

# Particulate matter (PM) emission from Small Combustion Installations (SCIs) – the secondary abatement measures

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## *Dust emission*

**Natural** TSP surces (volacanos, deserts, roads, soil etc.. (low abatement potential)

**Anthropogenic** TSP sources:

- termo-chemical conversion of fuels,
  - over 75% of Nox and SO<sub>2</sub>, about 70% of CO, **over 75% of dust** and over 90% of CO<sub>2</sub>
- mining and transportation of crude materials,
- the processes of chemical, petroleum, metallurgical and cement industries,
- storage of crude materials and by-products,
- transportation.

## Dust emission

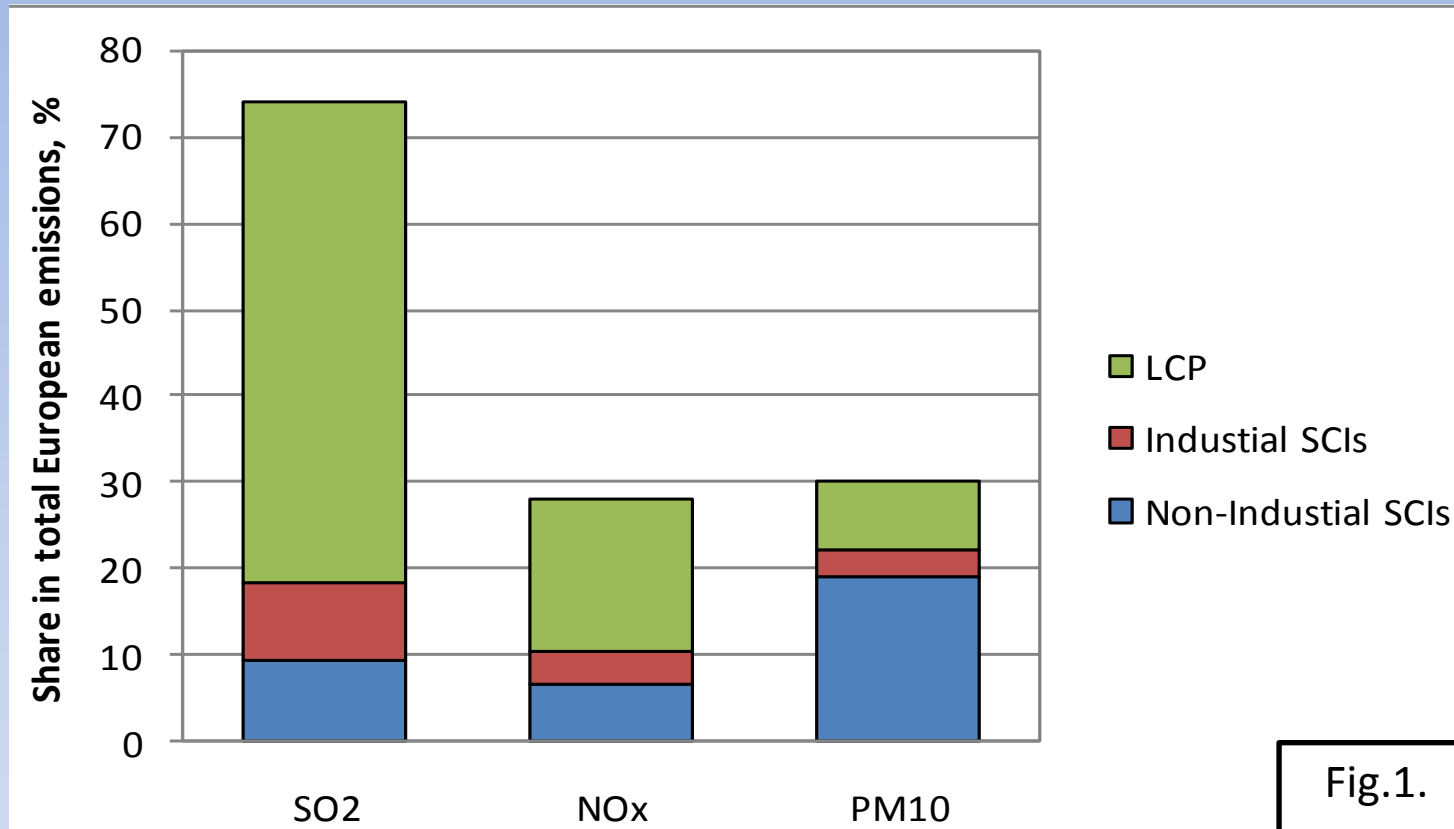


Fig.1.

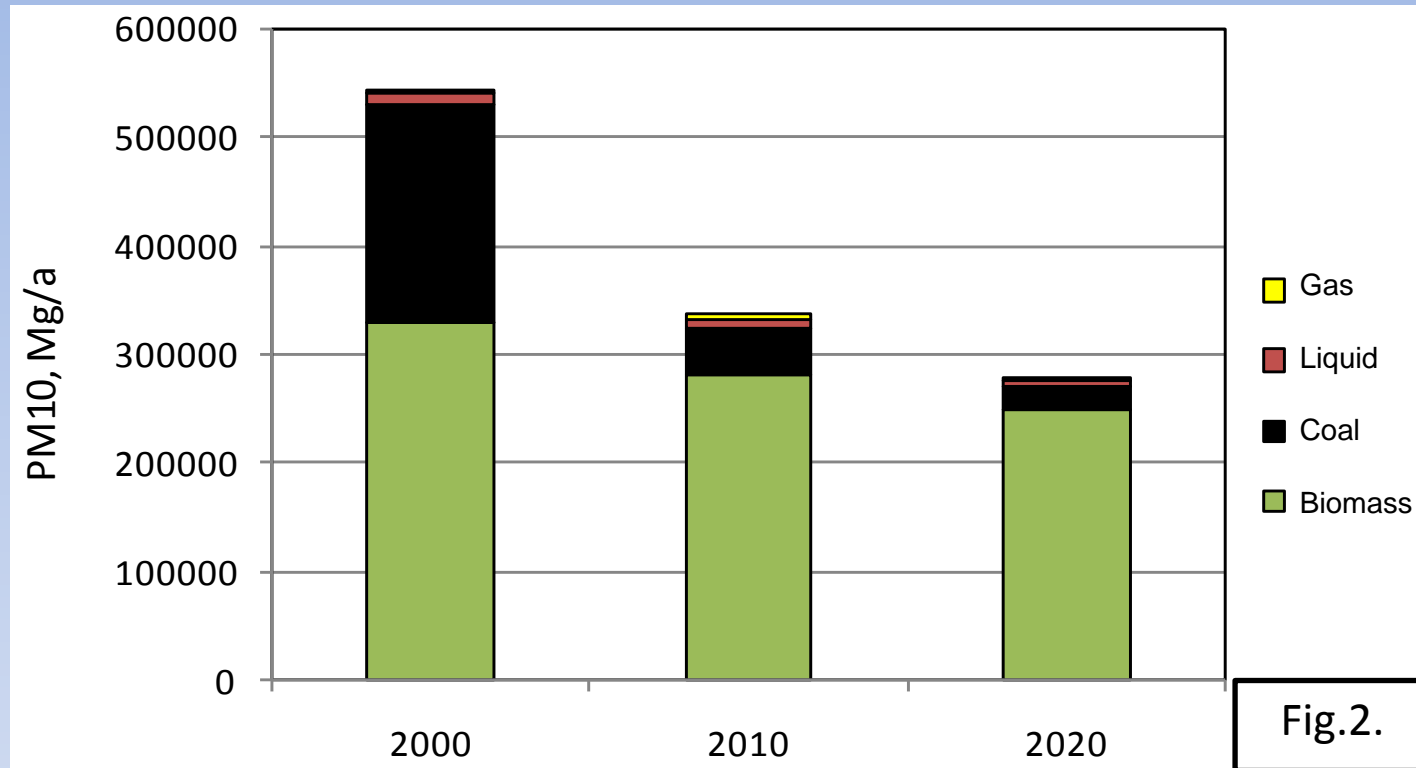
- Recognised, significant share of SCIs in the total emissions

Source: KCIE

Pye S., Jones G., Stewart R., Woodfield M., Kubica K., Kubica R., Pacyna J.; "Costs and environmental effectiveness of options for reducing mercury emissions.."; AEAT/ED48706/Final report v2, January 2006

Brussels, 27th of June 2013

## Dust emission

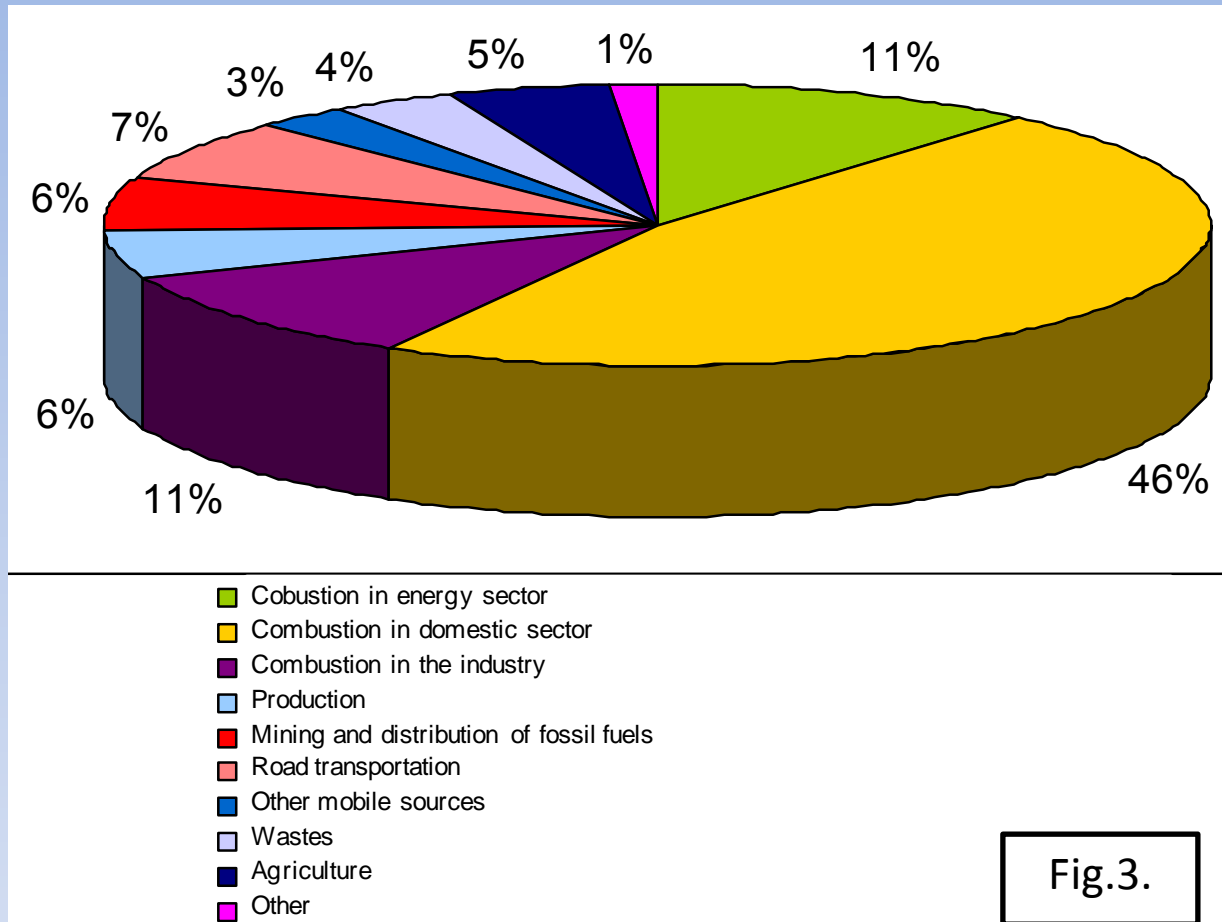


- Recognised, significant share of solid fuels in the total emissions

Source: KCIE

Pye S., Jones G., Stewart R., Woodfield M., Kubica K., Kubica R., Pacyna J.; "Costs and environmental effectiveness of options for reducing mercury emissions.."; AEAT/ED48706/Final report v2, January 2006

## Dust emission



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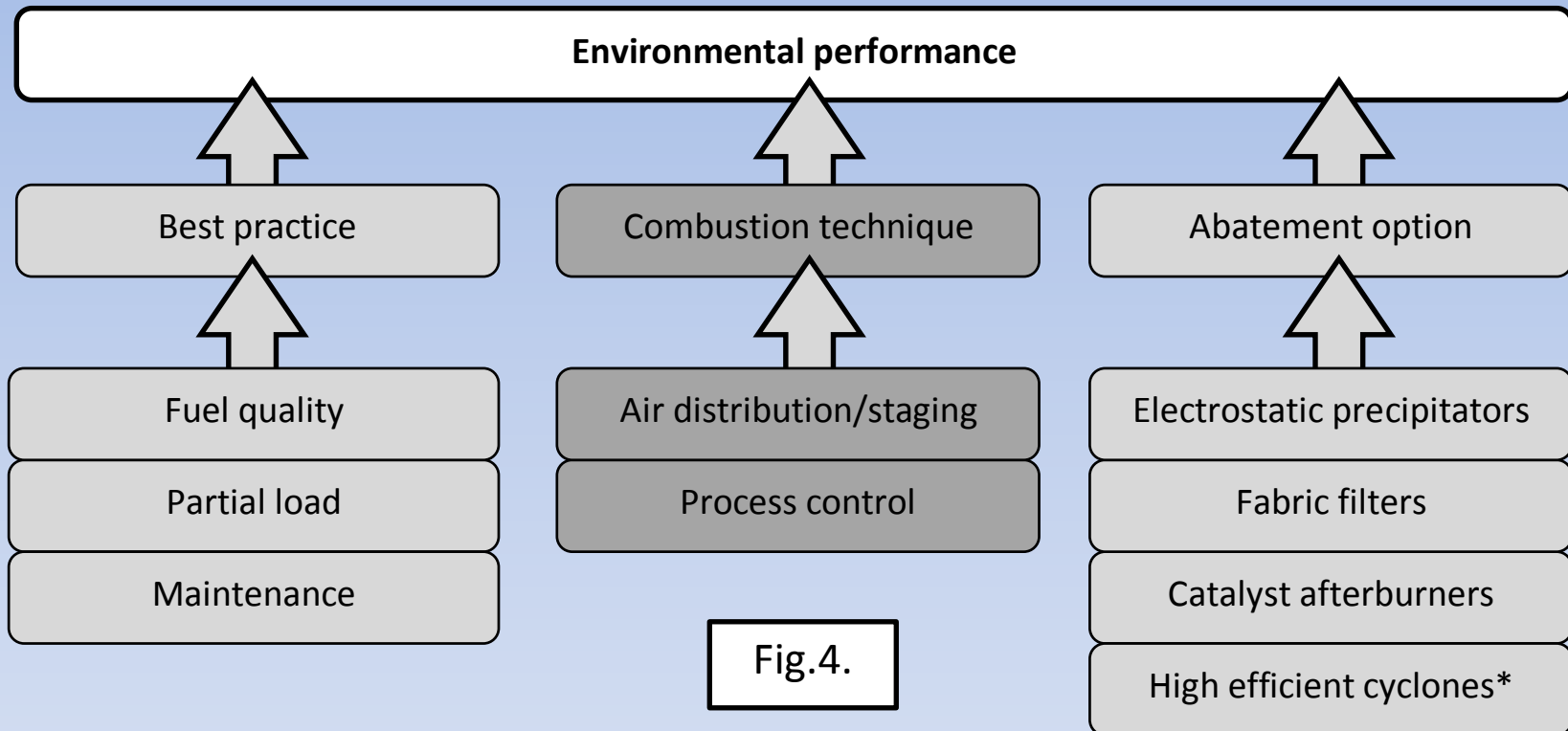
- Residential sector is a key field
- Stricter air quality requirements, lower allowable emissions for SCIs used by residential sector



## ***Drivers and pressures***

***„A right to breathe a clean air”***

# Emission abatement measures



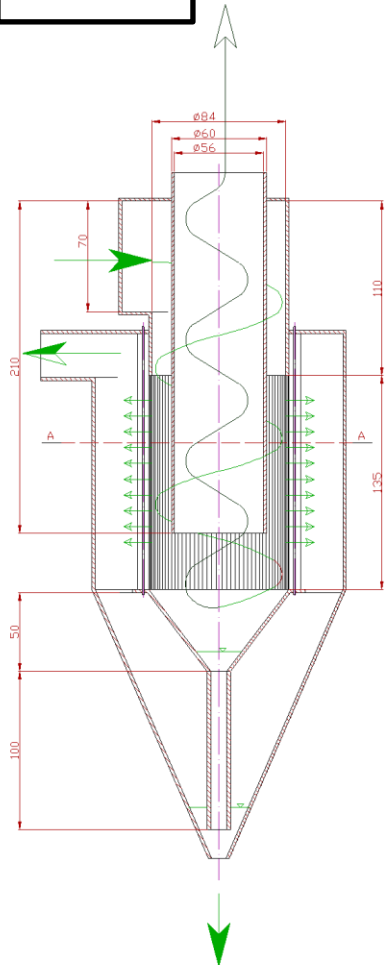
- How to tackle/solve the **problem** of PM emission

# Emission abatement measures – a prototype centrifugal deduster

Rys.5.

Centrifugal deduster with baffles for coal boilers of 200 kW nominal power output

Laboratory scale research carried out for 25kW boiler



Rys.6.



Overall efficiency  $\eta \sim 50\%$   
Dust conc. At the outlet  $\sim 50 \text{ mg/m}^3_u$

# Emission abatement measures – a prototype centrifugal deduster

Rys.7.



Pilot scale testing, coal boiler of 200 kW nominal power output

Tab.1.

|           | Dust concentration at reference oxygen O <sub>2</sub> level of 6% |                                      | Dedusting efficiency | Pressure drop |
|-----------|---|--------------------------------------|----------------------|---------------|
|           | C <sub>in</sub> , mg/m <sup>3</sup>                               | C <sub>out</sub> , mg/m <sup>3</sup> | η, %                 | Δp, Pa        |
| Coal      | 1032,6  | 93,3                                 | 91                   | 800           |
| Coal dust | 100,6   | 51,9                                 | 46                   | 780           |

# ***Emission abatement measures – a prototype centrifugal deduster***

Comercial application, 2 coal boilers 1MW each



Rys.8.



# Emission abatement measures – a prototype centrifugal deduster

Comercial application, coal boilers 2x1MW each

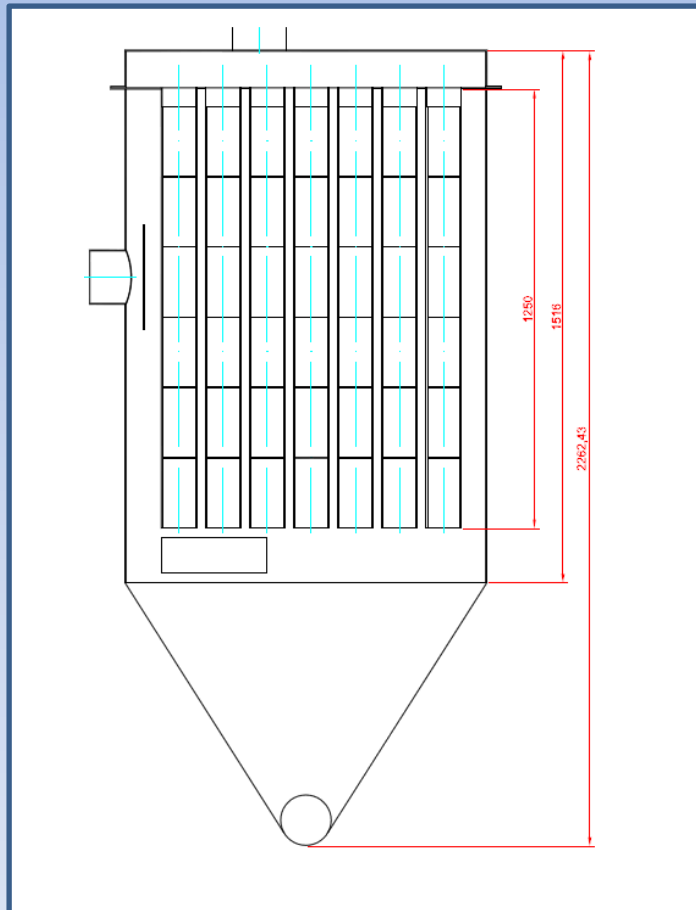
Tab.2.

|   |      |                   |       |       |               |       |                   |
|---|------|-------------------|-------|-------|---------------|-------|-------------------|
| Pollutant concentration in flue gases at reference oxygen O2 concentration of 6 % | Dust | mg/m <sup>3</sup> | 96,2  | 99,1  | <b>97,65</b>  | 9,43  | PN-Z-04030-7      |
|   | SO2  | mg/m <sup>3</sup> | 687,9 | 810,8 | <b>749,35</b> | 26,56 | PN-ISO 10396:2001 |
|   | NOx  | mg/m <sup>3</sup> | 369,4 | 387,4 | <b>378,40</b> | 19,48 | PN-EN 14792:2006  |
|   | CO   | mg/m <sup>3</sup> | 277,4 | 214,9 | <b>246,15</b> | 13,56 | PN-ISO 10396:2001 |

**Requirements; Emission Limit Values (ELVs) of 100 mg/m<sup>3</sup> at 6% reference oxygen level**

# Emission abatement measures – fabric filters

Pilot scale testing, coal boilers of 50 kW, with 1 stage of dedusting by cyclone type deduster with baffles



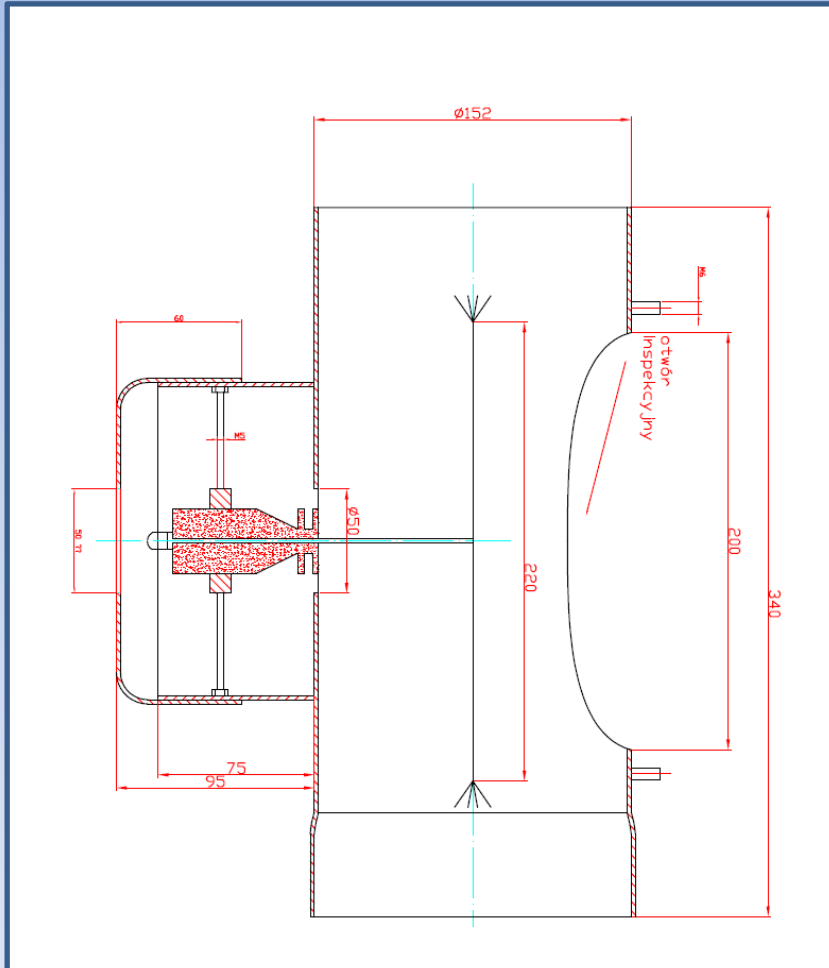
Rys.9.



Coal blend with molding dust; reduction of dust concentration above 98%

# Emission abatement measures – electrostatic precipitator ESP

A protoypte ESP for combustion apliesces up to 25 kW



Rys.10.

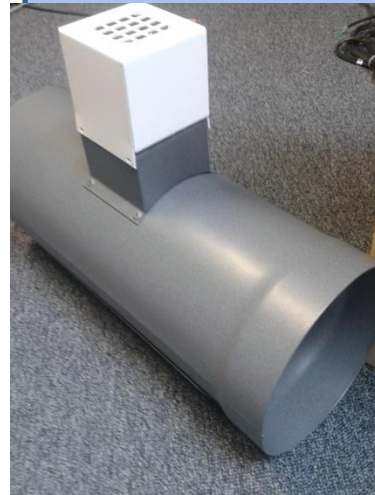
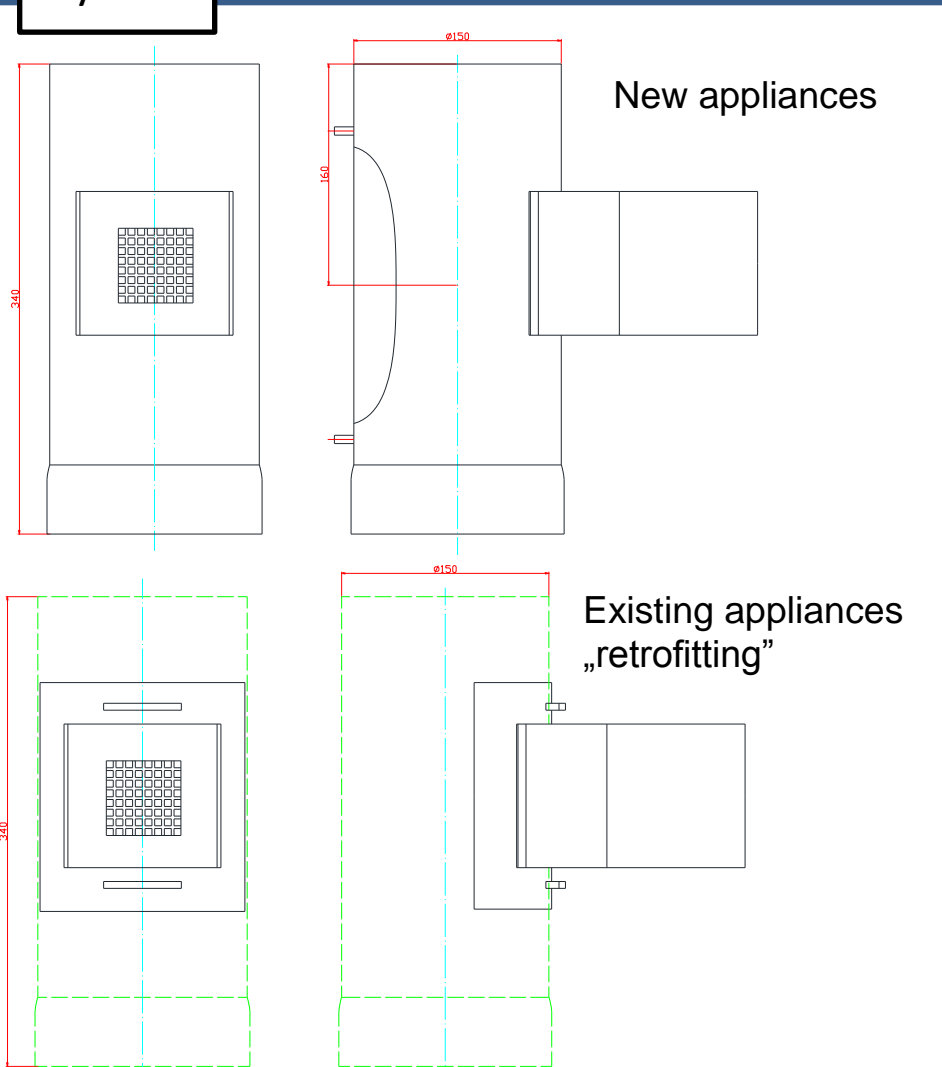


Dust concentration iat the outlet  $<30 \text{ mg/m}^3$  (at 6%O<sub>2</sub> )

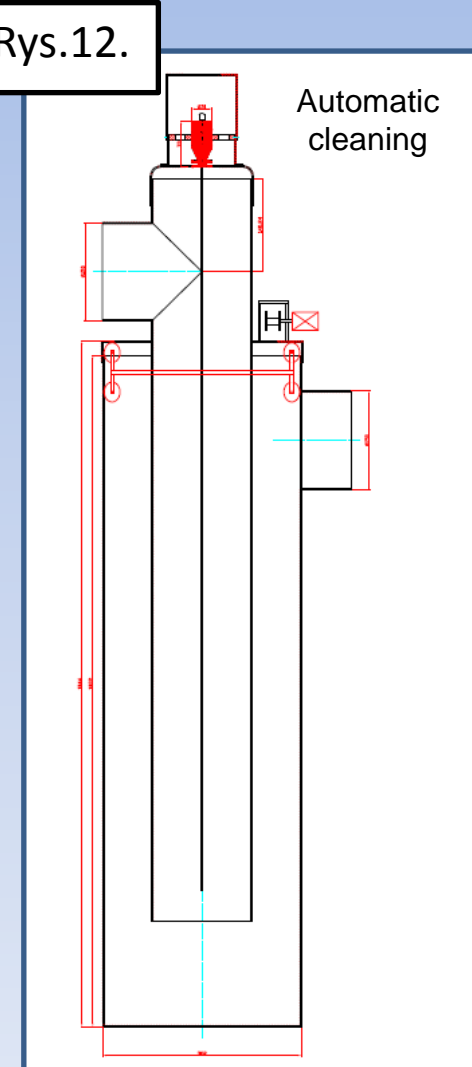
Brussels, 27th of June 2013

# Emission abatement measures –ESP

Rys.11.



Rys.12.



# Emission abatement measures – ESP

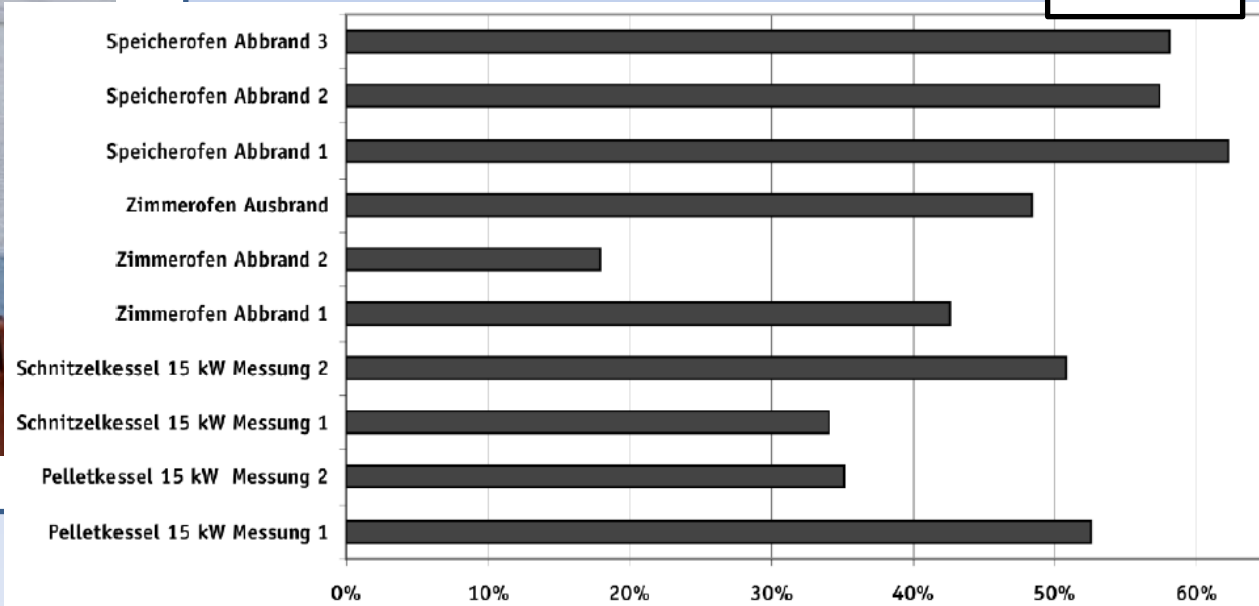
End of the pipe ESPs



Rys.13.

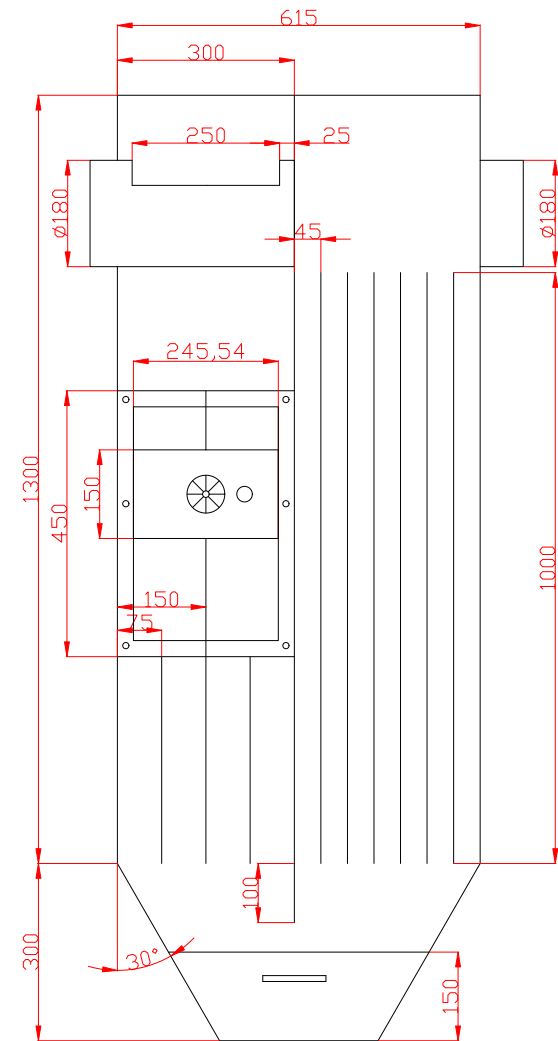
Voltage **20kV**  
 Electricity consumption **20kWh**

Rys.14.



# Emission abatement measures –ESP

ESPs for heating appliances up to 100 kW, including biomass fuelled



Rys.15.

# Primary abatement measures

Primary measures – limiting cause not the outcomes

|                    |                             | 1                  | 2          | 3            | 4            | 5              | 6                | 7                           | 8                       | 9                |            |
|--------------------|-----------------------------|--------------------|------------|--------------|--------------|----------------|------------------|-----------------------------|-------------------------|------------------|------------|
| Produkt            |                             | Kominiek zamknięty | Piec       | Piecokuchnia | Piec kaflowy | Piec pelletowy | Kocioł pelletowy | Kocioł zgazowujący (drewno) | Kocioł węglowy automat. | Kocioł na zrębki |            |
| Sprawność I emisje | Moc                         | kW                 | 7          | 7            | 8            | 15             | 7                | 25                          | 20                      | 25               | 160        |
|                    | Sprawność                   | %                  | 78<br>(82) | 79<br>(84)   | 78<br>(79)   | 82<br>(84)     | 90<br>(94)       | 92<br>(94)                  | 90<br>(92)              | 88<br>(89)       | 91<br>(92) |
|                    | Sprawność średnioroczna     | %                  | 75         | 76           | 75           | 79             | 87               | 75                          | 74                      | 72               | 75         |
|                    | E <sub>CO</sub>             | mg/m <sup>3</sup>  | 1500       | 1400         | 2000         | 1000           | 300              | 150                         | 100                     | 90               | 170        |
|                    | E <sub>Pył</sub>            |                    | 60         | 50           | 90           | 60             | 30               | 25                          | 40                      | 40               | 30         |
|                    | E <sub>O<sub>2</sub>C</sub> |                    | 100        | 90           | 110          | 100            | 30               | 30                          | 10                      | 10               | 10         |

Tab.3.



# Primary vs. secondary abatement techniques

Advantages of primary measures – *cost effectiveness*

Secondary measures - *Retrofitting of existing systems*

Tab.4.

| Wood Pellet Boiler             |         | BNAT<br>(UleWIN) | Base<br>Case | Improvement<br>(UleWIN vs.<br>BC) | BAT | Improvement<br>(UleWIN vs.<br>BAT) |
|--------------------------------|---------|------------------|--------------|-----------------------------------|-----|------------------------------------|
| Test standard efficiency       | (NCV %) | 94%              | 88%          | 7%                                | 94% | 0%                                 |
| Test standard CO               | (mg/MJ) | 9                | 233          | -96%                              | 29  | -69%                               |
| Test standard OGC              | (mg/MJ) | <1               | 2            | <-50%                             | 1   | <-50%                              |
| Test standard PM <sup>10</sup> | (mg/MJ) | 0.2              | 33           | -99%                              | 9   | -98%                               |

Source: Jürgen Brandt, WINDHAGER, EU-UltraLowDust – 1st Workshop of the Mirror Group 28th November 2012, Brussels, Belgium

- Improvement potential **Best Not yet Available Techniques (BNAT)** - UleWIN,
- **Best Available Techniques BAT**
- Almost „zero emission” emerging technologies (*triple combustion chamber, expensive, prolonged time frame – over 4 years*)

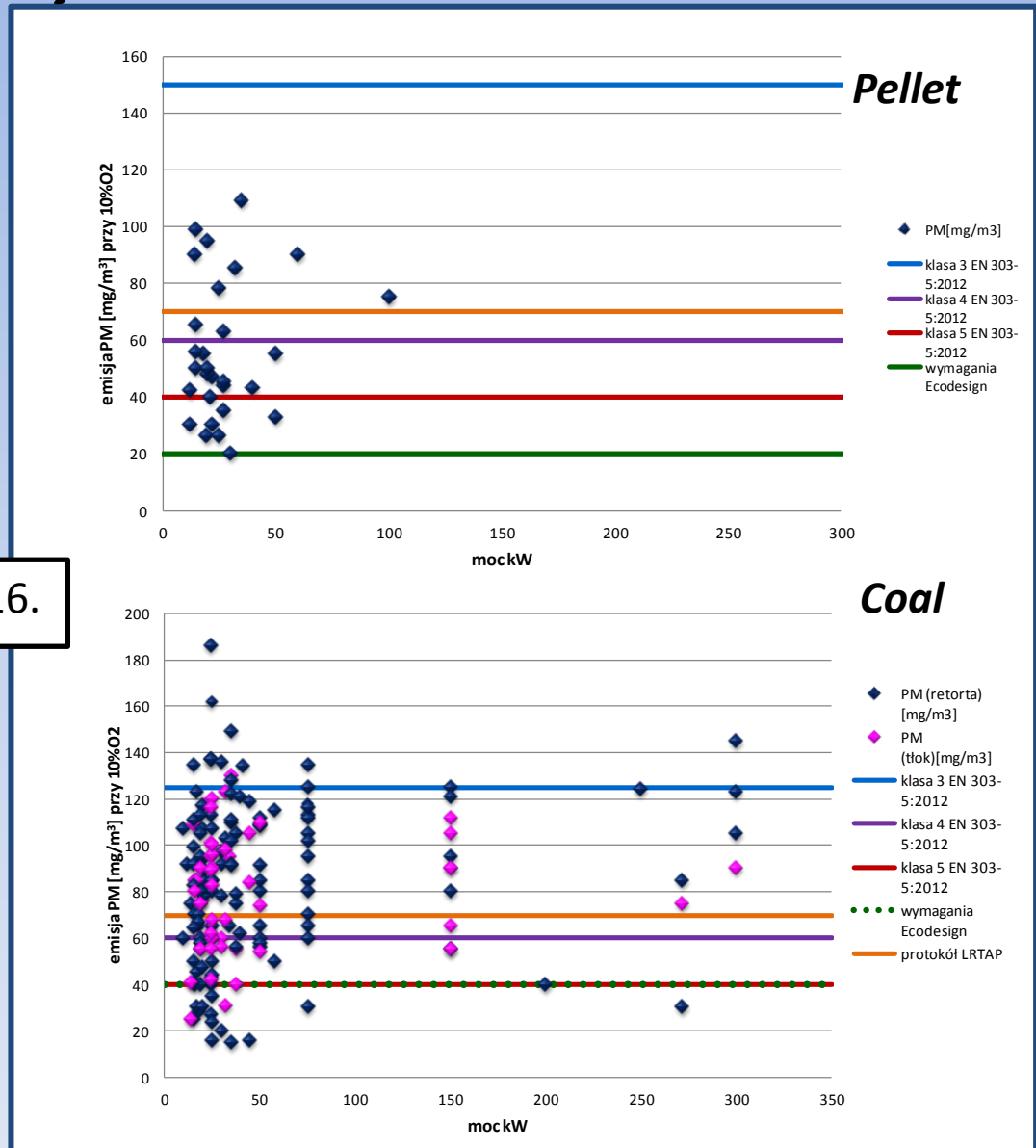
# PM secondary abatement measures

**Technical means for abatement of PM emission available**

**Combination of primary and secondary techniques - low emission combustion for solid fuels**

**Dust concentration in outlet flue  $\ll 20 \text{ mg/m}^3$  (at  $6\% \text{O}_2$ )**

Rys.16.





## **Emission Limit Values LRTAP, 303-5, EcoDesign technical means to fulfill them**

- The Best Available Techniques of combustion installation below 1MW (**BATs**), commercially available, **guarantee** performance at the **lowest required ELVs** relevant for **dust** emission.
- The use of **certified fuels** is required – appropriate quality of coal and biomass.
- Reaching the lowest **ELVs** by **non BATs** new appliances, and **existing systems** requires secondary abatement measures – **dedusting apparatus**.
- **Highest performance** is delivered by **fabric filters** and **electrostatic precipitators**, however the latest offer **ease of use** and **maintenance** as well as **low operating costs**.