BIOENERGIESYSTEME GmbH

Your partner for energy utilisation from biomass and energy efficiency
Research • Development • Engineering

ENGINEERING

Working fields – Expertises - References

8020 Graz, Hedwig-Katschinka-Straße 4, AUSTRIA
T: +43 (316) 481300
office@bios-bioenergy.at | www.bios-bioenergy.at

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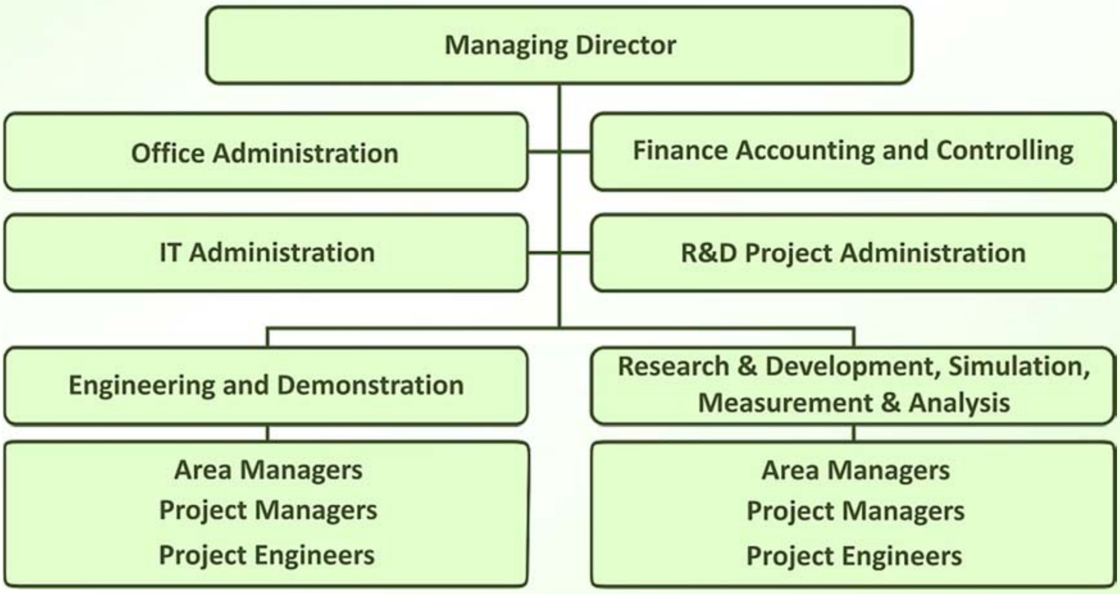
BIOS BIOENERGIESYSTEME GmbH
Key information

- **Founded in 1995 as a spin-off of the Graz University of Technology Re-organisation to a limited liability company in 2001**
- **2015 opening of the BIOS Innovation Centre**
- **General manager: Prof. Dr. Ingwald Obernberger**
- **Present staff: 25 (21 graduated engineers)**
- **Annual turnover in 2020: approx. 5.0 Mio €**
- **Markets:** Austria, Germany, Italy, Switzerland but also Belarus, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Greece, Hungary, Ireland, Montenegro, Norway, Russia, Serbia, Slovakia, Spain, The Netherlands, United Kingdom, Barbados, Canada, Chile, Honduras, USA, Bangladesh, Taiwan, South Africa

ORGANIGRAM of BIOS BIOENERGIESYSTEME GmbH



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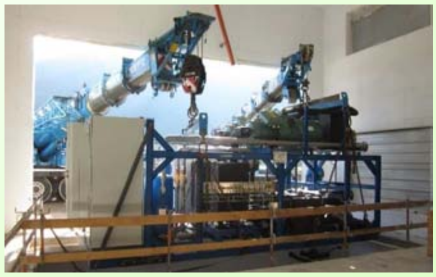
Working fields – Engineering I

- **Planning and optimisation of**
  - Heating and combined heat and power (CHP) plants
    - Application of different combustion based technologies (ORC, steam turbine, Stirling engine, screw-type steam engine, …)
    - Application of gasification and pyrolysis based systems
    - Utilisation of solid, liquid and gaseous biomass fuels and substrates
  - Waste heat recovery plants
    - e.g. downstream biomass combustion plants, industrial processes, gas turbines,…
  - Heat pumps, chilling plants
  - Energy centres
  - Process heat supply systems



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Working fields – Engineering II

- **Planning and optimisation of**
  - Hybrid plants (combination of different technologies)
    - Solar power / biomass
    - Solar power / heat pump / biomass
    - Industrial waste heat / biomass
    - Industrial waste heat / heat pump / biomass
  - Heat storage solutions
    - low and high temperature storage units, latent heat storage units
  - District heating networks
  - Pellet production and torrefaction plants
  - Biomass refinery concepts based on biomass pyrolysis

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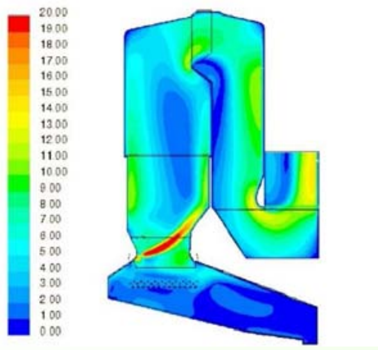
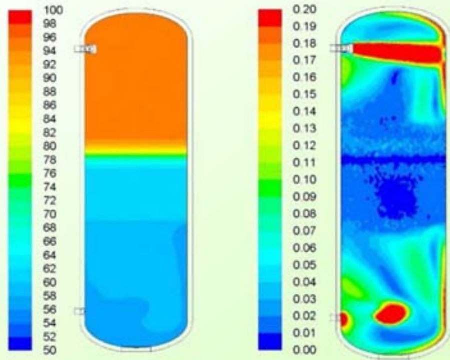
Working fields with engineering relevance

- CFD-based planning and optimization of biomass conversion processes, storage systems, flue gas cleaning systems and coolers
- Flue gas and efficiency measurements needed for plant commissioning and evaluation
- Analyses (biomass fuels, ashes and aerosols, waste water)
- Biomass and ash characterisation
- Development of concepts for sustainable ash utilization



Biomass-fired water tube boiler / D



Heat storage tank / A

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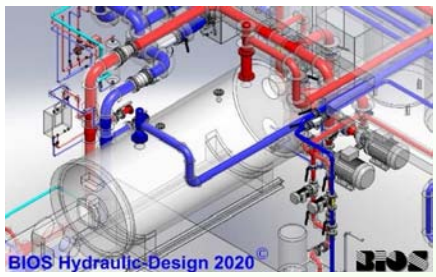
Working fields - consulting, assessment, quality management

- Process monitoring with accompanying measurements and analyses as a basis for plant optimisation
- Development and implementation of measures for increasing energy efficiency
- Consulting concerning energy efficiency policy
- Management of and participation in national and international R&D and demonstration projects
- Application and execution of national and international project funding
- Quality management of biomass heating systems according to Austrian „QM“ regulations
- Preparation of expertises concerning ash related questions, special biomass fuels, biomass combustion, gasification and pyrolysis technologies as well as process control and hydraulic circuits



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Engineering tools used

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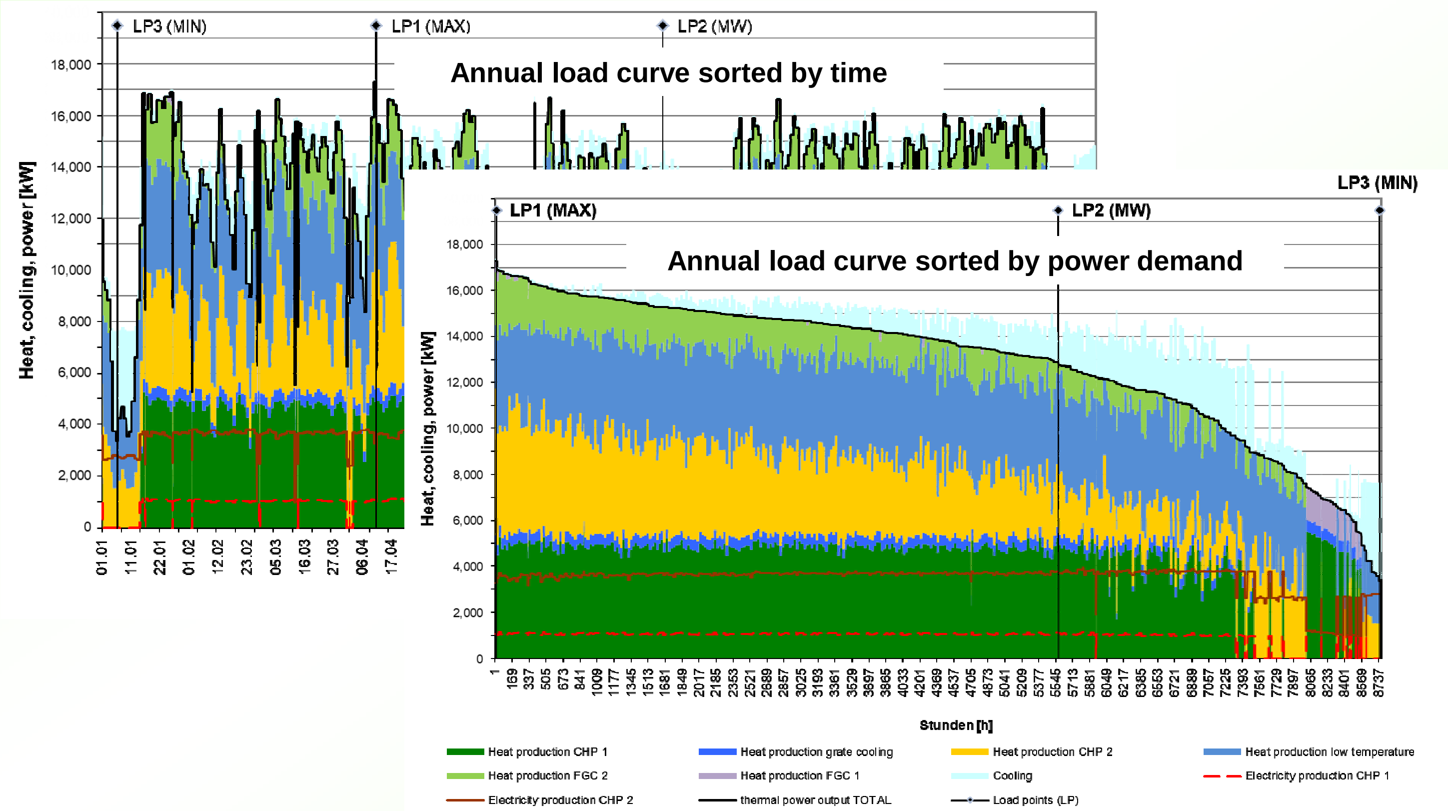
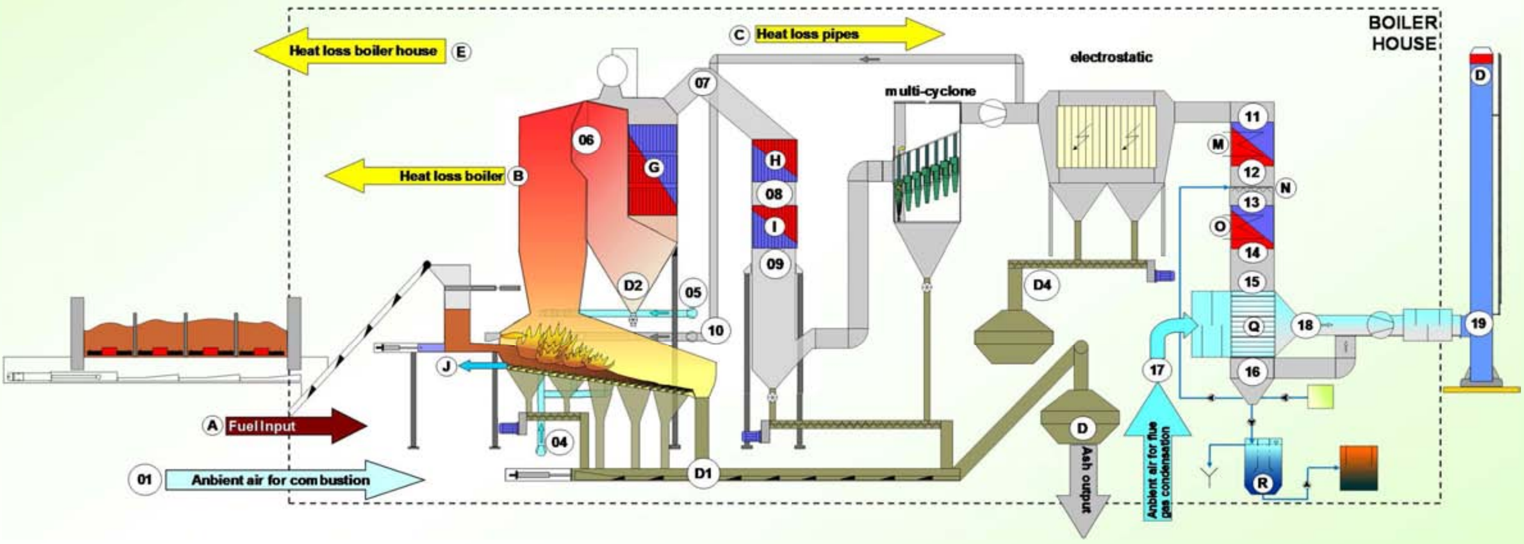
Overview of tools used

SE-Bilanz:	**Mass and energy balance calculations for entire plants over a whole year on an hourly basis**
BIOBIL:	**Mass and energy balance calculations for biomass combustion plants**
DK-Bilanz:	**Mass and energy balance calculations for steam cycles (based on water and organic working media)**
Hydraulic Design:	**Dimensioning of hydraulic components such as pumps, control valves, etc. based on the simulation of the entire plant**
BIOS design:	**Economic evaluations (according to VDI 2067 and to calculations of the dynamic amortisation period) including tools for sensitivity analysis**
AutoCAD Plant3D:	**Preparation of P&I diagrams and of 3D layout and piping plans**
R-Design:	**Design and optimisation of district heating networks, calculation of annual load curves and annual heat losses**

Balances for entire plants over a whole year on an hourly basis



Scheme for mass and energy balances of biomass heating and CHP plants

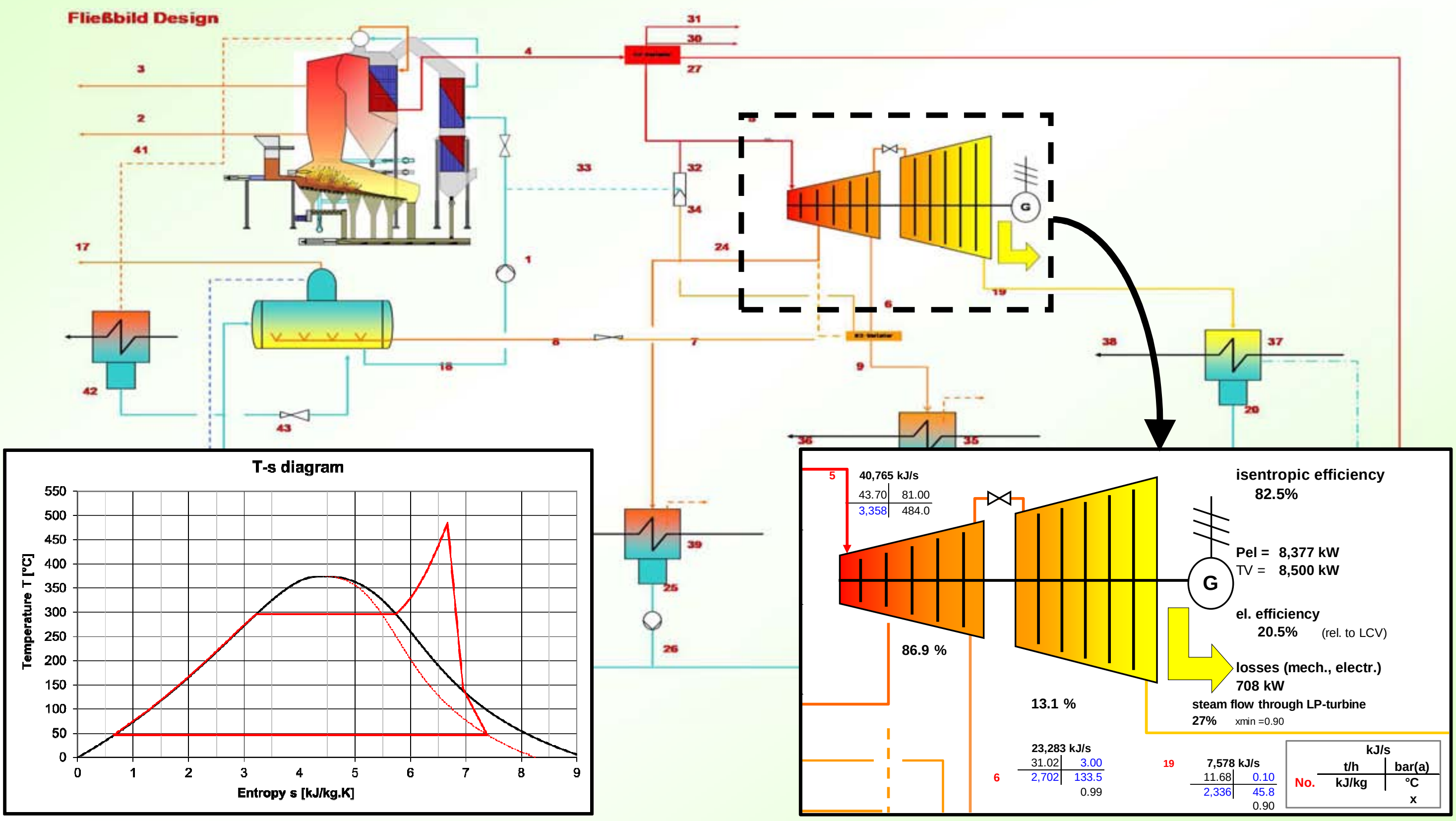


Mass and energy balance of biomass heating and CHP plants (excerpt)

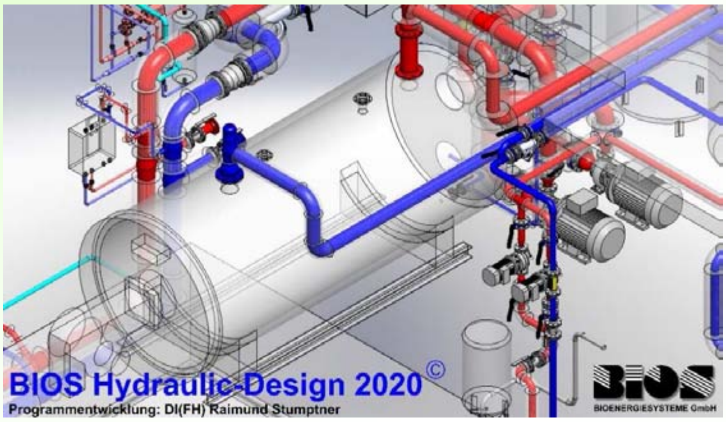
Refer. Point	Description Gaseous flow	Temp. [°C]	Dry gaseous flows Mass flow [kg/h]	Volume flow [Sm³/h]	Volume flow [m³/h]	Density [kg/m³]
01	Ambient air	0.0	61,507	47,785	50,877	1.209
02	Boiler house air	63.5	61,507	47,785	62,703	0.981
03	Combustion air	63.5	61,507	47,785	62,703	0.981
04	Primary air	63.5	26,712	20,752	27,232	0.981
05	Secundary air	63.5	34,795	27,032	35,472	0.981
06	FG in furnace (adiab. FG-Temp.)	950.0	79,848	58,940	281,012	0.284
07	FG out of the TO-Boiler	350.0	79,848	58,940	143,165	0.558
08	FG out of the TO-ECO HT	270.0	79,848	58,940	124,786	0.640
09	FG out of the TO-ECO LT	180.0	79,848	58,940	104,109	0.767
10	FG recirculation	150.0	15,341	11,324	18,678	0.821
11	FG into the economiser	150.0	64,506	47,616	85,430	0.755
12	FG out of the enconomiser	75.0	64,506	47,616	64,618	0.998
13	FG into the condenser	61.1	64,506	47,616	62,037	1.040
14	FG out of the condenser	55.0	64,506	47,616	60,906	1.059
15	FG into the air pre-heater	55.0	64,506	47,616	60,906	1.059
16	FG out of the air pre-heater	35.0	64,506	47,616	57,194	1.128
17	Devaporisation air into the air pre-heater	0.0	259,379	201,511	214,552	1.209
18	Devaporisation airout of the air pre-heater	52.5	259,379	201,511	255,812	1.014
	Drying air into the air pre-heater					
	Drying air out of the air pre-heater					
19	FG stack	48.9	323,885	249,127	312,735	1.036

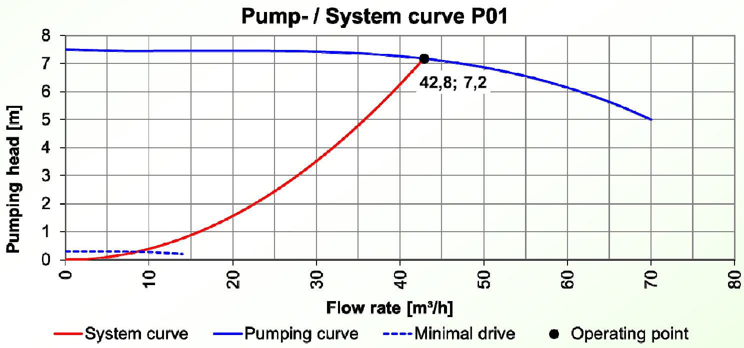
Refer. Point	Description	*Efficiency based on LHV*	Capacity [kW]
Total energy input (furnace)			**30,467.2**
A	**Fuel input (LHV)**	*100.0%*	**29,196.8**
	Heat fuel	-	98.1
03	Heat combustion air		669.6
10	FG recirculation		698.9
Total energy output (furnace)			**30,467.2**
07	Enthalpy of FG after TO-ECO 2		9,685.6
	Chemical bound heat FG		19.8
D	Enthalpy of ash		2.5
	Chemical bound heat ash		9.3
B+J	Heat losses boiler + grate cooling		750.0
G	Useful heat of: TO-Boiler, TO-ECO HT, TO-ECO LT		20,000.0
Heat use / heat recovery		*useful heat*	**25,609.8**
G	TO-Boiler	*68.5%*	20,000.0
H	TO-ECO HT	*8.4%*	2,456.6
I	TO-ECO LT	*9.3%*	2,703.2
J	Grate cooling	*1.5%*	450.0

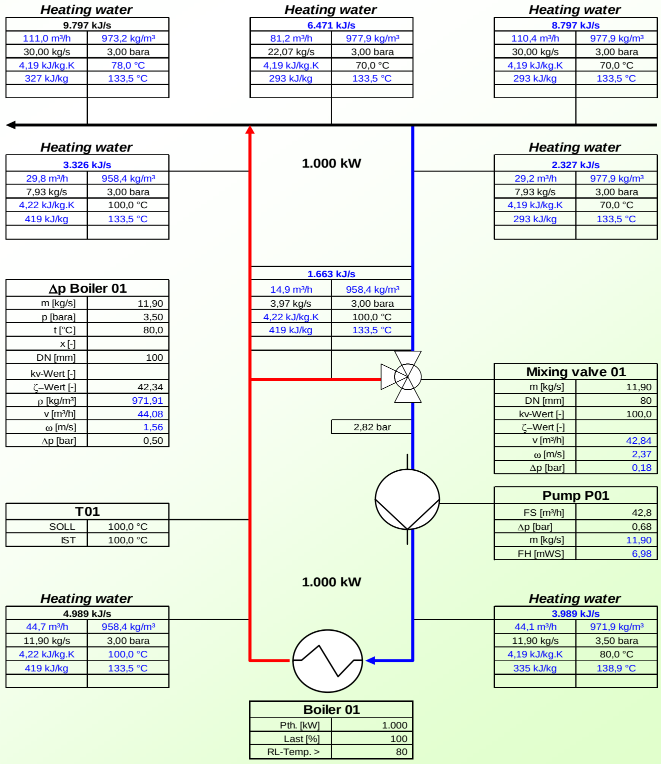
Mass and energy balances for steam cycles (based on water and organic working media)



Dimensioning of hydraulic components such as pumps, control valves, etc. based on the simulation of the entire plant



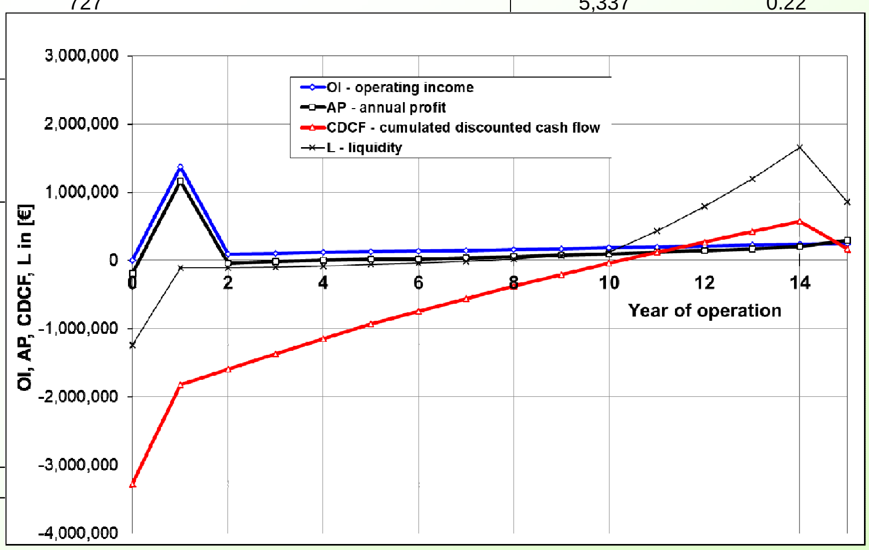




Economic evaluations (according to VDI 2067 and calculations of the dynamic amortisation period) including tools for sensitivity analysis

Economic calculation according to VDI 2067

	Investment costs €	capital bound costs € p.a.	maintenance costs € p.a.	consumption based costs € p.a.	operating costs € p.a.	total energy costs € p.a.	specific energy costs € / MWh sold
Construction costs							
Building	312,493	19,826	3,125			22,951	0.95
Storage area	72,673	4,611	727			5,337	0.22
Outside facility	21,802	1,383					
Infrastructure	7,267	461					
Network of pipes							
Pipes	130,811	8,464					
Trenching / backfilling	36,336	2,351					
Heat transfer stations	-	-					
Mechanical equipment							
Combustion and boiler	639,521	55,756					
Electricity							
Other costs							
Operational supplements CHP							
Rental fee (property)							
Sum of costs	**3,277,030**	**271,761**					
specific energy costs (w/o subsidies)		11.20					



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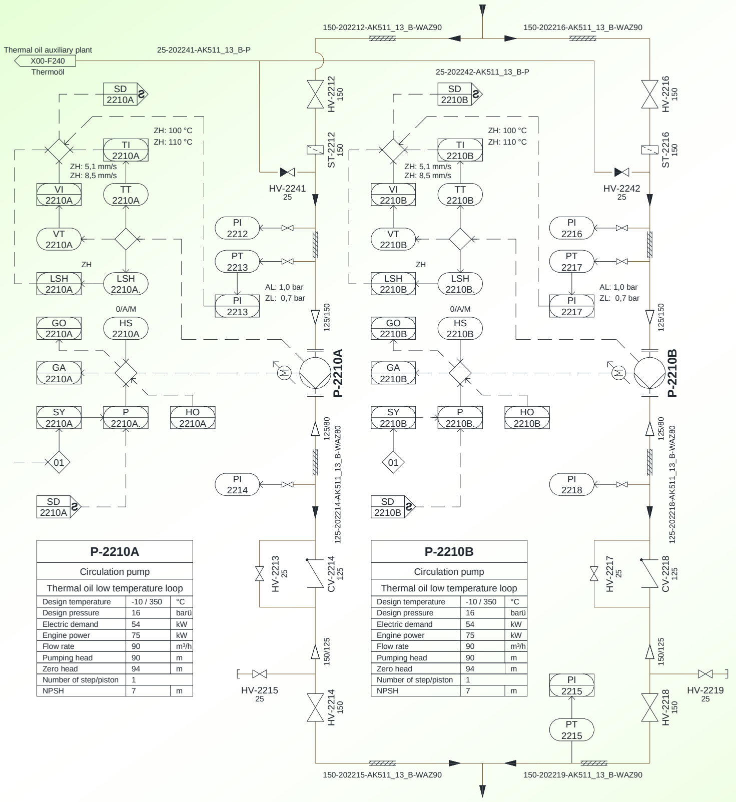
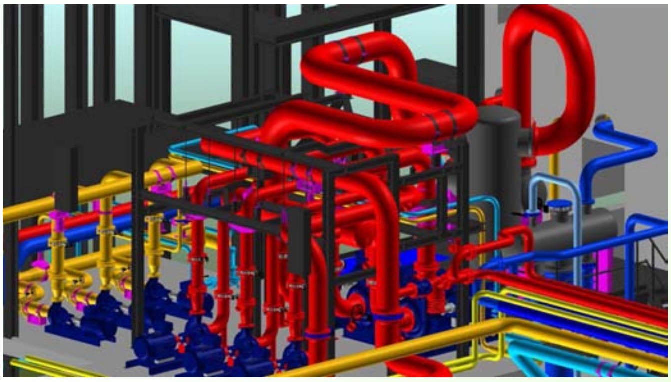
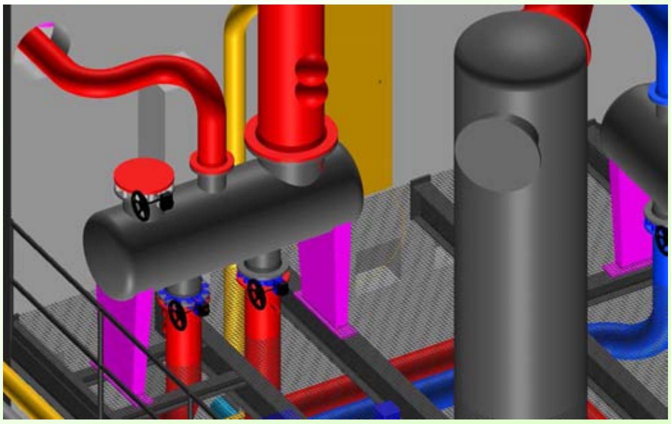
Autodesk® AutoCAD® Plant3D

Preparation of P&I diagrams and of 3D layout and piping plans







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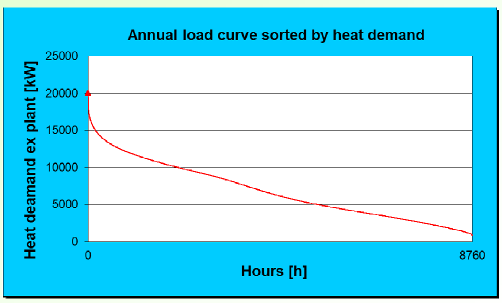
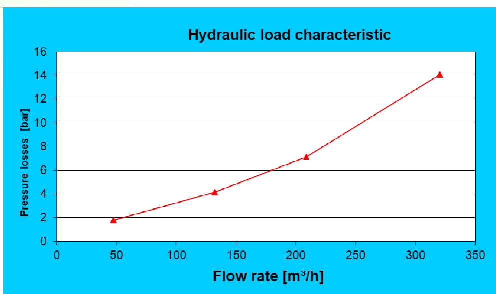
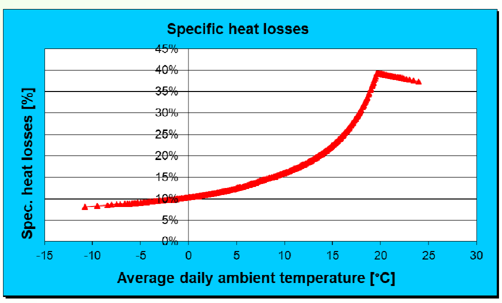
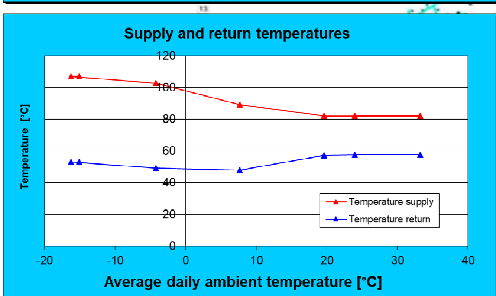
R-Design

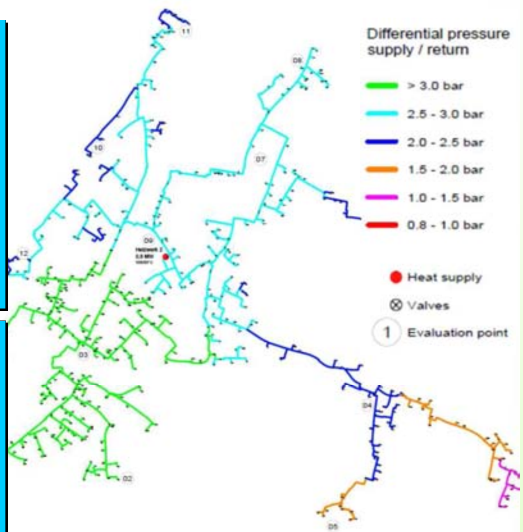
Design and optimisation of district heating networks, calculation of annual load curves and annual heat losses











Pressure analyses at minimum ambient temperture (AT -16°C)

DH-Network Point analysed	Sea level [m]	Geodesic pressure [bar]	Static pressure [bar]	Dynamic pres. supply [bar]	Dynamic pres. return [bar]	Differential pressure [bar]	Total pressure [bar]	max. pressure at valve shut off [bar]
1	675	3.6	5.8	14.3	0.2	14.1	20.1	21.3
2	712	-	2.2	9.7	5.2	4.5	11.9	17.7
3	658	5.3	7.5	9.6	5.3	4.3	17.1	23.0
4	658	5.3	7.5	8.6	6.5	2.0	16.1	23.0

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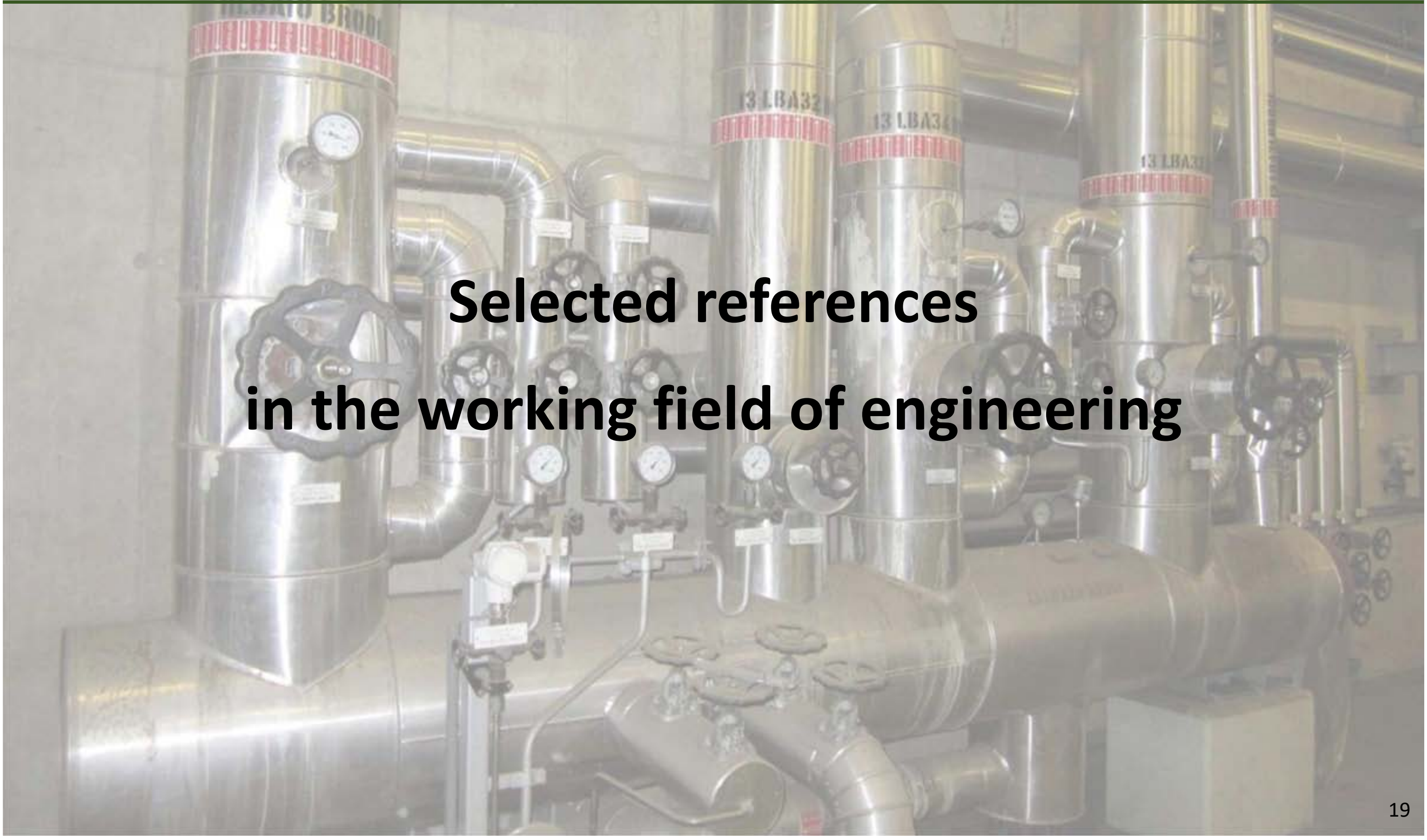

Selected references

in the working field of engineering

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Biomass steam boiler plant Tirol-Milch-Wörgl

- Wörgl (Tyrol, Austria)
- Process steam generation for a dairy
- 9.2 t/h saturated steam boiler, 14 bar

Wörgl / AFirebox / steam pipeline

Biomass hot water boiler plant Stadtwärme Lienz

- Lienz (Tyrol, Austria)
- Retrofitting of boiler plant
- 8 MW_{th} biomass hot water boiler

Lienz / A
Boiler assembly

Biomass CHP plant based on an ORC process
Holzindustrie STIA

- Admont (Styria, Austria)
- EU demonstration project
- First biomass CHP plant based on ORC technology within the EU

Admont / A
0.4 MW_{el} ORC process

Biomass CHP plant based on an ORC process
AS Kuressaare Soojus

- Kuressaare (Saare, Estonia)
- 2.2 MW_{el} ORC plant
- Integration of an ORC plant into an existing heat generation plant

Kuressaare / EE
Biomass CHP

Biomass CHP plant based on a steam turbine process
EVN AG

- Mödling (Lower Austria, Austria)
- 5 MW_{el} steam turbine
- 23.4 MW_{th} biomass-fired water tube steam boiler

Mödling / A
Grate of furnace

Biomass CHP plant based on a steam turbine process
Bioenergie Kufstein

- Kufstein (Tyrol, Austria)
- 6.5 MW_{el} steam turbine
- 24.5 MW_{th} biomass-fired water tube steam boiler with SNCR system for NOx reduction and flue gas condensation unit

Kufstein / A
Biomass CHP

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Selected references
Heat and power from biomass

Biomass CHP plant based on a steam screw-type engine cycle
Fernwärme Waldviertel

- Hartberg (Styria, Austria)
- EU demonstration project
- First biomass CHP plant based on steam screw-type engine technology worldwide

Hartberg / A
0.8 MW_{el} steam screw-type engine

Biomass CHP plant based on a Stirling engine process
TDZ Ennstal

- Reichraming (Upper Austria, Austria)
- National demonstration project
- First commercial demonstration of a biomass-fired Stirling engine worldwide

Reichraming / A
35 kW_{el} Stirling engine

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Selected references
Heat recovery plants

Heat recovery by economiser and coupled ORC
RHI AG

- Radenthein (Carinthia, Austria)
- Thermal-oil economiser placed in the flue gas flow downstream industrial furnaces
- Heat recovery combined with a 1.0 MW_{el} ORC process

Radenthein / A
5.8 MW_{th} economiser

Heat recovery by flue gas condensation for district heating – Stadtwerke Wörgl

- Wörgl (Tyrol, Austria)
- Heat recovery downstream a biomass-fired fire tube steam boiler plant
- 380 kW economiser and 1,000 kW flue gas condenser

Wörgl / A
Flue gas condensation

Heat recovery of exhaust gas in a steel foundry ORI Martin

- Brescia (Lombardy, Italy)
- EU demonstration project - PITAGORAS
- Exhaust gas heat exchanger capacity: 10 MW_{th} coupled with a 2.0 MW_{el} ORC process and extraxtion of district heat

Brescia / I
Steel foundry

Heat recovery in a cement industry Wopfinger Baustoffindustrie

- Waldegg (Lower Austria, Austria)
- National R&D project – INAZement
- Analysis of different options concerning heat recovery in the cement production process

Waldegg / A
Cement industry

Utilisation of industrial waste heat by heat pumps Stadtwerke Wörgl

- Wörgl (Tyrol, Austria)
- Utilisation of waste heat for district heating
- Compression heat pumps 1 x 1,150 kW and 2 x 1,500 kW heating capacity

Wörgl / A
Heat pumps

Development of a direct evaporation heat pump for flue gas condensation

- National research project – ICON
- Waste heat utlilisation by flue gas condensation with directly integrated heat pump
- Compression heat pump with 60 kW heating capacity

Bärnbach / A
Pilot plant ICON

CHP hybrid system consisting of biomass-fired ORC process and a large-scale solar panel field Marstal Fjernvarme

- Marstal (Ærø, Denmark)
- EU demonstration project
- CHP hybrid system based on biomass combustion and solar energy
- Biomass thermal-oil boiler
- ORC module 0.75 MW_{el}
- Flue gas condensation unit
- CO2 based compression heat pump 1.5 MW_{th}
- Large-scale pit heat storage 75,000 m^3
- Solar collector field of 18,300 m^2 and 15,000 m^2
- Share of solar energy on total district heat supply: 38%

Marstal / DK
Plant overview

Marstal / DK
CO_2 based heat pump

CHPC plant based on biomass Biostrom

- Fussach (Vorarlberg, Austria)
- National demonstration project
- Waste wood-fired combined heat, power and chilling (CHPC) plant based on an ORC cycle and an absorption chiller
- Waste wood pre-treatment unit
- Waste wood-fired thermal-oil boiler
- ORC module 1.1 MW_{el}
- Absorption chiller 2.4 MW
- Open wet cooling tower
- Dry cooler (glycol-water)
- District and process heat extraction

Fussach / A
Plant overview

Fussach / A
Absorption chiller

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Optimisation of a biomass CHP plant based on a steam turbine – Bioenergie Kufstein

- Kufstein (Tyrol, Austria)
- Evaluation of different options for steam-based CHP plants and operating conditions
- Retrofit from an extraction condensing turbine to a backpressure turbine

Kufstein / A
6.5 MW_{el} steam turbine

Optimisation of process heat supply Holzindustrie Pfeifer Kundl

- Kundl (Tyrol, Austria)
- Technical evaluation of expansion scenarios
- Hydronic optimisation and expansion of the heat distribution system
- Retrofit of the steam turbine and integration of a flue gas condensation system

Kundl / A
Factory site

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Biomass CHP plant with heat storage system – Stadtwärme Lienz

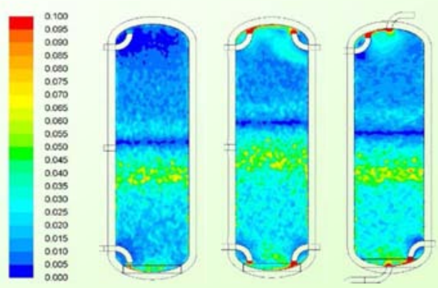
- Lienz (Tyrol, Austria)
- Integration of a 400 m³ heat storage tank (7 bar, 110°C)
- Optimised design and integration by a dynamic simulation of the heat demand over a year

Lienz / A

Biomass CHP plant

Power generation from waste heat supported by high temperature heat storage – voestalpine Tubulars

- Kindberg (Styria, Austria)
- National research project STORC
- Waste heat utilisation based on an ORC unit
- Transient CFD simulation of a high temperature heat storage (based on thermal oil) with discontinuous loading as a basis for an optimised design



CFD simulation of the high-temperature heat storage

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Selected references
District heating systems

District heat supply based on biomass Förderungsgenossenschaft Ulten

- St. Walburg (South Tyrol, Italy)
- Planning of the district heating network and the network extension
- Main supply line twin-pipes DN 100

St. Walburg / I
Twin-pipes

District heat supply based on waste heat Ortswärme St. Johann

- St. Johann (Tyrol, Austria)
- District heat supply with multiple supply points
- Evaluation and simulation of extension options

St. Johann / A
District heating network

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Selected references
Pellet production plants
Torrefaction plants

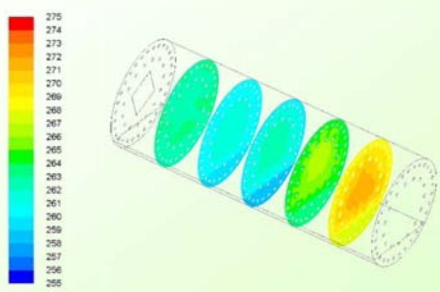
Retrofit and extension of a pellet production plant – H&H Pellets

- Stainach (Styria, Austria)
- Pellet production capacity: 40,000 tons per year
- Integration of a biomass- and a gas-fired CHP plant for heat and power supply

Stainach / A
Dryer for sawdust

Optimisation of a torrefaction reactor

- Frohnleiten (Styria, Austria)
- National R&D project – TorrReaktorTechnik – in cooperation with Andritz AG
- Indirectly heated rotating reactor (1 t/h demonstration plant)
- CFD simulation based on a 3D CFD model for fixed-bed torrefaction processes as a basis for design optimisation



CFD simulation of a torrefaction reactor

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8020 Graz, Hedwig-Katschinka-Straße 4, AUSTRIA

T: +43 (316) 481300

office@bios-bioenergy.at | www.bios-bioenergy.at

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