TFTEI

Under the Convention on Long Range Transboundary Air Pollution

# Review of the technical annex X of the Gothenburg Protocol
# Small and medium size combustion installations

TFTEI technical secretariat
Nadine Allemand (Citepa)

*7th TFTEI Annual Meeting, October 29th, 2021, Virtual meeting*

# Agenda

- ✓ Limit values in annex X of the Gothenburg Protocol (for combustion plants < 50 MW)
- ✓ Development of low emission stoves and boilers
- ✓ Could limit values including condensables be proposed?
- ✓ Could limit values for BC be proposed?
- ✓ Preliminary conclusions and further steps

# Annex X for small combustion plants

**16. Combustion installations with a rated thermal input < 50 MWth:**

**Limit values with only a recommendatory character for dust**

Table 12

Recommended limit values for dust emissions released from new solid fuel combustion installations with a rated thermal input

< 500 kWth to be used with product standards

(13% O2)

| Appliance | Dust mg/m3 |
|---|---|
| Open/closed fireplaces and stoves using wood | 75 |
| Log wood boilers (with heat storage tank) | 40 |
| Pellet stoves and boilers | 50 |
| Stoves and boilers using other solid fuels than wood | 50 |
| Automatic combustion installations | 50 |

Table 13

Recommended limit values for dust emissions released from boilers and process heaters with a rated thermal input of

100 kWth–1 MWth

$O_2$ reference content: wood, other solid biomass and peat: 13%; coal, lignite and other fossil solid fuels: 6%.

| | | Dust (mg/m³) |
|---|---|---|
| Solid fuels 100 kWth–500 kWth | New installations | 50 |
| | Existing installations | 150 |
| Solid fuels 500 kWth–1 MWth | New installations | 50 |
| | Existing installations | 150 |

Table 14

Recommended limit values for dust emissions released from boilers and process heaters with a rated thermal input of 1 MWth–50 MWth

$O_2$ reference content: wood, other solid biomass and peat: 11%; coal, lignite and other fossil solid fuels: 6%; liquid fuels, including liquid biofuels: 3%.

| | | Dust mg/m3 |
|---|---|---|
| Solid fuels > 1 MWth–5 MWth | New installations | 20 |
| | Existing installations | 50 |
| Solid fuels > 5 MWth–50 MWth | New installations | 20 |
| | Existing installations | 30 |
| Liquid fuels > 1 MWth–5 MWth | New installations | 20 |
| | Existing installations | 50 |
| Liquid fuels >5 MWth–50 MWth | New installations | 20 |
| | Existing installations | 30 |

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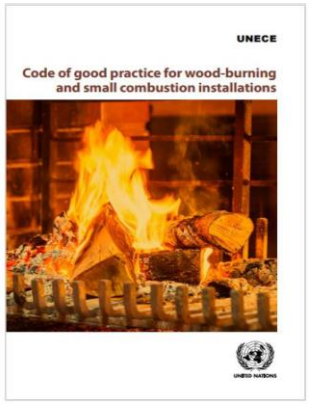
# BAT in small domestic appliances using wood

## Emissions of PM from domestic heating appliances in real life

Main focus of the **Code of good practice for wood-burning and small combustion installations**



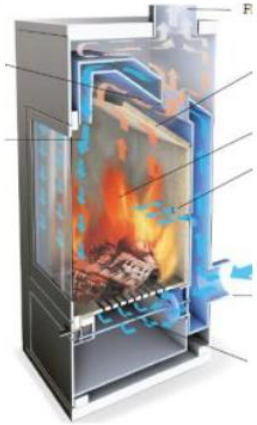

**BAT and limit values (regulations, labels)**

**Chimney**

- Material
- Dimensions
- Temperatures
- Weather conditions
- …

- Fuel selection
- Air settings
- Ignition technique
- Recharging (Frequency & Instant of time, batch mass)
- …

**User**



Source: TFZ Straubing

- Design of combustion chamber
- Materials and mass
- Combustion air supply (e.g. air staging concept)
- Leakage rate
- Integrated secondary emission abatement technologies (e.g. catalyst)
- …

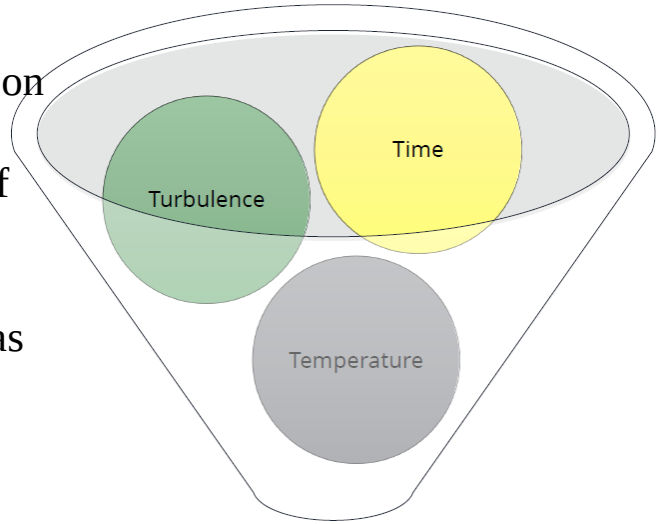
**Technology**

# Developement of low emission stoves

ERA-NET Bioenergy Project "WoodStoves2020" – Development of Next Generation and Clean Wood Stoves

**Turbulence or mixing of flue gasses**

- Distribution of window purge air
- Direction and geometry of additional air
- Velocities of flue gas and combustion air
- Geometry of main as well as post combustion chamber
- Geometry of deflection plate and the use of baffles in post combustion chamber.
- Avoidance of leakage streams (sealing)
- Avoidance of short-circuiting of the flue gas stream
- Groved surfaces
- …




**Sufficient residence time** needed and influenced by the following parameters:

- Gas volume flow
- Distribution of flue gas over combustion chamber
- Distribution of air
- Height of the combustion chamber
- …

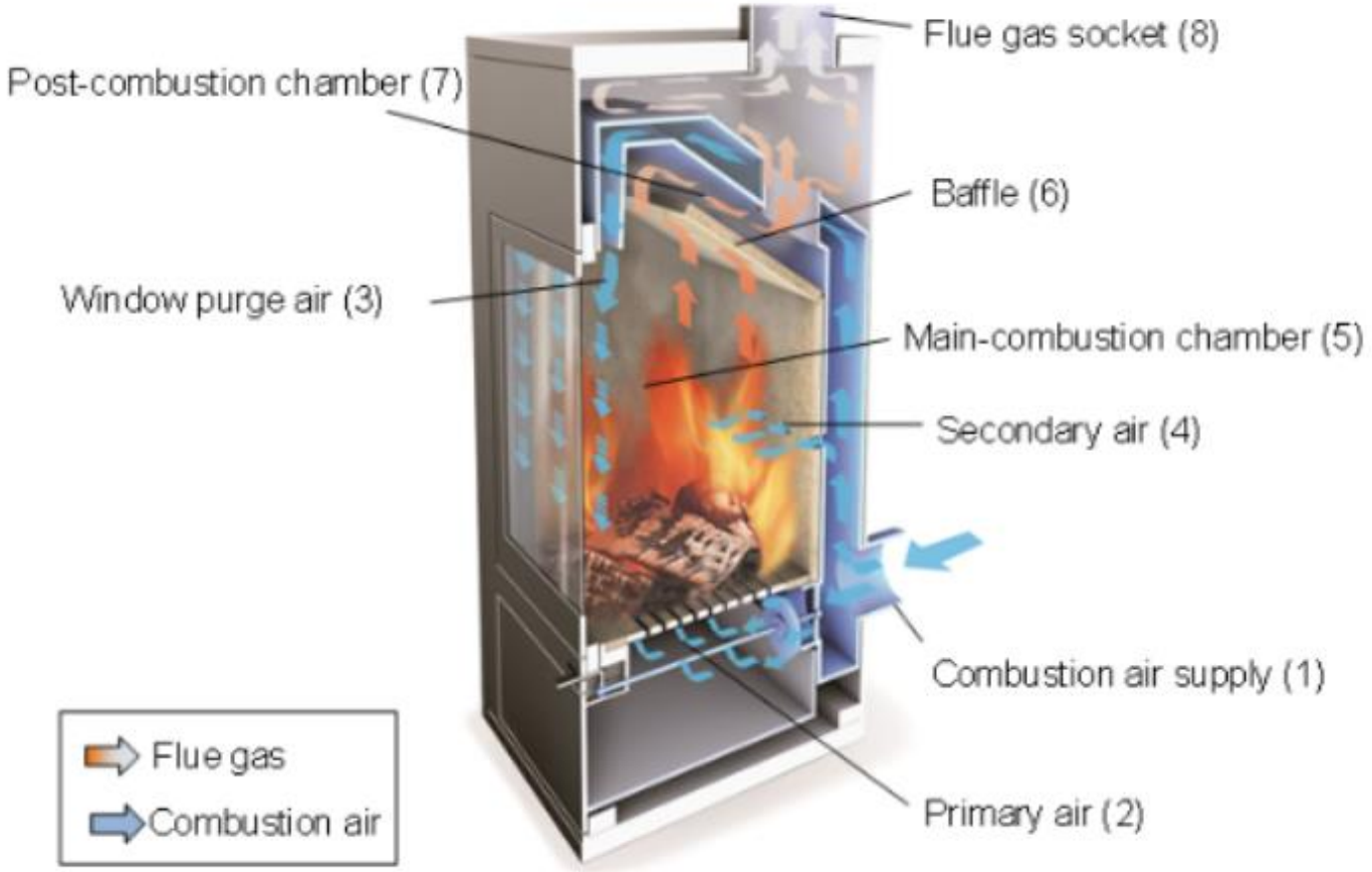
**Temperature things to consider**

- Refractory lining in the combustion chamber
- Shape and size of combustion chamber
- Material and isolation of the door as well as size of window and its radiation coefficient or alternatively coated glasses or double/triple windows with air gap between
- Windows should be of moderate size

Warming-Jespersen-Technical-guidelines-for-design-of-low-emission-stoves-IEA Bioenergy webinar series – May 2021

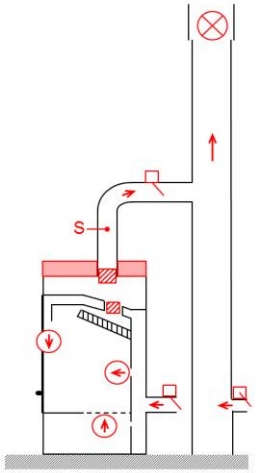
# Developement of low emission stoves

ERA-NET Bioenergy Project "WoodStoves2020" – Development of Next Generation and Clean Wood Stoves




Morten Gottlieb Warming-Jespersen - Head of Section Energy and Climate Danish Technological Institute Denmark - Technical-guidelines-for-design-of-low-emission-stoves-IEA Bioenergy webinar series – May 2021

**Guidelines for Low Emission and High Efficiency Stove Concepts**

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Report within the scope of the ERA-NET Bioenergy Project "WoodStoves2020" – Development of Next Generation and Clean Wood Stoves

July 2017

# BAT in small domestic appliances using wood

BAT for the design of the different type of appliances:

- **BAT:** the technique is considered necessary to achieve the BAT associated performance levels for the type of appliance concerned and **should therefore be fitted as standard in every new appliance of this type, regardless of the user's profile.**
- **BAT cbc**: the technique may contribute to achieving the BAT associated performance levels but is not necessarily present in every appliance.

| | Technique<br><br>*Techniques specifically aimed at eliminating (incorrect) user behaviour as much as possible and thus at reducing emissions during use are marked with an asterisk (*) in the left column.* | See paragraph | Open fireplace | Wood stove | Pellet stove | Mass stove | Wood-burning boiler | Pellet boiler |
|---|---|---|---|---|---|---|---|---|
| | Flame baffle plate | 4.1.1 | / | BAT | BAT | BAT | BAT | BAT |
| | Grate in the combustion chamber | 4.1.2 | / | cbc | BAT | cbc | cbc | BAT |
| | Insulation of the combustion chamber | 4.1.3 | / | BAT | BAT | BAT | BAT | BAT |
| | Use of heat-reflective material in the combustion chamber | 4.1.4 | / | cbc | cbc | cbc | cbc | cbc |
| | Keep the surface area of the glass window as small as possible | 4.1.5 | / | cbc | cbc | cbc | n/a[45] | n/a[45] |
| | Use double-glazed, triple-glazed or coated glass for the glass window | 4.1.5 | / | cbc | cbc | cbc | n/a[45] | n/a[45] |
| | A vertical instead of horizontal combustion chamber | 4.1.6 | / | cbc | cbc | cbc | BAT | BAT |
| | Presence of a 2nd combustion chamber or combustion zone/duct for post-combustion | 4.1.7 | / | BAT | BAT | BAT | BAT | BAT |
| | Staged air supply | 4.1.8 | / | BAT | BAT | BAT | BAT | BAT |
| * | Air supply control – mono-control | 4.1.9 | / | BAT[46] | n/a[47] | BAT[46] | BAT[46] | n/a[47] |
| * | Air supply control – automatic control of air supply and air circulation | 4.1.10 | / | cbc | BAT | cbc | BAT | BAT |
| | Airtight design of the appliance | 4.1.11 | / | BAT | BAT | BAT | BAT | BAT |

Source: Jansens G. and all: Best Available Techniques (BAT) for domestic wood heating. Flemish Knowledge Center on BAT (VITO) – 2020

# BAT in small domestic appliances using fuels

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|---|---|---|---|---|---|---|---|---|
| | Preheating air supply for combustion | 4.1.12 | / | BAT | BAT | BAT | BAT | BAT |
| | Flue gas heat recovery system | 4.1.13 | / | cbc | cbc | cbc | cbc | cbc |
| * | Stimulate stoking at nominal load as much as possible by offering appliances in different capacity classes and with a limited capacity range | 4.1.14 | / | BAT | BAT | BAT | BAT | BAT |
| * | Automatic fuel supply | 4.1.15 | / | cbc | BAT | cbc | cbc | BAT |
| * | Advanced combustion process control based on room temperature and weather conditions | 4.1.16 | / | cbc | cbc | cbc | cbc | cbc |
| | A catalyst integrated in the appliance | 4.2.1 | / | cbc | cbc | cbc | cbc | cbc |
| | An electrostatic precipitator integrated in the appliance | 4.2.2 | / | cbc | cbc | cbc | cbc | cbc |

Source: Jansens G. and all: Best Available Techniques (BAT) for domestic wood heating. Flemish Knowledge Center on BAT (VITO) – 2020

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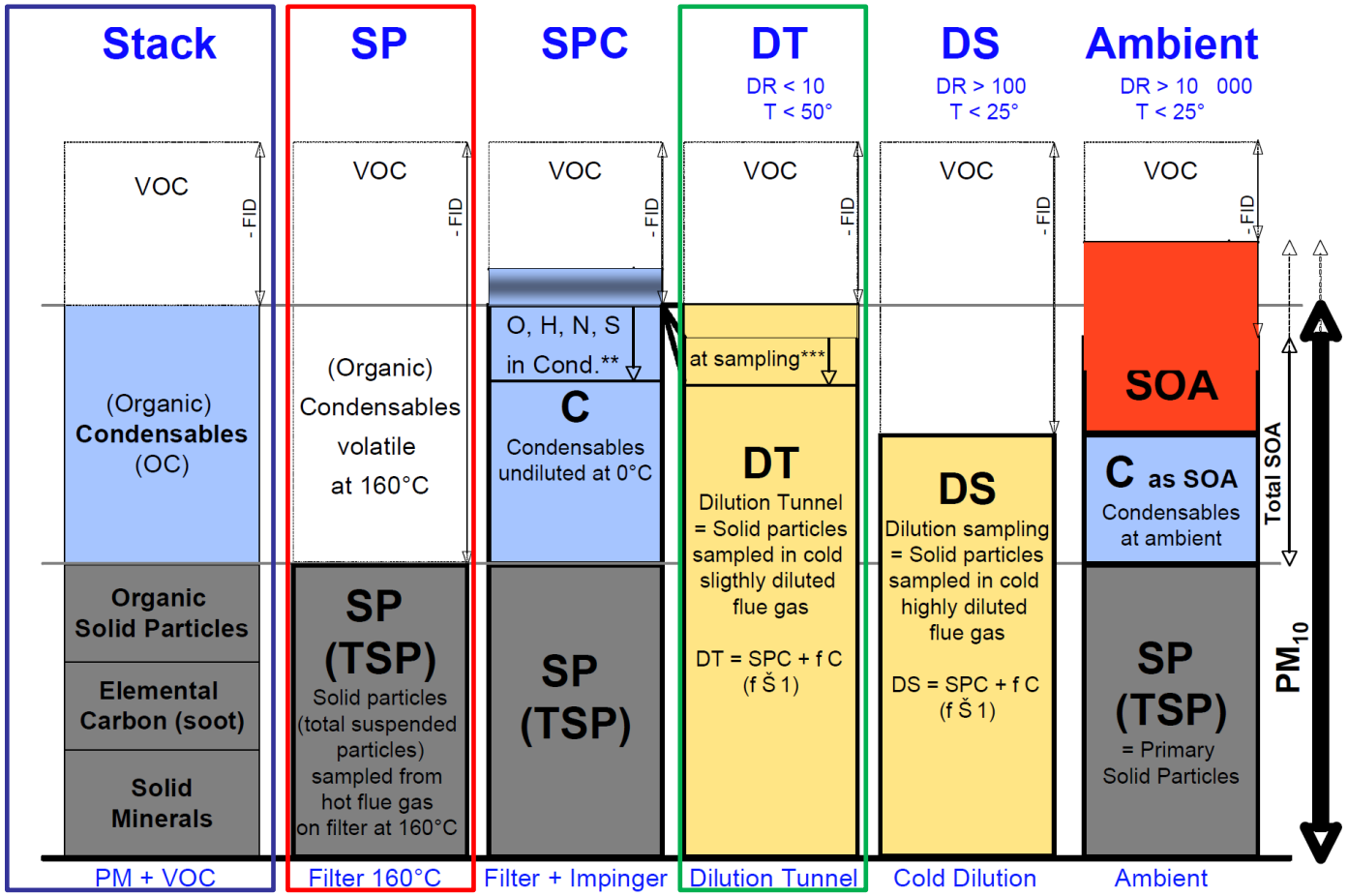
# A limit value including condensables?




Thomas Nussbaumer - 2010

**Overview on Technologies for Biomass Combustion and Emission Levels of Particulate Matter**

prepared for Swiss Federal Office for the Environment (FOEN)
as a contribution to the
Expert Group on Techno-Economic Issues (EGTEI) under the
Convention on Long-Range Transboundary Air Pollution (CLRTAP)

Comparison of PM sampling with PM in the ambient.

**SP: Filter (Method a)** resulting in solid particles SP (total suspended particles TSP).

**SPC: Filter + Impinger (Method b)** resulting in solid particles and condensables SPC.

**DT: Dilution Tunnel (Method c)** with typical dilution ratio (DR) in the order of 10 resulting in a PM measurement including SPC and most or all C.

DT is identical or slightly smaller than SPC + C due to potentially incomplete condensation, depending on dilution ratio and sampling temperature (since dilution reduces not only the temperature but also the partial pressure of contaminants).

**DS: Dilution Sampling** with high dilution ratio (DR > 100).

**PM10: Total Particulate Matter < 10 microns in the ambient including SP and SOA**

**SOA: Secondary organic aerosols**, consisting of condensables C at ambient and SOA formed by secondary reactions such as photochemical oxidation.

# A limit value including condensables?

Measuring methods used in different regulations and labels

| Standards or labels | SP | SPC | DT | Electrofilter |
|---|---|---|---|---|
| EN 13240<br>EN 13229 | X | | X | X |
| EN 16510-1 | X | | X | |
| US EPA 5H | | X | | |
| US EPA 5G | | | X | |
| NS 3058 | | | X | |
| Flame verte label (F) | X | | | |
| Blue Angel (D) | X | | | |

- Different practices in UNECE regions
- Lack of monitoring results including condensables

From INERIS adapted by Citepa
Synthèse des études à l'émission réalisées par l'INERIS sur la combustion du bois en foyers domestiques 2018

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# A limit value for BC?

No examples of regulation or labels including the BC limit values

In Norway, **a standardized test for emissions of elemental carbon and organic carbon from residential wood combustion has been established in 2016**.

- Such a standardized test can then be used for voluntary eco-labeling of wood stoves, specifically the Nordic Swan Ecolabel, “climate-friendly” stoves, and by manufacturers interested in testing and developing extremely low-emission, low-black carbon, “climate-friendly” stoves.
- The development of this testing protocol was part of a project supported by the Nordic Council of Ministers and the Climate and Clean Air Coalition (CCAC), and implemented by the International Cryosphere Climate Initiative (ICCI).

from Jes Sig Andersen and Morten Gottlieb Jespersen
A Protocol for Black Carbon Emissions
A Protocol for Measuring Emissions of Elemental Carbon and Organic Carbon from Residential Wood Burning – Norden 2016

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# Preliminary conclusions

- From 2012, PM reduction techniques have evolved
- Domestic appliances using wood present lower PM emissions than 10 years ago
- For larger combustion plants from 1 to 50 MW, better PM emission reduction efficiencies can be obtained with optimisation of combustion and adapted electrostatic precipitators and fabric filters

# Further steps

- Develop additional examples of low emission techniques used
- Provide an assessment for the Report on the review of the GP by 10 December 2021 (a summary table)
- Develop the associated informal document by March 2022 at the latest

# Thank you very much for your attention! Questions?

*TFTEI Technical Secretariat*

CITEPA

Karlsruher Institut für Technologie

MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE

*Liberté*
*Égalité*
*Fraternité*