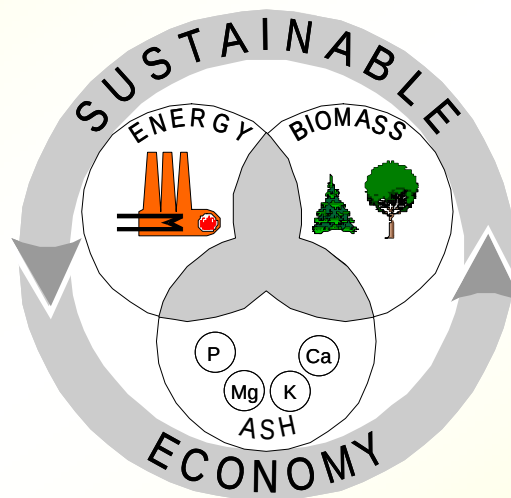


Austrian pellet boiler technologies – state-of-the-art, ecological evaluation and future developments

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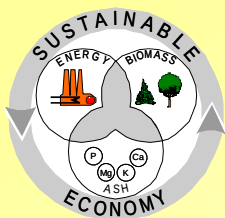
Homepage: <http://www.bios-bioenergy.at>



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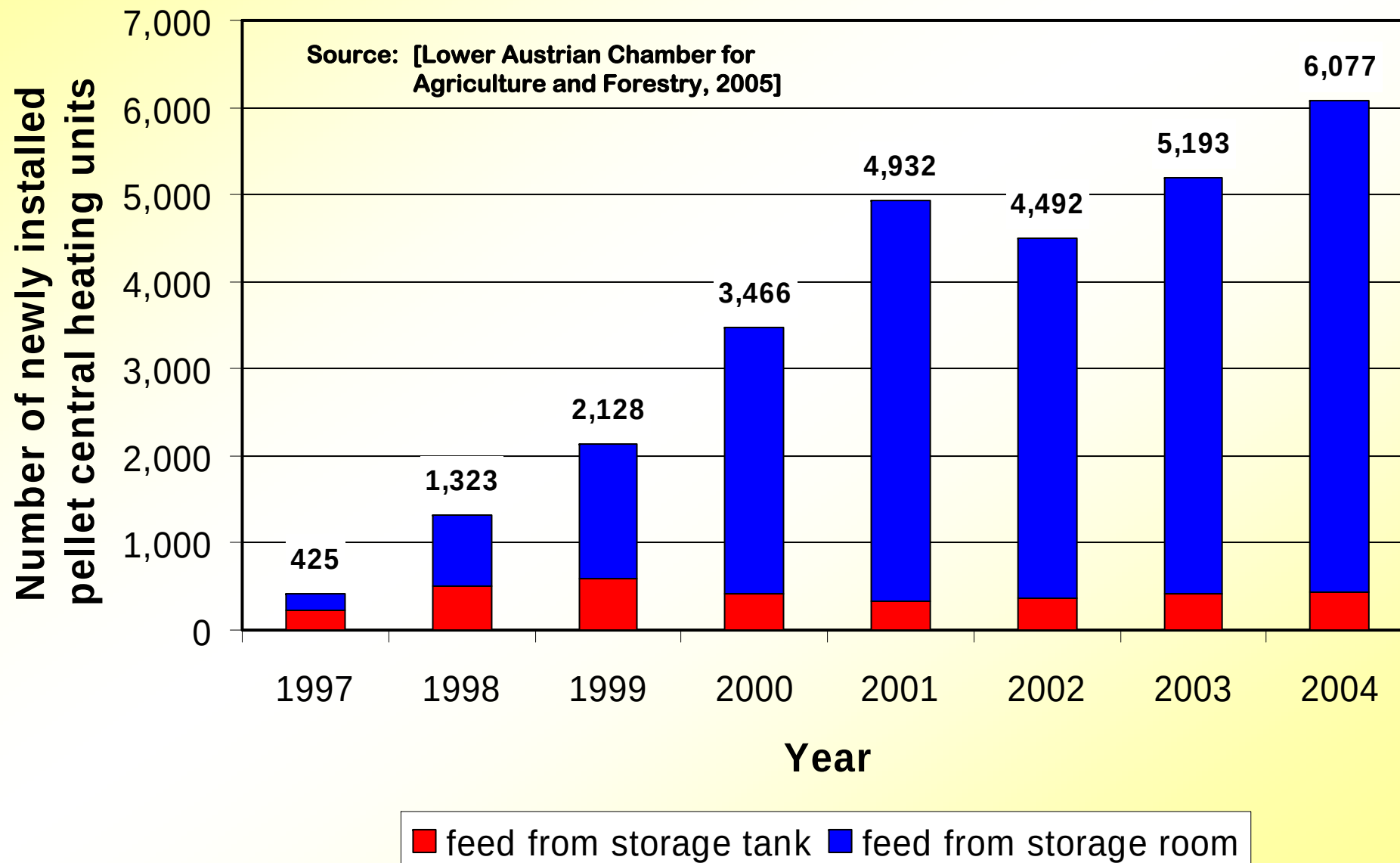
Introduction

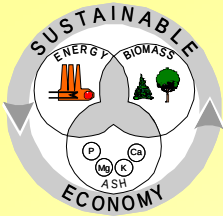
- Austrian pellet market
- Standards for pellet furnaces
- Pellet combustion technology
 - Feeding
 - Storage
 - Burn-back protection
 - Basic burner principles
 - Technical details
(furnace geometry, materials, control systems, boiler technology, de-ashing)
- Emissions
- Future developments



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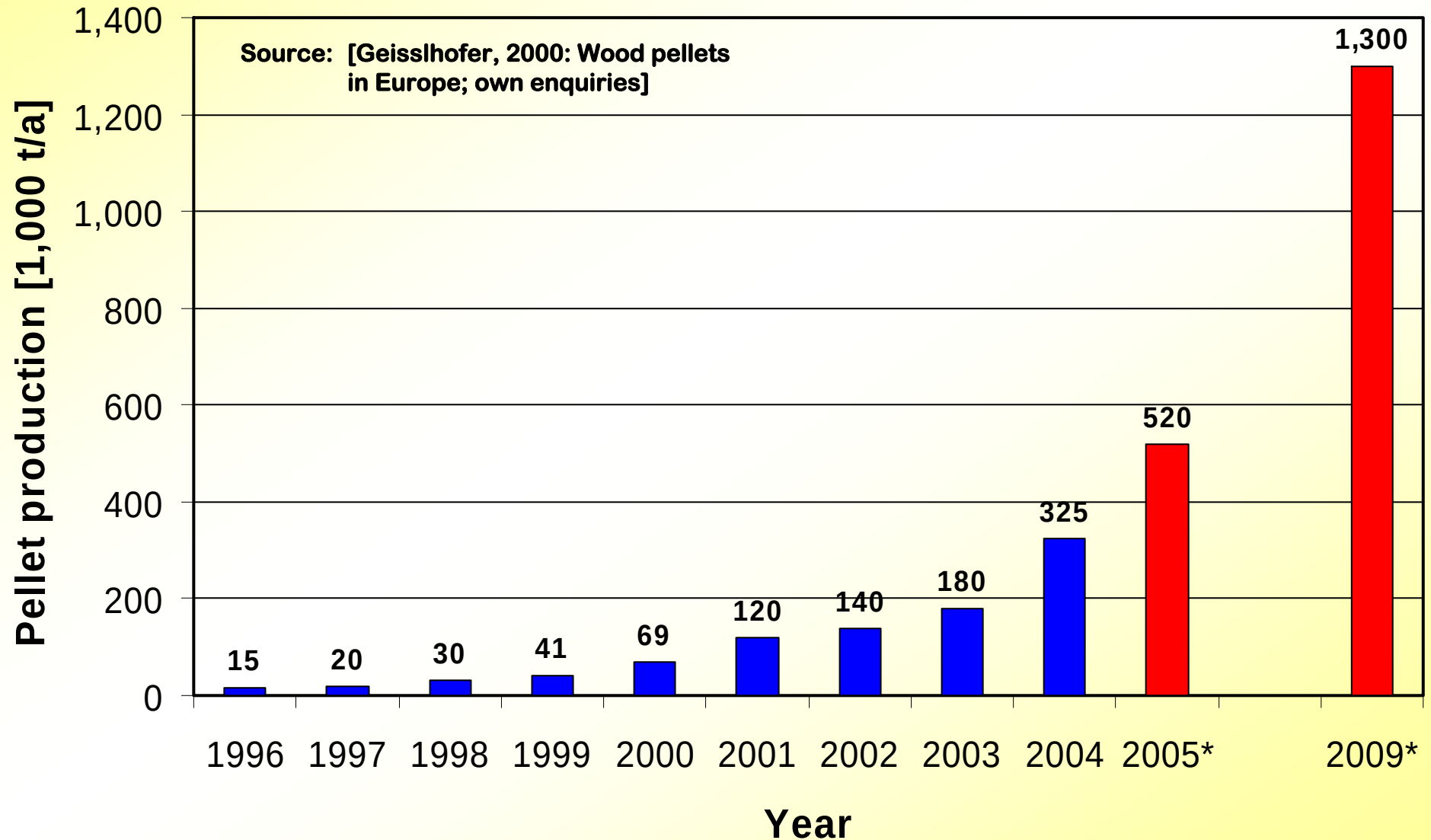
Development of small-scale pellet furnaces in Austria





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Pellet production in Austria – present state and outlook



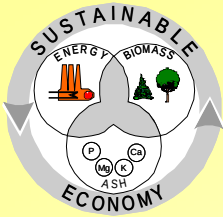
* estimate



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Pellet consumption in Austria (year 2004)

- About **28,000** pellet central heating systems already installed in Austria
- Total nominal boiler capacity installed: about **520 MW**
- Annual utilisation rate: about **74%**
- Boiler full load operation hours: **1,500 h p.a.**
- Net calorific value of pellets: **4.9 kWh/kg (w.b.)**
- ➔ Pellet consumption in Austria approximately **216,000 t/a**
(related to pellet central heating systems)
- ➔ Additional amounts related to pellet stoves and medium-scale pellet furnaces (**100 to 1,000 kW_{th}**)
- ➔ Difference to production: mainly **export**



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General framework in Austria

- Investment subsidies granted in Austria on average 25 % (depending on the Austrian provinces)
- Currently 18 pellet producers active or near start-up in Austria
- Pellet quality, transport and storage regulated by ÖNORM M 7135, M 7136 and M 7137
- Quality of pellet furnaces regulated by ÖNORM EN 303-5
- Supply of pellets in Austria assured throughout the country by a well organised distribution network
- About 30 manufacturers of small-scale pellet furnaces in Austria



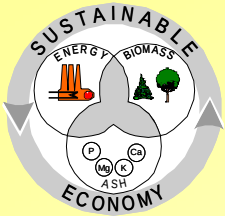
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Standards for furnaces fired with pellets

ÖNORM EN 303-5

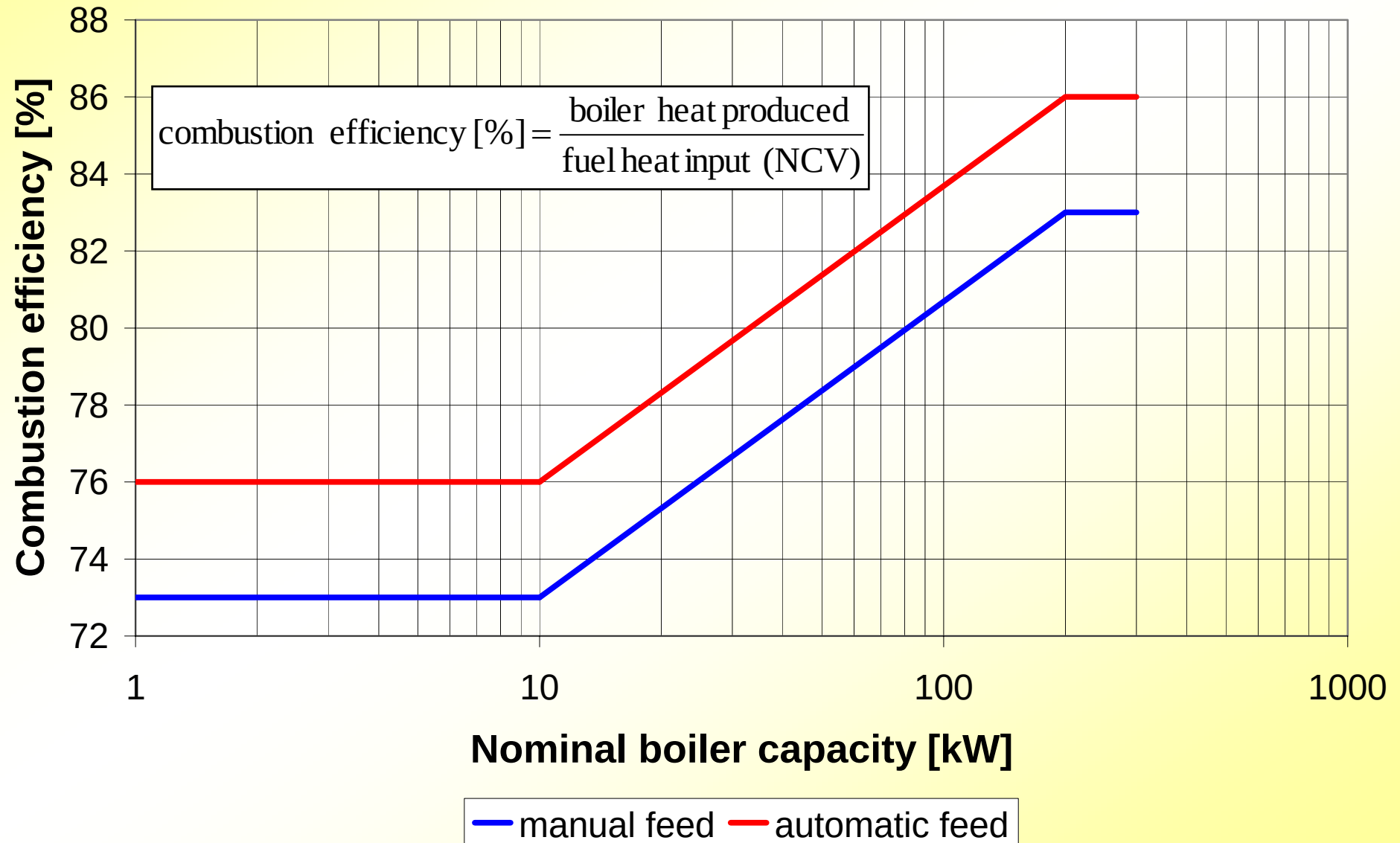
parameter	value
valid for heating boilers with a nominal boiler capacity up to	300 kW
testing required by law	yes
all solid fuels (biomass and fossil fuels) are permitted	yes
maximum organic carbon (OGC) emission [mg/MJ _{NCV}]	40
maximum CO emission [mg/MJ _{NCV}]	500
maximum NO _x emissions [mg/MJ _{NCV}]	150
maximum dust emissions [mg/MJ _{NCV}]	60
minimum combustion efficiency	*

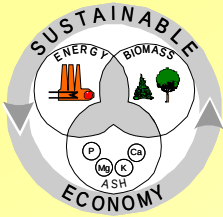
*depending on the nominal boiler capacity (see following slide)



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Minimum combustion efficiency according to ÖNORM EN 303-5





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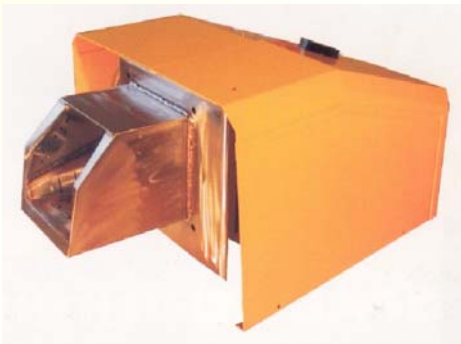
Pellet combustion systems

Pellet stoves



Source: [RIKA Metallwarenges.m.b.H. & Co KG, Austria]

Pellet burners



Source: [Gilles Energie und Umwelttechnik GmbH, Austria]

Pellet central heating systems



Source: [GUNTAMATIC Heiztechnik GmbH, Austria]

Grate fired pellet boilers for medium-scale applications (150 to 300 kW_{th})



Source: [KWB Kraft und Wärme aus Biomasse GmbH, Austria]



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Feeding and storage systems used

Feeding systems

- Screw conveyor (inflexible)
- Screw conveyor (flexible)
- Pneumatic system
- Pneumatic system / screw conveyor combination
- Agitator / screw conveyor combination

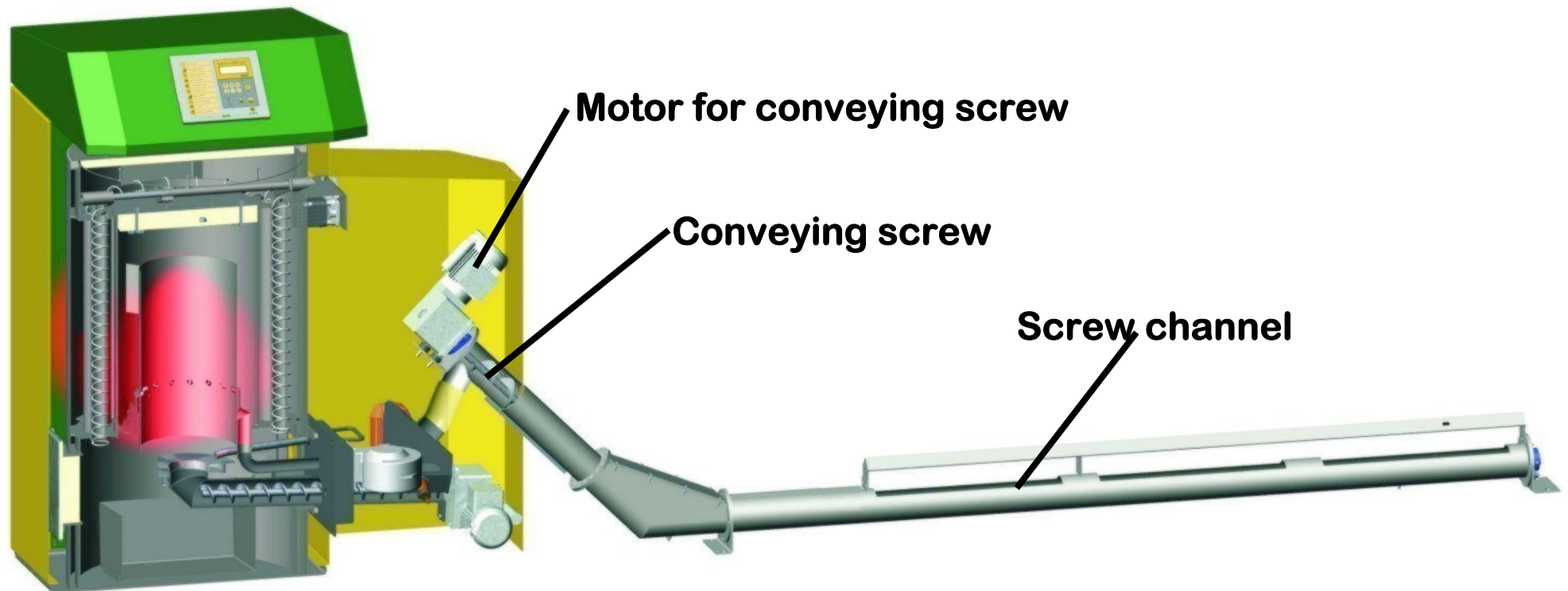
Storage systems

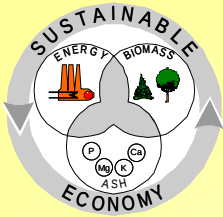
- Storage room (88 %)
- Integrated store (12 %)
- Underground storage tank



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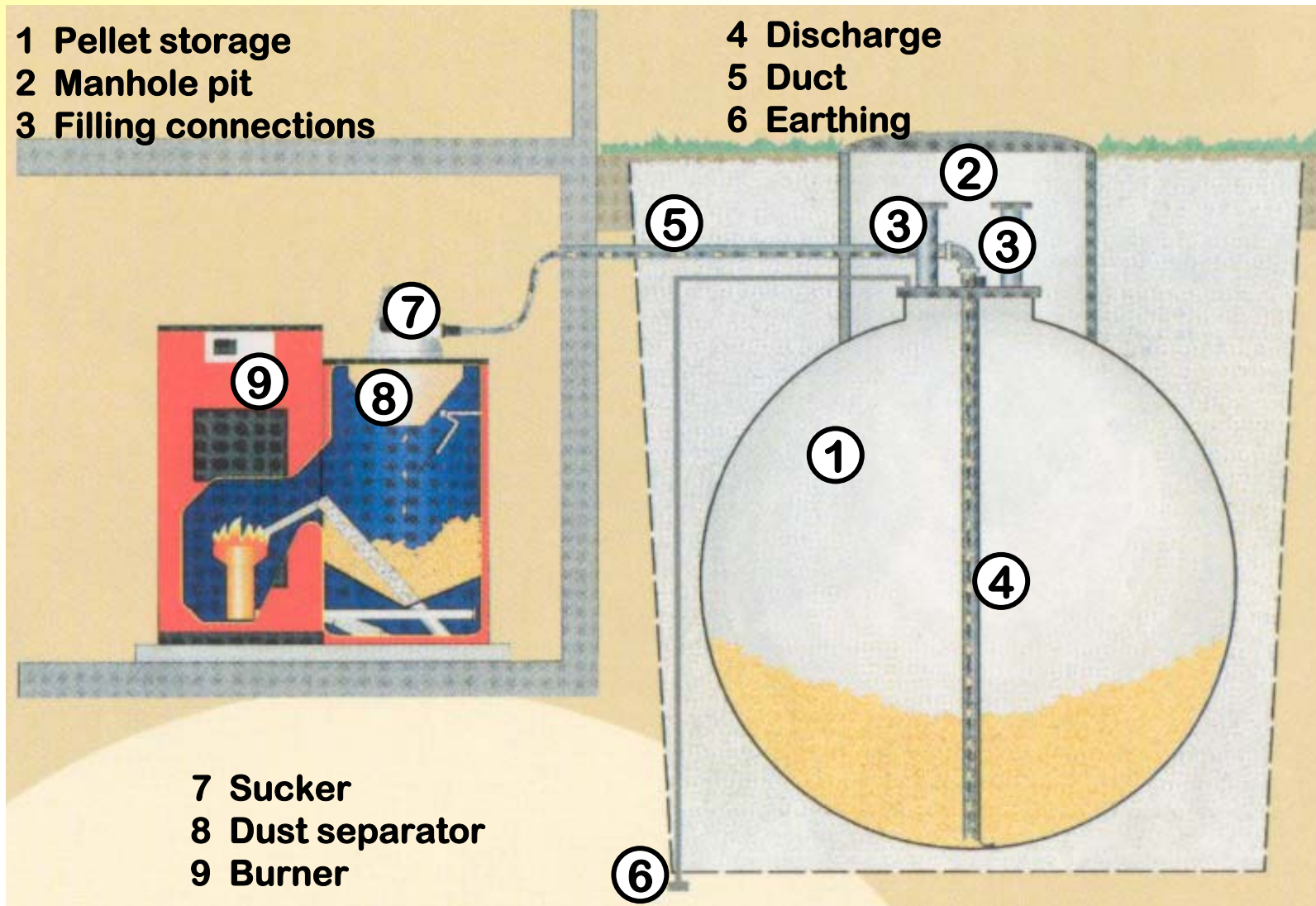
Screw conveyor (inflexible)



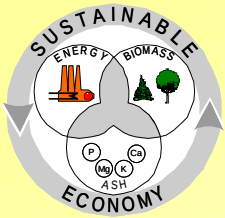


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Underground storage tank



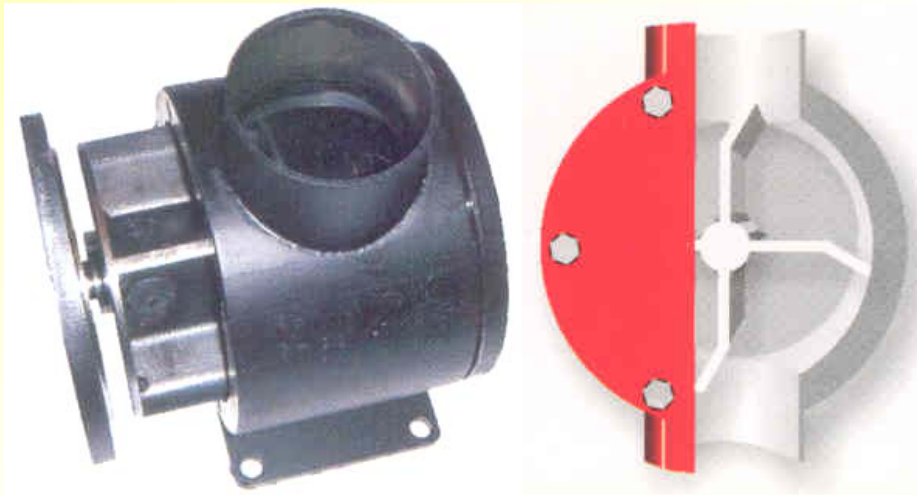
Source: [Stefan Nau GmbH & Co. KG, Germany, 2002]



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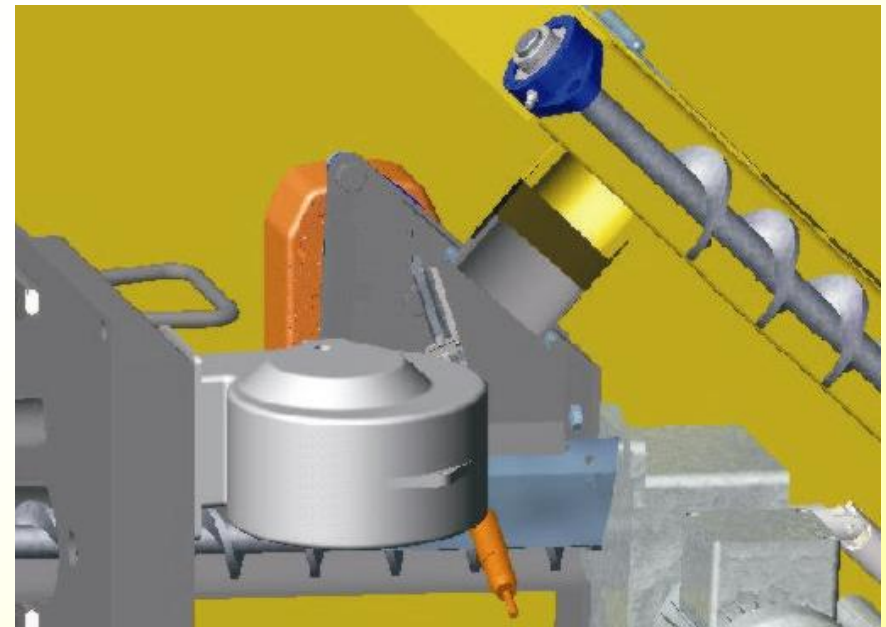
Burn-back protection systems (1)

Cellular wheel sluice



Source: [COMPACT Heiz- und Energie-systeme GesmbH,
Austria]

Fireproof valve



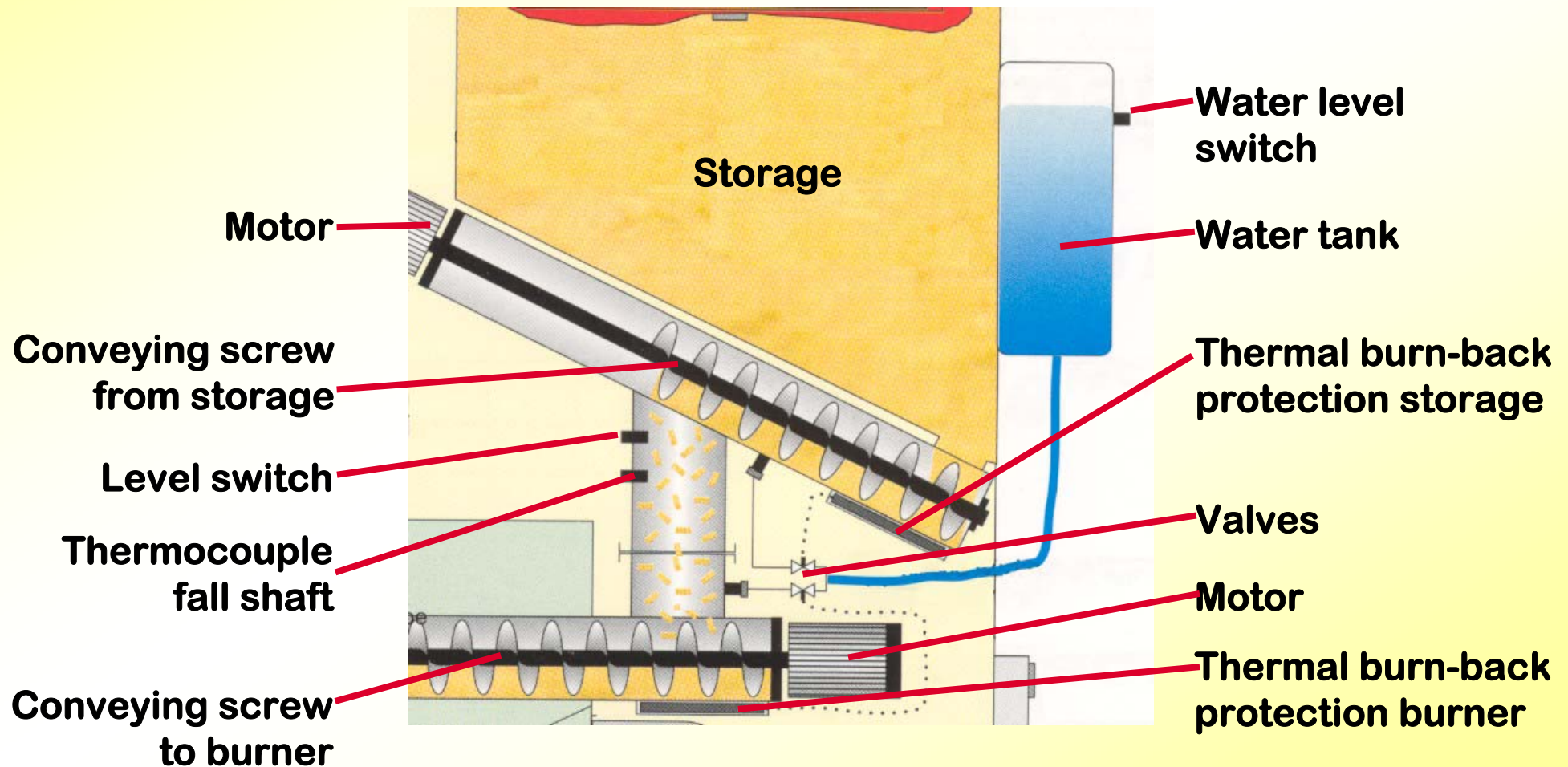
Source: [KWB – Kraft und Wärme aus Biomasse GmbH]



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Burn-back protection systems (2)

Extinguisher system

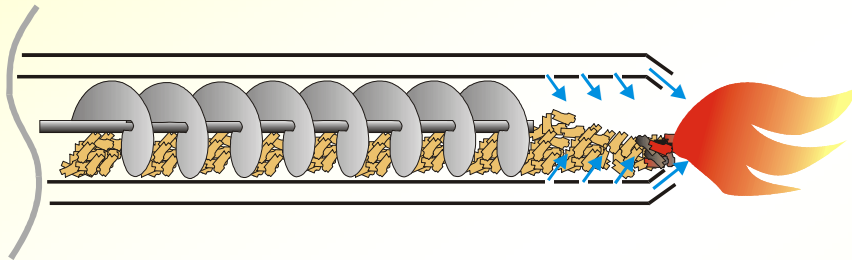




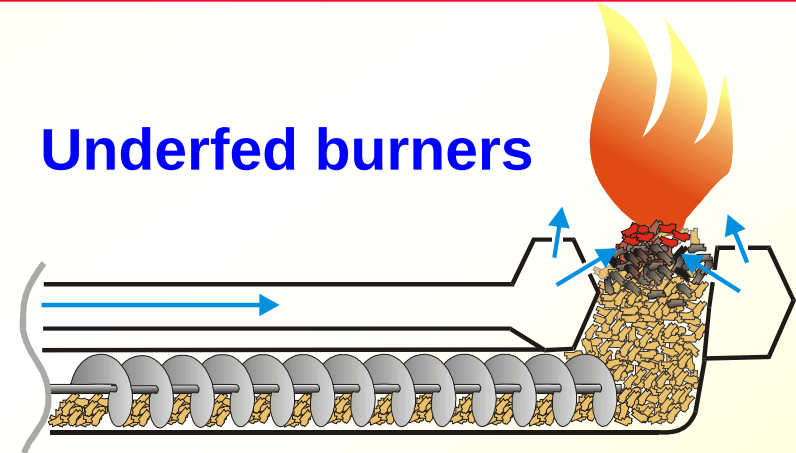
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Basic principles of wood pellet burners

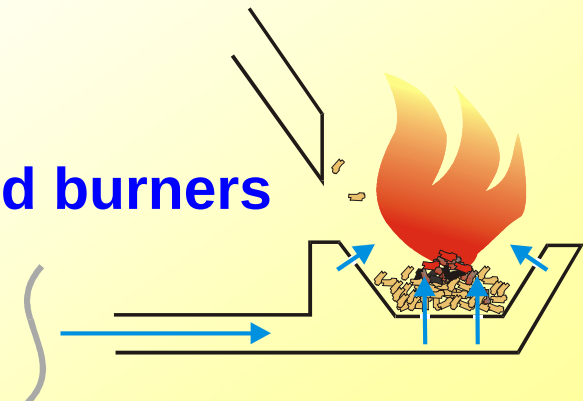
➤ Horizontally fed burners

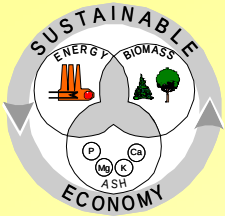


➤ Underfed burners



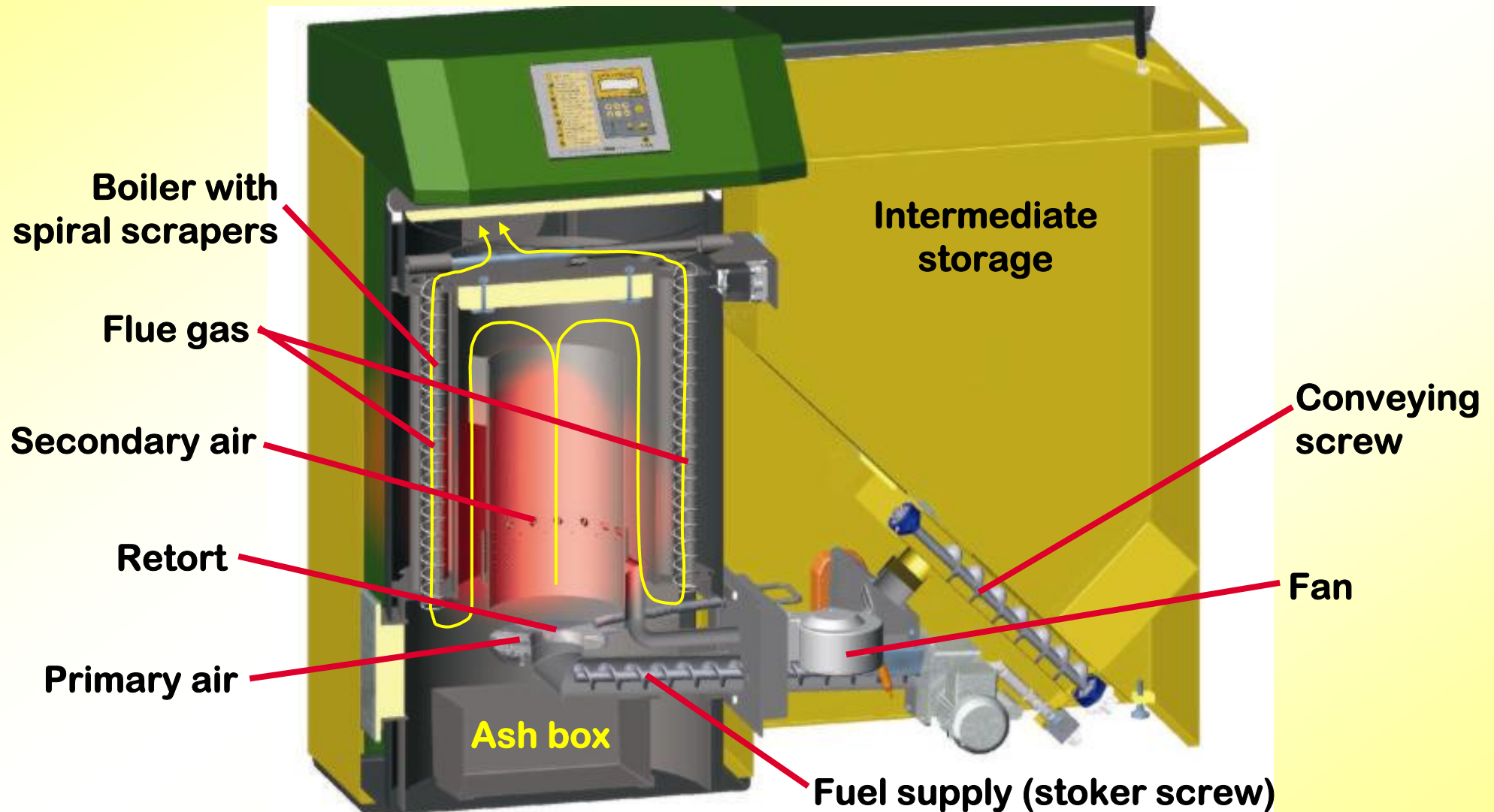
➤ Overfed burners





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Underfed burner



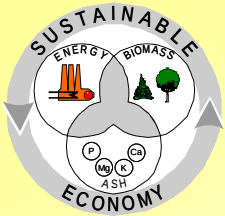
Source: [KWB – Kraft und Wärme aus Biomasse GmbH, Austria, 2002]



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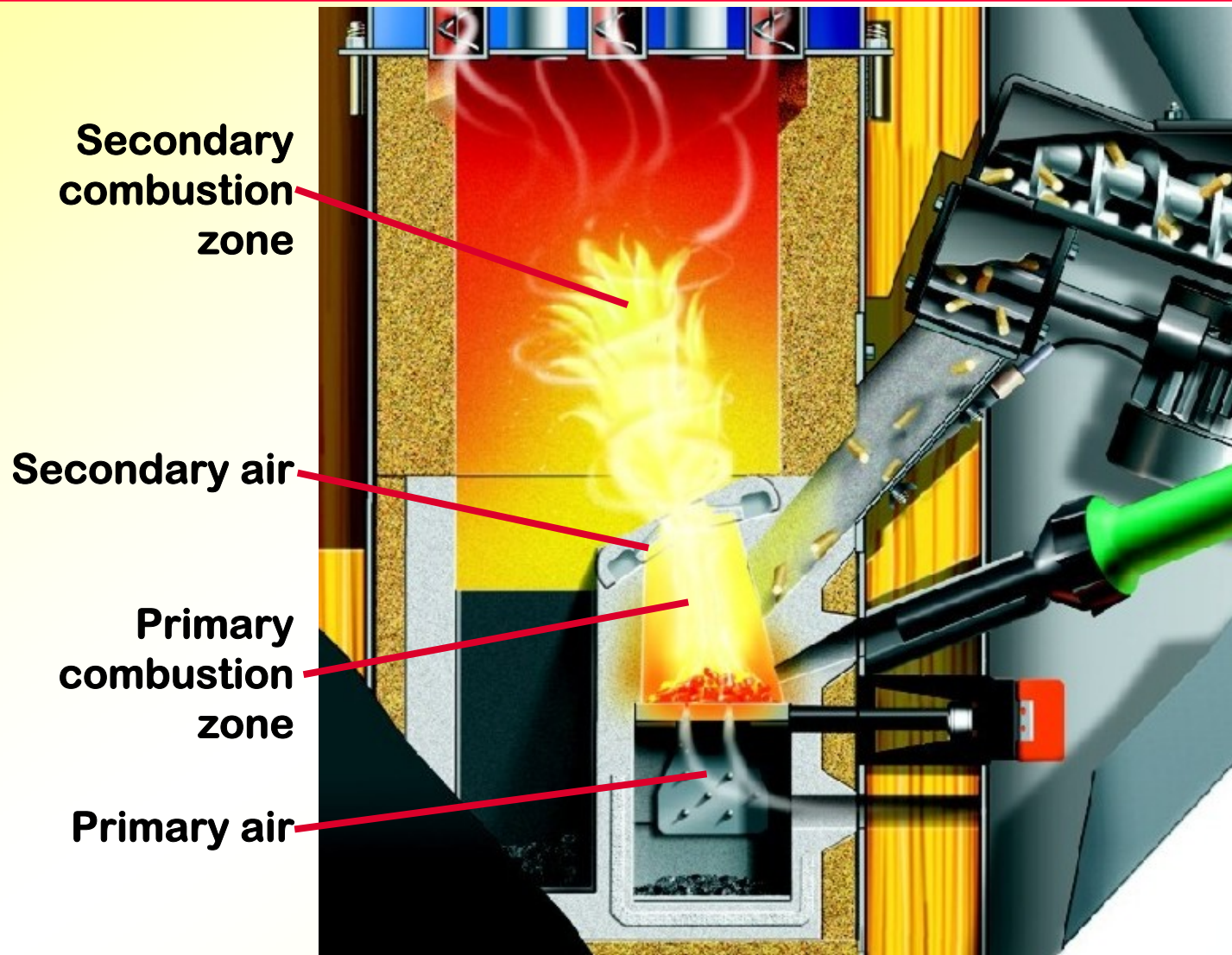
Geometry of the combustion chamber – important parameters

- Air staging
- Mixing of secondary air and flue gas
(position and design of the secondary air nozzles)
- Appropriate dimensioning of primary and secondary combustion zone
(residence time)
- Good utilisation of the furnace volume
(flow distribution)
- Even temperature distribution
(furnace temperature control)



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Air staging and optimised mixing between flue gas and secondary air

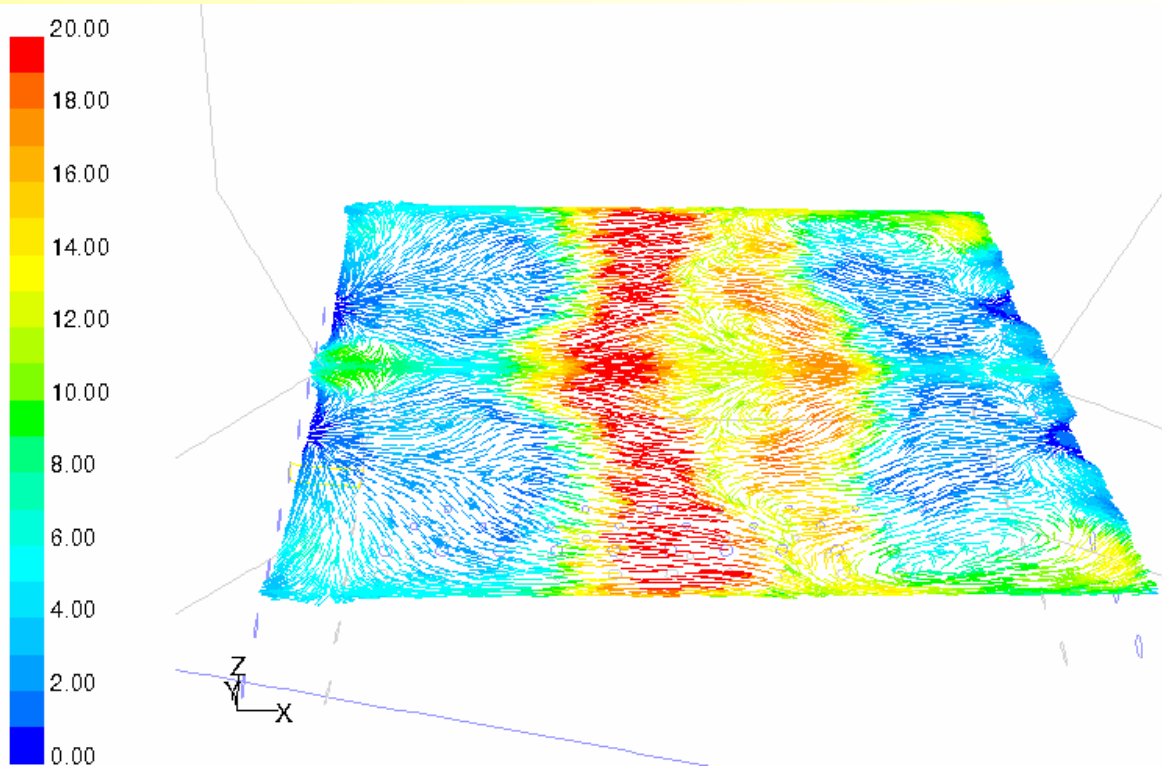




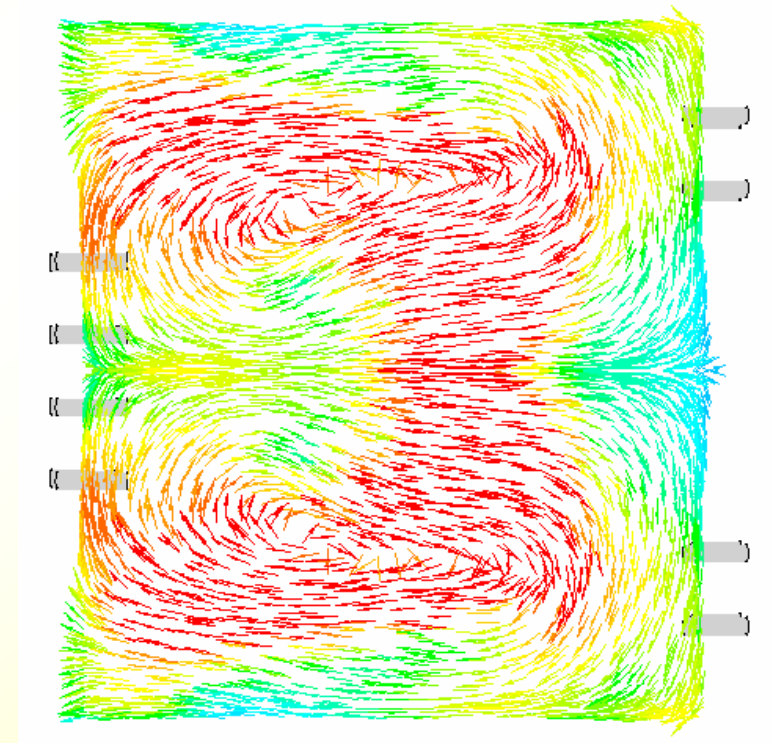
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Design and optimisation of the nozzles for the injection of secondary air

Vectors of the flue gas velocity [m/s]
in the horizontal cross-section right over the secondary air nozzles



Basic nozzle design



Improved nozzle design

➔ CFD-based furnace and nozzle design of great relevance



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Control systems

Load control

- **Guiding value:** feed water temperature
- **Variables:** fuel and primary air feed

Combustion control

- **Guiding value:** O_2 , CO or O_2 and CO concentration in the flue gas (lambda, CO or CO/lambda control)
- **Variable:** secondary air supply

Temperature control

- **Guiding value:** temperature in the combustion chamber
- **Variables:** flue gas recirculation or water-cooled furnace walls

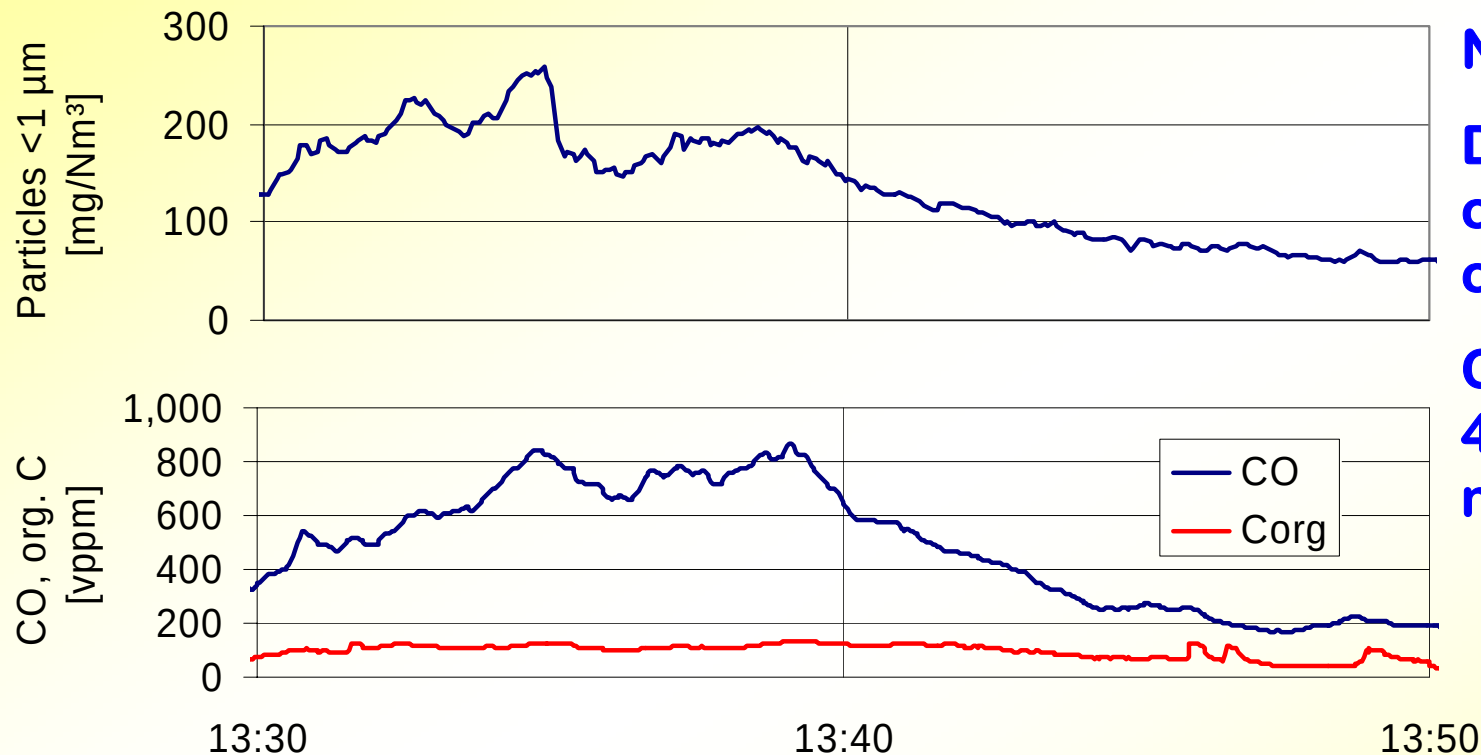
Pressure control

- **Guiding value:** pressure in the combustion chamber
- **Variable:** induced draught fan (frequency)



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Relevance of automatic control systems



Notes:

Data related to the current operating conditions

Change of load from 40% part load to nominal load

- Importance of automatic control systems to guarantee low CO, TOC and particulate emissions at all load conditions (start-up, shut-down, load changes, full and part load operation)



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Boilers

Geometry

- Usually vertical fire tube boilers (one or three-pass boilers)

Boiler cleaning

- Fully automatic by spiral scrapers in the fire tubes
- Semi-automatic by spiral scrapers in the fire tubes with a lever from the outside
- Manually

Automatic boiler cleaning systems increase the efficiency and reduce dust emissions



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Fully automatic boiler cleaning system



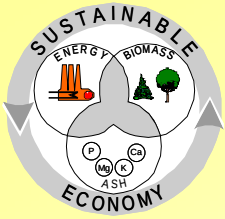
Source: [BIOS BIOENERGIESYSTEME GmbH, Austria, 2002; furnace of KWB - Kraft und Wärme aus Biomasse GmbH]



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De-ashing systems

- Usually ash collection in an ash box
→ ash box must be emptied periodically
- Ash compaction systems partly applied
→ ash box must be emptied periodically in longer periods of time
- Fully automatic de-ashing system by a screw conveyor in an external container
→ ash box must be emptied only about once a year

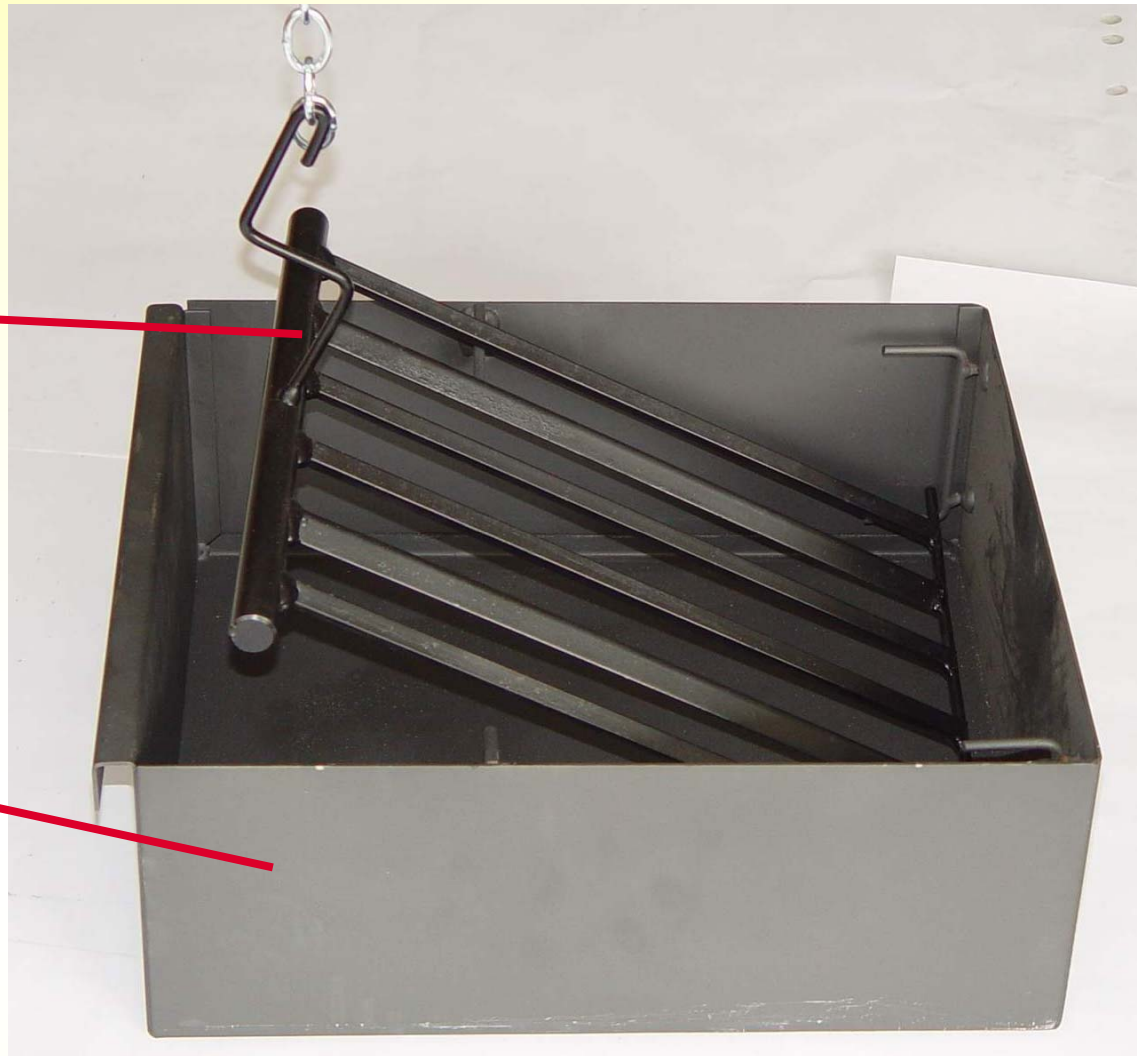


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Ash compaction system

Compactor

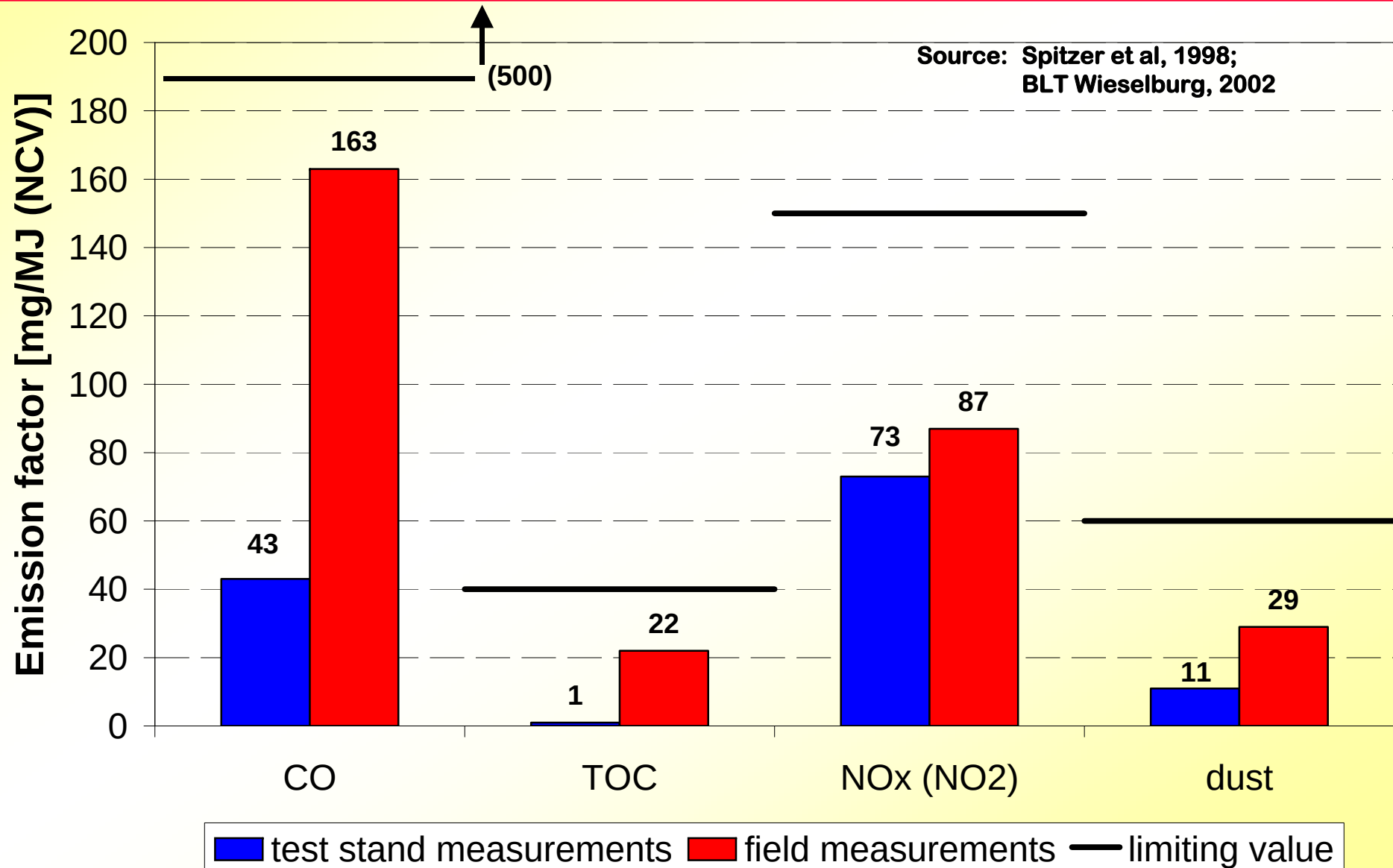
Ash box





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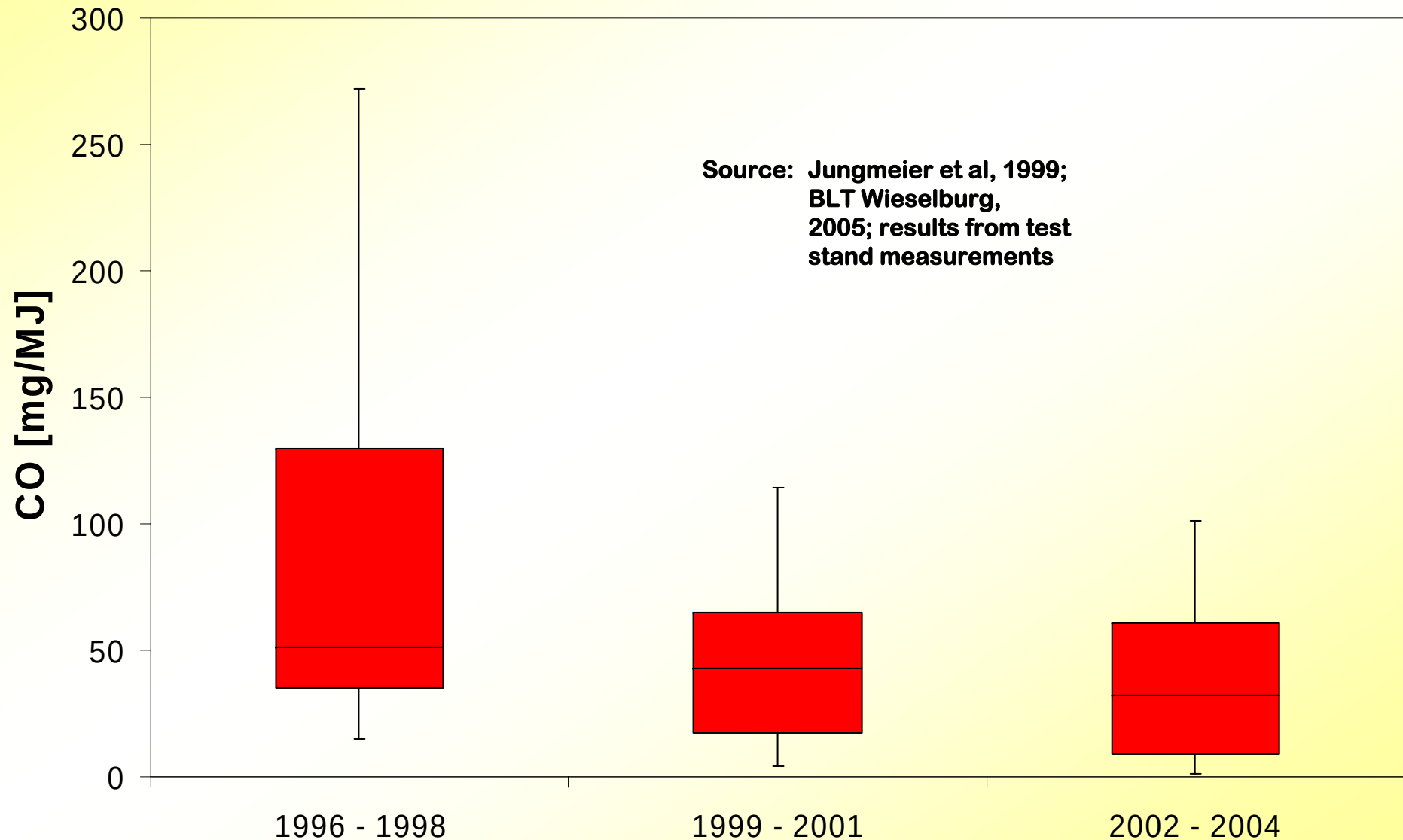
Emissions





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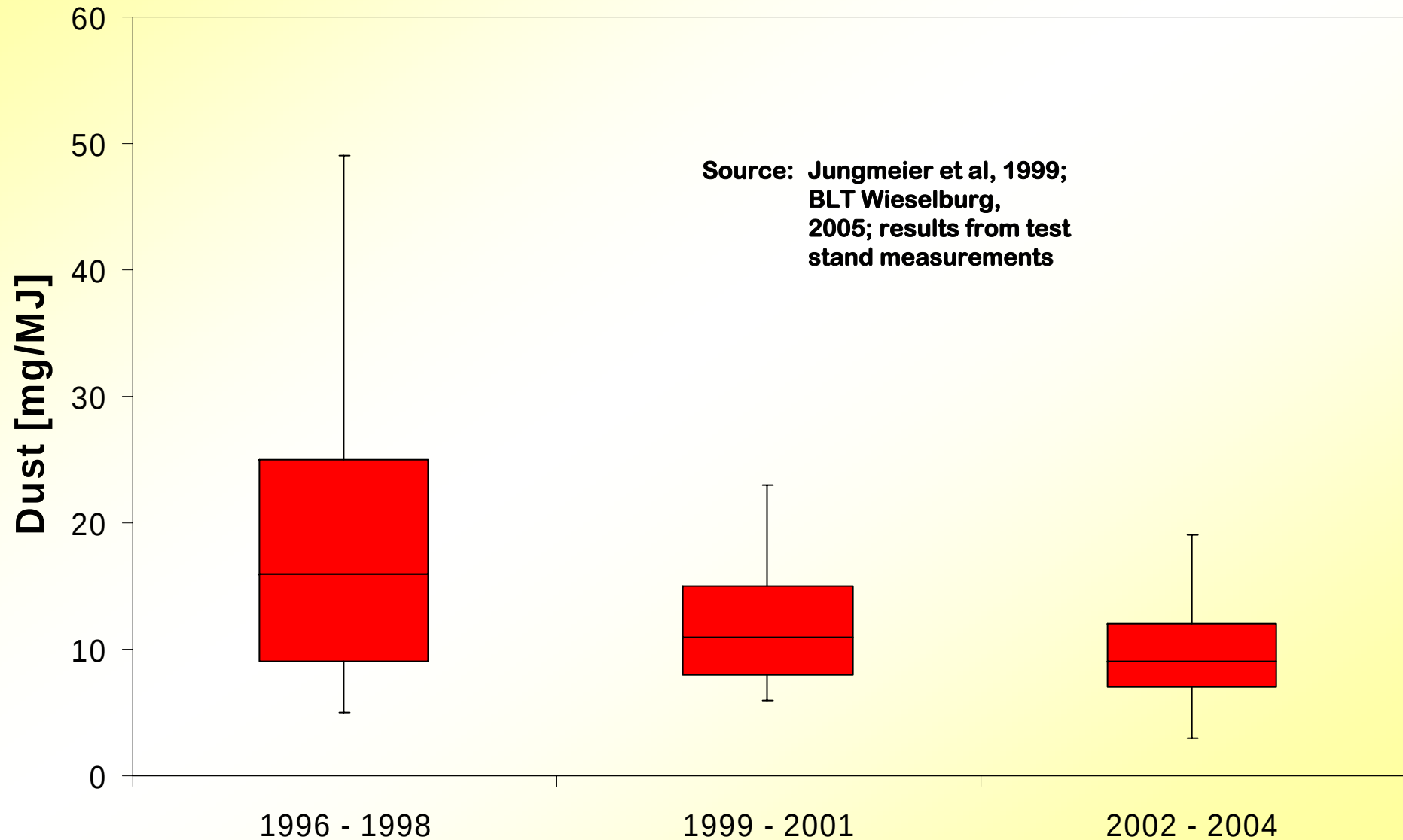
CO emissions – comparison between old and new pellet furnaces





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Dust emissions – comparison between old and new pellet furnaces





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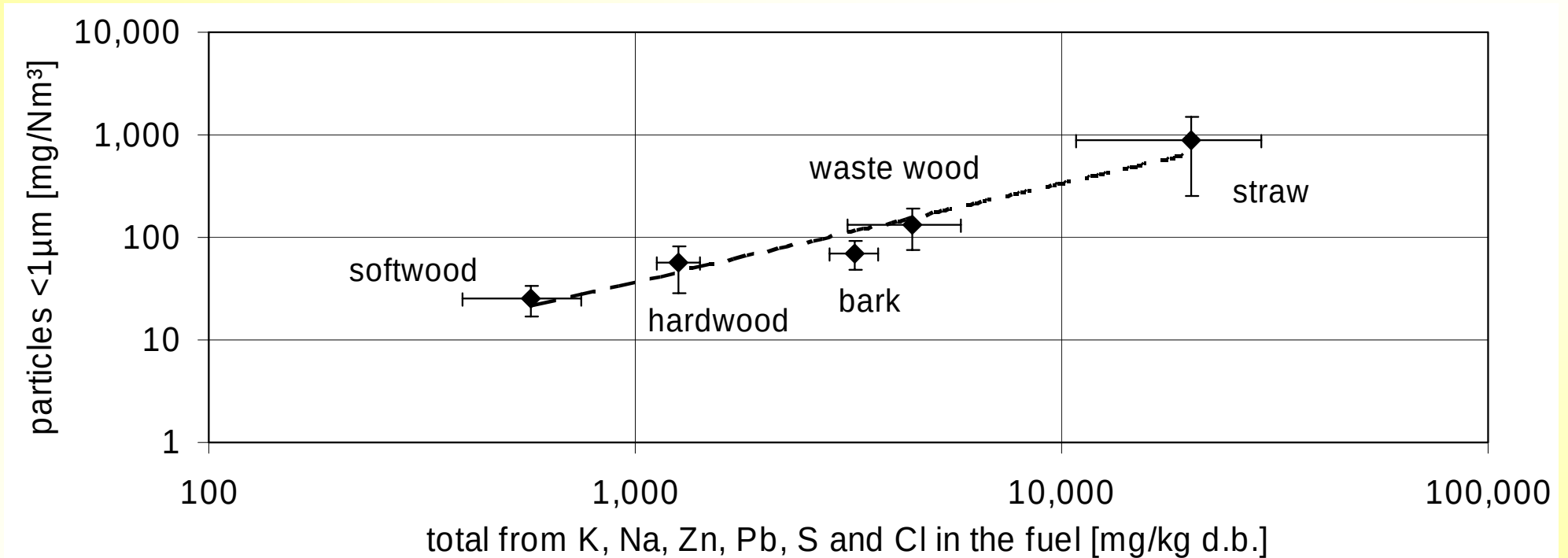
Fine particulate emissions – new pellet furnaces

- About **90 to 95%** of the total dust emissions are fine particles (**< 1 μm**)
- Fine particulate emissions from modern pellet furnaces usually have a mass mean diameter of about **0.15 μm**
- If combustion is complete about **1.5×10^7** particles per cm^3 are formed
- A complete burnout of the flue gas is very important to minimise fine particulate emissions
- The chemical composition of the fuel strongly influences fine particulate emissions



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Fine particulate emissions – influence of the fuel composition



Explanations: Emissions related to dry flue gas and 13 vol.% O₂; d.b. ... dry basis;
results from measurements at grate furnaces with nominal capacities between 400 kW_{th}
and 50 MW_{th}



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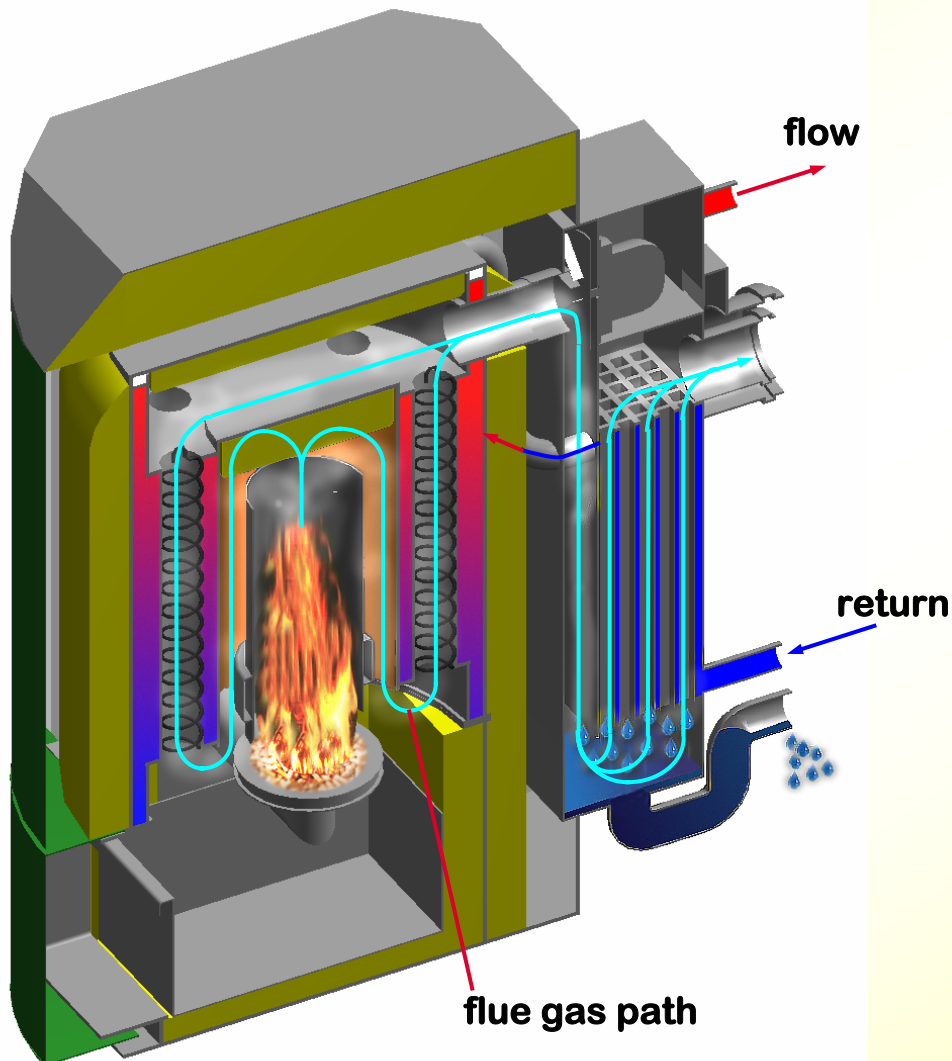
Future developments

- **CFD-aided furnace development and optimisation**
- **Medium-scale combustion systems**
(nominal boiler capacities between 100 and 1,000 kW_{th})
- **Reduction of particulate emissions (especially PM1)**
- **Small-scale dust burners**
(utilisation of pulverised pellets)
- **Utilisation of herbaceous / non-woody biomass fuels**
- **Combination of pellets with solar systems**
- **Pellet furnaces with flue gas condensation**
- **Small-scale CHP systems**
(e.g. Stirling engines)



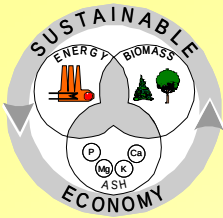
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Pellet furnace with flue gas condensation



- First pellet boiler with flue gas condensation
- Market introduction: 2004
- Efficiency: 103%
(according to type test by BLT Wieselburg)
- Nominal capacities:
8, 10, 15 and 20 kW

Source: [OkoFEN, Austria, 2004]



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New small-scale CHP technology based on Stirling engines for wood chip and pellet furnaces



- 2 pilot plants in operation
35 kW_{el} and 70 kW_{el}
- Start-up:
End of 2002 (35 kW_{el}) and
End of 2003 (70 kW_{el})
- Operating hours:
> 12,000 (35 kW_{el})
> 4,000 (70 kW_{el})
- Electric plant efficiency :
approximately 11 to 12%
- Fuels:
Pellets, wood chips, sawdust
- First small series production
(7 plants with 35 kW_{el})
- Comprehensive field tests ongoing
(2005/06)

Source: [BIOS BIOENERGIESYSTEME GmbH; MAWERA
Holzfeuerungsanlagen GesmbH, Austria, 2005]



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Summary

- **Rapidly expanding pellet market in Austria**
- **Several actors, quality standards and subsidies supporting this development**
- **Proven feeding and combustion technologies available from many furnace manufacturers which ensure a fully automatic operation**
- **Low emissions with a decreasing tendency for new furnaces**
- **Several research activities and promising developments focusing on new fields of application, new biomass fuels and emission reduction**