bioenergy2020+

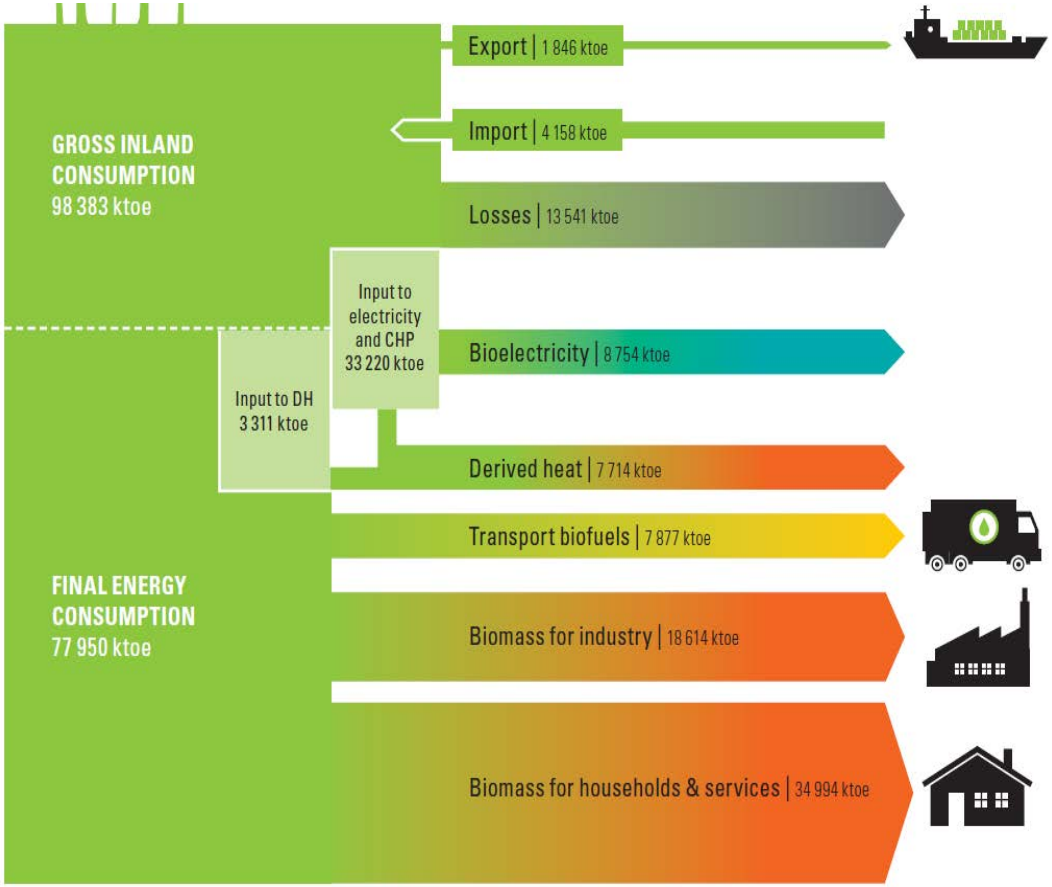
Modern Logwood Stoves –
Requirements, Development and Evaluation

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

IEA Bioenergy Conference, Vienna, November 2012

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%

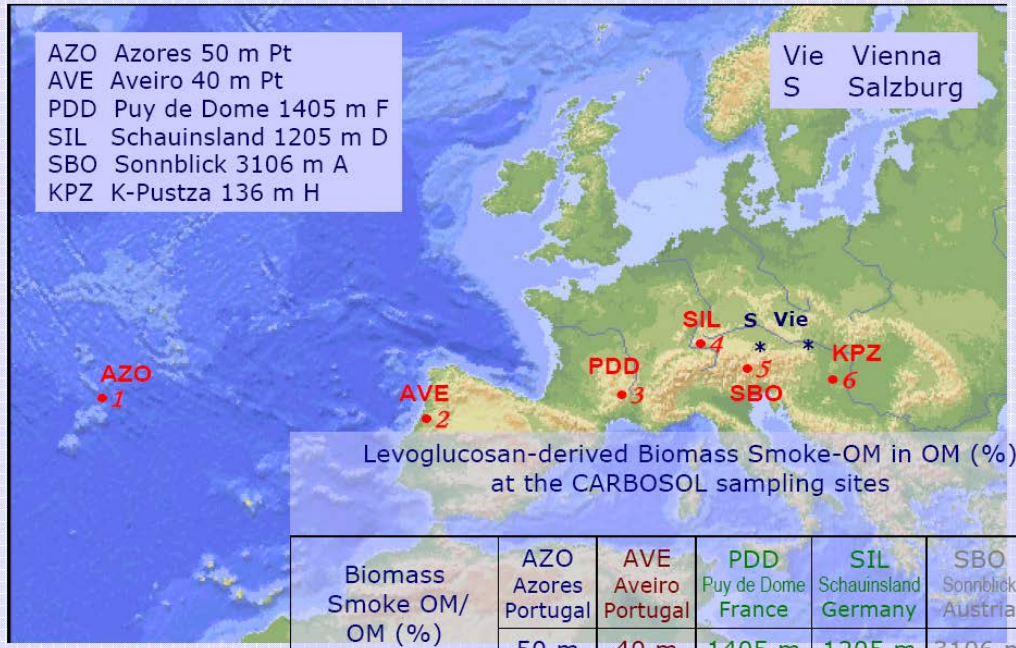
… of primary emissions.

→ 20-30% of PM2.5 in winter (source no. 1)

New environmental issue: Benzo[a]pyrene
Ambient threshold: 1ng/m³

Ambient (Source Apportionment)

CARBOSOL and AQUELLA SITES



Levoglucosan-derived Biomass Smoke-OM in OM (%) at the CARBOSOL sampling sites

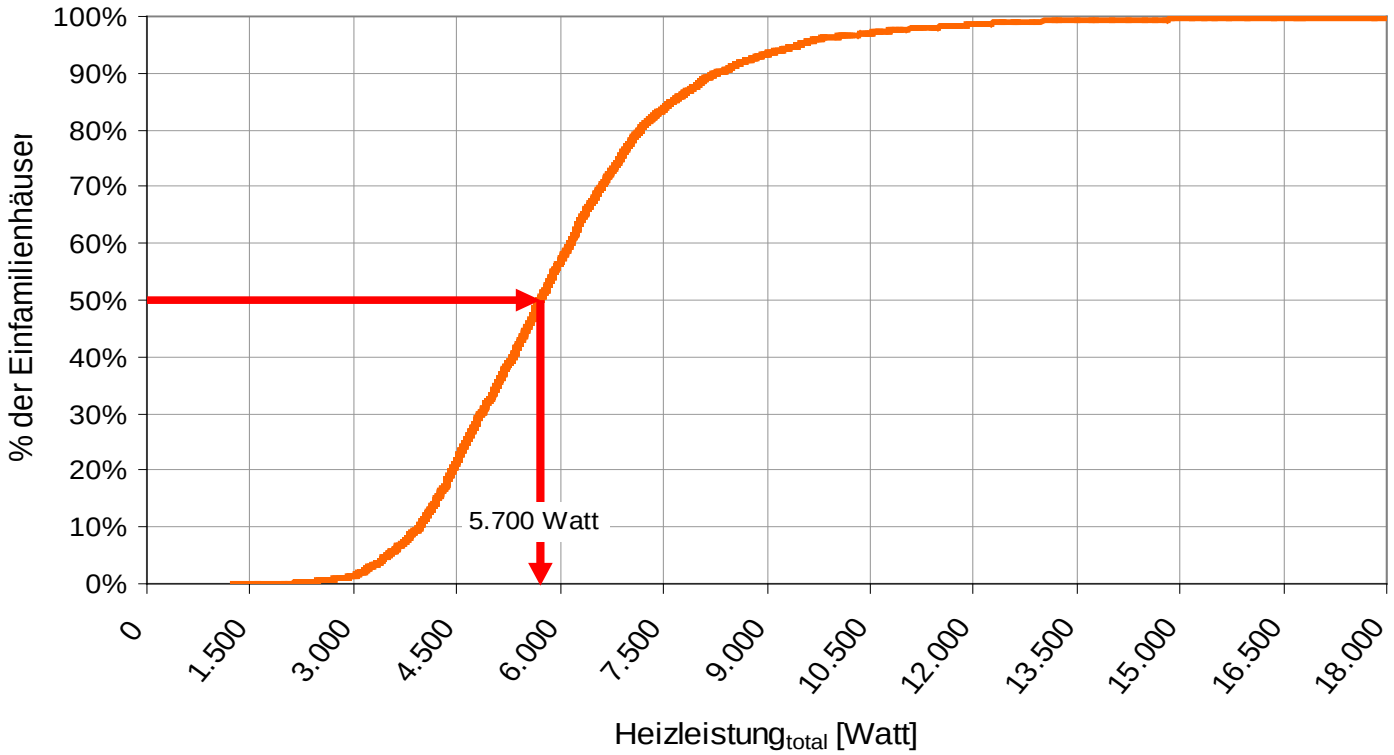
Biomass Smoke OM/ OM (%)	AZO Azores Portugal	AVE Aveiro Portugal	PDD Puy de Dome France	SIL Schauinsland Germany	SBO Sonnblick Austria	KPZ K-Puszta Hungary
	50 m	40 m	1405 m	1205 m	3106 m	136 m
Summer JJA	2	4	1	2	4	3
Winter DJF	18	46	21	21	23	47

AVE Emission Factor 4 Other Sites 7.1 OC/LG

Puxbaum et al. (2007) JGR 112, D23S05

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

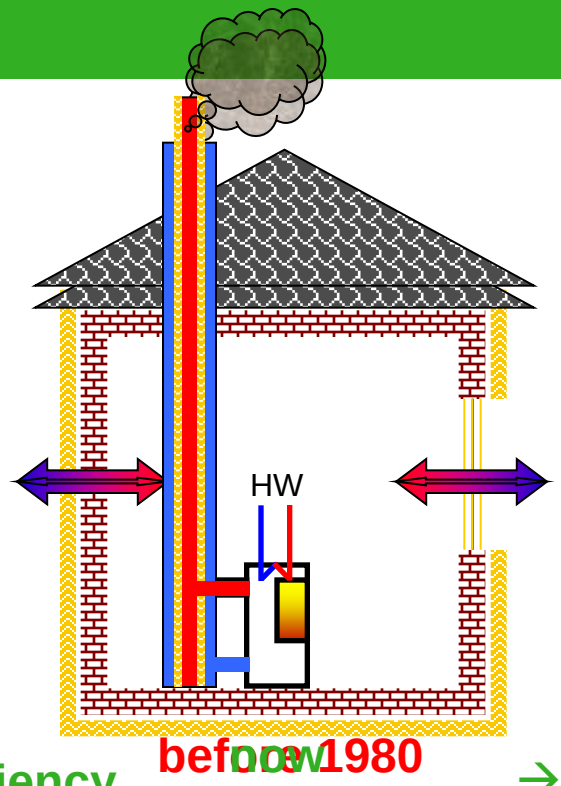
Conclusion: Requirements are changing...

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**



„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)

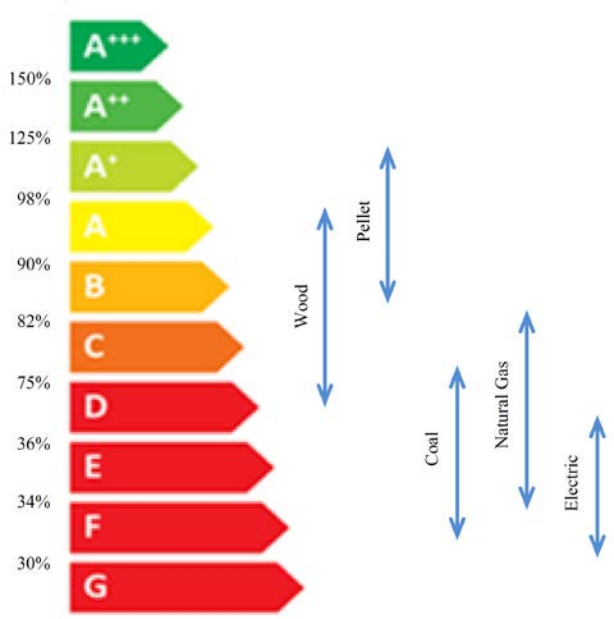
- Efficiency **> 50%**
- Carbon monoxide emission **< 1% (10.000 ppm)**
- No thresholds for dust and hydrocarbons

…still the only binding requirements in many European countries

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

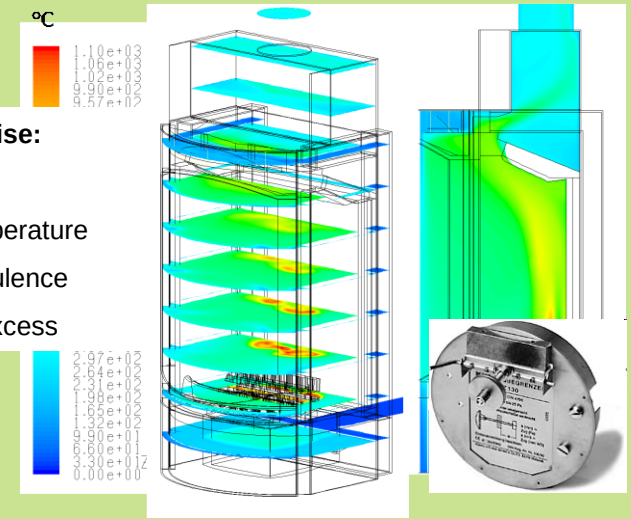
Requirements – Eco Design / Energy Labeling process for room heating appliances (LOT 20)

- 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



= Optimising primary combustion conditions

2) Secondary Measures

→ ESP

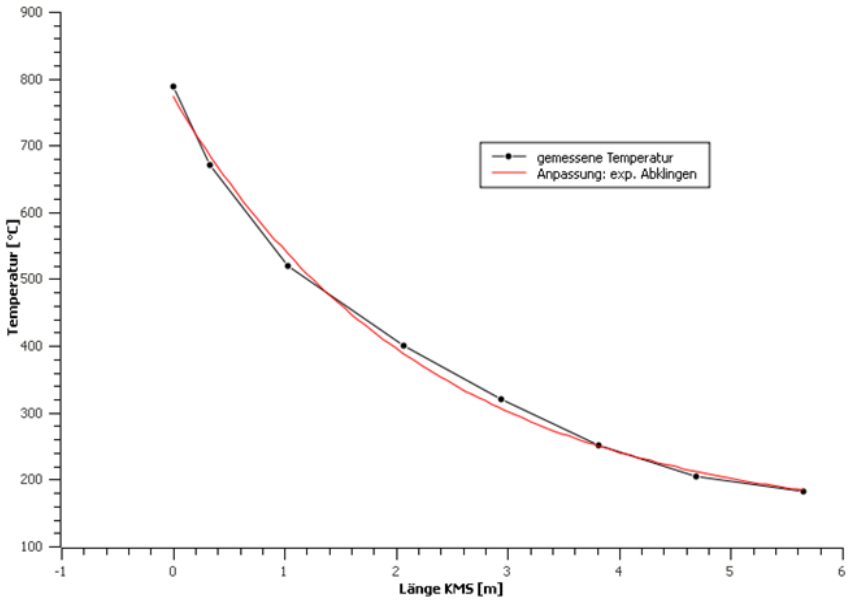
→ Catalyst

→ Filter

→ Heat Storage

3) Consider effects of secondary measures on primary conditions

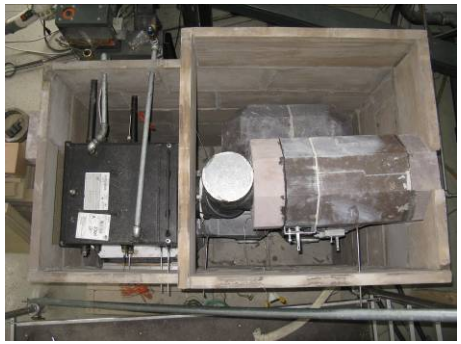
Example: Ceramic module heat storage for efficiency increase

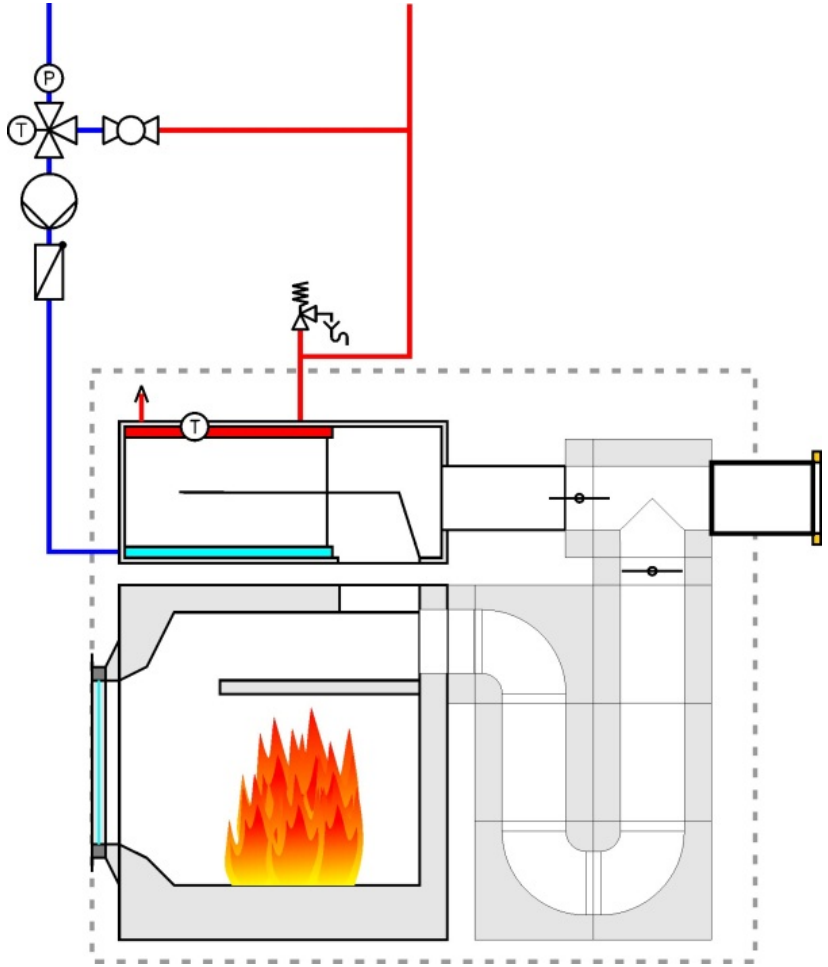


	Nr.	Lastzustand	Messergebnisse			Grenzwerte		
						Art. 15a	BImSchV - Stufe 1	EN 13240
			mg/MJ	%	mg/m³N (13%O2)	mg/MJ	mg/m³N (13%O2)	%
CO	1	Volllast	610	0,073	913	1100	2000	1
	2	Volllast	666	0,073	997			
NO_2	1	Volllast	68	-	101	150	-	-
	2	Volllast	69	-	91			
η (%)	1	Volllast		87,63		78	73	50
	2	Volllast		90,46				

Efficiencies > 90%
(without flue gas fan)

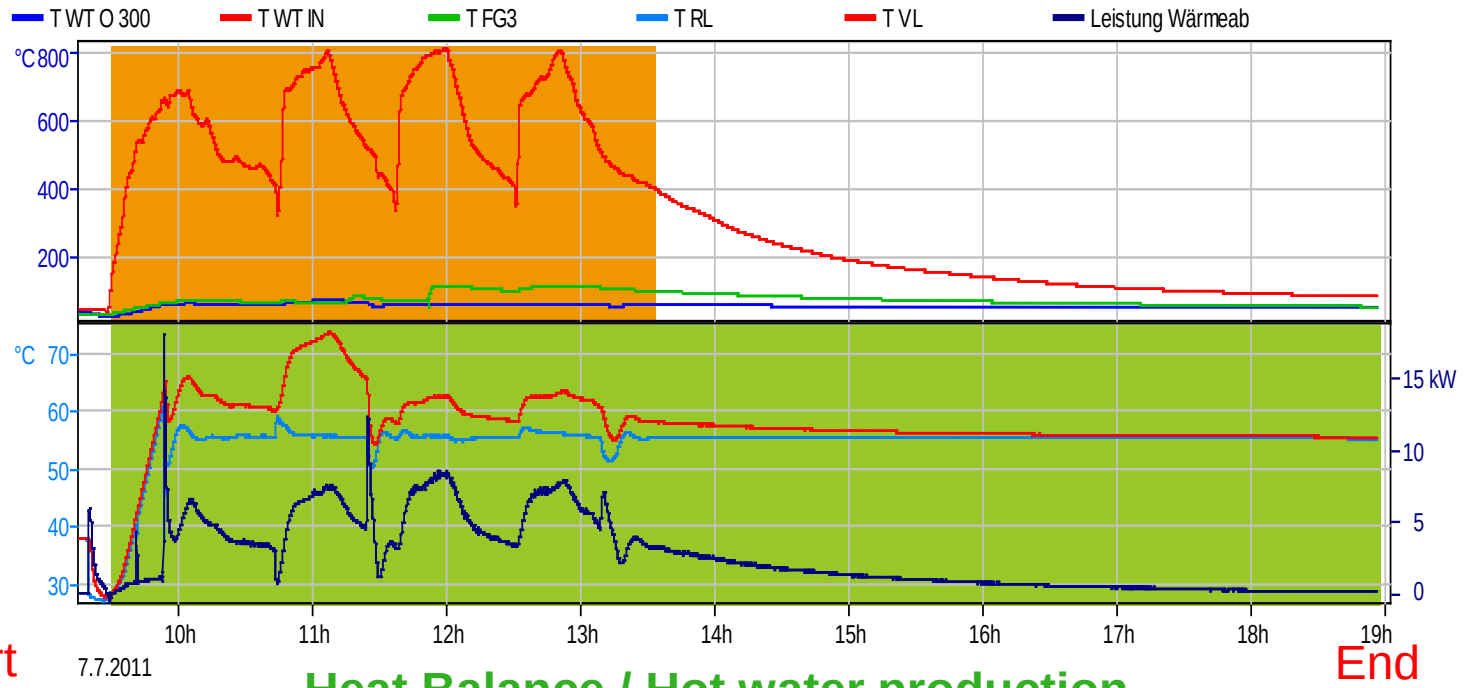
Example: Ceramic modular heat storage combined with hot water production





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

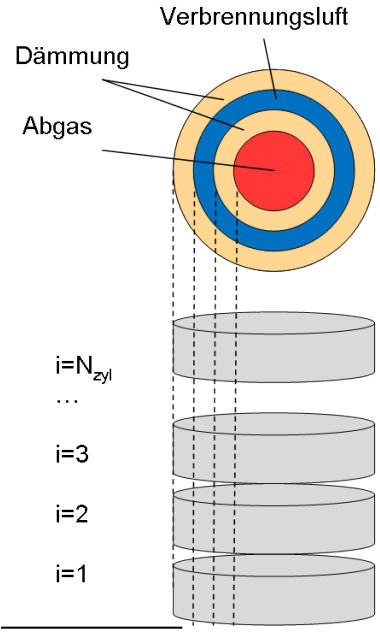
Airtight Buildings – Combustion Air Supply

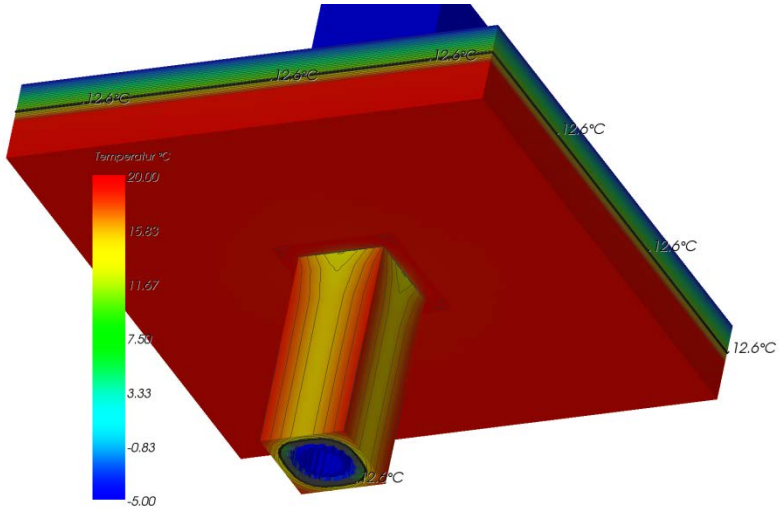
Double duct chimney systems:

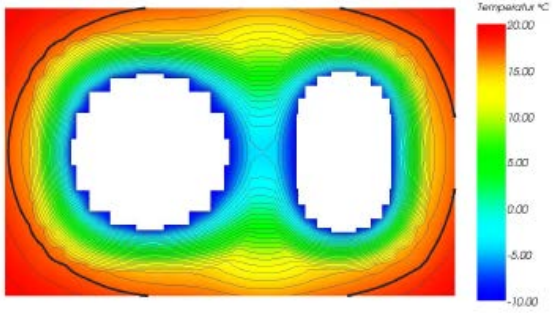
- Air supply (issue: pre-heating)
- Cooling effect of combustion air

Tools:

- Measurements
- Mathematical models / simulation







EVALUATION
Type-testing 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

EVALUATION-
Stove type-testing (EN13240)

Typical stove test according to EN13240,

four examples of „data analysis“:

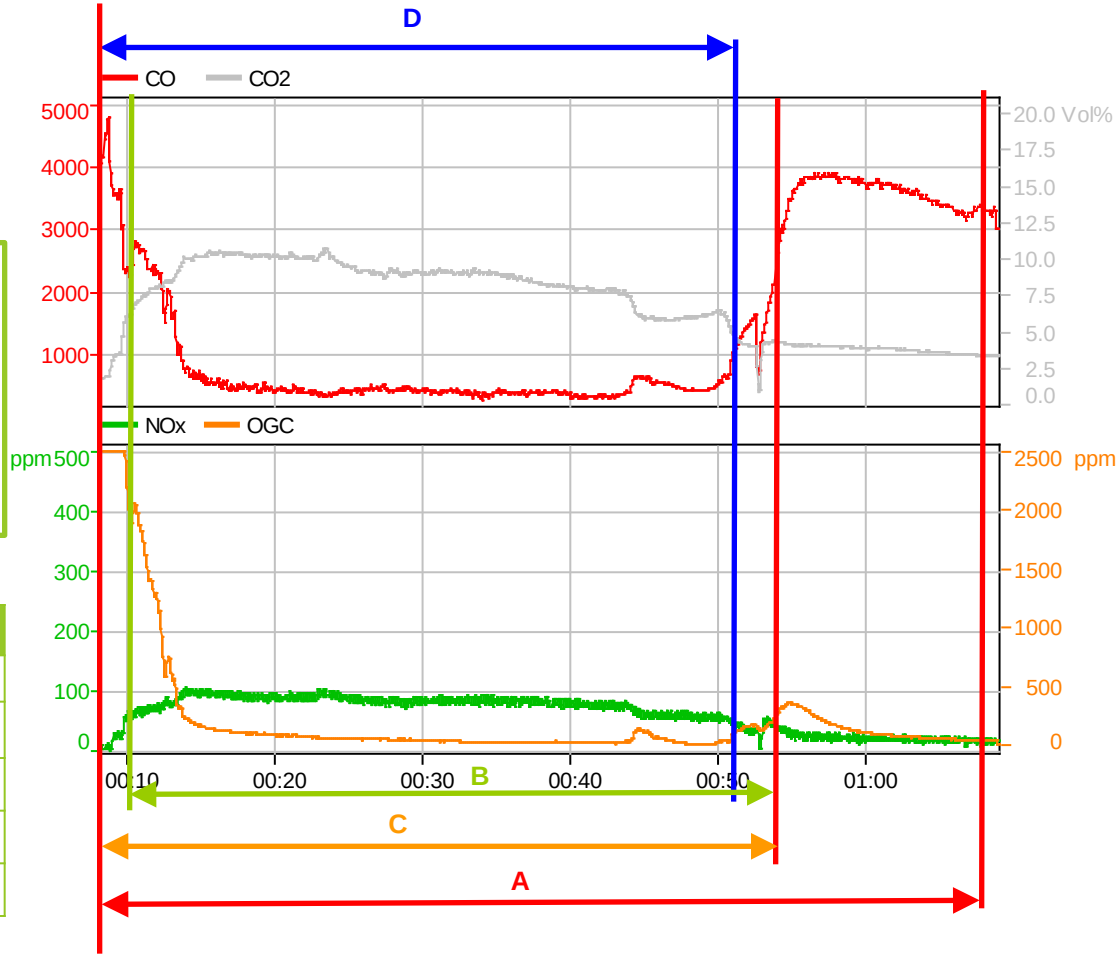
A – incl. start-phase until equal weight + ash

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	CO2	CO	NOx	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 gab to automatically fired systems
- New testing methods together with Europe-wide legal regulations are required to trigger technology improvement

Acknowledgements

Funding bodies

SEVENTH FRAMEWORK PROGRAMME

klima+ energie fonds

bmvit
Federal Ministry for Transport, Innovation and Technology

FFG

bmwfi
Federal Ministry of Economy, Family and Youth

Company partners

AUSTRO FLAMM

dr pley Environmental

ORTNER KACHELOFEN MIT SYSTEM

SCHIEDEL ENABLES ENERGY EFFICIENCY

PALAZZETTI

RIKA®

HAPERO ENERGIETECHNIK GMBH

STAFFIERI AG

Thank you!

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