HEATING AND COOLING
KNOWHOW AND SOLUTIONS

D3.2 - Topten HACKS Criteria Paper
Solid fuel boilers
Pellet and Logwood

Picture 1: Pellet boiler
Source: https://img.archiexpo.com/images_ae/photo-g/102620-5206529.jpg

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Germany, co2online www.co2online.de	Italy, Eliante www.topten.it	Lithuania, LNCF www.ecotopten.lt	Luxembourg, Oeko-Zenter www.oekotopten.lu
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About HACKS

The objective of the Heating and Cooling Knowhow and Solutions (HACKS) project is to achieve market transformation for heating and cooling (HAC) appliances and improve comfort and health of European citizens.
Across the EU almost half of all buildings have individual boilers that were installed before 1992 with efficiency of 60% or less. The expected energy savings from a speedy replacement are immense.
To achieve this goal, 17 HACKS partners in 15 countries are working together, thanks to the financial support of the European Horizon 2020 programme.
After scanning market actors, current policies and most commonly used products in each country, starting from April 2020 the HACKS partners will implement involvement campaigns to raise awareness of the economic and environmental benefits brought by good HAC products and solutions:

- HACKS will motivate households equipped with old and inefficient devices – boilers, water heaters, air conditioners, certain types of boilers and stoves, etc. – to replace them with new super efficient equipment.
- In each country, partners will set-up dedicated on-line platforms to assist consumers in their purchasing process. The platforms will propose: tools to assess households' needs and provide customised information; best product lists with technical specifications; direct links to suppliers of most efficient products; and advice on how to use and maintain equipment.
- For those households who need to improve their situation because they feel too hot, too cold, or too humid but who cannot invest in new equipment or can avoid getting equipped, HACKS will propose simple and low costs solutions. It is possible to reduce energy consumption and energy bills while improving winter and summer comfort, air quality and health conditions through the installation of shading devices, thermostats, water saving taps and showerheads, etc.

Beyond households, HACKS will target all relevant stakeholders ("multipliers") that participate in the decision-making process of consumers by setting up strategic partnerships to facilitate the purchase of energy efficient appliances. HACKS places a strong emphasis on installers but also retailers and consumer organisations because of their proximity to consumers, their capacity to involve them and bring them guidance on energy efficient equipment.
More information on the HACKS project can be found at www.topten.eu/hacks

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Executive summary

With these criteria papers the intention is to be able to identify and select the most energy efficient models available on the market. The primary objective is to help partners on their territory for their Topten and HACKS website, but the technical content may also support anyone willing to find good products from an environmental point of view.

This document gives an overview on solid fuel boilers burning wood (logwood and pellets). It does not include local space heaters located in the living room of the building. The selection criteria and the products selected according to them for the website topten.eu are presented and explained. They are based on the European energy label and the requirements for air quality, mandatory as of 2020 as defined in the Ecodesign regulation for this appliance group.

A brief technical overview is given on solid fuel boilers burning wood, while a more conclusive view is given in the annex with many different types of boilers and technologies used. Important to note is the influence of the consumer when it comes to air pollution. It is crucial that the dimensioning of the boiler and connected hot water tank is correct, so the boiler can burn at an optimal load, where it is the cleanest and most efficient.

Furthermore, the current EU regulations such as the Energy labelling regulation and the Ecodesign requirements are presented in detail. They include criteria on energy efficiency as well as on air quality, the major environmental issue when burning wood. The label, which is mandatory since 2019, is explained and the impact of the newly implemented Ecodesign requirements presented. This also includes a product fiche with all information that has to be provided.

The presented products are characterized with a number of attributes which can be used as filters for easier grouping, for example by boiler-type, size, fuel used, etc. These attributes are presented and discussed with regards to their relevance. In addition, recommendations are given on how to find the data for each product.

Finally, useful information is collected, such as various links, terms and a glossary. Inputs for consumers are given with a FAQ-section on important topics.

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1 Topten.eu: Solid fuel boilers - current selection criteria and products selected

1.1 Scope

For HACKS, the scope are single-family-houses. There, the focus lies on logwood and pellet boilers. Other types of boilers are presented in the appendix.
The term “solid fuel boilers” summarizes all heating devices using solid fuels that are located in the basement and are connected to a central heat distribution system. It does not include stoves for the living room that are especially designed to look good and provide a cosy atmosphere. Those are summarized under the term “local space heaters”, for which a separate criteria paper and product list can be found on topten.eu.
Solid fuel boilers can also use non-wood solid fuels such as coal or coke. The focus of this criteria paper are wood-type solid fuels as renewable source.

1.2 Current selection criteria on Topten.eu

The criteria for Topten.eu[1] were developed as part of the HACKS program. They were defined based on selection criteria from Austria, Germany and Switzerland, which already presented this category on their national Topten-websites. Topten presents the most energy efficient solid fuel boilers with low emissions. In order to reduce air-pollution, all products on Topten must fulfil air quality requirements as well as reaching top energy efficiency classes.

Table 1: Selection criteria for solid fuel boilers (Topten.eu)

Criteria	Pellets (automatic)	Logwood (manual)
Energy label	A+ or higher	A+ or higher
Dust [mg/m3]	15	30
CO nominal load [mg/m3]	30	100
C org nominal load [mg/m3]	5	15
NO_x [mg/m3]	150	150

1.3 Best available products

Here you can find the boilers presented on topten.eu
https://www.topten.eu/private/products/solid_fuel_boilers
With these selection criteria, in April 2020, various manufacturers are able to produce and distribute compliant models.

[1] www.topten.eu is the European portal where all the HACKS websites can be found

Table 2: Product list and distribution of models over efficiency classes

Manufacturer	Number of models	A++	A+	Website
Bösch	1	1		https://www.boesch.at
ETA	1		1	http://www.eta.co.at
Fröling	2		2	http://www.froeling.com/ch/
Hargassner	7		7	http://www.heitzmann.ch
Herz Energietechnik	1	1		http://www.herz-energie.at/
Hoval	3		3	http://www.hoval.ch
KWB	3		3	https://www.kwb.net/de-ch/
ÖkoFEN	2	2		http://www.oekofen.ch
Strebel-Thermostrom	1	1		https://www.strebel.at/en.html
Viessmann	2		2	http://www.viessmann.ch
Total	23	5	18	

Source: https://www.topten.eu/private/products/solid_fuel_boilers

1.4 National selection criteria

In addition to energy efficiency, one of the most relevant issues for solid fuel boilers is the associated emissions. Particulate matter emissions and air quality are critical topics all over the EU. Minimum requirements (MEPS) for emissions for solid fuel boilers as defined in EU 2015/1189 became mandatory as of January 1st, 2020.

Some countries already have stricter air quality requirements on a national level than the new EU MEPS. In this case, national Topten criteria might be adjusted to reflect the top product segment on the national market.

Because energy label declaration was not mandatory until very recently, the energy labels are sometimes difficult to find. As a result, many national associations have relied on their own test methods and criteria as is the case in Austria, Switzerland, France and Italy. An adjustment of their selection criteria to include the European label is expected.

1.5 Expected selection criteria in year 2022

As the Ecodesign requirements have only been mandatory since January 2020, the pace of market development cannot be estimated. However, it is expected that a clearer overview of the market situation will be possible. It is expected that the emissions requirements will become even stricter for most countries. A tightening of the minimum energy class from A++ to A+++ could be possible (cf. Table 3).

Table 3: Suggested selection criteria for solid fuel boilers (Topten.eu) for 2022

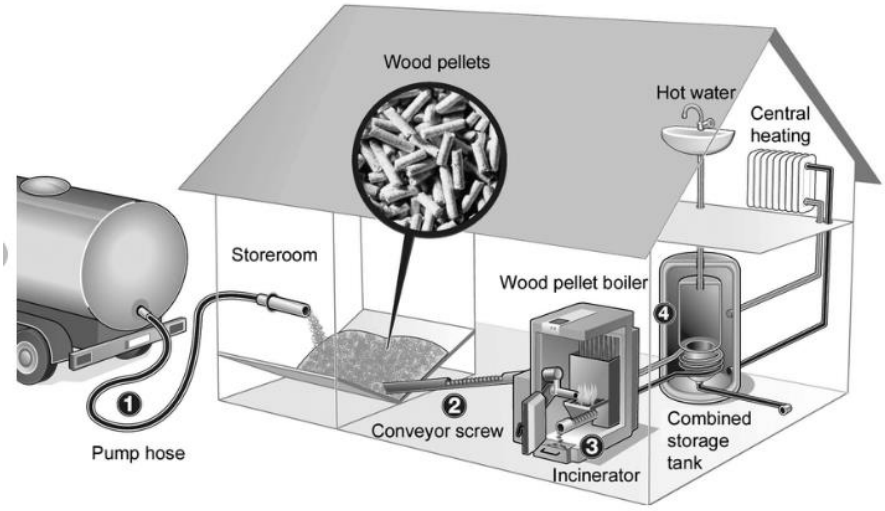
Criteria	Pellets (automatic)	Logwood (manual)
Energy label	A++	A++
Dust [mg/m3]	10	20
CO nominal load [mg/m3]	20	50
C org nominal load [mg/m3]	3	10
NO_x [mg/m3]	120	120

1.6 Technical background

One important aspect of solid fuel boilers is the correct dimensioning of the boiler. Even a very efficient boiler which only runs on partial load due to incorrect dimensioning is much less efficient than it could be and produces higher amounts of emissions during the burning process. This can be avoided by selecting a big enough hot water tank in combination with a smaller boiler, so the boiler doesn't have to run too often on a low load.

Proper system integration is key when using a wood boiler.

Picture 2: Functionality of heating systems with a pellet boiler



Source: https://www.researchgate.net/figure/Wood-pellet-heating-system-source-http-wwwunendlich-viel-energiede-modified-from_fig1_230645612

Picture 3: Functionality of heating systems with a pellet boiler, solar hot water generation

Source: https://www.energie-experten.org/heizung/pelletheizung/pelletkessel.html

It is also possible to further reduce emissions by installing additional filters. Depending on the filter, it requires regular maintenance and can substantially increase costs (either initially or on a regular basis).

2 Policy measures, standards and labels

2.1 List of existing regulations (Energy Labelling, Ecodesign, MEPS)

2.1.1 Energy label (EU 2015/1187)

A solid fuel boiler should have an energy label indicating its energy efficiency on a scale from A+++ (most efficient) to D (least efficient), applicable from September 26th, 2019. The label provides information such as the brand, the model, the energy efficient class, the direct and if relevant the indirect rated heat output, as well as the additional electricity generation function in kW. It applies to appliances with rated output up to 70 kW.

The calculation is defined as follows (excerpt from the regulation text):

$$EEI = \eta_{son} \times 100 \times BLF - F(1) - F(2) \times 100 + F(3) \times 100$$

- η_{son} is the **seasonal space heating energy efficiency** in active mode, calculated as set out in point 4(b) of Annex VIII;
- *BLF* is the **biomass label factor**, which is 1,45 for biomass boilers and 1 for fossil fuel boilers;
- *F(1)* accounts for a **negative contribution** to the energy efficiency index due to adjusted contributions of **temperature controls**; *F(1)* = 3;
- *F(2)* accounts for a **negative contribution** to the energy efficiency index by **auxiliary electricity consumption**, and is calculated as set out in point 4(c) of Annex VIII;
- *F(3)* accounts for a **positive contribution** to the energy efficiency index by the **electrical efficiency of solid fuel cogeneration boilers**, and is calculated as follows:
  $F(3) = 2{,}5 \times \eta_{el,n}$

2.1.2 Ecodesign (EU 2015/1189)

The regulation applies to appliances with rated output up to 500 kW. Requirements are specified for the following topics, applicable from the years mentioned onwards:

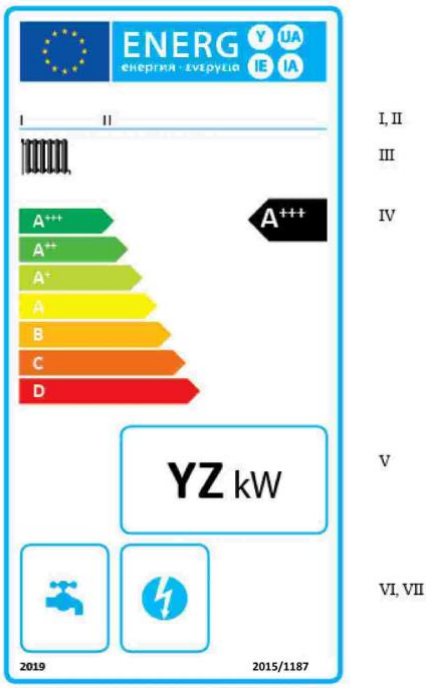
- 2017: information requirements (product fiche, technical documentation, product label)
- 2019: product database (upload of technical product documentation required)
- 2020: MEPS for energy efficiency, emission of particulate matter, organic gaseous compounds, carbon monoxide and nitrogen oxides.

Table 4: Requirements for Tier 1

	Pellets (automatic)	Logwood (manual)
Efficiency at rated load (%)	75% (<20kW), 77% (>20kW)	
Dust [mg/m3]	40	60
CO nominal load [mg/m3]	500	700
C org nominal load [mg/m3]	20	30
NO_x [mg/m3]	200	350

2.2 Explanation of energy label

Picture 4: Energy label for solid fuel boilers



Source: Energy label as described in 32015R1187 - OJ L 193, 21.7.2015, p. 53

I. supplier's name or trademark;
II. supplier's model identifier;
III. the space heating function;
IV. the energy efficiency class, determined in accordance with Annex II; the head of the arrow containing the energy efficiency class of the solid fuel boiler shall be placed at the same height as the head of the relevant energy efficiency class;
V. the rated heat output in kW, rounded to the nearest integer;
VI. for combination boilers, also the additional water heating function;
VII. for solid fuel cogeneration boilers, also the additional electricity generation function.

2.3 Table with efficiency class thresholds

Table 5: Energy efficiency classes for solid fuel boilers

Energy efficiency class	Energy efficiency index (*EEI*)
A+++	EEI ≥ 150
A++	125 ≤ EEI < 150
A+	98 ≤ EEI < 125
A	90 ≤ EEI < 98
B	82 ≤ EEI < 90
C	75 ≤ EEI < 82
D	36 ≤ EEI < 75
E	34 ≤ *EEI* < 36
F	30 ≤ EEI < 34
G	EEI < 30

2.4 Market analysis

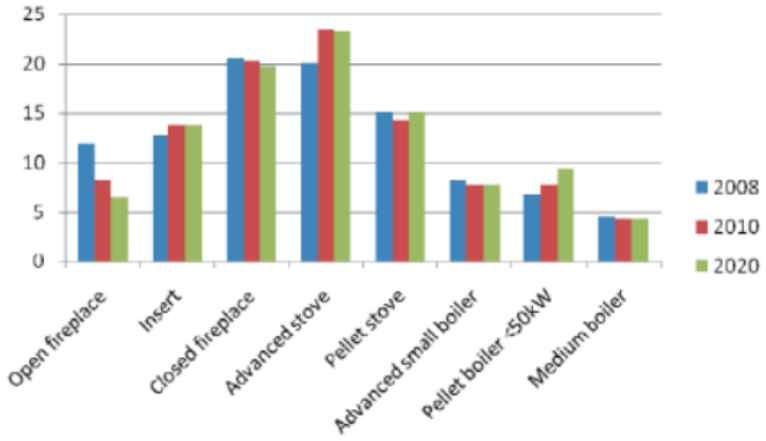
In the preparatory study from 2015 for solid fuel boilers, the following estimations have been made until 2025 (dating from 2009). Note that a « retort boiler » is a coal based boiler, whereas the rest are all wood based.

Picture 5: Evolution of sales for solid fuel boilers

Product Category	2004	2005	2010	2015	2020	2025
Small domestic manual boiler	N/A	N/A	163,000	87,400	49,600	28,200
Small domestic DD gasifying boiler	N/A	N/A	222,000	226,000	220,000	205,000
Retort boiler	N/A	N/A	3,900	3,500	3,100	2,700
Pellet boiler	14,000	20,000	45,700	70,900	68,500	59,200
Non-domestic chip boiler	N/A	N/A	1,600	1,400	1,300	1,100

Source: https://ec.europa.eu/transparency/regdoc/rep/other/SWD-2015-92-F1-EN-0-3.PDF, p.50. Sales for 2010ff are estimated, retort boilers are coal-based, rest is wood based)

Picture 6: Stock share (in %) of all solid fuel appliances (2010 and 2020 are estimates).



Source: https://ec.europa.eu/transparency/regdoc/rep/other/SWD-2015-92-F1-EN-0-3.PDF, p.70.

Picture 7: Stock of solid fuel boilers in Europe and by country for 2008 (others is mainly coal)

	Solid Fuel Boilers				
	Fossil Fuel/ Universal	Logwood	Woodchips	Pellets	Others
EU 27	277.300	111.700	16.100	56.850	50.130
Austria	1.400	7.300	5.000	11.500	300
Belgium	100	800		400	
Bulgaria	10.000	1.500		300	
Cyprus					
Czech Republic	35.000	5.000		1.700	200
Denmark	1.400	700		3.000	
Estonia	2.200	600		200	
Finland	1.700	1.400	600	900	100
France	1.600	18.000	1.300	6.000	600
Germany	1.000	16.000	3.000	22.000	
Greece	100	500	100	50	50
Hungary	23.000	2.000		300	30
Ireland	3.500	600	300	1.000	50
Italy	200	5.800	600	1.700	1.200
Latvia	7.000	900		500	
Lithuania	14.000	2.400		200	
Luxembourg					
Malta					
Netherlands		200	100	100	
Poland	120.000	11.000	300	2.000	47.000
Portugal	100	400		100	
Romania	30.000	24.000		400	100
Slovak Republic	15.000	4.000	600	900	200
Slovenia	4.600	700	3.200	1.200	200
Spain	400	2.500	700	700	
Sweden		5.200	200	900	
United Kingdom	5.000	200	100	800	100

Source: https://ec.europa.eu/transparency/regdoc/rep/other/SWD-2015-92-F1-EN-0-3.PDF, p.71.

Solid fuel boilers are expected to use 147'200 million kWh in the EU in 2030.
The annual saving potential with successful implementation of the EU Regulations (Ecodesign, Labelling) is 5'000 million kWh and 2000 t CO_2, as per Ecodesign 2015/1189, Article 18 of Directive 2009/125/EC, page 1 and 2:

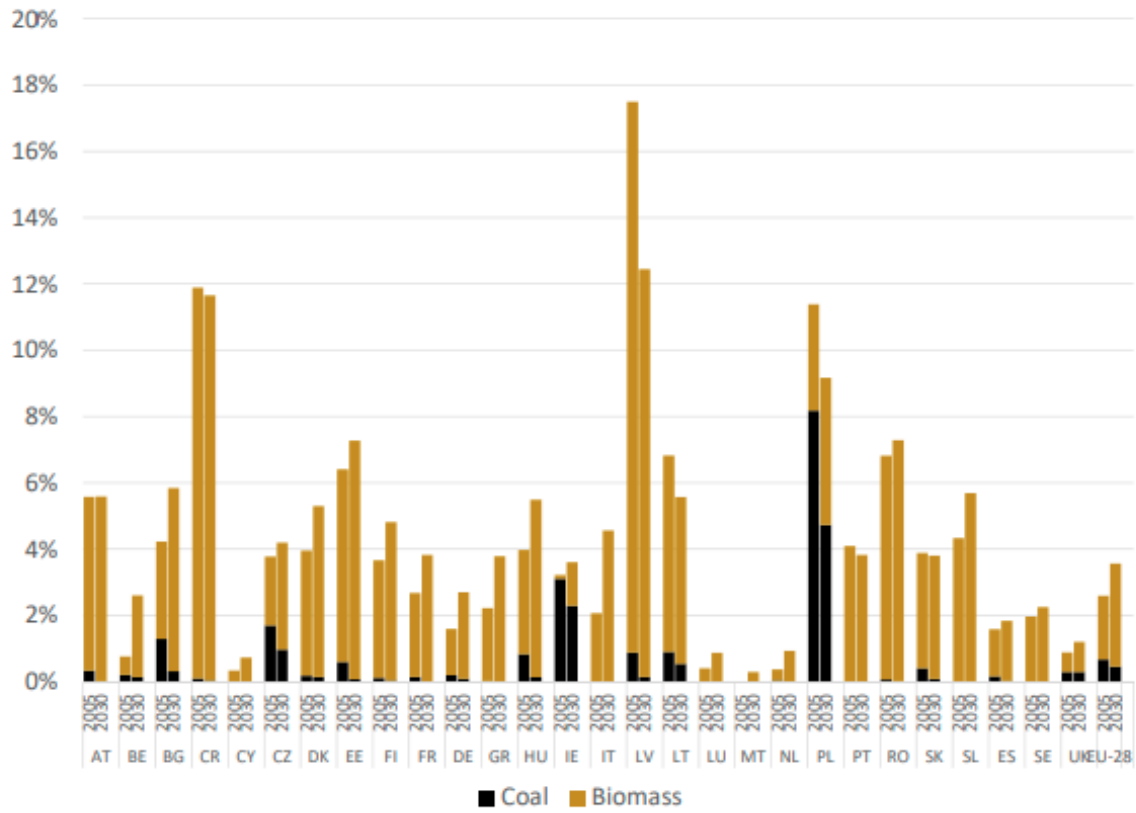
> The annual energy consumption related to solid fuel boilers is expected to be 530 petajoules ('PJ') (approximately 12,7 million tonnes of oil equivalent 'Mtoe') in 2030 and annual emissions are expected to be 25 kilotonnes ('kt') of particulate matter, 25 kt of organic gaseous compounds and 292 kt of carbon monoxide in 2030. Emissions of nitrogen oxides are expected to increase because of potential new solid fuel boiler designs aiming at higher energy efficiency and lower organic emissions.
>
> The combined effect of the ecodesign requirements set out in this Regulation and Commission Delegated Regulation (EU) 2015/1187 (1) is estimated to result by 2030 in annual energy savings of approximately 18 PJ (approximately 0,4 Mtoe), together with related carbon dioxide ('CO') emission reductions of approximately 0,2 Mt, and a reduction of 10 kt in particulate matter, 14 kt in organic gaseous compounds, and 130 kt in carbon monoxide.

In addition, also air pollution emissions are reduced considerably by implementing the regulations.

Overall, biomass combustion in the residential sector accounted for 1.9% of total primary energy use in the EU28 in 2005, while coal combustion accounted for 0.7% (cf. Picture 8).[2]

[2] https://ec.europa.eu/environment/air/pdf/clean_air_outlook_combustion_sources_report.pdf, p 9

Picture 8: Coal and biomass use in the household sector as shares of total energy use by country for 2005 and 2030.



Source: https://ec.europa.eu/environment/air/pdf/clean_air_outlook_combustion_sources_report.pdf, page 9

3 How to gather data

Topten.eu serves as reference and starting point for national Topten product lists.
National product lists should reflect market availability of most efficient products for each country. The following procedure is recommended for data gathering:

- Check what products are listed on topten.eu
- Check which of those products are available in your country
- Check national products which are only available in your country to see if they comply with the selection criteria. Inform Topten.eu about them so they can be added to the topten.eu list.

Since September 26th, 2019, manufacturers are required to display the energy label, declaration of emission values is mandatory since January 1st, 2020. Product catalogues and manufacturer websites are the places to find the labels and product details.
The mandatory data is not yet published for every product as it should be, but is present for the majority of the products.

3.1 Attributes

The following attributes are the information shown on the Topten.eu website for each product, because they are important to buyers and / or relate to the Topten selection criteria.

3.1.1 Attributes on Topten.eu

Table 6: Attributes for solid fuel boilers on Topten.eu

Product Data	Example
Brand	ÖkoFEN
Model	Pellematic Condens 18
Similar models	…
Energy Label	A++
Fuel type	Pellet
Weight (kg)	181
Height (cm)	104
Width (cm)	68
Depth (cm)	38
Max. heat output (kW)	18
Connected load boiler [kW]	2
Energy Efficiency Index	143
Refueling system	pneumatic conveyer
Auxiliary energy demand at nominal load (%)	0.7
Dust [mg/m3]	11.9
CO nominal load [mg/m3]	7.5
C org nominal load [mg/m3]	0
NOx [mg/m3]	104.3
Capacity (l)	
Max. log length (mm)	
Automatic cleaning	yes
Automatic de-ashing	yes

3.1.2 Attributes on national websites

Additional attributes on national Topten websites can be found in Appendix 7.2.

4 Input for Consumer Recommendations

4.1 Input for Recommendation pages

For Topten.eu, there are policy recommendations added to the recommendation page, as it is not specifically designed for consumers.

In general, wood as fuel is a sustainable, renewable energy source which should be pushed to replace fossil fuels. This can be achieved on a national/regional/local level with subsidy programs.
One of the main concerns is the emission of pollutants when wood is burnt. Many regions have forbidden certain biomass boilers as a result, especially in urban regions. This may be reversed

once the Ecodesign minimum requirements are strict enough and stoves emit less pollutants. Ecodesign measures for stoves and boilers needs to push for increasingly strict air-pollutant regulations. They are currently well above some regional limits.
In comparison to a traditional fuel or gas stove, less comfort is an issue. Wood fuelled boilers have a slightly higher maintenance effort (e.g. removing ash from the boiler and dispose of it). Another important aspect is proper maintenance of the chimney and stove, not only for a clean burning process but also for fire safety reasons. Some countries have national regulations on this (e.g. in Switzerland, control and cleaning is mandatory on a regular basis (depending on the oven once to twice a year). It would be advisable to include adequate requirements in the Ecodesign regulation. Requirements on maintenance for safety reasons are regulated on EU-level only for large boilers >70kW.

For national Topten recommendation pages, detailing some topics of special relevance for consumers such as what types of boilers exist, what the important aspects to consider are and links to pre-filtered product lists on Topten are suggested.
On Topten.eu the most efficient products are shown. However, if a country has stricter regulations or not enough products to list (e.g. Appendix for an example of a complete national recommendation page, “7.5 Example of a national recommendation page (in detail)”.

4.2 FAQ

- **How do I decide whether I should use a boiler fuelled with pellets or logwood?**

Most pellet boilers can be operated pretty much automatically (automatic refuelling, automatic ash-removal, regulation of power), whereas logwood boilers need manual refuelling (depending on the log depot and heat demand as to how often). However, pellets require energy during production and transportation, whereas most logwood is usually from a regional or even closer source with little to no transportation necessary. So especially for remote areas, logwood boilers can be a better choice if comfort aspects are not in the focus.

- **Why is the size of the hot water storage tank important?**

If you have a large hot water storage tank, you only need to use the boiler to reheat it and don’t let it run constantly on a low capacity where efficiency is low and air polluting emissions are high. If the hot water storage tank needs to be refilled, the boiler can run on full load until the temperature is reached again. This is more important for wood boilers than for traditional boilers fired with natural gas or fuel.

5 Terminology

- Boiler: is a heat generating device in the basement that connects to a central heat distribution system and is refuelled mostly automatically from a fuel storage/tank.
- Fireplace: a place to burn a fire, usually open or only closed with glass doors, some heat storage in the mass, but not necessarily.
- Logwood: pieces of wood, uniform in size (20, 25, 33 or 50 cm, incl. bark); humidity depending on storage duration is 20-60%.
- Stove: a freestanding or built-in device usually located in the living room, where a fuel is burnt and heats up either just the surrounding air, a storage mass or even a liquid which feeds into a central heat distribution system.
- Wood chips: 3-6cm pieces of wood, incl. bark, humidity of 20-30%, easier handling than logs, mostly used in multiple family houses.
- Wood pellets: 3x0.6cm pieces of pressed sawdust (no bark), very uniform, humidity of less than 10%. Best conditions to ensure equal, clean, efficient burning.

6 References and links

6.1 Useful links

- Topten.eu product list
  https://www.topten.eu/private/products/solid_fuel_boilers
- Topten.eu selection criteria
  https://www.topten.eu/private/selection-criteria/selection-criteria-solid-fuel-boilers
- Policy recommendations
  https://www.topten.eu/private/adviser/policy-recommendations-for-solid-fuel-boilers

6.2 References

- EU regulations
  - Regulation: EU energy labelling regulation for **solid fuel boilers** (EU) 2015/1187
    https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2015.193.01.0043.01.ENG
  - Regulation: Ecodesign regulation for **solid fuel boilers** (EU) 2015/1189
    https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2015.193.01.0100.01.ENG
  - Commission guidelines: Ecodesign requirements for **heaters**, and **solid fuel boilers** (2018)
    https://ec.europa.eu/energy/sites/ener/files/documents/guidelinesspacewaterheaters_final.pdf
  - Regulation: EU ecodesign regulation for **local space heaters** (EU) 2015/1188
    https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2015.193.01.0076.01.ENG
  - Regulation: EU ecodesign regulation for **solid fuel local space heaters** (EU) 2015/1185
    https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2015.193.01.0001.01.ENG
  - Regulation: Labelling regulation for **local space heaters** (EU) 2015/1186
    https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015R1186
  - Commission guidelines: Energy labelling and ecodesign requirements for local space heaters (2017)
    https://ec.europa.eu/energy/sites/ener/files/documents/2017guidelineslocalspaceheaters20171113.pdf

- Prep. Studies
  - Review study of ecodesign for solid fuel boilers, 2015
    http://www.ecosolidfuel.org/documents_15.html
  - Impact assessment
    https://www.vhk.nl/downloads/IA/IA_report-swd_2015_0092_en.pdf

- Other papers and presentations
    - Holzenergie Schweiz (Swiss Label):
      https://www.holzenergie.ch
      https://www.holzenergie.ch/fileadmin/user_resources/01_Holzenergie/Qualitaetssicherung/D_QS_Reglement.pdf
    - Bundesamt für Energie: Biomasse
      https://www.bfe.admin.ch/bfe/de/home/versorgung/erneuerbare-energien/biomasse.html
    - Energie Schweiz: Holzenergie
      https://www.energieschweiz.ch/page/de-ch/holzenergie
    - Topten Advisor Holzöfen:
      https://www.topten.ch/private/adviser/ratgeber-holzofen
    - Topten Advisor Pelletheizungen:
      https://www.topten.ch/private/adviser/ratgeber-pellet-heizung
    - Umweltzeichen (Austrian label)
      https://www.umweltzeichen.at
      https://www.umweltzeichen.at/file/Richtlinie/UZ%2037/Long/Uz37_R6.1a_Richtlinie_Holzheizungen_2017.pdf
    - Blauer Engel (German label)
      https://www.blauer-engel.de
      https://www.blauer-engel.de/de/produktwelt/gewerbe-kommune/holzpelletheizkessel
    - Flammes Verte (French label)
      https://www.flammeverte.org/
    - Italian label
      http://www.certificazioneariapulita.it
    - Campaign for “awareness heating”
      http://www.unicalor.it/calore-natura.html

7 Appendix

7.1 Criteria for solid fuel boilers in different countries and labels (April 2020)

Table 7: Selection criteria for solid fuel boilers (Topten Germany, https://www.ecotopten.de/)

	Pellet boiler
Efficiency at rated load (%)	Min. 90%
Auxiliary energy demand nominal load (%)	≤ 0.8%
Auxiliary energy demand partial load (%)	≤ 0.6%
Dust nominal load [[mg/Nm3]	15
CO nominal load [mg/Nm3]	150
C org nominal load [mg/Nm3]	5
NO_x [mg/Nm3]	150

Table 8: Selection criteria for solid fuel boilers (Luftreinhalteverordnung, Air quality regulation of Switzerland)

	Pellet boiler	Logwood boiler
Dust nominal load [[mg/m3]	40	60
CO nominal load [mg/m3]	300	800
C org nominal load [mg/Nm3]	-	-
NO_x [mg/Nm3]	-	-

Table 9: Selection criteria for solid fuel boilers (Topten Austria) (converted from mg/MJ)

	Pellet boilers	Logwood boilers
Efficiency at rated load (%) (Gold/Silver)	Min. 94% / 90% (<10 kW) Min. 95% / 93% (>10 kW) Min. 106% / 100% (condens. boilers)	Min. 94% / 91%
Dust [mg/m3]	54	108
CO nominal load [mg/m3]	217	903
CO part load [mg/m3]	487	-
C org nominal load [mg/m3]	11	108
C org part load [mg/m3]	11	-
NO_x [mg/m3]	361	433

Table 10: Requirements for Flamme Vertes (French Label)

	Pellet boilers	Logwood boilers
Efficiency at rated load (%)	>87%	>87%
Dust [mg/m3]	20	30
CO nominal load [mg/m3]	300	500
C org nominal load [mg/m3]	30	20
NO_x [mg/m3]	200	200

7.2 Attributes for solid fuel boilers in different countries

Table 11: Attributes from Topten Austria: Product

Product Data	Example
Brand	ÖkoFEN
Model	Pellematic
Certification	0165/6
Fuel type	Pellet
Weight (kg)	181
Height x Width x Depth	104x68x38 cm
Automatic cleaning	yes
Automatic ash removal	yes

Table 12: Attributes from Topten Austria: Service

Service Data	Example
Max. heat output (kW)	18
Boiler Capacity Range (kW)	6-18
Connected load boiler [W]	2.000
Smallest tested boiler output [kW]	6.0
Efficiency [%] at rated load	107.3
Efficiency [%] at partial load	104.4
Efficiency [%] at minimum tested partial load	104.4
Radiation losses at nominal heat output [%]	0.3
Screw conveying	yes
Pneumatic conveying	no
Average electricity consumption during normal operation in	0.7

Table 13: Attributes from Topten Austria: Exhaust

Exhaust data	Example
Dust [mg/MJ]	8.0
CO [mg/MJ] at rated load	5.0
CO [mg/MJ] at partial load	2.0
C org [mg/MJ] at rated load	< 1
C org [mg/MJ] at partial load	< 1
NO_x [mg/MJ]	70.0
Exhaust temp. at full load [° C]	30-40
Exhaust temp. at partial load [° C]	30-40

7.3 National product lists

Pellet boilers
Austria
https://www.topprodukte.at/de/Products-Lists/topproductscat1/115/topproductscat2/298/topproductscat3/481/topprodukte_sort_listing/x/topprodukte_sort_direction/x/topprodukte_how_many_ds/1.html
https://www.topprodukte.at/de/Products-Lists/topproductscat1/115/topproductscat2/298/topproductscat3/302/topprodukte_sort_listing/x/topprodukte_sort_direction/x/topprodukte_how_many_ds/1.html
Switzerland
https://www.topten.ch/private/products/pellet_heaters
Germany
https://www.ecotopten.de/waerme/holzpelletheizungen?waermeleistung%5B%5D=3804&waermeleistung%25255B%25255D=3804

Logwood boilers
Austria
https://www.topprodukte.at/de/Products-Lists/topproductscat1/115/topproductscat2/298/topproductscat3/306/topprodukte_sort_listing/x/topprodukte_sort_direction/x/topprodukte_how_many_ds/1.html

7.4 Technology of boilers

7.4.1 Types of firing systems

Drop firing system

The pellets are transported upwards with a screw conveyer and then dropped through a chute onto the grate or burning bowl. The burning then proceeds upwards.

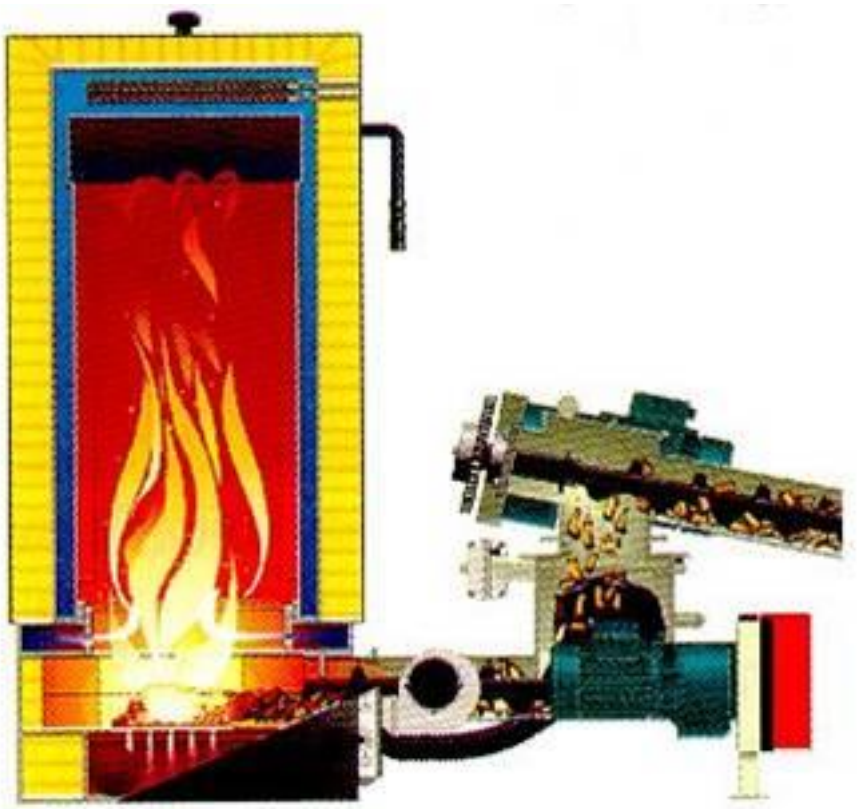
Picture 9: 3D-cut of a pellet boiler with a drop system

Source: http://energieberatung.ibs-hlk.de/images/windh_pmxschn.jpg

Insert firing system

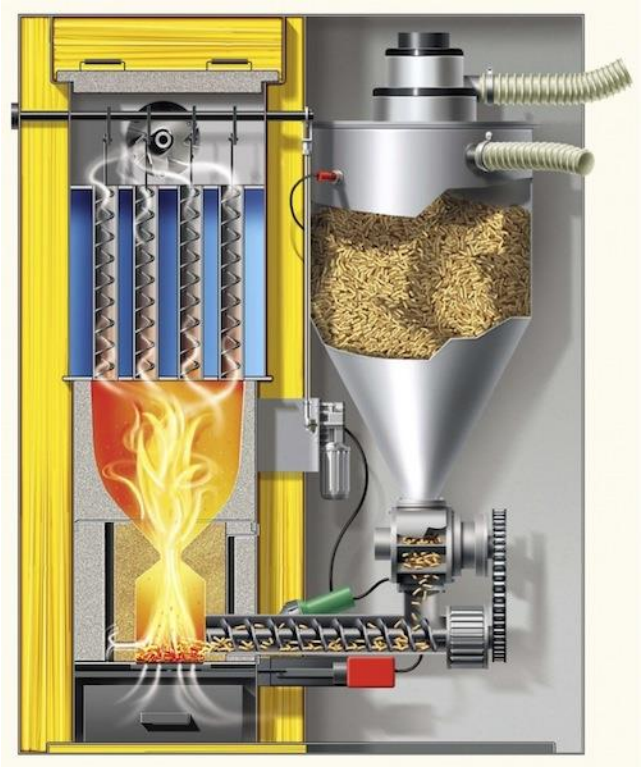
A separate burning chamber sits below the heat exchanger. In this burning chamber the pellets are being inserted from the side or from below. It includes ventilation with primary and secondary air.

Picture 10: Pellet boiler with an overfeed firing system, conveyer transportation from storage



Source: http://energieberatung.ibs-hlk.de/images/windh_unterschub.jpg

Picture 11: Pellet boiler with an overfeed firing system, pump transportation from storage



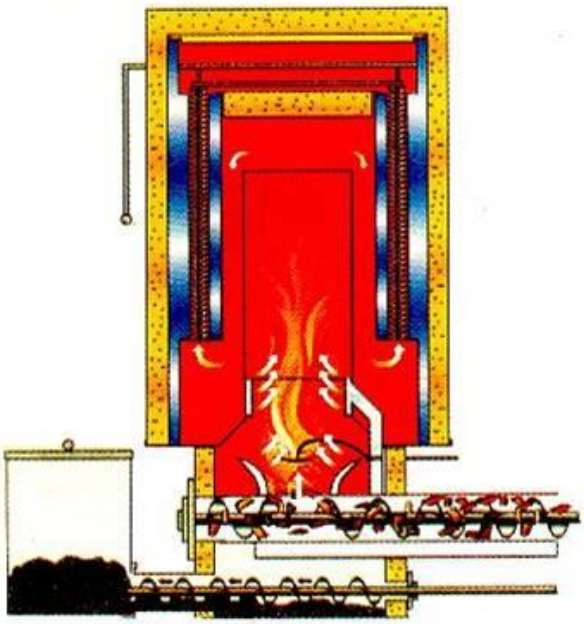
Source: https://www.propellets.at/assets/upload/pelletheizkessel/kesselquerschnitt.jpeg

Retort firing system

Another possibility is feeding by means of a screw conveyor from a silo. The fuel is fed from below to a fuel trough (retort) by a stoker screw.

This system is similar to the underfeed system, but instead of the grate it has a plate-shaped combustion retort with primary air openings, which is made of heat-resistant special steel or fireclay. Above the retort is the secondary air ring which ensures proper afterburning.

Picture 12: 3D-cut of a pellet boiler with a retort firing system



Source: http://energieberatung.ibs-hlk.de/images/retortenfeuerung.jpg

Picture 13: The retort firing system in detail (the pellets are pushed upwards)

Source: https://upload.wikimedia.org/wikipedia/commons/thumb/f/f8/Wood-pellet_heater.jpg/220px-Wood-pellet_heater.jpg

7.4.2 Types of fuels

Logwood and logwood boilers

Logwood is usually standardized to 30 – 50 cm logs (depending on the size of the oven) and needs to be refuelled manually (there are exceptions for central space heaters where you can fill up a bigger depot with logs, which burns for a longer period).

The burning process does not occur from the bottom to the top, but rather towards the side or

downwards in a separate burning chamber. This is called lower combustion. To accomplish it, the burning gases are sucked away from the primary incineration into the separate burning chamber, where they are further burnt by adding fresh air. The wood above the burning zone is for refuelling. Advantages: very steady, complete burning process. Disadvantage is the mandatory ventilation (electricity consumption).

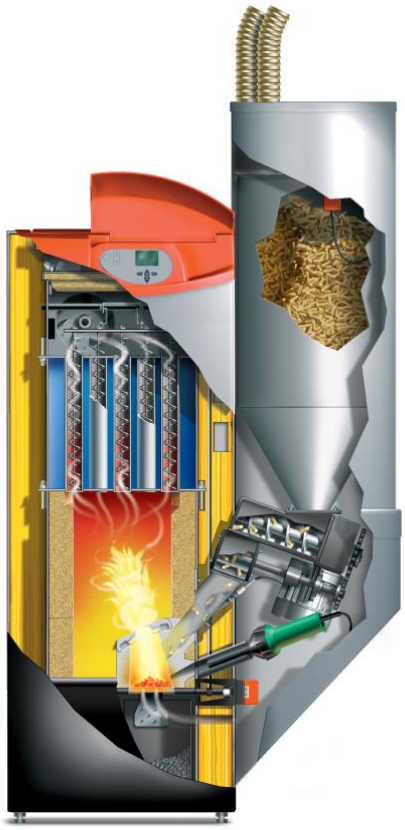
Picture 14: 3D-cut of a logwood boiler with lower combustion

Source: https://www.edergruppe.at/wp-content/uploads/2013/12/Biovent_SLC_Schnitt.png

Pellets and pellet boilers

Pellets are pressed from sawdust and wood shavings. They are very dry and thus ensure to possess the best conditions to ensure equal, clean, efficient burning. They are also easy to handle in that they can be stored in a bunker and transported automatically into to the oven almost like a liquid. Depending on the type of oven, there is a steady refuelling installed with a screw conveyer or the oven has a depot that can be filled manually.
The refuelling occurs depending on the heat demand, so these heaters ensure the same comfort than regular gas or fuel heaters.

Picture 15: 3D-cut of a pellet boiler with a drop system

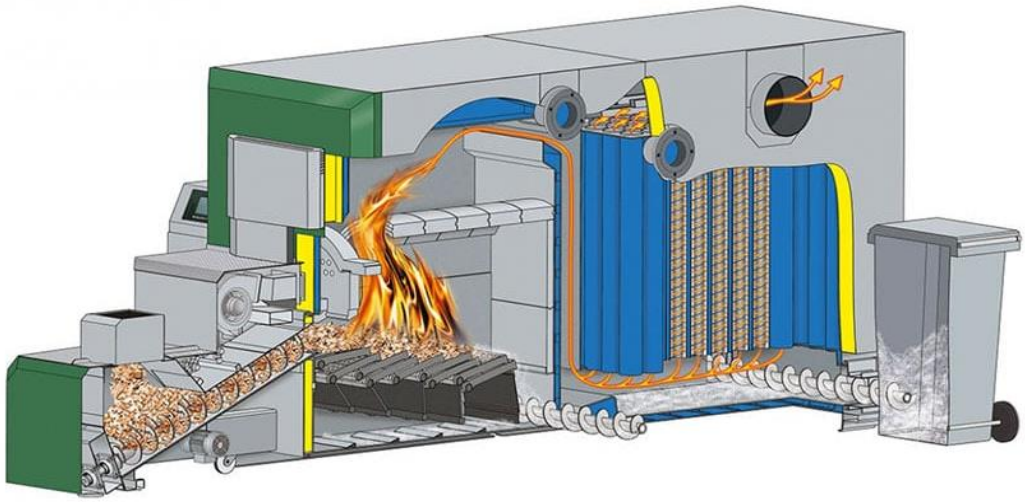


Source: https://upload.wikimedia.org/wikipedia/commons/a/a3/Pelletheizung_Biostar_Schnittbild.jpg

Woodchips and woodchip boilers

Woodchips are another type of fuel but are mostly used in multiple-family-houses in central space heaters. It is easier to handle than logwood, but the humidity is higher than in wood pellets thus also less efficient. It is also less uniform than wood pellets, thus the burning is not as clean and needs better air filters.

Picture 16: Woodchips boiler



Source: https://www.herz-energie.at/wp-content/uploads/2015/10/Herz-Hackgut-Pelletskessel-Biofire-500-1500_Schnitt.jpg

Combination of fuels

There are more and more boilers which can use both types of fuels. This can make sense if the owner is absent for a longer time and wants to keep the heating going. For these occasions, pellets can be used in combination with a regulated refuelling. For the other times, the homeowner can refuel manually with logwood.

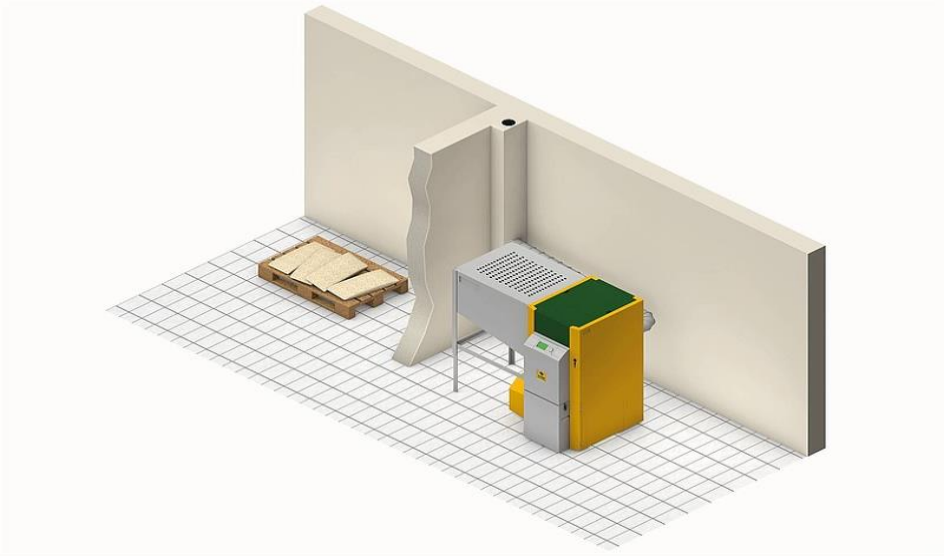
Picture 17: Hybrid boiler using both pellets and logwood

Source: https://www.geb-info.de/Cache/GENTNER/10022/p_NjE5MDkxWg.JPG

7.4.3 Types of transportation

Manual refilling of a larger depot

Picture 18: manual refilling of the depot from smaller bags

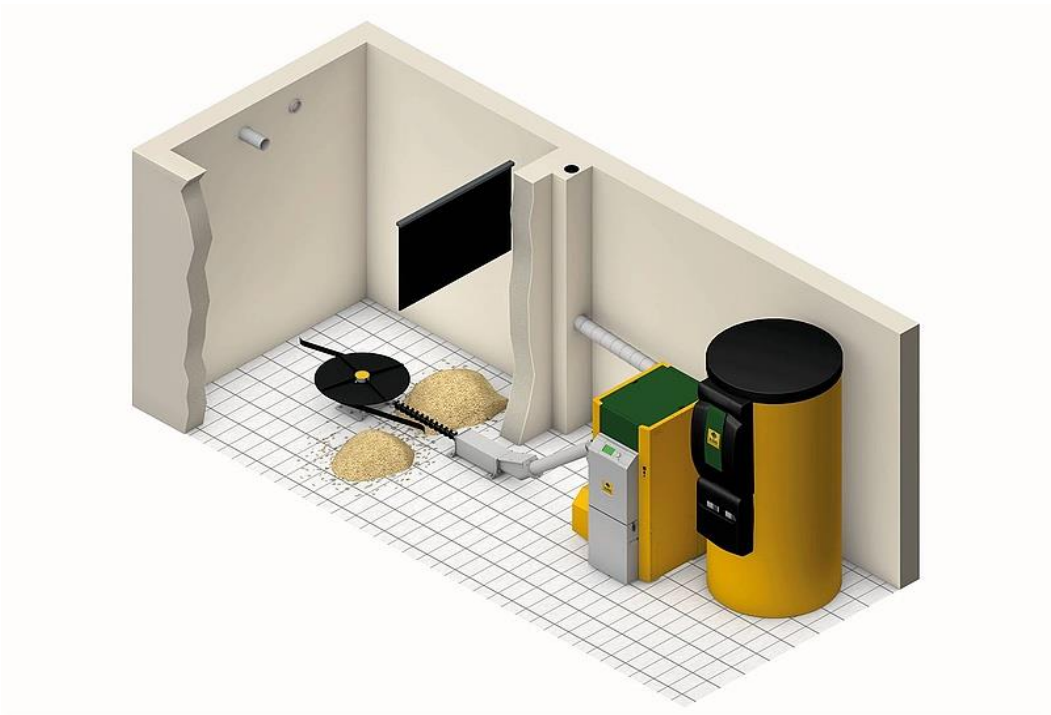


Source: https://www.energie-experten.org/fileadmin/_processed_/d/0/csm_Pelletheizung_Lagerung_und_Foerdersysteme_Vorratsbeh%C3%A4lter_mit_h%C3%A4ndischer_Bef%C3%BCllung_Grafik_KWB_06be361983.jpg

Mechanic transportation: Screw conveyers

Picture 19: mechanical transport with a screw conveyer from the adjacent pellet bunker. The bunker is usually filled, the stirring device is collecting the pellets towards the conveyer.

Source: https://www.energie-experten.org/fileadmin/_processed_/0/3/csm_Pelletheizung_Lagerung_und_Foerdersysteme_Pelletruehrwerk_Plus_mit_Knickschnecke_Grafik_KWB_3e5470ad87.jpg



Source: https://www.energie-experten.org/fileadmin/_processed_/0/3/csm_Pelletheizung_Lagerung_und_Foerdersysteme_Pelletruehrwerk_Plus_mit_Knickschnecke_Grafik_KWB_3e5470ad87.jpg

Pneumatic pellet suction system

Basically, a pneumatic pellet suction system works just like a vacuum cleaner. But instead of dust it sucks pellets and transports them to the boiler.

Pros: it can overcome larger distances with ease, e.g. with an external pellet storage outside somewhere.
Cons: it is noisier than a mechanic transportation. It also uses more energy for the turbine. And is more expensive than a mechanic transportation

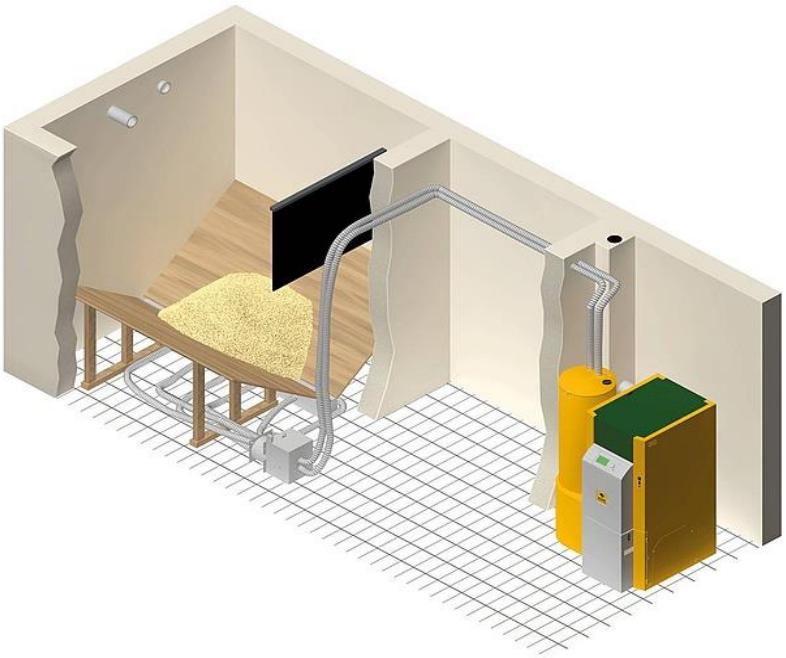
Picture 20: a mobile suction probe, called Mole

Source: https://www.energie-experten.org/fileadmin/_processed_/5/9/csm_Pelletheizung_Foerdersysteme_Maulwurf_Maulwurf_3000-E3_Foto_Mall_GmbH_9076ec7892.jpg

Picture 21: a mobile suction probe, called Mole

Source: https://www.energie-experten.org/fileadmin/_processed_/3/7/csm_Pelletheizung_Foerdersysteme_Saugsysteme_Maulwurf_3000_Foto_Mall_GmbH_3c79d694d5.jpg

Picture 22: pneumatic suction from a storage



Source: https://www.energie-experten.org/fileadmin/_processed_/f/c/csm_Pelletheizung_Lagerung_und_Foerdersysteme_Entnahmesonden_mit_Saugfoerderung_Grafik_KWB_869c9ec4a8.jpg

Picture 23: pneumatic suction from a big bag into the boiler

Source: https://www.energie-experten.org/fileadmin/_processed_/3/d/csm_Pelletheizung_Lagerung_und_Foerdersysteme_KWB_Pellet_Big_Bag_mit_Saugf%C3%B6rderung_Grafik_KWB_ce6bebf263.jpg

7.5 Example of a national recommendation page (in detail)

As an example, you can find the translation of Topten Switzerland here. (Also available online in:
German https://www.topten.ch/private/adviser/ratgeber-pellet-heizung
French https://www.topten.ch/private/adviser/recommandation-chauffage-a-granules-de-bois
Italian https://www.topten.ch/private/adviser/consigli-riscaldamenti-a-pellet

English translation:
Wood heating systems are an ecological alternative to oil and gas heating systems. If you don't want to bother with wood-bending and dragging around or if you don't have space for storing wood splinters, a modern pellet furnace can burn the renewable fuel wood very comfortably. Pellets are 1 to 5 cm long sticks, pressed from wood waste without additives, and can be filled into containers like a liquid and burned automatically.
Pellets - what is that? Pellet suppliers guide
Today, heating with wood pellets is rather cheaper than with heating oil or gas. In addition, a wood combustion does not release any additional CO2 (greenhouse gas) into the atmosphere, because the CO2 was taken from the air when the trees grew. With automatic firing of the type-tested pellet heaters, hardly any air pollution occurs and the efficiency is as high as with oil firing. And wood is an indigenous energy source, with the entire added value of its extraction lying within the country.
As a replacement for your oil and gas heating system or as central heating for a detached house, pellet heaters with output regulation offer a particularly high level of operating comfort, as they operate automatically and have an electric ignition system built in.

Here you can find the right pellet heating system

up to 20 kW capacity: The right models for 1-3 family houses
over 20 kW capacity: Models for apartment buildings

Checklist
Pellet heating boilers can usually be installed without any structural measures (except silo, see below) and connected to an existing chimney. They must be reported to the fire police. Older chimney systems may have to be renovated by means of pipe pulling in, in order to really achieve maximum efficiency (requires low exhaust gas temperatures, which could cause old and too large chimneys to become damp).
Those who do not like to lift weight regularly (pellet bags) will have a silo with automatic pellet discharge installed. This is usually possible in an oil-tank room and allows the cost-effective delivery of an annual supply of pellets by tanker and injection hose. Information on the requirements for a pellet silo (fire protection, size, etc.) is available from the suppliers of the plants. Corresponding information can also be found on the homepage of Holzenergie Schweiz (www.holzenergie.ch). If you do not want to install the rather expensive automatic discharge or only install it at a later date, you can refill the storage container at the boiler regularly from bags or with buckets from a silo as an interim solution. It should be noted that pellets in bags are considerably more expensive than those from a tanker truck.
You can find pellet suppliers in your area on the topten list of Swiss pellet suppliers, sorted by canton.

Ask for quotations: In a new building, the architect or building services planner will ask for several quotations for the pellet heating system. If it is a matter of heating system renewal, you may be able to do this yourself. In order to obtain really comparable offers, a description of the

services should be prepared. It is worthwhile to seek professional support, for example through advice from Holzenergie Schweiz or a heating specialist: on the one hand to draw up the system or service description, and on the other hand to assess the quotations with regard to price/performance ratio and technical details (e.g. no oversizing).

Tech Guide

Pellets are burnt automatically, which ensures optimum combustion quality regardless of operation, i.e. high efficiency and clean exhaust gases. Depending on the product, a demand-controlled reduction of the output is possible to 20 to 40% of the nominal output. If the heat requirement is less than the minimum output, the pellet boiler cycles, i.e. periodically switches off and on again. A (water) buffer storage tank is normally not necessary, but would reduce the frequency of the cycle (cleaner combustion!) and could also serve as a storage tank for a (possibly later to be installed) solar collector system. Most boilers are already too large, especially for very small heat output requirements of less than 10 kW (Minergie-SFH!), so that a buffer or solar combi-storage tank would make sense.

Due to the very good combustion, only little ash is produced, namely about 0.5% of the pellet weight. Therefore the ash container only needs to be emptied every few weeks. There are also boilers with automatic ash discharge (possibly as an option), which further simplifies operation. Wood ash (from pellets or clean wood!) can be used in the garden as fertiliser: spread it finely or add it to the compost. No more ash than 1,500 kg of pellets may be used per 100 m² of garden area per year; any excess must be added to the rubbish.

How does wood actually burn? Its combustion consists of three phases and takes place in this way: First, drying takes place at temperatures of up to about 150°C. During this process the water still contained in the wood is evaporated (less than 10% for pellets, 15 to 20% for dry lump wood). Between 150 and about 600°C the so-called pyrolysis or thermal decomposition takes place. During this process the gaseous compounds of the wood are released, leaving behind the charcoal. From about 400 to 1300°C, oxidation, the actual combustion process, takes place with the addition of air (oxygen). The gases released by the pyrolysis and the charcoal burn. Only now is energy released. The exact knowledge of the special characteristics of the combustion process of wood allows the construction of firings with high efficiency and lowest emissions.