



HEATING WITH BIOMASS IN THE TERTIARY SECTOR

Results of the demo plants in Spain

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DOMOHEAT PROJECT



Objectives



- Medium size domestic boilers
24 kW / 60 kW /100 kW
- Selection of agro/forest/wood wastes that are usable in the state of the art
- Test runs are focused on evaluate the energy and environmental potential, operational and significant factors
- Mediterranean biomasses in Austrian boilers



Evaluation of the fuel



1.- Logistic

2.- Feeding (completely automatic)

3.- Stability of combustion (long periods)

4.- Demanded power and efficiency (Norms)

5.- Low emissions and particles (Norms)

6.- Low ashes (costumer comfort)

7.- Long usable life (Fouling/slagging)

Selected Fuels



1	Popular -market	Pine chip
2	Big boilers	Eucalyptus chip
3		Oak chip
4		Poplar chip
5		Paulownia chip
6		Rye straw pellets
7	Popular - market	Pine pellet
8		Oak pellet
9		Pine bark
10		Pinecone chips
11		Pinecone seed shell
12		Almond shell
13		Hazelnut shell
14	Big boilers	Olive kernel
15		Vine shoot
16		Olive pruning

Regulations: UNE-EN 303-5



- CLASS = f(power, emissions)

- 1] = 47 + 6 log Qn (kW)

Qn nominal output of the boiler

- 2] = 57 + 6 log Qn

- 3] = 67 + 6 log Qn

Feeding method	Fuel	Nom. Output kW	Emission limit								
			CO mg/m ³ as 10 % O ₂			OGC mg/m ³ as 10 % O ₂			Particles mg/m ³ as 10 % O ₂		
			class 1	class 2	class 3	class 1	class 2	class 3	class 1	class 2	class 3
Manual feed	Biofuel	< 50	25 000	8 000	5 000	2 000	300	150	200	180	150
		50 -150	12 500	5 000	2 500	1 500	200	100	200	180	150
		150 - 300	12 500	2 000	1 200	1 500	200	100	200	180	150
	Fossil fuel	< 50	25 000	8 000	5 000	2 000	300	150	180	150	125
		50 -150	12 500	5 000	2 500	1 500	200	100	180	150	125
		150 - 300	12 500	2 000	1 200	1 500	200	100	180	150	125
Automatic feed	Biofuel	< 50	15 000	5 000	3 000	1 750	200	100	200	180	150
		50 -150	12 500	4 500	2 500	1 250	150	80	200	180	150
		150 - 300	12 500	2 000	1 200	1 250	150	80	200	180	150
	Fossil fuel	< 50	15 000	5 000	3 000	1 750	200	100	180	150	125
		50 -150	12 500	4 500	2 500	1 250	150	80	180	150	125
		150 - 300	12 500	2 000	1 200	1 250	150	80	180	150	125

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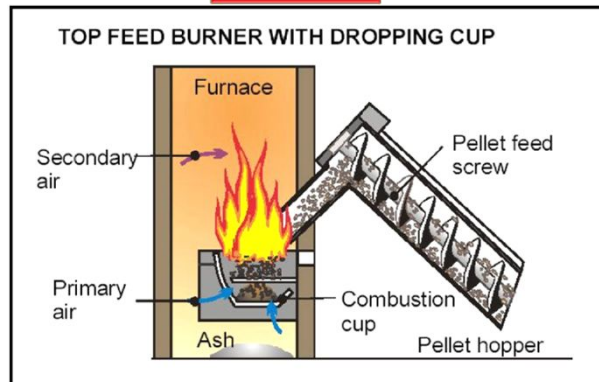
BOILERS AND METHODOLOGY



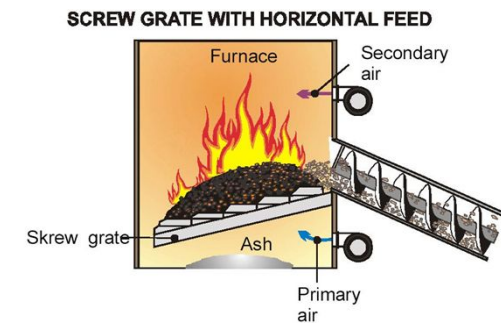
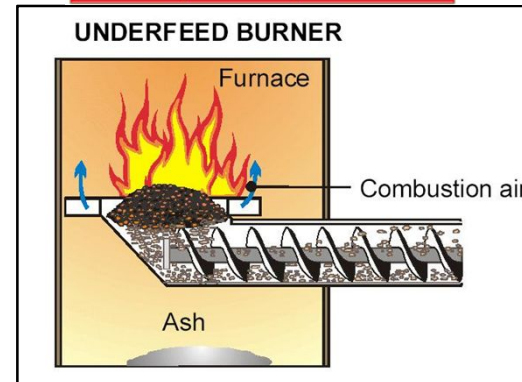
Technology: wood → pellet → chips + pellet



pellet



Chips+pellet



Experimental boiler: pellet (24 kW \rightarrow 18 kW)



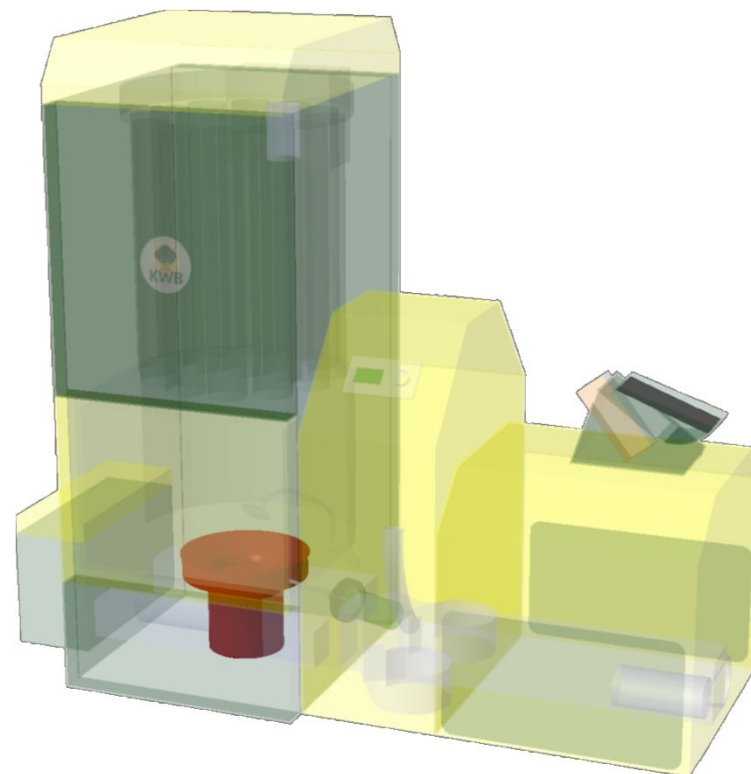
**Commercial
pellet boiler**



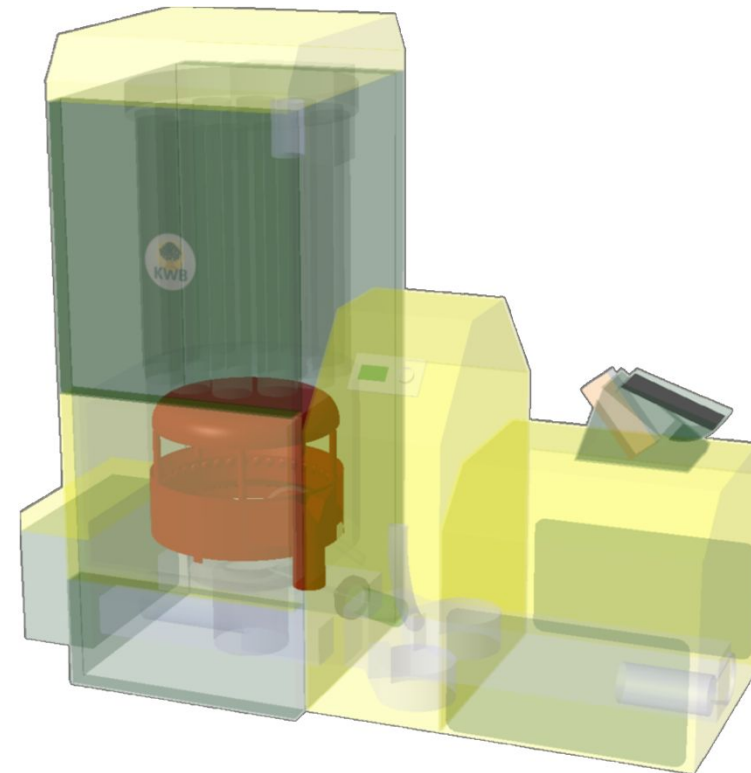
**Experimental
Regulation + control**



Monitoring boiler: chips + pellet (60 kW)

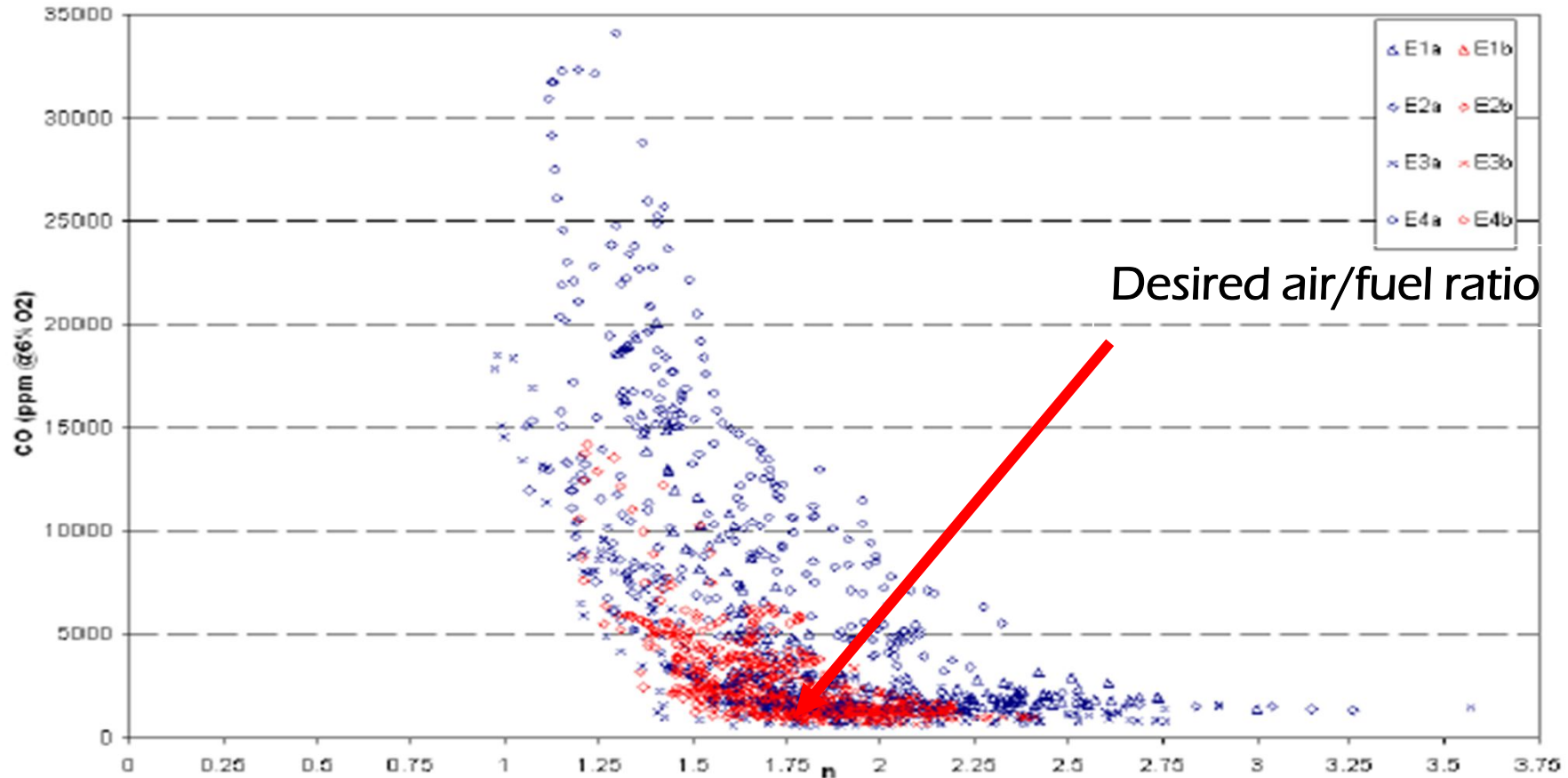


Monitoring boiler: chips + pellet (multi fuel)



Methodology: 1. Dynamic \rightarrow 2. Stable test

Consumer needs \neq monitoring requirements



RESULTS: Experimental boiler – PELLET 24 Kw



RESULTS: pellet boiler



Biomass	Combustion	CO		η_{H_2O}	η_{H_2O}	EN-303-5
		Class*		%	Class*	Lowest value
		Low load	High load	High load	High load	
Pine chips (01)	Failed	--	--	--	--	--
Eucalyptus wood chips (02)	Failed	--	--	--	--	--
Oak chips (03)	Failed	--	--	--	--	--
Poplar chips (04)	Failed	--	--	--	--	--
Pauwlonia chips (05)	Failed	--	--	--	--	--
Rye straw pellets (06)	OK but bad	--	--	--	--	--
Pine sawdust pellets (07)	OK	3	3	83	3	3
Oak sawdust pellets (08)	OK	3	3	78	3	3
Pine bark chips (09)	Failed	--	--	--	--	--
Pinecone chips (10)	Problems	1-2	2-3	59	1	1
Pinecone seed shells (11)	OK	3	2	81	3	2
Almond shells (12)	OK	0-1	1	73	2	0
Hazelnut shells (13)	OK	1-2	2-3	69	2	1
Olive kernel (14)	OK but bad	3	1-2	82	3	1
Vineshoot chips (15)	Failed	--	--	--	--	--
Olive Pruning (16)	Failed	--	--	--	--	--

RESULTS: pellet boiler



• Critical factors

1. Optical criteria

Homogeneity	no visible Heterogeneity ($D_{10} \leq \pm$ and $L \leq 4 \times D$)	Critical factor (according to CEN)
Visible Impurities	no other impurities	Critical factor

2. Fuel composition

Density		Depending on the velocity of the primary air according to CEN
N-content	$N_{3.0} \leq 3,0 \%$	according to Austrian law
Cl content (max.)	0.15 %	Critical factor
Ash content	1 %	according to Önorm C 4000
S content (max.)	0.2 %	

3. Fuel characteristic

Maximal size	10 mm	Critical factor (according to CEN)
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• Suggestions for feeding → pellet seized



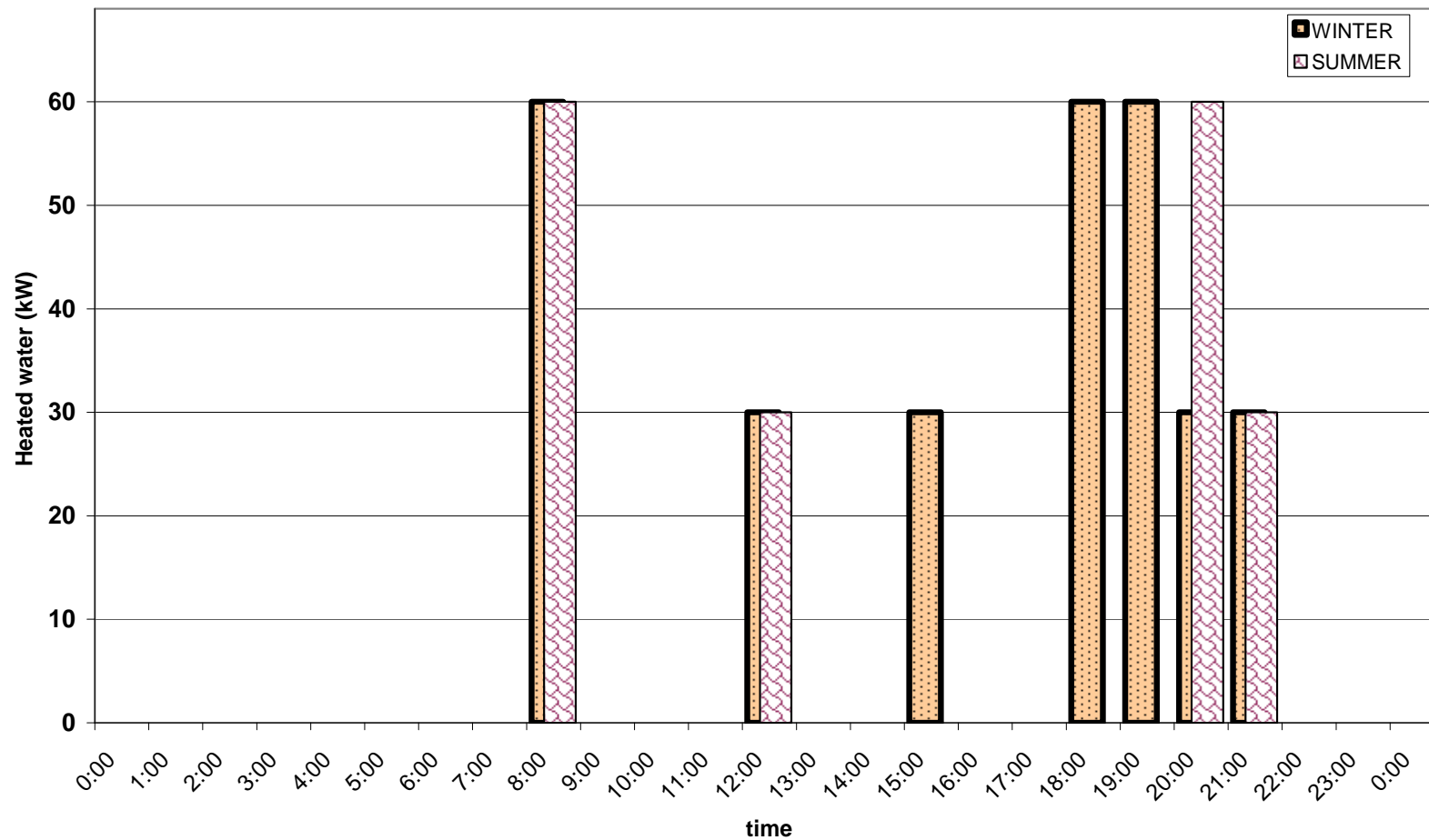
RESULTS: Monitoring – Pellet + chip 60kW



RESULTS: monitoring boiler



DEMONSTRATION - consumer profile



RESULTS: monitoring boiler



	Pine chip	Eucalyptus chip	Oak chip	Poplar chip	Paulownia chip	Rye straw pellets	Pine pellet	Oak pellet	Pine bark	Pinecon chips	Pinecone seed shell	Almond shell	Hazelnut shell	Olive kernel	Vine shoot	Olive pruning
Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Problems		Tunnels		Few	Few	Ash blocks				No stable					No	
Fuel factor	160	130	115	163	165	30	22	20	150	40	23	43	35	22		100
Target 60 kW	60	60	60	60	60	50-60	60	60	60	50-60	58-61	45	58-63	57-59		55-62
Target 30 kW	25-28	25 -27	25-30	-	-	20-28	27 -30	30	20-30	32-35	27-35	28-32	28-32	20-30		35-42
% at 60 kW	90-93	90-93	90-93	-	-	85-92	90-93	90-93	90-91	90	90-93	90-93	90-95	92-95		90-95
% at 30 kW	88-91	90-93	90-93	-	-	85-92	90-93	90-93	90-92	90	90-93	90-93	90-92	92-95		90-95

RESULTS: monitoring boiler



	Pine chip	Eucalyptus chip	Oak chip	Poplar chip	Paulownia chip	Rye straw pellets	Pine pellet	Oak pellet	Pine bark	Pinecone chips	Pinecone seed shell	Almond shell	Hazelnut shell	Olive kernel	Olive pruning
Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16
CO 60 kW	50	10-30	100	50	100 600	100 200	< 20	750	30	50 100	10 -20	2000 3500	< 50	100	200
Total particles [mg/Nm ³] 60 kW	58	37	72	110	122	407	25	30	56	198	76	275	169	177	136

RESULTS: conclusions



- Mixing could balance bad fuels with good fuels
- Mixed fuel: higher proportion of good fuel (70%-80%)

• 16



- Pine pellet + olive stone

RESULTS: monitoring boiler → MIXTURES



DOMOHEAT BIOMASS MIXTURES DEFINITION BASED ON SLAGGING AND FOULING INDICES															
Sample		DHT Index1	DHT Index2	DHT Index1	DHT Index2	DHT Index1	DHT Index2	DHT Index1	DHT Index2	DHT Index1	DHT Index2	DHT Index1	DHT Index2	DHT Index1	DHT Index2
Biomass 1	Pine sawdust pellet (#2)	Biomass 1 percentage in the Mixture (% dry weight)													
		95%		85%		80%		75%		70%		60%		50%	
+		Biomass 2 percentage in the Mixture (% dry weight)													
Biomass 2	Almond shell (#2)	5%		15%		20%		25%		30%		40%		50%	
		0.39	0.18	0.41	0.24	0.42	0.27	0.43	0.30	0.44	0.33	0.46	0.38	0.48	0.43
	Pinecone seed shell (#2)	5%		15%		20%		25%		30%		40%		50%	
		0.40	0.15	0.45	0.17	0.47	0.17	0.49	0.18	0.52	0.20	0.56	0.22	0.61	0.25
	Rye straw pellet (#2)	5%		15%		20%		25%		30%		40%		50%	
		0.40	0.15	0.45	0.19	0.48	0.20	0.50	0.22	0.53	0.23	0.58	0.26	0.63	0.30
	Olive stone (#2)	5%		15%		20%		25%		30%		40%		50%	
		0.38	0.16	0.39	0.21	0.40	0.23	0.40	0.25	0.40	0.27	0.41	0.31	0.42	0.34

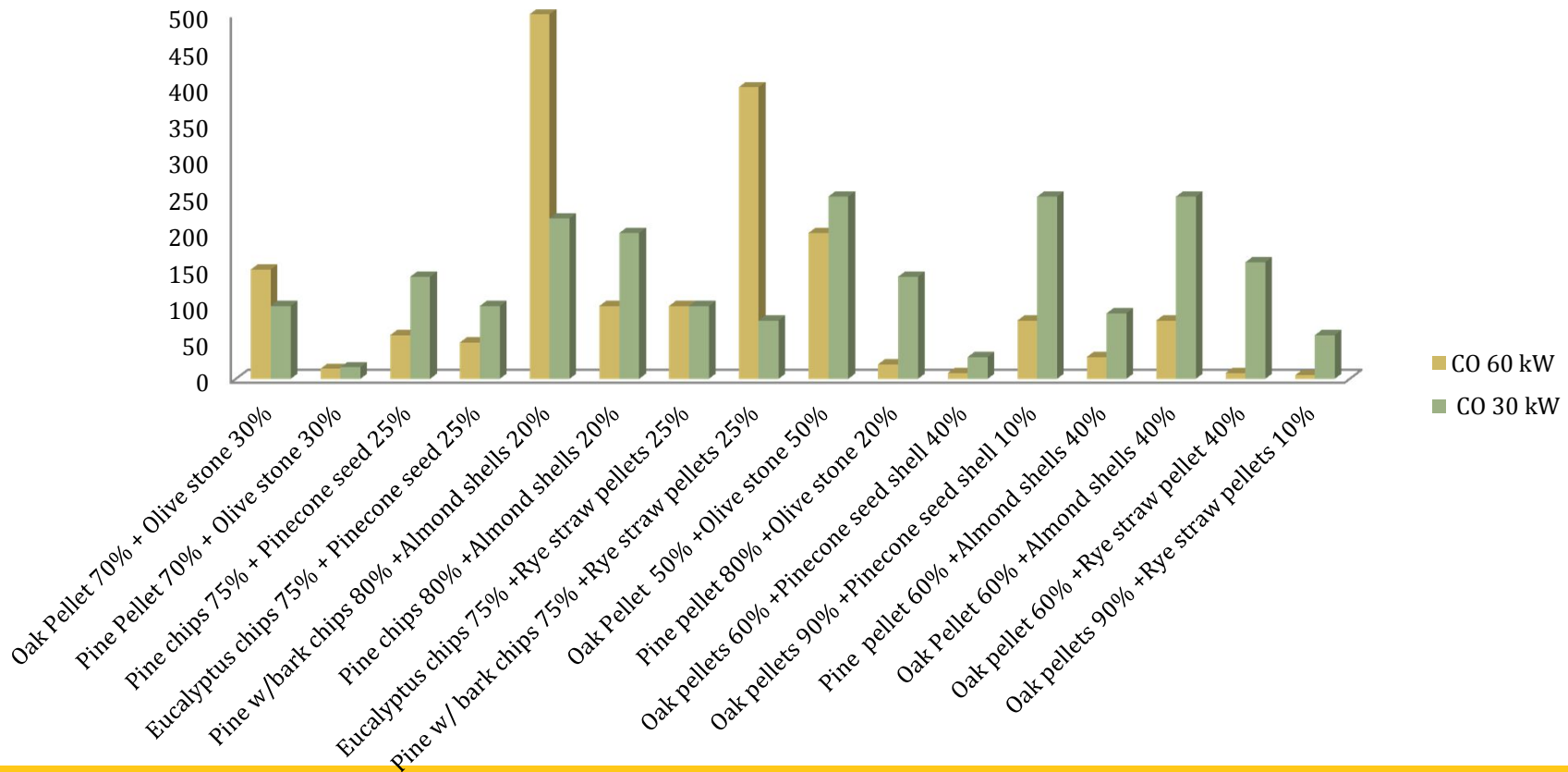
- Total of 16 “*expected*” good + bad mixtures were monitored
- Results in some cases even better as expected

RESULTS: monitoring boiler → MIXTURES



2500 ← Class 3 EN 303-5

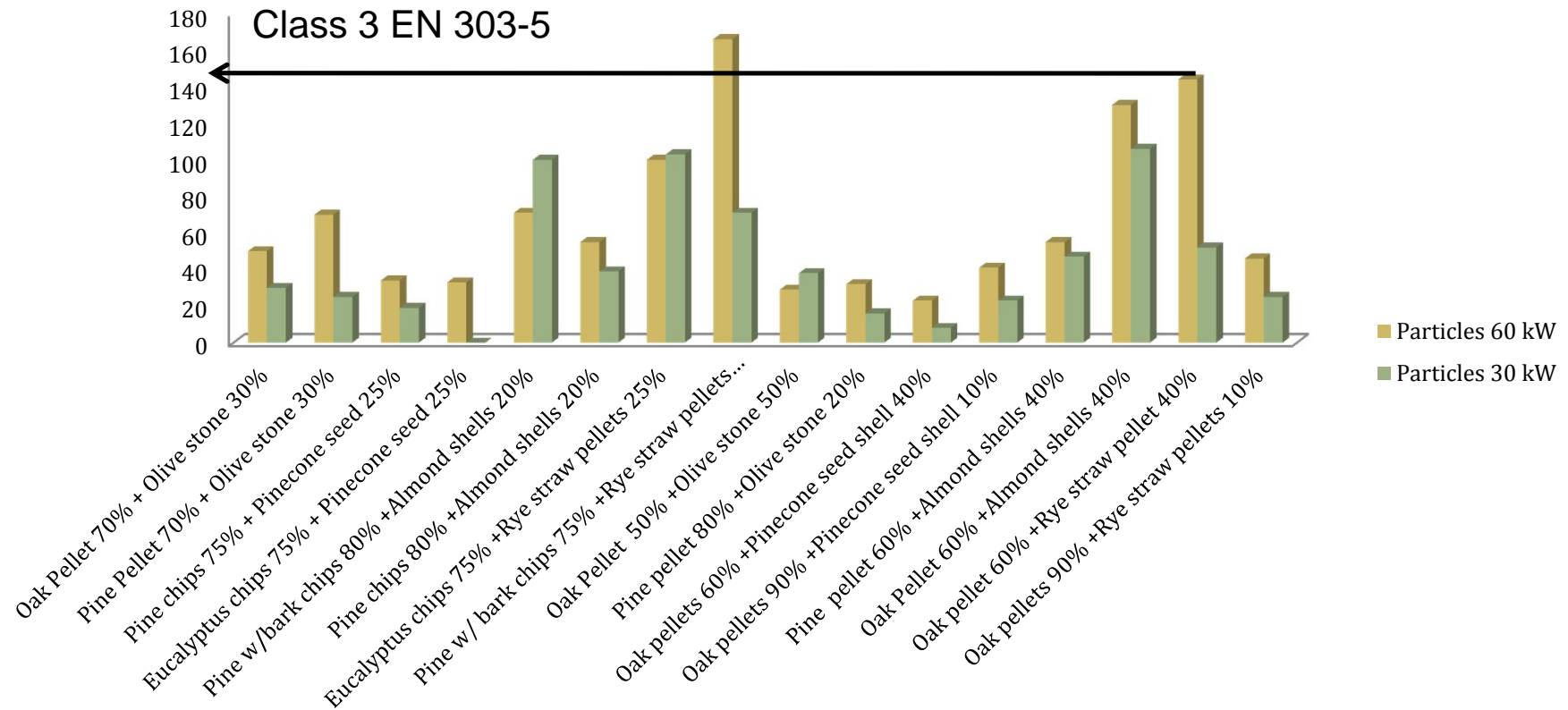
CO (ppm 10% O2)



RESULTS: monitoring boiler → MIXTURES



Particles [mg/Nm³]



RESULTS: monitoring boiler → MIXTURES



Aggregate (bad fuel)	with	Maximum % (bad)	Observations
Olive Stone	Oak pellet	50%	Stable power production
Olive Stone	Pine pellet	40%	Stable power production
Almond shells	Pine pellet	40%	Stable power production
Almond shells	Oak pellet	30%	Stable power production
Pinecone seed shells	Oak pellet	40%	Stable power production
Rye straw pellets	Oak pellet	10%	Stable power production
Pinecone seed shells	Eucalyptus chips	25%	Unstable power production
Pinecone seed shells	Pine chips	25%	Unstable power production
Almond shells	Eucalyptus chips	20%	Unstable power production
Almond shells	Pine chips	20%	Unstable power production



**Σας ευχαριστώ πολύ για την
προσοχή σας**