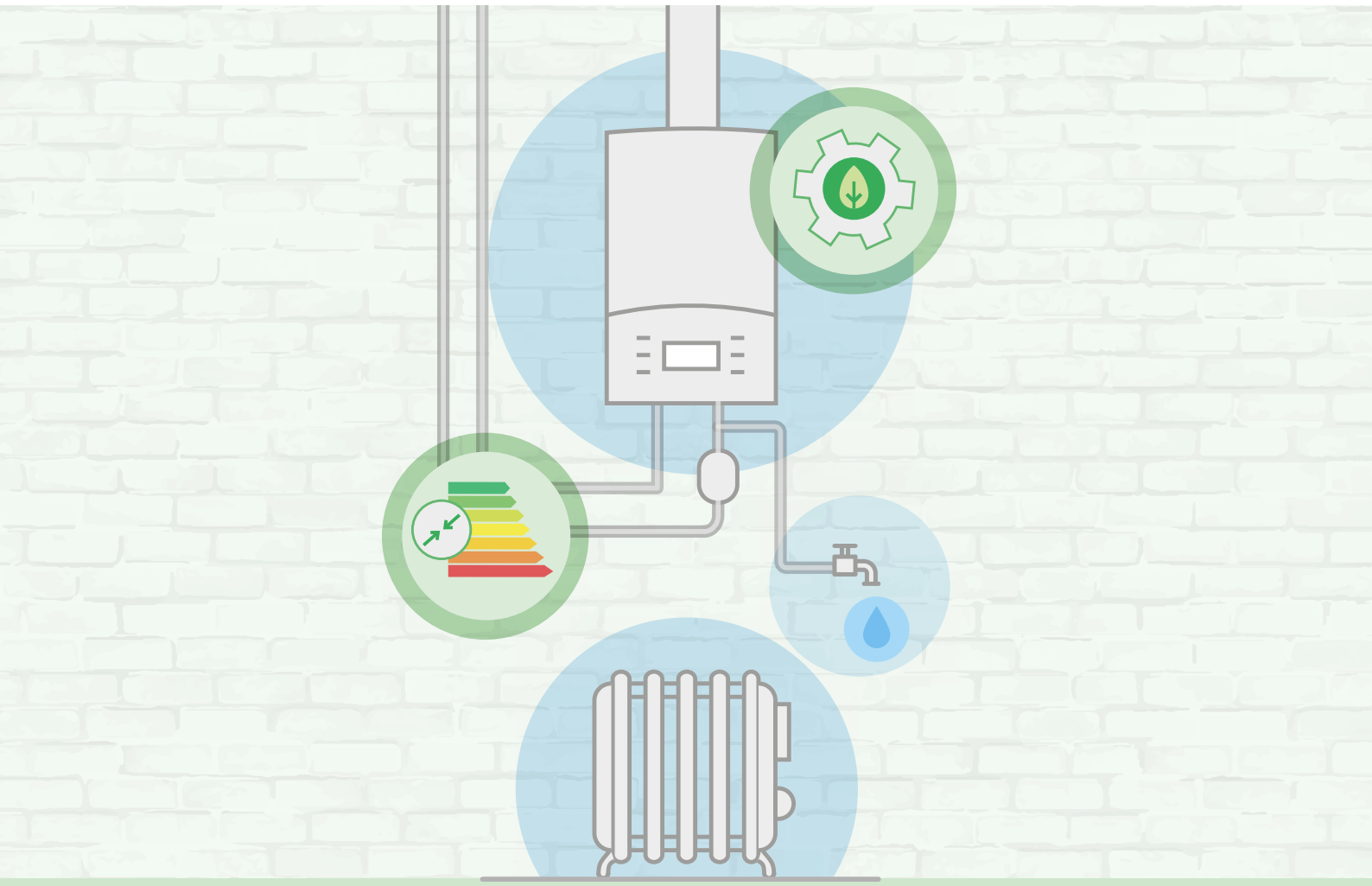
FIVE YEARS LEFT

How ecodesign and energy labelling can decarbonise heating



ECOS

coolproducts
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ECOS is an international NGO with a network of members and experts advocating for environmentally friendly technical standards, policies and laws.

We ensure the environmental voice is heard when they are developed and drive change by providing expertise to policymakers and industry players, leading to the implementation of strong environmental principles.

ECOS, together with European Environmental Bureau (EEB), co-leads the Coolproducts campaign, working to ensure that ecodesign and energy labelling truly work for Europeans and the environment.

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Executive Summary

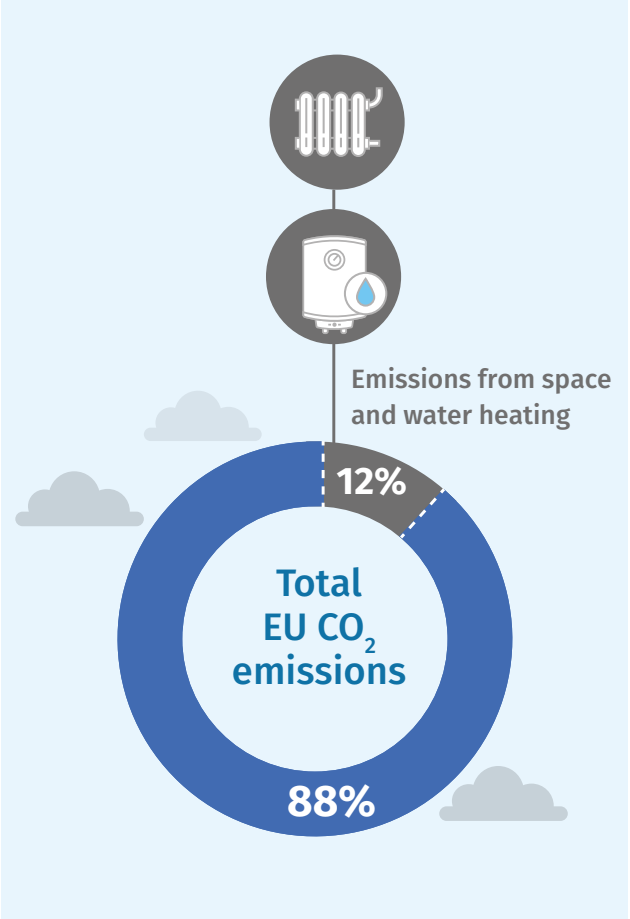
Decarbonising heating is both necessary and entirely possible. The good news is that the barriers to doing so are not technological — they are political. The legislative tools are already in place; they simply need sufficient strengthening.

28%[1] of the total energy consumed in the EU is used in space and water heating. For the residential sector, more than 75%[2] of the energy produced for heating currently comes from fossil fuels (gas, oil and coal). As a result, CO_2 emissions from space and water heating represent 12%[3] of the total EU emissions, as much as all cars in Europe combined. Most of us are now aware of the impact of emissions caused by cars, but we often overlook the amount of greenhouse gases emitted from our own homes - mostly due to heating.

Heating is essential, but in the face of the climate emergency we will need to find a way to heat our houses *and* reduce our energy consumption and CO_2 emissions at the same time. The European Union must take concrete actions to decarbonise the heating sector as an absolute priority. Otherwise, the EU simply does not stand a chance to achieve its 2030 climate goals: at least 55% emission reduction (proposed by the European Commission but not yet agreed) and climate neutrality by 2050.

Luckily, we do not need to look far for a solution to decarbonise space and water heating: relevant legislation is already in place in the EU. Adopted in 2013, the ecodesign and energy labelling regulations for space and water heaters currently contribute to cutting 80 million tonnes CO_2-equivalent emissions each year, compared to 2010 levels[4].

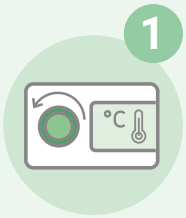
Now we must go one step further and make these regulations bolder. At their full potential, sufficiently strong rules could bring about additional **30 Mt of annual CO_2 savings by 2030, 90 Mt by 2040, and 110 Mt by 2050**. This represents nearly two thirds of the emission reductions needed from residential and public buildings to achieve carbon neutrality by 2050[1].



What needs to be done?

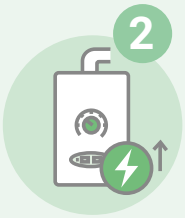
For the EU to reach at least a 55% reduction in emissions by 2030 – as proposed by the European Commission - and become climate neutral by 2050, a swift and massive decarbonisation of the heating sector is needed.

This will require extensive efforts in (at least) two directions:



Reduce heat demand

through thermal improvement of buildings and more conscious consumer use of space and water heating (e.g. lowering your thermostat by 1°C will help you save 3% of energy per day).



End the installation of fossil fuel-based and inefficient electric heating systems

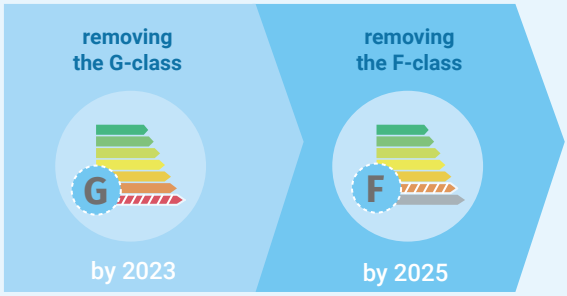
and replace them with renewable sourced ones, e.g. efficient heat pumps, solar thermal or hybrid heat pumps[5].

How can we do it?

Rescale the energy label and adapt the class boundaries

to downgrade the majority of fossil-fuel powered appliances, including condensing gas boilers, to the lowest grades: F and G.

then progressively phase out those appliances in a simple two-step process through ecodesign regulations:



The EU needs to end the installation of new fossil fuel boilers below 400 kW[6] by 2025. This could be done gradually, allowing both consumers and manufacturers to plan well ahead. Heating appliances usually last longer than 20 years: if we continue installing new gas or oil boilers from 2025 onwards, we will still use fossil-fuel powered boilers in 2050, by when we must already be climate neutral.

The European Commission is currently revising the ecodesign and energy labelling regulations, a process that started in 2018. However, at the moment we see a huge gap between the climate ambitions put forward by the Commission's leadership and the superficial proposals for the revision of the actual product legislation, still granting unfair legal advantages to fossil fuel technologies such as condensing gas boilers. Even more worrying, the current plans involve the mirage of 'decarbonised gases', such as hydrogen, as an option to decarbonise heating, despite the mounting evidence showing that these rare gases should be used only in priority sectors that are hard to electrify, which is not the case of domestic heating. If we do not act now, we will suffer the consequences well beyond 2030.

We are running out of time, and the EU must take action before it is too late.

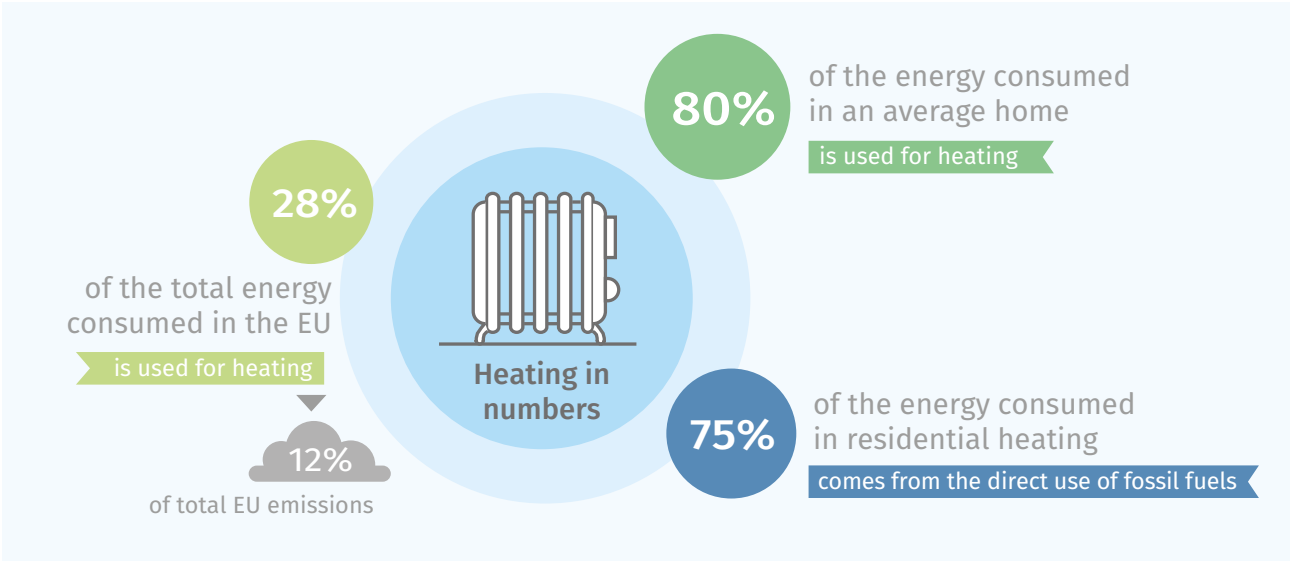
The scale of the problem and the challenge of decarbonisation

Heating is one of the EU's most energy-hungry sectors. 300 million tonnes of oil equivalent (Mtoe) of final energy consumption were devoted to space and water heating in residential and public buildings combined in 2017. That is 28% of the total energy consumed in the EU[7].

Those levels have remained relatively stable in the last couple of decades because technical progress in energy efficiency was cancelled out by the growth in population, number of heated spaces, and wasteful heating habits.

Heating represents about 80% of the energy consumed in an average home (65% for space heating and 15% for water heating)[8], although rates vary, based on the characteristics of buildings and the climate in their location.

More than 75% of the energy consumed in residential heating comes from the direct use of fossil fuels (gas, oil and coal)[9]. CO_2 emissions from space and water heating in EU homes reached about 500 Mt in 2015[10], representing 12% of the total EU emissions; polluting as much as all cars in circulation in Europe. In addition to this, emissions from public buildings amounted to about 220 Mt in 2015[11].



The European Commission has acknowledged that a switch of power sources is key for buildings to contribute to the 2030 climate target[12]. But that is only half a success. It is also essential to end the installation of new fossil fuel boilers earlier than in 2030.

Not all countries pollute to the same extent, however, and the CO_2 intensity of residential heating is highly variable from one country to another in the EU, depending on the energy mix and the main technologies in use:

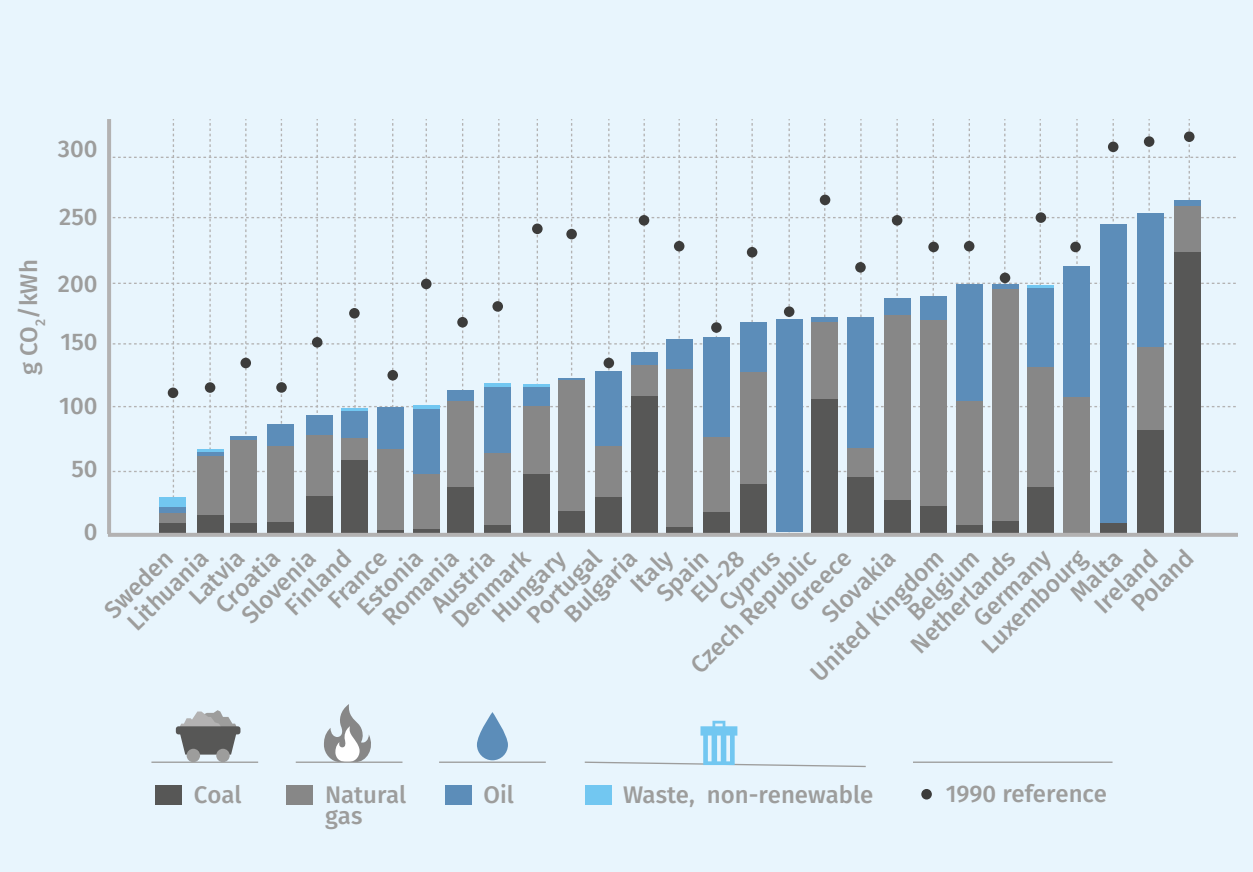
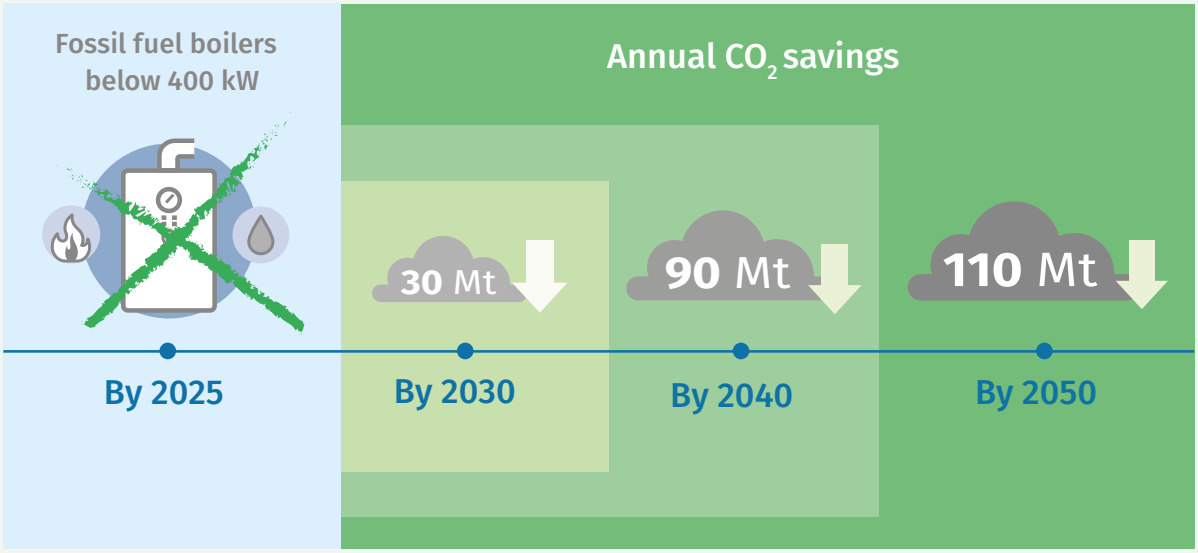


Figure 1 **Average g CO_2 per kWh heat used per EU Member State in 2015 with 1990 as a reference level[10]**

According to our calculations[13], removing fossil fuel boilers below 400 kW from the market by 2025 would bring about 30 Mt of annual CO_2 savings by 2030, 90 Mt by 2040, and 110 Mt by 2050 compared to the business-as-usual scenario, with the current legislation in place. The hypothesis assumed for this calculation considers widely implemented building insulation and renovation, driving a steady decrease in average heat demand per dwelling.



Savings brought by removing new fossil fuel boilers from the market would account for nearly two thirds of the emission reductions needed in homes and public buildings to achieve carbon neutrality by 2050 (according to the EU roadmap for a climate neutral economy[12]).

What are the options? An overview of the different heating technologies

Boilers are the most common heating systems used in Europe. Heat is produced by an appliance, often located in a basement or a closed room, and then distributed to different rooms or flats in a building through a system of radiators where hot water circulates.

To heat this water we need energy, which may originate from different sources

Directly burning (fossil) fuels

Boilers may be powered by gas from the piping system or a tank, or by oil stored in a deposit. Depending on the technology used and the conditions of the system, the efficiency of heaters directly converting fuel into heat can reach up to 92-94% for the most recent condensing gas and oil boilers. But efficiency rates are much lower for older appliances. The remaining heat is lost in the process.

Using solar energy to heat water

Solar thermal panels on the roof heat up water in a storage tank. This solution is particularly interesting for southern countries where it could cover 100% of the total hot water demand. It can be installed together with a backup boiler where solar thermal energy cannot fully cover the hot water needs[14].

Using electricity

1. With a heat pump, taking energy from the outside air or the ground through a heat exchanger. This is the best-performing heating technology. Electric heat pumps can reach efficiencies above 200%[15] as they amplify their output using technologies that take advantage of renewable energy sources to produce heat.

2. Directly, with a resistor emitting heat thanks to the Joule effect. This is the least efficient way to produce heat (35-40% efficiency because of the low efficiency of electricity generation): energy is needed to generate the electricity, which is distributed through the grid. This electricity is then converted into heat.

Different technologies are associated with different levels of CO_2 emissions, depending on their energy source.

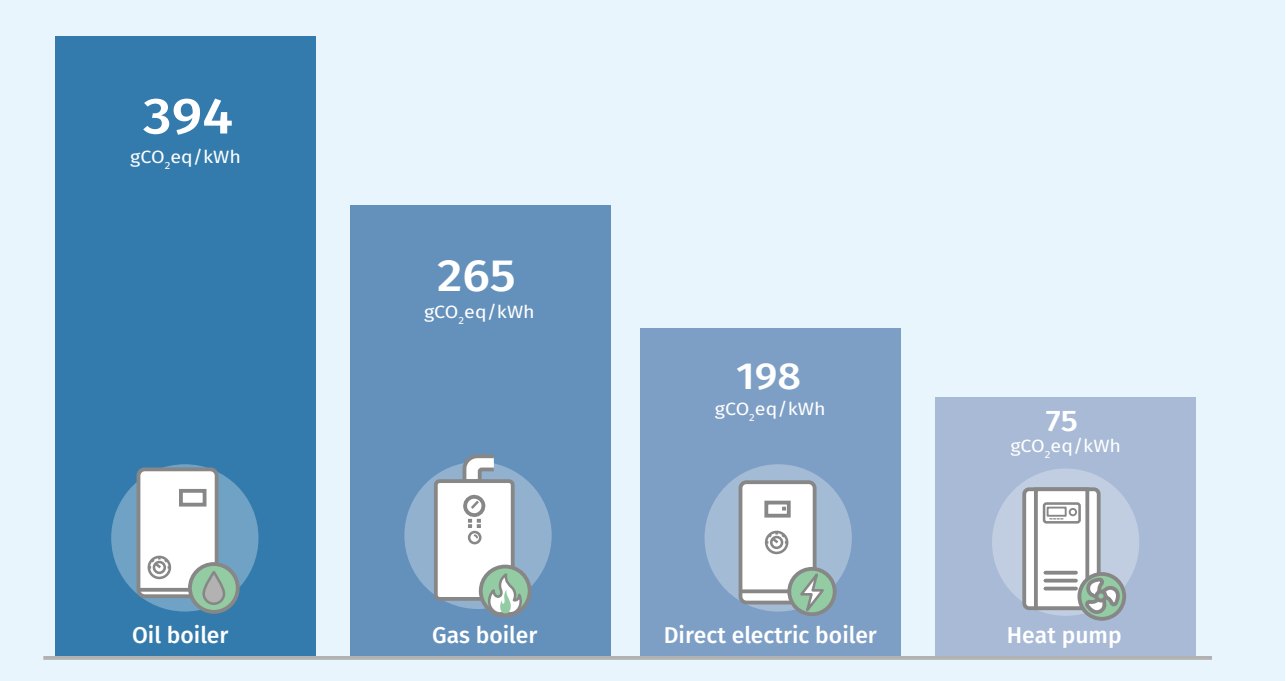


Figure 2 Average CO_2 emissions (gCO_2eq) per kWh of heat produced by technology[16]

Not all technologies are equally polluting, but most of the installed heaters are of the most polluting types. Among the 129 million boilers installed in the EU, more than 50% are inefficient, ranked in C or lower energy classes[17] (75-82% efficiency). Moreover, almost half of the buildings in the EU are equipped with boilers that were installed before 1992 and are still in use today[18].

Gas boilers account for most of this installed stock[19] (58%), and the regulation in place has been designed to push consumers to replace old gas boilers with condensing gas boilers. The latter are on average 30% more efficient, reaching up to 94% efficiency if properly installed, but still burn fossil fuels on a large scale, which makes them unfit for a climate-neutral world.

Heating appliances have long lives, and measures taken now will determine whether we can meet our climate neutrality objectives.

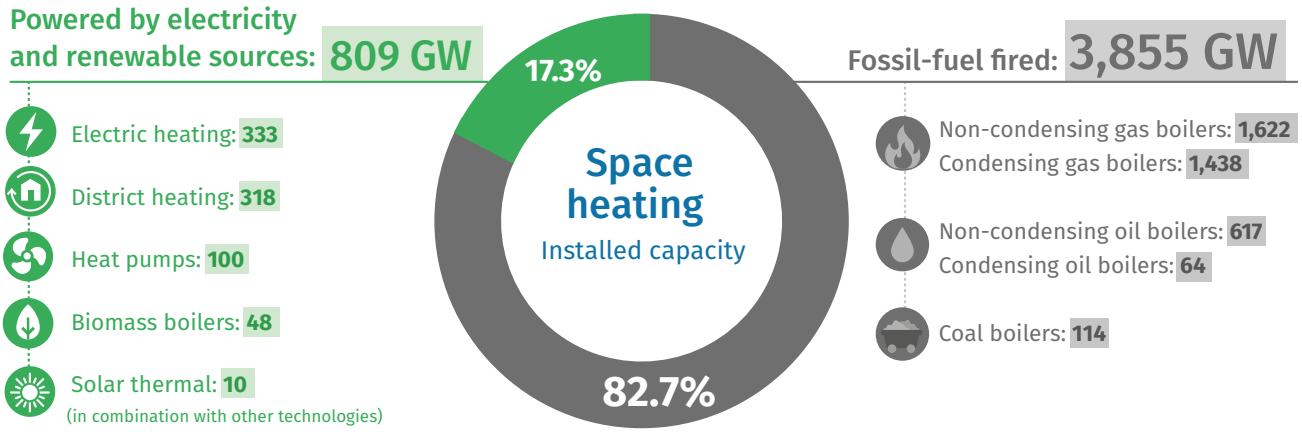


Figure 3 Installed capacity of space heating in the EU in 2017 (GW)[20]

The role of ecodesign and energy labelling

More than 70% of the heat produced in European homes is generated by systems regulated under the EU ecodesign and energy labelling policies[11]. The lion's share of space heating is provided by central heating systems, 84% of which directly use fossil fuels and emit large amounts of CO_2. Gas boilers are the dominant technology, representing 58% of the installed stock[21].

It is estimated that the first ecodesign and energy labelling regulations for space and water heaters, gradually applied from 2015, have enabled savings in CO_2 emissions of about 20 Mt in 2020[4] (while the total estimated emission reduction from ecodesign measures in 2020 amounts to 306 Mt[12]). This is of course good news, but we are still far from a sufficient level of emissions reduction to achieve decarbonisation by 2050. Worse still, it took as many as seven years of discussions (from 2006 to 2013) to adopt these measures.

The existing regulations present three major shortcomings:

1. They do not set an end date for fossil fuel heating systems;
2. Fossil fuel boilers and water heaters can get an 'A class' on their energy labels, sending a misleading message to consumers;
3. The most inefficient direct electric heating systems and electric water heating systems are still allowed on the market.

These regulations are currently under review, but the discussions at EU level are simply not in line with the required level of ambition with regard to emission reduction targets for 2030. To make matters worse, there seems to be no political pressure to fundamentally revise energy labels and remove fossil fuel heaters from the 'A class'.

A quick and successful phase-out: the case of incandescent light bulbs

Some argue that the ecodesign legislation is meant to gradually improve the performance of the products available on the market but not ban an entire technology. However, there already is a precedent that shows that the opposite is true: light bulbs.

In 2009, the EU set a calendar to phase out incandescent lightbulbs from the market, as part of a new ecodesign regulation for lamps. In several stages, the ban was successfully implemented, and it is now practically impossible to find traditional incandescent and halogen models in European shops.

The shift from incandescent to LED technology was not a simple one back in 2009, as the alternatives to incandescence still needed improvement. However, this radical phase-out has since proven to be worth the effort. The average energy efficiency of a lightbulb on the market is now 10 times higher than before the ban, and the lighting sector has been the most successful one in reducing its overall energy consumption in the last years.

Two rescalings for the energy label in the next 10 years

The current energy label for space heating appliances was designed primarily to encourage consumers to replace old, inefficient boilers with more efficient condensing boilers: this explains why condensing gas boilers are labelled A (or A+ when sold together with a thermostat control, which is almost always the case).

Since September 2019, energy labels for packages range from A+++ to G, and energy labels for products range from A+++ to D[22], favouring a positive perception of rather inefficient solutions such as condensing gas boilers. Today's 'A class' boiler would get an 'E' on a label rescaled to an A - G scale[23]. Consumers reportedly[24] tend to opt for higher efficiency classes and would be more likely to invest in efficient solutions if the label were rescaled. As it is, the existing labels ranging from A+++ to G miss their point, as they no longer give consumers reliable information.

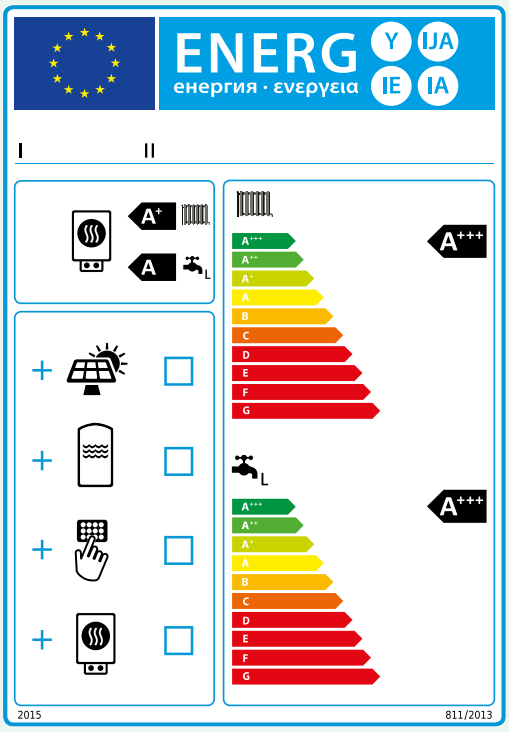


Figure 4 Package label in application since 2015

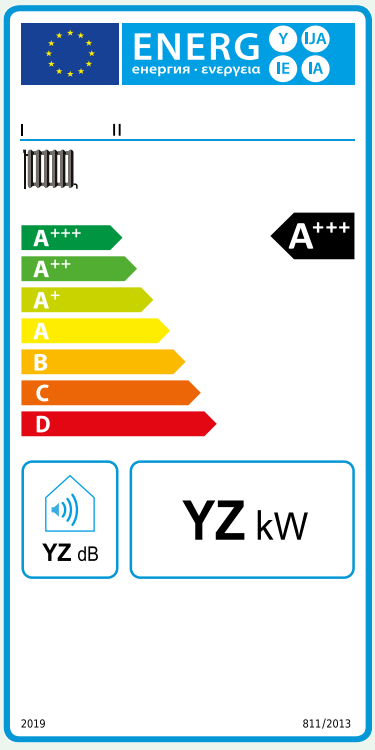


Figure 5 **Space heaters:** Product label applicable since 26 September 2019

Rescaled energy labels for a number of appliances

As of 2021, washing machines and washer-driers, dishwashers, fridges, TVs and electronic displays and lamps will sport new rescaled energy labels. The European Commission is going to great lengths to raise awareness about the new scale[25], highlighting its simplification and the fact that an A+++ appliance could now be labelled C in line with the new scale.

Two ongoing Horizon 2020 projects, LABEL 2020[26] and BELT[27] - with a combined funding of 5 million euros – are designed to promote and explain the new generation of labels, and Member States are spreading the word through their own communication channels, too.

This approach is radically different to the one for space and water heaters, for which a specific derogation could delay the rescaling of those products until 2030[28].

For water heaters, we have reached a point where the labels are so outdated that only the top four classes remain in use. Such use of the energy classes is far from optimal, as it limits the ability of consumers to tell products apart and hinders innovation efforts.

To make matters worse, the proposal to revise the energy label currently on the table puts forward keeping the A+, A++ and A+++ classes. Should this be the case, it would create confusion as other products are transitioning into a rescaled A-G label, with the European Commission informing consumers that the 'A+' family is a thing of the past.

It goes without saying that rescaling is a must. However, the European Commission needs to make sure that this process is smooth and efficient. Unfortunately, this does not seem to be the case: the Commission is putting minimal changes on the table for the near future, merely meant as an adaptation to the new Primary Energy Factor[29] (reflecting a higher proportion of renewables in the electricity grid).

However, an already adopted legislation obliges the European Commission to propose an A-G energy label for heaters by August 2026[30]. This means that the EU plans to rescale the energy label for heaters twice in five years - a waste of time and taxpayers' money.

Instead, only one comprehensive rescaling should be done as soon as possible. A much stronger signal needs to be sent to consumers who should not be given any incentives to invest in long-lasting products powered with fossil fuels.

The long and heavily-lobbied road to the first energy labels for boilers

2013

No less than seven years were needed to finalise the first ecodesign and energy labelling measures for central heating boilers and water heaters, adopted in 2013. Delays were partly due to the highly technical nature of the products, but the process was made deliberately harder by some industry representatives. They did not agree with some of the general principles of the Commission's regulatory approach: the technical reasoning in primary energy (to ensure that technologies using different fuels could be fairly compared), and their objective to give a strong push to solutions based on renewable energy (and not just fossil fuels).

Some conservative industry players still consider that the ultimate role of the energy label should be to merely pursue a shift from non-condensing to condensing fossil fuel boilers, which can deliver some savings but would keep us locked in unsustainable solutions for too long. The controversy was so strong at the time that even the then Energy Commissioner Gunther Oettinger became involved in the discussions[31]. As a result, a regrettable specific derogation was given to fossil fuel powered space and water heaters in the 2017 Energy Labelling regulation, granting some of them undeserved 'A-class' grades until 2030.

The introduction of the regulation in 2013 took so long that by the time the measures were adopted, the minimum energy efficiency level of 86% was already the average declared efficiency level of the space heaters sold that year[32].

Hydrogen is not the solution

Current plans point to a minor revision of the ecodesign regulations based on flawed hypotheses

A recent study reviewing these regulations - commissioned by the European Commission[33] - assumes that fossil fuel boilers and water heaters would continue to be installed until 2050, making it impossible to achieve the EU's climate targets for 2030 and 2050.

The only solution suggested in the report is to hope that by 2040 large amounts of hydrogen will suddenly be available and usable in piping systems to replace fossil gas[34] - which is improbable to say the least. Several studies directly contradict that assumption because decarbonised hydrogen is produced through electrolysis, a process with large conversion losses[35]. Not even the gas industry[36] foresees a role for hydrogen in buildings. They do speak of biomethane, but a study from the ICCT[37] - an independent organisation – has already shown that only less than 10% of the heat demand could be met by renewable methane.

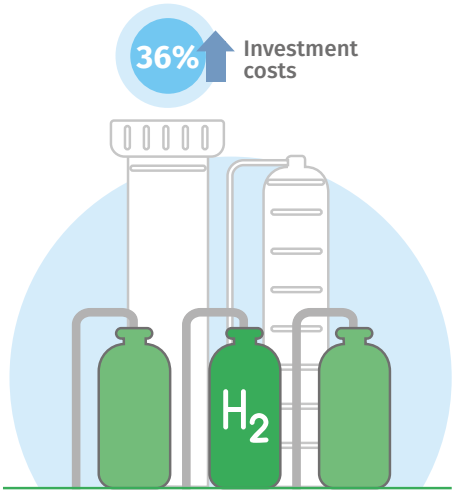
Hydrogen produced from renewable (ideally excess renewable electricity) will be limited in amount and highly valuable: it should therefore be channelled only to those sectors that, as of yet, have no other option to be decarbonised (for example energy-intensive industries or long-haul transportation such as maritime transport and aviation).

Besides the limited amounts of hydrogen available, there are also concerns about safety when burning hydrogen for heating, in particular associated to its high flammability.

In terms of costs, extending the use of renewable hydrogen to the heating and road transport sectors risks supersizing the energy infrastructure, adding up to 36% of investment costs[28].

Decarbonising heating will require a combination of different technologies and approaches. An important role needs to be given to large-scale deployment of heat pumps, district heating and thorough renovation of buildings.

The current approach of delaying meaningful decisions and placing risky technological bets on the future will not get us anywhere near our goals. Considering the long lifetime of heating systems, the EU must take much bolder steps towards climate neutrality right now and set an urgent expiry date to fossil fuel heaters.



Can the EU fix it? Policy recommendations

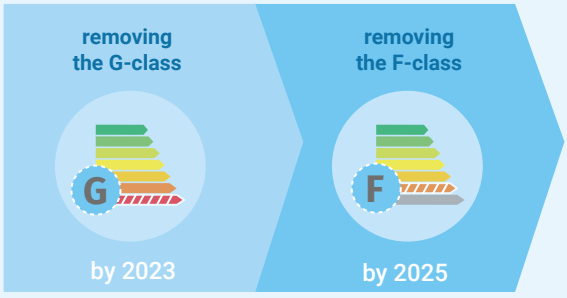
The technologies already exist to allow for a phase-out of fossil-fuel powered heating appliances. The necessary legislative tools are also available. It is now crucial to use them in a way that is coherent with Europe's emission reduction targets and climate objectives.

We call on the European Commission to act now. A revised, forward-looking regulation must be presented to the Ecodesign and Energy Labelling Consultation Forum[38] as soon as possible.

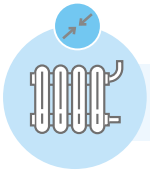
The phase-out of fossil fuel powered appliances should be done in two steps:

Rescaling of the energy label and adaptation of the class boundaries to downgrade the majority of fossil-fuel powered appliances, including condensing gas boilers, to the lowest grades: F and G.

A two-step phase-out for those appliances through ecodesign regulations:



Rescaling the energy label



Rescaling for space heaters

The current proposal by VHK, the consultancy in charge of the review studies for the European Commission, sets the following criteria for space heaters energy labels:

Proposal from VHK (PEF=2.1)[39]	Examples of space heaters falling into each category	Class width[40]
A+++ (Eff >150%)	Best ground source heat pumps with good controls, heat pumps + solar hybrids	n.a.
A++ (Eff 125 - 150%)	Heat pumps, best hybrids (gas or oil boiler + heat pump), heat pump + solar hybrids	14%
A+ (Eff 98 - 125%)	Heat pumps, hybrids (gas boiler + heat pump) heat pump + solar hybrids	15%
A (Eff. 90 - 98%)	mCHP[41] (micro Combined Heat & Power), solar hybrids, heat pumps, hybrids (gas or oil boiler+ heat pump)	15%
B (Eff. 82 - 90%)	Solar + boiler hybrids, mCHP (micro Combined Heat & Power)	15%
C (Eff. 75 - 82%)	Condensing boilers	21%
D (Eff. 36 - 75%)	Non-condensing B1 boilers	n.a.
E (Eff. 34 - 36%)	Electric boilers	
F (Eff. 30 - 34%)	(Empty class)	
G (Eff. > 30%)	(Empty class)	

Figure 6 **Revised energy classes on the space heater label as proposed by VHK**

X

This label would not be good solution, for several reasons:

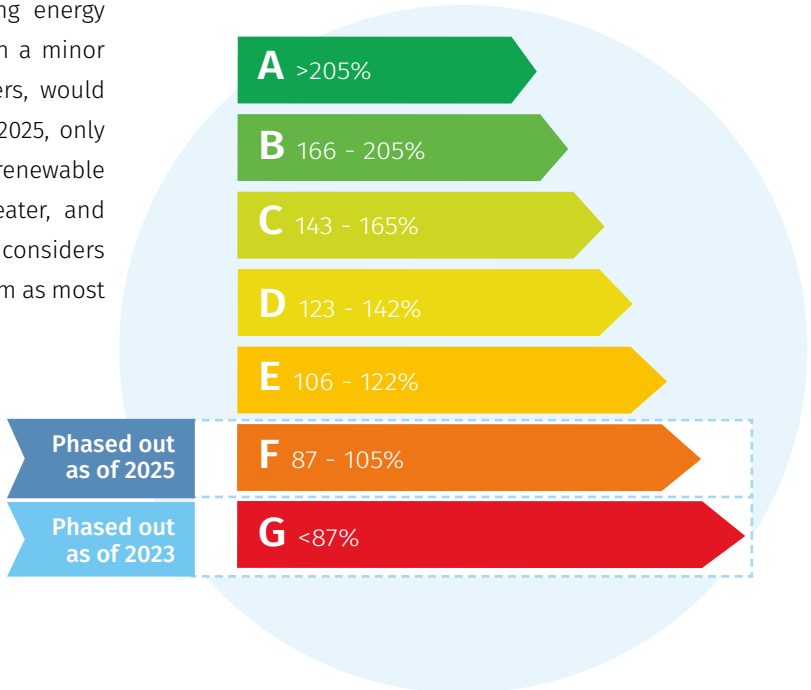
- The lowest classes are mostly empty,
- There are four different A classes, which sends a wrong and confusing message to consumers;
- It will have to be rescaled again before 2026.

We propose a rescaled energy label for space heaters as follows:

Proposal from Coolproducts (PEF=2.1)	Examples of space heaters with proposals	Class width
A (Eff. >205[42]%)	Empty as requested by the Energy Labelling Framework Regulation	n.a.
B (Eff. 166 - 205%)	Best ground source heat pumps with optimal controls, best hybrid heat pumps , best hybrids heat pumps+ solar	14%
C (Eff. 143 - 165%)	Heat pumps, boiler + HP hybrids, HP + solar hybrids	15%
D (Eff. 123 - 142%)	mCHP + solar hybrids, Heat pumps, boiler + HP hybrids	15%
E (Eff. 106 - 122%)	Solar+ boiler hybrids, mCHP	15%
F (Eff. 87 - 105%)	Condensing boilers (phased out as of 2025)	21%
G (Eff < 87%)	Non-condensing B1 boilers, Direct Electric boilers (phased out as of 2023)	n.a.

Figure 7 Rescaled energy label proposal by Coolproducts

The limit between F and E class should be set at 105% of efficiency rate level (Seasonal space heating energy efficiency η_s[43]). This way, fossil fuel boilers with a minor assistance of renewables, such as hybrid boilers, would be excluded from the market from 2025. After 2025, only efficient technologies operating mainly with renewable energy, possibly with a back-up fossil fuel heater, and mCHP would remain available for sale. This scale considers the efficiency of the product and its control system as most products are sold with it anyway.



Rescaling for water heaters

The current rules for energy labelling for water heaters are shown in Annex 3. As in the case of space heaters, only three to four energy classes are used in practice, which makes it close to useless as the differentiation between technologies is minimal.

The table below shows an overview of the technologies available, sorted by efficiency class:

Existing label (PEF=2.5)	Types of water heaters (WH) on the current energy label (including package label A++, A+++)
A+++	• XXS - S sizes[44]: Heat pumps and solar-assisted[45] WH Condensing gas or oil WH, Best non-available technologies (also for 3XS) • For bigger sizes: Solar-assisted WH, and heat pump WH using higher temperature sources
A++	• XXS - S: Heat pumps and solar-assisted WH Condensing gas or oil WH, Best non-available technologies (also for 3XS) • Size M and larger: High-end heat pumps using ventilation air or other higher temperature sources, solar assisted WH
A+	• 3 XS - S: Fuel fired, heat pump and solar-assisted WH • M and larger: Heat pump and solar-assisted WH
A	• 3XS - XXS: All technologies, including electric WH • XS and larger: Oil or gas fired, heat pump, and solar assisted WH
B	• 3XS – S: All technologies, including electric WH • M and larger: Oil or gas fired, heat pump, and solar-assisted WH
C	All sizes, all technologies, including electric WH
D	(Empty class)
E	(Empty class)
F	(Empty class)
G	(Empty class)

Figure 8 Water heater technologies on the current energy label, per size (see Annex 3 for further details)

For water heaters, the EU proposal currently under consideration suggests reworking the label for a more balanced distribution of available heaters across the scale (class width) and move from PEF = 2.5 to PEF = 2.1[46]. However, a complete rescaling is not even being considered. Instead, the proposal keeps several empty classes and reintroduces A++ and A+++, a confusing message for consumers, as in the case of space heaters.

Implementing two successive rescalings in the coming five to ten years and re-introducing the A+++ class will not help improve the efficiency of water heaters. Instead, we propose a bolder rescaling for this obsolete energy label, as follows:

Current proposal from Commission consultants	Coolproducts proposal	XXS-S	M	L	XL	XXL	3XL	4XL
A+++	A	169	251	306	346	366	418	473
A++	B	124	165	193	213	223	248	276
A+	C	96	117	130	140	145	158	172
A	D	77	88	95	99	102	108	115
B	E	64	69	72	75	76	79	83
C	F	54	56	58	59	60	61	63
D	G	45	47	48	48	49	49	50
E	In G	39	39	40	40	40	41	41
F	In G	33	33	34	34	34	34	34
G	In G	None	None	None	None	None	None	None

Figure 9 Efficiency limits of label classes of the new label scale with a PEF = 2.1

According to our proposed scale, technologies would be distributed as follows (see Annex 4 for more details):

Suggested label (PEF=2.1)	Technologies and sizes of water heaters (WH) that would be included in the class
A	Empty as requested by the Energy Labelling Framework Regulation
B	• Solar-assisted WH[47] • High-end heat pump (best next available technology) and heat pump using higher temperature sources WH
C	Heat pump WH and solar-assisted WH[40]
D	Heat pump WH and solar-assisted WH[40]
E	• XXS-X sizes: Heat pump WH, and solar assisted WH. Oil or gas combi-boilers • Size M and larger: Oil or gas fired WH, heat pump WH, and solar-assisted WH
F	Oil or gas fired, heat pump WH, and solar-assisted WH
G	All technologies, including electric WH

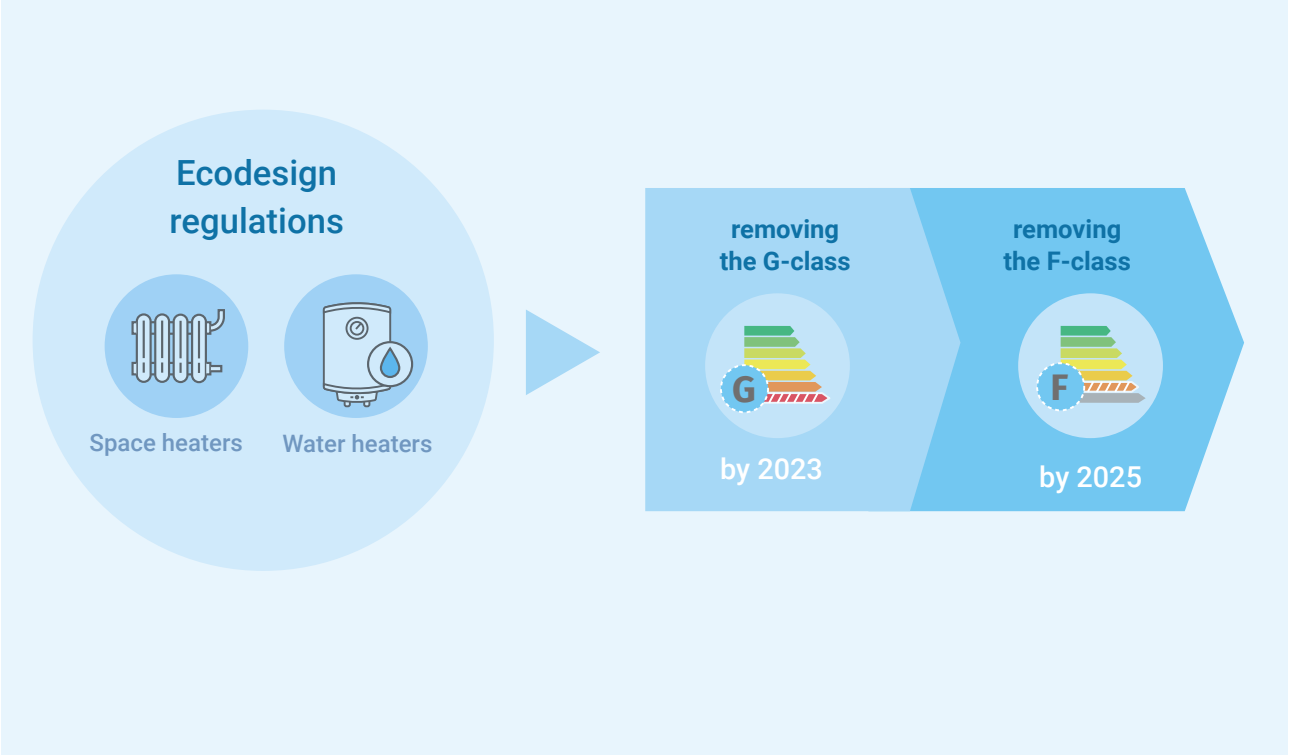
Figure 10 Rescaled energy label proposal by Coolproducts[48]

A two-step phase-out of fossil fuel appliances

Ecodesign regulations for space and water heaters should work together to phase out G-class by 2023 and F-class by 2025, setting a minimum efficiency threshold at 105% for space heating and at 65-100% for water heating appliances, depending on their size. The distribution of these tiers should be agreed and adopted in the current review.

The only fossil fuel fired appliances that ought to remain in the market are hybrid heat pumps and solar water heaters with fossil fuel back-up. In these cases, fossil fuel heaters are used as a back-up for renewable sourced technologies, and not the other way around.

According to our calculations, phasing-out fossil fuel space heaters below 400 kW by 2025 would bring about 30 Mt of annual CO_2 savings by 2030, 90 Mt by 2040, and 110 Mt by 2050 compared to business-as-usual with current legislation in place[49].



Annexes

Annex 1

Calculations behind our assessment of CO_2 savings by 2030, 2040 and 2050 by phasing out fossil fuel-fired space heaters

Two technical studies were conducted in 2017 to inform the revision of the ecodesign and energy labelling regulations for central heating boilers and water heaters. These studies were carried out by a consortium led by the consultancy VHK, and are available on

- www.ecoboiler-review.eu/Boilers2017-2019/documents-boilers-2017-2019.htm and
- www.ecohotwater-review.eu/documents.htm

It is important to note that these studies foresee a 25% decrease in heat demand per dwelling between 2015 and 2050, even in the business-as-usual scenario. Better insulation and renovation of homes is therefore considered essential and taken for granted. Even higher levels of heat demand reduction could be envisaged with aggressive renovation plans, which would make it even simpler to eliminate fossil fuels in heating.

The study on heaters proposes a legislative scenario which does not include the phase-out of fossil fuel boilers by 2050. It assumes the following levels of boiler sales and stock in the EU-28 (including the UK, as the assessment was carried out in 2019):

Sales ECO (000 units)	1990	2010	2015	2020	2025	2030	2035	2040	2045	2050
Gas non-cond	3,852	1,995	1,480	452	258	87	60	37	22	9
Gas cond	129	3,466	4,048	5,276	4,724	4,153	3,351	2,555	1,698	857
Jet non-cond	1130	350	118	40	30	22	16	10	6	3
Jet cond	0	117	196	274	270	261	239	208	161	96
Elec Joule	42	67	64	70	65	60	55	50	45	40
Hybrid	1	3	10	22	294	566	860	1154	1451	1747
Elec HP	20	285	346	589	1124	1658	2236	2814	3446	4077
Gas HP	1	3	8	18	95	173	260	347	435	524
mCHP	2	3	8	15	32	49	66	84	102	121
Solar combi (16 m^2)	19	33	39	38	46	54	65	76	87	99
Boiler >400 kW	30	30	30	30	30	30	30	30	30	30
Total central heating boiler, space heating	**5,226**	**6,354**	**6,348**	**6,825**	**6,969**	**7,112**	**7,238**	**7,365**	**7,484**	**7,603**

Stock ECO (000 units)	1990	2010	2015	2020	2025	2030	2035	2040	2045	2050
Gas non-cond	47,237	68,112	56,841	38,517	20,752	10,635	4,314	2,232	1,077	634
Gas cond	643	27,317	43,291	64,405	80,444	86,045	82,502	69,148	55,730	41,058
Jet non-cond	25,845	22,141	17,708	12,962	8,346	3,962	1,467	703	449	307
Jet cond	0	521	1,302	2,505	3,858	5,134	5,848	6,035	5,663	4,923
Elec Joule	729	942	1,035	1,177	1,255	1,218	1,168	1,054	963	873
Hybrid	17	25	52	133	1,054	3,327	6,994	11,904	17,092	22,391
Elec HP	349	2,506	3,836	5,863	9,693	15,379	23,561	33,209	43,559	54,369
Gas HP	5	25	48	112	428	1,123	2,210	3,637	5,161	6,731
mCHP	11	39	59	113	228	422	676	972	1,288	1,613
Solar combi (16 m^2)	270	437	529	616	710	802	896	1,045	1,229	1,429
Boiler >400 kW	524	545	552	558	564	565	554	543	543	543
Total central heating boiler, space heating	**75,630**	**122,611**	**125,252**	**126,960**	**127,330**	**128,612**	**130,189**	**130,481**	**132,752**	**134,871**

In our calculations, we assume that fossil fuel models (gas and jet non-condensing and condensing boilers) will no longer be available for sale as of 2026. This substantially reduces the stocks of fossil fuel boilers in 2030, 2040 and 2050. Likewise, we assume that the avoided sales of fossil fuel boilers will be replaced by the other listed technologies proportionally, so that stocks remain identical[50]. This would lead to the following full stocks in 2030, 2040 and 2050:

Stock OWN (000 units)	2030	2040	2050
Gas non-cond	9,858	0	0
Gas cond	64,138	36,422	0
Jet non-cond	3,836	0	0
Jet cond	3,811	3,694	812
Elec Joule	2,538	1,827	1,334
Hybrid	6,932	20,634	34,203
Elec HP	32,044	57,563	83,051
Gas HP	2,340	6,304	10,282
mCHP	879	1,685	2,464
Solar combi (16 m^2)	1,671	1,811	2,183
Boiler >400 kW	565	543	543
Total central heating boiler, space heating	**128,612**	**130,483**	**134,871**

By using the same CO_2 emission factors per technology and per year as in the study carried out by the Commission consultants (in other words, we consider the same heating loads and energy efficiency developments but disregard the potential use of hydrogen), we find total emissions from heating to correspond to approximately 265 $MtCO_{2eq}$ in 2030, 125 $MtCO_{2eq}$ in 2040, and 65 $MtCO_{2eq}$ in 2050.

When compared to the emission levels foreseen by the consultants for those years (297 $MtCO_{2eq}$, 216 $MtCO_{2eq}$ and 173 $MtCO_{2eq}$), our proposition represents savings of about 30 $MtCO_{2eq}$ in 2030, 90 $MtCO_{2eq}$ in 2040, and 110 MtC_{O2eq} in 2050.

Annex 2

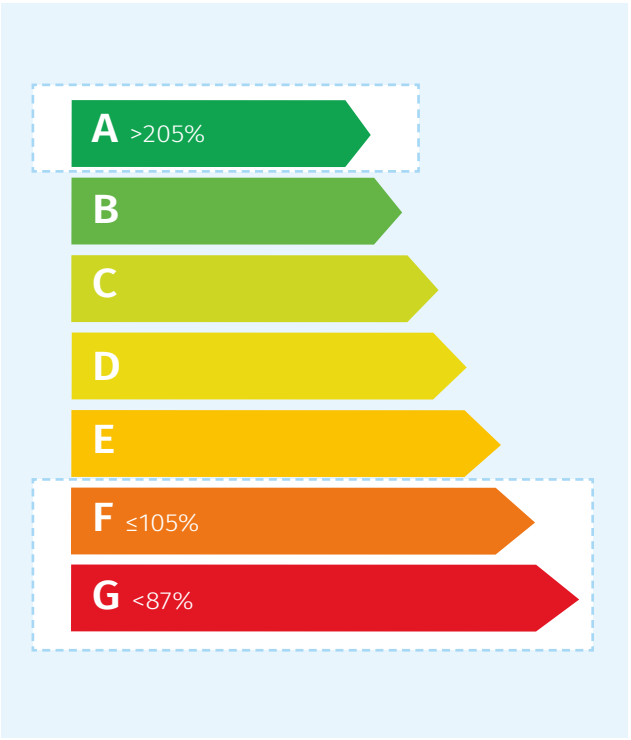
Calculations behind our proposed energy label for space heaters

Our calculations took into account the technologies currently available on the market and the existing methodology for energy labelling, adjusted to PEF=2.1. If the European Commission introduces changes in methodology when reviewing the current legislation, the resulting efficiencies will change. Our calculations may be affected by the proposals listed in the consultants' study, such as changes in methodology and conditions for heat pumps, methodology for mCHP or methodology for solar thermal.

The most efficient technologies chosen are realistic high-end technologies. It is possible to have higher efficiencies with larger solar thermal systems and with more efficient mCHP, for instance with fuel cell technology. All solutions are evaluated assuming heating controls class VI (with outdoor and room sensors). Control class VII gives a 1% higher efficiency than in the examples with control class VI, but controls of class VII require individual room thermostats, which can result in substantial costs compared with their benefits.

We support the revision of the methodology for solar and mCHP, allowing them to declare a higher efficiency than in the current methodology. This revision can start with the proposals presented in the revision of the ecodesign and energy labelling regulations for space and water heaters.

Using these efficiencies, the highest efficiency class (A) shall have efficiencies above 190%, while the lowest class (G) shall have efficiencies below 87% and the second-lowest class (F) would reach efficiencies below or at 105%. The 105% limit is proposed to avoid boilers combined with very small renewable inputs, e.g. so-called 'hybrid boilers', qualifying for the next label class (E).



This can be realised with the label scale shown in the left column in the table below with a PEF = 2.1. The second column of the table gives approximate equivalents for the proposed label scale with PEF = 2.5. The third column is the existing label scale made for a PEF = 2.5 and the fourth column lists the main technologies in the proposed label classes (for existing empty classes mentioned in brackets). The right column shows the class width for the corresponding proposal in the left column.

Annex 3

Current energy label for water heaters

The top classes, marked in blue, can only be used for package labels while the bottom classes, marked in grey, are empty as they are below the minimum efficiency levels set in the Ecodesign regulation.

PEF = 2.5	3XS	XXS	XS	S	M	L	XL	XXL
A+++	≥62	≥62	≥69	≥90	≥163	≥188	≥200	≥213
A++	53 - 62	53 - 62	61 - 69	72 - 90	130 - 163	150 - 188	160 - 200	170 - 213
A+	44 - 53	44 - 53	53 - 61	55 - 72	100 - 130	115 - 150	123 - 160	131 - 170
A	35 - 44	35 - 44	38 - 53	38 - 55	65 - 100	75 - 115	80 - 123	85 - 131
B	32 - 35	32 - 35	35 - 38	35 - 38	39 - 65	50 - 75	55 - 80	60 - 85
C	29 - 32	29 - 32	32 - 35	32 - 35	36 - 39	37 - 50	38 - 55	40 - 60
D	26 - 29	26 - 29	29 - 32	29 - 32	33 - 36	34 - 37	35 - 38	36 - 40
E	22 - 26	23 - 26	26 - 29	26 - 29	30 - 33	30 - 34	30 - 35	32 - 36
F	19 - 22	20 - 23	23 - 26	23 - 26	27 - 30	27 - 30	27 - 30	28 - 32
G	<19	<20	<23	<23	<27	<27	<27	<28

Annex 4

Explanations for the proposed energy label for water heaters

Suggested label (PEF=2.1)	Technologies and sizes of water heaters (WH) that would be included in the class
A	Empty as requested by the Energy Labelling Framework Regulation
B	• Solar-assisted WH[51] • High-end heat pump and heat pump using higher temperature sources WH
C	Heat pump WH and solar-assisted WH
D	Heat pump WH and solar-assisted WH
E	• XXS-X sizes: Heat pump WH, and solar assisted WH • Oil or gas combi-boilers • Size M and larger: Oil or gas fired WH, heat pump WH, and solar-assisted WH
F	Oil or gas fired, heat pump WH, and solar-assisted WH
G	All, including electric WH

The table above shows that, depending on their class size, oil or gas fired water heaters can be placed in class E or F.

For sizes M and above, we suggest increasing the lower limit of class E, so only solar-assisted water heaters, heat pump water heaters and hybrid water heaters can be granted class E grades. To make this possible, the definition of the class E may be modified by changing the element in the formula for the efficiency limit proposed by VHK.

With this change, oil or gas-fired water heaters will no longer be in class E but in class F, except for larger combi boilers that can have water heating efficiencies even above 100%[52].

The table also shows that within the products available today, only solar-assisted water heaters can reach class A and B (A+++ and A++ in VHK's proposal). The efficiency limits for class A and B would need to be lowered to allow high-end heat pumps to reach class B, using for instance ventilation air , and solar assisted water heaters with a reasonable size of solar panels to reach class A.

With these adjustments to the efficiency limits, other changes must be also considered for other size classes to have an appropriate bandwidth, in general above 15%. Therefore, we suggest the following changes in the parameters 'a' and 'b' to define the size classes, compared with VHK proposal in Annex I, table 30[53]:

Class (VHK)	Class (Coolproducts)	a (VHK)	b (VHK)	a (prop.)	b (prop.)
A+++	A	0.8	1.1	**0.66**	1.1
A++	B	0.4	0.95	**0.32**	**1.00**
A+	C	0.2	0.81	0.2	**0.88**
A	D	0.1	0.7	**0.14**	**0.79**
B	E	0.05	0.6	**0.1**	**0.7**
C	F	0.03	0.52	**0.05**	0.52

The changes brought in Coolproducts proposal are shown in bold.

The formula for the efficiency limits is: **Efficiency** = a*LN(Q_{ref}) + b

Where Q_{ref} is the energy content of the hot water draw specified for each size class in kWh/day.

This results in the following lower efficiency limits for energy label classes with our proposal:

Coolproducts proposal	XXS-S	M	L	XL	XXL	3XL	4XL
A	159	227	272	305	321	364	410
B	124	156	179	194	202	223	245
C	103	123	137	147	152	165	179
D	89	104	113	120	124	133	143
E	77	88	95	99	102	108	115
F	56	61	64	67	68	71	75
G	none	none	none	none	none	none	none

With this proposal, the width of the efficiency class is larger than 15% for size classes XXS-S and for size classes M and above it is larger than 18%.

With this label scale, each class will include the following technologies:

Suggested label (PEF=2.1)	Technologies and sizes of water heaters (WH) that would be included in the class
A	Empty as requested by the Energy Labelling Framework Regulation
B	• Solar-assisted WH • High-end heat pump and heat pump using using ventilation air and other higher temperature sources WH
C	• Heat pump WH and solar-assisted WH • For the small size XXS-S, only high-end heat pumps
D	Heat pumps and solar assisted WH
E	• Heat pumps, and solar assisted WH • For larger sizes (XXL and above) also fuel fired combi boilers
F	Oil or gas fired WH, heat pumps, and solar assisted WH
G	All, including electric WH

With this proposal most of the fossil fuel fired water heaters would automatically fall into the F and G class, facilitating their phase-out.

If the ecodesign requirements become technology specific, as proposed in the current review, the more efficient technologies will not be available in the lower efficiency classes.

Notes and References

1 Own calculation adding the residential and tertiary consumption found in several sources referring to Eurostat data (2017).

2 https://ec.europa.eu/energy/sites/ener/files/eu_renovation_wave_strategy.pdf - p.24.

3 Calculated on the basis of data found in Bertelsen, Nis & Mathiesen, Brian. (2020). EU-28 Residential Heat Supply and Consumption: Historical Development and Status. Energies. 13. 1894. 10.3390/en13081894.

4 VHK (2019), Space and combination heaters - Ecodesign and Energy Labelling Review Study. & VHK (2019), Water Heaters and Storage Tanks - Ecodesign and Energy Labelling Review Study.

5 Hybrid heat pump: appliance combining a heat pump and a condensing gas boiler, the heat pump covering most of the heat demand.

6 In the scope of the Ecodesign Regulation 813/2013 on space heaters.

7 Source: own calculation adding the residential and tertiary consumption found in several sources referring to Eurostat data Eurostat (2017).

8 Source: own calculation adding the residential and tertiary consumption found in several sources referring to Eurostat data: Eurostat (2017).

9 https://ec.europa.eu/energy/sites/ener/files/eu_renovation_wave_strategy.pdf - p.24.

10 Bertelsen, Nis & Mathiesen, Brian. (2020). EU-28 Residential Heat Supply and Consumption: Historical Development and Status. Energies. 13. 1894. 10.3390/en13081894.

11 VHK (2018), Ecodesign Impact Accounting.

12 https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1599?utm_source=POLITICO.EU&utm_campaign=ee571faa10-EMAIL_CAMPAIGN_2020_09_17_02_50&utm_medium=email&utm_term=0_10959edeb5-ee571faa10-190650760

13 See detail in Annex 1.

14 Solar thermal heating needs to be combined with another technologies (heat pump, gas boiler) to cover the needs in both space and water heating.

15 https://help.leonardo-energy.org/hc/en-us/articles/203047881-How-efficient-is-a-heat-pump-#:~:text=It%20is%20thermodynamically%20impossible%20to,COP)%20rather%20than%20an%20efficiency

16 Average calculated from http://www.carbone4.com/wp-content/uploads/2020/06/Publication-FE-Chaleur-et-e%CC%81lectricite%CC%81-.pdf and https://post.parliament.uk/research-briefings/post-pn-0523/

17 https://heating-retrofit.eu/wp-content/uploads/2020/02/D2.3-Final-1.pdf

18 https://ec.europa.eu/commission/presscorner/detail/en/MEMO_16_311

19 https://heating-retrofit.eu/wp-content/uploads/2020/03/HARP_D2.2_Building-vs-heating-stock-matrix-V1.2.pdf

20 HARP project deliverable 2.2 – Figure 41 page 64 - https://heating-retrofit.eu/wp-content/uploads/2020/03/HARP_D2.2_Building-vs-heating-stock-matrix-V1.2.pdf

21 https://heating-retrofit.eu/wp-content/uploads/2020/03/HARP_D2.2_Building-vs-heating-stock-matrix-V1.2.pdf

22 https://twitter.com/Energy4Europe/status/1313023952894087168

23 The energy label of space heaters exists in two versions: the product energy label (available for boilers, cogeneration units, heat pumps and low temperature heat pump space heaters) and the package label used for combinations of heating technologies (e.g. solar energy + boiler). More here: https://ec.europa.eu/energy/sites/ener/files/documents/fin_consumer_guide_space_heaters_en.pdf

24 On a rescaled label where the A class remains empty (as requested by the Energy Labelling Framework Regulation) and if sold without control.

25 https://clasp.ngo/publications/assessing-consumer-comprehension-of-the-eu-energy-label

26 https://cordis.europa.eu/project/id/847062. Project website: https://www.label2020.eu/

27 https://cordis.europa.eu/project/id/847043. Project website: https://www.newenergylabelt.eu/en

28 ECF, Towards Fossil Free Energy in 2050, March 2019.

29 https://www.eurelectric.org/media/2382/2018_industry_association_position_on_pef_revision-2018-030-0114-01-e-h-216CBE01.pdf

30 https://eur-lex.europa.eu/eli/reg/2017/1369/oj - Article 11.

31 https://www.euractiv.com/section/energy/news/oettinger-feels-the-heat-on-boiler-labelling-rules/

32 https://www.eca.europa.eu/Lists/ECADocuments/SR20_01/SR_Ecodesign_and_energy_labels_EN.pdf - page 20

33 VHK (2019), Space and combination heaters - Ecodesign and Energy Labelling Review Study. & VHK (2019), Water Heaters and Storage Tanks - Ecodesign and Energy Labelling Review Study.

34 https://www.ecoboiler-review.eu/index.html

35 https://www.iee.fraunhofer.de/content/dam/iee/energiesystemtechnik/en/documents/Studies-Reports/FraunhoferIEE_Study_H2_Heat_in_Buildings_final_EN_20200619.pdf

36 https://gasforclimate2050.eu/?smd_process_download=1&download_id=339

37 https://theicct.org/sites/default/files/publications/Role_Renewable_Methane_EU_20181016.pdf

38 https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3609

39 VHK is the consultancy developing the review study for the European Commission. https://www.ecoboiler-review.eu/documents.htm

40 The class width is the range between the lower and upper boundaries of each label class. Each label class represents a range of efficiency: for example, to be in the A class of the current energy label, a heater should have a seasonal efficiency ηs between 90 and 98.

41 Micro combined heat and power – a system that generates both electricity and heat from a single source of fuel (e.g. natural gas).

42 The best heat pump we found on the market as of November 2020 has an efficiency of 202%. This efficiency might be overestimated as the testing method included in EN14825 is not optimal and should be replaced by the dynamic method, more representative of real-life performance, see https://www.ecoboiler-review.eu/downloads/20200518_WG2_ECOS-EEB-Coolproducts_position.pdf

43 ηs : Seasonal space heating energy efficiency: ratio between the space heating demand for a heating season and the annual energy consumption required to meet this demand, in %.

44 3XS/XXS/XS/S/M/L/XL/XXL/3XL/4XL: load profiles or water heating tapping patterns for water heaters.

45 Reaching higher efficiencies may require large solar assistance to cover well above 50% of the energy demand.

46 Annex I - https://www.ecoboiler-review.eu/downloads/20200522_Water-Heaters-WG4-Interim-Report.pdf

47 Reaching higher efficiencies may require large solar assistance to cover well above 50% of the energy demand.

48 If the ecodesign requirements for water heaters become technology-specific (as proposed in the current review) the most efficient technologies will not be available in the lower efficiency classes.

49 The CO_2 emission reductions achieved by phasing out the inefficient electric and fossil fuel-fired water heaters is much more difficult to quantify which is why these have been left out of this calculation.

50 In reality, sales rates could be replaced by other heating options not listed here, for example by growth in district heating sales. This has not been modelled in our study.

51 Reaching higher efficiencies may require large solar assistance to cover well above 50% of the energy demand.

52 The efficiency of the water heating function is improved by the passive flue heat recovery from the space heating function.

53 Annex I - https://www.ecoboiler-review.eu/downloads/20200522_Water-Heaters-WG4-Interim-Report.pdf

FIVE YEARS LEFT

How ecodesign and energy labelling can decarbonise heating

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