



bioenergy2020+

Modern Logwood Stoves – Requirements, Development and Evaluation

*Christoph Schmidl, S. Aigenbauer, F. Figl., W. Haslinger,
W. Moser, V.K. Verma*

IEA Bioenergy Conference, Vienna, November 2012

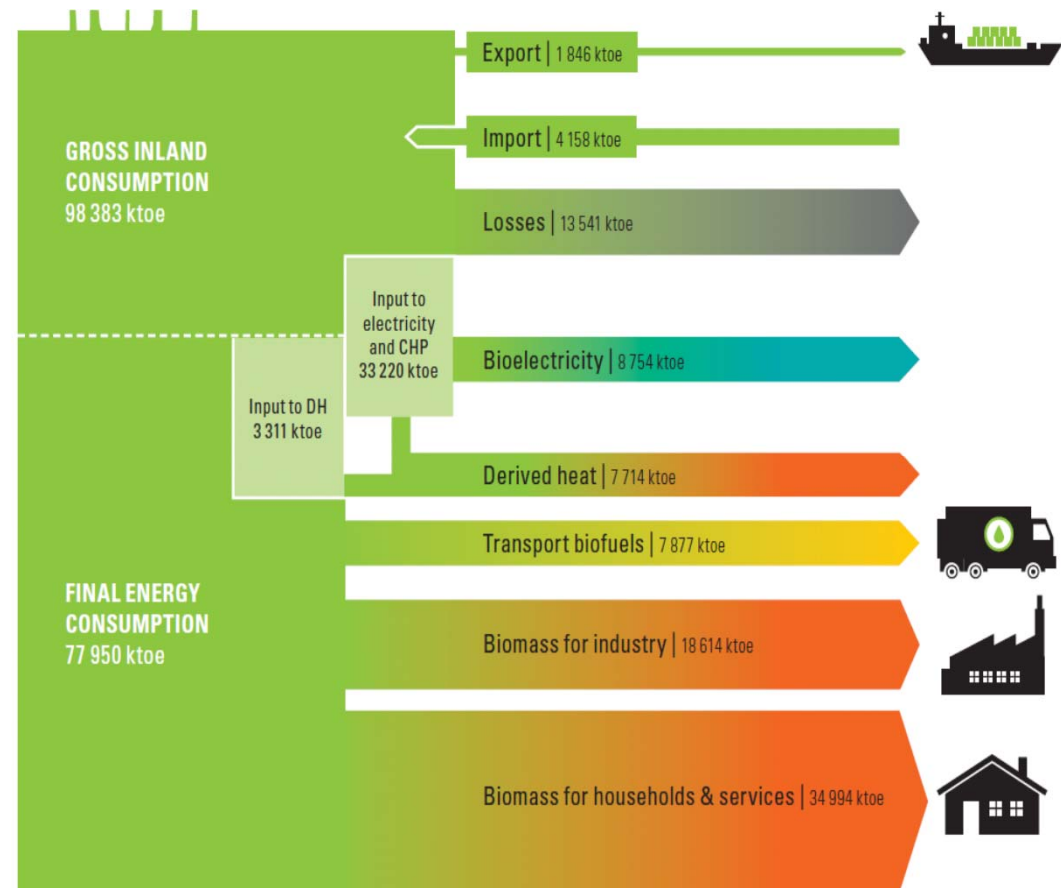


innovations 
kompetenz



Background – Bioenergy Market in Europe

- Almost 50% of Biomass used for energetic purposes go to households (without DH)
- These are 35Mtoe per anno (2008)
- **Approx. 80% are used in small Stoves!**
- **Average use with only 50% efficiency (!)**



Source: European Technology Platform „Renewable Heating and Cooling“: Biomass for Heating and Cooling – Visions document, 2010



Background – Air quality issues (Europe)

Emission

Schaap et al. 2004:

EU Emission Inventory:

- Woodsmoke annual average ~ 25%
- Woodsmoke winter average ~ 45%

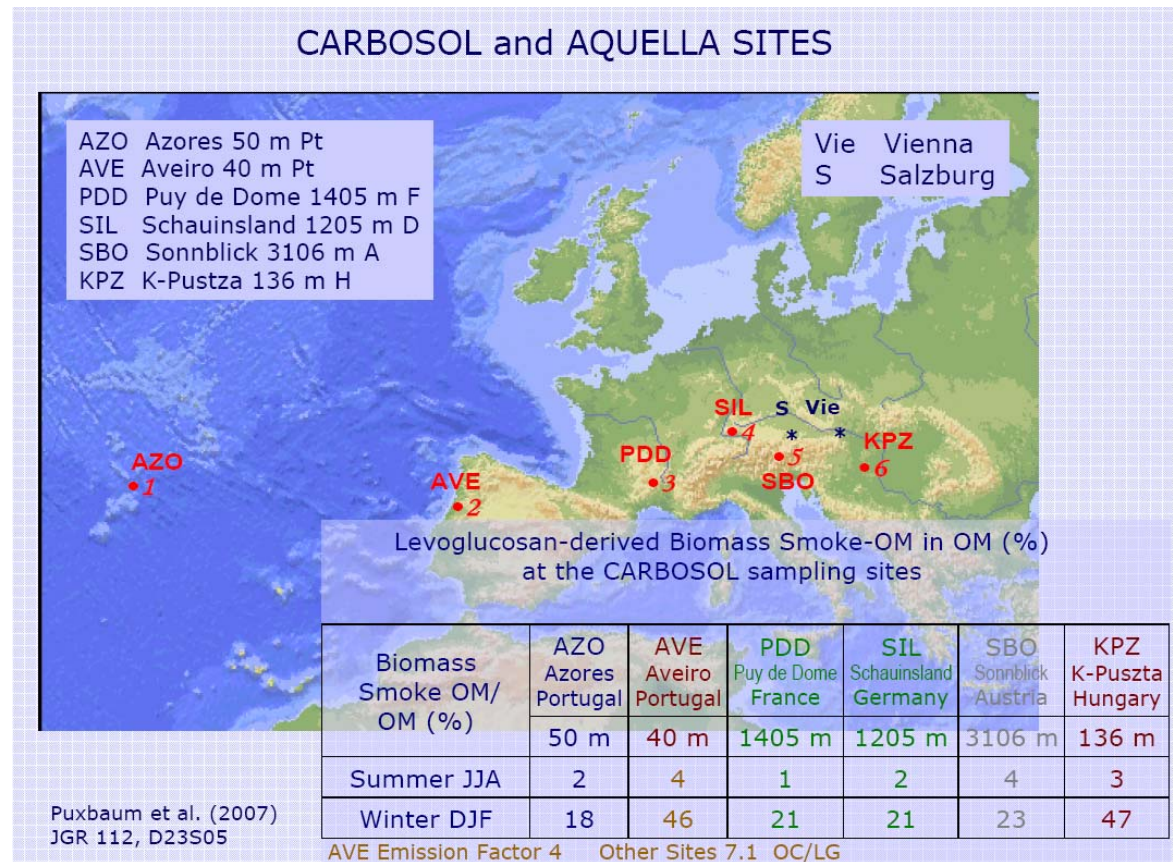
... of primary emissions.

→ 20-30% of PM_{2.5} in winter (source no. 1)

New environmental issue: Benzo[a]pyrene

Ambient threshold: 1ng/m³

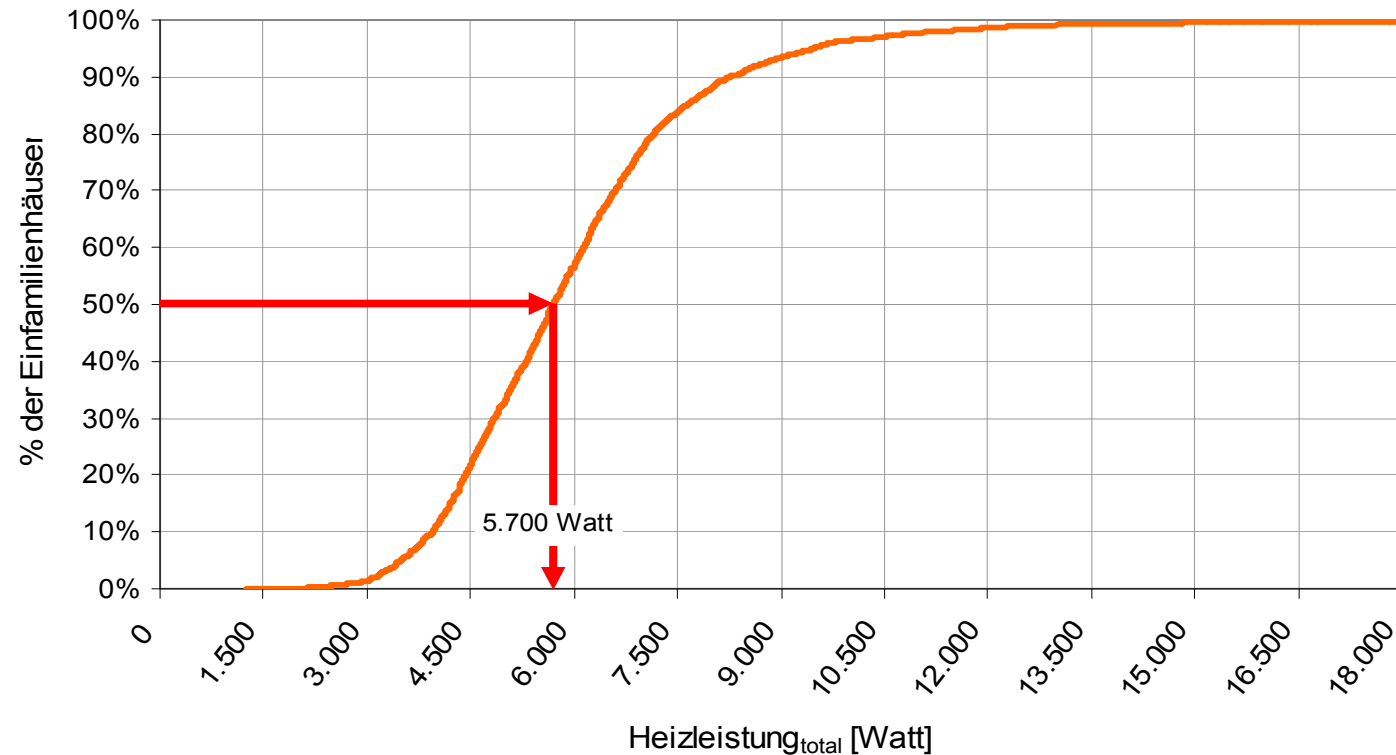
Ambient (Source Apportionment)





Background – Energy performance of buildings...

Source: e7 Energiemarktanalyse GmbH, Auswertung der Energieausweise für ein Bundesland 2008 - 2010



→ Regarding heat demands, stoves could serve as main biomass heating systems of the future



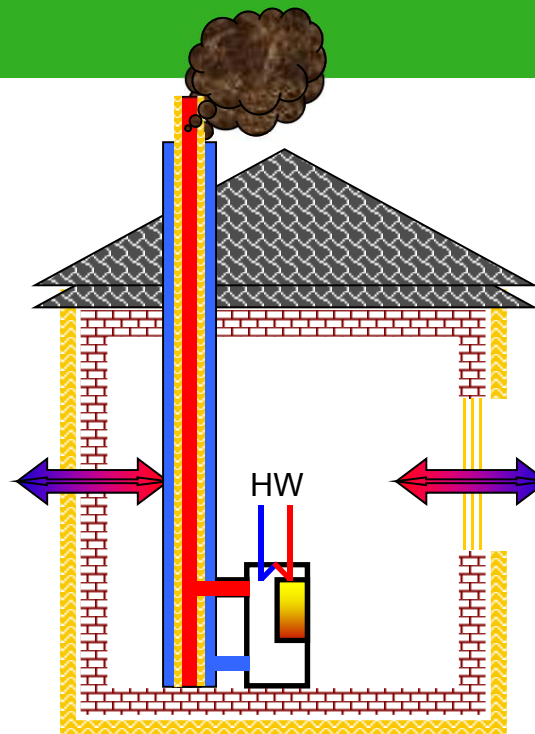
Conclusion: Requirements are changing...

Air Quality Issues

- Fine PM emissions
- Hydrocarbons (Pre-cursors of secondary organic aerosol (SOA), ozone formation)
- Indoor air quality

Energy Efficiency

- Real – life operation efficiency
- Close gap to automatically fired systems
- 90% are possible



before 1980

„Airtight Buildings“

- Room air independent combustion air supply
- Safety measures in case of underpressure in the room

Very low heat demand

- Low power concepts
- Heat storage concepts
- Combined hot water production



Requirements – Legal Situation Europe

CE Mark Requirements (EN 13240)

- Efficiency **> 50%**
- Carbon monoxide emission **< 1% (10.000 ppm)**
- No thresholds for dust and hydrocarbons

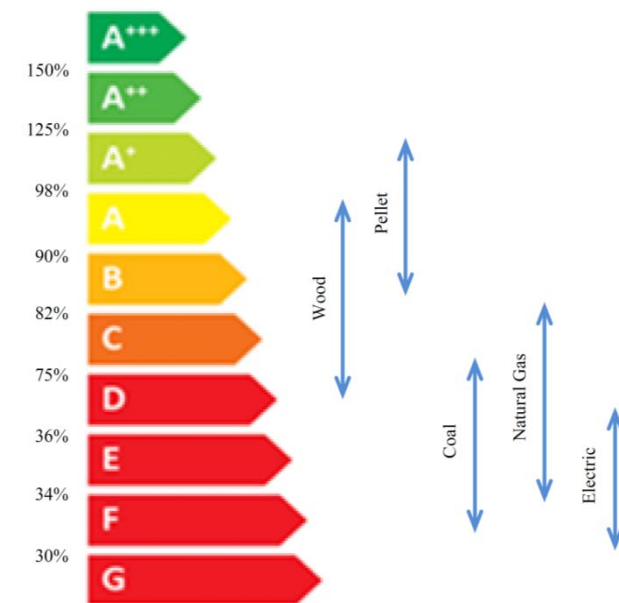
Still the only binding requirements in many European countries

(some countries have implemented more stringent requirements, some also including PM and HC)



Requirements – Eco Design / Energy Labeling process for room heating appliances (LOT 20)

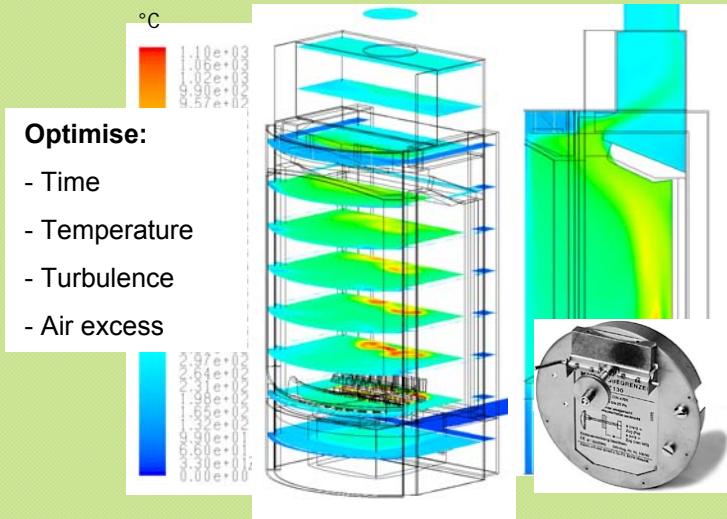
- Process has gained momentum after long inactive time
- High impact as requirements are binding
- Ambitious target values would be important
- Current proposal:
 - Same label for all technologies
 - Biomass Conversion Coefficient 1.4 (no scientific background)
 - Differentiation within one group difficult
 - Seasonal efficiency just by calculation (appropriate test needed)





Development of logwood stoves

1) Primary Measures



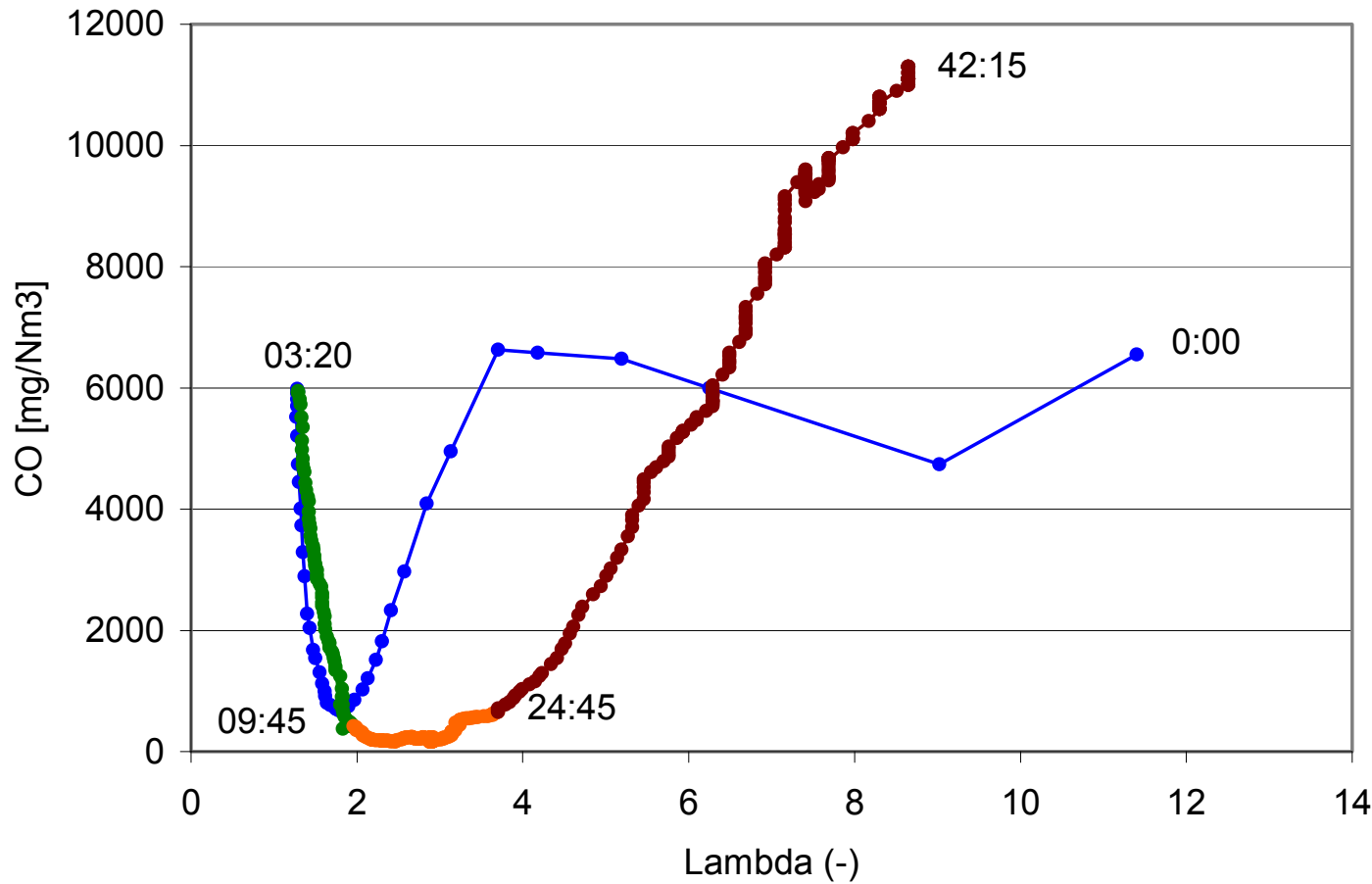
2) Secondary Measures



3) Consider effects of secondary measures on primary conditions



Primary Measures: CO-Lambda



Local lack of oxygen

Optimum conditions

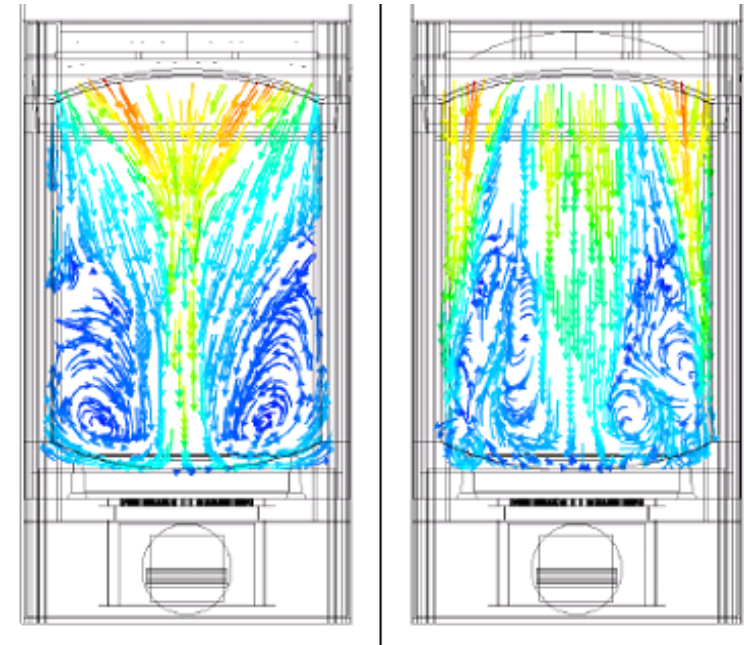
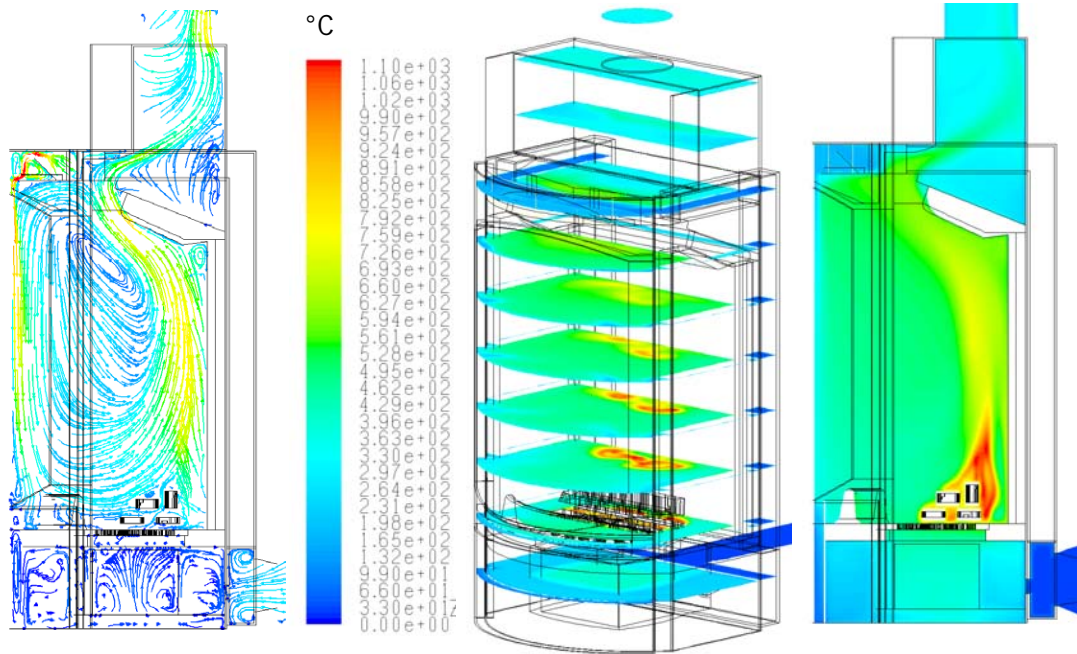
Temperature too low

- Start
- Bereich 1
- Bereich 2
- Bereich 3



Primary Measures – Geometry optimisation with Computational Fluid Dynamics (CFD)

Optimsation of air flow in combustion chamber



Improvement of window flushing air

Source: Autroflamm, Bioenergy2020+, TU Wien

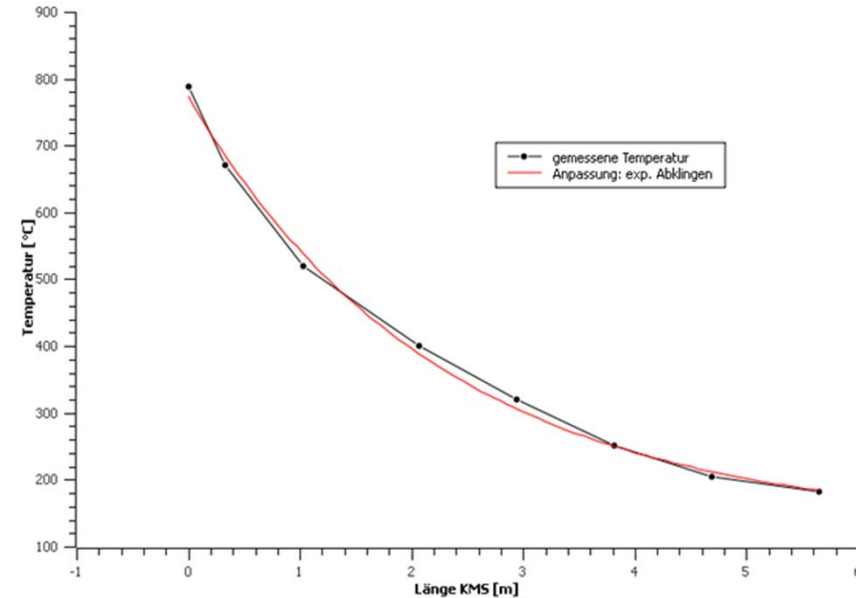


Secondary Measures

- Emission reduction
 - Electrostatic precipitators
 - Ceramic foam filters
 - Oxidation catalysts
- Efficiency improvement (and emission reduction)
 - Ceramic storage solutions
 - Parallel hot water production
 - Flue gas fan
 - Draft restrictors



Example: Ceramic module heat storage for efficiency increase



**Efficiencies > 90%
(without flue gas fan)**

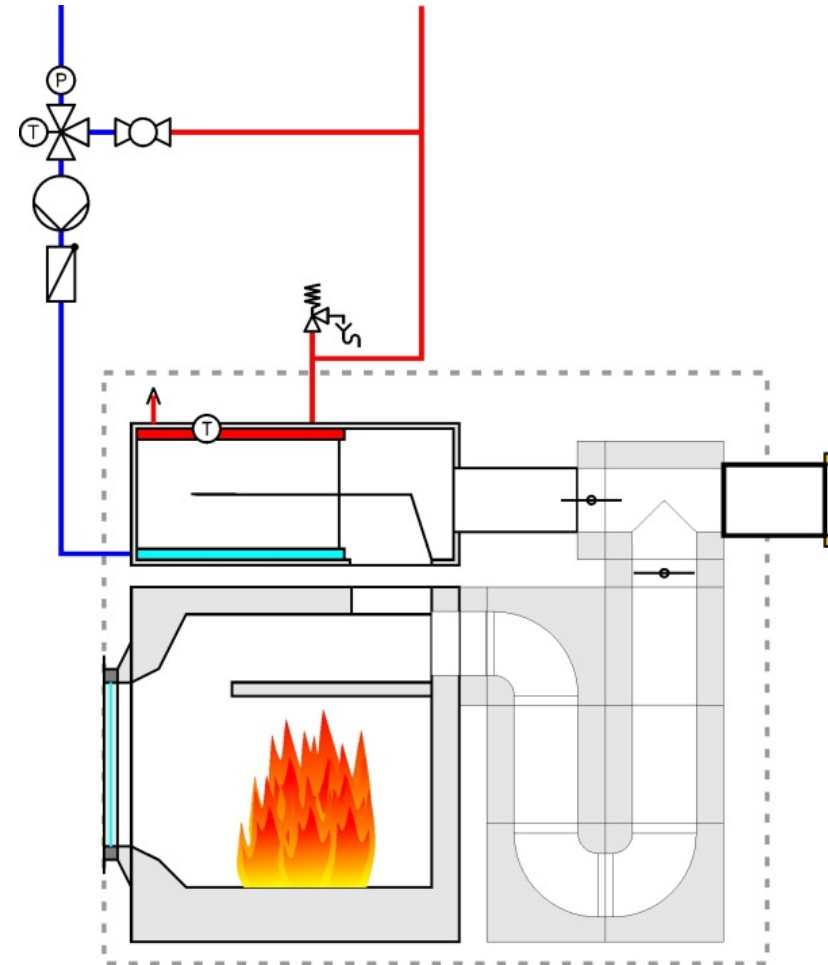
	Nr.	Lastzustand	Messergebnisse			Grenzwerte		
						Art. 15a	BImSchV - Stufe 1	EN 13240
			mg/MJ	%	mg/m ³ N (13%O ₂)	mg/MJ	mg/m ³ N (13%O ₂)	%
CO	1	Vollast	610	0,073	913	1100	2000	1
	2	Vollast	666	0,073	997			
NO ₂	1	Vollast	68	-	101	150	-	-
	2	Vollast	69	-	91			
η (%)	1	Vollast	87,62			78	73	50
	2	Vollast	90,46					

Als Mitglied des Fachverbandes vertreten bei





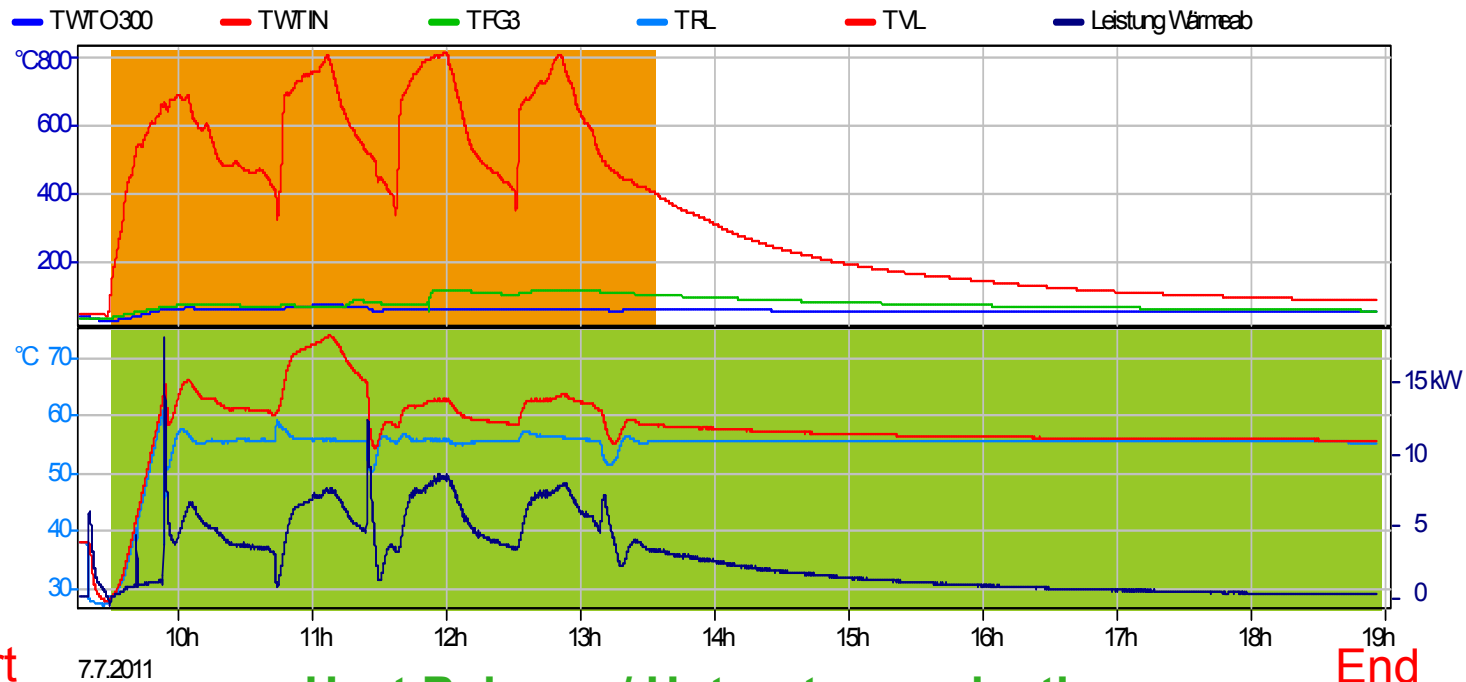
Example: Ceramic modular heat storage combined with hot water production





Hot water production with logwood – Testing results

Combustion Phase



Start
Ignition

Heat Balance / Hot water production

End
Feed T = 55°C

Energy Balance: 53% Room heat, 40% Hot water, 7% losses
Emissions: <350mg/MJ CO, <20mg/MJ PM



Airtight Buildings – Combustion Air Supply

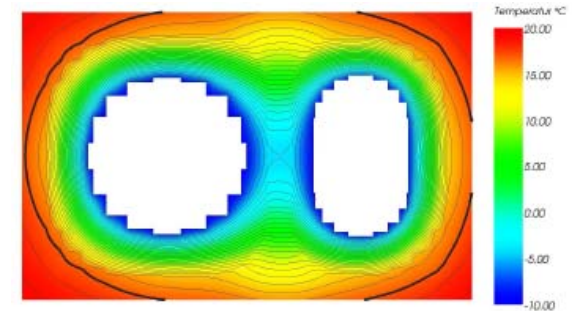
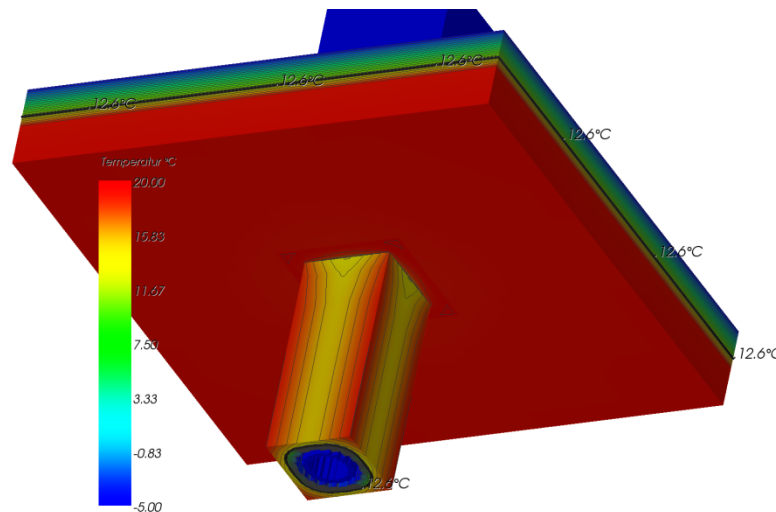
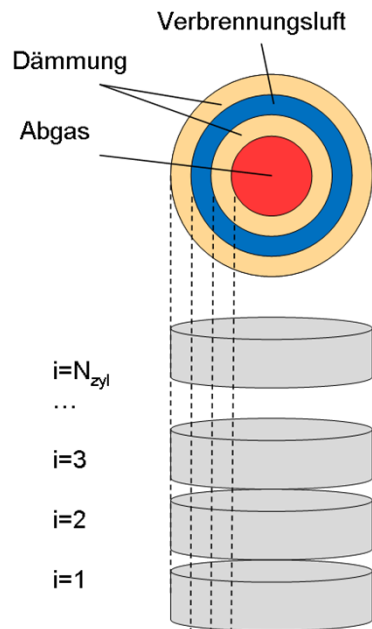


Double duct chimney systems:

- Air supply (issue: pre-heating)
- Cooling effect of combustion air

Tools:

- Measurements
- Mathematical models / simulation





Type testing (EN13240) issues

- Testing procedure description gives space for interpretations
 - E.g. Start/End of measurements
 - Some testing institutes even stretch the given space for interpretations
- Type-testing to field-performance factors are high
 - Start-phase not considered
 - No consecutive burn cycles necessary
 - Influence of user is not considered
- Type – testing results do not allow a distinction between high quality and low quality products in terms of environmental impact
- No systematic inspection if tested systems are equal to sold systems

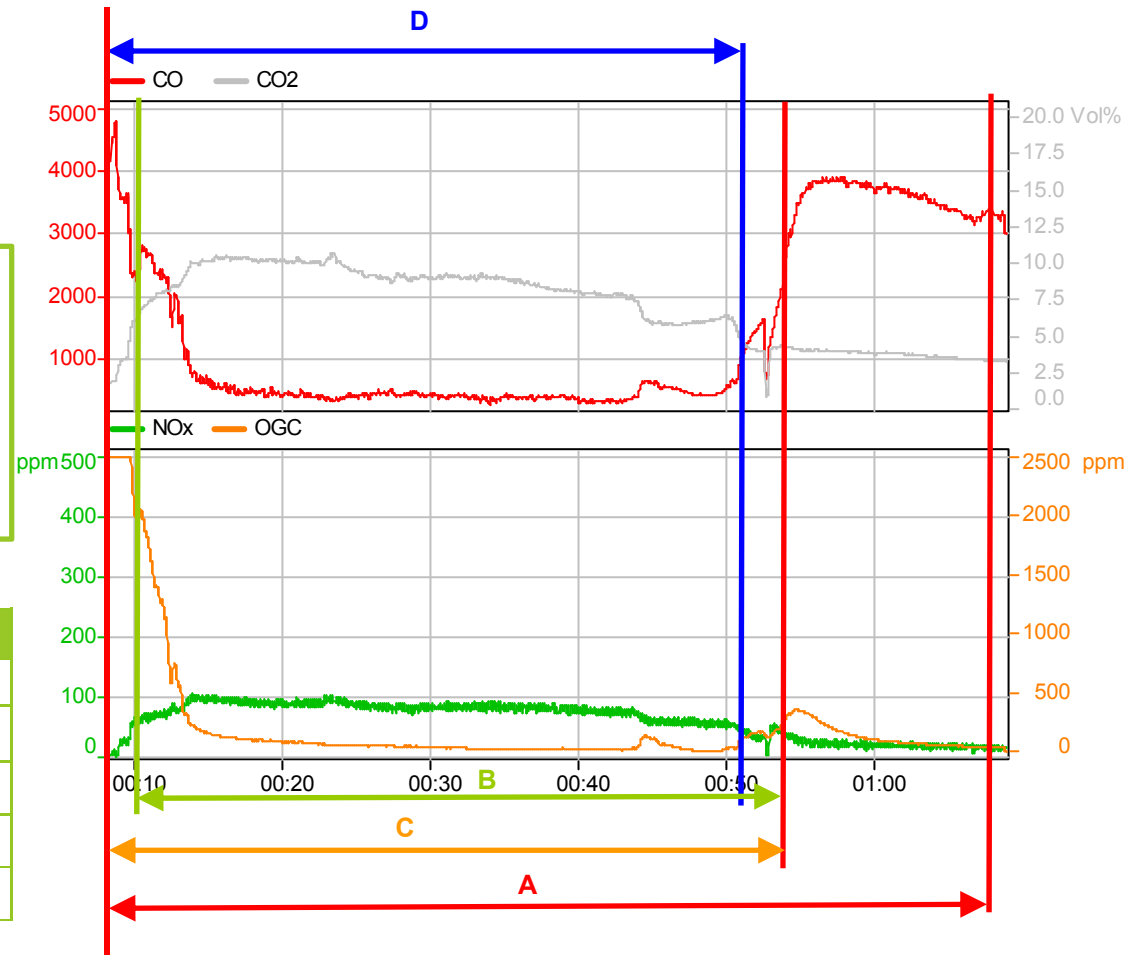


Stove type-testing (EN13240)

Typical stove test according to EN13240, four examples of „data analysis“:

- A – incl. start-phase until equal weight + ash
- B – no start-phase 4% CO₂ until 4 % CO₂
- C – incl. start-phase until 4% CO₂
- D – incl. start-phase until no visible flames

Interval	CO ₂	CO	NO _x	OGC	η [-]
	[%]	[mg/MJ]	[mg/MJ]	[mg/MJ]	
A	7,0	1177	99	83	72,4
B	8,0	586	104	27	74,4
C	7,8	751	104	22	74,2
D	8,3	546	106	22	75,5





Summary and conclusions....

- Direct heating with logwood has high potential to play a major role in Europe's renewable energy future
- Changing requirements (market and environment) are big challenges and big opportunities at same time
- Industry has quite a bit of homework to do in upcoming years
- Main development needs are:
 - Emission reduction + Efficiency increase
 - Optimisation of integration in modern buildings
- Final goal is to close the gap to automatically fired systems
- New testing methods together with Europe-wide legal regulations are required to trigger technology improvement

Vienna, 13.11.2012

bioenergy2020+



Thank you!



Christoph Schmidl
Senior Researcher & Head of Unit
Combustion Systems
BIOENERGY 2020+
Location Wieselburg
Tel: +43 7416 52238 24
christoph.schmidl@bioenergy2020.eu

Slide 19

