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# Metrics matter: Efficient renewable heating and cooling in the Renewable Energy Directive

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## Introduction

The current contribution of renewable energy in the European Union is around one-quarter of the total energy used for heating and cooling.[2] The EU's 2030 and 2050 climate targets mean that the buildings sector will need to rapidly decarbonise, with the future of heating and cooling in Europe provided from renewable energy rather than fossil fuels. This in turn requires a significant increase in deployment of clean heating and cooling technologies, as well as making efficient use of renewable energy.

Although the EU's Renewable Energy Directive (RED) sets targets for growing the use of renewables in providing heating and cooling, it encourages inefficient uses of renewables in buildings to meet these goals.

This paper suggests reforms to the RED to ensure a more efficient and balanced approach to renewable heating and cooling in the EU. It shows that the RED's metric for determining the contribution of renewable heating and cooling tends to favour less efficient technologies. Likewise, it discusses how the use of electricity for heating and cooling is not accounted for in the RED definition of renewable heating and cooling, nor in the methodology for the renewable contribution of heat pumps.

By adapting the definition of renewable heating and cooling (Article 7 (3)) and updating the definition of renewable heat from heat pumps (Annex VII), the RED can

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[2] Eurostat. (2022a). *Renewable energy statistics.* https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics

provide a more comprehensive overview of the status of decarbonising the sector.[3] Thus, it could avoid sending signals that may lead to misguided policy making and technology deployment.

# Decarbonising heating and cooling in the European Union

Renewable energy is a key plank to help the European Union reduce its reliance on Russian fossil fuels and meet its target of at least 55% reduction in greenhouse gas emissions by 2030. The Renewable Energy Directive (RED) aims to increase the amount of renewable energy used in the EU by setting a headline (economy-wide) renewables target and various sectoral subtargets to expand renewables across its Member States.

To meet national and European climate targets, buildings must completely decarbonise by 2050. Greenhouse gas emissions from the sector are also expected to fall 60% across the EU by 2030 compared with 2015 levels.[4] Delivering this reduction will require a rapid shift away from using fossil fuels for space and water heating, which account for more than two-thirds of residential energy consumption.[5]

The European Union uses the RED to legislate an indicative rise in the share of renewables used for heating and cooling. As of the recast RED II in 2018, Article 23 suggests a voluntary annual increase of 1.1 percentage points in the share of Member States' renewable energy in heating and cooling end uses. The increase should be 1.3 percentage points in Member States where waste heat is used.

The EU's renewable energy target for 2030 is expected to be increased. The European Commission's proposal for a revised RED III was unveiled in July 2021 in the Fit for 55 package.[6] The proposal was modest: to make mandatory at Member State level the 1.1 percentage point increase in the share of renewables in heating and cooling.

The Russian invasion of Ukraine in February 2022 sharpened the EU's focus on fossil energy imports into Europe from Russia, particularly gas. Previous analysis in response to the invasion identified significant opportunities for reducing gas imports through energy efficiency improvements and electrification of heating.[7]

In May 2022 the European Commission released the REPowerEU proposal, a plan to phase out Russian fossil fuels and accelerate the shift to clean energy. REPowerEU recommended raising the headline 2030 renewable energy target to 45% (previously 32% in the RED II and proposed 40% in Fit for 55), as well as doubling the annual

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[3] European Commission. (2018). *Directive 2018/2001 of 11 December 2018 on the promotion of the use of energy from renewable sources (recast).* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG

[4] European Commission. (2020). *Impact assessment accompanying the document COM(2020) 562 final: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of The Regions — Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people* [Commission staff working document]. SWD(2020) 176 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0176

[5] European Commission. (n.d.). *EU Buildings Factsheets.* https://ec.europa.eu/energy/eu-buildings-factsheets_en

[6] European Commission. (2021). *Proposal for a Directive of the European Parliament and of the Council amending Directive*. COM(2021) 557 final. https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf

[7] RAP, Ember, E3G & Bellona. (2022). *EU can stop Russian gas imports by 2025.* https://www.raponline.org/knowledge-center/eu-can-stop-russian-gas-imports-by-2025/

deployment rate of heat pumps, although this has yet to be accompanied by sufficient policy proposals.[8]

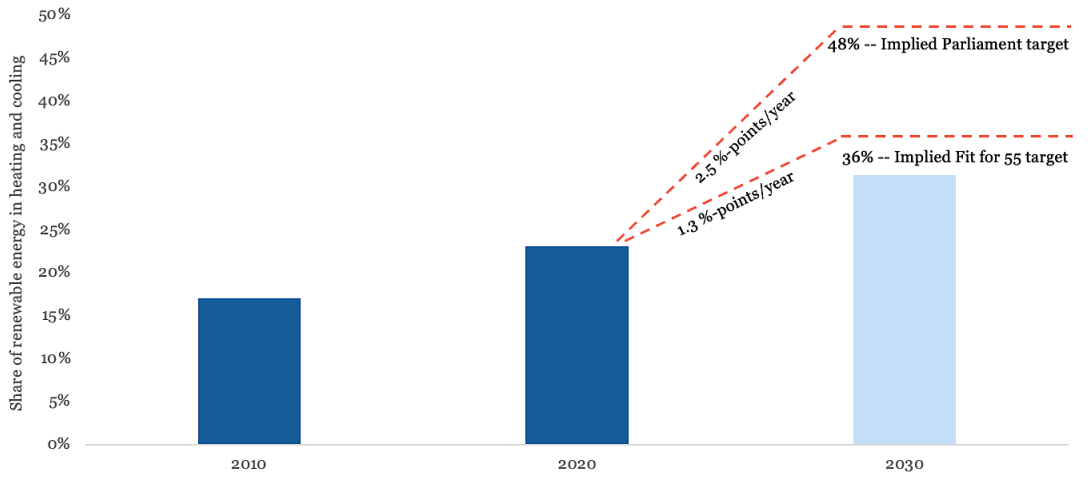
In July 2022, the European Parliament's Committee on Industry, Research and Energy (ITRE) approved a proposal to increase the renewable heating and cooling target to an indicative 2.5 points per year (up from 1.1), and 2.8 points, including waste heat and cold.[9] As of August 2022, the Fit for 55 proposals were still progressing through negotiations in Parliament and Council — influenced greatly by REPowerEU — before heading for final voting in autumn 2022 leading into trilogue negotiations between the two legislative bodies.

## Achieving the 2030 targets?

The most recent data show that the EU reached a share of 23.1% of renewable energy in heating and cooling in 2020.[10] This was an increase from 17% in 2010, corresponding to a rise of 0.6 percentage points per year, or about half as quickly as the original target set out in the RED II.

Under this same growth rate, the EU could be expected to achieve 31.4% renewables in heating and cooling by 2030. This result would be below the implied Fit for 55 target of 34% and implied target of 48% from the European Parliament's August 2022 proposal (Figure 1).[11] The implied targets are the shares in 2030 that should be reached if the 1.1 percentage point and 2.5 percentage point increases per year are reached.

**Figure 1. Share of renewables in energy for heating and cooling and existing indicative targets for 2010 and 2020 and projection for 2030**




2030 projection is RAP calculation based on compound annual average growth rate of the renewable energy share. over the previous decade. Source: Eurostat. (2022b). *Energy from renewable sources; shares.*

[8] European Commission. (2022a). *REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition.* https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

[9] European Parliament, Secretariat of the Committee on Industry, Research and Energy. (2022). *Compromise amendments.* Draft report: Amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/65. https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/ITRE/DV/2022/07-13/07-CAsRED_EN.pdf.

[10] Eurostat. (2022b). *Energy from renewable sources; shares.* https://ec.europa.eu/eurostat/web/energy/data/shares

[11] European Parliament, 2022; and Eurostat, 2022b.

Phasing out Russian gas and reaching the 2030 climate target means maximising the deployment and use of efficient heating and cooling technologies. Unfortunately, the metrics currently being used by the RED do not support this goal. They concurrently incentivise the use of less efficient technologies, such as biomass boilers, while disadvantaging the use of more efficient ones, such as heat pumps. The current slow progress and the expected strengthening of targets during the 2022 negotiations underline the importance of getting metrics right.

## Getting it wrong

There are two cases where the calculation methodology used in the RED sends the wrong signals:

- Calculating the share of heating and cooling from renewable sources (Article 7).
- Accounting for the renewable energy delivered by heat pumps (Annex VII).

### How much energy for heating and cooling is renewable?

A shared definition of renewable energy tracks progress towards the EU's headline target (Article 3 of the RED) and those in the Member States. The current methodology can be found in Article 7 of the RED II and covers:

- Gross final consumption of electricity from renewable sources.
- Final consumption of energy from renewable sources in the transport sector.
- Gross final consumption of energy from renewable sources in the heating and cooling sector.

The calculation methodology for the renewable share in heating and cooling first determines the total amount of renewable heating and cooling consumption ($\mathrm{Energy}_{\mathrm{RES}}$). To calculate the renewable heating and cooling share, this figure is then divided by the total energy used for heating and cooling.

$$\mathbf{Share_{RES}} = \mathbf{Energy_{RES}/Energy_{tot}}$$

$\mathrm{Share}_{\mathrm{RES}}$ is the share of renewables in heating and cooling, while $\mathrm{Energy}_{\mathrm{tot}}$ is the gross final energy consumption of energy used for heating and cooling.

According to Article 7 in RED II, $\mathrm{Energy}_{\mathrm{RES}}$ is 'gross final consumption of energy from renewable sources in the heating and cooling sector.' This is more concretely defined as 'the quantity of district heating and cooling produced in a Member State from renewable sources' (thus including losses from these networks) plus the final energy used for heating and cooling, defined as 'consumption of other energy from renewable sources… for heating, cooling and processing purposes.'[12]

Paraphrasing the European Union's Regulation on energy statistics (Regulation (EC) No 1099/2008), space and water heating are energy services that refer to the 'use of energy to provide heat in an interior area or to heat water.'[13] In other words, the definition of 'final energy' of renewable heating and cooling is the fuels used to produce the heat, rather than the useful heat itself.

[12] European Commission, 2018.

[13] European Union. (2008). *Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on Energy Statistics.* https://eur-lex.europa.eu/eli/reg/2008/1099/2022-02-20

This is a problem because heat production technologies have different conversion efficiencies. An electric heat pump, for example, typically produces 100 kilowatt hours (kWh) of heat with 33 kWh of input energy (electricity). A 100% efficient electrical resistance heater requires 100 kWh of input energy for the same useful heat outcome. An 85% efficient pellet boiler needs 117 kWh and a 50% efficient wood fireplace needs 200 kWh. Less efficient technologies require more final energy for achieving the same useful heat outcome.

The situation is further aggravated as the RED does not consider electricity for heating or cooling when calculating the gross final consumption of energy from renewable sources in the heating and cooling sector. Even though electricity could be considered a fuel in heat production, it is not included in the heating and cooling statistics.

The result is that electric resistance heaters and electricity used to drive heat pumps are not counted towards the renewable heating and cooling target. In the latter, only the ambient heat is considered (Table 1), which depends on the heat pump's seasonal performance factor and is discussed in the following section.

**Table 1. Energy needed to produce 100 units of useful heat and renewable value according to the Renewable Energy Directive**

| Technology | Tech. efficiency | Energy input | $Energy_{RES}$ |
|---|---|---|---|
| Wood fireplace | 50% | 200 | 200 |
| Pellet boiler | 85% | 117 | 117 |
| Electric resistance heater | 100% | 100 | 0 |
| Electric heat pump | 300% | 33 | 67 |

Energy Input refers to the calorific value of combusted fuels and excludes ambient heat. $E_{RES}$ is 0% for electric resistance heaters and 67 (ambient heat only) for heat pumps because electricity for heat is not counted.

Of course, consumption of renewable electricity is included in the RED, but it is allocated to the renewable electricity sector only and its end use (e.g., space and water heating) is ignored by this methodology. The root of the allocation issue is an attempt to avoid double counting electricity use in both sectors. If the headline target methodology is properly defined, however, electricity use can be counted in both the electricity sector and the heating and cooling sector. That way, a realistic share of renewables can be calculated for each.

Not only is electricity for heating not considered in the RED heating and cooling calculation, but renewable electricity used to provide cooling is also similarly omitted. As the vast majority of cooling is provided by electricity, cooling has effectively been omitted from the RED and did not count towards achieving the heating and cooling targets. In November 2021, the European Commission concluded a consultation on a methodology to calculate the amount of cooling provided by renewable sources that is

expected to be included in the RED III.[14] Similar to the RED's Annex VII on heat pumps (see next section), it accounts for the 'ambient air free cooling.' This is an improvement, as now some of the renewable cooling energy will be included. It does not, however, consider the electricity input to drive the process.

By counting the energy input as renewable heat, the RED encourages Member States to favour less efficient technologies that use more fuel to produce equivalent amounts of clean heat. It disincentivises switching to more efficient heating appliances and electrification and mitigates the energy system benefits of efficient technologies that require less input energy or use electricity to drive their heating and cooling processes. In general, these methodological decisions result in a clear advantage for inefficient renewable combustion technologies (e.g., biomass) over more efficient technologies (e.g., heat pumps).

Overall, the RED targets are specified in terms of final energy consumption. This approach makes sense in the power sector, as it considers the electricity consumption and not the fuel input (or lack thereof in the case of wind and solar PV) needed to produce the electricity. But its methodology in the heating and cooling sector encourages more fuel consumption.

To reach the targets set out in the RED, Member States are encouraged to promote technologies that consume more renewable fuel to produce equivalent amounts of useful heating and cooling. This does not result in the pursuit of efficient renewable heating and cooling across the EU.

## How much renewable energy do heat pumps deliver?

Heat pumps are a special case in energy statistics. Since they use a refrigeration cycle to transfer thermal energy from a low-temperature source to a higher temperature sink, they are effectively tapping into a near-inexhaustible source of ambient energy, for example, the outside air. Heat pumps use a source of external energy (input energy) to drive this process.

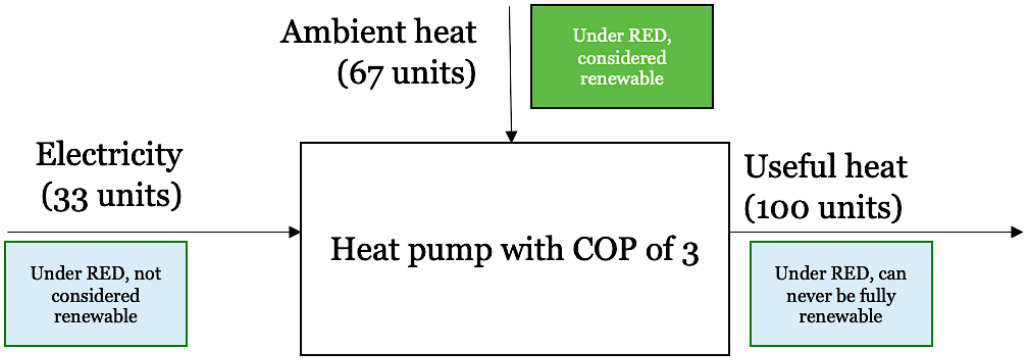
The RED does *not* consider this input energy (typically electricity) as renewable heat (Figure 2). It considers, however, the ambient energy used by heat pumps through a simple calculation involving an average seasonal performance factor (SPF).

$$\mathbf{Energy_{RES} = Q_{usable} * (1 - 1/SPF)}$$

SPF is the estimated average seasonal performance factor and $Q_{usable}$ is the estimated total useful heat delivered by heat pumps. Based on this definition, only ambient energy is considered when calculating the renewable energy from heat pumps. Thus, the renewable energy delivered by a heat pump is a function of the operational efficiency (the SPF) of the technology. The more efficient the technology, the more its heat is renewable.

[14] European Commission. (2022b). *Renewable cooling under the Revised Renewable Energy Directive*. https://energy.ec.europa.eu/renewable-cooling-under-revised-renewable-energy-directive_en

**Figure 2. How the Renewable Energy Directive defines renewable heat from a heat pump**




As mentioned, the electricity used to drive the heat pump is not factored into this calculation. It should be, otherwise heat pumps could be undervalued in terms of their renewable energy contribution. If the methodology does not even consider whether the electricity is renewables-based, the heat output of the heat pump can never be fully renewable. It will always be limited by the SPF and thus restricted in its total contribution to renewable heating and cooling under the RED.

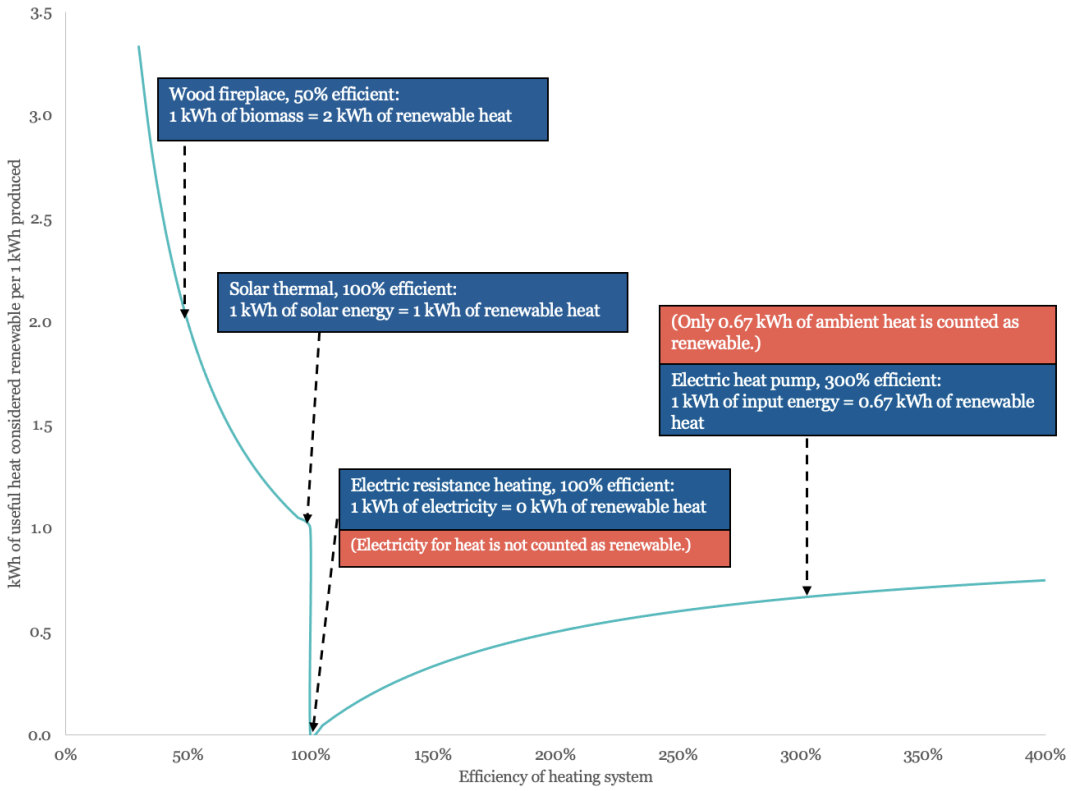
As the European electricity grid decarbonises, the amount of renewable heating provided by heat pumps will naturally increase as well. If the renewable share of electricity would be considered in the RED's methodology as a heating and cooling service provided by heat pumps, the incentive to promote heat pumps would even be stronger. Member States will thus be encouraged to implement policies that aim to achieve the heating and cooling target, with the ancillary benefit of growing the deployment of efficient heat pumps to do so.

## Metrics providing the wrong signals

Renewable heating and cooling in the RED is disadvantaged by these two methodological shortcomings. Together, they weaken the comprehensiveness of the RED and encourage Member States to incentivise less efficient technologies while undervaluing the contribution of heat pumps.

These metrics effectively mean that the least efficient heating systems are credited with producing the most renewable heat (Figure 3).

**Figure 3. The amount of renewable heat produced related to heating system efficiency according to the Renewable Energy Directive**




Note: Under the Renewable Energy Directive, the least efficient heating systems are credited with producing the most 'renewable heat.'

## Getting it right

The key metric for evaluating renewable heating and cooling consumption is *useful energy*. The Renewable Energy Directive's goal should be to promote efficient heating and cooling technologies that maximize the useful energy while minimizing the input energy.

Thus, the first step to improving the methodology is making the consumption of 'renewable heating and cooling' equivalent to the useful energy for renewable heating and cooling. This would require the fuel consumption (already available in energy statistics) as well as the average efficiencies of the heating technologies operating in a Member State. Then an estimate of the useful energy produced can be calculated.

The second step is to ensure that electricity used for heating and cooling is considered in the heating and cooling sector.[15] Many Member States already provide these values through statistical surveys, such as in France.[16] In these data, electricity used for space heating, sanitary hot water, cooking and cooling are available. They can be combined

[15] The electricity used for heating and cooling may *also* be counted in the electricity sector, as long as a consistent methodology for calculating the headline target ensures that it is not double counted.

[16] Ministère de la Transition Ecologique et de la Cohésion des Territoires. (2021, 24 December). *Consommation d'énergie par usage du résidentiel* [Energy consumption by residential use]. Données et études statistiques pour le changement climatique, l'énergie, l'environnement, le logement et les transports. https://www.statistiques.developpement-durable.gouv.fr/consommation-denergie-par-usage-du-residentiel

with the average share of renewable energy in electricity consumption to calculate the renewable electricity used for heating and cooling.

Existing energy statistics in some Member States, such as France, separate out the electricity used for heat pumps so that the full contribution of heat pumps can be calculated. In these cases, it is important to reconsider the definition of renewable energy from heat pumps in Annex VII of the RED.

For heat pumps, we propose:

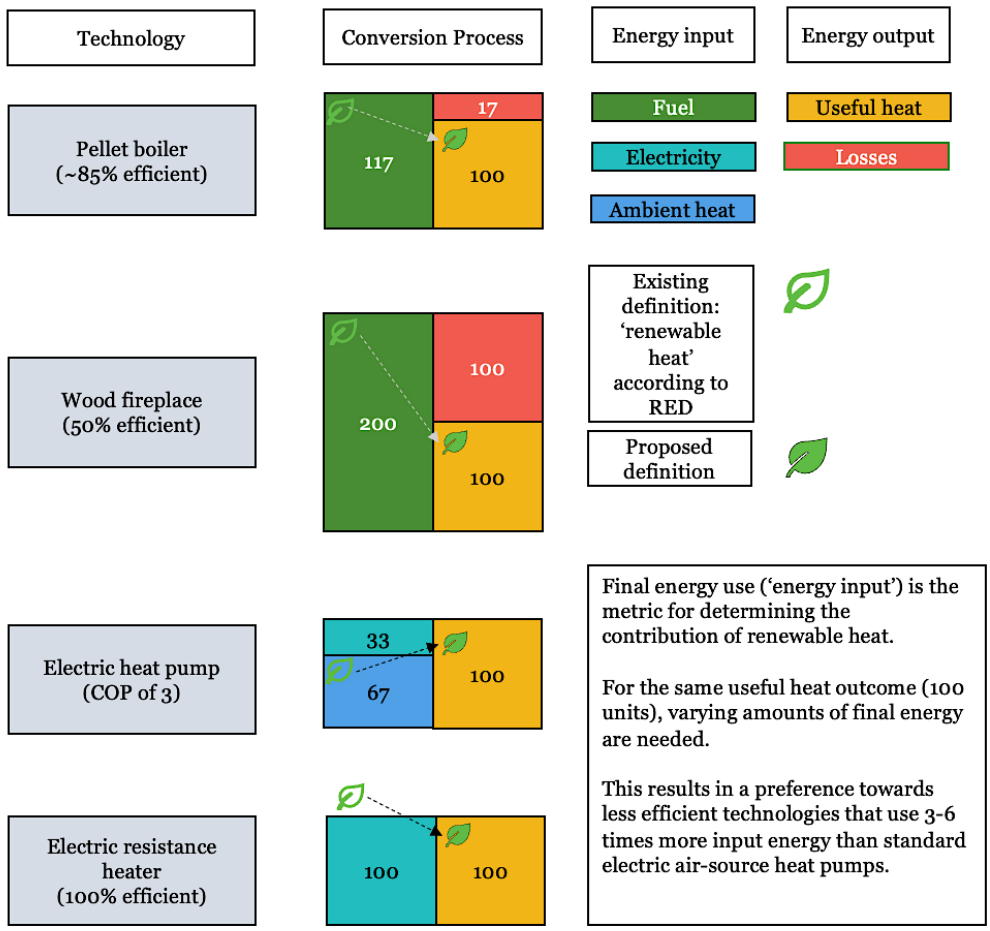
$$\boldsymbol{E_{RES} = Q_{usable} * (1 - 1/SPF) + Elec_{heat_{RES}}}$$

where $Elec_{heat_{RES}}$ is the electricity used to drive the heat pump that comes from renewable sources.

Different conventions exist for considering the share of renewable energy in electricity consumption. Article 27 of the RED II on renewable fuels of non-biological origin (RFNBO) uses the 'average share of electricity from renewable sources as measured two years before the year in question.' This is also consistent with the European Parliament's ITRE Committee proposal of July 2022.

These adjustments consider the useful energy provided by renewable heating and cooling and account for all electricity used for heating and cooling, allowing the full contribution of renewable energy from heat pumps. The proposed redefinition is shown in Figure 4. For illustrative simplicity, it assumes that the electricity input is fully renewable.

**Figure 4. Proposed redefinition of renewable heat for selected heating technologies**




This graphic is illustrative and assumes for simplicity that electricity input is fully renewable. In the European Union, around 40% of electricity was from renewable sources in 2021.

This proposal means that efficient technologies, such as heat pumps, statistically produce an equivalent amount of renewable heat for significantly less input energy.

One remaining point is the reallocation of electricity. The RED already counts gross final consumption of electricity from renewable sources in Article 7 (1a). If the renewable electricity accounted for in heating and cooling is accounted for in electricity as well, would that lead to double counting?

Electricity realistically contributes to both the headline renewable energy target (32% in the RED II and proposed 45% in REPowerEU), as well as the renewable heating and cooling target. Both calculations can and should factor it in so that the statistics are accurate. Once the headline target is calculated by summing the gross final consumption of energy from renewable sources, it can simply be ignored in the heating and cooling sector so that the headline calculation is statistically accurate.

If the European Union wishes to pursue complete and consistent reallocation, there is a precedent in the Fit for 55 package. Electricity used to produce RFNBO has been reallocated from the power sector to the sectors (mainly transport and industry) where the fuels are consumed. Consistency in methodology is important, and the procedure in the transport sector could be followed for electricity for heating and cooling as well.

# Policy recommendations

The rapid deployment of efficient renewable heating and cooling technologies is critical to phasing out Russian fossil fuels and achieving the European Union's goal for 55% greenhouse gas emissions reduction by 2030. To achieve this, the EU has set and is currently revising objectives for increasing the use of renewable heating and cooling.

However, the metrics in the Renewable Energy Directive currently encourage the use of less efficient technologies while undervaluing the contribution of more efficient devices towards meeting these goals. To have a more comprehensive overview of the use of renewables in heating and cooling, the metrics should evaluate the technologies in terms of useful energy produced. None of the RED amendments under discussion in the European Parliament or the Council address this point.

The calculation methodology also should fully account for electricity as input energy to heating and cooling uses. Amendments to the RED proposed by the European Parliament's ITRE Committee in July 2022 appear to take a step in this direction by opening a door: 'Member States may count renewable electricity used for heating and cooling by means of heat pumps.' It does not, however, provide a methodology for doing so, and the text is open to interpretation and compliance, which could result in inconsistent statistics. This amendment also singles out heat pumps without considering any other sources of electricity used for heating, nor is electricity for cooling accounted for.

Including electricity for heat in the statistics could also encourage switching to electric resistance heating, as previously outlined in Figure 4. As these devices tend to have lower upfront costs, there is a risk that consumers will prefer them to heat pumps, even though they use roughly three times more electricity for each kWh of useful heat produced. Implementing policies to achieve the RED targets should be accompanied by an impact assessment that evaluates the high uptake of electric resistance heat and explores strategies to encourage deployment of heat pumps.

Changing these metrics may also lead to a necessary adjustment of the RED targets, especially for heating and cooling. Ultimately, if the EU is striving towards a comprehensive picture of its renewable energy use, an accurate statistical accounting would help ensure the targets are realistic and suitably ambitious.

The following adjustments could help the European Union achieve its goals to phase out Russian fossil fuels and achieve 55% emissions reductions by 2030:

- Amend Article 7 (3) of the RED to calculate the useful energy produced instead of fuels consumed to produce it.
- Mandate Eurostat to develop a consistent method for counting the amount of (renewable) electricity used for different services including heating and cooling, both in general (e.g., from electric resistance heating) and from heat pumps. To avoid double counting, remove this electricity from the heating and cooling sector when calculating the headline renewable share.
- Amend Annex VII of the RED to include the electricity used to drive heat pumps so that the full contribution of heat pumps is accounted for.

As a final note, this definition does not account for inefficiencies in heat production, meaning that it does not disadvantage technologies that require more input energy. A further adjustment could create a new metric called efficient heat that evaluates the efficiency with which the renewable heat is provided by dividing useful heat/input energy.

An efficient heat metric would result in a fundamental shift in calculating the contribution of renewable energy for heating and cooling. For instance, the least efficient technologies, such as a wood fireplace at 50% efficiency, would be credited with 0.5 kWh of renewable heat for every kWh of input energy. This system could credit a pellet boiler with 0.85 kWh and electric resistance heating with 1.0 kWh, while a heat pump with a COP of 3 would receive a 3.0 kWh credit. The renewable heat credited would effectively be equivalent to the appliance efficiency. Existing EU legislation, such as Ecodesign, covers efficiency mandates already but does not associate it with the renewable energy targets.

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