

Solid fuel small combustion installations

Interim Stakeholder Meeting
Brussels, Belgium, 18 December 2008

*A study being conducted for DG TREN by Bio Intelligence Service
in cooperation with AEA Energy & Environment and ITT*



Bio Intelligence Service - Scaling sustainable development
Industrial Ecology - Nutritional Health

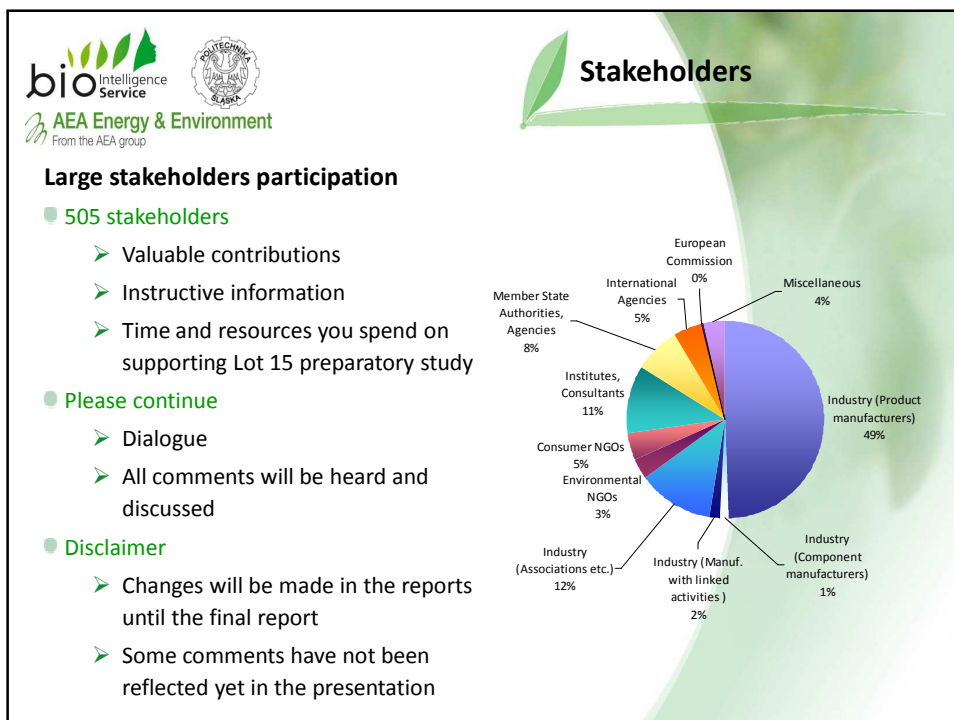
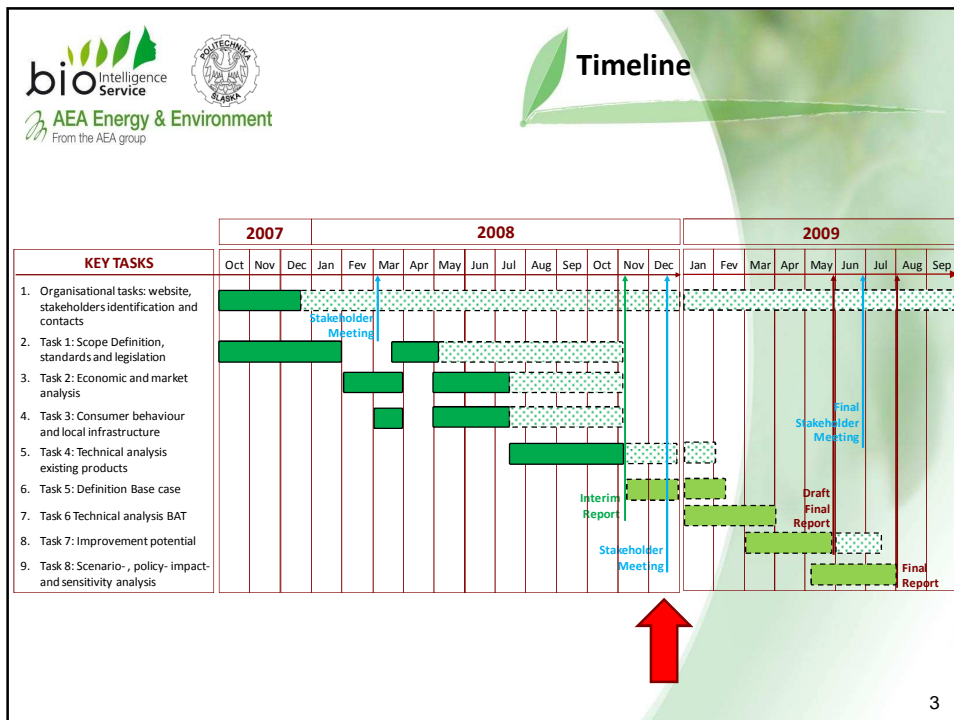
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Lot 15 preparatory Study

- 10:00 – 11:00 Introduction, study context and scope (Task 1)
- 11:00 – 12:00 Presentation and discussion of main results of Tasks 2-3
- 12:00 – 12:45 Discussion

- 12:45 – 13:45 Lunch

- 14:00 – 15:15 Presentation and discussion of main results of Task 4
- 15:15 – 16:30 Presentation and discussion of next steps (Tasks 5-6)
- 16:30 – 17:00 General discussion



Task 1: Scope of the study

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Aim:

- Define the product category and the scope of study → **Tasks 2-8**
- Identify the harmonised test standards and additional sector-specific procedures for product-testing → **Tasks 4,5,7**
- Identify the existing relevant legislation, voluntary agreements, and labelling initiatives at the EU and MS level, as well as outside Europe → **Task 8**

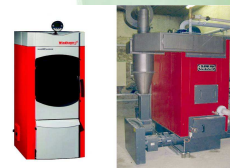
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Definition: “Solid fuel Small Combustion Installations”

- **Combustion installation:** single combustion appliance and related operating equipment
 - Space heating function
- **Small:** capacity below 500kW
- **Solid fuel**
 - Mineral raw or manufactured fuels (e.g. coals of various ranks, briquettes)
 - Biomass, raw or manufactured (e.g. wood logs, wood pellets, charcoal)
 - Peat

Within the scope: standard space heating installations

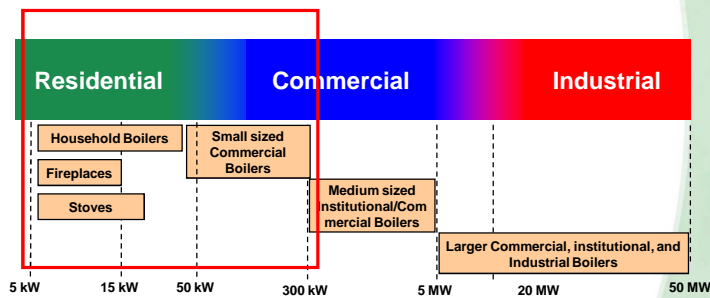
- **Indirect heating:**
 - Central heating boilers
- **Direct heating (primary or secondary heating source):**
 - Fireplaces
 - Stoves
- **Cooking**
 - Cookers



Excluded from the scope

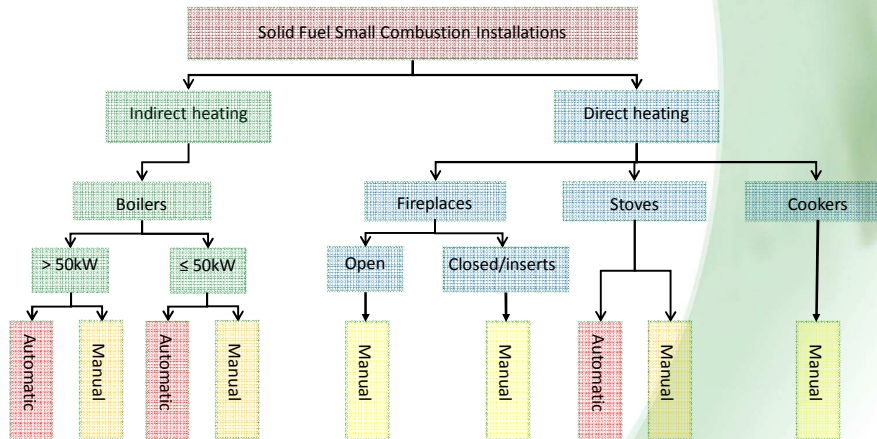
- **Different functionality:**
 - Outdoor combustion installations (e.g. fireplaces, barbecues)
- **Small market size:**
 - Process applications (e.g. metal refinery)
 - Waste recovery for energy production (e.g. incineration installations)
- **Both:**
 - Sauna stoves

Sector: mostly residential installations



- **Combustion technologies:** residential ≠ commercial
- **Use:** batch vs continuous

Product classification



European standards

EN	303-5	12809	13240	12815	13229	15250	14785
Lot 15 Appliance	Boilers (indirect heating)	Boilers (direct heating)	Stoves	Cookers	Open fireplaces/ inserts	Slow heat release stoves	Pellet stoves
Fuel	Solid mineral fuels and biomass						Wood pellets
Efficiency requirements	Direct (3 classes)	Indirect (checking)	Indirect (≥ 50%)	Indirect (≥ 60%)	Indirect (≥ 75% / ≥ 30%)	Indirect (≥ 70%)	Indirect (≥ 75%)
Emissions requirements	CO OGC PM NOx	CO (≤ 1%)	CO (≤ 1%)	CO (≤ 1%)	CO (≤ 0.2%)	CO (≤ 0.3%)	CO (≤ 0.04%)

Existing EU legislations

- **EU legislations** – directly related
 - Construction Product Directive (89/106/EEC)
 - Low Voltage Directive (2006/95/EC)
 - Machinery Directive (98/37/EC)
 - Pressure Equipment Directive (97/23/EEC)
- **EU legislations** – indirectly related
 - Air quality
 - Energy Performance of Buildings Directive
 - Directive on the promotion of renewable energy sources
 - Boiler efficiency Directive (92/42/EEC)
 - Large Combustion Plant Directive (2001/80/EC)

Other legislations

- **MS legislations:** several regulations on air combustion emissions
- **Third country legislations:**
 - Australia: emission limits for SCIs
 - New Zealand: emissions from residential wood burners
 - Switzerland: emission limits for SCIs
 - USA: emission limits for wood heating appliances

Labels and voluntary programs

- Several existing labels and certifications
 - Blue Angel (DE)
 - Nordic Swan (SE,NO,DK,FI)
 - EFA labelling scheme (Europe, fireplaces)
 - Umweltzeichen 37 (AU)
 - Flamme Verte (FR)
 - HETAS certification (UK)
 - Etc.
- Too many labels exist
 - Manufacturers often find no benefit in showing labels

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Main stakeholders comments on Task 1 (draft document)

- Categorisation of appliances:
 - Based on a range of heat outputs,
 - Air control (manual vs automatic; fan-assisted vs natural draught)
 - Function (decorative vs not)
- Direct vs Indirect heating – clarify throughout
- Clarify separation between <50kW residential; >50kW industry
- Scope of Standards needs some adjustments

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Task 2: Market analysis

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Aim:

- **Place of the products within the EU trade & industry sector**
- **Market size** → assess environmental impact (Tasks 5,7)
- **Expenditures** → to include in a life cycle cost calculation (Task 5,7)
- **Market trends** → assess changes in the future (Tasks 6,7)

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SCIs within the EU market:

- **PRODCOM data:** incomplete
 - 2 categories specific to SCIs: cookers, open fireplaces/inserts
 - 16 categories including SCIs, non specifically
- **Fragmented market**
 - No robust EU-wide estimates of sales and stocks

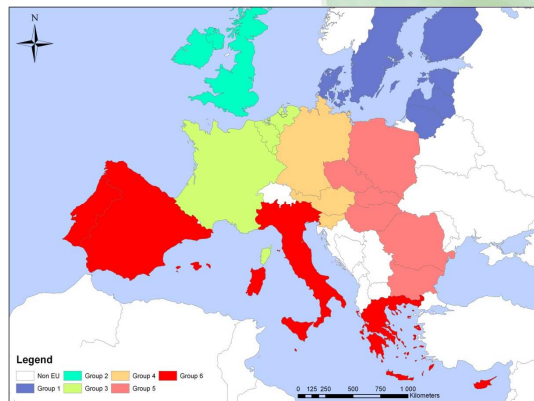
Approach to market data collection: estimates of market size

- **Market analysis reports**
 - Existing data from the literature
- **Questionnaires to industry**
 - 22 questionnaire replies
- **Extrapolations:**
 - Country groupings

Country groupings – for rough estimations of market size

Rationale:

- Number of heating degree days
- (Coal and wood resources)

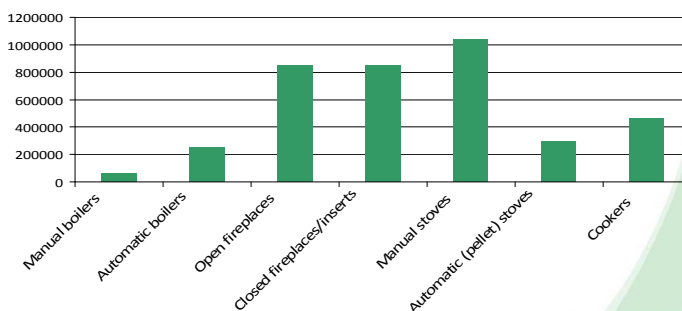


Use:

- Only when no market data available in an MS, for one product group

Annual sales in EU-27

- Total EU sales = 3.8 million SCIs
- Assumptions:
 - Sales open fireplaces = sales closed fireplaces
- New sales: between 85-100% of all sales (except for boilers: 40%)

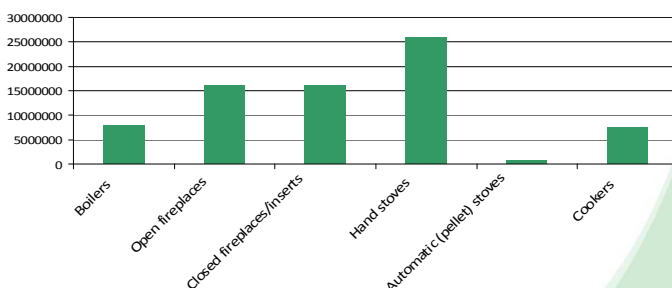


Annual sales

- Sales by capacity
 - Boilers: sales of boilers below 50kW represent 75% of the market (both for manual and automatic boilers)
 - Closed fireplaces: sales below 10kW represent 50-90% of the market
 - Manual stoves: sales of 5-10kW represent 50-80% of the market
 - Cookers: 90% < 15kW; 100% manual (1 or 2 automatic cookers on the EU market)
- Sales by fuel type
 - Boilers: variable but approx. 70% wood and 30% mineral fuels
 - Fireplaces: 100% log wood, except in country group 5
 - Manual stoves: 100% log wood, except in country group 5
 - Automatic (pellet) stoves: 100% wood pellets

Stocks

- Total EU stocks = 74.1 million SCIs
- Assumptions:
 - Stock EU-27 open fireplaces = stock EU-27 closed fireplaces
 - Stock EU-27 pellet stoves = stock FR+DE+IT+SE
 - Stock EU-27 heat-retaining stoves = stock DE+AU+FI+SE
- Realistic estimates: 20% of dwellings have a direct heating SCI



Average product life (years)

- CITEPA study vs stakeholders

	Biomass (CITEPA)	Mineral (CITEPA)	Stakeholders
Boilers - manual	15	15-25	10 – 25
Boilers - automatic	15	15-25	15 – 25
Fireplaces – open	25	25	20 – 50
Fireplaces - closed	15	15-25	15 – 25
Stoves - manual	15	15-25	15 – 40
Stoves - automatic			10 – 15
Cookers	15	15-25	10 – 30

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Costs (EU-27 average)

- Purchase prices:
 - Boilers: 3000 – 4000 €
 - Other product groups: 2000 €
- Installation costs:
 - Boilers: 1500 €
 - Other product groups: 500 – 1000 €
- Maintenance costs (over products lifetime):
 - Boilers: 500 €
 - Other product groups: 250-350 €
- Repair costs (over products lifetime):
 - Boilers: 500 €
 - Other product groups: 200-250 €

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Costs of solid fuels (estimates)

■ High variability among MS

■ EU-27 average purchase prices (€/GJ), based on 18 MS

	Forest residues	Firewood logs	Refined wood fuels	Coal
Austria	N.A	5.56	8.61	12.68
Belgium	N.A	3.9	10	N.A
Czech Rep.	2.79	5.51	4.57	1.29
Denmark	4.48	10.9	9.21	20.8
Estonia	N.A	1.43	N.A	3.31
Finland	N.A	8.33	7.21	N.A
France	7.13	5.1	10.03	15.03
Germany	2.87	5.31	10.83	9.23
Greece	N.A	8.39	22.65	N.A
Hungary	N.A	4.8	6.41	3.88
Ireland	3.77	23.18	16.7	12.59
Latvia	N.A	0.81	4.5	1.75
Netherlands	N.A	5.8	16	N.A
Poland	N.A	2.5	5.58	3.49
Portugal	2.78	3.61	6.8	N.A
Slovakia	N.A	1.55	5.38	4.49
Spain	4.09	15.89	12.93	N.A
Sweden	N.A	5.1	12.72	N.A
EU-27	4.0	6.5	10.0	8.0

Market trends

- Biomass boom:
 - 20% renewable energy use by 2020
 - Average share of Biomass in the energy mix: 4.1% [1.3% - 29.8%]
- Solid fuel boilers sales x2: 3% to 6% of all boiler sales from 2004 to 2010
 - Growing price of oil & gas
 - Environmentally-friendly image

Conclusions

- **Best estimates based on individual sources**, in the absence of a single source for comprehensive market data:
 - Accuracy of figures can be challenged
 - But clearly shows that the yearly sales of the SCIs are higher the 200 000 unit threshold set in the EuP directive
 - Basis for selecting representative products and input in Task 5
- **Growing market**, both in sales and stock
- **Market structure driven** mostly by energy prices and fuel availability

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Main stakeholders comments on Task 2 (draft document)

- **Country groupings**: this is used only for extrapolations, not for regulation

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Task 3: Consumer behaviour and local infrastructure

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Aim:

- Quantify user parameters affecting the use phase of SCIs → Tasks 5,7
- Real life efficiency of SCIs → Task 8
- Consumer behaviour: frequency and characteristics of use → Tasks 5,7
- Barriers and restrictions to possible eco-design measures → Task 6,7,8

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Key factors affecting the choice of an SCI:

- **Function:**
 - Primary heating (need)
 - Secondary heating (luxury)
- **For primary heating appliances:**
 - Price of the appliance
 - Environmental considerations
- **For secondary heating appliances:**
 - Design/aesthetics
 - Type of fuel, renewability of the fuel

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Key technical factors affecting real-life efficiency and emissions

Temperature, Turbulence, Time

- **Appliance:**
 - Correct dimensioning of the appliance for its function
 - System configuration
 - Air supply – presence of fan control or secondary air supply
 - Automatic fuel stoking and electronic controls
- **Fuel properties:**
 - Type of fuel – physico-chemical properties, appropriateness for the SCI
 - Fuel moisture
 - Fuel size (grain size distribution for coal)
- **Building properties - chimney:**
 - Dimensioning
 - Secondary air intake
 - Insulation and corrosion resistance

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Key use factors affecting real-life efficiency and emissions of SCIs:

- **User control of combustion parameters**
 - Choice of fuel and fuel quality
 - Way of operating
 - Fuel residence time
 - Air control
 - Automatic fuel stoking and electronic controls
 - Maintenance

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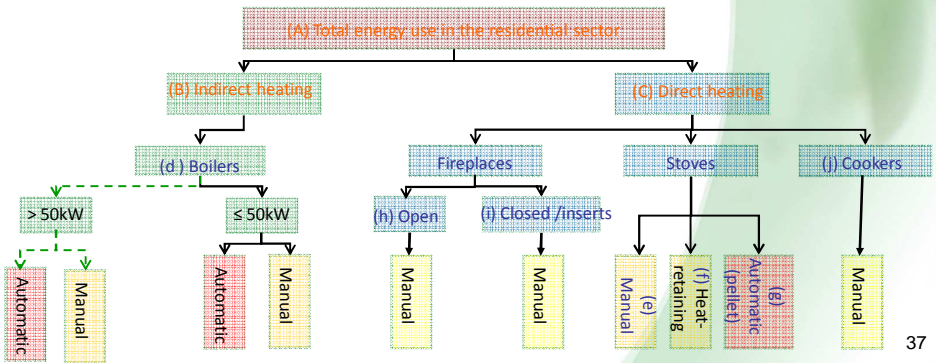
Frequency and characteristics of use: poor data

- **Substantial variability in use characteristics in EU-27**
 - Function of SCI: primary heating vs secondary heating vs decorative
 - Geographic location: number of cold days
- **Data availability**
 - No comprehensive data on use patterns of SCIs in each MS (literature)
 - Comprehensive data on **total solid fuel use** in the residential sector in each MS (Eurostat, JWEE, Euroserver)
- **⇒ Need to estimate energy use indirectly**
 - Top-down approach
 - (Bottom-up approach)

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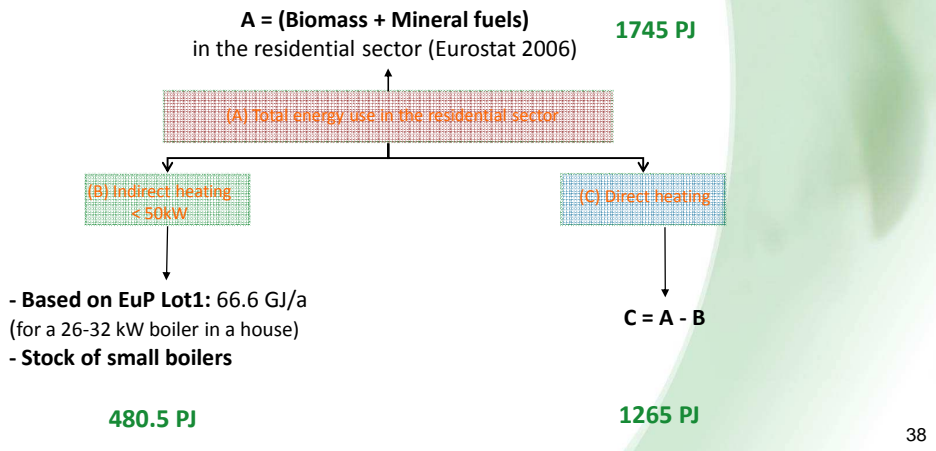
Estimation of energy use: top-down approach

- Based on:
 - Total energy use from solid fuels (Eurostat Energy Balance data, 2006)
 - Energy use per appliance (literature)
 - Stocks (Task 2)



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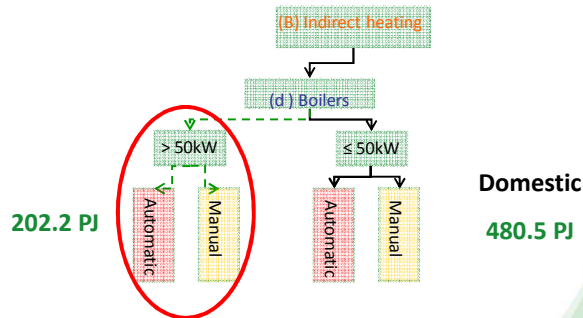
Estimation of energy use (domestic):



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Estimation of energy use (industry sector):

- **Boilers > 50 kW:**
 - Stock = 8% of total stock of boilers (estimation -Task 2)
 - EuP Lot1 → 322 GJ/yr (XXL, 70-150 kW)
 - Check estimates against Eurostat Energy Balance for agricultural/services data



Estimation of direct energy use per appliance:

$$E_{\text{total direct}} = E_{\text{stove}} + E_{\text{openfire}} + E_{\text{pellet-stove}} + E_{\text{appliance}(i)} + \text{etc}$$

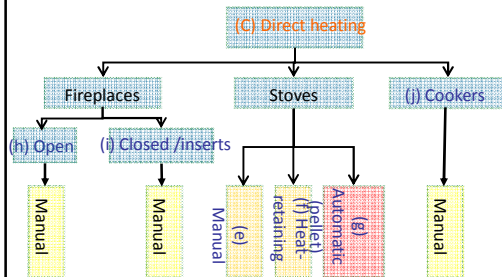
- **Energy use per appliance** obtained from 5 studies:
 - Finland (2), Germany (1), Italy (1), Denmark & Sweden (1)
 - 2 – 3 data points per appliance; reasonable estimates, except for pellets stoves
- **Calculation of a « Use factor »,** with « Stove » as a reference
- **Estimates can be improved** as additional data becomes available

Direct heating appliances	Average energy consumption (GJ/yr/appliance)	Standard deviation	Use factor Reference = stove
(e) Stove	12.27	4.89	1.0
(f) Heat retaining stove, tiled stove	17.09	5.44	1.4
(g) Pellet stove	17.63	19.32	1.4
(h) Open fireplace	6.66	2.51	0.5
(i) Closed fireplace and inserts	7.70	0.30	0.6
(j) Cooker	3.66	0.19	0.3

Estimation of direct energy use: top-down approach

$$E_{\text{total direct}} = EC_{\text{stove}} * (\text{stock}_{\text{openfire}} * uf_{\text{openfire}} + \text{stock}_{\text{pellet-stove}} * uf_{\text{pellet-stove}} + \text{stock}_{(i)} * uf_{a(i)} + \text{etc})$$

- e, f, g, h, i, j: based on (C), use factor per appliance, stock per appliance
 - Stock open fireplaces = stock closed fireplaces
 - Stock pellet stoves = stock 5 MS for which data
 - Stock heat-retaining stoves = stock 4 MS for which data
- Calculation of average energy consumption per appliance in EU-27



Direct heating appliances	Average energy consumption (GJ/yr/appliance)
(e) Stove	22.47
(f) Heat retaining stove, tiled stove	31.46
(g) Pellet stove	32.28
(h) Open fireplace	12.20
(i) Closed fireplace and inserts	14.10
(j) Cooker	6.71

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Estimation of energy use: by appliance and fuel type

- Country groups 2 and 5 (UK, IR, PO, CZ, SK, HU, RO, BG)
 - Indirect heating: mineral fuels and biomass used in proportion their availability
 - Direct heating: 2/3 of appliances use biomass and 1/3 of appliances use mineral fuels, except pellet stoves 100% biomass
- Other EU-27 countries
 - Indirect heating: 100% mineral fuel used; rest is biomass energy
 - Direct heating: 100% of appliances use biomass energy

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Best practices

- **Choice of the appliance:**
 - Matching the heat demand needs
 - Proper installation
 - Clean fuel combustion technology/eco-label
- **Use:**
 - Use recommended/certified fuels
 - Burning small hot fires
 - Never burning waste, plastics, contaminated fuels
- **Maintenance:**
 - Cleaning the chimney/heat exchanger/flue pipes
 - Checking/replacing electrical parts and seals
 - Removing ashes, cleaning the grate before use
 - Smoke and CO detectors

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Barriers to eco-design

- **Fuel quality**
 - Keep constant and adequate quality of fuels
 - Both for natural and manufactured fuels
- **Fuel supply**
 - Availability of a fuel
 - Supply infrastructure
- **Maintenance**
 - Availability of qualified professional maintenance services
- **Regulations**
 - Local, e.g. limitations due to air pollution concerns or chimneys not mandatory
- **Information**
 - Appliance, energy and environmental requirements

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Conclusions

- Real-life efficiency of SCIs differs from test standards: because of fuel, system design, user behaviour, ambient conditions (e.g. temperature)
- Customers have little information on variations in environmental performance among SCIs
- Frequency and characteristics of use of SCIs are challenging to estimate
 - Top-down approach, with clear assumptions
 - Can easily be improved as better data becomes available (e.g. JWEE for EU-27)

Main stakeholders comments on Task 3 (draft document)

- Relationship between output and environmental impact
- Energy use: method of calculation not clearly explained

Task 4 – Technical analysis of existing products

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Objectives

- Task 4 provides a technical analysis of the existing products on the EU-market. For each category of product defined in Task 1, existing products on the EU market are analysed to provide information on:
 - materials of construction or Bill of Materials ‘BoM’ (for impacts of product manufacture),
 - product volumes (for distribution impacts),
 - product energy efficiency and direct emissions (impacts of product use),
 - system impacts on product efficiency and,
 - the fate of product components on disposal (end of life impacts).

- The information gathered in Task 4 for product cases provides input for identifying and defining Base cases for Task 5.

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Open fireplaces

- A wide range of products from firebasket to products covered by EN13229
- Range presents an issue in that scope of one product could be very different from another

Open fireplaces

- Summary BoM

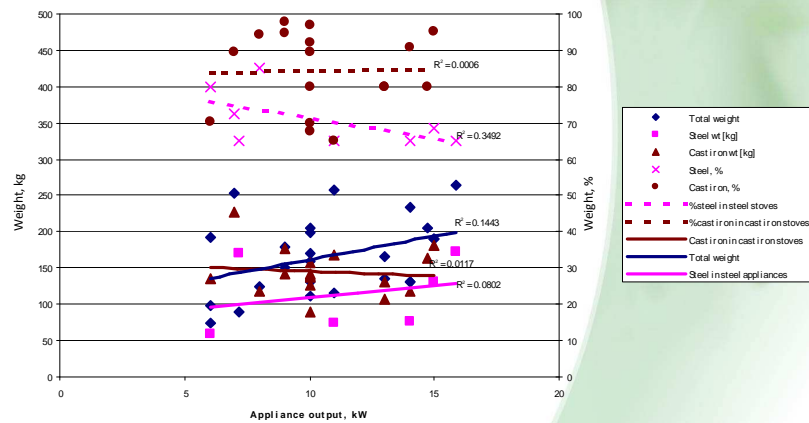
Product	Firebasket, firefront	Content		HKI
		3 Open appliances		
		Mean	Median	
Output [kW]	5-25	12.2	12.0	10-30
Weight [kg]	5-25	313.3	300.0	-
		Content [%]		
Steel	0	2.0	2.0	-
Cast Iron	100	8.0	8.0	-
Coatings	0	0.0	0.0	<1
Electronics	0	0.0	0.0	-
Stone/ceramics	0	86.7	90.0	10-30 kg
Glass	0	0.0	0.0	-
Sealing compound	0	0.0	0.0	-
		Content [kg]		
Plastic	<1	1	1	<1
Cardboard	<1	0	0	-
Wood	0	12	12	10-12

Closed fireplaces

● BoM data were collected manufacturers for 27 models of closed fireplaces of following three categories:

- Steel appliances (six appliances)
- Cast iron appliances (seventeen appliances)
- Appliance with boiler (one appliance)

Closed fireplaces



Task 4: Technical Analysis of Existing Products

Production phase (5/21)

Closed fireplaces

- BoM Summary (cast iron fireplaces):

Material	Content ^(Note 1)			
	Cast iron			
	Products (17)		HKI	CIV
	Mean	Median	(30)	
Product :				
Output, kW	10.6	10.0	5-15	5-15
Weight, kg	174.1	170.0	200-350	100-250
	Content, %			
Steel	4.2	2.1	>20	20
Cast Iron	84.4	89.4	>70	70
Other Ferrous metals	0.0	0.0	0	0
Non-ferrous metals	0.1	0.0	0	0
Plastics	0.0	0.0	0	0
Coatings	0.1	0.1	<1	<0.5
Electronics	0.1	0.0	-	0.2 kg ^(Note 2)
Stone/ceramics	9.3	4.0	10-30 kg	10-50 kg
Glass	0.6	0.2	1 kg	3-5 kg
Sealing compound	0.1	0.0	<0.5 kg	<0.5 kg
Packaging :	Content, kg			
Plastic	0.3	0.1	<1	<1
Cardboard	1.8	2.0	-	-
Wood	11.6	12.0	10-12	<10

Note :

- A '-' denotes no data.
- Where present

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Task 4: Technical Analysis of Existing Products

Production phase (6/21)

Closed fireplaces

- BoM Summary (steel fireplaces):

Material	Content ^(Note 1)		
	Steel		
	Products (6)		CIV
	Mean	Median	
Product :			
Output, kW	11.5	12.5	5-15
Weight, kg	161.5	152.5	90-250
Steel	72.8	70.5	80-90
Cast iron	0.0	0.0	0-10
Other Ferrous metals	0.0	0.0	0
Non-ferrous metals	0.0	0.0	0
Plastics	0.0	0.0	0
Coatings	0.4	0.4	<0.5
Electronics	0.0	0.0	0.2 kg ^(Note 2)
Stone/ceramics	25.4	26.9	10-50 kg
Glass	1.5	1.5	3-4 kg
Sealing compound	0.3	0.2	0.5 kg
Packaging :	Content, kg		
Plastic	0.7	0.5	<1
Cardboard	5.4	5.0	2-5
Wood	7.5	8.0	<10

Note :

- A '-' denotes no data.
- Where present

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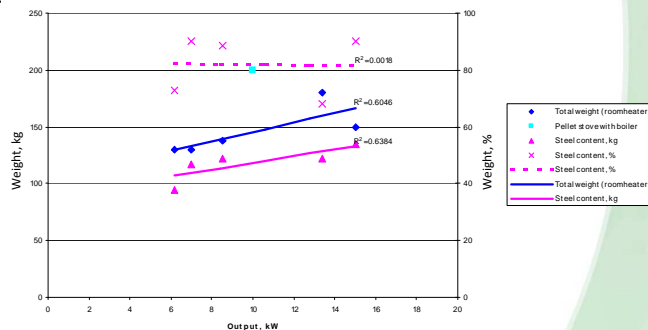
Closed fireplaces

- BoM Summary (products with boiler):

Material	Content	
	1 Product	HKI (10 appliances)
Product :		
Output, kW	14.5	5-15
Weight, kg	533	150-400
Content, %		
Steel	77.5	>87
Cast Iron	0.0	-
Other Ferrous metals	1.1	0
Non-ferrous metals	0.8	<3
Plastics	0.0	0
Coatings	0.1	<1
Electronics	0.0	-
Stone/ceramics	18.4	10-30 kg
Glass	0.8	1 kg
Sealing compound	0.1	<0.5 kg
Packaging : Content, kg		
Plastic	0	<1
Cardboard	8	-
Wood	12	10-12

Pellet stove

- Technically distinguishable by natural draught and fan-assisted types and, whether fitted with boiler. Few BoM but, data show reasonable correlation between weight and output.



Pellet stove

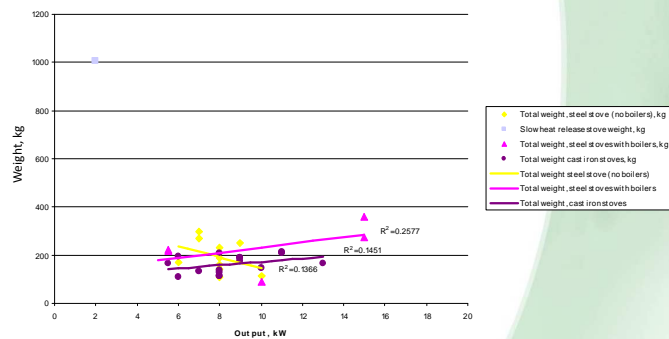
- BoM Summary:

Material	Content ^(Note 1)				
	Direct heaters			Heaters with boiler	
	Products (5)		HKI	Products	HKI
	Mean	Median	20 appliances	1 product	5 appliances
Product :					
Output, kW	10.0	8.5	5-15	10	5-15
Weight, kg	145.6	138.0	180-200	200	100-300
	Content, %				
Steel	81.9	88.4	>90	87	>87
Cast Iron	9.7	9.4	0	0	-
Other Ferrous metals	0.0	0.0	0	0	0
Non-ferrous metals	0.8	0.0	0	1	<3
Plastics	0.0	0.0	0	0	0
Coatings	0.2	0.3	<1	0.3	<1
Electronics	0.6	0.7	<1 kg	0.5	<1 kg
Stone/ceramics	7.2	0.0	10-30 kg	0	10-30 kg
Glass	0.7	0.7	1 kg	0.5	1 kg
Sealing compound	0.2	0.2	<0.5 kg	0.3	<0.5 kg
Packaging :	Content, kg				
Plastic	0.7	0.5	<1	1	<1
Cardboard	6.8	8.0	-	-	<3
Wood	11.0	12.0	10-12	11	8

Note :
1. A '-' denotes no data.

Other stoves

- About 35 questionnaires provided product data for a wide range of product types including steel, cast iron and slow heat release roomheaters :



Task 4: Technical Analysis of Existing Products

Production phase (11/21)

Other stoves

- BoM

(steel stove):

Material	Content ^(Note 1)				
	Steel stove (direct heating)				
	Products (11)		HKI	HKI	CIV
	Mean	Median	Simple 40 appliances	Roomheater 330 appliances	Steel stove
Product :					
Output, kW	7.9	8.0	5-15	5-15	5-15
Weight, kg	193.6	180.0	75-80	150-200	90-250
Content, %					
Steel	72.2	78.0	>90	>90	80-90
Cast Iron	6.0	1.1	-	-	0-10
Other Ferrous metals	0.4	0.0	0	0	0
Non-ferrous metals	0.0	0.0	0	0	0
Plastics	0.0	0.0	0	0	0
Coatings	0.3	0.2	<1	<1	<0.5
Electronics	0.0	0.0	-	-	<0.2 kg (Note 2)
Stone/ceramics	22.4	24.2	10-30 kg	10-30 kg	10-50 kg
Glass	1.2	0.9	1 kg	1 kg	3-4 kg
Sealing compound	0.6	0.2	<0.5 kg	<0.5 kg	0.5 kg
Packaging :					
Content, kg					
Plastic	0.6	0.7	<1	<1	<1
Cardboard	2.5	2.5	-	-	2-5
Wood	12.2	12.0	8	10-12	<10

Note :

- A "-" denotes no data.
- If present.

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Task 4: Technical Analysis of Existing Products

Production phase (12/21)

Other stoves

- BoM

(steel stove with boiler):

Material	Content ^(Note 1)		
	Direct heaters with boiler		
	Products (6)		HKI
	Mean	Median	10 appliances
Product :			
Output, kW	10.6	10.0	5-15
Weight, kg	233.6	224.0	180-230
Content, %			
Steel	81.1	80.0	>87
Cast Iron	5.1	0.0	-
Other Ferrous metals	1.2	0.0	0
Non-ferrous metals	0.2	0.0	<3
Plastics	0.0	0.0	0
Coatings	0.4	0.2	<1
Electronics	0.0	0.0	<1 kg
Stone/ceramics	8.9	10.5	10-30 kg
Glass	0.3	0.4	1 kg
Sealing compound	0.7	0.2	<0.5 kg
Packaging :			
Content, kg			
Plastic	0.8	1.0	<1
Cardboard	-	-	-
Wood	12.4	12.0	10-12

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Other stoves

- BoM

(cast iron stove):

Material	Content ^(Note 1)			
	Cast iron stove (direct heating)			
	Products (16)	HKI	CIV	
	Mean	Median	30 appliances	
Product:				
Output, kW	8.5	8.0	5-15	5-15
Weight, kg	162.0	165.0	180-250	100-250
	Content, %			
Steel	4.6	2.5	>20	20
Cast Iron	91.4	93.9	>70	70
Other Ferrous metals	0.2	0.0	0	0
Non-ferrous metals	0.0	0.0	0	0
Plastics	0.0	0.0	0	0
Coatings	0.1	0.1	<1	<0.5
Electronics	0.0	0.0	-	0.2 kg ^(Note 2)
Stone/ceramics	1.8	1.5	10-30 kg	10-50 kg
Glass	0.2	0.1	1 kg	3-5 kg
Sealing compound	0.0	0.0	<0.5 kg	<0.5 kg
	Content, kg			
Packaging:				
Plastic	0.4	0.1	<1	<1
Cardboard	2.5	2.5	-	-
Wood	10.6	12.0	10-12	<10

- Note:
1. A '-' denotes no data.
 2. Where present

Other stoves

- Slow heat release stove (one product questionnaire).
- BoM dominated by masonry component.

Task 4: Technical Analysis of Existing Products

Production phase (15/21)

Cooker

- Four product questionnaires,
- Limited data.
- BoM Summary:

Material	Content ^(Note 1)				
	Cooker			Cooker with boiler	
	Products (3)	HKI	Product	HKI	
	Mean	Median	20 appliances	1 product	5 appliances
Product :					
Output, kW	5.7	5.0	5-10	22	10-25
Weight, kg	157.8	160.0	110-220	164	170-260
	Content, %				
Steel	85.6	90.0	>90	87	>87
Cast Iron	3.7	0.0	-	0	-
Other Ferrous metals	0.0	0.0	0	0	0
Non-ferrous metals	0.0	0.0	0	2	<3
Plastics	0.0	0.0	0	0	0
Coatings	0.3	0.3	<1	0.3	<1
Electronics	-	-	-	-	-
Stone/ceramics	13.8	13.8	10-30 kg	0	10-30 kg
Glass	0.4	0.0	1 kg	0	1 kg
Sealing compound	0.2	0.3	<0.5 kg	0.3	<0.5 kg
Packaging :	Content, kg				
Plastic	1.0	1.0	<1	0.5	<1
Cardboard	3.0	-	-	-	-
Wood	13.5	13.0	10-12	13.5	10-12

Note : A '-' denotes no data.

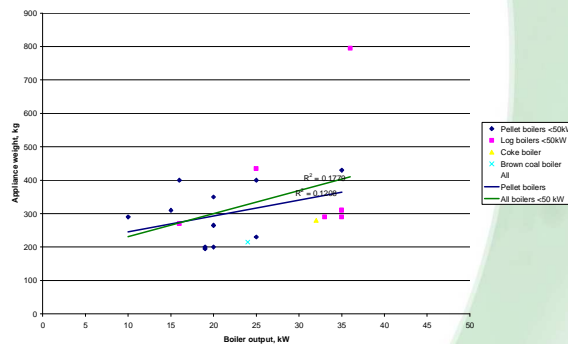
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Task 4: Technical Analysis of Existing Products

Production phase (16/21)

Boiler <50kW

- Standalone boilers have manual or automatic stoking and also natural or fan-assisted draught. Information provided for pellet, log and solid mineral fuel products:



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Task 4: Technical Analysis of Existing Products

Production phase (17/21)

Boiler <50kW

- BoM
- (pellet boiler):

Material	Content ^(Note 1)		
	Products (12)		ABC
	Mean	Median	State of the art
Product :			
Output, kW	20.3	20.0	15
Weight, kg	294.6	277.5	300-350
Content, %			
Steel	91.6	92.5	75
Cast Iron	0.4	0.0	5
Other Ferrous metals	0.2	0.0	-
Non-ferrous metals	2.0	0.4	2
Plastics	0.6	0.0	<1
Coatings	0.3	0.1	<1
Electronics	0.8	0.3	<1
Stone/ceramics	1.5	0.2	16
Glass	1.1	1.5	-
Sealing compound	-	-	-
Packaging : Content, kg			
Plastic	0.5	0.5	1
Cardboard	0.3	0.2	2.3
Wood	15.7	16.5	20

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Task 4: Technical Analysis of Existing Products

Production phase (18/21)

Boiler <50kW

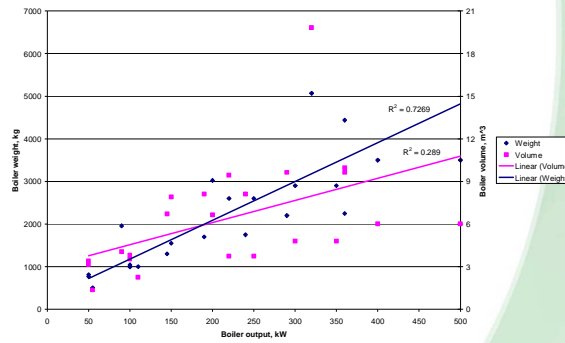
- BoM
- (wood log boiler):

Material	Content ^(Note 1)		
	Products (7)		ABC
	Mean	Median	State of the art
Product :			
Output, kW	30.7	35.0	25
Weight, kg	385.7	310.0	550-600
Content, %			
Steel	86.3	87.2	78
Cast Iron	4.6	0.5	1-2
Other Ferrous metals	0.0	0.0	-
Non-ferrous metals	0.1	0.1	1
Plastics	0.0	0.0	<1
Coatings	0.1	0.0	<1
Electronics	0.8	0.4	-
Stone/ceramics	6.6	5.3	20
Glass	0.5	0.5	-
Sealing compound	0.0	0.0	-
Packaging : Content, kg			
Plastic	0.6	0.4	1
Cardboard	2.9	0.8	1.3
Wood	31.4	15.0	15-20

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Boiler >50kW

- little information received, manufacturers' product data allow output vs weight correlation.



Boiler >50kW

- BoM derived from <50 kW pellet boiler product data – is this reasonable ?

Product :	Content ^(Note 1)				
	Mean	Median	Minimum	Maximum	Std Deviation
	Content, %				
Steel	91.6	92.5	84.5	95.1	3.1
Cast Iron	0.4	0.0	0.0	2.0	0.7
Other Ferrous metals	0.2	0.0	0.0	2.3	0.7
Non-ferrous metals	2.0	0.4	0.0	10.0	3.2
Plastics	0.6	0.0	0.0	3.8	1.3
Coatings	0.3	0.1	0.0	1.0	0.3
Electronics	0.8	0.3	0.1	3.8	1.1
Stone/ceramics	1.5	0.2	0.0	7.5	2.6
Glass	1.1	1.5	0.0	1.8	0.8
Sealing compound	-	-	-	-	-
	Content, kg				
Packaging :					
Plastic	0.5	0.5	0.1	0.8	0.2
Cardboard	0.3	0.2	0.0	0.6	0.3
Wood	15.7	16.5	7.0	23.5	6.1

Data gaps

- **Solid mineral fuel appliances**
 - Open fireplaces
 - Pellet stoves
 - Cookers
 - **Boilers 50-500 kW output**
- Clarification on outliers, heavy products, why some some individual steel/cast iron products have a high cast iron/steel content compared to others.

Residential products <50kW

- Typical volumes a little over 1 m³ , cooking products have highest volumes.

Boilers >50kW

- Information from product datasheets used.

Product volumes (1)

Appliance type	Dimension	Mean	Minimum	Maximum	
Open fireplace	Direct	Volume (m ³)	1.0	0.5	2.0
		Weight (kg)	166	75.0	265
Closed fireplace/ fireplace inset	Direct	Volume (m ³)	1.0	0.5	2.0
		Weight (kg)	166	75.0	265
	With boiler	Volume (m ³)	1.65	-	-
		Weight (kg)	533	-	-
Other Stove	All steel/cast iron	Volume (m ³)	1.4	0.9	2.0
	Steel direct	Weight (kg)	184	108	300
	Steel with boiler	Weight (kg)	244	90	360
	Cast iron direct	Weight (kg)	162	110	214
	Slow heat release	Volume (m ³)	2	-	-
		Weight (kg)	1005	-	-

Product volumes (2)

Appliance type	Dimension	Mean	Minimum	Maximum	
Pellet Stove	Direct	Volume (m ³)	0.9	0.5	2.0
		Weight (kg)	155	130	200
	With boiler	Volume (m ³)	2	-	-
		Weight (kg)	200	-	-
Cooker	All	Volume (m ³)	2.0	1.0	3.0
		Weight (kg)	158	131	183
Boiler <50kW	Pellet	Volume (m ³)	1.2	0.7	1.4
		Weight (kg)	295	195	430
	Log	Volume (m ³)	1.2	0.8	1.3
		Weight (kg)	386	270	795
	Mineral fuel	Volume (m ³)	0.8	-	-
		Weight (kg)	248	-	-
Boiler >50 kW	All	Volume (m ³)	6.6	1.4	20
		Weight (kg)	2389	505	6575

Data gaps

- Boilers >50 kW

Open fireplaces

- Product information from manufacturers for wood:

Parameters	Data			Unit
	Lower	Upper	Average	
Standard EN 13229 requirements				
Efficiency	-	-	> 30	%
CO	-	-	< 1	%
CO	-	-	< 12500	mg/m ³
Product data (5 appliances)				
Output	11.0	18.7	14.6	kW
Efficiency	40.2	63.6	55.0	%
CO	2625	3500	3050	mg/m ³

Note : Mass concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and standardised to 13% O₂.

Open fireplaces

Source		Product Data (5 appliances)	Canada		IEA	Corinair
Appliance type		Open fireplace inset	Conventional without doors	Conventional insert	Open fireplace	Fireplace
Test Standard/data type		EN 13229	National emission factor	National emission factor	Measurement (solid particles)	Default emission factor
Parameters	Units	Average				
Efficiency	%	55.0	-	-	-	-
CO	g/GJ	2033	4856	7213	-	6000
PM	g/GJ	-	1206	900	23-265	900
NOx as NO ₂	g/GJ	-	87.5	87.5	-	50
nmVOC/OGC	g/GJ	-	406	1331	-	1300
SO ₂	g/GJ	-	12.5	12.5	-	10
PM ₁₀	g/GJ	-	-	-	-	860
PM _{2.5}	g/GJ	-	-	-	-	850
Hg	mg/GJ	-	-	-	-	0.4
PCDD/F	ng I-TEQ/GJ	-	-	-	-	800
PAH	mg/GJ	-	-	-	-	600
BaP	mg/GJ	-	-	-	-	180

Closed fireplaces

- Product information from manufacturers (wood-fired inset appliances):

Parameters	Data			Unit
	Lower	Upper	Average	
Standard EN 13 229 requirements				
Efficiency	-	-	> 75	%
CO	-	-	< 1	%
CO	-	-	< 12500	mg/m ³
Product data for insert (18 appliances)				
Output	8.2	26.5	14.2	kW
Efficiency	66.1	80.9	76.0	%
CO	625	8742	2573 ¹⁾	mg/m ³
PM	38.0	69.1	46.7	mg/m ³
NOx as NO ₂	55	111	73	mg/m ³

- Notes :
- Three outlier data points were removed
 - Mass concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and standardised to 13% O₂.

Closed fireplaces

- Product information from manufacturers (wood-fired inset appliances with boiler):

Parameters	Data			Unit
	Lower	Upper	Average	
Standard EN 13 229 requirements				
Efficiency	-	-	> 75	%
CO	-	-	< 1	%
CO	-	-	< 12500	mg/m ³
Product data for insert with boiler (5 appliances)				
Output	14.1	27.5	20.4	kW
Efficiency	70.0	78.1	74.8	%
CO	1487	5870	3571	mg/m ³
PM	-	-	38.6	mg/m ³
Nox as NO ₂	-	-	148	mg/m ³

- Notes :
- Three outlier data points were removed
 - Mass concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and standardised to 13% O₂.

Closed fireplaces

Source		Product Data (18 appliances)	Product Data (5 appliances)	Canada		IEA	Corinair
Appliance type		Closed fireplace inset	Closed fireplace inset with boiler	Conventional with doors	Advanced technology	Closed fireplace	Fireplace
Test Standard/data type		EN 13229	EN 13229	National emission factor	National emission factor	Measurement (solid particles)	Default emission factor
Parameters	Units	Average	Average				
Efficiency	%	75.6	74.8	-	-	-	-
CO	g/GJ	1715	2381	6163	4400	-	6000
PM	g/GJ	31.1	25.7	844	319	47-83	900
NOx as NO ₂	g/GJ	48.7	98.7	87.5	87.5	-	50
nmVOC/OGC	g/GJ	-	-	1313	438	-	1300
SO ₂	g/GJ	-	-	12.5	12.5	-	10
PM ₁₀	g/GJ	-	-	-	-	-	860
PM _{2.5}	g/GJ	-	-	-	-	-	850
Hg	mg/GJ	-	-	-	-	-	0.4
PCDD/F	ng I-TEQ/GJ	-	-	-	-	-	800
PAH	mg/GJ	-	-	-	-	-	600
BaP	mg/GJ	-	-	-	-	-	180

Pellet stoves

- Product information from manufacturers (stoves):

Parameters	Data			Unit
	Lower	Upper	Average	
Product data for pellet stoves (10 appliances)				
Nominal output				
Output	5.3	11.8	9.0	kW
Efficiency	84.9	91.5	88.4	%
CO	100	250	160	mg/m ³
PM	12.6	29.4	21.0	mg/m ³
NOx as NO ₂	2.0	135	87.8	mg/m ³
OGC	1.5	45.0	14.3	mg/m ³
Reduced output				
Output	2.4	4.1	3.1	kW
Efficiency	88.5	93.0	90.2	%
CO	310	560	445	mg/m ³
PM	14.1	70.6	35.4	mg/m ³
NOx as NO ₂	-	-	-	mg/m ³
OGC	2.9	49.0	16.9	mg/m ³

Notes :

1. A „-“ denotes „no data“
2. Mass concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and standardised to 13% O₂ .

Pellet stoves

- Product information from manufacturers (stoves with boilers):

Parameters	Data			Unit
	Lower	Upper	Average	
Product data for pellet stoves with boiler (3 appliances)				
Nominal output				
Output	13.2	26.4	17.7	kW
Efficiency	86.8	90.5	88.6	%
CO	90	220	153	mg/m ³
PM	14.4	26.5	19.0	mg/m ³
NOx as NO ₂	102.9	118.8	113.9	mg/m ³
OGC	2.5	10.1	6.2	mg/m ³
Reduced output				
Output	3.9	6.8	5.0	kW
Efficiency	87.4	91.0	89.5	%
CO	350	660	490	mg/m ³
PM	-	-	13.0	mg/m ³
NOx as NO ₂	-	-	-	mg/m ³
OGC	4.1	25.1	15.1	mg/m ³

Notes :

1. A „-“ denotes „no data“
2. Mass concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and standardised to 13% O₂ .

Pellet stoves

Source	Product Data (10 appliances)	Product Data (3 appliances)	IEA	Corinair
Appliance type	Pellet stove	Pellet stove with boiler	Pellet stove	Pellet stove
Test Standard/data type	EN 14785	EN 14785	Measurement (solid particles)	Default factor
Parameters	Units	Average	Average	
Efficiency	%	88.4	88.6	-
CO	g/GJ	84.2	80.5	500
PM	g/GJ	11.1	10.0	10-50
NOx as NO ₂	g/GJ	46.2	59.9	90
nmVOC/OGC	g/GJ	7.5	3.3	20
SO ₂	g/GJ	-	-	20
PM ₁₀	g/GJ	-	-	76
PM _{2.5}	g/GJ	-	-	76
Hg	mg/GJ	-	-	0.4
PCDD/F	ng I-TEQ/GJ	-	-	50
PAH	mg/GJ	-	-	50
BaP	mg/GJ	-	-	15

Other stoves

- Product information from manufacturers (wood fuel stoves):

Parameters	Data			Unit
	Lower	Upper	Average	
Product data data for cast iron stove (10 appliances)				
Output	5.5	9.5	7.1	kW
Efficiency	70.0	78.0	74.9	%
CO	624	3497	2085	mg/m ³
Dust (TSP)	-	-	-	mg/m ³
NOx as NO ₂	-	-	-	mg/m ³
Product data for simple stoves (2 appliances)				
Output	5.5	6.3	5.9	kW
Efficiency	57.2	63.2	60.2	%
CO	2560	3809	3185	mg/m ³
Dust (TSP)	-	-	-	mg/m ³
NOx as NO ₂	-	-	-	mg/m ³

Notes
Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 13% O₂

Other stoves

- Product information from manufacturers (wood fuel stoves):

Parameters	Data			Unit
	Lower	Upper	Average	
Product data for room heaters (7 appliances)				
Output	7.9	12.0	9.7	kW
Efficiency	74.9	79.7	76.9	%
CO	1500	5375	3232	mg/m ³
Dust (TSP)	-	-	82.3	mg/m ³
NOx as NO ₂	-	-	-	mg/m ³
Product data for room heaters with boiler (1 appliance)				
Output	-	-	9.3	kW
Efficiency	-	-	84.4	%
CO	-	-	6750	mg/m ³
Dust (TSP)	-	-	111.7	mg/m ³
NOx as NO ₂	-	-	-	mg/m ³

Notes
Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 13% O₂

Other stoves (wood fuel)

Source		Product Data (7)	Product Data (10)	Product Data (1)	Product Data (2)	Canada	Corinair	
Appliance type		Other stove roomheater	Cast Iron stove	Roomheater with boiler	Simple stove	Advanced	Wood stove	Advanced wood stove
Test Standard/data type		EN 13240	EN 13240	EN 13240	EN 13240	National factor	Default factor	Default factor
Parameters	Units	Average	Average					
Efficiency	%	76.9	74.9	84.4	60.2	-	-	-
CO	g/GJ	2155	1390	4500	2123	4400	6000	3000
PM	g/GJ	55	-	74	-	319	850	250
NOx as NO ₂	g/GJ	-	-	-	-	87.5	50	90
nmVOC/OGC	g/GJ	-	-	-	-	438	1200	250
SO ₂	g/GJ	-	-	-	-	12.5	10	20
PM ₁₀	g/GJ	-	-	-	-	300	810	240
PM _{2.5}	g/GJ	-	-	-	-	300	810	240
Hg	mg/GJ	-	-	-	-	-	0.4	0.4
PCDD/F	ng I-TEQ/GJ	-	-	-	-	-	800	300
PAH	mg/GJ	-	-	-	-	-	820	290
BaP	mg/GJ	-	-	-	-	-	250	100

Other stoves (mineral fuel)

Source		Polish Data			Corinair	
Appliance type		Standard stove	Masonry stove	Kitchen stove	Coal-fired domestic stove	Manufactured mineral briquette-fired domestic stove
Test Standard/data type		-	-	-	Default emission factor	Default emission factor
Parameters	Units					
Efficiency	%	45-75	60-75	40-60	-	-
CO	g/GJ	3500-12500	2500-11000	3600-11000	5000	4000
PM	g/GJ	700-900	600-1200	300-1000	500	200
NOx as NO ₂	g/GJ	100-150	100-200	50-150	100	100
nmVOC/OGC	g/GJ	500-700	400-800	500-1100	600	300
SO ₂	g/GJ	200-800	200-800	200-800	900	500
PM ₁₀	g/GJ	-	-	-	450	100
PM _{2.5}	g/GJ	-	-	-	450	100
Hg	mg/GJ	-	-	-	5	3
PCDD/F	ng I-TEQ/GJ	-	-	-	1000	300
PAH	mg/GJ	20000-40000	15000-25000	50000-90000	920	220
BaP	mg/GJ	300-600	150-350	400-650	250	50

Cookers

- Product information, product data on efficiency for wood and mineral fuels:

Parameters	Data			Unit
	Lower	Upper	Average	
Product data				
Efficiency	64	78	71	%
CO	n.d.	n.d.	n.d.	mg/m ³

Note : 'n.d.' denotes no data.

Boilers <50 kW

- Product information for wood fuels (wood log boilers):

Parameters	Data			Unit
	Lower	Upper	Average	
Log wood boilers				
Nominal output				
Output	20	30	26.2	kW
Efficiency	86.4	90.1	88.6	%
CO	108	124	116	mg/m ³
PM	21	25	24.8	mg/m ³
NOx as NO ₂	94	115	103.3	mg/m ³
OGC	4	14	6.8	mg/m ³
Reduced output				
Output	11	14.5	13.1	kW
Efficiency	83.3	92.2	89.3	%
CO	75	1178	477	mg/m ³
PM	-	-	-	mg/m ³
NOx as NO	-	-	-	mg/m ³
OGC	3	80	24.3	mg/m ³

Note : Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 13% O₂

Boilers <50 kW

- Product information for wood fuels (pellet boilers):

Parameters	Data			Unit
	Lower	Upper	Average	
Pellet boilers				
Nominal output				
Output	16.9	40.5	28.1	kW
Efficiency	88.1	90.2	89.1	%
CO	34	212	148.0	mg/m ³
PM	11	24	18.8	mg/m ³
NOx as NO ₂	88	131	104.8	mg/m ³
OGC	1	3	1.5	mg/m ³
Reduced output				
Output	5.7	11.7	8.7	kW
Efficiency	85.3	92.8	88.6	%
CO	82	635	148.3	mg/m ³
PM	-	-	-	mg/m ³
NOx as NO	-	-	-	mg/m ³
OGC	1	10	6	mg/m ³

Note : Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 13% O₂

Boilers <50 kW

- Product information for wood fuels (chip boilers):

Parameters	Data			Unit
	Lower	Upper	Average	
Chips boilers				
Nominal output				
Output	15.6	49.7	8.6	kW
Efficiency	87.3	91.8	90.4	%
CO	3	101	68.8	mg/m ³
PM			21	mg/m ³
NOx as NO ₂	91	136	115	mg/m ³
OGC	<1	1	1	mg/m ³
Reduced output				
Output	4.5	13.1	8.6	kW
Efficiency	78.8	90.8	86.3	%
CO	14	644	282.5	mg/m ³
PM	-	-	-	mg/m ³
NOx as NO ₂	-	-	-	mg/m ³
OGC	1	7	6	mg/m ³

Note : Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 13% O₂

Boilers <50 kW

Source	Product Data (4)	Product Data (4)	Product Data (4)	IEA		Corinair		
				Log boiler	Pellet boiler	Wood boiler	Advanced wood (manual)	Advanced wood (automatic)
Appliance type	Wood log boiler	Pellet boiler	Wood chip boiler	Typical results	Typical results	Default factor	Default factor	Default factor
Test Standard/data type	EN 303-5	EN303-5	EN 303-5					
Parameters	Units	Average	Average	Average				
Efficiency	%	88.6	89.1	90.4	-	-	-	-
CO	g/GJ	76.8	96.3	43.5	-	-	300	3000
PM	g/GJ	16.0	12.3	17.3	10-600	10-50	70	80
NOx as NO ₂	g/GJ	101.3	71.5	96.3	-	-	150	150
nmVOC/OGC	g/GJ	5.0	1.0	<1	-	-	60	250
SO ₂	g/GJ	-	-	-	-	-	30	20
PM ₁₀	g/GJ	-	-	-	-	-	67	76
PM _{2.5}	g/GJ	-	-	-	-	-	65	76
Hg	mg/GJ	-	-	-	-	-	0.8	0.5
PCDD/F	ng I-TEQ/GJ	-	-	-	-	-	200	300
PAH	mg/GJ	-	-	-	-	-	40	150
BaP	mg/GJ	-	-	-	-	-	12	50

Boilers <50 kW

- Product information for mineral fuels:

Parameters	Data			Unit
	Lower	Upper	Average	
Manually fuelled boiler (8 appliances)				
Output	21	32	24.8	kW
Efficiency	78.1	83.9	81.2	%
CO	575	3410	2230	mg/m ³
Dust, TSP	60	245	117	mg/m ³
NOx as NO ₂	190	259	212	mg/m ³
OGC	70	219	122	mg/m ³
Automatically fuelled boiler (10 appliances)				
Output	18	37	24	kW
Efficiency	81.2	91.6	85.3	%
CO	115	1005	480	mg/m ³
Dust, TSP	65	140	90	mg/m ³
NOx as NO	270	520	400.0	mg/m ³
OGC	16	70	43.5	mg/m ³

Note : Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 10% O₂ as specified by EN 303-5.

Boilers <50 kW (mineral fuels)

Source	Product Data		Literature data (Poland)				Corinair, Mineral fuel boilers <50kW			
	Manual boiler (8)	Automatic boilers (10)	Updraft boiler	Advanced boiler	Stoker boiler	Underfeed boiler	Coal	Manufactured mineral briquettes	Advanced coal (manual)	Advanced coal (automatic)
Test Standard/data type	EN303-5	EN303-5	-	-	-	-	Default emission factor	Default emission factor	Default emission factor	Default emission factor
Parameters	Units	Average	Average							
Efficiency	%	81.2	85.3	50-67	76-82	77-89	77-84	-	-	-
CO	g/GJ	1338	257.1	1800-7000	200-1500	120-800	1500-4000	4000	3000	1500
PM	g/GJ	70.2	48.2	150-500	50-100	30-60	30-120	400	120	150
NOx as NO ₂	g/GJ	127.2	214.3	50-150	150-200	150-300	150-250	130	200	200
nmVOC/OGC <small>(Note 4)</small>	g/GJ	73.2	23.3	400-1200	60-120	1-50	2-50	300	200	100
SO ₂	g/GJ	-	-	200-800	200-800	130-350	250-750	900	500	450
PM ₁₀	g/GJ	-	-	-	-	-	-	380	100	140
PM _{2.5}	g/GJ	-	-	-	-	-	-	360	100	130
Hg	mg/GJ	-	-	-	-	-	-	6	3	6
PCDD/F	ng I-TEQ/GJ	-	-	-	-	-	-	500	200	200
PAH <small>(Note 5)</small>	mg/GJ	-	-	30000-90000	200-600	100-700	200-2000	710	150	290
BaP	mg/GJ	-	-	600-900	2-30	1-20	5-50	270	50	90

Boilers >50 kW

- Product information for wood fuels (log boiler):

Parameters	Data			Unit
	Lower	Upper	Average	
Log wood boilers (2 appliances)				
Nominal output				
Output	58.8	60.9	59.9	kW
Efficiency	90.6	91.3	91.0	%
CO	114	183	148.5	mg/m ³
Dust, TSP	15	31	23	mg/m ³
NOx as NO ₂	116	141	128.5	mg/m ³
OGC	1	2	1.5	mg/m ³
Reduced output				
Output	20.2	27.4	23.8	kW
Efficiency	90.9	93.6	91.0	%
CO	46	173	109.5	mg/m ³
Dust, TSP	-	-	-	mg/m ³
NOx as NO	-	-	-	mg/m ³
OGC	3	3	3	mg/m ³

Note : Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 13% O₂ (note that EN 303-5)

Boilers >50 kW

- Product information for wood fuels (pellet boiler):

Parameters	Data			Unit
	Lower	Upper	Average	
Pellet boiler (3 appliances)				
Nominal output				
Output	53.7	116	87.6	kW
Efficiency	91.8	93.2	91.8	%
CO	15	51	29.0	mg/m ³
Dust, TSP	5	106	43.3	mg/m ³
NOx as NO ₂	21	111	67.3	mg/m ³
OGC	<1	1	1	mg/m ³
Reduced output				
Output	15.8	33.2	25.3	kW
Efficiency	91.4	91.9	91.7	%
CO	8	139	52.3	mg/m ³
Dust, TSP	-	-	-	mg/m ³
NOx as NO	-	-	-	mg/m ³
OGC	< 1	< 1	< 1	mg/m ³

Note : Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 13% O₂ (note that EN 303-5)

Boilers >50 kW

- Product information for wood fuels (chip boiler):

Parameters	Data			Unit
	Lower	Upper	Average	
Chips boilers (4 appliances)				
Nominal output				
Output	52.6	152	97.7	kW
Efficiency	90.5	91.8	91.4	%
CO	11	114	57.5	mg/m ³
Dust, TSP	23	44	33	mg/m ³
NOx as NO ₂	124	149	141	mg/m ³
OGC	< 1	6	2	mg/m ³
Reduced output				
Output	15.3	41.9	27.5	kW
Efficiency	90.6	93.8	92.8	%
CO	34	253	137.8	mg/m ³
Dust, TSP	-	-	-	mg/m ³
NOx as NO ₂	-	-	-	mg/m ³
OGC	1	9	4.5	mg/m ³

Note : Concentrations expressed for a dry gas at STP (0°C, 101.3 kPa) and 13% O₂ (note that EN 303-5

Boilers >50 kW

Source	Product Data (2)	Product Data (3)	Product Data (4)	IEA		Corinair, boilers >50kW		
				Under stoker	Grate boiler	Wood boiler	Advanced wood (manual)	Advanced wood (automatic)
Appliance type	Wood log boiler	Pellet boiler	Wood chip boiler	Typical results	Typical results	Default emission factor	Default emission factor	Default emission factor
Test Standard/data type	EN 303-5	EN303-5	EN 303-5	Typical results	Typical results	Default emission factor	Default emission factor	Default emission factor
Parameters	Units	Average	Average	Average				
Efficiency	%	91.0	91.8	91.4	-	-	-	-
CO	g/GJ	74.5	19.0	38.3	-	-	3000	3000
PM	g/GJ	15.5	29.0	21.5	70-100	20-100	250	80
NOx as NO ₂	g/GJ	90.5	47.3	103.5	-	-	150	150
nmVOC/OGC	g/GJ	<1	<1	<1	-	-	250	250
SO ₂	g/GJ	-	-	-	-	-	50	20
PM ₁₀	g/GJ	-	-	-	-	-	240	76
PM _{2.5}	g/GJ	-	-	-	-	-	240	76
Hg	mg/GJ	-	-	-	-	-	0.6	0.5
PCDD/F	ng I-TEQ/GJ	-	-	-	-	-	500	300
PAH	mg/GJ	-	-	-	-	-	280	150
BaP	mg/GJ	-	-	-	-	-	80	50

Boilers >50 kW

- Product information for automatic mineral fuel boilers:

Parameters	Data			Unit
	Lower	Upper	Average	
Retort boiler (5 appliances)				
Nominal output				
Output	150	350	200	kW
Efficiency	81.2	86.5	84.2	%
CO	160	420	284	mg/m ³
Dust, TSP	40	105	65	mg/m ³
NOx as NO ₂	315	400	350	mg/m ³
OGC	28	52	35	mg/m ³
Reference O ₂	10	10	10	%
Burner boiler (1 appliance)				
Nominal output				
Output	-	-	250	kW
Efficiency	-	-	86.1	%
CO	-	-	165	mg/m ³
Dust, TSP	-	-	56	mg/m ³
NOx as NO ₂	-	-	355	mg/m ³
OGC	-	-	28	mg/m ³
Reference O ₂	10	10	10	%

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Boilers >50 kW (mineral fuel)

Appliance type	Mineral fuel boilers >50kW		Corinair			
	Retort boiler	Reciprocal feed	Coal fuels	Manufactured mineral fuels	Advanced coal (manual)	Advanced coal (automatic)
Test Standard/data type	EN303-5	EN303-5	Default emission factor	Default emission factor	Default emission factor	Default emission factor
Parameters	Units	Average				
Efficiency	%	84.2	86.1	-	-	-
CO	g/GJ	152.1	88.4	200	100	20
PM	g/GJ	34.8	30.0	200	100	80
NOx as NO ₂	g/GJ	187.5	190.2	160	150	200
nmVOC/OGC	g/GJ	18.8	15.0	200	100	20
SO ₂	g/GJ	-	-	900	500	450
PM ₁₀	g/GJ	-	-	190	80	140
PM _{2.5}	g/GJ	-	-	170	80	130
Hg	mg/GJ	-	-	7	3.5	6
PCDD/F	ng I-TEQ/GJ	-	-	400	100	200
PAH	mg/GJ	-	-	320	90	290
BaP	mg/GJ	-	-	100	30	90

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Task 4: Technical Analysis of Existing Products

Use phase (product) (26/26)

Gaps in data

- Open fireplaces
- Direct emissions for mineral fuel non-boiler appliances
- Direct emissions of non-CO₂, OGC species
- Electricity consumption (i) - controls, convection fans
- Electricity consumption (ii) – fuel transfer (mainly large >50 kW) appliances

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Task 4: Technical Analysis of Existing Products

Use phase (system)

System impacts

- Use of accumulator tanks
- Proportion of incorrectly sized appliances
- Annual efficiency/climate
- Built environment

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End of life

- 99% of metals components recovered for recycling – reasonable ?
- all the rest to landfill ?

- *glass can be recovered but this is not identifiable within the MEEuP methodology*

Main stakeholders comments on Task 4 (working document)

- More differentiated categorisation of appliances, in terms of heat output, fuel and combustion technique is needed
- Down-draught combustion not mentioned
- Emissions data: representativeness, methods, operating conditions

Next steps (Tasks 5-7)

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Base Case Analysis (Task 5)

- Assessment of average EU products, the so called “base cases”
- Environmental and Life Cycle Cost Analysis

Improvement potential (Tasks 6 and 7)

- Technical analysis of BAT
- Improvement potential

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Objectives

- Assessment of average EU products, the so called “Base Cases”
- The description of the Base Cases is the synthesis of the results of Tasks 1 to 4
- Most of the environmental and life cycle cost analysis are built on these Base Cases throughout the rest of the study and it serves as the point-of-reference for Task 6 (technical analysis of BAT), Task 7 (improvement potential), and Task 8 (policy analyses)

Definition of the Base Cases

- A Base Case is “a conscious abstraction of reality” which reflects the EU average product installed on the market (not the best technology, or the worst technology available)
- The MEEuP methodology foresees one or two Base Cases. However, not enough to cover appropriately the broad range of technical specifications and functionalities of solid fuel small combustion installations
 - Fireplaces
 - Stoves (other than pellet stoves)
 - Pellet stoves
 - Cookers
 - Boilers > 50kW
 - Boilers < 50kW

At least 6 Base Cases

- BOM
- Energy consumption (Efficiency, Output, Fuel type)



Methodology

material			
Bulk Plastics		Ferro metals	Electronics
1 LDPE		21 St sheet galv.	42 LCD per m2 scrn
2 HDPE		22 St tube/profile	43 CRT per m2 scrn
3 LLDPE		23 Cast iron	44 big caps & coils
4 PP		24 Ferrite	45 slots / ext. ports
5 PS		25 Stainless 18/8 coil	46 large IC
6 EPS		Non ferro metals	47 small IC
7 HI-PS		26 Al sheet/extrusion	48 SMD/ LED's avg.
8 PVC		27 Al diecast	49 PWB 1/2 lay 3.75kg/m2
9 SAN		28 Cu winding wire	50 PWB 6 lay 4.5 kg/m2
10 ABS		29 Cu wire	51 PWB 6 lay 2 kg/m2
TecPlastics (incl. Fillers, reinforcement, additives)		30 Cu tube/sheet	52 Solder SnAg4Cu0.5
11 PA 6		31 CuZn38 cast	Miscellaneous
12 PC		32 ZnAl4 cast	54 Glass for lamps
13 PMMA		33 MgZn5 cast	55 Bitumen
14 Epoxy		Coating / plating (per g coating)	56 Cardboard
15 Rigid PUR		38 pre-coating coil	57 Office paper
16 Flex PUR		39 powder coating	58 Concrete
17 Talcum filler		40 Cu/Ni/Cr plating	
18 E-glass fibre		41 Au/Pt/Pd	
19 Aramid fibre			

Pos	USE PHASE		unit	Subtotals
m	Description			
211	Product Life, in years		years	
	Electricity			
212	On-mode: Consumption per hour, cycle, setting, etc.	0	kWh	0
213	On-mode: No. Of hours, cycles, settings, etc. / year	0	#	
214	Standby-mode: Consumption per hour	0	kWh	0
215	Standby-mode: No. Of hours / year	0	#	
216	Off-mode: Consumption per hour	0	kWh	0
217	Off-mode: No. Of hours / year	0	#	
	TOTAL over Product Life	0.00	MWh (=000 kWh)	65
	Heat			
218	Avg. Heat Power Output	0	kW	
219	No. Of hours / year	0	hrs.	
220	Type and efficiency (Click & select)	84.0%		75-Wood pellets
	TOTAL over Product Life	0.00	GJ	67-Electr. heat pump 69-Gas, atmospheric 71-Gas, condensing 72-Oil, atmospheric 73-Oil, condensing 75-Wood pellets 76-Wood logs, low eff. 77-Wood logs, higher eff. 85-None
	Consumables (excl. spare parts)			
221	Water	0	m ³ /year	
222	Auxilliary material 1 (Click & select)	0	kg/ year	
223	Auxilliary material 2 (Click & select)	0	kg/ year	
224	Auxilliary material 3 (Click & select)	0	kg/ year	
	Maintenance, Repairs, Service			
225	No. of Km over Product-Life	0	km / Product Life	86
226	Spare parts (fixed, 1% of product materials & manuf.)	0	g	

Task 5: Base Case Analysis EcoReport (3/5)

Life Cycle phases →	
Resources Use and Emissions	P
Materials	unit
1 Bulk Plastics	g

Life Cycle phases →	Resources Use and Emissions	PRODUCTION			DISTRIBU	USE	END-OF-LIFE*		TOTAL
		Material	Manuf.	Total	BUTION	Disposal	Recycl.	Total	
6 Electronics	g								
7 Misc.	g								
Total weight	g								
Other Resources & Waste									
8 Total Energy (GER)	MJ								
9 of which, electricity (in primary MJ)	MJ								
10 Water (process)	ltr								
11 Water (cooling)	ltr								
12 Waste, non-haz./ landfill	g								
13 Waste, hazardous/ incinerated	g								
Emissions (Air)									
14 Greenhouse Gases in GWP100	kg CO ₂ eq.								
15 Ozone Depletion, emissions	g R-11 eq.								
16 Acidification, emissions	g SO ₂ eq.								
17 Volatile Organic Compounds (VOC)	g								
18 Persistent Organic Pollutants (POP)	ng I-Teq								
19 Heavy Metals	mg Ni eq.								
PAHs	mg Ni eq.								
20 Particulate Matter (PM, dust)	g								
Emissions (Water)									
21 Heavy Metals	mg Hg/20								
22 Eutrophication	g PO ₄								
23 Persistent Organic Pollutants (POP)	mg								

ECO-DESIGN OF ENERGY-USING PRODUCTS EUP EcoReport: RESULTS
Assessment of Environmental Impact

N°	Product name	Date	Author				
Life Cycle phases →							
Resources Use and Emissions							
		PRODUCTION	DISTRIBU	USE	END-OF-LIFE*	TOTAL	
		Material/Manuf.	Total	BUTION	Disposal	Recycl.	Total
Materials							
		unit					
1	Bulk Plastics	g		0		0	0
2	Ferrous	g		0		0	0
3	Ferro	g		0		0	0
4	Non-ferro	g		0		0	0
5	Coating	g		0		0	0
6	Electronics	g		0		0	0
7	Misc.	g		0		0	0
	Total weight	g		0		0	0
Other Resources & Waste							
8	Total Energy (GER)	MJ	0	0	0	0	0
9	of which, electricity (in primary MJ)	MJ	0	0	0	0	0
10	Water (process)	ltr	0	0	0	0	0
11	Water (cooling)	ltr	0	0	0	0	0
12	Waste, non-haz./ landfill	g	0	0	0	0	0
13	Waste, hazardous/ incinerated	g	0	0	0	0	0
Emissions (Air)							
14	Greenhouse Gases in GWP100	kg CO ₂ eq.	0	0	0	0	0
15	Ozone Depletion, emissions	g R-11 eq.	0	0	0	0	0
16	Acidification, emissions	g SO ₂ eq.	0	0	0	0	0
17	Volatile Organic Compounds (VOC)	g	0	0	0	0	0
18	Persistent Organic Pollutants (POP)	ng I-Teq	0	0	0	0	0
19	Heavy Metals	mg Ni eq.	0	0	0	0	0
	PAHs	mg Ni eq.	0	0	0	0	0
20	Particulate Matter (PM, dust)	g	0	0	0	0	0
Emissions (Water)							
21	Heavy Metals	mg Hg/20	0	0	0	0	0
22	Eutrophication	g PO ₄	0	0	0	0	0
23	Persistent Organic Pollutants (POP)	mg	0	0	0	0	0

*Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.

Intelligence Service

From the AEA group

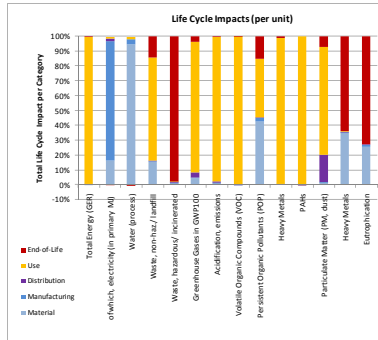
Task 5: Base Case Analysis EcoReport (4/5)

Table . Life Cycle Costs per product and Total annual expenditure (2005) in the EU-25

Products	LCC new product	total annual consumer expenditure in EU25
Item		
D Product price	0 €	0 min.€
E Installation/ acquisition costs (if any)	0 €	0 min.€
F Fuel (gas, oil, wood)	0 €	0 min.€
F Electricity	0 €	0 min.€
G Water	0 €	0 min.€
H Aux. 1: None	0 €	0 min.€
I Aux. 2: None	0 €	0 min.€
J Aux. 3: None	0 €	0 min.€
K Repair & maintenance costs	0 €	0 min.€
Total	0 €	0 min.€

Illustration of EcoReport analysis

- Open Fireplace
- Typical energy consumption as presented in Task 3
- Economic data inputs from Task 2
- Product lifetime is 35 years
- Direct emission data from GEMIS – « woodlog fireplace / Output 5kW»



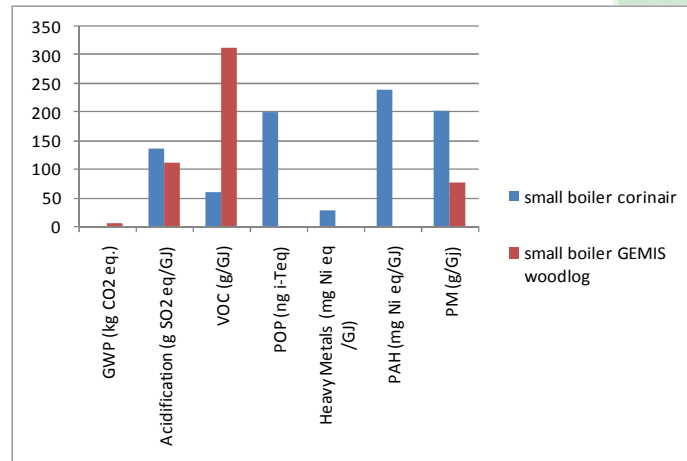
Products: Open fireplace / Woodlog	LCC new product
D Product price	2000 €
E Installation/ acquisition costs (if any)	0 €
F Fuel (gas, oil, wood)	1386 €
G Electricity	0 €
H Water	0 €
I Aux. 1: None	0 €
J Aux. 2: None	0 €
K Aux. 3: None	0 €
L Repair & maintenance costs	382 €
Total	3768 €

EcoReport

- Limited choice of solid fuels and direct emissions estimated only for CH boilers
- Does not allow to estimate the direct emissions for all SCIs and related fuels
- Necessary to complement the EcoReport data base with Direct emission inventories
- Direct emissions
 - Category of appliance
 - Technical parameter of the appliances
 - ...
- Data available from
 - GEMIS (Germany) – MEEuP uses the GEMIS database to estimate the direct emissions for CH boilers
 - Corinair (EU)

Direct emissions

- GEMIS vs. Corinair example for BIOMASS fuels



Preliminary Base Cases suggestion (in progress!)

Category	Technical parameter (for nominal output)	Fuel Consumption	Preliminary Main Base Cases	Preliminary "sub-Base Bases"
Fireplace	Open fireplace: Output ~12kW Efficiency ~55%	Assumes a certain share of "decorative use"	BC1	According to fuel type
	Closed fireplace: Output ~15kW Efficiency ~75%	Assumes a certain share of "decorative use"	BC2	According to fuel type
Stoves (other than Pellet stoves)	Manually controlled appliance with natural draught/Fuelling system based on share of manual and automatic appliances in stock: Output ~8kW Efficiency to be defined, maybe need for further splits	Based on what was calculated in Task 3	BC3	According to fuel type
Stoves (other than Pellet stoves) with boiler	Manually controlled appliance with natural draught/Fuelling system based on share of manual and automatic appliances in stock: Output ~11kW Efficiency to be defined, maybe need for further splits	Based on what was calculated in Task 3	BC4	According to fuel type
Heat retaining stoves	Manually controlled appliance with natural draught/Fuelling system based on share of manual and automatic appliances in stock: Output data and Efficiency to be defined	Based on what was calculated in Task 3	BC5	According to fuel type

Merge?

Preliminary Base Cases suggestion (in progress!)

Category	Technical parameter (for nominal output)	Fuel Consumption	Preliminary Main Base Cases	Preliminary "sub-Base Bases"
Pellet Stoves	Fan assisted and controlled appliance/ Fuelling system based on share of manual and automatic appliances in stock: Output ~9kW <i>Efficiency to be defined</i>	Based on what was calculated in Task 3	BC6	According to fuel type
	Automatic primary air controlled appliance with natural draught/ Fuelling system based on share of manual and automatic appliances in stock: Output~ 9kW Efficiency ~88%	Based on what was calculated in Task 3	BC7	According to fuel type
Pellet Stoves with boiler	Fan assisted and controlled appliance/ Fuelling system based on share of manual and automatic appliances in stock: Output ~18kW <i>Efficiency to be defined</i>	Based on what was calculated in Task 3	BC8	According to fuel type
	Automatic primary air controlled appliance with natural draught/ Fuelling system based on share of manual and automatic appliances in stock: Output ~18kW <i>Efficiency to be defined</i>	Based on what was calculated in Task 3	BC9	According to fuel type
Cookers	Manually controlled appliance with natural air draught/ Manual fuelling system: Output ~6kWh Efficiency ~75%	Based on what was calculated in Task 3	BC10	According to fuel type

Merge?

Merge?

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Preliminary Base Cases suggestion (in progress!)

Category	Technical parameter (for nominal output)	Fuel Consumption	Preliminary Main Base Cases	Preliminary "sub-Base Bases"
Boilers <50kW	Fan assisted and controlled appliance/ Fuelling system: based on share of manual and automatic appliances in stock: Output ~25kW <i>Efficiency to be defined</i>	Based on what was calculated in Task 3	BC11	According to fuel type
	Automatic primary air controlled appliance with natural draught/ Fuelling system based on share of manual and automatic appliances in stock: Output ~25kW <i>Efficiency to be defined</i>	Based on what was calculated in Task 3	BC12	According to fuel type
Boilers >50 kWh	Fan assisted and controlled appliance/ Fuelling system based on share of manual and automatic appliances in stock: <i>Output data and Efficiency to be defined</i>	Based on what was calculated in Task 3	BC13	According to fuel type
	Automatic primary air controlled appliance with natural draught/ Fuelling system based on share of manual and automatic appliances in stock: <i>Output data and Efficiency to be defined</i>	Based on what was calculated in Task 3	BC14	According to fuel type

Merge?

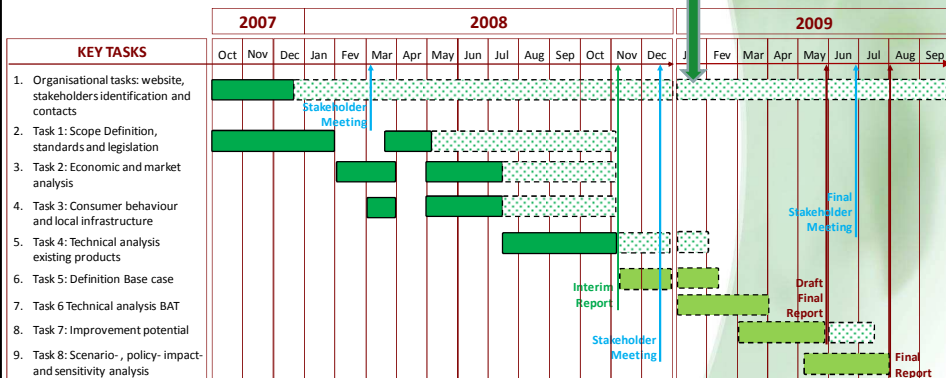
Merge?

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BAT Analysis and Improvement potential

- Identification of possible options to reduce the environmental impacts of SCIs (short term and long term options)
- Quantification of the improvement potential and of the impact on the product price
- Re-evaluation of the environmental impacts and LCC via EcoReport
- Identification of options leading to the Least life Cycle Costs (LLCC) and to the greatest reduction of environmental impacts (BAT)

Questionnaire BAT



Thank you for your kind attention!

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Stakeholders comments (specific)

● Task 1

- Differentiate between harmonised and non-harmonised Standards
- Scope of standards – needs some adjustments
- PM test method
- UK – most direct heating appliances also have indirect heating function

● Task 3

- Lambda for cookers, stoves and fireplaces
- Specify appliances to which emissions apply
- Best practices may also be appliance specific
- Account for fuel transportation impacts

● Task 4

- Quantification of the different types of losses (thermal approx 97%)
- Consistency in GCV figures
- Heat transfer

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