WOOD COMBUSTION IN DOMESTIC APPLIANCES

SYNOPSIS SHEET

Prepared in the frame work of EGTEI

1. Activity description and EGTEI contribution

Wood combustion in domestic appliances causes NMVOC and TSP (or PM) emissions which can be significant but also other pollutants such as NOx. TSP and NMVOC emissions in domestic appliances depend on combustion conditions (air excess, combustion temperature…), the wood type used (moisture content, wood nature, wood form (logs hand stoked in appliances, pellets in automatically stoked in appliances)), the configuration of the combustion chamber, the type of appliances…
Several types of domestic appliances are used. Combustion efficiencies and wood consumption differ from appliance to appliance. Some domestic appliances are used only as auxiliary means of heating (Open fire place for example), other ones are used as the main means of heating and run along the whole heating period without stop.

In EGTEI, five types of domestic appliances are considered:

- Open fire places,
- Inserts and closed fire places,
- Stoves,
- Hand stocked log wood boilers,
- Automatic stoked wood boilers.

The sector is obviously already considered in RAINS. Different values across European countries reflecting different operating practices, age of installations… are considered: Eastern and Western Europe are distinguished allowing for country specific values to be used [4].
The control options considered in RAINS include two stages of modern boilers/stoves to simulate the gradual replacement of old facilities and for fireplaces an option based on the use of a catalyst is added. Wood combustion in domestic appliances is included in the RAINS category "Residential, commercial, institutional, agricultural use" and fireplaces, stoves, manual single house boilers and automatic single house boilers are distinguished.
The representation of wood combustion in domestic appliances in RAINS is currently being modified. Latest information on the new representation is not yet available in September 2005.

Domestic appliances are not addressed by an EC Directive. They are addressed by several European standards defining the minimum thermal efficiency and the maximum pollutant emission for classifying the different appliances. This information provided is provided in details in the background document
EGTEI provides update of emission factors and costs of emission reduction techniques for wood domestic appliances. However, data provided by EGTEI such as emission factors, efficiencies and costs of reduction techniques have to be considered as a first attempt of definition. Significant uncertainties are associated with each default data provided. The work should be updated and improved for trying to obtain more robust information especially on the cost side.
However some EGTEI proposals are taken into account in the new RAINS version especially emission factors in the no control case. EGTEI considers the average wood consumption per unit as a country specific parameter since this parameter can be very different from country to country, from appliance to appliance and habits of inhabitants.
The methodology for this sector has been prepared on the basis of work carried out in close cooperation with an expert from ADEME [1].

Five reference appliances are considered to define the different appliances in use in Europe. Emission reduction is achieved through replacement of appliances with more efficient ones and with secondary measures.

EGTEI provides default emission factors (EF) with abatement efficiencies, investments, variable and fixed operating costs (OC) as well as unit costs expressed in €/t NMVOC, €/t TSP abated and €/GJ wood for the different reduction technique combinations.

Unit default costs range from -2616 €/t NMVOC abated to up 33777 €/t NMVOC abated according to the reduction measure considered, from -12550 €/t TSP abated to up 47710 €/t TSP abated according to the reduction measure considered and from -1.5 €/GJ to up 21.0 €/GJ. Unit costs mainly depend on wood saving provided by more energy efficient appliances and reduction efficiency of these appliances on emissions.

National experts have to collect only two country and sector specific economic parameters (wood log cost and wood ship cost). National experts have also to provide the trend in wood consumption from 2000 to 2020 as well as the application and applicability rates of each abatement measure. They also have to provide the average wood consumption in each of the five reference appliances with no control.

The results obtained by EGTEI have to be considered as preliminary results. Uncertainties are very high and additional work would be useful in the future, especially to improve definition of investment costs and better know real condition emission factors and efficiencies of new domestic appliances.

2. European regulation

No regulation is implemented at the European level to limit emissions of these appliances. However several standards have been implemented to classify the different equipment.

3. Methodology developed within EGTEI to represent the sector

3.1 Definition of reference installations

The reference installations are as follows:

Table 3.1: Definition of reference installations

Reference Installation Code RIC	Appliance	Combustion efficiency [%]	Autonomy [hours]	Lifetime [year]
01	Domestic open fireplaces	10	Few hours	25
02	Stoves and residential cooking	30 to 80	5 to 12	15
03	Closed fireplaces and inserts	30 to 85	5 to 12	15
04	Hand stoked log wood boilers	50 to 75	4 to 8	15
05	Automatically stoked boilers	85 to 90	24 hrs to all the heating season	15

3.2 Definition of emission abatement techniques

3.2.1 Primary measures

The primary measures considered are as follows:

Table 3.2.1: Primary measures

Primary Measure Code	Description
00	Conventional
01	Replacement with advanced insert or closed fireplaces (equivalent to class 1)
02	Replacement with advanced stove or residential cooking (equivalent to class 1)
03	Replacement with hand stoked log wood boiler (equivalent to class 3)
04	Replacement with automatically stoked log wood boiler (equivalent to class 3)

05	Addition of an accumulator tank on existing installation
06	Replacement with boilers (equivalent to class 3) with an accumulator tank

NB: For inserts, stoves, residential cooking and closed fireplaces, the most energy efficient appliance corresponds to class 1 and the less energy efficient to class 3.
For boilers, an opposite classification is used: the most energy efficient boiler corresponds to class 3 and the less energy efficient to class 1.

3.2.2 Secondary measures

The use of catalysts or similar system is considered.

4. Country specific data to be collected

Different types of country specific data have to be collected to give a clear picture of the situation in each Party. EGTEI proposes default values for these economical parameters which can be modified by the national expert if better data are available.
For wood combustion in domestic appliances, only two country and sector specific economic parameters are required. They are presented in table 4.1.

Table 4.1: Country and sector specific economic parameters

Parameter	Default costs provided by EGTEI	Country specific cost
Wood log [€/GJ]	6.48	to be provided by national experts
Wood ships [€/GJ]	19.48	to be provided by national experts

Information concerning activity levels from 2000 to 2020 as well as the description of the control strategy is also necessary (these data can be directly entered in ECODAT). A full definition of the work to be done by national experts is provided in the general EGTEI methodology.

The national expert has to provide the average wood consumption on the reference installations considered:

Table 4.2: Country specific wood consumption per appliance (GJ of wood / year)

RIC PMC SMC	Default consumption provided by EGTEI GJ /unit/year	Country specific wood consumption GJ/unit/year
01 00 00	28.63	to be provided by national experts
02 00 00	49.80	to be provided by national experts
03 00 00	62.01	to be provided by national experts
04 00 00	131.97	to be provided by national experts
05 00 00	131.97	to be provided by national experts

The national expert can also modify the default unabated emission factor proposed by EGTEI to represent the reference situation of the wood combustion in domestic appliances for all Parties in a range of ± 10% with appropriate explanations.

Table 4.3: Unabated emission factor [g /GJ]

Combination code	Default NO_x EF [g/GJ]	User NO_x EF [g/GJ]	Default VOC EF [g/GJ]	User VOC EF [g/GJ]	Default TSP EF [g/GJ]	Default TSP EF [g/GJ]
01 00 00	50		1700		750	
02 00 00	50		1600		310	
03 00 00	50		1600		310	
04 00 00	50		400		250	
05 00 00	50		80		20	

Remark: This activity is not yet implemented in ECODAT. For estimating country specific costs the EXCEL sheet “wood combustion cost” can be used.

5. Default emission factors and cost data defined with the EGTEI methodology

Tables 5.1, 5.2 and 5.3 present an overview of all data provided by the EGTEI methodology for the different combinations: default emission factors with abatement efficiencies, investments, variable and fixed operating costs as well as unit costs.
Emission factors are derived from information provided in reference [3] to [18] and [19] to [21].

Table 5.1: Emission factors (EF) for each combination

Combination code RIC PMC SMC	EF NO_x [g/GJ]	Abatement efficiency [%]	EF VOC [g/GJ]	Abatement efficiency [%]	EF TSP [g/GJ]	Abatement efficiency [%]
01 00 00	50	0	1700		750	0
01 01 00	50	0	60	96	77	90
01 01 01	50	0	30	98	27	96
02 00 00	50	0	1600	0	310	0
02 02 00	50	0	60	96	170	45
02 02 01	50	0	30	98	60	81
03 00 00	50	0	1600	0	310	0
03 01 00	50	0	60	96	77	75
03 01 01	50	0	30	98	27	91
04 00 00	50	0	400	0	250	0
04 03 00	50	0	40	90	20	92
04 04 00	50	0	20	95	10	96
04 05 00	50	0	80	80	250	0
04 06 00	50	0	40	90	20	92
04 03 01	50	0	20	95	20	92
04 04 01	50	0	20	95	10	96
04 05 01	50	0	40	90	88	65
04 06 01	50	0	20	95	20	92
05 00 00	50	0	80	0	20	0
05 04 00	50	0	20	75	10	50

Table 5.2: Investments, fixed operating costs (OC), variable operating costs and total annual costs for each combination

Combination code	Average additional investment [€]	Fixed OC [€/y]	Variable OC [€/y] wood consumption	Variable OC [€/y] catalyst replacement	Total annual cost [€/y]
01 00 00					
01 01 00	3300	0.0	-157.0		139.8
01 01 01	4400	55.0	-157.0	250.0	543.8
02 00 00	0		0.0		0.0
02 02 00	1100		-154.5		-55.6
02 02 01	2200	55.0	-154.5	250.0	348.4
03 00 00	0		0.0		0.0
03 01 00	1775		-124.1		35.6
03 01 01	2875	55.0	-124.1	250.0	439.5
04 00 00	0		0.0		0.0
04 03 00	2250		-285.0		-82.6
04 04 00	6100		587.6		1136.2
04 05 00	1400		-244.3		-118.4
04 06 00	2600		-352.1		-118.2
04 03 01	3350	55.0	-285.0	250.0	321.3
04 04 01	7200	55.0	587.6	250.0	1540.1
04 05 01	2500	55.0	-244.3	250.0	285.6
04 06 01	3700	55.0	-352.1	250.0	285.7
05 00 00	0		0.0		0.0
05 04 00	2725		-84.9		160.2

Table 5.3: Unit costs for each combination

Combination code	Unit cost €/GJ	Unit cost €/t NMVOC abated	Unit cost €/t TSP abated
01 00 00			
01 01 00	31.74	2888	6616
01 01 01	123.44	11201	25462
02 00 00			
02 02 00	-1.46	-573	-4364
02 02 01	9.13	3552	20574
03 00 00			
03 01 00	1.16	457	2719
03 01 01	14.34	5581	30083
04 00 00	0.00		
04 03 00	-0.94	-1677	-2646
04 04 00	15.50	22139	35221
04 05 00	-1.26	-2616	-12557
04 06 00	-1.52	-2379	-3760
04 03 01	3.65	6297	10288
04 04 01	21.01	30010	47743
04 05 01	3.03	5826	11563
04 06 01	3.68	5577	9088
05 00 00			
05 04 00	2.19	33777	4967

6. Relevance of EGTEI information for integrated assessment modelling (IAM)

Some data provided in the EGTEI approach have been implemented in the new version of the RAINS model. Update of RAINS is not yet completely finalised for this sector so,additional information can not be provided.

7. Perspective for the future

The EGTEI proposal for wood combustion in domestic appliances is a first attempt to define costs of emission reduction techniques. Uncertainties on emission factors are high. Efficiencies and costs of emission reduction techniques are also associated with uncertainties. Additional work would be useful. A working group including a larger participation of some Parties with high consumption of wood such as Norway and Finland could be useful.

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Annexe - Example of data collection and use of EGTEI data – Case of France

A. Country specific data collection and scenarios developed by the national expert

The collection of country specific parameter is not yet done and will depend on the energy scenario selected for france.

Country and sector specific economic parameters

The two country and sector specific economic parameters are as follows.

Table A.1: Activity and country specific economic parameter cost

Parameter	Default cost provided by EGTEI	French specific cost
Wood logs € [net of taxes]/GJ	6.48	6.48
Wood ships € (net of taxes)/GJ	19.68	19.48

Activity level

To be defined later in accordance to the energy scenario.