Karlsruher Institut für Technologie

EU-project RECOMBIO

REcovered fuels COMbined with BIOmass

IEA Bioenergy, ERFO, workshop „Production and utilisation options for Solid Recovered Fuels“
May 17, 2018, Bella Center Copenhagen

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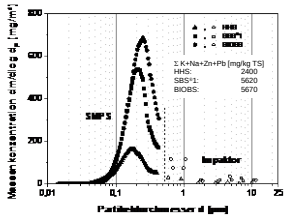
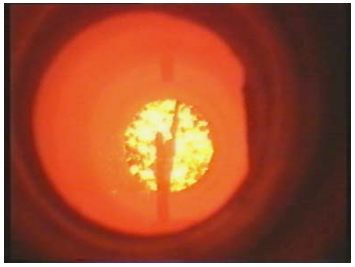
recombio REcovered Fuels COMbined with BIOmass

EUROPEAN UNION

SEVENTH FRAMEWORK PROGRAMME





Outline

- **Part 1: Project introduction**
- **Part 2: Production of BIOBS in Erftstadt**
- **Part 3: Use of BIOBS (R&D of KIT and IFK, industrial application)**
- **Part 4: Messages – Closing remarks**

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Aims/targets of RECOMBIO

- **Combined use of bio-residues and Solid Recovered Fuels**
  - **Enlarged fuel basis**
  - Increased **flexiblity** of fuel-producers and users
  - **Improved combustion behaviour** of fuel mixture
- Creation of **regional fuel markets**
- **High efficient combined heat and power generation and high availability** using bio-residues and SRF in CHP-plants (> 7.500h/a)
- Demonstration of a **sustainable** and short-term available **fuel production and utilisation**
- **Cost-effective CO_2-reduction**
- **No “food or fuel”-problematic**

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Project RECOMBIO

Partners

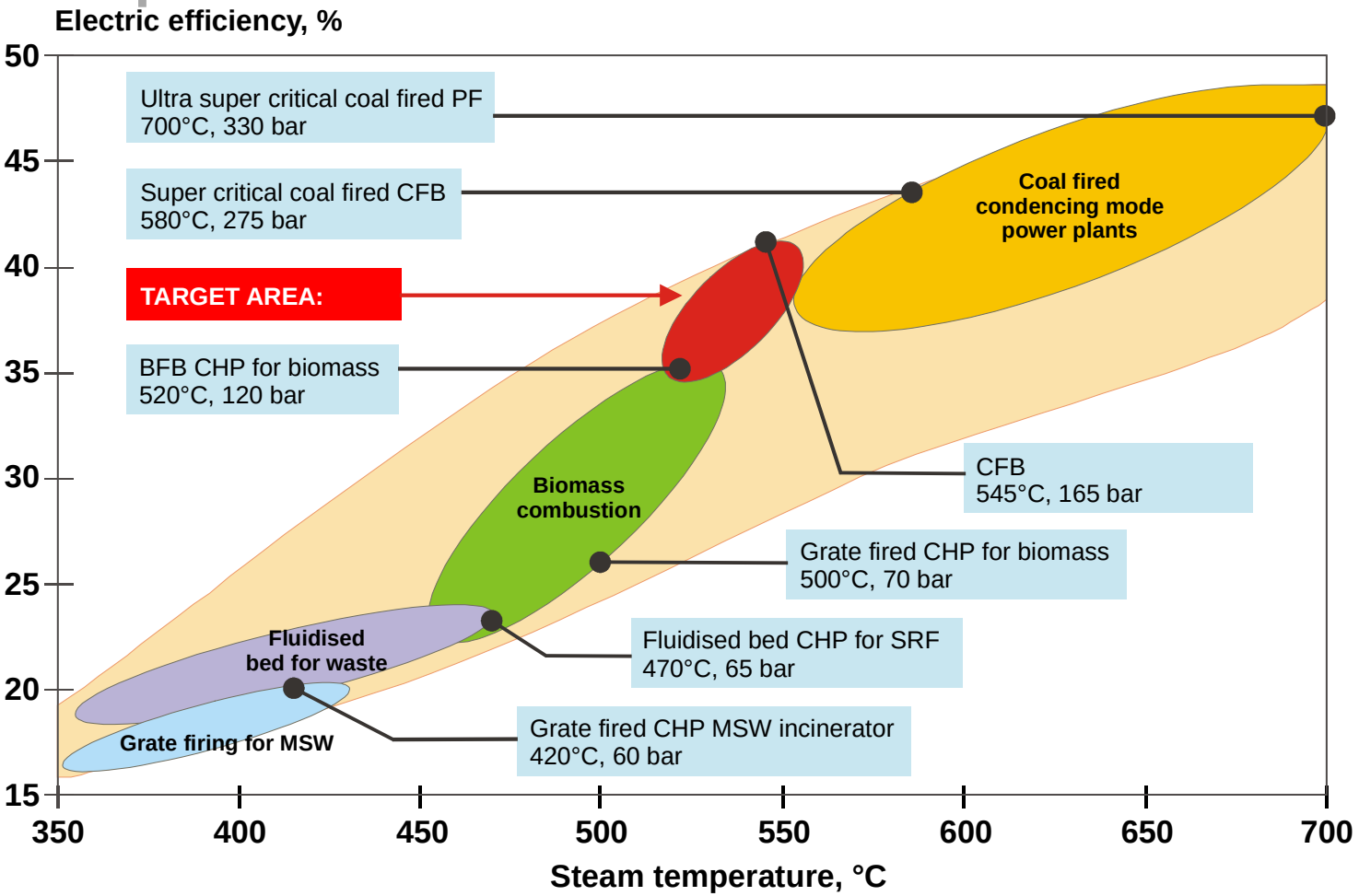
• REMONDIS	SRF-production + coordination
• RWE Power	SRF-use
• University Stuttgart	lab. and full scale measurements
• Forschungszentrum Karlsruhe	lab. and full scale measurements
• ECN	ash properties, corrosion, fuel characterisation
• L & T	SRF-production
• Stora	SRF-use
• VTT	lab. and full scale measurements
• Metso	additives, corrosion
• TiTech/TOMRA (Norway)	optical sorting technology (NIR)
• JRC (Belgium)	Life Cycle Analyses
• Turow/PGE (Poland)	dissemination

Total funding: 4,04 Mio € , 01.01.2010 – 31.12.2013, two demonstration cases

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Project RECOMBIO

Target area in terms of electric efficiency and steam temperature



Target area: efficiency > biomass plants and >> municipal solid waste incinerators

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

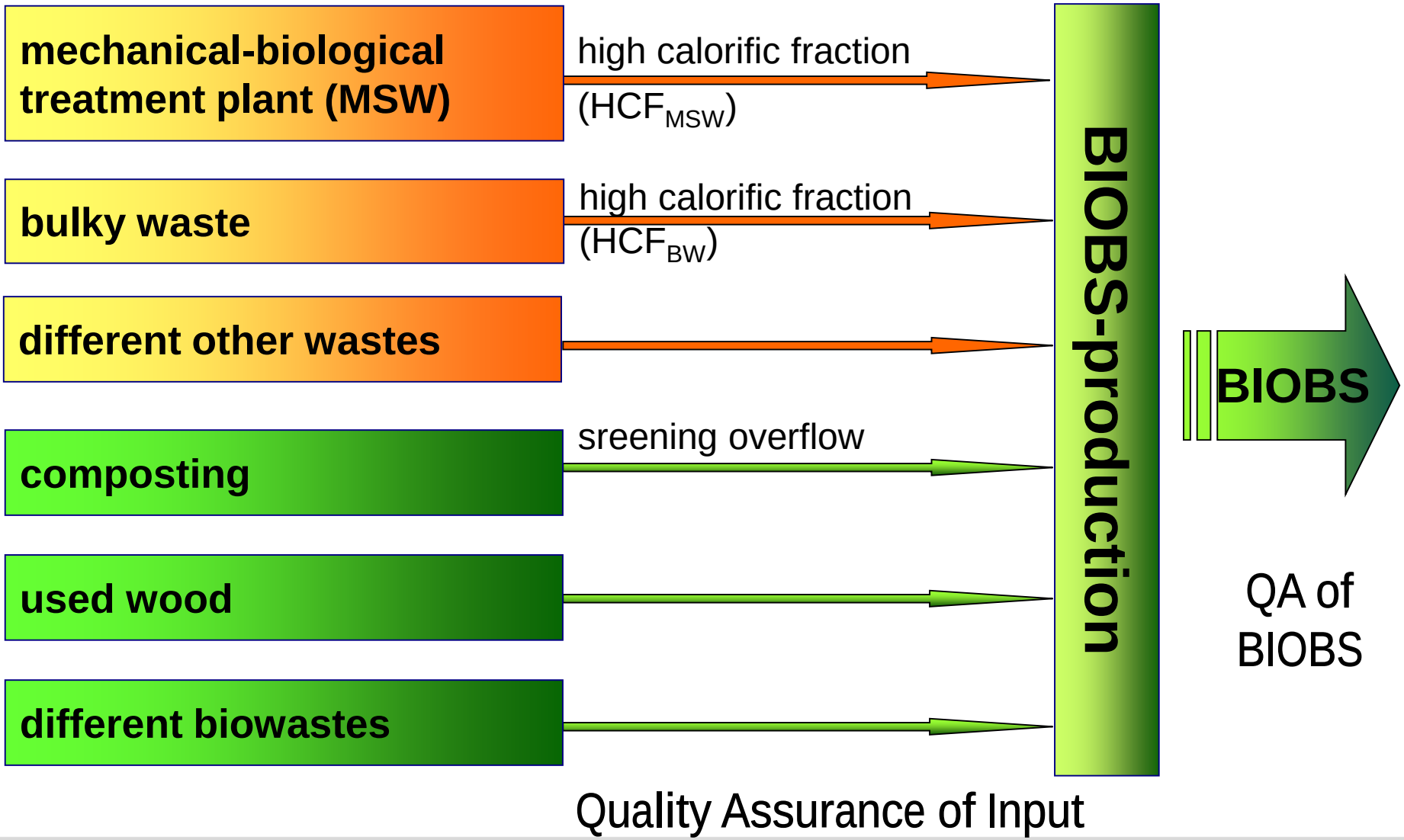
Three quality groups of SRF

since 1995/1998/2009

BPG®	SBS®	BIOBS
Brennstoff aus **P**roduktionsspezifischen **G**ewerbeabfällen	**S**ubstitut**B**renn**S**toff	**BIOB**renn**S**toff
Source seperated wastes / production residues	**High calorific fractions (HCF) sorted out from poste-use waste**	**High calorific fractions with a high biogenic content and different biowastes**

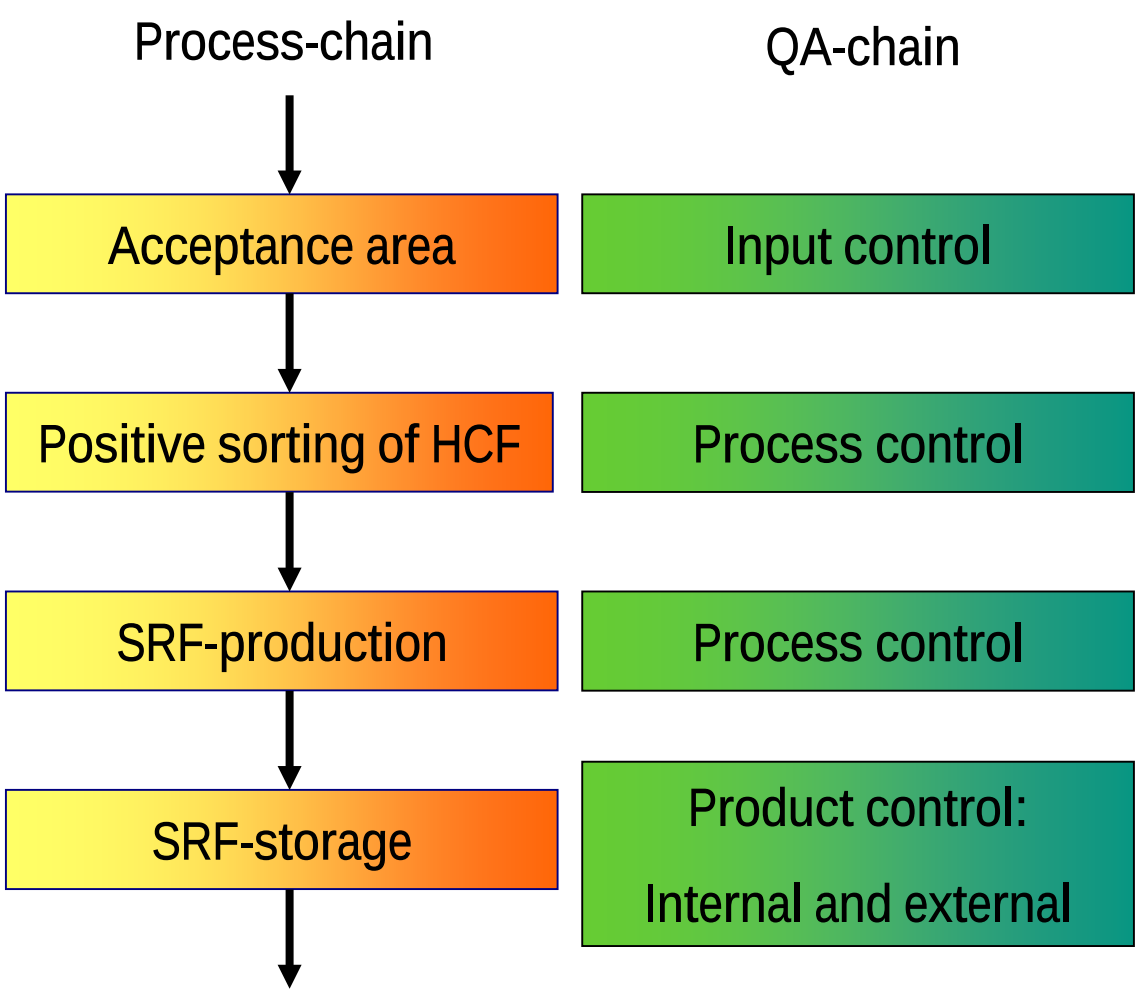
Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

SRF-quality BIOBS input materials



Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

QMS for the production of SRF in Erftstadt



ISO 9001: ✔

EFB: ✔

RAL-GZ 724 and 727: ✔

CEN/TC 343: ✔

RAL GÜTEZEICHEN Sekundärbrennstoffe

RAL GÜTEZEICHEN Biogener Anteil Ersatzbrennstoffe Sekundärbrennstoffe

QMS is the fundament for reliable SRF-qualities

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Online-analysis with NIR-device

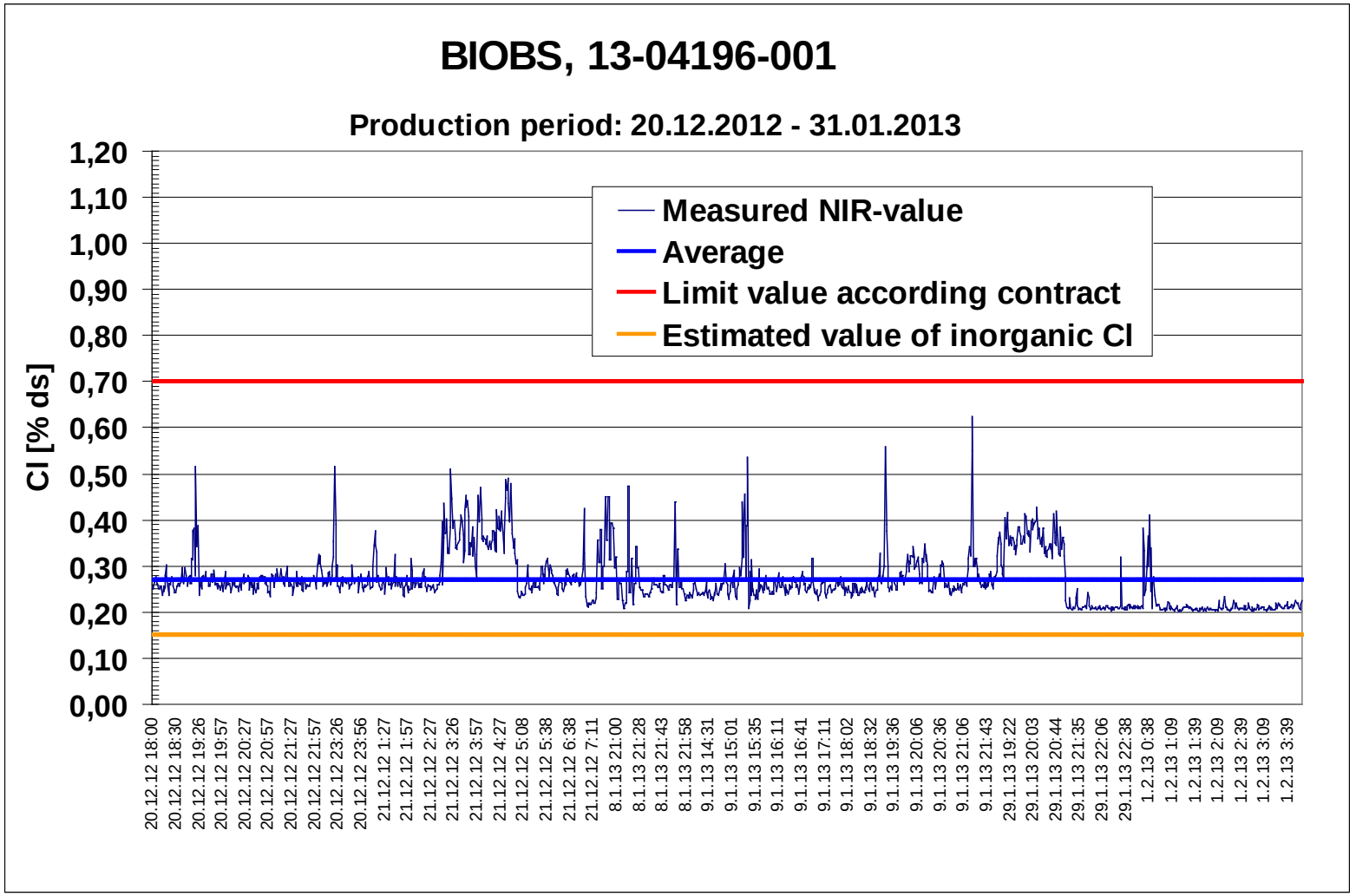
new position since 04/2012: product stream - 100%

New position after promising results of TAMARA-trials@KIT
(SRF-layer ca. 15 cm)

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Online-analysis with NIR-device

information for the control personnel (examplary lot)



Prevention of longer periods with higher Cl-values possible

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Quality of SBS®1$_{Erftstadt}$ and BIOBS
compared to Rhenish lignite (03/2014)

	Unit	Lignite from the Rhine, Mean (Berrenrath/Wachtberg)	SBS 1, Mean 2010 - 2013	SBS 2, Mean 2010 - 2013	BIOBS, Mean 2010 - 2013
Short analysis					
Net. Calorific Value	MJ/kg o.s.	10,1	13,2	18,2	11,9
H_2O	% o.s.	54	24,8	16,4	24,7
Ash	% o.s.	2,5	9,5	10,1	11,0
Chlorine	% o.s.	0,02	0,36	0,74	0,23
Volatile	% o.s.	23,5	53,5	60	52,7
Elementary analysis					
C	% o.s.	30,5	35,3	39,2	32,5
H	% o.s.	2,2	4,5	5,6	4,1
O	% o.s.	10,3	23,8	26,8	26,2
N	% o.s.	0,4	1,4	1,0	1,2
S	% o.s.	0,2	0,2	0,3	0,1
Addtional parameters					
Biogenic C	% of TC	0	74,3	50	84,4
Chlorides	mg/kg d.s.	300	2.005	1.655	1.575
Al	mg/kg d.s.	750	5.550	5.685	4.700
K	mg/kg d.s.	215	2.160	1.610	3.190
Na	mg/kg d.s.	1.400	2.665	2.213	1.420
Pb (50th. Percentile)	mg/kg d.s.	1	75	65	45
Zn (50th. Percentile)	mg/kg d.s.	3,5	275	350	210

Classification code according EN 15359 of SBS®1 and BIOBS: NCV: 4; Cl: 2; Hg: 1

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

R&D @ KIT and IFK- Selected results

- **Comparison of Chlorine- Concentration in BIOBS, determined by different methods**

- **Corrosion Measurements at CHP plant in Wachtberg**

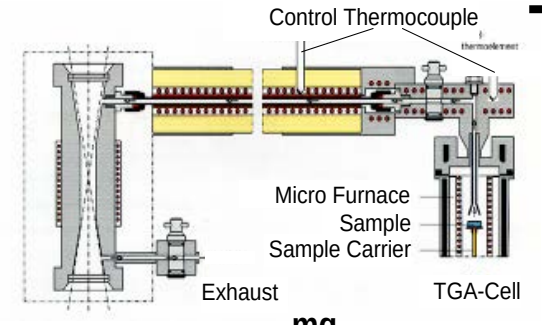
Three-stage characterization methodology

Stage 1

Chemical Analysis

TG / HR-FTIR coupling

FTIR



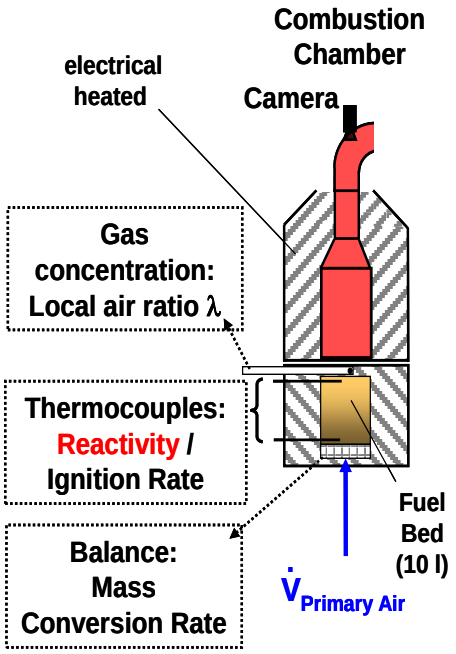
mg

Net calorific value, kinetics, C, H, O, N, S, Cl

Standard method

Stage 2

Fixed Bed Reactor KLEAA



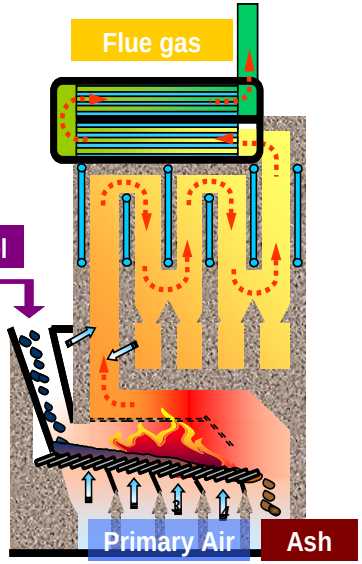
10 kg

Combustion behavior, Characteristic Numbers

Advanced method

Stage 3

Grate Incinerator TAMARA



200 kg/h

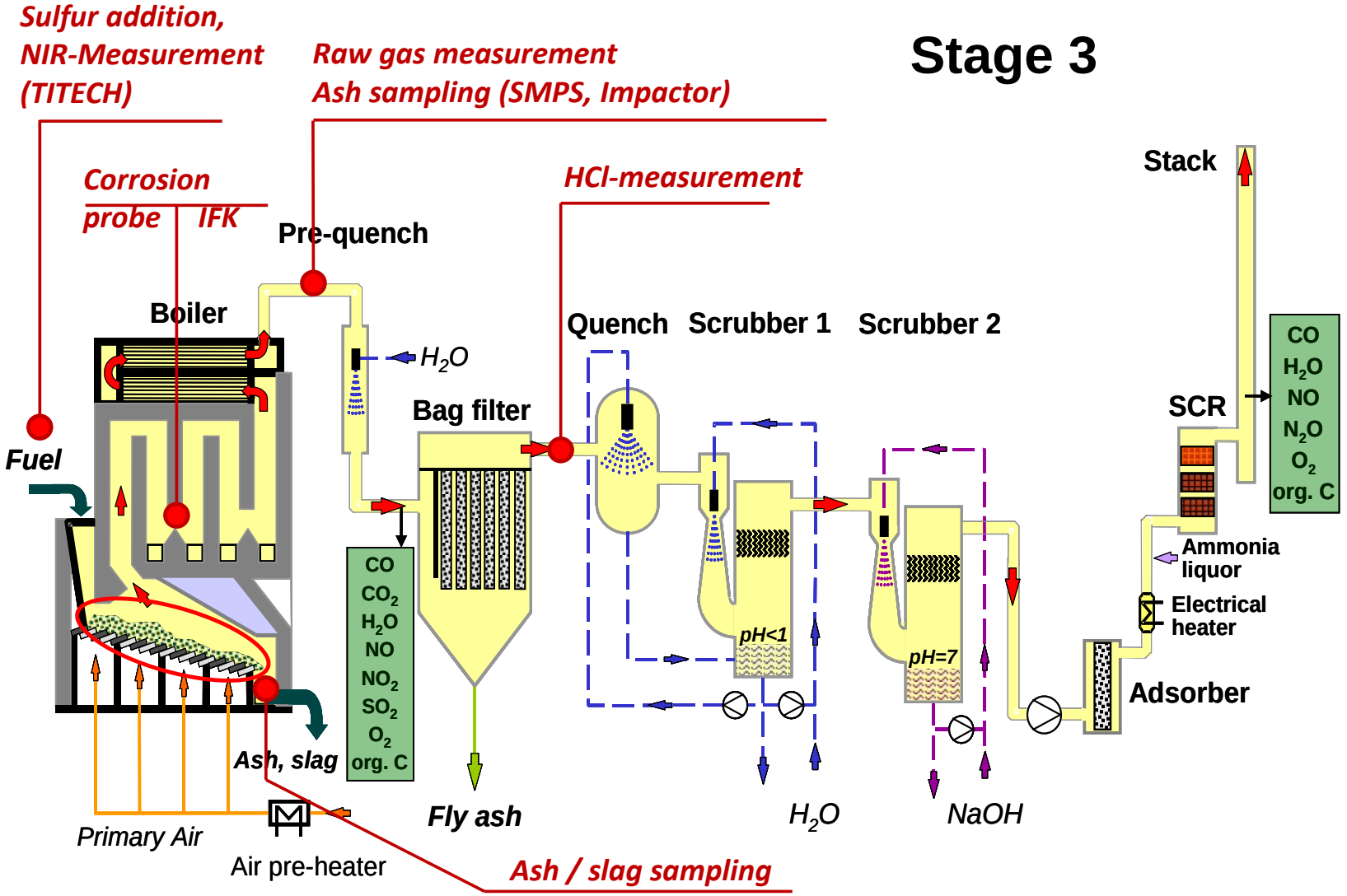
Scale-up, Validation, emissions

Advanced method

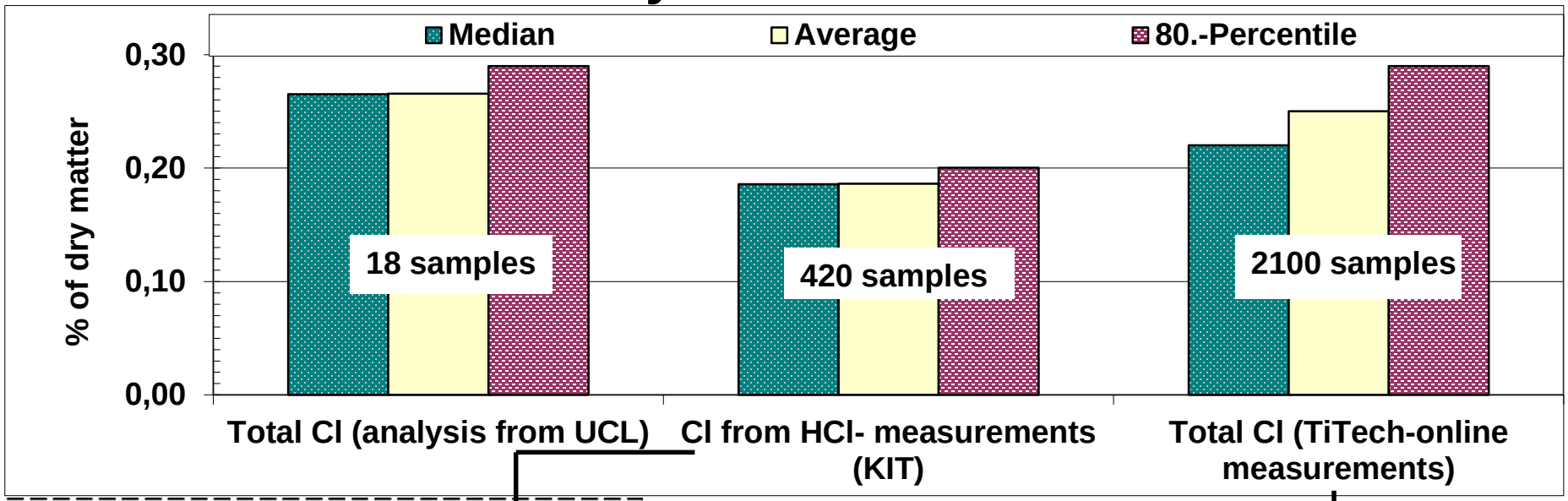
Pilot Plant TAMARA

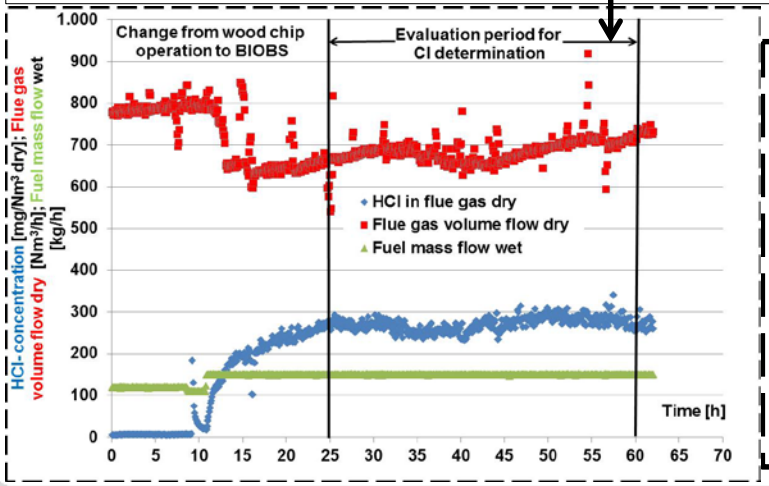
Thermal power: 450 kW

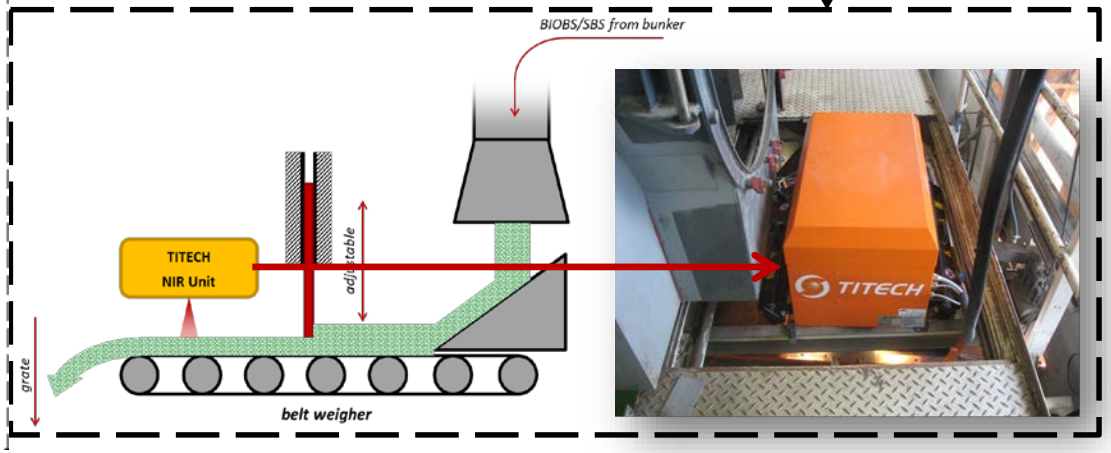
Stage 3



Combustion Tests at TAMARA – Comparison of Cl- Concentration in BIOBS, determined by different methods

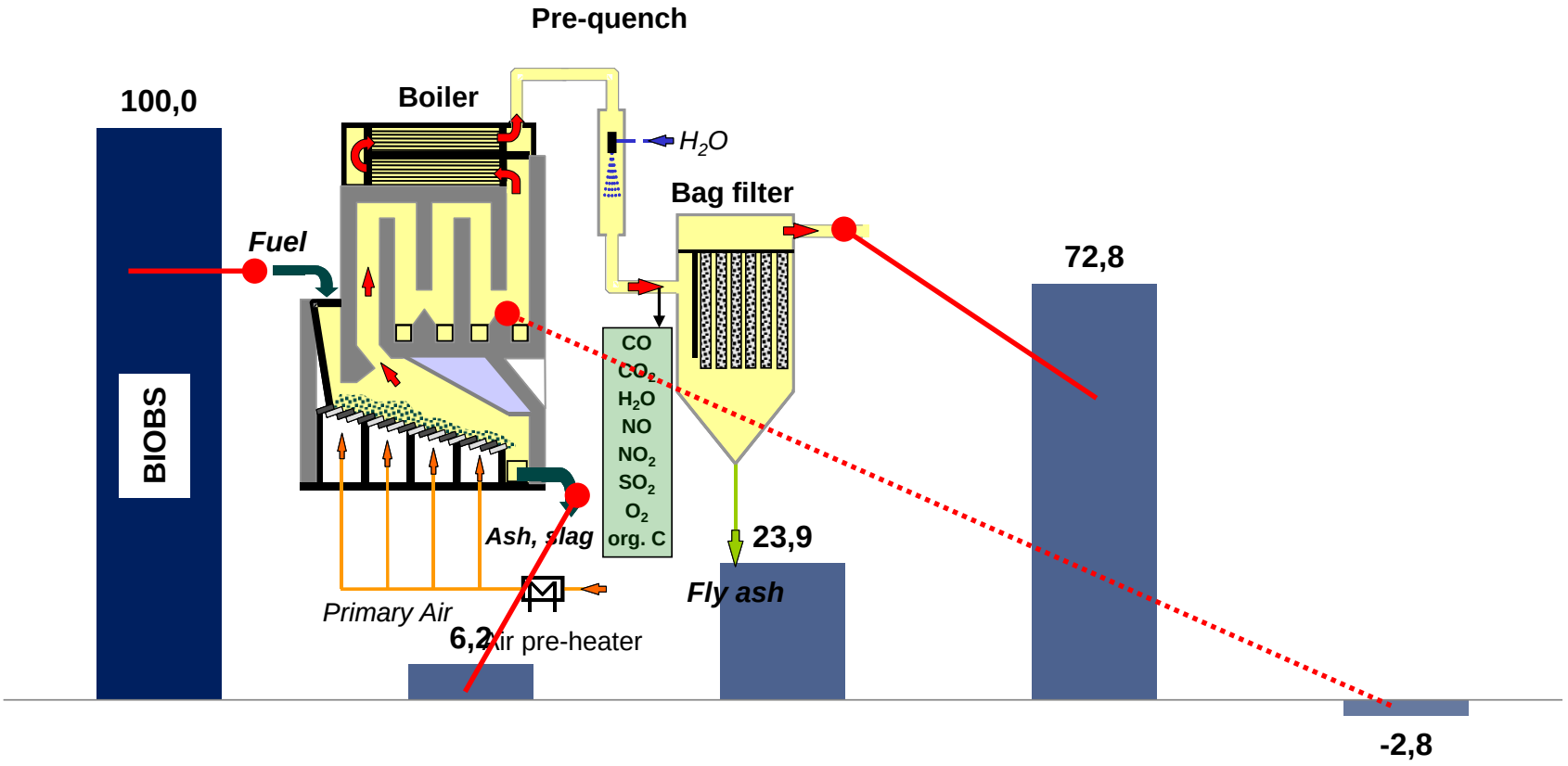






Chlorine Balance

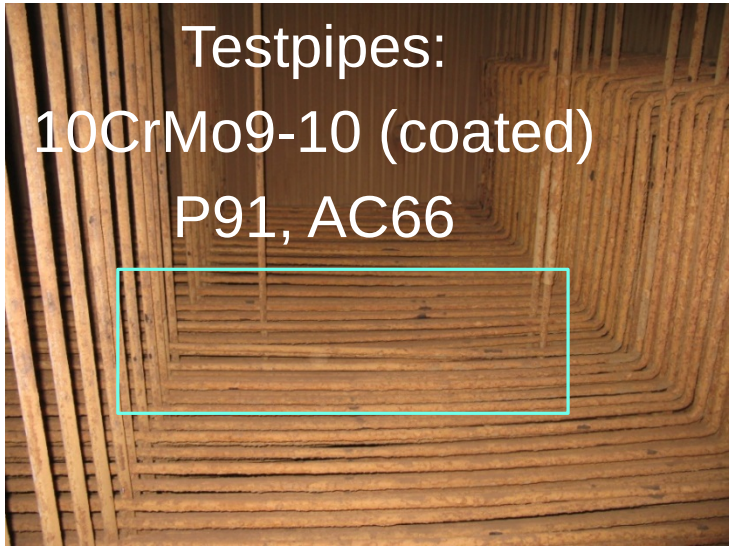
Chlorine balance BIOBS without sulfur supply- distribution in [wt.%], determined from loads

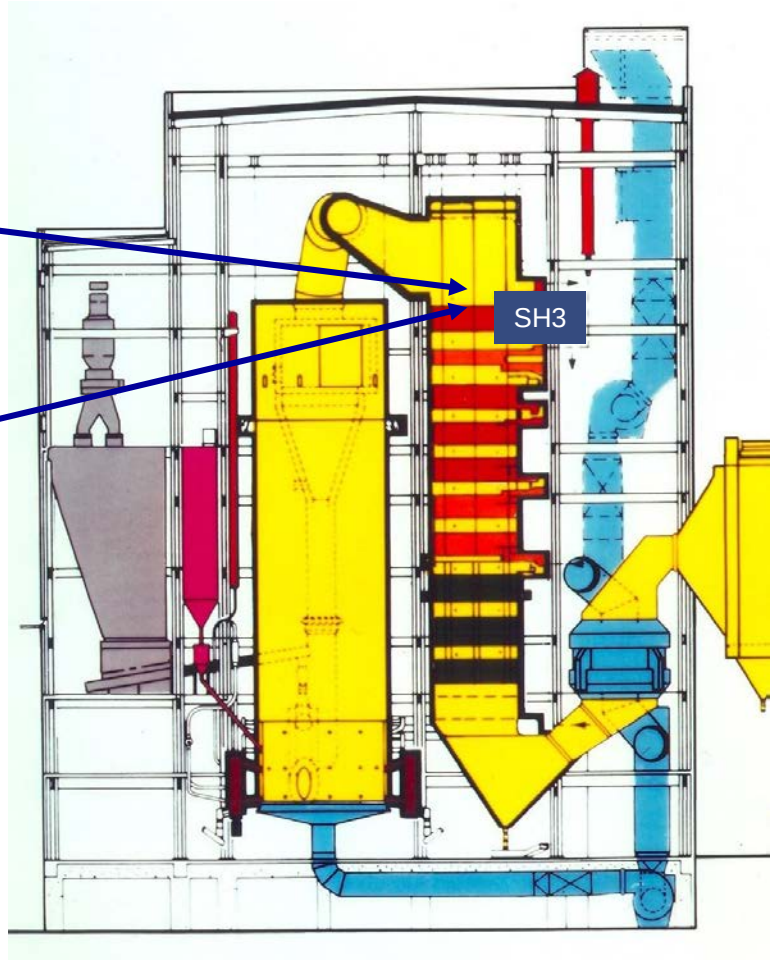


Operation and measurement campaigns

Measurement site in PP – boiler 1

IFK-Corrosion probe,
(temperature controlled), 41m





Source: Eva Miller, Jörg Maier (IFK), Franz-Josef Kipshagen (RWE Power AG)

Evaluation of BIOBS co-combustion in Wachtberg, IFK

12% of the firing thermal capacity

- **Quality of BIOBS** 
- **Delivery and transfer** 
- **Feeding and dosing** 
- **Combustion behaviour (ignition/burnout)** 
- **Reducing emission limits (17. BImSchV)** 
- **corrosion** 

20% of the firing thermal capacity

- **Quality of BIOBS** 
- **Delivery and transfer** 
- **Feeding and dosing** 
- **Combustion behaviour (ignition/burnout)** 
- **Reducing emission limits (17. BImSchV)** 
- **corrosion** 

Co-combustion of BIOBS in the lignite power plant Wachtberg is technical and environmentally feasible with lower amount (ca. 15%) and with some modifications especially of the feeding system

Source: Eva Miller, Jörg Maier (IFK), Franz-Josef Kipshagen (RWE Power AG)

Summary R&D

Fuel Characterization

- *(Co-)Combustion of BIOBS and SBS1® for grate incinerators successfully demonstrated*.
- *BIOBS- recipe improved*.
- Fixed bed combustion provide resilient results for design of grate incinerators.
- Co-firing of BioBS with a high biogenic content was successfully demonstrated in a large scale CFB and grate fired incinerator

Evaluation of different Measurement Methods

- Online-measurement with NIR-technique, HCl-laser and chemical analysis are validating each other
- *Application of NIR-technique in main flow of fuel preparation successfully demonstrated in TAMARA and implemented in Erftstadt.*

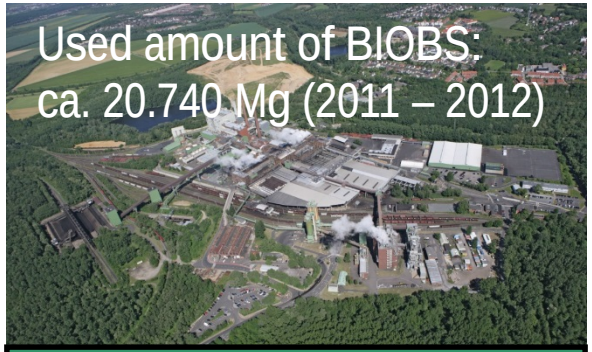
Demonstration cases

Finland: SRF-production in Kerava/Turku – SRF-use in Anjalankoski

SRF-production

SRF-use

Germany: SRF-production in Erftstadt – SRF-use in CFB in Wachtberg/Berrenrath



2 x 166 MW_{th} / η_{CHP} = 83%

2 x 235 MW_{th} / η_{CHP} = 83 %

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Summary RECOMBIO (1/3)

- **NIR-technology**
  - is the key to produce **high-quality fuels** based on high calorific waste fractions
  - can be used/developed as an **online-analysis**-system for **Cl** and (NCV, H_2O)
- **Certified SRF`s** (i.e. RAL-GZ 724) guarantee a high quality reliabilty and ensure an **environmently friendly use in cement industries and power plants**
- **Fuel-quality is the decisive tool for high efficiency**
- About **1t CO_2 reduction/t BIOBS** in lignite substitution

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Summary RECOMBIO (2/3)

- Results of external **LCA by the JRC Ispra** on behalf of the EU-Commission taking into account 15 life cycle impact categories **shows environmental sustainability**; this means that co-incineration of **quality assured SRF is ecologically useful**
  - Demonstration case Finland: improvements for 11 of 15 categories
  - Demonstration case Germany: **improvements for 15 of 15 categories**, **CO_2-reduction** effect ca. **2000g CO_2/kWh_{el}** (by aggregating effects of all measures to the functional unit kWh_{el})

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Summary RECOMBIO (3/3)

- **No “food or fuel“-problematic**
- **Production** and use **of SRF is recommended** for other (EU-) countries (i.e. GB, PL)
- **European potential SRF co-incineration** cement and power plants: **15 - 30 Mio t /a**
- **MSW-Incinerators** as the last step of modern waste management **(ultima ratio)**

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015

Anjalankoski, Finland

Thank you to the COM/DG ENER for funding the RECOMBIO-project

Source: Dr.-Ing. Th. Glorius, presentation @ ERFO workshop, Brussels, 22.4.2015