Regulation of air pollution from small biomass combustion

Ideas from INFORSE-Europe, December 2010

Introduction

The increasing use of biomass for combustion in the EU reduces CO2-emissions, but it also contributes to local pollution. While stoves and other combustion installations will always emmit some pollution, the amounts can be substantially rduced compared with the current practice, at affordable costs. There are therefore good reasons to regulate pollution at levels that drive the stock of biomass combustion installations to cleaner technologies. This will reduce local air pollution and related environmental costs. It will also justify increased use of biomass for heating in many parts of Europe.

National schemes are now regulating pollution from new and renewed installations in a number of countries. Additionally, voluntary environmental labelling informs consumers about performance of the best products.

The EU Ecodesign process includes regulation of small solid fuel combustion installations, which is primarily biomass fuelled installatons. The process has started in 2008 with preparations of preparatory studies that are made before regulation is discussed. Preparatory studies were discussed with stakeholders in 2009, but improved versions have not been released in 2010. The process is expected to continue in 2011.

There are reasons to regulate small combustion installations for energy efficiency and air pollution. This paper will only discuss possible regulation of air pollution.

Proposal

The main pollutents are particles while other air pollutants are VOC's (volatile organic compounds, in practice half-burned gases, part of OGC: Organic Gaseous Carbon), SO2, Nox, CO. As part of these are the most harmful substances usually found to be PAH's (Poly-aromatic hydrocarbons), and dioxines. The regulation is proposed to cover only particles, OGC's, NOx, and dioxines because:

- SO2 is insignificant for biomass-fired installations (but not for coal-fired installations)
- CO is not a problem in well working installations and should be treated as part of the safety regulation
- PAH are part of OGC and particles. Reduction in particles and OGC will also reduce VOC's and PAHs.

This gives the following proposals:

- The main regulation should be for particles and VOC's
- For particles EU could set classes for different use: a very clean class that can be used everywhere but that will require a filter (which is about 2000 €), a class for best availble combustion technology (as current Swan label, 5 g particls/kg wood), and a third class that can include installations for difficult fuels such as straw. Then only the first two classes are for urban areas and municipalities should be able to limit use to the highest class in denser areas and sensitive areas.
- For VOC's, in principle the same regulation as for particles. Regulation can start with a high class similar to Nordic Swan, a second class similar to current Swedis requirements, and a third class including instalations for difficult fuels such as straw.
- For Nox, EU could require levels of NOx so the installations only contribute marginally to acidification. NOx levels are higher than for gas boilers.
- For dioxines could be regulation of combustion principles, as dioxine measurements themselves are impractical. Further studies are needed before specific proposals can be suggested.

Not all air polllution can be reduced with better instalations. There is a major question of fuels. Wet firewood can ruin the performance of most smaller combustion installations. A requirement could be that wood sold for firewood must have less than 20% humidity
Also the user behavious is important, so the best regulation of of equipment cannot avoid some pollution from badly used installation. Focus on user behavious at the regular inspection by chimney cleaners can address this problem. Also well-functioning system of reporting by neighbours of problems can help to reduce this problem, in particular if combined with practice of closing fireplaces that are causing continued pollution problems.

Finnally regular maintenance plays a role in air pollution. For use of filters, there need to be regular cleaning. Lack of regular maintenance (cleaning of boiler pipes, removal of ash) is identifyed as a common cause of reduced efficiency and increased emissions.
That can be done with the regular cleaning by the chimney sweepers that is compulsory anyway.

The regulation of equipment is an EU competence as paert of the internatl market, but as the equipment is installed, countries can set additional requirements. This can for instance be useful to regulate installation in areas with higher impacts, such as cities where pollution affects more people and where sources can be more concentrated, and valleys where air circulation can be limited.

Background

Use of biomass for heating
The use of biomass in small combustion installations are divided on the following types of installations[1]:
Open fireplace: 248 PJ
Closed fireplace 281 PJ
Wood stoves 558 PJ
Pellet stoves: 28 PJ
Cookers: 56 PJ
Slow release stoves (Finnish Mass Ovens): 95 PJ
Domestic boilers: 480 PJ
Larger boilers: 202 PJ

Particulate Pollution

Particles are measured in mass in g/kg wood, in mg/m3 flue gas, in mg/MJ fuel. The mass can be for total particles, for only particles below 10 micro-meter (PM10) and for only particles below 2.5 micro-meter (PM2.5). PM2.5 particles are most important for health. According to Corinair[2] factors for calculation of air pollution, 80-90% of PM emmissions are small particles (PM-2.5)

PM emmissions are now typically below 450 mg/m3 and in the range 90-200 mg/m3 for existing installations according to HKI, Germany. Another source used by the Ecodesign preparatory study found PM emmisions of 18-25 mg/m3.

In a specific Danish measurement of 19 wood stoves was found average emission of 6.2 g total PM pr. krg wood, but with large variations up to 23 g/kg[3].

1 Ecodesign preparatory study, draft 2009, see www.ecosolidfuel.org
2 See for instance http://www.eea.europa.eu/publications/EMEPCORINAIR5
3 Danish National Environmental Research Institute, working report 235: Partikler og organiske

Austrian data for current market of boilers < 50 kW[4]:
manual fed: PM 4-52 g/GJ (from sample of 34)
automatic fed: efficiency PM 7-60 g/GJ (from sample of 120)

New stoves have particulate emmissions up to 7 times below existing stock[5]

The Ecodesign draft preparatory study found the following base canse and BAT for different solid fuel combustion installations:

Dust (PM) emissions	Power(kW)	Base case mg/m3	BAT mg/m3
1: Open fireplace	15	575	n.a.
2 Closed fireplace	10	105	40
3: Cooker	10	150	90
4: Stove, trad.	8	105	na.
5: Stove, modern	8	105	60/6*
6: boiler, hand fuelled < 50 kW	50	154	90
boiler auto. > 50 kW	>50	68	20/10*

Ecodesign lot 15, Task5, draft 2009: Following Din 303-5 and DIN+
* BAT for pellet stoves is best, represented by lower number
For base case 6: wood log boiler, pellet boiler is better
The values have been contested by stakeholders (see also measurement problems below)

The highest international standard (EN303-5, class 1) requires for boilers below 50 kW, PM (dust) 150 mg/m3

Stoves labelled with the Nordic Swan must have emissions below 5 g /kg wood, a strengthening of requirements in 2007 from 10 g /kg wood. The measurement is for average use, and emissions can be higher at certain power levels.

Norwegian and Danish standards require that only ovens are installed with emissions below 10 g /lg wood, in average use. In Norway is a supplementary requirement that emissions must be below 20 g g/kg wood in low power mode.

The best stoves have emissions below 200 g PM2.5/GJ, some are under 180 g PM2.5/GJ[6]. This is similar to 3 and 2.7 g PM2.5/kg wood. More than 150 Swan-labelled stoves are available on the

forbindelser fra træfyring - nye undersøgelser af udslip og koncentrationer. Published 2007

4 From Ecodesign lot15 stakeholder meeting,

5Danish National Environmental Research Institute, project report 1235, "Health effects assessment of exposure to particles from wood smoke", published 2008, www.dmu.dk.

6 Danish National Environmental Research Institute, research project 1164: Brændeovne og små kedler - partikelemissioner og reduktionstiltag, published 2007, www.dmu.dk

Danish market.

There are measurement problems with Particulate matter (PM) in smoke, as different methods give different results: a dillution tunnel test give 3 times higher PM than a gravimetric method. In the dillution tunnel test particles are formed in the smoke in a process similar to what (sometimes) happens in the chimney and after the smoke leaves the chimney. These particles are present immediately after the combustion but are found in smoke, though not necessarily in the same concentration as in the dillution tunnel measurement.

Gaseous Pollution

To reduce pollution, also the fraction of half-burned gasous emissions should be reduced, in short OGC, Organic Gaseous Compounds. The worst of these regardign local pollution are non-methanic volutile Organic Compounds, NMVOC og which PAH is an important subgroup.

According to HKI, Germany, OGC emission are typically 200-700 mg/m3. Another source used in the Ecodesign preparatory study found OGC 1-2.5 mg/m3 (could be for wood pellet stoves, see bwlow)

The Ecodesign preparatory study found the following base caseas and BAT for OGC

OGC Emissions	Power (kW)	Base Case mg/m3	BAT mg/m3
1: Open fireplace	15	900	n.a.
2 Closed fireplace	10	350	70
3: Cooker	10	600	110
4: Stove, trad.	8	350	n.a.
5: Stove, modern	8	350	80/1.5*
6: boiler, hand fuelled < 50 kW	50	90	20
7: boiler, automatic. fuelled < 50 kW	50	24	20/1.5*
8: boiler auto. > 50 kW	100	42	4/1.5*

Ecodesign lot 15, Task5, draft 2009, Following Din 303-5 and DIN+
* BAT for pellet stoves is best with OGC = 1.5
The values have been contested by stakeholders (see also measurement problems below).

The Nordic Swan require OGC levels below 150 mg/m3
Swedish regulation require OGC levels below 250 mg/m3

Other pollution - dioxines
Studies have found very different levels of dioxine in smoke from biomass combustion (I-TEQ index of dioxin (PCDD/F) variation from 0,027 to 140 ng of 19 measured ovens in use), but the levels are not clearly linked with PM or OGC[7] and that new stoves generally 5 - 15 times better than older stoves in Denmark[8]

Other issues than equipment performance
The dioxine emissions are significantly increased when plastic and chemically treated wood is included in the fuel.

Use of wrong fuel is causing pollution and loss of efficiency.
In one example (laboratory test) the change in a stove of fuel wood with 20% moisture to fuel wood with 30% moisture increased particles from 69 mg/m3 to 1144 mg/m3 (16 times). Other use of wrong fuel also causes large increases in pollution, e.g. using coal instead of coke or wood.

This note is made by INFORSE-Europe, see www.inforse.org/europe

7 Danish National Environmental Research Institute, working report 235: Partikler og organiske forbindelser fra træfyring - nye undersøgelser af udslip og koncentrationer. Published 2007, op. cit,
8Danish National Environmental Research Institute, project report 1235, "Health effects assessment of exposure to particles from wood smoke", published 2008, www.dmu.dk, op.cit.