EXECUTIVE SUMMARY

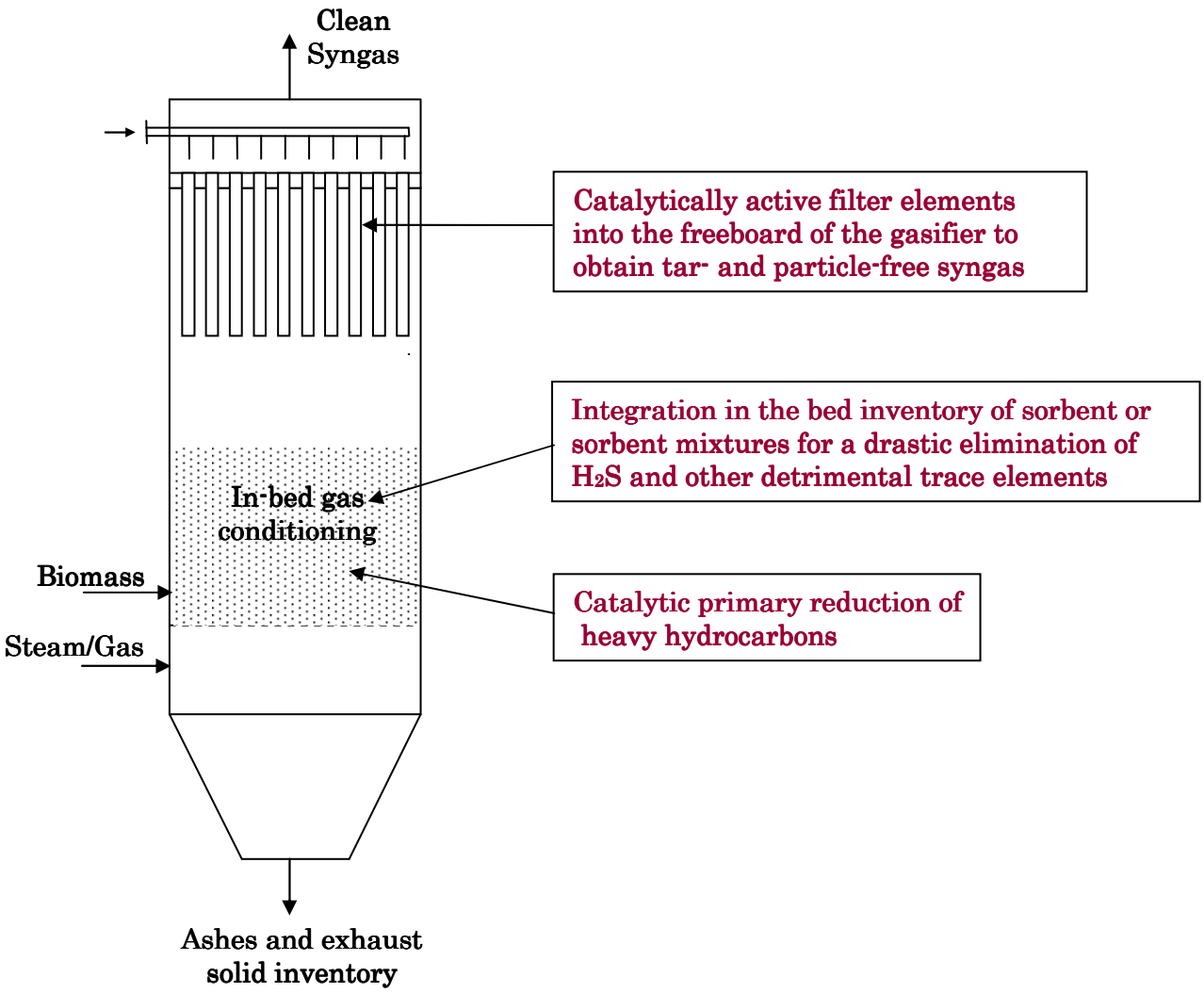


Figure 1: Innovations at the core of UNIQUE project

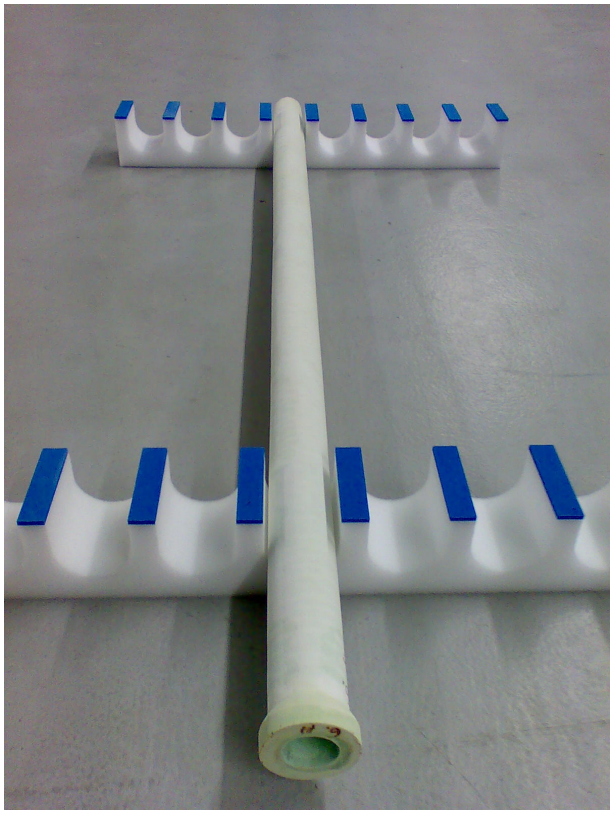


Figure 2. Newly developed Al_2O_3 based catalytic filter candle of catalytic layer design of the dimension 60/40 x 1500 mm

Figure 3: 8 MWth biomass CHP plant Güssing

Figure 4: 1 MWth UNIQUE prototype

DESCRIPTION OF THE MAIN S & T RESULTS/FOREGROUNDS

Table 1: Olivine, 10% Fe/olivine and 3.9% Ni/olivine activity in toluene (T) or methylnaphthalene (1-MN) steam reforming in complex gas mixtures (T = 825°C) (tars: 30 $g.Nm^3$).

Samples	Tar	Conversion (%)	V_{H2} ($mol_{H2}/h/g_{cat}$)	Dry product distribution (%vol)			
				H_2	CO	CO_2	CH_4
Initial composition				35.0	34.5	17.5	10.0
olivine	T	36.9	0.010	39.5	31.8	20.0	9.4
	1-MN	4.9	0.002	34.4	34.6	21.6	9.5
10%Fe/olivine	T	90.1	0.080	47.5	28.0	19.7	4.8
	1-MN	37.6	0.005	39.3	36.0	14.8	10.6
3.9 Ni/olivine	T	90.4	0.080	48.8	31.1	20.0	0.1
	1-MN	39.8	0.007	37.2	35.3	18.8	8.7

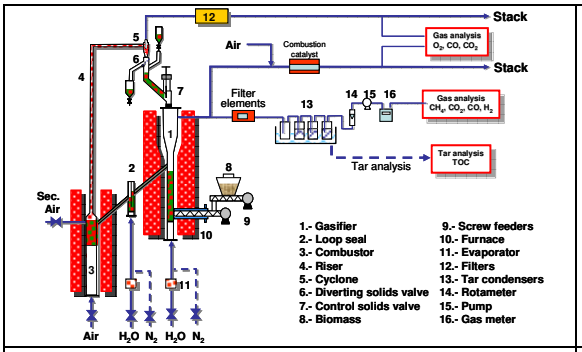


Figure 1: Scheme of the bench scale unit

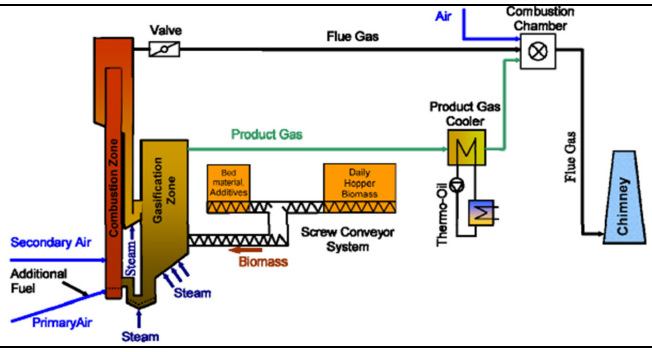


Figure 2: Scheme of the pilot plant scale

Table 2: Overview on experimental units and experimental aspects

	bench-scale unit	pilot plant scale unit	DCFB system
reference materials	silica sand, olivine	silica sand, olivine	olivine
	wood pellets		model gas mixture
process parameter variation with Fe-olivine	temperature, steam/fuel ratio	temperature, steam/fuel ratio, solid inventory, mixture (olivine/Fe-olivine), l_{Riser}	
Sorbents	not applicable	sulphur, alkali	-

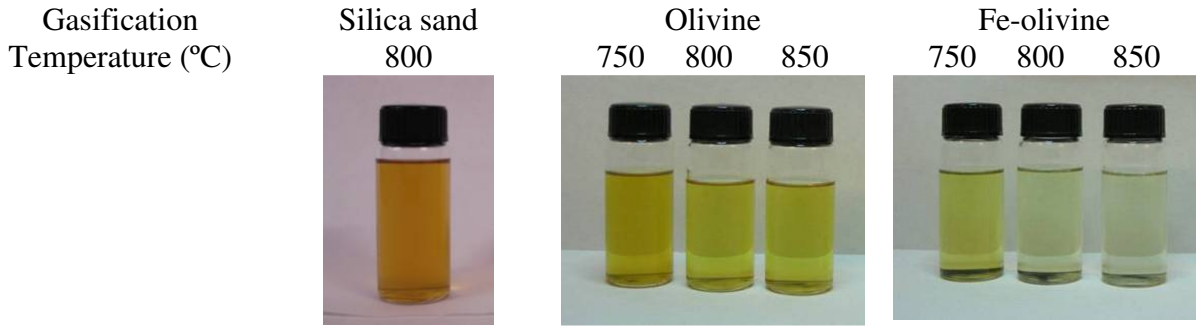


Figure 3: Example of the tars produced for different bed materials

Table 3: Brief summary on experiments at pilot scale

Gas composition in [vol.-%$_{db}$]	H_2	CO	CO_2	CH_4	tar [g/Nm³$_{db}$]
Silica sand	~ 35	~ 34	~ 14	~ 11	10 – 11
Olivine	~ 40	~ 19	~ 25	~ 9	~ 7
Fe-olivine	37 – 38	23 – 24	23 – 24	~ 8	2 – 3

Figure 4: Photographs of the catalytic filter elements of fixed bed design tested at the CSIC.

Without filter With filter

Figure 5: Effect of filter on tar recovered.

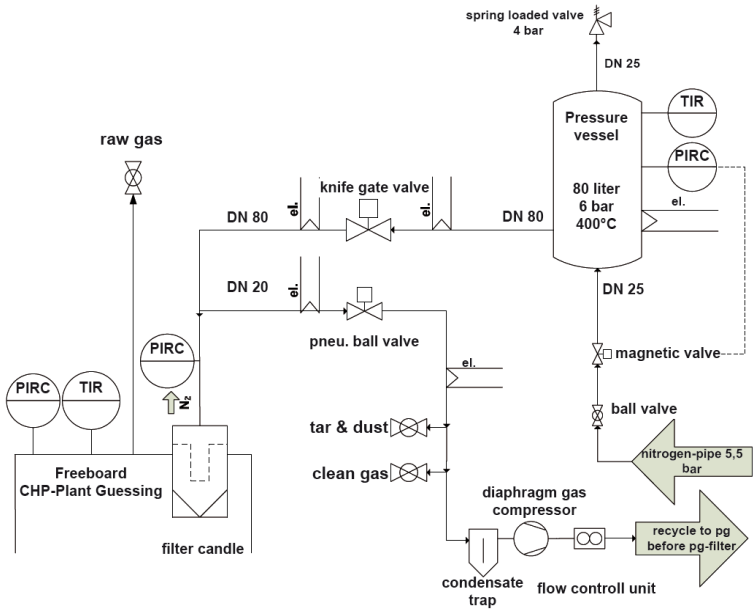


Figure 6: P & I flow sheet of the filter candle test module

Table 4: Design and process data

Volume flow over filter candle/face velocity:	4.5 – 5 Nm/h 60 ± 5 m/h	Filter candle dimensions:	length: 1520 mm diameter: 70 mm
Back pulsing:	nitrogen, at 400 °C, time controlled: 20 min. interval	Pipe system:	trace heating up to 500 °C

Table 5: Overview on applied filter candles

Filter candle notation	Design
DeTarCAT FB	Silicon carbide based filter candle with fixed bed design (Ni-catalyst)
DeTarCAT CL	Silicon carbide based filter candle with catalytic layer design (Ni-catalyst)
DeTarCAT CL-Al	Al_2O_3 based filter candle with catalytic layer design (Ni-catalyst)

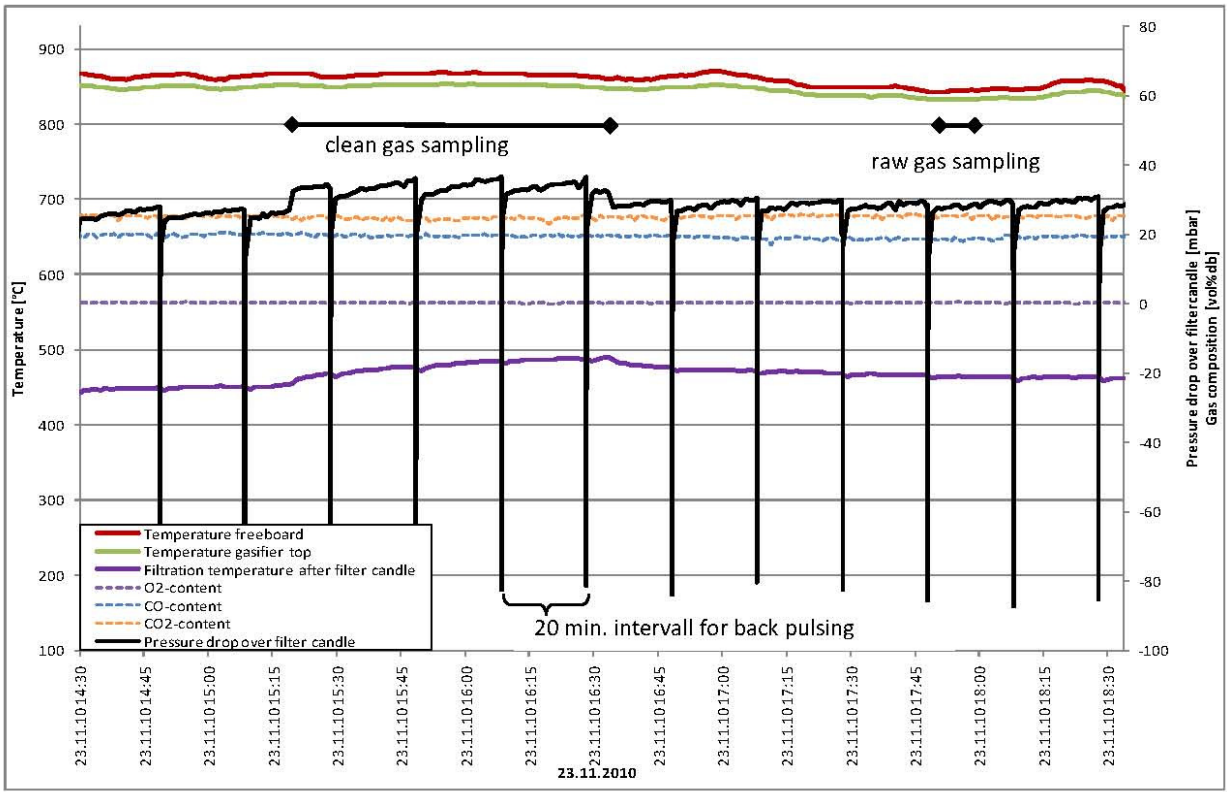


Figure 7: Progress of process parameters during test run with DeTarCAT CL-Al

Table 6: Gas composition, raw and clean gas, DeTarCAT CL-Al

vol.-%$_{db}$	O_2	N_2	CH_4	C_2H_4	C_2H_6	CO	H_2	CO_2
raw	0.3	1.7	10.4	3.5	0.3	18.7	42.9	26.2
clean	0.3	4.3	7.7	0.5	0.1	18.8	43.7	24.4

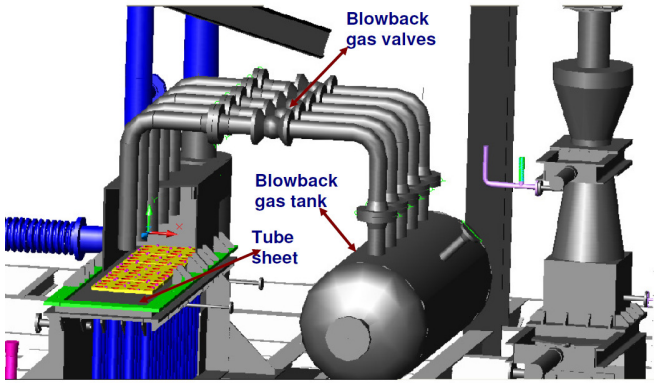


Figure 8: Plant layout including the filter system.

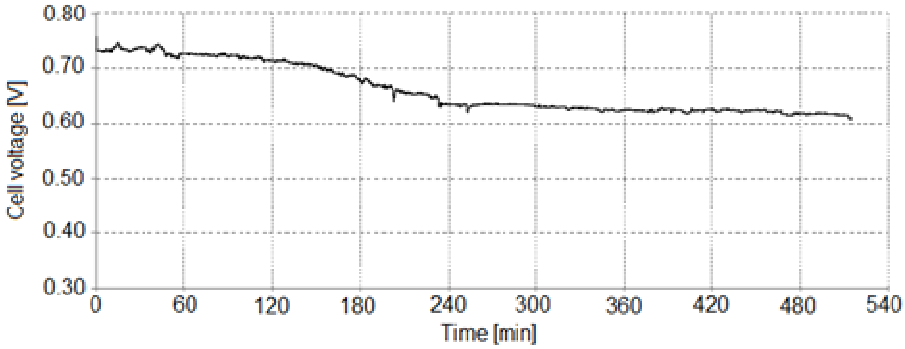


Figure 9: Performance of the SOFC cell fuelled with the syngas from the O_2/H_2O blown biomass gasifier under 0.25 A/cm^2 electric current load during the tests at ENEA Trisaia Research Centre.

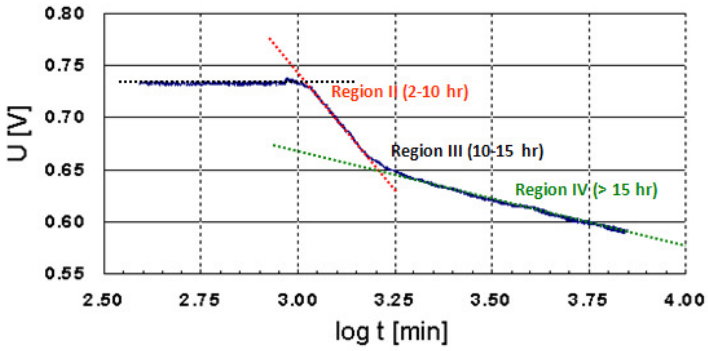
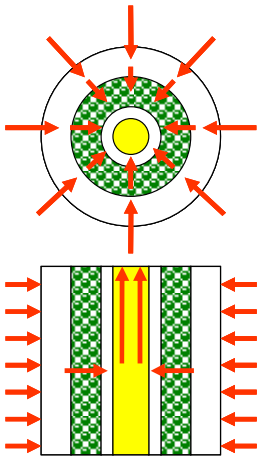
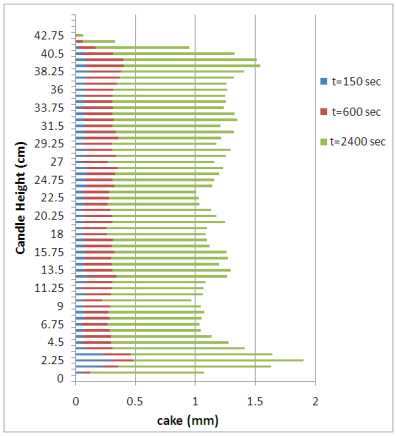


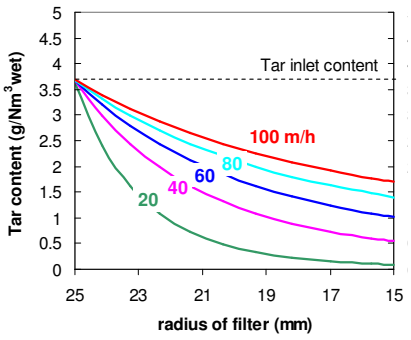
Figure 10: The effect of 1.5 ppm H_2S on the performance of the anode supported SOFC cell fuelled with the 47.5%H_2+47.5%N_2+3%H_2O gas at 750 ºC. Dotted lines – linear fit for the selected regions of cell performance response to H_2S introduction to fuel stream (at 10^3 min.)



Scheme of the catalytic candle.



Evolution of the cake with time.



Tar reforming efficiency at different face velocities.

Figure 11: Solids filtration and tar reforming modelling