AI - A III (17th BlmSchV)

**TECHNOLOGY**
Saturated steam boiler system 19 to/h, 26 bar(ü), inclined infeed grate combustion with partly-cooled combustion chamber, hybrid antechamber fire-tube boiler

**FUEL**
Waste wood AI - AIII, cuttings from landscape conservation, driftwood, potato scraps from the production of potato chips

**INCLUDED IN DELIVERY**
Complete plant technology including fuel supply and flue gas cleaning

**SCOPE OF SERVICE**
Plant concept and dimensioning, planning, construction

**SPECIFICS**
Sharp seasonal variation in fuel and load demands, approval of the system in accordance with 17th ordinance on the combustion and co-combustion of waste (BlmSchV), incorporation of the system into the existing boiler house, assembly and commissioning during full operation
EXAMPLE PROJECT (3) HEIDENROD: Efficient conversion of landscape conservation cut in decentralised industrial scale

TECHNOLOGY
Superheated steam boiler system 11 to/h 62 bar(a), 480°C with inclined infeed grate combustion in adiabatic chamber, vertical three-pass water-tube boiler

FUEL
Cuttings from landscape conservation and timber residues

INCLUDED IN DELIVERY
Complete plant technology including fuel supply, flue gas cleaning and water-steam circuit

SCOPE OF SERVICE
Plant concept and dimensioning, planning, construction

SPECIFICS
Transposition of larger-scale power plant technology to 5-12 MW, fuel with very low heating values (1.8 kWh/kg), high ash and chlorine content, sharp variation in water content and bulk density
EXAMPLE PROJECT (4) STRATHCONA, CANADA: Modular container system(s) for district heating and CHP

TECHNOLOGY
Hot-water boiler system, 840 kW th
Concept infeed grate combustion with cooled chamber, flame-tube/fire-tube boiler

FUEL
Waste wood (comparable to Al-All) and pelleted agrarian waste

INCLUDED IN DELIVERY
Complete plant technology including fuel supply and flue gas cleaning, pre-installed in container module

SCOPE OF SERVICE
Plant concept, construction

SPECIFICS
Construction in a modular container system, extreme weather conditions, Canadian regulations, collaboration with Canadian research institute, pilot system for "off grid towns"
LAMBION Energy Solutions GmbH
Auf der Walme 1
34454 Bad Arolsen
GERMANY

Phone: +49 (0) 5691 / 807-135
Mobile: +49 (0) 151 223 789 84

Email: rb@lambion.de
Website: www.lambion.de

Your contact person
Ralf Baues